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|---|---|
| **IN THE MATTER OF** | the Resource Management Act 1991 |
| **AND** | |
| **IN THE MATTER OF** | applications by Central Plains Water Trust to:<br><br>Canterbury Regional Council for resource consents to take and use water from the Waimakariri and Rakaia Rivers and for all associated consents required for the construction and operation of the Central Plains Water Enhancement Scheme<br><br>Selwyn District Council for resource consents to construct and operate the Central Plains Water Enhancement Scheme |
| **AND** | |
| **IN THE MATTER OF** | a notice of requirement by Central Plains Water Limited to:<br><br>Selwyn District Council for the designation of land for works associated with the construction and operation of the Central Plains Water Enhancement Scheme |

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**RESPONSE TO SECT. 42A OFFICERS' REPORTS**
**JULIAN JAMES WEIR**

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BUDDLE FINDLAY
Barristers and Solicitors
Christchurch

Solicitor Acting: **Rachel Dunningham**
Counsel: **Dr E D Wylie Q C**
Tel 64-3-379 1747 Fax 64-3-379 5659 PO Box 322 DX WP20307 Christchurch

## INTRODUCTION

1. My full name is Julian James Weir. I have described my qualifications and experience in my main brief of evidence prepared for this hearing.

2. The following is my response to section 42A Officers' Reports produced by David Scott, Howard Williams and Carl Hanson (all of ECan). This response is limited to the sections of the Officers' reports that relate to groundwater modelling, and as such I will respond to the report by David Scott in full, and to the reports by Howard Williams and Carl Hanson in part.

3. The paragraph numbers at the start of the following paragraphs refer to the paragraph numbering in the respective Section 42A Officers' reports.

4. Reference has been made by various ECan staff to the original Assessment of Effects on the Groundwater Environment prepared by Aqualinc for URS, dated June 2006. All components of this report relating to groundwater flow have been superseded by the assessment present in my main brief of evidence.

### Overall Comments on Modelling Work

5. The Canterbury groundwater model is the most advanced method available to predict the complex interactions of the groundwater system it represents. There is currently no better method of predicting the cumulative effects from the Central Plains Water Enhancement Scheme (CPWES). As part of the Rakaia-Selwyn hearing, Dr Hugh Thorpe (who provided evidence on behalf of the Director General of Conservation) alludes to this in paragraph 165 of his evidence stating that '*…such models remain the only feasible way of predicting aquifer responses to future development scenarios.'*

6. The model has been independently reviewed by Dr. Noel Merrick. Much of the content of the model review focussed on improving the reporting of the model, and these recommendations have been completed in the version of the report submitted as evidence. There was little in the way of necessary improvements to the model, except for suggestions to reduce the simulation run time.

7. In addition to the formal review by Dr. Merrick, ECan technical staff were consulted and provided informal review on several occasions throughout the model development. This is discussed in Aqualinc (2007)[1] and in my main evidence.

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[1] Aqualinc (2007): Canterbury Groundwater model 2. Report No L07079/1. July 2007. Aqualinc Research Ltd.

**RESPONSE TO OFFICER'S REPORT BY DAVID SCOTT**

**Summary of Conclusions**

8. Para 10, 1st bullet point: Mr Scott quotes the peer review stating that the model 'was not suitable for practical use'. Mr Scott has omitted the context of this statement. The review states in paragraph 3 of the executive summary that *'there is concern over the practical use of the model in its present form **due entirely to simulation runtime**'* (my emphasis added). The runtimes are not of concern if the modeller is prepared to wait for the extended runtimes.

9. Para 10, 1st bullet point cont.: Mr Scott is correct in stating that the reviewer had not seen the predictions for the CPWES. The CPWES model runs using the most recent version of the model had not commenced at the time of the review. However, the reviewer has concluded that *'the model has been developed competently, and is suitable for guiding regional water resource management decisions.'* In my opinion, predictions of the effects on groundwater flow from the operation of the CPWES is an ideal application of the model, that is to guide regional water management decisions.

10. Para 10, 4th bullet point: I disagree with Mr Scott's conclusions in this bullet point. This is discussed throughout my response.

11. Para 10, 5th bullet point: This is the case for *any* model. I refer to my comments under paragraph 5 above.

**Model Overview**

12. Para 16, 1st bullet point: Much of the model calibration was completed using the version of the model referred to by Mr. Scott as 'Model 2'. However, all information presented in my brief of evidence is from the version of the model referred to by Mr. Scott as 'Model 2a'. This includes the 'history matching' scenario.

**Model Conceptualisation**

13. Para 18: Changes in the spatial pattern of aquifer properties in aquifers 4 and 5 were made to improve the model's match to the field data available from these aquifers.

14. Para 19 and 20: As discussed in section 4.3.3 of Aqualinc (2007), the hydrogeological layering represents the 'big-picture' aquifer and aquitards. These were incorporated into the model to represent the broad scale anisotropy that is observed in bore logs, aquifer tests and vertical hydraulic gradients. As discussed in section 4.3.4 of Aqualinc (2007), the hydrogeological structure of the model is

consistent with the findings of Davey (2006)[2] in a regional sense. In addition, the Commissioners of the Rakaia-Selwyn hearing could not find evidence to support the alternative 'bathtub' theory proposed by ECan (this is discussed in paragraphs 279-323 of the Rakaia-Selwyn final decision).

15. Para 20 cont.: The Canterbury groundwater model incorporates vertical anisotropy to the scale of 1:100 in aquifers and 1:10 in aquitards. In addition, the vertical conductivity of the aquitards are in the order of 1:150,000–1:200,000 of the horizontal conductivity of the aquifers. These ratios were all calibration parameters. The layered sequence was not so much a *'**convenient** mathematical device to represent the effects of vertical anisotropy on a regional scale'* (my emphasis added) as it was a **necessary** parameter set to achieve suitable calibration with measured groundwater levels in wells at variable depths.

16. Para 20 cont.: I am pleased that Mr. Scott has observed by the particle tracking that vertical groundwater flow can be expected through the aquifer and aquitard layers. I have never attested that the aquitard layers in the model are impermeable. To the contrary, it is stated in section 3.4.2, paragraph 2 of Aqualinc (2007) that the aquitards are not impermeable. Within the model, water can only enter the deeper aquifers via vertical seepage from overlying layers.

17. Para 20 cont:. A key difference between the Canterbury groundwater model and the analytical model Mr. Scott refers to is complexity. The Canterbury groundwater model is a complex and specific representation of a very complex aquifer system. It takes into account all of the key components of the groundwater balance, and how these components interact with each other. The analytical model is a simplified and isolated representation of a hypothetical system. The resulting predicted effects on the environment are likely to be different between the two models, depending on the scale of the activity being modelled.

18. Para 21: Mr. Scott is quoting item 3.8 of Table 3. In item 3.3 of the same table, Dr. Merrick states that the conceptual model *is* consistent with project objectives and the required model complexity. The term '*unnecessarily complex*' referred to by Dr. Merrick in item 3.8 relates to the small time steps used in the model, which results in the long model run times. In Section 7 of the review, Dr Merrick suggest ways to reduced the run time. However, he also states that '*in the process, it can be expected that there will be some deterioration in performance*'. At this stage, I am not willing to reduce the performance of the model by reducing run times.

[2] Davey, G (2006): Definition of the Canterbury Plains aquifers. Environment Canterbury Technical Report U06/10.

### Calibration to Observed Groundwater Levels

19. Para 25, 1st and 2nd bullet point: In my opinion, the lack of response during extended wet periods is unlikely to be due to storativity parameters. If storage parameters were the cause, then for groundwater levels to respond higher, storage parameters would need to be smaller. However, the values are already at the lower range of reasonable values.

20. Para 25, 1st and 2nd bullet point cont.: A likely reason for the lack of groundwater level response during extended wet periods is attributed to unaccounted for recharge into deeper aquifers from the alpine foothills. This additional source of aquifer inflow has not been accounted for in the model, and has been highlighted in Aqualinc (2007) as an area for future research. A similar departure of simulated from measured groundwater levels was experienced by Bidwell *et al.* (1991)[3] in attempting to model the dynamic behaviour of Central Canterbury Plains groundwater using linear transfer function models. Bidwell *et al.* also attributed this departure to unaccounted for alpine rainfall recharge.

21. Para 25, 1st and 2nd bullet point cont.: If unaccounted for alpine foothills recharge to deep aquifers was the cause of the lack of response, then deeper groundwater levels would respond more in reality than what the model predicts, and shallow groundwater levels would remain relatively unchanged (except perhaps for shallow groundwater levels near the inland alpine boundary which may rise a little higher). This would have no effect on the shallow groundwater mound (or depth to shallow groundwater) predicted during dry and average periods, and only a small effect on the shallow groundwater mound (or depth to shallow groundwater) predicted during wet periods near the inland boundary.

22. Para 25, 1st and 2nd bullet point cont.: Another possible reason for the lack of response during wet periods is due to under representation of the rate of vertical water movement from shallow to deep aquifers during these extended wet periods. In other words, land surface and river recharge is not able to pass to deeper layers in the model as freely as it does in reality. If this was the cause, then the model presents a conservative assessment of groundwater mounding. I will explain this in the following paragraph.

23. Para 25, 1st and 2nd bullet point cont.: If water cannot percolate to deeper layers as freely as it does in reality, then the model will over-predict the magnitude of any groundwater mounding in the shallow aquifer, and under-predict the magnitude of

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[3] Bidwell, VJ; Callander, PF; Moore, CR (1991): An Application of Time Series Analysis to Groundwater Investigation and Management in Central Canterbury, New Zealand. Journal of Hydrology New Zealand. Vol. 30, No. 1, pp16-36.

any mounding in deeper layers. If this is the case, the model predictions are conservative because the potential adverse effects from shallow groundwater mounding (reduced depth to shallow groundwater levels) will be less than predicted, and the potential positive effects from deep groundwater mounding (improving supply reliability) will be greater than predicted.

24. Para 25, 1st and 2nd bullet point cont.: In most areas of the model, modelled groundwater levels in aquifer 1 suitably match measured. If anything, the modelled inter-annual response is a little greater than measured, which means the effects on shallow groundwater of additional recharge from the CWPES will be exaggerated.

25. Para 25, 3rd bullet point: The model's ability to match the response to longer timescales has not been degraded; the modelled time series has simply been moved upwards. This was not due to modifications to improve the simulation of Selwyn River flows but due to changes in the spatial pattern of properties in aquifers 4 and 5. These properties were adjusted (as mentioned in paragraph 57 of my main evidence) to improve the model's match to the data available from these aquifers.

26. Para 26: The model's purpose is to predict the regional scale response of the groundwater system from various development scenarios, including the CPWES, various groups of applicants seeking groundwater abstractions, and other proposed community irrigation schemes. Dr. Merrick was aware of the conceptual uses of the model and concluded that the model *'is suitable for guiding regional water resource management decisions'* (paragraph 3 of his executive summary).

**Calibration to Observed Stream Flow**

27. Para 27: Mr. Scott is quoting paragraph 3 on page 18 of the review and has taken this quote out of context. The full quote is reproduced next with the part missing from Mr. Scott's report highlighted in bold: *'**It is unusual to get accurate replication of river flows in a groundwater model, as flows have more than a baseflow component and the river algorithm is usually simplified.** Some flow duration curves and cumulative flow curves show divergences. However, one could not expect matches to be any better than this.'*

28. Para 29: I was not aware of this data at the time of model calibration and consequently calibration focussed on the recorder data from 1984 onwards. However, I make the following comments:

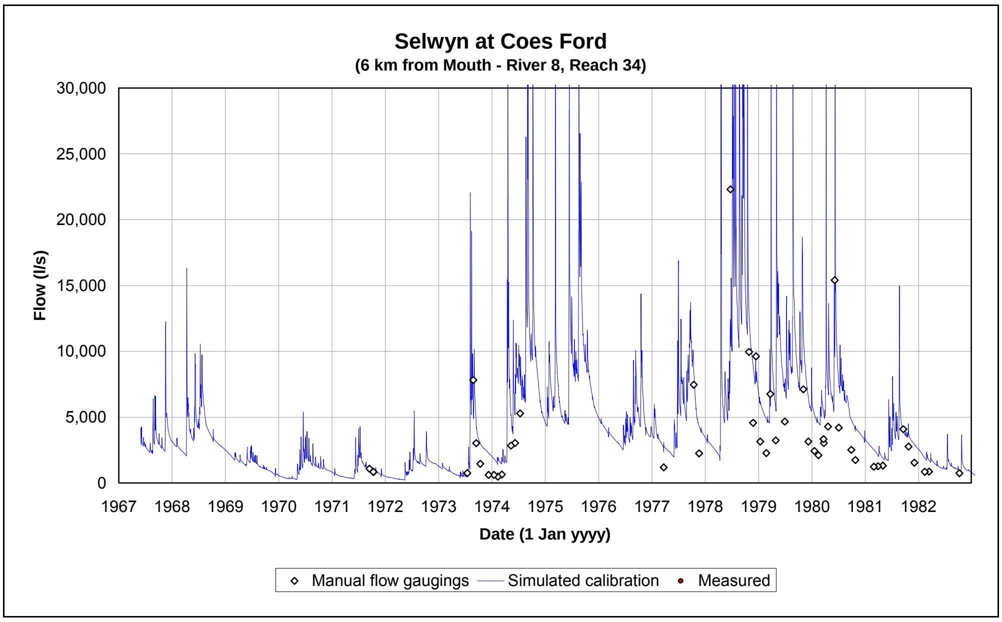
- The very low flows of the early 1970's and early 1980's match well.

- The higher low flows in the late 1970's don't match as well as the very low flows, but there is still a reasonable comparison between measured and modelled. Trends are certainly matched well.

- The Selwyn River bed at the Coes Ford recorder and gauging site is highly variable, moving and shifting over time. The groundwater model does not account for this variability.

- There is little information relating to the accuracy of these earlier gaugings. Many factors would influence the measurements, including surface water takes upstream of the gauging site.

- The model matches well to the few higher flow gaugings during the late 1970's. This is seen in the following plot which focuses on the period 1967-1983 with an enlarged vertical axis.




29. Para 30: Following my return from holiday, an offer was made to Mr. Scott on 30 January 2008 to view the stream package inputs.

30. Para 30 cont.: To explain the lack of wet-period response in deep groundwater and the higher flows in the Selwyn River, Mr. Scott has hypothesised that '*groundwater drains too easily from storage when groundwater levels in some areas of the model are above some threshold*'. Alternative hypotheses are discussed in paragraphs 19-23 above.

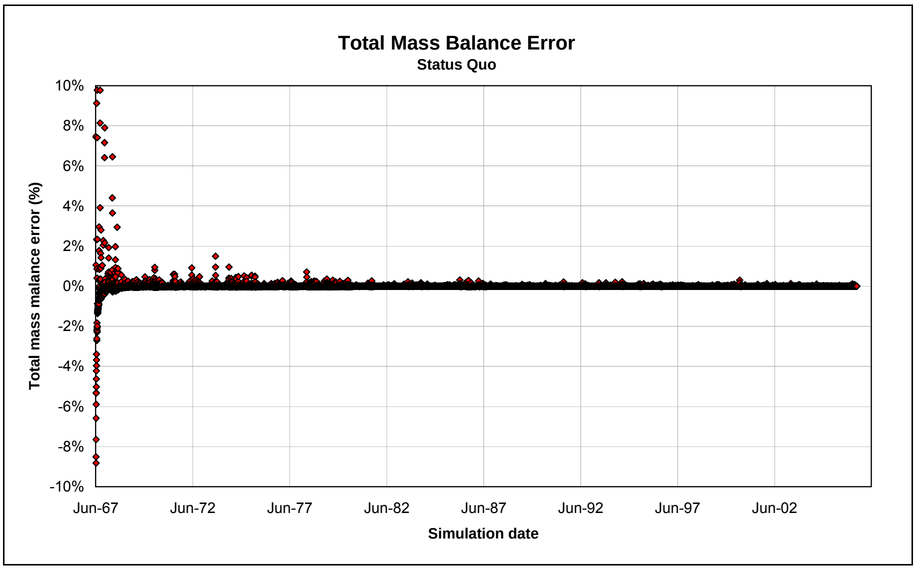
31. Para 30 cont.: As a summarising remark, I bring back into context the regional perspective of the groundwater system. Inland deeper wells have much larger seasonal variations than shallow wells and wells closer to the coast. In wells closer

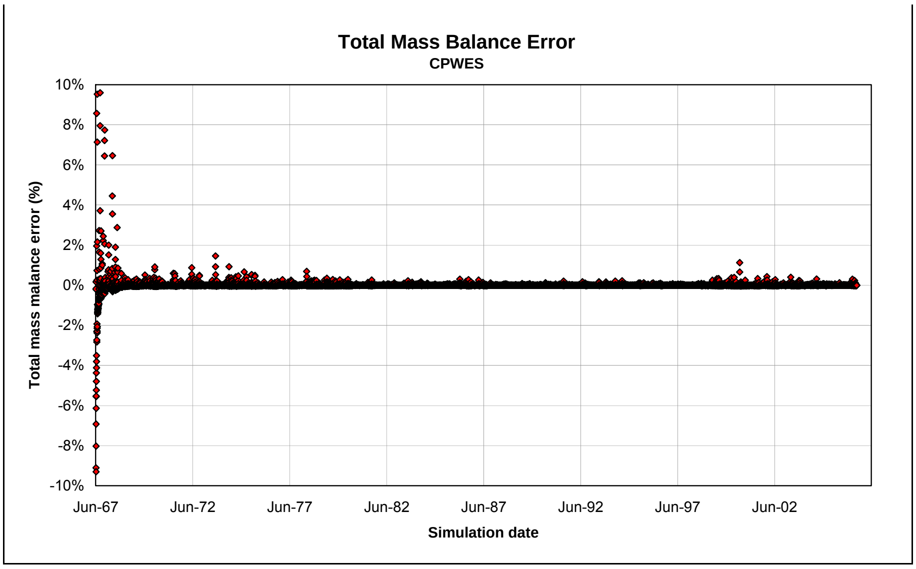
to the coast, the measured high groundwater levels of the late 1970's are much less prominent (or in some wells non-existent) compared to in deeper inland wells. In a regional context, the groundwater model suitably replicates the groundwater level response in these coastal wells over the full periods of measured data. It is the lower half of the plains and areas adjacent to the Selwyn River that may experience adverse effects of groundwater mounding, and the potential risks can be mitigated with appropriate engineering, as discussed in the evidence by Mr. Walter Lewthwaite. Given the model's ability to replicate groundwater levels in these areas, it is my opinion that it is entirely suitable to be used to predict the overall effects of the CPWES.

**Model Mass Balance**

32. Paras 32-34: Mr. Scott has considered the mass balances out of context. In paragraphs 91 and 186 of my main evidence, I state that the mass balance totals are indicative only and have been provided to show how the overall water balance changes with the inclusion of the CPWES. In paragraph 89 of my main evidence, I discuss how after the first 1-2 years of the simulation, total mass balance errors for the transient calibrated model are much less than 2%, with most time periods reporting mass balance errors of 1% or less. However, I did not present the equivalent information for the two development scenarios run to consider the effects of the CPWES. This is provided in the following paragraph.

33. Paras 32-34 cont.: Total mass balance error versus simulation run time for the two development scenarios are provided below. In both cases, after the first 1-2 years of the simulation, mass balance errors are much less than 2%, with most time periods reporting mass balance errors of 1% or less, much like the calibrated model.






34. Paras 32-34 cont.: Given the above, the mass balance discrepancies are within the limits suggested by MfE (2002)[4] as being acceptable.

**Model Water Budget**

35. Para 35: A brief investigation into the overall water balance of Lake Ellesmere and its tributaries was undertaken by me as part of the Rakaia-Selwyn resource consent hearing. This is reproduced in the following paragraph with some modifications and additional text.

36. Para 35 cont.: It is very difficult to measure the amount of water entering Lake Ellesmere via groundwater seepage through the bed of the lake. Ettema & Moore (1995)[5] conducted seepage metering in the bed of Lake Ellesmere during a period of low groundwater levels (and therefore low seepage rates). Results from this work were varied with seepage ranging from 0-0.0904 ℓ/min/m$^2$. The average for the Lake was reported from reliable measurements as about 0.014 ℓ/min/m$^2$. The effective seepage area of the lake was assumed by Ettema & Moore to be within 100 m of the shoreline, although there is no evidence that seepage is restricted to this area. Conversely, Ettema & Moore reported that a significant contribution of seepage may be occurring from other areas of the lake due to the influence of the upward hydraulic gradient. If it is assumed that seepage occurs over (an arbitrary) one-quarter of the 18,900 ha area of the lake (i.e. over 4,725 ha), then the seepage into Lake Ellesmere would be on average 11 m$^3$/s. Ettema & Moore reported that their seepage measurements make no allowance for springs discharging into the lake. This will mean more seepage is occurring than estimated by the previous calculations. The

[4] MfE (2002): *Groundwater model audit guidelines.* Prepared for the Ministry for the Environment by Pattle Delamore Partners Ltd under funding from the Sustainable Management Fund. October 2002.

[5] Ettema, M and Moore, CR (1995): Seepage in Lake Ellesmere. Report No U95/18. Environment Canterbury.

calculations are very approximate and are intended only to give an indication of the scale and range of seepage that may be entering Lake Ellesmere.

37. Para 35 cont.: As stated in paragraph 4 above, all earlier groundwater flow modelling work has been superseded by the most recent version of the model.

**Model Peer Review**

38. Para 37: Mr. Scott is quoting from paragraph 3 of section 7 of the review, and has again taken the quote out of context. As I have already stated in paragraph 8 above, the reservation expressed by the reviewer relates '*entirely to simulation runtime'*.

39. Para 39: In order to maintain Dr. Merrick's independence, Aqualinc specifically chose not to provide him with earlier model documentations and hearing evidence, as this may have lead to a preconditioned opinion of the model and its ability to represent the groundwater system. This is reflected in Dr. Merrick's comments in paragraph 6 of his introduction: '*…this reviewer is deliberately ignorant of modelling that has gone on before. In this way, an unbiased assessment of the current model in its own right can be offered.*'

40. Para 41: Given that Dr. Merrick had no knowledge of prior modelling work, he is in the best position to provide an unqualified conclusion that the model '*…is a faithful simulator of the behaviour of the aquifer system…*' (Executive Summary, paragraph 5).

41. Para 42: Earlier simulations to predict the response of the aquifer system from the CPWES were completed using the version of the model referred to by Mr. Scott as 'Model 1'. The scenarios for CPWES using 'Model 2a' had not commenced at the time of the review. My comments under paragraph 9 above are applicable here too.

42. Para 42, cont., Appendix A: Mr. Scott has made a reasonable assessment of section 7 of the review, except for the following:

- Item 7.5 – climate variability is briefly discussed in paragraph 46 below.
- Item 7.6 – In terms of effects on groundwater levels, any variations in land use, irrigation techniques, surplus water management and higher water use all affect the amount and rate of land surface recharge under the scheme. Scenarios of differing land surface recharge are presented in my main evidence.
- Item 7.8 – the consequence of the lack of response during periods of very high groundwater levels is discussed in paragraphs 20 through to 24 above.

Flow directions are approximate, not speculative (this is briefly discussed in paragraph 52 below).

**Prediction of Groundwater Mounding**

43. Para 47: Information on depth to groundwater of 5 m or less has been presented for the further purpose of considering effects on microbiological transport. Information on depth to groundwater of 1 m or less has been provided for the further purpose of considering land surface drainage.

44. Para 48, 1st bullet point: The lack of response of very high groundwater levels is limited to deeper wells located inland. Shallow wells and wells located towards the coast do not show this departure. As discussed in paragraphs 22 and 23 above, this is likely to be conservative when considering the effects from the CPWES.

45. Para 48, 2nd bullet point: A date of 1 March 1970 was chosen to represent the maximum groundwater mound based on modelled groundwater levels. The groundwater mound (calculated as the difference between the status quo and CPWES scenarios) was at (or close to) a maximum at approximately this date compared to any other period from the 40-year simulation. This date therefore represents the approximate maximum predicted groundwater mound, irrespective of antecedent groundwater levels. The groundwater mound was predicted to be at a maximum during March 1970 because simulated irrigation demand was very high throughout this season.

46. Para 48, 3rd bullet point: The use of historical climate patterns is the best method currently available to consider a worst-case scenario due to successive climatic events. If climate change predictions are correct and Canterbury experiences increased drought occurrences, then groundwater levels will naturally fall, and the effects of successive high irrigation use seasons from the scheme will be superimposed on top of these naturally lower levels. This is unlikely to result in groundwater levels higher than the wet period considered.

47. Para 49: Mr. Scott is correct in implying that if the scheme is developed progressively over several years, then the full effects of the scheme will take longer to be fully realised. I am unsure as to his comment regarding the '*issues around the model calibration*' and why he then considers the simulated times are underestimated.

48. Para 49 cont.: The study by Bidwell *et al*. (1991) indicates that the aquifer response time to reach about 90% of a new steady state condition after a hypothetical step change in steady state recharge input is approximately 6 years. A steady state

situation assumes that the step change in recharge occurs forever and therefore it takes longer to reach a new equilibrium than under transient conditions (where the changes are intermittent over time). Given this, the time taken to reach a new equilibrium by Bidwell *et al*. (approximately 6 years) is consistent with the time of hydraulic response predicted after the full onset of the CPWES (2-4 years). The timing of the transient response is discussed in paragraphs 190-197 of my main evidence.

49. Para 50: Mr. Scott comments that it will be difficult in the future to clearly distinguish CPWES induced effects from climate driven ones. I agree. This demonstrates the overriding influence of climate on the groundwater system.

**Prediction of Changes to Lowland Stream Flows**

50. Para 51, bracketed comment, and para 52: The simulated 7-day MALF for the Doyleston Drain, Hanmer Drain and Irwell River are zero, and remain zero under the CPWES scenario. The average and 50%ile flow values increase, which is understandable given there is more water passing through the aquifer system under the CPWES scenario than under the status quo scenario. The magnitude of the flow changes are not large, but if expressed as a percentage of the status quo flow (as done by Mr. Scott), then the changes are large. Difficulties in accurately representing stream flows is acknowledged. However, relative magnitude of flow changes can be relied upon, even if absolute precise values cannot. Again, this is the case with any model.

**Prediction of Effects on Surface Water/Groundwater Interaction**

51. Para 54: Information on the four items on Mr. Scott's list have been provided as follows:

- Sensitivity of model predictions to aquifer 1 hydraulic conductivity and stream bed conductivity are presented in paragraphs 198-211 of my main evidence.
- Varying irrigation efficiency results in varying land surface drainage. The sensitivity of the model to varying land surface drainage is discussed in paragraphs 198-211 of my evidence.
- An assessment of the groundwater response over the period between when the scheme commences through to full operation requires a prediction on the rate of uptake to the scheme, one that I am not qualified to make. However, I can comment that if the rate of uptake is progressive (rather than instantaneous at the onset of the scheme), then the transient response of the aquifer system will change progressively between the status quo scenario and the CPWES scenario over a period of time proportional to the uptake.
- I have not provided quantitative evidence on the effects on the groundwater system to the north of the Waimakariri River, as the model does not extend very far in this direction. However, the reduction of Waimakariri River flows may cause a very small lowering of shallow groundwater levels near the north bank of the river, and the magnitude and extent of this lowering will be similar to that predicted on the south of the Rakaia River. However, due to the presence of the Waimakariri-Ashley irrigation scheme and other privately operated schemes (such as the Spencer-Bower scheme), groundwater levels are highly modified and the scale of groundwater level variations are magnified significantly more than what might be caused by the diversion to the CPWES scheme. Groundwater levels on the north side of the Waimakariri River are expected to be even more variable with the future development of Ngai Tahu's Eyrewell forest scheme. I expect that the effects from the CPWES on the north side of the Waimakariri River (and also on the south side of the Rakaia River) will be very small.

52. Para 59: As previously discussed, the modelled hydraulic conductivities in aquifers 4 and 5 were adjusted to improve the match with the limited data that is available in these aquifers. There is uncertainty associated with these deeper layers due to the limited amounts of data. However, the flow paths generated are the best possible

prediction given the data that is available. They are therefore approximate, not speculative.

## RESPONSE TO OFFICER'S REPORT BY HOWARD WILLIAMS

### Key Conclusions Regarding the Applicant's Evidence

53. Para 9: Neither I, nor other Aqualinc staff, have received any requests for additional model data from Dr. Williams.

### Review of the Hydrogeology of the Central Plains Area

54. Paras 17-19: Differences in interpretation of hydrogeology are discussed in paragraphs 14 to 16 above. The groundwater model represents the '*general sheet-like characteristics'* at a regional scale as discussed by Prof. Schulmeister.

55. Para 21: The groundwater model incorporates vertical anisotropy to the ratios described in paragraph 15 above.

56. Paras 30-38: A date of 1 October 1978 was selected to represent a wet year because this period had higher measured and modelled groundwater levels than any other period from the 40-year simulation. The date was considered representative of a worst case high-groundwater level scenario, not necessarily the wet period predicted to have the largest groundwater mound.

57. Paras 30-38: cont.: Dr. Williams has presented well L36/0142 as an example to demonstrate that the difference in groundwater levels between the status quo and the CPWES scenario (i.e. the groundwater mound) is greater in the 2006/07 year than at 1 March 1970. For this particular well, he is correct, and there are a few other wells where this is the case. However, for many calibration wells, the predicted groundwater mound during March 1970 is either similar to, or greater than, the mounding predicted during the 2006/07 season. In a regional context, March 1970 represents the period of approximate maximum overall groundwater mounding, and is not much larger (in overall magnitude) to the mounding predicted during the 2006/07 season.

58. Paras 30-38: cont.: It is not appropriate to add the maximum groundwater mound on top of the highest groundwater levels because the aquifer system is highly non-linear. This non-linearity is due partly to the pressure relief mechanisms of the rivers, streams and drains. It is also partly due to the increased rate of groundwater level lowering that occurs following wet periods due to the increased flow of water through the groundwater system driven by high groundwater levels. In addition, groundwater

levels and land surface recharge must be coupled in time; extended periods of high irrigation demand (due to low rainfall) don't occur simultaneously with extended periods of naturally high groundwater levels (due to high land surface recharge).

### Other Effects Associated With Groundwater Mounding

59. Para 43: I refer to my comments in paragraphs 46, 56 and 57 above in response to Dr. William's comments on the cumulative effects of a succession of dry or wet years.

60. Paras 47-49: Dr. William's suggestion to superimpose the dry-period groundwater mound on wet-period groundwater levels results in a temporal decoupling of the aquifer system. I refer further to my comments in paragraph 57 above.

61. Para 68: I refer to paragraph 36 above for my comments on the prediction of seepage into Lake Ellesmere.

## RESPONSE TO OFFICER'S REPORT BY CARL HANSON

### Description of the Central Plains Groundwater System

62. Para 22: Differences in interpretation of hydrogeology are discussed in paragraphs 14 to 16 above.