Blue Mountains Conservation Society Inc

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Nature Conservation Saves for Tomorrow

Mining and Industry Projects,
NSW Department of Planning & Infrastructure,
GPO Box 39,
Sydney NSW 2001

Dear Sir / Madam,

Submission re Centennial Angus Place DA

State Significant Project – Angus Place Mine Extension (SSD 12_5602)

1. Description

As presented in the published EIS, this project will entail the following :-

- in general, include all currently approved operations, facilities and infrastructure of the Springvale Mine, except as otherwise indicated in this EIS;
- continue to extract up to 4 million tonnes per annum (Mtpa) of ROM coal from the Lithgow Seam underlying the Project Application Area;
- develop underground access headings and roadways from the current mining area to the east to allow access to the proposed mining areas;
- undertake secondary extraction by retreat longwall mining technique for the proposed longwalls LW1001 to LW1019;
- continue to use the existing ancillary surface facilities at the Angus Place pit top;
- continue to manage the handling of ROM coal through a crusher and screening plant at the Angus Place pit top, and the subsequent loading of the coal onto the existing overland conveyor system for despatch to offsite locations;
- continue to operate and maintain the existing ancillary surface infrastructure for ventilation, electricity, water, materials supply, and communications at the Angus Place pit top and on Newnes Plateau;
- install and operate seven additional dewatering bore facilities on Newnes Plateau and the associated power and pipeline infrastructure;
- upgrade and extend the existing access tracks from Sunnyside Ridge Road to the dewatering borehole facilities;

- install and operate dewatering reinjection boreholes and pipeline infrastructure at the existing ventilation facility site (APC-VS2);
- construct and operate a downcast ventilation shaft (APC-VS3) and upgrade the existing access track to the proposed facility from Sunnyside Ridge Road;
- manage mine inflows using a combination of direct water transfer to the Wallerawang Power Station, via the Springvale Delta Water Transfer Scheme (SDWTS), and discharge water through Angus Place Colliery's licensed discharge point LDP001 and Springvale Mine's LDP009;
- continue to undertake existing and initiate new environmental monitoring programmes;
- continue to operate 24 hours per day seven days per week, 52 weeks per year;
- continue to provide employment to a full time workforce of up to 300 direct employees and contractors;
- progressively rehabilitate disturbed areas at infrastructure sites no longer required for mining operations;
- undertake life-of-mine rehabilitation at the Angus Place pit top and the Newnes Plateau infrastructure disturbance areas to create final landforms commensurate with the surrounding areas and the relevant zonings of the respective areas; and
- transfer the operational management and physical infrastructure regarding coal processing and distribution infrastructure to the Western Coal Services Project.

Interestingly, the DA for the neighbouring Centennial mine, Springvale, undertakes to "*continue exploration activities, predominantly borehole drilling to further refine the existing geological model*", but the Angus Place EIS includes no such commitment. Surely their subsurface knowledge is not so complete as to render additional exploration unnecessary, particularly given the history of ground cracking and swamp destruction that will be highlighted by this submission. Or is this just a careless oversight?

However, even more confusing and concerning is the intention to "*include all currently approved operations, facilities and infrastructure of the Springvale Mine*". Why would Angus Place use the Springvale plant? This is surely just a careless oversight, another one, astonishing given the great length of time taken to prepare this suite of documents and the expensive battery of consultants employed. Logically, what faith can there be in the masses of data buried in the body of the EIS and its appendices, errors that are not so obvious?

2. The BMCS Position

The Blue Mountains Conservation Society is a highly regarded community based volunteer organisation with about 800 members whose goal is to promote the conservation of the environment of the Greater Blue Mountains area. The Society welcomes the opportunity to contribute its submission relevant to the proposed modifications presented in this application. The Society strongly opposes this mine expansion. The application poses a significant risk to

the environment, and is not welcomed by the people of the Blue Mountains who have long fought to protect the region's waterways from industrial pollution.

Before the details of this proposal are addressed, it needs to be restated that, seemingly as standard practice for this industry, the company in question spends much time and money preparing the document, using highly paid consultants, yet the system expects largely volunteer-based environmental organisations to react instantaneously and respond in a ridiculously short time frame. This *modus operandi* is heavily weighted in the proponents favour, and is clearly unfair, yet is seemingly done with government sanction.

The objections to this proposal principally concern waterway pollution from pumpouts, and streambed cracking and cliff collapse from subsidence in the area overlying the longwall development. Associated with streambed collapse is the dessication of shrub swamps (THPSS – temperate highland peat swamps on sandstone) and consequent destruction of these endangered and fragile ecosystems. The objection is based both on the historical performance of the company in question in this area, and on the natural consequence of this type of mining (collapse-retreat).

The real impact derives from the intended full project scope, namely 19 longwall panels. This is not a trivial undertaking. The proposed Angus Place extension underlies and will affect 2,638 hectares of the Plateau. The equivalent and simultaneous modification application for the neighbouring Springvale Colliery entails a further 1,860 ha.

Arguments for the continuation of coal mining include that it has been undertaken for many years and provides work. The same could have been said for the production of DDT, asbestos and ozone-depleting refrigerants. When human activities are found to have deleterious effects on mankind and on the wider environment, one would hope that we, as an intelligent species, would adjust accordingly. Past practice is no justification for future action. Such is the basis of the time-honoured truism variously quoted as "*Those who cannot remember the past are condemned to repeat it*."

Another justification given by the applicants in the EA document is that the mines are important employers. True, but irrelevant. Other major past employers in the Lithgow region include an iron foundry and a munitions factory. Times change; they've gone. Our industrial society changes through time, and as a consequence the makeup of industry in particular localities changes accordingly, and this is particularly a feature of the mining industry across Australia where mineral deposits are exhausted and the associated town typically dies (eg Mary Kathleen, Goldsworthy, Wittenoom). In an odd demonstration of ill-considered justifications for this project, the Environmental Assessment submitted in support of this project application notes "*The sustainability of the mining sector and its related employment is vital to the broader economic wellbeing of the area*." Given that the coal is a finite resource, it can never be mined sustainably unless the rate of mining is declining more quickly than the rate of depletion [1]. That is part of any depletion protocol of a finite resource. In this the only possible sustainable exploitation methodology, the rate of extraction quickly approaches an effective zero value. Did the author mean that, or is this

just another example of pro-development misuse of language in order to promote their commercial interests? Any other implied use of the term 'sustainable' is gobbledegook, but there is probably no other word in our language currently being so regularly misused. In reality, what must be used sustainably are the renewable resources, viz air, water and food (soil). These comprise our life support systems.

The emphasis on economic considerations is also illustrative of a dangerous mindset that pervades the coal mining industry, and their supporters in government, that places economic considerations ahead of environmental health, human health and human quality of life in general. That is not an enlightened basis for any sort of industrial development. In this regard it is clear that the obtuse assertion of a recent NSW premier, viz "What is the use of saving the planet if we ruin the economy doing so?", is alive and well and is the driver behind this destructive industry.

Regardless, from an environmental health perspective, these commercial aspects are irrelevant.

3. Detailed Comments and Concerns

3.1. Waterway Pollution

Just three years ago, the Blue Mountains Conservation Society won a landmark legal settlement that stopped Delta Electricity's Wallerawang power station dumping boron, zinc, arsenic and aluminium into the Coxs River. [2] [3] That should have been a watershed time, after which the coal mining industry should have developed a new paradigm of benign interaction with the environment, rather than continued damage. There is no place for BAU (business as usual). Yet this development application involves plans to pump up to 43 million litres of contaminated water a day into the same river, which feeds into the Lake Burragorang, an important part of Sydney's drinking water supply. Under the current proposal, the mine water would apparently be released into the river untreated, despite having elevated salt and heavy metal levels. The specific route is via Sawyers Swamp Creek into the Coxs River.

A further historical warning should be noted from the degradation of the Grose River below the discharge point from the now abandoned Canyon Colliery. Studies of the water chemistry and fauna assemblage below this point indicate elevated levels of zinc and loss of invertebrate species. [4] [5] [6]

More recently, studies of the Wollangambe River below the discharge point for Clarence Colliery, also owned by Centennial Coal, indicates water quality degradation and damage to the instream ecosystem.

The discharge to be made under the current application, of to 43.8ML/day of untreated eco-toxic mine effluent, would flow to the Coxs River via the Springvale-

Delta Water Transfer Scheme (SDWTS). Such an inappropriate discharge is inconsistent with the SCA Sydney Drinking Water Audit 2010 Recommendations.

Local mining history has demonstrated that subsidence damage and/or eco-toxic minewater effluent discharges from Angus Place and Springvale Colliery's have caused irreparable damage to a Federally Listed Endangered Ecological Community THPSS at Junction Swamp, Narrow Swamp, East Wolgan Swamp, Kangaroo Swamp, and Lamb's Creek Swamp. That is clearly an unacceptable situation. Any discharge needs to be subject to high level remediation, such as via reverse osmosis filtration, to remove environmentally damaging heavy metals and salts, so the treatment must be undertaken prior to the water leaving the mine site. It is essential that the Centennial Angus Place guarantees that ANZECC guidelines for upland waterways will be heeded. No ifs; no buts. In fact, the responsible approach would be to discharge only water that has been treated to a pristine level. Furthermore, malfunction of SDWTS, such as following a bushfire, must not result in emergency discharges to the World Heritage Area via Wolgan River or Carne Creek but reinserted underground into the mine.

The consultants have asserted '*that any effects on potential populations of the endangered Adams Emerald Dragonfly will be insignificant'*. It is impossible to make such a statement, considering that there have never been any ecological studies of this species and limited aquatic sampling was undertaken for this project.

It needs to be emphasised that Carne Creek is currently in a pristine state, and its waters are of the highest standard. This creek was a key determinant in the location of the Emirates eco-resort. The extensive fracturing of the sandstone associated with longwall mining of headwater swamps will release high levels of metals, notably manganese and iron, polluting Carne Creek. The comparative water qualities at the junction of Carne Creek and the Wolgan River, near the resort, clearly demonstrates the degree of pollution of the latter.

The Society's concerns are not without foundation; not only was Centennial Coal issued with a $1,450,000.00 Enforceable Undertaking under Section 486DA of the EPBC Act by the Federal Minister for Sustainability, Environment, Water, Population, and Communities the Honourable Tony Bourke on 12 October 2011 [7], but, under section 4 (The Undertaking) of the relevant document [8], Centennial arrogantly asserts "*Without conceding that it has breached the EPBC Act or any other Act*". This lack of *mea culpa* provides little comfort that future mining operations will be protective of the environment save for threats of punishment. There will clearly be no future voluntary compliance; threats and punishment are the sole deterrents. Elsewhere in our society, acknowledgement of guilt is a key aspect of the legal process; it provides comfort that those involved respect the law and that recurrence is unlikely.

There is also considerable concern on the figures quoted by the company, specifically the water discharge amounts. We are led to believe that the 43 million litres per day (max) for the life of the mine (5 times the mine's current discharge) will come only from the seam and not from nearer surface aquifers. This requires an apparently unreasonably large volume of produced water from the seam and no breaching of aquicludes above the seam being mined. This appears inaccurate and should be verified by an independent study. In this regard, the Society supports the establishment of a system of truly independent consultants to conduct all environmental impact assessments.

At this point it is appropriate to focus on the poor record of licence non-compliances attributable to the Angus Place colliery. Appendix 1 presents this list. The Society is of the view that there is clearly a systemic attitude problem/disregard for the law, and hence there must be reduced confidence in future compliance.

3.2. Streambed Cracking

Longwall mining is a preferred option for coal mining companies due the high recovery rate of the resource and hence higher profitability. However, as the wall advances, the void that it creates eventually leads to the collapse of the unsupported roof. Because fractured rock occupies more volume than solid rock, the depth of the seam being mined and the seam thickness are major determinants of how much subsidence occurs at the ground surface above the longwall sector, with thick, shallow seams being problematic and deep, thin seams having negligible surface effect. The panel width is a contributing factor to subsidence, with the Angus Place panels being wider than the adjacent Springvale mine's modification application.

The environmental impact statement lodged with this application provides a detailed map of predicted subsidence over the area of the panels, with a maximum subsidence of 1.9m, and a range of 1 to 1.9 m over the panel area. The Centennial colleries (Angus Place and Springvale) have no record of acknowledgement of surface damage from longwall-induced subsidence. In the recent past, when streambed cracking and the disappearance of water were noted in the East Wolgan swamp, above a recently extracted longwall panel of Springvale Colliery, the mine management and their consultants maintained that the subsidence was nothing to do with the mine, despite the geographical and time relationship of the panel's extraction and the overlying surface cracking. Figures1 & 2, below, show the before and after appearance of this swamp. Figure 3 presents an even more alarming proof of the total destruction to a swamp above a longwall mine. The stance taken by Centennial was a ludicrous position to adopt, and demonstrated an astounding level of effrontery. But such is the disregard of Centennial for what happens as a consequence to its operations.

Fig. 1.

Fig. 2.

Fig. 3

Centennial seem to have learnt little, and acceptance of guilt seems alien to them. Quite disregarding the clear evidence of swamp destruction shown in the above photographs, damage which remains, the groundwater impact section of their application states "*Three of the Newnes Plateau Shrub Swamps are listed as protected under the Federal Environment Protection and Biodiversity Act 1999, these are East Wolgan Swamp, Narrow Swamp and West Wolgan Swamp. As these swamps have already been undermined by the current approved longwall operations at Springvale and Angus Place, they have not been specifically included in the modelling assessment. However, all three swamps are part of the regular swamp monitoring and have been shown to have not been impacted by mining.*" Apparently, total destruction qualifies as no impact.

The EIS is a huge document, replete with extensive supportive data. Given the above clear evidence of a misleading EIS, little confidence can be placed in the value or application of such data.

Appendix G. of the EIS, Aquatic Ecology and Stygofauna Assessment, states that "*The potential for physical impacts has been minimised by setting the proposed longwalls back from the centreline of Wolgan River and Carne Creek and by aligning the longwalls with the general horizontal stress direction*." This is playing semantics. Minimal impact is zero impact. Since the document then states that "*Impacts that do arise would be managed by …"* clearly indicates that impacts are expected, not minimised. One of these management techniques is to monitor the creek lines, classic weasel words; if damage can't be remediated, there is no point in monitoring. Another management tool then listed is "*Remediation measures, such as grouting, in areas where fracturing of stream or swamp beds leads to protracted diversion of stream flow and/or drainage of pools*". There is no evidence from the Sydney Basin that such grouting of fractured stream beds will achieve remediation objectives and return stream flows to a pre-mining condition, and the same applies in the case of fracturing of bedrock under swamps, where there is no evidence that this has ever been successfully implemented.

The society strongly supports the consultants' recommendation to undertake more comprehensive, and better designed, pre-mining surveying, and finer resolution taxonomic identification of stygofauna; such surveying must be implemented if this project proceeds to ensure that the diversity of stygofauna is properly assessed and potential risks of the project determined.

Appendix E, part 1 of The Groundwater Impact Assessment for the proposal, asserts that ground cracking under the swamps would be temporary due to the cracks being filled by sediment. This presupposes that loose sandy sediment would have low permeability, a dubious contention that the Society rejects. For a start, it would depend on the size distribution of the particular sediment. It is instructive to reflect that coal seam gas extraction from fracking is enabled by the injection of sand into microfractures, yet in a curious twist the gentle washing of sand into the cracks under these swamps supposedly inhibits fluid flow.

Scientists describe undermining of these swamps as a 'key threatening process' as groundwater is lost from these diverse swamps that then dry out. The swamps are a vital refuge for many small mammals, birds and insects as they are virtually impenetrable to predators. Even a cursory glance at the above photographic evidence makes the results of this 'threatening process' diabolically clear.

The East Wolgan swamp demonstrated a rather perverse endless loop of increasing toxicity. Water from the mine was discharged above the swamp, damaging the downstream section until the water disappeared into the ground. Despite the undemonstrated assertion from the mine consultants that the water would resurface further downstream, due to the streambed cracking being attributed by the company to upsidence, the clear fate of the water would be to re-enter the mine workings via the broken, collapsed sequence above the long wall panel. The water would then have to be pumped and discharged again, presumably collecting more toxic components from successive trips through the coal seams.

Bord and pillar is a clearly more benign process, and has been practiced at Centennial's nearby Clarence Colliery. However, in this instance, the mining method was chosen for reasons of engineering safety (the stope back was too solid to collapse in a controlled manner) rather than any display of environmental sensitivity.

3.3. Shrub Swamp Dessication

One of the more important components of the Newnes Plateau environment is the system of shrub swamps (NPSS). The expansion of these mines would put at risk 17 swamps listed as nationally endangered, plus 31 hanging swamps. These swamps store water and release it gradually, maintaining stream flow even in drier periods. The loss of water into cracked streambeds upstream of, or under, these swamps leads

to their desiccation and the complete destruction of the ecosystem in each affected valley. This has been shown above in figures 2 and 3.

In the East Wolgan swamp, above the location of the cracked streambed, the swamp health was also being deleteriously affected by discharge of untreated mine water.

It is the opinion of the Society that an application to extend longwall mining in this colliery would have demonstrated a proper consideration for the risks posed to plateau swamp systems had the following been incorporated into the planning :-

- That no surface cracking of stream beds, under swamps or of pagodas, rock outcrops or cliffs;
- That the intensity of longwall mining be reduced so that all nationally endangered swamps are protected; this would include shortening longwalls 1017 and 1016 to protect Trail 6 swamp and shortening longwalls 1004, 1005 and 1006 to protect the Tri Star Swamp complex;
- That the longwall panels 1007, 1008, 1009 and 1010 be narrowed and/or split to prevent fracturing damage in the Birds Rock Flora Reserve; and
- That longwalls 1013 and 1014 be split to prevent damage to pagodas and cliffs, as proposed.

3.4. Swamp Flora and Fauna

For this analysis of the application, the Society draws on the work of ecologist Dr Ian Baird. The Society understands that Dr Baird has made a separate submission in his specialist area. (see Appendix 2 for a copy of the review of specific threats to these groundwater dependent peat swamps and their associated groundwater dependent species from his submission). What is clear is that he has found significant problem with the proposal.

Dr Baird's summation of Appendix H, Flora and Fauna Impact Assessment strongly disputes the conclusion by the consultant that there will be no significant impact upon threatened groundwater dependent swamp species and EECs. The consultants state that there is a "high level of confidence" that subsidence will not significantly affect threatened species such as the groundwater dependent *Petalura gigantea* (*Pg*) and *Eulamprus leuraensis* (*El*), and the NPSS and NPHS EECs. This is not good enough. Any risk is too much. A small, medium to long term lowering of the water table in a NPSS may result in a significant reduction in the potential habitat suitable for Pg and El, potentially leading to extirpation of one or both of these species from such a swamp. The same applies for other groundwater dependent flora (e.g. *Boronia deanei* ssp. *deanei*) and fauna. The consultants have demonstrated in their report a complete lack of understanding of the habitat requirements of Pg and El, in particular, which

invalidates their conclusions. Dr Baird disputes the conclusion of the consultants that there will be no significant impact in relation to the Key Threatening Process of subsidence from longwall mining. Their conclusions are based, in large part, upon the contentious conclusions of other consultants employed by Centennial Coal, in relation to the potential risk of subsidence and associated lowering of water tables. Existing photographic evidence of a totally dessicated swamp is eloquently damning of the surface effects of longwall mining.

3.5. Excessive Water Extraction

The aquifer interference policy requires that a proponent demonstrates variability to lawfully take water within the limits of their licence and the water sharing plan. The Society notes that there appears to be a discrepancy (deficit) between the extraction licence and the estimated inflow in 2023. That deficit is in relation to what is required for the Richmond groundwater source, and is approximately 7 GL. Furthermore, the society is strongly of the opinion that there is insufficient water to allow this level of extraction.

3.6. Land Clearing

As this mine progressively advances under the plateau, there is a concomitant advance of the associated industrial landscape across largely pristine woodland. Exemplifying this forest destruction is the proposed additional clearing of an extraordinary 23.25ha for a ventilation facility, seven dewatering bores and a ten metre wide pipeline easement connecting these sites. All this industrial development significantly adds to the burden of infrastructure on Newnes Plateau in the Gardens of Stone region; to date progressive rehabilitation has proven ineffective.

3.7. Cliff Collapse / Pagoda Damage

The western coalfield has a history of cliff collapses due to subsidence from longwall mining. As was demonstrated by the nearby Coalpac Consolidated Project, the companies involved greatly underestimated the level of cliff collapse that has already occurred, a clear case of wilful blindness or incompetence. Conservation volunteers have been able to find, locate and document a great many instances that mining consultants failed to find. Are we to finish up with an area like Hassan's Walls, where signs warn people of subsidence dangers? Is that what a monitoring regime entails, all care and no responsibility? That is a confession of failure to protect the wider community and environment from the excesses of mining-caused collapses.

3.8. Greenhouse Gas Pollution

Over and above local environmental issues is the crisis of global warming. Coal combustion is a major contributor to the rising levels of greenhouse gases, including both carbon dioxide (C02) from combustion and methane (CH4) from fugitive emissions. Recent studies are highlighting that methane release is approaching a level that makes CO2 irrelevant, due to the markedly higher radiative forcing value of methane over a variety of time scales [9].

As variously and recently reported by the London School of Economics' climate research unit, the nonprofit Climate Tracker Initiative, and the Climate Commission (co-authored by Professors Wil Steffen and Lesley Hughes), research has lead to the conclusiond that of the order of 80% of demonstrated reserves of fossil fuels must be left in the ground, unexploited (unburnt), if the planet is to avoid dangerous amounts of atmospheric warming, warming that would pose existential threats to most of humanity [10]. To meet international standards of greenhouse gas emissions targets Australia needs to be limiting coal exploitation, not expanding it.

3.9. Recreation

The plateaux and waterways of the Newnes / Gardens of Stone area, which will be damaged by this proposed mine extension, are increasingly a place of refuge and relaxation for an expanding city of Sydney. Indeed it is unique to have a region of such beauty and conservation value so close to one of the world's great cities. Water rendered toxic or otherwise nonpotable, loss of floral and faunal assemblages, dangerously destabilised cliffs, open subsidence cracks and destruction of our life support systems are all part of an unacceptable price for industrialising this precious region. The growing and sustainable tourist industry is being consistently damaged by the impacts of coal mining in this spectacular region. The price of this development is too high.

The Blue Mountains Conservation Society has made no donations to any political party.

Thank you for the opportunity for the Blue Mountains Conservation Society to comment on this mining proposal.

Yours Faithfully,

Peter Green

For the Management Committee

Blue Mountains Conservation Society

REFERENCES

[1] Peak Everything; Waking Up to a Century of Declines, p92. Heinberg, R.

[2] http://www.edonsw.org.au/pollution_cases

[3] http://www.smh.com.au/environment/water-issues/power-company-says-river-pollution-to-stop-20111017-1ltdz.html#ixzz2ypHZnvzn

[4] Wright I. A. & Burgin S. (2009) Comparison of sewage and coalmine wastes on stream macroinvertebrates within an otherwise clean upland catchment, Southeastern Australia. Journal of Water Air and Soil Pollution 204, 227-41.

[5] Wright I. A. & Burgin S. (2009) Effects of organic and heavy metal pollution on chironomids within a pristine upland catchment. Hydrobiologia 635, 15-25.

[6] Wright I. A., Wright S., Graham K. & Burgin S. (2011) Environmental protection and management: A water pollution case study within the Greater Blue Mountains World Heritage Area, Australia. Land Use Policy 28, 353-60.

[7] http://laptop.deh.gov.au/about/media/dept-mr/dept-mr20111021.html

[8] http://laptop.deh.gov.au/epbc/compliance/pubs/enforceable-undertaking-centennial.pdf

[9] "A Bridge to Nowhere: Methane Emissions and the Greenhouse Gas Footprint of Natural Gas," Howarth R. ; **Journal Energy Science and Engineering**, 20th May 2014.

[10] http://www.nature.com/nature/journal/v458/n7242/full/nature08017.html ; Malte Meinshausen, Nicolai Meinshausen, William Hare, Sarah C. B. Raper, Katja Frieler, Reto Knutti, David J. Frame & Myles R. Allen, **Nature** 458, 1158 – 1162 (30th April, 2009).

APPENDIX 1.

ANGUS PLACE COLLIERY

Licence No. 467

Non-Compliances 2000 - 2102

2012

Licence Condition number	Type of non-compliance	EPA actions	No. of times occurred
L2.1	Total suspended solids limit exceeded at two locations. Non-compliances resulted from a heavy rainfall event in March 2012.	S.58 notice being negotiated to change licence conditions(s)	2

2011

Licence Condition number	Type of non-compliance	EPA actions	No. of times occurred
L2.1	Limits for Total Suspended Solids exceeded at LDP1 (once), LDP2 (3 times) and LDP3 (twice) due to various reasons. Various action taken to prevent recurrence.	Appropriate Action taken by licensee	6
L2.2	90% concentration limit for pH and Total Suspended Solids exceeded at points LDP2 and LDP3 respectively. Various actions taken to prevent recurrence.	Appropriate Action taken by licensee	1
L6.1	Noise emissions above the evening criteria at receptors due to unusually high engine noise from trucks and weather conditios. Consultant engaged to assess noise reduction strategies.	Appropriate Action taken by licensee	2
M7.1	Volumetric sewerage monitoring at Point 5 was undertaken at the incorrect frequency due to equipment recording a cumulative flow rate. The flow monitoring program has been updated to allow weekly readings.	Appropriate Action taken by licensee	1

2010

Licence number: 467

Annual Return Start: 01 Jan 10

Annual Return End: 31 Dec 10

Date Received: 02 Mar 11

Licence Condition number	Type of non-compliance	No. of incidents
L3.1	Exceeded total suspended solids discharge limit at LDP2 (x6) & LDP3 (x7). and minor exceedance of pH limit at LDP2. Licensee report due to heavy rainfall events throughout the year. Commiissioned dosing plant in Jan 2011 to ensure future compliance.	1
L6.1	Noise emissions associated with truck movement along the Wallerawang private haul road exceeded evening criteria at 3 receptors on the 7/9/10. No complaints were received. Protocols were put in place to limit the number of trucks on road.	1
M6.1	Licensee monitored on an annual rather than weekly basis the volume of effluent irrigated on application area. Licensee was able to calculate average weekly	1

volumes No environmental harm resulted from non-compliance.

2009

Licence number: 467

Annual Return Start: 01 Jan 09

Annual Return End: 31 Dec 09

Date Received: 02 Mar 10

Licence Condition number	Type of non-compliance	No. of incidents
A2.1	Minor exceedance of total coal mined during the 2009 reporting period due to the cyclical nature of longwall mining (3.69 Mtpa mined versus a licence scale limit of 3.5 Mtpa). No environmental impact.	1
L3.1	Total suspended solids exceeded at LDP001 (x 3 - minor exceedances), LDP2 (x 2 - maximum of 111 mg/L) & LDP3 (x 1 at 320 mg/L).	1
M2.1	Failure to monitor surface water discharges at LDP3 on three occassions due to short duration of rain event and resultant discharge., and data logger not fitted with telemetry function to warn licensee of impending overflow.	1
M2.1	PM10 and TSP sampling not collected to time frame due to misinterpretation of licence condition. Measurments were collected over a 24 hour range rather than 6 day. Since corrected by licensee	1
M6.1	The volume of liquids discharged to water was not monitored for 24 days due to datalogger failure at LDP002. Temporary flow meter with data logger installed until New Monitoring Station complete.	1
O1.1	Pumping to the utilisation area from the sewage oxidation lagoons has not been carried out due to failure of the pumping system. Resulted in minor overflows at times of heavy rain.	1

2008

Licence number: 467

Annual Return Start: 01 Jan 08

Annual Return End: 31 Dec 08

Date Received: 02 Mar 09

Licence	Type of non-compliance	No. of

Condition number		incidents
L3.1	Minor exceedance of discharge concentration limits for Total Suspended Solids at LDP01, LDP02 & LDP03, and Oil & Grease at LDP02.	4
L6.1	Exceedance of evening noise limits at two residences	1
M2.1	TSP and PM10 high volume dust sampling not carried out until December 2008 due to difficulties in obtaining necessary equipment.	1
O1.1	Pumping to utilisation area from the sewage oxidation lagoons was not carried out resulting in minor overflows from pond on occasion following heavy rain.	1

2007

Licence number: 467

Annual Return Start: 01 Jan 07

Annual Return End: 31 Dec 07

Date Received: 29 Feb 08

Licence Condition number	Type of non-compliance	No. of incidents
L3.1	Minor exceedance of pH and TSS limits during the reporting period	6
M2.1	Failed to undertake TSP and PM10 high volume dust sampling as reguired by licence (point 15).	10
O1.1	pumping to the utilisation area from the sewage oxidation lagoons has not been carried out due to failure of the pumping system	1
R2.2	TSS and PH levels exceeded and were not reported to DECC within specified time frames	6

2006

Licence number: 467

Annual Return Start: 01 Jan 06

Annual Return End: 31 Dec 06

Date Received: 19 Feb 07

Licence Condition No.	Type of non-compliance	No. of incidents
L3.1	Multiple exceedances of pH and TSS at licensed Discharge Point 1	7

2005

Licence number: 467

Annual Return Start: 01 Jan 05

Annual Return End: 31 Dec 05

Date Received: 27 Feb 06

Licence Condition No.	Type of non-compliance	No. of incidents
L3.1	Exceedance of pH 8.5 for LD001 Exceedance of TSS 30mg/L for LD001	5

2004

Licence number: 467

Annual Return Start: 01 Jan 04

Annual Return End: 31 Dec 04

Date Received: 23 Feb 05

Licence Condition No.	Type of non-compliance	No. of incidents
L3.1	pH limit exceeded at Point 1 in November 2004	1

2003

Licence number: 467

Annual Return Start: 01 Jan 03

Annual Return End: 31 Dec 03

Date Received: 24 Feb 04

Licence Condition No.	Type of non-compliance	No. of incidents
L3.1	Exceedence of licence concentration limit for Total Suspended Solids from LD2	1
M6.1	Technical non-compliance whereby datalogger experienced problems resulting in 3 days where flow monitoring was not recorded at LD1.	1

2001

Licence number: 467

Annual Return Start: 01 Jan 01

Annual Return End: 31 Dec 01

Date Received: 07 Feb 02

Licence Condition No.	Type of non-compliance	No. of incidents
2.1	Licensee failed to sample at the frequency at monitoring point 3, as required by licence.	1
3.1	Licensee exceeded concentration limit for TSS and pH as required by the licence	1
3.2	Licensee exceeded pH quality limit for monitoring point 2.	1

2000

Licence number: 467

Annual Return Start: 01 Jan 00

Annual Return End: 31 Dec 00

Date Received: 23 Feb 01

Licence Condition No.	Type of non-compliance	No. of incidents
L3	Exceedance of licence limit for TSS at discharge point 3.	1
M2	Monitoring not undertaken on monthly basis for Discharge Point 3 as required by licence due to the infrequent discharge from the point.	1

Note: Licence Transfer (ref. no. 145029) on 20 June 2007 to SPRINGVALE SK KORES PTY LIMITED

Notice Number 1124602

File Number LIC07/996

Date 09-May-2011

NOTICE OF VARIATION OF LICENCE NO. 467

BACKGROUND

A. CENTENNIAL SPRINGVALE PTY LIMITED ("the licensee") is the holder of Environment Protection Licence No. 467 ("the licence") issued under the *Protection of the Environment Operations Act 1997*

(“the Act”). The licence authorises the carrying out of a Scheduled Activity - Premises Based at

WOLGAN ROAD, LIDSDALE, NSW.

B. Licence discharge point 1 (LDP1) discharges groundwater, sourced from the licensee’s underground

workings, to Kangaroo Creek which in turn flows to the Coxs River. The Coxs River catchment is part

of the Sydney drinking water catchment.

C. The EPA is concerned with the elevated concentrations of salts being discharged from LDP1 to the

Coxs River catchment. An estimate has been made by the EPA that approximately 1,000 tonnes of

salt is deposited in to Kangaroo Creek a year based on average flow rates (provided by the licensee)

and salinity concentrations (measured by the EPA) at LDP1.

D. The EPA wrote to the licensee on 15 September 2010 requesting that a preferred salinity management

option be developed for the discharge from LDP1. The licensee responded on 29 October 2010 with the preferred option identified being the piping of waters from LDP1 to the Wallerawang Power Station.

Notice Number 1109300

File Number LIC07/996

Date 17-Feb-2010

NOTICE OF VARIATION OF LICENCE NO. 467

BACKGROUND

A. CENTENNIAL SPRINGVALE PTY LIMITED and SPRINGVALE SK KORES PTY LIMITED (“the

licensee”) are the holders of Environment Protection Licence No. 467 (“the licence”) issued under the *Protection of the Environment Operations Act 1997* (“the Act”). The licence authorises the carrying out of Scheduled Activity - Premises Based at WOLGAN ROAD, LIDSDALE, NSW

B. The EPA recently completed an investigation/assessment into sources, distribution and concentrations of contaminants in the Upper Coxs River catchment. These contaminants include heavy metals, salts and nutrients. Part of study included the sampling of surface waters at key locations within the catchment including Kangaroo Creek, downstream of licence discharge point 1.

C. Laboratory results for total dissolved solids from this location, in conjunction with average discharge rates over the previous four years, indicates that Angus Place mine is discharging approximately 1,000 tonnes of salt into the Coxs River every year.

D. In line with pollution reduction programs being required by other licensees within the Upper Coxs River catchment where high concentrations of contaminants in the discharge have been identified, the EPA is varying the licence to include licence condition U1 which requires the licensee to investigate and report on options for the reduction or removal of salt being discharged from point 1.

APPENDIX 2.

Part A: Literature Review – From Submission of Dr I. Baird

Threats to groundwater dependent species

Petalura gigantea

Like most of the 11 species of petalurid dragonflies worldwide, the endangered (TSC Act 1995) *Petalura gigantea* (Petaluridae) is characterised by a burrowing larval lifestyle (Baird 2012: Chapter 1; in press; Tillyard 1911) that is unique in the Odonata (Corbet 1999). Studies to date suggest a larval stage of at least six years, and possibly more than 10 in *P. gigantea* (Baird 2012: Chapter 1). The long larval stage and the unpredictability of emergence events (Baird 2012: Chapter 7) means that the species is most unsuitable for the purpose of monitoring ecological changes associated with mining subsidence. Thus, any deleterious effects upon populations of the species, as a result of lowered water tables, will not be detectable until well after the event and thus too late.

Successful *P. gigantea* breeding sites are characterised by a groundwater regime that provides sufficient surface moisture to minimise risk of desiccation of eggs and early larval instars, supports development of organic-rich mire soils suitable for larval burrowing, and maintains a water table height that larvae can access within established burrows or adaptively through burrow deepening. Extensive burrow investigations and observation of hundreds of oviposition and burrow locations across a range of mire types in the Blue Mountains confirm *P. gigantea* as an obligate, groundwater dependent, mire-dwelling species (Baird 2012: Chapter 6). All investigated burrows included groundwater in the burrows, usually throughout the majority of the burrow depth (Baird 2012: Chapter 1; in press; Benson & Baird 2012). Although there is some evidence of putative adaptive burrow deepening by late stadia larvae in some circumstances, it is availability of suitable microhabitat for ovipositing and early larval establishment which is critical to persistence of populations of the specie. All observed oviposition occurred into waterlogged substrate, fissures in the substrate, amongst or under moist litter overlying the substrate, amongst roots at the base of plants in moist substrate, or into *Sphagnum*. Breeding habitat for the species is restricted to the wetter parts of these swamp systems where the water table is either emergent or causes saturation of the surface of the substrate, at least throughout the period of egg-laying, early larval development and burrow establishment. This is the critical life history stage and is dependent upon the presence of saturated organic-rich substrates associated with high, and frequently, emergent water tables.

Any long-term lowering of the water table will result in a proportional contraction or reduction in the spatial extent of potential breeding habitat within individual swamps, and potentially, to extirpation of the species from those swamps, with potential implications for metapopulation dynamics of this patchily distributed species (Baird 2012: Chapter 8).

Eulamprus leuraensis

The endangered (TSC Act 1995, EPBC Act 1999) lizard, *Eulamprus leuraensis* (Scincidae), is endemic to mid to upper elevation Blue Mountains Sedge Swamps (of Keith & Benson 1988) and NPSS (Dubey & Shine 2010a, b; Dubey & Shine 2011; Dubey et al. 2013; LeBreton 1996). The species is closely associated with, and dependent upon, the wetter parts of these swamp systems, where there is typically moist to saturated substrates and at least some surface water associated with an emergent water table. It is known to use burrows of the crayfish *Euastacus australasiensis* (Decapoda: Parastacidae), and possibly also of *P. gigantea* during and post fire, as both fire and predation refugia (pers. obs.). Any long-term reduction in groundwater levels in individual swamps will negatively impact upon the species through a reduction in the area of core habitat and in the abundance of the species within affected swamps. Although individuals may be recorded in adjoining non-swamp habitats, these areas do not represent core habitat of this obligate mire-dwelling species.

A recent genetic study has identified low rates of genetic exchange and high genetic divergence between discrete swamp populations, and recommended that most populations be treated separately as discrete conservation units (Dubey & Shine 2010b). Any loss of discrete swamp populations may contribute to eroding its genetic potential and capacity to adapt to projected climate change. Predicted contractions in the extent of the mire habitats of this species under projected climate change scenarios (see Ramp & Chapple 2010), and associated degradation in habitat value for the species, will further threaten the viability of populations of this species (Dubey & Shine 2011). These effects mirror, and would compound, those that will occur as a result of any lowering of water tables within these swamps as a result of subsidence associated with longwall mining. The distinctiveness of individual swamp populations is mirrored in Hose's (2009) work on genetics of stygofauna on the Woronora Plateau.

Euastacus australasiensis

The burrowing crayfish *Euastacus australasiensis* occurs in streams and upland swamps of the Sydney region (Growns & Marsden 1998; Merrick 1998; Morgan 1997) and can be abundant in the wetter parts of the swamps of the Newnes Plateau (pers. obs.); on current knowledge it is the only indigenous upland swamp dwelling crayfish within the Blue Mountains (see Merrick 1998; Morgan 1997).

Burrow investigations within Blue Mountains swamp systems have not been undertaken, but investigations of Tasmanian mire dwelling crayfish (*Parastacoides* spp.) have revealed complex burrow structures, groundwater dependence and unique functional roles (Growns & Richardson 1988; Richardson & Swain 1980, 1991). It is likely that *E. australasiensis* performs similar functional roles in NPSS. For example, the groundwater in its burrows may provide habitat for other specialised groundwater dependent fauna, in addition to providing refugia for *E. leuraensis* during and following fire events. The burrows of these crayfish can be referred to the Type 2 burrows (burrows connected to the water table) of the ecological classification system for burrows of Australian freshwater crayfish (Horwitz & Richardson 1986).

Studies of freshwater crayfish worldwide have revealed that their groundwater filled burrows may provide habitat for a diversity of organisms, including pholoteros (Lake 1977; Lake & Newcombe 1975), stygofauna (Gilbert et al. 1994a; Humphreys 2008), hibernating frogs (Irwin et al. 1999), aestivating commensal crayfish (Johnston & Robson 2009), and dragonfly larvae during drought and winter months (Harrington 2010; Pintor 2000). These diverse ecological relationships, and the shared reliance of different taxa upon groundwater, highlight the complexity of functional roles of these burrowing groundwater dependent organisms and their importance in these groundwater dependent ecosystems (GDEs). A lowering of water tables in these swamps can be expected to

reduce and potentially eliminate the habitat available to *Euastacu*s in affected swamps and negatively affect any associated species.

Additional groundwater dependent fauna

Our knowledge of the groundwater dependent invertebrate fauna in Australian mire ecosystems is negligible. Additional groundwater dependent species within these Blue Mountains swamp ecosystems may include stygofauna (e.g., Gilbert et al. 1994b; Hose 2009; Humphreys 2008), pholoteros (e.g., Creaser 1931; Lake 1977; Lake & Coleman 1977; Lake & Newcombe 1975; Suter & Richardson 1977), and other specialised mire (e.g., Larson & House 1990; Rosenberg & Danks 1987; Spitzer & Jaroš 1993) or moorland (e.g., Butterfield & Coulson 1983; Gardner 1991; Greenslade & Smith 1999) invertebrates. A lowering of water tables in any swamp is likely to have significant impacts upon any such groundwater dependent fauna, with possible extirpation from swamps where the water table is permanently lowered below a threshold level.

Boronia deanei deanei

The rare and vulnerable (TSC Act 1995) shrub, *Boronia deanei deanei* (Rutaceae), is restricted to NPSS and some bogs on the Boyd Plateau. It is associated with particular groundwater conditions and any lowering of water tables can be expected to reduce the distribution and abundance of the species in affected swamps, with implications for the persistence of the species more broadly (Benson & Baird 2012).

Dillwynia stipulifera

Dillwynia stipulifera (Fabaceae) is another small shrub restricted to swamps on the Newnes Plateau, with disjunct occurrences on the South Coast. Any contraction in its abundance or distribution on the Newnes Plateau will also have implications for its persistence in the area (Benson & Baird 2012). Benson and Baird (2012) have suggested that the species may qualify for listing as vulnerable under the TSC Act 1995.

Threats to peat swamps associated with longwall coal mining

Subsidence associated with Longwall coal mining is listed as a Key Threatening Process (KTP) under the TSC Act 1995. This determination recognises that subsidence may cause deleterious changes to the quality and/or quantity of groundwater available to GDEs and surface streams. Mine dewatering may have similarly negative effects on surface ecosystems due to the alteration of surface water flow regimes and water quality. The impact of long wall coal mining, in particular, upon groundwater dependent swamp and stream ecosystems is of concern (NSW Scientific Committee 2005a; Young 1982; Young & Wray 2000) and controversy, consistent with the increasingly well-documented negative impacts of longwall coal mining worldwide (e.g., Bell et al. 2000; Booth 2006; Booth & Bertsch 1999; Booth et al. 1998; Karaman et al. 2001).

Extensive longwall coal mining under the Woronora Plateau and nearby areas in the Southern Coalfields has resulted in well documented cases of subsidence, with fracturing of stream beds and loss of groundwater from streams and endangered Coastal Upland Swamps. Threats from longwall mining have been specifically identified in respect of the EEC determinations for NPSS (NSW Scientific Committee 2005b) and Montane Peatlands and Swamps in NSW (NSW Scientific Committee 2004), which includes the Coxs River Swamps (of Benson & Keith 1990). A large proportion of NPSS and Coxs River Swamps occur above underground coal mining leases. This occurs particularly in Newnes and Ben Bullen state forests where the area has either been subjected to mining or such mining is proposed. Hydrological changes generally have been identified as threats in the EEC determinations for NPSS (NSW Scientific Committee 2005b) and THPSS (Threatened Species Scientific Committee 2005). Extensive mine de-watering into headwater streams and directly into

swamp systems has occurred across this area, with significant and irreparable damage resulting. The well documented and irreparable damage to East Wolgan Swamp on the Newnes Plateau, resulting from loss of groundwater, associated with mine waste water discharge and subsidence following longwall coal mining by Centennial Coal, highlights the threat to all GDEs, including peat swamps, as a result of subsidence from long wall mining in this geological setting. 'Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands' is also listed as a KTP on Schedule 3 of the TSC Act 1995 (NSW Scientific Committee 2002) and is applicable in the context of the potential loss of groundwater from these swamps and of base-flow to headwater streams.

Globally, threats to groundwaters and their dependent ecosystems are increasingly being recognised (Boulton 2005; Boulton et al. 2003; Danielopol et al. 2003; MacKay 2006). Hatton and Evans (1998) identified a range of ecosystem dependencies on groundwater. Their class of *Ecosystems with proportional dependence on groundwater* appears to include all mire ecosystems in Australia, including NPSS. For this class of ecosystem, they suggested that '*it is likely that a unit change in the amount of groundwater will result in a proportional change in the health or extent of that ecosystem*'. Commenting on the level of groundwater dependency of wetland ecosystems, Clifton and Evans (2001) highlighted the importance of maintaining adequate groundwater levels in unconfined aquifers and adequate groundwater discharge flux for most wetland ecosystems to maintain the necessary level of wetness or waterlogging for key ecological stages: '*Changes in water table level may have important implications for these communities. Prolonged lowering or raising of the water table is likely to result in changes in species composition, favouring species adapted to drier or wetter conditions, respectively*'.

Changes in groundwater regime will potentially impact the biota of GDEs at species and community level. This will be caused by changes to critical habitat attributes, either variably, or (potentially) across threshold levels (Clifton & Evans 2001). Where groundwater levels are lowered, even seasonally, effects may include changes in the wetland vegetation community composition (Boulton & Brock 1999; Breeuwer et al. 2009; Wheeler 1999). Although many of the plants which are obligate swamp dwellers in NPSS and other upland swamps may persist across a spectrum of the hydrological gradient, the effects of a lowering of the water table upon individual species may not be measurable for some time. This may be most pronounced for long-lived species such as Buttongrass*, Gymnoschoenus sphaerocephalus* (Cyperaceae) (pers. obs.). The effect upon groundwater fauna, however, will be more rapid. With longer term lowering of the water table, effects may include succession from swamps to drier heath, sedgeland, grassland or forest communities(as has occurred to a former swamp on Lamb's Creek located above longwall mining carried out by Angus Place Colliery); extirpation of groundwater dependent species; changes in groundwater quality and soil chemistry (Wheeler 1999); and degradation of peat (Shearer 1997) and peatlands (Moore 2002; Whittington & Price 2006). There may be increased competitive interactions for terrestrial swamp fauna (e.g., the swamp rat *Rattus lutreolus, Eulamprus leuraensis*) with otherwise generally allopatric congeners of adjoining non-mire habitats (Baird 2012). Such increased competitive interactions, in conjunction with reduced habitat suitability for the mire dwelling species, will further contribute to extirpation of populations of these species. Bioclimatic modelling indicates a progressive contraction in the extent of Blue Mountains swamps (Ramp & Chapple 2010), and swamps of the Woronora Plateau and the Sydney region more broadly (Keith et al. 2014; Keith et al. 2010), under projected climate change scenarios; these contractions mirror and would compound the effects that can be expected from any lowering of water tables in association with subsidence from longwall coal mining.

Additional potential impacts associated with a lowering of the water table include weed invasion and increased fire risk (Keith et al. 2006; Kodela et al. 2001; NSW Scientific Committee 2005a). Weed invasion of NPSS has been documented (Henson 2010) and anthropogenically disturbed and drying swamps, in particular, are most vulnerable to weed invasion. Where drying of organic-rich,

peaty swamp substrates occur, fire effects may include burning of the organic soil component, resulting in the destruction of soil seed banks, rhizomes and lignotubers, thus also affecting re-sprouter species (Keith 1996). In the Blue Mountains region, including NPSS, substantial mortality of mature lignotubers of re-sprouter shrubs may occur as a result of fire during periods of reduced water levels in swamp soils (Benson & Baird 2012). Drying related oxidisation and/or combustion of the organic component of these peatlands leads to their shrinkage and has the potential to leave sterilised and (often) hydrophobic sandy or peaty soils, with an increased risk of erosion due to surface water flows. This, in turn, may lead to channelisation and further lowering of shallow water tables (e.g., Young & Wray 2000). Degradation of the hydrological function of these peatland ecosystems (capacity to store and slowly release water) will also occur (Keith et al. 2006; NSW Scientific Committee 2005a).

Fire is considered one of the main threats to Australian peatlands (Pemberton 2005). A more intense fire regime may cause unsustainable loss of peatland soils, as documented, for example, in moorland fires in the North York Moors (Maltby et al. 1990), for rare peatland in south-western Australia (Horwitz et al. 1999; Horwitz & Smith 2005; Semeniuk & Semeniuk 2005), in alpine peatland soils in Tasmania (Kirkpatrick & Dickinson 1984), in Buttongrass moorland (blanket bogs) in Tasmania (Bridle et al. 2003) and other organic terrains (peatswamps) in Tasmania and Victoria (Wein 1981). In addition to combustion of organic-rich peatland soils, fire induced changes include the potential for increased erosion, changes in water quality and loss of biodiversity (e.g., Horwitz & Sommer 2005). Fire effects are exacerbated where groundwater levels are lowered due to drought or anthropogenic influences (e.g., long wall mining) and by more intense fire regimes, for example, as reported also in New Zealand peatlands and bogs (Clarkson 1997; Johnson 2001; Timmins 1992). Similar effects have been reported for the upland swamps of the Woronora Plateau (Keith et al. 2006; Young 1982). Destruction of peat substrates as a result of fire in Blue Mountains Sedge Swamps has also been reported (Keith 1996; Stricker & Wall 1995). It may also lead to surface collapse over peatland piping, resulting in gully head initiation and channelisation (pers. obs.). An increase in periods where peatland soils are bare following fire events (or in response to drought or otherwise lowered water tables) will also contribute to increased rates of peatland photodegradation and loss of organic matter (Rutledge et al. 2010). A lowering of the groundwater table, for any reason, will compound these effects. The ecological damage resulting from any loss of groundwater from these swamp ecosystems as a result of subsidence from longwall mining will be compounded by subsequent long term effects of fire, and the potential compounding effects of predicted climate change (Baird 2012: Chapter 8; Benson & Baird 2012).

Fire is a natural and recurring event within the swamp communities in the Sydney region (Keith 1995; Keith et al. 2006). The temporal and spatial scales, and the intensity at which these fire disturbance events occur in particular swamp types are, however, critical to whether fire regimes result in long-term loss of organic terrains at a rate that exceeds net accumulation of organic matter, or exceeds fire regime thresholds for swamp plant (e.g., *Sphagnum* spp.) and animal species (e.g., *Rattus lutreolus*) (Keith 1996; Keith et al. 2002; Morrison 2002; Morrison et al. 1995; Watson 2006a, b). Fire impacts are directly correlated to swamp water levels and surface wetness (e.g., Horwitz & Smith 2005; Horwitz & Sommer 2005). Under a more intense fire regime, combined with reduced groundwater availability, long-term degradation and contraction of these ecosystems will occur. It will also threaten the persistence of groundwater dependent mire species such as *P. gigantea* and *E. leuraensis* (Baird 2012: Chapter 8; Benson & Baird 2012).

Conclusion

Reduced groundwater availability as a result of subsidence from longwall mining will result in long-term degradation and contraction of these NPSS, compounding predicted effects of climate change.

The result will be reduced spatio-temporal distribution of suitable breeding habitat for *Petalura gigantea,* and will threaten the persistence of other groundwater dependent species, including *Boronia deanei*, *Eulamprus leuraensis*, *Euastacus australasiensis,* and other organisms such as stygofauna. These unique and geographically restricted montane mire ecosystems must be protected. Maintenance of the necessary hydrological regime and groundwater levels will be fundamental to the persistence of these mire ecosystems and their groundwater dependent species. In view of the extensive evidence of damage from subsidence associated with longwall coal mining in the western Blue Mountains, across the Sydney region more broadly, and internationally, the threat to these ecosystems and their dependent species from an expansion of longwall mining under the Newnes Plateau is too great. Assessing the likely impacts of this proposal must be informed by the Precautionary Principle and the substantial body of available evidence of its damaging effects.

References

Baird I. R. C. (2012) The wetland habitats, biogeography and population dynamics of *Petalura gigantea* (Odonata: Petaluridae) in the Blue Mountains of New South Wales. PhD thesis, University of Western Sydney, Australia. Available from http://handle.uws.edu.au:8081/1959.7/509925.

Baird I. R. C. (2013) Emergence behaviour in *Petalura gigantea* (Odonata: Petaluridae): confirmation of upright emergence. *International Journal of Odonatology* 16, 213-8.

Baird I. R. C. (in press) Larval burrow morphology and groundwater dependence in a mire-dwelling dragonfly, *Petalura gigantea* (Odonata: Petaluridae). *International Journal of Odonatology*.

Baird I. R. C. & Burgin S. (2013) An emergence study of *Petalura gigantea* (Odonata: Petaluridae). *International Journal of Odonatology* 16, 193-211.

Bell F. G., Stacey T. R. & Genske D. D. (2000) Mining subsidence and its effect on the environment: some differing examples. *Environmental Geology* 40, 135-52.

Benson D. & Baird I. R. C. (2012) Vegetation, fauna and groundwater interrelations in low nutrient temperate montane peat swamps in the upper Blue Mountains, New South Wales *Cunninghamia* 12, 267-307.

Benson D. H. & Keith D. A. (1990) Natural vegetation of the Wallerawang 1:100,000 map sheet. *Cunninghamia* 2, 305-35.

Booth C. J. (2006) Groundwater as an environmental constraint of longwall coal mining. *Environmental Geology* 49, 796-803.

Booth C. J. & Bertsch L. P. (1999) Groundwater geochemistry in shallow aquifers above longwall mines in Illinois, USA. *Hydrogeology Journal* 7, 561-75.

Booth C. J., Spande E. D., Pattee C. T., Miller J. D. & Bertsch L. P. (1998) Positive and negative impacts of longwall mine subsidence on a sandstone aquifer. *Environmental Geology* 34, 223-33.

Boulton A. J. (2005) Chances and challenges in the conservation of groundwaters and their dependent ecosystems. *Aquatic Conservation: Marine and Freshwater Ecosystems* 15, 319-23.

Boulton A. J. & Brock M. A. (1999) *Australian Freshwater Ecology: Processes and Management*. Gleneagles Publishing, Adelaide.

Boulton A. J., Humphreys W. F. & Eberhard S. M. (2003) Imperilled subsurface waters in Australia: biodiversity, threatening processes and conservation. *Aquatic Ecosystem Health & Management* 6, 41-54.

Breeuwer A., Robroek B. J. M., Limpens J., Heijmans M. M. P. D., Schouten M. G. C. & Berendse F. (2009) Decreased summer water table depth affects peatland vegetation. *Basic and Applied Ecology* 10, 330-9.

Bridle K. L., Cullen P. & Russell M. (2003) *Peatland Hydrology, Fire Management and Holocene Fire Regimes in Southwest Tasmanian Blanket Bogs. Nature Conservation Report No. 03/07*. Nature Conservation Branch, Department of Primary Industries, Water and Environment, Hobart.

Butterfield J. & Coulson J. C. (1983) The carabid communities on peat and upland grasslands in northern England. *Holarctic Ecology* 6, 163-74.

Clarkson B. R. (1997) Vegetation recovery following fire in two Waikato peatlands at Whangamarino and Moanatuatua, New Zealand. *New Zealand Journal of Botany* 35, 167-79.

Clifton C. & Evans R. (2001) *Environmental Water Requirements of Groundwater Dependent Ecosystems, Environmental Flows Initiative Technical Report Number 2*. Commonwealth of Australia, Canberra.

Corbet P. S. (1999) *Dragonflies. Behaviour and Ecology of Odonata*. Cornell University Press, Ithaca, NY.

Creaser E. P. (1931) Some cohabitants of burrowing crayfish. *Ecology* 12, 243-4.

Danielopol D. L., Griebler C., Gunatilaka A. & Notenboom J. (2003) Present state and future prospects for groundwater ecosystems. *Environmental Conservation* 30, 104-30.

DEC. (2006) The Vegetation of the Western Blue Mountains. Unpublished report funded by the Hawkesbury-Nepean Catchment Management Authority. Department of Environment and Conservation NSW, Hurstville.

Dubey S. & Shine R. (2010a) Plio-Pleistocene diversification and genetic structure of an endangered lizard (the Blue Mountains water skink, *Eulamprus leuraensis*) in south-eastern Australia. *Journal of Biogeography* 37, 902-14.

Dubey S. & Shine R. (2010b) Restricted dispersal and genetic diversity in populations of an endangered montane lizard (*Eulamprus leuraensis*, Scincidae). *Molecular Ecology* 19, 886-97.

Dubey S. & Shine R. (2011) Predicting the effects of climate change on reproductive fitness of an endangered montane lizard, *Eulamprus leuraensis* (Scincidae). *Climatic Change* 107, 531-47.

Dubey S., Sinsch U., Dehling M., Chevalley M. & Shine R. (2013) Population demography of an endangered lizard, the Blue Mountains Water Skink. *BMC Ecology* 13, 4.

Gardner S. M. (1991) Ground beetle (Coleoptera: Carabidae) communities on upland heath and their association with heathland flora. *Journal of Biogeography* 18, 281-9.

Gilbert J., Danielopol D. L. & Stanford J. A. (1994a) *Groundwater Ecology*. Academic Press, San Diego.

Gilbert J., Stanford J. A., Dole-Olivier M.-J. & Ward J. V. (1994b) Basic attributes of groundwater ecosystems and prospects for research. In: *Groundwater Ecology* (eds J. Gilbert, D. L. Danielopol and J. A. Stanford), pp. 10-3. Academic Press, San Diego.

Greenslade P. & Smith D. (1999) The epigaeic arthropod fauna of buttongrass moorland in Tasmanian Wilderness World Heritage Area. In: *The Other 99%: the Conservation and Biodiversity of Invertebrates* (eds W. F. Ponder and D. Lunney), pp. 90-4. Transactions of the Royal Zoological Society of New South Wales, Mosman, NSW.

Growns I. O. & Marsden T. (1998) Altitude separation and pollution tolerance in the freshwater crayfish *Euastacus spinifer* and *E. australasiensis* (Decapoda: Parastacidae) in coastal flowing streams of the Blue Mountains, New South Wales. *Proceedings of the Linnean Society of NSW* 120, 139-45.

Growns I. O. & Richardson A. M. M. (1988) Diet and burrowing habits of the freshwater crayfish, *Parastacoides tasmanicus tasmanicus* Clark (Decapoda : Parastacidae). *Marine and Freshwater Research* 39, 525-34.

Harrington C. (2010) Return of the Dragon. A lost species reveals its secrets on a Wisconsin preserve. *Nature Conservancy* Summer 2010, 16.

Hatton T. & Evans R. (1998) *Dependence of Ecosystems on Groundwater and its Significance to Australia*. LWRRDC Occasional Paper No. 12/98. Land and Water Resources Research & Development Corporation, Canberra.

Henson M. (2010) Newnes Plateau Shrub Swamp Aerial Condition Assessment Report. Unpublished report. Save our Swamps project funded by Caring For Country and NSW Environmental Trust.

Horwitz P., Pemberton M. & Ryder D. (1999) Catastrophic loss of organic carbon from a management fire in a peatland in southwestern Australia. In: *Wetlands for the Future* (eds A. J. McComb and J. A. Davis), pp. 487-501. Gleneagles Publishing, Adelaide, South Australia.

Horwitz P. & Smith R. (2005) Fire and wetland soils and sediments on the Swan Coastal Plain: an introduction. *Journal of the Royal Society of Western Australia* 88, 77-9.

Horwitz P. & Sommer B. (2005) Water quality responses to fire, with particular reference to organic-rich wetlands and the Swan Coastal Plain: a review. *Journal of the Royal Society of Western Australia* 88, 121-8.

Horwitz P. H. J. & Richardson A. M. M. (1986) An ecological classification of the burrows of Australian freshwater crayfish. *Marine and Freshwater Research* 37, 237-42.

Hose G. (2009) Stygofauna baseline assessment for Kangaloon borefield investigations – Southern Highlands, NSW. Supplementary report – stygofauna molecular studies. Report to Sydney Catchment Authority Access Macquarie Ltd, North Ryde.

Humphreys W. F. (2008) Rising from down under: developments in subterranean biodiversity in Australia from a groundwater fauna perspective. *Invertebrate Systematics* 22, 85-101.

Irwin J. T., Costanzo J. P. & Lee Jr R. E. (1999) Terrestrial hibernation in the northern cricket frog, *Acris crepitans*. *Canadian Journal of Zoology* 77, 1240-6.

Johnson P. N. (2001) Vegetation recovery after fire on a southern New Zealand peatland. *New Zealand Journal of Botany* 39, 251-67.

Johnston K. & Robson B. J. (2009) Commensalism used by freshwater crayfish species to survive drying in seasonal habitats. *Invertebrate Biology* 128, 269-75.

Karaman A., Carpenter P. & Booth C. (2001) Type-curve analysis of water-level changes induced by a longwall mine. *Environmental Geology* 40, 897-901.

Keith D. A. (1995) Mosaics in Sydney heathland vegetation: the roles of fire, competition and soils. *CALM Science Supplement* 4, 199-206.

Keith D. A. (1996) Fire-driven extinction of plant populations: a synthesis of theory and review of evidence from Australian vegetation. *Proceedings of the Linnean Society of NSW* 116, 37-78.

Keith D. A. & Benson D. H. (1988) Natural vegetation of the Katoomba 1:100,000 map sheet. *Cunninghamia* 2, 107-43.

Keith D. A., Elith J. & Simpson C. C. (2014) Predicting distribution changes of a mire ecosystem under future climates. *Diversity and Distributions* 20, 440-54.

Keith D. A., McGaw L. & Whelan R. J. (2002) Fire regimes in Australian heathlands and their effects on plants and animals. In: *Flammable Australia: the Fire Regimes and Biodiversity of a Continent* (eds R. A. Bradstock, J. E. Williams and A. M. Gill). Cambridge University Press, Cambridge.

Keith D. A., Rodoreda S. & Bedward M. (2010) Decadal change in wetland - woodland boundaries during the late 20th century reflects climatic trends. *Global Change Biology* 16, 2300-6.

Keith D. A., Rodoreda S., Holman L. & Lemmon J. (2006) Monitoring change in upland swamps in Sydney's water catchments: the roles of fire and rain. Sydney Catchment Authority Special Area Strategic Management Research and Data Program. Project number RD07: Long term responses of upland swamps to fire. Final Report. Department of Environment and Conservation, Hurstville, NSW.

Kirkpatrick J. B. & Dickinson K. J. M. (1984) The impact of fire on Tasmanian alpine vegetation and soils. *Australian Journal of Botany* 32, 613-29.

Kodela P. G., Sainty G. R., Bravo F. J. & James T. A. (2001) Wingecarribee Swamp flora survey and related management issues. Unpublished report to Sydney Catchment Authority, New South Wales.

Lake P. S. (1977) Pholoteros - the faunal assemblage found in crayfish burrows. *Australian Society of Limnology Newsletter* 15, 57-60.

Lake P. S. & Coleman D. J. (1977) On the subterranean syncarids of Tasmania. *Helictite* 15, 12-7.

Lake P. S. & Newcombe K. J. (1975) Observations on the ecology of the crayfish *Parastacoides tasmanicus* (Decapoda: Parastacidae) from south-western Tasmania. *Australian Journal of Zoology* 18, 197-214.

Larson D. J. & House N. L. (1990) Insect communities of Newfoundland bog pools with emphasis on the Odonata. *Canadian Entomologist* 122, 469-501.

LeBreton M. (1996) Habitat and distribution of the Blue Mountains swamp skink (*Eulamprus leuraensis*). B. Zool. (Honours) thesis, University of New South Wales.

MacKay H. (2006) Protection and management of groundwater-dependent ecosystems: emerging challenges and potential approaches for policy and management. *Australian Journal of Botany* 54, 231-7.

Maltby E., Legg C. J. & Proctor M. C. F. (1990) The ecology of severe moorland fire on the North York Moors: effects of the 1976 fires, and subsequent surface and vegetation development. *The Journal of Ecology* 78, 490-518.

Merrick J. R. (1998) *Endemic Crayfishes of the Sydney Region: Distribution, Biology and Management Options*. Macquarie University, North Ryde, NSW.

Moore P. D. (2002) The future of cool temperate bogs. *Environmental Conservation* 29, 3-20.

Morgan G. J. (1997) Freshwater crayfish of the genus *Euastacus* Clark (Decapoda: Parastacidae) from New South Wales, with a key to all species of the genus. *Records of the Australian Museum* Supplement 23 (1997), 110 pp.

Morrison D. A. (2002) Effects of fire intensity on plant species composition of sandstone communities in the Sydney region. *Austral Ecology* 27, 433-41.

Morrison D. A., Cary G. J., Pengelly S. M., Ross D. G., Mullins B. J., Thomas C. R. & Anderson T. S. (1995) Effects of fire frequency on plant species composition of sandstone communities in the Sydney region: inter-fire interval and time-since-fire. *Australian Journal of Ecology* 20, 239-47.

NSW Government. (2002) *The NSW State Groundwater Dependent Ecosystems Policy*. Department of Land and Water Conservation and the State Groundwater Policy Working Group, Sydney.

NSW Scientific Committee. (2002) Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands. NSW Scientific Committee Key Threatening Process final determination. [Accessed December 10th 2009]. Available from http://www.environment.nsw.gov.au/threatenedspecies/AlterationNaturalFlowKTPListing.htm

NSW Scientific Committee. (2004) Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions - endangered ecological community listing. NSW Scientific Committee final determination. [Accessed August 13th 2008]. Available from http://www.environment.nsw.gov.au/determinations/MontanePeatlandsEndSpListing.htm

NSW Scientific Committee. (2005a) Alteration of habitat following subsidence due to longwall mining. NSW Scientific Committee Key Threatening Process final determination. [Accessed May 29th 2005]. Available from http://www.environment.nsw.gov.au/determinations/LongwallMiningKtp.htm

NSW Scientific Committee. (2005b) Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion - endangered ecological community listing. NSW Scientific Committee final determination. [Accessed August 13th 2008]. Available from http://www.environment.nsw.gov.au/determinations/NewnesPlateauShrubSwampEndSpListing.htm

Pemberton M. (2005) Australian peatlands: a brief consideration of their origin, distribution, natural values and threats. *Journal of the Royal Society of Western Australia* 88, 81-9.

Pintor L. (2000) The effect of drought on species interactions, behavior and habitat use by the Hine's emerald dragonfly, *Somatochlora hineana*. MSc Thesis. University of Illinois, Urbana-Champaign.

Ramp D. & Chapple R. (2010) Managing for Ecosystem Change in the GBMWHA: Final Report. ARC Project LP774833. University of NSW and Blue Mountains World Heritage Institute.

Richardson A. M. M. & Swain R. (1980) Habitat requirements and distribution of *Engaeus cisternarius* and three subspecies of *Parastacoides tasmanicus* (Decapoda: Parastacidae), burrowing crayfish from an area of south-western Tasmania. *Australian Journal of Marine and Freshwater Research* 31, 475-84.

Richardson A. M. M. & Swain R. (1991) Pattern and persistence in the burrows of two species of the freshwater crayfish, *Parastacoides* (Decapoda: Parastacidae), in southwest Tasmania. *Memoirs of the Queensland Museum* 31, 283.

Rosenberg D. M. & Danks H. V. (1987) Aquatic insects of peatlands and marshes in Canada. *Memoirs of the Entomological Society of Canada* 140, 174pp.

Rutledge S., Campbell D. I., Baldocchi D. & Schipper L. A. (2010) Photodegradation leads to increased carbon dioxide losses from terrestrial organic matter. *Global Change Biology* 16, 3065-74.

Semeniuk V. & Semeniuk C. A. (2005) Wetland sediments and soils on the Swan Coastal Plain, southwestern Australia: types, distribution, susceptibility to combustion, and implications for fire management. *Journal of the Royal Society of Western Australia* 88, 91-120.

Serov P., Kuginis L. & Williams J. P. (2012) *Risk assessment guidelines for groundwater dependent ecosystems, Volume 1 - the conceptual framework*. Department of Primary Industries, NSW Office of Water, Sydney.

Shearer J. C. (1997) Natural and anthropogenic influences on peat development in Waikato/Hauraki Plains restiad bogs. *Journal of the Royal Society of New Zealand* 27, 295-313.

Spitzer K. & Jaroš J. (1993) Lepidoptera associated with the Cervene Blato Bog (Central Europe): conservation implications. *European Journal of Entomology* 90, 323-36.

Stricker J. S. & Wall C. A. (1995) Wetlands of the Nepean – Hawkesbury Catchment. Sydney Water Corporation, Sydney.

Suter P. J. & Richardson A. M. M. (1977) The biology of two species of *Engaeus* (Decapoda : Parastacidae) in Tasmania. III. Habitat, food, associated fauna and distribution. *Marine and Freshwater Research* 28, 95-103.

Threatened Species Scientific Committee. (2005) Commonwealth listing advice on Temperate Highlands Peat Swamps on Sandstone. [Accessed August 12th 2008]. Available from http://www.environment.gov.au/biodiversity/threatened/communities/temperate-highland-peat-swamps.html

Tillyard R. J. (1911) Studies in the life-histories of Australian Odonata. 4. Further notes on the life-history of *Petalura gigantea* Leach. *Proceedings of the Linnean Society of NSW* 36, 86-96.

Timmins S. M. (1992) Wetland vegetation recovery after fire: Eweburn Bog, Te Anau, New Zealand. *New Zealand Journal of Botany* 30, 383-99.

Watson P. (2006a) *Hotspots Fire Project: Fire and the Vegetation of the Southern Rivers Region*. Nature Conservation Council of NSW and the NSW Government Environmental Trust, Sydney.

Watson P. (2006b) *Hotspots Fire Project: Fire Frequency Guidelines and the Vegetation of the Northern Rivers Region*. Nature Conservation Council of NSW and the NSW Government Environmental Trust, Sydney.

Wein R. W. (1981) Characteristics and suppression of fires in organic terrain in Australia. *Australian Forestry* 44, 162-9.

Wheeler B. D. (1999) Water and plants in freshwater wetlands. In: *Eco-hydrology: Plants and Water in Terrestrial and Aquatic Environments* (eds A. J. Baird and R. L. Wilby), pp. 127-80. Routledge, London.

Whittington P. N. & Price J. S. (2006) The effects of water table draw-down (as a surrogate for climate change) on the hydrology of a fen peatland, Canada. *Hydrological Processes* 20, 3589-600.

Young A. R. M. (1982) Upland swamps (dells) on the Woronora Plateau. PhD thesis. University of Wollongong.

Young R. W. & Wray R. A. L. (2000) The geomorphology of sandstones in the Sydney region. In: *Sandstone City: Sydney's Dimension Sandstone and other Sandstone Geomaterials: Proceedings of a Symposium held on 7 July 2000* (eds G. H. McNally and B. J. Franklin). Geological Society of Australia, Springwood.