BEFORE THE OTAGO REGIONAL COUNCIL AND CENTRAL OTAGO DISTRICT COUNCIL

IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications by Cromwell Certified Concrete Limited to the Otago Regional Council and Central Otago District Council for discharge permits, a water permit and a land use consent relating to expansion of an existing quarry at 1248 Luggate-Cromwell Road
REFERENCE NUMBER(S)	**RM20.360 and RC200343**

EVIDENCE OF ALEXANDRA MACDONALD BADENHOP - DRAFT

(GROUNDWATER)

23rd November, 2021

1. My full name is Alexandra Macdonald Badenhop.

2. I am the Technical Director -Water & Environmental Management with e3Scientific Limited.

3. I have been asked by the Otago Regional Council to prepare this evidence.

QUALIFICATIONS AND EXPERIENCE

4. I am a professional hydrogeologist and water quality specialist and a Principal Environmental Consultant at e3Scientific. I am a member of the International Association of Hydrogeologists and New Zealand Hydrological Society and a regular presenter at IAH and Hydrological Society conferences in New Zealand and Australia.

5. I hold a Bachelor of Engineering (Environmental) (Hons) (1999) from the University of New South Wales (UNSW) and a Masters of Engineering Science (Groundwater Studies) from UNSW in 2008. The subjects completed for my masters also fulfilled criteria for Master of Engineering Science (Water Quality).

6. I have over 15 years experience working in the water industry in Australia and New Zealand. My experience has encompassed a range of engineering studies including hydrogeochemistry and water quality assessments, groundwater testing and feasibility studies and hydrogeological investigations.

CODE OF CONDUCT

7. I confirm 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 upon 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.

EVIDENCE

8. My evidence pertains to the impact of the Amisfield Quarry Expansion on groundwater quality and quantity.

9. I provided a technical review of the original application for the groundwater take RM20.360: Badenhop, A (2020). "RM20.360 Cromwell Certified Concrete Groundwater Take Effects Assessment Review". Letter report 11 November 2020.Ref: 20028.30. This was based on the review of: Landpro (2020). Assessment of the effects of increased water take at Amisfield Quarry. Prepared for Cromwell Certified Concrete.

10. I provided comment via email on the s92 response: Landpro (2020). Request for Further Information under Section 92(1) of the Resource Management Act 1991 – Cromwell Certified Concrete. 1 December 2020.

11. I provided an assessment of bore interference for the AESI bore: Badenhop, A (2021). "RM20.360 Cromwell Certified Concrete Groundwater Take Affected Party Assessment". Letter report 9 July 2021. Ref: 20028.30.2

12. I have reviewed the following additional material provided by the Applicant:

    - Appendix 5: Freeman, M. (2021). "Notes on recent Amisfield groundwater quality, bore filter, and settling pond sediment analysis" 11 November 2021.
    - Appendix 8: Extraction Plan
    - Appendix 11: Draft Conditions

13. I have also reviewed the following additional material referenced by the Applicant:

    - PDP (2020). Technical Memorandum: Resource Consent Application Review for Smallburn Limited Partnership. 24th February 2020

SITE VISIT

14. A site visit is planned for 25th November, 2021.

HISTORICAL WATER QUALITY

15. There are inconsistent statements in the reports regarding historical groundwater quality monitoring, which refer to monitoring in wells G41/0455, G41/0101 (which doesn't exist), G41/0456, G41/0127 and G41/0220. The monitoring methodology, results and the construction details

of the bores have not been provided in any reports to enable assessment of the monitoring programme. This was noted in previous reviews.

AMISFIELD BURN STREAM DEPLETION

16. Landpro have asserted that Amisfield Burn is perched above and disconnected from groundwater in the vicinity of the groundwater take. Stream gauging was completed for the Smallburn Limited Partnership water take consent application (PDP, 2020) on 15 January 2019. This confirmed that the stream loses water to ground across the land from SH6 to Lake Dunstan and does not always flow continuously to the lake. This supports the assessment that constant or significant stream depletion from the take is unlikely. If, however, the stream is connected to groundwater closer to the lake where the separation between the water table and streambed decreases, it is possible for the duration and frequency of stream drying to increase when groundwater is pumped. Given the location of Lake Dunstan relative to the Amisfield Burn, the volumes of stream depletion are unlikely to be significant from an ORC Regional Water Plan perspective.

BORE INTERFERENCE

17. Assessing the bore interference effects of the Cromwell Certified Concrete groundwater take on the neighbouring bores was outside of the scope of my original assessment, rather my scope was to audit Landpro's assessment. The areas of uncertainty are as follows:

    a) Aquifer characteristics – whilst an 8-hour pumping test was completed on G41/0456, this is less than the recommended 48 hour pumping test duration for a take greater than 750 m^3/day. A longer pumping test increases the area of influence over which the aquifer characteristics are then calculated. However, the provided aquifer parameters (Transmissivity =1,100 m^2/day, specific yield = 0.1) are reasonable for the geology. A longer pumping test may or may not result in variation to the original assessment. A sensitivity analysis could be completed to determine the effects of variation in the aquifer characteristics.

    b) Return flows – As the water used for washing is returned to the aquifer via soakage pits, some of the take is considered non-consumptive. Soil moisture deficits should not have been used to calculate the potential

evaporation, rather open water evaporation statistics are more appropriate in this context of open water and bare earth. Regardless, the take is not likely to be more than 30% consumptive. The calculations of bore interference were completed using the percentage of consumptive take, however, given the water is returned in a different location (the soakage pits), it would be more appropriate to model the interference effects with the full take from the bores, and the return flow from the soakage pits.

18. The significance of drawdown in the neighbouring bores is assessed using the relevant regional council criteria for significance; for Otago this is 0.2 m drawdown in an unconfined aquifer. The impact of drawdown at each individual bore will depend on the cumulative effects of drawdown in the area (including drawdown in the bore being assessed), the depth of the bore, the screen length and the depth of the pump. Drawdown should be assessed taking into account recharge boundaries, locations of individual pumping wells, and locations of return flows into the aquifer.

19. It is possible that extracting gravel below the groundwater may have a localised impact on groundwater levels as the removal of gravel will result in additional water draining towards the extraction areas. Creating a new surface water body may also act as a recharge boundary (or source) to nearby groundwater abstraction wells.

APPENDIX 5: WATER QUALITY

20. The monitoring methodology, results and the construction details of the bores have not been provided to enable assessment of the monitoring programme. The water quality sample results provided in Appendix 5 provided analysis only of total metal results, not dissolved metal results and therefore it is difficult to make assumptions regarding the source of the metals.

21. Surveyed water levels were provided for G41/0456 and Lake Dunstan to confirm there is a 0.91 m difference in water levels. It would be helpful to survey all the surrounding bores and the soakage pits during site operation

to confirm local flow directions, both when bores are operating and not. There may be localised variations from assumed flow directions due to drawdown in surrounding bores and mounding from the soakage pits. In addition, if the soakage pits are at groundwater level, the soakage pits may actually be acting as a recharge boundary for upgradient wells, hence pumping may induce flow of turbid water from the soakage pits to the bores, even if they are upgradient in terms of the natural groundwater flowpath.

22. Landpro compared sediment samples from the G41/0321 wool filter with sediment samples from the second settling pond to try and identify whether they are from the same source. These sediments from the second settling pond may have different attributes than sediment samples from the first settling pond. They may also be different to sediment that is moving within the groundwater rather than that settling in the ponds. This comparison is therefore not necessarily meaningful. In addition, comparing these samples to NES soil contaminant guidelines for commercial land use is not meaningful in the context of a domestic water supply.

23. No assessment has been provided by the Applicant of likely water quality effects of gravel extraction underwater. It is possible that this disturbance may lead to increases in turbidity in downgradient bores. This new area of extraction may act as a recharge boundary (or source), and therefore nearby pumping may induce movement of turbid water into the aquifer.

MONITORING

24. Draft conditions for the Land Use Consent propose the monitoring of suspended sediment in G41/0456 and G41/0111. Draft conditions for the Discharge Consent propose monitoring of suspended sediment G41/0456 and G41/0220. These bores are screened at a range of depths below the water table, and therefore the results are difficult to compare to each other; for example, samples taken from G41/0456 are from approximately 20 m below the groundwater table, whereas samples taken from G41/0111 are from approximately 5 m below the water table.

25. A dedicated groundwater monitoring network should be established to monitor the impacts of the take and discharge. The locations should be confirmed based on localised flow variations, however monitoring locations

on the north-west corner of the property, along the western boundary and along the southern-boundary of the property would be appropriate. Each monitoring location should consist of a water table well and a piezometer screened 10 m below the water table.