ENVIRONMENTAL JUSTICE AUSTRALIA

Submission on

Mod 8 - Water Transfer to Western Coal Services (MP06_0021-Mod-8)

and

Mod 5 - Water transfer from Angus Place (SSD-5579-Mod-5)

prepared by

Environmental Justice Australia on behalf of Lithgow Environment Group

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About Environmental Justice Australia

Environmental Justice Australia (formerly the Environment Defenders Office, Victoria) is a not-for-profit public interest legal practice. We are independent of government and corporate funding. Our legal team combines technical expertise and a practical understanding of the legal system to protect our environment.

We act as advisers and legal representatives to community-based environment groups, regional and state environmental organisations, and larger environmental NGOs, representing them in court when needed. We provide strategic and legal support to their campaigns to address climate change, protect nature and defend the rights of communities to a healthy environment.

We have been providing legal advice and representation to the community for over two decades on pollution issues. We advocate for better air pollution laws at the state and federal level to protect the health of communities and the environment. Through our legal advice, law reform and community legal education services we provide support to the community to understand the health impacts of pollution sources and how to best prevent them.

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About Lithgow Environment Group

Lithgow Environment Group is a not-for-profit environmental organisation whose principal objectives are the conservation, protection and enhancement of the natural environment in the Lithgow region. Lithgow Environment Group promotes these objectives by contributing to community education and raising awareness, undertaking direct advocacy work and lobbying the government and participating in community consultation processes. Lithgow Environment Group is also a member of the Gardens of Stone Alliance, which works for the full protection and better management of the Gardens of Stone region.

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A Executive summary

1. This submission is made on behalf of Lithgow Environment Group (**LEG**) in respect of the following two state significant development modification applications lodged with the NSW Department of Planning and Environment (**the Department**):[1]
   a. Mod 8 – Water Transfer to Western Coal Services (MP06_0021-Mod-8), proposed by Centennial Angus Place Pty Ltd (**Mod 8**); and
   b. Mod 5 – Water Transfer from Angus Place (SSD-5579-Mod-5) (**Mod 5**), proposed by Springvale Coal Pty Limited.

2. Throughout this submission, we refer to both Centennial Angus Place Pty Ltd and Springvale Coal Pty Limited as "Centennial".

3. LEG **objects** to the projects on the basis that there has not been an adequate assessment of the likely impacts of the projects and that based on available information, the likely impacts on water resources are expected to be significant. We note that LEG is making a separate submission on the projects relating to those matters and we do not address those matters in this submission.

4. This additional submission is confined to addressing that both projects have not been referred under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) (**EPBC Act**) and should be referred by Centennial, or in the absence of Centennial, the NSW Minister for Planning and Public Spaces.

5. Centennial has fundamentally misunderstood the test for the water trigger in s 24D of the EPBC Act in stating "As the proposed modification does not involve extraction of coal…it is not within the definition of a 'large coal mining development' and the water trigger does not apply."[2] This position is plainly inconsistent with the relevant case law[3] and Commonwealth guidance.[4] The relevant criterion is instead whether the projects are integral to the mining of coal, which Centennial has repeatedly conceded. This submission sets out clearly how each of criteria the water trigger test is met.

6. Failure to refer the projects not only exposes Centennial to potentially acting in contravention of the EPBC Act but would also be contrary to the objects of the Bilateral Agreement between the State of New South Wales (**NSW**) and the Commonwealth.[5] In absence of Centennial referring, it is incumbent on the Minister for Planning and Public Spaces, Paul Scully, to do so to avoid potentially inconsistent and duplicative assessment of the projects and inefficient and ineffective assessment of the projects by governments.

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[1] We note that the projects are exhibited on separate webpages on the Major Projects website however a single Modification Report has been lodged to address both projects. We therefore address the projects collectively in this single submission.
[2] Centennial Western Coal Services and Angus Place Colliery, 'Modification report for modifications MP 06_0021 (MOD 8) and SSD-5579 (MOD 5)', (September 2023), 22, available at <https://www.planningportal.nsw.gov.au/major-projects/projects/mod-5-water-transfer-angus-place (**Modification Report**).
[3] *Australian Conservation Foundation Incorporated v Minister for the Environment* [2021] FCA 550 (**ACF v Minister**).
[4] Department of Climate Change, Energy, the Environment and Water, 'Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources', August 2022, available at: <Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources - DCCEEW> (**Guidelines**).
[5] Bilateral agreement made under s 45 of the *Environment Protection and Biodiversity Conservation Act* 1999 (Cth) relating to environmental assessment, Commonwealth of Australian and The State of New South Wales as amended in March 2020 (**Bilateral Agreement**).

7. **Annexure A** to this submission comprises the expert report of Dr Ian Wright. Dr Wright opines that the projects will result in likely impacts on water resources.

B Background to projects

Proposed projects

8. Mod 8 proposes to modify MP06-0021 by adding conditions to the consent that enable the following operations at Angus Place Colliery:

    a. to transfer up to 10ML/day of underground mine water from Angus Place Colliery to Western Coal Services via the existing water reticulation system until 31 August 2024;

    b. to maintain and upgrade the existing water reticulation system to provide sufficient capacity to transfer up to 10ML/day.

9. Mod 5 relates to proposed modifications to SSD-5597 relating to the Western Coal Services site (**WCS site**) to enable it to receive water transferred from Angus Place Colliery. The WCS site is a coal handling, processing, transportation and management operation hub that also comprises the Springvale Coal Services Site, which is a coal processing and storage facility.

10. Specifically, Mod 5 proposes to modify SSD-5597 by adding conditions to the consent that enable:
    a. the receipt of 10 ML/day, up from 2.5ML/day, of mine water from Angus Place Colliery at the WCS site
    b. the incorporation of the mine water into the existing the Surface Water Management System at the Springvale Coal Services Site, including the discharge of water to Wangcol Creek via discharge point LDP001.
    c. the operation of an offtake at the Springvale Coal Services Site from the existing Angus Place water transfer pipeline.

Angus Place Colliery

11. Angus Place Colliery is a coal mine located approximately 15km northwest of Lithgow, NSW. It has development consent (MP06-0021) for underground coal mining of up to 4 million tonnes per annum until 18 August 2024 when the consent expires.

12. Angus Place Colliery has been in care and maintenance since 2015, however Centennial proposes to recommence and expand mining at the mine via its ‘Angus Place West’ project (**APW Project**).

13. Groundwater inflows (referred to as mine water) occur continuously at Angus Place Colliery and are stored underground in previous mine working areas. According to the Modification Report, currently mine water levels in Angus Place Colliery are steadily increasing such that the mine is running out of underground storage capacity for mine water.[6] Usual management of the mine water is to:

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[6] Modification Report, Executive Summary.

a. transfer it to the Springvale Water Treatment Plant via the 940 borehole and the Springvale Delta Water Transfer pipeline for treatment and subsequent reuse at Mount Piper Power Station; and/or
b. transfer the mine water directly to Mount Piper Power Station via an existing pipeline, limited to 2.5ML/day.

14. Centennial justifies Mod 8 on the basis that it will ensure the safety of underground mine personnel and the continued extraction of coal for supply to Mount Piper Power Station.[7] It provides that increase in mine water at Angus Place Colliery cannot be managed through the usual processes and threatens its ability to recommence mining as part of the APW Project.[8]

15. Mod 8 therefore seeks approval to allow the transfer of 10 mega litres (**M/L**) per day of mine water from Angus Place Colliery to the WCS site. If approved, the modification could result in a total of up to approximately 3.24 billion litres of mine water being transferred from Angus Place Colliery to the WCS site.[9]

APW Project

16. We understand that public exhibition of the proposed APW Project is forthcoming and note that currently, only the Scoping Report for the APW Project is publicly available.

17. The Scoping Report identities that the APW Project proposes to recommence underground mining at Angus Place Colliery and expand mining into two new mine areas "AWP1" and AWP2" at an extraction rate of up to 2 million tonnes per annum.[10] It is proposed that if approved, it would involve the surrendering of the existing consent MP06-0021.

18. We note that APW Project was referred by Centennial under s 68 of the EPBC Act. On 26 August 2022, the Federal Environment Minister's delegate determined that the APW Project is a "controlled action" under s 75 of the EPBC Act and that the relevant controlling provisions are:
    a. World Heritage properties (ss 12 and 15A of the EPBC Act)
    b. National Heritage places (ss 15B and 15C of the EPBC Act)
    c. Listed threatened species and communities (ss 18 and 18A of the EPBC Act)
    d. Listed migratory species (ss 20 and 20A of the EPBC Act) and
    e. A water resource, in relation to coal seam gas development and large coal mining development (ss 24D and 24E of the EPBC Act).

C Relevant legislative framework

19. The EPBC Act provides the legal framework to protect and manage national and internationally important species, ecosystems, places and water resources – known as 'Matters of National Environmental Significance' (**MNES**) under the EPBC Act. Part 3 of the EPBC Act contains provisions that prohibit the taking of a proposed action, without relevant approval, if it "has", "will have" or "is likely to have" a significant (adverse) impact on

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[7] Modification Report, 1, 1.1.
[8] Modification Report, Executive Summary.
[9] Calculated based on 10ML/day being transferred between nominal period of 12 October 2023 to 31 August 2024.
[10] "EMM Consulting, 'Angus Place West Scoping report,' (August 2021) available at: <https://www.planningportal.nsw.gov.au/major-projects/projects/angus-place-extension-project"https://www.planningportal.nsw.gov.au/major-projects/projects/angus-place-extension-project > (**Scoping Report**).

any of the MNES protected by Part 3.[11] That is, a person must not take an action, that has, will have or is likely to have a significant impact on any of the MNES without the approval of the Australian Government Minister for the Environment. 'Action' includes a project or a development.[12]

20. The matters protected by Part 3, and the relevant controlling provision for each MNES, are listed in tabular form in s 34 of the EPBC Act. They are known as 'controlling provisions'. Section 34 makes it clear that each of the subsections of s 18 is a distinct controlling provision protecting a separate MNES.

21. An "impact" of an action can include an event or circumstance that is an indirect consequence of the action, provided the action is a substantial cause of that event or circumstance and, where relevant, the requirements in s 527E(2) are met.[13] As the Policy Statement acknowledges, an impact that evidence strongly suggests might manifest itself many years later, or occurs at a substantial geographic distance from the location of the original action, may still be an indirect consequence that is substantial enough to be considered an impact.[14]

22. A "significant" impact is an impact that is important, notable or of consequence having regard to its context or intensity.[15]

23. A significant impact is "likely" if it is a real or not remote chance or possibility.[16]

24. It is our submission that Mod 8 and Mod 5:

    a. will have or are likely to have a significant impact on a MNES, being water resources; and
    b. that because Mod 8 and Mod 5 are actions that involve a large coal mining development, this means that ss 24D and 24E of the EPBC Act, commonly referred to as the 'water trigger', apply to the projects thereby requiring referral to, and approval by, the Federal Environment Minister.

We address this further at Section E of this submission below.

25. Under the EPBC Act, there are a number of ways that a proposed project may be referred for consideration by the Federal Environment Minister, including if:
    a. the person proposing to take an action thinks it is or may be a controlled action they must refer it (s 68);
    b. the State, or agency of the State, that has administrative responsibilities relating to a proposal and is aware of the proposal to take an action then they may refer it (s 69); and
    c. the Federal Environment Minister believes a person proposes to take an action that they believe is or may be a controlled action then they may request that it be referred to them by either the proponent, or the State or agency of the State (s 70).

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[11] *Environment Protection and Biodiversity Conservation Act 1999* (Cth) Pt 3 (***EPBC Act***).
[12] *EPBC Act,* Part 23 s 524.
[13] *EPBC Act,* s 527E(1)(b).
[14] Department of Sustainability, Environment, Water, Population and Communities, *'IndirectConsequences' of an Action: Section 527E of the EPBC Act* (Policy Statement, 2013) 2 (Annexure 8).
[15] *VicForests v Friends of Leadbeater's Possum Inc* [2021] FCAFC 66; 389 ALR 552 [62]; Department of the Environment (Cth), *Matters of Environmental Significance: Significant Impact Guidelines 1.1* (2013), 3 ('*Significant Impact Guidelines 1.1*').
[16] *Polaris Coomera Pty Ltd v Minister for the Environment* [2021] FCA 254, [212]-[226]; *Significant Impact Guidelines* 1.1, 3.

26. The EPBC Act is therefore designed in a way to ensure that a proposal to take an action which *may* be a controlled action requiring approval is referred to the Federal Environment Minister. Section 68 imposes an obligation upon a person to refer a proposed action to the Environment Minister even though the action may not be a controlled action where the person simply thinks that it *might* be. A person may therefore refer an action to the Environment Minister for what might be described as 'the avoidance of doubt', even if the person does not think that the action is a controlled action.

27. Section 69 also clearly outlines the ability for the NSW Minister of Planning and Public Spaces to refer a project.[17]

D The 'water trigger' test

The provision and definitions

28. Sections 24D and 24E of the EPBC Act are commonly referred to as the 'water trigger' controlling provisions. Section 24D(1)[18] provides that:

> (1) A constitutional corporation, the Commonwealth or a Commonwealth agency must not take an action if:
> (a) the action involves:
> (i) coal seam gas development; or
> (ii) large coal mining development; and
> (b) the action:
> (i) has or will have a significant impact on a water resource; or
> (ii) is likely to have a significant impact on a water resource.
>
> Civil penalty:
> (a) for an individual—5,000 penalty units;
> (b) for a body corporate—50,000 penalty units.

29. A "constitutional corporation" is defined in s 528 as a corporation to which paragraph 51(xx) of the Constitution applies, which includes trading or financial corporations formed within the limits of the Commonwealth.

30. Section 528 defines "large coal mining development" to mean:

> … any coal mining activity that has, or is likely to have, a significant impact on water resources (including any impacts of associated salt production and/or salinity):
> (a) in its own right; or
> (b) when considered with other developments, whether past, present or reasonably foreseeable developments.

31. "Coal mining activity" is not defined in the EPBC Act. The phrase "water resource" is defined in s 528 as having the same meaning as in the *Water Act 2007* (Cth) (the **Water Act**).

32. Section 4(1) of the Water Act defines "water resource" to mean:
> (a) surface water or ground water; or
> (b) a watercourse, lake, wetland or aquifer (whether or not it currently has water in it); and includes all aspects of the water resource (including water, organisms and other

[17] Section 528 of the EPBC defines that an 'agency' means a Minister of the State.
[18] See also equivalent provisions in subsections (2)-(4).

> components and ecosystems that contribute to the physical state and environmental value of the water resource).

Judicial consideration of the water trigger

33. The interpretation and application of sections 24D and 24E were considered in *Australian Conservation Foundation Incorporated v Minister for the Environment* [2021] FCA 550 (**the ACF case**). In that case Perry J determined that the proposed action (the construction and operation of infrastructure to harvest and store up to 12.5 gigalitres (GL) of water from the Suttor River in order to provide "a secure and reliable water supply" to the Carmichael Coal Mine and Rail Project) did involve a coal mining activity.

34. Relevantly Justice Perry rejected the delegate's construction (and the proponent's submissions in support) that the requirement for an action to involve any coal mining activity was limited to activity that is extractive in nature.[19] The activity captured by the definition in s 528 is broader than that. In considering the correct interpretation of s 528 Perry J made the following remarks (emphasis added):[20]

> …regard can be had to the choice of the word "*development*" in ss 24D and 24E in construing the scope of the water trigger controlling provisions. That word suggests in its ordinary meaning that Parliament did not intend to limit coal seam gas and large coal mining developments to the physical process of mineral or coal seam gas extraction…Rather, the word "development" is suggestive of a broader concept which **embraces, at a minimum, those activities which are integral to the mining of coal.**
>
> Consistently with this construction, the so-called definition of large coal mining development is not limited to "*coal mining*". Rather it embraces "***any** coal mining **activity***". In line with orthodox principles of statutory construction, all of these words must be given meaning and effect…Yet the use of the word "*activity*", especially when combined with the word "*any*", **is strongly indicative of an intention to capture a broad range of activities within the concept of a large coal mining development** and **certainly those so closely associated with the mining of coal that mining could not be undertaken without the activity in question.**

35. Justice Perry found this construction "best promotes the purposes of the EPBC Act and must therefore be preferred" and that purpose was confirmed by the 2013 Second Reading Speech with respect to the Bill inserting ss 24D and 24E into the EPBC Act. The following was extracted from the Second Reading Speech at [95]:

> The challenge we have had up until now is that people quite reasonably expect the minister for the environment and water to take into account, by law, the impacts of coal seam gas and large coal mining on water resources. **They want to know that I am considering: if there is an irreversible depletion and contamination of our surface and groundwater resources; the impacts on the way critical water systems operate; and the related effects on our ecosystems.**

36. Justice Perry concluded the following (emphasis added):[21]

> Contrary to the delegate's view, an action will involve a large coal mining development for the purposes of the water trigger controlling provisions **if the action is so closely associated with the mining of coal as to be integral to it**. That being so, given the delegate's findings at [48] and [99] of the controlled action decision reasons (set out at

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[19] *Australian Conservation Foundation Incorporated v Minister for the Environment* [2021] FCA 550 [89]; [114] (***ACF v Minister***).
[20] *ACF v Minister* [93(1)]-[93(2)].
[21] *ACF v Minister* [114].

> [73] and [75] above), it follows that **the operation of infrastructure for the harvesting and supply of water from the alternative location for the proposed 60-year period is properly characterised as integral to the conduct of mining operations** at the Carmichael Coal Project. As such, the **proposed action involves a coal mining activity** within the "definition" of large coal mining development in s 528 of the EPBC Act, **subject importantly to the questions of whether that development is likely to have the significant impact on water resources** also required by the "definition" and satisfaction of the criteria in subs (1)(b) of ss 24D and 24E.

37. Finally we note that Perry J confirmed that integral does not mean that the coal mining activity must also be dependent on the action:

> Finally, I would emphasise that the delegate found that the Carmichael Coal Project was ***not*** dependent upon the proposed action the subject of the application for judicial review. This is because a source of water supply, being the infrastructure already approved as part of the Carmichael Coal Project, is potentially available in any event (see the delegate's reasons for the controlled action decision (controlled action decision reasons) at [50]). As I have said, the proposed action which was the subject of the controlled action decision under challenge here was to provide an alternative source of water.

38. The ACF Decision is reflected in the Government's 'Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources' (2022)[22] which provide (emphasis added):

> Under the EPBC Act, an action which involves a CSG or a large coal mining development requires approval from the Australian Government Environment Minister (the minister) if the action has, will have, or is likely to have a significant impact on a water resource. Whether a particular action can be described as involving a CSG or large coal mining development will be determined based on **whether that action is so closely associated with the extraction of CSG or the mining of coal as to be integral to that extraction or mining** (as relevant) (Australian Conservation Foundation Incorporated v Minister for the Environment (2021).[23]

39. The criteria to be met under section 24D and 24E can thus be separated into three parts:
    a. Is the proponent a constitutional corporation;[24]
    b. Is the Proposed Project is so closely associated with the mining of coal as to be integral to it; and
    c. Is the development likely to have a significant impact on water resources as required by s 528 and is the proposed action likely to have significant impact on water resources as required by 24D(1)(b).

E The application of the 'water trigger' to the projects

40. This section will first set out how Centennial's construction of the water trigger is inconsistent with the proper construction set out above before addressing and applying each criterion of the water trigger test in turn.

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[22] **Guidelines,** 1.1.1**.**
[23] Guidelines, 1.1.1.
[24] We note that there are alternative threshold criteria in subsections (2)-(3).

Centennial misconstrues water trigger test in Modification Report

41. It is LEG's submission that Centennial has fundamentally misunderstood the test for the water trigger in s 24D of the EPBC Act and in particular the definition of a 'large coal mining development'. In relation to Mod 8, the Modification Report states:

> As the proposed modification does not involve extraction of coal, in accordance with the EPBC Act, it is not within the definition of a 'large coal mining development' and the water trigger does not apply.[25]

42. Importantly as noted above at [33] this construction was rejected by Justice Perry in the ACF case.[26]

43. Further, in the ACF case Justice Perry confirmed that if the impact on water resources at the time of original approval was regarded as a MNES, there is no reason why it would lose that significance merely because the issue arose subsequently in relation to a different water source, as this would undermine the objects of the EPBC Act in s 3(1) and the purpose of the water trigger controlling provisions as elucidated in the Second Reading Speech.[27] Applying this to the Modifications, it is clear that regardless of whether Angus Place Colliery has been assessed under the EPBC Act previously and that the Angus Place West Project has been referred under the EPBC Act, the significance of the impacts on water resources as a result of Mod 8 and Mod 5 remain and therefore require assessment under the EPBC Act.

The proponents are constitutional corporations

44. Centennial Angus Place Pty Ltd (ACN 101 508 945) and Springvale Coal Pty Limited (ACN 052 096 769) are Australian companies.

The Modifications are so closely associated with the mining of coal as to be integral to it

45. Centennial itself admits that the projects are integral to the mining of coal at Angus Place Colliery. Throughout the Modification Report, Centennial justifies the projects on the basis that they are required to safeguard infrastructure, ensure safe maintenance operations – regardless of future mining activities, and enable the future viability of coal mining at Angus Place Colliery, particularly the Angus Place West Project. The following information contained in the Modification Report evidences the close association of the projects to the mining of coal at Angus Place Colliery:

    a. that the projects will "prevent the imminent flooding" of Angus Place Colliery workings and its critical underground infrastructure "to safeguard the feasible recovery of the coal resource remaining at the mine for the purposes of coal supply" to Mount Piper Power Station;[28]

    b. that the capacity of the underground storage areas at Angus Place Colliery have been decreasing, which is now at a point where the water levels are beginning to "compromise critical underground infrastructure, potentially

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[25] Modification Report, 22.
[26] *ACF v Minister* [89]-[93].
[27] *ACF v Minister* [103].
[28] Modification Report, Executive Summary, 4 [8].

compromising the viability of future coal mining opportunities at Angus Place" Colliery;[29]

c. that "unless the dewatering rate is increased the Angus Place underground workings will become fully flooded and inaccessible to a degree that care and maintenance operations will not be able to be carried out safely and the complexity and costs of recommencing mining could become prohibitive";[30]

d. that if Angus Place Colliery working were left to fill with water, "this would potentially close the mine and sterilise the resource and severely compromise the viability of future underground coal mining operations";[31]

e. that "the proposed modification will support the potential future operation of Angus Place and the broader mining industry… The ability for Angus Place to have an alternate mine dewatering strategy (albeit temporarily) that allows for the independent removal of mine water from the Angus Place storage areas will seek to secure the existing underground infrastructure enabling the ability for Angus Place to continue to provide coal (and energy security) to MPPS in the future via its Angus Place West project."[32]

f. that the Angus Place West Project "has been developed to secure coal supply" to Mount Piper Power Station and forms "a key component of a long term coal supply agreement recently completed with Energy Australia" and that "it is imperative that Angus Place's existing infrastructure be secured and free from flooding, so that it can support the Angus Place West Project (should it be approved) in the future. To this end, Centennial Angus Place needs to urgently dewater the mine to manage the imminent risk of flooding critical infrastructure, noting that if flooding does occur, the mine may cease to be feasibly operated in the future."[33]

46. The above statements demonstrate that Mod 8 (the proposed transfer of 10ML/day of water from Angus Place Colliery) and Mod 5 (the proposed incorporation of that transferred water into the WCS site) are integral to coal mining operations at Angus Place Colliery. The fact that Mod 5 is addressed in the same Modification Report as Mod 8 also indicates that the likely impacts of Mod 5 and Mod 8 are so interconnected that they must be assessed together: that is, the transfer of water from Angus Place Colliery, under Mod 8, also requires the management and discharge of that water elsewhere, under Mod 5.

47. In analogous circumstances, in the ACF case Justice Perry stated as follows (emphasis added):[34]

> No other reason was given by the respondents as to why the Parliament would have intended that water impacts be assessed when approval is being sought for a coal mine, **but not if it is later proposed to construct and operate**

[29] Modification Report, Executive Summary, 3 [5].
[30] Modification Report, Executive Summary, 10 [1].
[31] Modification Report, 10 [1.1].
[32] Modification Report, 36, Table 7.1 'Socio-Economics'.
[33] Modification Report, 46, 8.1.
[34] *ACF v Minister* [103].

infrastructure to harvest water for the mine from an alternative source. Nor is any such reason apparent. To the contrary, if the impact on water resources at the time of the original approval was regarded as a matter of national environmental significance, there is no reason why it would lose that significance merely because the issue arose subsequently in relation to an alternative water source. That would undermine the objects of the EPBC Act in s 3(1) and the purpose of the water trigger controlling provisions as elucidated by the Minister in the 2013 Second Reading Speech.

48. Equally, where it is proposed to operate infrastructure to pump and transfer mine water from a coal mine to enable mine operations to be carried out safely and to enable future coal mining, it is keeping with the objects of the EPBC Act in s 3(1) and the purpose of the water trigger controlling provisions outlined in the Second Reading Speech that the water trigger would apply.

There is likely to be a significant impact on a water resource

49. The definition of "water resource" is extracted above at [0]. In considering the definition in the ACF case, Justice Perry stated:[35]

> The importance of this is that a significant impact upon any of these aspects of the water resource, including organisms, other water systems, and ecosystems, will engage the prohibition. It is not simply a question of the volume of water being extracted and its potential impact on water supplies.

50. We also note that Justice Perry identified a distinction in the assessment of impacts of the 'action' in s 24D(1)(b) and the impacts of the 'large coal mining development' for the purposes of s 528.[36] In particular, when considering whether the development has significant impact on water resources consideration can also be given to other developments, whether "past, present or reasonably foreseeable developments".

<u>The impacts of the 'action', Mod 8 and Mod 5, on water resources</u>

51. Mod 8 and Mod 5 in their own right will likely have significant impacts on water resources, particularly due to the impacts associated with salinity. **Annexure A** to this submission is the expert report of Dr Ian Wright, which sets out in detail these impacts.

52. Water resources identified in the Modification Report include Wangcol Creek and the Coxs River. They are part of the Hawkesbury-Nepean catchment and the Sydney Drinking Water Catchment. The Coxs River supplies water to Sydney's main drinking water storage at Lake Burragorang/Warragamba Dam.

53. Centennial claims that the projects will "result in a general reduction and an overall improvement in the pollutant concentrations from LDP001 to the receiving environment and will have minimal impacts upon the stability of the receiving drainage lines".[37]

54. Centennial's conclusion that the projects will result in overall improvements to surface water quality in Wangcol Creek is reached despite the Modification Report indicating

[35] *ACF v Minister* [51]
[36] *ACF v Minister* [88].
[37] Modification Report, 35, 7.1.5.

degrees of uncertainty in relation to impacts, for example in relation to pollutant concentrations from discharge point LDP001:[38]

a. "Modelling results indicated minor increases in some metal *may* occur, but it is *possible* that they will precipitate as oxides and/or be at a concentration below the relevant Default Guidelines Values (**DGV**) through aeration."
b. "Increases in Total Suspended Solids (**TSS**) and turbidity are *possible*, however based on the dilution of calculation and recent monitoring data for Angus Place underground mine water it is likely that level will remain below EPL concentration limits for the majority of the time."

55. Dr Wright opines that whilst water concentrations being discharged from LDP001 could improve for some pollutants due to concentration being diluted in greater quantities of discharged water, this may not result in a reduction in impacts to waterways downstream of LDP001, including Wangcol Creek and the Coxs River, because there will be an overall increase in the total pollution load being discharged from LDP001. He has calculated that the load of several pollutants discharged from LDP001 will likely increase with the transfer of Angus Place Colliery mine water and that this will have likely impacts on and be harmful to aquatic ecosystems (this is summarised below).

56. Dr Wright is of the opinion that if approved in their current form, the projects will cause increases in pollutants in water resources and substantial water quality changes, many of which are likely to be harmful to the biodiversity of rivers and streams, particularly Wangcol Creek and the Coxs River.

57. Dr Wright has examined the estimated pollution load of a number of pollutants and likely impacts as follows:
    a. salinity:
        i. the concentration of salinity at LDP001 will continue to greatly exceed the trigger value in the ANZECC Guidelines and be hazardous to aquatic ecosystems and probably contribute to the impairment to the biodiversity of waterways downstream of LDP001;
        ii. the overall load of salinity in Wangcol Creek will increase from 6.076 tonnes/day to between 8.282 to 8.591 tonnes/day, contributing to already high and historically increasing salinity in the Coxs River that will exceed the salinity trigger value in the Australian and New Zealand Environment and Conservation Council Guidelines for Fresh and Marine Water Quality 2000 (**ANZECC Guidelines**) for the protection of aquatic ecosystems in upland NSW for slightly to moderately disturbed ecosystems.
        iii. it is likely that the salinity plume from LDP001 could increase the downstream harm from elevated salinity in Wangcol Creek and the Coxs River well above the trigger value in the ANZECC Guidelines;
        iv. the projects will potentially contribute to higher salinity levels in Lake Burragorang/Warragamba Dam;
        v. under all modelled scenarios, the projects will contribute to predicted salinity levels that are a very large and are an unnatural increase above natural background salinity levels in the western Blue Mountains that are environmentally harmful and impair stream and river biodiversity.[39]
    b. arsenic:

[38] Modification Report, 32, 7.1.3.
[39] Australian and New Zealand Environment and Conservation Council Guidelines for Fresh and Marine Water Quality 2000 (**ANZECC Guidelines**), available at: < ANZECC & ARMCANZ (2000) guidelines (waterquality.gov.au)>.

        i. based on modelled predicted scenarios, the overall load of arsenic discharged at LDP001 will increase from <12.88g/day to between 77.28g/day to 90.16g/day. This exceeds the trigger value for arsenic in the ANZECC Guidelines for the protection of aquatic ecosystems in upland NSW for slightly to moderately disturbed ecosystems and will be harmful to stream and river biodiversity.

   c. boron:
      i. based on modelled predicted scenarios, the overall load of boron discharged at LDP001 will increase from 2.592kg/day to between 2.70kg/day to 3.74kg/day. This exceeds the trigger value for boron in the ANZECC Guidelines for the protection of aquatic ecosystems in upland NSW for slightly to moderately disturbed ecosystems and will be harmful to stream and river biodiversity.
   d. cobalt:
      i. based on two of the three modelled predicted scenarios, the overall load of cobalt discharged at LDP001 will increase from 86.4g/day to 90.16g/day. The impact of this is unknown and ecotoxicology testing to infer safe concentrations for stream and river biota is needed.
   e. total suspended solids:
      i. the total sediment load discharged from LDP001 will increase from 14.4kg/day to 115.92kg/day t 128.8kg/day. Sediment is an important environmental stressor in streams, rivers, lake and wetlands and can block the gills of aquatic biota and blanket streams in fine sediment disrupting photosynthesis in waterways. The increase in the sediment load discharged from LDP001 will be harmful for the biodiversity of downstream streams and rivers.
   f. selenium:
      i. the overall load of selenium discharged at LDP001 will increase from <12.88g/day to up to 25.72g/day. This would have the likely impact of causing bioaccumulation and biomagnification of selenium in the biota and food web within the Coxs River and Lake Wallace, causing harm to aquatic biota in these water resources.
   g. nickel:
      i. under all the modelled predicted scenarios, the concentration of nickel discharged at LDP001 exceeds the trigger value for nickel in the ANZECC Guidelines for the protection of aquatic ecosystems in upland NSW for slightly to moderately disturbed ecosystems, and the future discharge plume of elevated nickel from the LDP001 discharge is likely to harm downstream aquatic ecosystems.
   h. zinc:
      i. under all the modelled predicted scenarios, the concentration of nickel discharged at LDP001 exceeds the trigger value for zinc in the ANZECC Guidelines for the protection of aquatic ecosystems in upland NSW for slightly to moderately disturbed ecosystems, and the future discharge plume of elevated zinc from LDP001 discharge is likely to harm downstream aquatic ecosystems.

58. We note that Centennial has only considered the projects' impacts on water quality and the flow conditions of Wangcol Creek. It has not considered whether the pumping of additional mine water from Angus Place Colliery will have an impact on groundwater availability and groundwater dependent ecosystems, which fall within the definition of 'water resource'.

59. We note that the Modification Report does not consider the impacts of Mod 8 on groundwater and this is an unsatisfactory omission. We address this further below by examining other impacts to groundwater that have occurred in relation to past developments and the potential impacts on groundwater for reasonably foreseeable projects in approximately the same location.

<u>The impacts on water resources when considering "past, present or reasonably foreseeable developments"</u>

60. We note that to satisfy the definition of 'large coal mining development' a project must satisfy *either* of the criteria contained in s 528 of the EPBC Act being that in its own right, or when considered with other developments, it will have or is likely to have an impact on water resources. We outline above that the first criteria of s 528 is satisfied. With regards to the second criteria, we outline that Centennial should be required to provide more information to assist decision makers.

61. Due to inadequate information contained in the Modification Report, it is unclear if the projects will have, or are likely to have, a significant impact on water resources when considered with other developments, whether past, present or reasonable foreseeable developments.

62. The Modification Report only briefly mentions cumulative impacts this is despite listing numerous other activities nearby that interact with water resources including Mount Piper Power Station, Pine Dale Coal Mine, Wallerawang Power Station and Lidsdale Siding.[40] No information is provided as to how these sites may or may not contribute to impacts on water resources of the projects.

63. Despite previous concerns relating to impacts on groundwater from dewatering Angus Place Colliery, the Modification Report does not adequately address potential impacts on groundwater for the projects. In 2018, Centennial was granted a modification to MP06_0021 titled "Mod-5". The modification was similar to the current proposed Mod 8, whereby Centennial sought consent to transfer up to 10ML/day of mine water from Angus Place Colliery to discharge point LDP001. Centennial's environmental assessment documents for the 2018 modification dismissed that there would be impacts on groundwater dependent ecosystems, including the federally protected Temperate Highland Peat Swamps on Sandstone ecosystem.

64. As part of public consultation undertaken in 2018 for the modification, our client raised their concern that the modification would potentially impact on groundwater availability, and consequently, groundwater dependent ecosystems. In response to these concerns and our client's observed changes in water levels in swamp environments, Centennial investigated the potential for impacts on swamp environments as a result of dewatering Angus Place Colliery. **Annexure B** comprises the report, which did not form part of the public consultation documents for the modification at the time despite being finalised prior to determination of the modification.[41] In Annexure B, Centennial found that there would be drawdown of 21 metres and 30 metres respectively in the 800 Panel and 900 Panel underground water storage areas at Angus Place Colliery.[42] If a similar outcome is expected or likely as a result of Mod 8, it should be included in the Modification Report and warrants proper assessment.

[40] Modification Report, 36, Table 71.
[41] Centennial Coal, Angus Place Colliery Coxs River Swamp Review, July 2018.
[42] Centennial Coal, Angus Place Colliery Coxs River Swamp Review, July 2018, 44.

65. Consideration must also be given to the Angus Place West Project, which is a reasonably foreseeable development that may also contribute to impacts on water resources including the proposed inter-basin transfer of water. Again, the fact that the Modification Report does not adequately address this makes it difficult to determine the likely impacts the projects, in combination with future developments, will have on water resources.

F Centennial or the State must refer

66. Centennial should refer the projects under the EPBC and if not, it risks contravening s 67A of the EPBC Act.

67. A Bilateral Agreement under s 45 of the EPBC Act has been in place between NSW and the Commonwealth since 2015 and was updated in 2020.[43]

68. The Bilateral agreement reflects a commitment by NSW and the Commonwealth to create a 'One-Stop Shop' for environmental assessment and approvals and reduce duplication.[44] The objects of the Bilateral Agreement also include "The parties will use their best endeavours to implement the commitments in this Agreement acting in a spirit of cooperation and consultation to achieve an efficient, timely and effective process for environmental assessment and approval."[45]

69. The Bilateral Agreement contains a section of "Cooperative approach to referrals". At the first instance NSW is under an obligation "to use its best endeavours to inform proponents that an action may need to be referred to the Commonwealth."[46] This section also draws attention to s 69 of the EPBC Act and the power of the State to refer a matter to Commonwealth Environment Minister for a decision.

70. It would be grossly inefficient and inconsistent with the objectives of the Bilateral Agreement and both Governments' commitments if the projects were to be assessed by each level of government separately and consecutively. It may also lead to inconsistencies in assessment decisions and, if approved, the conditions the approvals are subject to.

71. In the absence of Centennial referring the projects under the EPBC Act it is incumbent on the Minister for Planning and Public Spaces, Paul Scully, to do so in order to act consistently with the Bilateral Agreement and its key purpose to reduce duplication between the two levels of government.

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[43] Bilateral agreement made under s 45 of the *Environment Protection and Biodiversity Conservation Act* 1999 (Cth) relating to environmental assessment, Commonwealth of Australian and The State of New South Wales as amended in March 2020 (**Bilateral Agreement**).
[44] Bilateral Agreement, Objects, D.
[45] Bilateral Agreement, Objects, G.
[46] Bilateral Agreement, cl 5.1.

Review of: Modifications to Western Coal Services and Angus Place Colliery Modification report for modifications MP 06_0021 (MOD 8) and SSD-5579 (MOD 5)

12 October 2023

Prepared by Dr Ian A. Wright

MSc (by research) Macquarie University
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I have read the expert witness code of conduct. I have prepared this report in conformance with the code. I am willing to be bound by it (*Uniform Civil Procedure Rules 2005*).

I have been asked to produce an expert report that addresses the following questions:

24. Please prepare an expert report that addresses the following:

a. What, if any, concerns do you have about the likely environmental impacts of the proposed modifications, bearing in mind any mitigation measures proposed? In particular we ask that you opine on:

i. The likely impacts, if any, of discharges from LDP001 on Wangcol Creek, other water sources and aquatic ecology; and

ii. The likely impacts, if any, of the proposed modifications on the greater Hawkesbury-Nepean catchment; and

iii. The likely impacts, if any, of the proposed modifications on the Sydney Drinking Water Catchment.

b. In your opinion is the assessment of the environmental impacts of the modifications, as far as it relates to your area of expertise, appropriate and sufficient.

c. In relation to any likely impacts you have identified, are the mitigation measures identified in the Modification Report appropriate and sufficient? Please consider whether there are any actions that Centennial, the Department of Planning and Environment and/or the Environment Protection Authority could take to avoid or minimise any impacts on surface water and aquatic ecosystems.

d. To the extent you have not already identified in your responses to the above question, in your opinion what are the likely impacts on water resources (including any impacts of associated salt production and/or salinity and metals) of each of the proposed modifications:

i. in their own individual right; and

ii. when considered together along with any other developments (whether past, present or reasonably foreseeable)?

For the purposes of this question water resources include:

- surface water or ground water; or
- a watercourse, lake, wetland or aquifer (whether or not it currently has water in it);
- and includes all aspects of the water resource (including water, organisms and other components and ecosystems that contribute to the physical state and environmental value of the water resource).

For the purposes of this question 'likely' impact means one that has real or not remote chance or possibility.

e. Any other matters you identify which you consider to be relevant and within the limits of your expertise.

Likely impacts of proposed modifications on water resources

Increased pollutant loads

1. The proposed modifications, as described in the Modification Report for Mod 8 and Mod 5 (Centennial, September 2023) will increase the volume of water discharged from LDP001 (EPL 21229) into Wangcol Creek. The report (I will refer to as 'Modification Report') also claims that water quality concentrations discharged from LDP001 will improve.

2. Page 2 of the Executive Summary (under subheading proposed modifications) of the Modification Report states:

> "The primary purpose of the water transfer is to mitigate potential flooding of the Angus Place underground infrastructure resulting in an overall improvement of the water quality concentrations being discharged from LDP001".

3. Whilst 'water quality concentrations being discharged from LDP001' could improve for some pollutants, I remain concerned that *'improved water quality concentrations'* may not directly result in a reduction of environmental impacts to waterways downstream of LDP001 (Wangcol Creek and then Coxs River). In my opinion, it is possible that the proposed modifications could cause some water quality impacts to downstream waterways to increase the level of environmental harm,

relative to the existing LDP001 discharge. I have formed the opinion that environmental harm to Wangcol Creek and the Coxs River will be increased, particularly due to increased loads of several pollutants.

4. I have calculated that the load of several pollutants discharged from LDP001 will likely increase if the transfer of Angus Place mine water is implemented.

5. Pollutant loads are an important consideration in assessing water pollution / environmental impacts from a point source discharge of wastewater (Schnoor, 2014). Calculation of pollutant loads is achieved by combining the concentration of a pollutant (such as mg/L) with the volume discharged over a period of time (such as ML/day). For these projects, loads were calculated as mass per day. For example, the projected increased volume of water that is expected to be discharged from LDP001, according to the Modification Report, which is currently releasing 2.88 ML/day, is projected to increase by 10 ML/day to 12.88 ML/day after the proposed transfer of Angus Place mine water. Even if the increased discharge at LDP001 does achieve lower concentrations of pollutants, as detailed in the Modification Report, it is likely that there will be an increase in the load of pollutants. This is expressed as the mass of pollutants (in grams, kilograms or tonnes) per day of pollutants, disposed from LDP001 into downstream waterways (Wangcol Creek and then Coxs River).

6. The following paragraphs provide more details on my calculated comparison of existing versus future predicted loads of several pollutants at LDP001. The pollutants compared include salt (as total dissolved solids), arsenic, boron, cobalt, sediment (as total suspended solids) and selenium. Important documents that enabled calculation of loads is provided in the Modification Report, and also the GHD Water Assessment Report.

Pollutant load increases for specific pollutants and associated likely impacts

Salinity

7. Based on information provided in the Modification Report, I calculated that the salinity (as total dissolved solids, referred to as 'TDS') load discharged at LDP001 will increase from 6.076 tonnes of day under existing conditions. This is based on a current discharge volume of 2.88 ML/day. Table 2.1 in Water Assessment (GHD, September 2023) reports the 50^{th} percentile for total dissolved solids (TDS) of 2,110 mg/L. The future discharge of 12.88 ML is predicted to have a lesser concentration of salinity (TDS, Table 2.1, GHD Water Assessment) of 643 mg/L (900 area) and 667 mg/L (800 area). But the overall load of salinity (as TDS) based on the concentrations in Table 2.1 will increase to between 8.282 tonnes and 8.591 tonnes a day.

8. Based on this information, I calculated that the increased load of salt discharged from LDP001, will increase from the current 6.076 tonnes/day, to 8.282 to 8.591 tonnes a day (after the transfer of Angus Place mine water) and the increased salt load will contribute to already high and historically increasing salinity in Coxs River downstream.

9. The following graphs (Figure 1: Lake Lyell Historical Water Quality; Figure 2: Lake Wallace Historical Water Quality) were prepared and supplied by NSW EPA (Ref: GIPA EPA 724). These two lakes are large impoundments behind dams built on the Coxs River that were constructed to supply cooling water for coal-fired electricity generators (now closed Wallerawang Power Station, and currently active Mount Piper Power Station). They are also very popular for wildlife, heavily used for aquatic recreation and are part of Coxs River which supplies water to Sydney's main drinking water storage at Warragamba Dam.

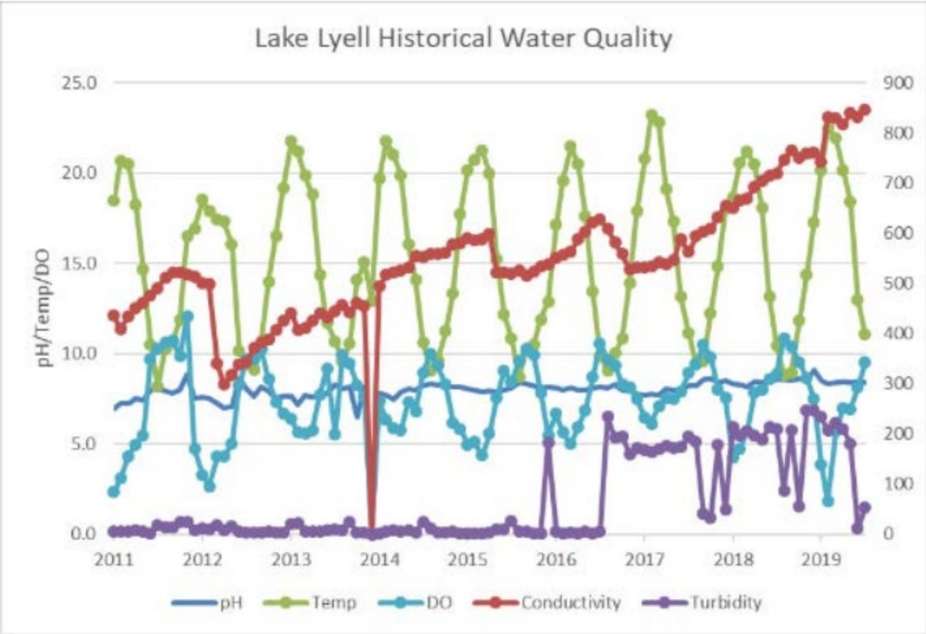

Figure 1. Water quality of Lake Lyell (Coxs River, near Lithgow). Salinity is represented by 'conductivity' and is in units µS/cm. Source: NSW EPA (Ref: GIPA EPA 724)

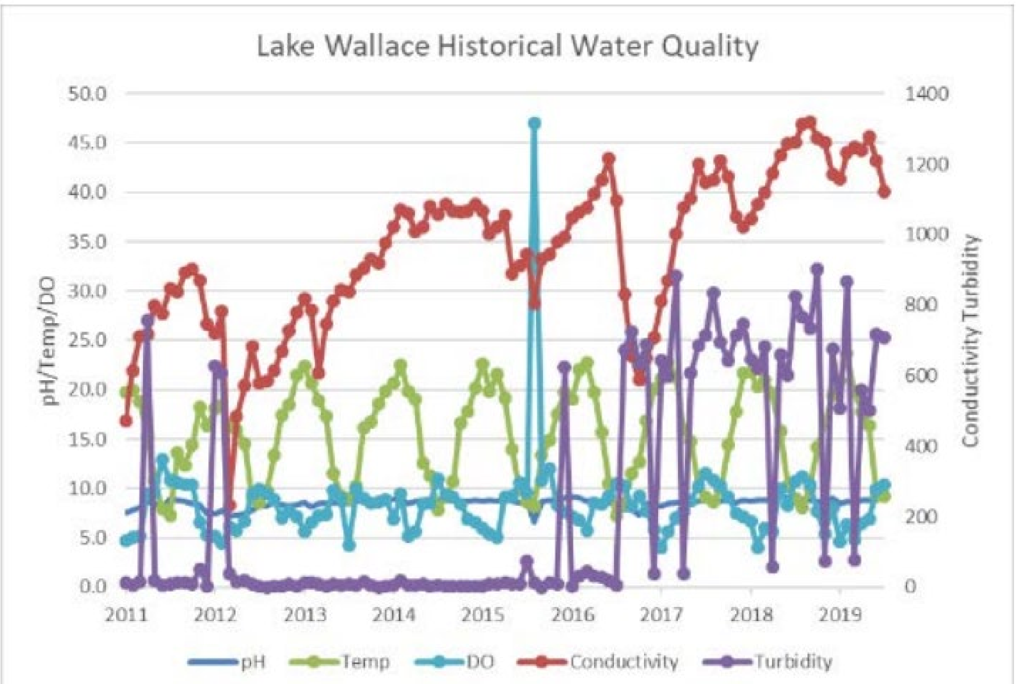

Figure 2. Water quality of Lake Wallace (Coxs River, near Wallerawang). Salinity is represented by 'conductivity' and is in units µS/cm. Source: NSW EPA (Ref: GIPA EPA 724)

10. Based on the salinity calculations I have made, I have formed the opinion that the proposed transfer of mine water will cause an increased load of salt from LDP001 that is likely to contribute to elevated salinity downstream in Coxs River, where salinity has been increasing for about a decade.

11. Detailed time series data for salinity in Coxs River is available for Lake Wallace and Lake Lyell. Both lakes are located on the Coxs River. Lake Wallace is about 8km downstream of LDP001 and Lake Lyell a further 8 km downstream. The two graphs of water quality (above) were supplied by NSW EPA (Ref: GIPA EPA 724).

12. Salinity in Lake Wallace increased steadily over the period 2012 to 2019 from about 200 µS/cm (in 2012) to more than 1200 µS/cm (in 2019). Salinity in Lake Lyell also increased steadily over the period 2012 to 2019 from about 300 µS/cm (in 2012) to more than 800 µS/cm (in 2019). These salinity levels exceed the recommended guidelines for protection of aquatic ecosystems of less than 350 µS/cm (ANZECC, 2000, 3.3. Physical and chemical stressors, Table 3.3.3).

13. As all three scenarios outlined in the Modification Report (after the proposed transfer of mine water) of water quality predict that salinity at LDP001 will be highly elevated (Scenario 1. 1261 µS/cm; Scenario 2. 1197 µS/cm; Scenario 3. 1336 µS/cm) combined with much higher flow volumes (and loads of salinity as TDS) I have formed the opinion that the proposed modification will contribute to higher salinity, above ANZECC guidelines, in the Coxs River.

14. I have also formed the opinion that an increased load of salt from LDP001 is likely to contribute to elevated salinity downstream within Lake Burragorang/Warragamba Dam. Coxs River is the second largest river supplying water into Lake Burragorang/Warragamba Dam. The 2019 Sydney Drinking Water Catchment Audit Report shows that salinity at several sampling sites located within Warragamba Dam (DWA2, DWA9, DWA12, DWA27, DWA39, DWA311) display a rising trend from 2010 to 2019 (Sydney Drinking Water Catchment Audit 2019 – Volume 3).

15. The graph below (Figure 3) was extracted from the Sydney Drinking Water Catchment Audit 2019 – Volume 3. Please note that the units of electrical conductivity used in this graph (mS/cm) are different to others used in ANZECC and previously in this report. For comparison, 0.2 mS/cm is equivalent to 200 µS/cm.

16. As:
    a. all three scenarios of water quality outlined in the Modification Report predict that salinity at LDP001 will be highly elevated by about five or six times the salinity of water in Warragamba Dam (Scenario 1. 1261 µS/cm; Scenario 2. 1197 µS/cm; Scenario 3. 1336 µS/cm); and

b. this is combined with much higher flow volumes of wastewater from LDP001 (and increased loads of salinity as TDS)

I have formed the opinion that the transfer of mine water from Angus Place will contribute wastewater of higher salinity, above ANZECC guidelines, downstream to the Coxs River and contribute to salinity in Warragamba Dam.

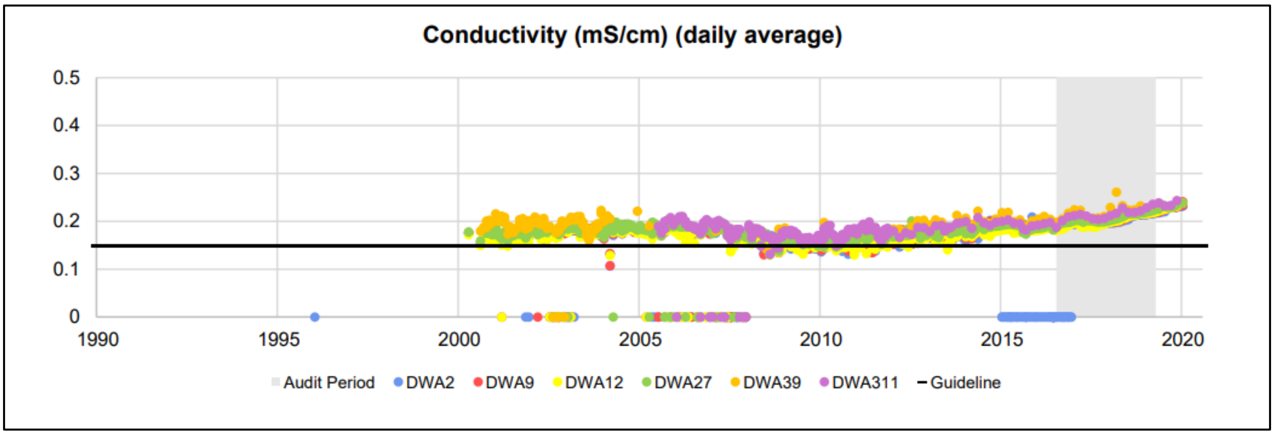

Figure 3. Salinity (as 'Conductivity') at six sampling sites within Lake Burragorang (Sydney's main drinking water supply impounded behind Warragamba d). Salinity is represented by 'conductivity' and is in units mS/cm. Source: Sydney Drinking Water Catchment Audit 2019 – Volume 3

17. The ANZECC salinity guideline (trigger value) for protection of aquatic ecosystems in upland NSW slightly disturbed ecosystems is 350 µS/cm (ANZECC, 2000, 3.3. Physical and chemical stressors, Table 3.3.3). The existing salinity of the LDP001 (Table 2.3, 'Predicted changes in water quality at LDP001', in Water Assessment, GHD, September 2023) is reported to be 2670 µS/cm. The predicted future salinity under three future scenarios are 1261 µS/cm (scenario 1), 1197 µS/cm (scenario 2), and 1336 µS/cm (scenario 3). These all exceed the 350 µS/cm ANZECC salinity trigger value. This indicates that the salinity will be hazardous to aquatic ecosystems (ANZECC, 2000, Section 3.4 Water quality guidelines for toxicants). Such levels of salinity are often recorded in coal mine wastes (Belmer et al. 2020; Price and Wright, 2016) and are at high risk of being 'harmful to aquatic life' and probably contribute to impairment to the biodiversity of waterways downstream of LDP001 (Kefford et al. 2005; Zalizniak et al. 2009).

18. The levels of salinity currently discharged from LDP001 wastewater is reported to be 2670 µS/cm. The predicted future salinity under three future scenarios are 1261 µS/cm (scenario 1), 1197 µS/cm (scenario 2), and 1336 µS/cm (scenario 3). The existing and the future scenarios all exceed the salinity levels recorded at naturally vegetated reference sites (25 - 130 μS/cm) in the western Blue Mountains (Belmer et al. 2020; Price and Wright, 2016; Wright and Ryan, 2016), indicating that the wastewater discharged from LDP001 (existing and three future scenarios) is a very large and unnatural increase above natural background salinity levels in the western Blue Mountains. I

consider such salinity concentrations to be environmentally harmful. Based on the findings of Kefford et al. 2005 and Zalizniak et al. 2009, stream and river biodiversity is impaired at higher levels of salinity, for example, species that are sensitive to salt will probably not survive.

19. As the total predicted volume of mine water (from 2.88 ML/day to 12.88 ML/day) and also the load of salt is projected to increased under the three future scenarios (Table 2.3, ‘Predicted changes in water quality at LDP001’, in Water Assessment, GHD, September 2023) I consider it to be likely that the salinity plume from the LDP001 discharge could increase the downstream harm from elevated salinity (Wangcol Creek, and the Coxs River) well above the 350 µS/cm ANZECC salinity trigger value (ANZECC, 2000, Section 3.4 Water quality guidelines for toxicants).

Arsenic

20. Based on information provided in the Modification Report, and the GHD Water Assessment Report, I have calculated that the arsenic load discharged at LDP001 will increase from <12.88 g of arsenic per day under existing conditions, to between 77.28 g/day (scenario 3), 90.16 g/day (scenario 1 and 2). Under all of the future predicted scenarios (from Table 2.3 in GHD Water Assessment Report) the daily load of arsenic released from LDP001 would increase, relative to the existing arsenic load.

21. These calculations are based on current LDP001 discharge volume of 2.88 ML/day. Table 2.3 (‘Predicted changes in water quality at LDP001’) in Water Assessment (GHD, September 2023) reports the existing concentration of arsenic at LDP001 was less than detection limits (<0.001 mg/L). Table 2.3 predicts future concentrations of arsenic discharged, for 12.88 ML volume released, to have a concentration of arsenic (from Table 2.3) under three different possible scenarios of 0.007 mg/L (scenario 1), 0.007 mg/L (scenario 2) and 0.006 mg/L (scenario 3). Based on these estimates (from Water Assessment, GHD September 2023) the overall future estimated load of arsenic discharged from LDP001 according to the three scenarios will be 90.16 g (scenario 1), 90.16 g (scenario 2) and 77.28 (scenario 3).

22. The concentrations of arsenic in the above three scenarios are above the ANZECC arsenic guideline (trigger value) for 99% protection of aquatic ecosystems (ANZECC, 2000, Table 3.4.1). In my opinion, this would be harmful to stream and river biodiversity.

Boron

23. Based on information provided in the Modification Report, and the GHD Water Assessment Report, I calculated that the boron load discharged at LDP001 will increase from 2.592 kg of boron per day under existing conditions, to 3.0912 kg/day (scenario 1), 2.7048 kg/day (scenario 2), 3.735 kg/day (scenario 3). Under all three future predicted scenarios (from Table 2.3 in GHD Water Assessment Report) the daily load of boron released from LDP001 would increase, relative to the existing boron load.

24. These calculations are based on current LDP001 discharge volume of 2.88 ML/day. Table 2.3 ('Predicted changes in water quality at LDP001') in Water Assessment (GHD, September 2023) reports the existing concentration of boron at LDP001 was 0.9 mg/L. This would make a current daily load of 2.592 kg/day. Table 2.3 predicts future concentrations of boron discharged, for 12.88 ML volume released, (from Table 2.3) under three different possible scenarios of 0.24 mg/L (scenario 1), 0.21 mg/L (scenario 2) and 0.29 mg/L (scenario 3). Based on these estimates (from Water Assessment, GHD September 2023) the overall future estimated daily load of boron discharged from LDP001 according to the three scenarios will be 3.091 kg (scenario 1), 2.705 kg (scenario 2) and 3.735 kg (scenario 3).

25. The concentrations of boron in the above three scenarios are above the ANZECC boron guideline (trigger value) for 99% protection of aquatic ecosystems (ANZECC, 2000, Table 3.4.1). In my opinion, this would be harmful to stream and river biodiversity.

Cobalt

26. Based on information provided in the Modification Report, and the GHD Water Assessment Report, I calculated that the cobalt load discharged at LDP001 will increase from 86.4 g of cobalt per day under existing conditions, to 90.16 g/day (scenario 1), 77.28 g/day (scenario 2), 90.16 g/day (scenario 3). Under two of three future predicted scenarios (from Table 2.3 in GHD Water Assessment Report) the daily load of cobalt released from LDP001 would increase, relative to the existing cobalt load.

27. There are no ANZECC guidelines for cobalt. Ecotoxicology testing is needed to infer safe concentrations for stream and river biota.

28. These calculations are based on current LDP001 discharge volume of 2.88 ML/day. Table 2.3 ('Predicted changes in water quality at LDP001') in Water Assessment (GHD, September 2023) reports the existing concentration of cobalt at LDP001 was 0.03 mg/L. Table 2.3 predicts future concentrations of cobalt discharged, for 12.88 ML volume released, (from Table 2.3) under three different possible scenarios of 0.007 mg/L (scenario 1), 0.006 mg/L (scenario 2) and 0.009 mg/L (scenario 3). Based on these estimates (from Water Assessment, GHD September 2023) the overall future estimated load of cobalt discharged from LDP001 according to the three scenarios will be 90.16 g (scenario 1), 77.28 g (scenario 2) and 115.92 (scenario 3).

Total suspended solids

29. Based on information provided in the Modification Report, and the GHD Water Assessment Report, I calculated that the sediment load (as total suspended solids, 'TSS') discharged at LDP001 will

increase from 14.4 kg of TSS per day under existing conditions, to 115.92 kg/day (scenario 1 and 3) and 128.8 kg/day (scenario 2).

30. These calculations are based on current LDP001 discharge volume of 2.88 ML/day. Table 2.3 ('Predicted changes in water quality at LDP001') in Water Assessment (GHD, September 2023) reports the existing concentration of TSS at LDP001 was 5 mg/L. Table 2.3 predicts future concentrations of TSS discharged, for 12.88 ML volume released, (from Table 2.3) under three different possible scenarios of 9 mg/L (scenario 1), 10 mg/L (scenario 2) and 9 mg/L (scenario 3). Based on these estimates (from Water Assessment, GHD September 2023) the overall future estimated load of sediment (as TSS) discharged each day from LDP001 according to the three scenarios will be 115.92 kg (scenario 1 and 3) and 128.8 kg (scenario 2).

31. Sediment is an important environmental stressor in stream, rivers lakes and wetlands. It can block gills of aquatic biota and blanket streams with fine sediment that can change photosynthesis in the waterway (ANZECC, 2001). Under all three future predicted scenarios (from Table 2.3 in GHD Water Assessment Report) the daily load of sediment (as TSS) released from LDP001 would increase, relative to the existing sediment load. In my opinion the transfer of mine water from Angus Place will increase the discharge of sediment from LDP001 and will be harmful for the biodiversity of downstream streams and rivers.

Selenium

32. Based on information provided in the Modification Report, and the GHD Water Assessment Report, I calculated that the selenium load discharged at LDP001 will increase from <12.88 g per day under existing conditions, to 25.72 g/day (scenario 1 and 2) and 12.88 g/day (scenario 3). Under all three future predicted scenarios (from Table 2.3 in GHD Water Assessment Report) the daily load of selenium released from LDP001 would increase, relative to the existing load.

33. These calculations are based on current LDP001 discharge volume of 2.88 ML/day. Table 2.3 ('Predicted changes in water quality at LDP001') in Water Assessment (GHD, September 2023) reports the existing concentration of selenium at LDP001 was <0.001 mg/L. Table 2.3 predicts future concentrations of selenium discharged, for 12.88 ML volume released, (from Table 2.3) under three different possible scenarios of 0.002 mg/L (scenario 1), 0.002 mg/L (scenario 2) and 0.001 mg/L (scenario 3). Based on these estimates (from Water Assessment, GHD September 2023) the overall future estimated load of selenium discharged each day from LDP001 according to the three scenarios will be 25.72 g (scenario 1 and 2) and 12.88 g (scenario 3).

34. Selenium bioaccumulation and biomagnification was documented in the biota and food web within the Coxs River, Lake Wallace (Jasonsmith et al. 2008). The concentration of Selenium in the water of Lake Wallace was (1.9 µg/L). This is a very similar concentration to the future predicted selenium

concentrations at LDP 001 (from Water Assessment, GHD September 2023). Given the increased load of selenium that is calculated above, I have formed an opinion that the future discharge could harm aquatic biota in Coxs River, and Lake Wallace, due to a contribution to selenium bioaccumulation. This is despite the concentration of selenium predicted under the three scenarios to be less than the total selenium guideline (ANZECC, 2000, Table 3.4.1). The research by Jasonsmith et al. (2008) demonstrated that selenium bioaccumulation and biomagnification was documented in Coxs River, Lake Wallace.

Nickel

35. The concentration of nickel in water discharged from LDP001, under all three future scenarios (Table 2.3, 'Predicted changes in water quality at LDP001', in Water Assessment, GHD, September 2023) range from 40 to 60 μg/L. All of these exceed the ANZECC nickel guideline (trigger value) for protection of aquatic ecosystems in upland NSW slightly to moderately disturbed ecosystems (seeking to protect 95% of species) which is 11 μg/L (ANZECC, 2000, Table 3.4.1). I consider it to be likely that the future discharge plume of elevated nickel from the LDP001 discharge could increase the downstream harm to aquatic ecosystems.

Zinc

36. The concentration of zinc in water discharged from LDP001, under all three future scenarios (Table 2.3, 'Predicted changes in water quality at LDP001', in Water Assessment, GHD, September 2023) range from 20 to 30 μg/L. All of these exceed the ANZECC zinc guideline (trigger value) for protection of aquatic ecosystems in upland NSW slightly to moderately disturbed ecosystems (seeking to protect 95% of species) which is 8 μg/L (ANZECC, 2000, Table 3.4.1). I consider it to be likely that the future discharge plume of elevated zinc from the LDP001 discharge could increase the downstream harm to aquatic ecosystems.

Mitigation Measures

37. I do not consider that any of the mitigation measures in section 7.1.4 of the Modifications Report will effectively reduce any of the water quality impacts that I have detailed in this submission.

Conclusion

38. In my opinion the increased volume of wastewater that is proposed to be transferred to LDP001 from Angus Place is likely to cause substantial water quality changes. Many of the changes are likely to be harmful to the biodiversity of downstream streams and rivers, particularly Wangcol Creek and Coxs River.

39. I am particularly concerned with the increased load of several pollutants, as I have detailed in this report. An example is the increased load of salt that I expect would contribute to elevated salinity, at ecologically harmful concentrations (ANZECC, 2000; Kefford et al. 2005 and Zalizniak et al. 2009)

within Coxs River and will also contribute to elevated salinity within Sydney's main drinking water supply, Warragamba Dam/Lake Burragorang.

40. There are several mitigation measures that could be used to reduce the concentration and load of pollutants, involving advanced treatment of the mine wastewater. In my opinion this proposal should include effective wastewater treatment technologies that could result in less harmful wastewater being released from LDP001.

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Qualifications and experience

I am an environmental and water scientist with more than 25 years of experience investigating the impact of human activities on waterways of the Sydney basin. I am currently employed as an Associate Professor in the School of Science at Western Sydney University. Earlier in my career I was an environmental scientist, working in various roles at Sydney Water. This included working as a scientific officer in Sydney Water's scientific laboratories at West Ryde. I also worked as catchment officer in Sydney Water's drinking water catchments. After I received my PhD, I was awarded a Postdoctoral Research Fellowship in freshwater ecology and water pollution research at Western Sydney University. Before becoming a fulltime lecturer in 2012, I established a consulting business, mainly helping local Government with projects associated with urban water quality and ecology. I am an advocate for sustainable water and catchment management and I strongly support multi-disciplinary projects. I seek to manage industry problems with evidence-based science. I have specialist scientific expertise in freshwater ecology, water chemistry, pollution ecology of waters, freshwater macroinvertebrates as pollution indicators, impact of urban development, sewage effluent, agricultural, and mine waste impacts on streams and rivers. I have expertise in the sampling design of environmental science studies and statistical analysis of environmental data. I have published (as senior or junior co-author) more than 80 peer-reviewed publications. I have provided independent expert testimonies for environmental science matters for the NSW Land & Environment Court. I am an enthusiastic participant in community engagement activities in my field of expertise.

Qualifications

2006. Doctor of Philosophy, University of Western Sydney.

1995. Master of Science (by research), Macquarie University.

1988. Bachelor of Applied Science (Agriculture), Hawkesbury Agricultural College.

Annexure B

Centennial Coal

ANGUS PLACE COLLIERY

Coxs River Swamp Review

July 2018

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1. INTRODUCTION

1.1. Project description

Centennial Angus Place Pty Limited (Centennial) are in the process of modifying Angus Place Colliery's Project Approval PA 06_0221. The modification (MOD 5) is associated with operational water management and aims to assist in providing flexibility in water management of both Angus Place and Springvale Mine.

The modification proposes to:

- temporarily increase mine water discharge to up to 10 ML/day, treated to an electrical conductivity (EC) of 350 µS/cm at the point of discharge, through Angus Place's Licensed Discharge Point (LDP) 001 from 01 July 2018 to 31 December 2019
- cease to discharge mine water (raw or treated) from LDP001 from 01 January 2020, or earlier:

The establishment and operation of the temporary water treatment plant (WTP) required for the treatment of the raw mine water to an EC of 350 µS/cm prior to discharge is not proposed in the modification. These components will be undertaken under a Pollution Reduction Program (PRP) (Condition U1.1) included in Angus Place Colliery's Environment Protection Licence (EPL) 467 via Centennial's licence variation application, submitted on 22 March 2018 and approved by the Environmental Protection Authority (EPA) on 11 May 2018. The inclusion of the PRP in EPL 467 allows the construction and operation of the WTP under Clause 6(e) of the *State Environmental Planning Policy* (*Mining, Petroleum Production and Extractive Industries*) 2007, and no development consent is required. The project includes the following components and timing:

- Construction of a Temporary Water Treatment Plant (WTP) at Angus Place Colliery by 30 June 2018.
- Continue discharge of raw mine water at up to 2 ML/day, through Angus Place LDP001, into Kangaroo Creek, until 30 June 2018.
- Operate the Temporary Water Treatment Plant from 1 July 2018 until 31 December 2019.
- From 1 July 2018 to 31 December 2019, discharge treated groundwater (to 350µS/cm and at up to 10ML/day), through Angus Place LDP001, into Kangaroo Creek.
- From 1 July 2018, temporarily store residuals generated from the Angus Place Water Treatment Project underground until 31 December 2019.
- From 1 January 2020, residuals stored underground at Angus Place Colliery, as relevant, will be, gradually, diverted to the Springvale Water Treatment Project.
- From 1 January 2020, cease to discharge to Kangaroo Creek through Angus Place LDP001.

As part of the Environmental Assessment (EA) for the modification, stakeholder consultation has identified concerns associated with the health and ongoing viability of the area identified as Long Swamp however for the purposes of this assessment is referred to as the Coxs River Swamp System.

1.2. Issues identified

During the preparation of the project, a call from a Lithgow Environment Group (LEG) representative was received by the Centennial Coal regarding the water levels within a swamp environment adjacent to Wolgan Road near Angus Place Tip (approximately 2 km north of Angus Place Pit Top).

Water levels were reported to have suddenly dropped by approximately 0.5 to 1 m over a period of 2 weeks based on observations by LEG members. The claim was made that drop in water level was as result of mining activities and hence it was requested that it be investigated. Notification of other State regulation bodies was also undertaken at this stage. It has not been determined whether measured baseline data exists from community stakeholders for this area, it should be noted that if data does exist, it has not been supplied to Centennial.

Following the notification of the identified issue, the area of concern was visually inspected as a group including representatives of both Centennial Coal and LEG. Following the inspection, a letter was prepared by the LEG whereby the following was outlined:

- General concerns on the potential impact to endangered ecological communities (EEC) of the Montane Peatlands & Swamps (identification code MU53) as a result of mining activities.
- Claims of historical impact to swamp environments in 2004 specifically as a result of Angus Place Colliery mining activities within the vicinity of the current identified impact area.
- Specific concerns of increased risk to existing communities of threatened species of which are groundwater dependent including the *Kunzea cambagei*, *Eucalyptus aggregata,* and *Veronica blakelyi*.

The EA for the proposed modification was submitted to Department of Planning and Environment on 11 May 2018 and the public exhibition commenced on 29 May for two weeks, completing on 12 June 2018. During the public exhibition LEG indicated further concerns in their submission, which included:

- Impact on EPBC Act listed swamp communities as a result of changes in groundwater levels.
- Impact on EPBC Act listed threatened species.
- Historical perspectives on mining within the catchment and the response of swamp environments.
- Specific monitoring recommendations.

1.3. Report purpose

Acknowledging the concerns of the LEG, Centennial Coal instigated an investigation into the swamp environments both local to Angus Place Colliery as well as a nearby site similar to that identified by LEG for reference. This report provides the outcomes of that assessment.

The investigation consisted of the engagement of ecology specialists through RPS (refer to **Appendix A**), aquatic ecology specialists through GHD, a hydrogeologist through JBS&G (refer to **Appendix B**) as well as technical staff within Centennial Coal.

The review document consists of the following structure:

- Environment data review (Section 2)
- Existing condition of the areas of swamp identified (Section 3).
- Historical mining within the upper Coxs River catchment (Section 4)
- Consideration of the swamp water cycle (Section 5).
- Swamp threat assessment (Section 6).
- Summary of findings and monitoring commitments (Section 7).

1.4. Assessment areas

It is acknowledged that the MU53 vegetation communities within the upper Coxs River area are often referred to as Long Swamp however due to the topographic mapping (1:25,000 m scale) indicating Long Swamp being below the Coxs River and Kangaroo Creek confluence, for clarity, in this investigation the following area identifiers have been established:

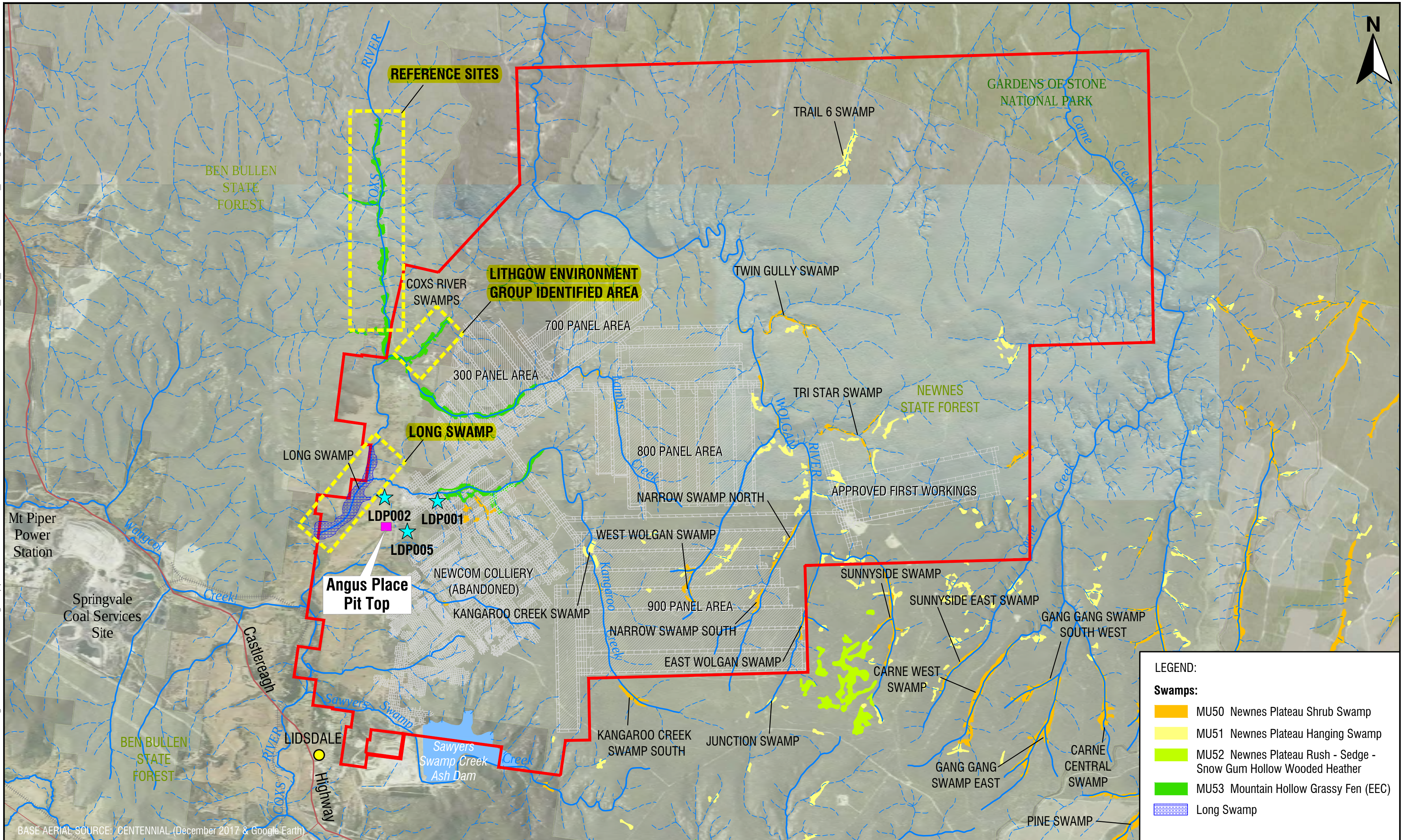
- **Long Swamp**. The identification of Long Swamp, as an area, was defined as per the topographic mapping by NSW Land Registry Services. This is an area of *Typha orientalis* wetland nearby the confluence of Kangaroo Creek and Coxs River, the Angus Place Pit Top and downstream of the current LDP001 discharges. This area is a key receptor for the proposed increased discharge volumes in MOD 5 (up to 10 ML/day) for a maximum of 18 months, and will also be returned to pre-mining hydrologic regime when the mine water discharge through Angus Place LDP001 is from 01 January 2020
- **LEG Identified Area**. The area identified by LEG as being influenced by Angus Place operations is located within on an unnamed tributary of Lambs Creek. It has been referred to as the LEG Identified Area, on the north-eastern arm of the Coxs River Swamp System. This area is mapped as a MU53 wetland In accordance with DEC (2006).
- **Reference Sites**. A reference area was identified from the initial field inspection with LEG within the upper sections of the Coxs River trunk waterway, which is referred to by the Baal Bone Mine environmental management plans as the Coxs River Swamp system (northern arm). This area is identified as MU53 wetland.

The use of the identifier Coxs River Swamp for all swamp environments within Coxs River north of Angus Place was adopted for this review to avoid further confusion between the topographically defined Long Swamp and the area of focus LEG identified covered in this review.

It is noted the mapped MU 53 vegetation community within the Coxs River swamp system is listed under the *Biodiversity Conservation Act 2016* (BC Act) as an endangered ecological community (EEC) commensurate with *Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions.*

At this stage the Coxs River system has not been listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as a Threatened Ecological Community (TEC).

Figure 1-1 presents the three areas covered as part of this review.



LEGEND:

- Angus Place Colliery Holding Boundary
- Major Roads
- Railway
- Built-up areas
- Town / City
- Watercourse - Non Perennial
- Watercourse - Perennial
- State Forest
- National Park
- Angus Place LDP
- Areas assessed in review

DATE	21.6.2018
SEAM	LITHGOW
REFERENCE	SLR63012413_F1-1__AREAASSESSED__01.dwg
SCALE	1:80000

Angus Place Project Site, Newcastle, Lithgow, Sydney

Figure 1-1

Areas Assessed in Review

0.0 1.25 2.5 KM

Centennial Coal

Prepared by: SLR

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1.5. Review methodology

This review document has been developed by Centennial to investigate the validity of claims made by community stakeholders into the influence of Angus Place operations on the lowering of the groundwater table, as measured by the members of LEG. The review has considered both field and desktop assessments to confirm the condition and response mechanisms of the swamp receptors within not only the LEG Identified Area but also influences to reference sites.

Swamp health performance indicators

The following criteria provided in **Table 1-1**, are typical of those used in the management of Temperate Highland Peat Swamps on Sandstone (THPSS), and was adopted as part of this review. The THPSS TEC is listed as an EEC under the EPBC Act and the BC Act (Newnes Plateau Shrub Swamp) and occurs on Newnes Plateau.

Table 1-1 Review criteria

Feature	Performance measure	Performance indicator
Flora	Negligible mining-related impacts on swamp vegetation communities	• Diversity of species • Overall change in species assemblages • Condition of key species • Non-live ground cover
Groundwater	Negligible mining-related impact on swamp hydrogeological regime	• Groundwater levels • Groundwater quality
Surface water	Negligible mining-related impact on swamp hydrological regime	• Surface water quality

Coxs River Swamp flora communities were evaluated through a comprehensive assessment of representative locations by RPS which is further discussed in Section 3.6.

Surface and groundwater monitoring information considered in this review is further discussed in Section 2.2 and 3.

Definition of Threatened Ecological Communities and Mapping of Coxs River Swamps as Temperature Highland Peat Swamps on Sandstone

The 2016 publication "The spatial distribution and physical characteristics of Temperate Highland Peat Swamps on Sandstone (THPSS)" (Hose *et al* 2016*)* was funded by an Enforceable Undertaking as per section 486A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) between the Minister for the Environment, Springvale Coal Pty Ltd and Centennial Angus Place Pty Ltd. These works used a 25 m Digital Elevation Model (DEM) coupled with ortho-rectified aerial photography to map the THPSS of the Sydney Basin in a Geographic Information System (GIS). It is emphasised with the documents prepared by Hose that this was a desktop analyses and considered only physical attributes of the swamps (e.g. swamp area, elevation above sea level, swamp slope, catchment area, swamp and catchment elongation ratio, swamp length and distance to coast).

The areas mapped by Hose et al (2016) at the headwaters of Coxs River, along Lambs Creek and in an unnamed tributary of Lambs Creek are shown below (**Figure 1-2**), and correspond approximately to area mapped by DEC (2006) as MU53 – Mountain Hollow Grassy Fen EEC, shown in **Figure 1-1** and identified as Coxs River Swamps. A fair correlation exists between these maps. It is important to note that no systematic ground-truthing was performed to verify the spatial accuracy of this mapping or the consistency of floristic assemblages with descriptions of THPSS, i.e. it has not been demonstrated that the mapped areas conform to the Species Profile and Threat Database (SPRAT Profile) for the EPBC listed THPSS available at: (http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=32).

Ground-truthing, as a minimum, would take into consideration several fundamental ecological facets (e.g. floristic composition, formation, position in the landscape, geological, substrate, soils etc.) when conducting vegetation community delineation and interpreting whether it is commensurate with any potentially occurring Threatened Ecological Communities (TECs) listed under the EPBC Act and/or the BC Act.

Limited vegetation mapping using field survey data has been undertaken of the Coxs River Swamp at the headwaters of Coxs River in the vicinity of Baal Bone Colliery longwall mining area (refer **Figure 1-3**) for the *Baal Bone Continued Operations Project* (Lembit, 2009). This assessment confirmed the presence of MU 53 – Mountain Hollow Grassy Fen DEC (2006a). Lembit (2009) further concludes that this vegetation community does not correspond to the EPBC listed THPSS endangered ecological community.

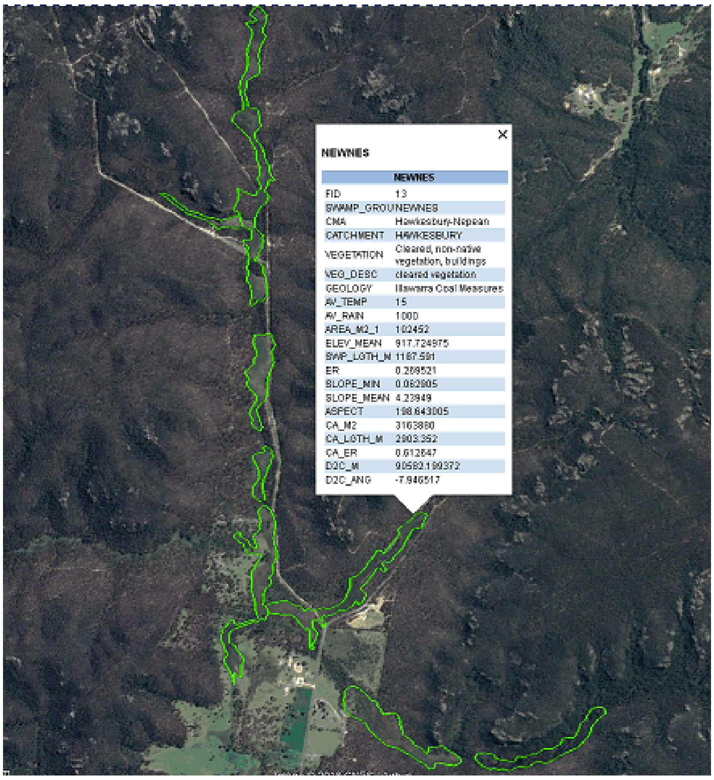


Figure 1-2 **Desktop Broad Mapping of THPSS in the Upper Coxs River Catchment (Adapted from Hose et al (2016))**

Figure 1-3 Study Area for Baal Bone Colliery Vegetation Mapping of Coxs River Swamp (Adapted from Lembit (2009))

A recent ecological investigation of lands located near the confluence of the Coxs River and Lambs Creek (RPS, 2017) identified a patch of MU53 within land adjacent to the Coxs River and, in so doing, concluded the absence of THPSS EEC at that location.

Discussions above confirm that the areas mapped by Hose et al (2016) have not been verified to be commensurate with the THPSS EEC. The Coxs River Swamps are MU53 – Mountain Hollow Grassy Fen EEC, and is only listed as an EEC under the BC Act.

2. SITE REVIEW AND DATA

2.1. Site Inspection

Following submission of the initial LEG consultation letter, Centennial undertook a site inspection on the 18 April 2018 to visually assess the area further and to undertake opportunistic monitoring of the shallow water table within the alluvial aquifer of the upper Coxs River and its tributaries. GPS coordinates and photos from the site inspections are provided in **Appendix C**.

The LEG Identified Area (refer to **Appendix C**, Figures C1 to C5) was inspected with alluvial groundwater monitoring undertaken at three locations. At this time, the Reference Sites (refer to **Appendix C**, Figures C6 to C11) were also inspected as a point of comparison for the swamps however monitoring was only undertaken visually.

A third area was inspected that was within Long Swamp but as this has a different hydrological and land use regime due to agricultural land uses and influence from current Angus Place mine water discharges, it was determined that it was not representative of the issue of potential impact from groundwater level changes identified by LEG.

2.2. Environmental monitoring data

Centennial undertake surface water, groundwater and aquatic ecology monitoring within the Coxs River. This monitoring is summarised as:

- Aquatic ecology seasonal monitoring locations upstream and downstream of discharge activities:
    - Coxs River 0 (CR0) and Coxs River 1 (CR1).
- Surface water monitoring upstream and downstream of discharge activities:
    - LDP001, Coxs River Far Upstream, Coxs River upstream, and Coxs River downstream.
- Groundwater monitoring for level and quality via extraction points:
    - 940DW Bore.

Centennial have an ongoing Upper Coxs River Aquatic Ecology Monitoring Program which covers the ongoing assessment of instream health in all three areas subject to this review. A summary of the results from 2017 monitoring is provided in Section 3.

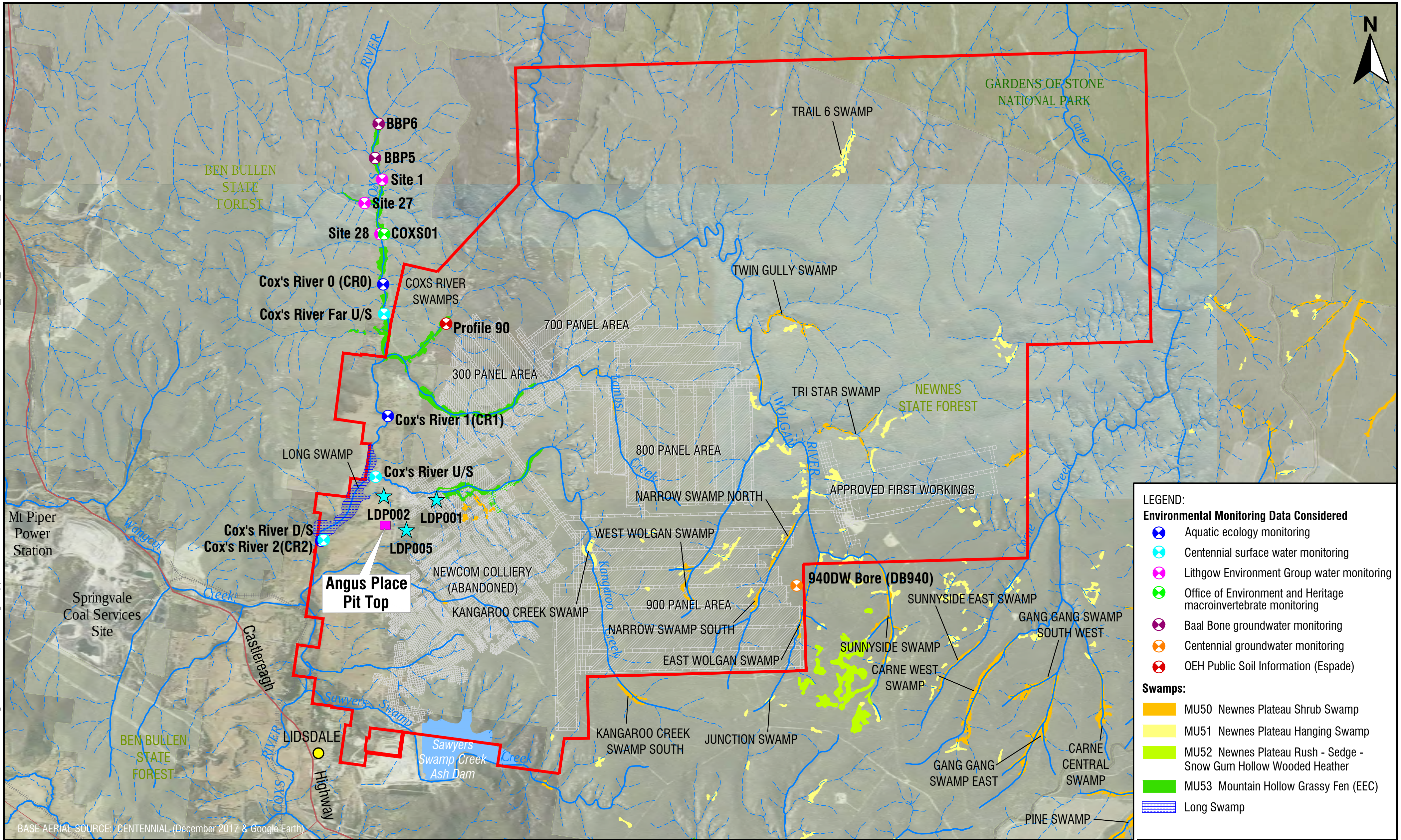
Surface water quality is monitored as part of Angus Place Colliery's site based operations, with data available publically online each month. Discharges via licensed discharge points (LDPs) are key to the basis of this review and are discussed in Section 4. Similarly groundwater quality and extraction information, relative to the operations is provided annually as part of environmental reviews. This is further discussed in Section 4.

No routine monitoring of groundwater is currently undertaken within the Coxs River Swamp system by Centennial. Whilst Centennial may not undertake groundwater monitoring of swamp systems specific to Coxs River, Baal Bone Colliery have existing shallow groundwater monitoring. Long-term groundwater level monitoring within the northern upper reaches of the Cox River Swamp system was considered as part of this review and was discussed in Section 4. This monitoring includes the shallow piezometers sites BBP5 and BBP6 (Figure 2-1) which consider water level within nearby swamp areas. Other monitoring points include BBP1 to BBP4 which are multi-level piezometers associated with the effects of depressurisation as a result of mining. These points are discussed further in Section 4, despite there location not being shown in **Figure 2-1**.

Office of Environment and Heritage (OEH), as part of studies undertaken in 2011, have sampled water quality and macroinvertebrate communities similar to ongoing monitoring activities undertaken by LEG within the Coxs River swamp system. This information has been considered for the review of Reference Sites within the swamps within Coxs River waterway trunk. The sites established by OEH are referred to as Coxs01 whereas LEG have a similar monitoring location, identified as Site 28. LEG also undertake water monitoring below the Baal Bone Colliery monitoring area (referred to as Site 1) and within a Coxs River tributary thought to be subject to historical discharges from Invincible Colliery (Site 28).

Soil profile information was found via OEH's ESPADE service for one location within the LEG Identified Area. The sample location, referred to as Profile 90, was gathered in 1990 and considers a single soil sample. This information was used in the review as an understanding of the typical soil profile of the area and the depth to water.

Environmental monitoring locations are presented in **Figure 2-1**.



LEGEND:
- Angus Place Colliery Holding Boundary
- Major Roads
- Railway
- Built-up areas
- Town / City
- Watercourse - Non Perennial
- Watercourse - Perennial
- State Forest
- National Park
- Angus Place LDP
- Areas assessed in review

DATE	28.6.2018
SEAM	LITHGOW
REFERENCE	SLR63012413_F2-1__ENVMONDATA__02.dwg
SCALE	1:80000

Figure 2-1
Environmental Monitoring Data Considered

0.0 1.25 2.5 KM

Centennial Coal

Prepared by: SLR

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3. EXISTING CONDITION ASSESSMENT

3.1. Topography

The areas of the Coxs Swamp system that were inspected were accessed via existing trails off Wolgan Road and Baal Bone Trail. The LEG Identified Area and Reference Sites are separated by a rocky ridge located approximately 1060 mAHD. This ridge forms the catchment boundary between the Lambs Creek catchment (where the LEG Identified Area is) and the Coxs River trunk waterway (where the Reference Sites are). Wolgan Gap defines the catchment extent for the LEG Identified Area whereas the Coxs River catchment extent is limited by the Blue Mountains Range in the north.

The LEG Identified Area has a slightly steeper (1.8%) longitudinal profile compared with that of the Reference Sites (1.2%). The valley floor elevation ranges between 940 to 920 mAHD for both areas. The valley floor has an average width of 200 m for the LEG Identified Area and 120 m for the Reference Sites. As the Lambs Creek and Coxs River waterways progress further south, the valley floors converge and create a much wider valley floor with a further reduction in longitudinal grades present downstream of the confluence between the two waterways.

3.2. Soils and geology

Based on information and data publically available from OEH (1990), soil sampling (Profile 90) has previously been undertaken within the LEG Identified Area. From the sample collected in 1990, to a depth of 0.6 m, the following was determined:

- General soil type is an alluvial soil.
- Organic matter of 50 mm with a pH of 5.0 transitioning to a sandy loam.
- At 0.2 m depth, clayey sand exists noted down to the depth of 0.6m with an expectation that soil would be become more sandy with depth.
- At the time of the soil sample, a subsurface water level was encountered at 0.5 m below ground level (mbgl).
- Erodibility of the soil type is moderate and drainage ability is generally poor.

Geology of the area can be generally summarised as sandstones of the Triassic Narrabean Group with inter-bedded shale and siltstone. The Narrabeen Group rocks near the surface belong to the Grose Sub-group and include the Banks Wall Sandstone, the uppermost part of which is deeply weathered and generally very friable.

Figure 3-1 summarises the local stratigraphy associated with the areas associated with the Lithgow area.

The Mount York Claystone and Caley Formation, both aquicludes, are suggested to be responsible for the formation of the Coxs River Swamp system, (Glencore 2018), dependent upon the position of swamps within the upper areas of the catchment. It is expected that in the vicinity of the LEG Identified Area, groundwater environments nearest to the surface, are influenced by strata units such as the shale/siltstone interburden of the upper Illawarra Coal Measures and the Denman Formation mudstone/siltstone further downstream in the vicinity of Long Swamp.

Further discussion on the swamp geology composition is further discussed in Section 3.4 and hydrogeology within Section 3.5.

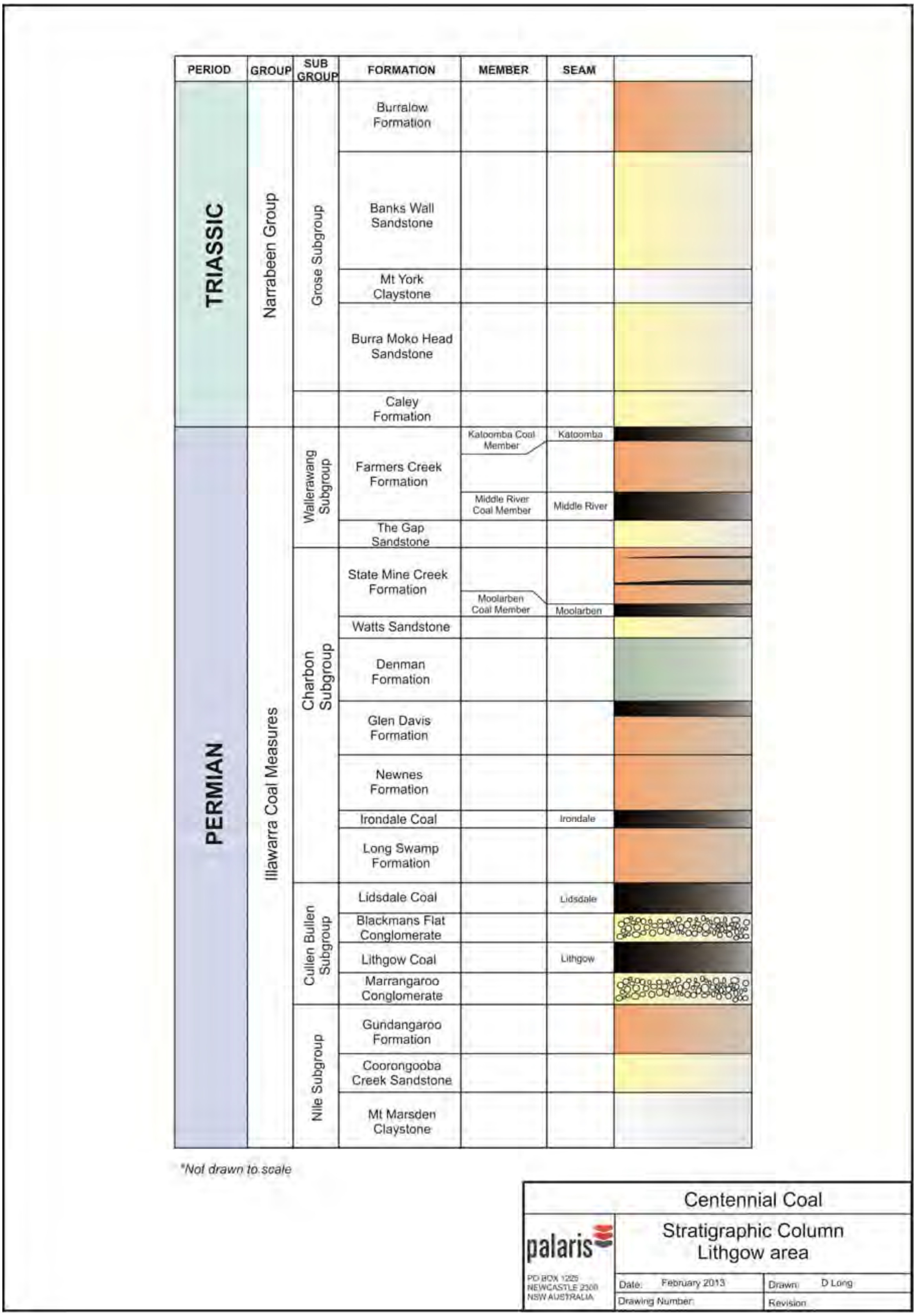


Figure 3-1 Stratigraphic Column of the Lithgow area

The Coxs River Lineament Fault Zone follows the Coxs River and is shown in **Figure 3-2**. Difficult underground mining conditions associated with the Coxs River Lineament have generally prevented direct undermining of the Coxs River, as can be seen in regional mine area mapping shown in **Figure 3-3**.

Glencore (2018) indicated that the presence of the Coxs River Fault/Lineament may serve as a preferential flow path resulting in localised variations in horizontal and vertical flow paths. AGE (2012) indicated that the fault zone is a north to south trending graben structure, approximately 250 m wide.

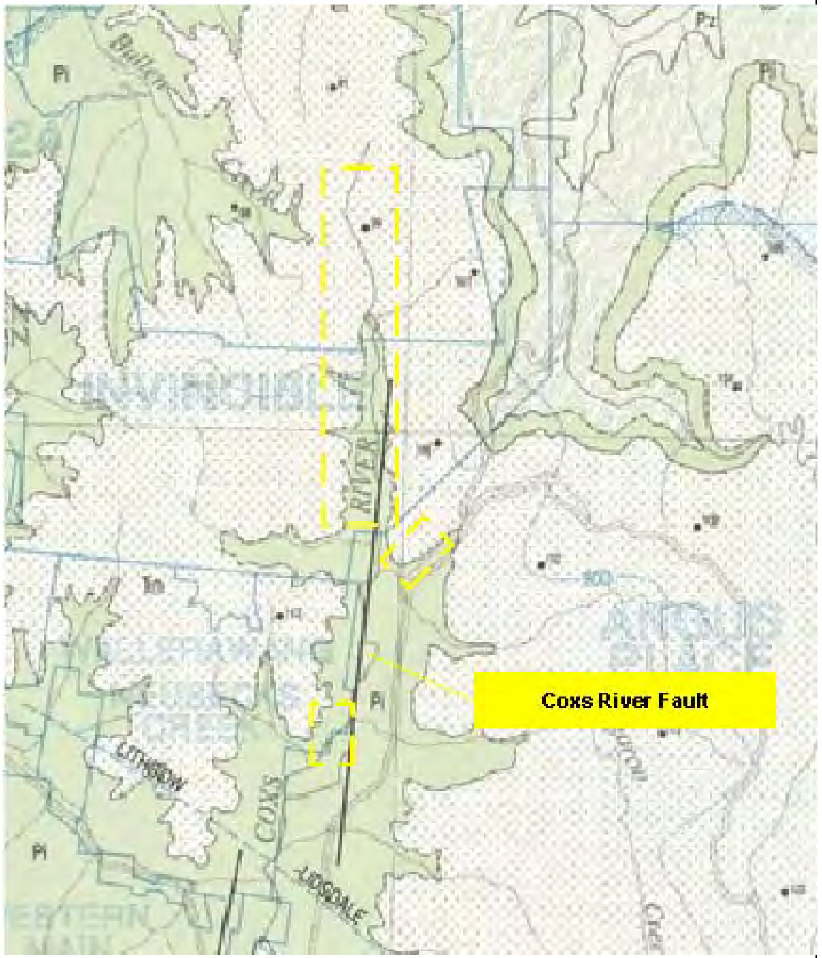


Figure 3-2 Geology mapping of Western Coalfield, Coxs River Fault (Source: Department of Minerals and Resources, 1992) –
Key
Solid green hatch – Illawarra Coal Measures
Dotted green hatch – Narrabeen Group

Figure 3-3 Underground mining within upper Coxs River catchment and the Coxs River Swamp environment

3.3. Rainfall

Annual rainfall totals extracted from the Bureau of Meteorology (BOM) rainfall gauge at Lidsdale (Station No: 63132) are summarised between 1992 and 2017 in **Figure 3-4**.

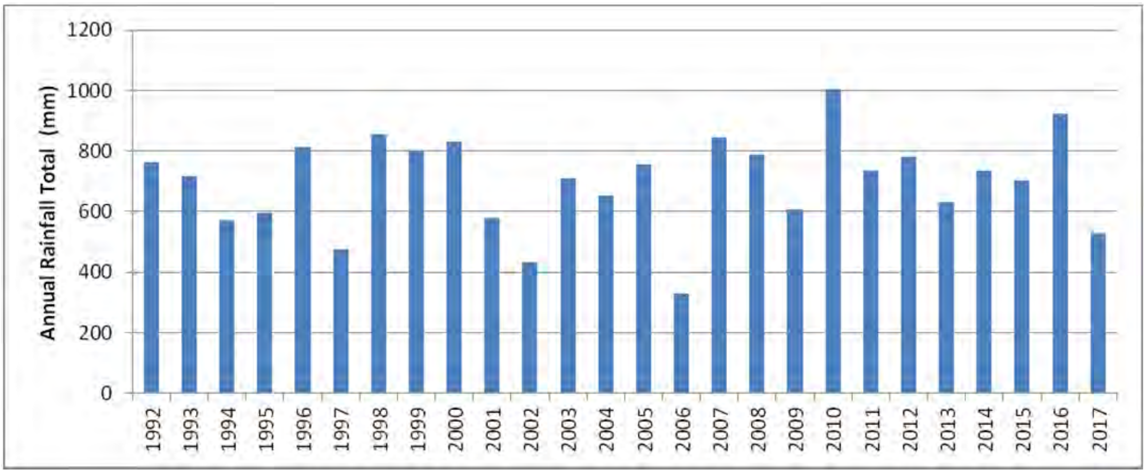


Figure 3-4 Annual rainfall totals (1992 to 2017) from BOM Station 63132

Over the preceding 25 year period rainfall has averaged approximately 698 mm. From the data presented in **Figure 3-4** the years of 1997, 2002, 2006 and 2017 were typically dry rainfall years with the worst of these in 2006 with only a total of 329.8 mm.

Figure 3-5 presents a Cumulative Residual Departure from Mean curve with respect to Rainfall (CRD curve) developed with rainfall data sourced from the Queensland Department of Science, Information Technology and Innovation (DSITI) SILO climatic database (data drill format). The data used in **Figure 3-5** was between 1 January 1992 and 5 June 2018, and was calculated based on internal monthly means but expressed on rainfall per day basis.

A negative (downward) slope on a CRD curve (refer **Figure 3-5**) indicates below-average rainfall conditions, a horizontal slope indicates average rainfall conditions and a positive (upward) slope indicates above-average rainfall conditions. Prolonged periods of negative slope, are indicative of drought.

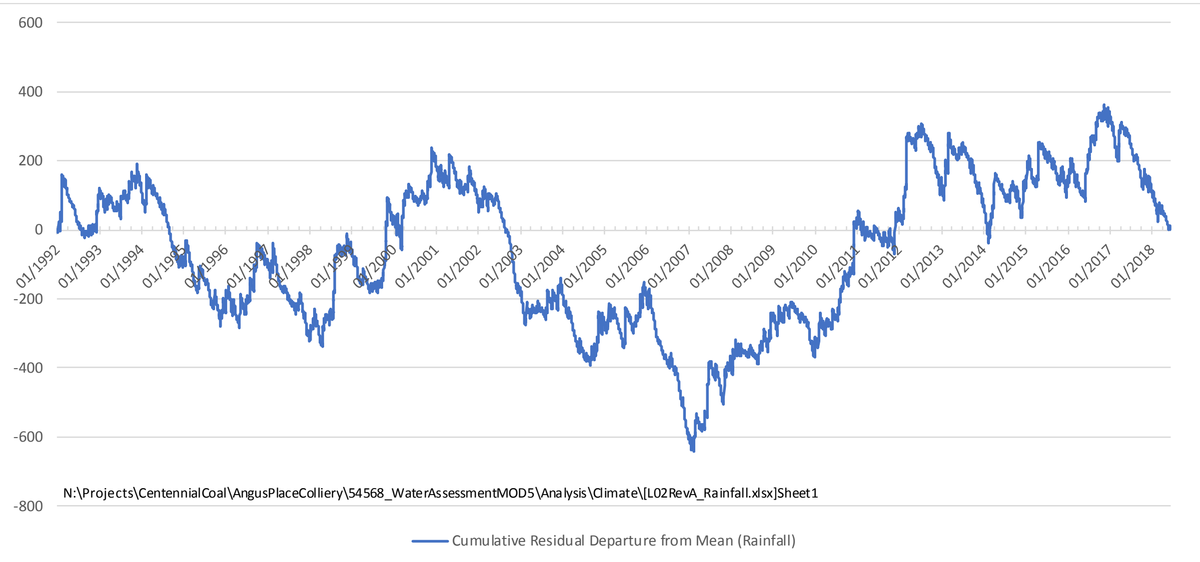


Figure 3-5 Cumulative Department from Mean (Rainfall) – Coxs River Swamp

As shown in **Figure 3-5**, the Millennium Drought, centered around 2008, was preluded by infrequent rainfall between 1996 to 2000, followed by strong drought conditions between 2001 to 2005. Occasional strong rainfall in 2003 and 2005 did not persist and conditions worsened considerably between late 2005 to early 2007.

The steep and consistent negative slope between June 2002 to February 2003, December 2003 to August 2004, and from December 2005 to February 2007 are noteworthy. The recent period, December 2016 through to present is also distinctive; however, this period is not as severe as the rapid decrease experienced during the Millennium Drought.

From a review of historical archive information from Angus Place Colliery environmental information, similar concerns with respect to mining impacts and the water levels within Coxs River Swamp have been raised previously. These concerns were raised in 2006 (likely as a result of the known dry conditions of the year as supported by data above) of which was a particularly low rainfall year (refer to **Appendix C**, Figures C12 to C14). Articles within the Lithgow Mercury were said to have covered community concerns with the desiccation of swamps however these could not be sourced as part of this assessment. More recently articles within the Lithgow Mercury (29 May 2018) have identified the lack of rainfall general within region with references to drought like conditions within the Lithgow and the central west regions.

3.4. Waterway geomorphology, swamp environments and hydrology

Geomorphology

Coxs River within the LEG Identified Area is a valley fill river style of low relief with no defined channel. Flow upstream of swamp environments is most likely dominated by shallow groundwater in the swamp's alluvium surcharging at a constricted valley section.

Swamp types within the upper Coxs River and its tributaries have been defined by studies discussed by the Independent Expert Scientific Committee (IESC). Many of the swamp environments located within the Coxs River and Cox River Swamp system are a valley infill swamp on alluvium. IESC (2014) define this type of swamps as being formed by a layer of peat material deposited within a broad valley underlined by sand or other alluvial based material. This is different to those swamps over sandstone where the supporting groundwater is a perched volume, the alluvial based swamp consider a much broader groundwater influence as surrounding terrain offers sources of recharge. **Figure 3-6** presents a schematic showing the typical components of the valley infill swamp on alluvium, presented within IESC (2014)

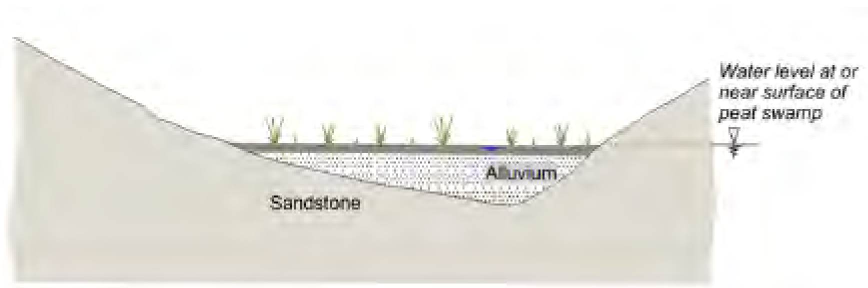


Figure 3-6 Typical cross section of a valley infill swamp on alluvium (IESC 2014)

IESC define the typical characteristics of this swamp type as generally located within low gradient waterways with dense low height vegetation and erosion debris resulting in reduced run-on rates and increased infiltration to the valley floor. Valley widths vary from 40 m to 200 m across the area of review. Vegetation within the valley floor was found to be generally consisting of sedges and rushes with the occasional pond usually found upstream of areas where the valley floor was constrained.

The Hawkesbury Nepean Catchment Management Authority (2008) values the swamp environments within the upper Coxs River catchment and considered them to be a unique aspect of the area which needs to be protected against degradation. The key threatening processes on swamps that the authority identified at that time included:

- Avoiding any underground mining that results in surface subsidence with impacts on the hydro-morphological functioning of the swamp.
- Restricting vehicle access to formal vehicle crossings.
- Limiting the upstream progression of the channel incision created by agricultural activities.

This review will consider the prevalence of the above threatening process as part of the assessment.

Hydrology

At the confluence of Lambs Creek, towards the upper extent of the assessment reach, the Coxs River has a catchment area of approximately 26 km^2. At this confluence, the Coxs River increases from a fourth to a fifth order streamline (Strahler stream ordering system and topographic information). The Coxs River remains fifth order until the confluence of Pipers Flat Creek, which joins the river near Wallerawang Power station. The section of Coxs River Swamp, identified by LEG, that contributes to Lambs Creek has a catchment of approximately 3 km^2 and is located on a third order stream. This waterway when compared to the swamp Reference Sites is less significant as the trunk of the Coxs River and swamp systems located within are located on fourth and fifth order streams generally.

Instream water quality and flow monitoring

Currently, there is no continuous monitoring of surface water flow or quality occurs within the reaches of Coxs River where swamp environments are present either by Centennial or publically via government agencies. However, LEG undertake a community based Stream Watch monitoring program. This program publishes data via the LEG website and provides records over a period between 2006 and 2010.

Of the monitoring program in place, the review of the monitoring sites 1 and 28 was undertaken. These monitoring locations were within this review's Reference Sites area within the Coxs River Swamp system. A summary of the data collected at monitoring Site 1 indicated:

- Electrical conductivity (EC) was typical of the upper portions of the Coxs River at an average 40 to 50 µS/cm
- Turbidity measurements indicated very low turbidity around 10 NTU on average
- pH level remained constant at around 6 pH units indicating a slight acidity to the flow.
- There were three references between 2009 and 2010 where no flow was observed. No comment on flow was made during 2006. From 2006 to 2009, the occurrence of flow within the Coxs River was consistent.

At monitoring Site 28, EC was much greater (average of 641 µS/cm between 2007 and 2010) indicating an external influence between the sites likely to be the Invincible Colliery dewatering point. A monitoring point directly downstream of the dewatering point was also monitored by LEG defined as Site 27. Monitoring information at this site however was limited to a maximum of 11 EC readings but supported the source of elevated EC into the Coxs River.

As part of inspections of the Coxs Swamp system at both the LEG Identified Area and Reference sites by Centennial in 2018, it was found that there was no flow within waterways inspected, which included the upper reaches of the Coxs River.

A review of more recent monitoring data at Centennial's surface water monitoring point Coxs River Far U/S indicates generally between 2013 and 2017 the following:

- EC was between 150 and 180 µS/cm.
- Turbidity measures indicated a low turbidity around 20 NTU on average.
- pH levels were between 6.0 and 6.8 pH units indicating a slight acidity to the flow.
- Low flow descriptions have been consistent since the end of 2016.

3.5. Hydrogeology and groundwater monitoring

With respect to the interaction between mining activities and swamp environments, three groundwater environments can be considered including alluvial, shallow and deep sources.

The alluvial sources, are those supporting the swamps environments the shallow sources can be defined as groundwater within the Banks Wall Sandstone strata, above the Mt York Claystone (where it exists in the Newnes Plateau), and the deep sources are those groundwater environments depressurised by existing mining activities associated with the Lithgow seam. As previously indicated, groundwater environments near to surface such as the alluvial sources, are influenced by 'locally shallow' lower permeability units which include the shale/siltstone interburden of the Illawarra Coal Measures with respect to the LEG Identified Area; and the Denman Formation mudstone/siltstone with respect to Long Swamp.

The current understanding on the potential connectivity between each groundwater source, as defined by JBS &G (refer to **Appendix B**), is based on historical monitoring within Angus Place Colliery and current revisions to numerical groundwater modelling. The understanding is that connectivity is not likely to be occurring due to the depressurisation of deep groundwater sources as result of mining. It is likely that deep groundwater levels are at or below the floor of the Lithgow Seam within the mining area extending out to the vicinity of the LEG Identified Area.

From investigations into the Lambs Creek swamp environments by the EPA (2017) groundwater within the region is typically characterised as a complex of localised flow paths largely influenced by topography and geology. This is a similar observation that can be made for both the LEG Identified Area and the Reference Sites.

Figure 3-7 below is an output from the current revisions to the regional numerical groundwater modelling (as discussed **Appendix B**). **Figure 3-7** presents a long section of the Coxs River Swamp System in the vicinity of the LEG Identified Area extending downstream to Long Swamp.

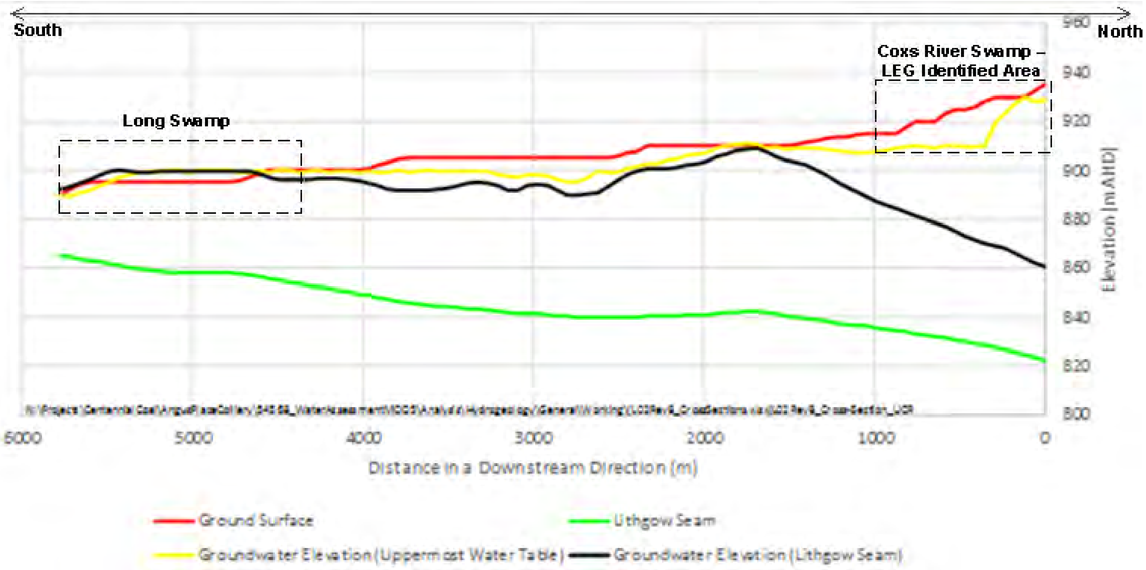


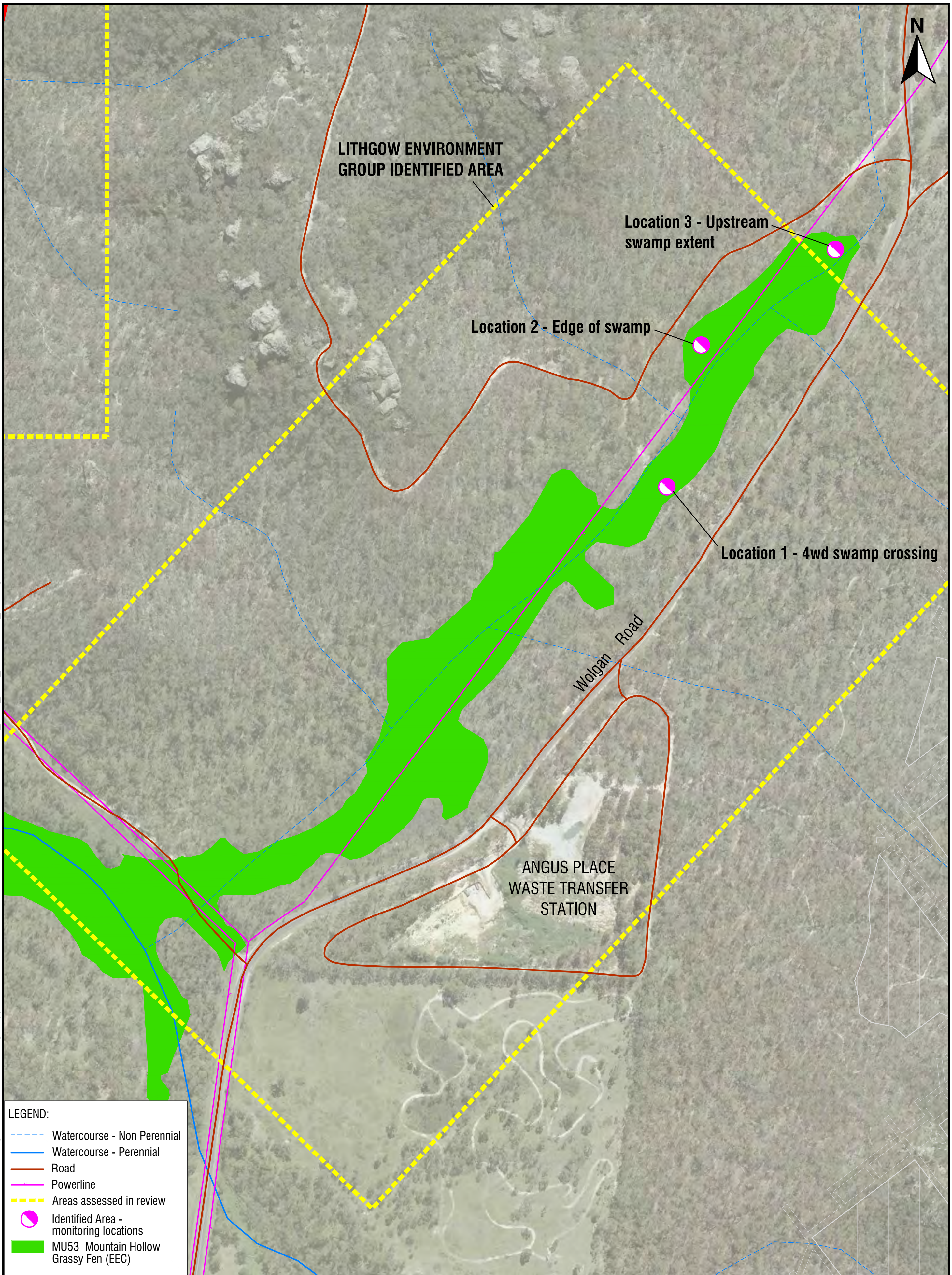
Figure 3-7 Long-Section: Upper Coxs River (Coxs River Swamp-North Eastern Arm to Long Swamp) (JBSG 2018 refer to Appendix B)

It is clear from **Figure 3-7** that groundwater elevations have been predicted to be in a drawn down state as a result of depressurisation occurring within the mining seam in the vicinity of the LEG Identified Area. When this is compared to Long Swamp, it is clear connectivity between the alluvial environment and deep groundwater sources is much greater.

As indicated previously, monitoring of the alluvial or deep groundwater environment is not undertaken by Centennial for any of the areas investigated as part of this review. As part of field inspections undertaken on 18 April 2018, the alluvial water level was recorded through the use of a hand auger in three locations specific to the LEG Identified Area. The monitoring was repeated with two follow up rounds following rainfall to understand the nature of the swamp environments response. The monitoring hole information is provided in **Table 3-1**, with the monitoring results provided in **Table 3-2** and monitoring locations shown in **Figure 3-8**.

Table 3-1 Alluvial groundwater monitoring locations and depths

Monitoring location (Figure 3-8)	Hole depth (mbgl)
1 – 4wd swamp crossing	1.1
2 – Edge of swamp	0.4
3 – Upstream swamp extent	1.3



DATE	29.06.2018
SEAM	LITHGOW
REFERENCE	SLR630.11413_F2-7_LEG_MONLOCS_03.dwg
SCALE	1 : 5000

Figure 3-8
Lithgow Environment Group Identified Area Monitoring Locations

Centennial Coal

Prepared by: SLR

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Table 3-2 Alluvial groundwater monitoring results

Monitoring round	Location (Figure 3-8)		
	1	**2**	**3**
18 April 2018 (no rainfall)	1.06 mbgl	0.37 mbgl	>1.3 mbgl
20 April 2018 (following 7.5 mm recorded at Angus Place)	0.91 mbgl	0.14 mbgl	1.1 mbgl
4 June 2018 (following 0.4 mm)	1.1 mbgl	0.43 mbgl	NA

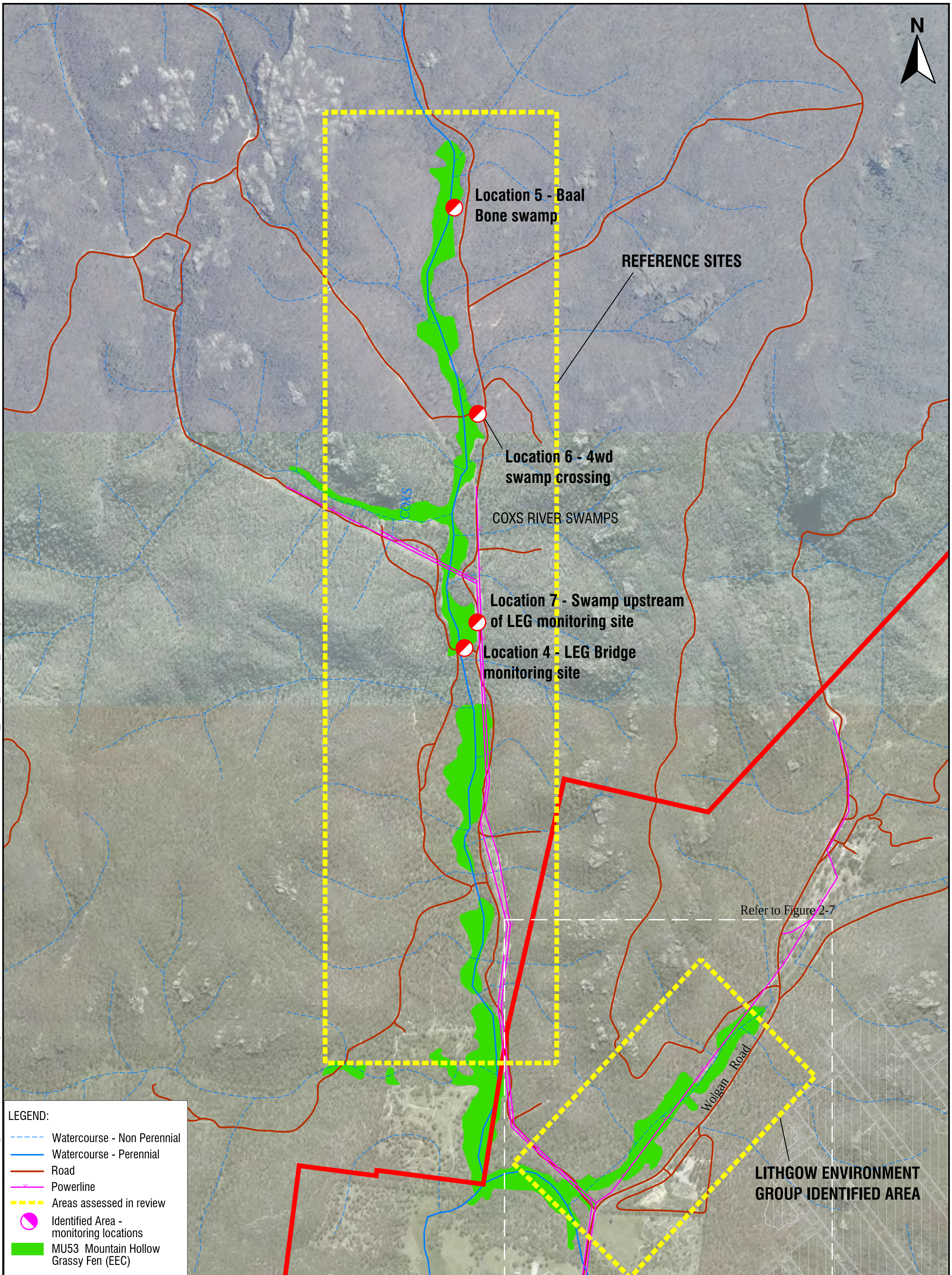
From the results of **Table 3-2** groundwater level was variable with the groundwater level generally deeper on the upstream extent of LEG Identified Area compared with groundwater levels at the fringes of the vegetation and downstream. It should be noted that pooled areas surround the LEG Identified Area as evident in the photos provided in **Appendix C**. Upslope to the north west groundwater sources perched above clay layers create pools amongst access tracks and man-made 4wd track features.

With rainfall that fell on the 20 April 2018, the shallow groundwater table had an immediate response with water level rising approximately 150 to 200 mm most likely as a result of direct catchment recharge. The immediate response is typical of the LEG Identified Area location within the headwaters of a tributary.

During the site inspection various locations in the Reference Sites area of the Coxs River Swamp system where visually monitored. The visual monitoring locations are provided in **Figure 3-9** below.

Figure 3-9 shows visual monitoring undertaken at Locations 4 to 7. These areas form the main trunk of Coxs River. Location 6 indicated some groundwater expression through depressed access tracks similar to the LEG Identified Area, however no other sites indicated groundwater expression at the surface. Location 4, historically a sampling location for the LEG Stream Watch Program was dry at the time of the inspection.

Further information on monitoring locations and photographs from the inspection are provided in **Appendix C**.



DATE	29.06.2018
SEAM	LITHGOW
REFERENCE	SLR630.11413_F2-8_REFVIS_03.dwg
SCALE	1 : 18000

Figure 3-9
Reference Sites - Monitoring Locations

0 300 600 M

Centennial Coal

Prepared by: SLR

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3.6. Aquatic ecology

Aquatic ecology monitoring within the Coxs River is undertaken seasonally by Centennial. Within the Coxs River Swamp system one monitoring location is reported on annually, Coxs River 0 site (CR0). From the 2017 monitoring a summary of the findings for the CR0 site included:

- Aquatic habitats observed at CR0 consisted of pools with soft substrate, large woody debris and emergent macrophytes. Riparian vegetation was dominated by grasses, with blackberry shrubs and large eucalypts also present in the riparian zone. At CR0 the river consists of deep isolated pools in which the substrate is covered in iron precipitate.
- Water quality sampling undertaken with Aquatic ecology indicated CR0 had a dissolved oxygen levels below guideline values for ANZECC, elevated total suspended solids, elevated zinc, manganese and iron (dissolved).
- During 2017, CR0 generally had the poorest macroinvertebrate community condition, with the lowest taxa richness of all Coxs River sites in spring 2017. The ephemeral nature of the river at this site means that the colonisation for macroinvertebrates is limited by water availability. The channel at CR0 is shallow, narrow and silty, without the substrate heterogeneity required to support a more diverse range of taxa, such as seen at some of the downstream sites.
- Given that this site is upstream of mine discharges, it is likely that these changes are due to the natural reduction in water level and related changes in macroinvertebrate habitat availability in spring.

Generally the outcomes of aquatic ecology monitoring in 2017 within the reference reach of the Coxs River Swamp system is exemplary of below average rainfall conditions faced by the catchment currently with clear connection between water availability and species abundance.

3.7. Threatened Species and Vegetation communities identified

The Specialist Interest Groups (LEG, BMCS) and members of the community have made submissions prior to and during the exhibition period. Their concerns relate to the following aspects that they regard could potentially impact on the swamp systems and individuals of threatened species that occur in the vicinity of the Angus Place pit top and underground mine water storage areas:

(i) cessation of mine water discharge (raw or treated) through LDP001 from 01 January 2020, which results in Kangaroo Creek and Upper Coxs River returning to pre-mining hydrological conditions

(ii) progressive drawdown of water levels in the underground water storage areas (800 and 900 Panel Areas) when the Springvale Water Treatment Project (SSD 7592) becomes operational and stored mine water from Angus Place Colliery will be transferred to the Mount Piper Power Station for treatment and beneficial industrial reuse.

The downstream impact due the proposed increase in treated water discharge followed by cessation of mine water discharge through LDP001 was assessed in the Surface Water Assessment (JBS&G, 2018a) prepared for the modification and summarised in the EA. The assessment demonstrated that the modification will meet the neutral or beneficial effect in the catchment, as required by the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011.* Cessation of mine water discharges will return the Kangaroo Creek downstream from LDP001 to an ephemeral hydrological regime, similar to that upstream of LDP001, and would be consistent with the pre-mining conditions.

The impact of the continuous emplacement of residuals waste stream underground followed by the dewatering of the underground storages was assessed in a Groundwater Impact Assessment that was prepared for the licence variation application (refer Section 1.1). An abridged version of the groundwater assessment is appended to this report as **Appendix B**. The report includes potential impact of the dewatering of the underground storages on Coxs River Swamps and watercourses due to seepage.

Potential Impact on Threatened Species

Community stakeholders have identified that there is a potential for the following threatened species, listed under the BC Act and EPBC Act, to exist within the investigation area and also in the vicinity of the Angus Place pit top:

- *Kunzea cambagei*
- *Eucalyptus aggregata*
- *Eucalyptus cannonii*
- *Veronica blakelyi*
- *Pultenaea glabra*
- *Genoplesium superba*

The concern relates to a potential impact on these threatened plants (known to be moisture sensitive) due to the progressive drawdown of water levels in the underground storage areas (proposed to commence from 01 January 2020 or earlier when water treatment and the residuals emplacement phases have been completed) and cessation of mine water discharge through LDP001.

From the Groundwater Impact Assessment (**Appendix B**), the dewatering of the underground 800 and 900 Panel Area storages is not expected to impact biodiversity values reliant on perched groundwater systems, including groundwater associated threatened species identified by LEG in their submission and listed in **Table 3-3**. As outlined in Section 2.5.6 and Section 2.4.3 of JBS&G (2018b) the perched groundwater system (being the uppermost groundwater table) is hydraulically separate from the deeper groundwater system to be dewatered. Therefore, the perched groundwater level is unlikely to be impacted during the dewatering of the underground storages. Given the terrestrial biodiversity depends upon this perched groundwater system the biodiversity values in the area will not be impacted.

The Principal Ecologist (Mark Aitkens) from RPS East Australia Pty Limited has prepared a summary of potential impacts on the threatened species (BC and EPBC listed) identified in the LEG submission, presented in **Table 3-3**. A conclusion for all threatened species assessed (BC and EPBC listed) is that "*The Project is not likely to have a direct or indirect impact on the habitat values.",* with the project being defined as including the modification elements (increase in mine water discharge followed by cessation of discharge) as well the treatment and dewatering phase of the Angus Place Water Treatment Project. Hence, no referral under the EPBC Act is required to be submitted.

Table 3-3 Summary of Impacts on Threatened Species Identified in LEG Submission

Threatened species identified in LEG Submission	[1]BC Act	[1]EPBC Act	Response
Pultenaea glabra	V	V	Grows in swamp margins, hillslopes, gullies and creek banks and occurs within dry sclerophyll forest and tall damp heath on sandstone (OEH 2018). The Project is not

Threatened species identified in LEG Submission	[1]BC Act	[1]EPBC Act	Response
			likely to have a direct or indirect impact on these habitat values.
Kunzea cambagei	V	V	Species restricted to damp, sandy soils in wet heath or mallee open scrub at higher altitudes on sandstone outcrops or Silurian group sediments. The Project is not likely to have a direct or indirect impact on these habitat values.
Eucalyptus aggregata	V	V	Species grows on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers. The Project is not likely to have a direct or indirect impact on these habitat values.
Eucalyptus cannonii	V	-	Capertee Stringybark has a broad altitudinal range, from around 450 m to 1,050 m. Within this range, the species appears to tolerate most situations except the valley floors. The Project is not likely to have a direct or indirect impact on these habitat values.
Genoplesium superbum	E	-	The Superb Midge Orchid occurs predominantly in wet heathland on shallow soils above a sandstone cap but has also been found in open woodland interspersed with heath and dry open shrubby woodland. The Project is not likely to have a direct or indirect impact on these habitat values.
Veronica blakelyi (*Derwentia blakeliyi*)	V	-	Occurs in eucalypt forest, often in moist and sheltered areas. Associated canopy species include *Eucalyptus dives*, *E. dalrympleana*, *E. rossii* and *E. pauciflora*. The Project is not likely to have a direct or indirect impact on these habitat values.

Note 1. V: Vulnerable, E: Endangered.

Potential Impact on Endangered Ecological Communities

Concerns have been raised on the potential impacts of the proposed dewatering of the underground storages on the EECs surrounding the Angus Place pit top from January 2010, specifically the impact on Coxs River Swamps in close proximity to the 300 Panel Area. As noted above, and in the Groundwater Impact Assessment (**Appendix B**), there is no direct connection between the Lithgow Seam (where the mine water is stored) and the swamps. For example, the north-eastern branch of the Coxs River Swamp (LEG Identified Area) shown in **Figure 1-1** is 86 to 106 m above the Lithgow Seam (refer to Figure 2.9 in **Appendix B**, reproduced as **Figure 3-7** above).

Given there is an existing hydraulic separation between the perched groundwater system and the deeper groundwater system, it is reasonable to conclude that biodiversity values dependent on the perched groundwater system would not be adversely affected by any dewatering of the groundwater stored in the underground storages within the Lithgow seam. These biodiversity values include threatened species (as discussed above) and groundwater dependent ecosystems (e.g. MU53 – Mountain Hollow Grassy Fen EEC) and vegetation communities like MU11 – Tablelands Snow Gum Grassy Woodland EEC which are 'facultatively dependent' on perched groundwater systems.

3.8. Field Surveys Undertaken

Floristic Surveys and Soil Testing

One round of ecology monitoring was undertaken in April 2018 by ecologists from RPS. Monitoring was undertaken using a methodology consistent with that applied elsewhere on the plateau for swamp health assessment and consisted of:

- Assessment of two swamp areas within the Coxs River Swamp system which included:
    - LEG Identified Area (referred to as Location 1 in the assessment in **Appendix A**); and
    - the Reference Sites (referred to as Location 2 in the assessment in **Appendix A**)
- Soil moisture monitoring within each assessed area.

The outcomes from monitoring of floristics indicated assemblages consistent with the MU53 vegetation type with both sites dominated by *Baumea rubiginosa* (60 to 70% coverage) and *Leptospermum obovatum* (20% coverage). Generally the inspection indicated percent live green cover was at least 80% across the two sites.

Due to the dominance of the *Baumea rubiginosa,* this can be used as key indicator for changes in water level. The species is known to respond quite rapidly to changes in water level as it requires regular water but would be subject to ongoing monitoring.

Of the metrics used in the ecology assessment there was no specific contrast in floristic assemblages between the LEG Identified Site and the defined reference site of Coxs River Swamp.

It was noted that of the initial list of threatened species identified by LEG, none were recorded at the identified impact site nor were they present in the Coxs River Swamp site. Generally, the threatened species are potentially at risk of influence as a result of groundwater changes however they are also reliant on rainfall. Detailed descriptions of the threatened species of concern have been provided in the specialist report (in **Appendix A**).

Soil moisture monitoring undertaken was relatively inconclusive as the reference site (19.4% average volume water content (VWC)) indicated a drier condition to that of the LEG identified impact site (25.8% average VWC). Similar to the outcomes gained from the floristics, there was only minor differences found in the two monitoring locations.

3.9. Water management of Angus Place Colliery

Water management activities both at the surface and underground at Angus Place have remained unchanged for the recent period. Underground water captured within goaf areas is dewatered at a constrained rate either via the SDWTS or LDP001. The SDWTS shares its total permissible volume of 30 ML/day between dewatering activities of Springvale Mine and Angus Place Colliery. Angus Place's LDP001 has a maximum permissible operating capacity of 2 ML/day. An average of about 8.7 ML/day of water is extracted from the workings.

The evaluation of the volumes monitored through these two groundwater extraction pathways clearly indicates that over the last 12 month period that discharge volumes have not either been on an increased trend or exceeded permissible limits. The data supporting the above statement is provided below in **Figure 3-10**.

Angus Place Colliery does not have any LDPs within the Lambs Creek or Wolgan River catchments and therefore is not permitted to discharge into either of these watercourses. With no other means of extracting groundwater from Angus Place flooded goaves, it is not currently possible to over extract groundwater volumes from the Angus Place operations.

Angus Place Colliery is currently operating under Care and Maintenance. Groundwater is continuously extracted from the Angus Place Colliery workings to prevent them from flooding.

There are two mine water storage areas underground at Angus Place Colliery, shown in **Figure 3-11**, comprising previously mined areas (existing workings or goaves).

- 800 Panel Area – comprising the contiguous 300, 700 and 800 Panel existing workings. The water level in this water storage has been maintained at 805 m AHD since 2006, i.e. at full capacity
- 900 Panel Area – comprising the 900 Panel existing workings. Mine water from this storage is extracted at an average rate of 6.9 ML/day and transferred to the Springvale Delta Water Transfer Scheme for discharge to Sawyers Swamp Creek via Springvale Mine's LDP009. The 900 Panel Area is not hydraulically connected to the 800 Panel Area.

The water levels in the Angus Place Colliery workings are steadily increasing since 2013, and if extraction rates are not increased, the mine will be flooded to a degree that underground Care and Maintenance operations will not be able to be carried out safely, and the costs of recommencing mining will become prohibitive.

The slow flooding of the underground storages at approximately 0.5 ML/day is a result of inadequate WAL allocation that Angus Place Colliery holds in the Richmond Groundwater (6.9 ML/day) and the limit of 2 ML/day volumetric limit at LDP001. As a result, the total mine inflows into both the 800 and 900 Panel Areas water storages currently exceed the extraction rates.

Stored water underground at Angus Place is shown in **Figure 3-11** and can be defined as two key volumes, the water held in the 900 district and the combined water held in the 300, 700 and 800 districts.

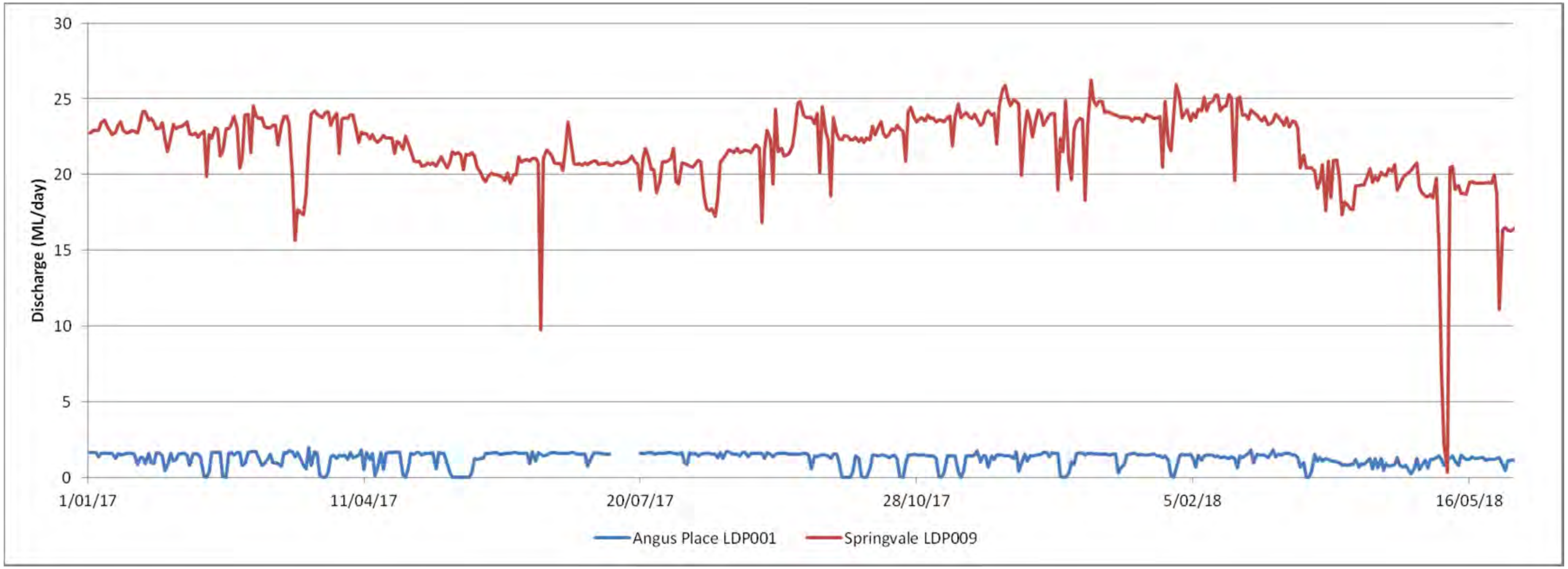
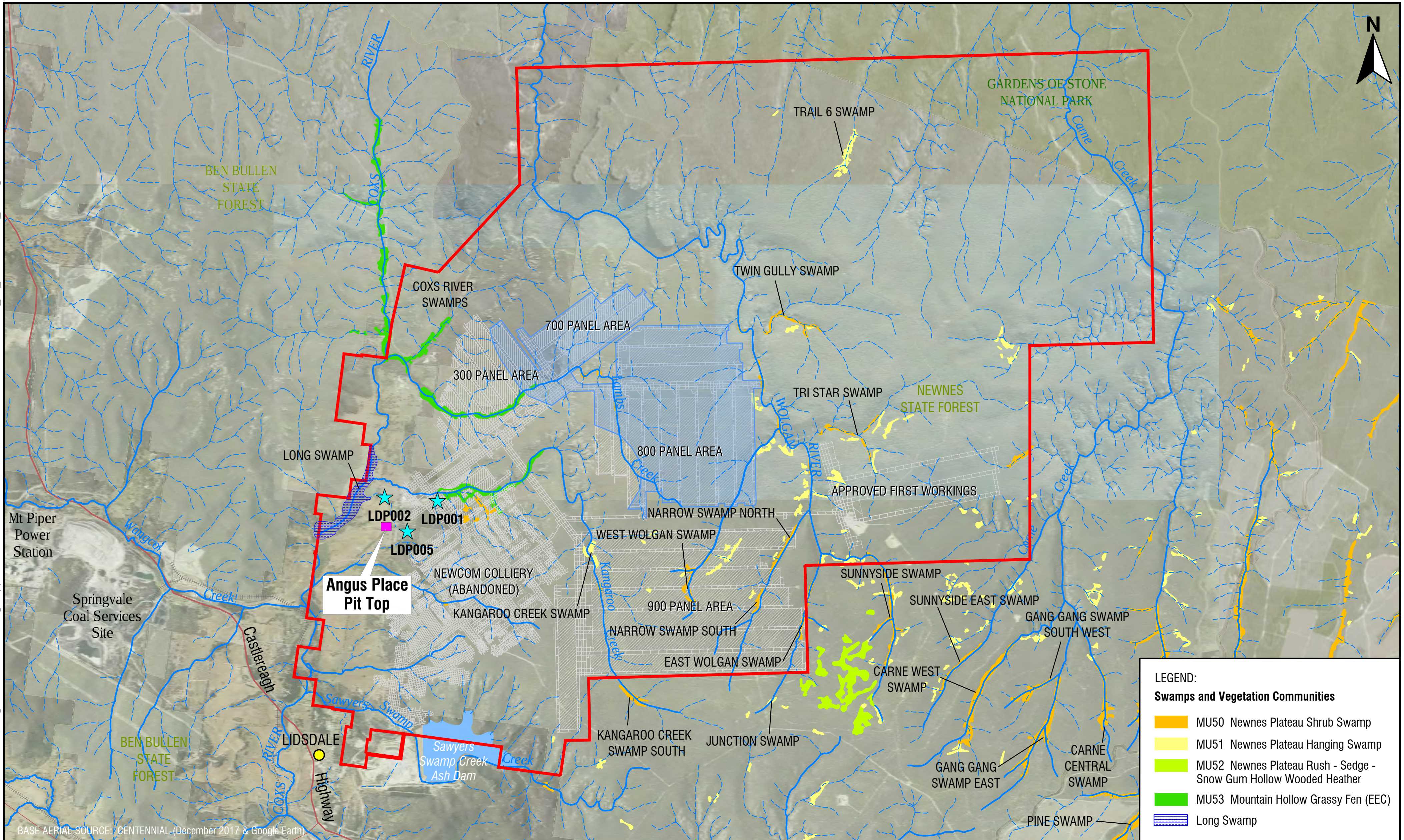


Figure 3-10 Discharge volumes for Angus Place LDP001 and Springvale LDP009 since 2017



H:\Projects-SLR\630-SrvNTL\630-NTL\630.12413 Angus Place REF Drafting Support\06 SLR Data\01 CADGIS\CAD\CURRENT\SLR63012413_F4_S&VEG-SMW_03.dwg

LEGEND:

- Angus Place Colliery Holding Boundary
- Major Roads
- Railway
- Built-up areas
- Town / City
- Watercourse - Non Perennial
- Watercourse - Perennial
- State Forest
- National Park
- Angus Place LDP
- Stored Mine Water

DATE	28.6.2018
SEAM	LITHGOW
REFERENCE	SLR63012413_F4_S&VEG-SMW_03.dwg
SCALE	1:80000

Figure 3-11
Swamps and Vegetation Communities Relative to Stored Mine Water

0.0 1.25 2.5 KM

Centennial Coal

Prepared by: SLR

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Mine water levels within the Angus Place underground workings have been recorded as part of the operational management of the site and are provided in **Table 3-4**.

Table 3-4 Underground water levels

Mining area	Average underground water level (mAHD)
900 district	792
700 and 800 district	808

Water levels are monitored within the 700 and 800 district through operation of the in-seam pump. As the pumps location is fixed vertically, the water level is known and maintained through operation of the pump. The monitoring of levels within the 700 and 800 district is not possible due to limited access underground to this area and no appropriate groundwater monitoring bore points able to represent this location.

In comparison, water levels are monitored at 940 Bore where groundwater extraction activities are undertaken for the 900 district. Storage levels over time within the 900 area are provided in **Figure 3-12**.

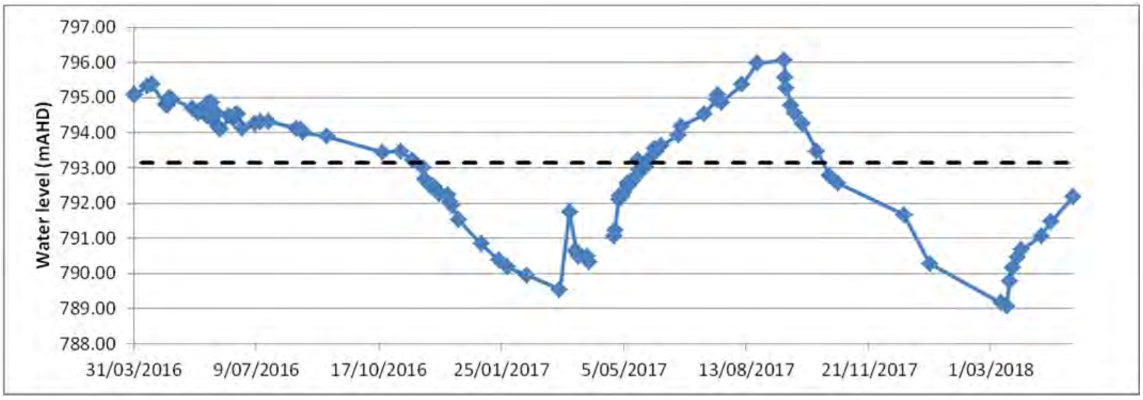


Figure 3-12 900 area water levels (since March 2016), black line indicates average water level over monitored period

From **Figure 3-12**, groundwater levels rise and fall dependent upon pump operation. Generally these elevation changes average out to result in a typical constant to rising water level within 900 district. As previously indicated, storage levels are increasing with time as result of constraints on dewatering capacity. It should be noted that the recent monitored levels in 900 district do indicate a minimum level in April of approximately 788 mAHD. However, this should not be considered as support for as potential water loss in the LEG Identified Area as the 900 district is a greater distance from the swamps under review then the 700 and 800 district. If connectivity was to exist then conversely the increasing groundwater storage level shown in **Figure 3-12** following April would also be represented at the surface to some form of water level recovery.

4. HISTORICAL MINING INFORMATION AND ASSESSMENT

The Coxs River Swamp system have all been historically influenced by mining operations undertaken by Angus Place Colliery (Centennial), Baal Bone Colliery (Glencore) and Invincible Colliery (Castlereagh Coal). Each mining operation along with there swamp interaction are detailed in the Sections below.

4.1. Angus Place Colliery

The following points outline the key aspects of mining operations at Angus Place Colliery:

- Longwall mining operations commenced in 1979.
- Mining areas 700 and 800 district are located within the Lambs Creek catchment and are closest to the LEG Identified Areas. These areas were extracted over the 80's and early 90's.
- Extracted areas (700, 800 and 900 areas) now serve as underground water storage areas, although the current water storage area does not extend into underground extracted areas that are adjacent to the LEG Identified Area (refer to **Figure 3-11**).

From **Table 3-4**, the average storage water levels are well below the associated topography and the LEG Identified Area (approximately 930 mAHD). Hence connectivity between stored water within the mine and surface water features is unlikely (JBS&G 2018). Within the 900 area, water levels have been shown to be variable and dependent upon operational pump rates, however over the past two years water levels have varied 7 m with levels recorded between 796 to 789 mAHD. The 700 and 800 districts historically have had a constant water level since 2006 controlled through pumping.

Outputs from the regional numerical groundwater model suggest a deep groundwater system has developed beneath the alluvial groundwater system upon which the LEG Identified Area resides, due to the effect of depressurisation of the mine in the past. Due to depressurisation, the modelled groundwater elevation in the Lithgow Seam beneath the LEG Identified Area is expected to be in the order of 870mAHD compared to the water table elevation in the swamp (assumed to be coincident with ground surface) of 925mAHD. Given that mining of the 300 Panel Area occurred in the 1980s, and the groundwater elevation in the Lithgow Seam adjacent Coxs River Swamp has been maintained at or below the floor of the Lithgow Seam since the time of mining, if there were not two, separated groundwater systems, then the Coxs River Swamp would have been already and continuously impacted.

4.2. Baal Bone Colliery

The following points outline the key aspects of mining operations at Baal Bone Colliery:

- Longwall's 29 to 31 were mined in 2010 to 2011.
- Longwalls located to the west and east of Coxs River adjacent to Coxs River Swamp.
- Environmental monitoring program for Coxs River swamps has been in place for some allowing decent background data.

Underground mining area - Baal Bone Colliery

Information on monitoring and subsidence as a result of longwalls 29 to 31 has been sourced from annual reviews, management plans and subsidence reports.

Mining in the area commenced in 2009 and continued through to 2011 at which time the operations entered care and maintenance.

As a result of mining Longwall 29 and existing fault zones, groundwater piezometer BBP1 and BBP2 had a sudden drop (approximately 5 m in BBP1) in pre-mining water level. This was identified in 2009 and a review of swamp health was undertaken. No immediate change in species diversity, plant species composition or weed invasion was noted in the 2009 report (Baal Bone Colliery 2009). BBP2 showed recovery back to pre-mining levels within 1 year however BBP1 has not recovered.

As part of the subsidence monitoring reports, one unpredicted subsidence impact was recorded at the surface which was associated with Longwall 30. The subsidence was in the form of a crack which the department of notified about (Baal Bone 2011).

BBP5 and BBP6 are located within Coxs River Swamp adjacent to Longwall 29 and monitor water levels within the alluvial environment. Following the drop in water levels at BBP1, assessment on the consequence of this on the swamp was undertaken. To date there have been no observed changes in the swamp condition as a result of the drop in level within BBP1 (Baal Bone 2016).

From comparison between subsidence monitoring reports and the last published annual review, groundwater levels within BBP5 and BBP6 have not had any major variances in the average water level with some response observed to reduced rainfall leading into 2018 (refer to **Figure 4-1**). It is expected based on the current monitored water level in BBP1 that groundwater is still able to migrate towards the swamp, regardless of a reduction in level being sustained.

In the event that future impacts do occur to swamp environments local to LW29 to 31, Baal Bone has committed to further investigation. They do note however that groundwater contribution to these areas plays only a minor role when compared to rainfall runoff, (Baal Bone 2018a)

Historical groundwater monitoring has indicated that there has been no correlation to changes in groundwater level within Coxs River Swamp as a result of mining, however variability due to rainfall has been observed.

Groundwater monitoring locations related to Coxs River Swamp undertaken as part of Baal Bone operations are provided in **Table 4-1** below. **Figure 4-1** presents the long term groundwater monitoring trends associated with longwalls 29 to 31.

Table 4-1 Groundwater monitoring undertaken by Baal Bone (AGE 2012)

Monitoring Bore ID	Depth of Bore (mbgl)	Elevation of Measurement Point (mRL)	Easting (MGA94, z56)	Northing (MGA94, z56)
BBP1 – GW108939	12.2	965.16	229920	6312320
BBP2 – GW108932	14.2	956.64	229739	6312080
BBP3 – GW109018	12.2	951.34	229847	6311364
BBP4 – GW108881	15.0	943.44	229580	6311150
BBP5 (Swamp)	3.6	942.91	229637	6311369
BBP6 (Swamp)	2.7	953.14	229671	6311952

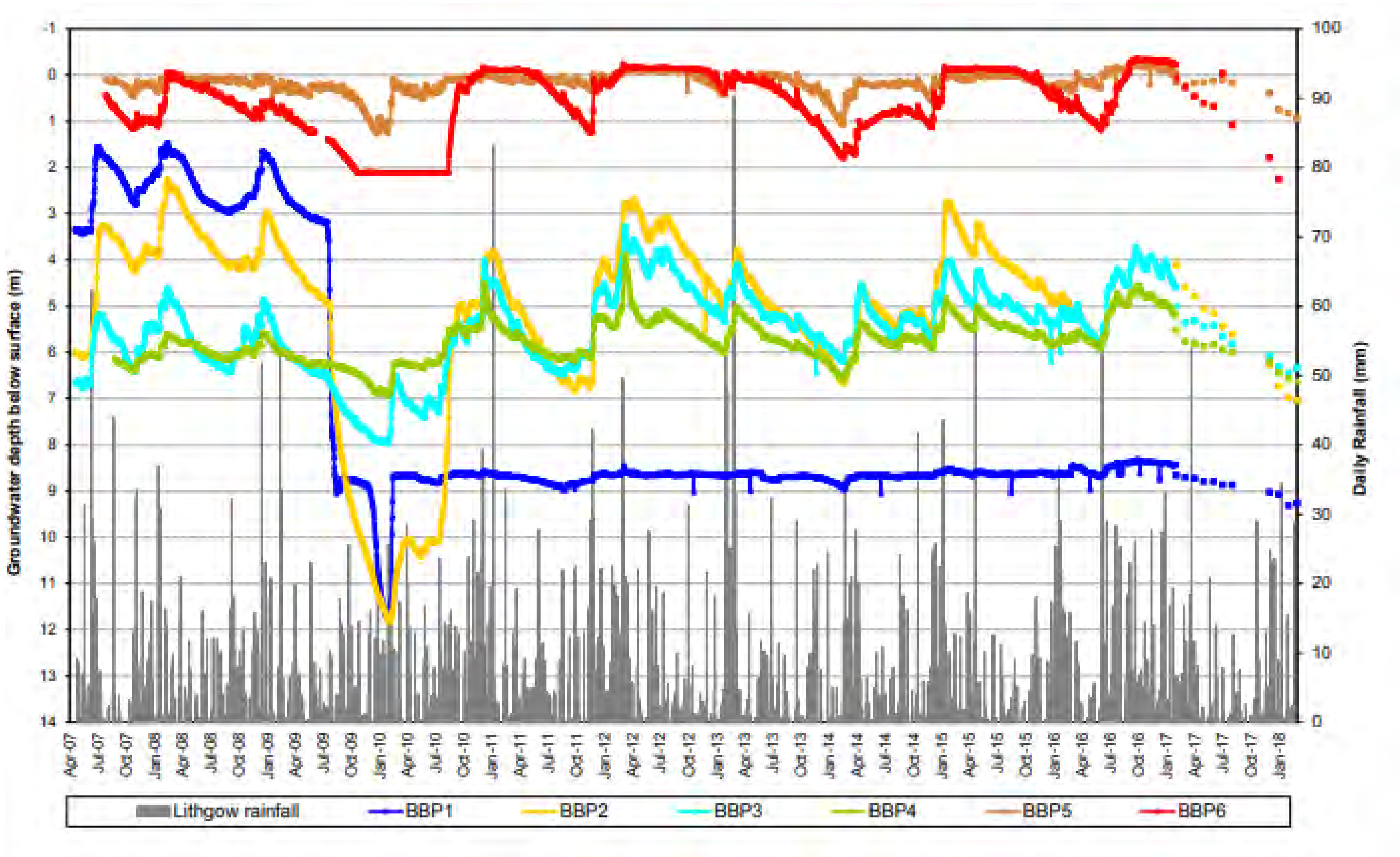


Figure 4-1 Baal Bone groundwater monitoring (Baal Bone 2018b)

4.3. Invincible Colliery

- Mining in the underground sections of Invincible Colliery began the 1950s and ceased in 1998. Mining operations were a combination of bord and pillar and longwall extraction.
- The Invincible Colliery underground area is located within the valley margin of the Coxs River, downstream of Baal Bone's longwalls.
- The underground area has been flooded for since 1998.
- Invincible bore pump has historically discharged into Coxs River Swamp (LEG records indicate, based on Site 28, that mine water discharged from June 2007 to at least July 2008, refer to **Figure 4-2** for photograph of approximate discharge location).

Figure 4-2 Invincible dewatering infrastructure

Underground mining area – Invincible Colliery

Based on public information available at the time of this assessment regarding the historical mining area of the Invincible Colliery, it was assumed that the mined area adjacent to the swamp Reference Sites, has become flooded since mining ceased in 1998. A bore hole connected to the workings that has been used as a discharge point (LD001) previously and water level monitoring is however possible. As part of this assessment a groundwater level was not monitored but monitoring undertaken in 2011 indicated that groundwater levels were approximately 882.8 mAHD (AGE 2012). A typical cross section running west to east by AGE, showing the Invincible Colliery's underground workings with respect to the Coxs River Swamp is provided in **Figure 4-3**.

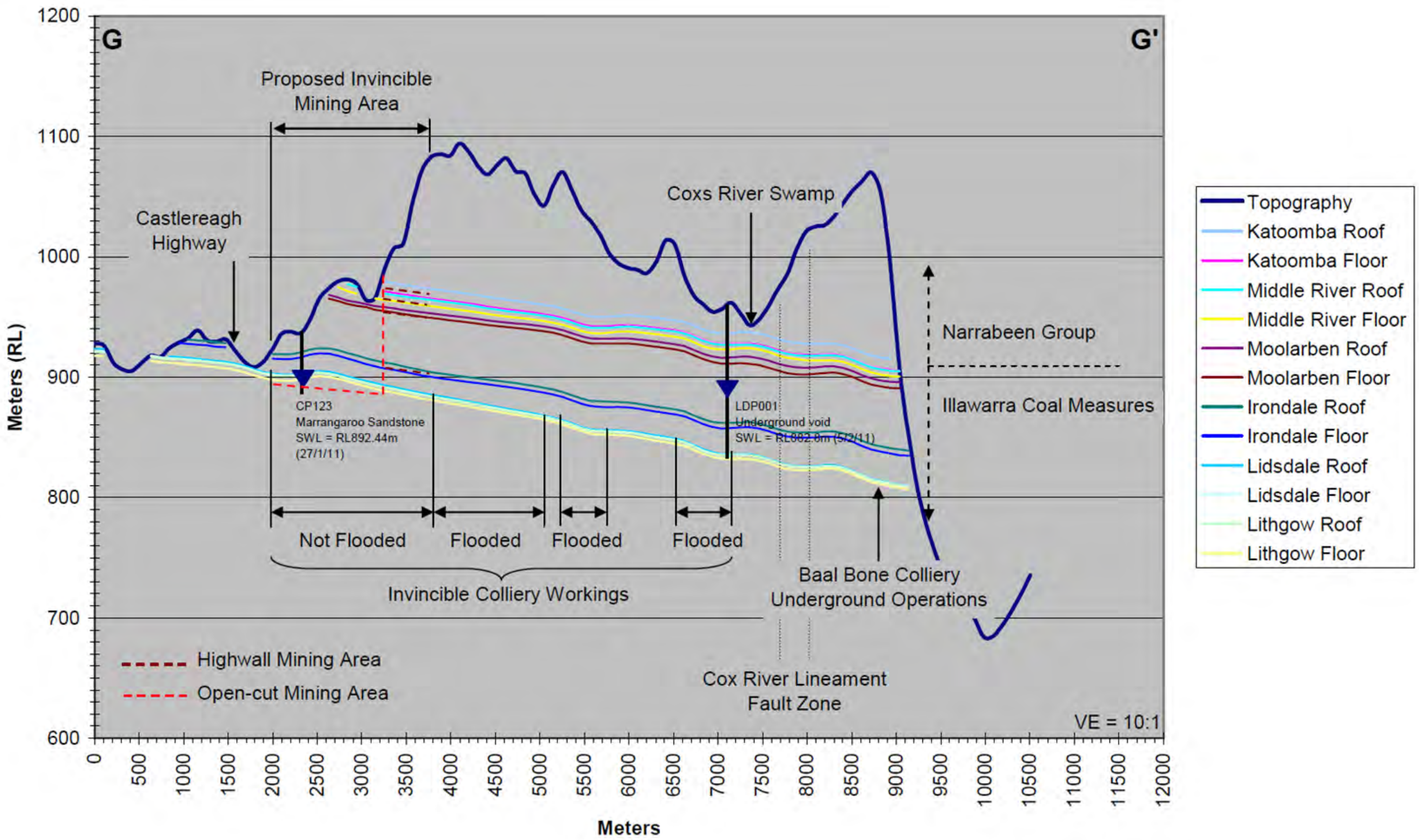


Figure 4-3 Cross section indicating Invincible Colliery underground with respect to Coxs River Swamp (AGE 2012)

From **Figure 4-3** it is clear that based on height the interaction of the Coxs River Swamp and flooded workings at Invincible Colliery is unlikely.

4.4. Other related investigations

EPA 2017 – Lambs Creek inspection and sampling

EPA, on the 30 December 2014, investigated a shrub swamp located on Lambs Creek within the Newnes State Forest (NSF) following a compliant made by the community as to water discoloration. Inspections were also undertaken in 2015 and 2016, before a report was prepared in 2017.

The section of shrub swamp, from the detail provided in the inspection, is likely to be located in the vicinity of the Angus Place Colliery longwalls relating to 700 and 800 districts. These areas were developed and mined in the late 80's (700 district) and 90's (800 district). The adjoining longwalls 25, 26 and 26N (810 district) were, however, extracted more recently with this area being completed in 2003. There are mapped pockets of swamp located on the Lambs Creek waterway defined as Mountain Hollow Grassy Fen (MU53).

The investigation concluded that potentially longwall mining within the area had modified the permeability and oxidation state of groundwater discharges in combination with geological factors have resulted in an intermittent discoloring of the creek. The discoloration is likely to be as a result of groundwater interacting with lenses of pyritic sediments common to the geology. This occurrence was seen previously by EPA in operations associated with the Cullen Bullen Mine.

The influence of this discoloration on the aquatic health of the creek was assessed using ecotoxicology testing which indicated acute toxicity in three of four tests undertaken for the rainbowfish (*Melanotaenia duboulayi*) bioassay and no acute toxicity in a bacteria bioassay (*Vibrio fischeri)*.

5. SWAMP WATER CYCLE

Typically swamp systems have a dominant catchment runoff with only supplementary alluvial groundwater baseflow. Evidence of the alluvial groundwater environments contribution to the LEG Identified Area is provided in **Figure 5-1** below.

Figure 5-1 Evidence of persistent lateral groundwater inflows to LEG Identified Area

Outflows from swamp environments typically comprise of uptake and evapotranspiration from vegetation, some vertical infiltration through the swamp floor and direct swamp discharge where topographic changes have resulted in the swamp geometry becoming exposed and drainage being allowed to occur under gravity (e.g. 4wd track or disturbance leading to redirection of flow or direct evaporative losses from exposed water surface).

Of the inflow and outflow elements typical within swamp environments the following considerations can be made:

- Inflows to swamps are driven by rainfall of varying scales. Catchment runoff is likely to be dependent on localised factors with a quick response period; compared with baseflow which is dependent upon larger catchment influence and occurs over a much longer period.
- Rainfall runoff typically provides the greatest inflow volumes to swamps accounting for the capture of between 20% and 30% of catchment flow. This is in contrast to 5% which typically infiltrates to groundwater systems (including alluvial environments), (DECCW 2010).
- Outflows from swamps can be sensitive to vegetative cover, changes in topography and changes in the subsoil conditions.

Underground mining has the potential to influence subsoil conditions of the swamp environment. As swamps within the Coxs River valley are largely located in areas corresponding with clay sills, where these clay sills are impacted or modified then the potential for an increase in outflow rate via vertical infiltration may occur with the water cycle.

Without monitoring of the alluvial aquifer within the LEG Identified Area, the determination of whether external factors are influencing the water levels within the swamp is only possible by making comparisons with the Reference Sites (not in proximity of influence of mine workings) within the Coxs River Swamp system. A suitable comparison site is located at the upstream end of the Reference Sites, in the area monitored by Baal Bone Colliery piezometers BBP6, which demonstrate stable pre and post mining behavior. Water level changes monitored at BBP1 are not reflected at BBP6, and no change to swamp condition has been measured. Analysis of swamp piezometer data indicates a correlation to changes in groundwater level within Coxs River Swamp as a result of mining, however variability due to rainfall has been observed. Moving into the future, in order to measure swamp water level change local to the LEG Identified Area, shallow groundwater monitoring will be required.

A comparison of the LEG Identified Area and the Reference Sites from a floristic perspective is considered relevant from the perspective of swamp flora outcomes of the hydrological regimes present at the different sites. RPS identified that *Baumea rubiginosa* was dominant at both the LEG Identified Area and the Reference Sites. *Baumea rubiginosa* is an inundation tolerant Cyperaceae species that grows in swamps and other damp areas on sandy soils and is an ideal indicator to be considered for assessing potential water loss impacts. Outcomes from the floristic monitoring indicated little difference between the two assessed sites. RPS indicate without baseline information little inference can be determined on potential impact at the LEG Identified Area but generally the assessment did not indicate current signs of stress as a result of potential water loss.

Soil moisture monitoring undertaken by RPS was generally higher at the LEG Identified Area compared to the Reference Sites. Results indicated a highly variable result spatially for both monitoring locations with no clear relationship able to be determined. Ideally soil moisture results are an ideal assessment tool when a baseline data set is available. Unfortunately due to the lack of soil moisture data prior to the LEG observed drawdown little inference could be made by RPS with respect to potential water loss.

The recovery of swamp flora within the LEG Identified Area, presented in LEG (2018) between 2004 and 2018 provides relevant time series information at the site. The recovery of Long Swamp vegetation community and recent reduction in water levels in Long Swamp identified by LEG has occurred in the context of mine water storage and management which has not changed in many years.

6. SWAMP THREAT ASSESSMENT

Threats to swamps include the alteration of surface hydrology through the undertaking of underground mining. Impact mechanisms are typically associated with subsidence related changes to near surface hydrology or the discharge of excess groundwater.

History indicates that direct discharge of water through swamp environments can also have a detrimental effect. Impacts to swamp vegetation communities can occur due to differences in water quality (e.g. pH, EC, metals) between mine water and that of the natural swamp water, or as the result of erosion of swamp peat / soil profile and resultant removal of vegetation. This impact mechanism may be relevant to the downstream end of the Reference Sites (below Invincible pore pump discharge), but is not considered relevant to LEG Identified Area or within the upstream extents of the Reference Sites.

Areas surrounding Lambs Creek and the Upper Coxs River have not been mined since 1980 for Lambs Creek catchment and 2004 for Upper Coxs River. Based on monitoring data, mine subsidence and related changes to hydrology occur soon (days to months after mining in the vicinity), thus further changes as a result of mine subsidence are unlikely.

The typical type of longwall mining impact on swamps is through subsidence, surface cracking and increased permeability. From the monitoring undertaken by Baal Bone it is clear that changes to the shallow groundwater regime as a result of longwall mining can be localised and may not result in swamp impact.

As increased flow volumes are discharged to Kangaroo Creek, increased flow volumes will also enter the Long Swamp area, downstream of Kangaroo Creek tributary. Areas of incision that exist in the watercourse and lower reaches of Long Swamp may increase. This increase in channel depth and width may inadvertently divert a small portion of surface water runoff that would have contributed to the swamp, instead to the channel. Should this occur, there would be some risk of desiccation of swamp vegetation downstream of incised areas, though it is noted that there is significant contribution of shallow groundwater to Long Swamp from western sub-catchments of Coxs River, and any change in the concentrated channel form is likely to be negligible. It is noted that mine water discharge to Kangaroo Creek (and Coxs River including lower reaches of Long Swamp) were in the range of 6-9ML/day prior to July 2013, and have been up to 19 ML/day in 2002-2003.

As part of regulatory feedback on the project, post approval visual monitoring programs are required to assess the risk of ongoing change to Long Swamp as a result of increased discharge volumes.

7. SUMMARY AND MANAGEMENT COMMITMENTS

7.1. Summary of concerns raised

The summary of concerns raised included:

- Impact on EPBC Act listed swamp communities and threatened species as a result of changes in groundwater levels.
- Claims of historical impact to swamp environments in 2004 specifically as a result of Angus Place Colliery mining activities within the vicinity of the current identified impact area.

7.2. Summaries of review and technical assessments

Summary of review

The summary of the review has indicated the following:

- Coxs River Swamp is an extensive endangered vegetation community (MU53) under the BC Act that has interactions with three different mining operations.
- There has been no change in the underground water management of Angus Place Colliery. In addition, there is unlikely to be connectivity between the Cox River Swamp system at the LEG Identified Area and the underground stored water volumes at Angus Place based on current revisions in numerical groundwater modelling.
- Below average rainfall is likely to have resulted in lower water levels within Upper sections of the Coxs River including alluvial environment.
- To date no wide spread vegetation changes have occurred as a result of the below average rainfall however some browning of vegetation was noted within the LEG Identified Area and Reference Sites from various field inspection.
- Mining operations have the potential to influence shallow groundwater which is supporting groundwater dependent ecosystems however there is no evidence to support Angus Place influencing the LEG Identified Area.
- Given complex groundwater interactions between geology and groundwater resources, groundwater monitoring can provide further information on the potential interaction with swamp environments.

Summary of groundwater impact assessment

- The groundwater system in the vicinity of the Angus Place pit top and the underground water storages comprise the perched groundwater environment (the highest water table) and the deep groundwater system associated with the Lithgow Seam.
- There is no direct connection between the Lithgow Seam (where the mine water is stored) and swamps and watercourses. For example, the north-eastern branch of the Coxs River Swamp is 86 to 106 m above the Lithgow Seam. As such, seepage from the underground water storages and the swamps or watercourses flowing into the Sydney Drinking Water Catchment is unlikely.
- Whilst there is a vertically downward hydraulic gradient between Kangaroo Creek, Lambs Creek and Long Swamp and the Lithgow Seam (due to the presence of an unsaturated zone between the perched and deep groundwater system above the mined longwalls) there will be negligible additional effect on the perched groundwater system due to the dewatering of the underground storages. While there will be re-drawdown of 21 m and 30 m, respectively, in the 800 Panel and the 900 Panel Areas during the dewatering phase, impacts are unlikely, since the perched and deep groundwater system are hydraulically separated, i.e. there are multiple water tables.
- Dewatering of the underground storages will not result in a drop in the uppermost water table (perched groundwater system) that sustain groundwater dependent

ecosystems around the Angus Place pit top because this water table is not hydraulically connected to the deep groundwater system associated with the Lithgow Seam that will be dewatered.

- The dewatering of the underground storages will not commence till after the water treatment phase, and could take five years to dewater, based on the modelling results included in JBS&G (2018b).

Summary of floristic surveys, soil testing and 'spot' groundwater monitoring

Key findings of the floristic, soil testing and 'spot' groundwater monitoring undertaken to date are as follows.

- The floristic assemblage and other landscape factors at both sites (LEG Identified Site and Reference Site) are consistent with the NSW Scientific Committee final determination for the MU53 – Montane Peatlands and Swamps EEC listed under the BC Act.
- The ecological survey results suggest there is little difference floristically at the two sites (in the absence of a rigorous before after control impact designed monitoring program with adequate base line data available).
- Of the metrics used in the ecology assessment there was no specific contrast in floristic assemblages between the LEG Identified Area and the defined reference site of Coxs River Swamp.
- A comparison between the biometric plot results and the Moderate/Good condition benchmark scores for vegetation community HN602 indicated that the LEG Identified Area met or exceeded the benchmark scores for all metrics with the exception of native ground cover grass and native ground cover other. The Reference Site plot also generally met all of the benchmark scores for HN602.
- The ecological investigation concluded there was little evidence to suggest plants in the LEG Identified Area exhibited the effects of water stress given the apparent condition and current community assemblages present. The species *Baumea rubiginosa*, an inundation tolerant species that requires regular water, showed no sign of water stress at the time of the investigation.
- Results for soil moisture testing (EC and VWC) showed that soil moisture is potentially highly variable spatially but is comparatively similar at the two sites, with the average at the LEG Identified Area being approximately 10% greater than the Reference Site. Based on this one set of sampling, the results suggest the LEG Identified Area is damper and better suited to supporting a GDE compared to the Reference Site.
- The floristic and soil moisture results suggest the swamp system in the LEG Identified Area is currently in fair condition having met the required benchmark values for the community HN602 in Moderate/Good condition. The RPS ecologists did not record any measured or anecdotal evidence to suggest impacts had occurred at the LEG Identified Area.
- Anecdotal visual evidence and groundwater-related 'spot' data from the near-surface layers acquired by Centennial Coal representatives during a number of site visits (opportunistic and after rainfall events) to both the LEG Identified Area and the Reference Site showed the LEG Identified Area was more water-logged than any other area in the Coxs River Swamp system, regardless of the generally dry conditions in the area (see below). This observation suggests the perched groundwater system (or the highest water table) is consistently sustained at a higher level despite the separation of this water table from the deep groundwater system associated with the Lithgow seam. This observation is also consistent with the ecological survey results discussed above.

Centennial Coal has investigated other factors that could potentially contribute to the lowering of water table Coxs River Swamps (north-eastern arm) reported by LEG, including the potential impact of rainfall patterns. This is discussed in detail in Section

3.3. A conclusion that can be drawn is that any drop in the water table that LEG may have observed in March 2018 (noting that no baseline dataset was supplied by LEG) is may be due to the current dry weather conditions being experienced in the region. However, the ecological survey and soil testing results discussed above do not support any drop in water level in the swamps.

However, the 2004 dieback in Coxs River Swamp vegetation coincided with the Millennium Drought discussed in the Groundwater Impact Assessment (JBS&G, 2018b) appended as **Appendix B**. As provided in Table 2.1 of JBS&G (2018b) longwall mining at Angus Place in the 300 Panel Area (LW3 to LW10), representing the closest longwalls to the Coxs River Swamp (northeastern arm, being the LEG Identified Area) commenced in February 1981 and was completed in August 1987. No mining has been undertaken in the vicinity of the Coxs river Swamp for nearly 30 years and the water level in the 300 Panel Area has not changed since 2006.

7.3. Commitments

Typical mitigation strategies for swamps include:

- Fencing to control impacts of certain introduced animals
- Identify seasonal and long-term fluctuations in water flows and water quality regimes within the swamps
- Minimise impacts from changes to water flow and water quality
- Where conservation covenants do exist, manage weeds within and immediately adjacent to existing remnant vegetation communities
- Where impact has occurred and conservation covenants do exist, rehabilitate degraded remnant vegetation communities with local species known to occur within those swamps.

Monitoring program and adaptive management

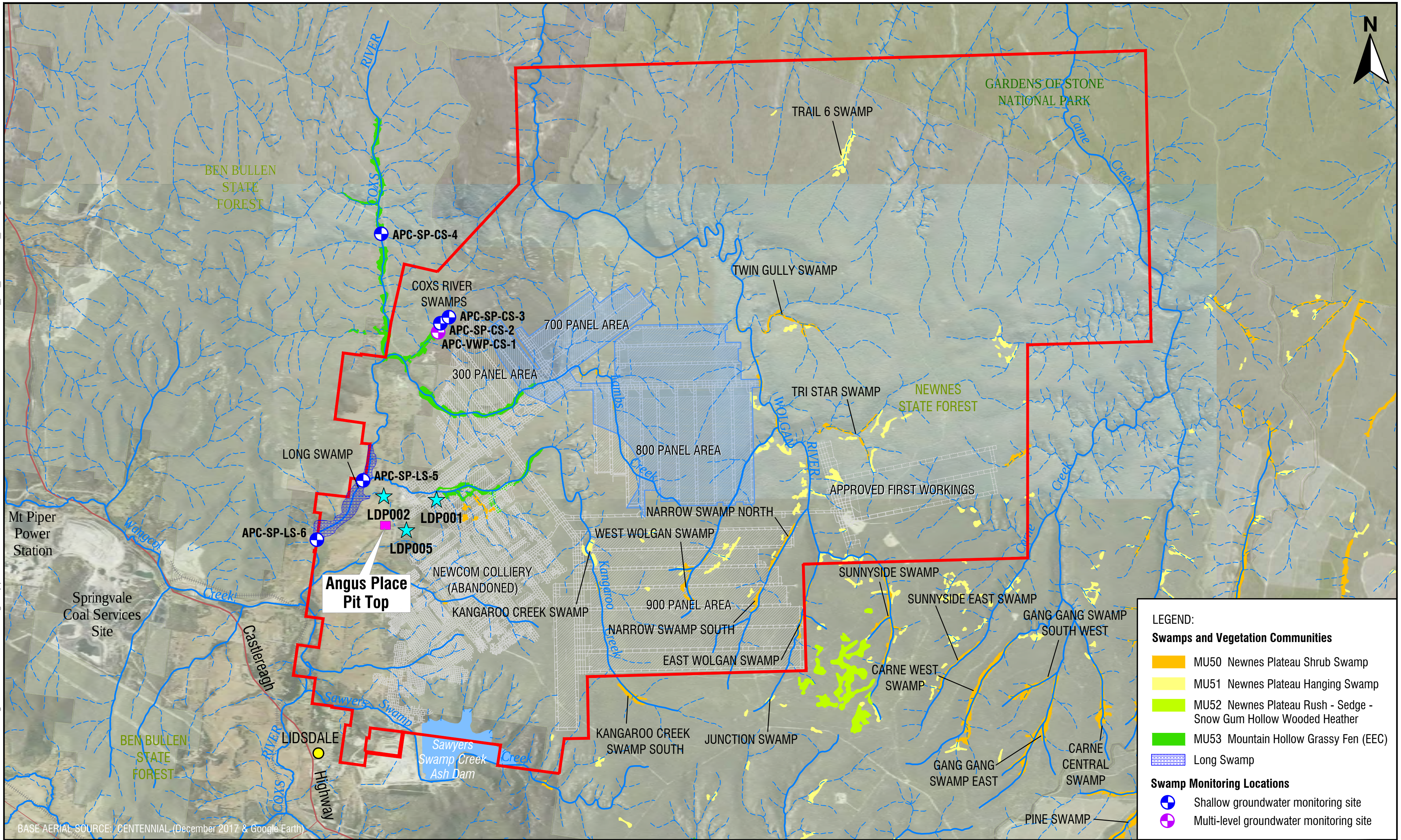
Centennial propose to initiate shallow groundwater monitoring through the installation a number of piezometers within both the north eastern arm (Lambs Creek) and northern arm / trunk of the upper Coxs River. **Table 7-1** summarises the proposed piezometers to be installed including their details.

It is emphasised the perched groundwater level (uppermost water table) will be monitored using a combination of swamp piezometers and multi-level vibrating wire piezometers to assess any impacts due to the dewatering of the underground storages. Adaptive management, for example by reducing dewatering rates, will be implemented should a strong correlation between the lowering of the underground stored water level and any drop in the perched water table be established from the monitoring data.

Table 7-1 Shallow groundwater monitoring locations to be implemented

Name	Monitoring purpose	Monitoring frequency
APC-VWP-CS-1 (4wd Access – LEG Identified Area)	Monitoring for connectivity between perched and deep groundwater environments	Automatic multi-level logger
APC-SP-CS-2 (Edge of swamp – LEG Identified Area)	Monitoring of water level in perched groundwater environment	Automatic level logger
APC-SP-CS-3 (Upstream edge of swamp – LEG Identified Area)	Monitoring of water level in perched groundwater environment	
APC-SP-CS-4 (LEG Bridge site – Reference sites)	Monitoring of water level in perched groundwater environment	
APC-SP-LS-5 (Kangaroo Creek, Coxs River confluence – Long Swamp)	Monitoring of water level in perched groundwater environment	
APC-SP-LS-6 (Upstream of Haul Road - Long Swamp)	Monitoring of water level in perched groundwater environment	

Figure 7-1 below presents the layout of the monitoring locations with respect to Angus Place operations.



LEGEND:

- Angus Place Colliery Holding Boundary
- Major Roads
- Railway
- Built-up areas
- Town / City
- Watercourse - Non Perennial
- Watercourse - Perennial
- State Forest
- National Park
- Angus Place LDP
- Stored Mine Water

DATE	29.6.2018
SEAM	LITHGOW
REFERENCE	SLR63012413_F6_SMLOCS_02.dwg
SCALE	1:80000

Figure 7-1
Swamp Monitoring Locations

0.0 1.25 2.5 KM

Centennial Coal

Prepared by: SLR

A4

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APPENDIX A ECOLOGY REVIEW

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RPS Australia East Pty Ltd ABN 44 140 292 762
A member of the RPS Group Plc

Date: 11/07/2018
Our Ref: 140459
Via: Email

Attn: Peter Corbett
Centennial Coal Company Limited
1384 Castlereagh Highway
Lidsdale NSW 2790

Dear Mr Corbett,

Flora and soil moisture investigation: Coxs River Swamp and Long Swamp

1 Introduction

RPS has been engaged by Centennial Angus Place Pty Limited to prepare an ecological response to an unpublished letter to Centennial Coal dated the 27th of March 2018 produced by Lithgow Environment Group (LEG). This report aims to address concerns raised by LEG in relation to potential impact of the proposed Angus Place Water Treatment Project (APWTP) on the swamp systems along the Coxs River.

RPS conducted rapid flora and soil moisture assessments in the Upper Coxs River area within swamp systems located off Wolgan Road, upstream of the Angus Place pit top (**Figure 1).** The swamp systems, locally referred to as the "Long Swamp System" or "Coxs River Swamps", comprises predominantly of groundwater dependent ecosystem mapped as the vegetation community with the Map Unit (MU) 53 – Mountain Hollow Grassy Fen, (DEC, 2006)[1]. MU 53 – Mountain Hollow Grassy Fen is commensurate with an endangered ecological community (EEC) listed under the *Biodiversity Conservation Act 2016* (BC Act), namely, *Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions* (this community is hereafter referred to as Montane Peatlands and Swamps EEC) .

2 Background

In this report the definition of Long Swamp is that based on the NSW Geographical Names Board and its boundary is shown in **Figure 1**. Long Swamp is located in the vicinity of Angus Place pit top on the Coxs

[1] DEC (2006) The Vegetation of the Western Blue Mountains. Unpublished report funded by the Hawkesbury – Nepean Catchment Management Authority. Department of Environment and Conservation. Hurstville.

River from above the confluence with Kangaroo Creek through to below the Mt Piper Haul Road, however, above the confluence of Wangcol Creek and Coxs River.

The swamps above the Kangaroo Creek / Coxs River confluence, referred to as the Coxs River Swamps and have been described in IESC (2014)[2] as a "peat swamp". These swamps comprise predominantly vegetation communities mapped as MU 53 by DEC (2006) and are the subject of this report. Limited ground-truthing of these swamps this assessment, RPS (2017)[3] and Lembit (2009)[4] have confirmed the MU53 vegetation community.

As aforementioned, this report provides responses to issues raised by the LEG relating to potential impact of the proposed Angus Place Water Treatment Project (APWTP) on the swamp systems along the Coxs River. The LEG has identified specifically the following aspects as their concerns.

(i) A specific location within the Coxs River Swamp system on an unnamed tributary of Lambs Creek marked as Location 1 in **Figure 2**, which they highlight as an area that had previously been impacted by longwall mining and could be impacted in the future by the APWTP. The area has been mapped as MU53 in accordance with DEC (2006). It is noted the area is in the vicinity of Angus Place's 300 Panel Area existing workings located approximately 400 metres below the surface within the Lithgow Seam.

(ii) Threatened flora and fauna species included below, listed under the State (Biodiversity Conservation Act 2016 (BC Act)) and Commonwealth (Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)) legislations, which are alleged to be impacted by the APWTP:

a. Kunzea *cambagei* (Vulnerable under the EPBC Act and BC Act);

b. *Eucalyptus aggregata* (Vulnerable under EPBC Act and BC Act); and

c. *Veronica blakelyi* (Vulnerable under BC Act).

3 Project Description

The APWTP comprises two components for which approvals have been sought separately due to timing constraints.

- **Establishment and operation of a temporary water treatment plant (WTP**) – to be constructed following a variation to Angus Place Colliery's Environment Protection Licence (EPL) 467 for the inclusion of these works as a Pollution Reduction Program. The emplacement of the residuals from the WTP within the underground workings was assessed in a groundwater impact assessment (JBS&G, 2018a)[5] included with the environmental impact assessment supporting the licence variation application.

[2] IESC (2014), Temperate Highland Peat Swamps on Sandstone: longwall mining engineering design-subsidence predictions, buffer distances and mine design options, Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development, Commonwealth of Australia, Canberra, August 2014.
[3] BioBanking Agreement Report: Lot 56 DP751636 Wolgan Road North. Report prepared by RPS Newcastle for Centennial Coal.
[4] Baal Bone Colliery Continued Operations: Flora Assessment. Report prepared by Gingra Ecological Surveys for Baal Bone Colliery Pty Limited.
[5] JBS&G (2018a). Angus Place Water Treatment Project: Section 75W Modification 5 - Surface Water Assessment.

- **Increasing mine water discharge (treated to an EC of 350 µS/cm) through LDP001 to up to 10 ML/day** – subject to an approval via a proposed modification (Modification 5) to Angus Place Colliery's project approval PA 06_0221. A surface water assessment (JBS&G, 2018b)[6] and an aquatic ecology assessment (GHD, 2018)[7] were undertaken as part of the *Environmental Assessment* (EMM, 2018)[8], prepared to support Modification 5.

[6] JBS&G (2018b). Angus Place Water Treatment Project: Section 75W Modification 5 - Groundwater Assessment (Abridged). Report prepared for Centennial Coal, Springvale NSW.
[7] GHD (2018). Angus Place Modification 5 – Increased mine water discharges at Angus Place Colliery's LDP001: Aquatic ecology impact assessment. Report prepared for Centennial Coal, Springvale NSW.

[8] EMM (2018). Angus Place Water Treatment Project: Section 75W Modification Environmental Assessment. Report prepared for Centennial Coal, Springvale NSW.

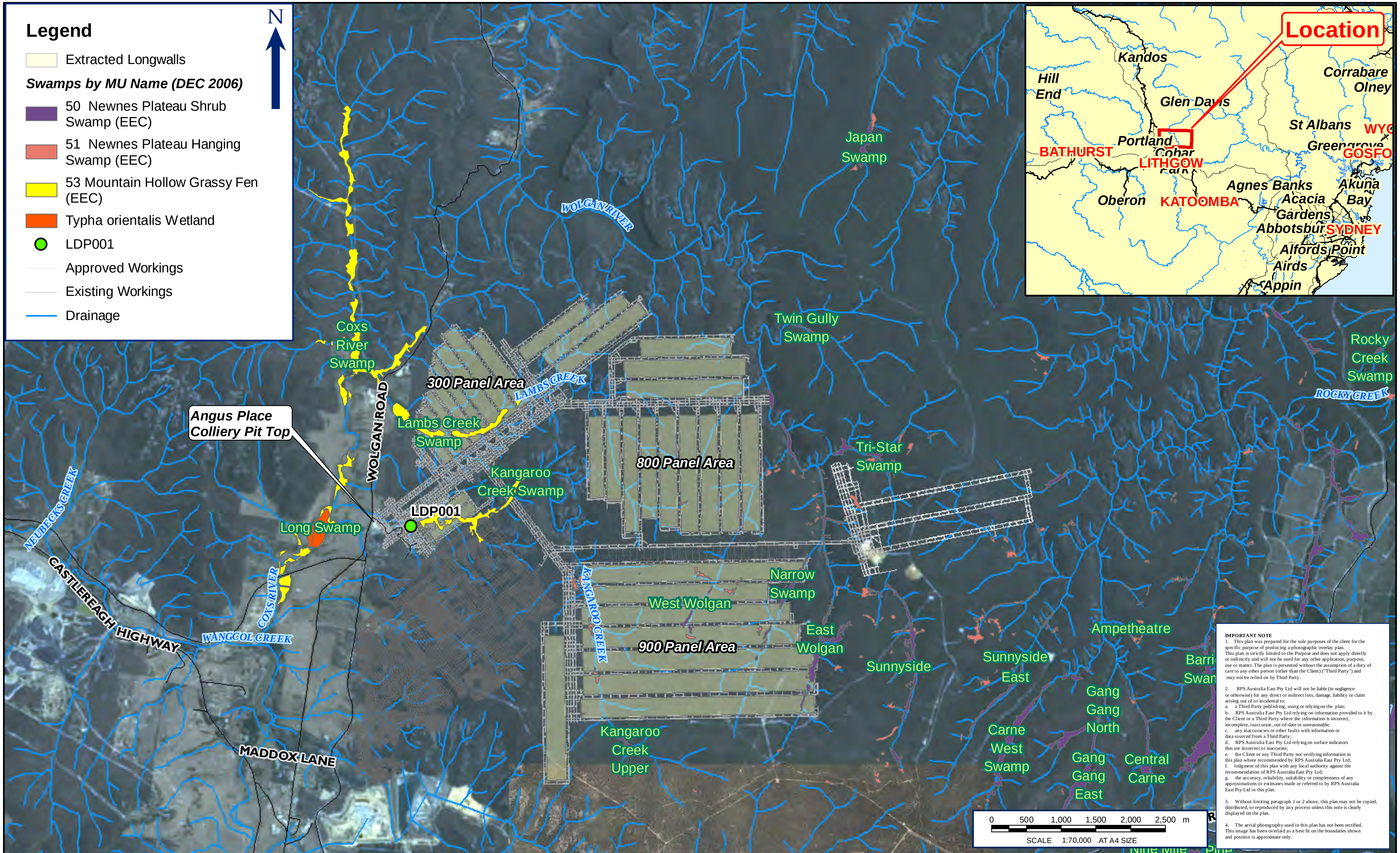

Figure 1: Site Location

LOCATION: ANGUS PLACE

PURPOSE: ECOLOGY

Technician: Natalie.Wood Date: 11/07/2018

Path: S:\Centennial\All Jobs\140459 Long Swamp Eco Assessment\10 - Drafting\Arcgis Map Documents\Eco\140459 Figure 1 Site Location Map C

VERSION (PLAN BY): C A4

DATUM: GDA94
PROJECTION: MGA Zone 56

Data Sources:
RPS, Client
Land and Property 2015

CLIENT: CENTENNIAL COAL
JOB REF: PR140459

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NEW_A4_Landscape 2017 Rev:A Produced:NW Reviewed: NW Date: 11/08/2017

4 Methodology

4.1 Floristics

Two sites were inspected, by two RPS ecologists on the 19th April 2018, in the Coxs River Swamp catchment areas using a combination of two biometric floristic plots and six rapid data points (RDPs) (identified as Location 1 and Location 2 in **Figure 2**). Location 1 and Location 2 were investigated to ascertain the species richness and condition of the community present in relation to the concerns raised by the LEG. Specifically, two concerns were raised pertaining to potential damage to Montane Peatlands and Swamps EEC and damage to potentially groundwater dependant threatened flora species within proximity to the swamp. The threatened flora species of concern are as noted in **Section 2**, comprise; *Kunzea cambagei*, *Eucalyptus aggregata* and *Veronica blakelyi*.

As noted above, Location 1 has been identified by the LEG as an area within the Coxs River Swamp system as likely to have been previously impacted by longwall mining. As also noted above, the area is mapped as MU53 vegetation community in accordance with DEC (2006). Location 2 has been selected as a reference or background plot and the area has also been mapped as MU53 vegetation in accordance to DEC (2006).

4.2 Soil moisture

Location 1 was the area identified by the LEG, in an unpublished letter to Centennial Coal dated the 27th of March 2018, as experiencing lowered water levels. Location 2 was chosen by RPS as an upstream reference location that is considered independent from the Angus Place extraction areas.

Soil moisture readings, including electrical conductance (EC) and volumetric water content (VWC), were recorded at the six RDPs using a HydroSense II by Campbell Scientific® on the 1st of May 2018. Photographs were taken at the start of each plot and at each RDP.

These results were interpreted and combined with the following desktop research and investigations:

Depth of cover from ground level to the longwall ceilings;

Distance of the longwalls relative to swamp boundaries and the Coxs River fault;

Time since longwall mining occurred in the area; and

Precipitation data analysis.

5 Results and discussion

5.1 Floristics

The floristic assemblage and other landscape factors at both sites are consistent with the NSW Scientific Committee final determination for the Montane Peatlands & Swamps EEC.

Thirteen native species were identified in the flora plot at Location 1 and eight native species at Location 2 (see **Appendix A**). Two exotic species were identified at Location 1 and one at Location 2. The locations were both dominated by *Baumea rubiginosa* and *Leptospermum obovatum*. The exotic species at both locations occurred at very low cover abundances relative to their typical growth form. The RDPs showed similar dominance patterns with the addition of *Baeckea utilis* at three of the six sites. Percent live green cover was 85% and 81.7% for Location 1 and 2 respectively.

The results suggest there is little difference floristically at the sites in the absence of a rigorous before after control impact (BACI) designed monitoring program with adequate base line data available. *Baumea* *rubiginosa* is the most dominant species by cover at both sites (60% and 70% at Locations 1 and 2 respectively) with *Leptospermum obovatum* the second most dominant by cover (20% at both sites). *Baumea rubiginosa* is an inundation tolerant Cyperaceae species that grows in swamps and other damp areas on sandy soils[9]. *Leptospermum obovatum* grows in swampy locations among granite or sandstone rocks and along with *B. rubiginosa* and commonly occurs in shrub swamp communities. If a change in water availability has occurred *Baumea rubiginosa* is likely to respond quite rapidly as it requires regular water[10]. Further investigations are required to monitor for any changes over time.

[9] PlantNET (2018). PlantNET: NSW flora online. National Herbarium of New South Wales. Accessed 03/05/2018 http://plantnet.rbgsyd.nsw.gov.au/

[10] http://plantsandlandscapes.com.au/prov_site/Baumea_rubiginosa accessed 04/05/2018

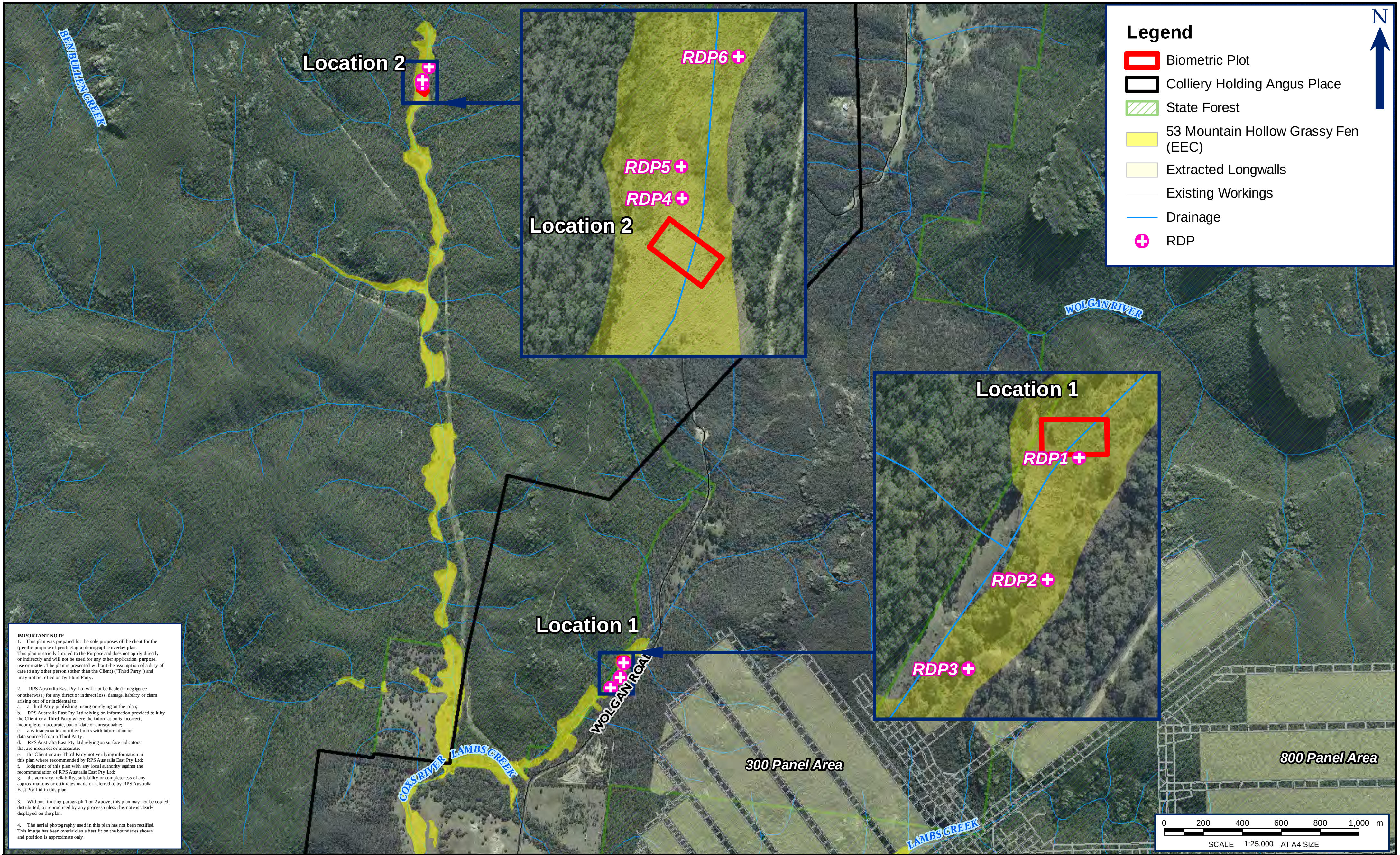

FIGURE 2: SURVEY LOCATIONS INCLUDING METHODOLOGY

LOCATION: ANGUS PLACE

PURPOSE: ECOLOGY

Technician: Natalie.Wood Date: 11/07/2018

Path: S:\Centennial\All Jobs\140459 Long Swamp Eco Assessment\10 - Drafting\Arcgis Map Documents\Eco\140459 Figure 2 Survey Locations C A4

VERSION (PLAN BY): C A4

DATUM: GDA94
PROJECTION: MGA Zone 56

Data Sources:
RPS, Client
Land and Property 2015

CLIENT: CENTENNIAL COAL
JOB REF: PR140459

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A comparison between the biometric plot results and benchmark condition scores obtained from the VIS database are presented in **Table 1** below.

A comparison between the biometric plot results and the Moderate/Good condition benchmark scores for vegetation community HN602 are presented in **Table 1** below. These results indicated that the plot data obtained from the area of potential EEC damage met or exceeded the benchmark scores for all metrics with the exception of native ground cover grass and native ground cover other. This discrepancy may be explained by the local dominance in this waterway of the grass like *Carex appressa* over grass species. The reference plot at Location 2 also generally met all of the benchmark scores for HN602.

Table 1 Biometric plot results vs Vegetation Identification System (VIS)[11] database benchmark scores for Vegetation Community HN602-Tableland swamp meadow on impeded drainage sites of the western Sydney Basin Bioregion and South Eastern Highlands Bioregion.

Biometric Plot ID	Native plant species	Native over-storey cover	Native mid-storey cover	Native ground cover (grass)	Native ground cover (shrub)	Native ground cover other	Exotic plant cover	Number of trees with hollows	Over-story regen	Total length of fallen logs
Location 1- Location of Potential Damage	12	0	22	0	12	100	2	0	1	0
Location 2- Reference Plot	8	5.5	0	4	8	100	6	0	1	0
Benchmark *Moderate/ Good condition* (HN602)	>=9	0.0 to 11.0	1.0 to 40	21.1 to 38.3	8.2 to 45.2	21.1 to 38.3	-	>=0	1	>=0

There is little evidence to suggest plants at Location 1 are exhibiting the effects of water stress given the apparent condition and current community assemblages present. In the absence of appropriate base line data for a BACI study there is little inference to be made about the original state of either of these locations, particularly given the history of mining, land clearing and grazing in the area.

None of the threatened species identified in **Section 1** were recorded near Locations 1 or 2. Records of *Eucalyptus aggregata* and *Veronica blakelyi* occur within the catchment areas away from the Locations surveyed.

Eucalyptus aggregata is associated with low lying poor draining flats and hollows adjacent to creeks and small rivers. The species can occur as isolated paddock trees and is not necessarily associated with

[11] Office of Environment and Heritage, NSW, Vegetation Information System Database, http://www.environment.nsw.gov.au/research/Vegetationinformationsystem.htm Accessed on 08/05/2018

RPS

Groundwater Dependent Ecosystems (GDEs). The species is likely more reliant on rainfall than groundwater and its location in a landscape context[12].

Veronica blakelyi is associated with moist and sheltered areas in eucalypt forests in moist areas of the Western Blue Mountains. Habitat clearing and fire regime are the identified threats to the species persistence[13].

Kunzea cambagei has been found recently in the nearby Kangaroo Creek catchment area. It was recorded in an upstream area in heath on a sandstone outcrop to the south-east. The species occurs in moist heath and mallee in communities that are not ground water dependent and no critical habitat has been declared[14].

A drop in the water table may affect these species and the effects may be exacerbated by the extremely low levels of rainfall. However, there is a paucity of information available for these species including whether they are groundwater dependant and no experimental investigations into responses to water stress were identified.

5.2 Soil moisture

Electrical conductance and VWC were both higher at Location 1 (investigation) compared to Location 2 (reference) (**Table 2**). These results suggest soil moisture is potentially highly variable spatially but is comparatively similar, if not higher at Location 1 compared to Location 2. Suggesting the investigation area is damper and better suited to supporting a GDE compared to the reference location. Similarly, to the floristics little inference can be drawn from these results given the lack of data prior to the LEG alleged draw down event and subsequent loss of water.

Table 2 Soil moisture probe results.

RDP		Electrical Conductance (µS)	Volumetric Water Content (VWC) (%)
Location 1			
1	Reading 1	3.151	53.4
	Reading 2	3.020	50.2
	Reading 3	2.792	44.6
	Average	**2.988**	**49.4**
2	Reading 1	2.224	25.8
	Reading 2	1.893	12.8
	Reading 3	2.022	17.9

[12] NSW Scientific Committee 2000. *Derwentia blakelyi* (a shrub) – vulnerable species listing. NSW Scientific Committee – final determination. http://www.environment.nsw.gov.au/determinations/DerwentiaBlakelyiVulSpListing.htm Accessed 04/05/2018
[13] NSW Scientific Committee 2000. *Eucalyptus aggregata* Deane & Maiden (Black Gum) - vulnerable species. NSW Scientific Committee – final determination. http://www.environment.nsw.gov.au/determinations/eucalyptusaggregateFD.htm Accessed 04/05/2018
[14] DEWHA 2008. Commonwealth Conservation Advice for *Kunzea cambagei* http://www.environment.gov.au/biodiversity/threatened/species/pubs/11420-conservation-advice.pdf Accessed 04/05/2018

RDP		Electrical Conductance (µS)	Volumetric Water Content (VWC) (%)
	Average	**2.046**	**18.8**
3	Reading 1	1.840	10.6
	Reading 2	1.619	2.7
	Reading 3	1.949	14.7
	Average	**1.803**	**9.3**
Location 1 averages		**2.279**	**25.8**
Location 2			
4	Reading 1	2.209	25.1
	Reading 2	1.949	14.8
	Reading 3	2.081	19.8
	Average	**2.080**	**19.9**
5	Reading 1	2.169	23.4
	Reading 2	2.196	24.5
	Reading 3	2.161	23.1
	Average	**2.175**	**23.7**
6	Reading 1	1.922	13.8
	Reading 2	1.739	6.9
	Reading 3	2.149	22.8
	Average	**1.937**	**14.5**
Location 2 averages		**2.064**	**19.4**

5.3 Summary of mining history

The nearest longwalls to Location 1 form part of the Angus Place workings and include Longwalls 3 to 10 within the 300 Panel Area. Extraction for these longwalls started early 1981 and was completed in the third quarter of 1987. Depth of cover for the longwalls ranges from 115 m to 285 m with longwalls 8 and 9 being the closest to the LEG investigation area. No mining activity has occurred within the area in the last 30 years. There has been no mining of coal from Angus Place since March 2015 and recent mining activities at Angus Place are unlikely to have caused localised drops in water levels.

Additionally, the mine water level in the 300 Panel Area, contiguous with the 700 and 800 Panel Areas, is maintained at 805 m AHD, representing the full capacity level. These underground storages have been maintained at this water level since 2006 as the location of the pump station which prevents flooding of the mine from 800 Panel has not changed and water levels are maintained at a near constant level.

The water level in the 900 Panel Area, also used for the storage of mine water has been steadily increasing at approximately 0.5 ML/day and in March 2018 this area was >85% flooded, as discussed in Section 1.4.1 of the EA.

Location 2 is in the vicinity of Baal Bone Colliery's LW29, consequently, it has a number of water level monitoring bores (two aquifer piezometers (BBP1, BBP2) and three swamp piezometers (BBP4 – BBP6) and a nearby reference piezometer (BBP3), shown in **Figure 3**.

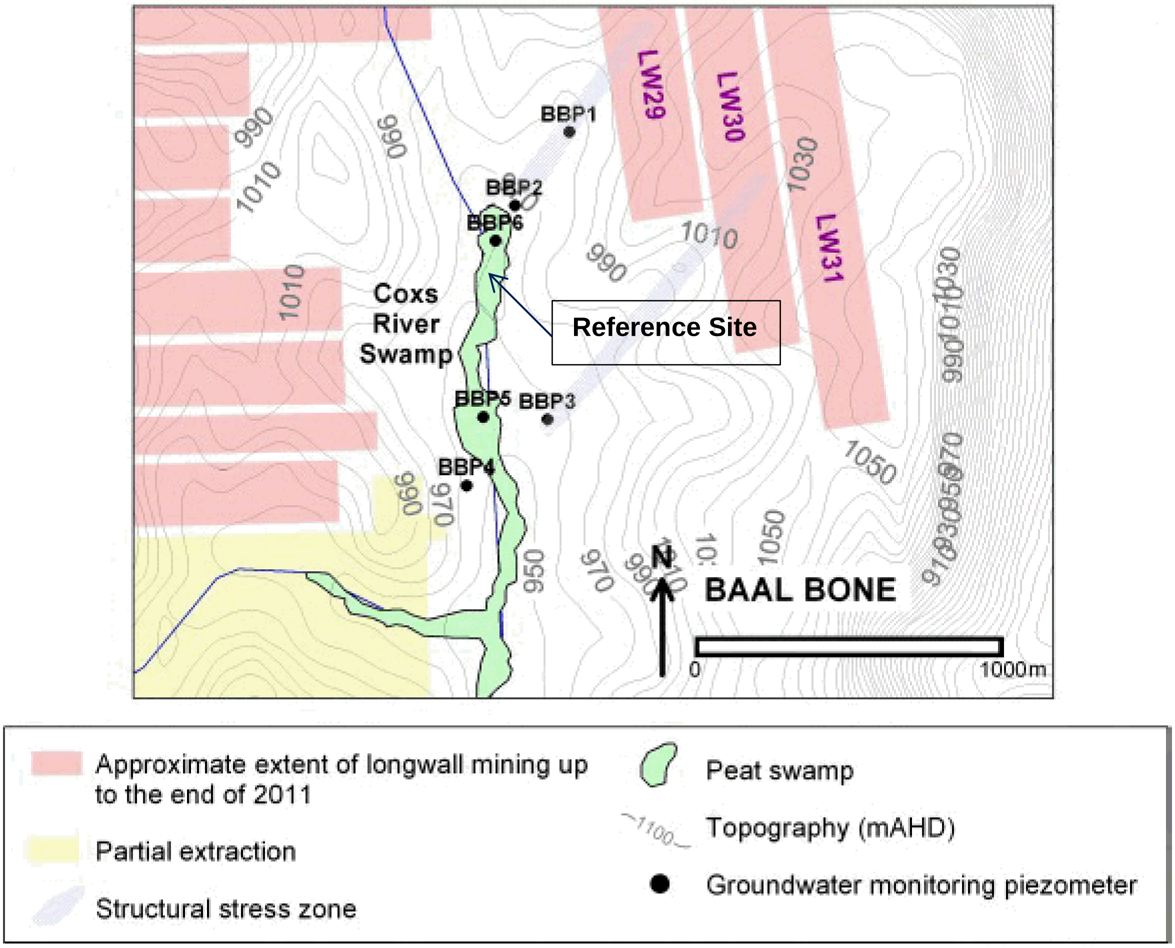

Figure 3 – Context of Reference Location 2 with respect to Baal Bone Colliery's mine layout (Adapted from IESC (2014))

These monitoring bores have long data records, which show generally high stable water levels (within the swamp), and Location 2 thus represents a good "control" site to compare to Location 1 in the absence of groundwater data at the latter location. The floristic survey undertaken as part of this survey (discussed in **Section 5.1**) show the vegetation community at the two sites is similar and thus provides a relative comparison of flora community composition and condition.

5.4 Rainfall

Below average rainfall has occurred in ten of the previous twelve months up to and including March 2018. Over that twelve-month period there has been a total of 506.8 mm of rainfall compared to a long term average of 743.3 mm (weather station 63132 Maddox Lane, Lidsdale). The weather station at Angus Place Licensed Discharge Point 3 (APLDP003) located within 5 km of Location 1, recorded identical rainfall over the 12 months prior to the investigation. The substantially lower rainfall compared to annual averages over the past 12 to 15 months may contribute to an observed decrease in surface water levels, particularly given the 10 years prior to this year had 5 years of below to slightly below average rain and 5 years of above average rainfall including 2 years substantially higher than the annual average (2010 = 1006 mm and 2016 = 924.4 mm).

The below figure (**Figure 4**) illustrates annual rainfall variation from 1971 to 2017 with a 12 year floating average to illustrate long term rainfall trends, the trough centred around 2006 corresponds to the driest years within "millennium drought"[15]. The break of this drought in 2010 attributed to the emergence of la Nina weather conditions corresponds to a 20 year high in the rainfall data below. The average rainfall during this drought period was 633 mm, given that the rainfall for 2017 at this weather station was only 526.8 mm it is likely that this will have had an impact on water levels throughout the Coxs River catchment.

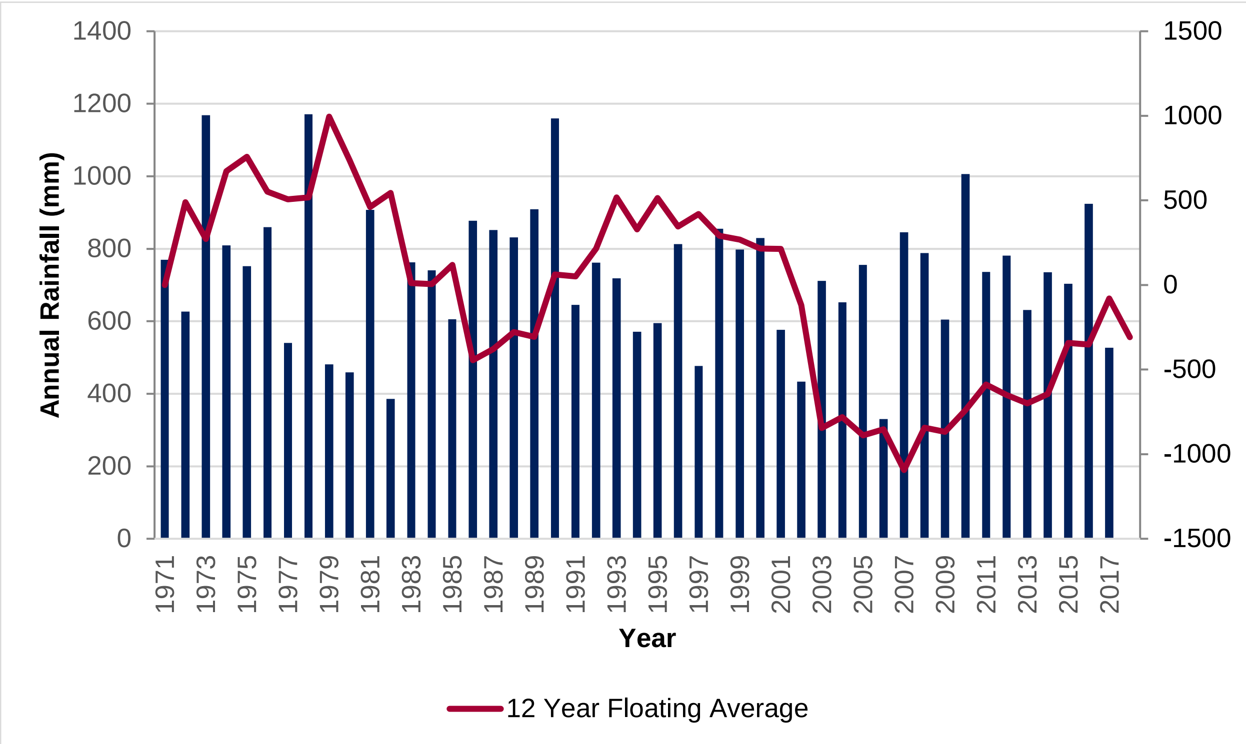

Figure 4 Annual Rainfall Lidsdale Maddox Lane (BOM Weather Station 63132[16])

Further information pertaining to rainfall departure and groundwater influences may assist further understanding of the water balance of the system.

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[15]Bureau of Meteorology, Australia
http://www.bom.gov.au/climate/updates/articles/a010-southern-rainfall-decline.shtml Accessed 04/05/2018

[16]Bureau of Meteorology, Weather Station Directory, Recent rainfall, drought and southern Australia's long-term rainfall decline.
http://www.bom.gov.au/climate/data/stations/ Accessed 04/05/2018,

Figure 7 presents a Cumulative Residual Departure from mean curve with respect to rainfall (CRD curve), developed from the Queensland Department of Science, Information Technology and Innovation (DSITI) SILO climatic database (data drill format) for the period 01 January 1992 to 05 June 2018 (JBS&G, 2018).

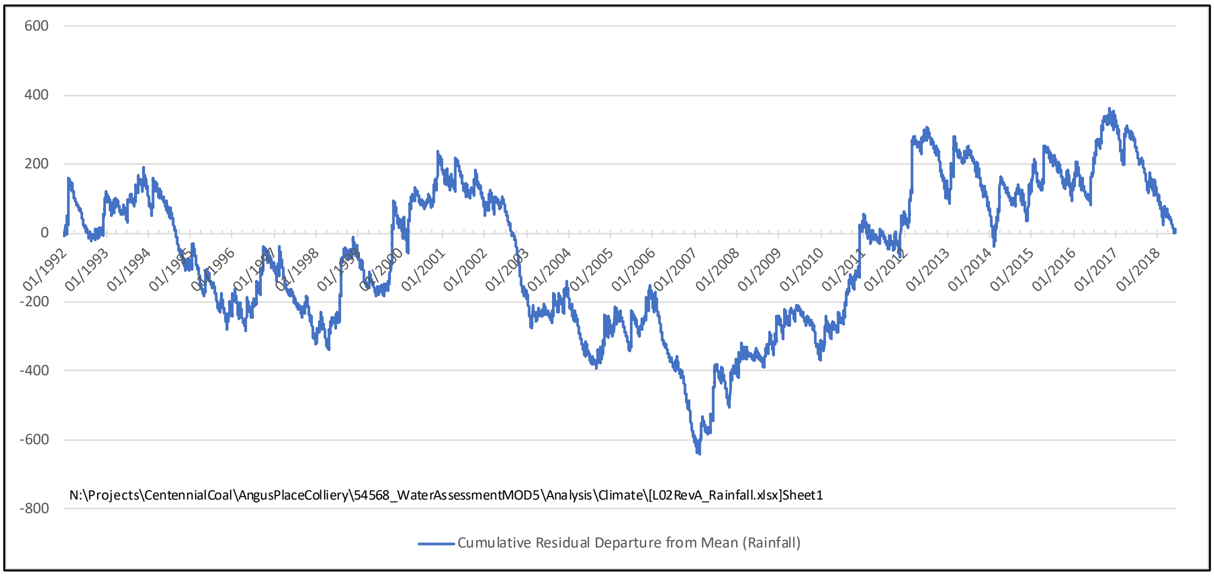


Figure 2 – Cumulative Residual Departure from Mean Rainfall for Coxs River Swamp (Adapted from JBS&G (2018))

A negative (downward) slope on a CRD curve indicates below-average rainfall conditions, a horizontal slope indicates average rainfall conditions and a positive (upward) slope indicates above-average rainfall conditions. Prolonged periods of negative slope, are indicative of drought.

As shown in **Figure 7**, the Millennium Drought, centred around 2008, was preluded by infrequent rainfall between 1996 and 2000, followed by strong drought conditions between 2001 and 2005. Occasional strong rainfall in 2003 and 2005 did not persist and conditions worsened considerably between late 2005 to early 2007. The steep and consistent negative slope between June 2002 to February 2003, December 2003 to August 2004, and from December 2005 to February 2007 are noteworthy. The recent period, December 2016 through to present is also distinctive, however, this period is not as severe as the rapid decrease experienced during the Millennium Drought.

6 Conclusions and Recommendations

The floristic and soil moisture results suggest the swamp system is currently in fair condition having met the required benchmark values for the community HN602 in Moderate/Good condition. RPS did not record any measured or anecdotal evidence to suggest otherwise at this stage. *Baumea rubiginosa* is an inundation tolerant species that requires regular water. The species showed no sign of water stress at the time of the investigation.

Inference of the data collected is limited by the 'snapshot in time' nature of the survey. A rigorous BACI monitoring program is not possible here as the opportunity for collecting baseline data has passed. A BACI framework designed monitoring program could potentially link cause and effect in environmental impact scenarios[17].

The results of the soil moisture investigation support the above conclusion given the proportion of live green cover and community structure. Location 1 and 2 both had relatively similar values for EC and VWC across most sites, except for RDP 1 (substantially higher) and RDP 6 (substantially lower). These results suggest that the investigation area at Location 1 is wetter and potentially has greater water availability for plants than the reference area at Location 2.

No mining activity has occurred within the closest longwalls for more than 30 years. There has been no mining of coal from Angus Place since March 2015 and these mining activities are unlikely to have caused localised drops in water levels. Water levels in the 800 Panel storage area have not changed significantly since 2006, through controlled pumping at a rate that balances the inflows.

Lower than average rainfall for up to 15 months, with 2017 recording the lowest annual rainfall since 2002 and 1982 prior to that, are likely to have contributed to lower ground and surface water levels, however, it is beyond the scale of inference of the collected data to directly address. Further investigations into the ground water and surface water systems could assist in accounting for the contribution of substantially low rainfall.

At the time of the investigation RPS did not record any obvious signs of decline in the vegetation condition; however, the investigation was temporally and spatially limited. The following recommendations are made to expand the scope and inference of the investigation into the future:

- Include swamp monitoring points at locations both up and down stream to record continuous water levels for the duration of the project;
- Engage hydrogeologists to investigate the groundwater systems (perched, shallow and deep) that exist in the area and their connectivity and undertake monitoring to understand the multiple water tables in the region.

We trust this information is sufficient for your purposes.

Yours sincerely,

RPS
Arne Bishop
Ecology Discipline Leader

[17] Underwood, A.J., 1992. Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world. *Journal of experimental marine biology and ecology*, *161*(2), pp.145-178.

Appendix A

Floristic data

RPS

Table 2 Floristic plots

Species name	Cover	Abundance
Plot 1 – Location 1		
Acaena novae-zelandiae	1	2
Baeckea utilis	1	3
Baloskion australe	10	1000
Baumea rubiginosa	60	2000
Carex appressa	5	100
Eleocharis sphacelata	2	20
Empodisma minus	1	10
Galium leiocarpum	2	150
*Holcus lanatus**	1	15
Juncus continuus	1	5
Leptospermum obovatum	20	50
Leptospermum polygalifolium	1	2
Panicum effusum	1	2
*Rubus fruticosus sp. agg.**	1	3
*Senecio madagascariensis**	1	5
Plot 2 – Location 2		
Baeckea utilis	1	2
Baloskion australe	5	200
Baumea rubiginosa	70	2000
Carex appressa	10	150
Euchiton sphaericus	1	5
Galium leiocarpum	2	100
Geranium neglectum	2	100
*Holcus lanatus**	1	10
Juncus sp.	1	10

Table 3 Rapid Data Points

RDP	Eastings	Northings	Details	Photo
1	230688.9	6308767.6	Percent live cover – 80 Native Species: *Baumea rubiginosa, Baeckea utilis, Carex appressa* and *Galium leiocarpum*	
2	230669.2	6308692.6	Percent live cover – 85 Native Species: *Baumea rubiginosa, Baeckea utilis, Leptospermum polygalifolium, Baloskion australe* and *Galium leiocarpum*	
3	230620.5	6308637.9	Percent live cover – 90 Native Species: *Baumea rubiginosa,* and *Leptospermum obovatum*	

RDP	Eastings	Northings	Details	Photo
4	229653.4	6311740.3	Percent live cover – 85 Native Species: *Baumea rubiginosa, Geranium neglectum* and *Poa labillardieri*. Exotic species – *Holcus lanatus* (Yorkshire fog)	
5	229652.7	6311760.0	Percent live cover – 75 Native Species: *Leptospermum obovatum*, *Baumea rubiginosa, Geranium neglectum, Carex appressa* and *Poa labillardieri*	

RDP	Eastings	Northings	Details	Photo
6	229688.1	6311827.6	Percent live cover – 85 Native Species: *Baeckea utilis Empodisma minus, Baloskion australe, Geranium neglectum* and *Carex appressa*	

APPENDIX B JBS&G GROUNDWATER ASSESSMENT (ABRIDGED)

JBS&G54568-115920 (L02_Rev0)
L02_Rev0_GroundwaterAssessmentAbridged.docx

10 July 2018

Dr Nagindar Singh
Centennial Angus Place Pty Ltd
Locked Bag 198
WALLERAWANG NSW 2845
Via email: nagindar.singh@centennialcoal.com.au

Angus Place Water Treatment Project: Section 75W Modification 5 - Groundwater Assessment (Abridged)

Dear Nagindar,

1. Introduction

JBS&G Australia Pty Ltd (JBS&G) have been engaged by Centennial Angus Place Pty Ltd (Centennial Angus Place) to abridge the Groundwater Assessment (JBS&G, 2018a) prepared in support of the establishment and operation of the temporary water treatment plant of the Angus Place Water Treatment Project (the Project).

As noted in the Surface Water Assessment (JBS&G, 2018b), Section 1.2.2, construction and operation of the temporary water treaatment plant will be undertaken in accordance with Clause 6(e) of *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries)* 2007 (NSW) for pollution reduction works permissible without development consent in conjunction with an activity approval under Part 5 of the *Environmental Planning and Assessment Act* 1979 (NSW) for the establishment of the required infrastructure.

This letter report, which summarises the outcomes of the Groundwater Assessment prepared in support of the variation to EPL (Environment Protection Licence) 467 with respect to pollution reduction works, is provided as supplementary information to the Section 75W Modification 5 Surface Water Assessment (JBS&G, 2018b).

2. Groundwater Assessment

2.1 Water Management Strategy – Proposed Change

As presented in JBS&G (2018b), Section 1.2.2, the Project seeks to:

- Construct a Temporary Water Treatment Plant at Angus Place Colliery by 30 June 2018
- Continue discharge of ‘raw’ mine water at up to 2ML/d, through Angus Place LDP001, into Kangaroo Creek, until 30 June 2018. Discharge of ‘raw’ mine water at 2ML/d is currently permitted
- Operate the Temporary Water Treatment Plant from 1 July 2018 until 31 December 2019
- From 1 July 2018 to 31 December 2019, discharge mine water (treated to 350µS/cm and at a rate of up to 10ML/d), through Angus Place LDP001, into Kangaroo Creek
- From 1 July 2018 to 31 December 2019, continue to discharge ‘raw’ mine water, at up to 6.9ML/d, which is the limit based on the current interpretation of the relevant Water Access

Licence however may be revised in the future, to the SDWTS through the Bore 940 facility, if required

- From 1 July 2018, temporarily transfer residuals generated from the Project underground within the 800 Panel Area
- From 1 January 2020, or earlier, as relevant, up to 13.4ML/d of mine water from the underground workings (800 and 900 Panel Areas) at Angus Place Colliery will be, transferred to the Springvale Water Treatment Project for treatment and beneficial re-use within the Mt Piper Power Station cooling water system. This may occur via transfers to the SDWTS using the 940 Bore or through a new pipeline to be installed from the Angus Place pit top to the raw water pipeline in the Springvale Water Treatment Project (SSD 7592).
- From 1 January 2020, or earlier, as relevant, cease to discharge mine water (raw or treated) to Kangaroo Creek through Angus Place LDP001.

2.2 Expected Changes and Potential Impacts due to the Project

As identified in JBS&G (2018a), the following list of potential changes (groundwater-related) is expected due to the Project:

- change to site water management
- change to groundwater quality (salinity, as well as other analytes)
- change to groundwater/surface water interaction
- extraction of stored mine water (post treatment phase)

Given the above, potential impacts (groundwater-related), due to the Project, may occur to:

- the Groundwater Environment
- Neutral or Beneficial Effect to the Drinking Water Catchment
- Groundwater Dependent Ecosystems
- Licensed Water Users
- Groundwater/Surface Water Interaction

This letter report presents an analysis and impact assessment with respect to the above groundwater-related aspects. It is noted that a summary of detailed analyses presented in JBS&G (2018a) is provided in this letter report, where required.

2.3 Hydrogeological Setting

2.3.1 Environmental Setting

2.3.1.1 Geology

Angus Place Colliery is situated in the southwest corner of the Western Coalfields of NSW.

The target seam that is mined at Angus Place Colliery is the Lithgow Seam. The Lithgow Seam is one of several coal seams within the Illawarra Coal Measures. The Illawarra Coal Measures are of Late Permian age. Overlying the Illawarra Coal Measures are the Narrabeen Group (of Triassic Age).

2.3.1.2 Hydrology

Surface watercourses in the vicinity of the Project include Lambs Creek, Kangaroo Creek, the Upper Coxs River and the Wolgan River. A component of mine water discharge from Angus Place Colliery currently occurs to the Coxs River via a tributary of Kangaroo Creek through Licensed Discharge Point (LDP) 001. The remainder of mine water make is transferred to the adjacent Springvale Mine.

Lambs Creek is located to the north of Angus Place Pit Top, in an adjacent catchment. Lambs Creek is also a tributary of the Upper Coxs River.

Figure 2.1 presents the location of the various watercourses in the vicinity of the Project. As well, the location of Angus Place LDP001 is presented in **Figure 2.1**, and the location of Angus Place Pit Top, Newcom Colliery (which operated between 1949 and 1978), the 300 Panel Area, 800 Panel Area and 900 Panel Area.

The potential change to groundwater/surface water in Lambs Creek and Kangaroo Creek due to the Project is assessed in **Section 2.4.3** below.

Down-gradient of the 800 Panel Area, to the northeast of Angus Place Colliery, is the Wolgan River. There is no mine water discharge to the Wolgan River; however, there is potential for seepage to occur from the mine water store in the 800 Panel Area toward the Wolgan River. This aspect is assessed in **Section 2.4.3** below and mitigation measures presented in **Section 2.4.4**.

2.3.1.3 Climate

Figure 2.2 presents a Cumulative Residual Departure from Mean curve with respect to Rainfall (CRD curve) developed from the Queensland Department of Science, Information Technology and Innovation (DSITI) SILO climatic database (data drill format). The data used in **Figure 2.2** ranged between 1 January 1992 through to 5 June 2018, and was calculated based on internal monthly means, however, expressed on a daily basis. It is noted that the CRD curve was constructed from 1 January 1992, as opposed to 1 January 2005, which is what is adopted in the swamp piezometer hydrographs regularly produced as part of the monitoring program at Angus Place Colliery, so as to allow consideration of the effect of the Millennium Drought.

A negative (downward) slope on a CRD curve (refer **Figure 2.2**) indicates below-average rainfall conditions, a horizontal slope indicates average rainfall conditions and a positive (upward) slope indicates above-average rainfall conditions. Prolonged periods of negative slope, are indicative of drought.

From **Figure 2.2**, the Millennium Drought was preluded by patchy rainfall between 1996 to 2000, followed by strong drought conditions between 2001 to 2005. Occasional strong rainfall in 2003 and 2005 did not persist and conditions worsened considerably between late 2005 to early 2007.

From **Figure 2.2**, the very steep, and consistent negative slope between June 2002 to February 2003, December 2003 to August 2004, and from December 2005 to February 2007 are noteworthy. The recent period, December 2016 through to present is also distinctive; however, is not as severe as the rapid decrease experienced during the Millennium Drought.

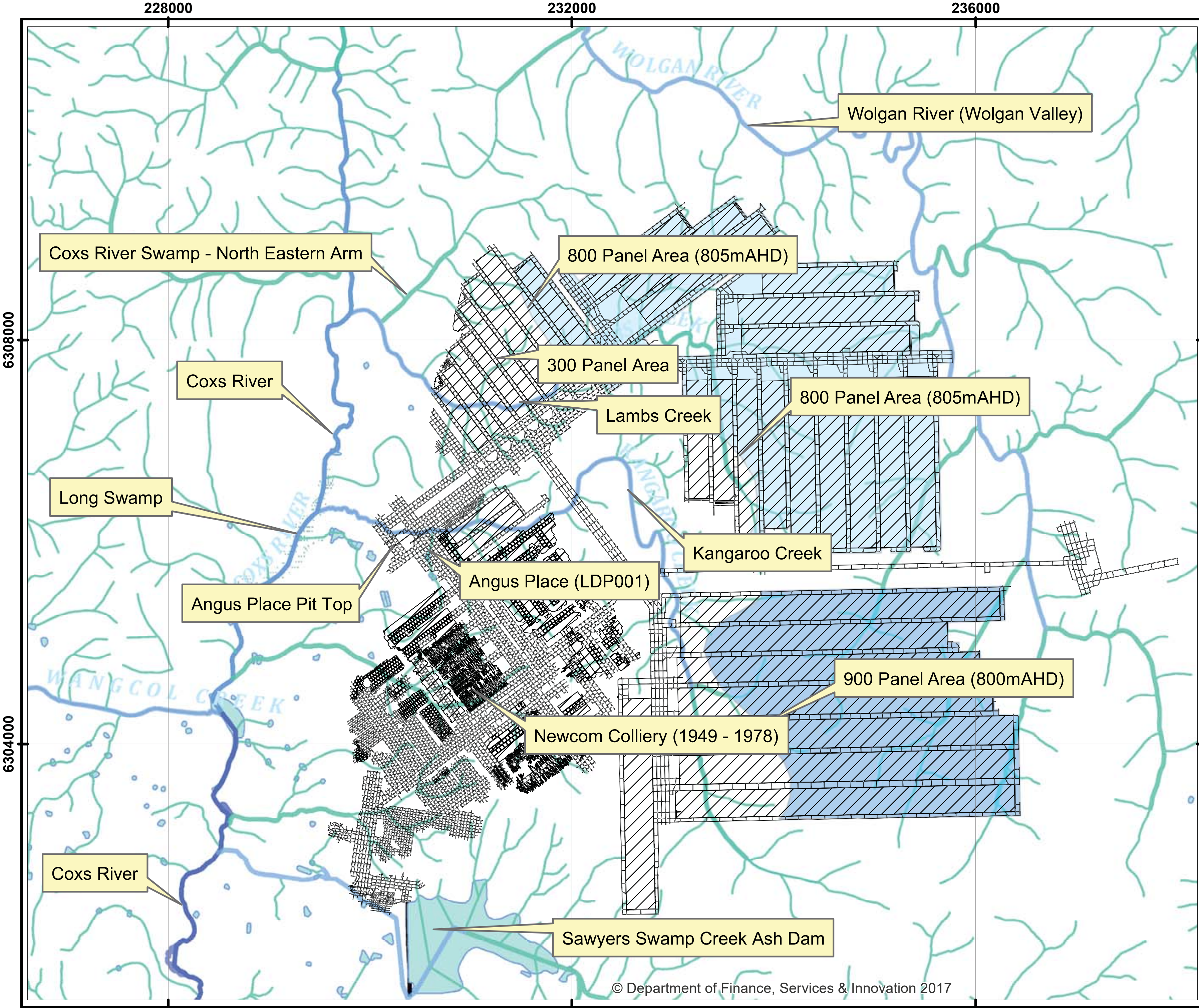
2.3.1.4 Ecology

Temperate Highland Peat Swamps on Sandstone (Newnes Plateau)

Temperate Highland Peat Swamps on Sandstone (THPSS) are identified on the Newnes Plateau. Those swamps underlie the historical mine workings at Angus Place Colliery.

There will be no subsidence-related change to groundwater or surface water conditions with respect to the THPSS on the Newnes Plateau, since the Project does not comprise any mining, and no mining currently occurs at Angus Place Colliery due to the mine being under Care and Maintenance, and has been since March 2015.

An analysis of the potential change due to dewatering of the 800 and 900 Panel Area is presented in **Section 2.4.3**.



Legend:
- Angus Place Workings
- 800 Panel Area - Mine Water Store
- 900 Panel Area - Mine Water Store

NB. Nomenclature of Hydrology Layer is indicative only and is not Strahler Order.

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Scale 1:50,000

0 1,000 2,000 metres

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Angus Place Colliery
LIDSDALE NSW

EXTENT OF CURRENT WORKINGS

FIGURE: 2-1

File Name: N:\Projects\CentennialCoal\AngusPlaceColliery\54568_WaterAssessmentMOD5\Figures\GIS\Delivery\L02RevB_D003_ExtentCurrentWorkings.mxd
Reference: Layer from NSW LPI Web Services, 2018

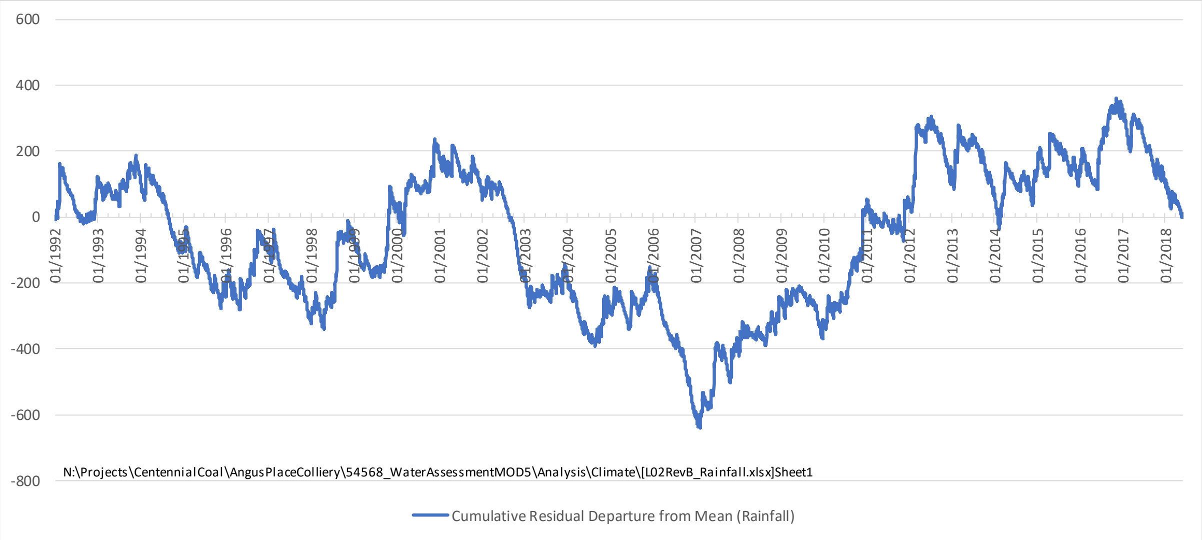


Figure 2.2: Cumulative Department from Mean (Rainfall) – Coxs River Swamp

Montane Peatlands and Swamps

Within the Coxs River catchment, the Coxs River Swamp[1], is identified as a Montane Peatland and Swamp. **Figure 2.3** presents the mapped extent of the Montane Peatlands and Swamps (MU 53) from DEC (2006), as well as recent work undertaken by NSW EPA (2016).

From **Figure 2.3**, there has been a refinement in the mapped extent of the Montane Peatlands and Swamps in the recent work undertaken by NSW EPA (2016) compared to the initial mapping presented in DEC (2006) with respect to the Coxs River Swamp.

It is noted that the recent work by the NSW EPA was undertaken in collaboration with, and on behalf of, Forestry Corporation NSW. Accordingly, it is expected that the updated mapping did not extend outside of the estate of Forestry Corporation NSW and, as such, Lambs Creek and Kangaroo Creek is expected will still contain vegetation that would be mapped as Montane Peatlands and Swamps.

The MU 53 – Mountain Hollow Grassy Fen (DEC, 2006) vegetation community is listed under the *Biodiversity Conservation Act 2016* (BC Act) as an endangered ecological community (EEC) commensurate with *Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions.*

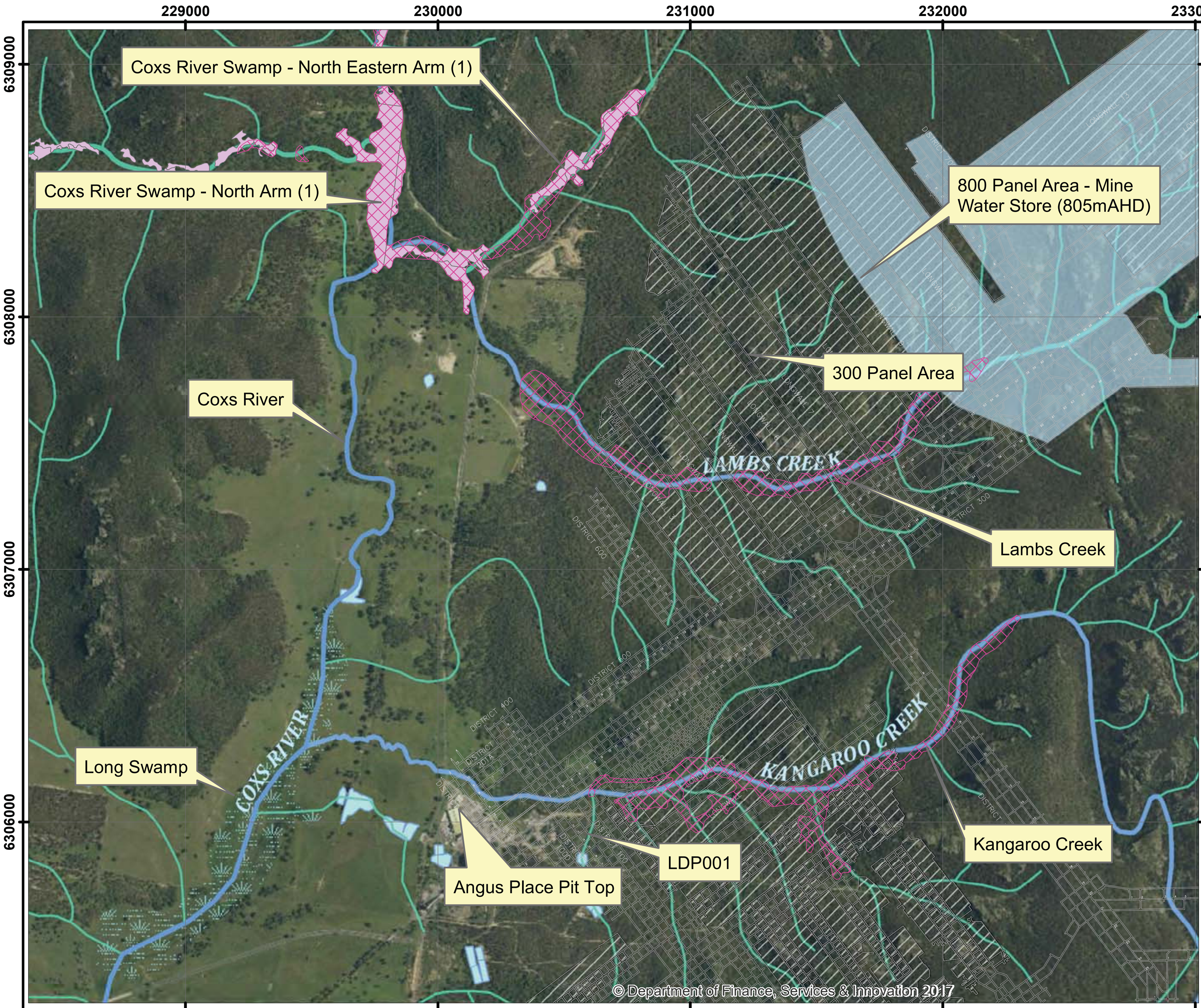
An analysis of the potential change to the Coxs River Swamp due changes to groundwater/surface water interaction is presented in **Section 2.4.3** below.

Long Swamp

Long Swamp represents one of the largest swamps (wetlands) in the vicinity of the Angus Place Colliery Pit Top. It straddles the upper reach of the Coxs River and is mapped as *Typha orientalis Wetland* in accordance with DEC (2006). Recent work by Centennial Angus Place's ecologists have confirmed the mapping by DEC (2006). The definition and the boundary of Long Swamp been obtained from the NSW Geographical Names Board (GNB5939, dated 30 May 1975). Long Swamp extends along the Coxs River from above the confluence of Kangaroo Creek with the Coxs River to below the confluence and further downstream to below the culvert on the Mt Piper Haul Road.

Long Swamp is discussed in detail in the Surface Water Assessment (JBS&G, 2018b) and that assessment is not repeated here. In summary, it was found in JBS&G (2018b) that there is a

[1] It is noted that the name 'Coxs River Swamp' is provisional and subject to confirmation.



Legend:

Montane Peatlands and Swamps

MU 53 (DEC, 2006)

MU N/A (NSWEPA, 2016)(2)

Mine Workings

Angus Place (Historical)

800 Panel Area - Mine Water Store

Notes: 1) The title of this swamp is provisional;
2) It is expected that mapping did not extend outside of Forestry Corporation NSW land holdings. As such, Lambs and Kangaroo Creek may contain MU 53.

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Scale 1:20,000

0 400 800
metres

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Angus Place Colliery
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MAPPED EXTENT OF MU 53 (DEC, 2006) AND MONTANE PEATLANDS AND SWAMPS (NSWEPA, 2016)

FIGURE: 2-3

File Name: N:\Projects\CentennialCoal\AngusPlaceColliery\54568_WaterAssessmentMOD5\Figures\GIS\Delivery\L02RevB_D001_MU53.mxd
Reference: Hydrology Layer and Imagery from NSW LPI Web Services, 2018; Biodiversity Layer from DEC, 2006 and NSW EPA, 2016.

potential change to the vertical hydraulic gradient between the perched groundwater system at Long Swamp and the underlying deep groundwater system (Lithgow Seam) due to the Project, however that change is expected to be minor to negligible in magnitude, and negligible in impact.

As noted in the Surface Water Assessment (JBS&G, 2018b), the groundwater elevation in the Lithgow Seam at the mine portal at Angus Place Pit Top is maintained at 841mAHD or below to provide mine access. The mine portal was established in 1979.

2.3.1.5 Historical Mining

Table 2.1 presents the longwall mining history (selected) at Angus Place Colliery. Of note is Longwall 3 to Longwall 10, as these longwalls are near the north-eastern branch of the Coxs River Swamp[1].

Table 2.1: Longwall Mining History (Angus Place Colliery)

Longwall	Start	Finish
3	16 February 1981	6 July 1981
4	11 August 1981	13 November 1981
5	16 February 1982	15 June 1982
6	13 July 1982	18 November 1982
7	17 January 1983	1 August 1983
8	10 August 1983	14 December 1984
9	28 March 1985	8 July 1986
10	18 August 1986	27 August 1987

From **Table 2.1**, mining in the 300 Panel Area (Longwall 3 to Longwall 10) occurred in the 1980s.

An analysis of the potential change due to interaction between historical workings, the mine water store and the Coxs River Swamp is presented below, in **Section 2.4.3**.

2.3.2 Hydrogeological Environment

2.3.2.1 Groundwater Environment

There are three groundwater systems described in the conceptual hydrogeological model for Angus Place Colliery.

The perched groundwater system, near to surface, is influenced by 'locally shallow' lower permeability units such as the clay aquitard plies of the Burralow Formation on the Newnes Plateau; the shale/siltstone interburden of the Illawarra Coal Measures with respect to the Coxs River Swamp; and the Denman Formation mudstone/siltstone with respect to Long Swamp.

The shallow groundwater system exists within the Banks Wall Sandstone, above the Mount York Claystone, on the Newnes Plateau system. The shallow groundwater system is not considered to be present along the Coxs River, since the Banks Wall Sandstone and Mount York Claystone are absent, having been eroded away through naturally occurring processes. It is noted that groundwater monitoring is not currently undertaken along the Coxs River or beneath the Coxs River Swamp[1].

A deep groundwater system has developed in the target Lithgow Seam beneath the Newnes Plateau, due to the effect of depressurisation during mining. The deep groundwater system is considered to have also developed beneath the Coxs River Swamp[1]. i.e. an unsaturated zone exists between the perched groundwater system, upon which the Coxs River Swamp resides, and the deep groundwater system beneath the Coxs River Swamp.

The Project will consist temporary transfer of residuals underground to the 800 Panel Area. An analysis of this change to the groundwater environment is presented in **Section 2.4.1** and **2.4.2**.

2.3.2.2 Neutral or Beneficial Effect to the Drinking Water Catchment

Mine water discharge occurs to the Coxs River via Kangaroo Creek. The Coxs River eventually feeds into Lake Burragorang, some 100km downstream. The impact of mine water discharge is assessed in the Surface Water Assessment (JBS&G, 2018b), which has already been presented.

Analysis of the potential change to groundwater/surface water interaction, with respect to seepage from the mine water store into a tributary of the Coxs River, and hence the catchment of Lake Burragorang, is presented in **Section 2.4.3**.

2.3.2.3 Groundwater Dependent Ecosystems

The following ecosystems in the vicinity of the Project are considered to be groundwater dependent:

- Temperate Highland Peat Swamps on Sandstone (THPSS)
- Montane Peatlands and Swamps (Coxs River Swamp[1])
- Long Swamp

It is noted that an assessment of Long Swamp has already been presented in the Surface Water Assessment (JB&G, 2018b) and is not repeated here.

The location of the Coxs River Swamp[1], which has been mapped as Montane Peatlands and Swamps is presented in **Figure 2.3**. The location of Long Swamp is also presented in **Figure 2.3**, however, Long Swamp is not mapped as Montane Peatland and Swamps.

The potential change to groundwater dependent ecosystems is presented in **Section 2.4.3** below.

2.3.2.4 Licensed Water Users

As is presented in JBS&G (2018a), there are no groundwater works (extraction bores and monitoring locations) between the 800 Panel Area and the Wolgan Valley that could be subject to change in groundwater water level or quality due to the Project. There are no also groundwater users adjacent to Lambs Creek, Kangaroo Creek or the Coxs River, in the vicinity of Angus Place Colliery, that could be subject to a change due to the Project.

There are no surface water users in the vicinity of Angus Place Colliery. An assessment of the impact of the proposed change to mine water discharge, however, on downstream surface water users is presented in the Surface Water Assessment (JB&S, 2018b). In summary, it was found that the impact of the Project to those users was not significant.

2.3.2.5 Groundwater/Surface Water Interaction

The following surface watercourses may be subject to change to due to the Project:

- Lambs Creek and Kangaroo Creek, which are tributaries of the Coxs River
- Wolgan River, on the Newnes Plateau and in the Wolgan Valley.

An assessment of the potential change to groundwater/surface water interaction is presented in **Section 2.4.3**.

2.4 Hydrogeological Analysis

2.4.1 Water and Salt Balance Modelling of Stored Mine Water

2.4.1.1 Proposed Change

The proposed change to site water management and groundwater quality due to the Project consists:

- transfer of residuals into the mine water store in the 800 Panel Area (treatment phase)

- dewatering of the mine water store in the 800 Panel Area (post-treatment phase)

2.4.1.2 Analysis

A new GoldSIM model was prepared and is referred to as the Springvale-Angus Place Residual Management Model (SAPRMM).

The objectives of the model were to:

- maximise utilisation of available discharge capacity
- assess the time-series change in salinity in the mine water store in the 800 Panel Area
- assess the time-series change in storage in the mine water store in the 900 Panel Area
- create contingency storage for the Project
- crease contingency storage for the, soon to commence, Springvale Water Treatment Project
- demonstrate that the proposed EPL limit on Angus Place LDP001 of 350µS/cm at up to 10ML/d (volumetric discharge) is plausible
- demonstrate that the current EPL limit on Springvale LDP009 of 1,200µS/cm at up to 30ML/d (volumetric discharge) can be met
- confirm modelled, combined, take from the 800 and 900 Panel Area, is less than 13.4ML/d, which was the predicted mine inflow for existing operations, as presented in RPS (2014).

Detailed layout of the model assumptions and setup is presented in JBS&G (2018a); however, the pertinent results are presented in **Section 2.4.1.3**, immediately below.

2.4.1.3 Results of Analysis

The SAPRMM indicated that the temporary transfer of residuals into the 800 Panel Area will lead to an increase in salinity. **Figure 2.4** presents the time-series change in water quality (salinity).

From **Figure 2.4**, the modelled water quality (salinity) will increase from 804mg/L (1,200µS/cm, assumed (conservative)) on 1 July 2018 to 2,541mg/L (~3,792µS/cm) on 2 January 2020, under the assumed Water Treatment Plant treatment efficiency.

Figure 2.5 presents the time-series modelled storage volume in the 800 Panel Area.

From **Figure 2.5**, the stored volume is maintained until 1 January 2020, upon which dewatering commences and proceeds until the mine water store is dissipated.

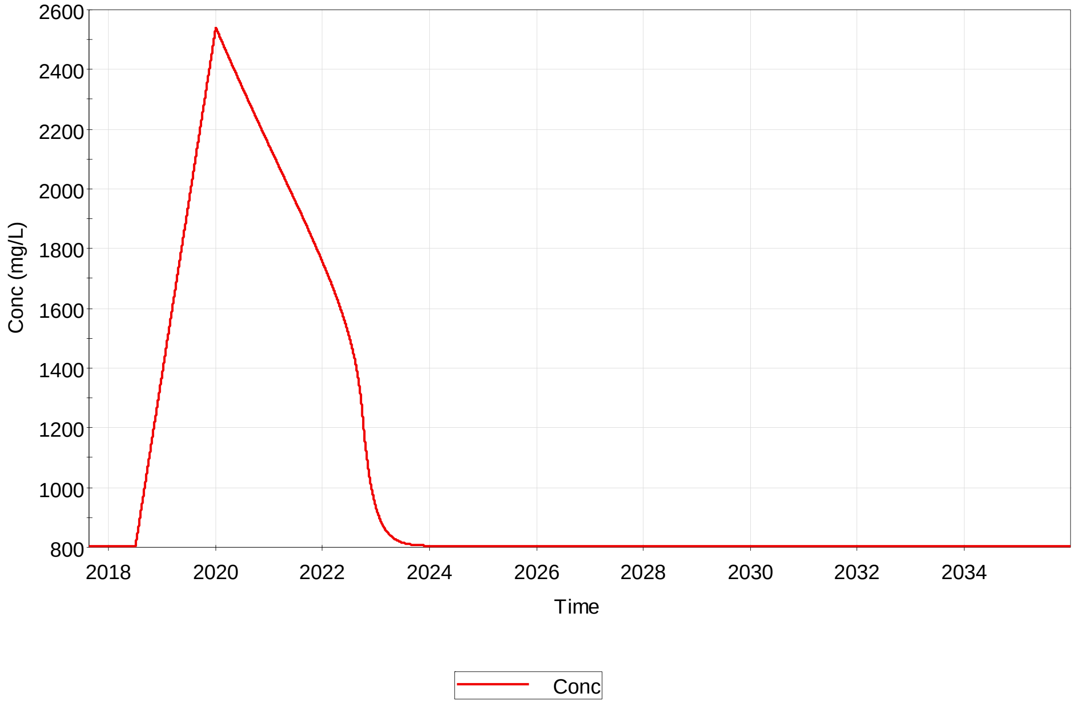


Figure 2.4: Modelled Groundwater Quality (Salinity) – 800 Panel Area (mg/L)

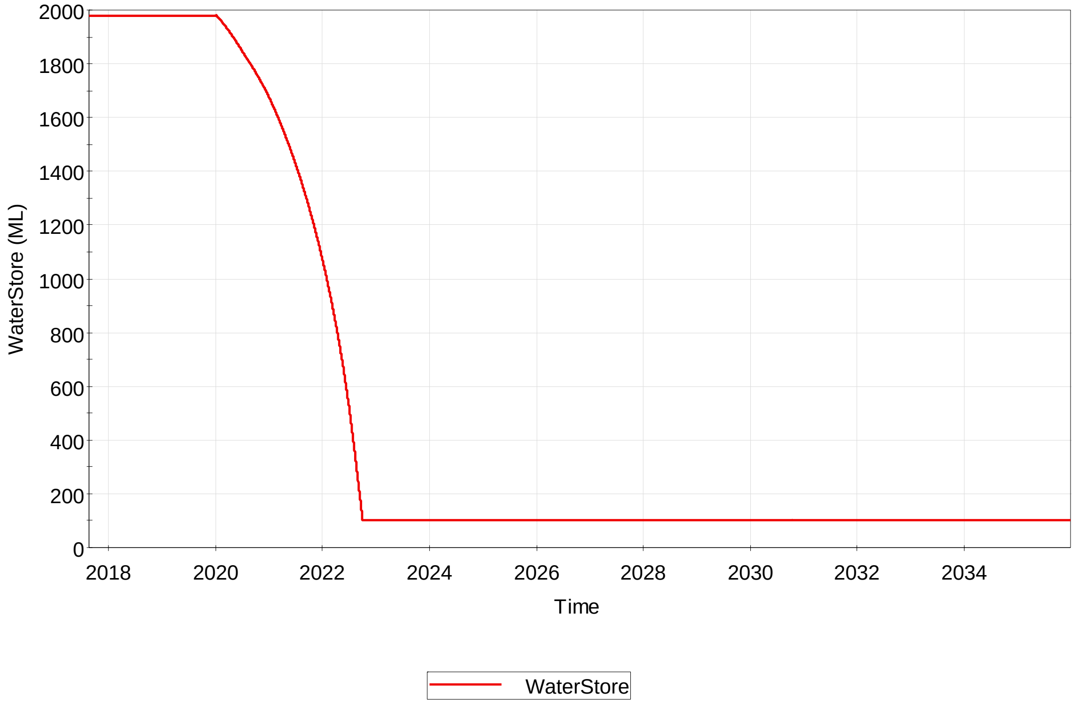


Figure 2.5: Modelled Storage Volume – 800 Panel Area (ML)

Modelling indicates that the mine water store will be dissipated (return to background salinity, 99%) by August 2023 (812mg/L (1,212µS/cm) on 30 July 2023).

2.4.2 Water Quality Modelling of Stored Mine Water (Other Analytes)

2.4.2.1 Proposed Change

The proposed change to groundwater quality (other analytes) due to the Project consists:

- transfer of residuals into stored mine water within the 800 Panel Area

2.4.2.2 Analysis

To investigate the effect of the Project on water quality (other analytes), a model was developed using the United States Geological Survey (USGS) aqueous speciation software PHREEQCi.

Detailed information about model setup and assumptions is presented in JBS&G (2018a); however, the pertinent results are presented in **Section 2.4.2.3**, immediately below.

2.4.2.3 Results of Analysis

Modelling indicates that the resultant water quality of the mine water store in the 800 Panel Area, at the end of the treatment phase on 2 January 2020 (maximum salinity from the SAPRMM), is a Na-HCO_3 (Sodium Bicarbonate) type water, with near neutral pH, that is brackish but not saline.

Modelling indicates there are no exceedances of the default guideline values for the 95th% protection level for slightly to moderately disturbed freshwater aquatic ecosystems, aside from salinity, which is significantly exceeded. It is noted mine water with elevated salinity within the 800 Panel Area will not be discharged to the environment without any treatment to reduce the salinity.

2.4.3 Groundwater/Surface Water Interaction

2.4.3.1 Proposed Change

The proposed change to groundwater/surface water interaction due to the Project consists of:

- transfer of residuals into stored mine water within the 800 Panel Area leading to potential change in surface water quality through groundwater/surface water interaction via seepage
- potential to reduce the standing water level in groundwater dependent ecosystems and surface watercourses during dewatering of the 800 and 900 Panel Areas.

2.4.3.2 Analysis

The mine water store within the Lithgow Seam of the 800 Panel Area has been maintained at an elevation of 805mAHD since approximately 2006. i.e. at the ‘full’ storage capacity level. The groundwater flow direction from the 800 Panel Area is toward the Wolgan Valley, consistent with the regional ‘dip’ of the Lithgow Seam. The elevation of the mine water store in the Lithgow Seam of the 900 Panel Area is currently 800mAHD.

The location of the mine water store in the 800 Panel Area with respect to the Coxs River Swamp is presented in **Figure 2.6**, together with the elevation of the Lithgow Seam (green contours), the elevation of ground surface (red contours), hydrologic drainage lines (blue lines), the historical workings at Angus Place Colliery (grey outline) and an interpretation of output from the update to the numerical groundwater model which is currently underway (black contours). An equivalent figure with respect to Long Swamp is presented in **Figure 2.7**. The location of several long-sections are presented in **Figure 2.8**, with charts from those sections presented further below.

An analysis of potential change to groundwater/surface water interaction due to the Project, both during the treatment phase and the post-treatment phase is presented below.

Temperate Highland Peat Swamps on Sandstone (Newnes Plateau)

The THPSS on the Newnes Plateau exist at an elevation that is well above the Lithgow Seam. As such, there can be no seepage of groundwater stored in the 800 Panel Area 'uphill' into the THPSS.

During dewatering of the mine water store in the 800 Panel Area (post-treatment phase) and during dewatering of the 900 Panel Area (treatment phase), there will be a re-drawdown in groundwater elevation within the Lithgow Seam (deep groundwater system).

As presented in **Section 2.3.2.1**, however, the perched groundwater system, upon which the THPSS reside, is hydraulically separated from the deep groundwater system, due to the presence of multiple phreatic (water tables) surfaces. i.e. an unsaturated zone exists between the perched groundwater system and the shallow groundwater system and another unsaturated zone exists between the shallow groundwater system and the deep groundwater system. Accordingly, changes to the groundwater elevation in the deep groundwater system will have negligible effect on the water table elevation in the perched groundwater system.

The Project does not comprise additional mining and therefore, there will also be no subsidence-related change to THPSS on the Newnes Plateau.

Montane Peatlands and Swamps (Coxs River Swamp[1])

From **Figure 2.6**, the north-eastern branch of the Coxs River Swamp[1] is located immediately adjacent the 300 Panel Area (Longwall 3 to Longwall 10). From **Table 2.1**, mining occurred in the 300 Panel Area in the 1980s.

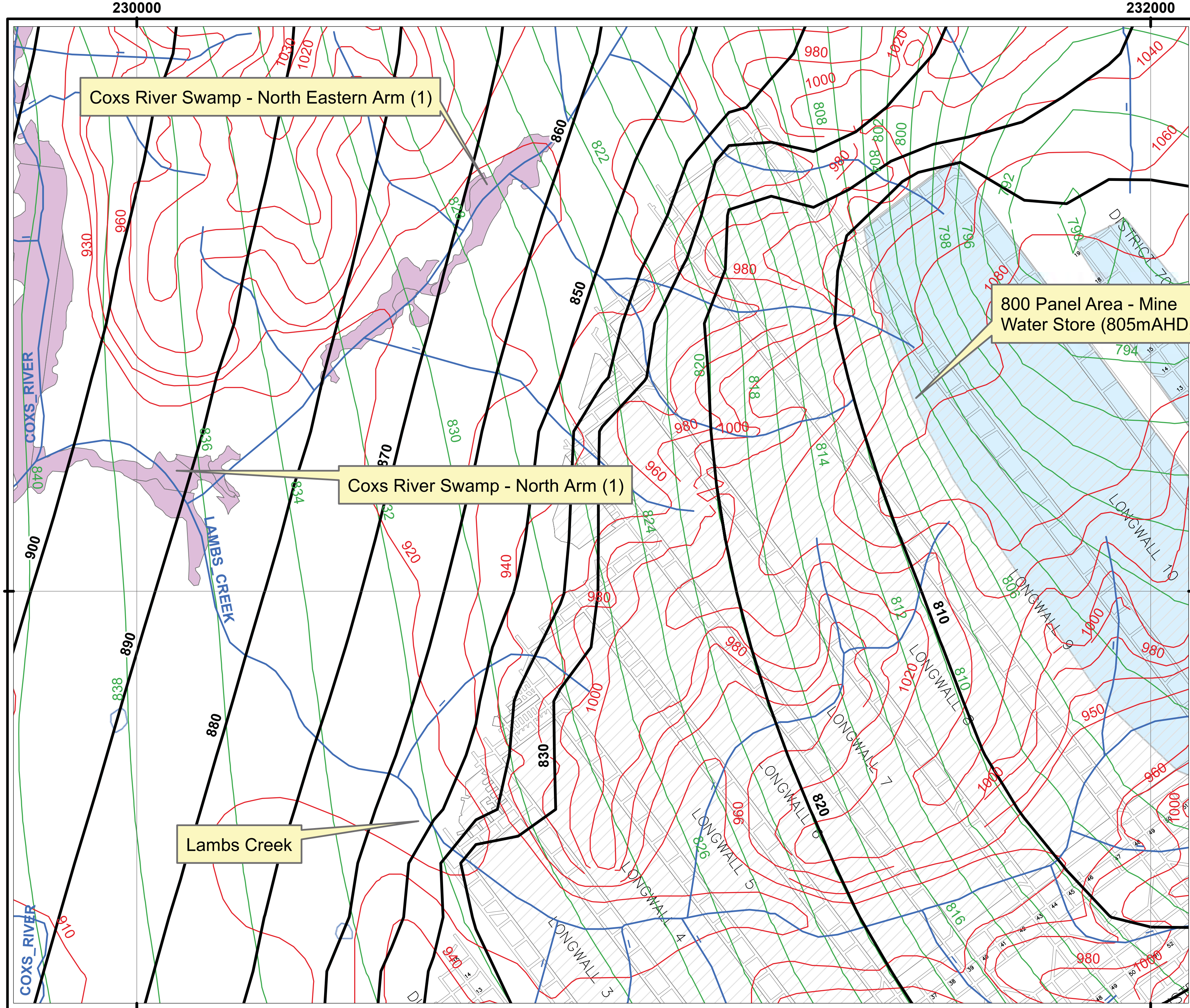
Since 2006, the groundwater elevation in the mine water store in the 800 Panel Area has been, essentially, constant at 805mAHD. Prior to 2006, the 300 Panel Area and other panels would have been maintained in a dewatered (dry, therefore at or below the floor of the Lithgow Seam) state since the time of mining; presumably to 784mAHD with respect to Longwall 11 to 13 (800 Panel Area) and presumably, progressively, from 815mAHD through to 770mAHD with respect to Longwall 16 to 26N (within the 800 Panel Area). This is because mining of Longwall 26N in the 800 Panel Area (refer to Figure 1.1 of JBS&G (2018b) for the location of the 800 Panel Area and other panels) was completed in September 2003. i.e. Longwall 26N is the northernmost and lowest, down-dip, panel at Angus Place Colliery and, as such, the whole mine would have needed to be maintained in a dewatered (dry) state to allow access to that panel.

From **Figure 2.6**, the ground surface elevation of the north-eastern branch of the Coxs River Swamp ranges between 930mAHD in the northeast to 918mAHD in the southwest. i.e. the Coxs River Swamp flows from the northeast to the southwest. The water table elevation within the Coxs River Swamp is not known, but could reasonably be assumed to correspond with ground surface.

From **Figure 2.6**, the elevation of the floor of the Lithgow Seam ranges from 824mAHD in the northeast to 832mAHD in the southwest. The Coxs River Swamp is therefore 106m (930mAHD – 824mAHD = 106m) above the Lithgow Seam in the northeast and is 86m (918mAHD – 832mAHD = 86m) above the Lithgow Seam in the southwest. It is highlighted that the Lithgow Seam dips from the southwest to the northeast, which is the opposite direction to the slope of the ground surface through the Coxs River Swamp.

Because the Coxs River Swamp is 106 to 86m above the floor of the Lithgow Seam, at respective locations, seepage from mine water stored in the 800 Panel Area during the treatment phase into the Coxs River Swamp cannot occur.

During proposed dewatering of the 800 Panel Area (post-treatment phase), concern has been expressed that this may lead to a drawdown in the water table elevation within the Coxs River Swamp. In 2004, for instance, it was observed that the north-eastern branch of the Coxs River Swamp suffered significant dieback. This issue is discussed in detail below.



Legend:
Contours (mAHD)
Deep Groundwater Level(2)
Ground Surface
Lithgow Seam Floor
Angus Place
Mine Workings (Historical)
800 Panel Area - Mine Water Store
Montane Peatlands and Swamps
MU N/A (NSWEPA, 2016)

Notes: 1) The title of this swamp is provisional.; 2) Deep groundwater contours (Lithgow Seam) interpreted from preliminary groundwater model output (R01RevA_CAL-Oct17_03a.gwv)

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Client: Centennial Angus Place Pty Ltd	
Version: L02RevB	Date: 30-Jun-2018
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Scale 1:10,000	

0 200 400
metres

Coor. Sys. GDA 1994 MGA Zone 56

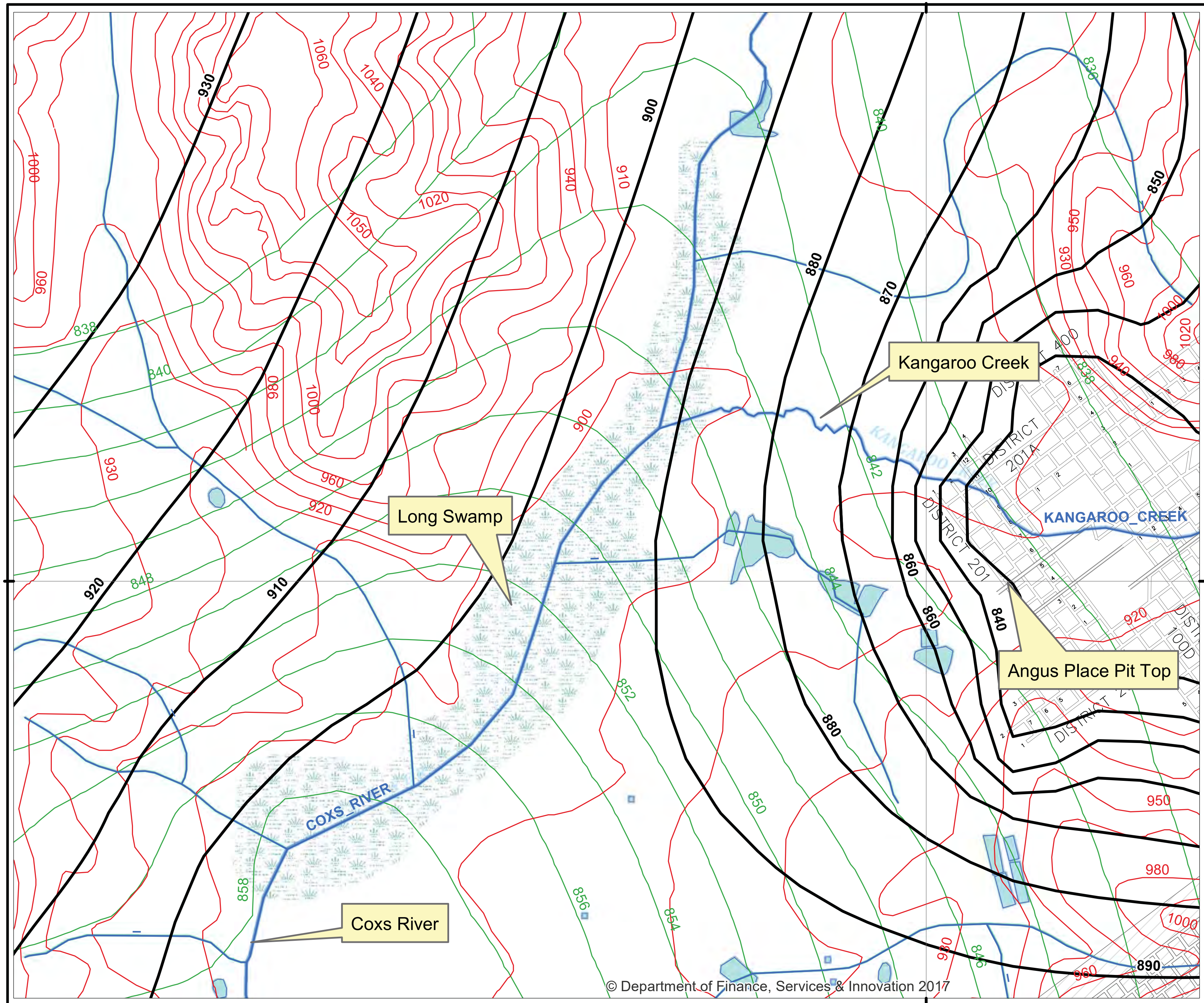
Angus Place Colliery
LIDSDALE NSW

GROUNDWATER AND SURFACE WATER INTERACTION

COXS RIVER SWAMP

FIGURE: 2-6

File Name: N:\Projects\CentennialCoal\AngusPlaceColliery\54568_WaterAssessmentMOD5\Figures\GIS\Delivery\L02RevB_D002_GroundwaterSurfaceWaterInteraction.mxd
Reference: Hydrology Layer from NSW LPI Web Services, 2018; Biodiversity Layer from NSW EPA (2016).



Legend:

Contours (mAHD)

- Deep Groundwater Level(2)
- Ground Surface
- Lithgow Seam Floor

Angus Place

- Mine Workings (Historical)

Notes: 1) The title of this swamp is provisional.; 2) Deep groundwater contours (Lithgow Seam) interpreted from preliminary groundwater model output (R01RevA_CAL-Oct17_03a.gwv)

JBS&G

Job No: 54568

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Scale 1:10,000

0 200 400 metres

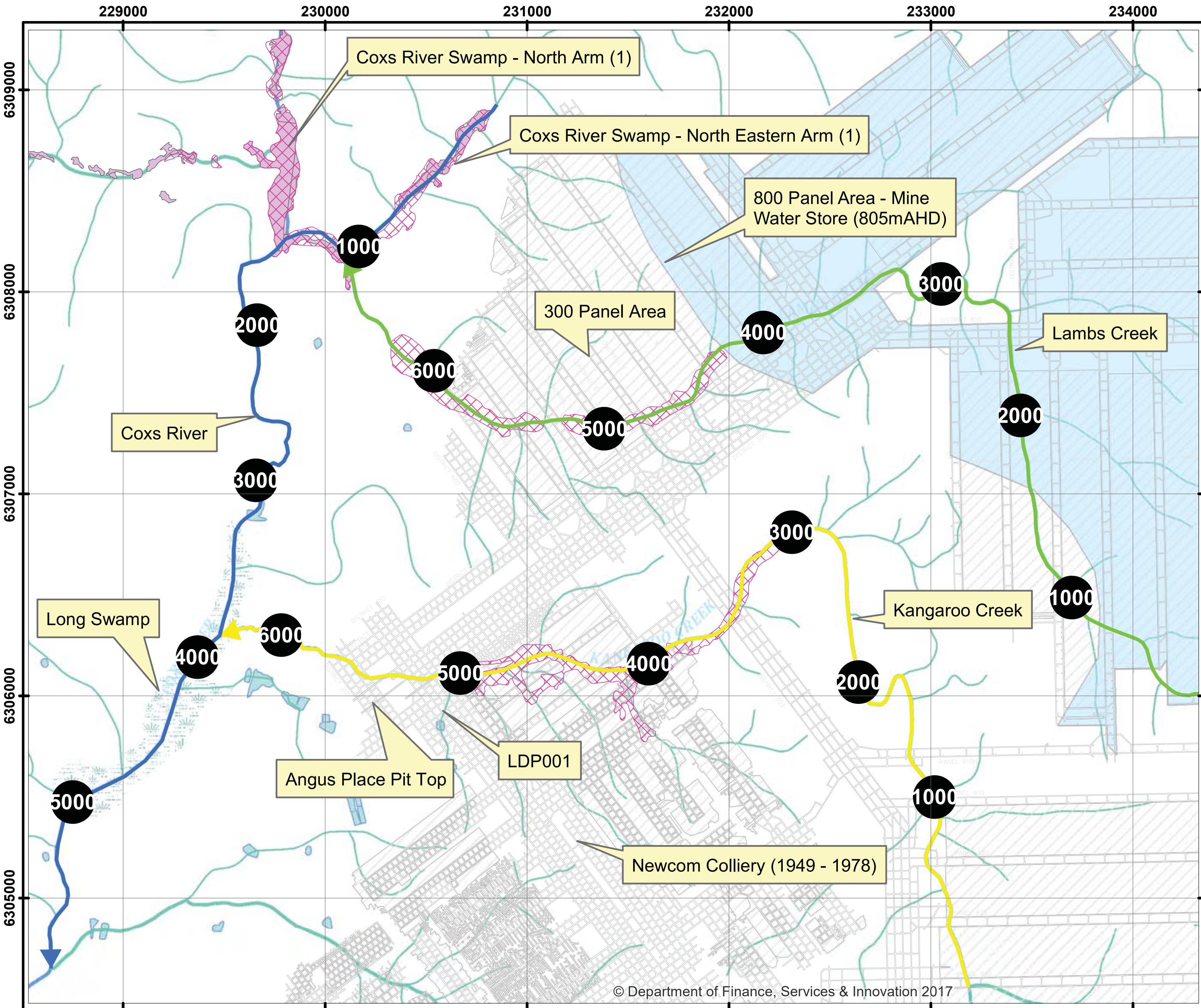
Coor. Sys. GDA 1994 MGA Zone 56

Angus Place Colliery
LIDSDALE NSW

GROUNDWATER AND SURFACE WATER INTERACTION

LONG SWAMP

FIGURE: 2-7



Legend:

Long-Sections

- Upper Coxs River
- Lambs Creek
- Kangaroo Creek

Montane Peatlands and Swamps

- MU 53 (DEC, 2006)
- MU N/A (NSWEPA, 2016)(2)

Angus Place

- Mine Workings (Historical)
- 800 Panel Area - Mine Water Store

Notes: 1) The title of this swamp is provisional;
2) It is expected that mapping did not extend outside of Forestry Corporation NSW land holdings. As such, Lambs and Kangaroo Creek may contain MU 53.

Job No: 54568

Client: Centennial Angus Place Pty Ltd

Version: L02RevB	Date: 29-Jun-2018
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Scale 1:25,000

0 500 1,000
metres

Coor. Sys. GDA 1994 MGA Zone 56

Angus Place Colliery
LIDSDALE NSW

LOCATION OF LONG-SECTIONS AND DISTANCE MARKERS (M)

FIGURE: 2-8

File Name: N:\Projects\CentennialCoal\AngusPlaceColliery\54568_WaterAssessmentMOD5\Figures\GIS\Delivery\L02RevB_D004_Long-Sections.mxd
Reference: Hydrology Layer from NSW LPI Web Services, 2018; Biodiversity Layer from DEC, 2006 and NSW EPA, 2016.

As identified in **Section 2.3.2.1**, the shale and siltstone interburden, between the various coal seams that outcrop along the north-eastern branch of the Coxs River Swamp, is the 'locally shallow' lower permeability units upon which the perched groundwater system has developed.

Whilst groundwater monitoring does not currently exist along Coxs River Swamp, a hydrogeological interpretation can be developed from the information that is available.

From **Figure 2.6**, preliminary output from the update to the numerical groundwater model suggests a deep groundwater system has developed beneath the perched groundwater system upon which the Coxs River Swamp resides, due to the effect of depressurisation of the mine in the past. i.e. the modelled groundwater elevation in the Lithgow Seam beneath the Coxs River Swamp is 870mAHD compared to the water table elevation in the swamp (assumed to be coincident with ground surface) of 925mAHD, although the modelled uppermost water table suggests it may be 910mAHD.

Given that mining of the 300 Panel Area occurred in the 1980s, and the groundwater elevation in the Lithgow Seam adjacent Coxs River Swamp has been maintained at or below the floor of the Lithgow Seam since the time of mining, if there were not two, separated groundwater systems, then the Coxs River Swamp would have been already and continuously impacted.

A long-section from above the Coxs River Swamp downstream through Long Swamp is presented in **Figure 2.9**. The location of the long-section is presented in **Figure 2.8**, including distance markers. From **Figure 2.8**, Coxs River Swamp – North Eastern Arm occurs at distance between 0m and 1000m in **Figure 2.9**.

In **Figure 2.9**, red represents ground surface elevation, green is the elevation of the Lithgow Seam, black is the preliminary output from the groundwater model for the deep groundwater system and yellow is the preliminary output from the groundwater model for the uppermost water table. It is noted that the contours of the modelled uppermost water table are not presented in **Figure 2.6** for the purpose of clarity. It is further noted that, in the groundwater model simulation, the Lithgow Seam was assumed to be dewatered and is maintained, in the model, in a dewatered state (conservative).

A review of **Figure 2.2,** presents the CRD curve for the locality, presented in **Section 2.3.1.3** notes periods of well below-average rainfall occurred between June 2002 to February 2003, December

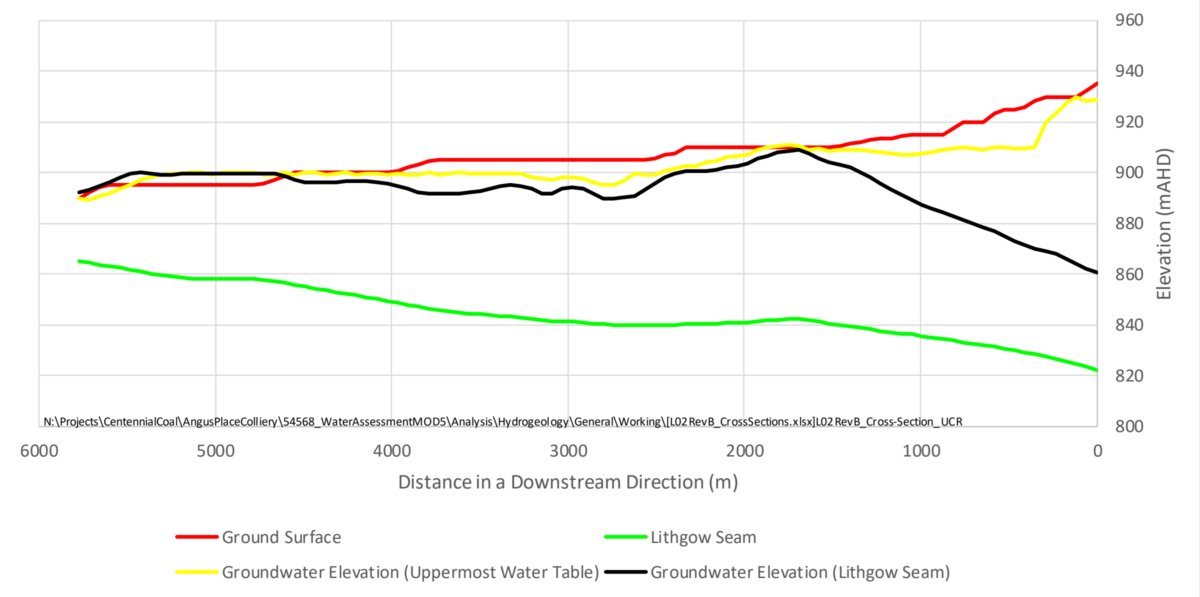


Figure 2.9: Long-Section: Upper Coxs River (Coxs River Swamp-North Eastern Arm to Long Swamp)

2003 to August 2004, and from December 2005 to February 2007. From **Figure 2.2**, the almost constant negative slope in the period December 2003 to August 2004 implies that there was almost no rainfall during that time. It is considered that observed period of dieback in 2004 noted above coincides with the Millennium Drought and recent observation (March 2018) of a drop in the water table elevation in part of the wetland is consistent with the protracted below-average rainfall conditions currently being experienced throughout the region.

It is highlighted that the resilience of the Coxs River Swamp to prolonged dry periods, such as the Millennium Drought, is expected to have been reduced due to the past effect of mining. A simulation of the groundwater system without the past effect of mining is not currently available, however, it is expected that the groundwater elevation in the Lithgow Seam beneath the Coxs River Swamp would have been close to ground surface or at ground surface. In that circumstance, during a prolonged dry period, whilst the perched groundwater system would have 'gone dry', as it did in 2004, the 'regional' groundwater system would still have been contributing.

Despite the possible separation of the aquifer systems following mining in the 1980s, recovery of the Coxs River Swamp from 2004, inclusive of period of protracted dry weather such as 2006 through 2007, implies the perched groundwater system remains functionally intact. It is highlighted that there will have been no subsidence-related impacts to Coxs River Swamp in the past because mining was not undertaken beneath the Coxs River Swamp. As already noted, there is no new mining at Angus Place Colliery proposed as part of the Project.

In terms of the impact of the Project during dewatering of the 800 Panel Area, depressurisation of the Lithgow Seam beneath the Coxs River Swamp has already occurred. Modelling indicates that there are now two groundwater systems, which are hydraulically separated. Accordingly, the Project will have negligible additional effect. Following completion of mining at Angus Place Colliery, the groundwater systems beneath the Coxs River Swamp will return to their pre-development state.

Long Swamp

The analysis of Long Swamp is presented in the Surface Water Assessment (JBS&G, 2018b) prepared for the Environmental Assessment supporting the modification application.

From **Figure 2.8**, Long Swamp occurs at distance from ~3200m to 5000m in **Figure 2.9**. From **Figure 2.9**, the modelled uppermost water table (yellow) beneath Long Swamp is below ground surface (red). Field investigation will confirm whether this is actually the case.

Figure 2.7 presents the ground surface elevation (red), the elevation of the Lithgow Seam (green), hydrologic drainage lines (blue) and preliminary modelled groundwater elevation of the Lithgow Seam (black).

From **Figure 2.7**, groundwater elevation in the Lithgow Seam intersects with ground surface along the western margin of Long Swamp. i.e. the 900mAHD ground surface elevation contour and the 900mAHD groundwater elevation contour in the Lithgow Seam coincide. Whilst contours from the modelled uppermost water table are not presented in **Figure 2.7**, for the purpose of clarity, the 900mAHD contour from uppermost water table also coincides with the 900mAHD ground surface elevation contour. This suggests there is no separation of the aquifer systems along the western margin of Long Swamp.

Lambs Creek

Lambs Creek flows from east to west.

From **Figure 2.6**, the elevation of the thalweg, which is the minimum channel elevation, along Lambs Creek ranges between 1150mAHD, at the headwater of Lambs Creek, to 915mAHD, at the confluence of Lambs Creek and the Coxs River. In comparison, the elevation of the floor of the

Lithgow Seam, at equivalent locations, ranges between 804mAHD and 840mAHD. As such, Lambs Creek is 346m to 75m above the floor of the Lithgow Seam.

Figure 2.10 presents a long-section of Lambs Creek from upstream (right hand side of chart) to downstream (left hand side of chart). The long-section terminates at the confluence with the Upper Coxs River. In **Figure 2.10**, red presents ground surface elevation, green is elevation of the Lithgow Seam, black is preliminary modelled groundwater elevation in the Lithgow Seam and yellow is preliminary modelled uppermost water table.

From **Figure 2.10**, the modelled groundwater elevation in the Lithgow Seam coincides with the elevation of the floor of the Lithgow Seam, which is expected. This is expected because the mine is depressurised to that level.

From **Figure 2.10**, the modelled elevation of the uppermost water table (yellow) is close to ground surface and, therefore, there is a significant difference between it and the deep groundwater system. It is noted that the elevation of the shallow groundwater system, above the mined area, has not been extracted from the numerical model and is therefore not presented in **Figure 2.10**.

From **Figure 2.10**, at the downstream end of the long-section, at the confluence with the Upper Coxs River, the modelled groundwater elevation in the Lithgow Seam increases from coincident with the Lithgow Seam upward toward ground surface.

From the above, seepage from the mine water store in the 800 Panel Area (treatment phase) at 805mAHD cannot occur into Lambs Creek.

During dewatering of the 800 Panel Area (post-treatment phase) and 900 Panel Area (treatment phase), there will be negligible additional effect on the perched groundwater system, since the perched groundwater system and deep groundwater system are hydraulically separated. Hydraulic separation has occurred as a result of past depressurisation.

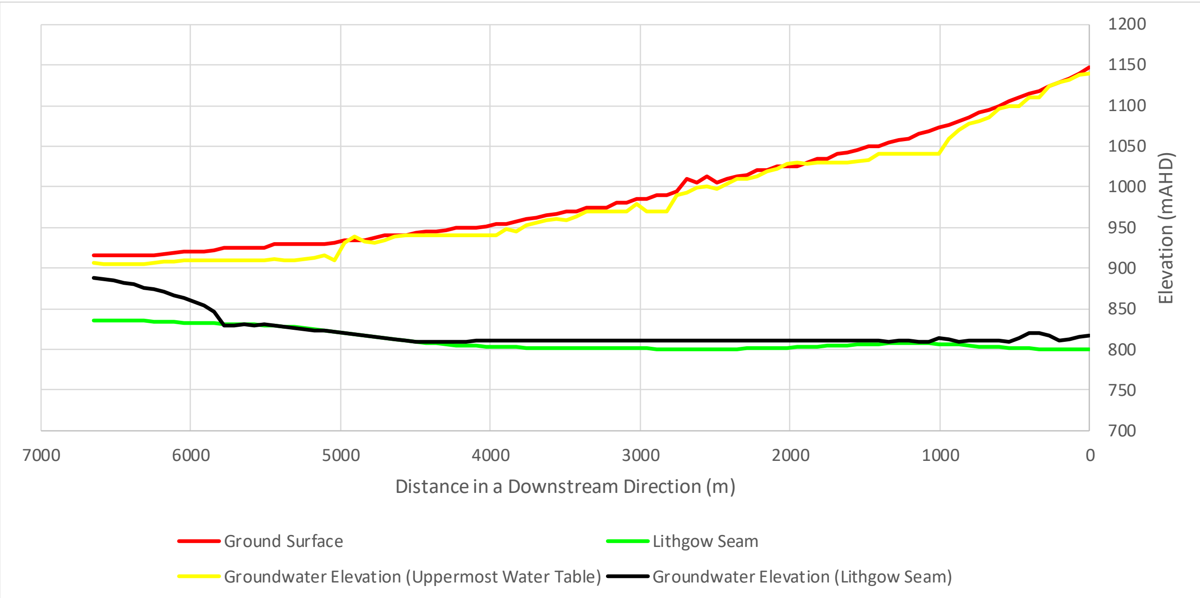


Figure 2.10: Long-Section: Headwater of Lambs Creek to confluence with Upper Coxs River

Kangaroo Creek

Kangaroo Creek flows from east to west.

Whilst not illustrated in **Figure 2.6**, the elevation of the thalweg of Kangaroo Creek ranges between 1080mAHD, at the headwater of Kangaroo Creek, and 905mAHD at the confluence of Kangaroo

Creek with the Upper Coxs River. In comparison, the elevation of the floor of the Lithgow Seam, at equivalent locations, ranges between 804mAHD and 846mAHD. As such, Kangaroo Creek is 276 to 59m above the floor of the Lithgow Seam.

Figure 2.11 presents a long-section of Kangaroo Creek from upstream (right hand side of chart) to downstream (left hand side of chart). In **Figure 2.11**, red presents ground surface elevation, green is elevation of the Lithgow Seam, black is preliminary modelled groundwater elevation in the Lithgow Seam and yellow is preliminary modelled uppermost water table.

From **Figure 2.11**, the modelled groundwater elevation in the Lithgow Seam corresponds with the elevation of the Lithgow Seam, which is expected. Near the confluence of Kangaroo Creek with Coxs River, the groundwater elevation in the Lithgow Seam increases.

From **Figure 2.11**, the modelled uppermost water table (yellow) is close to ground surface.

From **Figure 2.11**, at the downstream end of the long-section, at the confluence with the Upper Coxs River, the modelled groundwater elevation in the Lithgow Seam increases from coincident with the Lithgow Seam upward toward ground surface.

From the above, seepage from the mine water store in the 800 Panel Area at 805mAHD (treatment phase) cannot occur into Kangaroo Creek.

During dewatering of the 800 Panel Area (post-treatment phase) and 900 Panel Area (treatment phase), there will be negligible additional effect on the perched groundwater system, since the perched groundwater system and deep groundwater system are hydraulically separated because of the effect of past mine depressurisation.

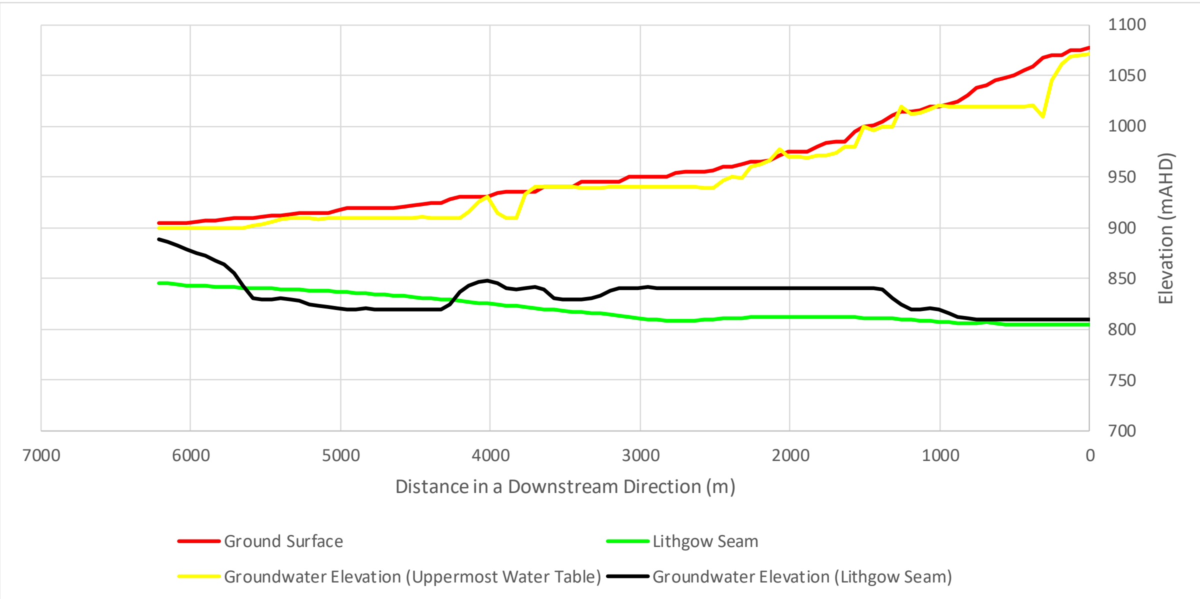


Figure 2.11: Long-Section: Headwater of Kangaroo Creek to confluence with Upper Coxs River

Wolgan River on the Newnes Plateau

The Wolgan River, on the Newnes Plateau, flows from south to north.

The location of the mine water store in the 800 Panel Area with respect to the Wolgan River is presented in **Figure 2.12**, together with the elevation of the Lithgow Seam (green contours), the elevation of ground surface (red contours), hydrologic drainage lines (blue lines), the historical workings at Angus Place Colliery (grey outline) and an interpretation of output from the update to the numerical groundwater model which is currently underway (black contours).

It is noted, in the preliminary output from the numerical groundwater model presented in **Figure 2.12**, that the model simulation assumed that the Lithgow Seam was dewatered and maintained in a dewatered state (conservative), rather than be allowed to recover to 805mAHD. This is the explanation of why there is a 790mAHD contour at the north-eastern end of Longwalls 11 to 13 in **Figure 2.12**. This assumption is conservative and its consequence is not significant with respect to both the discussion presented below and also above.

A long-section has also been prepared and its location is presented in **Figure 2.13**. The long-section extends from the Newnes Plateau, adjacent Longwall 26N (800 Panel Area) northward toward the Wolgan Valley, and then along the Wolgan River within the Wolgan Valley.

Figure 2.14 presents the long-section of the Wolgan River from upstream (right hand side of chart) to downstream (left hand side of chart). In **Figure 2.14**, red presents ground surface elevation, green is elevation of the Lithgow Seam, black is preliminary modelled groundwater elevation in the Lithgow Seam and yellow is preliminary modelled uppermost water table.

From **Figure 2.14**, the thalweg of the Wolgan River (on the Newnes Plateau), ranges from 995mAHD, at the start of the long-section, to 950mAHD at the top of the Wolgan Valley. The top of the Wolgan Valley occurs at a distance of 3800m along the long-section. In comparison, the elevation of the floor of the Lithgow Seam is 768mAHD at the start of the long-section and is also 768mAHD at a distance of 3800m along the long-section. Accordingly, the Wolgan River (on the Newnes Plateau) is 227 to 182m above the floor of the Lithgow Seam.

From **Figure 2.14**, the modelled groundwater elevation in the Lithgow Seam is 860mAHD at the start of the long-section and is 850mAHD at a distance of 3800m along the long-section. The modelled groundwater elevation in the Lithgow Seam is above the elevation of the floor of the Lithgow Seam in **Figure 2.14** because the long-section lies outside of the mined area. From **Figure 2.14**, the modelled elevation of the uppermost water table is close to ground surface.

As per the findings for Lambs Creek and Kangaroo Creek, seepage from the mine water store in the 800 Panel Area (treatment phase) cannot occur into the Wolgan River (on the Newnes Plateau) because the Wolgan River lies well above the Lithgow Seam.

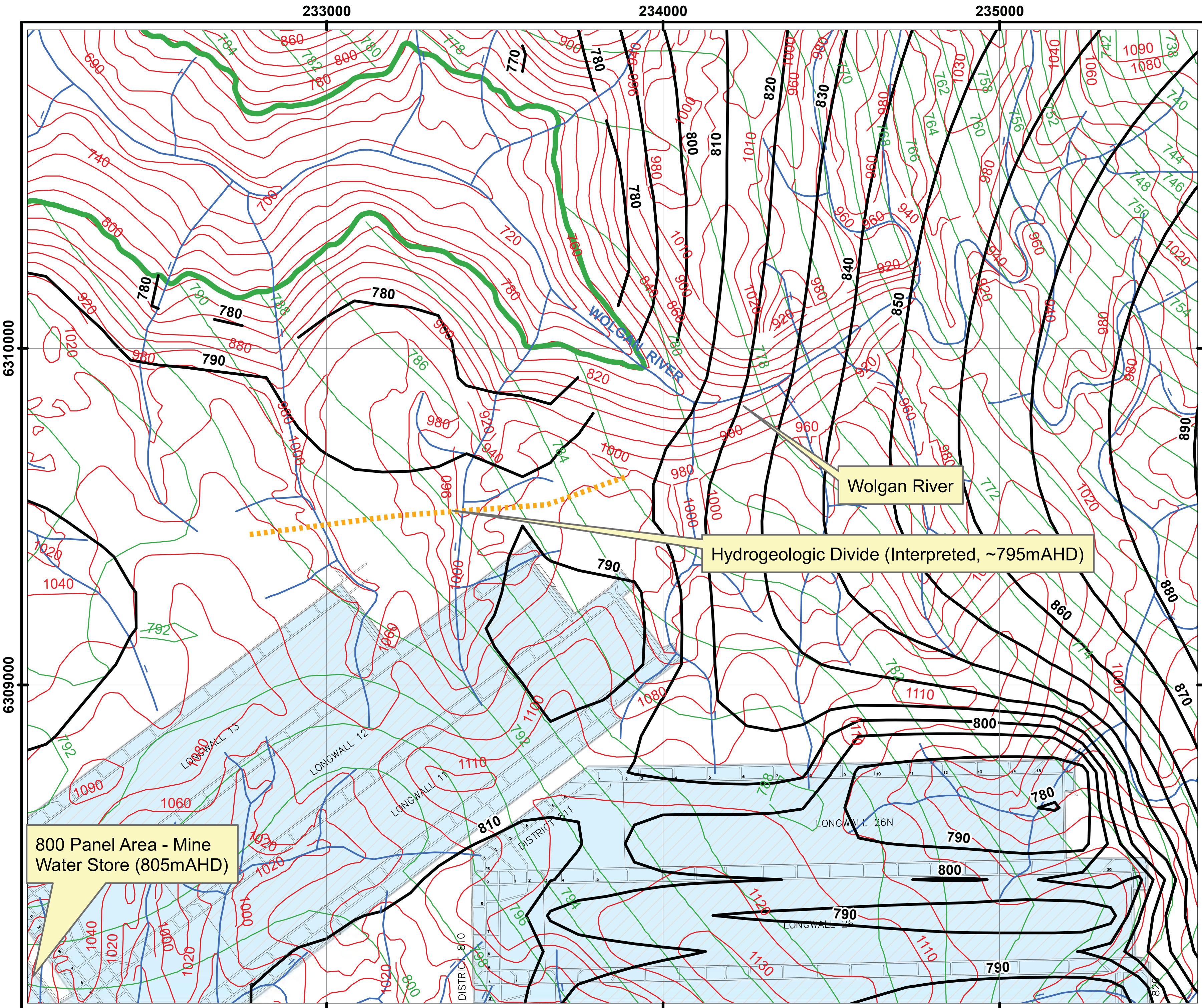
Wolgan River within the Wolgan Valley

For the Wolgan River within the Wolgan Valley, the thalweg of the river ranges from 950mAHD at the top of the Wolgan Valley to 700mAHD within the Wolgan Valley, as illustrated in **Figure 2.14**.

In **Figure 2.14**, along the long-section (thalweg of the Wolgan River), the Lithgow Seam outcrops at the top of the Wolgan Valley at 768mAHD.

From **Figure 2.12**, Lithgow Seam, at its closest point to the 800 Panel Area, outcrops along the southern cliffside of the Wolgan Valley at between 806mAHD and 782mAHD.

As such, the Wolgan River (within the Wolgan Valley) lies below the floor of the Lithgow Seam and, accordingly, there can be connection (via a seepage face along southern cliffside) between the mine water store in the 800 Panel Area (treatment phase) and Wolgan River (within the Wolgan Valley).



Legend:

Contours (mAHD)

- Deep Groundwater Level(2)
- Ground Surface
- Lithgow Seam Extent
- Lithgow Seam Floor

Angus Place

- Mine Workings (Historical)
- 800 Panel Area - Mine Water Store

Notes: 2) Deep groundwater contours (Lithgow Seam) interpreted from preliminary groundwater model output (R01RevA_CAL-Oct17_03a.gwv)

JBS&G

Job No: 54568

Client: Centennial Angus Place Pty Ltd

Version: L02RevB | Date: 01-Jul-2018

Drawn By: JRB | Checked By: JRB

Scale 1:15,000

0 250 500
metres

Coor. Sys. GDA 1994 MGA Zone 56

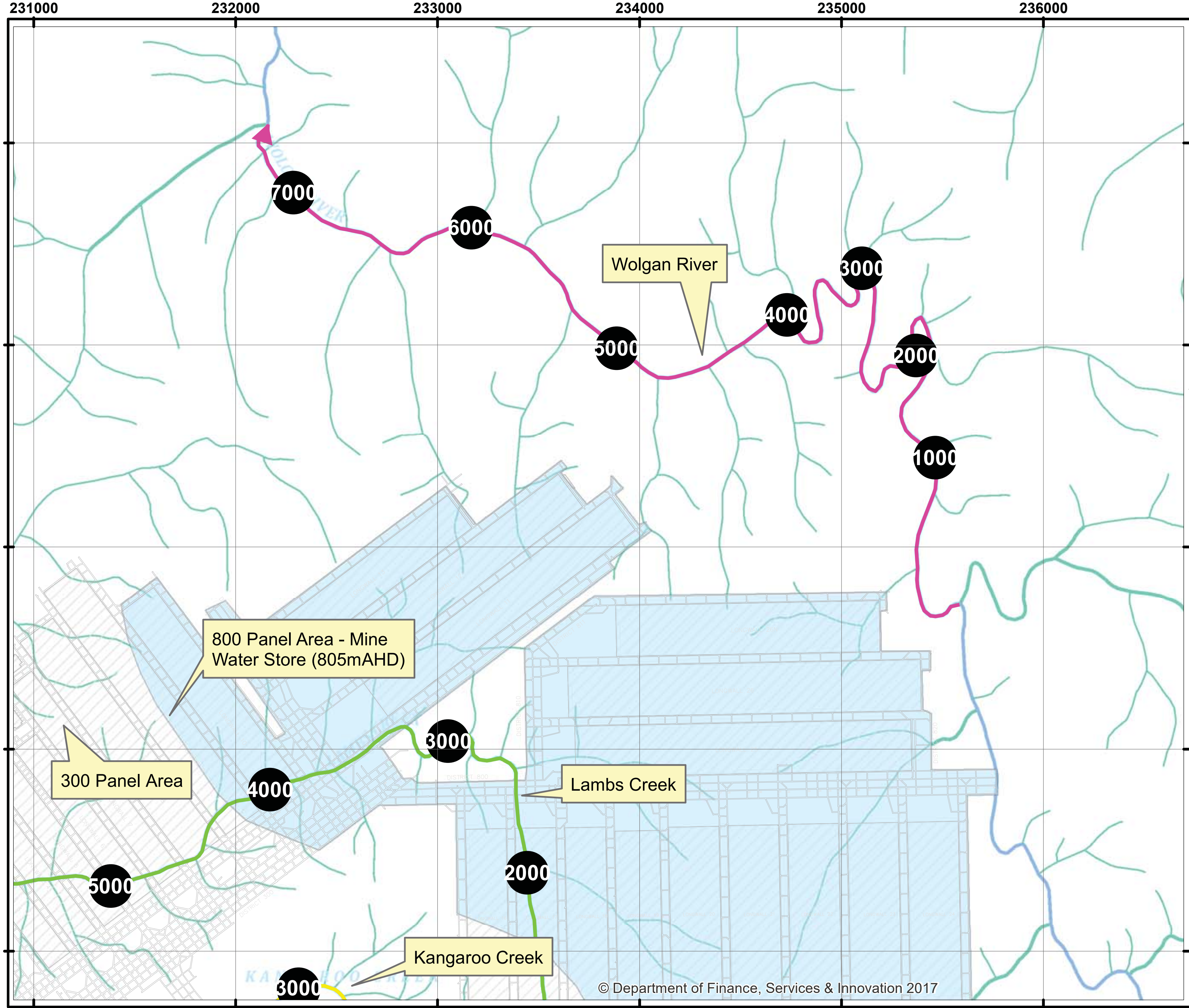
Angus Place Colliery
LIDSDALE NSW

GROUNDWATER AND SURFACE WATER INTERACTION

WOLGAN RIVER

FIGURE: 2-12

File Name: N:\Projects\CentennialCoal\AngusPlaceColliery\54568_WaterAssessmentMOD5\Figures\GIS\Delivery\L02RevB_D007_GroundwaterSurfaceWaterInteraction.mxd
Reference: Hydrology Layer from NSW LPI Web Services, 2018; Biodiversity Layer from NSW EPA (2016).



Legend:

Long-Sections

- Lambs Creek
- Kangaroo Creek
- Wolgan River

Angus Place

- Mine Workings (Historical)
- 800 Panel Area - Mine Water Store

JBS&G

Job No: 54568

Client: Centennial Angus Place Pty Ltd

Version: L02RevB | Date: 01-Jul-2018

Drawn By: JRB | Checked By: JRB

Scale 1:25,000

0 500 1,000 metres

Coor. Sys. GDA 1994 MGA Zone 56

Angus Place Colliery
LIDSDALE NSW

LOCATION OF LONG-SECTIONS AND DISTANCE MARKERS (M)

WOLGAN RIVER

FIGURE: 2-13

File Name: N:\Projects\CentennialCoal\AngusPlaceColliery\54568_WaterAssessmentMOD5\Figures\GIS\Delivery\L02RevB_D006_Long-Section-WolganValley.mxd
Reference: Hydrology Layer from NSW LPI Web Services, 2018.

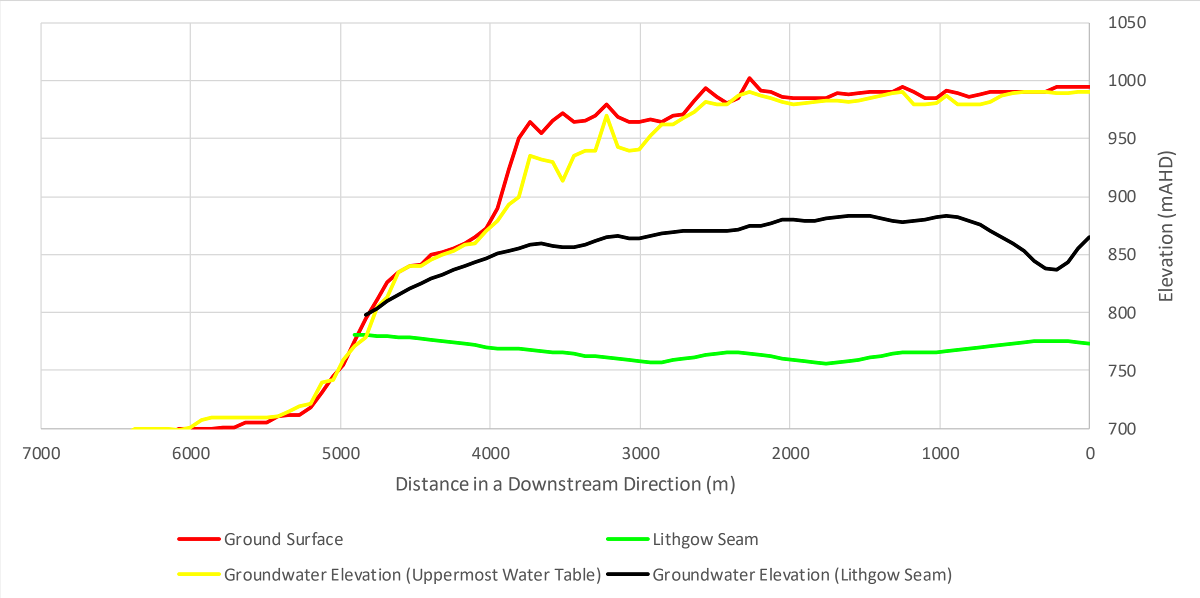


Figure 2.14: Long-Section: Wolgan River from Newnes Plateau into the Wolgan Valley

Review of the average groundwater velocity indicates that groundwater stored within the 800 Panel Area may seep 48m toward the Wolgan Valley over the five year storage period (at a rate of 9.7m/year).

The groundwater quality within 48m of the existing workings would be, at worst, the same as that proposed to occur within the 800 Panel Area, and would represent a large change (conservative).

Further detail of the derivation of the average groundwater velocity is presented in JBS&G (2018a).

It was noted in JBS&G (2018a) that a hydrogeologic divide may exist between Longwalls 11 to 13 and the Wolgan Valley, based on outcomes of the CSIRO model prepared at the time. From **Figure 2.12**, updated groundwater modelling, whilst preliminary output at this stage, also indicates that a hydrogeologic divide may exist between Longwalls 11 to 13 and the Wolgan Valley. The interpreted hydrogeologic divide is at about 795mAHD, and is located between the 790mAHD contours, as indicated in **Figure 2.12**. As already mentioned, the groundwater model simulation presented assumes the Lithgow Seam was dewatered at the time of mining (minimum of 784mAHD in Longwall 11) and was maintained in a dewatered state (conservative). This is the explanation of why there are contours presented in **Figure 2.12** that are below 805mAHD.

2.4.3.3 Results of Analysis

Analysis indicates that seepage from the mine water store in the 800 Panel Area (treatment phase) into Lambs Creek, Kangaroo Creek, Coxs River Swamp and the Wolgan River (on the Newnes Plateau) cannot occur since the thalweg of those watercourses are above the floor of the Lithgow Seam at respective locations. Analysis indicates, however, that seepage from the mine water store in the 800 Panel Area (treatment phase) into the Wolgan River (within the Wolgan Valley) can occur because the thalweg of the Wolgan River (within the Wolgan Valley) lies below the floor of the Lithgow Seam. The extent of migration of potentially impacted groundwater from the mine water store toward the Wolgan Valley is 48m over the five year storage period (at a rate of 9.7m/year).

Analysis indicates that dewatering of the 800 Panel Area during the post-treatment phase of the Project will not cause additional effect on the north-eastern branch of the Coxs River Swamp, since modelling indicates that a deep groundwater system has formed beneath the Coxs River Swamp and, as such, the perched groundwater system, upon which the swamp resides, and the deep groundwater system are hydraulically separated. Along similar lines, dewatering of the 800 Panel

Area (post-treatment phase) and the 900 Panel Area (treatment phase) will not lead to additional effect on Lambs Creek, Kangaroo Creek and the Wolgan River (on the Newnes Plateau).

2.4.4 Extraction of Stored Mine Water

2.4.4.1 Proposed Change

The proposed change to groundwater extraction due to the Project consists:

- seepage of the mine water store in the 800 Panel Area toward the Wolgan Valley
- extraction of the mine water store in the 800 Panel Area (post-treatment phase).

2.4.4.2 Results of Analysis

To dewater the 800 Panel Area, it will be necessary for the groundwater elevation in the Lithgow Seam to be drawn down again to the 'low point' with respect to each longwall.

Dewatering is necessary to facilitate recovery of the mine water store in the 800 Panel Area.

Upon commencement of dewatering of the 800 Panel Area (post-treatment phase), at the north-easterly end of the 800 Panel Area, the hydraulic gradient between the 800 Panel Area and the point of outcrop of the Lithgow Seam in the Wolgan Valley will be nullified. Nullification of the hydraulic gradient will facilitate recovery of potentially impacted groundwater that may have seeped toward the Wolgan Valley.

The following target dewatering elevations are suggested to be necessary to achieve recovery of the mine water store from the 800 Panel Area:

- 784mAHD for Longwall 13
- 778mAHD for Longwall 26N or 26
- 770mAHD for Longwall 24.

It is noted that the above targets are indicative and the final dewatering design, expected to consist of both existing infrastructure (such as Bore 940) and new boreholes, if required, will be determined by site personnel.

2.5 Impact Assessment

2.5.1 Cumulative Impact

This section provides discussion on potential cumulative environmental impacts of temporary storage of residuals from the Project underground in the 800 Panel Area.

Significant mining projects near Angus Place Colliery include:

- Baal Bone Colliery (inactive)
  - located to the northwest of Angus Place Colliery, on the other side of the Upper Coxs River
- Springvale Mine
  - located to the immediate south of Angus Place Colliery
- Angus Place Mine Extension Project (if approved)
  - located to the north east of Angus Place Colliery

With respect to Springvale Mine, Springvale is located hydrogeologically up-gradient of Angus Place Colliery. Accordingly, transfer of residuals from the Project into the mine water store in the 800

Panel Area will have no impact on groundwater quality in Springvale Mine because the 800 Panel Area is down-gradient of Springvale Mine.

With respect to the Angus Place Mine Extension Project, the Project will be completed (dissipation of stored residuals by August 2023) prior to the expected commencement of longwall extraction within the 1000 Panel Area included in the Angus Place Mine Extension Project, if approved.

2.5.2 Impact to Groundwater Environment

Water and Salt Balance Modelling of Stored Mine Water

The outcome of modelling with the residual management model (SAPRMM) indicates that temporary transfer of residuals will result in an increase in salinity of stored mine water (800 Panel Area) from 804mg/L (1,200µS/cm) currently, which was the assumed salinity (conservative) in the model, to 2,541mg/L (3,792µS/cm) on 2 January 2020.

Analysis indicates that dewatering of stored mine water will be achieved (return to background salinity, 99%) by August 2023 (812mg/L (1,212µS/cm) on 30 July 2023). The impact of the Project to groundwater quality is significant, however, is manageable.

The Project will lead to a reduction in groundwater elevation (deep groundwater system) in the 900 Panel Area from 800mAHD to, approximately, 770mAHD (Longwall 24), which was the fully depressurised level prior to restriction in volumetric discharge limit from Angus Place Colliery through LDP001.

Dewatering of the 800 Panel Area, following completion of the Project (post-treatment), will reduce the groundwater elevation (deep groundwater system) from 805mAHD to 784mAHD. It is noted that the fully depressurised level in the 800 Panel Area was 784mAHD prior to being allowed to flood.

Outcomes from the SAPRMM indicate that the assigned maximum rate of groundwater extraction from Angus Place Colliery during the Project of 13.4ML/d can be achieved. The 13.4ML/d limit is based on the predicted inflow to existing working at Angus Place Colliery presented in the Surface and Groundwater Assessment for Modification 4.

Following completion of the Project (post-treatment phase), transfer to the Springvale Water Treatment Project from Angus Place Colliery occurs at up to 13.4ML/d until the 800 Panel Area is dewatered.

Water Quality Modelling of Stored Mine Water (Other Analytes)

The potential change in groundwater quality to other analytes was assessed using the aqueous speciation model PHREEQCi.

Analysis indicates that the concentration of major and minor ions in the mine water stored in the 800 Panel Area increases by a factor of 3.13 due to the Project. The water quality of the stored mine water is Na-HCO_3 type water, with near neutral pH that is brackish but not saline, with no exceedances of ANZECC (2000) default guideline values, with the exception of salinity, which is significantly exceeded. The impact of the Project to groundwater quality is significant, however, is manageable. Details of how the impact to groundwater quality will be managed are presented below.

2.5.3 Impact to Neutral or Beneficial Effect to the Drinking Water Catchment

As presented in **Section 2.4.3**, there is no predicted change to Lambs Creek and Kangaroo Creek with respect to seepage of stored mine water into these watercourses, since their thalwegs are well above the elevation of the floor of the Lithgow Seam at respective locations.

Because there is no change to water quality in Lambs Creek or Kangaroo Creek due to the Project, there is no change to water quality within the Sydney Drinking Water Catchment.

The increase in mine water discharge through Angus Place LDP001, to up to 10ML/d (treated to 350µS/cm), was assessed in the Surface Water Assessment (JBS&G, 2018b) and, whilst not discussed in detail here, the impact was found to be neutral or beneficial (refer Section 5.4 of JBS&G, 2018b).

2.5.4 Impact to Groundwater Dependent Ecosystems

Temperate Highland Peat Swamps on Sandstone (Newnes Plateau)

There is no change to mining proposed with the Project, and therefore the THPSS located on the Newnes Plateau will not be impacted due to the Project by subsidence-related processes.

There is also negligible expected impact to the water table elevation in THPSS on the Newnes Plateau due to re-drawdown of the Lithgow Seam in the 800 Panel Area and 900 Panel Area because the perched groundwater system and the deep groundwater system are hydraulically separated.

Coxs River Swamp

The thalweg of the north-eastern branch of the Coxs River Swamp crosses a sequence of outcropping seams of the Illawarra Coal Measures. Analysis indicates that the identified period of dieback in 2004 coincided with the Millennium Drought and recent observation (March 2018) of a drop in standing water level in part of the wetland is consistent with the protracted below-average rainfall conditions currently being experienced throughout the region.

There is no impact to the north-eastern arm of the Coxs River Swamp during the treatment phase of the Project since the thalweg of the swamp is 106 to 86m above the floor of the Lithgow Seam and, accordingly, seepage from the mine water store in the 800 Panel Area into the swamp cannot occur.

Following treatment, dewatering of the mine water store in the 800 Panel Area, from 805mAHD currently to 784mAHD, could increase the vertical hydraulic gradient between the perched groundwater system in the Coxs River Swamp and the Lithgow Seam beneath the swamp, if an unsaturated zone did not exist. Modelling suggests, however, that an unsaturated zone does exist, which implies the perched groundwater system is hydraulically separated from the deep groundwater system and, accordingly, changes to the deep groundwater system will have negligible expected impact on the perched system upon which the swamp resides.

2.5.5 Impact to Licensed Water Users

Groundwater Users

There are no groundwater users in the immediate vicinity of Angus Place Colliery and therefore there are no impacts to groundwater users due to the Project.

Surface Water Users

There are multiple surface water users within the Hawkesbury and Lower Nepean River Water Source, located downstream of Angus Place Colliery within the Wolgan Valley and below.

There is potential for impact to these users from seepage from stored mine water within 800 Panel Area into the Wolgan River (within the Wolgan Valley), however, this impact can be managed through dewatering of the 800 Panel Area following completion of the treatment phase of the Project.

2.5.6 Impact to Groundwater/Surface Water Interaction

Lambs Creek

There is no impact to Lambs Creek due to seepage from the 800 Panel Area into the watercourse.

There is negligible impact to Lambs Creek due to dewatering of the 800 and 900 Panel Areas since the perched groundwater system is hydraulically separated from the deep groundwater system.

Kangaroo Creek

There is no impact to Kangaroo Creek due to seepage from the 800 Panel Area into the watercourse.

There is negligible impact to Kangaroo Creek due to dewatering of the 800 and 900 Panel Areas since the perched groundwater system is hydraulically separated from the deep groundwater system.

Wolgan River (on the Newnes Plateau)

There is no impact to the Wolgan River (on the Newnes Plateau) due to seepage from the 800 Panel Area, since the thalweg of the river lies well above the elevation of the floor of the Lithgow Seam.

There is negligible impact to the Wolgan River (on the Newnes Plateau) due to dewatering of the 800 and 900 Panel Areas, since the perched groundwater system is hydraulically separated from the deep groundwater system.

Wolgan River (within the Wolgan Valley)

The potential seepage from the mine water store in the 800 Panel Area into the Wolgan Valley is assessed in **Section 2.4.3**. It was found that the seepage velocity is very low, at 9.7m/year, however, groundwater quality may be impacted at up to 48m from the existing workings, toward the Wolgan Valley, over the five year storage period. It is noted that the storage period includes both the treatment phase and the dewatering phase.

The potential change to groundwater quality outside of the 800 Panel Area, toward the Wolgan Valley, would be significant. That impact can be managed, however, through nullifying the hydraulic gradient between the 800 Panel Area and the Wolgan Valley, as presented in **Section 2.4.4**, thereby facilitating recapture of potentially impacted groundwater.

Furthermore, a hydrogeologic divide may exist between Longwalls 11 to 13 and the Wolgan Valley, which would prevent flow from the 800 Panel Area into the Wolgan River, in any regard.

2.6 Licensing, Management, Mitigation and Monitoring

2.6.1 Groundwater Licensing

As identified within JBS&G (2018a), there are no implications with respect to Water Access Licences due to the Project. Extraction of groundwater from the 800 Panel Area and 900 Panel Area will be undertaken in accordance with aquifer access licences currently held by Centennial Coal.

2.6.2 Management

2.6.2.1 Coxs River Swamp

During investigation of the Coxs River Swamp, it was identified that the swamp exists within Lot 7002 of DP1026540. Lot 7003 of DP1026540 appears to be the Angus Place Waste Transfer Station operated by Lithgow City Council, however, this has not been confirmed.

It is not currently known whom owns Lot 7002, however, nonetheless, it is no longer Crown land. It is noted that there is an electricity transmission and fibre optics corridor immediately adjacent to and through the mapped extent of the swamp.

Figure 2.15 is extracted from Google Earth StreetView and was taken in 2010 from Wolgan Road, at the northern end of Coxs River Swamp – North Eastern Arm, looking southwest. **Figure 2.16** is also extracted from Google Earth StreetView and was also taken in 2010 from Wolgan Road, at the southern end of the Coxs River Swamp – North Eastern Arm, looking northeast.

Figure 2.15: Utilities corridor parallel to Wolgan Road – looking southwest (StreetView image from Google Earth, 2018)

Figure 2.16: Utilities corridor parallel to Wolgan Road – looking northeast (StreetView image from Google Earth, 2018)

It is recommended that the owner of Lot 7002 be identified and approached as to potential site management protocols to reduce damage due to vehicular access.

2.6.3 Mitigation

It is recommended that a trigger level (standing water level of the uppermost water table) is developed for the Coxs River Swamp – North Eastern Arm site.

As presented in **Section 2.4.3**, it is interpreted that the 2004 dieback episode was caused by the Millennium Drought; however, is speculated may have been exacerbated by the historical impact to groundwater elevation within the Lithgow Seam.

Accordingly, dewatering will commence as modelled, following completion of the treatment phase (refer to JBS&G (2018a), as summarised in **Figure 2.5**), however the rate of dewatering may be adjusted if any impact to the perched groundwater system, upon which the Coxs River Swamp – North Eastern Arm, is detected.

As noted in **Section 2.4.3**, the groundwater elevation in the Lithgow Seam beneath the Coxs River Swamp is not currently known and may be higher than 870mAHD, which was the modelled groundwater elevation at that location. Nonetheless, due to mining of the 300 Panel Area occurring in the 1980s and the groundwater elevation being maintained at or below the floor of the Lithgow Seam since that time, the formation of the deep groundwater system is supported by inference.

2.6.4 Monitoring

It is recommended that monitoring of the Coxs River Swamp is undertaken, as well as at Long Swamp. It is expected that this will comprise:

- two standpipe piezometers with respect to Coxs River Swamp (North-Eastern Arm), targeting the uppermost water table.
- one multi-level vibrating wire piezometer located between Coxs River Swamp (North-Eastern Arm) and the 300 Panel Area, targeting the perched/shallow groundwater system (uppermost water table) and the deep groundwater system (Lithgow Seam).
- one standpipe piezometer with respect to Coxs River Swamp (Northern Arm), targeting the uppermost water table. This site will serve as a reference site.
- one standpipe piezometer at the Coxs River/Kangaroo Creek confluence, targeting the uppermost water table.
- one standpipe piezometer with respect to Long Swamp, targeting the uppermost water table.

Subject to access constraints, and security (formal steel monuments, concreted into the ground, with a padlock, is suggested), it is recommended that electronic water level logging is undertaken at each site.

Surface water and groundwater monitoring has also been proposed with respect to Condition U1.2 (Pollution Reduction Program) on EPL 467. That monitoring comprises:

- Surface water quality monitoring at two locations in the Wolgan River (within the Wolgan Valley), upstream and downstream of the 800 Panel Area
- Groundwater quality monitoring at one location down-gradient of the 800 Panel Area.

3. References

DEC, 2006. *The Vegetation of the Western Blue Mountains*. Internal report prepared by the NSW Department of Environment and Conservation on behalf of the NSW Hawkesbury – Nepean Catchment Management Authority.

JBS&G, 2018a. *Angus Place Water Treatment Project – Groundwater Assessment*. Consultant report prepared by JBS&G Australia Pty Ltd for Centennial Angus Place Pty Ltd. Reference No. JBS&G54568-113824/R02_Rev0, dated 22 March 2018.

JBS&G, 2018b. *Angus Place Water Treatment Project: Section 75W Modification 5 – Surface Water Assessment*. Consultant report prepared by JBS&G Australia Pty Ltd for Centennial Angus Place Pty Ltd. Reference No. JBS&G54568-113738/R01_Rev1, dated 8 May 2018.

NSW EPA, 2016. *Assessment of Montane Peatlands and Swamps EEC on NSW Crown Forest Estate*. Project initiated by the NSW Environment Protection Authority and Forestry Corporation NSW. Reference No. ISBN 978-1-76039-538-4, dated October 2016.

RPS, 2014. *Angus Place Colliery Modification 4 – Surface Water and Groundwater Impact Assessment*. Consultant report prepared by RPS Aquaterra Pty Ltd for Centennial Angus Place Pty Ltd. Reference No. S251B/003, dated 1 April 2014.

4. Closing

Should you require clarification, please contact the undersigned on 02 8245 0313 or by email jbell@jbsg.com.au.

Yours sincerely:

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APPENDIX C SUPPORTING DATA AND PHOTOGRAPHS

Table B1 Centennial inspection monitoring locations and descriptions

Location	Description	Corresponding investigation area	Eastings (m / MGA56)	Northings (m / MGA56)
1	4wd swamp crossing – north east arm of Coxs River Swamp system	LEG Identified Area	230629	6308642
2	Upstream of Location 1at fringe of swamp site – north east arm of Coxs River Swamp system	LEG Identified Area	230664	6308786
3	Upstream edge of swamp site – north east arm of Coxs River Swamp system	LEG Identified Area	230800	6308883
4	Common monitoring location for community and regulators (COXS 1) at Bridge – North arm of Coxs River Swamp system	Reference Sites	229724	6310210
5	Swamp environment local to Baal Bone shallow groundwater monitoring – North arm of Coxs River Swamp system	Reference Sites	229687	6311820
6	Swamp environment downstream of Baal Bone shallow groundwater monitoring – North arm of Coxs River Swamp system	Reference Sites	229773	6311066
7	Upstream swamp environment from bridge – North arm of Coxs River Swamp system	Reference Sites	229771	6310304

CURRENT PHOTOGRAPHS

Figure C1: Location 1 – 4wd access track, (18 April)

Figure C2: Location 1 - 4wd access track, (20 April following 7.5 mm of rainfall)

 Figure C3: Location 2 – Recovered swamp fringe, looking south-east (18 April)	 Figure C4: Location 2 - Recovered swamp fringe, looking north-east (18 April)

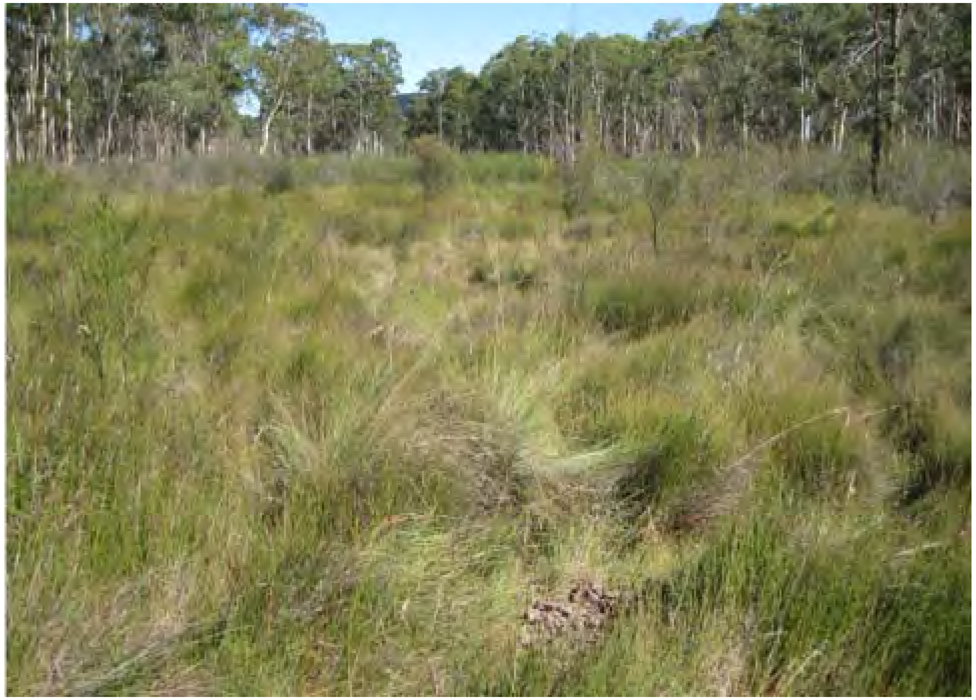

Figure C5: Location 3 – Upstream edge of swamp recovery site, looking south west (18 April)

 Figure C6: Location 4 – From bridge, Coxs River looking upstream (18 April)	 Figure C7: Location 4 – From bridge, Coxs River looking downstream (18 April)

Figure C8: Location 5 – Swamp environment within Baal Bone monitoring locations BBP5 and BBP6 (18 April)

 Figure C9: Location 6 – Swamp environment downstream of Baal Bone monitoring (4 April)	 Figure C10: Location 6 – Swamp environment downstream of Baal Bone monitoring (18 April)

Figure C11: Location 7 – Swamp environment upstream of bridge looking north west (18 April)

HISTORICAL PHOTOGRAPHS

Figure C12: Location 1 – 4wd access track (28 August 2006). This location reportedly was submerged November 2005.

Figure C13: Location 1 - 4wd access track (28 August 2006), looking downstream (south).

Figure C14: Location 1 - 4wd access track (28 August 2006), looking upstream (north).

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