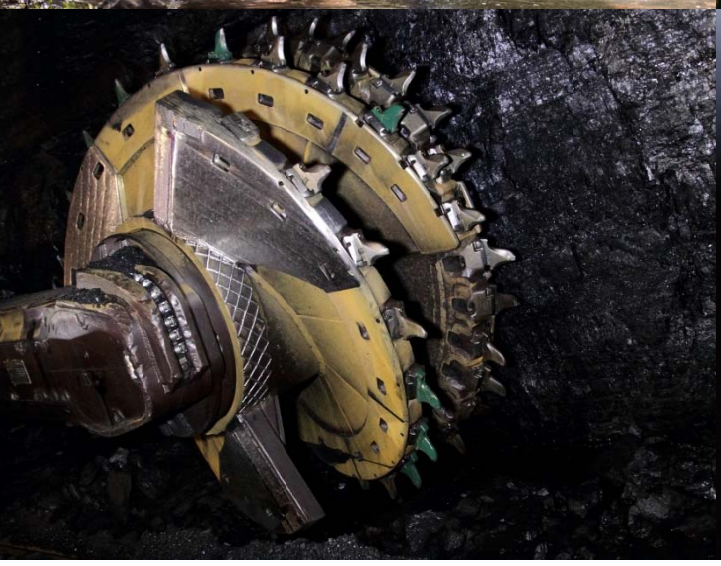
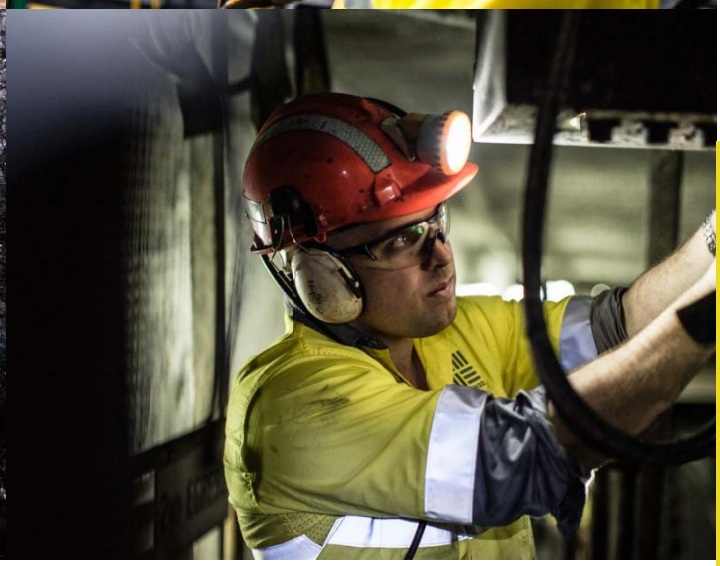
SOUTH32

DENDROBIUM
AREA 3B
WC21
REHABILITATION
PLAN

DECEMBER 2015



WC21 REHABILITATION PLAN

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Review History

Revision	Description of Changes	Date	Approved
A	New Document for submission to DPE	December 2015	GB

Persons involved in the development of this document include:

Name	Title	Company
Josh Carlon	Environmental Coordinator	Illawarra Coal
Kim Vaux	Approval Advisor	Illawarra Coal
Gary Brassington	Manager Approvals (Mining)	Illawarra Coal

1 INTRODUCTION

Illawarra Coal (IC) operates underground coal mining operations at Dendrobium Mine, located in the Southern Coalfield of New South Wales. Longwalls from the Wongawilli Seam are currently being extracted from Area 3B (DA3B).

IC was granted Development Consent by the NSW Minister for Planning for the Dendrobium Project on 20 November 2001. In 2007 IC proposed to modify its underground coal mining operations and the NSW Department of Planning advised that the application for the modified Area 3 required a modification to the original consent. The application followed the process of s75W of the Environmental Planning and Assessment Act 1979 (EP&A Act) and required the submission of a comprehensive Environmental Assessment (Cardno 2007). The Environmental Assessment (EA) described the environmental consequences likely from cracking and diversion of surface water as a result of the proposed mining. These impacts included diversion of flow, lowering of aquifers, changes to habitat for threatened species as well as other impacts and environmental consequences.

On 8 December 2008, the Minister for Planning approved a modification to DA_60-03-2001 for Dendrobium Underground Coal Mine and associated surface facilities and infrastructure under Section 75W of the EP&A Act.

On 4 October IC submitted a Subsidence Management Plan (SMP) for approval by the Directors General (now Secretaries) of the Department of Planning and Infrastructure (now the Department of Planning and Environment, DoPE) and Trade and Investment (T&I). The SMP incorporates the Watercourse Impact, Monitoring, Management and Contingency Plan (WIMMCP). The SMP was approved by the Secretary T&I 5 February 2013 and the Secretary DoPE 6 February 2013.

Mining of Longwalls 9 and 10 were undertaken in accordance with the approved SMP and WIMMCP. Impacts associated with Longwalls 9 and 10 have been identified in WC21, a tributary to Wongawilli Creek.

Reporting of impacts has been carried out as required under the SMP and WIMMCP. Inspections and measurements have identified iron staining and rock fracturing to pools and rockbars along WC21. A decline in pool water levels below baseline and extended periods of no flow and dry pools has also been recorded.

1.1 SCOPE

The WIMMCP has been prepared to comply with the Dendrobium Consent and the SMP Approval for Area 3B. The WIMMCP outlines the requirements for and proposed approach to rehabilitation in DA3B.

The WIMMCP is subject to Schedule 3 Condition 4 of the Consent as provided below.

4. Prior to carrying out any underground mining operations that could cause subsidence in either Area 3A, Area 3B or Area 3C, the Applicant shall prepare a Watercourse Impact Monitoring, Management and Contingency Plan to the satisfaction of the Secretary. Each such Plan must:

(a) demonstrate how the subsidence impact limits in conditions 1 - 3 are to be met;

(b) include a monitoring program and reporting mechanisms to enable close and ongoing review by the Department and DPI of the subsidence effects and impacts (individual and cumulative) on Wongawilli Creek, Sandy Creek and Sandy Creek Waterfall;

(c) include a general monitoring and reporting program addressing surface water levels, water flows, water quality, surface slope and gradient, erodibility, aquatic flora and fauna (including Macquarie Perch, any other threatened aquatic species and their habitats) and ecosystem function;

(d) include a management plan for avoiding, minimising, mitigating and remediating impacts on watercourses, which includes a tabular contingency plan (based on the Trigger Action Response Plan structure) focusing on measures for remediating both predicted and

unpredicted impacts;

(e) address third and higher order streams individually but address first and second order streams collectively;

(f) be prepared in consultation with DECC, Water NSW and DPI;

(g) incorporate means of updating the plan based on experience gained as mining progresses;

(h) be approved prior to the carrying out of any underground mining operations that could cause subsidence impacts on watercourses in the relevant Area; and

(i) *be implemented to the satisfaction of the Secretary.*

The WIMMCP addresses:

- Impact assessment and how the subsidence impact limits, specified in the approval, will be met;
- Monitoring and reporting;
- Trigger levels that initiate the implementation of management or remedial measures (including contingency measures);
- Implementation of remedial measures should mining induced degradation to the watercourses be observed or measured (including contingency measures); and
- Access to watercourses and rehabilitation of access routes to watercourses.

This Plan addresses the proposed rehabilitation activities for the observed subsidence impacts to WC21 as a result of the extraction of Longwall 9 and 10. Additional impacts are expected as a result of extracting Longwall 11 and these will be addressed in an update to this Plan.

1.2 OBJECTIVES

As outlined in the SMP and WIMMCP the approach to reducing impacts within Area 3B includes avoidance, minimising, mitigation and remediation measures.

The aims and objectives of this Plan include:

- Characterising the impacts at WC21 to inform an assessment of the potential efficacy of any remediation.
- Avoiding additional impacts during rehabilitation where possible.
- Implementing the WIMMCP TARPs and responding to impacts to watercourses.
- Carrying out mitigation and remediation works in a manner that protects to the greatest practicable extent the environmental values of the area.
- Achieving the Performance Measures outlined in the Area 3B SMP Approval, to the satisfaction of the Secretary.
- Monitoring and reporting effectiveness of this Plan.

The Corrective Management Actions (CMA) described in this Plan will be developed in consultation with key stakeholders. The CMAs are implemented to manage the observed impacts in accordance with relevant approvals. This Plan provides for the implementation of mitigation and remediation of mining impacts to WC21.

This Plan addresses:

- Aims and objectives for corrective actions;
- Consideration of relevant aspects from the SMP and WIMMCP;
- Description, analysis and assessment of the impacts compared to prediction;

- Assessment of the need for management options and contingent measures;
- Specific actions required to mitigate/manage and timeframes for implementation;
- Roles and responsibilities;
- Gaining appropriate approvals from landholders and government agencies; and
- Reporting, consultation and communication.

If the performance measures in Table 1 of the SMP Approval are not met, then following consultation with OEH, Water NSW and T&I, the Secretary of DoPE may issue a direction in writing to undertake actions or measures to mitigate or remediate subsidence impacts and/or associated environmental consequences. The direction must be implemented in accordance with its terms and requirements, in consultation with the Secretary and affected agencies.

The Secretary wrote to IC 28 August 2015 to request, under Condition 4 of Schedule 3, that IC prepare a remediation program for the impacts to WC21. This Plan is to comply with the Area 3B SMP Approval Conditions including Condition 9 Performance Measures for Area 3B.

1.3 CONSULTATION

This Plan was developed by IC, with a draft to be distributed for comment to WaterNSW (previously SCA) and T&I. Approved Plans and other relevant documentation are available on the IC website (*Condition 11 Schedule 8*).

The SMP and WIMMCP were developed with extensive consultation, including:

- Detailed submissions from OEH (26 October, *an undated submission* and 13 December 2012) and Water NSW (December 2012 *undated*). IC provided a detailed response to submissions 20 December 2012.
- A revised WIMMCP was provided to DoPE, OEH, NoW, WaterNSW and T&I 10 May 2013.
- The Wollongong Office of T&I hosted a joint agency workshop with IC to discuss the WIMMCP. The workshop was held 27 May 2013 with the following agencies attending DoPE, OEH, Water NSW and T&I. Following the workshop the agencies provided submissions.
- The Wollongong Office of T&I hosted a second joint Agency workshop with Illawarra Coal to discuss the WIMMCP. The workshop was held 16 December 2013 with the following agencies attending DoPE, OEH, Water NSW and T&I.

2 APPROVALS

Table 2-1 lists the Conditions of Consent relevant to this Plan and where the conditions are addressed.

Table 2-1 Dendrobium DA-60-03-2001 Approval Conditions

Project Approval Condition	***Relevant Section***
Condition 4 – Schedule 3 Prior to carrying out any underground mining operations that could cause subsidence in either Area 3A, Area 3B or Area 3C, the Applicant shall prepare a Watercourse Impact Monitoring, Management and Contingency Plan to the satisfaction of the Secretary. Each such Plan must: (a) demonstrate how the subsidence impact limits in conditions 1 - 3 are to be met; (b) include a monitoring program and reporting mechanisms to enable close and ongoing	Sections 3, 4, 5 and Attachment 1 Section 3 and Attachment 1

Project Approval Condition	*Relevant Section*
review by the Department and DPI of the subsidence effects and impacts (individual and cumulative) on Wongawilli Creek, Sandy Creek and Sandy Creek Waterfall;	
(c) include a general monitoring and reporting program addressing surface water levels, water flows, water quality, surface slope and gradient, erodibility, aquatic flora and fauna (including Macquarie Perch, any other threatened aquatic species and their habitats) and ecosystem function;	Section 3 and Attachment 1
(d) include a management plan for avoiding, minimising, mitigating and remediating impacts on watercourses; include a tabular contingency plan (based on the Trigger Action Response Plan structure) which focuses on measures for remediating both predicted and unpredicted impacts on watercourses;	Section 4, 5 and Attachment 1
(e) address third and higher order streams individually but address first and second order streams collectively;	Sections 4
(f) be prepared in consultation with DECC, Water NSW and DPI;	Section 1.3
(g) incorporate means of updating the plan based on experience gained as mining progresses;	Section 5
(h) be approved prior to the carrying out of any underground mining operations that could cause subsidence impacts on watercourses in the relevant Area; and	Section 2
(i) be implemented to the satisfaction of the Secretary.	

The following licences and permits may be applicable to this Plan:

- Dendrobium Mining Lease as shown in **Table 2-2**;
- Environmental Protection Licence (EPL) 3241 which applies to the Dendrobium Mine. A copy of the licence can be accessed at the EPA website via the following link http://www.environment.nsw.gov.au/poeo;
- Dendrobium Mining Operations Plan (MOP) FY 2016 to FY 2022;
- Relevant OH&S and HSEC approvals; and
- Any additional leases, licences or approvals resulting from the Dendrobium Approval.

Table 2-2 Dendrobium Leases

Mining Lease - Document Number	Issue Date	Expiry Date/ Anniversary Date
CCL 768	7 May 1998	7 September 2026

As indicated in Schedule 2 Conditions 1 and 14 of the Development Consent (Minister for Planning 2008) and Condition 10 of the Area 3B SMP Approval (Secretary DoPE 2013), the mitigation and rehabilitation described in this Plan are; required for the development, and an

integral component of the proposed mining activity. To the extent these activities are required for the development approved under the Dendrobium Mine Development Consent no other licence under the TSC Act is required in respect of those activities.

At the time of grant of the Dendrobium Development Consent there was no requirement for concurrence in respect of threatened species or ecological communities. The requirement for concurrence was, at that time, governed by section 79B of the EPA Act. At the time of grant of the Dendrobium Consent there was a requirement for consultation with the Minister administering the TSC Act and this consultation was undertaken.

3 MONITORING AND REPORTING

Dendrobium Mine lies in the southern part of the Permo-Triassic Sydney Basin. The geology mainly comprises sedimentary sandstones, shales and claystones, which have been intruded by igneous sills.

The sandstone units vary in thickness from a few metres to as much as 120m. The major sandstone units are interbedded with other rocks and, though shales and claystones are quite extensive in places, the sandstone predominates.

The major sedimentary units at Dendrobium are, from the top down:

- The Hawkesbury Sandstone.
- The Narrabeen Group (including the Bulgo Sandstone).
- The Eckersley Formation.

Extensive geomorphological mapping has been completed for WC21 as well as other streams within Dendrobium Area 3. WC21 flows to Wongawilli Creek which is located between Areas 3A and 3B.

The geomorphology of the WC21 sub-catchment is characterised by upland plateau and a series of ‘benches’ comprised of catenary hill-slopes and swamps enclosed in roughly crescent-shaped cliff lines.

Monitoring in WC21 and Wongawilli Creek commenced in 2001 (**Table 3-1**).

Table 3-1 Monitoring in Wongawilli Creek and WC21

Watercourse	Catchment	Monitoring
Wongawilli	Wongawilli	Water Quality, Observations, Photo, Water Level, Flow
WC21	Wongawilli	Water Quality, Observations, Photo, Water Level, Flow

The IC Environmental Field Team undertakes structured monitoring and assessment in Area 3B, including in Wongawilli Creek and WC21:

- Water: location, volume and flow characteristics;
- Significant features: rockbars, pools and flow channels;
- Vegetation: location, species, height and observed health; and
- Sediment: composition, depth and moisture.

This data is used to compare differences in site conditions of watercourses before and after mining. Sites that will not be mined under are also monitored to provide a comparison of sites mined under and sites not mined under during different climatic conditions.

Pool water levels in WC21 are measured using installed benchmarks (**Figure 3-1**). Water level/flow gauges and data loggers are installed at key stream flow monitoring sites (**Figure 3-2**).

Pool water levels are measured monthly before and after mining, on a weekly basis during active subsidence and in response to any identified impacts.

Flow monitoring sites are installed downstream of the mining area to assess any changes in surface flow from a catchment resulting from the mining. Due to the general requirement to not install V notch weirs or other large artificial flow controls within the catchment areas, the sites are predominately installed using natural flow control features such as rockbars. For this reason, the monitoring program focuses largely on recessional, baseflow and small storm periods where the flow data is of sufficient quality i.e. lies below the upper limit of validity of the rating curve.

These sites are not installed directly over the longwalls as mining induced surface fracture networks typically result in receding flows being entirely diverted below the surface, which is the case for WC21. The downstream monitoring sites are specifically designed to answer the question: do diverted flows within the surface fracture network return to the surface downstream of the mining area.

Water quality monitoring has been undertaken since 2003 (**Figure 3-2**) and includes parameters such as pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Oxygen Reduction Potential (ORP) and laboratory tested analytes (DOC, Na, K, Ca, Mg, Filt. SO4, Cl, T. Alk., Total Fe, Mn, Al, Filt. Cu, Ni, Zn, Si).

Pools within streams are measured monthly before and following mining, weekly during active subsidence and in response to any observed impacts.

Standardised transects in potential breeding habitat for the threatened frog species Littlejohn's tree frog and Giant burrowing frog have been established in DA3B, including WC21 which commenced in 2012 (**Figure 3-3**).

Along each transect the monitoring includes: counts of frogs, an assessment of pools being used for breeding as well as counts of tadpoles and egg masses.

Aquatic ecology monitoring includes direct measures of aquatic flora and fauna as well as biophysical measures. Aquatic ecology monitoring sites for Area 3B are shown in **Figure 3-4**. These sites are located in watercourses that contain “significant” or “moderate” aquatic habitat and are suitable for AUSRIVAS assessment (i.e. are at least 100m long).

Two methods are used to sample aquatic macroinvertebrates: the AUSRIVAS protocol for NSW streams (Turak et al. 2004) and artificial aquatic macroinvertebrate collectors, a quantitative method developed by CEL for freshwater environmental impact assessment.

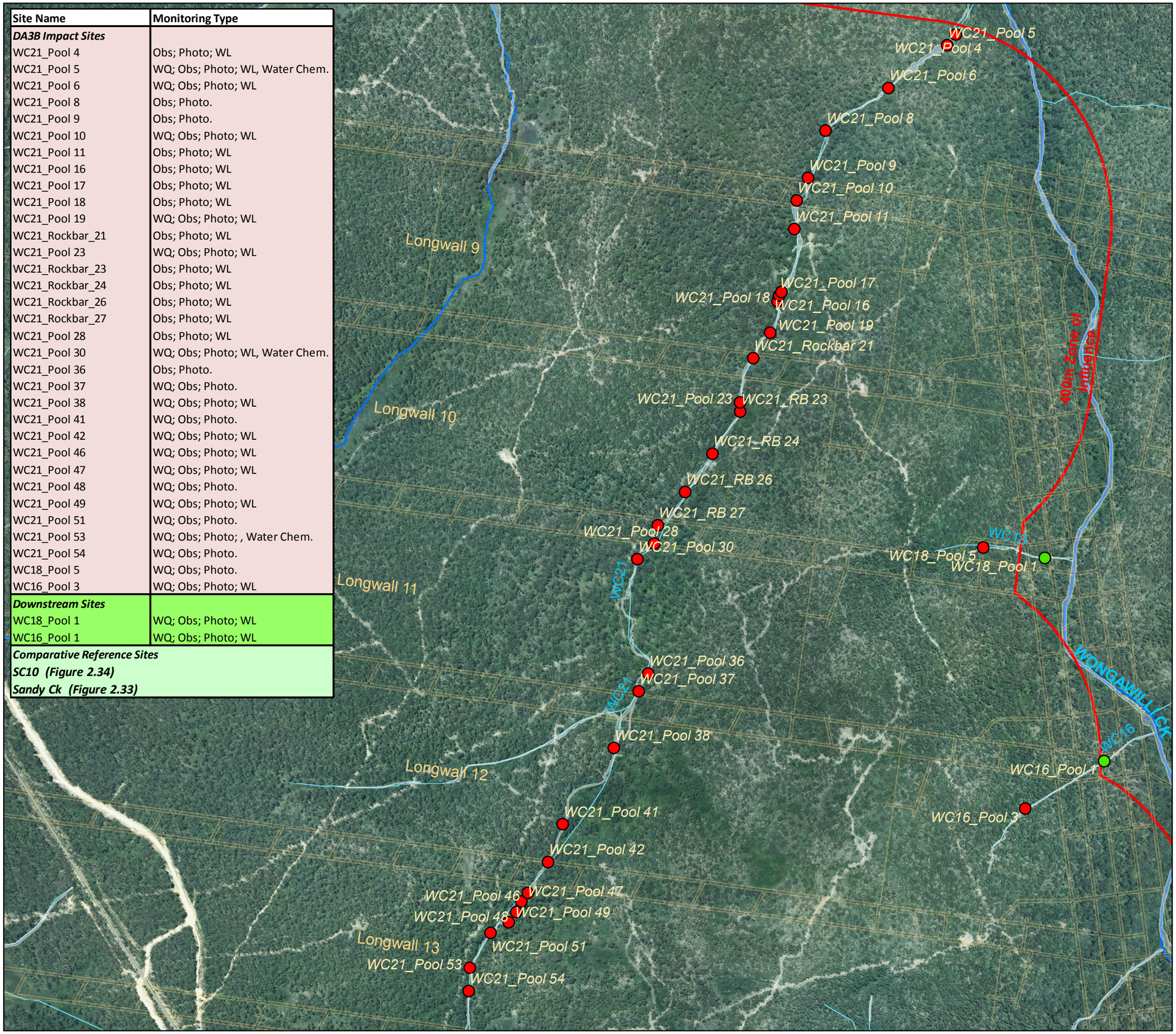
Fish are sampled using a back-pack electrofisher (model LR-24 Smith-Root) and baited traps.

Aquatic ecology monitoring Sites 1, 2, 3, 4, 5, X4, X5 and X6, are situated in Wongawilli Creek and Sites X2, X3 and 6 are located in WC21.

End of Panel Reports are prepared in accordance with *Condition 9 Schedule 3* of the Dendrobium Area 3 Modification Approval. Results from the monitoring program are included in the End of Panel Report and in the Annual Environmental Management Report (AEMR). These reports detail the outcomes of monitoring undertaken; provide results of inspections, and determine whether performance indicators have been exceeded.

Monitoring results are reviewed monthly by the IC Subsidence Management Committee.

Site Name	Monitoring Type
DA3B Impact Sites	
WC21_Pool 4	Obs; Photo; WL
WC21_Pool 5	WQ; Obs; Photo; WL, Water Chem.
WC21_Pool 6	WQ; Obs; Photo; WL
WC21_Pool 8	Obs; Photo.
WC21_Pool 9	Obs; Photo.
WC21_Pool 10	WQ; Obs; Photo; WL
WC21_Pool 11	Obs; Photo; WL
WC21_Pool 16	Obs; Photo; WL
WC21_Pool 17	Obs; Photo; WL
WC21_Pool 18	Obs; Photo; WL
WC21_Pool 19	WQ; Obs; Photo; WL
WC21_Rockbar_21	Obs; Photo; WL
WC21_Pool 23	WQ; Obs; Photo; WL
WC21_Rockbar_23	Obs; Photo; WL
WC21_Rockbar_24	Obs; Photo; WL
WC21_Rockbar_26	Obs; Photo; WL
WC21_Rockbar_27	Obs; Photo; WL
WC21_Pool 28	Obs; Photo; WL
WC21_Pool 30	WQ; Obs; Photo; WL, Water Chem.
WC21_Pool 36	Obs; Photo.
WC21_Pool 37	WQ; Obs; Photo.
WC21_Pool 38	WQ; Obs; Photo; WL
WC21_Pool 41	WQ; Obs; Photo.
WC21_Pool 42	WQ; Obs; Photo; WL
WC21_Pool 46	WQ; Obs; Photo; WL
WC21_Pool 47	WQ; Obs; Photo.
WC21_Pool 48	WQ; Obs; Photo; WL
WC21_Pool 49	WQ; Obs; Photo; WL
WC21_Pool 51	WQ; Obs; Photo.
WC21_Pool 53	WQ; Obs; Photo; , Water Chem.
WC21_Pool 54	WQ; Obs; Photo.
WC18_Pool 5	WQ; Obs; Photo.
WC16_Pool 3	WQ; Obs; Photo; WL
Downstream Sites	
WC18_Pool 1	WQ; Obs; Photo; WL
WC16_Pool 1	WQ; Obs; Photo; WL
Comparative Reference Sites	
SC10 (Figure 2.34)	
Sandy Ck (Figure 2.33)	



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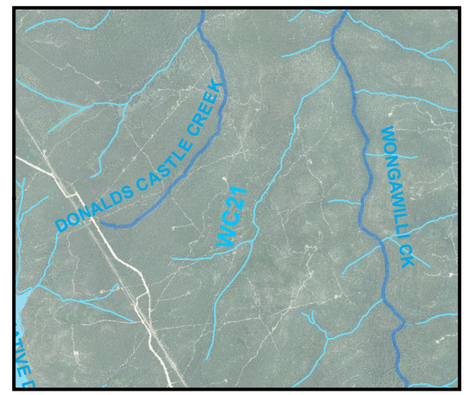
Dendrobium Area 3B
Watercourse Monitoring Sites
WC21, WC18 and WC16

Figure 3-1

Legend

- Impact Monitoring Site
- Dendrobium Layout
- 400m Zone of Influence (DA3B)
- Stream Mapping
- Creeks
- Tributaries



Date: December, 2015
Author: J. Carlon
Signed Off: G. Brassington

Version 1
Horizontal Datum
MGA - Zone 56

N
W E
S

0 50 100 200 300 400
Metres

Site Name	Monitoring Type
Impact Sites	
WC_Pool 46	WQ; Water Chem.
WWM2	WQ; Water Chem.
WC_Pool 43b	WQ; Water Chem.
LA4S1	Flow.
LA4_S1	WQ; Water Chem.
WC21S1	Flow.
WC21_Pool 5	WQ; Water Chem.
WC21_Pool_30	WQ; Water Chem.
WC21_Pool_53	WQ; Water Chem.
WC15_Pool 9	WQ; Water Chem.
WC15_Pool 28	WQ; Water Chem.
WC15S1	Flow.
LA5_S1	WQ; Water Chem.
LA5_S2	WQ; Water Chem.
LA4_S2	WQ; Water Chem.
LA3_Pool 4	WQ; Water Chem.
LA2_Pool 5	WQ; Water Chem.
LA_1	WQ; Water Chem.
NDC4	WQ; Water Chem.
WC_Pool 49	WQ; Water Chem.
SC10S1	Flow.
SC10CS1	Flow.
Upstream Control Sites	
WWU1	WQ; Water Chem.
WWU4	WQ; Water Chem.
WWU	Flow.
NDC1	WQ; Water Chem.
D10	WQ; Water Chem.
Downstream Sites	
Wongawilli Ck (FR6)	WQ; Wchem.
WWL	Flow.
Donalds Castle Ck (FR6)	WQ; Wchem;
DCL3	WQ; Wchem.
DCU	Flow.
DC13S1	Flow.
DC13_Pool 2b	WQ; Wchem;
WC_S1	WQ; Wchem.
DCS2	Flow.
DC_Pool 22	WQ; Wchem;
SCk_Rockbar 5	WQ; Wchem;
SCL2	Flow.
DA3B Weather Station	Daily Rainfall

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Dendrobium Area 3B Water Quality and Flow Monitoring

Figure 3-2

Legend

- Upstream Control Site
- Downstream Reference Site
- Impact Site
- DA3B Weather Station
- Wongawilli Creek Waterfall (WF_54)
- 400m Zone of Influence (DA3B)
- Creeks
- Tributaries
- Dendrobium Layout
- Elouera Workings

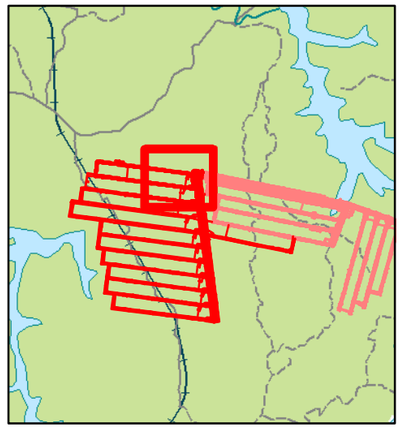
Date: December, 2015
Author: J. Carlon
Signed Off: G. Brassington

Version 1
Horizontal Datum
MGA - Zone 56

N W E S

0 500 1,000 Metres

DC_Pool_23
DC_Pool_29
DC_Pool_30
DC(1) Transect
DC_Pool_32
DC_Pool_33
DC_Pool_34
DC(1)-T-E
DONALDS CASTLE CREEK
WC22
WC21-T-S
WC21_Pool_4
WC21_Pool_5
WC21_Pool_6
WC21_Pool_8
WC21
WC21_Pool_10
WC21_Pool_11
WC21 Transect
WC21_Pool_17
WC21_Pool_16
WC21_Pool_18
WC21_Rockbar_21
WC21_Pool_23
WC21_Rockbar_23
WC21_Rockbar_24
WC21_Rockbar_26
WC21_Rockbar_27
WC21_Pool_30
WC21-T-E
WC Pool 41
WC Pool 42b
WC20
WONGAWILLI CK
WC Pool 43a
WC19
WC18
WONGAWILLI CREEK



Legend

- Pool Level Monitoring Sites

Threatened Frog Monitoring

- Impact - Transect Start
- Impact - Transect End
- Threatened Frog Transect

BHP Creek and Swamp Naming

- BHP Creekline

0 50 100 150 200 250

Metres
Scale: 1:5,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

biosis
Biosis Pty Ltd

Ballarat, Brisbane, Canberra, Melbourne,
Sydney, Wangaratta & Wollongong

Matter: 17994
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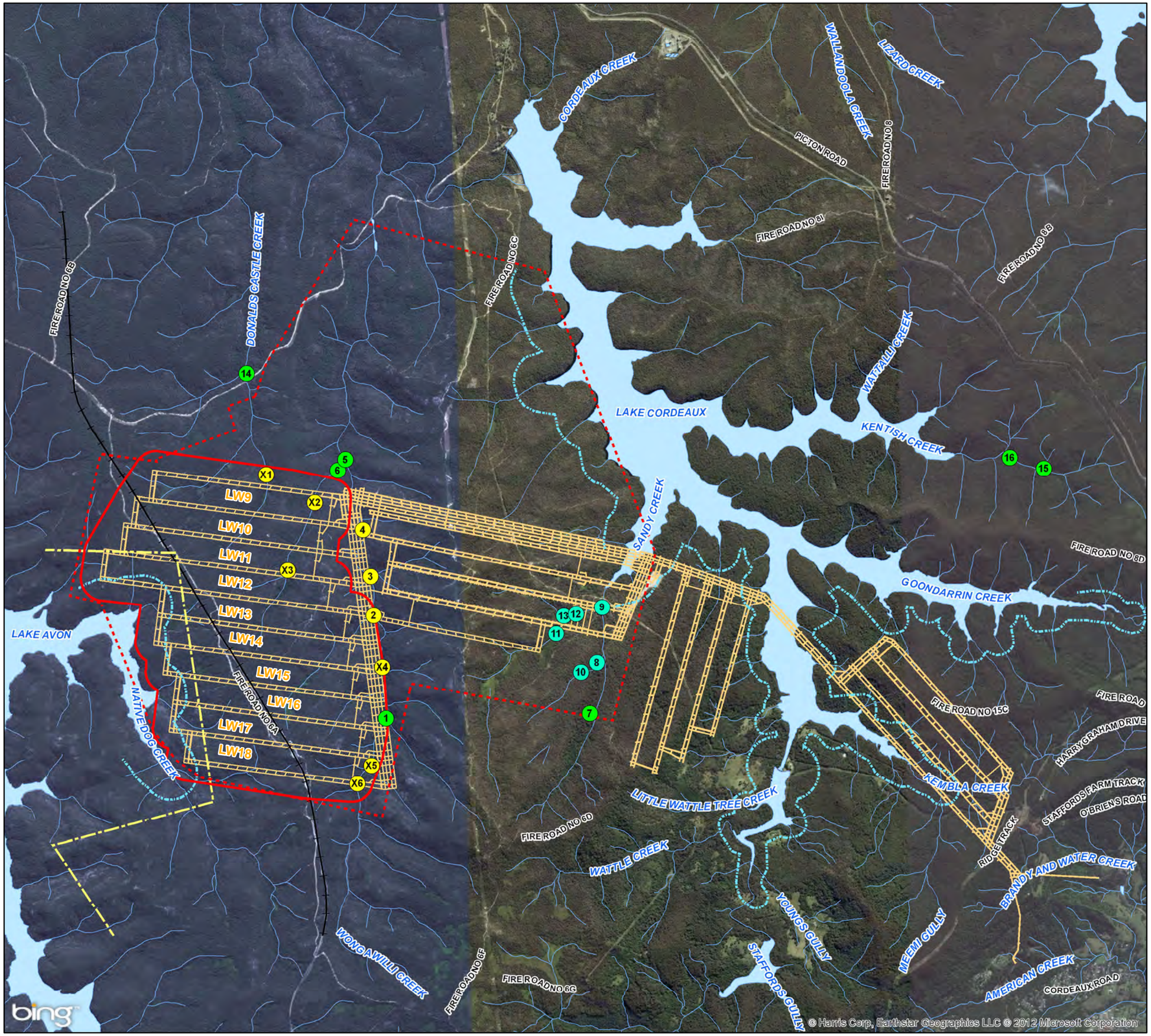
17994 Dend 3B TF Transects



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Aquatic Ecology Monitoring Locations

DENDROBIUM AREA 3B SMP

Legend

Monitoring Sites (Cardno Ecology Lab)

- Area 3A Monitoring Sites
- Control Sites
- Potential Impacts Sites
- Watercourses (LPI)
- SMP Area (1,199 ha)
- Maximum Footprint Area 3
- Restricted Zone
- DSC Notification Zone
- Maldon to Dombarton Rail
- Longwall Layout (BHPBIC, 2012)
- Waterbodies (LPI)

N
W E
S

FIGURE 3-4

1:45,000 Scale at A3

Metres
0 500 1,000 1,500 2,000

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2012-09-21
Coordinate System: GDA 1994 MGA Zone 56
Project: 112041-01
Map: G1038_AquaticMonitoringSiteTypes.mxd 01

Data supplied by MSEC (2012) unless otherwise stated
Aerial imagery supplied by Bing Maps and associated third party suppliers

4 MANAGEMENT AND CONTINGENCY

The potential impacts of mine subsidence to watercourses and associated features in Area 3B, including WC21 is described in the WIMMCP. The impact minimisation, mitigation and remediation measures proposed for WC21 are described below. Contingency measures, offsets and research are also addressed.

4.1 WC21 IMPACTS

The Strahler stream classification system is commonly used to define the class of a watercourse and was used in the Southern Coalfield Inquiry. Streams are classified based on the number of contributing tributaries, with headwater streams classed as first and second order streams and third and higher order streams given the classification of 'streams of significance'. The impacted portion of WC21 is a second order stream.

In accordance with the findings of the Southern Coalfield Inquiry:

- **Subsidence effects** are defined as the deformation of ground mass such as horizontal and vertical movement, curvature and strains.
- **Subsidence impacts** are the physical changes to the ground that are caused by subsidence effects, such as tensile and sheer cracking and buckling of strata.
- **Environmental consequences** are then identified, for example, as a loss of surface water flows and standing pools.

Subsidence is an unavoidable consequence of longwall mining and includes vertical and horizontal movement of the land surface. Subsidence effects include surface and sub-surface cracking, buckling, dilation and tilting. These effects have occurred within WC21 which has resulted in changes to the hydrology of the watercourse.

WC21 overlies the goaf and therefore, underwent temporary extensional "face line" cracking (perpendicular to the long axis of the panel) as the panels retreated, followed by re-compression as the maximum subsidence occurs at any one location. In addition, it underwent both longer term extensional "rib line" cracking (parallel to the long axis of the panel) along the outer edge and compression within the central portion of the subsidence trough. WC21 is located within a valley and was therefore, subject to downslope and valley closure movements.

Impact predictions were completed for the Study Area, including predictions for WC21 in order to record potential and likely impacts from the proposed mining. The predictions are based on mathematical and empirical models and utilised the best available information for the Southern Coalfield at that time and in particular Dendrobium Mine conditions. This comprehensive impact assessment is provided in the DA3B SMP (Cardno 2012).

The broad mechanisms of subsidence which have impacted WC21 include:

- The bedrock of the watercourse has fractured as a consequence of strains.
- Surface flow and pool water has drained into the fracture network.
- The size and depth of the fractures are such that the impacts will persist in the medium to long-term.
- It is not expected that the fractures extend to the mine workings.
- It is likely that bedding shear pathways have developed to the surface lower in the catchment.
- Surface water diverted through freshly fractured sandstone and groundwater that returns to the surface through the fracture network has increases in iron concentrations and other minerals.

Changes to watercourse hydrology and water quality have resulted in environmental consequences. The environmental consequences in WC21 relate to changes in hydrology

and water quality and include loss of aquatic ecology and habitat resulting from a reduction of surface water quality, flows and standing pools.

Based on the predicted systematic and non-systematic subsidence movements (MSEC 2012 and 2015) the bedrock of WC21 was likely to fracture as a consequence of subsidence induced strains.

It was predicted that surface flows would be captured by the fracture network and re-emerge further downstream. This prediction is based on an assessment of the depth of fracturing resulting from valley closure movements and measurements of water balances during the modelled periods of recessional, baseflow and small storm unit hydrograph periods downstream of mining areas.

Prior to remediation works within WC21 the depth and characteristics of the fracturing will be assessed by standard techniques such as drilling, coring, geophysical logging, establishment of piezometers, down-hole cameras and calliper measurements. The hydraulic conductance of these fracture networks will also be assessed. Tracer tests will be used to determine likely flow paths for the diverted water.

Subsidence, upsidence and closure along WC21 were predicted. A summary of the maximum predicted values of total subsidence, upsidence and closure at WC21, after the extraction of the proposed longwalls is provided in **Table 4-1**.

Table 4-1 Maximum Predicted Total Subsidence, Valley Related Upsidence and Closure at WC21

Maximum Predicted Subsidence (mm)	Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
3500	700	700

4.2 TRIGGER ACTION RESPONSE PLAN

The WIMMCP TARPs relate to identifying, assessing and responding to impacts to watercourses (including impacts greater than predicted). The TARPs for Area 3B watercourses are included in **Attachment 1**.

TARPs include actions to be taken upon reaching a defined trigger level. This Plan includes Corrective Management Actions (CMA) to manage observed impacts to WC21.

The following Watercourse TARP Triggers have been observed in WC21:

- Level 1
    - Fracturing, uplift and dilation of existing joints (between Pools 26 to 10)
    - Iron staining (from Pools 10 to 1)
- Level 2
    - Fracturing with associated flow diversion
    - Surface water loss
- Level 3
    - No Level 3 impacts observed to date

There are 37 pools mapped in WC21 within the 3B mining area. Ten mapped pools have been impacted with Level 1 changes in water appearance. The percentage of pools impacted by change in water appearance in WC21 in the mining area is 27%.

Three mapped pools have been impacted with Level 2 fracturing and flow diversion within WC21. The percentage of mapped pools impacted by fracturing and flow diversion in WC21

in the mining area is 8%. Six rockbars in WC21 have experienced Level 2 fracturing with flow diversion.

The WC21 aquatic ecology monitoring Sites X2 and X3 are on a biennial monitoring schedule and monitoring is currently being undertaken for these sites. Site X2 has been impacted with fracturing and flow diversion along the extent of the monitoring site, with water accumulating in a small number of pools only. A full suite of sampling was unable to be undertaken (in the most recent survey late September 2015) due to insufficient habitat. There are no observed impacts to Site X3 to date.

The Aquatic Ecology survey undertaken in 2014 included Site 14. This site is downstream of the physical mining impacts observed in WC21. There was no evidence in macroinvertebrate and fish data of any impacts to the aquatic ecology at Site 6 on WC21 during these surveys.

The impacts to aquatic ecology further upstream in WC21 (e.g. loss of aquatic habitat due to flow diversions) appears to be localised to these directly affected areas (CEL, 2015).

WC21 is surveyed for threatened frogs as described in the WIMMCP. Survey data shows a declining trend in abundance of all Littlejohn's Tree Frog life stages following subsidence related impacts within WC21. Littlejohn's Tree Frog numbers have remained lower than that recorded pre-mining. However baseline data is limited at WC21 and it is unknown how large the Littlejohn's population at WC21 was and what impacts mining may have had on this population (Biosis, 2015).

A statistical analysis of the threatened frog data (from 2010 to 2014) found that for pre-mining or control observations the average probability of detection is 73%, while for post mining observations the probability of detecting an adult Littlejohn's Tree Frog reduces to 50%.

4.3 MITIGATION AND REHABILITATION

Where the bedrock base of any significant permanent pool or controlling rockbar within Wongawilli Creek or Donalds Castle Creeks are impacted from subsidence and where there is limited ability for these fractures to seal naturally they will be sealed with an appropriate and approved cementatious or alternative grout (WIMMCP).

If the performance measures in Table 1 of the SMP Approval are not met, then following consultation with OEH, Water NSW and T&I, the Secretary of DoPE may issue a direction in writing to undertake actions or measures to mitigate or remediate subsidence impacts and/or associated environmental consequences. The direction must be implemented in accordance with its terms and requirements, in consultation with the Secretary and affected agencies.

The Secretary wrote to IC 28 August 2015 to request, under Condition 4 of Schedule 3, that IC prepare a remediation program for the impacts to WC21.

4.3.1 Sealing of Rock Fractures

Grouting will be focused where fractures result in diversion of flow from pools or through the controlling rockbar. Significant success has been achieved in the remediation of the Georges River where four West Cliff longwalls directly mined under the river and pool water level loss was observed.

A number of grouts are available for use including cement with various additives. Grouts can be used with or without fillers such as clean sand, depending on the grout design. Grouts will be mixed on-site and injected into the fracture network or placed by hand.

Such operations do have the potential to result in additional environmental impacts and will be carefully planned and executed to avoid contamination. Mixing areas will be restricted to cleared seismic lines or other open areas wherever possible. Bunds will be used to contain any local spillage at mixing points. The selection of grouting materials will be determined in

consultation with Water NSW and be based on demonstrated effectiveness and ensuring that there is no significant impact to water quality or ecology.

4.3.2 Injection Grouting

Injection grouting involves the delivery of grout through holes drilled into the bedrock targeted for rehabilitation. A variety of grouts and filler materials can be injected to fill the voids in the fractured strata intercepted by the drill holes. The intention of this grouting is to achieve a low permeability 'layer' below any affected pool as well as the full depth of any significant rockbar. Where alluvial materials overlie sandstone, grouts will be injected through grout rods to seal voids in or under the soil profile.

Grouting holes will be drilled in a pattern, usually commencing at a grid spacing of 2m x 2m. The holes will be installed using handheld drills. The drills will be powered by compressed air which is distributed to the work area from a compressor. The necessary equipment will be sited on cleared seismic lines or other clear areas wherever possible with hoses run out to target areas. Where no cleared areas exist, small areas will be cleared for access and grouting operations in WC21.

Grout will be delivered from a small tank into the ground via mechanical packers installed at the surface. All equipment will be transported with vehicles capable of travelling on tracks, seismic lines and cleared access sites. The grout will be mixed and pumped according to a grout design. A grout of high viscosity will be used if vertical fracturing is believed to be present since it has a shorter setting time. A low viscosity grout will be used if cross-linking is noted during grouting. Once the grout has been installed the packers will be removed and the area cleaned.

Grouting will commence at the upstream sections of the impacted area to allow for catchment water to flow into the rehabilitated area for pool integrity testing. To ensure there is sufficient time for the product to set the flow from upstream will be temporarily blocked and/or diverted around the grouting area. Once a pool is tested the area may be in-filled with additional grouting holes that target areas of significant grout take from the previous grouting or areas where flow diversion is observed. Wherever possible the set up and mixing areas will be restricted to cleared seismic lines and other open areas. Bunds are used to contain any local spillage at mixing points.

Grouting volumes and locations are recorded and high volume areas identified for monitoring purposes. The rate at which the water drains is measured and compared to pre-grouting results. The grouting process is iterative; relying on monitoring of grout injection quantities, grout backpressures and measurements of water holding capacity. In the Georges River the majority of pools were sealed with two to three grout passes.

Where flow diversion is observed through a large rockbar it may be more appropriate to implement alternative grouting techniques such as a deeper grout curtain which can be delivered via traditional or directional drilling (track or wheel mounted). These techniques will be implemented where there is limited success using hand-held equipment. Grouting will be undertaken at the completion of subsidence movements in the area to reduce the risk of the area being re-impacted. **Figure 4-1** shows grouting operations in the Georges River.

(a) Drilling into the bedrock

(b) Grout pump station setup

(c) Injecting grout into bedrock via a specially designed packer system

Figure 4-1 Rockbar Grouting in the Georges River

4.3.3 Alternative Remediation Approaches

IC has successfully implemented a subsidence rehabilitation program in the Georges River where there were impacts associated with mining directly under streams. This rehabilitation focused on grouting of mining induced fractures and strata dilation to reinstate the structural integrity and water holding capacity of the bedrock. Metropolitan Colliery is currently undertaking work aimed at rehabilitating areas impacted by subsidence using Poly-urethane Resin (PUR) and other grouting materials. IC is consulting with Metropolitan Colliery in relation to these new and emerging technologies. The best grout option available for the rehabilitation work will be identified and agreed with Water NSW.

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 prevailing erosion and depositional processes of a specific area will determine the rate of infill of cracks and sealing of any fracture network.

4.3.4 Remediation Success

Baseline studies have been completed to record the biophysical characteristics of WC21. Monitoring of WC21 has been conducted before, during and after mining. The monitoring is based on the BACI design.

The monitoring program will remain in place during and after the implementation of the rehabilitation measures in WC21. The monitoring locations for WC21 will be reviewed during the rehabilitation as required and can be modified (with agreement) accordingly.

Analyses of monitoring data from pre-mining, control, impact and mitigation sites will be used to determine the success of the rehabilitation. Observations will be made as part of the monitoring program and be used to provide contextual information to the above assessment approach. Monitoring data and observations will be mapped, documented and reported.

4.4 WC21 IMPACTS AND REMEDIATION

Longwall 9 and 10 passed directly beneath tributary WC21. As predicted, surface impacts including iron staining, rock fracturing; flow diversion and small rockfalls have been identified within the stream or directly adjacent to the tributary. As mining continues in DA3B, Longwalls 11 to 14 will also pass beneath the tributary, it is predicted that these surface impacts will continue to occur. Any remediation works undertaken prior to completion of Longwall 14 should consider the potential for further subsidence movements and reduction in surface flow from upstream ultimately reaching the remediation sites.

4.4.1 WC21_Pool 30

Pool 30 will be mined beneath by Longwall 11.

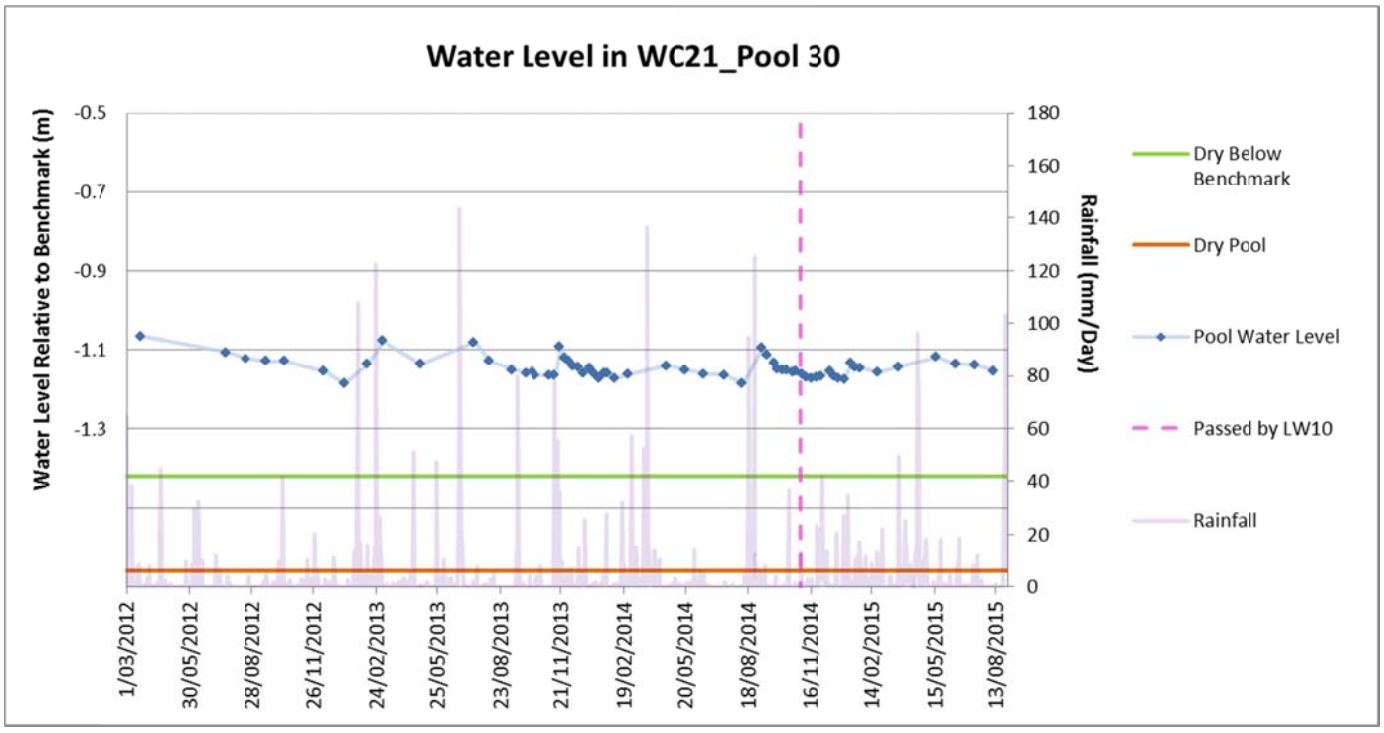
Baseline description: Pool is 8m long, 3m wide and 0.3m deep.

Impacts to feature: No surface impacts have been identified and no change in water levels following extraction of Longwall 11 (**Graph 1**) has been observed to date. **Photo 1** and **Photo 2** show recent conditions at Pool 30.

Recommendation: No remediation works are recommended at the site.

Photo 1: WC21_Pool 30, looking upstream. Taken on 10/09/2015.

Photo 2: WC21_Pool 30, looking downstream. Taken on 10/09/2015.



Graph 1: Water level recorded in WC21_Pool 30 throughout the monitoring period.

4.4.2 WC21_Pool 28

Pool 28 overlies the chain pillar between Longwall 10 and Longwall 11.

Baseline description: Pool is 30m long, 6m wide and 1m deep.

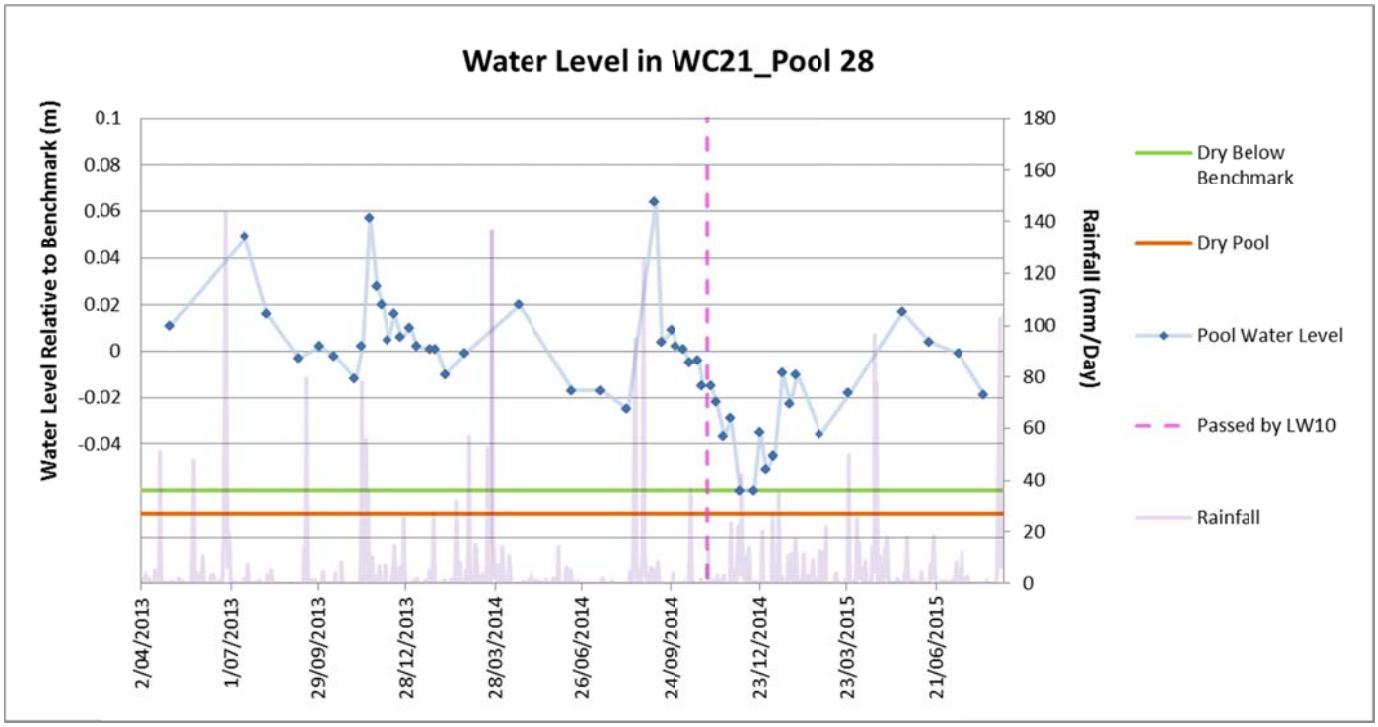
Impacts to features: No surface impacts have been identified to date. Localised subsurface flow diversion into the upstream sediment bank was recorded during baseline monitoring. Surface water flow reappears directly upstream from Pool 28 (**Photo 3**). **Photo 4** and **Photo 5** show recent pool conditions. A drop in water level, below baseline, was experienced following passing of Longwall 10 (**Graph 2**).

Recommendation: No works are recommended at this time as the pool is within the Longwall 11 mining area and subject to future subsidence movements.

Photo 3: Re-emergence of flow from bank in to WC21_Pool 28, looking across stream. Taken on 14/10/2015.

Photo 4: Inflow to WC21_Pool 28, looking downstream. Taken on 10/09/2015.

Photo 5: Outflow from WC21_Pool 28, looking upstream. Taken on 10/09/2015.



Graph 2: Water level recorded in WC21_Pool 28 throughout the monitoring period.

4.4.3 WC21_Rockbar 27

Rockbar 27 overlies the chain pillar between Longwall 10 and Longwall 11.

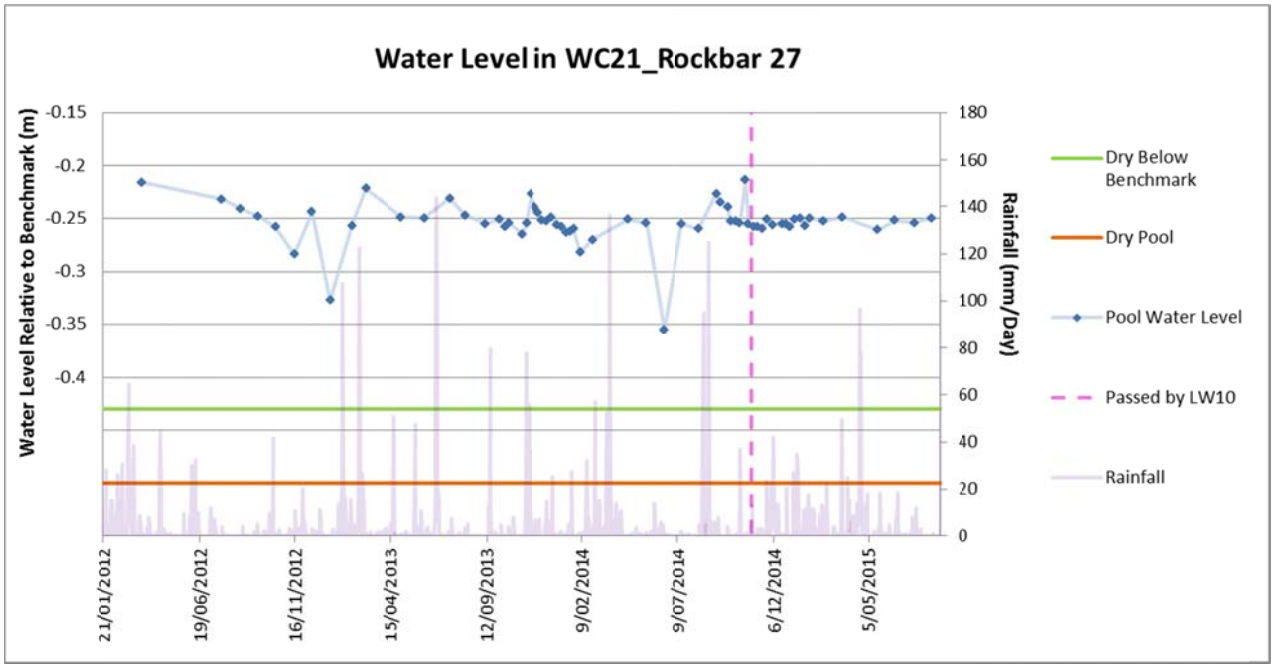
Baseline description: Feature is 40m long, 3m wide with pooling of up to 0.3m deep.

Impacts to features: No surface impacts or changes in water level have been observed to date (**Graph 3**). **Photo 6** and **Photo 7** show recent pool conditions.

Recommendation: No works are recommended at this time.

Photo 6: WC21_Rockbar 27, looking upstream. Taken on 10/09/2015.

Photo 7: WC21_Rockbar 27, looking downstream. Taken on 10/09/2015.



Graph 3: Water level recorded in WC21_Rockbar 27 throughout the monitoring period.

4.4.4 WC21_Rockbar 26

Rockbar 26 was mined beneath by Longwall 10. No routine water level monitoring is installed at this site.

Baseline description: Rockbar is 20m long and 2m wide with pooling along rockbar.

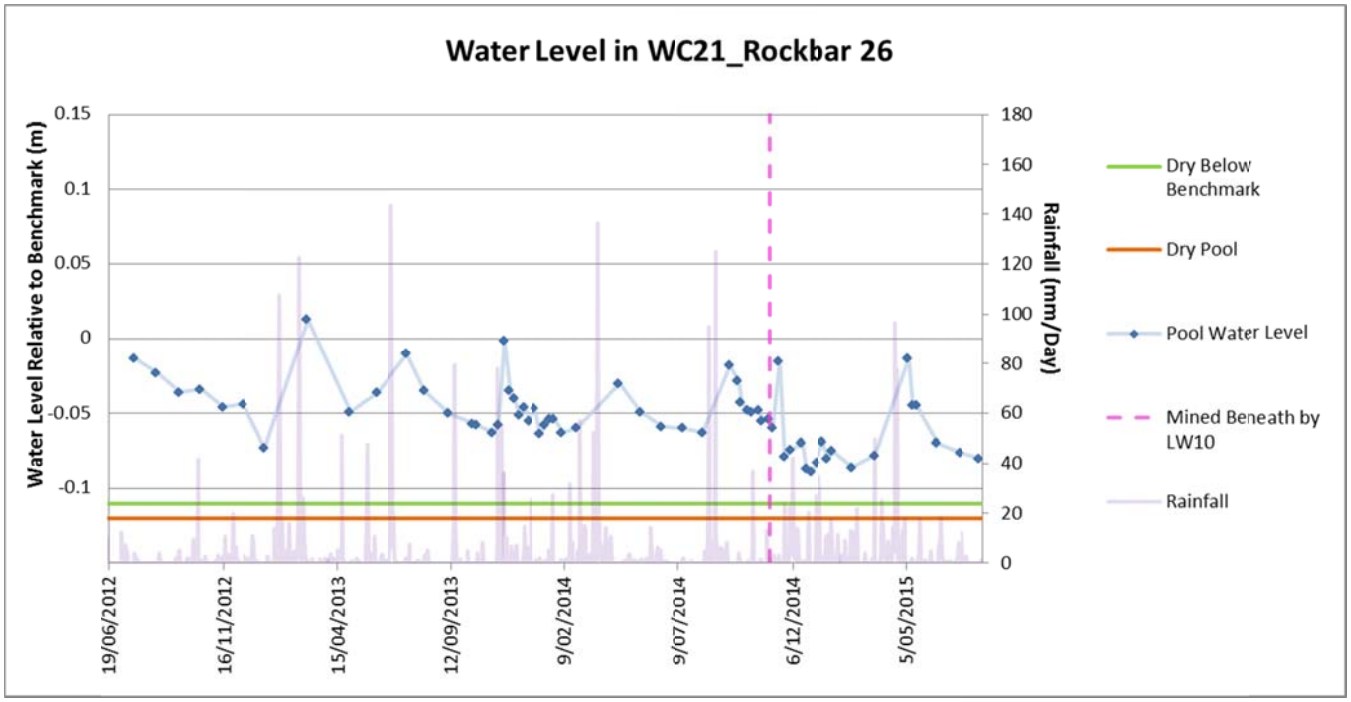
Impacts to features: Impact LW10_007- Fracturing was observed to the downstream end of Rockbar 26 (**Photo 10**). Some localised flow diversion was observed during low flow conditions. **Figure 4-2** shows the location of the impact. The water level dropped below baseline following the mining of Longwall 10 (**Graph 4**). **Photo 8** and **Photo 9** show recent conditions.

Recommendation: No works are recommended at this time as this site will be subject to movement from Longwall 11.

Photo 8: WC21_Rockbar 26, looking upstream. Taken on 10/09/2015.

Photo 9: WC21_Rockbar 26, looking downstream. Taken on 10/09/2015.

Photo 10: Impact LW10_007- Fracturing to downstream end of Rockbar 26. Taken on 18/11/2014.



Graph 4: Water level recorded in WC21_RB 26 throughout the monitoring period.

4.4.5 WC21_Pool 26

Pool 26 was mined beneath by Longwall 10. No routine water level monitoring is installed at this pool.

Baseline description: Pool is 20m long, 2m wide and 0.3m deep.

Impacts to features: Impact LW10_010- Dilation of a joint on the base of Pool 26 (**Photo 11**). No flow diversion has been observed to date. **Figure 4-2** shows the location of the impact.

Photo 12 and **Photo 13** show recent conditions at the pool.

Recommendation: Surface flow remains present through this section and as a result no works are recommended at this stage.

Photo 11: Impact LW10_010- dilation of joint on base of pool, looking downstream. Taken on 25/11/2014.

Photo 12: WC21_Pool 26, looking upstream. Taken on 10/09/2015.

Photo 13: WC21_Pool 26, looking downstream. Taken on 10/09/2015.

4.4.6 WC21_RB 24

Rockbar 24 was mined beneath by Longwall 10. No routine water level monitoring is installed at this site.

Baseline description: The rockbar is approximately 60m long with a total vertical drop of approximately 2m. The pool at the downstream end of Rockbar 24 is approximately 6m long, 4m wide with pooling up to 0.3m deep.

Impacts to features:

Impact LW10_011- Multiple fractures and uplift have been observed at Rockbar 24. Flow diversion is evident with a general decline in surface water over the rockbar following mining by Longwall 10 (**Photo 14** and **Photo 15**).

Impact LW10_020- Rock fractures to the downstream section of Rockbar 24 has been observed (**Photo 16**). **Figure 4-3** shows the location of surface impacts. Water levels and surface flow have returned to Rockbar 24 during recent monitoring (**Graph 5**). **Photo 17** and **Photo 18** show recent flow conditions.

Recommendation: Flow diversion has been observed through fracturing and an existing joint which runs perpendicular to the rockbar (**Photo 15**). This location is proposed as an initial tracer injection point for assessment of downstream outflow (**Figure 4-6**). Following the use of this point for tracer injection and on cessation of subsidence movements, injection grouting is recommended to target fracturing in the joint (**Figure 4-6**). Coffer dams and diversion piping will be used to locally divert surface flow during works if required.

A drill site is also proposed directly adjacent to Rockbar 24 (**Figure 4-6**). This is for the purpose of downhole investigations including packer testing, visual analysis using a downhole camera and installation of piezometers. These investigations aim at building a better understanding of the impacted strata and ways of targeting remediation works.

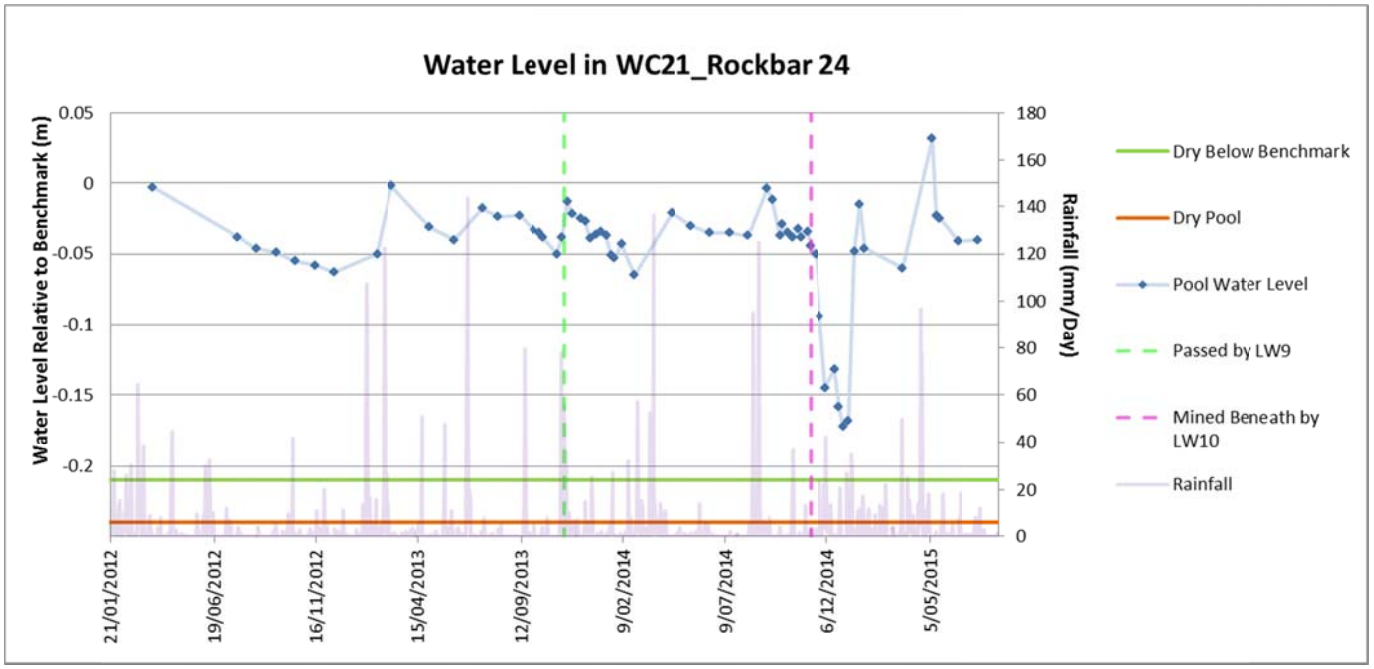
Photo 14: Impact LW10_011- fracturing with dislodged fragment on Rockbar 24, looking downstream. Taken on 25/11/2014.

Photo 15: Impact LW10_011- fracturing in joint and decline in surface flow, looking upstream. Taken on 25/11/2014.

Photo 16: Impact LW10_020- fracturing to downstream end of Rockbar 24, looking downstream. Taken on 30/01/2015.

Photo 17: WC21_Rockbar 24, looking upstream. Taken on 15/10/2015.

Photo 18: Downstream end of WC21_Rockbar 24, looking upstream. Taken on 15/10/2015.



Graph 5: Water level recorded in WC21_Rockbar 24 throughout the monitoring period.

4.4.7 WC21_Pool 24

Pool 24 was mined beneath by Longwall 10. No routine pool water level monitoring is installed at this site.

Baseline description: The pool is 50m long, up to 5m wide and 1m deep. The upstream section contains the widest and deepest section of the pool. Sediment covers much of the base in this upstream section. The downstream section of the pool is narrow and channel-like in appearance before merging into downstream Rockbar 23.

Impacts to features: Impact LW10_008- Rock fracturing and uplift was identified in the base of Pool 24 towards the downstream section of the pool (**Photo 19**). There is an absence of surface water during most inspections. **Figure 4-3** shows the location of the impact.

Subsurface inflow to the sediment base of the upstream section of the pool is evident (**Photo 20**). The pool continues to hold water for periods following rainfall (**Photo 21**).

Recommendation: Injection grouting to the upstream section of Pool 24 is recommended following completion of Longwall 11. The site is close to an existing vehicle access track. Staging Area 1 is proposed for storage and mixing of grouts (**Figure 4-6**). Overlying sediment needs to be managed during the drilling and grouting process. Coffer dams and diversion piping will be used to locally divert surface flow during works if required.

Reassessment of the downstream section of Pool 24 is recommended following the upstream works to the pool (**Figure 4-7**).

Photo 19: Impact LW10_008- fracturing and decline in surface flow, looking upstream. Taken on 25/11/2014.

Photo 20: Upstream end of WC21_Pool 24, without water in pool, looking downstream. Taken on 15/10/2015.

Photo 21: Upstream end of WC21_Pool 24, with water in pool, looking downstream. Note: this is often dry. Taken on 10/09/2015.

Photo 22: Downstream section of WC21_Pool 24, looking upstream. Taken on 10/09/2015.

Photo 23: Downstream section of WC21_Pool 24, looking downstream. Taken on 10/09/2015.

4.4.8 WC21_Rockbar 23

Rockbar 23 was mined beneath by Longwall 10.

Baseline description: The rockbar has shallow pooling and multiple flow paths.

Impacts to feature:
Impacts LW10_018- Rock fracture upstream from Rockbar 23. Surface flow absent (**Photo 24**).
Impact LW10_019 - Multiple rock fractures to Rockbar 23. Surface flow absent (**Photo 25**).
Impacts LW10_009- Multiple fractures to the downstream end of Rockbar 23. Surface flow absent (**Photo 26**).
Impacts LW10_013- Rock fracturing to base of Pool 23 on western margin (**Photo 27**).
Impacts LW10_026- Multiple rock fractures to the downstream section of Rockbar 23. Surface flow absent (**Photo 28**).

An absence of surface flow has been identified following Longwall 10 mining beneath the site. Recorded water levels at the site are below baseline conditions (**Graph 6**). **Figure 4-3** shows the location of the impacts.

Recommendations: Reassessment of surface flow conditions on the rockbar are proposed following return of surface water flow to upstream features. Grouting of any flow diversion is recommended. It is recommended that remediation initially target Pool 23 should surface flow be delivered from upstream.

Photo 24: Impact DA3B_LW10_018. Taken on 18/12/2014

Photo 25: Impact DA3B_LW10_019. Taken on 18/12/2014

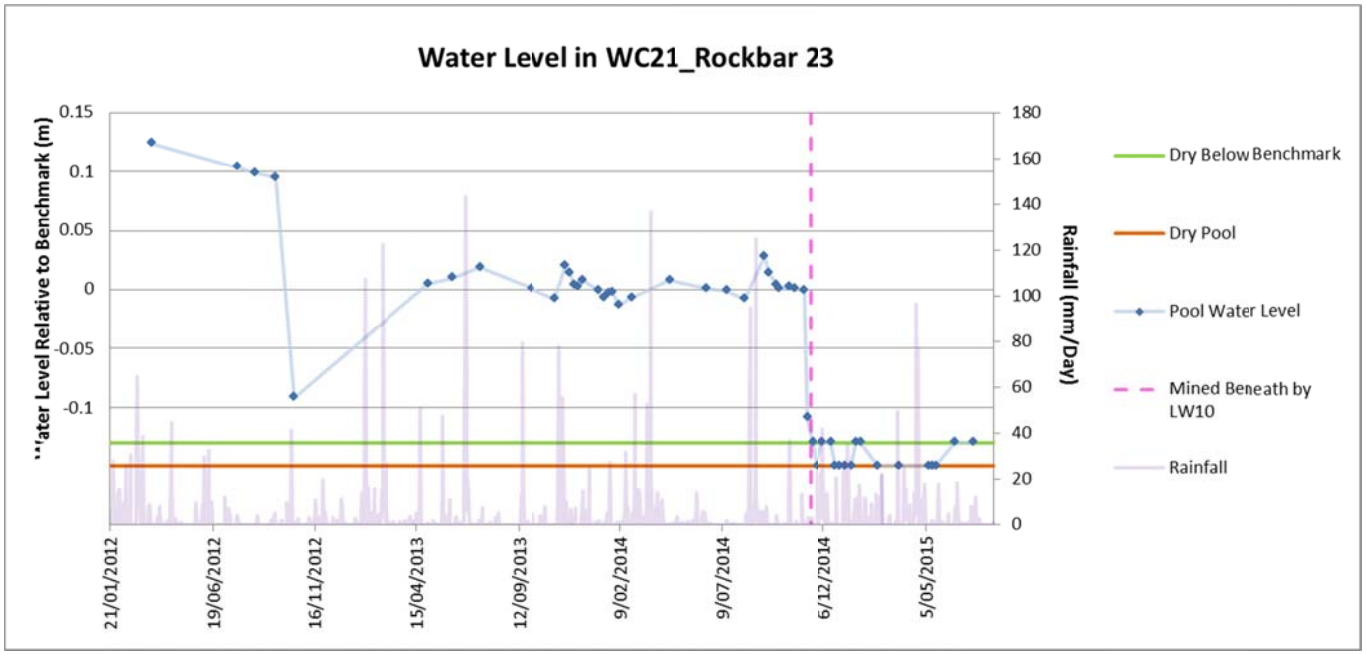
Photo 26: Impact DA3B_LW10_009. Taken on 18/11/2014

Photo 27: Impact DA3B_LW10_013. Taken on 4/12/2014

Photo 28: Impact DA3B_LW10_026. Taken on 3/3/2015.

Photo 29: WC21_Rockbar 23, looking upstream. Taken on 10/09/2015.

Photo 30: WC21_Rockbar 23, looking downstream. Taken on 10/09/2015.



Graph 6: Water level recorded at WC21_Rockbar 23 throughout the monitoring period.

4.4.9 WC21_Pool 23

Pool 23 was mined beneath by Longwall 10.

Baseline description: Pool is 18m long, 5m wide and 1m deep.

Impacts to feature:
Impact LW10_014- Fracturing to the base of WC21_Pool 23 was identified (**Photo 31** and **Photo 32**). An absence of surface flow was also observed.
Impact LW10_015- Hairline fracturing was identified downstream from Pool 23. An absence of surface flow was also observed (**Photo 33** and **Photo 34**).

Pool 23 has been dry on the majority of inspections since Longwall 10 mined under the site (**Graph 7**). **Photo 35** and **Photo 36** show recent conditions at the site. **Figure 4-3** shows the impact locations.

Recommendation: Injection grouting is recommended at Pool 23 once upstream works have been successfully completed. As the closest existing access track is 80m to the east of the pool, a new access track and staging area will be required for equipment to position close to the site of proposed works (**Figure 4-7**). Grout will be pumped to the pool for injection from Staging Area 2. Coffer dams and diversion piping will be used at the site if diversion of surface flow is required.

A borehole is proposed for Staging Area 2 for the prposes of downhole investigations (**Figure 4-7**).

Photo 31: Impact DA3B_LW10_014-Fracture to base of WC21_Pool 23, looking across stream. Photo taken on 4/12/2014.

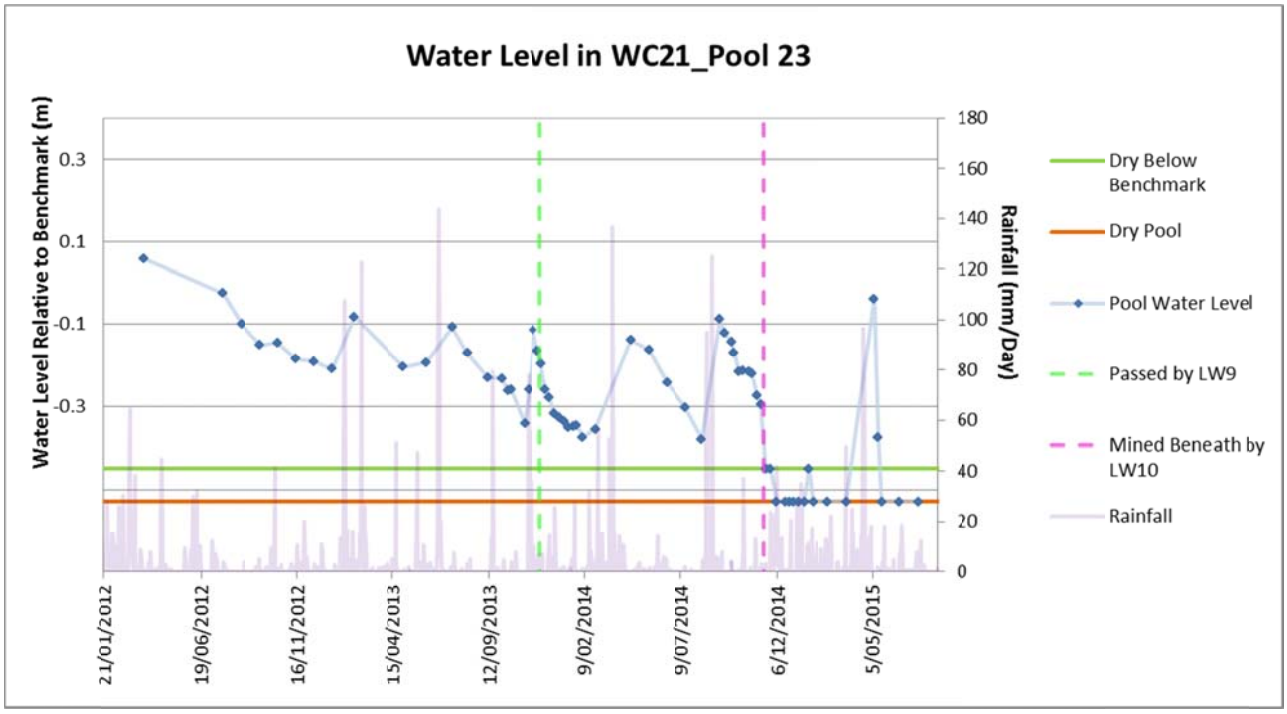
Photo 32: Impact DA3B_LW10_014-Fracture to base of WC21_Pool 23. Photo taken on 4/12/2014.

Photo 33: Impact DA3B_LW10_015-Fracturing downstream from WC21_Pool 23, looking upstream. Photo taken on 4/12/2014.

Photo 34: Impact DA3B_LW10_015-Fracturing downstream from WC21_Pool 23. Photo taken on 4/12/2014.

Photo 35: WC21_Pool 23, looking upstream. Taken on 10/09/2015.

Photo 36: WC21_Pool 23, looking downstream. Taken on 10/09/2015.



Graph 7: Water level at WC21_Pool 23 throughout the monitoring period.

4.4.10 WC21_Pool 22

Pool 22 was mined beneath by Longwall 10. No routine pool water level monitoring is installed at this site.

Baseline description: The pool is 20m long, 1m wide and 0.5m deep.

Impacts to feature: No surface impacts have been observed however a reduction in surface water is evident following mining (**Photo 37** and **Photo 38**).

Recommendation: Reassessment of surface flow conditions at the site are proposed following the return of upstream surface water flow. The pool continues to hold areas of surface water. Grouting would target any observed flow diversion.

Photo 37: WC21_Pool 22, looking upstream. Taken on 10/09/2015.

Photo 38: WC21_Pool 22, looking downstream. Taken on 10/09/2015.

4.4.11 WC21_Rockbar 21

Rockbar 21 overlies the chain pillars between Longwall 9 and Longwall 10.

Baseline description: The rockbar is 50m long, 4m wide with pooling up to 0.4m deep.

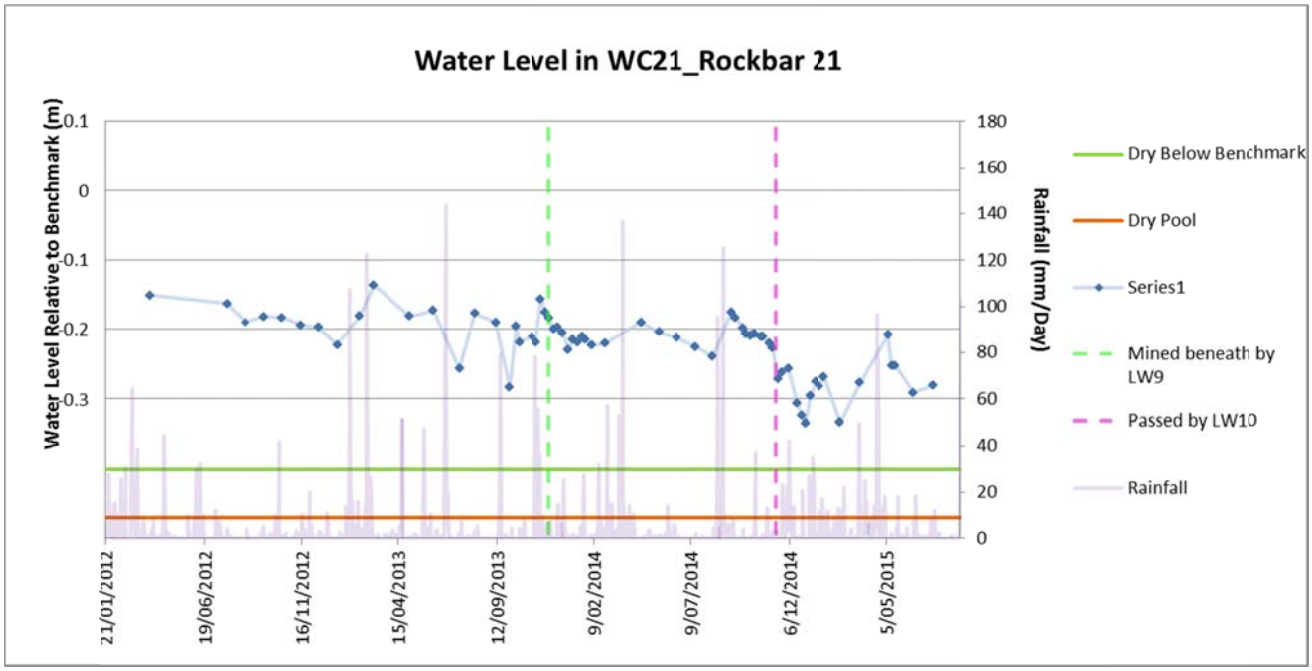
Impacts to feature:
No surface impacts have been observed however a reduction in surface water is evident following mining (**Photo 39** and **Photo 40**).

A drop in monitored pool water level was observed following Longwall 10 mining under the site. The site however continues to retain water and responds to rainfall (**Graph 8**).

Recommendation: Reassessment of surface flow conditions at the site are proposed following the return of upstream surface water flow. The pool continues to hold areas of surface water. Grouting would target any observed flow diversion.

Photo 39: WC21_Rockbar 21, looking upstream. Taken on 10/09/2015.

Photo 40: WC21_Rockbar 21, looking downstream. Taken on 10/09/2015.



Graph 8: Water level at WC21_Rockbar 21 throughout the monitoring period.

4.4.12 WC21_Pool 21

Pool 21 was mined beneath by Longwall 9. No routine pool water level monitoring is installed at this site.

Baseline description: The pool is 12m long, 3.5m wide and 0.6m deep.

Impacts to feature: No surface impacts have been observed however a reduction in surface water is evident following mining (**Photo 41** and **Photo 42**).

Recommendations: Reassessment of this area is proposed following return of upstream surface water flow. The pool continues to hold areas of surface water. Grouting would target any observed flow diversion.

Photo 41: WC21_Pool 21, looking upstream. Taken on 10/09/2015.

Photo 42: WC21_Pool 21, looking downstream. Taken on 10/09/2015.

4.4.13 WC21_Rockbar 20

Rockbar 20 was mined beneath by Longwall 9. No routine pool water level monitoring is installed at this site.

Baseline description: Rockbar is 15m long, 4m wide with pooling up to 0.2m deep.

Impacts to feature: Impact LW10_016- Rock fracturing and dilation of an existing joint on Rockbar 20 and an absence of surface flow observed (**Photo 45**). Flow diversion has not been observed through the fracture; however there has been a reduction in surface flow reaching the site (**Photo 43** and **Photo 44**).

Recommendations: The rockbar continues to hold areas of surface water for periods after rainfall. Grouting would target any observed flow diversion through the rockbar. Remediation is proposed at the downstream Pool 20 (see following section).

Photo 43: WC21_Rockbar 20, looking upstream. Taken on 10/09/2015.

Photo 44: WC21_ Rockbar 20, looking downstream. Taken on 10/09/2015.

Photo 45: Impact LW10_016- Rock fracture extending across rockbar and through joint, looking across stream. Taken on 04/12/2014.

4.4.14 WC21_Pool 20 (Monitoring site WC21_Pool 19)

Pool 20 was mined beneath by Longwall 9.

Baseline description: Pool is 12m long, 5m wide and 0.6m deep.

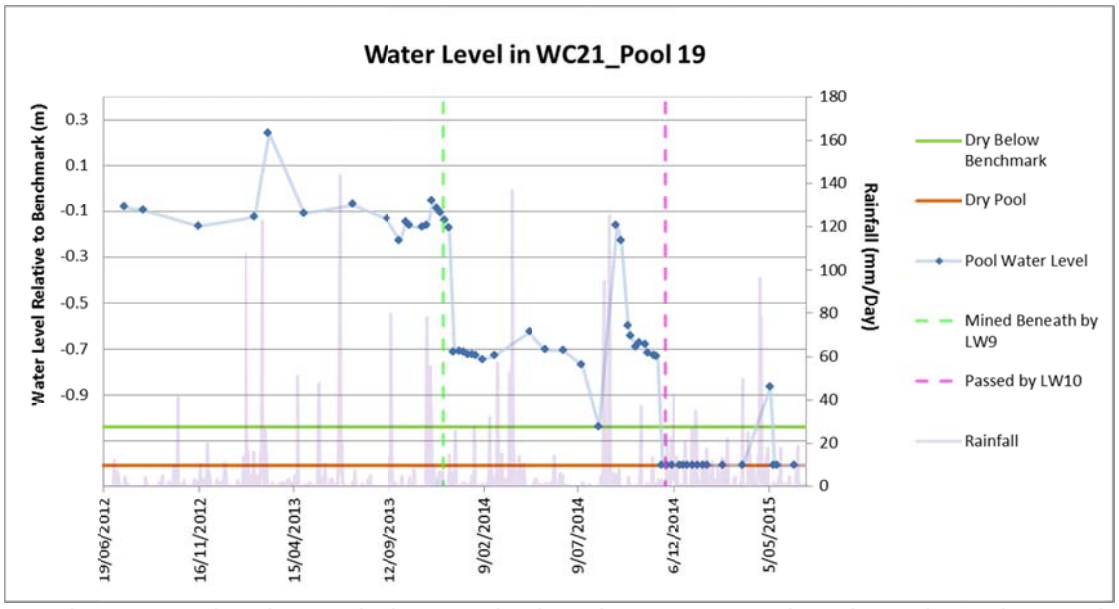
Impacts to feature: No surface impacts have been observed; however a reduction in pool water level has been recorded following Longwall 9 and Longwall 10. The pool has been dry on most inspections following Longwall 10 (**Graph 9**).

Recommendations: The impacts at Pool 20 will be reassessed once surface water flow is restored from upstream to this pool. This allows for the identification of surface water flow diversion. Where diversion is identified injection grouting will be used. Initially the grouting will target the base of the pool, focussing beneath the sediment on the downstream end and angled towards the western bank (**Figure 4-8**). Other areas of observed diversion or high graout take will also be targetd. Coffer dams and diversion piping will be used to temporarily divert surface flow if required. Primary clearing of Staging Area 3 and an access track from south east is proposed to allow for vehicle and equipment access and preparation of materials for Pool 20.

A borehole is also proposed for Staging Area 3 for the purpose of downhole and groundwater investigations (**Figure 4-8**).

Photo 46: WC21_Pool 19, looking upstream. Taken on 10/09/2015.

Photo 47: WC21_Pool 19, looking downstream. Taken on 10/09/2015.



Graph 9: Water level recorded at monitoring site WC21_Pool 19 throughout the monitoring period. Note: feature retains the mapping name of 'Pool 20'.

4.4.15 WC21_Rockbar 18

Rockbar 18 was mined beneath by Longwall 9.

Baseline description: The rockbar is 30m long, 6m wide with small areas of pooling up to 0.4m deep. Incision of cross-bedded strata is evident.

Impacts to feature:
Impact LW9_021- Multiple rock fractures to the upstream end of Rockbar 18 and an absence of surface flow has been observed (**Photo 48**).
Impact LW9_022- Fracturing and dilation of a joint on the downstream section of Rockbar 18 and an absence of surface flow has been observed (**Photo 49**).

Photo 50 and **Photo 51** show recent conditions at the pool.

Recommendation: Grouting of Impact DA3B_021 is recommended due to the open nature of the fracture (**Figure 4-4**). Material will be carried from Staging Area 3 (**Figure 4-8**). Coffer dams and diversion piping will be used to temporarily divert surface flow if required.

Photo 48: Impact LW9_021- Rock fracturing to Rockbar 18. Taken on 2/01/2014.

Photo 49: Impact LW9_022- Rock fracturing to Rockbar 18. Taken on 2/01/2014.

Photo 50: WC21_Rockbar 18, looking upstream. Taken on 10/09/2015.

Photo 51: WC21_ Rockbar 18, looking downstream. Taken on 10/09/2015.

4.4.16 WC21_Pool 18

Pool 18 was mined beneath by Longwall 9.

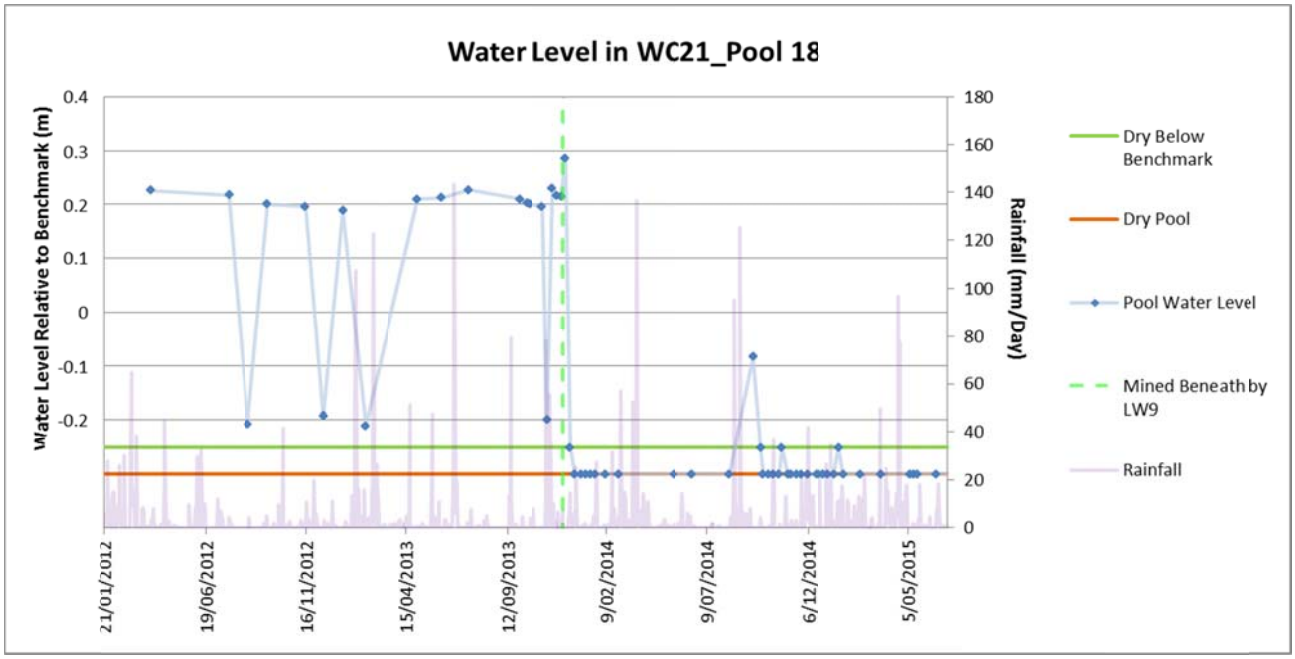
Baseline description: The pool is 7m long, 4m wide and up to 0.5m deep.

Impacts to feature: No surface impacts have been observed however a reduction in pool water level has been recorded following Longwall 9. The pool has been dry on most inspections following Longwall 9 (**Graph 10**). **Photo 52** and **Photo 53** show recent conditions at the site.

Recommendation: The successful return of upstream surface water flow will allow for a full assessment of the condition of Pool 18. The absence of any visible fracturing and observed flow diversion makes any initial remediation difficult at this pool. Should flow diversion be identified within this pool injection grouting is recommended. Grouting would target any observed flow diversion.

Photo 52: WC21_Pool 18, looking upstream. Taken on 10/09/2015.

Photo 53: WC21_Pool 18, looking downstream. Taken on 10/09/2015.



Graph 10: Water level recorded at WC21_Pool 18 throughout the monitoring period.

4.4.17 WC21_Rockbar 17

Rockbar 17 was mined beneath by Longwall 9.

Baseline description: The pool is 6m long, 5m wide with flow over the rockbar.

Impacts to feature: Impact LW9_016- Dilation of joints and fracturing to Rockbar 17 and an absence of surface flow observed (**Photo 54** and **Photo 55**).

Recommendation: Remediation is not currently proposed at this location due to the shallowness of the pool and the localised nature of flow diversion at the site. Surface flow at the site should be reassessed following successful return of flow upstream. It is recommended that remediation initially target Pool 16, approximately 10m downstream (**Figure 4-9**).

Photo 54: Impact LW9_016, dilation of joint looking across stream. Taken on 17/12/2013.

Photo 55: Rockbar 17, looking upstream at fracturing. Taken on 10/09/2015.

4.4.18 WC21_Pool 17

Pool 17 was mined beneath by Longwall 9.

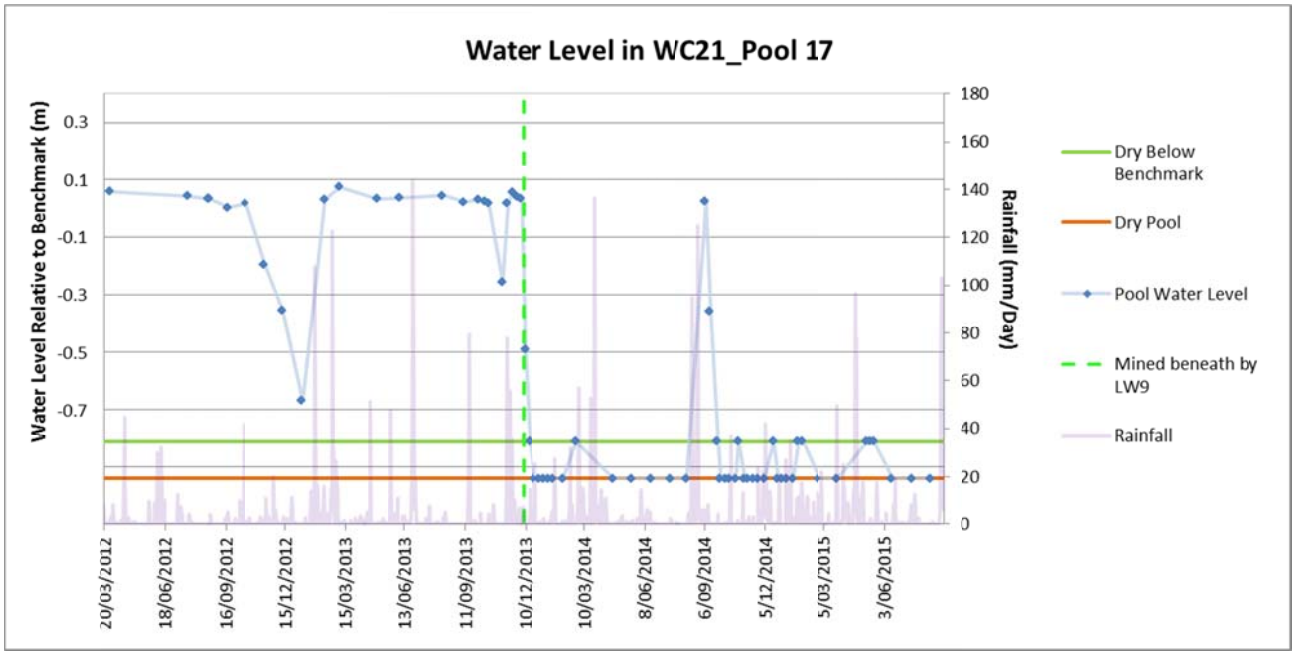
Baseline description: Pool is 8m long, 3m wide and up to 0.8m deep.

Impacts to feature: No surface impacts have been observed in the pool however a reduction in pool water level has been recorded following Longwall 9 (**Photo 56** and **Photo 57, Graph 11**). The pool has been dry on multiple inspections following Longwall 9.

Recommendation: The absence of any visible fracturing or observation of flow diversion makes any initial remediation difficult at this pool. The pool's position directly upstream and 'above' Pool 16 suggests that any loss of water ultimately flows into Pool 16, where targeted remediation is proposed. Any flow diversion identified in Pool 17 would be targeted with grouting.

Photo 56: WC21_Pool 17, looking upstream. Taken on 10/09/2015.

Photo 57: WC21_Pool 17, looking downstream. Taken on 10/09/2015.



Graph 11: Water level recorded at WC21_Pool 17 throughout the monitoring period.

4.4.19 WC21_Pool 16

Pool 16 was mined beneath by Longwall 9.

Baseline description: The pool is 6m long, 5m wide and up to 0.8m deep.

Impacts to feature:
Impact LW9_014- Fracturing to the rock shelf adjacent Pool 16 (**Photo 60**) which does not intersect the pool.
Impact LW9_015- Fracturing, uplift and dilation of jointing on the base of Pool 16 with an absence of surface flow observed (**Photo 61**). **Figure 4-4** shows the location of surface impacts. The pool retains water for short periods following rainfall (**Graph 12**).

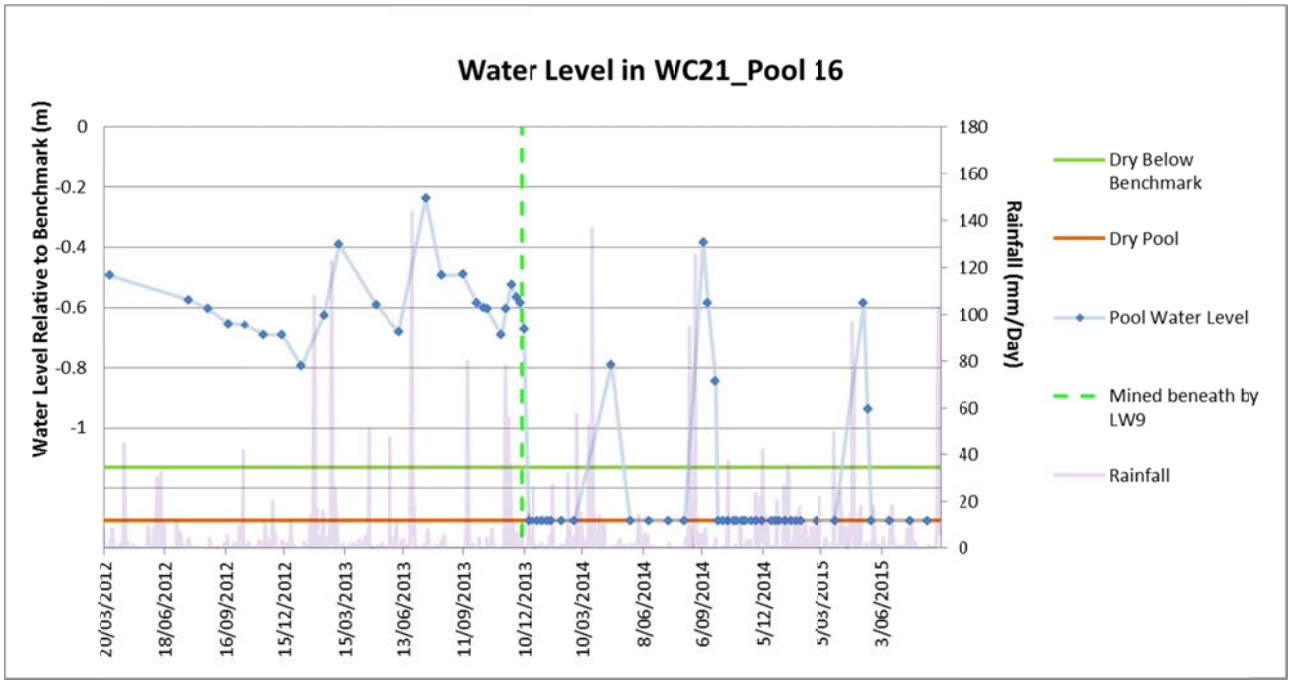
Recommendation: Injection grouting is recommended at the site (**Figure 4-9**). Coffer dams and diversion piping will be used to temporarily divert surface flow if required. Equipment and materials needed for remediation works will be stored at Staging Area 4. From this location, grout can be pumped approximately 20m to Pool 16. Primary clearing will be required to position Staging Area 4 directly adjacent to an existing, previously cleared seismic track. Secondary clearing of this track is required for vehicular access (**Figure 4-9**).

Photo 58: WC21_Pool 16, looking downstream. Taken on 10/09/2015.

Photo 59: WC21_Pool 16, looking upstream. Taken on 10/09/2015.

Photo 60: Impact DA3B_LW9_014- fracturing to rock shelf adjacent to WC21_Pool 16. Taken on 10/12/2013.

Photo 61: Impact DA3B_LW9_015- fracturing to base of WC21Pool 16, looking downstream. Taken on 15/10/2015.



Graph 12: Water level at WC21_Pool 16 throughout the monitoring period.

4.4.20 WC21_Pool 15

Pool 15 was mined beneath by Longwall 9.

Baseline description: Pools is up to 6m long, 2m wide and 0.5m deep. Pool consists of cross-bedded strata which is incised and overlain with fluvial material.

Impacts to features: No surface impacts have been observed at this site however there is an absence of surface water (**Photo 62** and **Photo 63**).

Recommendation: The absence of any visible fracturing and observed flow diversion makes any initial remediation difficult at this pool. Reassessment of the site is proposed following successful return of flow upstream. Any flow diversion identified will be targeted with grouting.

Photo 62: WC21_Pool 15, looking upstream. Taken on 10/09/2015.

Photo 63: WC21_Pool 15, looking downstream. Taken on 10/09/2015.

4.4.21 WC21_Pool 14 to WC21_Pool 11

Pools 14 to 11 were mined beneath by Longwall 9

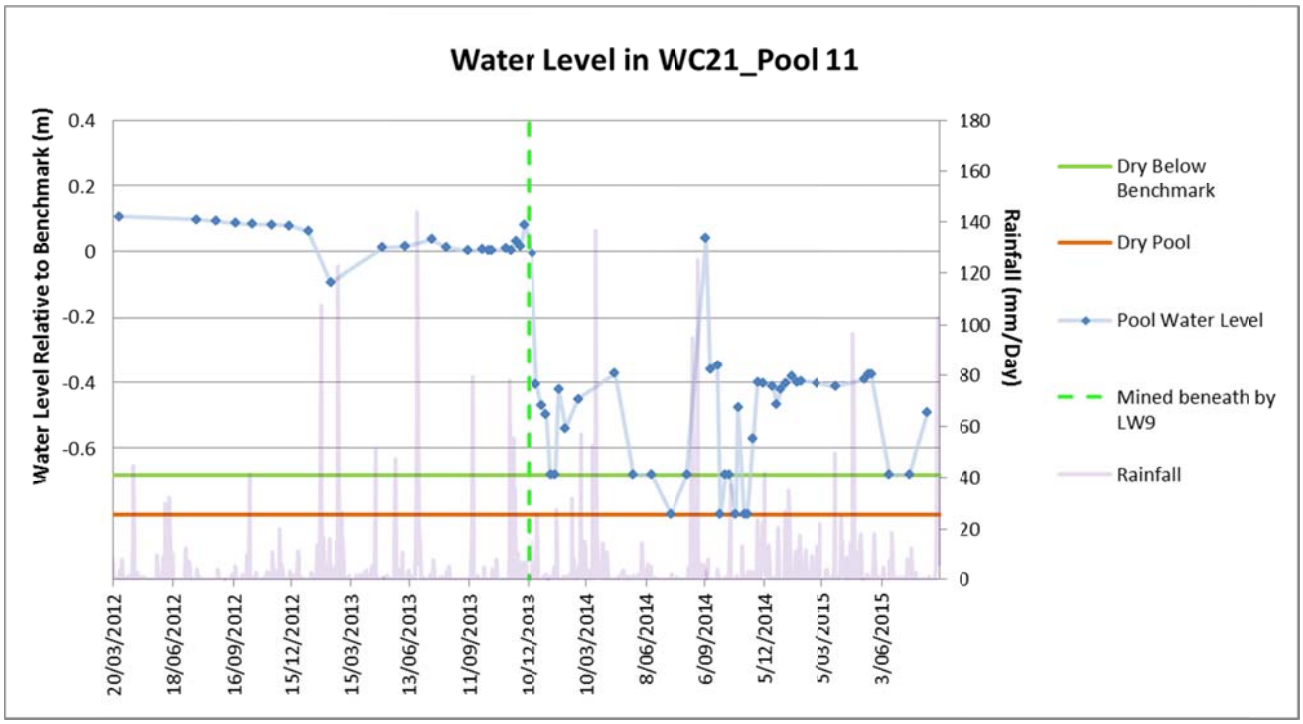
Baseline description: This section of the tributary consists of rockbar sections intersected with small pools.

Impacts to features:

Impact LW9_018- hairline fracture and dilation of jointing on Rockbar 12 (**Figure 4-5**) and an absence of surface flow observed (**Photo 64**).

No other surface impacts have been observed throughout this section of the tributary. There is an absence of surface flow across the majority of this section of WC21. It continues to hold surface water in sections following rainfall (**Photo 65** to **Photo 72**). **Graph 13** shows WC21_Pool 11, which has been dry on various occasions following extraction of Longwall 9.

Recommendation: Visible fracturing is negligible in size and influence to surface flow across this section of tributary, making any initial remediation difficult. No remediation of this pool is proposed due to the small size of Pool 11 and re-emergence of flow directly downstream.



Graph 13: Water level recorded at WC21_Pool 11 throughout the monitoring period.

4.4.22 WC21_Pool 10

Pool 10 overlies the northern edge of Longwall 9.

Baseline description: Pool is 35m long, 10m wide and up to 1.5m deep. Pool is often intersected by accumulation of sand during different flow conditions.

Impacts to features:
Impact LW9_027- small rockfall to overhang directly to the west of Pool 10 (**Photo 75**).
Impact LW9_028- small rockfall to overhang directly to the east of Pool 10 (**Photo 76**).
Impact LW9_019- iron staining originating from subsurface outflow upstream from Pool 10.

Iron staining is shown in **Photo 73**. While pool water level has dropped below baseline during periods of low rainfall this is likely a result of reduced inflows from the impacted section of WC21. The pool water level does not appear to be directly impacted by mining (**Graph 14**).

Recommendation: No remediation is proposed at this site. It is recommended that the site be monitored during the implementation of upstream remediation and an assessment be made of any resulting changes at this pool.

Photo 64: Impact LW9_018, looking across stream. Taken on 24/12/2013.

Photo 65: WC21_Pool 14, looking upstream. Taken on 10/09/2015.

Photo 66: WC21_Pool 14, looking downstream. Taken on 10/09/2015.

Photo 67: WC21_Pool 13, looking upstream. Taken on 10/09/2015.

Photo 68: WC21_Pool 13, looking downstream. Taken on 10/09/2015.

Photo 69: WC21_Pool 12, looking upstream. Taken on 10/09/2015.

Photo 70: WC21_Pool 12, looking downstream. Taken on 10/09/2015.

Photo 71: WC21_Pool 11, looking upstream. Taken on 10/09/2015.

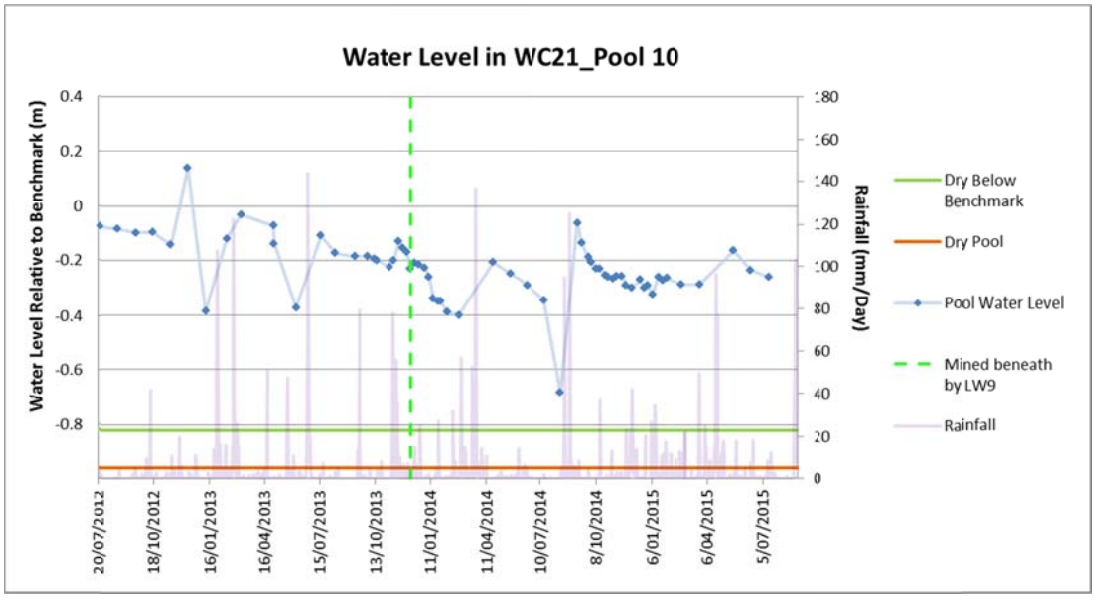
Photo 72: WC21_Pool 11, looking upstream. Taken on 10/09/2015.

Photo 73: WC21_Pool 10, looking upstream. Taken on 10/09/2015.

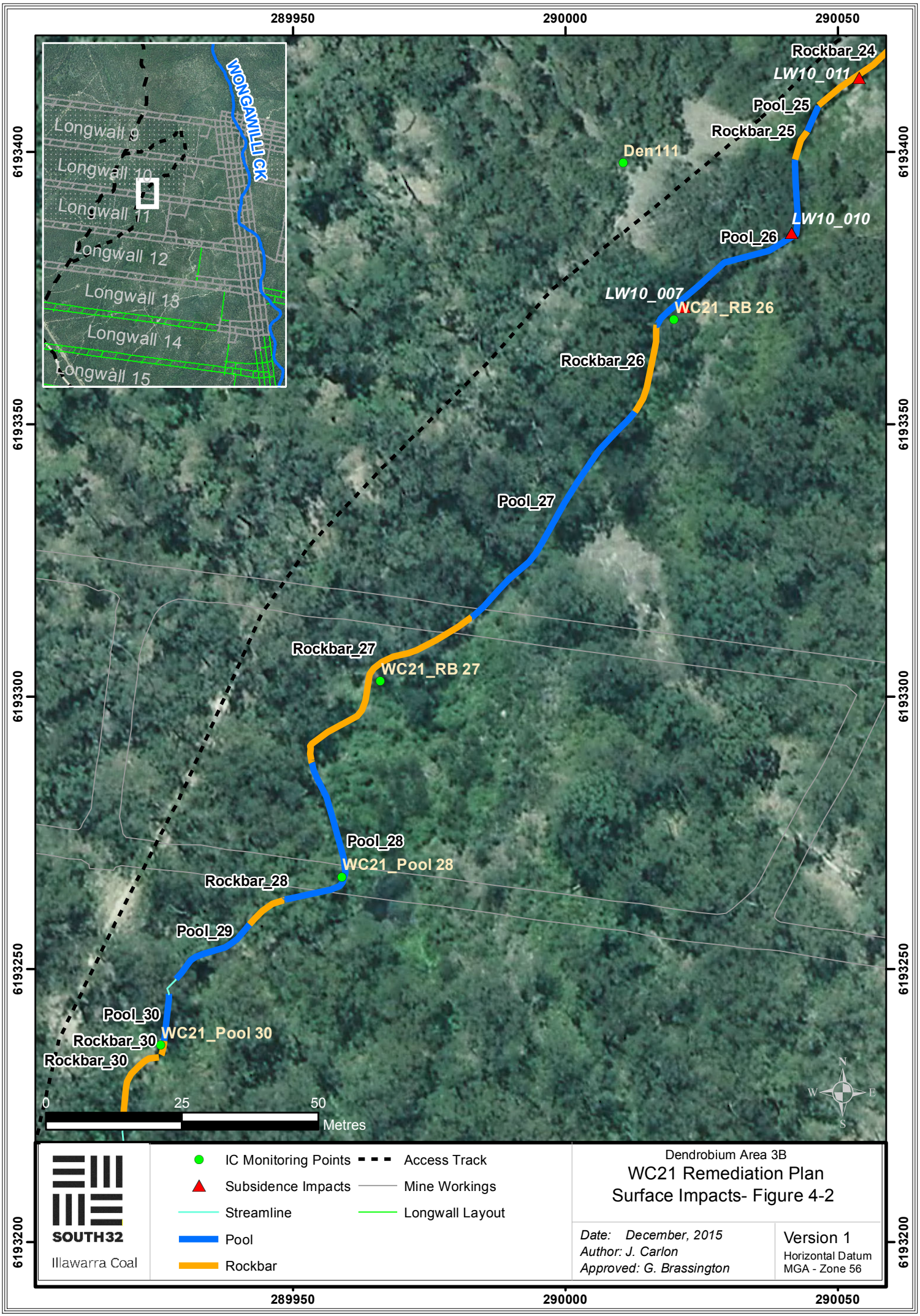
Photo 74: WC21_Pool 10, looking across stream. Taken on 10/09/2015.

Photo 75: Impact LW9_027, small rockfall adjacent to Pool 10. Taken on 28/01/2014.

Photo 76: Impact LW9_028, small rockfall to overhang adjacent to Pool 10. Taken on 17/03/2014.



Graph 14: Water level recorded at WC21_Pool 10 throughout the monitoring period.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Longwall 13
Longwall 14
Longwall 15
Rockbar_24
LW10_011
Pool_25
Rockbar_25
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LW10_010
Pool_26
LW10_007
WC21_RB 26
Rockbar_26
Pool_27
Rockbar_27
WC21_RB 27
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WC21_Pool 28
Rockbar_28
Pool_29
Pool_30
WC21_Pool 30
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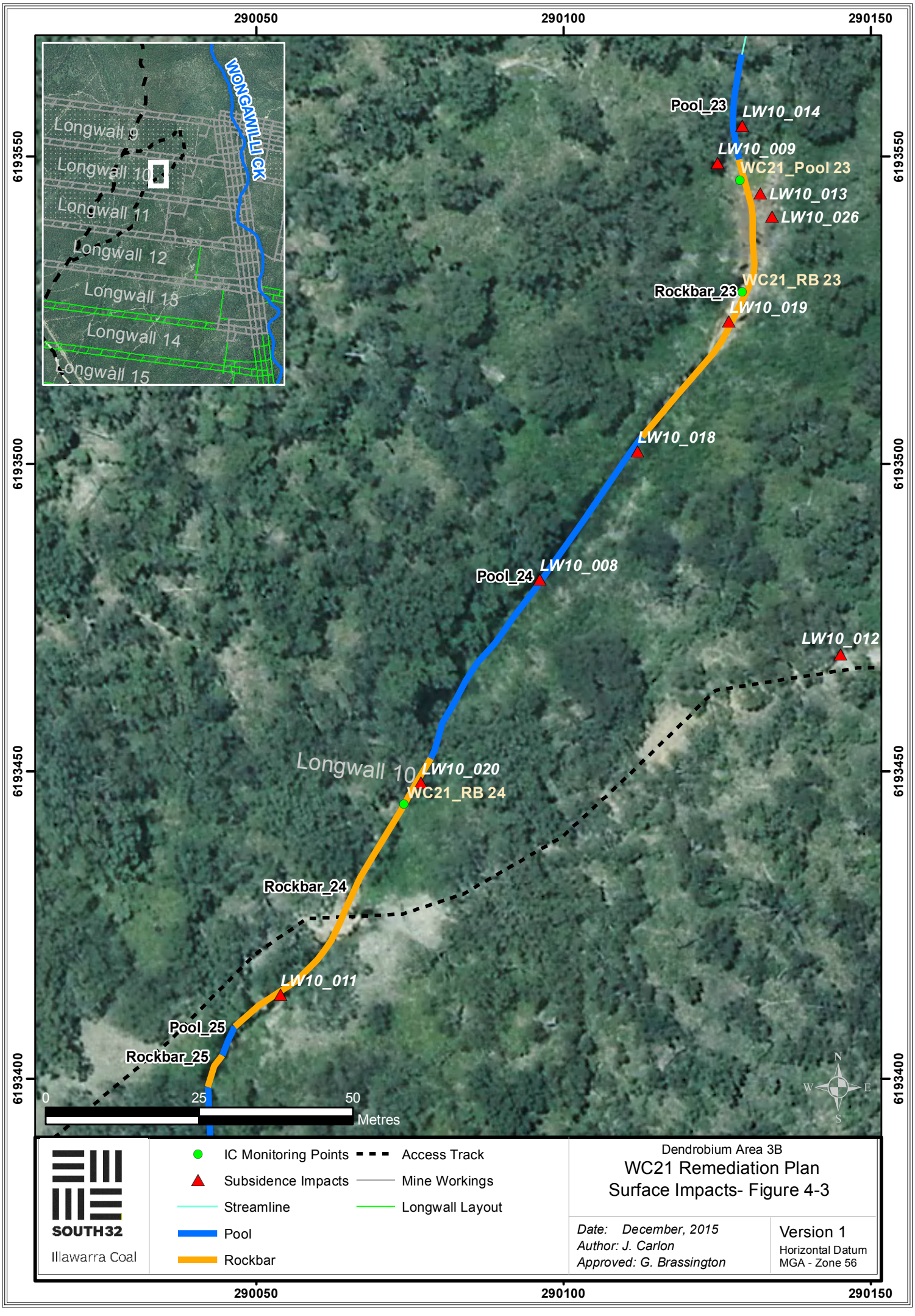
SOUTH32
Illawarra Coal
IC Monitoring Points
Subsidence Impacts
Streamline
Pool
Rockbar
Access Track
Mine Workings
Longwall Layout
Dendrobium Area 3B
WC21 Remediation Plan
Surface Impacts- Figure 4-2
Date: December, 2015
Author: J. Carlon
Approved: G. Brassington
Version 1
Horizontal Datum
MGA - Zone 56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Longwall 14
Longwall 15
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LW10_014
LW10_009
WC21_Pool 23
LW10_013
LW10_026
WC21_RB 23
Rockbar_23
LW10_019
LW10_018
Pool_24
LW10_008
LW10_012
Longwall 10
LW10_020
WC21_RB 24
Rockbar_24
LW10_011
Pool_25
Rockbar_25
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IC Monitoring Points
Subsidence Impacts
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Longwall Layout
Dendrobium Area 3B
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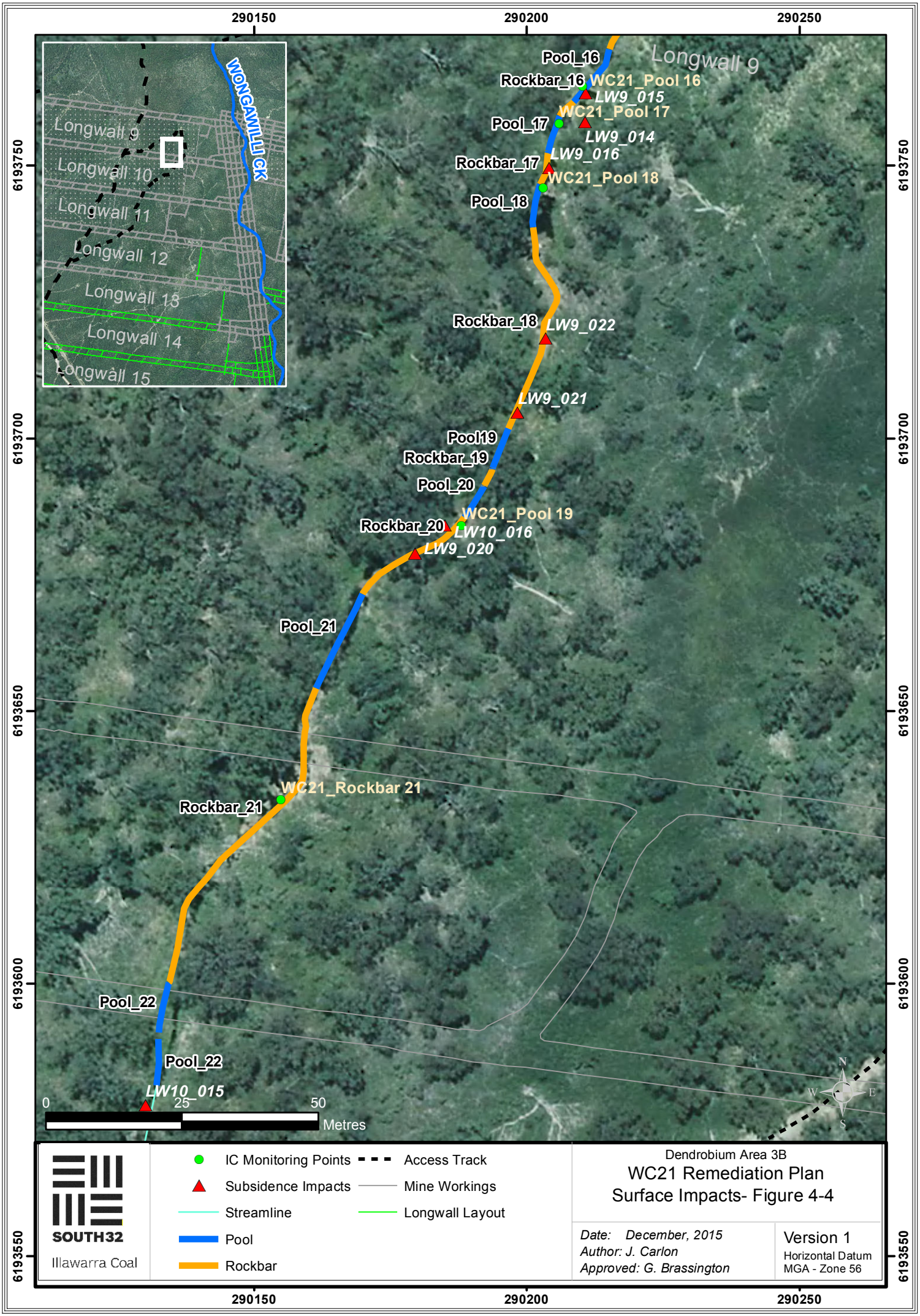
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Longwall 11
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Longwall 13
Longwall 14
Longwall 15
Longwall 9
Pool_16
Rockbar_16
WC21_Pool 16
LW9_015
WC21_Pool 17
Pool_17
LW9_014
LW9_016
Rockbar_17
WC21_Pool 18
Pool_18
Rockbar_18
LW9_022
LW9_021
Pool19
Rockbar_19
Pool_20
WC21_Pool 19
Rockbar_20
LW10_016
LW9_020
Pool_21
WC21_Rockbar 21
Rockbar_21
Pool_22
Pool_22
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Illawarra Coal
IC Monitoring Points
Subsidence Impacts
Streamline
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Rockbar
Access Track
Mine Workings
Longwall Layout
Dendrobium Area 3B
WC21 Remediation Plan
Surface Impacts- Figure 4-4
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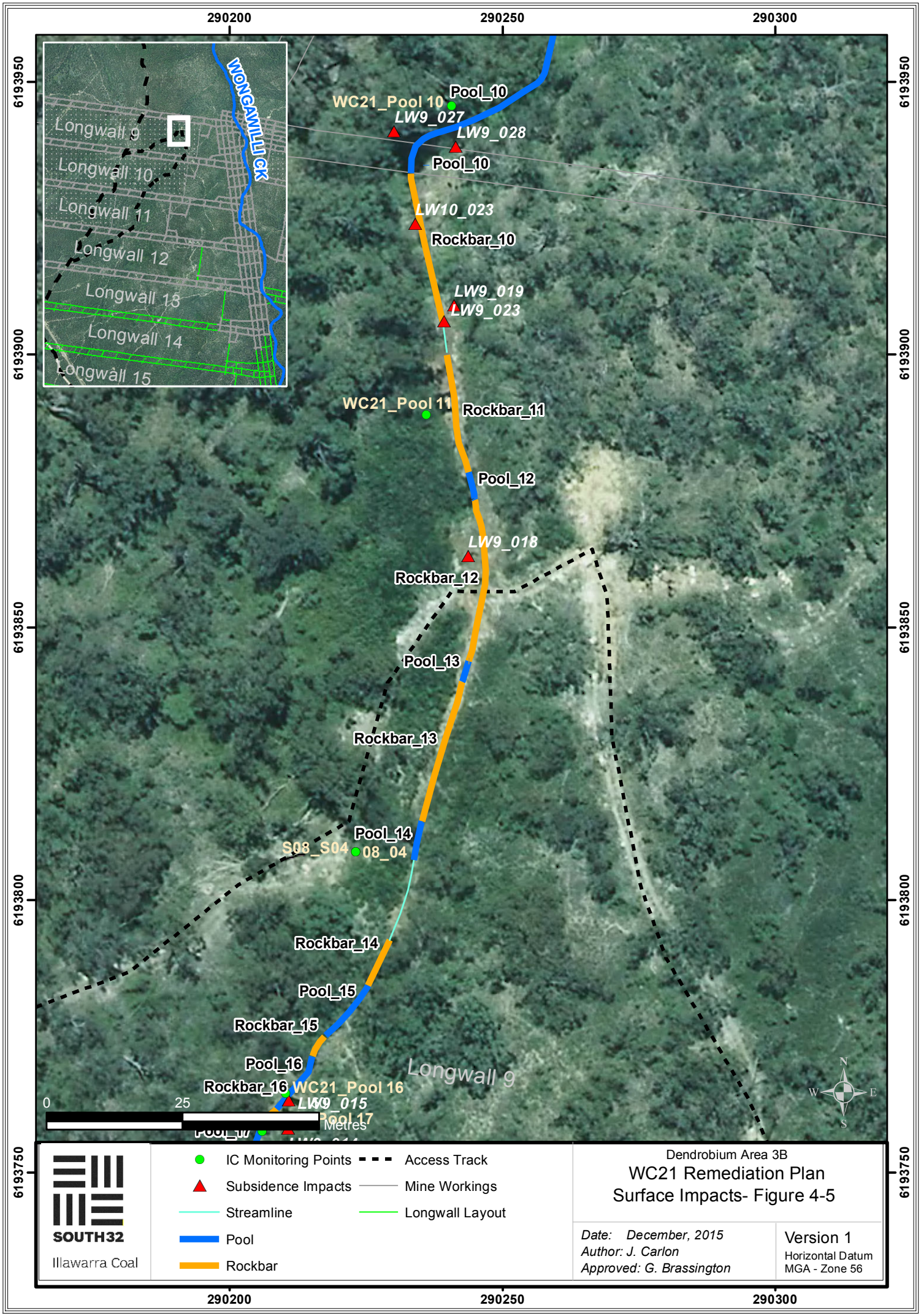
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Longwall 13
Longwall 14
Longwall 15
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LW9_027
LW9_028
Pool_10
LW10_023
Rockbar_10
LW9_019
LW9_023
WC21_Pool 11
Rockbar_11
Pool_12
LW9_018
Rockbar_12
Pool_13
Rockbar_13
Pool_14
S08_S04
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Rockbar_14
Pool_15
Rockbar_15
Pool_16
Rockbar_16
WC21_Pool 16
LW9_015
Pool_17
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IC Monitoring Points
Subsidence Impacts
Streamline
Pool
Rockbar
Access Track
Mine Workings
Longwall Layout
SOUTH32
Illawarra Coal
Dendrobium Area 3B
WC21 Remediation Plan
Surface Impacts- Figure 4-5
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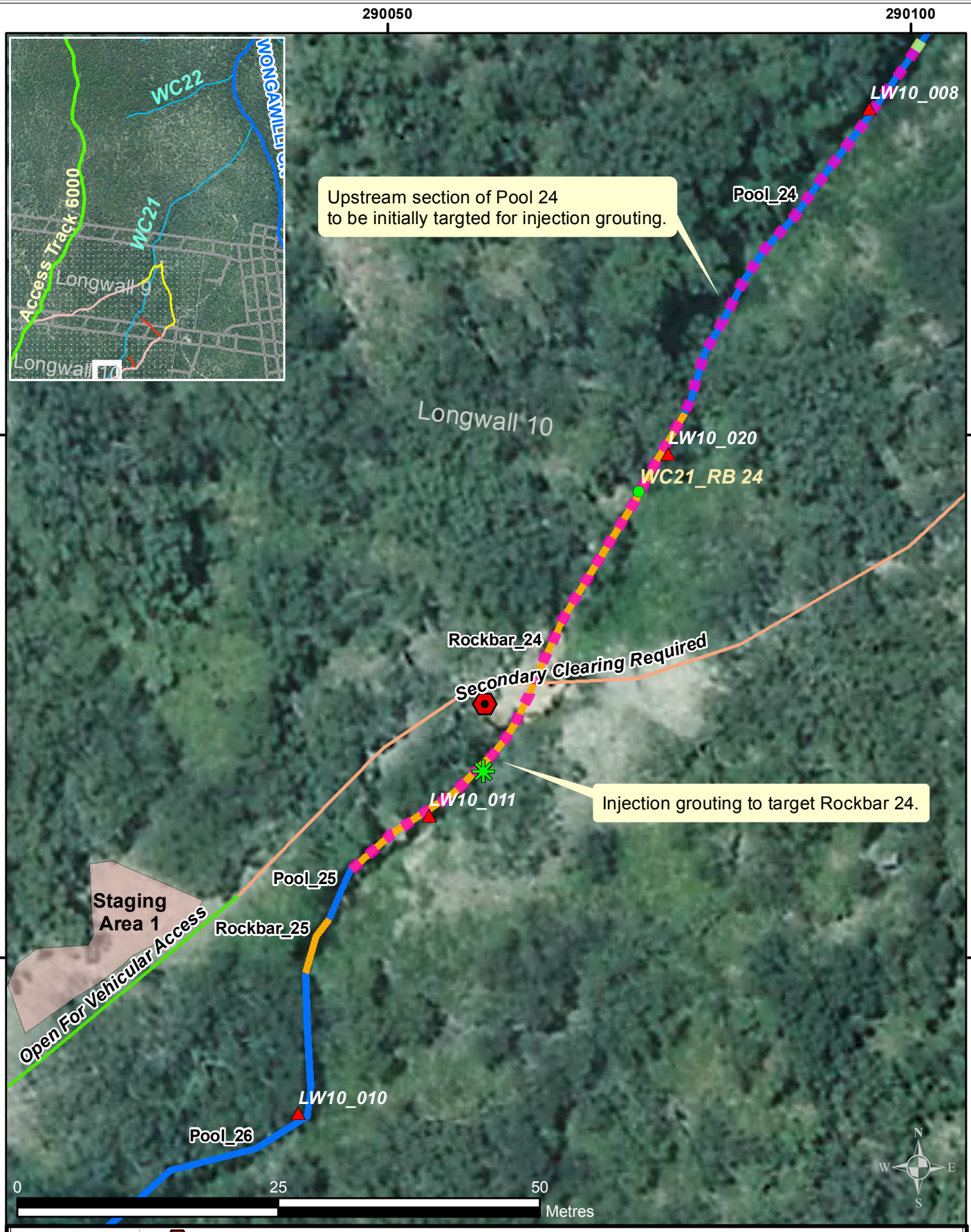
Horizontal Datum
MGA - Zone 56



SOUTH32
Illawarra Coal

- Location of Drill Rig
- Tracer Dye Injection
- Subsidence Impacts
- IC Monitoring Points
- Existing Walking Access
- Open For Vehicular Access
- Primary Clearing Required
- Secondary Clearing Required
- Streamline
- Pool
- Rockbar
- Stage 1 Remediation
- Targeted Remediation Following Reassessment

Dendrobium Area 3B

WC21 Remediation Plan

Remediation- Figure 4-6

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Horizontal Datum
MGA - Zone 56


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Pool_23
Injection grouting to target Pool 23.
LW10_014
LW10_009
WC21_Pool 23
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WC21_RB 23
Rockbar_23
LW10_019
Staging Area 2
LW10_018
Pool_24
LW10_008
LW10_012
Primary Clearing Required
Secondary Clearing Required
WC22
WONGAWILLI CR
WC21
Access Track 6000
Longwall 9
Longwall 10
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Location of Drill Rig
Subsidence Impacts
IC Monitoring Points
Existing Walking Access
Open For Vehicular Access
Primary Clearing Required
Secondary Clearing Required
Streamline
Pool
Rockbar
Stage 1 Remediation
Targeted Remediation Following Reassessment
SOUTH32
Illawarra Coal
Dendrobium Area 3B
WC21 Remediation Plan
Remediation- Figure 4-7
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Horizontal Datum
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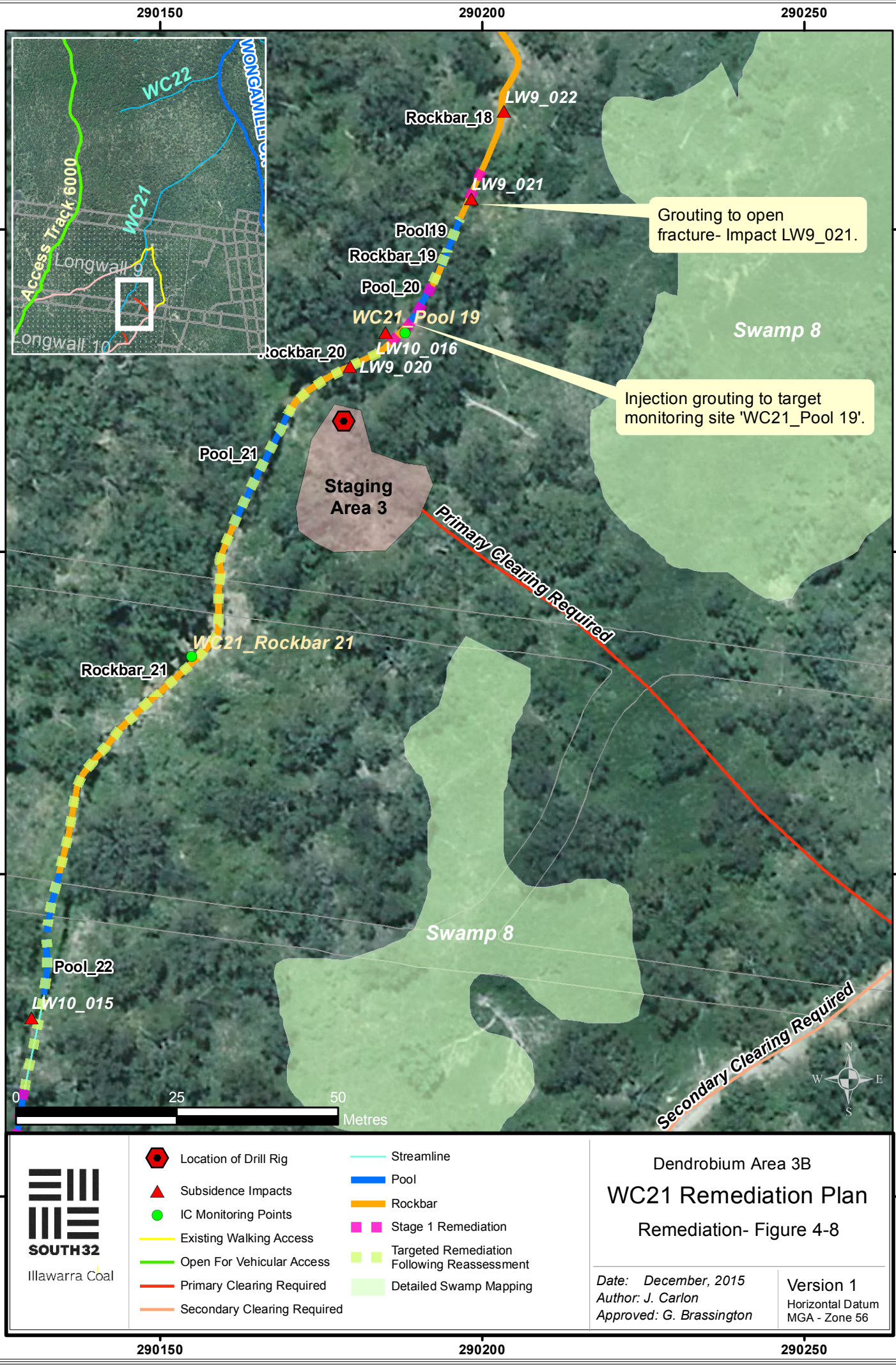
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WONGAWILLI CR
Access Track 6000
WC21
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Longwall 10
LW9_022
Rockbar_18
LW9_021
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Pool19
Rockbar_19
Pool_20
WC21_Pool 19
LW10_016
Rockbar_20
LW9_020
Swamp 8
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Staging Area 3
Primary Clearing Required
WC21_Rockbar 21
Rockbar_21
Swamp 8
Pool_22
LW10_015
Secondary Clearing Required
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SOUTH32
Illawarra Coal
Location of Drill Rig
Subsidence Impacts
IC Monitoring Points
Existing Walking Access
Open For Vehicular Access
Primary Clearing Required
Secondary Clearing Required
Streamline
Pool
Rockbar
Stage 1 Remediation
Targeted Remediation Following Reassessment
Detailed Swamp Mapping
Dendrobium Area 3B
WC21 Remediation Plan
Remediation- Figure 4-8
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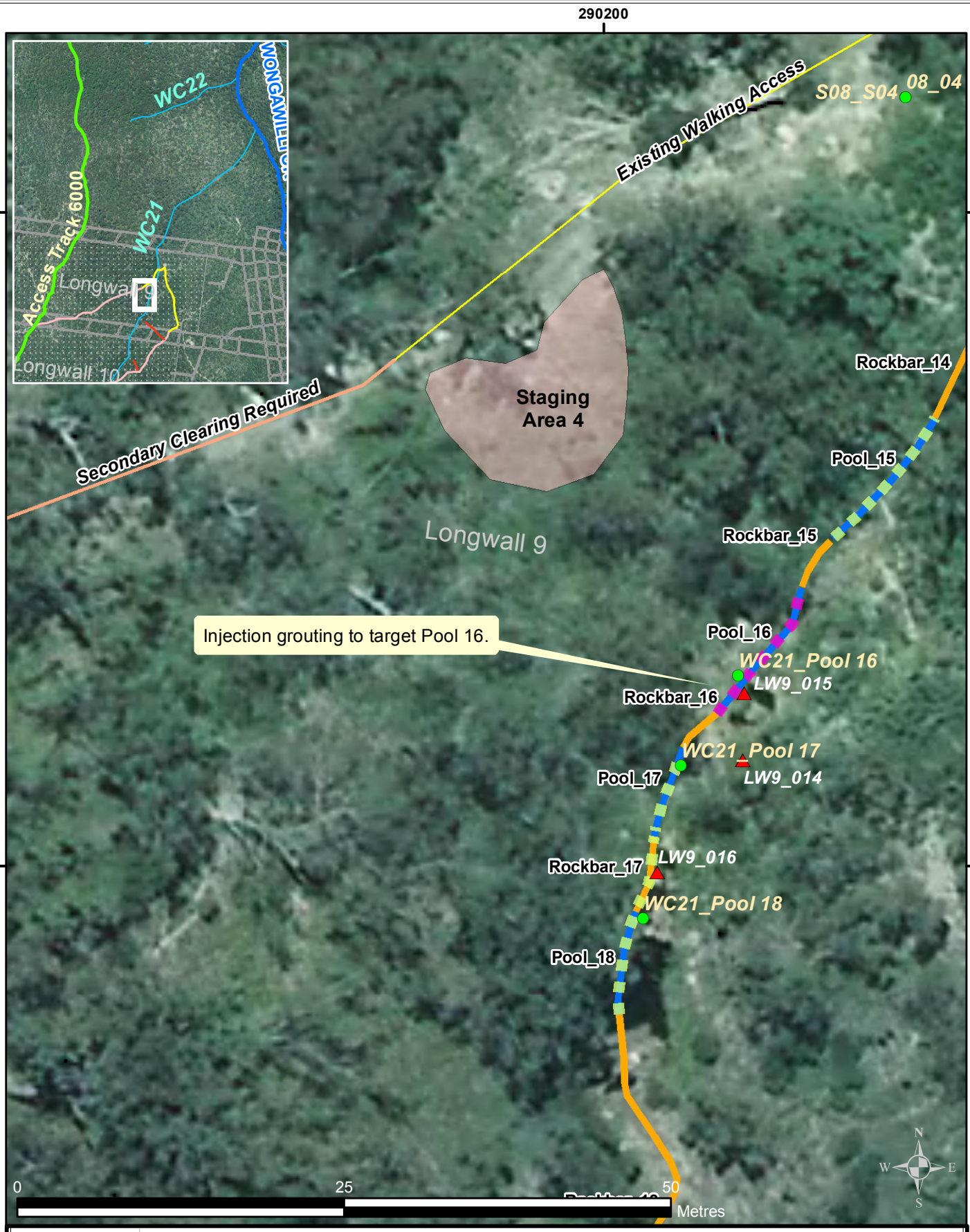
Version 1
Horizontal Datum
MGA - Zone 56



SOUTH32
Illawarra Coal

- Subsidence Impacts
- IC Monitoring Points
- Existing Walking Access
- Open For Vehicular Access
- Primary Clearing Required
- Secondary Clearing Required
- Streamline
- Pool
- Rockbar
- Stage 1 Remediation
- Targeted Remediation Following Reassessment

Dendrobium Area 3B

WC21 Remediation Plan

Remediation- Figure 4-9

Date: December, 2015
Author: J. Carlon
Approved: G. Brassington

Version 1
Horizontal Datum
MGA - Zone 56

4.5 ENVIRONMENTAL CONTROLS

Safety of the Rehabilitation Team, the community and personnel using the area will be the primary consideration in all aspects of the rehabilitation. The Program is within the Water NSW Catchment Area and all access will be subject to the strict access controls implemented by Water NSW. All persons accessing the site will be inducted, including all requirements for the safety of people and the site.

Rehabilitation activities will ensure that the areas are left stable without risk of increased erosion in the future. To this end, disturbance during rehabilitation will be kept to a minimum, and where disturbance is unavoidable, stabilisation of the surface will occur following the completion of the works.

The aesthetics of the area is a consideration in the rehabilitation activities. The intended results of the remediation activities are to leave the area as natural as possible, and limit activities that will have permanent unnatural visual impacts in the landscape.

During rehabilitation activities, impacts on native flora and fauna will be avoided or minimised wherever feasible. The amount of vegetation disturbance required by the Program will be of a size that revegetation of the disturbed area would occur naturally from adjacent native vegetation. Monitoring of the areas will occur and should it be necessary, actions will be taken to ensure that before the area is no longer monitored, the flora and fauna habitat will be in a similar state to that in the area prior to mining.

Potential impacts on water quality as a result of the works include sedimentation and the possibility of release of materials brought onto site. These could include fuel, lubricants, grout and domestic waste. Safeguards would be put in place to control these potential impacts.

Temporary sediment controls (e.g. sand bags, filter fabric) will be installed where appropriate to intercept sediment movement that may occur during the works and for a period after completion. Erosion and sediment control works will be designed and installed in accordance with applicable erosion and sediment control principles and guidelines (e.g. the requirements of the NSW Blue Book “Managing Urban Stormwater – Soil and Conservation”).

These controls would be maintained as required by removing any excessive build-up of sediment and repairing any failure of the structures e.g. due to storm activity. Sediment fencing and/or sandbags and coir logs would be proposed for the sediment controls.

Fuels and lubricants will be kept in self-contained vessels or appropriately bunded. Volumes of material on site will be limited to that to be used for day to day operations. Emergency spill response equipment would be located appropriately at the work sites.

Consumables and rubbish would be removed from work sites daily. Fully maintained chemical toilets would be made available for the work crews for the duration of the Program.

The rehabilitation area is remote from sensitive receivers and noise would not be expected to be an issue. Operations would only be conducted during daylight hours.

The rehabilitation techniques proposed would not generate dust. Dust generated on access tracks and Fire Roads will be controlled using standard road maintenance techniques and via reduced speed limits.

Specific monitoring strategies to reduce potential for release of grout material will include:

- Implement an ‘inject and confirm’ approach. Once grouting is complete in one section of WC21, a small section will be tested to confirm its effectiveness, before moving off-site. Each section will be allowed to fill with water to see if the treatment has been effective. In this way a feedback loop would be established;
- Water monitoring will be undertaken to ensure quality is maintained; and
- Measure the injection pressure and volumes at the hole so that the potential for hydraulic fracturing (and therefore wastage of grout product) can be assessed.

Once remediation activities are completed in the vicinity of the river, all equipment and materials used in the works will be removed. Routine monitoring would continue as described in the WIMMCP.

4.6 ENVIRONMENTAL OFFSETS

Subject to Condition 14 of Schedule 3 of the Development Consent:

> The Applicant shall provide suitable offsets for loss of water quality or loss of water flows to Water NSW storages, clearing and other ground disturbance (including cliff falls) caused by its mining operations and/or surface activities within the mining area, unless otherwise addressed by the conditions of this consent, to the satisfaction of the Secretary. These offsets must:
>
> (a) be submitted to the Secretary for approval by 30 April 2009;
>
> (b) be prepared in consultation with Water NSW;
>
> (c) provide measures that result in a beneficial effect on water quality, water quantity, aquatic ecosystems and/or ecological integrity of Water NSW's Special Areas or water catchments.

It has been agreed to transfer 33ha of land adjacent to the Cataract River to Water NSW to meet the above condition.

A biodiversity offset strategy has been developed in consultation with OEH and Water NSW for the approval of the Secretary of DoPE. The strategy proposes a process whereby suitable residual environmental offset can be provided where the actual impacts on watercourses exceed those predicted in the SMP.

4.7 RESEARCH

To assist in further understanding the impacts of subsidence and rehabilitation IC will undertake research. The research will be directed to improving the prediction, assessment, remediation and/or avoidance of subsidence impacts and environmental consequences. The knowledge and techniques developed through implementing rehabilitation at WC21 will assist with this research.

5 PROGRAM ADMINISTRATION

The WC21 Rehabilitation Program will be administered in accordance with the requirements of the Dendrobium WIMMCP, Environmental Management System (EMS) and the Dendrobium Area 3 Approval Conditions.

5.1 INCIDENTS AND NON-CONFORMANCES

IC will notify DoPE and other relevant agencies of any incident associated with the rehabilitation of WC21 as soon as practicable after IC becomes aware of the incident. IC will provide DoPE and relevant agencies with a report on the incident within seven days of confirmation of any event.

IC will:

- Provide a readily accessible contact point through a 24 hour toll-free Community Call Line (1800 102 210). The number will be displayed at the WC 21 work site.
- Respond to complaints in accordance with the IC Community Complaints and Enquiry Procedure.
- Maintain good communication lines between the community and IC. The rehabilitation activities within WC21 will be discussed with the Dendrobium Community Consultative committee (DCCC).

- Keep a register of any complaints.

The requirement to comply with all approvals, plans and procedures is the responsibility of all personnel (staff and contractors) employed on or in association with Dendrobium Area 3 operations, including the WC21 rehabilitation program.

Non-conformances, corrective actions and preventative actions are managed in accordance with the IC *Non-Conformance, Preventative and Corrective Action Procedure (ICHP0107)*. This procedure details the processes to be utilised with respect to the identification of non-conformances, the application of appropriate corrective action(s) to address non-conformances and the establishment of preventative actions to avoid non-conformances.

5.2 ROLES AND RESPONSIBILITIES

The overall responsibility for the implementation of the WC21 Rehabilitation Program resides with the Manager Approvals. Specific responsibilities for implementation of the WC21 Rehabilitation program include:

General Manager Energy and Engineering

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

Manager Approvals

- Authorise the Program and any amendments and to document any approved changes.
- Provide regular updates to IC and other stakeholders.
- Prepare any report and maintain records.
- Organise and participate in review meetings.
- Respond to any queries or complaints.
- Address any identified non-conformances, assess improvement ideas and implement if considered appropriate.
- Arrange implementation of any agreed actions, responses or remedial measures.
- Ensure monitoring and analysis is conducted.

Program Coordinator

- Implement the Program as described in this document.
- Instruct suitable person(s) in the required standards and be satisfied that these standards are maintained.
- Investigate any additional impacts that may result from the rehabilitation of WC21.
- Identify and report any non-conformances.
- Participate in assessment and review meetings.

Environmental Field Team Coordinator

- Implement the monitoring, assessment and reporting requirements of the WIMMCP.
- Instruct suitable person(s) in the required standards for inspections, recording and reporting and be satisfied that these standards are maintained.
- Identify and report any non-conformances.
- Participate in assessment and review meetings.

Survey Coordinator

- Collate survey data and present in an acceptable form for review at assessment meetings.

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.

Person(s) Performing Inspections

- Conduct inspections in a safe manner.

5.3 RESOURCES REQUIRED

The General Manager Energy and Engineering provides resources sufficient to implement the WC21 Rehabilitation Program.

Equipment will be needed for the implementation of the Program. Where this equipment is of a specialised nature, it will be provided by the supplier of the relevant service. All equipment will be appropriately maintained, calibrated and serviced as required in operations manuals.

The Manager Approvals shall ensure personnel and equipment are provided as required to allow the Program to be implemented.

5.4 TRAINING

All staff and contractors working on IC sites, including the WC21 Rehabilitation Program, are required to complete the IC training program which includes:

- An initial site induction (including all relevant aspects of environment, health, safety and community).
- Safe Work Method Statements and Job Safety Analyses, Toolbox Talks and pre-shift communications.
- On-going job specific training and re-training (where required).

All training records are maintained by the IC Safety and Training Department (STAX database system), which can be accessed by IC staff via the online information system iPick.

It is the responsibility of the Manager Approvals to ensure that all persons and organisations having responsibilities under this Program are trained and understand their responsibilities.

The persons implementing the Program will be under the supervision of the WC21 Rehabilitation Program Coordinator and be trained in the requirements of this Program. The Program Coordinator shall be satisfied that the persons performing the works are capable of meeting and maintaining the standards required by this Program.

The person(s) performing regular inspections shall be under the supervision of the Environmental Field Team Coordinator and be trained in observation, measurement and reporting. The Environmental Field Team Coordinator shall be satisfied that the person(s) performing the inspections are capable of meeting and maintaining this standard.

5.5 RECORD KEEPING AND CONTROL

Environmental Records are maintained in accordance with the IC procedure *Records Management (ICHP0108)*. The IC *Document Control Procedure (ICHP0103)* outlines the method for control of defined 'business critical' documentation for all IC operations, including the WC21 Rehabilitation Program.

Program operations and implementation will be reviewed on a monthly basis by the IC Subsidence Review Committee. The WC21 Rehabilitation Program Steering Committee will

review overall success against the aims and objectives of the Program. These reviews include involvement from senior management and other key personnel.

If deficiencies in the Program are identified it will be modified, with agreement of relevant Government Agencies.

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Attachment 1 – TARP

Table 1.1 – Dendrobium Area 3 Watercourse Monitoring

Watercourses monitoring within Dendrobium Area 3B will be installed ahead of mining to achieve 2 years baseline data (subject to timing and approval timeframes of any request to install additional monitoring). Monitoring is generally conducted through the mining period and for 2 years following active subsidence. Where impacts are observed the monitoring period will be reviewed and this review will be reported in Impact Assessment Reports and End of Panel Reports. For Level 2 and 3 Triggers and for impacts exceeding prediction this review is conducted in consultation with key stakeholders. The location of monitoring sites is indicated on Figures 2-1 to 2-57.

	MONITORING SITE	SITE TYPE	MONITORING FREQUENCY	PARAMETERS
OBSERVATIONAL, PHOTO POINT AND WATER MONITORING				
AREA 3A	Sandy Creek and tributaries (including SC7 and SC10) *Refer to Figure 2-1*	Observation and photo point monitoring: • Sites based on an assessment of risk • Streams and swamps • Pools and rockbars • Previously observed impacts that warrant follow-up inspection	• Monthly 2 years pre and post mining, weekly when longwall is within 400m of monitoring site • Reference sites 6 monthly	Visual signs of impacts to creeks and drainage lines (i.e. cracking, vegetation changes, increased erosion, changes in water colour, soil moisture etc.) determined by comparing baseline photos with photos during the mining period Key water quality parameters in pools analysed to identify any changes resulting from mining Pool water levels to identify any changes resulting from mining
AREA 3B	**Impact Sites:** • Native Dog, Wongawilli and Donalds Castle Creeks, WC21, WC15, LA4, DC13, LA5, ND1, WC6, WC7, WC8, WC9, WC12, WC16 and WC18 • Swamps 5, 10, 11, 13, 14, 23, 35a, 35b, 1a, 1b, 8, 3 and 4 *Refer to Figures 2-2 to 2-11 and 2-25 to 2-32* **Reference Sites:** • Wongawilli Creek, Sandy Creek, LC7B, WC11, SC9A, SC10A, NDC1, DC10 and D10 •Swamps 2, 7, 15a, 22, 24, 25, 33, 84, 85, 86, 87 and 88 *Refer to Figures 2-12 to 2-25, 2-28 to 2-30 and 2-33 to 2-35*			
WATER QUALITY				
AREA 3A	**Wongawilli Creek** WWU1, WWU4, WC_Pool 46, WWM2, WC_Pool 43b and Wongawilli Ck (FR6) **Sandy Creek** SCk_Rockbar 5 (Sandy Creek adjacent to LW7) *Refer to Figure 2-1*	• Grab sample • Field water quality	• Monthly monitoring pre, during and post mining for two years	Manual Field Testing: • Field pH, Temp, EC, DO and ORP • Lab. analytes (incl. lab check of pH, lab. check of EC, DOC, Na, K, Ca, Mg, Filt. SO4, Cl, T. Alk., Total Fe, Mn, Al, Filt. Cu, Ni, Zn, Si)

AREA 3B	**Wongawilli Creek** WWU1 (Wongawilli Creek headwaters) WWU4 (Wongawilli Creek upstream) WC Pool 49 (Wongawilli Creek adjacent to LW15) WC_Pool 46 (Wongawilli Creek adjacent to LW12) WWM2 (Wongawilli Creek adjacent to LW11) WC_Pool 43b (Wongawilli Creek downstream of LW9) Wongawilli Ck (FR6) (Wongawilli Creek downstream) WC21_Pool 5 (Wongawilli Creek tributary downstream of mining) WC21 Pools 30 and 53 (Wongawilli Creek tributaries over mining) WC15_Pool 9 (Wongawilli Creek tributary downstream of mining) **Lake Avon** LA4_S1, LA4_S2, LA5_S1, LA5_S2, LA3 Pool 4, LA2 Pool 5 and LA_1 (Lake Avon tributaries downstream of mining) NDC4 (Native Dog Creek downstream of mining) NDC1 (Native Dog Creek upstream of Area 3B) **Donalds Castle Creek** Donalds Castle Ck (FR6) (Donalds Castle Creek lower) DCL3 (Donalds Castle Creek @ Cordeaux River) DC_Pool 22 (Donalds Castle Creek downstream of mining) DC13_Pool 2b (Donalds Castle Creek tributary downstream of mining) *Refer to Figure 2-35*			

WATER FLOW				
AREA 3A	**Wongawilli Creek** WWU (Wongawilli Creek upstream) WWL (Wongawilli Creek downstream) **Sandy Creek** SCL2(Sandy Creek at downstream) SC10S1 and SC10CS1 (Sandy Creek tributary) *Refer to Figures 2-35 and 2-36*	• Pressure transducer with data logger	• Continuous 1 hour logging intervals	Automatic pool water level measurements which are converted to flows by calculation of rating curves using measured creek cross sections/measured flows at the monitoring point
AREA 3B	**Wongawilli Creek** WWU (Wongawilli Creek upstream) WWL (Wongawilli Creek downstream) WC21S1 (Wongawilli Creek tributary downstream of mining) WC15S1 (Wongawilli Creek tributary downstream of mining) **Donalds Castle Creek** DCU (Donalds Castle Creek @ FR6) DC13S1 (Donalds Castle Creek tributary downstream of mining) DCS2 (Donalds Castle Creek downstream of mining) **Lake Avon** LA4S1 (Lake Avon tributary downstream of mining) *Refer to Figures 2-35 and 2-36*			
AQUATIC ECOLOGY				
AREA 3A	Sandy Creek Catchment: Sites 8, 9, 10, 11, 12 and 13 *Refer to Figure 2-57*	• Quantitative and observational monitoring	• Two baseline monitoring campaigns prior to mining during autumn and spring • Monitoring during mining in autumn and spring • Monitoring post mining for two years or as otherwise required • Monitoring targets sites as mining progresses through the domain	Macroinvertebrate sampling and assessment using the AUSRIVAS protocol and quantitative sampling using artificial collectors In consideration of Adams Emerald Dragonfly and Sydney Hawk Dragonfly, individuals of the genus Austrocorduliidae and Gomphomacromiidae are identified to species level if possible Fish are sampled by visual observations and dip netting in Area 3A, and sampled using a back-pack electrofisher and baited traps in Area 3B
AREA 3B	**Impact Sites:** Sites 2, 3, 4, X4, X5 and X6 (Wongawilli Creek) Sites X2 and X3 (WC21) Site X1 (Donalds Castle Creek) **Reference Sites:** Site 1 (Wongawilli Creek – until LW15) Site 5 (Wongawilli Creek) Site 14 (Donalds Castle Creek)			

	Site 6 (WC21) Site 7 (Sandy Creek) Sites 15 and 16 (Kentish Creek) *Refer to Figure 2-57*			
TERRESTRIAL FAUNA – THREATENED FROG SPECIES				
AREA 3B	**Impact Sites:** DC13 (Donalds Castle Creek tributary) DC(1) (Donalds Castle Creek) WC15 and 21 (Wongawilli Creek tributaries) LA4A (Lake Avon tributary) ND1 (Native Dog Creek tributary) *Refer to Figures 2-42 to 2-47* **Reference Sites:** WC10 and 11 (Wongawilli Creek tributaries) SC6, SC7-1, SC7-2, SC7A and SC8 (Sandy Creek tributaries) DC8 (Donalds Castle Creek tributary) NDC (Native Dog Creek) *Refer to Figures 2-48 to 2-56*	• Standardised transects in potential breeding habitat for two threatened frog species, Littlejohn's Tree Frog and Giant Burrowing Frog	• Surveys are undertaken in optimal periods over the season (i.e. when frogs are calling and/or active at known sites)	Frog surveys are conducted along creeks with a focus on features susceptible to impacts e.g. breeding pools. Potential breeding habitat for Littlejohn's Tree Frog and Giant Burrowing Frog will be targeted. Standardised transects have been established to record numbers of individuals recorded at each site from one year to the next. Tadpole counts will also be undertaken as part of the breeding habitat monitoring transects. These transects are surveyed by walking down the creekline and counting all amphibians seen or heard on either side of the line

Table 1.2 – Dendrobium Watercourse Impacts, Triggers and Response

Monitoring	Trigger	Action
OBSERVATIONAL, PHOTO POINT AND WATER MONITORING		
Native Dog, Wongawilli and Donalds Castle Creeks, WC21, WC15, LA4, DC13, LA5, ND1, WC6, WC7, WC8, WC9, WC12, WC16 and WC18 General observation of streams in active mining areas when longwall is within 400m Relevant Performance Measure(s): • Wongawilli Creek - minor environmental consequences • Donalds Castle Creek - minor environmental consequences • Waterfall WC-WF54 – negligible environmental consequences	***Level 1 **** • Crack or fracture up to 100mm width at its widest point with no observable loss of surface water or erosion • Crack or fracture up to 10m length with no observable loss of surface water or erosion • Erosion in a localised area (not associated with cracking or fracturing) which would be expected to naturally stabilise without CMA and within the period of monitoring • Observable release of strata gas at the surface • Observable increase in iron staining within the mining area	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion • Crack or fracture between 10 and 50m length • Soil surface crack that causes erosion that is likely to stabilise within the monitoring period without intervention • Observable increase in iron staining within the mining area continues to outside the mining area i.e. 400m from the longwall	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Crack or fracture over 300mm width at its widest point • Crack or fracture over 50m length • Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water • Soil surface crack that causes erosion that is unlikely to stabilise within the monitoring period without intervention • Gas release results in vegetation dieback, mortality or loss of aquatic habitat • Observable increase in iron staining within the mining area continues more than 600m from the longwall	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success • Review relevant TARP and Management Plan in consultation with key stakeholders
	Exceeding Prediction • Structural integrity of the bedrock base of any significant pool or controlling rockbar cannot be restored i.e. pool water level within the pool after CMAs continues to be lower than baseline period • Gas release results in vegetation dieback that does not	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the

Table 1.2 – Dendrobium Watercourse Impacts, Triggers and Response

Monitoring	Trigger	Action
	revegetate • Gas release results in mortality of threatened species or ongoing loss of aquatic habitat • Iron staining and associated increases in dissolved iron resulting from the mining is observed in water at Wongawilli Creek downstream monitoring site WONGAWILLI CK (FR6) • Iron staining and associated increases in dissolved iron resulting from the mining is observed in water at the Donalds Castle Creek downstream monitoring site Donalds Castle Ck (FR6) • Rock fall at WC-WF54 or its overhang • Impacts on the structural integrity of WC-WF54, its overhang or its pool	Development Consent
WATER QUALITY		
Wongawilli Creek Wongawilli Ck (FR6) Baseline means: • pH 5.98 • EC 98.8 uS/cm • DO 89.5% Relevant Performance Measure(s): • Wongawilli Creek - minor environmental consequences	***Level 1*** * • One exceedance of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Two exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Develop site CMA (subject to stakeholder feedback). This may include: – Limestone emplacement to raise pH where it is appropriate to do so – Grouting of fractures in rockbar and bedrock base of any significant pool where flow diversion results in pool water level lower than

Table 1.2 – Dendrobium Watercourse Impacts, Triggers and Response

Monitoring	Trigger	Action
		baseline period • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
	Exceeding Prediction • Mining results in two conecutive exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
Donalds Castle Creek Donalds Castle Ck (FR6) Baseline means: • pH 5.41 • EC 116.0 uS/cm • DO 85.6% Relevant Performance Measure(s): • Donalds Castle Creek - minor environmental consequences	***Level 1*** * • One exceedance of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Two exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Collect laboratory samples and analyse for: – pH, EC, major cations, major anions, Total Fe, Mn & Al – Filterable suite of metals • Develop site CMA (subject to stakeholder feedback). This may include:

Table 1.2 – Dendrobium Watercourse Impacts, Triggers and Response

Monitoring	Trigger	Action
		– Limestone emplacement to raise pH where it is appropriate to do so – Grouting of fractures in rockbar and bedrock base of any significant pool where flow diversion results in pool water level lower than baseline period • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
	Exceeding Prediction • Mining results in two conecutive exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
Lake Avon Lake Avon tributary (LA4_S1) Baseline means: • pH 5.38 • EC 90.8 uS/cm • DO 89.9% (24 months of baseline data available - to be updated with additional baseline data) Relevant Performance Measure(s): • Lake Avon - negligible reduction in the quality of surface water inflows to Lake Avon	***Level 1*** * • One exceedance of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Two exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Collect laboratory samples and analyse for: – pH, EC, major cations, major anions, Total Fe, Mn & Al

Table 1.2 – Dendrobium Watercourse Impacts, Triggers and Response

Monitoring	Trigger	Action
		– Filterable suite of metals • Develop site CMA (subject to stakeholder feedback). This may include: – Limestone emplacement to raise pH where it is appropriate to do so – Grouting of fractures in rockbar and bedrock base of any significant pool where flow diversion results in pool water level lower than baseline period • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
	Exceeding Prediction • Mining results in two conecutive exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean of the Lake Avon inflows during the monitoring period: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
POOL WATER LEVEL		
Mapped pools in the mining area: • Wongawilli Creek • Donalds Castle Creek Relevant Performance Measure(s): • Wongawilli Creek - minor environmental consequences • Donalds Castle Creek - minor environmental consequences	***Level 1*** * • Fracturing not resulting in diversion of flow	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Fracturing resulting in diversion of flow	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Fracturing resulting in diversion of flow such that <10% of the pools have water levels lower than baseline period	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders

Table 1.2 – Dendrobium Watercourse Impacts, Triggers and Response

Monitoring	Trigger	Action
		• Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
	Exceeding Prediction • Fracturing resulting in diversion of flow such that >10% of the pools have water levels lower than baseline period	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
Waterfall WC-WF54 Relevant Performance Measure(s): • Waterfall WC-WF54 – negligible environmental consequences	***Exceeding Prediction*** • Fracturing in Wongawilli Creek within 30m of the waterfall which results in observable flow diversion • Fracturing in Wongawilli Creek which results in observable flow diversion from the lip of the waterfall	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
MODELLED PERIODS OF RECESSIONAL, BASEFLOW AND SMALL STORM UNIT HYDROGRAPH PERIODS		
Subcatchments of Wongawilli and Donalds Castle Creeks and Lake Avon tributaries **	***Level 1 **** • Change 6-12% less than average annual precipitation ***	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Change 12-18% less than average annual precipitation ***	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Change >18% less than average annual precipitation ***	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success

Table 1.2 – Dendrobium Watercourse Impacts, Triggers and Response

Monitoring	Trigger	Action
		• Review relevant TARP and Management Plan in consultation with key stakeholders
Inflows to Lake Avon and Cordeaux River ** Relevant Performance Measure(s): • Lake Avon - negligible reduction in the quantity of surface water inflows to Lake Avon • Cordeaux River - negligible reduction in the quantity of surface water flows from Wongawilli Creek to Cordeaux River	***Exceeding Prediction*** • Measured surface water flow reduction in Wongawilli Creek at its confluence with Cordeaux River that is greater than predicted by the groundwater model (to the satisfaction of the Director General - Condition 13 of the SMP) that cannot be attributed to natural variation • Surface water flow reduction into Lake Avon is greater than predicted by the groundwater model (to the satisfaction of the Director General - Condition 13 of the SMP) that cannot be attributed to natural variation	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
AQUATIC ECOLOGY		
Pool water level, interconnectivity between pools and loss of connectivity, noticeable alteration of habitat • Wongawilli Creek catchment – 8 sites • Donalds Castle Creek catchment – 1 site	***Level 1 **** • Reduction in aquatic habitat for 1 year	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Reduction in aquatic habitat for 2 years following the active subsidence period	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidence period	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
TERRESTRIAL FAUNA – THREATENED FROG SPECIES		
Pool water level, interconnectivity between pools and loss of connectivity, noticeable alteration of	***Level 1 **** • Reduction in habitat for 1 year	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other

Table 1.2 – Dendrobium Watercourse Impacts, Triggers and Response

Monitoring	Trigger	Action
habitat • Wongawilli Creek catchment – 2 sites • Donalds Castle Creek catchment – 2 sites • Lake Avon tributary – 1 site • Native Dog tributary – 1 site		relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Reduction in habitat for 2 years following the active subsidence period	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Reduction in habitat for > 2 years or complete loss of habitat following the active subsidence period	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success

* These may be revised in consultation with DoPE and T&I and other key stakeholders following analysis of natural variability within the pre-mining baseline data. These TARPs relate to Dendrobium Area 3B and impacts resulting from mining in Areas 1, 2 and 3A were managed under previous TARPs.

** Water budgets during recessional, baseflow and small storm unit hydrograph periods would be determined by hydrologic modelling of pre- and post-mining hydrographic data using the Free University of Amsterdam RUNOFF2005 model and validation of model-determined ETs against those estimated by the independent CSIRO Land and Water Division (Zhang et al.) method. These TARPs would apply only to the whole of catchment water delivered to Lake Cordeaux, Lake Avon and Cordeaux River. Model reliability is maintained only for catchments in excess of 1 km^2 in area. Average annual precipitation is modelled using the most recent 5 years of local record.

*** Hydrologic modelling conducted in the manner described above for the baseline period routinely produces mean estimated water budgets lying within about ±6% of average annual precipitation at the one standard deviation level and within about ±12% at the two standard deviation level.

Office of Environment and Heritage (OEH)

Department of Planning and Environment (DoPE)

Trade and Investment: including Division of Resources and Energy, Office of Water, Fisheries (T&I)

Water NSW (formally SCA)