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Dear Jessie

Subject: Dendrobium Mine Area 5 Extension Project

WaterNSW appreciates the opportunity to comment on the Environmental Impact Statement (EIS) for the Dendrobium Mine Area 5 Extension Project (the Project). The Project has been declared as State Significant Infrastructure (SSI) under the *Environmental Planning and Assessment Act* 1979 and will be determined by the Minister for Planning and Public Spaces.

Background

The proposed mining area is wholly located within the declared catchment area (the Sydney Drinking Water Catchment) and land jointly managed by WaterNSW and National Parks and Wildlife Services (NPWS) as Schedule 1 Special Area (Metropolitan Special Area). WaterNSW has an important statutory role "to protect and enhance the quality and quantity of water in declared catchment area".

In February 2021, the Independent Planning Commission (IPC) rejected the previous Dendrobium Area 5 and 6 extension project on the grounds that its environmental damage would outweigh economic benefits.

WaterNSW objected to the previous project due to the significant impacts on water quantity, water quality and ecological integrity within the Special Areas of the declared catchment. The main reason for the significant impacts was related to mine design, specifically the adoption of 305 m wide longwalls. Several submissions, including to the IPC, were made by WaterNSW as part of the assessment of the previous Dendrobium extension proposal.

WaterNSW refers to our published Mining Principles which underpin our decision making in relation to managing mining impacts in the declared Sydney catchment area and on catchment infrastructure. WaterNSW has considered the following reports in the assessment of this Project:

- recommendations made by the 2021 IPC Reasons of Refusal and submissions made by the IAPUM (or IAP) and WaterNSW on the previous application for Areas 5 and 6
- recommendations by IEPMC in 2019, and
- WaterNSW's statutory role, Special Areas, SEARs for the Project and Mining Principles.

Position on the project

WaterNSW notes that the revised proposal for the Dendrobium Area 5 Extension Project continues the previous mine design (Area 3B) which includes having 305 m wide longwalls. These wide longwalls have caused, and will continue to cause, groundwater depressurisation, fracturing of watercourses and swamps, and result in significant surface water losses.

The cumulative water losses (mine inflows, leakage from reservoir, and surface water losses) due to Dendrobium mine's current and future operations (and previous mining at Elouera Mine) will continue to occur long after the mine is closed.

WaterNSW considers that the revised Project has not adequately addressed some key recommendations in the IPC Reasons for Refusal for the previous project.

Firstly, there is inadequate consideration of the "key risk mitigation measure to confine fracturing from the seam to below the Bald Hill Claystone and avoid interacting with the surface fracturing zone".

- Subsurface cracking for the proposed mine design is predicted to extend through the Bald Hill Claystone and reach up into the Hawkesbury Sandstone (HBSS). This means it is likely to connect to the surface cracking zone. The EIS estimates that to prevent interaction between the subsurface fractured zone and the surface cracking zone the panel width would need to be reduced to approximately 205 m.
- Notwithstanding the above, and as it was for the assessment of the previous proposal (Area 5 & 6), the EIS reiterates "adverse environmental impacts are still anticipated for reduced longwall widths down to approximately 150 m and the potential for losses in surface flow and diversion of water from the bases of pools and/or upland swamps would occur, and largely be unchanged by the adoption of narrower longwall panels".
  WaterNSW disagree with this statement because surface and subsurface impacts would be reduced (see **Attachment 1**).

Secondly, the IPC Reasons for Refusal also noted there is inadequate "consideration to the environmental assessment of alternative mine designs, the risk evaluation of options, and associated environmental impacts".

- Details on the assessment of environmental impacts for narrower longwalls are not included in the EIS except in a single graph showing a 10% reduction in peak water flow in a watercourse if the longwall width is reduced from 305 to 205 m.

The submitted proposal is considered **unacceptable to WaterNSW** in its current form due to impacts on water quantity, water quality and ecological integrity within the Metropolitan Special Area.

Summary of key concerns (Details in **Attachment 1**).

1. **Mine design**:
   - IPC Recommendations: does not adequately address matters raised by the IPC, IAP and WaterNSW on the previous Area 5 and 6 mining project i.e., a mine design that minimises surface and subsurface impacts.
   - Precautionary Principle: does not adequately consider a Precautionary Principle or Mitigation Hierarchy best practice (Avoidance, Minimisation, Restoration and Offsets). The mine design uses 305 m wide longwall panels maximising coal extraction and moves directly to water and biodiversity offsets.
2. **Adaptive management:** adaptive management for the protection of Avon Reservoir and Avon Dam is not possible for the proposed direction of mining i.e., from west to east.
3. **Water quantity**:
   - Cumulative mine inflows: of 103 GL calculated from predicted mine inflows is exceptionally high compared to other mines in the Special Areas. WaterNSW considers the losses to be underestimated.
   - Water Offsets and Water Licensing: uncertainties regarding IMC's offer for water offsets based on 'actual surface water losses' calculated using the Project's groundwater model (which would be recalibrated as required).
4. **Water quality**: increases in metals within streams immediately above the proposed mining area and extending beyond the mining area impacting water quality. The project is unlikely to meet a Neutral or Beneficial Effect assessment for water quality during mining and post-mining.
5. **Ecological integrity:** causes significant fracturing of the tributaries of Avon River, Lake Avon and Donald Castle Creek and also causes changes in stream flow patterns. 16 Coastal Upland Swamps will be impacted, including two large swamps.
6. **WaterNSW infrastructure**: mining is proposed within the Dam Notification Area of 1500 m and there is potential for differential far-field horizontal movements which could cause cracking

on the existing Avon dam wall. There is also inadequate assessment of geological features and basal shear plane near the dam.

Conclusion

The predicted water losses during and post mining and impacts on water quality and the ecological integrity of the Metropolitan Special Area are **unacceptable** to WaterNSW, as they:

- would affect WaterNSW's ability to deliver one of its core statutory functions which is to protect and enhance the quality and quantity of water in the declared catchment area (under section 7(1)(g) of the *Water NSW Act 2014*), and
- are inconsistent with one of the key purposes for declaring the Metropolitan Special Area, which is to maintain the ecological integrity of the land (under section 47(2)(b) of the *Water NSW Act 2014*).

The project, as currently proposed, is not consistent with WaterNSW's statutory role "to protect and enhance the quality and quantity of water in declared catchment areas" or its Mining Principles. The proposed mine design is likely to cause significant or irreversible damage to environmental features, including numerous watercourses and swamps.

Recommendation

WaterNSW considers that risk mitigation measures such as narrower longwalls, not undermining large swaps, and some avoidance through increased setbacks will reduce (not eliminate) the impacts on water quantity, water quality and ecological integrity of Metropolitan Special Area.

In relation to mine design and surface water losses, WaterNSW recommends that the Department, as a minimum:

1. Requires the IMC to consider changes to the mine design and mining sequence including:
    - reduction in longwall widths to further increase the vertical distance between the surface cracking zone and subsurface fractured zone
    - changes to longwalls 501 to 503 to avoid undermining two large swamps overlying these longwalls,
    - increasing the setback of longwalls to Avon dam wall to 1,500 m
    - increasing setback from LA13 or change to bord and pillar mining of the three proposed longwalls in the south, and
    - changing mining direction from east to west to allow adaptive management of Avon Dam and Avon Reservoir.
2. Provide:
    - revised environmental assessment including surface water loss predictions for modified mine design, and
    - an assessment of cumulative impacts as per DPE Guidelines requiring assessment of past, present, and reasonably foreseeable future projects.
3. Refer the project to the Independent Expert Panel on Mining in the Catchment (IEPMC), an IAP, or a similar technical panel of experts (including a groundwater expert, surface water expert and dams engineer) for advice on the mine design and potential impacts.

WaterNSW requests that it continues to be included as stakeholder in the assessment of this project. If you wish to discuss this letter further, please contact Ravi Sundaram via e-mail at environmental.assessments@waternsw.com.au.

Yours sincerely

FIONA SMITH
Executive Manager, Strategy and Performance

Attachment 1 – WaterNSW Detailed Comments

Impacts from Narrower Longwalls

WaterNSW disagree with the reasons in the EIS for adopting 305 m longwall panel and not reducing the vertical extent of HoCF and surface impacts:

- Panel width would need to be reduced to approximately 205 m to confine height of connective fracturing below the Bald Hill Claystone for the entirety of Area 5.
- Significant reductions in panel width may marginally reduce, but not eliminate potential surface water losses for panel widths down to 205 m. The predicted reduction in surface water losses because of limiting the height of fracturing to be below the Bald Hill Claystone is not expected to be significant.
- Adverse subsidence impacts (fracturing of rockbars, pools and bedrock above and adjacent to the longwalls) are still anticipated for reduced longwall widths down to approximately 150 m and the potential for losses in surface flow and diversion of water from the bases of pools and/or upland swamps would be largely unchanged by the adoption of narrower longwalls.

Data available from the extraction of a range of longwall widths and associated impacts including subsidence, height of fracturing and mine inflows within catchment **clearly demonstrate lesser impacts from narrow longwalls** (see details below).

Subsidence

Table 1 demonstrates that the narrower panels have lesser vertical subsidence therefore likely to have lesser non-conventional subsidence effects such as tilts, strains, and valley closure i.e., surface impacts.

The average depth of cover and extraction height more or less the same but the extent of vertical subsidence at Elouera Mine (a former IMC Mine) is between 0.2 and 1.38 m compared to 1.75 to 2.4 m at Dendrobium Mine.

Table 1. Longwall mines in Special Areas included in cumulative loss assessment (including future approved panels in Dendrobium and Metropolitan mines)

Mine	Period of mining		Number of extracted panels	Panel width	Undermined Area	Vertical Subsidence
	Start	End	No.	m	km²	m
Appin (Area2)	Jan-1986	Jun-1998	15	205-257	3.55	0.2 – 1.35
Appin (Area3)	Oct-2006	Sep-2007	2	205-257	0.56	0.6 – 0.65
Metropolitan	Jul-1995	Jul-21	36	130-168	7.72	0.9 – 1.4
Dendrobium	Apr-2005	Mar-2021	17	245-305	10.08	1.75 – 2.4
Elouera	Feb-1993	Apr-2007	12	130-185	4.05	0.1 – 1.38
Wongawilli	Aug-2009	Feb-2014	6	84-190	0.78	0.09 – 0.57
Russell Vale	Aug-2009	Jul-2015	3	150-150	0.26	0.72 – 1.8
South Bulli (Ba)	Jan-1970	Dec-1981	16	140-140	1.38	0.6 – 1.4
Kemira (Wo)	Jun-1988	Dec-1991	6	105-105	0.75	1.5 – 1.5
Cordeaux	Sep-1980	Dec-2001	33	110-205	8.26	1.1 – 1.3
South Bulli (Bu)	Nov-1970	Feb-1981	13	95-150	1.38	1 .0- 1.1
South Bulli (200 series LWs)	Jul-1979	Oct-1993	13	140-205	2.98	1.0
South Bulli (300 series LWs)	Nov-1981	Jun-1993	9	140-190	2.45	1.0
Bellambi West (500 series LWs)	Jul-1993	Dec-2001	18	110-190	2.01	0.3 – 1.0

Height of Connective Fracturing (HoCF)

The groundwater assessment for Area 5 EIS presented estimated height of connective fracturing for narrower panels at Elouera Mine (120-175 m). The estimates based on the Tammetta or Ditton concept suggested that the HoCF extends to about 100 to 150 m below the ground surface and therefore extending up to the Bald Hill Claystone. Figures D3 and D4 in Appendix D of the groundwater assessment (Appendix B of EIS) show the spatial variation in inferred height and depth of HoCF at Dendrobium and neighbouring mines.

HoCF estimates (based on Tammetta concept) for narrower panels at Metropolitan Mine suggested a 160 m separation between the deep fractured zone and surface fracturing, whilst the 305 m panels in past mining at Dendrobium Mine and the proposed mining in Area 5 clearly result in HoCF that extends into the Hawkesbury Sandstone, interacting with the surface cracking zone.

Mine inflows into historical mines

Narrower panels result in significantly lower inflows (groundwater) and surface water losses at all mines other than Dendrobium in the Special Areas. A comparative analysis with Metropolitan Mine by the IEPMC (2019) highlighted this issue.

Narrower panels (110 to 205 m) at Metropolitan and Cordeaux Mines led to significant reductions in mine inflows and surface water losses (Table 2):

Table 2 Comparison of mine inflows of mines in the Southern Coalfield

Mine	Average depth of cover (m)	Area (km2)	Inflow (ML/day)	Inflow (ML/day/km2)	Time of inflow estimate	Reference
Metropolitan	455	7.155	0.5	0.070	Modelled inflow	Groundwater model (HS, 2018)
Dendrobium	325	8.819	4.25	0.482	Daily average (2005-2019)	Dendrobium data
Tahmoor	427	16.7	3.1	0.1862	Monthly average	EIA Groundwater model (HS, 2019)
Cordeaux	450	8.262	1.295	0.157	Historic	Williamson, 1978

Based on the relationship between depth of cover, mining panel width and mine inflows SCT (2018) reports the following behaviour can be expected at 280 m overburden (depth of cover over the seam mined) based on experience elsewhere in NSW:

- panels narrower than 1/3 depth (93 m at 280 m) would not be expected to show significant connection to the surface even below standing water bodies (Reynolds 1977)
- panels less than about 0.5 times depth (140 m at 280 m) do not typically show strong connection to the surface but there may be some inflow depending on circumstances
- panels that are wider than 0.64 times depth (180 m at 280 m) consistently see strong connection to the surface with average inflow rates of about 25% of average rainfall over the extracted area
- panels between 0.5- and 0.64-times depth (140-180 m at 280 m) can go either way depending on other factors such as depth, geology, and mining height (West Cliff, Metropolitan, Tahmoor and Appin (W/D in range 0.44-0.56) are not connected, Elouera Longwalls 1-3 (W/D = 0.56) appears likely to have been).

The width to depth ratio for the proposed mine design ranges from 0.77 to 1.2 suggesting that the proposed longwall mining will have consistent connection between the surface cracking and subsurface fractured zones resulting in significant water losses. This is of significant concern to WaterNSW.

Mine Design and Subsidence

The IPC in its Reasons for Refusal of the previous Area 5 and 6 Project highlighted that the mine design is a primary determinant of impact for the Project and subsidence cracking would cause infiltration of surface water from Upland Swamps, watercourses, and the water table.

The key findings related to mine design and subsidence presented in the IPC conclusions are:

- *Subsidence assessment provides no basis for assessing the sensitivity of environmental impacts and consequences to setback distances from natural features, longwall panel width, extraction height, and longwall panel orientation.*
- *The extent and nature of the predicted subsidence, the lack of adequate risk assessment and uncertainty as to appropriate setbacks and impacts of alternative mining panel widths is unacceptable and incapable of being sufficiently addressed by conditions of consent.*

- *Consideration of key risk mitigation measure – confine fracturing from the seam to below the Bald Hill Claystone and avoid interacting with the surface fracturing zone that would result in very little surface water loss; and*
- *Inadequate consideration has been given to the environmental assessment of alternative mine designs, the risk evaluation of options and associated environmental impacts*.

WaterNSW assessed that the EIS has not adequately considered the above concerns with the revised mine design continuing with 305 m wide panels. The key concerns related to the mine design and subsidence are discussed below.

Geological Structures

WaterNSW is concerned that there is insufficient assessment (supported by investigations) of geological structures within and near the study area. The potential risk of interaction between Area 5 mining and the Avon Reservoir and Avon dam wall is of concern.

There is also a known north-north-east trending fault that crosses the proposed LW501 to LW506 and LW508. The interaction of this fault with subsidence, and resulting environmental consequences for surface features, is also of significant concern to WaterNSW.

The impact of mining on the dam will be exacerbated by any geological structures near it, especially any extending towards the mine. Two dykes are noted near the dam and there may be others. The geological investigations need to be more focussed on structures around the dam, up of the valley (near the dam) and between the dam and the mine.

Basal shear planes

Basal Shear Planes were activated at Sandy Creek Waterfall valleys above and below the waterfall. They are also present in the barrier pillar between Avon Reservoir and Area 3B (and potentially Area 5) longwalls. Basal shear planes overlying/near extracted longwalls in areas of topographic lows (valleys of Wongawilli and Native Dog Creek) have been identified at Elouera Mine. Basal shear planes have also been identified in Wongawilli Creek valley adjacent to Dendrobium mining Area 3B.

WaterNSW notes that the EIS has not addressed concerns raised by the Dams Safety Committee (DSC) in its assessment of the refused Area 5 & 6 application:

- Noted that uplift on the valley floor below the dam walls that may be triggered by Basal Shear Planes and Far-Field Horizontal Movement. This may impact the dam foundation.
- Requested an assessment of the potential for movement at the dam walls and impacts on the foundation of the dam as a result of Basal Shear Plane movement that may be triggered by the extraction of longwalls.

The Project does not address the issue of basal shear planes in the strata and their implications. Concerns surround the area between the proposed longwalls and Avon Reservoir, areas with low depth of cover and steep valleys in the southern part of Area 5. The Lake Avon Tributary LA13, a third order watercourse is also likely to be impacted.

Far field horizontal movements

The proposed longwalls are within the Notification Area set by Dams Safety NSW, which is offset 1,500 m from the dam structure. The Mine Subsidence Engineering Consultants (EIS Appendix A, Section 6.3.2) concludes that 'it is unlikely that the dam walls would experience adverse impacts due to the proposal longwalls'.

Far-field horizontal movements of up to 25 mm were recorded at Cataract Dam, where longwall mining was undertaken up to 1,500 m of the dam structure in around 1996. The longwalls mined at this time are *noted to be narrower than those proposed for Dendrobium Area 5*. WaterNSW therefore considers that the potential for far-field horizontal movements at Avon Dam due to the proposed longwall mining cannot be discounted.

It can be inferred from the MSEC Subsidence Prediction report Figure 4.3 that the incremental horizontal movement at 1,000 m from the longwalls is expected to be in the range of 35-40 mm. WaterNSW considers this to be very notable movement with potential dam safety and

environmental consequences. For comparison, ongoing dam monitoring surveys record less than 5 mm horizontal movement at Avon Dam between 2021 and the base survey in 1970. So, the predictions suggest an eightfold increase in incremental horizontal movement due to the proposed Area 5 longwalls setback 1,000 m from Avon Dam wall. The subsidence predictions in the EIS for horizontal far field movements are vastly underestimated.

The potential structural impact of the proposed longwall mining to Avon Dam from predicted valley closure/opening and the incremental far-field horizontal movements has not been assessed by a suitably experienced and qualified Dams Engineer.

Avon Dam is a High A (sunny day) and Extreme (flood) consequence category dam. WaterNSW as owner and operator of the dam is very concerned that the safety of the dam may be compromised by the proposed longwall mining. The differential movement on the dam walls could cause cracks to open in the dam walls.

Echoing the feedback previously provided by the DSC (previous Regulator) to the previous Dendrobium application, WaterNSW requests IMC to address the above and provide the following information to make an informed decision on the adequacy of currently proposed setbacks of the longwall from the dam wall:

- Undertake a structural and risk assessment for Avon Dam reviewing the potential impacts from the proposed longwall mining. This should be completed by a suitably qualified dam engineer, and independently reviewed by a suitably experienced dam engineer.
- The assessment must:
    - Consider the site-specific foundation geology/conditions at the dam.
    - Provide information on the minimum setback distance necessary from the dam wall for the proposed longwalls to ensure there is no harm to the dam wall and reduce the likelihood of cracking the dam walls.
- Mining be carried out from the east to west so that adaptive management can be considered as longwalls approach Avon Reservoir (600m from longwalls) and Avon Dam (1,500m from longwalls).

WaterNSW also requests that the Department seek expert advice, including the IAP, on the concerns related to geological structures, basal shear plane and far field horizontal movements and impacts on Avon dam and the integrity of the reservoir.

Setbacks distances from natural features

The proposed changes in the mine layout plan have avoided/minimized mining under/near some watercourses, primarily Donalds Castle Creek, Avon River tributaries AR31 and AR 19. However, mining is still proposed under/near:

- several tributary creeks of first, second and third including LA17 (the closest to dam wall) and LA13, a third order watercourse, with significant stream features; and
- 16 upland swamps located under or within 60m of the mining footprint and along/near the tributary streams.

The IAPUM, IPC and WaterNSW have serious concerns on the setback approach proposed by IMC.

The proposed setbacks for key stream features from the longwalls are inadequate because the Type 3 impacts have occurred in Area 3B at distances of 115 m to 290 m from longwall panels. The setback distances for the selected stream features are based on reducing the potential for environmental impacts, rather than total avoidance, and on facilitating their remediation should impacts occur. Remediation is confined to partially re-establishing the site-specific functionality of individual features. It is not intended to and will not restore the function and values of a stream system.

WaterNSW considers that alternative mining methods and/or mine design (narrower panels), and consideration of avoidance measures from natural and built features (avoid undermining key large swamps and increasing setbacks from third order unnamed watercourses) are necessary and can be implemented in the proposed mining area. These changes are needed for improved environmental outcomes in the Metropolitan Special Areas.

Revised conceptual model of HoCF

The groundwater assessment presented in the Area 5 EIS implemented a revised conceptual model of height of connective fracturing (HoCF) based on post-mining investigations and monitoring in Area 3B and 3A.

WaterNSW is concerned that:

- Despite extensive post-mining drilling investigations and groundwater monitoring implemented over Areas 3A and 3B longwalls, there is still significant uncertainty in the estimation of the height of connective fracturing.
- There is insufficient data to support development of the site-specific empirical model. The expert review (Hebblewhite, 2020) of height of depressurisation investigations (HGEO, 2020) commented that lack of significant differential in height of depressurisation with the reduced panel widths (249 m wide panels in Area 3A vs 305 m panels Area 3B) means that the range of the dataset available to develop an improved prediction model remains inconsistent, and insufficient to enable any further model development based on empirical methods.
- The discontinued fracture zone presented in the updated conceptual model above Area 3B appears to disagree with assessment of the extent of high angle fracturing reported by HGEO (2020). HGEO concluded that mining-induced fracturing, including high angle fracturing, is highly variable but appears to extend to the surface above longwalls of width 249 m in Area 3A and 305 m in Area 3B. The density of fracturing decreases with height above the goaf, with anomalous fracturing within the BHCS and below 120 m above the goaf.
- The groundwater model is moderately sensitive to the estimate of HoCF, but conceptual uncertainty has not been included in groundwater assessment and model predictions.
- There appear to be disagreement on surface to seam connectivity between experts involved in assessments of Dendrobium groundwater monitoring data and height of fracturing or depressurisation (PSM, 2017; Mackie, 2017; SCT, 2017 and 2018; Hepplewhite, 2020 and 2022).
- There is a lack of confidence in the peer review process when the details of the conceptual models under review are not fully understood.

Groundwater

The IPC in Reasons for Refusal of the previous Area 5 and 6 Project concluded there are unacceptable uncertainties as to:

- *how close to pre-mining levels the regional groundwater table which support the surface water flows, will return to after mining or how long this will take.*
- *mine outflow volumes and quality following mine closure and re-pressurisation.*
- *whether it is possible to seal the mine and the long term and potentially irreversible impact upon the quality of surface water in perpetuity.*

Key WaterNSW considerations in this regard as well as additional concerns are summarised below.

Mine inflows, groundwater depressurization and regional water table

The reduction of mine footprint by 60%, revision of HoCF for already mined and proposed longwalls and not assuming surface fracturing in Area 5, has resulted in much lower predicted inflow rates compared to the previous Area 5&6 assessment. The **key WaterNSW concerns** are:

- Mine inflow is still high compared to other mines in the Special Areas. The WaterNSW estimate of cumulative inflow for the base case scenario presented in Area 5 EIS is about 103 GL. Based upon ~ 30 GL of groundwater pumped to date (2005-2022) the continuous dewatering of existing and proposed underground workings is predicted to result in removal of an additional 70 GL of groundwater over the next 17 years.
- The groundwater model recalibration improved simulated average inflow rates to individual mining areas, however still failed to simulate peak inflows, particularly in Area 2. Groundwater assessment does not comment on surface water proportion of mine inflow.

- Mine inflows have not been managed sustainably and the proposed mine closure predict the permanent groundwater discharge at rates of up to 1.2 ML/day outside Special Areas.

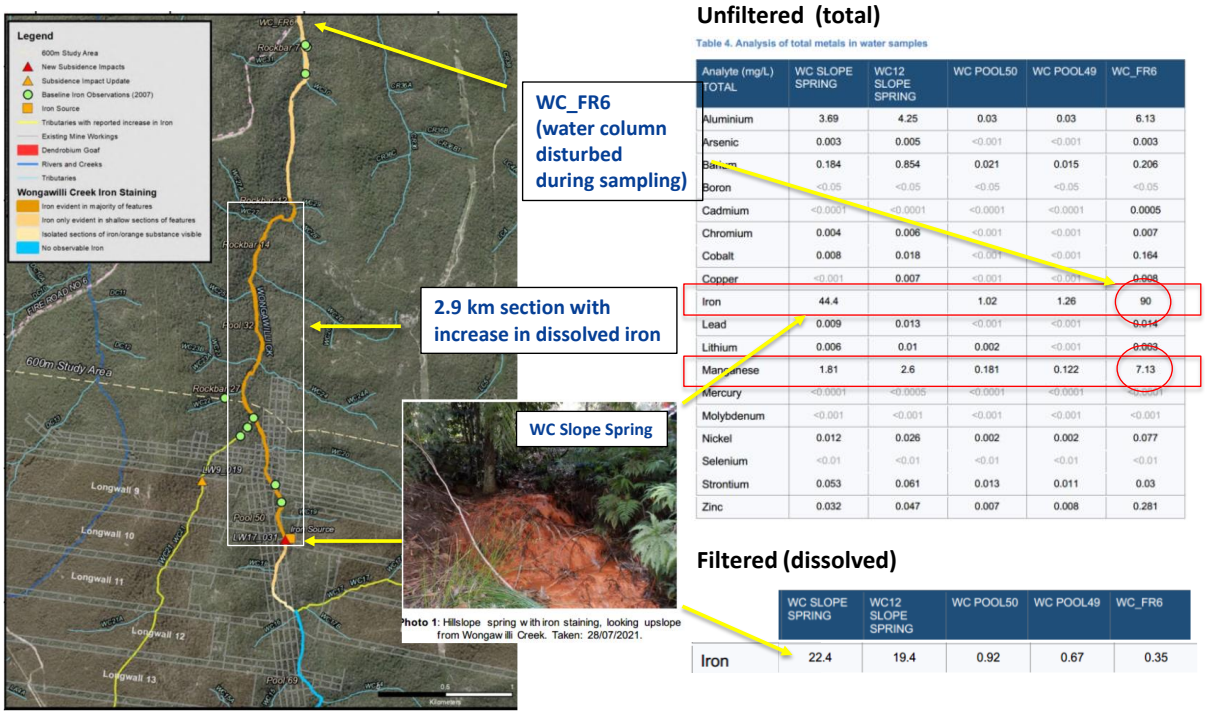
WaterNSW is concerned with the magnitude of predicted groundwater drawdown, long term recovery and permanent changes in hydrological regime within the Dendrobium mine footprint.

Water quality impacts

WaterNSW is concerned with water quality impacts associated with the recovery of shallow groundwater systems overlying the Dendrobium mine area, as well as other mines (Elouera and Metropolitan Mine) in the catchment areas.

- Surface water assessment for End of Panel Longwall 17 has reported water quality impacts over past month. Groundwater recovery caused transient or persistent increases in EC, changes in pH or dissolved metals concentrations and increasing extent of iron staining in watercourses (WC, WC21, LA5, LA5, SC10C) that flow across longwalls in Areas 3A and 3B.
- Groundwater seepages observed in Wongawilli Ck and WC12 tributary appear to have dissolved concentration of iron up to 22.4 mg/L and manganese up to 1.77 mg/L. Ecoengineers (2012) reported the ferruginous springs over Dendrobium mine area may exhibit elevated concentrations of up to 40 mg/L of iron and up to 2 mg/L of manganese. Similar iron concentrations have been also observed in shallow groundwater at other undermined areas by Metropolitan mine (20-35 mg/L). In the context of other water quality parameters, dissolved iron in groundwater from subsided areas may reach concentrations levels comparable or exceeding major ions (sodium, calcium).
- Observed water quality impacts become more widespread as proportions of undermined areas are increasing. Iron staining has been noted or reported in catchments undermined by other mines (Elouera, Metropolitan).
- Water quality impacts are not confined to the surface groundwater interaction within mine footprint as is described in groundwater assessment. For example, the extent of iron staining has been reported at a distance of more than 2.9 km downstream of iron spring in Wongawilli Creek (Figure 1). The water quality data presented in Figure 1 demonstrate that iron precipitates are likely to be transported over greater distances particularly during drought breaking rainfall events and storms. Routine monitoring programs will not capture true extent of iron staining and metals loads mobilised from mining impacted areas.

The IPC expressed concerns about postmining water quality impacts as groundwater system will repressurise. From the information provided in the EIS, it is difficult to predict the impacts on water quality due to mine closure and groundwater re-pressurization. Key learnings from the Berrima mine closure and consequent impacts on receiving water quality must be considered as such impacts are possible and likely at Dendrobium Mine.



Analyte (mg/L) TOTAL	WC SLOPE SPRING	WC12 SLOPE SPRING	WC POOL50	WC POOL49	WC_FR6
Aluminium	3.69	4.25	0.03	0.03	6.13
Arsenic	0.003	0.005	<0.001	<0.001	0.003
Barium	0.184	0.854	0.021	0.015	0.206
Boron	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	<0.0001	<0.0001	<0.0001	<0.0001	0.0005
Chromium	0.004	0.006	<0.001	<0.001	0.007
Cobalt	0.008	0.018	<0.001	<0.001	0.164
Copper	<0.001	0.007	<0.001	<0.001	0.008
Iron	44.4		1.02	1.26	90
Lead	0.009	0.013	<0.001	<0.001	0.014
Lithium	0.006	0.01	0.002	<0.001	0.003
Manganese	1.81	2.6	0.181	0.122	7.13
Mercury	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001
Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	0.012	0.026	0.002	0.002	0.077
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	0.053	0.061	0.013	0.011	0.03
Zinc	0.032	0.047	0.007	0.008	0.281

	WC SLOPE SPRING	WC12 SLOPE SPRING	WC POOL50	WC POOL49	WC_FR6
Iron	22.4	19.4	0.92	0.67	0.35

Figure 1. Iron staining in Wongawilli Creek and reported results as presented in assessment of exceedance against the performance measure (HGEO, 2021)

Surface Water

The IPC Reasons for Refusal for the previous project concluded that:

- *there is uncertainty with mine closure planning, including whether it is possible to seal the mine and the long term and potentially irreversible impact upon the quantity and quality of surface water in perpetuity*
- *there is uncertainty in accurately quantifying water losses and hence it is not possible to assess the appropriateness of the Applicant's proposed financial offset for surface water losses and water quality impacts*

Surface water losses

WaterNSW is concerned about surface water loss predictions made from the groundwater model in the EIS, for the following reasons:

Reliability of the model predictions. The groundwater model results presented in Figure 6-13 suggest that the predicted long-term (2043-2200) postmining surface water losses from the water supply catchment (Pheasant Nest Weir) will be higher compared to surface water losses predicted during mining in 2022.

Surface water losses are likely to be underestimated when compared with other available estimates and modelling.

- The IEPMC (2019) estimated that total surface water loss rate over the Dendrobium mine (Area 1, Area 2, Area 3A and partially Area 3B) was about 5 ML/day. The following estimates are reported:
  - 3 ML/day that corresponds to surface flow diversion into the mine (calculated by disaggregating mine inflow),
  - 1 ML/day of baseflow loss due to depressurisation in all catchments affected by Dendrobium mine (based on groundwater model),
  - 0.73 ML/day leakage from Avon reservoir (for LW12-16).

It is also pointed out that loss rates increase as the area of excavated coal seam is increasing and vary over time depending on rainfall.

- The estimates of reservoir leakage presented in groundwater assessment are likely to be underestimated. This conclusion is based on the results of local groundwater modelling presented in the End of Panel Report for longwall 17:
    - The recently revised local groundwater model estimated seepage rate from lake Avon of 0.36 ML/day/km of shoreline. This is equal to a loss of 0.89 ML/day for the 2.3 km shoreline from longwall 12 up to NDT1. This leakage can easily exceed 1 ML/day for a different estimate of the shoreline length.
    - Assuming the same leakage rate of 0.36 ML/day/km for the proposed Area 5 and assuming Area 5 shore length of 4 to 5.2 km, the estimated leakage would range from 1.44 to of 1.9 ML/day. The total leakage from Lake Avon due to Area 3B and Area 5 could range from 2.3 to 2.93 ML/day.

Surface water losses will be long term and potentially in perpetuity because the mine will not be completely sealed. The proposed continuous discharge from a partially sealed Dendrobium Areas 2-5 were estimated at about 1.2 ML/day.

- The annualised post mining loss (2043-2200) estimates for water supply catchments indicate continuous loss of around 600 ML/year or over 1.6 ML/day.
- The greatest losses are predicted for catchments to Avon Reservoir, Donalds Castle Creek and Avon River downstream of the reservoir. The losses in the Donalds Castle Creek catchment are predicted to reduce approximately a decade after the cessation of Area 5, but the post-mining effects on the Avon Reservoir and Avon River catchment are predicted to persist which is significant concern to WaterNSW.

Streams hydrology

Permanent changes in stream flow dynamics that will impact on ecological integrity of the streams within the footprint of the mine.

WaterNSW is concerned with the EIS predictions that fracturing of bedrock and reduction in baseflow may result in partial or complete loss of pool holding capacity. Approximately 15% of the stream controlling features (i.e., rockbars, steps etc) in third order sections of steams located within 400 m of the proposed longwalls could experience Type 3 impacts.

The hydrological impacts are best demonstrated using monitoring data from Area 3B reported in the End of Panel longwall 17 report:

- Figure 2 shows interpretations of visual observations of **loss of water holding capacity** of pools in WC15 watercourse undermined by several longwalls. These pools were supposed to overflow during higher-than-average rainfall in 2021 but remained empty during reporting period (HGEO, 2022).
- The estimated median flow in headwater streams decreased by 20-60%. Level 3 stream flow TARPs for median flow continue to be triggered in DC13, DCS2, WC21S1, WC15S1 and LA3S1 and increased from Level 2 to Leve 3 at LA4S1 despite above average rainfall during mining of longwall 17.
- Low flow increased by 14% of time compared to pre-mining at DCU (TARP Level 1) and by 31 to 57% of time) at DC13, DCS2, WC21, WC15 and LA3 (TARP Level 3).
- Ceased to flow frequency increased by 11-24% of time compared to baseline at DC13, WC21, WC15 and LA4 (triggered TARP Level 2), and by 35-40% at DCS2 and LA3 (Level 3).

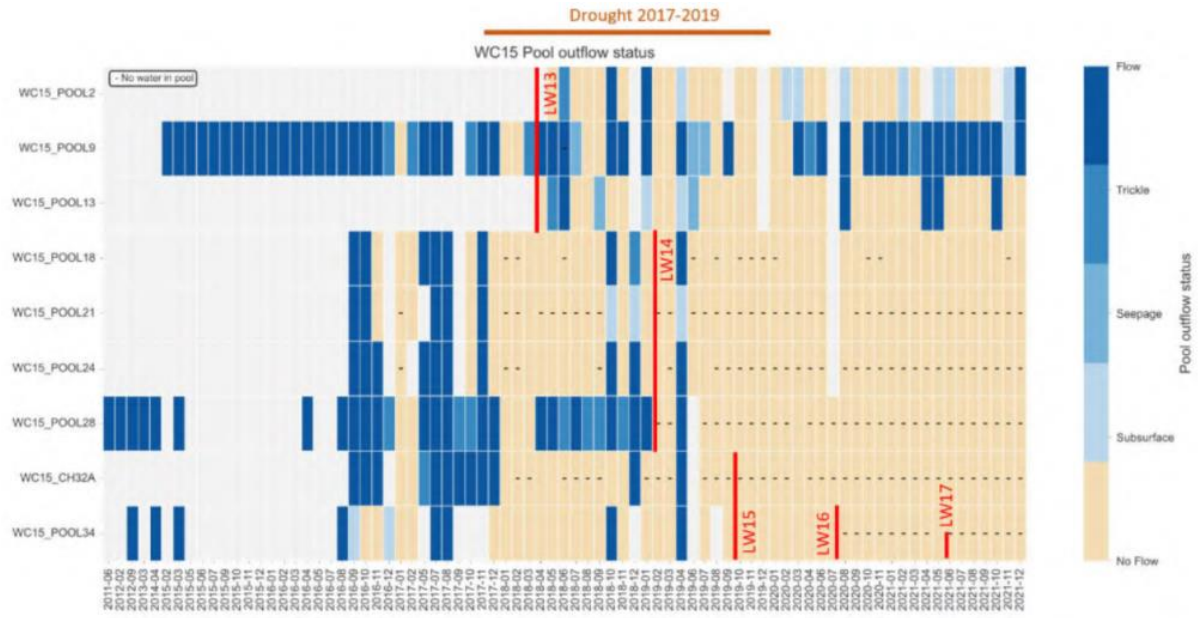


Figure 2. Flow observations in pools in WC15 over Area 3B (HGEO, 2022).

Upland Swamps

IPC Reasons for Refusal are:

- *The principal areas of concern regarding consequences for the ecological integrity of those parts of the Special Areas that are expected to be affected by the Project are the loss of stream habitat in low order streams, the potential impacts of widespread reduction in near-surface groundwater levels and the direct impacts on upland swamps*
- *Bushfires and the drying of swamps can increase the likelihood of erosion which can affect catchment yields and water quality*
- *The subsidence effects of longwall mining would impact upon the hydrological regime and hence result in drier conditions for up to 22 Upland Swamps in or near Area 5.*
- *Impacts on swamps are inconsistent with one of the key purposes for declaring the Metropolitan Special Area, which is to maintain the ecological integrity of the land.*

WaterNSW is concerned with the following:

1. The irreversible change in hydrological function of upland swamps undermined by the Dendrobium mine to date. Aquatic Ecology Assessment by Cardno (Appendix E) commented swamp impacts as follows:

- Previous longwall and bord and pillar mines have impacted approximately 5 square kilometres (km^2) or 35% of the total 14.3 km2 of swamp habitat within the upper Avon and Cordeaux River catchments. Longwall mining in Areas 1, 2, 3A, 3B at the Dendrobium Mine resulted in increased rates of groundwater recession, reduced soil moisture, reductions in size and/or changes in the vegetation community in swamps.
- Monitoring results of shallow Hawkesbury sandstone aquifers adjacent to swamps or perched aquifers within swamps suggest that the Dendrobium Mine has impacted each swamp that has been mined under and each immediately adjacent swamp (Advisian 2016).

2. The significant number of swamps (16 swamps undermined within 60 m of mining or 22 swamps within the 600 m of the Project boundary) that will be impacted, particularly the two large swamps directly overlying the proposed mining area. Mine design changes are possible to further minimise hydrological impacts on swamps and reduce/avoid water losses from swamps.

3. There is potential that erosion and scouring could occur at Den 105, Den 107, and Den 108 during a rare flow event (represented by the 1% AEP peak flow) because of mining induced tilt.

4. Uncertainties in estimated seepage losses from undermined upland swamps using the modelling approach presented in the EIS. The model was calibrated to one swamp, while 17 swamps are being monitored from 2017.

The conceptual model for "height of connective fracturing" in the groundwater model has been changed for the proposed Dendrobium Area 5 proposal, however the conceptual uncertainty in the groundwater assessment and model predictions have not been included in the EIS.

WaterNSW recommends that the Department seeks independent expert advice to ensure the predictions for the total water losses including mine inflows, leakage from reservoir and surface water losses and impacts on watercourses and swamps are not underestimated.

Landscape Impacts

Mining at Dendrobium to date has resulted in widespread surface impacts (Figure 3) on the area overlying the mining footprint that are having a very significant impact on water quality and the ecological integrity of the Metropolitan Special Areas.

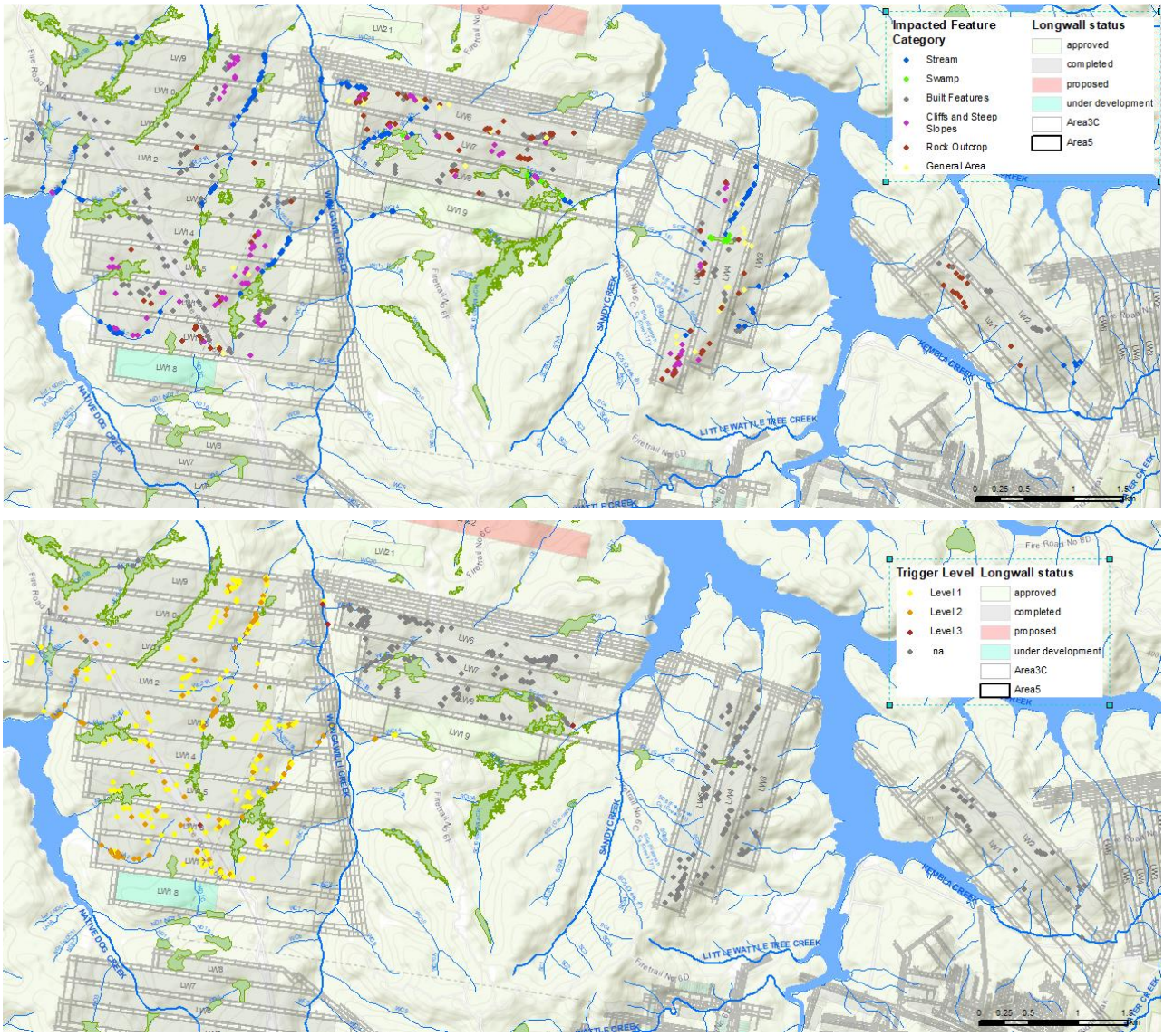


Figure 3 Landscape impacts by feature and trigger level

WaterNSW estimates that over 670 impacts have been reported to date by IMC in impact assessment reports and End of Panel reports and is based on specific targeted monitoring locations. As such it is likely that the extent of these impacts in the areas mined will be much larger and hidden by vegetation cover. The reported impacts include impacts to streams, swamps, cliffs and steep slopes, rock outcrops, built features and general catchment area. These impacts have been classified into TARP trigger levels 1, 2 and 3 (in increasing order of severity).

Mining surface exploration activities and implementation of environmental monitoring have also resulted in significant clearing of land which are at various stages of rehabilitation. The cumulative impacts of exploration activities (to the end of 2019, only for Area 5, and only for Surveys 14-16 submitted by IMC to WaterNSW) – indicate that exploration activities 'disturb' a very large area (approximately 49 ha) geographically. These impacts also have implications for loss of biodiversity and water quality. **These impacts shall also be included in consideration of compensation and offsets for the project**.

Cumulative Impact Assessment

The Cumulative Impact Assessment Guidelines (DPIE November 2021 - Cumulative Impact Assessment Guidelines for State Significant Projects) provide guidance and advice to ensure cumulative impacts are effectively and consistently considered in State Significant projects. This will support better assessment, well-informed and appropriate decision-making, and achieve better outcomes. As per the guidelines CIA shall include:

- The assessment of cumulative impacts at the strategic-level and site-specific (or project) level
- The assessment of environmental, social, economic, and other impacts which result from a project when added to past, present, and reasonably foreseeable future projects.

Very little detail is presented in the EIS in assessing the cumulative impacts of mining in Area 3C (which are likely to also have 305 m wide panels) as is required in the CIA guidelines.

WaterNSW is concerned that there is no comprehensive cumulative impact assessment included in the EIS with due consideration of the guidelines. A cumulative impact assessment consistent with the guidelines shall be provided.

Offsets and Compensation

WaterNSW has concerns including:

- the uncertainties regarding IMC's offer of annual payments for water offsets that is based on 'actual surface water losses' as calculated using the Project's groundwater model (which would be recalibrated as required).
- the adequacy of compensation to address widespread catchment impacts (Fire Management $371,500, Roads $146,000, Barriers $100,000, and transfers of land owned by IMC). It is not specified as to whether these are one-off payments or yearly instalments but either way further discussion is required.

Consideration should be given to the draft Greater Sydney Water Strategy which suggests climatic variability could result in a water deficit of 40 to 70 GL/year under a moderate growth scenario resulting in a shortage of drinking water with more and longer periods of severe drought.

Consideration should also be given to the potential reuse of mine water - like that achieved by Centennial Coal in the western coalfield rather than discharging outside the Special Areas which largely accounts for the losses.

IMC shall consult with WaterNSW to address above concerns should the Project be approved.