

INDEPENDENT MONITORING PANEL FOR SPRINGVALE MINE

ADVICE RE:

**SPRINGVALE COAL MINE
EXTRACTION PLAN
LONGWALLS 428-432**

November 2021

EXECUTIVE SUMMARY

In June 2021, the Independent Monitoring Panel for Springvale Mine (the ‘Panel’) submitted an advice to the Department of Planning, Industry and Environment (DPIE, the ‘Department’) regarding the Extraction Plan proposed by Centennial Coal for Longwall Panels 428 to 432 (LW428-432). Subsequently, Centennial Coal has remapped and reclassified a number of hanging swamps (which have a performance measure of ‘negligible environmental consequences’ and no provision to offset exceedances) and provided a higher level of protection to some of these swamps as a result of reducing the lengths of LW431 and LW432.

On 12 August 2021, Mr Steve O’Donoghue, the Director – Resource Assessment, DPIE requested additional advice from the Panel. Specifically:

The Department requests the Panel review the response provided by Centennial Coal on the Panel’s advice and recommendations, and provide further advice on:

- *The proposed approach to protect the Newnes Plateau Hanging Swamps by stepping back longwalls by the angle of draw only for hanging swamps located below the YS4 aquitard.*
- *Whether the proposed monitoring set out in updated swamp monitoring plan is adequate to satisfactorily identify significant subsidence impacts and related environmental consequences on Newnes Plateau Hanging Swamps? If not, does the Panel have any further recommendations for the monitoring program?*
- *The revised Trigger-Action-Response Plans.*

The Panel should also feel free to provide any other advice it considers would assist the Department in reviewing the response.

The reader is referred to the main report for full responses to the Department’s request. In regard to its three specific questions:

- Inconsistencies in the identification and mapping of hanging swamps now appear to have been resolved in response to Panel queries. This has had implications for the mine design.
- The Panel does not fully endorse the hanging swamp impact model, specifically the role of YS4 aquitard, put forward by Centennial Coal, albeit that it has considerable merit. It considers that there are a number of additional factors that require further investigation and assessment.
- The Panel does not fully endorse the concept of angle of draw as a control to prevent some hanging swamps from experiencing more than negligible environmental consequences. However, there appears to be no other experience base to help inform a view.
- This advice includes an assessment by the Panel on a swamp-by-swamp basis of the potential for LW428-432 to impact hanging swamps.
- Recommendations are made for additional groundwater monitoring to assess shallow groundwater trends more comprehensively at a number of key sites.
- The Panel would be in a position to provide more detailed advice on the TARPs after the submittal of an updated consolidated Swamp Management Plan. In the interim, a number of improvements have been suggested.

Furthermore, it is also now clear from new and updated formation produced since the Panel’s June 2021 advice that the mine plan initially proposed for LW428-432 will result in significant environmental impacts on Marrangaroo Swamp and Marrangaroo Creek. The Panel considers that

these fall outside the consent conditions for the project. The Independent Monitoring Panel (i.e. this Panel) constitutes an element of the consent conditions and has obligations place upon it by the consent, one of which relates to advising on all possible adaptive management measures.

Accordingly, the Panel advises that:

- The proposal by Centennial Coal to reduce the lengths of LW431 and LW432 also goes some way to mitigating adverse environmental impacts on Marrangaroo Swamp and Marrangaroo Creek, subject to how the high permeability zone recently intersected immediately to the south of these panels behaves. Centennial Coal has advised that the zone is still under investigation.
- The length of LW430 should also be reduced so that, at the very least, Marrangaroo Swamp and Marrangaroo Creek fall outside the angle of draw of this longwall panel. This action would also reduce the likelihood of direct and indirect impacts to hanging swamps in the area.
- If the length of LW430 were to be reduced by an appropriate distance, some of the recommendations contained in this advice may become redundant.
- The Panel has previously advised that the length of LW429 should be determined on the basis of a cost-benefit analysis. That advice stands but the cost-benefit study should have regard to the latest predictions of subsidence impacts.
- It may be too late to reduce the length of LW428. However, the environmental impacts of not doing so are likely to be significantly less than for the other longwall panels in the series.
- Given the current state of knowledge and the time required to advance this knowledge, the Department should give consideration to a staged approval for progressing the Extraction Plan for LW428-432, with the initial approval being restricted to LW428 and LW429.

TABLE OF CONTENTS

1	SCOPE OF WORKS.....	1
2	SOURCE INFORMATION	2
3	PERTINENT ASPECTS OF PANEL’S JUNE 2021 ADVICE.....	3
4	ADVICE.....	4
4.1	Question 1	4
4.1.1	Identification and Reclassification of Swamps.....	4
4.1.2	Hanging Swamp Impact Model.....	8
4.1.3	Assessment of Potential for Impacting Hanging Swamps.....	11
4.1.4	Summary Answer to Question 1.....	13
4.2	Question 2	14
4.2.1	Groundwater Monitoring Requirements.....	14
4.2.2	Ecological Monitoring Requirements.....	17
4.2.3	Summary Answer to Question 2.....	17
4.3	Question 3	17
4.4	Other Advice.....	19
5	REFERENCES.....	21

1 SCOPE OF WORKS

Newnes Plateau Shrub Swamps (NPSS) and Newnes Plateau Hanging Swamps (NPHS) are listed endangered ecological communities under both NSW and Commonwealth legislation and overlie Longwall Panels 428 to 432 (LW428-432) for which Centennial Coal's Springvale Mine is currently seeking approval to extract. In February 2021 and June 2021, the Independent Monitoring Panel for Springvale Mine (the 'Panel') responded to requests from the Department of Planning, Industry and Environment (DPIE – the 'Department') for advice focussed on Centennial Coal's predictions and management of subsidence impacts and related environmental consequences on these swamps.

Subsequent to the Panel's June 2021 advice, Centennial Coal has reduced the lengths of LW431 and LW432. On 12 August 2021, Mr Steve O'Donoghue, the Director – Resource Assessment, DPIE requested additional advice from the Panel. Specifically:

The Department requests the Panel review the response provided by Centennial Coal on the Panel's advice and recommendations, and provide further advice on:

- *The proposed approach to protect the Newnes Plateau Hanging Swamps by stepping back longwalls by the angle of draw only for hanging swamps located below the YS4 aquitard.*
- *Whether the proposed monitoring set out in updated swamp monitoring plan is adequate to satisfactorily identify significant subsidence impacts and related environmental consequences on Newnes Plateau Hanging Swamps? If not, does the Panel have any further recommendations for the monitoring program?*
- *The revised Trigger-Action-Response Plans.*

The Panel should also feel free to provide any other advice it considers would assist the Department in reviewing the response.

The Panel comprised:

- Em. Professor Jim Galvin – Chair – Subsidence and Mining
- Mr John Ross - Groundwater and Surface Water (who has succeeded Liz Webb on the Panel since the preparation of the Panel's June 2021 advice)
- Dr Ann Young – Swamps and Ecology

2 SOURCE INFORMATION

The following documentation was made available to the Panel as part of the Department's request for advice on 12 August 2021

1. Springvale 428-432 Extraction Plan - Response to Submissions.
2. Figure 1_Proposed Piezometer Locations
3. A report by Centennial Coal titled "*Springvale Longwall 428-432 Extraction Plan Adaptive Management Mine Design Justification*".
4. Groundwater Model Update (JBS&G, Aug)
5. Swamp Water Balance Model Update
6. Revised LW 415-432 Swamp Monitoring Program (provided in PDF and track changed Word format)
7. Revised LW 415-432 Biodiversity Management Plan (provided in PDF and track changed Word format)

The Panel also sought additional information through:

1. Queries and points of clarification addressed to Centennial Coal through the Department on 29 September 2021 and responded to in writing on 1 October 2021, supported by a videoconference on 15 October 2021 between Centennial Coal, the Department and the Panel.
2. A field inspection by Ann Young and John Ross on 27 October 2021, accompanied by Centennial Coal management and consultants engaged by Centennial Coal.
3. Queries and requests for additional information arising out of the field inspection, submitted through the Department on 27 October 2021 and responded to on 4 November 2021.

3 PERTINENT ASPECTS OF PANEL'S JUNE 2021 ADVICE

The following extracts from the Panel's report of 21 June 2021 are particularly pertinent to this current advice:

-currently there is insufficient information for the Panel to form a firm opinion on whether any hanging swamps over LW429-432 are likely to be adversely impacted from mining and, therefore, require a change in longwall panel length.
- In respect of shrub swamps, there is little doubt that the extraction of LW429 as per the current mine plan would severely and permanently adversely impact a very large portion of Marrangaroo Swamp. Notwithstanding offset provisions, the Panel recommends that the dimensions of this panel should also be determined by the Department on the basis of a review of all key social, economic and environmental factors, noting that impacts are likely to extend well beyond the mining footprint of LW429. This review should include consideration of the Commonwealth Government's objectives with respect to managing impacts on shrub swamps.
- Extraction of the remaining longwall panels (LW430-432) as per the current mine plan is virtually assured to result in nearly all of Marrangaroo Swamp being permanently adversely impacted. It is possible that the entire swamp will be adversely impacted in any case due to the extraction of earlier longwalls, but to a lesser degree if Marrangaroo Swamp is not undermined by some or all of LW429-LW432.
- Should a staged approval not be feasible and mining is still to proceed, then the Panel recommends that the mine layout be modified at least to the extent that all hanging swamps lie outside of the angle of draw of mining. The Panel hastens to add that it is not in possession of adequate and appropriate monitoring data and assessment to conclude a firm view that this approach will guarantee success.

4 ADVICE

4.1 QUESTION 1

Re: *The proposed approach to protect the Newnes Plateau Hanging Swamps by stepping back longwalls by the angle of draw only for hanging swamps located below the YS4 aquitard.*

The approach proposed by Centennial Coal is in response to some of the matters raised in Section 3 of this report. The Mine Design Justification Report states:

Springvale Coal proposes an adaptive management mine design review for the Longwall 428-432 Extraction Plan area based on protection of NPHS aquifers. Table 2 contains calculations of relevant mine design and hydrogeological parameters, for representative sites above and adjacent to Springvale Mine workings, as a basis for comparison with Hanging Swamp sites in the Longwall 428- 432 Extraction Plan area. Based on analysis of data in table 2, design criteria have been identified to enable protection of water supply aquifers for NPHS above and adjacent to proposed mining area has been completed, and it is proposed to reduce the length of Longwalls 431 and 432 to set back longwall mining by greater than 26.5 degrees where NPHS water supply aquifers lie below the YS4 aquitard. Where NPHS water supply aquifers lie above the YS4 aquitard, no change to mine design is proposed, because evidence from the monitoring program associated with Springvale's northern mining area indicates that water levels in aquifers above YS4 aquitard remained within the range experienced at Control sites not affected by mining. The proposed design criteria are satisfied for identified NPHS above and adjacent to the Longwall 428-432 Extraction Plan area.

There are three basic elements to consider when addressing Question 1, namely:

1. Have all hanging swamps within the possible area of impact of LW428-432 now been unequivocally identified?
2. Is the model and supporting data now put forward by Centennial Coal to predict if hanging swamps will be impacted by LW428-432 sound and reliable?
3. For each hanging swamp, what is the potential that it will be impacted by the extraction of LW428-432 based on the proposed revised mine design?

4.1.1 IDENTIFICATION AND RECLASSIFICATION OF SWAMPS

RPS (2021) reports on the location and classification of swamps in the area at risk of impact from LW428-432. It was prepared in response to the Panel's concerns raised in its June 2021 advice regarding inconsistencies in the identification and mapping of hanging swamps and has subsequently been updated in response to further queries raised by the Panel. In part, this confusion arises due to differences in how swamps are listed as endangered ecological communities (EEC) under NSW and Commonwealth legislation. Only Newnes Plateau Shrub Swamps (NPSS) are listed as an EEC under the NSW Biodiversity Conservation Act. However, under the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act, both NPSS and Newnes Plateau Hanging Swamps (NPHS) are listed within the Temperate Highland Peat Swamps on Sandstone (THPSS) EEC. The Commonwealth listing does not include a clear definition of the floristics of the two types of swamps, so they are mapped using the mapping units (MU) defined for the vegetation of the Western Coalfield by NSW Dept of Environment and Conservation (DEC 2006). The Panel is aware that in large swamps such as those that occur in the Marrangaroo Creek catchment, the valley floor shrub swamp (MU50) vegetation may extend

upslope onto the valley sides and merge with hanging swamp (MU51) vegetation and that there are several species common to both mapping units described by DEC (2006).

Figure 1 of this advice has been prepared by the Panel on the basis of the latest mapping and advice from Centennial Coal in response to the Panel's queries and is a slight update of Figure 4 of RPS (2021) that shows the type and location of swamps identified by RPS in the vicinity of LW428-432. Notable outcomes are:

- Small swamps previously mapped as shrub swamp overlying the roadway area between LW428 and LW429 have been reclassified and named Marrangaroo Hanging Swamp 1 and Marrangaroo Hanging Swamp 2.
- A previously unnamed hanging swamp located just beyond the southwest corner of LW430 has been named Marrangaroo Hanging Swamp 3.
- A 300 m x 50 m section of Lower Marrangaroo Shrub Swamp south of LW431-432 has been reclassified as Lower Marrangaroo Hanging Swamp.
- The transitional hanging swamp areas adjacent to the Marrangaroo Shrub Swamp areas in the lower Marrangaroo Creek area west of LW430 and south of LW431 have floristic characteristics similar to Marrangaroo Shrub Swamp and are now mapped as shrub swamps.
- Neither Figure 1 of this advice nor Figure 4 of RPS (2021) record the hanging swamp shown within the footprint of LW432 in the *Springvale Longwall 428-432 Extraction Plan Adaptive Management Mine Design Justification Report* (the 'Mine Design Justification Report'), prepared in August 2021 and reproduced as Figure 2 of this Panel advice. This area has been reclassified as part of the Marrangaroo Shrub Swamp.
- The only hanging swamps that occur below the YS4 aquitard in the vicinity of the proposed longwalls are Lower Marrangaroo (south of LW431-432), most of the Lost City complex located south of LW432 and Ninox located west of LW432. The remaining hanging swamps (Marrangaroo Hanging Swamps 1, 2 and 3, Wishbone, Lost City (upper), and Plum all occur above the YS4 aquitard.

The Panel's advice henceforth is based on the mapping of hanging swamps and shrub swamps shown in Figure 1 of this advice.

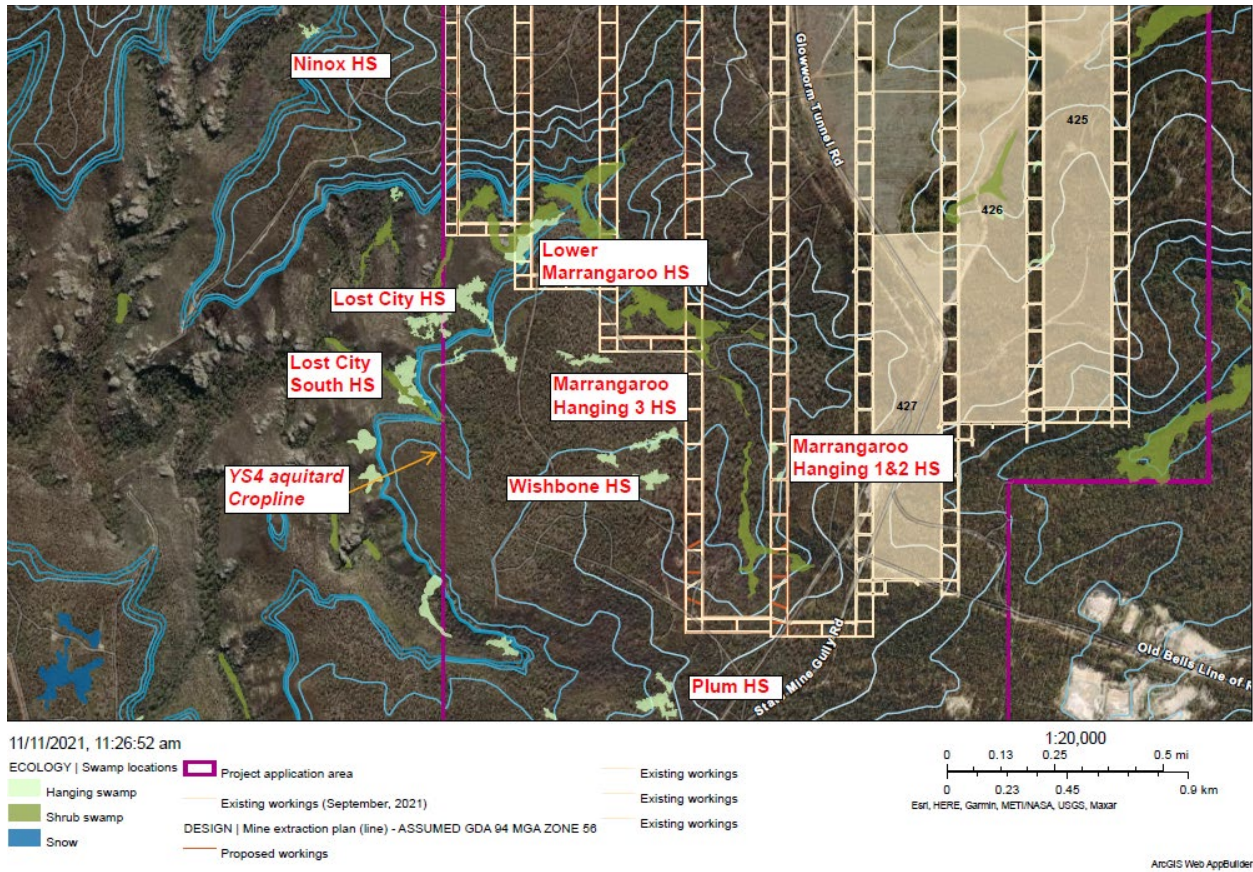


Figure 1: Hanging swamp locations in the vicinity of LW 428 to 432 as now advised to the Panel (the mine design is as originally planned - it does not reflect the recent proposal to shorten LW431 and LW432).

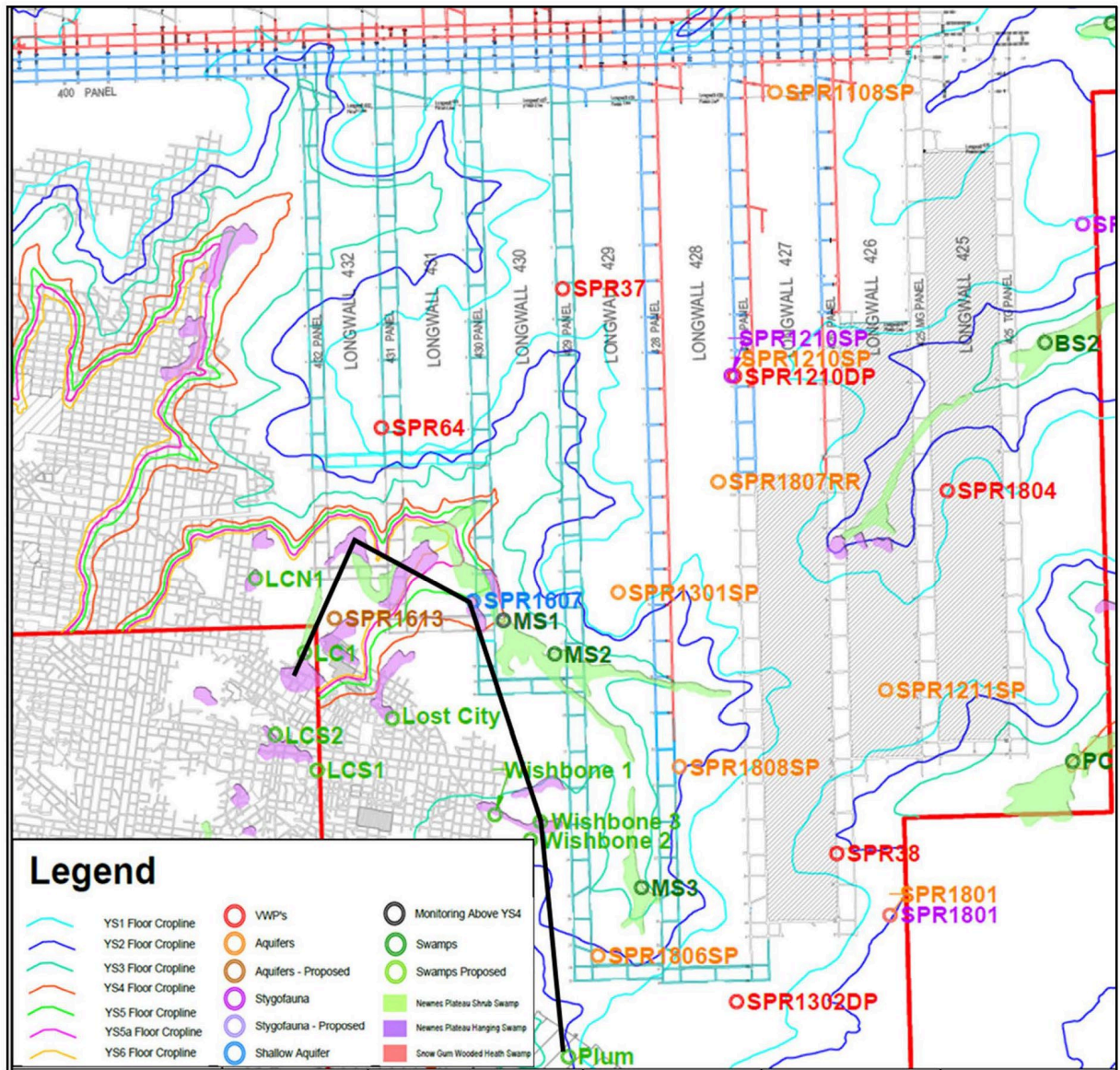


Figure 2: Hanging swamp locations in the vicinity of LW428-432 as recorded in Figure 18 of the *Springvale Longwall 428-432 Extraction Plan Adaptive Management Mine Design Justification* Report (showing both the original mine design and the now proposed shortening of LW 431 and 432).

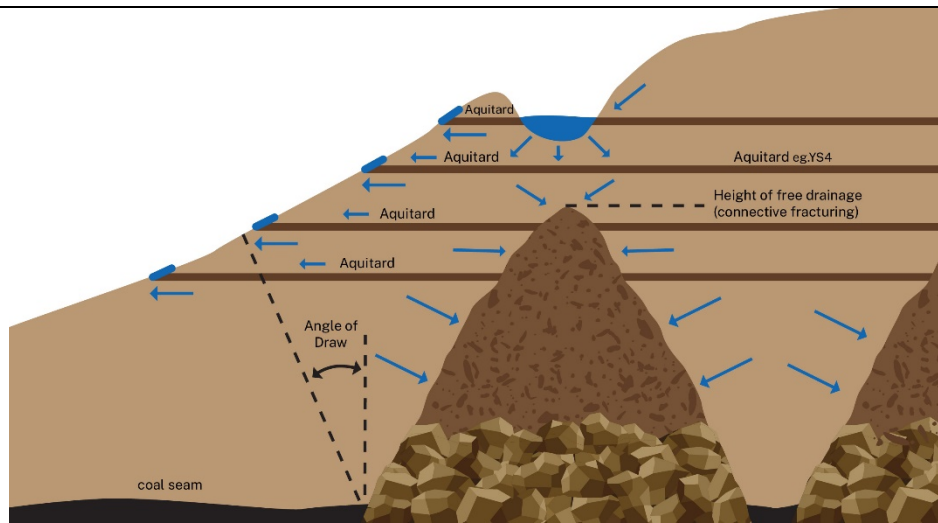
4.1.2 HANGING SWAMP IMPACT MODEL

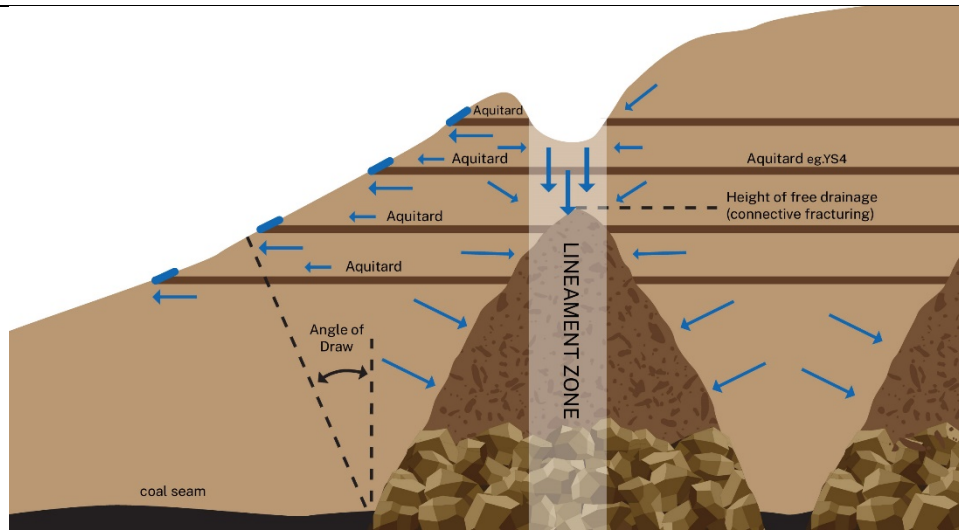
It is the view of the Panel that the hydrology of the Newnes Plateau hanging swamps is sustained by three water sources, namely rainfall falling directly on the swamps; run-on and interflow seeping from the unsaturated zone/soil profile during/after a rainfall event; and longer-term shallow groundwater contributions from perched aquifers located upgradient of the swamps.

The maintenance of each hanging swamp depends on these hydrological processes being unaffected. Natural seasonal variations will occur due to high rainfall and drought, and fires will accentuate these variations. However, mining places an additional stress on hanging swamps if these hydrological processes are disrupted.

Mining induced impacts on the groundwater regime in the vicinity of LW428-432 can be conceptualised as follows and are shown schematically in Figure 3(a) and 3(b):

- Free drainage of groundwater from deep aquifers into the goaf area immediately above the longwall (i.e. primarily from the Illawarra Coal Measures and lower Narrabeen Group formations where there is connective fracturing to the mine workings).
- Tortuous flow of groundwater from shallow aquifers in the Banks Wall Sandstone and (lower) perched aquifers in the Burrallow Formation towards the goaf area from the constrained zone located above and adjacent to the goaf area.
- Uncertain impacts on flow of groundwater in the (upper) perched aquifers in the Burrallow Formations in the area above and adjacent to the constrained zone that sustain hanging swamps.
- Enhanced flow and drainage of groundwater from multiple aquifers along basement lineaments that are reactivated due to slippage resulting from mining induced stresses. These lineament features extend near-vertically, potentially connecting perched aquifers to the goaf area





(b) Simple conceptual model in the presence of a lineament

Figure 3: Conceptual hydrogeological models of changed groundwater flowpaths resulting from longwall mining

The Mine Design Justification Report concludes that hanging swamps on the northern side of Springvale Mine have not been impacted to date and that this is due to them being located on a perched water table above the YS4 aquitard. Centennial Coal has applied this conclusion to assessing the potential for hanging swamps above the YS4 aquitard on the southern side of the mine to be impacted by LW 428-432. The Panel inquired of the company as to whether the conditions in the southern area are sufficiently similar to those in the northern area to justify relying on this past performance to inform the design of LW428-432. The Panel also undertook its own analysis. It notes that the analysis of impacts to NPHS in the northern area relied on piezometric data from just two sites and was not supported by a before-and-after-mining floristic analysis of the hanging swamps to confirm the lack of mining impacts.

The Panel concludes that the proposition is reasonable but not fully proven. The Panel is not convinced by the evidence supplied to it that the YS4 aquitard is always the critical factor for the maintenance of hanging swamps, even though it is acknowledged that the higher a hanging swamp sits in the Buralow Formation, the less the likelihood that the swamp will be impacted by mining. The catchment size that is feeding water to hanging swamps and the dip of the strata maintaining the lateral groundwater flow from these perched aquifers is considered by the Panel to be as important, if not more so, than where a swamp sits in relation to the inferred location of the YS4 aquitard. It considers that additional factors such as the potential reactivation of lineaments that could drain perched groundwater thereby impacting hanging swamps above the YS4 aquitard require further investigation and assessment.

In the southern area, some hanging swamps are also located at elevations lower than the YS4 aquitard. Centennial Coal contends that there is negligible potential for these swamps to be impacted when they are located outside the angle of draw of longwall panels.¹ The technical basis that the company has put forward to support this approach is based primarily on field experience of its effectiveness in limiting or preventing the drainage of lineament zones. While of some relevance, the Panel does not consider this experience provides an adequate level of confidence that a set-back distance of 26.5° will protect hanging swamps lying below YS4 from mining-induced changes to regional aquifers in the Banks Wall Sandstone or local perched aquifers in the Buralow Formation. However, there appears to be no other experience base to help inform a view.

Although Centennial Coal has advised that it is now proposed *to reduce the length of Longwalls 431 and 432 to set back longwall mining by greater than 26.5 degrees where NPHS water supply aquifers lie below the YS4 aquitard*, it has not explicitly stated that it is the angle of draw that has determined the final setback distance for these longwall blocks. It appears to the Panel (based on Figure 2 and depth of cover contours) that the setback distances are considerably greater than half depth (which is around 150m for a 26.5° angle of draw).

At its meeting with Centennial Coal on 15 October 2021, the Panel was advised that an in-seam exploratory borehole had encountered a zone of enhanced permeability between the inbye end (start face line) of LW431 and the adjacent flooded old workings of Lithgow State Mine and that investigations were ongoing. The impact of this feature needs careful consideration. It is possible that, if in fact it has not already done so, this feature will primarily determine the length of LW431 and LW432. Otherwise, as a

¹ Angle of draw is a concept employed in surface subsidence engineering to delineate the lateral extent of mining-induced vertical displacement on the surface, as shown in Figure 3. It is defined by the angle between two lines drawn from the edge of the mine workings, one a vertical line and the other a line to the limit of vertical displacement on the surface, typically taken to be the 20 mm subsidence contour. It has become customary in NSW to assume an angle of draw of 26.5° for design purposes. This conveniently corresponds to a stand-off distance from mine workings that is equal to half their depth below surface.

result of the reclassification of swamp types noted earlier, the length of LW432 is no longer constrained by the presence of hanging swamps. However, longwall panel length may still need to be constrained if it is decided that mining impacts on the Marrangaroo Shrub Swamp (which now incorporates the reclassified hanging swamp) need to be restricted. This is discussed further in Section 4.4

The company has not proposed any reduction in the length of LW428, 429 and 430.

4.1.3 ASSESSMENT OF POTENTIAL FOR IMPACTING HANGING SWAMPS

The Panel has completed an independent assessment of potential impacts to the hanging swamps shown in Figure 1 based on whether the swamps are located above or below the YS4 aquitard and having regard to other criteria such as the proximity of basement lineaments.

(i) Hanging Swamps below YS4

The swamp complexes located below the YS4 aquitard in the vicinity of LW428-432 include Lower Marrangaroo Hanging Swamp, Lost City Hanging Swamp, South Lost City Hanging Swamp and Ninox Hanging Swamp.

The proposed shortening of LW 431 and LW432 should provide additional protection for Lower Marrangaroo Hanging Swamp and Lost City Hanging Swamp and a degree of protection for the Marrangaroo Shrub Swamp. However, it is noted that the Lower Marrangaroo Hanging Swamp is intersected by SE-NW trending lineaments and potentially a SW-NE trending lineament. Therefore, the Panel advises that impacts beyond the angle of draw require further investigation and assessment at this site. The site would benefit from having a shallow swamp piezometer installed to enable water levels in the hanging swamp to be compared against the water levels in the nearby shallow aquifer monitoring sites SPR1607 and 1613. From a groundwater perspective, moving the starting location of these two longwalls north should maintain the natural (horizontal) discharge of groundwater from perched aquifers in the Burrallow Formation into the Marrangaroo Creek valley, and minimise impacts to both the Lower Marrangaroo Hanging Swamp and the Marrangaroo Shrub Swamp.

Unlike other hanging swamps nearby, the Lower Marrangaroo Hanging Swamp is contiguous with the large Marrangaroo Shrub Swamp, and the ecotone between NPHS and NPSS may well shift under natural conditions (e.g. varying fire recovery of particular species, as noted by RPS, 2021). At this site, any mining-related impact on the Marrangaroo Shrub Swamp is also likely to affect the Lower Marrangaroo Hanging Swamp. If groundwater levels in the Banks Wall Sandstone aquifer or in the Marrangaroo Shrub Swamp sediments decline due to reduced flows downvalley or the presence of lineament/s, impacts to the Lower Marrangaroo Hanging Swamp can also be expected. In this respect, this hanging swamp differs from Lost City Hanging Swamp and South Lost City Hanging Swamp, and consequently there is still a residual risk of impact to Lower Marrangaroo Hanging Swamp after shortening LW431 and LW432 (by moving their start line further north).

The Lost City/South Lost City Swamp complex (except for south-eastern arm of Lost City Hanging Swamp above the YS4 aquitard) is located below the YS6 aquitard on Banks Wall Sandstone and is more than 1000 m south of the proposed LW432. This complex is now considered to be sufficiently distant from LW428-432 so as not to be at likely risk of groundwater impacts.

Ninox Hanging Swamp is located about 300 m west of LW432 and is both above and below the YS6 aquitard. It is unlikely to be affected as it is supported by an extensive area of Burralow Formation catchment to its north and northwest.

In summary, although a hanging swamp is no longer recorded within the footprint of LW432, the shortening of LW431 and 432 is strongly supported by the Panel. Final advice on the potential for disruption to groundwater below the YS4 aquitard can only be provided once additional monitoring data is obtained and assessed, particularly in relation to the Lower Marrangaroo Hanging Swamp.

(ii) Hanging Swamps above YS4

The hanging swamps located above YS4 in the potential zone of impact of LW428-432 are Marrangaroo Hanging Swamp 1, Marrangaroo Hanging Swamp 2, Marrangaroo Hanging Swamp 3 and, potentially, the eastern portion of Wishbone Hanging Swamp. The western portions of Wishbone Hanging Swamp and Plum Hanging Swamp are located beyond the angle of draw and mining-induced impacts are unlikely.

Marrangaroo Hanging Swamp 1 and Marrangaroo Hanging Swamp 2 are small. They overlie the chain pillars between LW428 and LW429 and have the potential to be impacted by mining of these longwalls. However, as these swamps are located above the YS3 aquitard, mining impacts may be negligible provided fracturing in the constrained zone does not extend above the YS4 aquitard. There are no known nearby lineaments. Nevertheless, it is noted that nearby ridge standpipe piezometer SPR1808, which is monitoring the AQ5 aquifer immediately below the YS4 aquitard, has been impacted by a water level decline of 15 m since 2019 with the mining of LW426 and LW427 immediately to the east. This site would benefit from having a shallow swamp piezometer and nested piezometers adjacent to the swamp in the sandstone above YS4 to observe the impacts (if any) of the passage of LW428 and LW429. The site would then become an important validation site for those hanging swamps located further west and south of Marrangaroo Creek. A reduction in length of LW428 and LW429 may not be warranted given the very small size of these two swamps and their value as indicators of potential impacts on larger hanging swamps to the west.

Of the remaining hanging swamp areas, Marrangaroo Hanging Swamp 3 is located south of LW430 and LW431, is mostly within the 26.5° angle of draw for LW430 and has the potential to be impacted. This site may be affected by fracturing in the constrained zone (although this swamp is located just above the YS4 aquitard) and the reactivation of lineaments (there is a mapped SW-NE lineament though the swamp and an intersecting SE-NW lineament immediately to the north of the swamp). This site would benefit from having a shallow swamp piezometer installed at a convenient location. Further assessment of this data and data from the passage of LW428 and LW429 and monitoring locations to the east is required before informed advice can be provided on the potential impact on Marrangaroo Hanging Swamp 3 of mining LW430.

Wishbone Hanging Swamp is partially within the 26.5° angle of draw for LW429 but is located within a reasonable sized catchment and is above the YS3 aquitard at a similar elevation to the much smaller Marrangaroo Hanging Swamp 1 and Marrangaroo Hanging Swamp 2. There are no known nearby lineaments. From a groundwater perspective, it is uncertain whether shallow swamp and perched aquifer water levels will be impacted in the vicinity of this swamp; however, the risks are considered negligible to low. A transect of shallow swamp piezometers at the southern and easternmost lobe of this swamp would help in confirming the connectivity between the swamp and the shallow perched sandstone aquifers above YS4. The understanding of potential impacts at this site would also benefit from the existing and proposed monitoring of Marrangaroo Hanging Swamp 1 and Marrangaroo Hanging Swamp 2.

Plum Hanging Swamp is located about 220 m southwest of LW429, above the YS3 aquitard, and is considered to be too distant from this longwall to be impacted from a groundwater perspective. There are no known nearby lineaments. Monitoring at this location would be a useful control site to assess impacts to all other hanging swamps located above YS4 in the area south of LW428 to 432.

In summary, there is no compelling evidence to suggest that the proposed lengths of LW428 and LW429 need to be changed in order to protect hanging swamps (as opposed to shrub swamps). However, some additional monitoring is required to assess potential impacts to the western hanging swamps and to provide advice on potential impacts associated with LW430. The Panel supports in principle the company's proposal to reduce the lengths of LW431 and LW432 but does not have sufficient information to inform a firm view that the proposed reductions in length for LW431 and LW432 are adequate.

4.1.4 SUMMARY ANSWER TO QUESTION 1

Only four (out of eight) hanging swamps located in the vicinity of LW428-432 are located below the YS4 aquitard. All these swamps occur in the area south and west of LW431 and LW432 and are outside the proposed angle of draw. The Panel supports the company's proposed approach to protect these swamps by stepping back these longwalls by at least the angle of draw and moving the longwall panels north of Marrangaroo Creek. However, the impact of lineaments at greater distances is uncertain and impacts may occur to the Lower Marrangaroo Hanging Swamp even with the commitment to move LW431 and LW432 north of Marrangaroo Creek. Further monitoring and assessment are required.

For the four hanging swamps located above the YS4 aquitard, two (Marrangaroo Hanging Swamp 1 and Marrangaroo Hanging Swamp 2) are located above chain pillars between LW428 and LW429 and two (Marrangaroo Hanging Swamp 3 and the eastern portion of Wishbone Hanging Swamp) are located within the angle of draw of LW429 and LW430. Only one site is potentially intersected by lineaments (Marrangaroo Hanging Swamp 3). It is uncertain whether the hanging swamps within the angle of draw will be impacted, although the risk is considered negligible to low. Further monitoring and assessment are required. Marrangaroo Hanging Swamp 1 and Marrangaroo Hanging Swamp 2 are recommended as validation sites and Plum Hanging Swamp as a control site.

4.2 QUESTION 2

Re: *Whether the proposed monitoring set out in updated swamp monitoring plan is adequate to satisfactorily identify significant subsidence impacts and related environmental consequences on Newnes Plateau Hanging Swamps? If not, does the Panel have any further recommendations for the monitoring program?*

4.2.1 GROUNDWATER MONITORING REQUIREMENTS

The consolidated Centennial Swamp Monitoring Program LW415-428 Springvale Mine (CC 2021a) is the latest swamp monitoring plan (SMP) and covers the groundwater monitoring in the shallow colluvium and perched aquifers in the Burralow Formation. Updated groundwater monitoring requirements for several hanging swamps in the vicinity of LW428-32 need to be included in an updated version of this monitoring program. Seven new sites have recently been constructed by Centennial Coal and ten others are recommended by the Panel as part of this advice.

The consolidated Centennial Water Monitoring Plan LW415-428 Springvale Mine (CC 2021b) is the latest water monitoring plan (WMP) that addresses the deeper groundwater systems in the Banks Water Sandstone and Illawarra Coal Measures. The ridge piezometers and vibrating wire piezometers (VWPs) that are referenced in this plan are adequate for monitoring ongoing impacts at depth across LW428-432 and these monitoring locations are not considered further in this advice.

The location of the existing groundwater monitoring locations in relation to each of the shrub swamps and hanging swamps is shown in Figure 4.

Summary details of all the shallow groundwater monitoring locations in the vicinity of both the shrub swamps and the hanging swamps are provided in Table 1, with the locations proposed by the Panel indicated in italics. The Panel notes that these locations were discussed with Centennial staff and consultants on its field trip of 27 October 2021, although no formal agreement was made at that meeting. Swamp piezometers are those located in saturated swamp colluvium; shallow aquifer piezometers are mostly those located at the base of the Burralow Formation in AQ5; and perched aquifer piezometers are mostly those located in the upper Burralow Formation above the YS4 aquitard in AQ6.

It is acknowledged there are additional existing ridge piezometers and VWPs overlying and adjacent to these longwall panels in deeper aquifers that are not included in Table 1 and which should continue to be monitored as part of the WMP

The site IDs for proposed sites in Table 1 are just indicative tags from the Panel and can be changed to fit Centennial Coal's naming conventions.

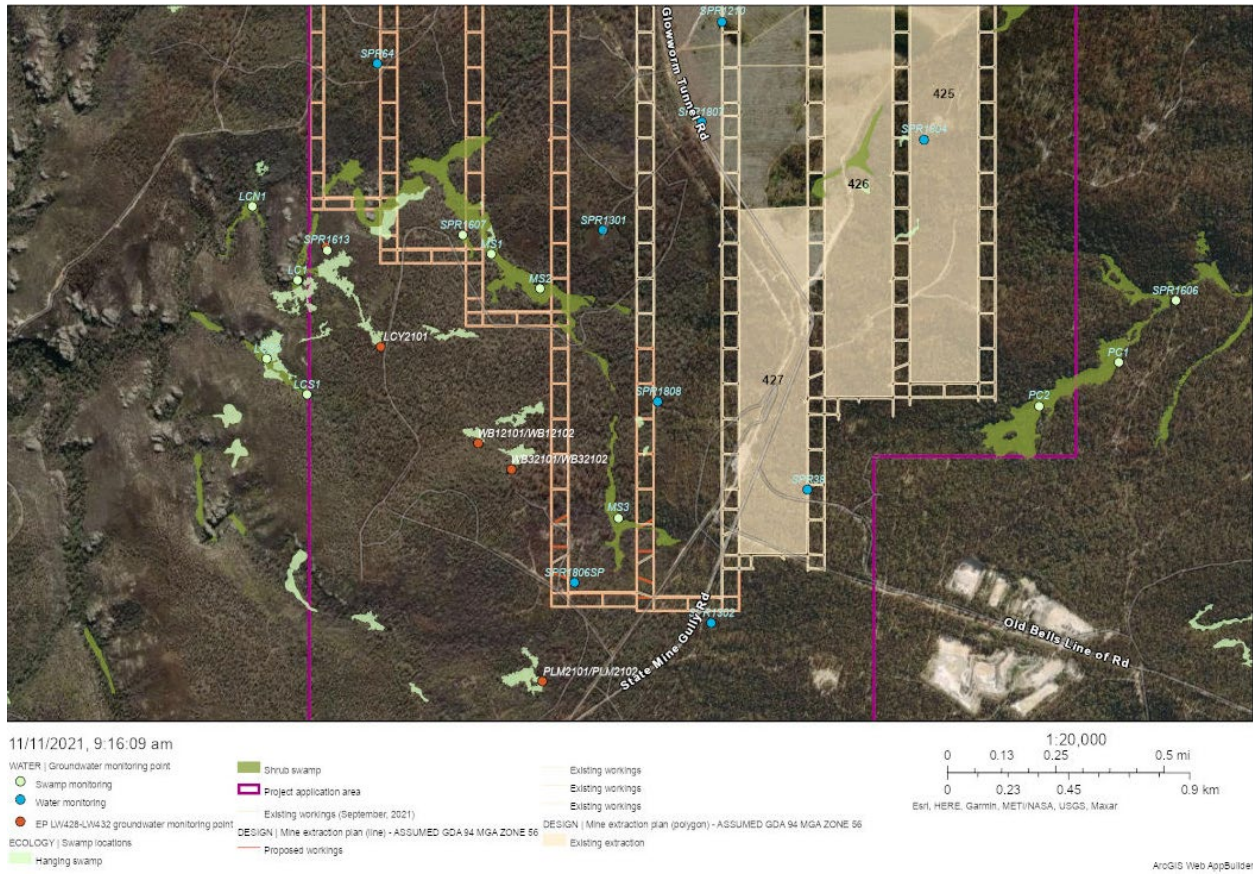


Figure 4: Existing groundwater monitoring locations in the vicinity of longwall panels 428 to 432

Table 1: Proposed Groundwater Monitoring Locations surrounding Swamps – LW428-432

Swamp	Site	Site Type	Unit Monitored	Parameters
Shrub Swamps				
Marrangaroo	MS1 *	Swamp piezometer	Swamp colluvium	GW level Field parameters ^
	MS2 *			
	MS3 *			
	SPR1607 *	Shallow aquifer piezometer	AQ5 below YS5	GW level
Lost City (lower)	LC1 *	Swamp piezometer	Swamp colluvium	GW level Field parameters ^
	LCN1 *			
	LCS1 *			
	LCS2 *			
	SPR1613 *	Shallow aquifer piezometer	Possibly AQ4 in the Banks Wall SS	GW level
Hanging Swamps				
Lost City (upper)	LCY2101 #	Perched aquifer piezometer	AQ6 above YS4	GW level
Lower Marrangaroo	<i>LMHS1</i>	<i>Swamp piezometer</i>	<i>Swamp colluvium</i>	<i>GW level</i>
	SPR1607 *	Shallow aquifer piezometer	AQ5 below YS5	GW level
	SPR1613 *	Shallow aquifer piezometer?	Possibly AQ4 in the Banks Wall SS	GW level
Wishbone	WB12101 #	Perched aquifer piezometer	AQ6 above YS3	GW level
	WB12102 #		AQ6 above YS4	
	WB32101 #		AQ6 above YS3	
	WB32102 #		AQ6 above YS4	
	<i>WB32103</i>	<i>Shallow aquifer piezometer</i>	<i>AQ5 below YS4</i>	<i>GW level</i>
	<i>WBHS1</i>	<i>Swamp piezometer</i>	<i>Swamp colluvium</i>	<i>GW level</i> <i>Field parameters at 1 site ^</i>
	<i>WBHS2</i>			
	<i>WBHS3</i>			
	<i>WBHS4</i>			
Marrangaroo Hanging 1&2	SPR1808 *	Ridge piezometer ~	AQ5 below YS4	GW level
(validation site)	<i>MExxx01</i>	<i>Perched aquifer piezometer</i>	<i>AQ6 above YS3</i>	<i>GW level</i>
	<i>MExxx02</i>		<i>AQ6 above YS4</i>	
	<i>MEHS1</i>	<i>Swamp piezometer</i>	<i>Swamp colluvium</i>	<i>GW level</i> <i>Field parameters ^</i>
Marrangaroo Hanging 3	<i>MWHS1</i>	<i>Swamp piezometer</i>	<i>Swamp colluvium</i>	<i>GW level</i>
	SPR1607 *	Shallow aquifer piezometer	AQ5 below YS5	GW level
Plum	PLM2101 #	Perched aquifer piezometer	AQ6 above YS3	GW level
(control site)	PLM2102 #		AQ6 above YS4	
	SPR1806 *	Ridge piezometer	Possibly AQ4 in the Banks Wall SS	

Legend: * established existing location; # new existing location; *those in italics are proposed new locations*
~ referenced as a Ridge Piezometer but actually monitoring a shallow aquifer in the lower Burralow Formation
^ – Parameters = pH, T, EC, Eh, and DO

4.2.2 ECOLOGICAL MONITORING REQUIREMENTS

The 2021 Swamp Monitoring Plan to date has not addressed all the concerns raised in the Panel's advice of June 2021, specifically with respect to monitoring of Giant Dragonfly and soil moisture. Additional monitoring is recommended as detailed in Section 4.2.3.

The Brownstein vegetation monitoring sites shown on Figure 11.1 of the Swamp Monitoring Plan appear to be in the shrub swamp areas of Lower Marrangaroo Swamp. Given that a significant area of this swamp has now been identified as hanging swamp, at least one vegetation monitoring point should be established in that reclassified area, in conjunction with a swamp piezometer (see Table 1 and Section 4.2.3 below). Further, if the Panel's advice is adopted and Plum Hanging Swamp is designated as a control swamp, soil moisture monitoring should be undertaken at the site. The Panel appreciates that Giant Dragonfly have not been reported in the area of LWs 428-432 to date but considers as a matter of due diligence that the company should check whether Giant Dragonfly are present in the hanging swamps and monitor appropriately if they are found.

4.2.3 SUMMARY ANSWER TO QUESTION 2

The Panel recommends additional groundwater monitoring to assess the shallow groundwater trends more comprehensively (particularly groundwater levels in the swamp colluvium and underlying Buralow Formation perched aquifers) at a number of key sites. These are in addition to the recently constructed sites at Plum, Wishbone and (upper) Lost City hanging swamps. The recommended new sites are listed in Table 1 and are:

- One swamp piezometer at Lower Marrangaroo Hanging Swamp
- Four swamp piezometers at (eastern) Wishbone Hanging Swamp north of WB32101/32102 locations
- One deeper shallow aquifer piezometer at (eastern) Wishbone Hanging Swamp beside the WB32101/32102 locations
- One swamp piezometer at Marrangaroo Hanging Swamp 1
- Two perched aquifer piezometers at Marrangaroo Hanging Swamp 1
- One swamp piezometer at Marrangaroo Hanging Swamp 3

The Panel recommends additional ecological monitoring as follows:

- Monitoring in Lower Marrangaroo Hanging Swamp – Giant Dragonfly, vegetation and soil moisture
- Monitoring for Giant Dragonfly in hanging swamps near piezometers LCY2101, WB12101
- Monitoring for Giant Dragonfly and soil moisture in Plum Hanging Swamp

4.3 QUESTION 3

Re: *The revised Trigger-Action-Response Plans.*

The proposed shortening of LW431 and LW432 causes their starting points to be moved to the north side of Marrangaroo Creek and means that swamp piezometer sites LC1, LCS1 and LCS2 should no longer be considered impact sites. Therefore, performance indicators and trigger levels should not apply to these (now remote) sites. They are no longer within the Trigger Investigation Area (TIA). Nevertheless, it would be prudent to continue the established groundwater, vegetation and ecological monitoring in Lost City Hanging Swamp and South Lost City Hanging Swamp.

The following new proposed swamp piezometer locations should be included as impact assessment sites:

- Swamp piezometer at Lower Marrangaroo Hanging Swamp (LMHS1)
- Central swamp piezometer at Wishbone Hanging Swamp (WBHS1)
- Swamp piezometer at Marrangaroo Hanging Swamp 1 (MEHS1)
- Swamp piezometers at Marrangaroo Hanging Swamp 3 (MWS1).

Swamp piezometer groundwater quality triggers should be applied at the other Marrangaroo Swamp and Lost City Swamp piezometers and the two new sites added to cover Wishbone Hanging Swamp and Marrangaroo Hanging Swamp 1.

Plum Hanging Swamp should be listed as a control swamp.

The Updated Swamp Management Plan should reference and align with the Aquifer Interference Policy (DPI OoW, 2012) and the minimal impact criteria for porous rock water sources given that the Newnes Plateau Swamps are referenced in the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 (NSW Govt 2011) as a high priority groundwater dependent ecosystem (GDE).

The Panel would be in a position to provide more detailed advice on the TARPs after the submittal of an updated consolidated Swamp Management Plan. It would also be helpful to know of any changes to monitoring requirements or TARPs under Commonwealth EPBC requirements. In the interim, the following comments are offered for consideration:

- Swamp Monitoring Plan Table 14.1
 - Flow – ‘noticeable deviation from historical hydrological trends’. A quantitative measure would be preferable.
 - Subsidence – ‘unpredicted irregular subsidence’. This trigger needs to be defined in quantified terms.
 - Groundwater level swamp piezometers – depth criteria are set but it is usual to also specify changes to the recession curves and frequency of falls below baseline
- Biodiversity Monitoring Plan Table 13.1
 - Erosion and sedimentation – visual inspections show impacts that do ‘not threaten material environmental harm’. A quantitative measure may be preferable e.g. affecting >5% of the swamp surface.

4.4 OTHER ADVICE

Re: *The Panel should also feel free to provide any other advice it considers would assist the Department in reviewing the response*

The Department's request for this advice arises out of the Panel's advice of June 2021 and has a focus on hanging swamps. The Panel has addressed the Department's questions based on the revised mine design submitted by Centennial Coal in response to the Panel's June 2021 advice.

However, since June 2021, the Panel has been provided with a range of documents that contain new and updated information relevant to assessing other aspects of the Extraction Plan for LW428-432. This information has been complimented by a site inspection and a series of responses to questions put to Centennial Coal by the Panel. The information provides much better insight into mining-induced environmental impacts and consequences that were not predicted in the EIS. Some of these are very significant, in particular, the impacts of longwall mining through lineaments on hanging swamps, shrub swamps and watercourses. The management of the unpredicted behaviour has implications for the lengths of the longwall panels comprising the LW428-432 Extraction Plan.

In addition to managing impacts on hanging swamps, mine design for LW428-432 must also manage impacts on other features, including Marrangaroo Shrub Swamp and its associated watercourse, Marrangaroo Creek, in order to comply with the Consent Conditions for the Springvale Mine Extension Project (the 'consent conditions'). Schedule 2, Clause 1 of the consent conditions imposes an overarching requirement on Springvale Mine to implement all reasonable and feasible measures to prevent and/or minimise any harm to the environment that may result from mining. Schedule 3, Clause 1 designates specific performance measures for hanging swamps, shrub swamps, watercourses and other features.

Schedule 3, Clause 10 of the consent conditions requires the Extraction Plan to include a Contingency Plan that expressively provides for adaptive management where monitoring indicates that there has been an exceedance of any performance measures or where such exceedance appears likely. Adaptive management is defined by the consent conditions as:

Adaptive management – includes monitoring subsidence effects and impacts and, based on the results, modifying the mine plan.....as mining proceeds to ensure that the effects, impacts and/or associated environmental consequences remain within the predicted and/or designates ranges and in compliance with the conditions of this consent.

The consent conditions also define the role of the Independent Monitoring Panel (that is, this Panel). This includes a requirement under Schedule 3, Clause 11(d) for the Independent Monitoring Panel to undertake iterative risk assessment in Extraction Plans, including consideration of all options for avoiding or minimising damage to swamps and all possible adaptive management measures. The following advice is provided in accordance with this consent condition.

Table 1 of the consent conditions specifies a Performance Measure for Marrangaroo Creek of *no greater subsidence impacts or environmental consequences than predicted in the EIS*. The EIS predicted zero change to base flow contribution (Part 2, Table 10.2)² and a decline in standing groundwater level (pre-

² p302 (Pdf p104)

mining base value of 0.115 m) of only 0.004 m by 2022 and 0.015 m by 2032 (Part 2, Table 10.2)³. The influence of lineaments was not appreciated at the time.

The consent conditions require the groundwater model to be updated every six months and the associated reports provide points of reference as to actual versus predicted performance. In December 2020, Centennial Coal's groundwater consultant identified that *'further work may be needed on the Swamp Water Balance Model to reconcile differences between predicted and observed streamflow where mining impact has occurred, such as in Carne West Swamp'* (JBS&G, 2021a). In the six-monthly groundwater modelling update produced in August 2021, the consultant reported that observed mine dewatering rates from Springvale Mine and Angus Place Colliery had been updated, along with groundwater elevations from the Swamp Monitoring Program (SMP) and the Water Management Plan (WMP) and that these data had been used as a validation dataset. The report concluded that *Significant impact to Marrangaroo Swamp is....expected. Modelling indicates that completion of mining of LW428-432 will lead to large declines in swamp water level and shallow aquifer levels.*⁴

The complimentary report on the updated Swamp Water Balance Model (JBS&G, 2021b) makes the following predictions of the impacts of LW428-432 on Marrangaroo Swamp and Marrangaroo Creek:

- *Updated model predictions ...indicate, due to changes in catchments contributing to THPSS, rather than just impacts to THPSS by direct undermining, that there will be significant changes to streamflow as mining is completed at Springvale.*
- *median (50th%) flow rate is predicted to decline in Marrangaroo Swamp from 0.79ML/d to 0.531ML/d in the U10 simulation and to decline from 0.613ML/d to 0.451ML/d in the U90 simulation. This equates to a large change, being a 33% decline and a 26% decline respectively.*
- *the low flow rate (10th%) in Marrangaroo Swamp is predicted to decline from 0.377ML/d to 0.0926ML/d in the U10 simulation and is predicted to decline from 0.281ML/d to 0.0862ML/d in the U90 simulation. The predicted changes are large and equate to a 74% and 66% decline respectively.*

The EIS concluded (Section 10.3.9) that the mine plan had been designed to avoid consequences to the most sensitive ecological areas and that significant impacts of threatened species or EECs are unlikely. It is apparent that the consent conditions were based on an expectation that significant impacts to the environment were very unlikely. However, it is now clear from the preceding analysis and a range of other field monitoring that the mine plan initially proposed for LW428-432 is almost certain to result in significant environmental impacts on Marrangaroo Swamp and Marrangaroo Creek.

In light of the emerging knowledge base, it is very unlikely that any feasible longwall mining plan can be devised which will ensure that there are no adverse environmental impacts on shrub swamps and watercourses within the footprint of an Extraction Plan for LW428-432. However, an adaptive management approach based on reducing the lengths of the longwall panels to avoid directly undermining Marrangaroo Swamp and Marrangaroo Creek should significantly mitigate environmental impacts.

The Panel advises, therefore, that:

- The proposal by Centennial Coal to reduce the lengths of LW431 and LW432 also goes some way to mitigating adverse environmental impacts on Marrangaroo Swamp and Marrangaroo Creek,

³ p303 (Pdf p105)

⁴ p32

subject to how the high permeability zone recently intersected immediately to the south of these panels behaves. Centennial Coal has advised that the zone is still under investigation.

- The length of LW430 should also be reduced so that, at the very least, Marrangaroo Swamp and Marrangaroo Creek fall outside the angle of draw of this longwall panel. This action would also reduce the likelihood of direct and indirect impacts to hanging swamps in the area.
- If the length of LW430 were to be reduced by an appropriate distance, some of recommendations contained in this advice may become redundant.
- The Panel has previously advised that the length of LW429 should be determined on the basis of a cost-benefit analysis. That advice stands but the cost-benefit study should have regard to the latest predictions of subsidence impacts.
- It may be too late to reduce the length of LW428. However, the environmental impacts of not doing so are likely to be significantly less than for the other longwall panels in the series.
- Given the current state of knowledge and the time required to advance this knowledge, the Department should give consideration to a staged approval for progressing the Extraction Plan for LW428-432, with the initial approval being restricted to LW428 and LW429.

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