IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications by Central Plains Water Trust to: 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 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: 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 S42A OFFICERS' REPORT OF MARK CHARLES GRACE MABIN

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1. My name is Mark Charles Grace Mabin and my qualifications and experience, and the basis on which I am preparing this brief are set out in my previous brief of evidence prepared for this hearing. I have prepared this supplementary brief of evidence to address issues raised in the s42A reports of Mr Leo Fietje for the Canterbury Regional Council, and Mr Nick Boyes for the Selwyn District Council.

Scope of Evidence

2. In my evidence I will address matters raised in the s42A reports related to the effects of the proposed Central Plains Water Enhancement Scheme (CPWES) on:

- The mouth of the Rakaia River ;
- Bed load sediment transport in the Waimakariri and Rakaia Rivers;
- Suspended sediment transport processes in the Waimakariri River and Rakaia River;
- Water clarity in the Waimakariri River and Rakaia Rivers;
- Geopreservation sites in the CPWES area.

3. Mr Fietje at paragraphs 195 – 198 summarises a report prepared by Mr Duncan that forms part of the Canterbury Regional Council s42A report. Mr Duncan's report in part reviewed two responses I provided to s92 requests for further information issued by the Canterbury Regional Council. The s92 requests were dated 16th October 2006 and 2nd November 2007. My responses were dated 22nd March 2007 and 3rd December 2007.

4. Mr Fietje notes that Mr Duncan is in general agreement with my overall assessments in relation to fluvial processes and river morphology, albeit for different reasons. We are therefore in general agreement that:

   4.1 There will be little change in the overall capacity of the Rakaia and Waimakariri Rivers to transport sand and gravel;

   4.2 There should be no significant effect on braided channel patterns; and

   4.3 There will be little change in the morphology of the mouths of the rivers.

5. In paragraphs 66 to 82 of his report Mr Duncan identifies a number of issues relevant to my assessment that I will address below. A general concern identified by Mr Duncan was the lack of information. He was reviewing the

s92 responses I had provided, and these were narrowly focussed on the issues raised in the s92 requests. I have provided a broader assessment of the issues in my brief of evidence prepared for this hearing.

Rakaia River mouth

6. At paragraph 69 of his report Mr Duncan discusses the Rakaia River mouth and the various processes that occur here during periods of low flows, floods and high tides. In particular he notes in this paragraph that:

> *…with prolonged low flows, there is some thought that the bar opposite the river thickens, at least sometimes, making it harder for the river to cut a re-centred opening. In turn, this can lead to more extensive flooding and perhaps no new break-out opposite the river at all. …it would seem to be the most likely side effect of CPW at the Rakaia mouth.*

7. Mr Duncan does not refer to these potential effects as though they were his own observation of the Rakaia River mouth. His use of the words "there is some thought", "at least sometimes", and "perhaps" suggests some diffidence as to the significance of the proposed effect. In addition, these statements do not identify how the CPWES could be the cause of the potential effects. I presume Mr Duncan's point is that CPWES would prolong the periods of low flow, during which time the bar opposite the river thickens, leading to flooding around the lagoon margins and potentially no breakout of the river at all.

8. No observational data is presented to support the contention that the bar actually does thicken during periods of low flow. There could be an appearance of bar thickening, but this could also arise from lowered water levels in the lagoon due to the reduced flow in the river.

9. However, I consider it unlikely that actual bar thickening will occur during periods of reduced flow and I base this on my understanding of the coastal geomorphology of the Rakaia River mouth.

10. Professor Kirk has studied the Rakaia River mouth in some detail[1]. Combining his observations I interpret the typical sequence of bar development stages to be as follows:

    10.1 A flood in the Rakaia River results in a breach of the bar opposite the main river channel.

[1] Kirk, R. M. 1991 River-beach interaction on mixed sand and gravel coasts: a geomorphic model for water resource planning *Applied Geography* 11: 267 – 287.

10.2 After the flood a spit rapidly forms across the mouth and migrates northeast along the coast. This spit forms the bar that blocks the river from direct access to the sea.

10.3 Continued spit growth results in the displacement of the river mouth further to the northeast.

10.4 As the spit continues to grow the parts where the original flood mouth had been are starved of sediment supply and the spit thins.

This model requires that instead of the bar thickening during periods of low flow in the river, it will get thinner as the period of time from the last bar-breaching flood increases.

11. Mr Duncan's proposed effect of bar thickening during periods of low flow is not consistent with the above model. For thickening to occur there must be a source of beach sediment from the southwest. This can only come from longshore drift of sediment along the beach. Professor Kirk shows that the southern part of the lagoon shoreline has been eroding at 0.67 m/yr. Thus, while longshore drift does occur here, it is not enough to cause the shoreline to build up.

12. At low flows the river carries almost no bed load sediment. Thus any potential thickening of the bar can only occur due to wave action on the ocean side and thus is unrelated to flow in the river. In paragraph 10 above I quoted Professor Kirk's finding that the long term trend of coastal change here is one of shoreline erosion. While a flood event will deliver sediment to the coastal zone, this is only an episodic influx of material sediment. Coastal processes will rapidly redistribute this sediment and shoreline erosion will again set in. Therefore, bar thickening is not a likely process, and even if it were to occur, flow reduction resulting from CPWES cannot be the direct cause.

13. The other aspect of this process is of course the bar breaching that results from flood discharges in the Rakaia River. Professor Kirk states that (p 281):

It is thought that most flows larger than the mean discharge … have the capability to initiate breaches, particularly after prolonged periods of spit extension (low river flow).

I interpret this statement to mean that prolonged periods of reduced flow result in a thin bar opposite the main river channel, and only a moderate flood magnitude of around the mean flow is then required to initiate a breach.

14. Professor Kirk's work clearly shows that reduced flows will not result in less bar breaching and attendant flooding problems, and I concur with these findings. I therefore conclude that Mr Duncan's suggestion that with prolonged low flows there will be more extensive flooding and perhaps no new break-out opposite the river is not supported by analysis of coastal geomorphology at the Rakaia River mouth.

Bed load sediment transport in gravel bed rivers

15. In paragraph 71 of his report, Mr Duncan disagrees with my interpretation that the Rakaia and Waimakariri Rivers shows characteristics consistent with them being undersupplied with bedload. In part he bases this on the implication that I have applied the results of a study of the Waiau River in Southland by Dr Hicks to the Waimakariri and Rakaia Rivers. He correctly points out that these rivers are not appropriately comparable. However, I have not attempted to compare the Waiau River with the Waimakariri or Rakaia Rivers. Therefore this part of Mr Duncan's critique is not relevant to my assessment. As discussed in paragraphs 29 to 32, and 34 to 36 of my evidence in chief I consider that the coarse bed layer of sediment and the fact that in most parts of these rivers there is no evidence for bed aggradation are consistent with them being generally under supplied with bed load sediment.

16. Mr Duncan correctly observes (paragraph 71) that there are sections of the lower Waimakariri River where the bed is clearly aggrading. He also suggests that a reach-by-reach analysis would be appropriate here. I have taken account of these issues in my evidence in chief at paragraphs 92 to 101, and 124 to 129. I conclude (paragraph130) that the effects of the CPWES on sediment transport and landforming processes will be less than minor.

17. In paragraph 72 of his report Mr Duncan requests information on bedload transport by flow bands before and after the scheme, and in relation to freshes and floods and intake gate closure during floods. This information is provided in my evidence in chief in paragraphs 25, 71 to 91, and 110 to 122.

18. In paragraph 73 of his report Mr Duncan notes that I have mis-applied the FRE3 parameter in my s92 response, and I concur with the general thrust of this remark as it applies to the transport of gravel sized particles. In my evidence in chief I do not rely on this interpretation. Rather, it is my view that the FRE3 flow is a useful guide to the flow at which it is likely that sand transport has been initiated. Mr Duncan further infers that in assessing the

difference between pre- and post-CPWES flow regimes, I did not take account of the fact that the entrainment threshold would stay the same. This is incorrect. As stated in my evidence in chief, I have taken the natural flow regimes and their sediment transporting processes and compared them to the post-CPWES flow regime. This ensures my assessment is conservative as the rivers have already been modified by water takes and are no longer in their natural condition.

Suspended load sediment transport in rivers

19. In paragraph 75 of his report Mr Duncan addresses suspended sediment concentrations, inferring that it was my assessment they would decrease downstream of the takes. This is incorrect. My comment on this matter was that any change in suspended sediment concentration would be undetectable.

20. I am therefore in agreement with Mr Duncan's assessment that the water takes will not alter the concentration of suspended sediment downstream. I discuss these issues in more detail in paragraphs 17 to 27 of my evidence in chief.

21. Suspended sediment concentration is also relevant to the issue of water clarity, fishability, and other ecological effects. Dr Meredith addresses this matter at paragraph 62 in his s42A report that forms part of Mr Fietje's report. Dr Meredith refers to a report by Kingett Mitchell[2] and the material in this report is presented in the evidence in chief of Mr Kennedy.

22. One factor that contributes to fishability is water clarity, and it is my understanding that for salmon fishing it is preferable that the water not be too clear. Thus if the CPWES resulted in a decrease in water clarity it could have an adverse effect on fishability. Water clarity is measured by black disc clarity and is strongly affected by the amount of suspended sediment being carried by the river. Suspended sediment is measured by the weight of suspended sediment per cubic metre of water (g/m^3). In general the higher the suspended sediment concentration the lower the water clarity.

23. Dr Meredith's view is that (paragraph 62):

…the Waimakariri River is likely to increasingly clear at low flows, as sediments will increasingly settle out at lower flows down the length of the river.

He provides no data to support this view, and it is one not shared by scientists who have expertise in the transport of suspended sediment in rivers.

24. For example, Hicks and Davies, 1997[3] state that (p 132):

…the washload (i.e. the fine fractions of the suspended load) tends to be limited by the supply from the catchment rather than the capacity of the stream to transport it.

Mr Duncan in his s42A report to this hearing (paragraph 75) states:

It is unlikely that suspended sediment concentrations will reduce downstream of the extraction points. The suspended sediment load is largely washload (silt and clay) and is supply limited, so diverting part of the flow into a canal will not alter the concentration in the water left in the river.

25. Dr Meredith's view that reduced discharge will result in increased sedimentation of the river washload reflects a misunderstanding of the processes involved. While relationships can be calculated between suspended sediment concentration and river discharge (see paragraph 20 of my evidence), and these show that suspended sediment concentrations decline with discharge, this does not mean there is a direct causative relationship between these two parameters. Rather, as discharge declines there is less input of suspended sediment from the upper catchment. Reduced suspended sediment concentrations are caused by reduced supply from upstream, not settling out of the washload in the reduced discharge.

26. Therefore, Dr Meredith's concerns relating to effects of the CPWES water takes on fishability, and other ecological effects that may arise as a result of possible increased sedimentation (paragraphs 62 to 66 of his evidence) are unfounded, at least in as much as they relate to the possibility that increased sedimentation could occur.

Geopreservation sites

27. Mr Davis in paragraphs 3.27 and 4.20 of his s42A report that is part of Mr Boyes's s42A report for the Selwyn District Council notes that there has been no assessment of the potential effects of the CPWES on geopreservation sites.

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[2] Kingett Mitchell 2006 *Central Plains Water Enhancement Scheme: effects of water abstraction on the Waimakariri River.* Report prepared for URS New Zealand Limited, December 2006.

[3] *Erosion and sedimentation in extreme events* pp115-141 *in* Mosley, P. & C.P. Pearson (eds) *Floods and droughts: the New Zealand experience* New Zealand Hydrological Society.

28. I have examined three relevant inventories of sites of geological or geomorphologic interest in the CPWES area[4]. They are:

28.1 Curiosity Shop lime quarry at map reference K36: 084-381. This is near the proposed CPWES intake on the Rakaia River.

28.2 Racecourse Hill outwash terrace at map reference L35: 344-506. This is adjacent to the western side of State Highway 73 about 6 km north of Darfield. Water race SH 2 will run adjacent to this feature.

28.3 Sheffield Hill outwash terrace at map reference L35: 307-576. This is adjacent to the northeast side of Wrights Road on the outskirts of Sheffield. Water race SP 2.1 will run adjacent to this feature.

28.4 Rakaia River braids at map reference L36: 325-177. These cover the whole bed of the Rakaia River and extend 3.5 upstream and 2 km downstream of State Highway 1 road bridge. Bywash discharge point from water race SP2.6 will be on the eastern edge of this site.

29. The Curiosity Shop lime quarry is at the base of a high terrace on the north bank of the Rakaia River. The nearest CPWES structures will be the flow control gates and fish screen that are part of the intake works (see Figure C-203 in Appendix B to the evidence of Mr Lewthwaite). These will be about 150 m away on the river flats and below the level of the quarry. I consider that the scheme will have no effect on the Curiosity Shop geopreservation site.

30. The Racecourse Hill outwash terrace covers about 25 ha and rises some 30 m above the surrounding plains. The closest CPWES structure will be water race SH2 that will be approximately 290 m to the east across on the other side of State Highway 73 and the Midland Railway Line. I consider that the scheme will have no effect on the Racecourse Hill outwash terrace geopreservation site.

31. The Sheffield Hill outwash terrace covers about 13 ha and rises some 2 – 5 m above the surrounding plains. The closest CPWES structure will be water race SP 2.1 that will be approximately 450 m to the west. I consider that the

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[4] *Sites of geomorphological and geological significance in Malvern County, Canterbury*. Compiled by Ian Whitehouse. DSIR Division of Land and Soil Sciences Technical Record CH 7.
Inventory of important geological sites and landforms in the Canterbury region including the Chatham Islands Edited by J.A. Kenny and B.W. Hayward. 1993. Geological Society of New Zealand Miscellaneous Publication 75
Inventory and maps of important geological sites and landforms in the Canterbury Region, including the Chatham Islands Edited by J.A. Kenny and B.W. Hayward. 1998. Geological Society of New Zealand Miscellaneous Publication 98

scheme will have no effect on the Sheffield Hill outwash terrace geopreservation site.

32. The Rakaia River braids are in the bed of the Rakaia River upstream and downstream of the State Highway 1 road bridge, and the site covers over 7 km^2. The bywash discharge from water race TP2.6 will discharge into this site on the north side of the railway bridge. A 0.5 ha wetland will be constructed here. This represents less than 0.7 % of the area of the geopreservation site and is an already disturbed area adjacent to the railway line. Emergency bywashes of up to 16.5 m^3/sec could also occur here. The flow in the Rakaia River when the braids are being formed is over 1,500 m^3/sec, and this is 90 times greater than the emergency bywash discharge. I therefore consider that as the footprint of the wetland and discharge volume of the bywash are both very small in relation to the natural environment here the CPWES will have a less than minor effect on the Rakaia River braids geopreservation site.

M.C.G. Mabin
21st February 2008