Before a Hearings Panel Appointed by the Selwyn District Council and Canterbury Regional Council

Under	the Resource Management Act 1991
And	
In the Matter	applications under section 88 of the Act by Bathurst Coal Limited in relation to the completion of mining and closure and rehabilitation of the Canterbury Coal Mine in the Malvern Hills, Canterbury

Statement of Evidence in Reply of **Paul Antony Weber (Mine Waste Management)** for Bathurst Coal Limited

Dated: 25 February 2022

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INTRODUCTION

Qualifications and Experience

1. My full name is Dr Paul Antony Weber.

2. I have the qualifications and experience set out at paragraphs 1 – 4 of my Statement of Evidence dated 1 October 2021 (**EIC**). I am a subject matter expert for acid and metalliferous drainage (**AMD**) and other mine influenced waters, providing advice to both regulators and mining companies here in New Zealand and internationally. I have been involved in the research and operational management of AMD for 20+ years. I have been an author for > 50+ papers on AMD.

Code of Conduct

3. I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014. This evidence is within my area of expertise, except where I state I am relying on material produced by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

4. My evidence will address the following matters that were raised at the hearing on 26 to 29 October 2021 and matters that were raised at post hearing conferencing on 23 and 24 November 2021 including:

    (a) Previous studies.

    (b) Monitoring and compliance limits.

    (c) Mine closure Infrastructure.

    (d) Future land use.

    (e) Consent Authority Summary Statements.

    (f) 23/24 November 2021 Conferencing.

    (g) Draft Resource Consent Conditions.

    (h) Trigger Action Response Plans (**TARP**).

EXECUTIVE SUMMARY

Previous Studies

5. At the hearing I was asked to provide water quality data as far back as possible for the Canterbury Coal Mine (**CCM**). In this evidence, I have provided additional information on previous studies that relate to work done at the site prior to Bathurst Coal Limited (**BCL**) taking on the mine ownership. These data show that the site was affected by acid rock drainage in 2004 and has had coal combustion residues (**CCR**) being returned to site since 2009, but that also CCR was present on site for field trials in 2004.

Compliance Monitoring and Performance Monitoring

6. I have reviewed the final draft consent conditions and agree with the proposed approach that water quality monitoring be split into:

    (a) Compliance monitoring - with associated compliance limits as agreed in proposed consent condition 22 (operational and active closure phases) and proposed consent condition 27 (post closure phase); and

    (b) Performance monitoring - frequent multiparameter monitoring (as explained in proposed consent condition 35), some of which support the TARP implementation as shown in Table 1 and Table 2 of the TARP (REV4); with no compliance limits.

7. I have provided further recommendations on this monitoring (frequency and parameters) in my evidence (paragraphs 20 – 48):

    (a) I support some additional performance monitoring as suggested by Dr Michael Massey and Dr Adrian Meredith on behalf of Environment Canterbury (**ECan**) for other Potential Contaminants of Concern (**PCOC**), although I believe there are sufficient data available to indicate the environmental risks from the PCOC are low. The exception is monitoring for polycyclic aromatic hydrocarbons (**PAHs**), where there is currently limited data for PAH concentrations in water discharges.

(b) In this regard I recommend annual performance monitoring for certain PCOC, which is explained further in Paragraphs 29-38 of my evidence below.

Key Review Requirements

8. I am of the opinion that three key reviews are required for the CCM closure project:

   (a) As per proposed consent condition 37 within the discharge to Tara Stream consent, a review of the TARPs and water monitoring requirements will be undertaken prior to moving into the post closure phase. I support this.

   (b) I also recommend that water quality data and flow rates, including contaminant loads be reviewed in March 2024.

   (c) Furthermore, as stated in proposed general consent condition 7, "The consent holder shall review the Environmental Management Plan (**EMP**) and Mine Closure Management Plan (**MCMP**), on a six-monthly basis during the active closure phase of the Project, and at least annually during the post closure phase (and for no less than 5 years), and if necessary, update it".

9. I believe the reviews presented above are sufficient to assess and analyse data, identify risks through a formal risk assessment process (i.e. BCL risk assessment process), and implement any changes or correct actions that are necessary to avoid, remedy, or mitigate adverse effects to the receiving environment.

Trigger Action Response Plans

10. At conferencing the experts also discussed the TARPs. In this reply evidence I discuss aspects of the TARPs where they fall within my expert opinion.

11. I have reviewed the final draft version of the TARPs (REV4), which are provided in Appendix 1 of the evidence of Mr Eden Sinclair, and I have provided additional comment where this is my area of expertise.

12. It is my expert opinion that the TARPs (REV4) are suitable in the initial instance and cover key water quality risks identified for the closure of the CCM. TARPs provide for adaptive management and will change as new information

comes to hand to improve risk management and mitigate adverse effects. As noted, the MCMP will be reviewed every 6 months during the active closure phase and the TARPs are part of the MCMP.

Other Recommendations

13. I support the retention of the North ELF[1] ponds (Pond 1 and Pond 2) and the Tara Pond. In my opinion, these are essential closure infrastructure (see Paragraph 55 of my evidence below).

14. In regard to future land use and the environmental hazards associated with PAF[2] materials being exposed due to tree toppling or other mechanisms, I believe this is a low risk for the reasons outlined in my evidence (see paragraph 56-61 of my evidence below).

Other

15. I have reviewed the Summary Statements of Evidence provided by the experts for ECan and Selwyn District Council (**SDC**) and have provided additional comment where this is my area of expertise.

PREVIOUS STUDIES

16. At the hearing I was asked to provide water quality data as far back as possible. The CCM has been operating as an open cast coal mine since 2003 and is within an area of historical underground mining dating back to 1872.

17. At the hearing it was requested that further information be provided on acid and metalliferous drainage (**AMD**) effects prior to BCL taking over ownership of the site in 2013. I provided one paper after the hearing (Bell & Seale, 2004) that showed acidic rock drainage was an issue for the site with pH decreasing to ~pH 3.5 (**Appendix 1**). The below section of my evidence sets out further information as to the historic effects of the mine prior to BCL taking ownership.

18. I first visited Canterbury Coal Mine site in ~2004 to support two student research projects on AMD (Alipate, 2005; and de Boer, 2005). BCL has since provided these dissertations for my review, and I make the following high-level observations:

[1] ELF = Engineered Landform.
[2] PAF = Potentially Acid Forming.

(a) Alipate (2005) notes that two seepages from old underground workings are present and are managed by routing the water to the settling pond for treatment.

(b) Samples of toe drain pooled water was as low as pH 2.0 (Alipate, 2005).

(c) Alipate (2005) discusses the use of coal combustion by-products for the remediation of acidity.

(d) Investigations were undertaken on oxygen ingress into track rolled trial pads showing oxygen was < 0.3% in both pads at 2 m depth; at 1 m depth oxygen concentrations were 16.9 – 12.6%. The test pads (5 m x 3 m) included a control pad and a pad containing a 0.5 m layer of coal combustion residue (Alipate, 2005). No seepage was recorded coming through these trial pads suggesting low permeabilities.

(e) Alipate (2005) notes site discharge pH was around 4 and "*the wetlands act as a natural remediation tool in improving water quality by raising pH of the water and removing dissolved iron and sulfate. The pH of the water exiting the wetland has remained circum neutral throughout the study period even when the pH of the upstream is below 4.*"

(f) These observations by Alipate (2005) are important as they show:

(i) That AMD from historic underground workings has been discharging for many decades from the site into the Tara Wetland prior to BCL undertaking activities at the CCM.

(ii) The CCM was impacted by AMD prior to BCL taking over ownership.

(iii) That CCR was being assessed as an option to manage AMD prior to 2005.

(iv) That it was established in 2005 that overburden material, if rolled, effectively reduced oxygen and water ingress into the overburden.

(v) That the Tara Stream wetland was being affected by AMD in 2005.

19. BCL also recently provided me with a report from Bell Geoconsulting Limited (**BGL**) dated 6 April 2008 regarding coal boiler ash (**CBA**) disposal at the Malvern Hills Mine site for Canterbury Coal Limited. A key recommendation of the BGL (2008) report due to boron being elevated in a TCLP[3] test was that "*it is now recommended that all CBA materials delivered to the mine site be disposed of by burial within the mine footprint"*. Resource consent CRC081869 was granted in February 2009 for the disposal of up to 2,500 tonnes of coal combustion residue (**CCR**) at site.

(a) The report and resource consent indicate that CCR has been disposed of at the CCM for a number of years prior to BCL taking over ownership. It would be reasonable to assume that any significant effect on water quality because of this CCR disposal would now be observed over a decade later.

(b) Although the historical (pre-2012) volume of CCR is low, the corresponding volume of waste rock would also have been low, hence effects should be similar.

(c) The BGL (2008) report also had water quality data from 2004 and 2008, which provides some historical data for the site and is discussed in subsequent sections of my evidence. Some of this is provided in **Appendix 2** to my evidence – Table 3.

COMPLIANCE MONITORING AND PERFORMANCE MONITOING

20. The nature of and duration of contaminant monitoring required moving forward remains a live issue between the relevant experts. This part of my evidence is my reply to the various matters raised by the experts called by ECan and SDC with respect to this matter.

Compliance Monitoring and Compliance Limits – CC02

Compliance location CC02

21. During conferencing the location of the compliance point for CC02 (Tara Stream discharge) was discussed, which was raised as an issue previously

[3] Toxicity Characteristic Leach Procedure (USEPA methodology 1311).

by Dr Meredith in his summary statement.[4] In conferencing and as provided in proposed consent condition 3[5]:

(a) During the operational and active closure phases it is proposed that the current CC02_tele water quality monitoring site would remain in place as the compliance point during times of pumped discharge or when Tara Pond is overflowing via the spillway as this location measures the water quality associated with these discharges. At all other times the compliance point shall be at the bottom of the Tara spillway mixing structure (**TSMS**), which for clarity is now defined as water quality monitoring location (**CC02_TSMS**). This is also now defined in the TARPs (REV4); and

(b) During the post closure phase the compliance point shall be the bottom of the Tara spillway mixing structure after mixing has taken place. (CC02_TSMS), which will monitor discharge from the Mussel Shell Bioreactor (**MSR**) once it commences and/or discharge from the Tara Pond Spillway, including any potable water discharge and subsequent mixing.

Water Quality Compliance limits

22. Following the hearing I retain the view that the following compliance monitoring should be undertaken as shown in Table 1 for CC02_tele and CC02_TSMS:

Table 1. Compliance Monitoring Parameters (CC02_tele and CC02_TSMS)

Contaminant[##]	**Limit**	**Frequency**
pH[#]	Between 6-9	Continuous (15 mins) with monthly grab samples
Electrical Conductivity (**EC**)[#]	-	Continuous (15 mins) with monthly grab samples
Turbidity**	-	Continuous (15 mins) with monthly grab samples
Boron (**B**)	1.5 mg/L	Monthly grab samples
Manganese (**Mn**)*	1.9 mg/L	Monthly grab samples

[4] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [13,14]
[5] Proposed Consent Condition 3 – CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water

Contaminant[##]	**Limit**	**Frequency**
Nickel (**Ni**)***	0.011 mg/L	Monthly grab samples
Zinc (**Zn**)***	0.008 mg/L	Monthly grab samples
Iron (**Fe**)*	1 mg/L	Monthly grab samples
Aluminium (**Al**)*	0.055 mg/L	Monthly grab samples

** - Mn, Fe, and Al will also be assessed for totals metals at CC02_TSMS. Data will be for performance monitoring purposes. This was agreed in conferencing where total metals would be of benefit, to "provide additional information to understand data"[6]. Further discussion is provided in Paragraph 91 on this matter.*

***Only for operational and active closure mine closure phases.*

****Hardness modification is required for these metals presented in Table 1.*

[#] Field pH and Field EC should also be undertaken to support laboratory data and interpretations.

[##] The above suggested water quality compliance monitoring limits[7] are for dissolved metals.

23. Besides the additional monitoring for total metals as well as dissolved metals at CC02_TSMS, which I support, the only other change to Table 1 above from the contaminant monitoring that I supported at the hearing is the requirement to measure dissolved Al and Fe at all times. Previously Fe was only measured if pH was < 4.5 and Al was only measured if pH is < 5.5 or > 7.5 to avoid the effects of colloidal metals in oxygenated waters. I still have reservations about the effects of colloidal metals on compliance monitoring, which is discussed in the following section with my recommended approach.

Assessment of dissolved Fe and Al

24. I note the following areas of possible uncertainty with respect to the above proposed compliance water quality monitoring (Table 1).

[6] Proposed Consent Condition 20 comments – CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water

[7] Proposed Consent Condition 20 comments – CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water

25. Dissolved Fe analysis can be problematic in some instances. Previous work has indicated that nano-particulate Fe (colloidal Fe) can be present in AMD impacted waters and this Fe-hydroxide can pass through 0.45 µm filters (Blanco et al., 2018), which affects the assessment of the dissolved metal fraction.

    (a) As presented in my evidence in chief[8] there is already significant colloidal Fe in the catchment even when the site is not discharging waters.

    (b) I expect there may be instances when dissolved Fe may be measured as being elevated due to colloidal (Total) Fe. This may require additional investigations such as 0.2 µm filters, assessment of dissolved oxygen concentrations, and other chemical parameters.

    (c) I recommend that any condition of consent be worded to enable additional investigations when colloidal Fe is present or suspected as explained above. I understand that the proposed consent condition 23[9] will include the ability to resample and/or retest as soon as practicable, which I support.

26. Dissolved Al analysis can also be problematic when colloidal aluminium is present. Resource consent CRC170541 only required the analysis for Al when pH is < 5.5 or > 7.5[10]. This acknowledged the fact that within this pH regime the aluminium will be predominantly present as an Al-hydroxide precipitate and not in the dissolved form.

    (a) Previous research has shown that the analysis of the dissolved Al fraction in AMD impacted waters was impacted by colloidal Al (Waters and Webster-Brown, 2013). It is likely that similar issues may occur at Canterbury Coal Mine when analysing circum-neutral waters.

[8] Statement of Evidence of Paul Weber, 1 October 2021 at [Appendix 7]
[9] Proposed Consent Condition 23: CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water
[10] Waters and Webster-Brown (2013) note that free Al^{3+}, the most toxic Al species was dominant in AMD impacted waters at Stockton Coal Mine between pH 3.8 – 4.8, hence the range used at Canterbury of 5.5 – 7.5 for when Al monitoring was not required is reasonable.

(b) I expect there may be instances when dissolved Al may be measured as being elevated due to colloidal Al. This may require additional investigations such as 0.2 µm filters, or other testing methodologies. For instance, Waters and Webster-Brown (2013) demonstrated that the Aluminon laboratory method did not react with particulate Al or strong Al complexes, often registering as little as 53% of the dissolved Al concentration determined by ICP-MS

(c) I recommend that any condition of consent be worded to enable additional investigations when colloidal Al is present or suspected. This might include a smaller filtration size and/or the Aluminon laboratory method. I understand that the proposed consent condition 23[11] will include the ability to resample and/or retest as soon as practicable, which I support.

Dissolved Oxygen

27. In the marked up proposed consent condition comments[12], Dr Massey requests continuous dissolved oxygen (**DO**) monitoring. I do not believe that compliance monitoring is necessary. Instead DO monitoring has been proposed as monthly discrete samples (Table 2 below). My justification for this is that once the MSR achieves steady-state conditions it is unlikely the DO will change significantly. Dr Hickey notes that aeration will be via a corrugated pipe prior to the Tara spillway mixing structure and will reliably generate a well oxygenated discharge. As noted in my Evidence in Chief,[13] DO monitoring will be part of the MSR commissioning work, which will address this risk. Confirmation that waters are suitably aerated at the bottom of the Tara Spillway Mixing Structure (**TSMS**) will require trials to confirm that suitable mixing is occurring. I recommend that trials are conducted to confirm that DO is acceptable and that the mixed water is recirculated back (from a collection system) to site during the MSR commissioning phase to test this process. I

[11] Proposed Consent Condition 23: CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water
[12] Proposed Consent Condition 20: CRC[discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water
[13] Statement of Evidence of Paul Weber, 1 October 2021 at [90]

also recommend the field DO be measured using a handheld DO meter at CC02_TSMS.

28. In conferencing it was proposed that understanding total and dissolved metal concentrations would be important in mixed discharge from the MSR and Tara Pond. I support this at site CC02_TSMS, which has been included in Paragraph 22 – Table 1 as a footnote.

Performance Monitoring – Additional Potential Contaminants of Concern

Summary

29. A number of additional PCOC have been raised by the experts for ECan and SDC as a result of CCR placement and AMD effects and continue to be a concern for their review. It was proposed by Dr Meredith[14] and Dr Massey[15] these contaminants could be included as part of the site monitoring activities.

30. I have provided additional evidence in **Appendix 2**– Table 3 on these PCOC that indicates effect on water quality by these PCOC is low. This is in addition to the data that was previously provided in my Evidence in Chief[16].

31. Given the longevity of CCR placement at site since ~2009 (Paragraph 18) and that acid rock drainage has been present in the past (since 2004 – see **Appendix 1**) it would be reasonable to assume that any effects of PCOC from AMD or CCR would have been identified by now in water quality monitoring data.

32. However, I recognise the concerns raised by the experts for ECan and SDC and therefore support annual performance monitoring to validate the current trends in water quality for PCOC. I believe there is sufficient data available to indicate the environmental risks are low; the exception is for polycyclic aromatic hydrocarbons (**PAHs**), where there are currently limited data for site water discharges; hence my recommendation for annual monitoring to validate the current water quality trends.

33. My recommendation to monitor additional PCOCs is in alignment with the recommendation of Dr Meredith[17]: "w*hile a core suite of mine contaminant parameters should be monitored regularly, there should also be occasional*

[14] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [44, 46]
[15] Summary Statement of Dr Michael Massey, 28 October 2021 at [76, 77]
[16] Evidence in Chief of Paul Weber, 1 October 2021 at [141]
[17] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [47]

screening for a greater suite of potential metal, elemental, and organic contaminants to address this level of uncertainty, maybe annually, or when underdrain flows deviate from steady discharge"

Performance Monitoring Program - PCOC

34. PCOC are presented below in Table 2 with my recommendations for annual monitoring. I believe the monitoring regime proposed in Table 2 should be considered performance monitoring rather than compliance monitoring as previous data indicates that concentrations of these PCOC are low, noting that the current PAH dataset is limited (Appendix 2-Table 3).

35. Other water quality parameters that are important for performance monitoring are also provided in Table 2 (i.e. dissolved oxygen (**DO**) for monitoring of discharge at CC02_TSMS and N02 Pit Pond for stratification; and dissolved organic carbon (**DOC**) as suggested by Dr Meredith,[18] which may modify toxicity; Ca and Mg to calculate hardness for hardness modification of metals; sulfate as an indicator of longer-term geochemical trends, and temperature). Monthly monitoring is recommended for these other parameters at most sites as explained in Table 1 and Table 2 of the TARPs (REV4).

36. As set out in the TARPs (REV4) performance monitoring is proposed at CC02_tele, CC02_TSMS, and CC20 for the PCOC presented in Table 2. This addresses key discharge sites for CCM for the Tara catchment and the Bush Gully catchment.

Table 2. Proposed PCOC and other performance monitoring parameters proposed by expert witnesses for ECan and BCL.

PCOC	**Monitoring**
Arsenic (**As**)	Annual
Cadmium (**Cd**)*	Annual
Copper (**Cu**)*	Annual
Chromium (**Cr**)*	Annual
Lead (**Pb**)*	Annual
Mercury (**Hg**)	Annual
PAHs[19]	Annual
Other Water Quality Parameters	**Monitoring**
Dissolved oxygen (**DO**)*	Monthly

[18] Section 42A report of Adrian Meredith at [95]
[19] Polycyclic aromatic hydrocarbons

PCOC	Monitoring
Dissolved organic carbon (**DOC**)	Monthly
Hardness (**Ca** + **Mg**)	Monthly
Sulfate	Monthly
Temperature	Monthly

** Water quality targets for DO are discussed by Dr Hickey[20] as being 50% saturation as measured by a handheld field DO meter.*

The above suggested water quality monitoring parameters are for dissolved metals.

37. It is recommended that the data collected be reported and discussed in the annual report.

38. Performance monitoring is required as part of the TARPs. These monitoring requirements are included in that document (REV4) in detail together with a table that summarises the monitoring parameters and frequency.

Oyster Gully

39. I agree with Dr Meredith[21] that the following monitoring should be undertaken in Oyster Gully based on the fact that there is a low level of risk, but a possible risk, hence some trend monitoring is warranted:

    (a) Visual inspection for active seeps that could develop.

    (b) Ongoing water monitoring at the CC12 water quality monitoring site on a monthly basis.

    (c) Dr Meredith notes that the monitoring proposed is to verify that following active closure that no issues arise. I recommend such verification monitoring is defined as performance trend monitoring for the contaminants.

40. Performance monitoring is proposed as part of proposed consent condition 35a(b)[22].

[20] Statement of Evidence in Reply of Dr Hickey, 25 February 2022 at [86].
[21] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [9]
[22] Proposed Consent Condition 35: CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water

41. Further discussion is provided by Mr Sinclair on this matter at paragraphs 17 – 22.

42. I support the proposed performance monitoring approach for Oyster Gully and recommend:

    (a) Performance monitoring parameters should include those parameters presented in Table 1, excluding turbidity, and should be conducted on a monthly basis. Data should be compiled into the CCM water quality monitoring database.

    (b) The requirements for monitoring for effects should be reviewed as part of the review process proposed (see Paragraph 8).

43. I note that recent water quality monitoring data have been provided by BCL for CC57, which is the small holding sump in the West Pit above Oyster Gully. It should be noted that the early water quality data for this sump (CC57) was the analogue data used to predict the N02 Pit Pond Water quality (0.67 – 2.52 mg/L boron) during the active closure phase as explained in MWM Memo 2 Table 1 (MWM, 2021). Recent data shows that in October 2021 the sump had a boron concentration of 0.413 mg/L, which is within the range of the analogue model used for N02 Pit Pond post closure water quality of 0.4 – 0.6 mg/L (MWM, Table 1, 2021b) demonstrating an improvement in water quality following rehabilitation activities can be expected. This also indicates the analogue models for post closure water quality remain suitable. Further on-going monitoring will confirm this assumption.

44. No TARPs are proposed for Oyster Gully as the risks for environmental impacts are considered low. I recommend that if ongoing performance monitoring identified potential effects / risks worse than current baseline conditions, then a TARP could be developed. As noted in proposed consent condition 35[23] the TARPS shall include, but not be limited to the key water management structure. This indicates that an additional TARP could be added for Oyster if this was required. I therefore support the proposed performance monitoring approach for Oyster Gully.

[23] Proposed Consent Condition 35: CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water

Proposed Review of Water Quality Data

45. I am of the opinion that three key reviews are required for the CCM closure project:

(a) As stated in draft consent condition 7,[24] "*The consent holder shall review the EMP and MCMP, on ~~a six monthly~~an annual basis during the active ~~closure phase of the Project,~~ and ~~at least annually during the~~ post closure ~~phase~~phases (and for no less than 5 years), and if necessary, update it. The consent authority shall be provided with any updates of the plan(s) within 30 working days of any update occurring.* The MCMP contains the TARPS, so effectively these documents would also be reviewed.

(b) As per proposed consent condition 37, a review of the TARPs and water monitoring requirements will be undertaken prior to moving into the post closure phase. I support this.

(c) I also recommend that water quality data and flow rates, including contaminant loads be reviewed in March 2024, set out below.

46. As noted in my EIC[25] I recommend that the water quality trends and flow rates be reviewed in 2024. This date aligns with the mine closure management plan presented by BCL, provides time for a number of activities to be completed on site and allow for a period of data collection from a steady-state and final landform operating under post closure conditions.

(a) The date therefore provides the opportunity to make informed decisions on ongoing monitoring sites, monitoring parameters, and TARPs, and provide data to better understand any contaminant decay curves and the expected duration of treatment.

(b) However, it is noted that some monitoring programmes and data may be limited in March 2024 and of insufficient duration (e.g. flow rates from the N02 Pit Pond; stratification effects of the N02 Pit Pond).

[24] Proposed Consent Condition 7: CRC [General conditions].
[25] Statement of Evidence of Paul Weber, 1 October 2021 at [78]

(c) The 2024 water quality review should include a review of performance monitoring and compliance monitoring data including frequency of monitoring and monitoring parameters.

(d) Longer-term climatic cycles and potential effects should also be considered as part of this review.

(e) The empirical water balance model for the N02 Pit Pond should also be prepared for this review, if it is required, to support interpretations and monitoring requirements. This model has been agreed to as proposed consent condition 13a[26] prior to permanently using N02 Pit Pond water for dilution of the MSR effluent.

47. I accept that this date of March 2024 is a placeholder date and subject to data reliability and could be shorter or longer, which will be a function of data confidence.

48. I believe these reviews are sufficient to assess and analyse data, identify risks through a formal risk assessment process (i.e. BCL risk assessment process), and implement any changes or correct actions that are necessary to avoid, remedy, or mitigate adverse effects to the receiving environment.

MINE CLOSURE INFRASTRUCTURE

Mussel Shell Bioreactor (MSR)

49. Dr Massey requested clarification on the maintenance that is needed for the MSR and that it may be more than just sludge management[27]. I agree that there may be other maintenance activities. I understand that this clarification has been added to the proposed consent condition 18a[28]

[26] Proposed Consent Condition 13a: CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water.
[27] Comment of Michael Massey in conferencing version of draft consent condition 18a - CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water.
[28] Proposed Condition 18a - CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water.

50. Dr Massey requests that data on the MSR sludge quality that is removed during maintenance activity should be provided as part of the annual report[29] It is proposed this clarification will be added as an advice note including where the material was disposed to. I agree that the provision of these data is reasonable. This clarification has been added to the proposed consent condition 18b.[30] The test methodology should be clarified in the proposed consent condition and I recommend the TCLP[31] test should be utilised including a total digest of the materials to understand the composition of the sludge, which will help with mass balances and understanding environmental risks.

51. TARPS are in place for the MSR to manage key risks that were identified during conferencing and include water quality and quantity monitoring during the active closure phase and the post closure phase. Further details are provided in the TARPs (REV4).

N02 Pit Pond

52. Dr Meredith has raised concerns about the potential for stratification of the N02 Pit Pond[32]. In my opinion this issue has been resolved by the inclusion of appropriate monitoring in the associated TARPs, including pH, EC, dissolved oxygen, and temperature (of surface and pond bottom waters) as leading performance indicators of risks associated with stratification.

53. Dr Meredith raised a number of concerns in regard to the N02 Pit Pond decanting discharge[33], which are addressed below:

    (a) TARPs are in place to monitor water quality and provide triggers for further actions.

    (b) Dr Meredith raised concerns about the number of zero flow occurrences that have been modelled[34]. This model is conservative for the reasons explained at the hearing (e.g., it

[29] Comment of Michael Massey in conferencing version of Consent Condition 18b - CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water.
[30] Proposed Condition 18b- CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water.
[31] Toxicity Characteristic Leach Procedure (USEPA methodology 1311).
[32] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [16]
[33] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [18-23]
[34] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [22]

uses the design flow rate for the Mussel Shell Reactor of 0.2 L/s, when 10th percentile data (2019/2020) suggests the flow rate of the CC02 underdrain being treated by the MSR is 0.076 L/s). As I have stated[35], the model is a simplistic surface water flow model to understand failure modes and risks and I have recommended that BCL develop an empirical model to understand any future risks (Paragraph46(e)). This is important as it is not just flow rates that could affect water quality discharges but the quality of these waters as well. This recommendation has been adopted in proposed consent condition 13a.[36]

North ELF Ponds

54. At the hearing the commissioners questioned the retention of the North ELF ponds (Pond 1 and Pond 2). There was also discussion about the quality of the sediment in these ponds. Dr Adrian Meredith also raised concerns in regard to the retention of these ponds[37]. I understand that the removal and/or retention of the North ELF ponds does not fall within the scope of the applications before the commissioner. Despite this, I provide the following clarifications on the future use of the North ELF ponds:

    (a) The North ELF Pond 1 located at the toe of the North ELF is an essential component for AMD management of this mine domain. Its purpose is to flood the toe of the North ELF underdrain to prevent oxygen ingress back into the waste rock / ELF. Oxygen ingress back through the underdrain will facilitate oxidation of sulfides within the core of the North ELF, which could lead to the generation of AMD.

        (i) I strongly recommend that this pond remain at closure.

        (ii) With time, if the pond became overgrown with vegetation, I do not see this as an issue provided discharge from the underdrain could still occur.

[35] Statement of Evidence of Paul Weber, 1 October 2021 at [111-112]
[36] Proposed Condition 13A- CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water.
[37] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [48-52]

(b) The lower North ELF Pond 2 receives flow from Pond 1. I understand that it is proposed by BCL that the North ELF Pond 2 decant system will be removed and a spillway constructed to allow water to flow unrestricted into the tributary of the Bush Gully Stream. I understand that it is proposed by BCL that the North ELF ponds perimeters will be planted out with native plants.

(i) I expect that retaining Pond 2 would be beneficial for closure as the system would continue to provide dilution of underdrainage from the North ELF during dryer periods.

(ii) There is no data available on the quality of the sediments in these ponds. If they are not going to be removed, I expect the environmental risks are low and any effects would be identified by monitoring of the ponds at CC20 (such monitoring is contained in the TARPs (REV4)). Dr Hickey[38] states that he does not consider that the sediment contaminants present in the ponds on the CCM site represent an unacceptable risk for adverse effects on downstream ecology caused by the release of chemical contaminants.

Tara Pond

55. The Tara Pond is currently identified in consent conditions[39] as being part of the post closure infrastructure. I support the retention of the Tara Pond.

FUTURE LAND USE

56. At the hearing the concern was discussed that PAF materials could be exposed by future forestry activities and acid rock drainage could occur. For instance, by tree toppling, by erosion, or as a result of an earthquake.

57. Furthermore, Dr Massey also notes[40] and supports Mr Gardner's comment that "*Depending on future land use, there is a risk of the loss of land integrity (i.e., increased permeability), which might result in increased mobilisation of contaminants due to the intrusion of oxygen or water*".

[38] Statement of Evidence in Reply of Dr Hickey, 25 February 2022 at [122-123]
[39] Proposed Consent Condition 14 comments - CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water.
[40] Summary Statement of Dr Michael Massey, 28 October 2021 at [14]

58. In regard to oxygen ingress I do not see this being a material risk for AMD at this site and further justification is provided by student work that showed oxygen concentrations < 0.3% after 2 m depth (Paragraph 18(d) and the construction techniques used at site, which have created very low modelled oxidation rates / acidity generation (Paragraph 59(b) below). This suggests only the outer edge of the ELFs would be influenced by the diffusion of oxygen with the ingress of oxygen controlled by short lifts and sealing the underdrains by flooding.

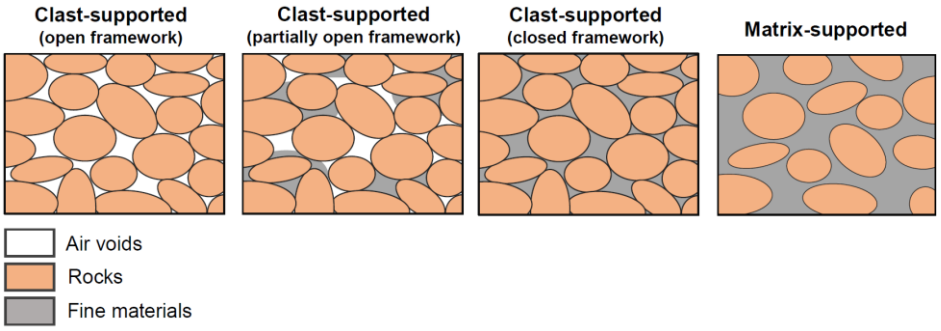
59. Furthermore, I believe the risks of PAF materials being exposed and significant acid drainage occurring are low for the following additional reasons:

    (a) As explained in my Evidence in Chief[41], the site has a robust management approach for PAF materials, with mine waters historically being classified as acid rock drainage due to poor material management, yet drainage is now classified as circum-neutral metalliferous drainage due to good material management practices.

    (b) Materials at CCM are fine grained materials with few competent rocks, leading to matrix supported mine rock rather than clast supported waste rock. This means there are less air voids for oxygen ingress in matrix supported rock compared to clast supported waste rock (see Figure 1). This is supported by modelling (BCL, 2016), which indicates only 3-8 t/ha/yr of acidity will be generated from ELF mine domains. Not all of this acidity will be mobilised. As shown by circum-neutral pH values in mine drainage the acidity load has been neutralised by the acid neutralisation capacity of the rock.

[41] Statement of Evidence of Paul Weber, 1 October 2021 at [12]

Figure 1: Clast (orange) supported versus matrix (grey) supported materials. Matrix supported materials have fewer pathways for oxygen ingress (oxygen shown in white).



(c) Material permeabilities are low at the CCM due to the matrix-supported materials, inherent clays, and traffic compacted lifts, which are reported as ~1 x 10^{-8} m/s (BRL, 2018). Flow rates from ELFs are low due to low permeabilities. Work undertaken by BCL, as reported in the EMP indicate that models predict 33 - 77 mm/year average net percolation (BCL, 2018; Section 6.4). Low permeabilities minimise the risk to the receiving environment. Low permeabilities are supported by student work completed in 2005 (Paragraph 18(d)).

(d) International best practicable methodologies to minimise AMD are undertaken at site (e.g., INAP, 2020)[42]. This includes placement of PAF materials within the core of the ELF away from oxygen ingress where it is encapsulated by 10-15 m of non-acid forming materials and the construction of the ELF in short lifts (1 - 2 m) to prevent the advective ingress of oxygen via chimney zones (i.e. French Drains). The prevention of oxygen ingress through significant advection minimises the risk of AMD due to regular traffic compacted surfaces[43]. This means that oxygen ingress will be diffusion controlled, which means that pyrite oxidation will be low in the event of a tree toppling over and exposing any underlying PAF materials.

[42] Three Bathurst mine sites (Stockton, Cypress, and Escarpment) are recognised in this report demonstrating that the company uses best practicable technologies to minimise AMD.
[43] Statement of Evidence of Paul Weber, 1 October 2021 at [52]

(e) As stated in my evidence[44] the acid base accounting data (**ABA**) indicates that the site is non-acid forming (**NAF**) with a negative net acid production value (**NAPP**). This means the bulk materials are unlikely to generate acidity if PAF materials are well managed. At CCM the materials are well managed (as shown by circum-neutral drainage).

(f) Only 12% of the waste rock at site is potentially acid forming (PAF). BCL note this is buried within the core of the waste rock dump and is surrounded by 10-15 m of NAF waste rock.

(g) BCL has indicated that highwalls will only be covered with 0.5 m of NAF materials as a capping layer, not the 10-15 m built into ELFs as they are constructed. As noted in my evidence in chief[45] the majority of the highwalls contain NAF or low risk materials. The 0.5 m NAF cover is suitable where PAF is present as the rock beneath is competent with a low reactive surface area (compared to disaggregated waste rock), oxygen ingress will be low, the amount of acidity generated will be low and the risk of significant AMD generation is low. As noted by Mr Jenkins, the highwall area does contain PAF as shown in Memo 2 (MWM, 2021b)[46]. Surface runoff from these areas will be into the N02 Pit Pond. Accordingly, the N02 Pit Pond TARP monitoring programme is in place to determine if this process does happen with management options in place as required (lime dosing, NaOH dosing etc). Mr Jenkins[47] (and at Paragraph 65) notes that such monitoring will definitely be necessary. Proposed consent condition 13[48] addresses the requirement for this 0.5 m cover layer (further discussion provided in Paragraph 64 below).

(h) One failure mechanism that could expose PAF in the ELFs is a significant earthquake. As stated previously[49] Dr Begbie notes in his evidence, the mine has previously experienced a M7.1

[44] Statement of Evidence of Paul Weber, 1 October 2021 at [47]
[45] Statement of Evidence of Paul Weber, 1 October 2021 at [Appendix 2]
[46] Mine Waste Management Memorandum 2, Figure 7 (MWM, 2021b)
[47] S42A Report Presentation Notes of I Jenkins at section 3.4 to 2.6
[48] Proposed Consent Condition 13 comments - CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water.
[49] Statement of Evidence of Paul Weber, 1 October 2021 at [133]

seismic event and the site reported minimal damage. Furthermore, Dr Begbie notes that a displacement of up to 0.1 m could be expected for a 250-year earthquake event. Mr Macfarlene was engaged by Selwyn District Council (SDC) and also notes there is a very low risk of future instability of the ELFs. Given the PAF materials are encapsulated by 10-15 m of NAF overburden the risk of exposing PAF materials would be low.

60. Overall, I believe the risk for materially higher seepage rates from rehabilitated slopes is low and that the risk of significant oxygen ingress is also low.

61. I conclude based on the reasons above that the exposure of significant PAF materials is unlikely and that minor exposures are likely to have less than minor effects on receiving waters.

CONSENT AUTHORITY EXPERT SUMMARY STATEMENTS

62. Summary Statements for the hearing were available from Mr Ian Jenkins, Dr Adrian Meredith and Dr Michael Massey, which I have reviewed and provide the following comments where I have not discussed these previously, or when additional clarifications are required:

Section 42A Presentation Notes of Mr Jenkins

63. Mr Jenkins commented that the development of a water balance model is good practice. As noted in my Evidence in Chief[50] I agree this is needed.

64. Mr Jenkins noted that 1 m of NAF material over PAF areas would be significantly more effective than 0.5 m of NAF cover, and that verification monitoring in the N02 Pit Pond will be necessary. The proposed closure plan is 0.5 m of NAF. As I discuss at Paragraph 59 above, monitoring of the N02 Pit Pond will confirm if this is suitable.

65. Mr Jenkins discusses the proposed TARPs presented in my evidence[51]. It is noted the TARPs and my evidence has been updated and replaced with the new TARPs (REV4), which is contained in Statement of Evidence in Reply of Mr Sinclair, which address the matters raised in his evidence.

[50] Statement of Evidence of Paul Weber, 1 October 2021 at [116]
[51] Statement of Evidence of Paul Weber, 1 October 2021 at [152 -161]

Summary Statement Section 42A Reporting Office – Dr Michael Massey

66. Dr Massey notes[52] that Mr Gardner, recommended sampling a wider suite of contaminants than are currently measured in monitoring activities including trace elements and PAHs. This has been addressed above at paragraphs 29 - 38.

67. Dr Massey requests a water monitoring programme lasting for at least some decades[53] and that a period of 10 years or more of monitoring would be reasonable[54] As noted in my Evidence in Chief, AMD might last for years to decades for the CC02 underdrain[55] and long- term monitoring will be required. Other sites may not require this and hence the purpose of the proposed reviews (Paragraph 8). I would also note that in some instances, certain parameters have been monitored since 2004 (~18 years) and remain below detection or at very low concentrations. This suggests that the geochemical environment does not contain these PCOC in highly mobile concentrations, and hence it seems an unnecessary cost to monitor for them. I have recommended annual monitoring of these PCOC to validate current trends, as explained in Paragraph 33.

68. Dr Massey compares the monitoring requirements and longevity of monitoring required at CCM to that required for petrol stations and landfills[56]. I believe there is a distinction between such sites where petrol stations and landfills have introduced contaminants, quite different to their geological setting, and a significant time period is required to understand the migration of such contaminants in groundwaters. At CCM the rocks are the greater reservoir of boron compared to the CCR[57], which means any water migration through these materials is likely to be already elevated in such contaminants if they were an issue. Furthermore, I expect that any PCOC are already being assessed as part of the monitoring parameters, although the concentrations may vary.

[52] Summary Statement of Dr Michael Massey, 28 October 2021 at [12]
[53] Summary Statement of Dr Michael Massey, 28 October 2021 at [24]
[54] Summary Statement of Dr Michael Massey, 28 October 2021 at [25]
[55] Statement of Evidence of Paul Weber, 1 October 2021 at [94]
[56] Summary Statement of Dr Michael Massey, 28 October 2021 at [20,21]
[57] Statement of Evidence of Paul Weber, 1 October 2021 at [34] as summarised from MWM memorandum (2021c).

69. Dr Massey mentioned that caution is needed on the amount of nitrogen-based fertiliser applied at site as it can oxidise pyrite in the absence of oxygen[58]. I do not believe this is an issue for AMD at this site. For clarification I would note that nitrate oxidation of pyrite generates 75% less acidity compared to oxidation of pyrite by oxygen (Weber et al., 2021), hence the risk for acid drainage is lesser. The difference in acidity is explained in Figure 2.

Figure 2: After Reid et al. (2016):

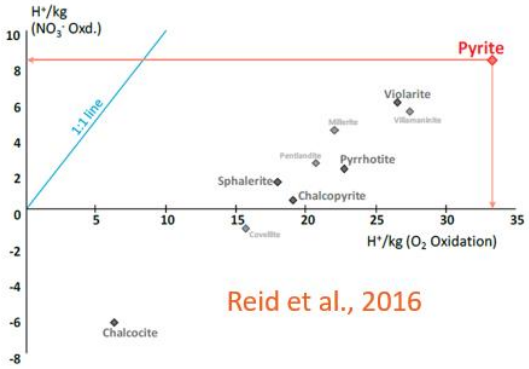


Figure 1: Predicted acid production for various sulfides with oxygen (x axis) or nitrate (y axis) acting as the dominant oxidant, compared with equal acid production (1:1) line. Nitrate-amended pyrite oxidation produces ~ 25% of the acidity, compared with 'normal' oxidation with dissolved O_2.

70. Dr Massey appears to have reservations about adaptive management[59] and requests that key monitoring provisions, trigger limits, and responses be codified as consent conditions. Such performance monitoring is part of the proposed TARPs. The TARPs will change as more information becomes available through the closure process. In my experience, having the TARPs as part of a formal regulatory condition means the conditions will constantly have to be updated. I recommend that there is a condition that requires appropriate TARPs, but not have it 'codified' in consent conditions.

Summary Statement Section 42A Reporting Office – Dr Adrian Meredith

71. Dr Meredith requests additional monitoring in Oyster Gully Stream and Surveyors Gully Stream[60]. This is discussed in paragraph 39-44.

72. Dr Meredith requests monitoring and aeration of the MSR discharge is required[61]. This was discussed extensively during conferencing. The MSR effluent discharges into the Tara Spillway Mixing Structure (**TSMS**), which will be designed to mix the two waters providing additional aeration, with monitoring at CC02_TSMS. I note that Dr Hickey, in his Statement of

[58] Summary Statement of Dr Michael Massey, 28 October 2021 at [67-69]
[59] Summary Statement of Dr Michael Massey, 28 October 2021 at [74]
[60] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [9]
[61] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [11, 12]

Evidence in Reply recommends a dissolved oxygen (DO) target for monthly monitoring of 50% saturation, although this should not be a compliance limit[62]. This clarification and recommendation for performance monitoring has been incorporated into Table 1 and Table 2 of the TARPs (REV 4).

73. Dr Meredith raises some concerns about the provenance of CCR in that some CCR was from other locations[63]. Previously I have explained that Clandeboye CCR is a blend of ash derived from ~50% Takitimu coal and 50% Canterbury coal and that CCR from Clandeboye is lower in total boron, iron, nickel, and zinc compared to other ash sources tested[64]. These data suggest the contaminant reservoir is thus less for Takitimu CCR. To support this statement BCL have provided additional SPLP data for CCR from Canterbury Coal mine and CCR from Takitimu Coal Mine (Appendix 3), which demonstrates that the leachates derived from these materials, as determined by the SPLP test are not unusually different.

74. Dr Meredith notes that CCR have only been disposed of in the past 3 years and "*are unlikely to have fully stabilised or losses from all of them not yet arisen in sampling of seeps and discharges*". I disagree with this statement. CCR has been disposed of at the CCM since 2009 by the previous mine owner as per Resource Consent CRC081869 granted 17 February 2009.

75. Dr Meredith raises concern about the appropriate monitoring parameters and the need to have a more complete list of parameters, supporting Dr Massey's statements[65]. I believe the data provided in this statement, as summarised in Paragraph 29 - 38 and in Appendix 2 provides further clarification and justification for the proposed performance monitoring regime. I have recommended annual performance monitoring of these additional PCOC (as shown in Table 2) to confirm trends.

76. Dr Meredith states that the "*degraded receiving environment is in many respects a consequence of the treatment of this environment by the BCL CCM mining activities*". As noted in Paragraph 16 and 17 the receiving environment has been affected historically by opencast mining activities since 2004 and before that for many decades due to the discharge of AMD from underground

[62] Statement of Evidence in Reply of Christopher Wayne Hickey at [9D(ii), 84)
[63] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [42]
[64] Summary Statement of Dr Paul Weber, 26 October 2021 at [36]
[65] Summary Statement of Dr Adrian Meredith, 28 October 2021 at [46,47].

workings in the area. I would suggest the statement by Dr Meredith could be moderated to reflect a catchment with historical impacts prior to BCL ownership.

DRAFT RESOURCE CONSENT CONDITIONS

77. I make the following comments on the proposed consent conditions. I have only addressed those consent conditions where I think:

    (a) Further support is required for the proposed consent condition;

    (b) Clarifications would be useful for the proposed consent condition; or

    (c) A general comment is needed on the proposed consent conditions.

General Conditions

78. Definitions: (Recommendation): I recommend that the definition for mine influenced water (MIW) include treated MIW. Otherwise MIW water passing through the MSR is missing as one form of discharge, which has been removed from general proposed consent condition 1[66].

79. Condition 10: (Clarification): I support the annual reporting process, which includes water quality monitoring. I support a minor clarification being provided here to say this includes compliance monitoring and performance monitoring water quality data.

CRC184166 s9 Land use consent to undertake earthworks in the high soil erosion risk area and earthworks and vegetation clearance in riparian margins, including removal of wetlands

80. I have no material comments on this proposed consent.

CRC200500 – Discharge permit, to discharge contaminants into air (fugitive dust) from within the Mine Operations Area

81. I have no material comments on this proposed consent.

[66] Proposed Consent Condition 1 - CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water.

CRC201366 s14 Water Permit to take, divert and dam water

82. Condition 9: (Clarification): In some instances, the water from the N02 Pit Pond may not be directed through the MSR. For instance, when maintenance is taking place. In these situations, the water may be diverted from the MSR. This has been clarified in the proposed consent condition. The focus of the condition is the permissible use of the water for dilution not the function of the MSR. Therefore, I support the removal of the reference to the MSR from the consent condition.

CRC201367: Water permit to take and use groundwater (via drainage systems)

83. I have no material comments on this proposed consent.

CRC[discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water

84. Condition 3: (Clarification): It has been agreed by BCL that the monitoring point at the bottom of the Tara Spillway Mixing Structure will be identified as the CC02_TSMS water quality monitoring site. I support a change to this proposed consent condition to clarify and name this water quality compliance monitoring site.

85. Condition 3: (Support): I support the term mixing structure. The purpose of the TSMS is to mix MSR effluent, potable water discharge, N02 Pit Pond discharge, and Tara Pond discharge such that the combined discharges are adequately mixed. This was a concern of Dr Meredith. It is proposed that performance monitoring is undertaken for dissolved oxygen, see Table 2, Paragraph 36 at CC02_TSMS.

86. Condition 6: (Support): I support the requirement in this proposed consent condition that monitoring to be undertaken by a suitably qualified and experienced person in accordance with an appropriate guideline. BCL have indicated that the National Environmental Monitoring Standard for Sampling, Measuring, Processing and Archiving of Discrete River Water Quality Data (MfE, 2019) will be used. I support the use of this standard and a requirement to ensure appropriate training is provided to personnel undertaking the sampling activities.

87. Condition 13: (Support): I support the requirement in this proposed consent condition for 0.5 m of NAF to be placed against final backfill areas containing insitu PAF (i.e. pit walls) and reshaped surfaces in the N02 Pit Pond high wall catchment. It is not needed on areas of NAF. As noted in Paragraph 59(g), water quality monitoring is proposed to take place in the N02 Pit Pond, which will identify any problematic and elevated contaminant concentrations. This monitoring is addressed in the TARPs (REV4) and includes for instance pH, EC, metals, boron and other key performance monitoring parameters.

88. Condition 13a: (Support): This proposed consent condition requires the development of an empirical water balance model for the site (including a water balance model, CC02 underdrain contaminant load model and N02 Pit Pond water quality model) prior to permanently using N02 Pit Pond water for dilution of the MSR effluent. All these models are interlinked to understand effects in Tara Stream As stated in my evidence in chief[67] this model is important. I support the development of this model and the proposed consent condition as stated.

89. Condition 16: (Clarification): For proposed consent condition 16(d) there is benefit in stating that the mixing structure is designed to mix and provide additional aeration for the combined discharges from the MSR effluent and the other discharges (potable water discharge, N02 Pit Pond discharge, and Tara Pond discharge).

90. Condition 18:(Recommendation): I recommend this proposed consent condition is clarified to say a commissioning phase will be undertaken before the MSR discharges to the Tara Stream, which provides good risk mitigation. I would expect this process would involve the collection of data to support the commissioning process.

91. Condition 20: (Support): I support the proposed compliance monitoring parameters presented in this proposed consent condition, being updated as per paragraph 22 of this evidence. In my opinion these are the key contaminants, although total metals need to be included for Al, Fe, and Mn at CC02_TSMS. Other minor issues as noted in footnotes to Table 1 need to be considered as well in the proposed consent conditions.

[67] Statement of Evidence of Paul Weber, 1 October 2021 at [116]

92. Condition 20: (Clarification): It was noted (in the proposed consent condition comments) that total and dissolved metals should be monitored. This was only for Fe, Al, Mn at CC02_TSMS. The proposed consent condition should clarify this (see Paragraph 22 (Table 1 footnotes).

93. Condition 20: (Recommendation) There was agreement to remove the requirements to analyse for Fe and Al when pH values were outside of certain pH ranges. As noted in paragraphs 25 and 26 there may be problems with colloidal Fe and Al. I recommend the consent conditions be drafted in a way that allows additional investigations may be required when colloidal Fe and/or Al are present or suspected as explained above. However, I also understand that the proposed consent condition 23 will include the ability to resample and/or retest as soon as practicable, which I support

94. Condition 20: (Recommendation): I recommend that field pH and field EC be undertaken as well as laboratory measurements as part of the proposed compliance monitoring (Table 1). Field pH was supported by Mr Jenkins in the proposed consent condition comments.

95. Consent Condition 23: (Recommendation): I recommend the ability to resample and/or retest that parameter to address exceedances and/or the effects of colloidal materials such as Al and Fe.

96. Condition 35a: (Support): As discussed above (paragraphs 39-44), I support performance monitoring of Oyster Gully.

97. Consent Condition 36: (Clarification): It is proposed that if red trigger levels are exceeded, as noted in proposed consent condition 36, the consent holder shall notify the Consent Authority within 5 working days and provide confirmation of the action that are being undertaken, or will be undertaken. I agree with the necessity of notification but recommend this should only be for Red Triggers. TARPS are management tools for the company to ensure it achieves its closure objectives and compliance targets. I recommend the validity of these trigger levels can be reviewed as being suitable during the proposed reviews, of which there are many (Paragraph 8).

CRC[CCR discharges] – To discharge CCR, lime products and mussel shells to land and to water

98. Consent Condition 4: (Clarification): Change ‘acid mine drainage’ to ‘mine influenced water’. I support the use of mine influenced water as a simple terminology.

TRIGGER ACTION RESPONSE PLANS

99. In my experience TARPs are a key management tool for adaptive management processes. Through the hearing process a number of possible updates to the TARPs were identified. Such amendments have been addressed. Myself and the other experts for BCL have spent a considerable amount of time on the TARP document to address key risks including partaking in conferencing discussions with the ECan and SDC experts, who have also spent considerable time on these documents.

100. Following the above process, it is my opinion that the TARPs (REV4) are suitable in the initial instance and cover key risks identified. TARPs provide for adaptive management and will change as new information comes to hand to improve risk management and mitigate potential effects on the receiving environment.

101. Dr Massey had reservations about the trigger values and that some need to be lower. I support the level as proposed by BCL in the interim until more data are available, and I believe the risk, associated with the current trigger levels is low in the Active Closure Phase given that:

(a) The risks associated with N02 Pit Pond acidity; N02 Pit Pond boron concentrations, N02 Pit Pond zinc concentrations are mitigated by the fact the N02 Pit Pond is being actively managed with no direct overflow discharge to Tara Stream (i.e. pumped discharge); and

(b) The MSR Effluent will not be discharged until the commissioning phase is complete with data to support the process of discharge.

(c) Risks associated with trigger levels for the closure phase can be reviewed at the proposed reviews as explained in paragraphs 45-46.

102. I agree that the TARP trigger values should be reviewed prior to moving into the Post Closure Phase (which aligns with proposed consent condition 37)[68]. Prior to the post closure phase, Trigger values can then be considered against a larger water quality and quantity dataset to make more informed decision. It should be noted the TARPs are part of the MCMP, which will be reviewed annually during the Post Closure Phase.

103. In the proposed consent condition[69] comments, Dr Massey requests continuous DO monitoring. I do not believe that compliance limits are necessary as discussed in Paragraph 27. I recommend monthly discrete samples (using a handheld DO meter) as part of the performance monitoring program following confirmation that adequate aeration is achieved during the MSR commissioning phase.

104. The current TARPs have been reviewed, key risks identified, and in my view are suitable at this current stage. These have been updated and are included in the Statement of Evidence in Reply of Mr Sinclair. However, I acknowledge that data uncertainties remain. In my view, this uncertainty is more relevant to the post closure phase rather than the active closure phase.

105. The performance monitoring programs, which are included in the TARPS for the different mine phases as Table 1 and Table 2 (of the TARPs) explains the monitoring site, a description of its purpose (compliance / performance monitoring), the type of monitoring (continuous / discrete), frequency and the parameters to be monitored. These tables have been updated by BCL to include other PCOC as requested by the experts for ECAN and SDC in the TARP (REV4).

106. Following the above management and review processes, it is my opinion that the TARPs (REV4) are suitable in the initial instance and cover key risks identified.

[68] Proposed Consent Condition 37 - CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water.
[69] Proposed Consent Condition 20 - CRC [discharges to Tara Stream]: Discharge permit to discharge sediment, mine influenced water, drainage water and residual contaminants from the treatment of water.

CONCLUSION

107. In summary I believe the management processes developed by BCL and refined through this conferencing process are suitable and address the key risk to the receiving environment.

108. There are uncertainties in regard to water quality and quantity. TARPS have been developed to address these key risks and key uncertainties. These TARPs will need updating as more information comes to hand. This is a learning-orientated adaptive management approach to environmental management where uncertainty exists.

109. Adaptive management is a recognised management option under the Resource Management Act (**RMA**) (e.g. Leckie, 2017). However, it requires clear environmental objectives against which management options can be measured. The environmental objectives for water quality have been identified in proposed consent condition 22 and 37. The MCMP has been developed together with the TARPs to ensure these compliance criteria can be achieved with clear performance monitoring to confirm when additional management activities are required.

110. Key review dates are available for the Consent Authority and the Consent holder to review data and management plans and ensure the closure objectives can be achieved.

111. In conclusion:

    (a) I consider the MCMP will result in an effective closure of the CCM and that appropriate measures are proposed to ensure that environmental effects are appropriately managed.

    (b) I support the TARPs in their current form, noting they will change as more information becomes available through the closure process.

    (c) I support the proposed draft conditions, where I have expertise to comment, and have set out clarifications and support in Paragraphs 77-98.

Paul Antony Weber

25 February 2022

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MWM, 2021d. Canterbury Coal Mine Closure (Memorandum 4) – AMD Closure Criteria. Memorandum produced for Bathurst Coal Limited by Mine Waste Management Limited. 19 April 2021. Report No. J-NZ0130-005-M-Rev0.

Reid, N., Boxall, N., Donn, M.J., Gray, D.J., Kaksonen, A.H., Meakin, R., Robson, T., Shiers, D., 2016. Low acid sulfide leaching project review. CSIRO Report EP163134, pp 69.

Waters, A.S., Webster-Brown, J.G., 2013. Assessing aluminium toxicity in streams affected by acid mine drainage. Water Science & Technology 67.8 p 1764 – 1772.

Weber, P., Reid, N., Robson, T., 2021. Nitrate and AMD: An opportunity to innovate. Virtual ICARD 2021, 21 – 23 September 2021. International Conference on Acid Rock Drainage (Virtual): https://www.icard2021.com/

Appendix 1

Bell and Seale Data: The following figures are from Bell & Seale (2004) which show that waters at site are affected by acid rock drainage with low pH being recorded in 2004.

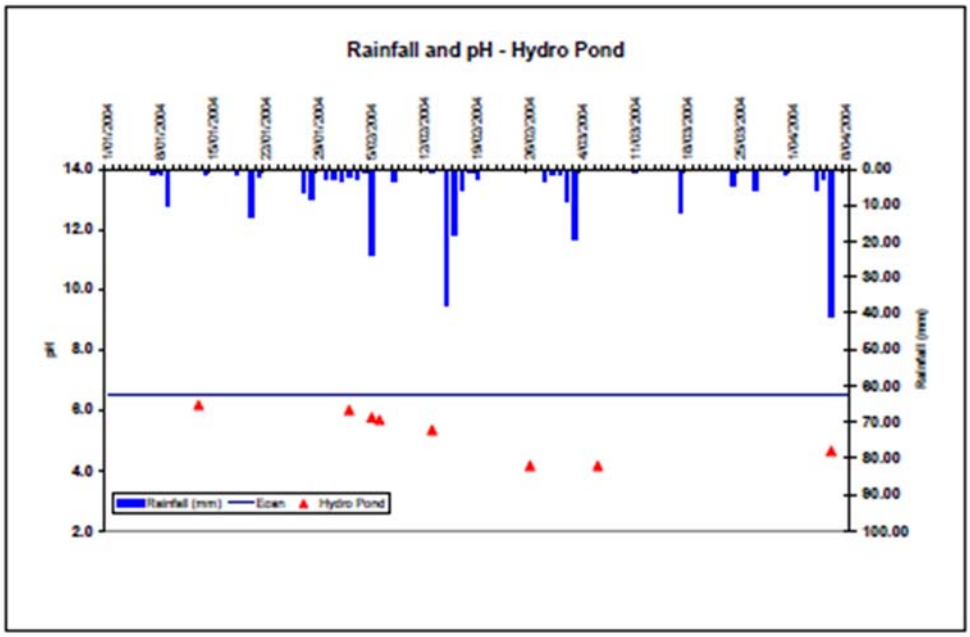

Figure 3. Rainfall – pH plot for Hydro Pond in period January to April 2004. Note that this pond is not actively receiving mine waters.

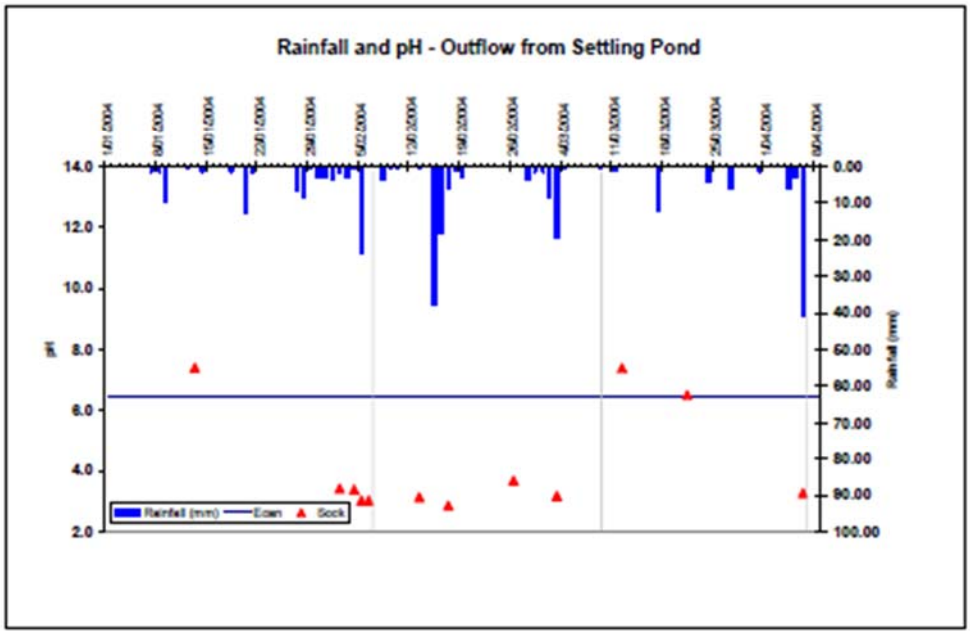

Figure 4. Rainfall – pH plot for Main Settling Pond in period January to April 2004. Horizontal line is lower Ecan pH limit (6.5) and three vertical bars are hydrated lime dosing times.

Appendix 2

PCOC Monitoring Data

1. The following appendix summarises the current water quality data for certain PCOC available for the Tara Catchment. This includes data collected at the water quality monitoring sites representative of CCM site discharge (site CC02 between March 2014 and November 2016, site CC02-conf between December 2016 and October 2017, and site CC02-tele from September 2017 onwards) and CC02 underdrain / Tara Pond (site CC02 from December 2016 onwards). All available data are presented to maximise the size of the PCOC dataset. This includes a two-month overlap in CCM site discharge sampling at CC02-conf and CC02-tele between September and October 2017.

2. Appendix 2 – Table 3 provides data, which demonstrate the PCOC were often below the imit of Quantification (**LOQ**) and always less than 95% ANZECC (2000) trigger values, even under acidic conditions when pH was < 5. The exception to this are two datapoints for mercury (Hg) in 2014 and 2015 when the LOQ was 0.001 mg/L, which is higher than the ANZECC (2000) trigger value of 0.0006 mg/L. Subsequently the LOQ for Hg was 0.0005 mg/L.

3. Arsenic (As): As has been monitored occasionally for a number of years with data available back to 2004.

    (a) In total there are 49 As datapoints for the CCM site discharge and the CC02 Underdrain. Results indicate that As is nearly always below the LOQ of 0.001 mg/L and always below the 95% ANZECC guidelines of 0.013 mg/L.

    (b) BCL applied to the Consent Authority to remove the requirements for As monitoring in 2016 as part of the current consent application, as this contaminant concentration was low. This was approved. Data presented in Appendix 2 – Table 3 shows the risk remains unchanged.

    (c) TCLP data for mixed CCR / overburden, as presented in MWM Memorandum 3, Appendix I (MWM, 2021c), indicated that the measured As was below the LOQ of < 0.021 mg/L for the 5 samples reported.

    (d) Additional monitoring was undertaken in December 2021 to January 2022 to confirm As trends following the concerns raised by the Consent Authority

experts in regard to PCOC. Data demonstrates that As was below the LOQ of 0.001 mg/L.

4. Cadmium (Cd): Cd has been occasionally monitored for a number of years with data available back to 2014.

   (a) In total there are 19 Cd datapoints for the CCM site discharge and the CC02 Underdrain. Results indicate that Cd is often below the LOQ of 0.0002 mg/L and always below the 95% ANZECC guidelines once hardness modification is incorporated into the analysis, which is shown in Appendix 2 _Table 3.

   (b) TCLP data for mixed CCR / overburden, as presented in MWM Memorandum 3, Appendix I (MWM, 2021c), indicated that the measured Cd was below the LOQ of < 0.0011 mg/L for 2 of the 5 samples reported with other results ranging from 0.0011 – 0.0014.

   (c) Additional monitoring was undertaken in December 2021 to January 2022 to confirm Cd trends following the concerns raised by the Consent Authority experts in regard to PCOC. Data demonstrates that Cd was below the LOQ of 0.0002 mg/L.

5. Copper (Cu): Cu has been monitored occasionally for a number of years with data available back to 2004.

   (a) In total there are 23 Cu datapoints for the CCM site discharge and the CC02 Underdrain. Results indicate that Cu is on occasion below the LOQ of 0.0005 mg/L and always below the 95% ANZECC guidelines once hardness modification is incorporated into the analysis, which is shown in Appendix 2.

   (b) TCLP data for mixed CCR / overburden, as presented in MWM Memorandum 3, Appendix I (MWM, 2021c), indicated that the measured Cu was below the LOQ of < 0.011 mg/L for the 5 samples reported.

   (c) Additional monitoring was undertaken in December 2021 to January 2022 to confirm Cu trends following the concerns raised by the Consent Authority experts in regard to PCOC. Data demonstrates that Cu was below 95% ANZECC guidelines and the LOQ of 0.0005 mg/L.

6. Chromium (Cr): Cr has been occasionally monitored for a number of years with data available back to 2004.

(a) In total there are 21 Cr datapoints for the CCM site discharge and the CC02 Underdrain. Results indicate that Cr is < LOQ of 0.001 mg/L, which is equal to the 95% ANZECC guidelines of 0.001 mg/L. Once hardness modification is incorporated into the analysis, which is shown in Appendix 2, these data are < the 95% ANZECC guideline data.

(b) TCLP data for mixed CCR / overburden, as presented in MWM Memorandum 3, Appendix I (MWM, 2021c), indicated that the measured Cr was below the LOQ of < 0.011 mg/L for the 5 samples reported.

(c) Additional monitoring was undertaken in December 2021 to January 2022 to confirm Cr trends following the concerns raised by the Consent Authority experts. Data demonstrates that Cr was below 95% ANZECC guidelines and below the LOQ of 0.001 mg/L.

7. Lead (Pb): Pb has been occasionally monitored for a number of years with data available back to 2004.

(a) In total there are 47 Pb datapoints for the CCM site discharge and the CC02 Underdrain. Results indicate that Pb is often < LOQ of 0.0005 mg/L, and always below the 95% ANZECC guidelines of 0.0034 mg/L once hardness modification is incorporated into the analysis, which is shown in Appendix 2.

(b) BCL applied to the Consent Authority to remove the requirements for Pb monitoring in 2016 as part of the current consent, as this contaminant concentration was low. This was approved. Data presented in Appendix 2 shows the risk remains low.

(c) TCLP data for mixed CCR / overburden, as presented in MWM Memorandum 3, Appendix I (MWM, 2021c), indicated that the measured Pb ranged between 0.0036 – 0.0046 mg/L for the 5 samples reported.

(d) Additional monitoring was undertaken in December 2021to January 2022 to confirm Pb trends following the concerns raised by the Consent Authority experts. Data demonstrates that Pb was below the LOQ and the 95% ANZECC trigger value.

8. Mercury (Hg): Hg has been occasionally monitored for a number of years with data available back to 2004.

(a) In total there are 52 Hg datapoints for the CCM site discharge and the CC02 Underdrain. Results indicate that Hg is always < LOQ and always below the 95% ANZECC guidelines of 0.0006 mg/L.

(b) BCLapplied to the Consent Authority to remove the requirements for Hg monitoring in 2016 as part of the current consent, as this contaminant concentration was low. This was approved. Data presented in Appendix 2 shows the risk remains low.

(c) TCLP data for mixed, Appendix I CCR / overburden, as presented in MWM Memorandum 3 (MWM, 2021c), indicated that the measured Hg was < LOQ of 0.0021 mg/L for the 5 samples reported.

(d) Additional monitoring was undertaken in December 2021 to January 2022 to confirm Hg trends following the concerns raised by the Consent Authority experts in regard to PCOC. Data demonstrates that Hg was below the LOQ and the 95% ANZECC trigger values. The exception to this are two datapoints for mercury (Hg) in 2014 and 2015 when the LOQ was 0.001 mg/L, which is higher than the ANZECC (2000) trigger value of 0.0006 mg/L.

9. Polycyclic aromatic hydrocarbons (PAHs): PAHs have been monitored at a number of sites in December 2021 following the concerns raised by the Consent Authority experts.

(a) Data demonstrates that PAHs were below the LOQ in all instances from all sites monitored (Appendix 2).

(b) TCLP data for mixed CCR / overburden, as presented in MWM Memorandum 3, Appendix I (MWM, 2021c), indicated that the measured PAHs was <LOQ (see Appendix 2).

(c) Given there is only one data point for PAHs I recommend that additional performance monitoring would be useful.

	Non-modified parameters			Hardness modified parameters								
Date	**pH**	**As (V)***	**Hg**	**Hardness**	**Cd**		**Cr (III)*/****		**Cu**		**Pb**	
CRC1705041 / ANZECC (2000) 95% limits	**6 - 9**	**0.013**	**0.0006**	**n/a**	**0.0002**	**Cd HMTV**	**0.0033**	**Cr HMTV**	**0.0014**	**Cu HMTV**	**0.0034**	**Pb HMTV**
		(mg/L)	**(mg/L)**	**(mg $CaCO_3$/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**
CCM site discharge - including surface water influence												
21/03/2004	5.5	0.001	***0.0001***	426			***0.002***	0.029	0.0040	0.013	***0.0005***	0.099
31/01/2008	8.0	***0.001***	***0.0005***	351			***0.001***	0.025	0.0015	0.011	***0.0005***	0.077
17/09/2012		***0.0011***	***0.00008***									
10/10/2012	5.6	***0.0011***	***0.00008***									
10/10/2013	3.5		***0.00008***	545					0.011	0.016		
15/10/2013	3.6			784					0.014	0.022		
23/09/2014	4.1	***0.002***	***0.001***	1,098	0.001	0.0049	***0.001***	0.063	***0.005***	0.030	***0.001***	0.33
5/08/2015	3.5	0.003	***0.001***	1,114							0.0020	0.34
16/09/2015	3.3	0.002	***0.0005***	1,011							0.0022	0.30
3/11/2015	3.5	0.001	***0.0005***	1,182							0.0022	0.36
4/12/2015	3.6	***0.001***	***0.0005***	1,243							0.0019	0.39
12/01/2016	3.1	***0.001***	***0.0005***	917							0.0029	0.26
15/02/2016	3.1	***0.001***	***0.0005***	54							0.0007	0.0072
15/03/2016	2.9	0.003	***0.0005***	950							0.0048	0.27
15/04/2016	3.2	***0.001***	***0.0005***	726							0.0037	0.19
16/05/2016	3.3	***0.001***	***0.0005***	727							0.0026	0.19
13/06/2016	3.7	***0.001***	***0.0005***	712							0.0011	0.19
18/07/2016	4.2	***0.001***	***0.0005***	1,023							***0.0005***	0.30
17/08/2016	4.8	0.001	***0.0005***	1,015							***0.0005***	0.30
26/08/2016	5.4	***0.001***	***0.0005***	1,028							***0.0005***	0.30
16/09/2016	3.8	***0.001***	***0.0005***	965							***0.0005***	0.28
14/10/2016	5.0	***0.001***	***0.0005***	996							***0.0005***	0.29
15/11/2016	5.9	***0.001***	***0.0005***	1,024							***0.0005***	0.30
15/12/2016	3.4	***0.001***	***0.0005***	1,032							0.0012	0.30
17/01/2017	3.3	***0.001***	***0.0005***	1,017							***0.0005***	0.30
15/02/2017	3.4	***0.001***	***0.0005***	569							***0.0005***	0.14
15/03/2017	4.6	***0.001***	***0.0005***	771							***0.0005***	0.21
13/04/2017	4.1	***0.001***	***0.0005***	398							0.0015	0.091

	Non-modified parameters			Hardness modified parameters								
Date	**pH**	**As (V)***	**Hg**	**Hardness**	**Cd**		**Cr (III)*/****		**Cu**		**Pb**	
CRC1705041 / ANZECC (2000) 95% limits	**6 - 9**	**0.013**	**0.0006**	**n/a**	**0.0002**	**Cd HMTV**	**0.0033**	**Cr HMTV**	**0.0014**	**Cu HMTV**	**0.0034**	**Pb HMTV**
		(mg/L)	**(mg/L)**	**(mg $CaCO_3$/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**
15/08/2017	5.1	***0.001***	***0.0005***	269	0.0004	0.0014	***0.001***	0.020	0.0014	0.0090	***0.0005***	0.055
13/09/2017	6.0	***0.001***	***0.0005***	429	***0.0002***	0.0021	***0.001***	0.029	***0.0005***	0.013	***0.0005***	0.10
16/10/2017	4.0	***0.001***	***0.0005***	134	***0.0002***	0.0008	***0.001***	0.011	0.0013	0.0050	***0.0005***	0.023
27/09/2017	5.7	***0.001***	***0.0005***	391	0.0002	0.0020	***0.001***	0.027	0.0005	0.012	***0.0005***	0.089
16/10/2017	5.5	***0.001***	***0.0005***	122	***0.0002***	0.0007	***0.001***	0.010	0.0011	0.0046	***0.0005***	0.020
15/11/2017	6.4	***0.001***	***0.0005***	634	***0.0002***	0.0030	***0.001***	0.040	***0.0005***	0.019	***0.0005***	0.16
15/12/2017	5.8	***0.001***	***0.0005***	584	***0.0002***	0.0028	***0.001***	0.038	0.0019	0.018	***0.0005***	0.15
16/01/2018	6.1		***0.0005***	343								
13/12/2021	7.5	***0.001***	***0.0005***	378	***0.0002***	0.0019	***0.001***	0.026	0.0008	0.012	***0.0005***	0.085
15/12/2021	6.7	***0.001***	***0.0005***	275	***0.0002***	0.0014	***0.001***	0.020	***0.0005***	0.0092	***0.0005***	0.057
22/12/2021	7.4	***0.001***	***0.0005***	287	***0.0002***	0.0015	***0.001***	0.021	0.0006	0.0095	***0.0005***	0.060
7/01/2022	7.1	***0.001***	***0.0005***	291	***0.0002***	0.0015	***0.001***	0.021	0.0007	0.0097	***0.0005***	0.061
CC02 underdrain – underdrain / seepage water												
15/12/2016	6.2	***0.001***	***0.0005***	1,056							***0.0005***	0.31
17/01/2017	6.5	***0.001***	***0.0005***	1,091							***0.0005***	0.33
15/02/2017	6.5	***0.001***	***0.0005***	948							***0.0005***	0.27
15/03/2017	6.2	***0.001***	***0.0005***	993							***0.0005***	0.29
13/04/2017	6.1	***0.001***	***0.0005***	1,058							***0.0005***	0.31
15/08/2017	5.7	***0.001***	***0.0005***	779	0.0011	0.0036	***0.001***	0.048	***0.0005***	0.022	***0.0005***	0.21
13/09/2017	7.6	***0.001***	***0.0005***	306	***0.0002***	0.0016	***0.001***	0.022	***0.0005***	0.010	***0.0005***	0.065
27/09/2017	5.3	***0.001***	***0.0005***	321	0.0004	0.0016	***0.001***	0.023	0.0022	0.011	***0.0005***	0.069
16/10/2017	3.8	***0.001***	***0.0005***	557	0.0012	0.0027	***0.001***	0.036	0.0038	0.017	***0.0005***	0.14
15/11/2017	6.2	***0.001***	***0.0005***	656	***0.0002***	0.0031	***0.001***	0.041	***0.0005***	0.019	***0.0005***	0.17
15/12/2017	5.8	***0.001***	***0.0005***	1,031	***0.0002***	0.0047	***0.001***	0.060	***0.0005***	0.028	***0.0005***	0.30
16/01/2018	6.0		***0.0005***	628								
15/12/2021	6.2	***0.001***	***0.0005***	1,128	***0.0002***	0.0050	***0.001***	0.065	***0.0005***	0.031	***0.0005***	0.34

* As assumed to be As(V) speciation, Cr assumed to be Cr(III) speciation.

** Freshwater trigger value of 3.3 µg/L for Cr (III) taken from ANZECC (2000) Chapter 8, page 8.3-116.

NB: Values in ***bold italics*** at Level of Quantification (LOQ).

NB: Values shaded grey are hardness or hardness modified trigger values.

NB: Values shaded yellow exceed the CRC170541 pH range or ANZECC (2000) threshold for protection of 95 % of species.

NB: Blank cells had no data reported.

Site	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b+k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Sum Benzo(g,h,i)perylene and ndeno(1,2,3)pyrene
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
CC02-tele	***0.0001***	***0.001***	***0.001***	***0.0001***	***0.0001***	***0.001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.001***
CC03	***0.0001***	***0.001***	***0.001***	***0.0001***	***0.0001***	***0.001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.001***
CC20	***0.0001***	***0.001***	***0.001***	***0.0001***	***0.0001***	***0.001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.001***
CC24	***0.0001***	***0.001***	***0.001***	***0.0001***	***0.0001***	***0.001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.001***
No2 Pit Pond	***0.0001***	***0.001***	***0.001***	***0.0001***	***0.0001***	***0.001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.0001***	***0.001***

NB: All PAH samples collected on 22 December 2021

NB: Values in ***bold italics*** at Level of Quantification (LOQ).

Appendix 3

SPLP Data for Takitimu and Canterbury CCR

Table 4. Comparison of the Canterbury and Takitimu CCR SPLP results.

PARAMETER	UNITS	CANTERBURY COAL CCR	TAKITIMU CCR	RPD*
pH of leachate	SU	5.1	5.9	-
Chloride	g/m^3	< 0.5	0.8	220%
Sulphate	g/m^3	320	400	25%
Total Barium	g/m^3	0.42	0.180	-57%
Total Bismuth	g/m^3	< 0.0021	< 0.0021	0%[A]
Total Caesium	g/m^3	0.011	0.005	-58%
Total Calcium	g/m^3	240	560	133%
Total Lanthanum	g/m^3	0.015	0.007	-52%
Total Magnesium	g/m^3	15.6	31	99%
Total Phosphorus	g/m^3	< 0.42	< 0.42	0%[A]
Total Potassium	g/m^3	8.8	17.8	102%
Total Rubidium	g/m^3	0.061	0.049	-20%
Total Selenium	g/m^3	< 0.021	< 0.021	0%[A]
Total Silver	g/m^3	< 0.0022	< 0.0022	0%[A]
Total Strontium	g/m^3	8	6.9	-14%
Total Thallium	g/m^3	0.004	< 0.0011	-86%[A]
Total Uranium	g/m^3	0.001	< 0.00042	-70%[A]
Total Aluminium	g/m^3	2.9	10	245%
Total Antimony	g/m^3	0.011	< 0.0042	-81%[A]
Total Arsenic	g/m^3	< 0.021	< 0.021	0%[A]
Total Boron	g/m^3	15.3	11.6	-24%
Total Cadmium	g/m^3	0.002	< 0.0011	-66%[A]
Total Chromium	g/m^3	< 0.011	< 0.011	0%[A]
Total Cobalt	g/m^3	0.179	0.290	62%
Total Copper	g/m^3	< 0.011	< 0.011	0%[A]
Total Iron	g/m^3	< 0.42	< 0.42	0%[A]
Total Lead	g/m^3	0.020	< 0.0021	-95%[A]
Total Lithium	g/m^3	0.110	0.047	-57%[A]
Total Manganese	g/m^3	0.450	0.640	42%
Total Molybdenum	g/m^3	< 0.0042	0.013	519%[A]
Total Nickel	g/m^3	0.240	0.240	0%
Total Tin	g/m^3	< 0.011	< 0.011	0%[A]
Total Vanadium	g/m^3	< 0.021	< 0.021	0%[A]
Total Zinc	g/m^3	1.25	0.34	-73%

[A] - calculated using half the "<" value

* - relative percent difference

CRL Energy Ltd

REPORT OF ANALYSIS

Client: Bathurst Resources Ltd. **Date Received:** 18-Jul-19

Description: Canterbury Coal ash. **Purchase Order:** 9593

CRL Ref:	**114/060**
Paste pH	8.7

EPA Method 1311 - Toxicity Characteristic Leaching Procedure
Extraction Fluid #3. Deionised water.

The sample was leached at a ratio of 90g of sample to 1800ml of extraction fluid (pH 4.93) and tumbled for 18 hours. The pH of the leachate was measured, filtered at 0.45um and then dispatched to Hill Laboratories for analysis.

pH of leahate		5.1
Chloride	g/m3	< 0.5
Sulphate	g/m3	320
Total Barium	g/m3	0.42
Total Bismuth	g/m3	< 0.0021
Total Caesium	g/m3	0.0114
Total Calcium	g/m3	240
Total Lanthanum	g/m3	0.0149
Total Magnesium	g/m3	15.6
Total Phosphorus	g/m3	< 0.42
Total Potassium	g/m3	8.8
Total Rubidium	g/m3	0.061
Total Selenium	g/m3	< 0.021
Total Silver	g/m3	< 0.0022
Total Strontium	g/m3	8
Total Thallium	g/m3	0.0038
Total Uranium	g/m3	0.00069
Total Aluminium	g/m3	2.9
Total Antimony	g/m3	0.011
Total Arsenic	g/m3	< 0.021
Total Boron	g/m3	15.3
Total Cadmium	g/m3	0.0016
Total Chromium	g/m3	< 0.011
Total Cobalt	g/m3	0.179
Total Copper	g/m3	< 0.011
Total Iron	g/m3	< 0.42
Total Lead	g/m3	0.02
Total Lithium	g/m3	0.11
Total Manganese	g/m3	0.45
Total Molybdenum	g/m3	< 0.0042
Total Nickel	g/m3	0.24
Total Tin	g/m3	< 0.011
Total Vanadium	g/m3	< 0.021
Total Zinc	g/m3	1.25

Methods of analysis:
SPLP Method 1311.
Metals sub-contracted to Hill Laboratories for analysis by ICP-MS.

Trevor Dine
Manager Gracefield Laboratories

Date of Issue: 5-Aug-19

THIS REPORT MUST NOT BE QUOTED EXCEPT IN FULL

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CRL Energy Ltd

REPORT OF ANALYSIS

Client: Bathurst Resources Ltd. **Date Received:** 12-Jul-19

Description: Takitimu ash. **Purchase Order:** 9525

CRL Ref:	**114/042**
Paste pH	11.1

EPA Method 1311 - Toxicity Characteristic Leaching Procedure
Extraction Fluid #3. Deionised water.

The sample was leached at a ratio of 90g of sample to 1800ml of extraction fluid (pH 4.93) and tumbled for 18 hours. The pH of the leachate was measured, filtered at 0.45um and then dispatched to Hill Laboratories for analysis.

pH of leachate		5.9
Chloride	g/m3	0.8
Sulphate	g/m3	400
Total Barium	g/m3	0.18
Total Bismuth	g/m3	< 0.0021
Total Caesium	g/m3	0.0048
Total Calcium	g/m3	560
Total Lanthanum	g/m3	0.0071
Total Magnesium	g/m3	31
Total Phosphorus	g/m3	< 0.42
Total Potassium	g/m3	17.8
Total Rubidium	g/m3	0.049
Total Selenium	g/m3	< 0.021
Total Silver	g/m3	< 0.0022
Total Strontium	g/m3	6.9
Total Thallium	g/m3	< 0.0011
Total Uranium	g/m3	< 0.00042
Total Aluminium	g/m3	10
Total Antimony	g/m3	< 0.0042
Total Arsenic	g/m3	< 0.021
Total Boron	g/m3	11.6
Total Cadmium	g/m3	< 0.0011
Total Chromium	g/m3	< 0.011
Total Cobalt	g/m3	0.29
Total Copper	g/m3	< 0.011
Total Iron	g/m3	< 0.42
Total Lead	g/m3	< 0.0021
Total Lithium	g/m3	0.047
Total Manganese	g/m3	0.64
Total Molybdenum	g/m3	0.013
Total Nickel	g/m3	0.24
Total Tin	g/m3	< 0.011
Total Vanadium	g/m3	< 0.021
Total Zinc	g/m3	0.34

Methods of analysis:
SPLP Method 1311.
Metals sub-contracted to Hill Laboratories for analysis by ICP-MS.

Trevor Dine
Manager Gracefield Laboratories

Date of Issue: 5-Aug-19

THIS REPORT MUST NOT BE QUOTED EXCEPT IN FULL

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