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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SECOND BRIEF OF EVIDENCE OF WALTER LEWTHWAITE
31/01/08

BUDDLEFINDLAY
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

1. My full name is Walter James Lewthwaite. My qualifications and experience are set out at paragraph 1 of my first brief of evidence dealing with engineering and construction aspects of the scheme.

2. I confirm that this brief, which deals with effects on lowland drainage, and the proposed mitigation of those effects, is prepared on the same basis as I set out at paragraph 2 of my previous brief.

Drainage in lowland plains

3. The scheme will replenish the aquifers by surface recharge from irrigation and rainfall, and leakage from scheme races and bywashes. This will bring higher groundwater levels in the lower plains, which, while beneficial to some parties, are a concern to a number of submitters who consider their interests will be adversely affected. The evidence of Dr Bright and Mr Tipler deals with some aspects of this and I will move the assessment of effects from their broad scale information to a practical level by describing how the effects on drainage in the lower plains could be managed.

4. A review of drainage history[1],[2],[3],[4] indicates that drains were installed in the lower central plains from the mid 1800s, and these were recognised and regularised by the Ellesmere and Forsyth Reclamation Act 1876 and other Acts. In the early 1940s the North Canterbury Catchment Board took over control of Lake Ellesmere, and two new lower level ocean discharge culverts were installed, enabling significant expansion of drainage systems through the 1940s and beyond. Apart from two new outlet structures to drains in the Taumutu district, no significant new scheme drains have been installed since the early 1960s.

5. There are currently ten recognised drainage schemes in the area affected by CPWES, see Table 1 and Figure 1. Nine are administered by Selwyn District Council, and one (the Halswell Drainage District) by Canterbury Regional Council. The schemes contain about 502.5 km of drains and rivers, and service about 36,900 ha of land on about 2530 properties (plus properties in the Halswell district). In addition there are significant natural streams outside the rated drainage districts, particularly in the area between Southbridge and Taumutu, which discharge direct to the sea. Numerous secondary private drains feed into the streams and scheme drains.

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[1] *Land Drainage Activity Management Plan, draft for discussion*. Selwyn District Council, April 2005
[2] Singleton, George, 2007. *Ellesmere, the Jewel in the Canterbury Crown*, Selwyn District Council
[3] *Asset Management Plan, Halswell Drainage District,* Canterbury Regional Council, June 2005
[4] *The Halswell in the 1980s*. North Canterbury Catchment Board, August 1978

Scheme	Length of drain/ river (km)	Area served (ha)	Properties served
Taumutu	8.2	500	14
Taumutu Culverts	4 culverts	1000	200
Leeston	207.9	12,847	393
Leeston Township	3.9	89.9	640
Ellesmere	25.7	1,329	74
LII	64.6	5,068	1,055
Greenpark	21.2	2,433	90
Osbornes	9.5	1,256	49
Hororata	5.5	677	15
Halswell	156	11,700	n.a.
Total	**502.5**	**36,900**	**2530 (+ Halswell)**

Table 1: Drainage schemes potentially affected by CPWES. (Note that some data are approximate and subject to confirmation and interpretation)

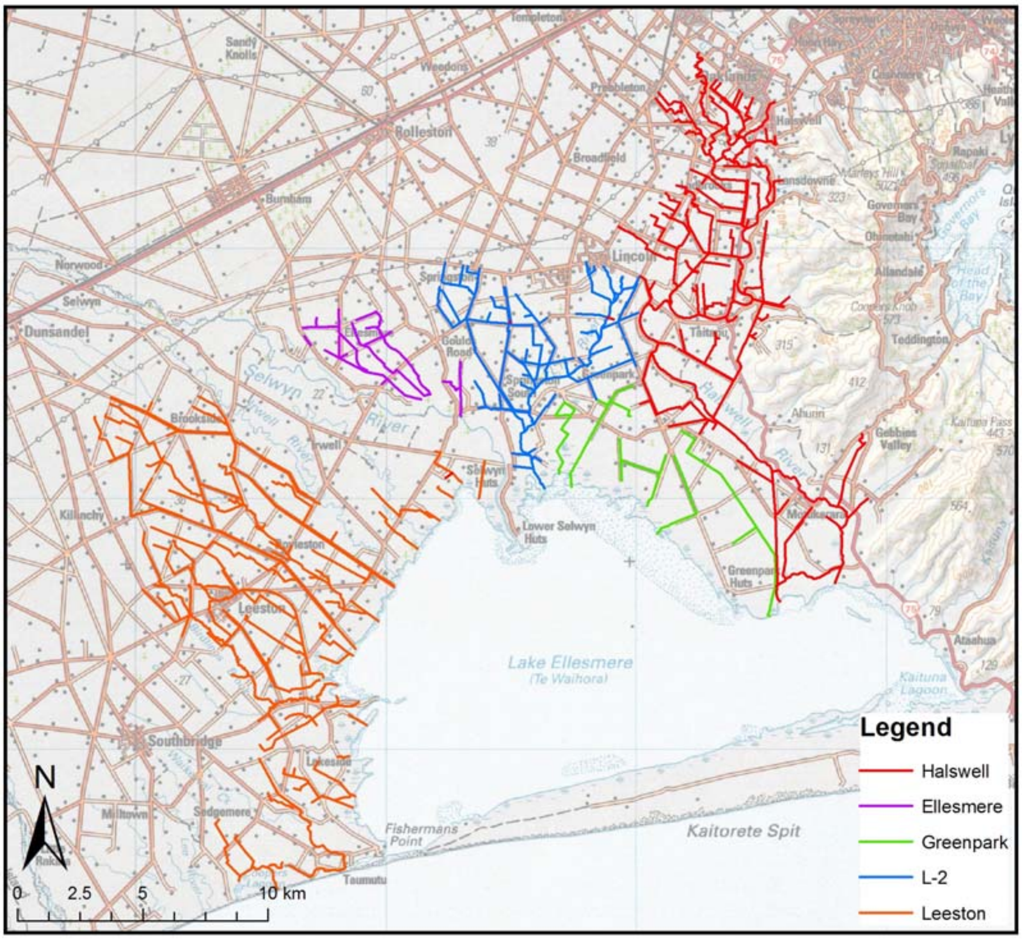

Figure 1: Map of drainage schemes in lower central plains. Some schemes listed in table 1 have been lumped together in the map**.**

6. To put my comments about management of the effect of CPWES on these streams and drains into context we should be aware of a number of points.

   6.1 The evidence of Mr Weir shows the areas that will experience the highest groundwater levels, potentially reaching ground level, i.e. potentially causing a drainage problem. These areas occur particularly in the Tai Tapu-Lincoln area, and, depending on the climate, progressively westwards towards Rolleston, around Burnham, around Dunsandel, west of Leeston, around the Rakaia Huts, and further inland around Hororata. I attach as figure 2 one example from Mr Weir's evidence. This example shows the areas where groundwater will be within 1 m of the land surface, both historically as recorded, and predicted as a result of CPWES by modelling. This example was for wet conditions, i.e. 1 October 1978, and presents the upper limit of groundwater levels. (Mr Weir and Dr Bright advise that the relativities between different scenarios, rather than the exact areas, are the main conclusions that should be drawn from the modelling, as in the table below. The precision of the background data, particularly ground levels, is not well suited to taking the numbers as precise.) Mr Weir considers that the groundwater modelling outputs reliably indicate the highest groundwater levels that will occur after the development of the scheme.

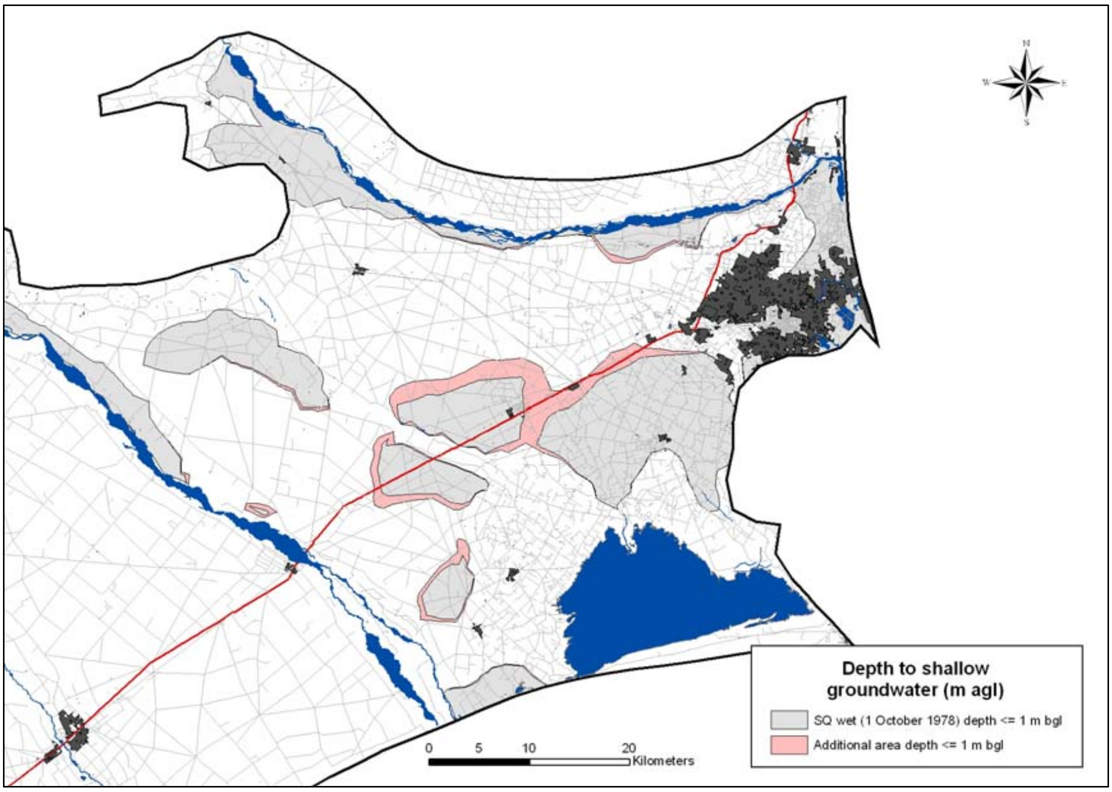

Figure 2: Map of areas with potential drainage problems

6.2 Historically the highs and lows of groundwater levels have been dominated more by climatic trends than by seasonal fluctuations or irrigation abstractions (Dr Bright, pers comm.). The groundwater storage is sufficiently large and the time of travel from the upper plains sufficiently slow to provide a buffer for short term, i.e. seasonal, fluctuations. Annual cycles have typically peaked in spring, but in the lower plains where drainage is of most concern these peaks have been relatively small. As an example see figure 3 (this figure is for ECan’s well L36_0092 in the Waimakariri fan zone). From the evidence of Mr Weir I conclude that seasonal fluctuations in the future will also be small.

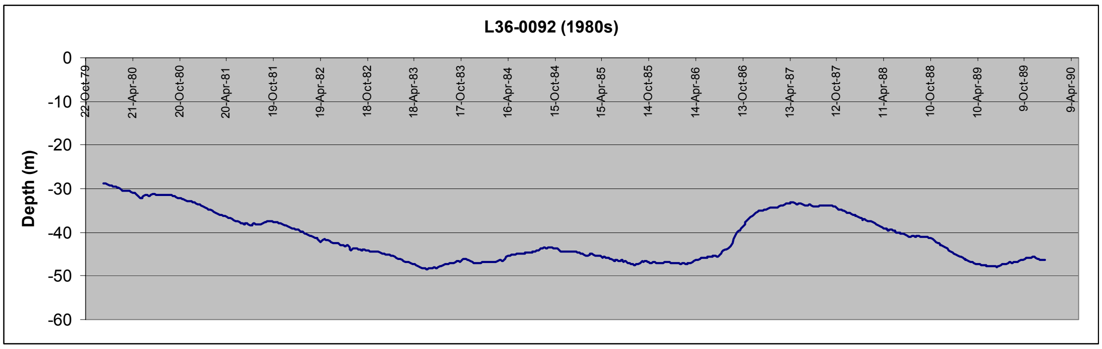

Figure 3: Fluctuations in groundwater level, 1980s; Well L36-0092

6.3 The model's outputs show that groundwater level fluctuations will continue to be influenced more by climatic variations than by the increased drainage that will result from irrigation. Table 2 (from Mr Weir's evidence) presents the modelled area where, as a result of fluctuations in level, the groundwater is predicted to be at or close to the ground level, i.e. areas where it is predicted there could be problems with drainage.

Scenario	Area where groundwater is within 1 m of surface (ha)	Increase in area between SQ and CPWES (ha)	Increase in area between SQ and CPWES (% of total land area)
SQ (dry conditions)	37,656	6,613	2.3%
CPWES (dry conditions)	44,269		
SQ (average conditions)	45,020	10,945	3.7%
CPWES (average conditions)	55,965		
SQ (wet conditions)	85,680	9,501	3.2%
CPWES (wet conditions)	95,181		

Table 2: Areas with shallow groundwater i.e. within 1 m of ground surface ("SQ" means "status quo")

Using this table it can be seen that the increase in groundwater level between dry and wet conditions is predicted to be 48,024 ha (SQ wet conditions, 85,680 ha, less SQ dry conditions, 37,656 ha), while the increase as a result of CPWES will be between 6,613 ha (CPWES dry conditions, 44,269 ha, less SQ dry conditions, 37,656 ha) and 10,945 ha (CPWES average conditions, 55,956 ha, less SQ average conditions, 45,020 ha).

6.4 There is a further significant model output regarding the difference in the effects of the scheme between dry and wet years. The increased mounding of groundwater, i.e. the change in height of the groundwater as a result of CPWES, will be greatest in the dry conditions but less in wet conditions. This is demonstrated from Mr Weir's evidence, see table 2 above, and figures 4(a) and 4(b), copied from Mr Weir's evidence. So I conclude that CPWES-induced mounding in the lower plains will be small in the times of greatest concern to lowland landowners.

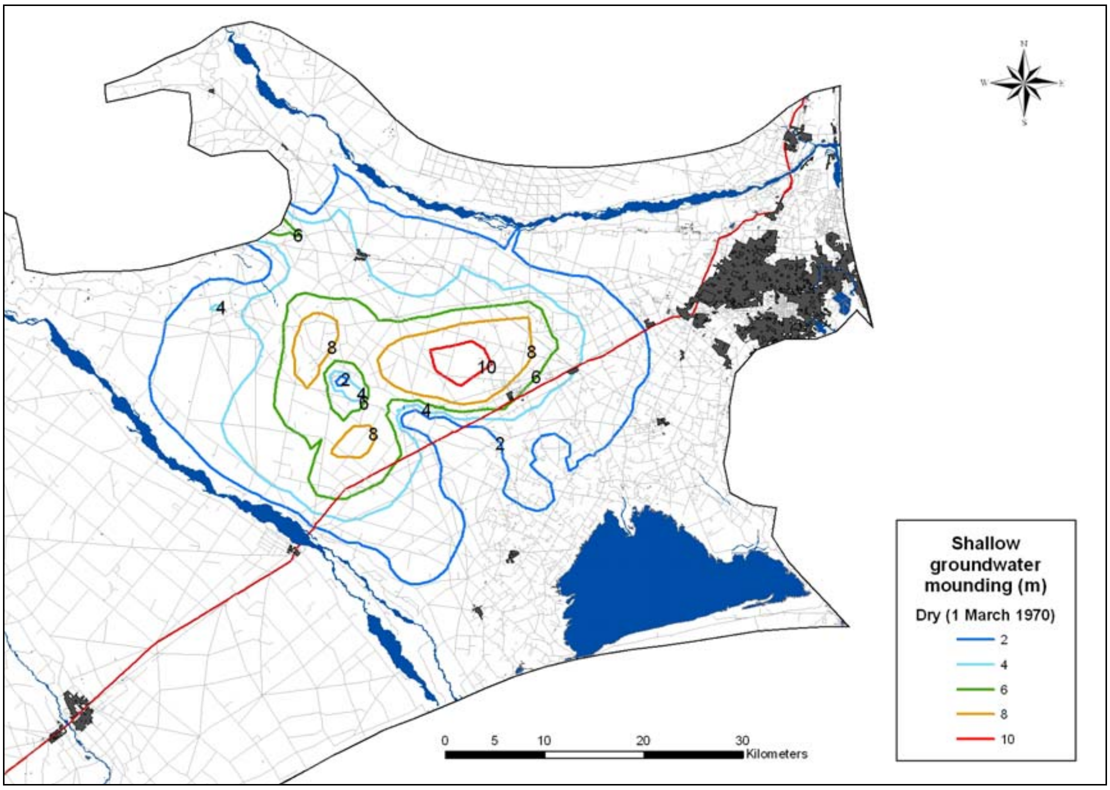

Figure 4(a): Effects of CPWES on groundwater mounding, dry conditions

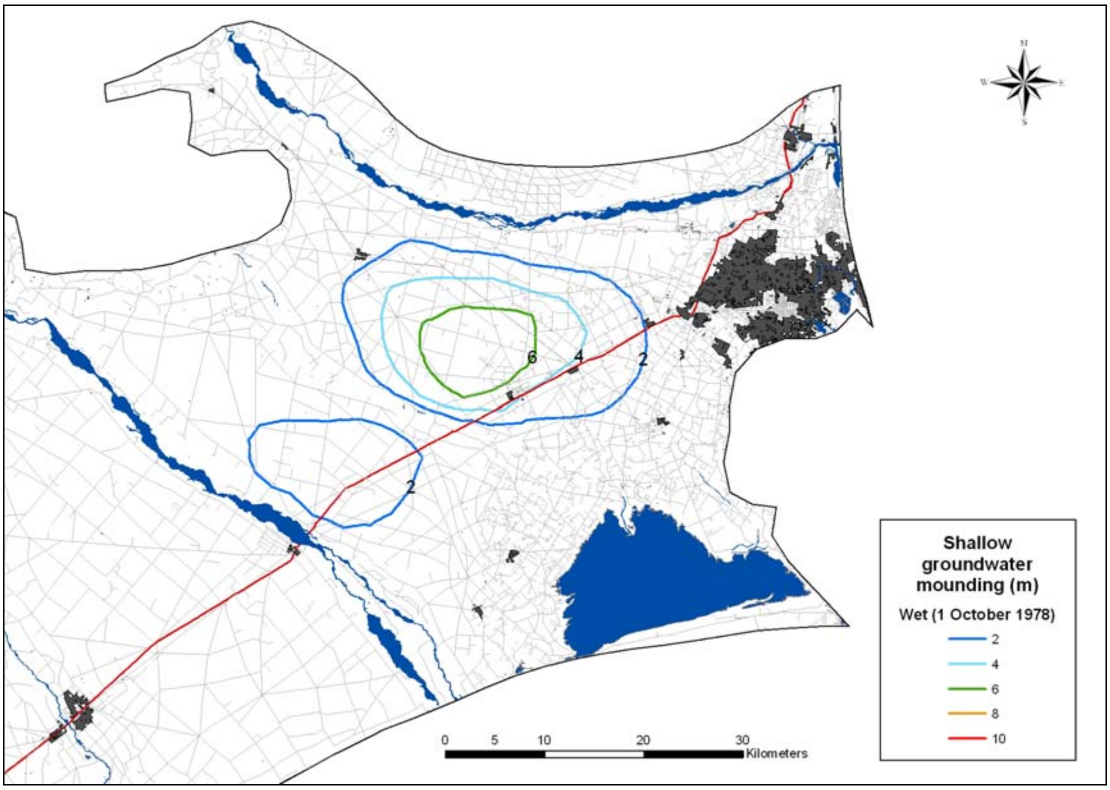

Figure 4(b): Effects of CPWES on groundwater mounding, wet conditions

6.5 Mr Weir's evidence addresses the time of travel of the hydraulic effects of irrigation application in the upper plains. He concludes that with CPWES the highest groundwater levels each year will generally occur from early winter to early spring, and to a large degree this mimics the past seasonal pattern of peak groundwater levels.

7. Therefore, in summary, I conclude that on average, and on a broad areal basis, CPWES will not significantly alter the historic patterns and magnitudes of groundwater levels and movements in the lower plains, as these will continue to be dominated by climatic variables and natural recharges that will not be altered significantly by CPWES. So the post CPWES groundwater situation will be similar to what has occurred in the recent past and is reasonably well known. This gives confidence in the ability of CPWES to propose feasible solutions to any adverse effects that might eventuate.

8. Another factor that reinforces this conclusion regarding the lack of impact of CPWES on the rise of groundwater in the lower plains is the presence of the drains and streams themselves. These are sufficiently closely spaced to provide an effective 'relief valve' that captures groundwater flows and, in practice, limits the rise of groundwater. That is their purpose. They perform

this function successfully now and will continue to do so in the future after implementation of CPWES.

9. I turn now to consider the effects of CPWES on drainage needs in the lower plains. In doing so I accept that the scheme, while bringing benefits to some interests from higher groundwater levels, and despite the comments above, will have adverse effects, and that though these will be small overall and small relative to natural variations, they might be significant to some people.

10. To assess these effects I have read the history of drainage development in the lower plains and current drain asset management plans, met with representatives of the drainage committees and overseers and engineers from Selwyn District Council and Environment Canterbury, discussed design considerations with other drainage experts, inspected a significant portion of drainage schemes and streams in the lower plains, calculated additional drainage needs that could be considered, and reviewed my findings with a selection of relevant professional and residents. I am also drawing on my experience from overseeing the development of drainage needs and solutions in the Amuri Plain with implementation of irrigation there in the 1970s and 1980s, and from other areas.

11. The Asset Management Plan for the Halswell Drainage District states (paragraph 1.3) that "The main purpose of the drains is to remove water from the land, both rainfall (stormwater) and groundwater (springs) and to control groundwater levels. The system is not designed as a flood control system, but to control water levels and remove surplus water after a flood event." It is accepted that short term ponding will occur in heavy rainfall events. See figure 5.

Figure 5: Halswell Canal at Duck Pond Rd. This canal copes well with long term drainage needs, but the capacity is not adequate in all sections to contain stormwater runoff.

12. It has been apparent for a long time that the capacity of the Halswell drainage system is limited[5]. In 1953 the North Canterbury Catchment Board put up a proposal to "deal with the problems of flooding in the Halswell Catchment", but this was turned down by ratepayers. Then in the 1970s and 1980s the Catchment Board prepared further proposals for upgrading, "to give acceptable and reasonable relief from flooding". None of these plans have been implemented. Hence the Asset Management Plan of 2005 goes on to say "Because of the limited capacity of the Halswell River system, the Council has a policy of restricting improvements to the drainage system unless they are programmed to a consistent standard from Lake Ellesmere upstream. This, in effect, retains the problems throughout the Halswell catchment at the existing levels. Urbanisation in the upper reaches and possible diversion of water from the Heathcote catchment is of concern to the Halswell Drainage District. Without comprehensive channel improvements, particularly in the downstream reaches of the system, any improvements in performance in the upstream reaches will only transfer flooding to the downstream low lying areas."

[5] See section 1.1 of the Asset Management Plan

13. From my discussions with SDC officers and landowners in the area, and from my own observations, I understand that the SDC-administered drainage schemes are, like the Halswell drainage system, not designed to handle all stormwater. Rather, localised and brief flooding is a normal expectation following intense storms. See figure 6 for an example of one such site.

Figure 6: Hanmer Road Drain by Lake Road. This is an example of a well maintained drain that generally has adequate capacity, but where short term flooding occurs following high intensity rainfall. Land in this location was under water for about 12 hours following a storm in 2002.

14. I conclude therefore that there are existing drainage needs in the lower plains prior to implementation of CPWES, and CPWES will in some places, increase the existing drainage needs by a small amount. However it will not and should not be considered to be the primary cause of drainage needs.

15. There is a concern about the potential for increased drainage needs in low lying land near Lake Ellesmere as a result of an increase in lake levels. Dr Mabin's evidence indicates an expectation of an increase of about 58 mm in the average lake level. ECan staff consider this could lead to a noticeable effect for some distance upstream from the edge of the lake. However to alleviate this Dr Mabin's evidence indicates there will be no change in the range of lake levels that normally occur a few times each year, i.e. the highest levels will be no higher than now so no new land will be affected. His

evidence also indicates there will be no increase in the average levels in the time of greatest concern, i.e. winter. I conclude that CPWES is unlikely to have an adverse effect on the drains and streams in the lower plains through a higher level in Lake Ellesmere.

16. Regarding the capacity of trunk drains, a good trunk network exists now and this is unlikely to need significant expansion as long as the purpose remains the same as in the past, i.e. for relief post-flooding and long term lowering of water levels. I have calculated that for the common size of drains in the drainage schemes, and depending on the local situation, a flow increase of 20% will flow about 50 mm deeper, and an increase of 50% would flow about 200 mm deeper. (From the evidence of Mr Weir, CPWES is expected to increase wet weather flows in the lowland streams and drains by between about 1% and 20%, with higher percentage increases in average or dry conditions.) As these drains were installed prior to the wet period in the late 1970s it can be concluded that their capacity will generally be enough to handle the extra flow provided by CPWES.

17. In addition to the main trunk drains there is an extensive secondary system that drains land between the trunk drains and feeds water to the trunk drains. These are mainly open drains, running perpendicular or parallel to the trunk drains, and in some areas there are also subsurface drains, mainly tiled.

18. I consider these secondary drains also generally provide an adequate system for long term lowering of the water table and major expansions will not be needed as a result of CPWES.

19. Urban areas require special consideration, because of the extra facilities and utilities that exist there and the greater potential consequences of flooding. In general one must assume that urban subdivisions have been designed to deal with natural events including the high water tables and extent of flooding that occurred in the late 1970s. These situations are the major determinants of performance and CPWES will have only a small effect on the potential for damage from flooding.

20. Consultation with SDC and ECan has indicated the following relevant assets in or downstream from the CPWES area:

- Reticulated wastewater systems in Christchurch, Tai Tapu, Lincoln, Springston, Prebbleton, Rolleston, Burnham, Dunsandel, Leeston and Southbridge, with their treatment or disposal systems (see analysis below),

- Septic tanks on individual farms, and within communities further up the plains such as Kirwee, Darfield, Sheffield, Springfield, Coalgate, Glentunnel and Hororata,

- Piped urban stormwater systems in Christchurch and the main rural centres.

- Sports grounds, cemeteries and gravel reserves (At the time of preparing this evidence – January 2008 – we had not been able to obtain site specific information from SDC about these assets and I am therefore not able to address site specific matters. However I consider the potential solutions and processes outlined below will apply).

21. Regarding reticulated wastewater systems. SDC has several such assets in its urban communities. These services are usually installed greater than 0.6 m below ground and up to 4 m depth in some locations. During wet winters, and in the lower plains where there are generally higher groundwater levels, SDC has already noted increased groundwater inflow into the reticulation systems due to leaking pipes in the older parts of the pipe network. (SDC has another report on this topic with additional details that at the time of preparing this evidence – January 2008 – we have not seen). SDC is concerned that, with higher groundwater levels as a result of CPWES, there will be increased infiltration into the wastewater reticulation systems, with adverse effects on collecting, pumping and treating its wastewater.

22. We have used Aqualinc's groundwater modelling outputs to assess the likely effect of the increased groundwater flows on SDC's wastewater systems. Figure 7 shows the reticulated areas in communities in the lower plains superimposed on one of Aqualinc's maps of shallow groundwater, with and without CPWES. This map is for peak wet conditions (1 October 1978) and indicates, for example, that in those conditions the groundwater level over most of Rolleston would have risen to within 0.5 m of the land surface. (The 0.5 m level may be significant as that is likely to include the entire wastewater reticulation system.) As a further illustration and example figure 8 shows a frequency plot for Lincoln of groundwater levels at a particular well, with and without CPWES. This shows, for example, that the amount of time that the groundwater would be within 0.5 m of the surface will increase from about 29% of the time (or 106 days per year) to about 40% of the time (or 146 days per year). In the absence of SDC's report (noted above) or other information,

we have not been able to correlate these modelling outputs with recorded data. Further, as stated earlier, Aqualinc's modelling has been developed to address broader regional groundwater issues and is not suited to site specific predictions or design solutions. However it is likely that CPWES will have an adverse effect on at least some reticulated SDC wastewater systems in the lower plains.

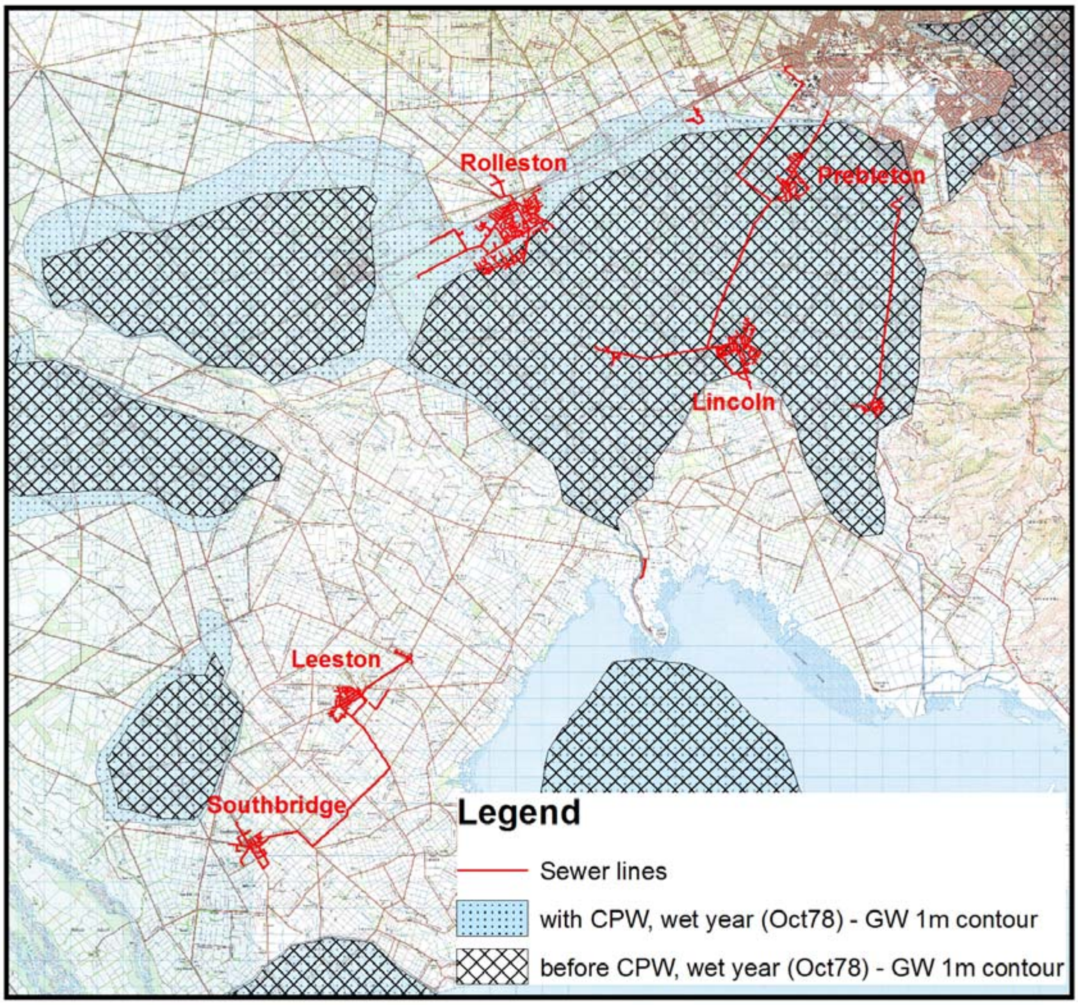

Figure 7: Reticulated wastewater schemes in lower central plains. This shows the areas that could be affected by present and increased groundwater levels in wet conditions.

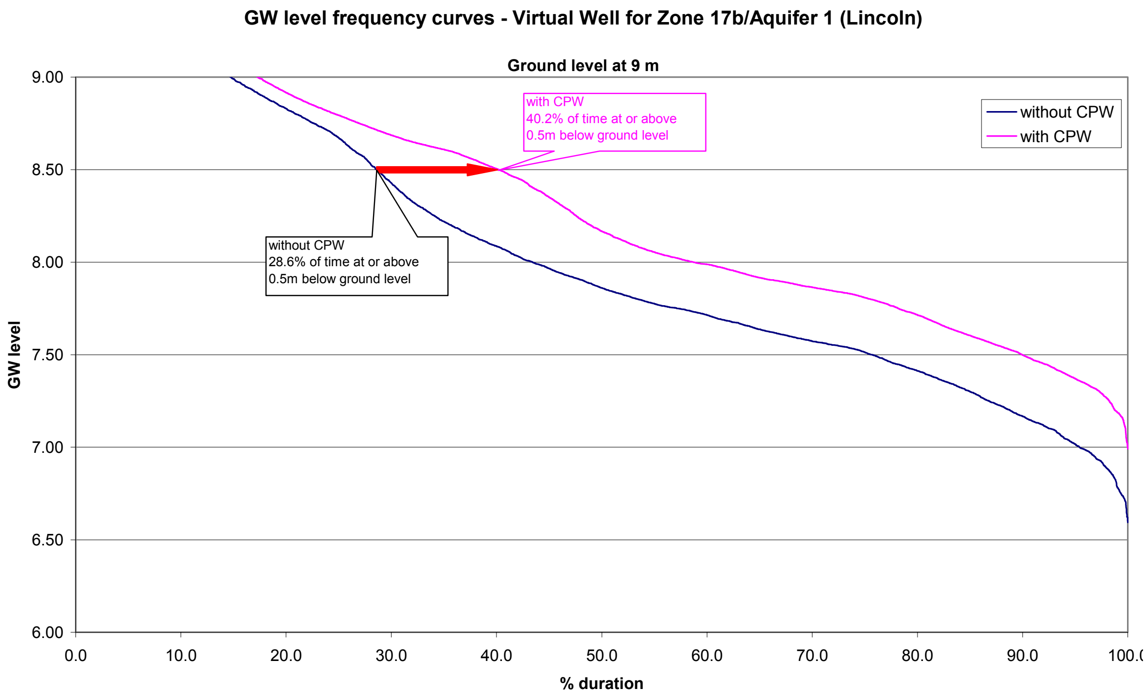

Figure 8: Potential effect of CPWES on groundwater infiltration in Lincoln sewerage

23. For all these assets, i.e. for trunk drains, secondary drains and urban or other utilities and facilities, if it can be demonstrated that there are adverse effects as a direct consequence of CPWES then the following solutions could be considered for case-by-case adoption:

(i) Tolerate a limited amount of short term flooding. The drainage schemes have not been designed to prevent inundation of land in heavy rainfall events. In peak events I understand water ponds on agricultural land for up to about 12 hours, or longer in some isolated locations, and I consider that CPWES should not be expected to improve these historic situations,

(ii) Widen drains to increase their capacity. If and where necessary many of the trunk drains could be widened to increase their capacity. This would not require a large amount of work. For example, for the common size of scheme drain, a 20% increase in flow would require a drain to be about 300 mm wider to maintain the same water level as now. Or a 50% increase in flow would commonly require a drain to be 500 mm wider than now. In my opinion widening will generally be a practical solution, where it is required at all,

(iii) Deepen drains to increase their capacity. This will be a suitable solution in some places. However it could be more problematic than widening and might not be practical in all areas as I understand that in some places a deeper drain would penetrate into underlying gravel layers. This could cause instability in the banks of the drains and in places it would draw extra water into drains from underlying aquifers,

(iv) Install more drains to provide a more intensive secondary system. Where groundwater levels rise between streams and trunk drains it will be feasible in many locations to install more drains to lower water tables and take water to the trunk systems, or to widen or deepen secondary drains as for trunk drains. Open drains could be located on fencelines to minimise disruption to farming operations, or made shallow so they can be driven over, see figure 9. These could be either parallel to trunk drains or as cutoffs, perpendicular to trunk drains. In some locations subsurface drains could be needed,

Figure 9: Swale drain alongside fence. This is an example of an unobtrusive drainage improvement that could be suitable in some locations

(v) Provide pumped drainage (I expect these would be needed in very few locations, if any, and would be likely to be part of a more comprehensive drainage and flood prevention plan, separate from CPWES),

(vi) Upgrade sewerage reticulation systems to reduce infiltration. The capacity of a number of existing wastewater reticulation systems is limited and costs of operations, including pumping, are high because of excessive infiltration of water from groundwater,.

(vii) Provide more frequent maintenance of existing drains, including cleaning. The condition of the SDC drains was assessed in its Asset Management Plan of 2005, and based on inspection of a sample of drains, as being of moderate grade, and the performance was assessed as good (using NZWWA Grading Guidelines, 1999). The condition and performance of the Halswell drains has not been published using the same criteria. However it is clear from my consultation, from records of maintenance and site inspections that the capacity of many drains could be improved by more frequent cleaning, see figure 10.

Figure 10: Overgrown drain by Lake Road. This is an example of a drain whose capacity and performance could be improved by more frequent cleaning

24. I have described in general terms the kinds of solutions that I consider will be effective and feasible, if required. But subsurface geohydrology is complex with very particular local responses, and significant variations can occur in subsurface structures within a distance of even 100 m. I consider it would be generally impossible at this stage of scheme development to identify specific site needs and solutions. The principle of adaptive management will be crucial in the future administration of drainage aspects of the scheme, i.e.

situations will have to be considered and solutions implemented case by case as the scheme develops.

25. In my opinion it would be reasonable to expect CPWL to agree to remedy adverse effects of drainage in the lower plains that result from operation of the scheme. However it needs to be noted that these effects will be small and it will not always be clear to what extent the scheme is the cause of drainage difficulties or where, alternatively, these arise from other causes such as climatic variations and rainfall events. I recommend that the scheme should contribute to monitoring and that a decision making process be set up to administer possible drainage consequences.

26. Regarding monitoring I recommend that between consenting and scheme implementation CPWES compile a baseline survey and report covering the areas noted above. This survey would include:

    (1) Inventory of drains and streams, their location, sizes, etc,

    (2) Inventory of sewerage systems (reticulated and individual septic tanks),

    (3) Conditions of these facilities, their capacities, maintenance activities, dates of installation, histories of water-level related issues,

    (4) History of their flows and other information on groundwater levels,

    (5) Existing management and administration arrangements,

    (6) Current costs of maintenance and operation.

    A substantial part of this baseline survey and report would be compiled from existing records and reports from ECan and Selwyn District Council, including their asset management plans.

27. I further recommend that after scheme implementation the following monitoring should be done:

    (1) Existing arrangements for monitoring flows and groundwater levels should be continued for all utilities (There are extensive networks and programs of monitoring currently conducted by ECan regarding stream and drain flows and groundwater levels, and by SDC regarding the sewerage systems that have established a database for an initial baseline report, and these should be continued),

(2) Changes in groundwater consents and use of groundwater throughout the plains, and water use from a CPWES supply should be monitored and assembled into an annual report (This would be a cooperative exercise between CPWES and ECan),

(3) Groundwater modelling should continue periodically, including upgrading and rerunning a suitable groundwater model, to aid understanding of contributions to effects from the scheme and natural events (This would be a cooperative exercise between CPWES and ECan).

28. Regarding decision making processes a core issue will be to determine in both broad guidelines and on a case-by-case basis the cause of drainage situations and therefore responsibility for costs of possible mitigatory actions. I recommend that a two-tier system be established to address this matter.

29. The first tier, and the normal operating group would be a technical review panel with the task of advising CPWES and other parties on drainage activities and responsibilities for payment for works done to improve drainage outcomes. This panel should operate by consensus. I suggest the panel should consist of people with the following backgrounds:

(1) A representative of CPWES management,

(2) A representative of drainage schemes management from the lower plains,

(3) An engineer with expertise and experience in both large scale and localised solutions to land drainage needs,

(4) An engineer or scientist with expertise and experience in Canterbury groundwater systems.

30. In addition I consider a review panel should be appointed as a second tier to arbitrate in the event of disagreement by other relevant parties with the recommendations of the technical review panel, or inability of the technical review panel to reach a consensus. This arbitration panel should have technical and legal expertise.

Walter Lewthwaite