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)

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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 50th 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.

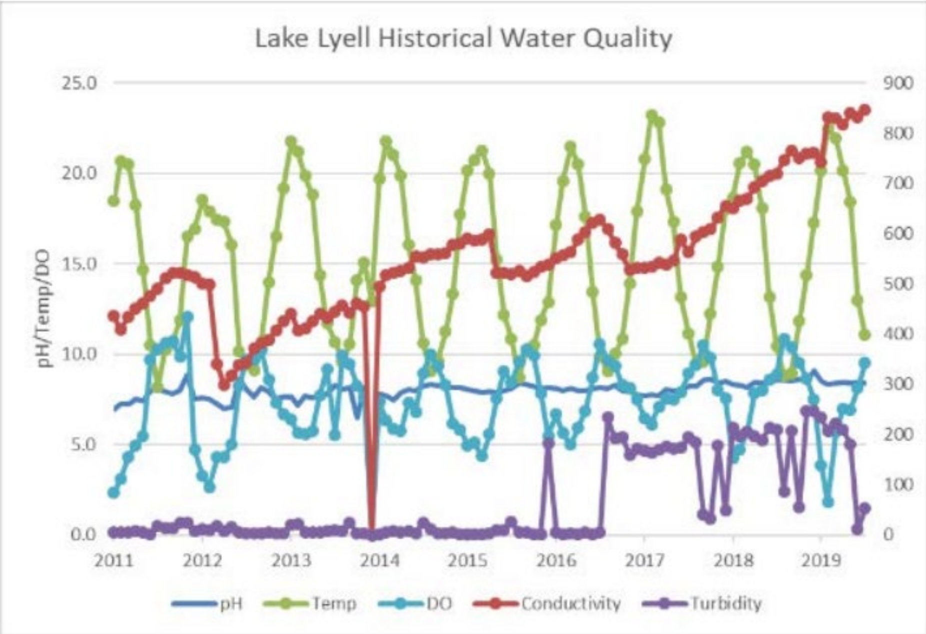

Figure 1. Water quality of Lake Lyell (Coxs River, near Lithgow). Salinity is represented by 'conductivity' and is in units µS/cm. Source: NSW EPA (Ref: GIPA EPA 724)

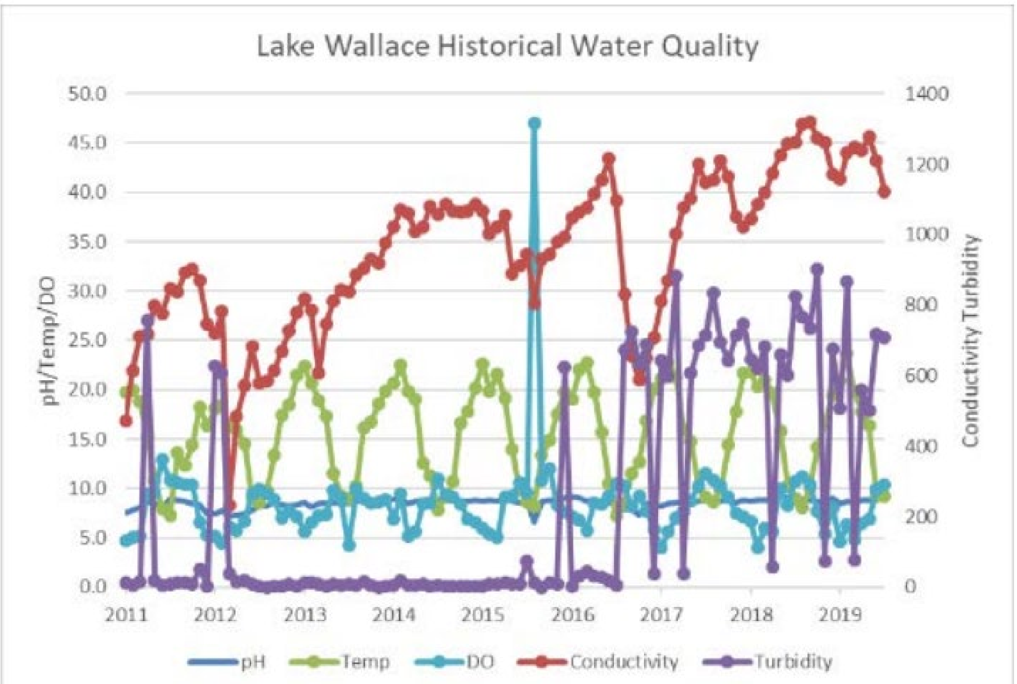

Figure 2. Water quality of Lake Wallace (Coxs River, near Wallerawang). Salinity is represented by 'conductivity' and is in units μS/cm. Source: NSW EPA (Ref: GIPA EPA 724)

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.

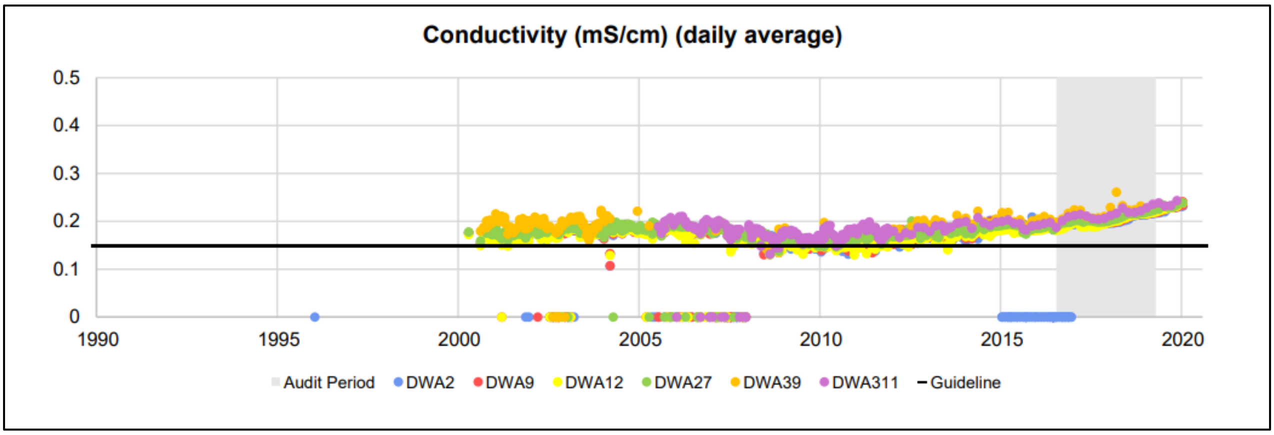

Figure 3. Salinity (as 'Conductivity') at six sampling sites within Lake Burragorang (Sydney's main drinking water supply impounded behind Warragamba d). Salinity is represented by 'conductivity' and is in units mS/cm. Source: Sydney Drinking Water Catchment Audit 2019 – Volume 3

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.

References

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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.