SUMMARY STATEMENT OF NEIL THOMAS FOR WAIMAKARIRI IRRIGATION LIMITED

INTRODUCTION

1. My full name is Neil Malcolm Thomas. I am a hydrogeologist with Pattle Delamore Partners Limited and have prepared this summary statement to provide a brief overview of the key points from my evidence in chief for Waimakariri Irrigation Limited dated 17 July 2020, as well as additional comments arising from my participation in expert caucusing and the groundwater Joint Witness Statement (JWS) and key points from my rebuttal evidence dated 18 September 2020. My qualifications and experience are provided in my evidence in chief. My comments here are divided into the following three themes:

    1.1 Existing water quality and Environment Canterbury's modelling of future nitrate concentrations;
    1.2 The 'Load to come' issue; and
    1.3 Flow under the Waimakariri River.

EXISTING WATER QUALITY AND MODELLING OF FUTURE NITRATE CONCENTRATIONS AND THE LOAD TO COME ISSUE

2. The current median nitrate concentration in all 2,641 private water supply wells within the Waimakariri Zone is 3.1 mg/L. Even if only the areas within and downgradient of the WIL command area are considered, the median concentration is 3.5 mg/L. This can be compared with the Ministry of Health's Maximum Acceptable Value of 11.3 mg/L (nitrate nitrogen) specified in the Drinking Water Standards for New Zealand 2005 (revised 2018). Further, on average, groundwater nitrate-N concentrations have been relatively stable in the Waimakariri zone for the past three decades, **as shown in slide 2 of the PowerPoint file attached to this statement**. Except where shown on the slides, the figures shown are drawn from my evidence in chief and rebuttal evidence.

3. These observed concentrations and trends are at odds with the results from the modelling exercise carried out by Environment Canterbury. The modelling exercise is based on 'Current Pathways' which includes Good Management Practices and a 50% uptake of land use intensification under the PC5 permitted activity rules. Because of the lag time between land use at the ground surface and effects occurring in underlying groundwater, the modelling exercise will not directly simulate the effects of existing land use, however it would be reasonable to expect that it would result in a generally similar

pattern of groundwater concentrations. Based on the data provided by Environment Canterbury, this is not the case (**as shown in slide 3).**

4. This slide shows a comparison between the observed concentrations in the Private Water Supply Areas and the simulated concentrations from the Environment Canterbury modelling exercise. There are large discrepancies between the two sets of data with the modelled results showing much higher concentrations compared to the observed data. Environment Canterbury indicate that this is due to the 'Load to come', that is the lag time between the effects at the surface and effects in groundwater.

5. I do not believe that this is an adequate explanation for the very large differences. If the 'Load to come' explanation is correct, a rising trend in observed groundwater concentrations would be expected, but this is not the case. As I noted previously, groundwater concentrations are generally stable.

6. Environment Canterbury note that, in terms of contaminant concentrations, their model is essentially uncalibrated, given that it attempts to predict a future set of groundwater concentrations. However, they have picked fourteen bores in the Waimakariri area, which they indicate represent areas where groundwater concentrations should represent the effects of land use at the surface **(see slide 4)**. That is because the land use in those areas has remained consistent for some time, and therefore the modelled results should be consistent with the observed data. However, even in these selected areas, there are significant differences between the modelled and observed data.

7. Environment Canterbury state that on average, across all fourteen bores, the modelled concentrations are similar to the observed concentrations. This averaging approach may be reasonable for a cluster of bores in a small area, but the fourteen bores are distributed across the whole of the Waimakariri zone. Therefore, the difference between modelled and observed concentrations in these bores simply indicates that the model does not represent observed concentrations in many of the selected areas.

8. In my opinion, it is very difficult to conclude that the model has provided a realistic prediction of nitrate concentrations in groundwater. As noted in my evidence in chief, it would be appropriate to undertake further monitoring to compare to the projected model results. This monitoring should feed back into the model to confirm, or otherwise, its projections.

9. In my evidence in chief I also highlight the issue of denitrification, where nitrate is removed from groundwater as a result of biogeochemical processes. Environment Canterbury note that this process is generally unlikely to be significant across the majority of the Waimakariri plains because of the rapid movement of oxygenated shallow groundwater. In general, I agree with that comment, although I note that locally, low oxygen environments that are conducive to denitrification do occur across the plains, as evidenced by occasional detections of iron, manganese and/or arsenic in groundwater. However, the potential for denitrification is another reason why actual nitrate concentrations will be lower than the values predicted by the ECan model. Denitrification is particularly important in respect of nitrate transport within very deep groundwater, where low oxygen environments are expected to be more common.

FLOW UNDER THE WAIMAKARIRI RIVER

10. In my evidence in chief I discuss the possibility for groundwater flow beneath the Waimakariri River, from the Eyre River groundwater management zone in the north to the Christchurch West-Melton zone in the south. This topic comprises the majority of the JWS, which also records additional model results that were not previously available prior to the caucusing. Comment on some of those model results were included in my rebuttal evidence.

11. There are therefore a number of differing documents discussing the possibility of flow beneath the Waimakariri River and the following comments summarise my viewpoint on this matter.

12. The JWS produced at the end of the groundwater caucusing indicated that the experts agreed that there was *potential* for groundwater movement to the Christchurch Aquifers from north of the Waimakariri River. It is important to emphasise the word *potential*. In my opinion, the balance of evidence is that groundwater flow beneath the river is unlikely, but it is a possibility. The evidence does not support a view that it is likely to occur.

13. The original suggestion that flow beneath the river could occur arose in a 2003 report (Stewart, 2002)[1] investigating dissolved oxygen ratios in groundwater around the Canterbury Plains. Dissolved oxygen ratios in groundwater can provide an indication of the recharge source of groundwater. Some results from some deeper bores in

[1] Stewart, M., Tropetter, V., van der Raaj, R. (2002). Age and source of Canterbury plains groundwater. Environment Canterbury Technical Report U02/30. Environment Canterbury, Christchurch.

Christchurch showed a ratio that could indicate a land surface recharge source, whereas at that time, groundwater beneath Christchurch was thought to be derived principally from seepage from the Waimakariri River. Therefore, a suggestion was made that the land surface recharge component could come from north of the river, although the source could equally be from land surface recharge inland of Christchurch and south of the river. The dissolved oxygen ratio did not allow that distinction to be made.

14. In 2015, I investigated the possibility of interzone movement in a report for Environment Canterbury (Environment Canterbury Report R15/108). This is the report whose existence is disputed by Mr Mike Thorley in his rebuttal evidence. It is freely available on the Environment Canterbury website. I have provided a summary of the data considered in that report, and the conclusions drawn from that data. I am aware that Environment Canterbury have collected some additional data since the time that report was written, including groundwater level surveys as well as consideration of other groundwater quality data. However, I do not think that additional data alters my conclusions that:

    14.1 Groundwater level data for shallower bores does not indicate the possibility of flow beneath the river except for upstream of Courtenay Road (i,e. on the inland plains, towards the foothills). There is a lack of data for deeper bores, but groundwater mounding is likely to extend to more than 50 m depth based on response to changes in river stage in bores of that depth (slide 5); and

    14.2 A lack of very low permeability strata across the plains (apart from around Christchurch city itself) implies that a groundwater mound would be expected to extend to depth, which would provide a hydraulic barrier to flow under the river.

15. The overall conclusion from that report was that the Waimakariri River formed a boundary to groundwater to at least 50 m depth downstream of Courtenay Road. However, very limited data was available to determine patterns of deeper groundwater movement and further data was required.

16. Environment Canterbury installed three clusters of bores on both sides of the Waimakariri River in 2017/2018, with one cluster of bores located on the north side of the river and two on the south side of the river. All three clusters include a 50 m deep bore, a 100 m deep bore and a 150 m deep bore. I understand that one of the purposes

of the bores was to help clarify deep groundwater flow directions in the vicinity of the Waimakariri River.

17. Three groundwater levels in three separate bores can be used to estimate likely groundwater flow directions, because the groundwater levels define the surface of a plane. In this case, the groundwater flow directions based on groundwater levels in the deepest three bores indicate a flow direction that is parallel to the river (the green lines in **slide 6**). These three bores provide the best source available of measured data regarding deep groundwater flow directions. They indicate that there is no groundwater flow underneath the river from the north side to the south side even though the ECan model incorrectly predicts that is what is occurring (the red line in **slide 6**).

18. As noted in my rebuttal evidence, the Environment Canterbury groundwater model does not match the observed groundwater levels in all of these bores. In two of the bores, the modelled water levels are around 7 m to 8 m higher than the observed levels, whereas groundwater levels in the other bore is approximately correct. As a result, the groundwater flow direction in the model indicates cross boundary flow, whereas the observed data indicates that is not the case in this area.

19. Given the lack of deep groundwater level data generally, the data from these three bores should have been more accurately represented in the model, particularly given that they are located in a critical area of the model. In my opinion, had the model more accurately represented observed groundwater levels in these bores, it is likely that cross boundary flow would, at least, be of a much lesser scale than represented by Environment Canterbury.

20. Given the lack of actual data showing cross boundary flow, Environment Canterbury indicate that the model itself represents one of the key lines of evidence showing that cross boundary flow is likely. However, the model is demonstrably in error at key points where cross boundary could potentially occur. In my opinion, reliance on the model itself as evidence of the migration of nutrients under the Waimakariri River is incorrect.

21. I would also like to highlight the final paragraph from the JWS regarding the model peer review process, where the experts, except for the ECan experts, all agreed that the model review process has not been sufficiently documented, and that they do not have a high level confidence in the model results.

22. Given the uncertainty regarding the model and its predictions of cross boundary flow, my opinion is that a risk to the Christchurch Aquifers is not established with any confidence and should not be used to influence the outcome of the consideration of PC7 submissions.

Neil Thomas

11 November 2020