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 **James Andrew Griffiths (Hydrology)** for Bathurst Coal Limited

Dated: 1 October 2021

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INTRODUCTION

1. My name is James Andrew Griffiths. I am a Hydrologist and Group Manager (Hydrological Processes) at NIWA Taihoro Nukurangi (**NIWA**).

2. I hold a Bachelor of Arts (Geography) and a PhD in Geography/Hydrology both from King's College London. I have been a Fellow of the Chartered Institute of Water and Environmental Management (since 2011); a Chartered Water and Environmental Manager (since 2011); and a Chartered Engineer since 2013. I became a chartered member of Engineering New Zealand this year (2021) and am a member of the New Zealand Hydrological Society.

3. I have 20 years' experience as a hydrologist. I was hydrologist at the Centre for Ecology and Hydrology from 2002 to 2007; a senior hydrologist at SRK Consulting (mining consultancy) in the UK from 2008 to 2010; an assistant professor at the University of Nottingham in China (Ningbo) from 2011 to 2016; and I have been a hydrologist (Scientist level 3) and Group Manager (Hydrological Processes) at NIWA since 2017.

4. I have experience of contributing to mine water management plans and as independent expert in reviewing mine water management (including closure planning). Example projects include Craig-Yr-Hesg Coal Mine (Hanson UK), Zanaga Iron ore Mine (Xstrata), Kiaka Water Management (Volta Resources), Geita Gold Mine (AngloGold), and Tonkolili Iron Ore (African Minerals).

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 Closure – Hydrology Response" (**Hydrology Response**), which is attached as Appendix 7 to the Addendum AEE for Closure and Rehabilitation for the Canterbury Coal Mine (**CCM**).

7. I also prepared other hydrological studies in relation to the CCM, including the hydrological assessment for the subject applications as originally lodged and in response to the requests for further information as part of the consenting process.[1]

8. I do not repeat the contents of the Hydrology Response and my previous hydrological assessment in full in my evidence. My evidence:

   (a) provides a brief description of the hydrological characteristics of the CCM site, describes historic activities and their impacts, and the surrounding environment;

   (b) outlines the hydrological implications of the final landform at the CCM site and the proposed management measures;

   (c) confirms my assessment of the hydrology effects;

   (d) responds to relevant submissions; and

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

9. I visited the Canterbury Coal Mine on 15 September 2021 and visited a number of locations within this site including the N02 pit; location of surge pond and dust pond; the Wīwī rushland seepage to the north of the mining operation area (**MOA**); the North Engineered Landform (**ELF**) pond; the Bush Gully and associated wetland area and the Tara Pond and Tara Gully.

EXECUTIVE SUMMARY

10. During the mining operation of the CCM, managed runoff was treated then predominantly directed into the Bush Gully Stream or Tara Gully Stream and this will continue in the active closure phase and post closure phase (albeit under a gravity driven system rather than pumped system after mine closure).

11. The effects of mine closure on the hydrology of the CCM site have been well documented within the Mine Closure Plan and associated Surface Water

[1] Griffiths, J.A. 2021. Memo on Canterbury Coal Mine Closure – hydrology, prepared for Bathurst Coal Ltd, Client Report No: 2021053CHa
Griffiths, J.A. 2020. Memo on Canterbury Coal Mine consents application - RFI Hydrology, prepared for Bathurst Coal Ltd.

Management Plan. The final landform design aims to minimise surface water flows convergence and concentration, and so limit the potential for soil erosion and sediment transport. This is achieved by the re-introduction of topsoil and vegetation cover. Where flow convergence is unavoidable (for example, where runoff is directed surface water ponds in high rainfall events), engineered structures including lined drainage channels, culverts and spillways are used to protect the underlying surfaces from erosion.

12. The area of natural surface water catchments that encircle the CCM site will be marginally different (< ±1%) after mine closure compared to pre-mining conditions. As a result, there should minimal volumetric change to flow inputs to the Waianiwaniwa and Selwyn River catchments.

SITE AND SURROUNDING ENVIRONMENT

General hydrology of the site

13. The CCM is situated the western foothills (Malvern Hills) of the Canterbury region, approximately 70km west of Christchurch. The mine site straddles a hill crest at 375 to 400 m above mean sea level. The site has relatively steep slopes that feed surrounding stream valleys (see **Figure 1** at **Appendix 1**) including Bush Gully, that drains the area north of the mine and runs west to east; Tara Gully and Oyster Gully that drain the area south of the mine and also run west to east; and Surveyors Gully that drains the area to the south-west of mine in a southerly direction. Bush, Tara and Oyster Gullys drain into the Waianiwaniwa River which lies east of the mine site and flows from the hills into the larger floodplain where it meets the Selwyn River approximately 18 km downstream of CCM. Surveyors Gully drains directly to the Upper Selwyn River some 16 km before its convergence with the Waianiwaniwa at **Appendix 1**.

14. Regional groundwater flows from the Southern Alps across the Canterbury plains towards the coast. Groundwater is reported to be 20 to 30m below ground level in the floodplains southeast of Coalgate but will be closer to the surface in the foothills and associated rivers and tributaries.[2] Assuming homogenous material around the CCM shallow groundwater would be expected follow the contours and shape of the landscape; appearing in

[2] Sephira Environmental Limited, 2018. Preliminary Hydrologic and Hydrogeologic Conceptual Site Model, Canterbury Coal Mine, Prepared for: Bathurst Resources Limited, BRL-A0278-002R-v2

stream channels when antecedent precipitation and where sub-surface storage allows. Top-soils in hillslope areas around the mine are generally thin and overlie clay subsoils.

15. Annual precipitation at the CCM ranges from 1000 to 1200mm. Combined with an annual evapotranspiration ranging from 459 to 722mm, annual runoff from the catchment has been estimated by Woods et al. (2006) to be in the range of 400 to 800mm.

16. Infiltration of surface water into soils around the CCM site is limited by a semi-continuous layer of low permeability loess (pallic soils) which occur over much of the unmined hills in the area. By contrast, areas of overburden fill and glacial outwash gravels can see increased infiltration. However, compacted waste rock areas within the CCM site were found to be of low permeability (c.1 x 10^{-8} m/s).

17. Any percolating water in the mine will move downslope to emerge in surface channels unless intercepted by the dipping beds, which within the MOA will direct water towards Tara Gully and Surveyors Gully catchments.

18. The presence of historic underground mines and associated voids that were formed prior to Bathurst Coal Limited (**BCL**) taking over the CCM site may provide conduits for sub-surface water. For example, water from the mine access road may seep into the opening of the Victory Underground Mine (adjacent to the access road about 0.5 km south of Bush Gully Road).

19. The primary land use in both Bush Gully and Tara Gully sub-catchments is forestry and agriculture, which have and will continue to influence the development of surface water drainage patterns. There are relatively small areas of wetland habitat or riparian buffers.

Surface water catchments prior to mining

20. **Figure 1** attached at **Appendix 1** provides good illustration of the arrangement of natural surface-water catchments that encircle the CCM site. It can be seen that the site is situated on the boundary between Bush Gully (upper and middle), Surveyor’s Gully, upper Oyster Gully and the upper Tara Gully.

21. Prior to mining, the south boundary of Bush Gully (now adjacent and within the north MOA boundary) consisted of 'small ill-defined water courses' that carried surface water from near the ridge crest of the catchment.[3] A number of ephemeral lateral seepages also fed into farm drains that fed into the Bush Gully Stream. To the south of Bush Gully Creek, surface water drained south-east into Tara Gully or Oyster Gully Streams.

22. There is limited information available relating to groundwater at the site prior to mining activities (apart from a single borehole (N2) where water levels were indicated in a shallow water-table at 1m below ground surface level). Whilst there was no water level or pumping data available for the old mine works, anecdotal information indicates that minimal pumping was required (thus indicating that seepages into such works was low).

BCL management of the CCM site

23. During the time that BCL have managed the mining operations, surface water discharges from the mine areas have been diverted to the upper Tara and Bush Gully Streams. The main pit (N02) discharged water to Tara Stream via sediment removal and chemical treatment. The edge of the highwall (unexcavated uphill side of the exposed overburden) formed the southern border of the Bush Gully catchment.

Bush Gully flows

24. During periods of no rainfall, the small channels in upper Bush Gully are known to stop flowing when the shallow groundwater store is drained (this is because there is limited groundwater storage in the underlying soils). Calculated low flows in upper small sub-catchments range from 0.16 to 1.41 L/s when groundwater seepages are present (in the upper tributaries).

25. Average flows in the middle Bush Gully are between 0.04 and 0.07 m^3/s, with low flows of 0.002 to 0.006 m^3/s. The continuity of flow in the middle/upper stream (to mudfish road) may be compromised in dry summer conditions. Flows in the lower stream are likely to be more continuous as it is supported by a greater number of seepages and has a larger area.

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[3] Kingett Mitchell & Associates LTD, 1998. Malvern Hills Coal Mine Assessment of Environmental Effects, Prepared for Canterbury Coal Limited, (section 3.5)

26. The downstream section of Bush Gully is less steep and wetlands are supported throughout the year by tributaries from both sides of the valley. Numerous drainage ditches and alterations from farming practices are likely to have influenced the development of current surface water drainage patterns in the gully over the years. I do not consider that flows in Bush Gulley will be impacted given the relatively small change in catchment surface water contributing area as indicated in Table 1 (-0.307%).

Tara Gully flows

27. Under pre-mining conditions, the Tara Gully drained the south-east section of the MOA. During mining drainage from the MOA effectively increased the catchment area of the gully by up to 54.2 ha (through redirection of water from Bush Gully, Oyster Gully and Surveyors Gully). After mine closure, the catchment area will be returned to pre-mining conditions (as indicated in Table 1 at paragraph 35 below).

28. During mining, average flows in Tara Gully were estimated to range from 0.009 to 0.05 m^3/s and portions of Tara Gully are dry in summer; except the underdrain which contributes approximately 0.0005 m^3/s (though this is commonly as low as 0.08 L/s).[4] Estimated low flows were predicted to range between 0.0005 to 0.004 m^3/s.

29. During mine operation and transition to closure, additional runoff from the mine was diverted and stored and treated before controlled release via the Tara Gully Water Management System. As illustrated in **Figure 2** at **Appendix 2**, the Tara Gully catchment is expected to have increased by only 0.7 Ha (0.364%) and thus would be expected to exhibit similar flow characteristics to pre-mining conditions.

30. Downstream of the MOA the Tara Gully Stream enters the Tara Gully wetland area. If pre-mining drainage rates to the Tara Gully are maintained (as indicated by the proposed post-mining catchment areas) the drainage to the wetland will be sufficient to maintain pre-mining conditions in the wetland.

31. Downstream of the wetland, the Tara Gully Stream enters a number of holding ponds owned by local farmers. The holding ponds represent the

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[4] Pers. Comm. Eden Sinclair

main control of drainage rates from the Tara Gully into the Waianiwaniwa stream.

HYDROLOGICAL IMPLICATIONS OF CLOSURE AND MANAGEMENT

32. I agree with the potential hydrological implications of mine closure on the hydrology of the CCM site as have been well documented within the Mine Closure Plan.[5] The aim of the plan is to ensure compliance with consent conditions, prevent or minimise concentration of surface water flows and associated soil erosion and sediment transport, and enable the staged dispersal of water to the surrounding catchments.

Final landform design

33. The final landform has been designed to prevent concentration of surface and subsurface drainage from the CCM site wherever possible and allow the dispersal of sheet flow runoff into the surrounding catchments without risk of erosion. Ponds used to manage sediment laden runoff or provide flow attenuation will have lined drainage and engineered spillways to avoid risk of erosion. Where areas of flow concentration exceed 0.5 Ha, engineered spillways and drains are designed to manage 1:100 year time of concentration events.

34. The seepage/spring area which provides wetland habitat on the north-west side of the mine includes a distinctive raised spring area. The ridge on the northern margin of the MOA has been removed during mining so that the surface water contributing area above the raised spring has been reduced. As part of the mine closure planning, the quarried ridge on the northern margin of the MOA will not be reinstated. As a result, surface water run-off that previously drained north into the Bush Gully, will drain towards the proposed N02 pond to the south of the original catchment divide. As the spring is suspected to depend on sub-surface hydrostatic pressures as opposed to surface water drainage reduction of the surface water catchment up-gradient of the spring should not impact its flow. It has also been noted that during site visits that flows from the spring continue to be unaffected by

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[5] Bathurst Resources Ltd, 2021. . Canterbury Coal Mine – Mine Closure Final Landform Surface Water Management Report.

the reduced surface water catchment even in summer (thus confirming its sub-surface origins).

Expected post mining flows

35. **Figure 2** attached at **Appendix 2** of my evidence illustrates the changes in surface water sub-catchments within which the CCM lies (and expected final catchment boundaries). Changes to all surrounding sub-catchments that overlap the mined area are small, range from 0.617% (Oyster catchment) to -0.307% (Bush Gully). Table 1 illustrates the changes in all catchment areas that are influenced by drainage from the CCM. Total change in area of the receiving Waianiwaniwa and Selwyn catchments are also shown. It can be seen that there is minor differences (all less than 1%) to all catchment areas.

Catchment	Before (Ha)	After (Ha)	Change (Ha)	% Change
Tara	192.1	192.8	0.7	0.364%
Bush Gully	898.1	895.3	-2.76	-0.307%
Oyster	372.9	375.2	2.3	0.617%
Surveyors Lower	321.2	320.9	-0.28	-0.087%
Waianiwaniwa River	9690.2	9690.5	0.28	0.003%
Selwyn River	30250.0	30249.7	-0.28	-0.001%

Table 1 Final sub-catchment sizes

Mine closure works

Active closure phase

36. Preparation for mine closure will involve cover of exposed rock and completion of stable and largely self-regulating surface water and seepage drainage system. The drainage response of the mine site will be influenced by re-vegetation of new landforms and surface and sub-surface drainage systems. The inclusion of holding ponds and sumps with the drainage system will reduce peak hydrograph response from runoff during active closure phase but such ponds will be gravity driven and controlled after closure where possible.

37. Apart from the North ELF area, channelised surface water drainage will be directed to the N02 pond (as illustrated in **Figure 3** at **Appendix 3**). Active pumping and use of the surge and dust ponds allows flexibility of water management response to large rainfall events during the active closure phase. The N02 pond, spillway and drainage channel will be used to buffer

long-term surface water runoff by reducing peak runoff but sustaining low flows. Drainage from the N02 pond will be managed with the lower Tara pond to allow controlled release of water to the surrounding environment and ensure minimum low flows to the Tara catchment are sustained.[6]

Post closure phase

38. **Figure 4** at **Appendix 4** to my evidence illustrates the final landform surface water sub-catchments. Analysis of individual drainages in post closure condition has been performed. Surface water flow rates have been calculated at drainage exit points that feed into engineered water structures such as drain linings, spillways, and culverts. Key parameters used in the calculations included consideration of rainfall intensity (derived from NIWA's High Intensity Rainfall Design System) and the potential impacts of climate change. The rational method was used for peak runoff calculation and Hydraulic Engineering Circular No.15 (HEC15) for drainage structure sizing as is standard practice. Catchment areas greater than 0.5 Ha required engineered structures including drain lining/armouring, culverts, and permanent pond spillways.

39. Remaining ponds on the CCM site (North ELF Ponds, N02 and Tara) will be utilised to provide natural buffering to high flow events and be gravity drained through engineered spillways and lined drains according to calculated maximum flow rates (with up to 1:100 return period for time of concentration).

Proposed management

40. Post mining water management will minimise sediment transport to surrounding environment by reducing the potential for concentrated (high velocity) flows and channelisation. This is achieved by contouring, replacement of topsoil and promoting revegetation of bare soil or compacted rock. This in-turn will promote infiltration and sheet flow runoff (as opposed to rills and gullies). Where channelisation cannot be avoided (in flow convergence areas) channel lining and slope armouring is applied to prevent erosion and subsequent sediment transport. Similar measures are used to enable the controlled release of storm and drainage water into the surrounding environment.

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[6] Mitchell Daysh, 2021. Addendum AEE for Closure and Rehabilitation, Canterbury Coal Mine, Bathurst Coal Limited.

41. The final landform designs will reduce the peak flow of draining water before it is released to the environment by creating buffer ponds that hold and then slowly release draining stormwater. This methodology has already been implemented on the North ELF, Oyster and Green ELF and is working well (in that it ensures controlled release of water to the surrounding environment).

42. The impact of the N02 pit pond, spillway and drainage channel (shown in **Figure 4** at **Appendix 4**) will be to buffer surface water runoff, i.e., reduce peak runoff but sustain low flows (to an extent determined by the designed spillway threshold). The spill level of the N02 pond could be designed with respect to the lower Tara pond capacity and drainage characteristics to ensure minimum low flows to the Tara catchment are sustained.

43. As previously indicated1 at paragraph 29 of my evidence, the extent to which flow downstream of the Tara wetland (to the Waianiwaniwa) is influenced by flows from the Tara Pond will depend on the buffering capacity of the wetland (i.e. its capacity to store water from high flow events). Any impact to downstream flows would be masked by three farm water storage ponds that lie downstream of the wetland.

ASSESSMENT OF HYDROLOGY EFFECTS

44. As explained above, managed runoff during mining was predominantly directed into the Bush Gully Stream or Tara Gully Stream and this is expected to continue after closure. During rainfall, surface water run-off will drain to the remaining sumps and settling ponds. This water will then undergo controlled discharge to the tributaries at the headwaters of Tara Stream.

45. A small portion of rain that infiltrates will be lost to shallow groundwater and then be discharged via seepages to valley streams or rivers. It is unlikely, that groundwater at or near the mine site is hydro-logically connected to groundwater abstracted from gravel units at lower elevations in the region (because of both distance and differing geology). Thus, it is unlikely that groundwater abstraction by local farms lower in the catchment would be affected by groundwater dewatering at the mine (whereby local groundwater drains under gravity to receiving ponds).

46. Whilst existing and planned CCM operations (pit excavation, development of overburden dumps, and subsequent closure planning), have changed the surrounding the natural surface water catchments' receiving areas, it has been to a minimal extent compared the original catchment size (ranging from -0.3 to +0.6%). As a result, there has been little volumetric change to streams and rivers that drain from the CCM site. At a wetland specific scale, relatively small seepage wetland areas that surround seepages emerging from the direction of the MOA do not appear to have been adversely impacted and will likely continue to remain as such given the outlined closure planning. The final landform designs for the CCM site aim to return drainage patterns to pre-mining conditions whilst taking into consideration the risk of peak flows on soil and slope erosion and subsequent sediment transport.

47. In summary, the low percentage change to catchment area that surround the mine site means that changes in the volume of surface water runoff will be low. The remaining engineered infrastructure is designed to reduce excessive peak storm runoff and replicate pre-mining conditions (including low flow characteristics). The designs, conditions and management plans proposed are appropriate to ensure this outcome.

RESPONSE TO SUBMISSIONS

48. 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.

49. Some submitters raised concerns about hydrology effects, including impacts on seepage and recharge to groundwater. I have addressed the submissions raising these hydrology matters below.

50. As has been previously stated, whilst some surface water catchment area changes will be evident on mine closure, such changes will be relatively small compared to the total size of the catchments. As a result, the total surface water drainage to wetlands around the MOA will be equivalent to the changes is sub-catchment areas (as indicated in Table 1 at paragraph 34 of my evidence).

51. Current groundwater contribution to existing wetland areas is more difficult to quantify than surface water contribution as it is harder to measure and

make visual estimates flow rates and flow pathways. However, for wetlands outside the MOA, it is considered unlikely that the planned closure works would disrupt existing groundwater patterns as no additional excavation work will take place and final landscape will be designed to replicate surface properties of surrounding landscape. Seepage contributions to wetland areas as surrounding catchments areas will be largely the same as pre-mining conditions.

52. In response to concerns about the ability of surface water management to cope with large flood events, it is noted that engineered structures such as spillways and lined drains have been designed to be able to handle 1:100 year events. Consideration of the impacts of climate change on such events was also made (HIRDS RCP6.0), thus adequately addressing flood management risk for all but exceptionally large flows (for which the entire area would likely be in flood).

53. Impacts of the flow regime of the wider Selwyn Te Waihora catchment should be minimal after closure as the response of the landscape is expected to be close to that of the original but will include buffer ponds to reduce hydrograph peaks (and thus reduce the risk of flooding). The catchment area of Surveyors Gully will be reduced by 0.28 Ha so should not contribute to an increased risk of flooding.

RESPONSE TO SECTION 42A REPORTS

54. The Section 42A Report from Environment Canterbury raises some issues that relate to hydrology, which I respond to below.

Seepage areas outside the MOA Boundary

55. Concerns have been raised about the impacts of the closure plan on the raised spring and seepage wetlands outside of the MOA. At paragraph 492 the Section 42A Report author raises concerns about the changes to the hydrology on the north west slopes due to the landform not being reinstated to its original form. The Section 42A Report author states that this is due to the contributing hydrological catchment for surface water and shallow subsurface water flow being reduced by half. For the reasons outlined below I disagree with this assessment.

56. At paragraph [650] the Section 42A Report author refers to Dr Alkhaier's assessment that describes the possible sources of water to the raised spring and seepages on the north of the MOA (north west slopes) – described as a combination of confined groundwater, shallow groundwater and surface water runoff. However, there is uncertainty as to which is the dominant process that sustains both the raised spring and seepage wetlands.

57. The seepage areas and wetlands on the north side of the MOA boundary (draining into the Bush Gully Stream) have continued to exist despite a reduction in the surface water catchment area (due to the expansion of the MOA). These seepages and flow from the raised spring were still evident in a site visit made on 15 September 2021. I therefore suspect that the seepage and wetlands areas are not only a result of surface and shallow sub-surface water runoff but are at last partly the result of hydrostatic pressures within the sub-surface strata, which occurs despite the strata having an angle of dip in the north-south direction (as described in para 33 of this document). Also it is noted that there are topographic gradient changes in the east-west direction in addition to the south-north direction, which will continue to promote lateral sub-surface flows towards the raised spring and seepages flows.

58. Previous hydrological work indicated that the seepage wetlands are most likely sustained by shallow or superficial groundwater movement in a downslope direction.[7] In addition, the deeper groundwater movement is controlled by preferential permeability along the strike of the strata (i.e., in the east-west) direction rather than the dip (south-north) direction.

59. Given the small area of the north west slope seepages relative to the Bush Gully catchment it is unlikely that the loss of upgradient slope within the MOA would significantly impact baseflow in the middle and lower Bush Gully. Despite this, I understand that the offsetting and compensation package that will be protected in perpetuity and is discussed by others will provide additional benefits to the current seepages.

Catchment drainage, sub-catchment hydrology and ecosystems

60. At paragraph [139] the Section 42A Report author acknowledges that the Mine Closure Management Plan aims to ensure that surface water flows

[7] Bathurst Resources Ltd – Further Information Response. [03_01 Final Bathurst RFI 19Dec19_SUBMITTED.pdf]

from the final landforms into Bush Gully and Tara Gully are comparable to surrounding catchments, and [140c] that Tara Pond discharge will be managed to ensure a residual MALF flow. It is noted at [153] that post-closure flow monitoring will be conducted to ensure the drainage performance is as envisaged.

61. At paragraphs [299-309] the Section 42A Report author notes that to date the use of storage ponds will change the hydrological regime of drainage flow at the top of Tara Stream. I do not comment on the impact of the flows on ecology but note that the Section 42A Report author further states at paragraph 309 that based on the advice of Dr Grove, restoring the flows will enable the wetland vegetation to recover.

62. In terms of ensuring the necessary future flows, a key concern raised by the section 42A report author is the impact of the storage ponds on future flows. On closure, the Tara Pond pumps will be decommissioned, and the Tara Pond will spill through a constructed drain to the Tara Wetland.

63. Using the method of Jens Rekker, Ms Dodson has calculated the potential impact of sub-catchment area changes on MALF (+0.394% in Tara Stream; -0.299% in Bush Stream) [Appendix 4; para 26]. I agree that the method is an appropriate way to estimate MALF and related changes caused by change in catchment area.

64. It is noted that the estimated MALF7d of 0.08 L/s to the Tara gulley from CC02 will be maintained by the system which has been designed to produce dilution flows in the range of 0.48 to 0.18 (cross reference Paul Weber evidence [109-1010] describing the combined Tara Stream discharge system and section 6.4 of the MWMP).

65. At paragraphs [310-325] of the Section 42A Report, it is noted that a low flow discharge of approximately 0.48 L/s will flow from N02 to Tara Pond and then to the Tara Stream. However, concern remains from the Section 42A Report author as to the practicality of delivering the required low flow from N02 to the Tara Pond and thence to the Tara Stream. The concern is largely based on:

(a) the assumption that the flows from N02 to Tara Pond will be impacted by evaporative and other losses; and

(b) concern from Dr Meredith that there will be a reduction in small fresh summer events due to capture of runoff by storage ponds at the top of Tara Stream.

66. In response to the above points, it should be noted that the Tara Pond will operate at a full level and with a spill threshold so that the volume outflow from the pond to the Tara Stream will equal the volume inflow. This means that any runoff produced by 'small fresh summer rainfall events' within the Tara catchment will be drain to the Tara Pond and thence down to the Tara Stream without obstruction.

67. It should also be noted that in addition to 6.56 Ha of runoff directly into the Tara Pond and 12.9 Ha of runoff into of N02, an addition 21.8 Ha of runoff will feed into the Tara stream from the natural catchment area that lies southwest of CC02 (area described as upstream of CC02 on **Figure 1** of **Appendix 1**).

68. Given the above catchment areas, evaporation rates from the NO2 pond and Tara Pond are not suspected to be significant, given the size of the ponds relative to their throughflow.

69. I also note that, the proposed consent conditions include demonstration and checking of the new hydrological boundaries after completion of landform changes; monitoring of N02 and Tara pond spillways (as stated in the MCMP); and inclusion of a monitoring weir to allow monitoring of flows from the Tara Pond (to the Tara Stream). In my view, the conditions (or equivalent) are appropriate to ensure sufficient flows are released from the Tara pond to maintain the integrity of the downstream wetland.

James Andrew Griffiths
1 October 2021

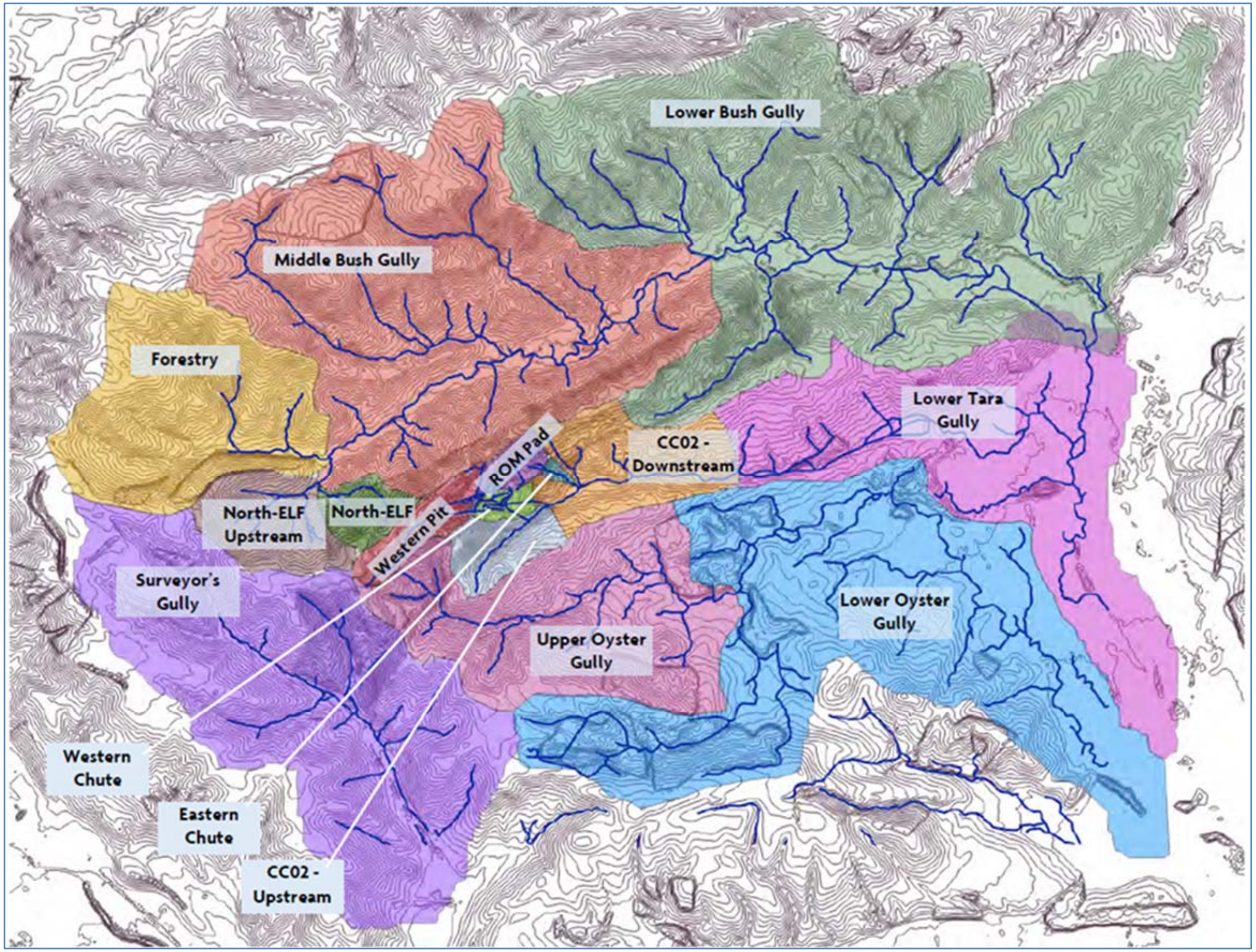
REFERENCES

Woods R, J Hendrix, R Henderson and A Tait. 2006. Estimating mean flow of New Zealand rivers. National Institute of Water and Atmospheric Research. New Zealand Hydrological Society. Journal of Hydrology (NZ) 45 (2): 95-110 2006.

APPENDIX 1

LOCAL HYDROLOGICAL SUB-CATCHMENTS

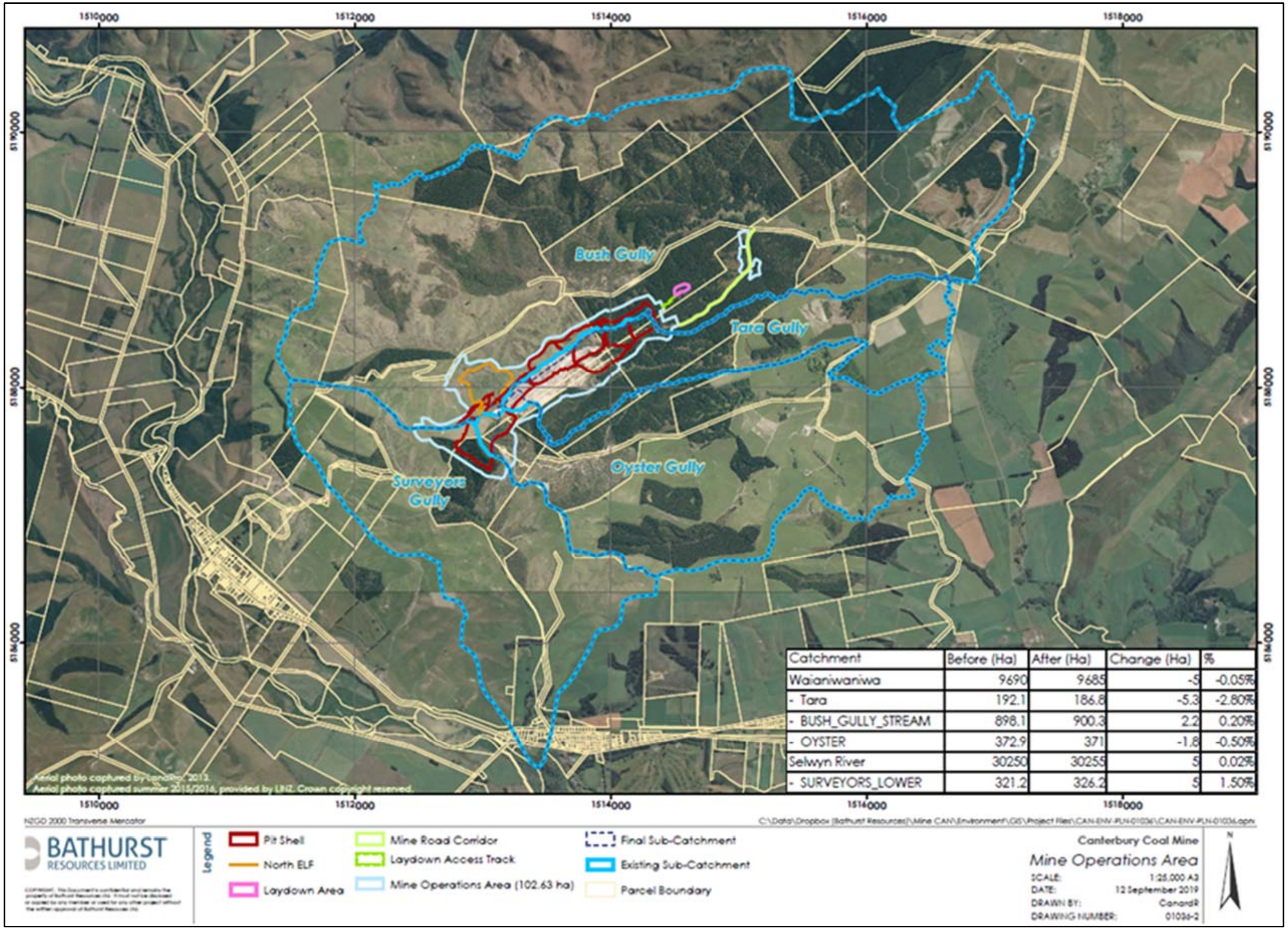
APPENDIX 1 - FIGURE 1 - LOCAL HYDROLOGICAL SUB-CATCHMENTS (FROM SEPHIRA, 2018).



APPENDIX 2

LOCAL HYDROLOGICAL SUB-CATCHMENTS ASSOCIATED WITH CANTERBURY COAL MINE WITH EXPECTED CATCHMENT CHANGES FOR WP-N05 MINING

APPENDIX 2 - FIGURE 2 LOCAL HYDROLOGICAL SUB-CATCHMENTS ASSOCIATED WITH CANTERBURY COAL MINE WITH EXPECTED CATCHMENT CHANGES FOR WP-N05 MINING (CCM ENVIRONMENTAL MANAGEMENT PLAN 2021)

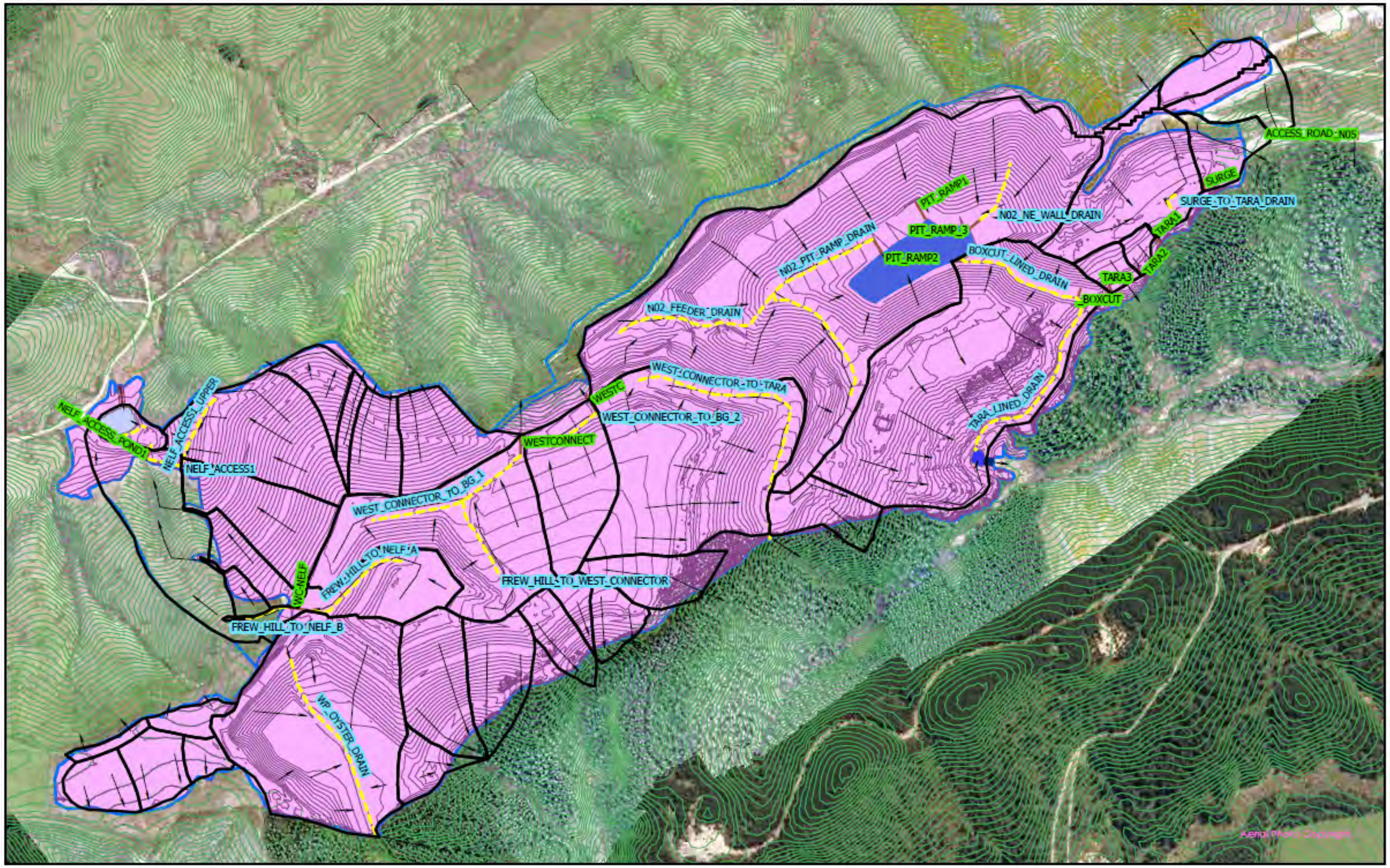


Catchment	Before (Ha)	After (Ha)	Change (Ha)	%
Waianiwaniwa	9690	9685	-5	-0.05%
- Tara	192.1	186.8	-5.3	-2.80%
- BUSH_GULLY_STREAM	898.1	900.3	2.2	0.20%
- OYSTER	372.9	371	-1.8	-0.50%
Selwyn River	30250	30255	5	0.02%
- SURVEYORS_LOWER	321.2	326.2	5	1.50%

APPENDIX 3

CCM DRAINS AND CULVERTS

APPENDIX 3 - FIGURE 3 CCM DRAINS AND CULVERTS



NZGD 2000 Transverse Mercator

D:\DATA\Dropbox (Bathurst Resources)\Mine CAN\Environment\GIS\Map Files\CAN-ENV-PLN-01203-2.aprx

BATHURST RESOURCES LIMITED

Legend

- Lined/Reinforced Drains
- Culverts

Ponds

- N02 ELF Pond
- North ELF Pond 2
- Tara Pond 1
- Surface Water Flows
- Final Landform Contours (2m)
- Surrounding Land Contours (2m)
- Surface Water Drainage Domains
- Final Landform extent
- Mine Closure MOA
- N02 Spillway
- North ELF Pond Spillway
- Tara Spillway

Canterbury Coal Mine

Drains and Culverts

SCALE:	A3
DATE:	06 April 2021
DRAWN BY:	SinclairE
DRAWING NUMBER:	1203-4

N

APPENDIX 4

CCM SURFACE FLOW SUBCATCHMENTS

APPENDIX 4 - FIGURE 4 CCM SURFACE FLOW SUBCATCHMENTS