ILLAWARRA COAL
DENDROBIUM MINE




Water NSW
Asset Protection Plan
Longwall 14 and 15

Review History

Revision	Description of Changes	Date
4-Draft 1	Updated to cover changes in the APP associated with Area 3A and the modified Development Consent. This revision now only covers WaterNSW Assets	30th July 09
4-Draft 2	Updated to incorporate WaterNSW comments and updated MSEC predictions	23rd Oct 09
4-Draft 3	Updated to incorporate WaterNSW comments	19th Feb 10
4-Draft 4	Updated with new Area 3A layout and incorporated WaterNSW comments on Draft 3	7th April 10
4	Final Plan agreed to by WaterNSW	14th April 10
5-Draft 1	Updated to cover changes in the APP associated with the inclusion of Area 3B (Longwalls 9 & 10 only)	8th August 2012
5-Draft 2	Updated to incorporate WaterNSW comments	12th November 2012
5	Comments and Changes accepted by WaterNSW. Final Plan	20th December 2012
6	Final Plan. Revision 5 has been updated as a result of DSC endorsement and Trade and Investment Approval for Longwall 11 to extract coal in the Avon Reservoir DSC Notification Zone and the SMP approval for Longwalls 9 to 13	21st March 2013
7 – Draft	Updated to cover Longwalls 12 & 13.	November 2014
7a	Incorporating WaterNSW comments	September 2015
7b	Incorporating further WaterNSW comments	February 2016
7c	Update for Longwall 13	August 2016
8	Update for Longwall 14 and 15	August 2017

Document Approval

Authorising Officer (Illawarra Coal)	Acceptance of APP (WaterNSW)
Principal Surface Infrastructure Protection	Mining Manager
Chris Brunero	Peter Dupen
Signature: 	
Date: 22/12/2017	Date: 09/01/2018

CONTENTS

LIST OF FIGURES, TABLES AND APPENDICES

Figures

Tables

Appendices

CONTACT LISTING IN ASSOCIATION WITH THIS PLAN

NAME	CONTACT DETAILS	ALTERNATE	ALTERNATE CONTACT DETAILS
Water NSW		Parramatta Office: (02) 9865 2500 *Mt. Annan* Office: (02) 4640 1200 Incident Notification Number: 1800 061 069	
Marlo Vergara *Mining Infrastructure Specialist*	Ph: (02) 9865 2508	Peter Dupen *Mining Manager*	Ph: (02) 9865 2509
Steven Bayliss *Maintenance Team Leader Upper Nepean*	Ph: (02) 4774 4414 Mob: (0427) 261 511	Ben Shallis *Maintenance Supervisor Upper Nepean*	Ph: (02) 4640 1235 Mob: (0418) 965 466
NSW Dams Safety Committee			
Bill Ziegler *Manager, Mining Impacts*	Ph: (02)98428077	Chris Salkovic *Executive Engineer*	Ph: (02) 98428070 Fax: (02) 98428071 Mobile: (0403) 681 645
Department of Trade and Investment			
Bob Myatt *Inspector of Mines*	Ph: (02) 4222 8320 Mobile(0488) 219 417	Bill Barraclough *Area Manager-South East*	Ph: (02) 4222 8309 Mob: (0438) 467 989
Dendrobium Mine			
Wayne Green *Mining Engineer*	Mob: (0417) 947 203	Matt Johnson *Geotech Engineer*	Ph: (02) 4255 4429 Mobile: (0402) 501 662
Bryony Andrew *Operations Manager*	Mob: (0423) 828 271	Wayne Green *Mining Engineer*	Mob: (0417) 947 203
Control Officer *Dendrobium Control Room*	Ph: (02) 4255 4402 Mob: (0438) 868 401	Not Required Office always staffed	
South32 Illawarra Coal			
Chris Brunero *Principal Surface Infrastructure Protection*	Ph: (02) 4224 6220 Mob: (0403) 585 427	Clinton Page *Planning Manager*	Ph: (02) 4286 3507 Mob: (0418) 473 267
Gary Brassington *Principal Planning Approvals*	Ph: (02) 4286 3318 Mob: (0438) 042897	Richard Walsh *Superintendent Brownfields Exploration*	Ph: (02) 4286 3302 Mob: (0419) 592 614

1 INTRODUCTION

Under section 75W of the Environmental Planning and Assessment Act 1979, the Minister for Planning modified the original consent for Dendrobium Mine on 8th December 2008 with further minor amendments (April 2015). Condition 7 Schedule 3 of the modified Consent "Specific Environmental Conditions - Mining Area" requires a Subsidence Management Plan be prepared, as described below.

"Prior to carrying out any underground mining operations that could cause subsidence in either Area 3A, 3B or 3C, the Applicant shall prepare a Subsidence Management Plan (SMP) to the satisfaction of the Secretary and the DRE. Each such SMP must:

(a) integrate ongoing management of Areas 1 and 2;

(b) integrate the Watercourse and Swamp Impact Monitoring, Management and

Contingency Plans required under conditions 4 and 6;

(c) include monitoring of subsidence effects;

(d) include a Water NSW (SCA) Assets Protection Plan;

(e) include monitoring, management, and contingency plans for all other significant natural features and all significant man made features which may be impacted by subsidence, including:

- *landscape (including cliffs and steep slopes);*
- *groundwater (see condition 13);*
- *terrestrial flora and fauna and ecology (including all threatened species assessed as being likely to be significantly affected by the development and their habitats);*
- *Aboriginal and other cultural heritage (see condition 12); and*
- *electrical, communications and other infrastructure;*

(f) be prepared in consultation with OEH, Water NSW (SCA) and DRE;

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

(h) be implemented to the satisfaction of the Secretary and the DRE.

Notes:

The Water NSW (SCA) Assets Protection Plan required under this condition must also be prepared and implemented to the satisfaction of the Water NSW (SCA).

The contingency plans required under paragraph (e) must address remediation (as appropriate) and be based on a TARP structure."

1.1 PURPOSE & SCOPE

This Asset Protection Plan (APP) is designed to meet the requirements in Schedule 3 Condition 7 (d) of the Dendrobium Development Consent. Specifically, it aims to identify the likely or possible subsidence impacts on WaterNSW's built assets and stored waters from mining of Longwalls in Area 3B, what triggers will be used to identify when remedial or mitigation works are required, and what actions IC will take if these triggers are exceeded. The APP includes consideration of dam walls and extends to the management of potential leakages of water contained in those reservoirs. The APPs for Areas 3A and 3 B are included as Appendix A and B of this Document. The APP has been developed in consultation with WaterNSW and relevant regulatory authorities.

Subsidence associated with longwall extraction has been identified as the most likely potential cause of impacts to surface features and structures. Vertical and horizontal subsidence movements are predicted to occur above and adjacent to the longwall extraction. Some mining induced regional horizontal movements are also expected, but the impacts from these movements have been assessed as minimal.

The APP has been developed to address the incremental subsidence effects associated with Longwall 14 and 15, however the APP remains applicable due to cumulative impacts from Areas 1, 2 and 3A. The APP (and associated Management Plans) will remain in effect for the life of Dendrobium Mine and until impacts after mining in Areas 1, 2, 3A and 3B are assessed as completed and impacts are rehabilitated to the satisfaction of WaterNSW, NSW Dams Safety Committee (DSC), Department of Planning and Environment (DoPE) and the Department of Industry (DI).

It is ***not*** the objective of the APP to address other potential sources of impact on man-made assets such as exploration, construction or surface facilities as these are addressed by other approval processes and requirements.

It is also ***not*** the objective of the APP to identify natural features such as creeks, steep slopes and flora and fauna as assets, nor to propose mitigation and remediation measures with regard to such features. These aspects are addressed in the other Dendrobium Management Plans, required by conditions of Schedule 3 of the modified Consent and are developed separately to the APP.

1.2 DEFINITIONS

Approved Plan	The current mine plan approved by the Mine Manager. This can include mining approved by NSW Government and proposed mining yet to be approved.
Assets	In relation to this Plan, "Assets" are items of Built Infrastructure, including dammed water bodies in the WaterNSW Catchment Area, but excluding natural features and items of Archaeological significance.
APP	Asset Protection Plan
CMH&SA	Coal Mine Health and Safety Act 2002
CMH&SR	Coal Mine Health and Safety Regulation 2006
DoPE	Department of Planning and Environment
EPAA	Environmental Planning and Assessment Act 1979
DTI	Department of Trade and Investment (previously referred to as DII, DPI-MR, T&I)
WaterNSW	WaterNSW (formerly SCA)
Section 88 Application	An application made under Section 88 of the CMH&SR 2006 to mine a block of coal by methods other than the Bord and Pillar method.
SMP	Subsidence Management Plan (requirement of 2008 Development Consent conditions)
FSL	Dam Full Supply Level

1.3 THE MINING AREA

The Dendrobium Mine (Figure 1) extracts coal from the Wongawilli Seam using longwall mining techniques. Three separate groups of longwalls will be mined in the areas referred to in Figure 1 as mining Areas 1, 2 and 3. Areas 1 and 2 have been mined. Area 3 consists of Area 3A, 3B and 3C. The APP particularly addresses issues related to Longwall 14 and 15 in Area 3B.

Area 3B is located between the eastern side of Lake Avon (Native Dog Creek arm) and Wongawilli Creek. A small section of the western end of Area 3B falls within the NSW Dams Safety Committee Lake Avon Notification Area (Figure 1). The longwalls have been arranged to avoid longwall extraction under Lake Avon and Wongawilli Creek.

The Dendrobium Mine Plan shown in Figure 1 and 2 is consistent with the current Proposed Plan layout for Dendrobium Mine (for Longwalls 16 to 18). Approval to mine within the Avon Notification Area for Longwall 11 to 13 has been endorsed by NSW Dams Safety Committee (DSC). An application has been made to DSC for endorsement of mining Longwalls 14 to 18 within the Lake Avon Notification Area.

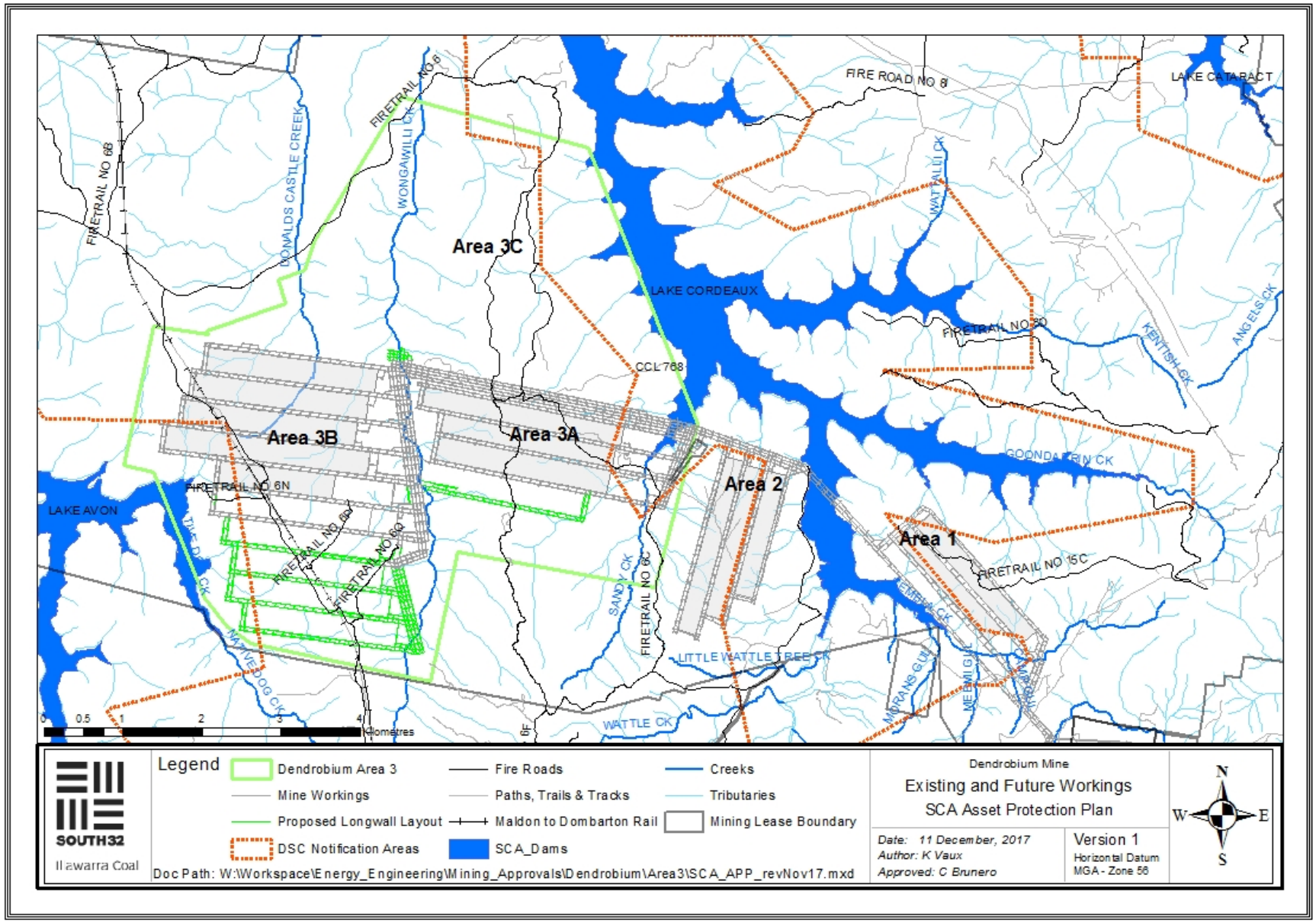


Figure 1: Dendrobium Mine Plan

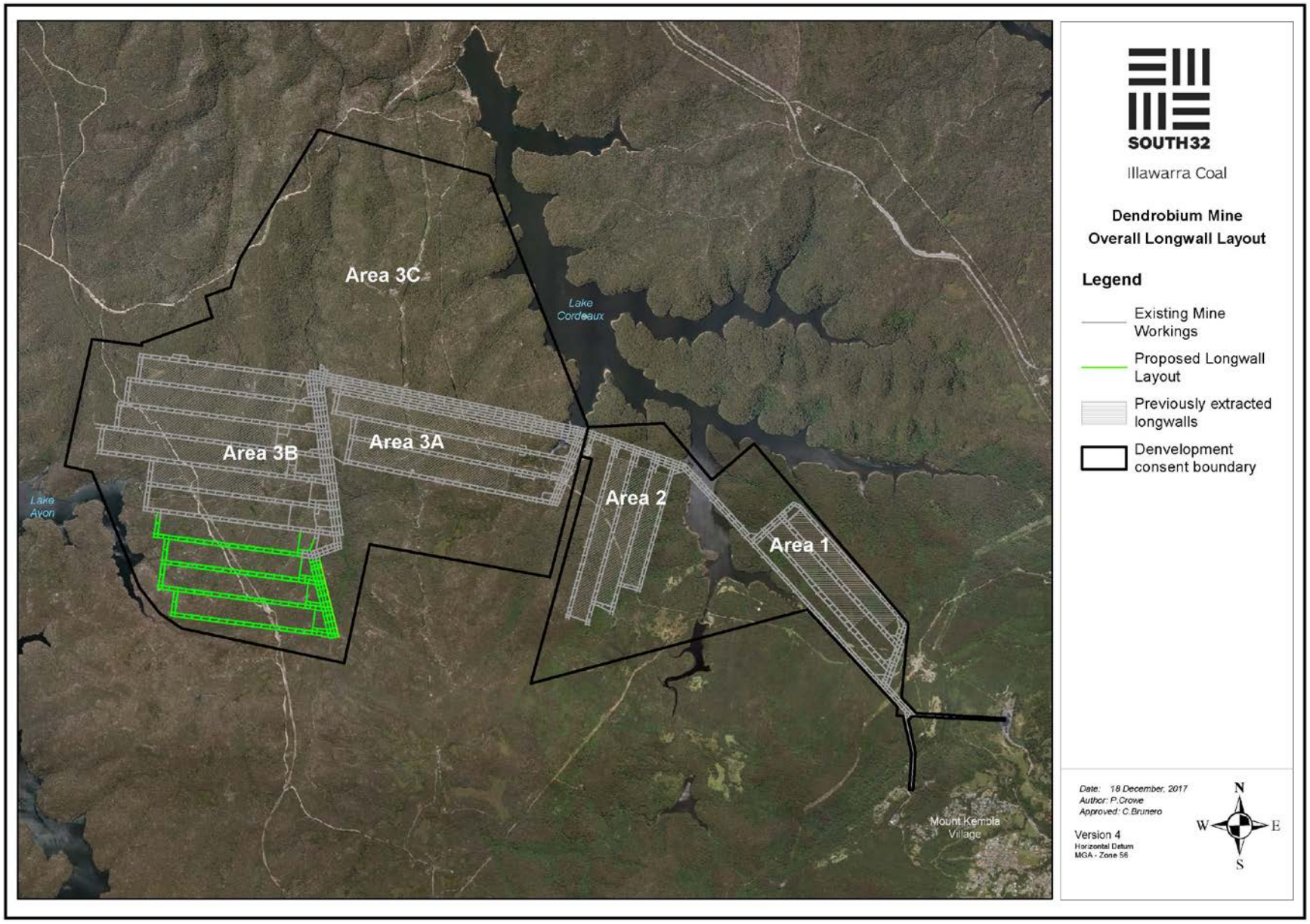


Figure 2: Layout of Longwalls 9 to 18 in Area 3B

The proposed layout of Longwalls 9 to 18 in Area 3B is shown in Figure 2. A summary of the proposed dimensions of these longwalls are provided in Table 1.

Table 1: Proposed Dimensions of Longwalls 9 to 18 in Area 3B

Longwall	Overall Length	Void Width including Headings (m)	Solid Chain PillarWidth (m)
Longwall 9	2200	305	50
Longwall 10	2220	305	45
Longwall 11	2205	305	45
Longwall 12	2600	305	50
Longwall 13	2225	305	50
Longwall 14	1985	305	50
Longwall 15	1965	305	50
Longwall 16	1870	305	50
Longwall 17	2010	305	50
Longwall 18	1925	305	50

Longwalls 9 to 18 in Area 3B are extracted from the Wongawilli Seam, which underlies the Bulli Seam by approximately 20 metres. There is currently no approval or plans to mine the Bulli Seam within Area 3B.

The depth of cover to the Wongawilli Seam (Figure 3) within the Study Area varies between a minimum of 310 metres, above the eastern end of Longwall 9 and a maximum of 450 metres above the eastern ends of Longwalls 17 and 18. The seam floor within the mining area generally dips from the south to the north, having an average dip of around 2%, or 1 in 50. The maximum seam dip is 10% or 1 in 10 which occurs locally in the south-east corner of the mining area.

The Wongawilli Seam in Area 3B is nominally 10 metres thick and contains numerous bands of non-coal material. The economic section of the Wongawilli Seam is the basal 3 metres to 5 metres. For Longwalls 14 and 15 DoPE have conditioned the SMP Approval to extract a maximum thickness of 3.9 metres. Due to poor roof conditions, it is typical for the mine to not achieve the proposed maximum extraction height in all areas.

Dendrobium Mine submitted a SMP in June 2012. T&I approved the Dendrobium Area 3B SMP for Longwalls 9 to 13, on 5th February 2013 and DoPE approved the SMP on 6th February 2013. Further Approval of the Secretary of DoPE was provided for Longwalls 14 and 15 on 16th December 2016.

The Dendrobium Mine underground workings lie underneath WaterNSW land known as the Metropolitan Special Area which is zoned 7(a) Environmental Protection Special (Water Catchment) Area. The infrastructure directly and potentially affected by the mining of Area 3B is shown on Figure 3.

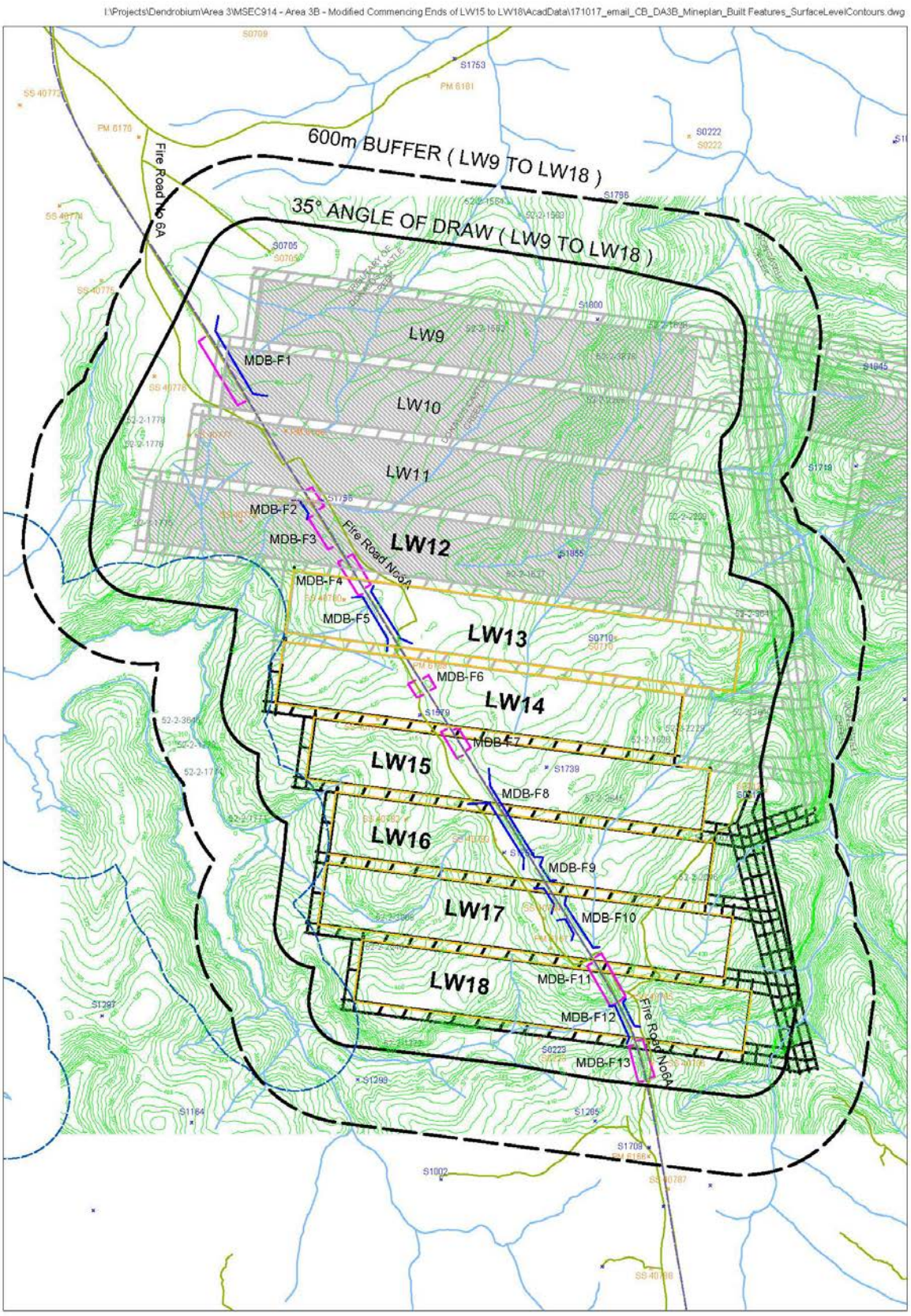


Figure 3: Longwall 9 to 18 Layouts Showing Depth of Cover and Infrastructure in the vicinity of Area 3B (Extract from drawing MSEC459-06)

1.4 GEOLOGY

The geology of the Dendrobium Area was outlined in WKA77, which was included as Volume 2 of the EIS for the Dendrobium Mine Project. Dendrobium Mine has continued to undertake exploration within the area and the description of the geology in the area has been updated in subsequent MSEC Reports (MSEC311, MSEC459 and MSEC792). The geology mainly comprises sedimentary sandstone shale and claystone of the Permian and Triassic Periods, which have been intruded by igneous sills. The major actual and inferred geological features in Area 3B are shown in Figure 4.

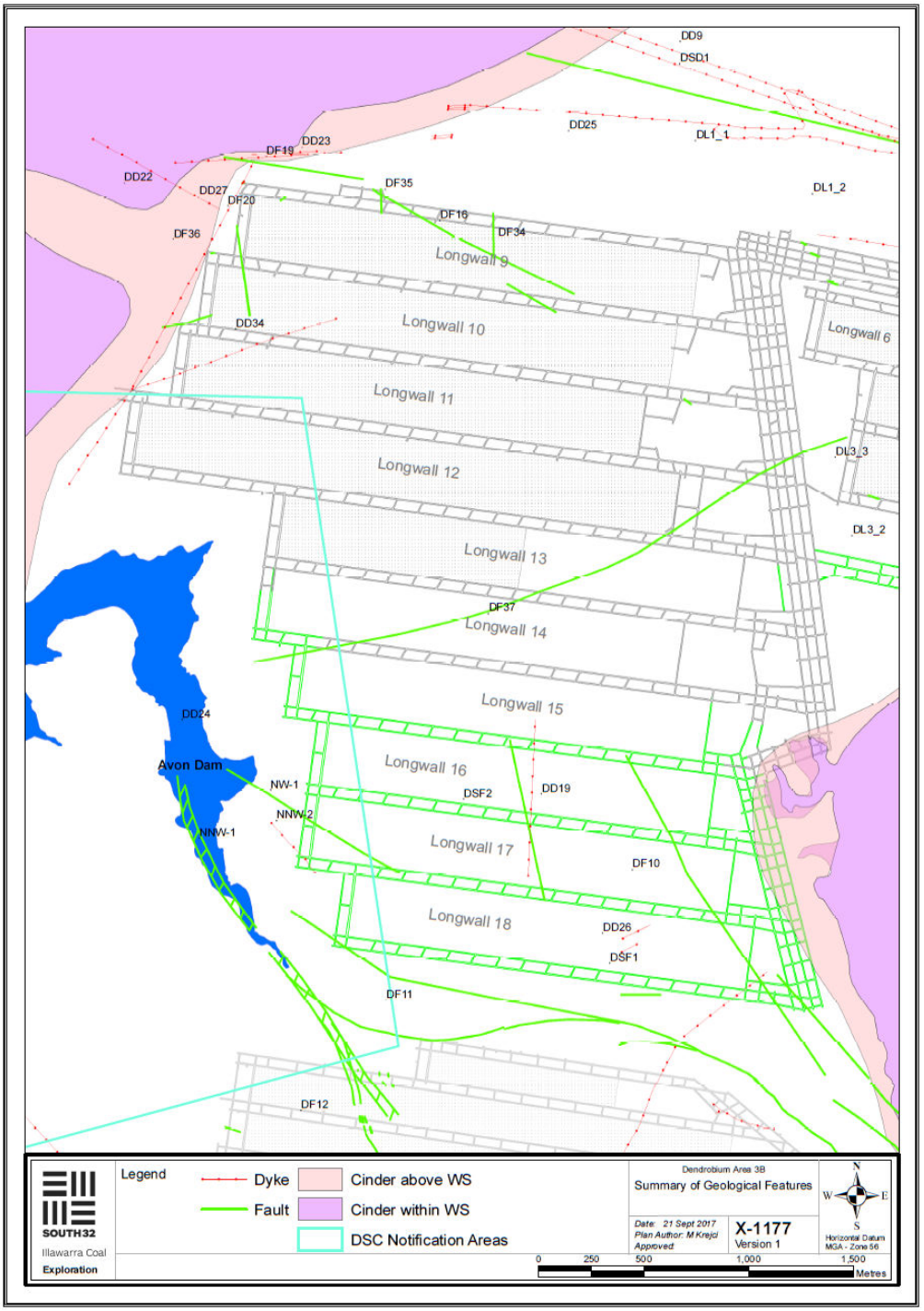


Figure 4 : Geological Features in Area 3B

A generalised sedimentary stratigraphic section is shown in Figure 5. The sandstone units vary in thickness from a few metres to as much as 120 metres. The major sandstone units are interbedded with other rocks and, though shale and claystone are quite extensive in places, the sandstone predominates.

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

- The Hawkesbury Sandstone,
- The Narrabeen Group, and
- The Illawarra Coal Measures.

The Narrabeen Group contains the Newport Formation (sometimes referred to as the Gosford Formation), the Bald Hill Claystone, the Bulgo Sandstone, the Stanwell Park Claystone, the Scarborough Sandstone, the Wombarra Shale and the Coalcliff Sandstone.

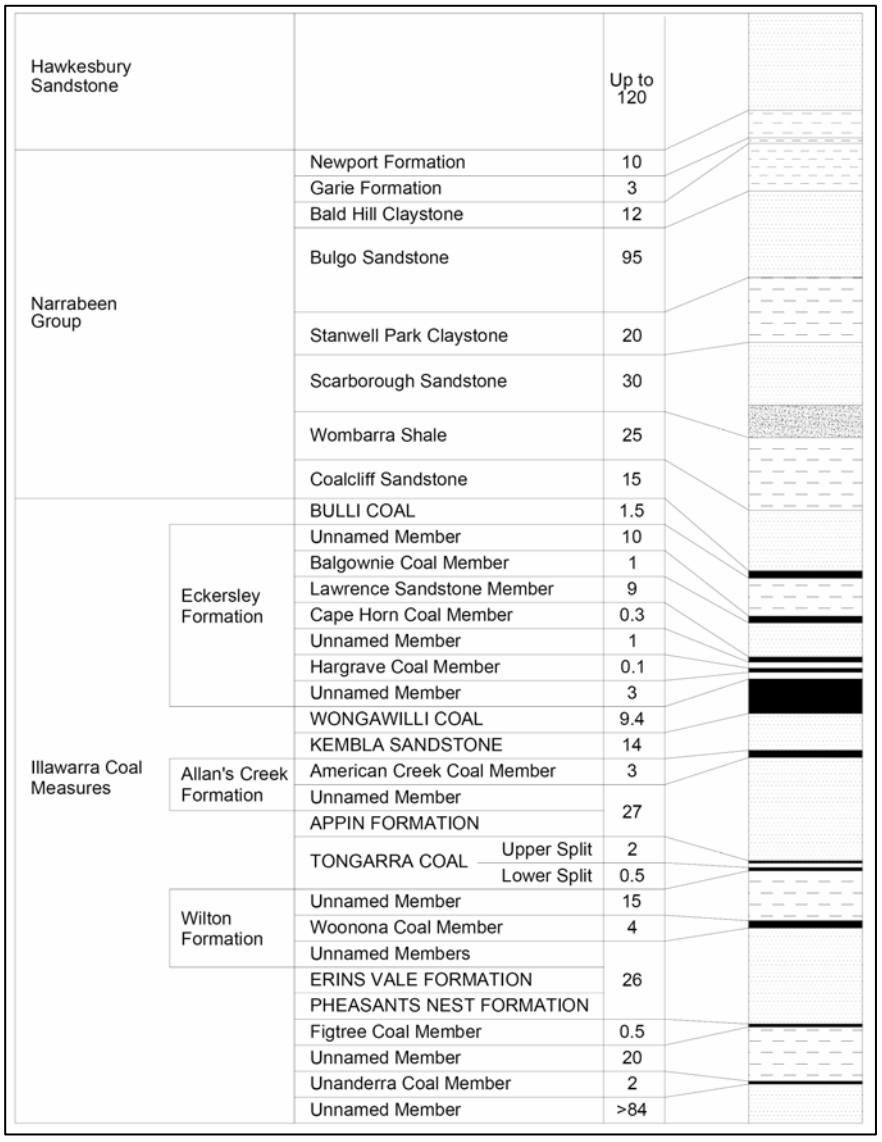


Figure 5 : Generalised Stratigraphic Column (after Williams, 1979)

The Bulli Seam is the top unit in the Illawarra Coal Measures. The interval between the Bulli Seam and the Wongawilli Seam is known as the Eckersley Formation which consists of sandstones, shales and minor coal

seams. The longwalls are proposed to be extracted from the Wongawilli Seam, which is located directly below the Eckersley Formation.

The major claystone units are the Bald Hill and Stanwell Park Claystones, which lie above and below the Bulgo Sandstone at the base of the Hawkesbury Sandstone.

There are several igneous structures within Area 3B with the most noteworthy igneous sill being the Nepheline Syenite intrusion, in the south-eastern part of the mining area, with the approximate location shown in Figure 4. Mapping of the sill will be refined as further geological investigations are undertaken using in-seam drilling. The extent of this sill cannot be mapped using surface geophysical techniques and drilling from the surface has provided the present definition of the margin. Another sill and cindered zone have been identified north-west of the proposed longwalls.

Several geological structures have been identified at seam level in the vicinity of the proposed longwalls in Area 3B. A series of faults have been identified south of Longwall 18, between the proposed longwalls and the Elouera workings, having throws between 25 metres and 40 metres which reduces in magnitude to <5m as it extends west near the Avon Reservoir. Further in seam drilling shall be undertaken as mining encroaches on the Avon Notification Area which may assist in delineation of the faults. In addition, a surface drilling and investigation program will be undertaken to determine the nature of the Elouera Fault and any implications for mining and the Avon Reservoir. Dykes have been identified north, south-west and south-east of the proposed longwalls.

1.5 SUBSIDENCE PREDICTIONS

Subsidence predictions for Dendrobium Area 3B were reported in MSEC459 which was included in the SMP Application for Area 3B. Revised predictions for Area 3B have been provided in MSEC792 (MSEC 2015) and MSEC914 (2017).

The following extracts are from MSEC459.

The predicted subsidence, tilt and curvature have been obtained using the Incremental Profile Method, which has been calibrated for Dendrobium Mine, as described in Section 3.6, of the report. The predicted strains have been determined by analysing the strains measured at other NSW Collieries, where the longwall width-to-depth ratios and extraction heights are similar to those for the proposed longwalls.

The maximum predicted subsidence parameters and the predicted subsidence contours provided in this report describe and show the conventional movements and do not include the valley related upsidence and closure movements, nor the effects of faults and other geological structures. Such effects have been addressed separately in the impact assessments for each feature provided in Chapters 5 and 6 of the report.

The following extract is from MSEC914 (modified layout from previous layout in MSEC 792).

The maximum predicted subsidence parameters for the natural and built features, based on the Modified Layout, are less than the maxima predicted based on the Previous Layout...The assessed levels of potential impact for the natural and built features are the same or reduce as a result of the proposed modifications to the commencing ends and maximum extraction heights for Longwalls 15 to 18. The recommendations and the management strategies for these surface features, therefore, are the same as those previously provided in Report Nos. MSEC459, MSEC651, MSEC652, MSEC785, MSEC792, MSEC865 and the SMP Application.

1.6 PREDICTED SUBSIDENCE TILT AND CURVATURE

The maximum predicted conventional subsidence parameters resulting from the extraction of the proposed longwalls were determined using the calibrated Incremental Profile Method, which is described in MSEC459 and MSEC792. A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature, due to the extraction of each of the proposed longwalls, is provided in Table 2.

Table 2 : Maximum predicted incremental vertical subsidence, tilt and curvature resulting from the extraction of each of the longwalls

Due to longwall	Maximum predicted incremental vertical subsidence (mm)	Maximum predicted incremental tilt (mm/m)	Maximum predicted incremental hogging curvature (km^{-1})	Maximum predicted incremental sagging curvature (km^{-1})
LW14	2350	30	0.50	0.65
LW15	2650	30	0.55	0.70
LW16	2450	30	0.60	0.70
LW17	2550	35	0.85	0.90
LW18	2750	35	0.80	0.80

The predicted total conventional subsidence contours, resulting from the extraction of Longwalls 9 to 18 are shown in Drawing MSEC792-14. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature, after the extraction of each of the proposed longwalls, is provided in Table 3.

Table 3 : Maximum predicted total vertical subsidence, tilt and curvature after the extraction of each of the longwalls

After longwall	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km^{-1})	Maximum predicted total sagging curvature (km^{-1})
LW14	3500	35	1.2	1.2
LW15	3500	35	1.2	1.2
LW16	3500	35	1.2	1.2
LW17	3500	40	1.2	1.2
LW18	3500	40	1.2	1.2

The predicted tilts provided in the above table are the maxima after the completion of each of the proposed longwalls. The predicted curvatures provided in the above table are the maxima at any time during or after the extraction of each of the proposed longwalls.

The maximum predicted subsidence, after the completion of the proposed longwalls, is 3600mm which represents around 78% of the extraction height. The maximum predicted conventional tilt is 50mm/m (i.e. 5%), which represents a change in grade of 1 in 20. The maximum predicted conventional hogging and sagging curvatures are both $1.4km^{-1}$, which represent minimum radius of curvature of 0.7km.

The predicted conventional subsidence parameters vary across the SMP Area as the result of, amongst other factors, variations in the longwall geometry and the depths of cover. Further details can be found in report MSEC792.

1.7 PREDICTED STRAINS

The maximum predicted conventional strains resulting from the extraction of Longwalls 9 to 18, based on applying a factor of 15 to the maximum predicted curvatures, are both 20mm/m tensile and compressive.

At a point, however, there can be considerable variation from the linear relationship, resulting from non-conventional movements or from the normal scatters which are observed in strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strain for low

magnitudes of curvature. In this report, therefore, we have provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of potential strains above Longwalls 9 to 18 has been determined using monitoring data from Dendrobium Area 3A and 3B, as well as previously extracted longwalls in the NSW Coalfields where the mine geometries were reasonably similar to that for Dendrobium Area 3B. Comparisons of the longwall void widths, depths of cover, longwall width-to-depth ratios and extraction heights are provided in Table 4.

It can be seen from the table, that the range of the longwall width-to-depth ratios used in the strain analysis was similar to but slightly higher, on average, than the width-to-depth ratios of the proposed Dendrobium Longwalls 9 to 18. The average extraction height for the longwalls used in the strain analysis was also similar to the extraction height for the proposed longwalls. The strain analysis, therefore, should provide a reasonable indication of the range of potential strains resulting from the extraction of Dendrobium Longwalls 9 to 18.

Table 4 : Comparison of the mine geometry for Dendrobium Longwalls 14 to 18 with the longwalls from the NSW coalfields used in the strain analysis

Parameter	Dendrobium Longwalls 14 to 18		Longwalls used in strain analysis	
	Range	Average	Range	Average
Longwall width	305	305	160 ~ 200	175
Depth of cover	280 ~ 395	360	150 ~ 250	175
W/H ratio	0.77 ~ 1.1	0.9	0.8 ~ 1.2	1.03
Extraction height	3.9	3.9	3.8 ~ 4.8	4.5

1.8 PREDICTED HORIZONTAL MOVEMENTS

The maximum predicted conventional tilt within the SMP Area, at any time during or after the extraction of the proposed longwalls is 50mm/m, which occurs adjacent to the maingate of the proposed Longwall 18. The maximum predicted conventional horizontal movement is, therefore, approximately 750mm, i.e. 50mm/m multiplied by a factor of 15.

1.9 PREDICTED FAR FIELD HORIZONTAL MOVEMENTS

The predicted far-field horizontal movements resulting from the extraction of the proposed longwalls are very small and could only be detected by precise surveys. Such movements tend to be bodily movements towards the extracted goaf area, and are accompanied by very low levels of strain, which are generally less than survey tolerance. The impacts of far-field horizontal movements on the natural features and items of surface infrastructure within the vicinity of the SMP Area is not expected to be significant, except where they occur at large structures which are sensitive to small differential movements (MSEC459 and MSEC792).

2 MAJOR ITEMS OF INFRASTRUCTURE

Report MSEC459 and MSEC792 identifies the surface features, including man- made assets of interest to WaterNSW that could be affected by the mining of Longwalls 9 to 18 in Area 3B. The APP addresses the following WaterNSW assets:

- Unsealed roads
- Drainage culverts
- The stored water contained by the Avon and Cordeaux Reservoirs

Comprehensive descriptions of these items are provided in MSEC459 and the Dendrobium Area 3B SMP.

2.1 UNSEALED ROADS

There are no public roads within the SMP Area. There are, however, unsealed fire trails and four wheel drive tracks within the SMP Area, which are used by the WaterNSW and other groups for firefighting and other activities. The locations of the unsealed roads are shown in Figure 1.

2.2 DRAINAGE CULVERTS

There are small drainage culverts located across the SMP Area associated with the unsealed fire trails and four wheel drive tracks. The culverts comprise small pipes (concrete and other typical construction materials) which are located at drainage lines. The culverts could experience the full range of predicted subsidence movements.

2.3 STORED WATERS IN THE AVON AND CORDEAUX RESERVOIRS

There are two reservoirs in the area, being Lake Cordeaux and Lake Avon, the locations of which are shown in Figure 2. The NSW Dams Safety Committee Notification Area for Avon Reservoir is located within the Study Area, which is also shown in Figure 1.

Avon Reservoir is located to the west of the proposed longwalls. The commencing ends of Longwalls 11 to 18 are located within the Notification Area. Avon reservoir is located at a distance of 300 metres from Longwall 16, at its closest point to the longwalls in Area 3B.

Avon Reservoir is fed by the Avon River and its tributaries and has a length of approximately 19km. Avon Reservoir has an operating capacity of approximately 147,000 ML.

Cordeaux Reservoir is located approximately 3km east of the longwalls. At this distance, the lake is not predicted to experience any measurable mine subsidence movements. It is not expected, therefore, that the lake would experience any impacts resulting from the extraction of the longwalls.

There are no dam structures or associated works within the SMP Area. The closest dam walls are the Cordeaux Dam Wall, the Upper Cordeaux No. 2 Dam Wall and the Avon Dam Wall which are located approximately 5km north, east and northwest respectively, from the proposed longwalls.

At these distances, the dam walls are not predicted to experience any measurable mine subsidence movements. It is not expected, therefore, that the walls of any of the dams would experience any impacts resulting from the extraction of the proposed longwalls.

Where the coal seam is intruded by hard competent rock such as a dyke or sill, minor controlled blasting may be used to break up this competent rock but not compromise the integrity of surrounding rocks. Vibration from this small scale localized blasting is considered to be insignificant.

3 SUBSIDENCE IMPACT ASSESSMENTS

Comprehensive subsidence impact assessment is provided MSEC459 and MSEC792. Predicted subsidence parameters for items of surface infrastructure within the Study Area are provided in these reports. Impact assessments have been made for items of surface infrastructure based on the predicted subsidence parameters. All significant items of surface infrastructure located outside the Study Area, which may be subjected to far-field movements and may be sensitive to these movements, have also been included as part of these assessments.

Actual subsidence parameters are normally greater or less than those predicted for specific features, depending on their relative position within the subsidence trough, so an additional factor of safety is applied by applying the predicted maximum values of subsidence, tilt, curvature and strain within 20 metres of the perimeter of each feature. The predictions should, therefore, provide the best available indication of the overall subsidence parameters that are likely to be experienced by each feature.

Subsidence models and predictions are used by other experts in their field to predict impacts and potential consequences for specific features. The APP incorporates these assessments and where required any recommendations from the results of the expert assessments in relation to the management of specific features. This is particularly the case for the stored waters where the assessment and management actions draw on the Dendrobium regional groundwater model which has been developed and is supported by mathematical modelers, hydrogeologists and hydrogeochemists. The key assessments used to develop the APP are provided in the Reference list.

3.1 UNSEALED ROADS

3.1.1 Predictions for Unsealed Roads

The fire trails are located across the Study Area and directly above the longwalls based on both the Previous and Modified Layouts. These trails therefore could experience the full range of predicted movements as summarised in Section 1.5 (refer to Table 3). The maximum predicted subsidence parameters for the fire trails, based on the Modified Layout, are less than the maxima predicted based on the Previous Layout. The extent of subsidence and, therefore, the overall length of the fire trails affected by subsidence reduce due to the proposed modifications. The assessed levels of potential impact for the fire trails, based on the Modified Layout, are similar to or less than those assessed based on the Previous Layout. The recommendations and the management strategies for the fire trails, therefore, do not change from those previously provided in Reports Nos. MSEC459, MSEC651, MSEC652, MSEC785, MSEC792, MSEC865 and the SMP Application..

The predicted tilts provided in Table 3 are the maxima after the completion of any or all of the proposed longwalls. The predicted curvatures provided in the above table are the maxima at any time during or after the extraction of each of the proposed longwalls.

The maximum predicted conventional hogging and sagging curvatures for the unsealed roads and tracks, resulting from the extraction of the proposed longwalls, are both $1km^{-1}$, which represents a minimum radius of curvature of 1km.

The maximum predicted conventional strains for the unsealed roads, based on applying a factor of 15 to the maximum predicted conventional curvatures, are both 15mm/m tensile and compressive. The analysis of strains measured in the NSW Coalfields, for previously extracted longwalls having similar width-to- depth ratios and extraction heights as the proposed longwalls, is provided in MSEC459 and MSEC792.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, amongst other things, anomalous movements and downslope movements.

3.1.2 Impact Assessments for Unsealed Roads

The maximum predicted conventional tilt for the unsealed roads, resulting from the extraction of the proposed longwalls, is 50mm/m (i.e. 5%), which represents a change in grade of 1 in 20. The predicted maximum tilt could result in some changes in the surface water drainage for the unsealed roads and tracks. Any changes would be localised and would be remediated by regrading the affected sections of road or track.

It is expected, at the magnitudes of predicted curvatures and strains, that cracking and heaving of the unsealed road surfaces would occur. Examples of surface cracking and heaving along the fire roads above the previously extracted longwalls at Dendrobium Mine are provided in MSEC459.

The unsealed roads in Dendrobium Areas 1, 2, 3A and 3B have been maintained in a safe and serviceable condition during mining using normal road maintenance techniques. It is expected that the unsealed roads in the proposed Area 3B would also be maintained using similar remediation measures, including regrading and re-compacting the unsealed road surfaces during mining.

3.1.3 Impact Assessment for the Unsealed Roads on Increased Predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum changes in grade at the unsealed roads would be 100mm/m. It would still be expected that the unsealed roads could be maintained in a safe and serviceable condition by remediation during mining using normal road maintenance techniques. If the actual curvatures or ground strains exceeded those predicted by a factor of 2 times, the likelihood and extent of cracking and heaving of the unsealed road surfaces would increase. It would still be expected that any impacts would be managed and repaired using normal road maintenance techniques.

The unsealed roads will be monitored as the proposed longwalls mine beneath them, so that any impacts can be identified and rectified accordingly. IC will develop in consultation with WaterNSW, management strategies for the unsealed roads if impacts are observed. With these strategies in place, it is likely that the unsealed roads can be maintained in a safe and serviceable condition throughout the mining period. Inspections will be undertaken by the survey and field crews in conjunction with other routine activities in the relevant areas.

3.2 DRAINAGE CULVERTS

There are small drainage culverts located across the SMP Area associated with the unsealed fire trails and four wheel drive tracks. The culverts comprise small pipes which are located at the drainage lines. The drainage culverts could experience the full range of predicted subsidence movements, which are summarised in MSEC459 and MSEC792.

The maximum predicted tilt within the SMP Area of 50mm/m (i.e. 5%) represents a change in grade of 1 in 20. The predicted changes in grade could be of sufficient magnitude to affect the flow of water through the culverts in the location of maximum tilt. If the serviceability of any culverts were to be adversely affected, as a result of the extraction of the longwalls, this would be remediated by relevelling the impacted culverts.

The maximum predicted conventional strains for the drainage culverts, based on applying a factor of 15 to the maximum predicted conventional curvatures, are both 20mm/m tensile and compressive. The predicted strains could be of sufficient magnitude to result in cracking in concrete culverts. Any impacted culverts would be repaired or, where required, the culverts would be replaced. It would not be expected that the strain would impact pipes of steel or poly construction.

3.3 CORDEAUX AND AVON RESERVOIRS

The locations of Cordeaux and Avon Reservoirs are shown in Figure 2. Cordeaux Reservoir is approximately 3km east of the proposed longwalls. At this distance, the lake is not predicted to experience any measurable mine subsidence movements. It is not expected, therefore, that the lake would experience any impacts from the subsidence resulting from the extraction of the longwalls.

The western ends of Longwalls 11 to 18 lie within the Avon Notification Area. As was the case for Areas 1, 2 and 3A, none of the current and proposed Area 3B longwall extraction is undertaken below stored waters. Longwalls 9 and 10 are outside the Avon DSC Notification Area and Longwall 11 is just inside the Area. Longwalls 12 to 18, though partially within the Notification Area, are set back from the Avon Reservoir Full Storage Level (FSL) a minimum of 300m.

3.3.1 Impact Assessments for Avon Reservoir

Avon Reservoir is located at a distance of 300 metres from Area 3B longwalls, at its closest point. At this distance, the lake is predicted to experience conventional subsidence of less than 20mm as a result of mining. While it is possible that the lake could experience subsidence slightly greater than 20mm, it would not be expected to experience any significant conventional tilts, curvatures or strain.

The maximum predicted total upsidence and closure at Avon Reservoir, resulting from the extraction of proposed longwalls, are 40mm and 80mm, respectively,

The maximum predicted total upsidence and closure for Lake Avon, based on the Modified Layout, are slightly less than the maxima predicted based on the Previous Layout. The predicted valley related effects reduce due to the increased distances of the longwall commencing ends from the lake.

The lake could also experience far-field horizontal movements due to the extraction of the longwalls. The predicted far-field horizontal movements at Lake Avon, based on the Modified Layout, are slightly less than those predicted based on the Previous Layout.

The Avon Dam Wall is located approximately 7 km north-west of the commencing ends of Longwalls 15 to 18. At this distance, the dam wall is not expected to experience measurable mine subsidence movements due to the extraction of these longwalls.

The assessed levels of potential impact for Lake Avon slightly reduce as a result of the proposed modifications to the commencing ends of Longwalls 15 to 18. The recommendations and the management strategies for the lake, therefore, do not change from those previously provided in Reports Nos. MSEC459, MSEC651, MSEC652, MSEC785, MSEC792, MSEC865 and the SMP Application.

A cross-section through Lake Avon and Longwall 16, where the lake is located closest to the proposed longwalls, is shown in Figure 6. It can be seen from this figure that the stored water in the lake is located outside the 35 degree angle of draw line from the proposed longwalls.

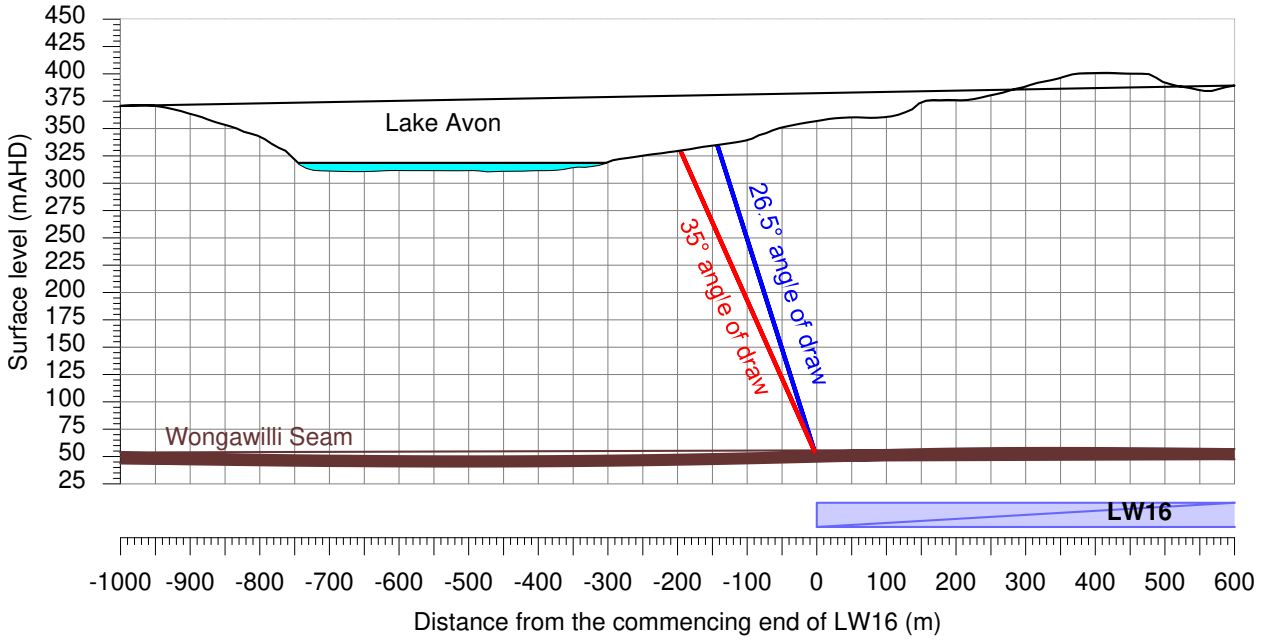


Figure 6 : Cross-Section through the Lake Avon and the Proposed Longwall 16

Directly above the proposed longwalls there is likely to be a significant increase in the conductance of the strata within the collapsed zone and, to a lesser extent, within the fractured zone. These zones are located well inside the 26½ degree angle of draw lines from the goaf edges of the longwalls.

A detailed assessment of the potential impact of the proposed mining on groundwater has been undertaken by Hydrosimulations (2015) and Hgeo (2017).

Hgeo was engaged by South32 to assess groundwater conditions at borehole S2314A, located between Lake Avon and Longwall 13 in Dendrobium Mine Area 3B (HGEO, 2017). Borehole S2314 was drilled in July 2015 to monitor baseline groundwater conditions within the barrier zone between Lake Avon and Longwall 13. The site was redrilled in August 2017 (S2314A), following the start and partial completion of Longwall 13 to assess changes in the rock mass and groundwater conditions at the site, associated with the passage of Longwall 13.

A simple calculation was made of the potential seepage from the reservoir to the mine using Darcy's Law and the elevated permeability profile observed in the post-Longwall 13 borehole S2314A. The approach is conceptually very similar to that used by SCT (2016), but assumes that seepage occurs through all strata between the base of the lake and the Avon Full Supply Level.

The results indicate that, using conservative assumptions, lateral seepage from the reservoir to the fracture zone overlying the longwall goaf would be no greater than 0.44 ML/day per km of shore length. This estimate is based on the elevated permeability profile observed in the post-Longwall 13 borehole S2314A, and is approximately five times the estimated seepage rate per km using the pre-Longwall 13 permeability profile from S2314. By multiplying the higher (S2314A) seepage estimates by the cumulative length of lake shoreline adjacent to each longwall, the (maximum) cumulative seepage rate can be determined. In reality, the incremental seepage rate will decrease as the longwalls progress southward and the Native Dog arm of the reservoir becomes shallower upstream.

3.3.2 Impact Assessment for the Reservoir based on Increased Predictions

If the actual subsidence at Avon Reservoir exceeded the prediction by a factor of five times, the maximum predicted subsidence would still be less than 20mm and not be significant.

If the actual upsidence and closure movements exceeded the predictions by factors of two times, it is possible that more fracturing could occur in the bedrock beneath Avon Reservoir, within 400m of the

proposed longwalls.

Any fracturing resulting from the valley related movements within the Avon Reservoir would still be expected to be less than 15m depth (SCT, 2003 and Mills and Huuskes, 2004 and BHP Billiton Illawarra Coal, 2006 and Mills, 2009) and unlikely to result in loss of water from the lake. A detailed assessment of the impact of the proposed mining on the conductance of mining impacted strata has been undertaken by Hydrosimulations (2015), Parsons Brinkerhoff (2015), SCT (2017) and Hgeo (2017).

3.3.3 Dendrobium Regional Groundwater Model

The Area 3B SMP approval conditions stipulated further development of the Dendrobium numerical groundwater model by 31st October 2013. Relevantly, Condition 13 states:

- *The Applicant must address the following water storage performance measures for Avon Reservoir including:*
    - *negligible reduction in the quantity of surface water inflows to the reservoir;*
    - *negligible reduction in the quantity of groundwater inflows to the reservoir; and*
    - *negligible leakage from the reservoir to underground mine workings.*
- *The Applicant shall ensure the development does not result in reduction (other than negligible reduction) in the quality or quantity of surface water or groundwater inflows to Lake Cordeaux or Lake Avon or surface water inflow to the Cordeaux River at its confluence with Wongawilli Creek.*

To address the SMP requirements, the groundwater model was enhanced by HydroSimulations (2013). Following this work further enhancements of the HydroSimulations (2013) model were requested by DoPE, including these relevant to the Reservoirs:

- Revise the simulated height of fracturing used by HydroSimulations (2013), using a method such as that of Ditton (2012).
- Revise the method used to simulate the fractured zone by HydroSimulations (2013), using time-varying material properties to simulate an enhanced permeability zone (EPZ) rather than stacked MODFLOW drain boundaries.
- Extend the calibration period to include shallow groundwater calibration sites in Area 3B.

HydroSimulations limited the calibration to the same period as used by Coffey (2012b), namely 1st March 2005 to 4th November 2009.

These additional requirements have been addressed and the Dendrobium Regional Groundwater Model was updated based on the assessment. The following results were obtained from the revised groundwater model:

- In the case of the Avon Reservoir, the simulated maximum total reduction in reservoir storage as a result of mining Area 3B is 0.56ML/day; of this, the induced leakage from the reservoir is about 0.13ML/day; the remainder is due to diverted baseflow and reduction in surface water inflows. This maximum is reached approximately 20 years post-mine cessation (i.e. post-2023). The maximum cumulative impact on Avon Reservoir leakage to groundwater from Dendrobium mine Areas 1, 2 and 3 is 0.13 ML/day, whilst the maximum total cumulative impact is 0.94 ML/day.
- In the case of the Cordeaux Reservoir, the simulated maximum total reduction in reservoir storage as a result of mining Area 3B is 0.045ML/day; of this, the induced leakage from the reservoir is about 0.004ML/day. This maximum is reached approximately 25 years post- mine cessation (i.e. post-2023). The maximum cumulative impact on Cordeaux Reservoir leakage to groundwater from Dendrobium mine Areas 1, 2 and 3 is 0.03ML/day, whilst the maximum total cumulative impact is 0.8ML/day. The estimated effects on groundwater discharge to and leakage from Lake Avon are considered negligible.

In terms of water quality impacts to the reservoirs, the simulated impacts will if anything pose a net benefit, given that the electrical conductivity of groundwater in the area is typically higher than that of runoff and water in reservoir storage, and hence any reduction in groundwater discharge into the reservoirs is likely to have a positive, albeit unmeasurable effect on water quality.

The SMP Approval for Longwalls 14 and 15 required further updates of the groundwater model. These updates are currently in progress and will be available prior to the commencement of Longwall 14.

3.3.4 Potential for Connectivity to the Mine

The fracture zone comprises in-situ material lying immediately above the caved zone which have sagged downwards and consequently suffered significant bending, fracturing, joint opening and bed separation (Singh and Kendorski, 1981; Forster, 1995). Where the panel width-to-depth ratio is high and the depth of cover is shallow, the fracture zone would extend from the seam to the surface. Where the panel width-to-depth ratio is low, and where the depth of cover is high, the fracture zone would not extend from the seam to the surface.

It should be noted that the theoretical height of the fracture zone should be viewed in the context of fracturing only and should not necessarily be directly associated with an increase in permeability.

There are numerous models for the height of fracturing and height of desaturation. A review of these matters was conducted for the Bulli Seam Operations Project Response to PAC deliberations (Hebblewhite 2010). Another review has recently been published by DPE (PSM, 2017).

The Regional Groundwater Models at Dendrobium use site specific data to determine the height of desaturation. Dendrobium monitors in excess of 1,000 piezometers in ~100 boreholes and has analysed many thousands of samples for field parameters, laboratory analysis, algae and isotopes.

The results of water analysis and the interpretation of the height of connective fracturing was peer reviewed by Parson Brinckerhoff (2012). The peer review states that "the use of standard hydrogeochemical tools clearly demonstrated the geochemical difference between water from the Wongawilli Coal Seam and goaf, and the overlying sandstone formations and surface water from Lake Cordeaux". Although the report acknowledged limitations of the available data, this review is based on one of the most comprehensive datasets available in the Southern Coalfield. On the basis of the available data and the Parson Brinckerhoff (2012) review, Illawarra Coal considers that the height of desaturation used for the Dendrobium Groundwater Models is conservative.

In January 2015 SRK Consulting conducted a detailed independent review of the Dendrobium water chemistry data, to:

- Assess the level of detail, quality of science, depth and technical appropriateness of the water chemistry data.

- Evaluate associated interpretations in relation to underground operations of Dendrobium Mine, with specific focus on how these address the question of hydraulic connectivity between the mined areas and the reservoirs.

Based on the review SRK concluded that the observed geochemical trends are not consistent with a high degree of hydraulic connectivity between the underground workings and the surface water bodies.

Evidence from piezometer monitoring can provide useful data points to ascertain whether there is direct connectivity to the collapsed zone or not. The following relationship between caving/fracture zones and groundwater effects can be noted:

- The collapsed zone will consist of broken rock material through which there is potential for significant increases in both horizontal and vertical permeability.

- Above the collapsed zone there is potential for significant increases in horizontal permeability.
- There is not expected to be open-path continuous vertical fracturing above the collapsed zone.

The height of fracturing based on significant bed separation and dilation as measured by extensometers does not necessarily imply that vertical permeability is increased. Extensometer readings of fracturing and bed separation resulting in horizontal permeability increases can occur without corresponding increases in vertical permeability.

Parson Brinckerhoff and IC have completed testing to characterise the pre and post mining permeability above Longwall 9, the first longwall in Area 3B (PB, 2015). After Longwall 9 mined under the site it was tested to quantify the change to vertical and horizontal permeability of the strata, including the Bulgo and Hawkesbury Sandstones as well as the Bald Hill Claystone. The testing involved core, packer and borehole interference testing, groundwater flow and tracer testing.

Mining of Longwall 9 resulted in a significant increase in fracturing compared with pre-mining. Down-hole camera surveys identified a number of open horizontal and inclined fractures with apertures of several centimeters. Groundwater ingress was noted at several open fractures.

Most post-mining test bores showed decreases in groundwater level and strong downward hydraulic gradients. Groundwater levels in the shallow Hawkesbury Sandstone were observed to remain perched at the study site for a short monitored period.

Horizontal hydraulic conductivity increased between one to three orders of magnitude due to mine subsidence and strata fracturing. Increases in hydraulic conductivity are observed in every geological unit, but are greatest below the base of the Hawkesbury Sandstone.

In contrast to pre-mining testing in which no breakthrough was observed, horizontal tracer testing after the passage of Longwall 9 resulted in breakthrough in about 40 minutes. This indicates a bulk hydraulic conductivity in the order of 10m/day; at least two orders of magnitude higher than pre- mining conditions.

No breakthrough in tracer was observed in either the pre-mining or the post- mining tests through the Bald Hill Claystone, indicating that the vertical conductance was below the detection limit of the test, estimated to be approximately 0.7m/day. Post-mining testing did however, also indicated that the claystone was strongly fractured and permeability increased following passage of the longwall.

Estimates for the height of fracturing at Dendrobium based on published methods range from 122m to 357m. This range in estimates is large and presents a challenge to those wishing to model hydrogeological impacts of mining on a regional scale based on mine site data.

3.3.5 Recommendations for the Reservoir

IC will consult with WaterNSW and NSW Dams Safety Committee in relation to management of any potential impacts on Avon Reservoir. Management strategies have been developed and implemented to ensure that there is no unacceptable water loss from the lake. With these management strategies and actions in place, it is unlikely that there would be any significant impacts on the lake resulting from the mining.

Monitoring, Contingency and Closure Management Plans have been developed and endorsed by NSW Dams Safety Committee for the Cordeaux Reservoir for Areas 1, 2, 3A and (part) Area 3B. Updated Management Plans for the Area 3B operations have been submitted to NSW Dams Safety Committee (DENMP0072)

3.3.6 Risk Assessments and Management Plans

There have been risk assessments carried out for mining in Areas 1 and 2 by HMS Consultants, Area 3A SMP by AXYS Consulting in August 2007 and Area 3B was reviewed in September 2016 following DSC feedback.. During these assessments inflow mechanisms and initiators were identified for the primary risk issues, being water storage loss from the reservoir.

Potential failure mechanisms assessed as being credible, which may lead to such a loss of water were identified. Controls were identified for each potential hazard and these formed the basis of the Management and Action Response Plans that direct operations within Area 1, Area 2 and Area 3A to limit losses from the Cordeaux Reservoir to within limits imposed by the NSW Dams Safety Committee.

These are described by the NSW Dams Safety Committee as "Tolerable Loss of Dam Water" and are a loss of more than 1ML/day long-term and 2ML/day short-term for the Cordeaux Reservoir and a sustained loss of 1ML/day for Avon Reservoir.

To assist the Mine identify and control hazards associated with the loss of water and damage to the Reservoirs, the following hazards have been identified as potential causes for loss of water into Dendrobium Mine:

- Inflow from sub-vertical, through-going geological structure connected to the Reservoirs (such as diatreme, fault, dyke, fault associated with dyke, joint or joint swarm). A specific plan has been prepared for the potential inflow along the Dendrobium Dyke into Area 3A at the request of the NSW Dams Safety Committee;

- Inflow from low angle through-going geological structure connected to the Reservoirs (faults, sills, bedding, bedding plane shears) resulting from intersection during extraction of longwall panels and goaf formation;

- Inflow through the longwall caved zone due to:

  - Intersection with high permeability strata or zones that connect with the Reservoirs, or

  - Inflow from fractures associated with valley closure and upsidence with high permeability zones, or

  - 'Through going' structure;

- Inflow through fractured rockmass associated with igneous intrusions, causing hydrogeological connection with Reservoirs;

- Inflow via abandoned exploration borehole(s);

- Underground mining in a regional context impacting on Reservoir walls;

- Seal bypass or failure as a result of increased head of water against seal or strata failure or leakage around seal resulting in outflow of stored

water from the mine portals;

- Inflow through fractured rockmass associated with igneous intrusions, causing hydrogeological connection with the Reservoirs (e.g. Cordeaux Crinanite);

- Inflow through horizontal shear planes that exist naturally and others that are likely to form as a result of downslope movements associated with mining subsidence; and
- Failure of the NSW Dams Safety Committee Management Plan and/or the

Contingency Plan to reduce flows to acceptable levels.

Prior to the installation of permanent hydraulic seals the Review Team will evaluate all closure options and recommend actions to be authorised by NSW Dams Safety Committee.

The potential for loss of Stored Water from the Avon Reservoir whilst mining Area 3B was considered in a risk assessment held in February 2014 which was conducted by AXYS Consulting. The objective of the assessment was to assist Illawarra Coal control identified risks associated with the mining of Longwalls 12 to 18 which may cause the loss of stored water.

The following hazards were identified as potential causes for such losses:

- Water inflow from the Avon Reservoir into the Dendrobium Mine workings (existing mine plan). Loss of stored water. Porous flow outside the influence of mining, fracture flow within the mining induced fracture zone.
- Water inflow from the Avon Reservoir into Wongawilli Creek or Dendrobium Mine workings. Loss of stored water. Basal shear creates high conductivity zone between Avon Reservoir and the extent of goaf fracturing.
- DF11 Elouera Fault Zone (DF11) acts as a conduits between the Avon Reservoir and the mine workings (development or longwall) resulting in loss of stored water.
- Aeromag Fault (NW-1) acts as a conduit between the Avon Reservoir and the mine workings (development or longwall) resulting in loss of stored water.
- Aeromag Dyke (NNW-2) acts as a conduit between the Avon Reservoir and the mine workings (development or longwall) resulting in loss of stored water.
- Unsealed borehole within the Notification Area acts as a conduit between the Avon Reservoir and the mine workings (development or longwall) resulting in a loss of stored water. Assumes that borehole intersects high conductivity Basal Shear zone.
- Unknown geological structure within the Notification Area like the potential WSW extension of DF37 acts as a conduit between the Avon Reservoir and the mine workings (development or longwall) resulting in loss of stored water.
- Seismic event changes hydraulic conductivity of geological structures between the Avon Reservoir and the mine workings (development or longwall).

The following Plans have been developed (amongst other purposes) to reduce the risk to the stored waters as low as reasonably practicable:

Inundation or Inrush of any Substance – Principal Hazard Management Plan DENMP0005. This Plan addresses all issues concerning potential Inrush into Dendrobium Mine, one of which is related to surface waters

The Cordeaux Dam Notification Area - Monitoring Management Plan DENMP0003. This Plan defines the monitoring undertaken to assess the volume and provenance of the water entering the mine, specifically to understand if water from the dam is reporting to the workings.

The Cordeaux Dam Notification Area - Contingency Plan DENMP0049

This Plan defines the remedial actions to be taken should seepage or inflows from Cordeaux Reservoir exceed pre-defined levels. The Contingency Plan is based on key criteria of acceptable short and long term loss of water from the reservoir that was determined by the WaterNSW and NSW Dams Safety Committee.

The Cordeaux Dam Notification Area - Closure Plan DENMP0030. This Plan defines the strategy and details relating to the construction and monitoring of seals within the mine in the event of:

- The need to seal the mine at the completion of operations; or
- The need to seal the mine upon failure of the Inrush Management Plan provisions to control an inrush, or
- The need to seal the mine upon failure of the Contingency Plan provisions to control inflows from the Reservoirs below limits set by the NSW Dams Safety Committee.

These Plans are in place and endorsed by NSW Dams Safety Committee for Area 1, Area 2 and Area 3A operations.

Avon and Cordeaux Reservoirs DSC Notification Area – ManagementPlans DENMP0078

The purpose of the Avon and Cordeaux Reservoirs DSC Notification Area Management Plan is to define the standards, procedures and responsibilities required to:

- Clearly describe the monitoring requirements to detect potential impacts on the Cordeaux and Avon Reservoirs,
- Maintain a system for effectively managing the risk of inflow of stored water into the Mine, and
- To protect the long term security of the dams and stored waters from any deterioration that may be caused directly or indirectly by operations associated with Dendrobium Mine.

The Plan applies to all development and longwall extraction – i.e. first and second workings within the DSC Avon and Cordeaux Reservoirs Notification Areas and other underground areas and operations at Dendrobium Mine.

Dendrobium is currently mining Longwall 13.

DSC conditions for mining in the Notification Areas were detailed in their correspondence of the 24th December 2008, 22nd December 2009, 22nd November 2010 and the attached DSC Annexure's 'D' (Standard Mining Conditions), 'D1' (Special Mining Conditions) and 'E' (Frequency of Monitoring and Reporting).

The DSC wrote to IC 15th July 2014 to indicate their requirements for mining within the Avon Notification Area. The following requirements have been addressed in the Avon and Cordeaux Reservoirs Dams Safety Management Plan:

- Water chemistry data is reviewed by an independent expert.

- Boreholes are established between the mine workings and the Avon Reservoir. The purpose of the boreholes would be to monitor the pressure heads in strata and to sample formation waters. Boreholes should be established in time to provide baseline data before Longwall 12 commences.

- Water sampling and analytical programme as well as interpretation to continue while mining progresses in Area 3B.

- A comprehensive review/analysis of water chemistry and piezometer data for Areas 2, 3A and 3B. The review should include a discussion of the deficits in the current sampling regime.

The Dam Safety NSW wrote to IC 15th June 2016 to indicate their requirements for mining Longwall 13 within the Avon Notification Area. Additional information required by the DSC includes the results, analysis and interpretation of the redrilling of boreholes at S2313 and S2314 as per the conditions in Appendix D1 of the Approval Dendrobium - 7. This condition refers to the permeability of shear planes in the area between the FSL and Longwalls 12 to 14. Analysis and interpretation of piezometers and water chemistry in this area is ongoing (SCT, 2016) and (HydroSimulations, 2016).

The successful mining within Dendrobium Area 1, Area 2 and Area 3A with no significant inflow of water from the Cordeaux Reservoir provides confidence that mining adjacent to the Avon Reservoir has an acceptable risk. The systems and management plans developed in consultation with NSW Dams Safety Committee for Areas 1, 2, and 3A have enabled NSW Dams Safety Committee to confirm in its

2012/13 Annual Report that "the Dendrobium Mine completed further extraction from Cordeaux Dam Notification Areas without adverse effects".

Area 3B is a relatively simple sequence of sedimentary stratigraphy and there are no complications associated with overlying workings. The longwall domain is between geological features that have negligible risk of providing a conduit from the reservoir to the workings. Longwall mining over a period of 10 years has not resulted in any measurable reservoir water reporting to the mine.

Dendrobium has installed and is currently monitoring an extensive array of piezometers in the area. In addition, the underground water balance and chemistry sampling provides data that can be used to trigger actions within the Avon and Cordeaux Reservoir Notification Area Contingency Plan.

IC believes the proposed mining in Area 3B presents a tolerable risk to Avon Reservoir and that the Area 3B SMP performance measures for Lake Avon will be met.

4 PREVENTATIVE AND REMEDIAL MEASURES

Table 5 summarises the predicted subsidence impacts and proposed preventative or remedial measures.

Table 5 : Summary of Subsidence Impacts with Associated Preventative or Remedial Measures

WaterNSW Infrastructure	Subsidence Impact Predictions	Reference	Management Strategy
Unsealed Roads + Culverts	• Maximum predicted total subsidence along typical Fire Trails 6A, 6N & 6Q of 3500 mm. • Maximum predicted travelling tilt along typical Fire Trails 6A of 35-40 mm/m.	MSEC914	• Actions will be carried out in accordance with the "Subsidence Management Plan" and associated TARP document. This will include o Monitoring during extraction of LW 9-18 o Baseline survey and monitor condition of road as mining occurs o Repair and/or re-grading as appropriate as specified in SMP TARP
Stored Waters in Avon and Cordeaux Reservoirs	• Lake Cordeaux is not expected to experience any subsidence impacts • Lake Avon is predicted to experience subsidence in Area 3B of < 20mm • Maximum predicted total upsidence in Area 3B will be 40 mm • Maximum predicted total closure in Area 3B will be 80mm	MSEC914 Lake Avon Risk Assessment Lake Avon and Cordeaux NSW Dams Safety Committee Notification Area Management Plan	• Liaise with the asset owner and NSW Dams Safety Committee and address under the provisions of the Management Plans (see below). These include Monitoring, Contingency and Closure Plans including Trigger Action Response Plans (TARPs).

The impacts of subsidence on man-made surface features and infrastructure, due to mining the longwalls, are considered to be manageable. With appropriate management plans in place all items of surface infrastructure can be maintained in a safe and serviceable condition throughout and after the mining.

4.1 MONITORING

Monitoring will be conducted according to the provisions of the WaterNSW Assets Management Plans specified in Section 4.3 (and detailed as Appendices A, B and C) and to the standards that will be defined within the NSW Dams Safety Committee Avon and Cordeaux Reservoirs Management Plan.

4.2 WATERNSW ASSETS MANAGEMENT PLANS

The predicted subsidence effects, monitoring and preventative and/or remedial measures for infrastructure are detailed in WaterNSW Assets Management Plans developed in consultation with WaterNSW. The Plans are:

1. WaterNSW Assets (including stored waters) for Area 3A (as documented in Revision 4 of the APP) – Appendix A.

2. WaterNSW Assets (including stored waters) for Area 3B- Appendix B.

5 MASTER AGREEMENT

A Master Agreement letter has been sent to WaterNSW by IC specifically for the development of Area 3A and Area 3B roadways and the extraction of Longwall 9 to 13 similar to that developed in relation to preceding longwalls. WaterNSW will be financially protected against mining impacts. Heritage values will be protected in accordance with heritage approvals. Appendix C details that the terms of the existing Master Agreement (Area 1, 2 and 3A) will remain valid for development drivages and Longwall extraction of Area 3B until Umbrella and Master Agreements for IC operations impacting on WaterNSW assets are developed.

6 QUALITY ELEMENTS

6.1 AUDIT REVIEW AND REPORTING

The provisions described in the APP will be reviewed and the results of the review may be used to initiate a revision of the Plan.

The Asset Protection Plan will be audited within the IC Management System. A comprehensive review of the objectives and targets associated with the Dendrobium Area 3 operations is undertaken on an annual basis via the IC Balanced Planning (1 year outlook) and Balanced Strategy (5 year outlook) processes. These reviews, which include involvement from senior management and other key site personnel, assess the performance of the mine over the previous year and develop goals and targets for the following period.

An annual review of the environmental performance of Dendrobium Area 3 operations will also be undertaken in accordance with the Consent Condition 5 Schedule 8. More specifically this APP will be subject to review (and revision if necessary, to the satisfaction of the Secretary) following:

- The submission of an annual review under Consent Condition 5 Schedule 8.
- The submission of an incident report under Consent Condition 3 Schedule 8.
- The submission of an audit report under Consent Condition 6 Schedule 8.
- Any modification to the conditions of this approval.

If deficiencies in the EMS and/or APP are identified in the interim period, the plans will be modified as required. This process has been designed to ensure that all management measures continue to meet current requirements, including changes in technology and operational practice, and the expectations of stakeholders. Regular meetings will be held between IC, WaterNSW and the NSW Dams Safety Committee to review the progress of the mining related activities that may impact on the surface assets described in the APP.

Copies of all relevant reports will be provided to NSW Dams Safety Committee and WaterNSW. The NSW

Dams Safety Committee Monthly report (including compliance report) will be provided to WaterNSW.

6.2 PERSONNEL RESPONSIBILITIES

Dendrobium Mine Operations Manager

The Manager will ensure that the resources required by the APP are provided as and when required by any Official with defined responsibilities.

Principal Surface Infrastructure Protection

The Manager Infrastructure Protection will:

- Be IC's Authorising Officer for the APP.
- Attend liaison meetings with WaterNSW on a regular basis to review the progress of all mining related activities, which may impact on WaterNSW infrastructure and discuss and assess those impacts.
- Be IC's representative to provide liaison and notification of monitoring results (including anomalies) to WaterNSW.
- Provide advice to the Principal Approvals if there is mining related impacts on the WaterNSW infrastructure.
- Participate in any review and amendment of the APP.
- Ensure the subsidence surveys and monitoring requirements on surface infrastructure are carried out in accordance with the requirements of the APP.

Principal Approvals

The Principal Approvals will:

- Attend liaison meetings with NSW Dams Safety Committee to review the progress of all mining related activities, in relation to relevant approval conditions.
- Be IC's representative to provide regular reports and notification of monitoring results (including anomalies) to NSW Dams Safety Committee.
- Participate in any review and amendment of the APP.
- Ensure data, records and reports relating to the APP are forwarded to relevant parties and kept in accordance with the provisions of the APP.
- Be a member of the NSW Dams Safety Committee water monitoring team which meets regularly.
- Shall advise the Principal Surface Infrastructure Protection and the Dendrobium Mine Operations manager of any issues in relation to the APP that require their attention or action.

6.3 RECORD KEEPING AND CONTROL FOR RELIABILITY

Data derived from the APP will be archived and stored for a period of at least 5 years. Reports containing information relating to monitoring, inspections and observations, relevant correspondence, notification and approvals, records of communication, particularly with statutory authorities, audit reports and review recommendations shall be maintained for a period of at least 2 years.

Reports relating to any remedial actions taken in relation to surface structures or the stemming of flows from Avon or Cordeaux Reservoir shall be kept for a period of at least 5 years.

Illawarra Coal uses the electronic data control system "Documentum".

6.4 DOCUMENT CONTROL

The APP shall be controlled as part of the IC Document Control System. Modifications to the APP or the standards and procedures that are referenced by the Plan may occur as a result of the auditing and review process, the assessment and implementation of a corrective action or as a result of system improvements or

modifications. The Principal Surface Infrastructure Protection, in consultation with WaterNSW shall approve all modifications and amendments to the APP or associated documentation.

The Principal Surface Infrastructure Protection shall delegate, to an appropriately qualified person, the responsibility to document any changes to the APP, decide the personnel who are to receive controlled copies of the Plan and its associated standards and procedures.

The APP forms part of the Dendrobium SMP which requires approval by DoPE.

6.5 DOCUMENT HISTORY AND DISTRIBUTION

Revision	Date	Description
Drafts A to H	To 19/11/04	Versions – for consideration of the WaterNSW
0	9/03/05	Initial – for WaterNSW Approval of Area 1
1	28/4/05	Finalised Plan incorporating modifications to gain WaterNSW endorsement
2-Draft 1	26/10/06	Update to incorporate LW 2 extension and mining of Area 2 and results of audit carried out after completion of Longwall 1
2-Draft 2	22/2/07	Incorporate WaterNSW comments received 1/2/07
2	15/3/07	Finalised Plan incorporating WaterNSW comments received 14th March 2007
3-Draft 1	18/7/08	Revised to incorporate changes to Area2 LW layout including the addition of LW 5A and the recommendations of the audit carried out after LW 2 & 3
3-Draft 2	20/11/08	Revised to incorporate the shortening of Longwall 5 and the removal of the proposed Longwall 5A.
3	28/11/08	Finalised Plan covering Areas 1 and Area 2 incorporating WaterNSW comments received 27/11/08
4-Draft 1	30/7/09	Plan revised to cover Area 3A Longwalls 6 to 10 Previous Area still covered by Revision 3
4-Draft 2	23/10/09	Plan updated to incorporate comments provided by WaterNSW
4-Draft 3	19/2/10	Plan updated to incorporate comments provided by WaterNSW
4-Draft 4	7/4/10	Plan updated to incorporate comments provided by WaterNSW on Draft 3 and modified Area 3A layout
4		Finalised Plan covering Area 3A
5-Draft 1	3/8/12	Plan revised to cover Area 3B Longwalls 9 and 10.
5-Draft 2	12/11/12	Plan updated to incorporate comments provided by WaterNSW.
5	20/12/12	Comments and changes accepted and Plan finalised
6	21/3/13	Finalised Plan covering Area 3B, Longwalls 9 to11
7- Draft	November 2014	Plan covering Area 3B, Longwalls 12 & 13
7a	September 2015	Update following WNSW feedback
7b	February 2016	Update following additional WNSW feedback
7c	August 2016	Updated for Longwalls 13 - 18
8	September 2017	Updated for Longwall 14 and 15

The APP will be updated from time to time as agreed and approved and be provided to:

1. NSW Dams Safety Committee

2. WaterNSW

3. Principal Approvals

4. Principal Surface InfrastructureProtection

5. Dendrobium Mine Manager

6. Dendrobium Mining Engineer

Persons using uncontrolled copies must be mindful to ensure that they have the most up-to-date version before they apply any provisions. WaterNSW will be provided with an electronic copy of the current APP and all the Appendices.

7 ASSOCIATED DOCUMENTATION AND REFERENCES

AXYS, 2016. South 32 Illawarra Coal – Loss of Stored Water from Avon Reservoir Risk Assessment Report. AR1664 Revision 3. 8 September 2016

BHP Billiton Illawarra Coal, 2006. Georges River Report: Assessment of Georges River Remediation Longwalls 5A1-4. November 2006.

Cardno Forbes Rigby, 2007. Area 3A Subsidence Management Plan Longwalls 6 to 10. Prepared for BHPBIC.

Cardno Forbes Rigby, 2007. Dendrobium Area 3 Environmental Assessment. Prepared for BHPBIC.

Coffey, 2012. Groundwater Study Area 3B Dendrobium Coal Mine: Numerical Modelling. GEOTLCOV24507AA-AB2 2 October 2012.

Ditton, S., and Merrick, N.P. 2014. A new sub-surface fracture height prediction model for longwall mines in the NSW coalfields. Paper presented at the Australian Earth Science Convention, Newcastle, NSW.

DGS, 2016. Review of Sub-Surface Fracture Height Predictions for the Proposed Lws 14 to 18 in Area 3B and LW19 in Area 3A at Dendrobium Mine. Dated 26/5/16

EcoEngineers, 2007. Surface Water Quality and Hydrology Assessment to Support SMP Application for Dendrobium Area 3.

Ecoengineers, 2012. Surface Water Quality and Hydrological Assessment: Dendrobium Area 3B Subsidence Management Plan Surface and Shallow Groundwater Assessment.

Forster, 1995. Impact of Underground Mining on the Hydrogeological Regime, Central Coast NSW. Engineering Geology of the Newcastle-Gosford Region. Australian Geomechanics Society. Newcastle, February 1995.

GHD, 2007. Dendrobium Area 3A Predicted Hydrogeologic Performance. Report for BHP Billiton, Illawarra Coal. November 2007.

Hebblewhite, 2010. BHP Billiton Illawarra Coal: Bulli Seam Operations Project – Independent Review. 31 March 2010.

Helensburgh Coal Pty Ltd, 2007. Submission to: Independent Expert Panel - Inquiry into NSW Southern Coalfield July 2007, Helensburgh Coal Pty Ltd.

Heritage Computing, 2009. Dendrobium Colliery Groundwater Assessment: Mine Inflow Review, Conceptualisation and Preliminary Groundwater Modelling. Merrick, N.P., Heritage Computing Report HC2009/2, February 2009.

Heritage Computing, October 2011. Recalibration of the Dendrobium Local Area Groundwater Model after Completion of Longwall 6 (Area 3A). Report prepared for Illawarra Coal. Report HC2011/13.

Hgeo, 2017. South32 Dendrobium Mine – Assessment of changes in strata permeability at boreholes S2314 and S2314A, Dendrobium Mine Area 3B. Report D17274. September 2017.

HydroSimulations, 2014. Dendrobium Area 3B Groundwater Model Revision: Swamps, Stream Flows and Shallow Groundwater Strata. Report: HC2014/4 March 2014.

HydroSimulations, 2016. Review of Groundwater Levels at Dendrobium Mine (August 2016). Dated 14 September 2014.

Illawarra Coal, 2008. Dendrobium Mine, Environmental Management System, Asset Protection Plan Area 1 and 2, DENMP0040 Revision 3 dated 28/11/08.

Illawarra Coal, 2010. The Cordeaux Dam Notification Area – Monitoring Management Plan DENMP0003 - Rev 10 dated 6/4/10.

Illawarra Coal, 2010. The Cordeaux Dam Notification Area - Closure Plan DENMP0030 – Rev 4 dated 6/4/10.

Illawarra Coal, 2010. Dendrobium Mine, Environmental Management System, Asset Protection Plan Area 3A, DENMP0040 Revision 4 dated 14/4/10.

Illawarra Coal, 2011. The Cordeaux Dam Notification Area - Contingency Plan DENMP0049 - Rev 5 dated 22/2/11.

Illawarra Coal, 2012. Dendrobium Area 3B –Longwalls 9 to 18 Subsidence Management Plan Application; June 2012.

Mills, 2002. Assessment of the Effectiveness of a Slot for Protecting the Rock Bar at Marhnyes Hole – Georges River. West Cliff Colliery. Dated 19/6/02.

Mills, 2009. Damage Criteria and Practical Solutions for Protective River Channels. Dated 25/5/09.

MSEC, 2012. Dendrobium Area 3B Subsidence Predictions and Assessments for Natural Features and Surface Infrastructure in Support of the SMP Application.

MSEC, 2015. Dendrobium Area 3B – Longwalls 12 to 18 Review of the Subsidence Predictions and Impact Assessments for Natural and Built Features in Dendrobium Area 3B based on Observed Movements and Impacts during Longwalls 9 and 10.

MSEC, 2017. Dendrobium Mine – Area 3B. The effects of the Proposed Modified Commencing Ends of Longwalls 15 to 18 in Area 3B at Dendrobium Mine on the Subsidence Predictions and Impact assessments. MSEC901, Revision A. August 2017.

NSW Minister for Planning, 2001. Consent Conditions for Dendrobium Underground Coal Mine. Determination of Development Application Pursuant to Sections 76(A)9 & 80 File No. S00/01177.

NSW Minister for Planning, 2008. Consent Conditions for Dendrobium Underground Coal Mine. Notice of Modification pursuant to Section 75W, dated 8th December 2008.

OEC, 2001. Environmental Impact Statement Dendrobium Coal Project. Olsen Environmental Consulting, Figtree, N.S.W.

Parson Brinckerhoff, 2012. Independent Review of Dendrobium Area 2 and 3A Hydrochemical Data. August 2012.

Parsons Brinckerhoff, 2015. Connected fracturing above longwall mining operations, Part 2: Post-longwall investigation. For BHP Billiton Illawarra Coal. Document number 2172268F-WAT-REP-002 RevB. 6 March 2015.

Pells Sullivan Meynink (PSM), 2017. Height of Cracking – Dendrobium Area 3B, March 2017. For Department of Planning and Environment.

SCT, 2003. Mitigation and Remediation Activities at Marhnyes Hole – Georges. Dated 22/12/03.

SCT, 2016. Avon Reservoir: Basal Shear Inflow Assessment – Post Mining Update. Dated 5/9/16.

SCT, 2017. Review of Potential Interactions Between Dendrobium Mine and Avon Reservior: Longwall 13 Update. DEN4740. 6 September 2017.

Tammetta, P. (2013). Estimation of the height of complete groundwater drainage above mined longwall panels. Groundwater, 51(5), 723-734.

Appendix A

Management Plans for Area 3A

APPENDIX "A" -- WNSW Assets Management Plan for Area

Asset Item	Predicted Movement	Predicted Impacts	Monitoring		Mitigatory or Preventative Measures
			Type	Frequency	
Cordeaux Dam	• Unlikely to be subject to any significant systematic or valley related movements. • Unlikely to be subjected to any significant far-field horizontal movements.	Negligible	Nil	Nil	Nil
Upper Cordeaux No2 Dam	• Less than 2mm subsidence-survey tolerance • Expected to be less than Area 1 • Area 2 LW expected to redistribute any in situ horizontal stress • No influence expected from Area 3B	Negligible.	• *Water NSW (*SCA) to carry out normal dam surveillance.	As Required	Nil
Fire Trails and 4WD tracks	• Predicted subsidence up to 2275mm • Predicted Travelling Tilt 21mm/m • Predicted Travelling Tensile strain 4.5mm/m • Predicted Travelling Compressive Strain is 11mm/m.	• Cracking in unsealed surfaces of roads. • Bucking and cracking in bedrock.	• Visual inspection by IC personnel. • Additional visual inspections by asset owner during their routine operations.	• Pre-mining survey of roads to be carried out. • In accordance with SMP s19.5. ie nominally 6mthly increasing to monthly during active subsidence areas. (ie 100m in front of LW to 400m behind) • Resulting from any reports	Repairs and/or minor regrading as applicable and as necessary as mining occurs.

Items of Historical and Heritage Significance. (not including Dam Walls) at the Upper Cordeaux No 2 Dam site.	• Unlikely to be subject to any significant systematic or valley related movements. • Unlikely to be subjected to any significant far-field horizontal movements.	• Negligible	• Nil	• Nil	• Nil
Stored Waters in Cordeaux Reservoir	• Max. Predicted Subsidence of lake <20mm. • Max Predicted Upsidence 20mm at LW 6 to 120mm at LW 10. • Max predicted closure of 50mm at LW 6 and 180mm at LW 10. • Potential for water losses from Cordeaux Reservoir, where considered to be credible, are assessed generally as 'low' to 'very low'.	• Predicted systematic subsidence <20mm • Possible minor isolated cracking in bed of Lake. Potential Inflow mechanisms and likely initiating circumstances have been identified. The risk issues relate primarily to storage loss from the reservoir.	As per DSC Monitoring and DSC Contingency Plan provisions.	The frequency and triggers for monitoring are included in the DSC Contingency Plan.	Dendrobium has developed : • Inrush Management Plan, • DSC Contingency Plan, • DSC Closure Plan and • DSC Monitoring Plan to address the issues relating to the potential for leakage of Cordeaux Reservoir stored waters.

Appendix B

Management Plans for Area 3B

APPENDIX "B" -- WNSW Assets Management Plan for Area 3B

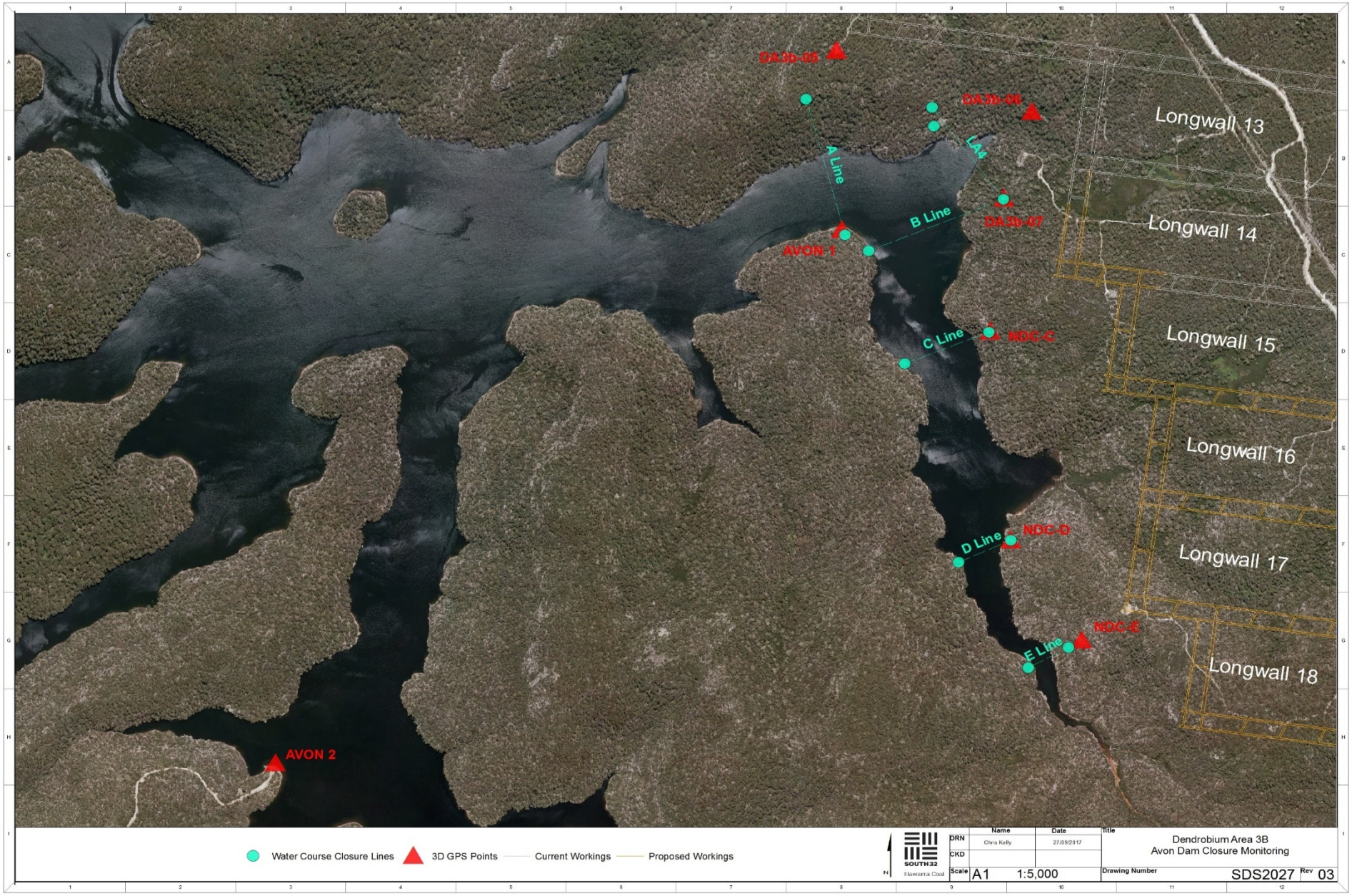
Asset Item	Predicted Movement	Predicted Impacts	Monitoring		Mitigatory or Preventative Measures
			Type	Frequency	
Unsealed Roads (including Fire Trails 6A, 6N & 6Q)	• Maximum predicted subsidence up to 3500mm • Maximum predicted Travelling Tilt along fire trails of 35-40mm/m	• Cracking in unsealed surfaces of roads • Buckling and cracking in bedrock	• Actions will be carried out in accordance with the "Subsidence Management Plan" (SMP) and associated TARP. This will include - Visual monitoring during extraction of LW 9-18	• Conduct initial baseline survey and monitor condition of road as mining occurs. • In accordance with the SMP	Repair and/or minor regrading as appropriate and necessary as mining occurs. As specified in SMP TARP
Drainage Culverts	• Could experience full range of predicted subsidence movements • Maximum predicted tilts could be 40mm/m • Maximum Predicted curvatures are both 1.2km^{-1}tensile and compressive	• Changes in culvert gradient • Cracking in concrete culverts	• Actions will be carried out in accordance with the "Subsidence Management Plan" and associated TARP. This will include - Visual monitoring during extraction of LW 9-18	• Conduct initial baseline survey and monitor condition of road as mining occurs. • In accordance with Subsidence Management Plan	Repair and/or minor regrading as appropriate and necessary as mining occurs.

APPENDIX "B" -- WNSW Assets Management Plan for Area 3B

Asset Item	Predicted Movement	Predicted Impacts	MonitoringS		Mitigatory or Preventative Measures
			Type	Frequency	
Stored Waters in Avon Reservoir	• Max. Predicted Subsidence of lake <20mm • Max Predicted Upsidence 40mm • Max predicted closure of 80mm • Unlikely to any significant impacts on the lake from proposed mining. (MSEC792. MSEC914)	• Predicted systematic subsidence <20mm • Possible minor cracking in bed of Lake • Shear plane development along bedding planes • Increased porosity between the goaf and the Lake Potential Inflow mechanisms and likely initiating circumstances have been identified for Lake Cordeaux and Lake Avon	• Total Station closure measurements to fixed prisms • Long occupation static GNSS (GPS) sessions for 3D positional moves • Monitoring bores between the goaf and the Lake See Plan S2027 for details of approximate position of marks.	• Start of Longwall extraction • Every 500m of extraction • End of longwall extraction • Pre-mining and post-mining	Dendrobium will update/develop and agree on the following: Inrush Management Plan, DSC Management Plan which incorporates Monitoring, Contingency and Closure Requirements to address the issues relating to the potential for leakage of Avon Reservoir stored waters

- This table summarises the TARP process which underlies the APP.
- IC will undertake the actions when the triggers have been exceeded in consultation with WNSW in a timely manner having regard to the nature of the trigger and actions required.

APPENDIX "B" -- WNSW Assets Management Plan for Area 3B



Appendix C

Master Agreement, Letter Extension

Illawarra Coal
South32
Innovation Campus
Enterprise 1 Bldg.
Level 3 Squires Way
NORTH WOLLONGONG
NSW 2500
PO Box 514
UNANDERRA NSW 2526
T +61 2 4286 3000
South32.net

19 December 2017

David Harris
Chief Executive Officer
Water NSW
PO Box 323
PENRITH, NSW, 2571
delivered via email

Dear Mr Harris,

RE: DENDROBIUM MASTER AGREEMENT

Area 3B Longwall Extraction

As has been discussed at the regular meetings between WaterNSW and South32 Illawarra Coal (Illawarra Coal), the Master Agreement between our two organisations in relation to Dendrobium Mine is not valid for Area 3B. We acknowledge that an Umbrella Master Agreement for all Illawarra Coal operations is being currently developed and is expected to be finalised in the future.

Illawarra Coal continues to support the fundamental premise of the Master Agreement that ensures:

- that WaterNSW should not be disadvantaged in any way due to mining activities that impact on the infrastructure,
- that WaterNSW requirements for water supply associated with the Cordeaux, Upper Cordeaux and Avon Reservoirs are met when the Mining Activity is undertaken, and
- that the structural integrity and heritage value of the associated infrastructure is protected when the Mining Activity is undertaken.

In return, WaterNSW will make every effort to ensure that mining is not unnecessarily delayed or impeded.

To this end, Illawarra Coal agrees that the current Master Agreement for Area 1 and its extension for Area 2 and Area 3A at Dendrobium Mine remains in place and is extended to cover the development driveages of Area 3B and the extraction of Longwalls (following development of appropriate APP documentation). This letter shall cease to be valid once the new Umbrella and Master Agreements are in place.

If there are any issues that you wish to discuss at any time please do not hesitate to contact me directly.

Yours Sincerely,

Lucas Dow
Vice President
South 32 Illawarra Coal

Illawarra Coal Holdings Pty Ltd
ABN 69 093 857 286

Registered Office 108 St Georges Terrace Perth WA 6000 Australia
ABN 84 093 732 597 Registered in Australia