ASHTON COAL PROJECT

EXTRACTION LAND MANAGEMENT PLAN PIKES GULLY SEAM LW 6B

Version 30/05/2013

Ashton Coal Operations Pty Limited

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Version History

Version	Status	Details	Authors	Authorised/Approved for Issue	
				Name/Position	Date
A	Draft	For Consultation	AECOM	L. Richards, Environment & Community Relations Manager	16/4/2012
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1 INTRODUCTION

This Extraction Land Management Plan (ELMP) documents the proposed monitoring and management measures associated with subsidence impacts on land condition as a result of secondary extraction within Longwall Panel 6B (LW6B) in the Pikes Gully (PG) Seam. LW6B is the only remaining longwall block in the PG Seam which is yet to be extracted. This is because the extraction of this panel is contingent on the completion of, and diversion of water into, the (eastern) Bowmans Creek diversion channel.

In accordance with DA 309-11-2001-i (as modified) this ELMP has been prepared as a component of the Extraction Plan for PG LW6B to manage the potential impacts and/or environmental consequences on land in general as identified through the revised subsidence predictions (SCT 2011) and relevant approval documents, including the Environmental Impact Statement (EIS) for the overall project (HLA, 2001) and Environmental Assessment (EA) for the Bowmans Creek Diversion (Evans and Peck 2009).

This plan supplements the site-wide Land Management Plan (LMP) approved pursuant to Condition 3.58 of DA 309-11-2001 with respect to specific management regimes for PG LW6B only. The site-wide LMP still provides for overall land management across the ACP.

1.1 BACKGROUND

The modification of DA 309-11-2001-i in December 2010 approving the Bowmans Creek diversions also replaced the requirement (under the development consent) for the preparation, approval and implementation of a Subsidence Management Plan(s) with that of an Extraction Plan. Under this new subsidence management regime the development consent becomes the principle approval authorising first workings, while an approved extraction plan governs the monitoring and management of subsidence effects from second workings.

1.2 SCOPE

This ELMP applies only to the management of surface impacts resulting from secondary extraction of LW 6B in the PG Seam and details:

- Measures for the monitoring and repair of subsidence-induced cracking; and
- Management of surface ponding and changes in drainage of the landform.

1.3 RELATED DOCUMENTS

This ELMP has been prepared for the PG LW6 Extraction Plan and will fit within ACOL's Environmental Management System (EMS), as a sub-plan. In particular, the following management plans (or their future iterations) as required by the ACOL current development consent are of relevance to land management within the LW 6B Extraction Area:

- Flora and Fauna (Biodiversity) Management Plan;
- Rehabilitation Management Plan;
- Archaeology and Cultural Heritage Management Plan;
- Landscape and Revegetation Management Plan; and
- Bushfire Management Plan.

1.4 CONSULTATION REQUIREMENTS

Should significant amendments to this document be required as a result of operational changes, statutory requirements or following an internal audit/review, the amendments will be made in consultation with relevant stakeholders and to the satisfaction of the Division of Resources and Energy (DRE). Contact details of the relevant stakeholders are listed in **Table 1**.

Table 1 Relevant Stakeholders and Representatives

ORGANISATION	REPRESENTATIVE	PHONE	ADDRESS
Macquarie Generation (Landowner – Property 155)	Production Manager	(02) 6542 0711	Private Mail Bag 2 Muswellbrook NSW 2333
Division of Resources and Energy	Director, Mine Safety Operations	(02) 4931 6644	PO Box 344 Hunter Regional Mail Centre, NSW 2310

1.5 STRUCTURE OF THIS REPORT

The remainder of this ELMP is structured as follows:

Section 2: Outlines the **objectives** of this management plan and sets out the **performance measures** and **performance indicators** relevant to the management of land in general.

Section 3: **Describes** the existing environment within the LW 6B Extraction Area.

Section 4: **Identifies** potential subsidence impacts and environmental consequences of mining within the ULD Seam on land in general.

Section 5: **Details** the proposed management and monitoring actions relevant to the management land in general.

Section 6: **Summarises** the responsibilities, reporting and auditing processes under this LMP.

Appendix A Lists relevant development consent requirements.

Appendix B Sets out methodology for the monitoring of subsidence impacts.

Appendix C Sets out methodology for the management of subsidence impacts.

2 OBJECTIVES AND PERFORMANCE

2.1 OBJECTIVES

ACOL's overall land management objectives include:

- To prevent land degradation and to rehabilitate disturbed land as soon as practicable to a level equal to or better than the original landscape; and
- Restore land affected by subsidence to a free draining landform suitable for agriculture and native vegetation establishment consistent with the long term rehabilitation objectives for the site.

The intent of this ELMP is to document the proposed monitoring and management measures associated with subsidence impacts to the land surface (due to PG LW6B), consistent with ACOL's statutory obligations and conditions of the development consent. In addition to the requirements of the consent, ACOL has made a number of commitments for managing the subsidence effects to the land, including:

- Reinstating surface drainage to create a free draining landform and, where practicable, provision of minor drainage works;
- Preventing soil erosion and sedimentation as a result of construction works, placement of temporary stockpiles or as a result of changes in land slope resulting from subsidence;
- Fencing designated riparian and revegetation corridors so as to prevent impact from domestic stock; and
- Progressing towards meeting closure and post-mining land use objectives in a timely and cost effective manner.

2.2 STATUTORY REQUIREMENTS

Development consent (DA 309-11-2001-i) requirements relevant to this LMP are reproduced in **Appendix A**.

2.3 PERFORMANCE MEASURES

Performance measures and success indicators for the management of land at the ACP have been developed in accordance with condition 3.12 to Schedule 2 of DA 309-11-2001-i and are presented in **Table 2**.

Monitoring will be used to assess the impact of the ACP against these performance measures and indicators as detailed in **Section 4**. If monitoring and assessment indicates that a performance indicator has been exceeded, or likely to be exceeded, ACOL will implement the contingency measures outlined in **Section 6.1**.

Table 2 Performance Measures

CRITERIA	PERFORMANCE MEASURE	INDICATOR OF SUCCESS	KEY ASSESSMENT CONSIDERATIONS
LAND MANAGEMENT			
Land in general	Restore land affected by subsidence to a free draining landform.	Surface cracking remediated as soon as practically possible. All remediation works provide a stable landform with comparable functionality. Adequate groundcover has been maintained. Erosion and slope stability issues as they relate to subsidence are remediated.	1. Does the monitoring and assessment indicate that a performance measure or development consent condition has been exceeded, or likely to be exceeded? 2. Does this exceedance increase the risk for any of the environmental consequences? 3. What is the nature of the risk? ▪ Altered surface flow. ▪ Increased risk of erosion. ▪ Soil loss and/or exposure of subsoil. ▪ Large surface cracks. ▪ Increased sedimentation. ▪ Altered soil moisture or nutrient distribution patterns. 4. What are the potential factors that may have contributed to the risk i.e. subsidence, inadequate management measure or climatic conditions? 5. What actions, if any are required to mitigate and/or minimise the potential for future impacts and monitor the long term impacts of the exceedance?
	Restore ecosystem function, including maintaining or establishing self-sustaining ecosystems comprised of native plant species and a landform consistent with the surrounding environment.		
	Maintain and/or re-establish land capability comparable to that of the pre-disturbance environment.		
Feral Animal Control	Feral animal control for any declared pest species known on the ACP.	Feral animals managed so that they do not have deleterious impacts on threatened species, threatened populations, endangered ecological communities or their habitats.	
Weed Control	Weeds controlled in accordance with the requirements of the relevant legislation and weed/land management authorities.	Weed densities and sprawl across the site broadly comparable to (or less than) previous surveys. (Note annual surveys confirm that all areas targeted during previous years weed control program had been controlled with limited regrowth).	

3 EXISTING ENVIRONMENT

The pre-mining land capability and value was described in the EIS (HLA, 2001) and Bowmans Creek Diversion EA (Evans & Peck, 2009). A brief description is provided below, with further details regarding land use, condition and land values, vegetation and weeds, and agricultural value provided in the site-wide LMP. **Figure 1** provides a site overview whilst **Figure 2** identifies land ownership for the site and immediate surrounds.

The ACP has been cleared previously for agricultural purposes, including grazing and some improved pasture. Natural vegetation within the western portion of the ACP (i.e. LW 5-8) is limited to a narrow riparian corridor along the banks of Bowmans Creek. This vegetation corridor is not continuous and in some parts consists only of a single row of trees/shrubs on the creek bank with grasses/sedges within the creek channel.

3.1 SOILS AND TOPOGRAPHY

In general the land overlying LW 6B is predominantly gently sloping with ground slope generally ranging between two and three degrees. The soil landscapes across the underground mining area are characterised by the Hunter and Bayswater soil landscape units (Kovac and Laurie, 1991). The Hunter soil landscape unit lies along the floodplains of the Hunter River and its tributaries, with the main soils formed in the alluvium. The Bayswater unit generally occurs on areas with high relief and steeper slopes.

Minor stream bank erosion occurs on the watercourses with minor sheet and gully erosion on adjacent terraces. Bowmans Creek has been the subject of significant bank stabilisation works since the 1960s, with some steep sided banks of Bowmans Creek noted to be unstable, as they are typically in areas with limited riparian vegetation. Whilst active bank erosion has been reported for some areas, annual erosion rates appear to be relatively low to moderate.

3.2 LANDUSE

Agricultural activities historically and currently taking place on land in and adjacent the project area include cattle grazing on less productive slopes and ridges (generally across the ACP), dairying on the alluvial flats (i.e. Hunter River and Glennies Creek) and some irrigation and cultivation on the Bowmans Creek (prior to ACOL ownership) and Hunter River floodplain. The area is predominantly owned by ACOL (see **Figure 2**) and much of it has previously been subsided by longwall mining in the PG Seam. The northwest corner of the area includes a triangle of land (Property 155) owned by Macquarie Generation (MacGen) that fringes the now completed and backfilled Ravensworth East Open Cut Mine and encompasses the north west extent of LW6B.

3.3 LAND CAPABILITY

Land Capability is a system of categorising rural land on the basis of the physical ability of the land to remain stable under particular rural land uses. The particular capability class into which land is placed depends of the physical characteristics of the site, the soils and specific limitations to their use, land management constraints and the local climate. The capability of land can be affected if not protected from various forms of soil degradation such as erosion and loss of topsoil, water logging, and so on.

Land Capability across LW6B ranges from Class II to Class V. Class II land generally follows the alluvial soils along the floodplain of Bowmans Creek with Class V land extending north west from the northern end of LW6B. The land classes are defined as follows:

- Class II – Land capable of being regularly cultivated. Usually gently sloping land suitable for a wide range of uses.

- Class V - Land not capable of being regularly cultivated but suitable for grazing with occasional cultivation. Considerable limitations include slope gradient, soil erosion, shallowness or rockiness, climate or a combination of these factors.

3.4 SURFACE WATER

The major natural feature in the Extraction Area is Bowmans Creek. Flows in Bowmans Creek are unregulated and surface flows periodically cease during droughts.

ACOL has consent to divert Bowmans Creek to allow more efficient recovery of the coal resource, while ensuring through flow of the creek is maintained. The creek diversion channels will realign the creek away from LW6B, thus enabling recovery of coal within this longwall block.

Subsidence has the potential to alter some topography, impacting on surface water catchment flow patterns. Most of the affected tributaries drain into Bowmans Creek. A detailed description of surface water flow across the whole of the Extraction Area at the ACP is provided in the approved site wide Water Management Plan.

4 POTENTIAL ENVIRONMENTAL CONSEQUENCES

A detailed Subsidence Impact Assessment was prepared for the proposed secondary extraction of PG LW6B - 8 (SCT 2011) and has been provided in full as an Appendix to the Extraction Plan.

A primary impact of longwall mining is surface subsidence. There are a number of potential consequences of subsidence, including: surface cracking, subsurface cracking, slope instability and erosion, valley closure and uplift, and ponding. A number of environmental responses relating to land management in general may be triggered where these subsidence effects are realised. ACOL's proposed response to potential environmental consequences are summarised in **Table 3**. In addition to these consequences there is potential to increase weed species and alter vegetation coverage through changes to site management and water movement.

Other potential environmental consequences of surface cracking, including 'trapping' of ground dwelling fauna, risks to public safety and damage to infrastructure; these are the subject of other management plans which form part of the PG LW6B Extraction Plan.

Table 3 Consequences Associated with Land Subsidence (PG LW6B)

SUBSIDENCE IMPACT	SUMMARY OF SUBSIDENCE PREDICTIONS (SCT 2011)	POTENTIAL ENVIRONMENTAL CONSEQUENCE
Surface Subsidence Trough	Maximum incremental subsidence associated with mining PG LW6B is expected to be typically 1.6 m. The maximum estimated total subsidence below the alignment of the diversion of Bowmans Creek is less than 0.1 m and in most areas less than 20 mm, which will be non-discernible.	Altered surface flow. Redirection of soil moisture and nutrient distribution patterns. Increased risk of erosion.
Surface Cracking	Surface cracks associated with mining in the LW 6B in the PG Seam are expected to be generally less than 100 mm wide and generally adjacent to, and parallel with the goaf edge. Some remediation is expected to be necessary to reduce ingress of surface water to underground mine workings, injury to livestock and entrapment of small animals. Within the LW6B Extraction Area, this remediation activity will not cause disturbance to any woodland areas.	Cracks in soil surface. Increased surface drainage. Increased risk of erosion.
Ponding	Subsidence troughs are expected to increase the storage volume available on the surface in topographic low points and water falling as rain, water flowing as runoff from adjacent areas and water that overtops the Bowmans Creek diversion during a flood event is expected to flow to these low points in the landform and pool there. Surface water flow is diverted away from the excised channel of Bowmans Creek above LW6B to the eastern diversion by temporary low level block banks. Construction of full height block banks diverting flows up to the 5 year ARI are scheduled for construction approximately 3 years after construction of the temporary block banks. Until this time, temporary block banks will be overtopped during flow events greater than the 6 month ARI, with resulting flows entering areas of excised creek channel affected by subsidence above LW6B. Subsidence troughs resulting from secondary extraction of LW6B may lead to pooling of surface water within the excised Bowmans Creek channel.	Altered surface flow. Increased erosion and localised changes in water availability. Altered soil moisture or nutrient distribution patterns.

5 MANAGEMENT, MITIGATION AND RESPONSIBILITIES

The actions that ACOL undertake to fulfil the relevant consent conditions are shown in **Table 4**. These actions have been categorised into Monitoring and Management, Incident Response and Notification/Consultation. Detailed methodologies are provided in the site-wide LMP and/or the subsidence monitoring program provided as an Appendix to the Extraction Plan.

Monitoring of the stability and geomorphic function of Bowmans Creek following the construction of the diversions will be addressed in the Bowmans Creek Diversion Management Plan. (Note the existing construction management plan will be revised following the completion of construction works). Monitoring of Bowmans Creek is therefore not part of the scope of this ELMP.

The dispersive nature of the soils on the ACP creates the potential for land degradation as a function of site disturbance. Preventative measures such as the use of native species to vegetate environmental bunds, seeding of stockpiles and incorporation of extensive habitat corridors are detailed within the existing Landscape and Revegetation Management Plan, Bowmans Creek Diversion Rehabilitation Strategy and the Erosion and Sediment Control Plan.

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Table 4 Management, Monitoring and Responsibilities

ITEM	ACTION	TIMING	RESPONSIBILITY	REPORTING
	MONITORING			
1.1	Visual inspection of the area immediately behind the longwall face passage to identify/map subsidence cracking.	Weekly	Underground Mining Engineer	Fortnightly Status Report
1.2	Light Detection and Ranging (LiDAR) data will be captured across the entire Extraction Area to document baseline landscape morphology and to quantify topographic change, including creek slope, width and depth as outlined within **Appendix B**.	Prior to and following completion of secondary extraction of PG LW6B	Mine Surveyor	Nil
1.3	Visual inspections of drainage lines (including constructed creek diversion channel) to identify potential erosion, or the development of nick points where erosion could advance.	Following rainfall (>50mm in 24 hours) and weekly during active subsidence.	Underground Mining Engineer	Fortnightly Status Report
1.4	Visual inspections of alluvial material stockpiles (as a result of the creek diversion construction) to ensure adequate vegetative cover, erosion controls and integrity of stockpiles.	Following rainfall (>50mm in 24 hours) and weekly during active subsidence.	Environment and Community Relations Coordinator/ Underground Mining Engineer	Nil
1.5	Visual inspection of low lying areas to identify if any surface ponding is occurring.	Following rainfall (>50mm in 24 hours) and weekly during active subsidence.	Environment and Community Relations Coordinator/ Underground Mining Engineer	Fortnightly Status Report
	MANAGEMENT			
2.1	All land management works will be conducted in accordance with the relevant management plan.	Ongoing	All staff	Nil
2.2	Repair any persistent subsidence cracking (i.e. they have not closed within one month of the longwall passing) by filling or ripping, and revegetated to prevent erosion and reduce safety risks as outlined within **Appendix C**.	Post-subsidence	Underground Mining Engineer	End-of Panel Report

ITEM	ACTION	TIMING	RESPONSIBILITY	REPORTING
2.4	Redistribute material from alluvial stockpiles as subsidence of the floodplain occurs in order to maintain a free draining landform as far as practicable. Revegetate in a manner consistent with the final landuse.	Post-subsidence	Underground Mining Engineer	Annual Environmental Management Report (AEMR)
2.5	Undertake drainage works and rehabilitation of subsidence troughs as necessary to maintain a free draining landscape. (Note additional ponding in the excised section of Bowmans Creek above LW6B will not be rectified unless this leads to increased mine inflows and mine safety risks).	Post-subsidence	Underground Mining Engineer	AEMR
	INCIDENT RESPONSE			
3.1	If a free-draining landform is considered as not practically or cost-effectively achievable based on post-subsidence landform and/or environmental constraints (i.e. impacts to vegetation or heritage), an assessment will be undertaken into the suitability of creating a permanent wetland with due consideration given to the: ▪ Overall rehabilitation and final land use objectives of the ACP; ▪ Feasibility of providing sustainable wetland habitat based on its likely long-term hydrology and its potential to support threatened species; ▪ Impacts to terrestrial threatened species and /or loss of agricultural land; and ▪ Risk of inrush into the underground workings. Any proposed works will be developed in consultation with DRE and DP&I.	If areas of ponding are unable to be (or planned not to be) practically drained (e.g. excised section of Bowmans Creek) or filled to create a free-draining landform.	Underground Mining Engineer , Environment and Community Relations Coordinator	Notify DRE and DP&I, report in AEMR
	NOTIFICATION & COMMUNICATIONS			
4.1	Notify affected landowner/s of potential for surface cracking and impacts of subsidence generally in accordance with the relevant components of the Extraction Built Features Management Plan and Extraction Public Safety Management Plan.	As longwall progresses.	Underground Mining Engineer	Fortnightly status report
4.2	Consult with affected landowners and convey the need to access property for the purposes of monitoring and to undertake remediation works. Access to private property should be in accordance with any relevant access agreements (where in place) with the property owner and suitable notice provided (where required).	If repair or remediation works are required on land owned by third parties.	Environment and Community Relations Coordinator	Fortnightly status report

6 IMPLEMENTATION

6.1 CONTINGENCY RESPONSE

In the event the performance measures provided in **Section 2.3** are considered to have been exceeded, or are likely to be exceeded, ACOL will undertake the following:

- Report the likely exceedance of the performance indicator to the relevant agencies as required under the development consent or legislation after becoming aware of the exceedance;
- Assess public safety and where appropriate implement safety measures in accordance with the Public Safety Management Plan;
- Identify an appropriate course of action with respect to the identified impact in consultation with appropriate specialists and relevant agencies;
- Submit the proposed course of action to the relevant government agencies for consultation/approval (where required);
- Implement the approved course of action, consistent with other relevant management plans to the satisfaction of the appropriate agencies (where required); and
- Review the effectiveness of this ELMP to adequately manage potential impacts within the limits of the project approval.

6.2 REPORTING

The Annual Environmental Management Report (AEMR) (or a successor to this report), is the primary reporting tool for the ACP. The AEMR is required to be prepared under the ACP development consent and Mining Lease and its purpose is to review the performance of the mine against the Environmental Management Strategy and the relevant Mining Operations Plans, the conditions of consent, and other licenses and approvals relating to the mine. The AEMR is required to include:

- An annual compliance audit of the performance of the project against conditions of the consent and statutory approvals; and
- Assess the development against the predictions made in the EIS/EA and the terms and commitments.

In context of land management the AEMR will report against and review the findings of monitoring conducted in relation to the items in **Tables 2** and **3**. Following submission of the report to the relevant agencies, the AEMR will be made publicly available via ACOL's website.

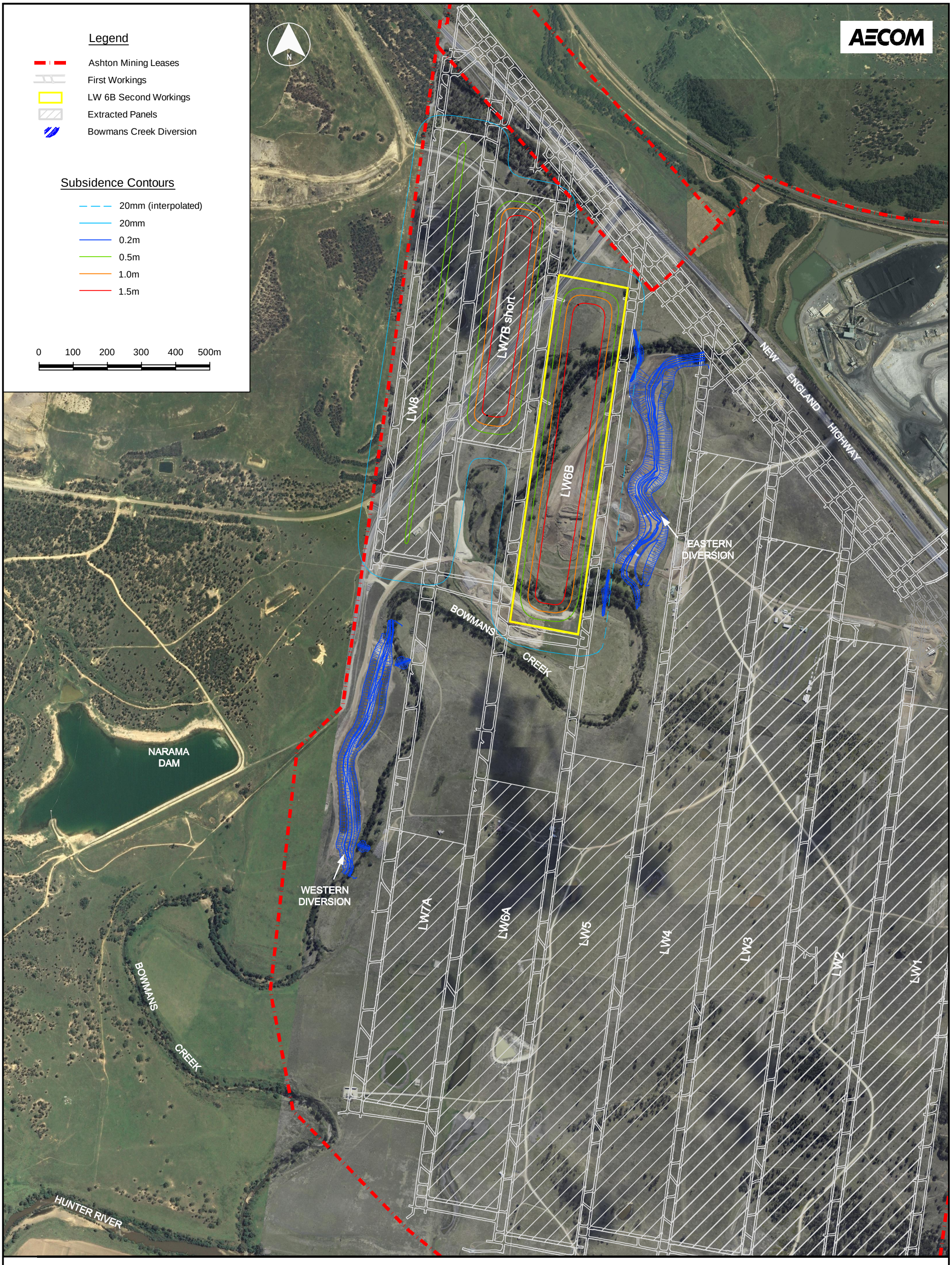
6.3 AUDITS AND REVIEWS

This ELMP may be audited (if required) under the scope of any external environmental compliance audits. An internal review of this ELMP will be conducted in response to:

- An incident recorded as a result of the operations that potentially affects the long term management of land in general;
- A significant change in operation that may affect the implementation of this management plan;
- Statutory requirements or directions/conditions of approvals requiring such action; or
- Recommendations as a result of internal or external audits.

A review and any associated amendments to this plan will be based on:

- Comparison of results of subsidence monitoring to predicted subsidence (SCT, 2011);
- Review of monitoring results under this ELMP and confirmation that observed impacts are within predicted limits; and
- Review of monitoring and management practices under this plan and their adequacy to capture and address the environmental consequences of secondary extraction.



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Extraction Land Management Plan
Pikes Gully Seam LW6B

Figure 1
Site Overview

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AECOM

Legend

- Ashton Mining Leases
- EL Boundaries
- Ashton Coal Mines Limited (ACML)
- Glendell Land Leased to ACML
- Savage Mineral Ltd & Enex Foydell Ltd
- Glendell Tenements PTY Ltd
- Macquarie Generation
- Renison Ltd - Ravensworth Operations PTY Ltd
- Crown Land
- Freehold Land
- Singleton Council
- ACOL First Workings (PG Seam)
- Bowmans Creek Diversion
- Bowmans Creek
- Excised Bowmans Creek
- LW 6B Second Workings (PG)

0 100 200 300 400 500m

1 : 10000 (A3)

N

NEW ENGLAND HIGHWAY

LW8

LW7B short

LW6B

LW4B

EASTERN DIVERSION

BOWMANS CREEK

WESTERN DIVERSION

BOWMANS CREEK

LW7A

LW6A

LW5

LW4A

LW3

LW2

LW1

CAD REF:\\AUWTLFP001\PROJECTS\60219842_EXTRACTION_PLANS CADD\S3 WORKING\DRG\PIKES GULLY FIGURES\LMP - FIGURE 2 - LAND OWNERSHIP.DWG

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Extraction Land Management Plan
Pikes Gully Seam LW 6B

Figure 2
Land Ownership

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7 REFERENCES

Evans and Peck. (2009). Bowmans Creek Diversion Environmental Assessment. Evans and Peck, Sydney NSW Australia.

HLA (2001) Ashton Coal Project Environmental Impact Statement. Prepared for White Mining Limited, HLA Envirosciences Pty Ltd, Newcastle, NSW, Australia.

SCT (2011) Subsidence Assessment for Ashton Coal Mine Longwalls 6B to 8 in the Pikes Gully Seam based on the Bowman's Creek Diversion Mine Plan, prepared for Ashton Coal Mine, Strata Control Technology Operations Pty Ltd, Wollongong, NSW, Australia

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APPENDIX A – APPROVAL CONDITIONS

Table 5 Development Consent (309-11-2001-i) Conditions

CONDITION NUMBER	CONDITION REQUIREMENT	ADDRESSED IN ELMP
3.12(h)	The Applicant shall prepare and implement an Extraction Plan for the second workings within each seam to be mined to the satisfaction of the Director-General. Each Extraction Plan must: h) include a: ▪ Land Management Plan, which has been prepared in consultation with any affected public authorities, to manage the potential impacts and/or environmental consequences of the proposed second workings on land in general.	This ELMP
Sched. C	**Statement of Commitments**	
2.	**General**	
2.1	Subsidence troughs will be reshaped and fill will be used where practicable to create a free-draining landform. This approach is expected to reduce the potential for surface pooling and inflow into the mine.	Table 4, Item 2.5
9.	**Rehabilitation and Land Management**	
9.1	Subsidence troughs will be rehabilitated to provide a free draining surface.	Table 4, Item 2.5
9.4	Stock proof fencing (at least 5 m from the alignment of any riparian trees) will be installed along both sides of the functioning diverted creek for its full length between the New England Highway and the Hunter River.	Table 4, Item 2.6
9.5	Stock watering troughs will be installed at strategic locations on pasture areas adjacent to the creek in the post-mine landscape, where required.	Table 4, Item 2.7

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APPENDIX B – MONITORING

Given the size of the ACP and key environments a multi-scale monitoring approach has been developed to monitor the consequences of longwall mining on land in general above LW 6B.

SURFACE CRACKING

Surface cracking is likely to occur rapidly following subsidence, causing risk of erosion, creation of nick points and headcut initiation, consequences to flora and fauna as well as potentially hazardous public safety risks.

Monitoring of surface cracking will be undertaken during and post-mining. Visual inspections for surface cracking of areas immediately behind the longwall face passage will take place on a weekly basis to monitor for active subsidence. Opportunistic observations of any subsidence impacts (including surface cracking, ponding, landslips and erosion) will also be undertaken by ACOL during other routine monitoring and operations. Observations are recorded using a visual subsidence inspection sheet recording the characteristics, impacts and extent of surface cracking and any remedial action required.

REMOTE SENSING

It is proposed to use remote sensing data to provide for quantitative comparison of key land surface condition parameters. Light Detection and Ranging (LiDAR) data will be captured across the entire underground mine area. The baseline data and all subsequent LiDAR captures will be processed into a land surface digital elevation model (DEM). Each new dataset will be subtracted from those produced from earlier captures creating a series of DEM change images.

LiDAR datasets are capable of describing channel width and depth, especially where the creek has formed a distinct channel (>1 m depth and 2 m wide). These datasets will enable the profiling (long- and cross-section) of Bowmans Creek within the Extraction Area and will assist in the detection of changes in creek slope, width and depth.

The best results will be derived from repeat data capture and image to image comparison. These comparisons may provide accurate assessment of erosion and deposition. Each dataset produced will be used to create a map for visual interpretation and analysis and for communication of results.

Table 6 Remote Sensing Monitoring Program

DATA SOURCE	PARAMETERS	ANALYSIS	PURPOSE	SAMPLING FREQUENCY
LiDAR	High resolution topography.	Comparative statistics. Visual assessment.	Document baseline landscape morphology. Quantify topographic change.	Baseline Repeat following completion of each seam
	Creek line slope and volumes.	Description of long-profile and creek volume.	Document baseline creek slope, width and depth. Document changes in creek slope, width and depth.	

LAND AREA SURVEYS

In 2007 five pasture monitoring sites were established across the ACOL property (ACOL's Farmland Monitoring Program) with an additional woodland site established in 2008. Each of the six permanent monitoring sites consists of a 20 m x 20 m quadrat (centred along an established transect line) and five 1 m^2 quadrats. One of these monitoring sites is located adjacent to and south of the realigned Lemington Road within the very northern part of LW6B.

Existing site-wide surveys undertaken in accordance with the Rehabilitation Management Plan and annual Farmland Monitoring Program have been designed to track any changes in landscape function, soil characteristics and vegetation cover.

BOWMANS CREEK MONITORING

Monitoring of the stability and geomorphic function of Bowmans Creek following the construction of the diversions will be addressed in the Bowmans Creek Management Plan. The existing plan (which covers the construction phase of the creek diversions) will be revised following completion of the construction works. Monitoring of Bowmans Creek is therefore not part of the scope of this ELMP.

APPENDIX C – GENERAL LAND MANAGEMENT PROCEDURES

SURFACE CRACKING

Surface cracking that appears as the longwall face passes is to be monitored and recorded using GNSS. Subsidence cracks (i.e. they have not closed within one month of the longwall passing) will be repaired (after full subsidence development for a given longwall) by filling or ripping, and revegetated to prevent erosion and reduce safety risks. Species used for revegetation will be selected based on the strategic land use for the affected area (i.e. endemic species for creation of habitat, or pasture species for agricultural land). Temporary fencing may be necessary during the interim period between the longwall face passing and when remediation measures are undertaken (refer to Public Safety Management Plan).

Where the slope or vegetation limits the availability of ACOL to remediate surface cracks, a diversion bank will be constructed at the top of bank to divert stormwater from running off the slope. The diversion bank will be designed and constructed in accordance with the 'Blue Book' (Landcom, 2004 and DECCW, 2008). Any diversion banks that are installed will be removed once surface cracks have filled naturally to return the natural hydrologic regime to the impacted areas.

Where erosion along drainage lines has been identified from visual inspections or remote sensing, appropriate control measures as identified in the Erosion and Sediment Control Plan and Water Management Plan shall be implemented. If necessary advice will be sought from a qualified geomorphologist or other suitably qualified professional.

AGRICULTURAL AREAS

Pasture species will be regularly monitored as part of the rehabilitation program as outlined within Appendix B. The program is to identify composition of species and identify any requirements for pasture improvement to support cattle grazing. Areas with low ground pasture cover are to be supplementary planted with native grasses. Cattle access to these areas is to be restricted until sufficient ground cover is established and the soil stabilised.

PREVENTION AND REHABILITATION OF LAND DEGRADATION

The dispersive nature of some of the soils across the ACP creates the potential for land degradation as a function of site disturbance. Preventative measures such as the use of native species to vegetate environmental bunds, seeding of stockpiles and incorporation of extensive habitat corridors are detailed within the Landscape and Revegetation Management Plan and the Erosion and Sediment Control Plan.

DRAINAGE AND LANDFORM CHANGES

Subsidence across the Extraction Area will not be uniform and it is predicted that areas will form that are unable to drain and/or that are lower than the diverted and natural sections of Bowmans Creek. Ponding will most probably occur in areas of flatter slopes, such as on the floodplain adjacent to the creek, but can also occur on the nearby slopes where a trough forms perpendicular to the slope and drainage can no longer happen freely across the surface above the chain pillar. It is noted that the excised sections of Bowmans Creek channel are likely to form ponds that will be unable to be freely drained, and at this stage, there is no commitment to ensuring these areas can drain and they will likely remain to form additional aquatic habitat, provided that no adverse impacts to underground mining (i.e. ingress of excess water to the mine) are observed.

Following completion of the Bowmans Creek diversion, temporary stockpiles of alluvial material will remain on the floodplain which will be stabilised with grass species. Following subsidence, these stockpiles will be used to assist in reshaping the landform to achieve a free draining surface. Filling of the troughs is not uniformly proposed, and will depend on an assessment of the extent of ponding and works required. The general process to correct ponding and provide a free-draining landform will consist of:

- Identification of ponding areas during regular inspections of the surface above the current longwall position – should be particularly evident following runoff-producing rainfall events.
- Assessment of ponding area, and identification of possible solutions, including undertaking filling using stockpiled alluvial materials remaining from the creek diversion construction, or by undertaking earthworks to reshape the land, and or provide a drainage path to the nearest watercourse. Solutions will depend on the particular constraints of the affected area and will aim to minimise impacts to vegetation and cultural heritage.
- Undertaking works, in accordance with all relevant ACOL management plans, including the installation of erosion and sediment controls, careful stripping and stockpiling of topsoil material, vegetation clearance protocols, and the Aboriginal Cultural Heritage Management Plan.
- Confirmation that the area is free-draining by survey methods.
- Stabilisation of the remediated area by applying topsoil, and revegetating in accordance with the Rehabilitation Management Plan.

Monitoring of the works and revegetation until such time the area is considered stable.