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

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

Statement of Evidence of **Kristy Lynn Hogsden (Aquatic Ecology)** for Bathurst Coal Limited

Dated: 1 October 2021

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INTRODUCTION

1. My name is Kristy Lynn Hogsden. I am a Periphyton Ecologist and Group Manager (Freshwater Ecology) at NIWA Taihoro Nukurangi (**NIWA**).

2. I hold a BSc Hons from Trent University (Canada), MSc in Ecology and Environmental Biology from the University of Alberta (Canada), and PhD in Ecology from the University of Canterbury (New Zealand). I am a member of the New Zealand Freshwater Sciences Society.

3. I have over 10 years' experience as a freshwater ecologist. I have worked at as a periphyton ecologist at NIWA since 2019. Previously, I worked in the area of freshwater ecology as a research fellow, research associate, community liaison and postdoctoral fellow at the University of Canterbury (2013 – 2018) and as an Environmental Scientist at Fundy Engineering and Consulting Ltd (2007 – 2008).

4. My work involves assessing environmental impacts on aquatic communities (periphyton, macroinvertebrates and fish) in streams and lakes using survey and experimental approaches. I have worked across a range of environmental issues related to freshwater ecosystems, including mining, acidification and agriculture. I design and undertake field surveys and monitoring programmes, data analysis and reporting to support freshwater research and consultancy projects. My PhD research contributed to our understanding of the complex ecological effects of acid mine drainage on the structure and function of food webs in stream ecosystems on the West Coast. I have published six scientific papers and written one book chapter on the effects of mining on water quality and aquatic ecology in New Zealand. I visited the Canterbury Coal Mine on 22 July 2020 for a site visit and on 30 November 2020 for aquatic ecology surveys.

5. While this is not an Environment Court hearing, 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 that 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 expressed in my evidence.

SCOPE OF EVIDENCE

6. I prepared the "Canterbury Coal Mine – Aquatic Ecology Monitoring Programme Memorandum" (**Aquatic Ecology Memorandum**), which is attached as Appendix 6 to the Addendum AEE for Closure and Rehabilitation for the Canterbury Coal Mine (**CCM**).

7. I do not repeat the contents of the Aquatic Ecology Memorandum in full in my evidence. My evidence:

   (a) provides a brief description of the CCM site and surrounding environment from an aquatic ecology perspective, including the current state of Bush Gully Stream and Tara Stream;

   (b) confirms my assessment of effects of the CCM due to current mining operations, during the closure and rehabilitation phase and post closure on aquatic ecology;

   (c) outlines the proposed management measures for potential aquatic ecology effects;

   (d) responds to relevant submissions; and

   (e) responds to the relevant parts of the Council officers' Section 42A Reports.

EXECUTIVE SUMMARY

8. The soft-sedimentary beds and slow-flowing nature of Tara Stream and Bush Gully Stream support macroinvertebrate communities dominated by snails, worms, and crustaceans. The fish communities are comprised of three native species (kōwaro or Canterbury mudfish, Canterbury galaxiid, and upland bully).

9. The surrounding historic and current land uses (mining, forestry, agriculture) have had detrimental effects on aquatic ecology through inputs of sediment and Acid Mine Drainage (**AMD**) over time. I consider that AMD and turbidity (due to mine operations) are unlikely to currently be a significant issue in these waterways due to on-site water management that has been reflected in improved discharge compliance in recent years.

10. The CCM site will be adaptively managed and monitored during closure, rehabilitation and post closure to meet water quality and contaminant compliance levels and minimise adverse effects on receiving water bodies and aquatic values. The land will be returned to pre-mining land uses, specifically pastoral farming and production forestry.

11. Provided compliance with the existing contaminant limits is achieved and maintained and there is no large-scale disturbance of rehabilitated areas on CCM site, I consider it likely that the existing aquatic values in receiving water bodies will be protected. Erosion control measures during closure (until acceptable levels of revegetation are achieved) will minimise sediment runoff into streams and associated adverse impacts on macroinvertebrates and fish. The restoration of near natural runoff pathways and proposed continuous flow to Tara Stream wetland should increase the availability of wetted habitat.

12. Wetland compensation and rehabilitation measures may improve the availability and quality of habitat for indigenous freshwater species, particularly kōwaro.

SITE AND SURROUNDING ENVIRONMENT

13. My understanding of the CCM site and surrounding environment from an aquatic ecology perspective is based on a site visit on 22 July 2020 and monitoring of macroinvertebrates and fish in Tara Stream and Bush Gully Stream, which receive discharges from the CCM site, that was undertaken in November 2020 and April 2021 (monitoring sites shown in **Appendix 1** to my evidence) and review of recent ecological assessments[1,2,3,4,5]. These

[1] Boffa Miskell Limited (2019) Canterbury Coal Mine – N06-N12 Extension: summary of baseline ecological surveys. Memo prepared for Bathurst Resources Limited

[2] Boffa Miskell Limited (2017) Canterbury Coal Mine: Ecological significance assessment of Tara Stream wetland, the North ELF and Bush Gully Stream. Report prepared for Bathurst Resources Limited.

[3] Water Ways Consulting Ltd (2016) Tara Stream Ecological Report. Report prepared for Canterbury Coal Limited.

[4] Water Ways Consulting Ltd. (2016) Canterbury Coal: ELF Project Bush Gully Assessment. Report Number 34-2016-B. Report prepared for Canterbury Coal Limited.

[5] Golder Associates Ltd. (2014) Aquatic baseline assessment of ecological values of the streams in the Wainiwaniwa Valley. Client report 1378110242-006-R-Rev 1. Report prepared for Canterbury Coal Ltd.

assessments were one-off surveys in waterways around the CCM site (including Tara Stream, Bush Gully, Oyster Gully, and Surveyors Gully), with a targeted focus (e.g., North ELF Project) and undertaken in different seasons, sometimes at different sites and using different sampling methods for fish. I have been asked to focus on Tara Stream and Bush Gully Stream in my evidence.

14. The CCM site is located in the Waianiwaniwa catchment, in the Malvern Hills, Canterbury. Tara Stream (1st order stream) and Bush Gully Stream (2nd order stream) are hill-fed, headwater tributaries that flow into the Waianiwaniwa River, which then flows into the Waikirikiri Selwyn River and eventually into Te Waihora Lake Ellesmere in the Selwyn Waihora zone. Two other waterways are located near the mine site: Oyster Gully, which is located to the south of the mine site and also flows into the Waianiwaniwa River; and Surveyors Gully, which flows directly into the Waikirikiri Selwyn River.

15. Tara Stream and Bush Gully Stream have soft sedimentary beds owing to the underlying geology of the Malvern Hills, comprised of clay, mudstone, and sandstone[6]. Substrate in both streams is comprised primarily of fine sediment (clay/mud, silt/sand) with cobbles and gravel also present in the lower reaches of Bush Gully Stream. The Waianiwaniwa catchment is a low-water yielding catchment and surface water flows can be low; both Tara Stream and Bush Gully Stream gain water from groundwater, seeps and rainfall. Tara Stream is characterised by pool habitats and Bush Gully Stream is characterised by a mix of run and pool habitat, with some riffles in the upstream reaches. Both streams contain wetland habitat along their reaches that flow near the CCM site. Three farm ponds, including one large pond (estimated total capacity ~ 80, 000 m^3 [7]) are located downstream of the Tara Stream wetland. Riparian vegetation is currently dominated by grass and sedges on both streams, with wetland plants and deciduous trees present in mid-lower reaches of Bush Gully Stream and coniferous trees upstream and deciduous trees downstream of the farm ponds on Tara Stream.

[6] Kingett Mitchell (1998) Malvern Hills Coal Mine - Assessment of Environmental Effects. Prepared for Canterbury Coal Ltd.
[7] MWM. (2020) Canterbury Coal Mine, Request for Further Information: Geochemistry Response, Document Number: J-NZ0111-001-R-Rev0.

16. The land uses directly surrounding Tara Stream and Bush Gully Stream are mining, pastoral farming and production forestry.

17. The Waianiwaniwa River is a hill-fed, slow-flowing river dominated by soft bed sediments and pool habitats, which can be deep in places. Nutrient (total nitrogen, total phosphorus, and dissolved reactive phosphorus) and *E. coli* concentrations are high and water clarity is low, suggesting degraded water quality in the Waianiwaniwa River likely due to surrounding agricultural land uses. The Wainiwaniwa River experiences low summer flows, during which sections of the mainstem can partially or completely dry, especially during periods of low rainfall or droughts[8,9]. Water quality and quantity are key freshwater issues in the wider Selwyn Waihora zone.

Water quality

18. Water quality in Tara Stream and Bush Gully Stream are influenced by surrounding current land uses, which include pastoral farming and production forestry and historical mining. Recent mining at the CMM site has also impacted water quality and has had the effects on water quality as set out below.

19. Water quality data collected during recent aquatic ecology monitoring[10] indicated stream water was slightly acidic to circumneutral (pH 5.5 to 8.1) and specific conductivity ranged from 177 to 768 µS/cm across both streams, with the highest conductivity value recorded at the most downstream site on Bush Gully Stream (CC26). Conductivity and pH (November 2020 only) were within the ranges reported in on-site monthly water quality monitoring[11] from January 2020 to May 2021 for four sites (CC03, CC09, CC23, and CC26); whereas pH values in November 2020 only were lower than minimum values (i.e., more acidic). These data suggest

[8] Harding, J.S. et al. (2007) Persistence of a significant population of rare Canterbury mudfish (*Neochanna burrowsius*) in a hydrologically isolated catchment. New Zealand Journal of Marine and Freshwater Research 41: 309-316.

[9] Meijer, C. (2020) Disentangling the multiple effects of stream drying and riparian canopy cover on the trophic ecology of a highly threatened species. Freshwater Biology 66: 102-113.

[10] Hogsden, K. (2021) Canterbury Coal Mine – Aquatic Ecology Monitoring Programme Memorandum. NIWA Client Report 2021131CH. Prepared for Bathurst Resources Ltd.

[11] Eden Sinclair. Canterbury Coal Mine water quality data. Provided 24 June 2021.

that current water treatment on site is effectively managing pH in both streams.

20. Conductivity, a measure of ions in water, can include metals, nutrients and other pollutants (e.g., pesticides, herbicides) and could be indicative of inputs from different sources or land use activities. I consider the conductivity levels to be moderate to high but there is insufficient information to be able to attribute source. All values (except 768 µS/cm) are within the baseline range described for waterways around the site in a survey conducted prior to open cast mining[6].

21. Dissolved oxygen concentrations (> 5 mg/ l) and water temperatures (7.1 to 14.8 ºC) were in suitable ranges for supporting aquatic organisms at all sites during monitoring in November 2020 and April 2021.

22. On-site water quality monitoring data provided[11] from 2020 to 2021 indicates water clarity in both Tara Stream (2–75 NTU) and the mid-lower reaches of Bush Gully Stream (6–40 NTU) can be variable and poor at times. The soft sedimentary geology and soils are a natural source of sediments to both waterways and contribute to reduced water clarity. Sediment controls measures at discharge points have minimised sediment inputs to streams since 2017, with turbidity compliant with consent conditions over the past two years as noted in the evidence of Ms Hartwell[12].

Macroinvertebrate Community

23. The macroinvertebrate community at Tara Stream and Bush Gully Stream comprised 21 and 33 taxa, respectively, across all monitored sites in November 2020 and April 2021; with often very low abundances (i.e., less than 10 to 20 individuals) of non-dominant species present at each site.

    (a) The New Zealand mud snail (*Potamopyrgus antipodarum)* was numerically dominant, accounting for 50 to 92% of the community at all sites but two (Tara Stream, CC09; Bush Gully Stream, CC26), which were dominated by oligochaete worms.

    (b) Cladocerans (crustaceans, ostracods) were the next most abundant taxa.

[12] Evidence of Ms Sioban Hartwell dated 1 October 2021 at [27].

(c) The number of pollution-sensitive mayfly (Ephemeroptera), stonefly (Plectoptera) and caddisfly (Trichoptera) taxa (EPT) was low (0 to 4), which can be typical of slow-moving, soft-bottomed streams as many EPT taxa tend to prefer flowing waters and cobble substrate in riffle habitats.

24. The macroinvertebrate community scored poorly across a range of biotic metrics used as indicators of stream health (i.e., MCI[13], QMCI[13], EPT[14] richness, ASPM[15]) in November 2020 and April 2021. In addition, AMDI[16] scores indicated three sites (CC09 on Tara Stream, CC19_mainstem and CC23 on Bush Gully Stream) were "severely impacted" in November only and all other sites were classified "impacted"." However, the dominance of *Potamopyrgus* snails, which are sensitive to acidic waters (AMDI tolerance score of 10, which indicates intolerant of AMD), at most sites suggests AMD is unlikely to be currently impacting the streams

25. As noted above, the macroinvertebrate communities in Tara Stream and Bush Gully Stream were comprised of taxa (e.g., snails and oligochaete worms) that prefer slow-moving waters and are commonly found in soft-bottom streams but are also generally tolerant of a range of flow, water quality and habitat conditions, including degraded conditions, which resulted in low biotic metric scores. For example, both snails and worms are considered low-scoring taxa in the MCI (scores <4 in MCI for hard-bottom and soft-bottom streams).

26. Macroinvertebrate community composition was comparable to previous ecological assessments in both streams since 2014, noting species-poor communities with low abundances of taxa[1,3,5]. The dominant taxa (snails, crustaceans and oligochaete worms) have been similar over time in Bush Gully and at the downstream site (CC09) in Tara Stream. These taxa were also dominant at sites in a survey conducted prior to open cast mining[6].

[13] Macroinvertebrate Community Index (MCI) and its quantitative variant (QMCI), are based on the tolerance of taxa to organic pollution.

[14] EPT richness, taxa from the EPT orders are generally considered to be more sensitive to pollution than other orders of aquatic macroinvertebrates.

[15] Average Score Per Metric (ASPM), integrates multiple macroinvertebrate community metrics into a single score that reflects ecological condition.

[16] The Acid Mine Drainage Index (AMDI) is a biotic index specific to the impacts of acid mine drainage on macroinvertebrates.

Snails had not been reported in Tara Stream below the wetland (CC03) before November 2020.

27. I consider that the macroinvertebrate communities in Bush Gully Stream and Tara Stream reflect the natural, soft sedimentary beds and slow-flowing nature of these waterways. Mining and other land uses have also had some detrimental effects on macroinvertebrate habitat overtime, primarily through the deposition of fine sediments and AMD inputs. However, the similarity in community composition over time, including prior to open-cast mining, suggests that water quality effects from recent mining are not the main driver of macroinvertebrate communities in these streams.

Fish Species

28. Three non-migratory native fish species with different conservation status ranking were recorded in monitoring surveys in November 2020 and April 2021, including:

    (a) kōwaro (Canterbury mudfish, *Neochanna burrowsius*) - 'Threatened, Nationally-critical[17]';

    (b) Canterbury galaxias (*Galaxias vulgaris*) - 'At Risk, Declining[18]'; and

    (c) upland bullies (*Gobiomorphus breviceps*) - 'Not threatened'[19].

29. All three species can complete their life cycle within the Waianiwaniwa catchment.

    (a) One individual kōwaro was found in Tara Stream, just downstream of the wetland (CC03), and one was found at the downstream site (CC26) in Bush Gully in November 2020.

[17]'Threatened, Nationally-critical' classification is: population (irrespective of size or number of subpopulations) with a very high ongoing or predicted decline of >70%; kōwaro are listed with the additional qualifers: conservation dependent (CD), extreme fluctuations (EF), range restricted (RR), and sparse (Sp).

[18]'At Risk, Declining' classification is: moderate to large population and low ongoing or predicted decline, total area of occupancy ≤1000 ha (10 km^2), predicted decline 10–30%; Cantebury galaxias are listed with the additional qualifiers: data poor (DP) and partial decline (PD).

[19] Dunn et al. (2018) Conservation status of New Zealand freshwater fishes, 2017, New Zealand Threat Classification Series. Department of Conservation, Wellington.

(b) Canterbury galaxias were uncommon (6 individuals total recorded) and only found in downstream reaches of Bush Gully Stream.

(c) Upland bullies were the most common fish found, present at all sites in Bush Gully Stream only.

30. The presence and abundance of these three species have been reported in previous aquatic ecology assessments[1,4,5] that were completed in different seasons, sometimes at different sites and using different fish sampling methods (e.g., unbaited minnow traps versus spotlighting), which limits our comparison of data. The most recent assessment in Bush Gully Stream in March 2019, using the same methods as current aquatic ecology monitoring (i.e., baited minnow traps) reported comparable findings, with respect to the number of fish captured, fish species captured, dominance of upland bullies and relative abundance of fish (CPUE, catch per unit effort). Kōwaro had not been recorded at CC03 prior to November 2020[10].

31. Kōwaro are taonga, or treasure, to the local iwi Ngā Tahu. Kōwaro can be found across a range of habitats (e.g., spring-fed streams flowing through wetlands, modified roadside drains and farm ponds) but are often found in slow-flowing, overgrown, swampy streams that dry out over summer months[20]. Drought-tolerant kōwaro can burrow into the moist sediments, stream banks or under vegetation during dry periods in the summer months to aestivate (i.e., hibernate), but prolonged dry periods and vulnerability to predation by other fish make them susceptible to local extinction. The current distribution of kōwaro is restricted to the Canterbury Plains and fragmented due to destruction of suitable habitats with land use change over time. The significant population of kōwaro in the Waianiwaniwa catchment is due to a combination of suitable habitat and low-flow conditions in the Waianiwaniwa River that limit or exclude predatory fish[8].

ASSESSMENT OF EFFECTS

Mine Operation at CCM

32. During mine operation at CCM, AMD-affected waters have been controlled at two discharge points (CC20 to Bush Gully Stream and CC02-tele to Tara

[20] O'Brien, L. and Dunn, N. (2007) Mudfish (*Neochanna* Galaxiidae) literature review. Science for Conservation 277. Department of Conservation, Wellington.

Stream wetland), where treatment has been undertaken to meet resource consent compliance limits for contaminants (pH, turbidity, boron, manganese, nickel, zinc, iron, aluminium, and total suspended solids). With on-site water management in recent years, discharges have consistently met limits at the compliance monitoring site (CC24) downstream of CC20 since 2017 and have generally met compliance limits at CC02-tele[7,21]. I consider that this indicates AMD and turbidity (due to mine operations) are unlikely to currently be a significant issue in these waterways.

33. Water quality at two sites on Tara Stream located downstream of the wetland (CC03) and a large farm pond (estimated capacity 80, 000 m^3; CC09) also showed declining trends in sulfate from 2015 to 2021[18] and relatively low and stable concentrations of sulfate and boron (at CC09) from 2017 to 2019[7] suggesting downstream effects are minimised, likely through the buffering capacity of Tara Stream wetland and dilution in the farm ponds.

34. Macroinvertebrate communities have been relatively similar in Bush Gully Stream and Tara Stream based on aquatic ecology assessments since 2014[1-5]. The communities are numerically-dominated by a core group of taxa (snails, oligochaete worms, dipterans) and often sparsely populated with other taxa, suggesting minimal adverse effects of recent water quality. In particular, the dominance of snails at most sites indicates AMD is unlikely to be currently impacting the streams as snails are sensitive to acidic waters. However, I note that aquatic monitoring has not been conducted at a frequency sufficient to detect any potential short-term effects (e.g., declines in species abundance) of reported contaminant compliance exceedances.

35. As noted above, kōwaro, Canterbury galaxias, and upland bullies are present in Bush Gully Stream and kōwaro and Canterbury galaxias have been reported in Tara Stream. However, little existing data on fish abundance and distribution in recent years limits our understanding and assessment of effects on these populations. Stream water pH during sampling in November 2020 and April 2021 was within the known tolerance ranges for kōwaro, Canterbury galaxias and upland bullies.

[21] MWM. (2021) Canterbury Coal Mine Closure – Tara catchment discharge water quality. Memorandum produced for Bathurst Coal Limited by Mine Waste Management Limited. 19 March 2021. J-NZ0130-004-M-Rev0

Mine closure, rehabilitation, and post-closure

36. The CCM site will be adaptively managed and monitored during closure, rehabilitation and post closure to meet water quality and contaminant compliance levels and minimise adverse effects on receiving water bodies and aquatic values. The compliance limits have been established, in part, to support the protection of aquatic values. The proposed activities for closure, rehabilitation and post-closure phases are outlined in the Mine Closure Management Plan (**MCMP**). Flows will be restored to near natural runoff patterns. The land will be returned to pre-mining land uses, specifically pastoral farming and production forestry.

37. Water discharging into Tara Stream will be passively-treated (using a mussel shell reactor; MSR) and diluted by a decanting flow from water stored in the N02 Pit pond, closely monitored, and adaptively managed until contaminant loads decrease such that compliance limits can be met without treatment. Modelling data indicates contaminant exceedances may occur for boron, manganese, and/ or zinc under low flow, untreated scenarios and for boron during a low flow, treated and undiluted scenario[21],[22]. The untreated scenarios are unlikely to occur. The treated, undiluted scenario would likely occur infrequently (during prolonged, dry periods when N02 Pit pond dries, and alternative source of dilution flows are unavailable). I consider that due to low flows the extent of contamination would be localised in Tara Stream wetland just below the discharge point (CC02) under this scenario. Macroinvertebrates and fish have not been sampled at this location due to low water levels and lack of suitable habitat. Based on the evidence of Dr Hickey, the Tara Stream wetland downstream of the CC02 discharge will likely provide efficient removal of boron by plant uptake or dilution, reducing exposure to downstream aquatic species[23]. Furthermore, the predicted boron concentrations are not expected to have lethal or sub-lethal effects on kōwaro[24], which have been reported at CC03 (1.09 km downstream of CC02). Based on the evidence of Dr Hickey[25], I understand that potential

[22] Evidence of Dr Paul Weber dated 1 October 2021 at [46] –[61].
[23] Evidence of Dr Chris Hickey dated 1 October 2021 at [18d, 24].

[24] Hickey, C.W. et al. (2018) Chronic sensitivity of juvenile Canterbury mudfish (*Neochanna burrowsius*) and periphyton (*Rhizoclonium* sp.) to boron. NIWA Client Report 2018199HN. Prepared for Bathurst Resources Ltd.

[25] Evidence of Dr Chris Hickey dated 1 October 2021 at [58 - 59].

adverse ecological effects of manganese and iron downstream of the Tara Stream wetland will require efficient treatment of discharges that will be provided by the proposed system when considered together with decreasing mass loads of manganese and iron.

38. Once fully rehabilitated, AMD discharge from the North ELF into Bush Gully Stream is unlikely[26].

39. The potential influence of future legacy AMD issues from historical mining at the site (e.g., leaching from old dump seeps) on receiving waterbodies and aquatic biota has been minimised with the placement and capping of acid-forming material in the ELF.

40. Provided compliance with the contaminant limits is achieved and maintained and there is no large-scale disturbance of rehabilitated areas on CCM site, I consider it likely that the existing aquatic values in receiving water bodies will be protected.

41. Short-term erosion control measures applied during closure activities (until acceptable levels of revegetation of landforms are reached) will minimise sediment runoff into streams and associated adverse impacts on macroinvertebrates and fish. Settling ponds will mitigate the risk of sediment runoff to the streams during large rainfall events.

42. The restoration of near natural runoff pathways and progressive reduction in on-site water use for consented activities (e.g., dust suppression, active water quality treatment) and proposed continuous flow will minimise potential flow regulation effects into Tara Stream wetland, particularly during dry, low rainfall periods (e.g., summer). I acknowledge that water will be retained in the N02 Pit Pond during closure, rehabilitation and post-closure as part of passive treatment system for discharges and for other purposes during landform rehabilitation (e.g., irrigation for revegetation) as part of the MCMP. Overall, there should be an increase in flow and availability of wetted habitat in the wetland and stream, which would minimise low dissolved oxygen conditions that can develop in shallow, warmed waters, and affect the solubility of contaminants (e.g. iron and manganese) as well as the

[26] MWM. (2021) Canterbury Coal Mine Closure – AMD closure criteria. Memorandum produced for Bathurst Coal Limited by Mine Waste Management Limited. 19 March 2021. J-NZ0130-005-M-Rev0

presence and survival of macroinvertebrates and fish. Flows further downstream of the wetland are regulated by the farm ponds, such that flows at CC09 only occur when inflows exceed farm pond capacity.

43. Wetland habitat enhancements, including riparian buffer planting, along the palustrine wetland adjoining Bush Gully Stream and the permanent protection of part of the North Property wetland (a raised seepage bog) to compensate for wetland area (predominantly wiwi rush and seepage areas) lost during mining operation may improve the quality and availability of habitat for indigenous freshwater species, particularly kōwaro.

MONITORING MEASURES

44. Stream health monitoring measures outlined in the MCMP[27], include aquatic ecology monitoring during mine closure and post-closure. This programme currently includes twice-yearly surveys (in spring and autumn) of established sites in Bush Gully Stream and Tara Stream to monitor macroinvertebrates and fish. Recent results (as described above) showed the macroinvertebrate community was dominated by snails and oligochaete worms, with low abundances of other taxa. Many of these taxa are also considered "tolerant" of poor water quality and habitat conditions, which resulted in Bush Gully and Tara Stream scoring poorly across a range of biotic metrics used as indicators of stream health (as in paragraph 22). Upland bullies were the most common fish species captured and present only at Bush Gully sites. Low numbers of kōwaro (2 individuals) and Canterbury galaxias (6 individuals) we are also recorded.

45. Additional monitoring focused on kōwaro populations could be undertaken to determine the extent, persistence and changes in abundance and condition over time, in the streams and wetlands. Abundance and size are important measures to understand the population structure and resilience to change over time.

RESPONSE TO SUBMISSIONS

46. As outlined in Craig Pilcher's and Claire Hunter's evidence for BCL, the closure proposal for the CCM is now substantially reduced from the expansion proposal that submitters originally commented on.

[27] Canterbury Coal Mine Mine Closure Management Plan. CAN-TEC-PLN-0xx V1.0 p 67

47. A number of submitters raised concerns about discharges and effects on water quality and the aquatic ecosystem. These submitters generally did not provide specific information about these matters in their submissions. I have addressed aquatic ecology effects in my evidence above.

48. Some submitters raised specific concerns about impacts on stream ecosystems, in particular mudfish populations, and about effects within the wider Selwyn Te Waihora catchment. I appreciate these concerns and have addressed the submissions raising these matters below.

49. Kōwaro (Canterbury mudfish) are present in Bush Gully Stream and Tara Stream. However, as noted above, our understanding and assessment of effects on kōwaro populations in these waterways is limited by little existing data on abundance, distribution, and condition collected over time. The slow-flowing nature and soft-sedimentary beds of both streams and adjacent wetlands provide suitable habitat for kōwaro. The perched culverts along Bush Gully Stream provide barriers to predatory fish, while deep pools and farm ponds (Tara Stream) provide refugia for kōwaro during periods of low flows. On-site water management in recent years has meant that contaminants from mine discharge are unlikely to currently be a significant issue for kōwaro or other native fish species. Provided that contaminant compliance limits are maintained through mine closure, rehabilitation and post-closure, water quality should not degrade further and exclude kōwaro populations. Wetland creation and habitat improvement undertaken as compensation may also improve the availability and habitat for kōwaro along Bush Gully Stream.

50. With long-term passive treatment (Tara Stream) and adaptive management during mine closure, rehabilitation and post-closure, contaminant loads and concentrations discharged into the streams are expected to decline over time and protect existing aquatic values. Any downstream water quality effects to the Waianiwaniwa River or Selwyn River are expected to be negligible due to dilution and buffering through wetlands. Furthermore, during low summer flows and rainfall, sections of the Wainiwaniwa River and Selwyn River can dry partially (or completely) creating a series of isolated low-flow sections or pools, which would restrict any downstream flows during this period as well as upstream movement of predatory fish that are a threat to kōwaro. I consider that any impacts on aquatic ecology values in the Waianiwaniwa River, Selwyn River or further downstream in the Te Waihora

Selwyn catchment related to the closure and post-closure of the CCM would be negligible.

RESPONSE TO SECTION 42A REPORTS

Sediment and flows - effects on aquatic ecology of Tara Stream

51. Suspended and deposited sediments are an issue for freshwater ecosystems and can have direct physical effects (e.g., clog gills) or indirect effects on water clarity or habitat that affect feeding, cover, or reproduction of aquatic biota.

52. I acknowledge the previous non-compliant suspended sediment discharges from CCM to Tara Stream wetland in the evidence of Ms Hartwell[28]. However, I agree with Ms Dawson about the uncertainty surrounding the extent of the adverse sediment effects that occurred due to non-compliant discharges (CRC S42a report, paragraph 388). I am not aware of habitat data on existing sediment cover, accumulation, or quality in the upper reaches of the stream and wetland. I would also expect there to be uncertainty about the source of sediments given adjacent land use (plantation forestry). Furthermore, it is not clear whether deeper pools (that could provide fish habitat in the wetland) previously existed. Tara Stream wetland is not known to support kōwaro (Canterbury mudfish) or other native fish species above CC03, but I agree with Ms Dawson that it may provide *potential* habitat for Canterbury mudfish (CRC S42a report, paragraph 222).

53. Plans to continuously discharge from the site to Tara Stream during closure and post-closure , combined with resumed seepage flows and natural runoff, should increase the extent of wetted area and permanence of standing water along the stream and wetland, with likely positive future effects for riparian wetland vegetation and habitat for aquatic biota relative to regulated flows during mine operation. Concerns regarding the ability to ensure a continuous discharge from the site occurs are noted (CRC S42a report, paragraph 357). However, adaptive management of flows is intended to minimise the extent of dry periods in the Tara Stream wetland as referred to in the evidence of Dr Weber and Dr Griffiths. With respect to Tara Stream wetland (upstream

[28] Evidence of Ms Sioban Hartwell dated 1 October 2021 at [Appendix 1].

of CC03) providing potential habitat for kōwaro, it is noted that kōwaro can tolerate periods of dry conditions and stagnant flows.

Aquatic ecology monitoring

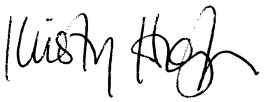
54. I note that recent aquatic ecology monitoring was undertaken in spring and autumn and no surveys were planned for summer (January/February 2021) and not completed (CRC S42a report, Appendix 5, paragraph 174). I acknowledge that reaches of Tara Stream can have very low water levels and the likelihood of drying increases during low flow periods. It has been my observation that Tara Stream downstream of CC02-tele has limited areas with a defined stream channel and contains a greater proportion of wetland habitat, as reflected by pool habitats and the plant communities.

55. Regarding the future aquatic ecology monitoring of waterways following closure and post-closure of the mine (CRC S42a report, Appendix 5, paragraph 204 to 206), I note that the objectives of current monitoring programme, which were originally designed to assess the effects of mine activities, will be reassessed. I agree that a one-off fish survey in Osyter Gully could provide some further information on the status of native fish (including kōwaro) populations (CRC S42a report, Appendix 5, paragraph 442). However, is unlikely to be conclusive.

Consent conditions

56. I support consent conditions proposing: monitoring of discharges of downstream flows (CRC S42a report, paragraph 325; actions to minimise sediment erosion and discharges during rehabilitation and active closure (CRC S42a report, paragraph 395); and that TARPS should be developed to form part of the consent conditions (CRC S42a report, paragraph 395).

57. Overall, I agree with Mr Henderson (SDC S42a, paragraph 151) that provided associated risks and uncertainties related to closure and post-closure activities are appropriately monitored, managed, and mitigated, the closure and rehabilitation of the CCM site presents a positive outcome for the environment.



Kristy Lynn Hogsden

1 October 2021

APPENDIX 1

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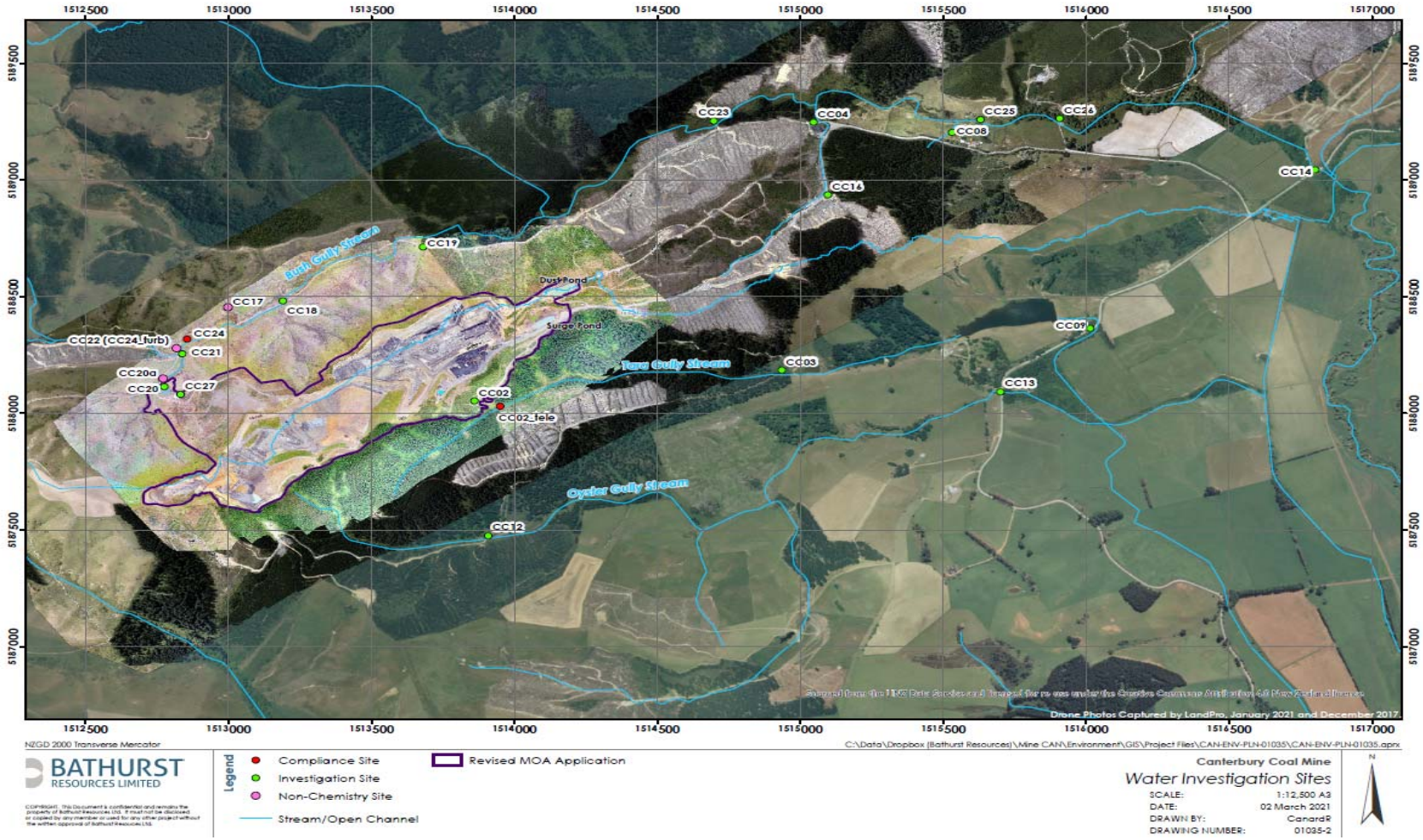

Appendix 1: Waterways, water quality monitoring and aquatic ecology sampling sites at Canterbury Coal Mine. Macroinvertebrates were sampled at CC03 on Tara Stream and CC24, CC19_mainstem, CC23, and CC26 on Bush Gully Stream (sites listed from upstream to downstream). Fish were also sampled at CC09 on Tara Stream. Map provided by Bathurst.