

IN THE MATTER OF

the Environment Canterbury
(Temporary Commissioners and
Improved Water Management Act)
2010 and the Resource
Management Act 1991

AND

IN THE MATTER OF

submissions and further
submissions by **Christchurch
International Airport Limited.**

EVIDENCE OF CARL CEDRIC STEFFENS

INTRODUCTION

- 1 My name is Carl Cedric Steffens.
- 2 I hold the qualifications of Bachelor of Science in Geology and a Post Graduate Diploma in Engineering Geology from the University of Canterbury. I am a member of the New Zealand Hydrological Society. I have been employed as a Environmental Scientist with Pattle Delamore Partners Limited since 2004, an environmental consulting firm specialising in ground and water resources. I am primarily involved in projects related to groundwater quantity and quality.
- 3 My work experience relevant to this evidence includes a variety of work related to groundwater quantity, quality and groundwater-surface water interaction; providing staff in Environment Canterbury's consents section with technical advice on groundwater issues; modelling impacts of land use on groundwater quality and the

analysis and interpretation of groundwater and surface water quality data.

- 4 A copy of my CV is attached to my evidence as Appendix A.
- 5 Although this is a Council hearing I have read the Expert Code of Conduct contained in the Environment Court's Practice Note 2011 and I agree to comply with it. I have prepared this evidence in accordance with the Practice Note.

SCOPE OF EVIDENCE

- 6 I have been engaged by Christchurch International Airport Ltd (CIAL) to prepare this evidence.
- 7 Although CIAL have submitted on the whole of the plan (on the basis of concerns around the means of achieving the objectives and the extent to which the notified plan does not take a balanced approach towards the social, economic and cultural wellbeing of the Canterbury community), my evidence focuses on the technical issues (within my area of expertise) with the following specific plan provisions:

(i) The definition of "changed land use" in Section 2.10 and the extent which it should allow for greater flexibility in nitrogen fluctuations over time, in line with current fluctuations that occur on farms from year to year;

(ii) Table 1c and the need for it to provide more realistic and achievable outcomes for aquifers that are in line with the PLWRP's provisions for providing groundwater for abstraction;

(iii) The status of the Christchurch West Melton Zone as a "red nutrient allocation zone" and whether this has been justified or whether further evaluation is required - in addition to the consideration of sub-zones that reflect the varying nature of water quality across the city (activities are restricted in accordance with Policy 4.34 based on the

zone's classification so it is important that both the classification and zone boundaries are well justified);

(iv) Rules 5.39 and 5.46 which require the use of the nutrient accounting programme OVERSEER™ and whether this is unnecessarily onerous and costly for small-scale low intensity farming operations, such as those that occur at the airport.;

(v) The requirement for a Water Supply Strategy (which specifies management measures to reduce water demand in times of restriction), for community supply water takes to be classed as restricted discretionary under Rule 5.88. In this respect it is noted that there are no restrictions in place at the airport – my evidence considers where it would be best to limit this requirement to only where water restrictions occur;

(vi) Policy 9.4.1 (e) which requires maintenance of a 3 m confining layer, (but does not restrict this requirement to areas where such a confining layer exists);

(vii) Section 9.6.2 which provides a prohibition on groundwater abstraction that applies specifically within the Christchurch - West Melton groundwater allocation zone. Within this it is noted that no estimate of the allocation limit for this zone has been included in the plan; and

(viii) In line with CIAL's further submission, some changes are sought to the rules relating to the non-consumptive use of groundwater, for heating and cooling in particular.

POINTS OF SUBMISSION

Page 2-5 2.10 Definitions, Translations and Abbreviations

8 Christchurch International Airport Limited submitted on this part of the PLWRP because they run a farming operation of approximately 600
Document Number: 448421

hectares, of which around 300 hectares of that is irrigated. It is run as a low intensity sheep farm.

- 9 Section 2.10 provides a definition of 'changed' land use with respect to the farming rules 5.42 to 5.45. The definition of a land use change based on an increase of more than 10% in nitrogen loss is unduly constraining, particularly for low intensity farming operations where year to year changes in crops or stock numbers in response to climatic and stock price variations could easily trigger a modelled increase in N loss of more than 10%.
- 10 CIAL are seeking that the nitrogen loss trigger threshold for defining land use change be increased to a level that more appropriately reflects significant and genuine changes to the farm system. Alternatively, a threshold such as 20 kgN/ha/yr could be used where farms whose nitrogen leaching remains below this value after any changes is a permitted activity. This nitrogen loss threshold describes generally low leaching losses, and is indicative of a low to moderate intensity farming system.

Page 4.4 of the pLWRP- Table 1c

- 11 Policy 4.1 makes reference to Table 1 as the default outcomes that are to be met if more specific outcomes are not established in the sub-regional sections 6-15. CIAL raised concerns in their submission that Table 1c, which defines the outcomes for Canterbury aquifers, contains several unrealistic outcomes, such as:
 - (i) Much of the shallow groundwater in western Christchurch does not fall within the Guideline value for pH specified in the Drinking Water Standards for New Zealand 2005 (revised 2008) (DWSNZ) due to natural processes. Rainfall infiltrating through soils west of Christchurch has a natural acidity that results in groundwater having a pH outside of the guideline range specified in the DWSNZ. Therefore it is not practical to achieve that outcome stated in Table 1c.

(ii) Many of the aquifers do not have an upwards hydraulic pressure gradient, so it cannot be maintained in all aquifers. **Figure 1**, included in Appendix B of my evidence, shows how to the west of Christchurch City, near the airport, there is a natural downwards gradient as rainfall and river losses recharge the deeper aquifers. Furthermore, in areas where there is an upwards gradient it is readily reversed by deep abstraction bores, even though such abstractions do not cause an adverse effect. Although the requirement in Table 1c is restricted to the coastal confined gravel aquifer system, away from the airport area, it could still unnecessarily restrict deep abstractions in the CIAL area.

(iii) Any groundwater abstraction contributes in some small way to a landward movement of the salt-fresh water interface, but that does not necessarily cause adverse effects. The salt-fresh water interface is a naturally occurring zone within all coastal aquifers that typically occurs close to the shoreline or may be some distance offshore in deep confined aquifers as shown schematically in **Figure 2** attached at the end of my evidence. Its position moves backwards and forwards depending on the groundwater levels and the rate of groundwater flowing through the aquifer. Therefore any abstraction of groundwater will contribute to the movement of the salt-fresh water interface in a landward direction. The wording in Table 1c at present could be interpreted as promoting a natural groundwater flow system with no groundwater abstraction. This outcome is in conflict with Policy 4.2, which refers to managing the cumulative effect of abstractions, Policy 4.4, which refers to managing abstractions and it is also not consistent with the enabling approach of Policy 4.46.

(iv) It is unrealistic to seek an outcome for unconfined aquifers in Canterbury whereby long-term average groundwater water levels, and the flow and levels in surface

bodies is maintained, unless no groundwater is allocated for abstraction. All groundwater abstractions cause a lowering of water levels and ultimately a reduction in surface flows, which is only a problem when cumulative effects exceed environmental thresholds. The only way to achieve the outcome that is currently stated is to not have any groundwater abstraction, which is not what the PLWRP intends to occur. This outcome is also inconsistent with Policy 4.2, Policy 4.4 and Policy 4.46 as outlined in the previous paragraph.

(v) There are some areas of poor quality water, particularly close to the water table, although this is not an area where groundwater is used for abstraction. The requirement to maintain good groundwater quality should be specified as those areas where it is used for abstractive purposes and where it emerges into springfed streams.

- 12 CIAL is seeking that Table 1c be modified to allow for naturally occurring hydrogeologic conditions and to ensure that achievement of the outcomes is focussed on those parts of the groundwater environment where groundwater use or exposure occurs. A revision of Table 1c should provide for more water to be abstracted up to certain limits.
- 13 I note that the Section 42A report recommends no change to Table 1c. Page 112 of the report states that Dr Adrian Meredith, an Environment Canterbury surface water quality scientist, technically reviewed Tables 1a to c and recommended no changes. However, Dr Meredith's technical memorandum appears on page 456 (Appendix 1) and only reviews Tables 1a and 1b with respect to surface water. Based on this, it appears that there has been no technical review by Environment Canterbury of Table 1c or consideration of the submissions which sought a review or replacement of its contents.

- 14 For this reason, CIAL is still seeking review and modification of Table 1c.

Page 4-9 of the pLWRP - Nutrient zone Policy 4.34.

- 15 CIAL submitted on this policy on the basis that there is insufficient justification for the red nutrient allocation status across the broad and diverse area encompassed by the Christchurch West Melton zone. For example, nitrate-nitrogen concentrations in the shallow groundwater within the Christchurch West Melton zone range from less than 1 mg/L in the area of river recharge (encompassing the CIAL owned land) to over 6 mg/L in specific areas to the south-west of the zone, where land-surface recharge dominates. This is illustrated in **Figure 3**, which is sourced from Environment Canterbury (2010).
- 16 The status of a nutrient allocation zone has been determined by Environment Canterbury on the basis of whether the receiving water bodies are meeting the outcomes sought by Environment Canterbury. Meredith et al. (2012) reviewed water quality information across Canterbury and compared this to periphyton and macrophyte objectives in Table WQL5 of the NRRP (now incorporated into Table 1a in the PLWRP), chronic nitrate toxicity thresholds to aquatic life and the drinking water standards, to assess whether the outcomes were met in different areas of Canterbury. They noted how an expert opinion assessment approach was used in combination with this comparison. In areas where all groundwater flows directly to the sea and there are no receiving rivers or lakes, groundwater quality was compared to national drinking water standards (11.3 mg/L nitrate-N as the Maximum Allowable Value (MAV) and 5.6 mg/L nitrate-N as the (0.5 MAV) alert trigger).
- 17 For the Christchurch West Melton zone, Meredith et al. (2012) classified the principle receiving environment as a combination of groundwater and surface water. Unlike other areas where they evaluated whether the outcomes were being met, they classified this zone as *“A special purpose zone already managed to protect*

Christchurch drinking water supply and urban spring fed rivers.” It is unclear how this zone has therefore been classed in the PLWRP as over-allocated in terms of nutrients.

- 18 In general, the groundwater quality within most of the Christchurch West Melton zone is very good and most waterways do not experience problems with periphyton growth. Macrophyte issues occur in some streams primarily as a result of excessive fine sediment accumulation, rather than due to nutrients in inflowing groundwater.
- 19 Given the apparent absence of an evaluation of whether the water quality outcomes are currently being met in the Christchurch West Melton zone, it seems unjustified to include this zone in the PLWRP as a red nutrient allocation zone and to restrict productive land use opportunities on this basis.
- 20 It is clear that further work is required by Environment Canterbury to justify the status of the zone. It would also be wise to consider separating the Christchurch West Melton zone into nutrient allocation sub zones that better reflect the varying water quality of the zone, particularly the differences between the area that receives predominantly Waimakariri river recharge and has very high water quality and assimilative capacity (which is where the airport is located) from the southern parts of Christchurch that experience more land-surface recharge and are more prone to elevated concentrations of some water quality determinands.

Pages 5-11 - Farming rule 5.39

- 21 This permitted activity rule for all farming activities prior to 1 July 2017 requires nitrogen losses to be calculated annually using the OVERSEER® nutrient model and made available to Environment Canterbury on request.
- 22 While CIAL supports responsible nutrient management practices, CIAL have lodged a submission on this rule as it considers the

requirement for OVERSEER® analyses on all farms, regardless of the scale of operation and location, to be unnecessarily onerous on smaller or low nutrient use enterprises such as the farming operations on CIAL land. OVERSEER® analyses are not commonly used on small and/or less intensive farming operations, rather they are typically undertaken by fertiliser representatives or farm consultants for large farming operations (e.g. dairy farms, large sheep and beef farms). This requirement poses an unnecessary cost on these less intensive farming operations with little environmental benefit because of the low risk such operations pose to the environment. The CIAL farm has been operating for many years over a groundwater resource that shows very low and stable nitrate concentrations (generally less than 1 g/m³) indicating no adverse effect is occurring.

- 23 CIAL are seeking that farming activities that require OVERSEER® analyses be limited to large/intensive farming operations in locations where elevated nutrient concentrations have the potential to contribute to an adverse effect. This could be defined as operations that leach more than 20 kg N/ha/yr as can be reasonably deduced from the Canterbury nitrate leaching look-up tables (Lilburne et al. 2010).

Pages 5-12 - Farming rule 5.46

- 24 From 1 July 2017, the permitted activity rule for all farming activities requires annual nitrogen losses calculated using OVERSEER™ to not exceed the rate for the relevant farming activity in Schedule 8, which is currently blank. CIAL have no means of determining and, therefore, ensuring that their farm operations will comply with this rule until Schedule 8 is completed. Furthermore as discussed above, the requirement for use of OVERSEER™ analysis for small and/or low intensity farming activities is unnecessarily onerous. That requirement would be more reasonably limited to operations that lose greater than 20 kg N/ha/yr.

- 25 CIAL are seeking the farming activities that require OVERSEER™ analyses and farm environment plans be limited to large and/or intensive farming operations.

Page 5-21 of the pLWRP- Rule number 5.88: the taking and using of water for a group or community water supply from groundwater or surface water (restricted discretionary)

- 26 Compliance with this rule requires that an operative Water Supply Strategy is in place. The PLWRP defines this as a document with strategies to reduce water demand during times when minimum flow or water level restrictions are in force. CIAL noted in their submission that the airport water supply has not been subject to minimum flow or water level restrictions in the past so it is unclear why such a plan should be required now in order for the take and use to be considered discretionary.
- 27 The Section 42A report notes that any abstraction that is not subject to those low flows or water level restrictions is exempt from preparing a strategy. If this is the intention then it should be clearly spelt out in Rule 5.88. However, the Section 42A report also notes that one purpose of the strategy is to put in place measures to reduce water demand during times when the water source is on restriction, regardless of whether or not the water permit has conditions with minimum flow or water level restrictions. This seems contradictory to the previous comment and there is no current restriction threshold for the groundwater source in this area, meaning that if a Water Supply Strategy was prepared for CIAL, there would be no reference point as to when water restrictions were required.
- 28 On this basis, CIAL are still seeking modification to Rule 5.88 such that the requirement for an operative Water Supply Strategy should be limited to those water supplies that are subject to minimum flow or water level restrictions.
- 29 It is also noted that the Section 42A report recommends a new definition for a Community Water Supply. The definition in the notified version of the PLWRP was:
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(i) a drinking-water supply that is recorded in the drinking-water register maintained by the Chief Executive of the Ministry of Health (the Director-General) under section 69J of the Health Act 1956 that provides no fewer than 501 people with drinking water for not less than 60 days each calendar year.

The Section 42A report recommended definition is:

(ii) water taken primarily for group drinking water supply and includes group drinking water supply, and community drinking water supply but that may also be used for other purposes such as supply to institutional, industrial, processing, stockwater, or amenity irrigation use and fire-fighting

30 CIAL generally supports the inclusion of the other activities in this definition, which is in line with its further submission. However, depending on the interpretation of 'primarily for group drinking water' this could limit future water takes for CIAL, as new takes are used for a number of purposes. In many cases, the component of water used for drinking may be small compared to that used for other activities such as in the airport toilets, for cleaning and for amenity irrigation use. On this basis, CIAL request that that the word "primarily" be removed from this definition.

Page 9.2 of the pLWRP- Section 9 Christchurch-West Melton Sub Regional Area, Policy 9.4.1 (e)

31 CIAL is concerned that this policy, which seeks to ensure that any land uses maintain an overlying confining layer above the aquifer of at least 3 m, is not practicable for sites that do not have a 3 m confining layer. The airport land does not have a 3 m confining layer above the aquifer as they are located over an unconfined aquifer.

32 CIAL are seeking a modification to this policy so that it only applies to sites where there is a naturally occurring confining layer of 3 m or more.

Section 9.62 - restriction on Future Allocations in Christchurch - West Melton Zone

- 33 Section 9.6.2 prohibits further groundwater abstraction within the Christchurch - West Melton groundwater allocation zone, except for group or community water supply as set out in Rule 5.88. This exclusion does provide for some non-drinking water supply use of water at the airport, as per the Section 42A report's proposed amendment to the definition of Community Water Supply. However, in some instances consent applications may need to be lodged to take groundwater for commercial or industrial use at the airport without a drinking water supply component. An example could be a new airport service building or business located on CIAL's land but away from CIAL's existing servicing infrastructure.
- 34 The key issue with Section 9.6.2 is that no estimate of the allocation limit for this zone has been included in the plan, so a prohibition on further allocation seems entirely unjustified. Such a restriction would place a severe restriction on future economic options within Christchurch and its surrounds for any activity requiring water other than for group or community supply.
- 35 The Section 32 Summary report advises that

(i) "... when updating the Christchurch groundwater model the groundwater quantity scientist estimated total actual annual abstraction to reach a maximum of 128 million m³ per annum, which is equivalent to about 4 m³/s. It is expected that actual use will be less than total allocation, but the quantum is uncertain.

Most water permits in the zone state a maximum rate of take and tend not to have a maximum volume specified. The result of estimating annual volume entitlements from short-term maximum rates on resource consents using consent inventory information is that the volume estimate is unsustainable as an allocation limit.

Until a sustainable volume limit can be arrived at, the zone has been declared to be fully allocated."

- 36 The uncertainty about how much water is actually used and what a sustainable limit volume should be means there is poor justification for placing such as a severe restriction on water use.
- 37 The Christchurch - West Melton Zone committee have recently released their draft Zone Implementation Plan (ZIP). While the draft ZIP identifies the need to abstract water in a sustainable manner, it does not indicate a need to prohibit further abstraction. The draft ZIP emphasises that abstracted water should be used efficiently, as per the following excerpt:

(i) "the Committee believes that if we are to realise the vision of the CWMS by 2040, we need to work out the best way for people in the Christchurch-West Melton Zone to use water more efficiently and manage demand both individually and collectively. It is essential that water continues to be available for community water supplies, industrial, commercial, and environmental uses."

- 38 This emphasis on ensuring water is available for a wide range of uses is appropriate and the prohibition described in section 9.6.2 of the PLWRP is not consistent with the intentions of the Christchurch West Melton Zone Committee.

Further submission on rules relating to non-consumptive groundwater use

- 39 CIAL supports Fonterra's submission to delete condition 2 of Rule 5.105 so that the non-consumptive use of groundwater, including for heating and cooling purposes, and the associated discharge to groundwater, as a permitted activity applies to commercial purposes (and not just non-commercial purposes). I note that the Section 42A report recommends this is changed to "domestic". It appears that the intention is to limit Rule 5.105 to small takes and require larger takes

under Rule 5.106. An alternative would be to specify a volumetric limit rather than rely solely on the definition of domestic takes.

- 40 CIAL supports Horticulture New Zealand's submission to define 'non-consumptive' takes. The Section 42A report considers them adequately defined, but CIAL is still seeking that the PWLRP needs to clarify that a non-consumptive take of water is not subject to groundwater allocation limits, such as that in Section 9.6.2 for the Christchurch West-Melton Groundwater Allocation Zone.
- 41 CIAL supports Geothermal Heat-pump Association of New Zealand (GHANZ's) submission which is to ensure Rule 5.105 and Rule 5.106 does not cause a significant limitation on the options available for groundwater sourced heat exchange systems, such as that used at the airport, by restricting the take and discharge to the same aquifer rather than groundwater allocation zone. I note that the revised rule in the Section 42A Officer's report removes the limit that water must be returned to the same aquifer, and therefore, provides more options. CIAL supports the proposed changes.

CONCLUSION

- 42 The changes sought by CIAL to the PLWRP that I have presented will help ensure the on-going safe and efficient operation of the airport and its contribution to the social and economic well-being of the community whilst at the same time still achieve a sustainable environmental outcome without any adverse effects that are more than minor.

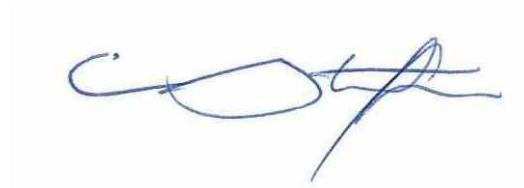
REFERENCES

Environment Canterbury. 2010. Annual groundwater quality survey, spring 2010.

Lilburne, L., Webb, T., Ford, R., Bidwell, V. 2010: *Estimating nitrate-nitrogen leaching rates under rural land uses in Canterbury*. Environment Canterbury report R10/127

Meredith, A., Stevenson, M., Kelly, D. (2012) Derivation of Nutrient Status Zones in Canterbury. Environment Canterbury memorandum. 30 June 2012.

Carl Cedric Steffens, 4 February 2013

A handwritten signature in blue ink, appearing to read 'C. Steffens', is centered on the page. The signature is fluid and cursive, with a prominent loop at the end.

Curriculum Vitae – Carl Steffens



Expertise

- ✦ Groundwater resource evaluation and modelling
- ✦ Contaminant transport modelling
- ✦ Environmental sampling and monitoring
- ✦ Drilling/contractor site supervision
- ✦ Resource consent assessments, applications and processing
- ✦ Preparation and presentation of evidence for resource consent hearings
- ✦ Mine Dewatering
- ✦ Numerical modelling with MODFLOW
- ✦ Autocad, GIS and Surfer use

Name	Carl Steffens
Nationality	New Zealander
Qualifications	BSc. Geology, 2001, University of Canterbury Post Grad Diploma. Engineering Geology, 2004, University of Canterbury
Professional Affiliations	New Zealand Hydrological Society Executive Committee Member
Employment Record	2004 – Present Environmental Scientist Pattle Delamore Partners Limited, Christchurch

Experience

Carl is a hydrogeologist with 8 year's experience working on groundwater projects throughout New Zealand. He has experience in hydrogeological field testing and monitoring, data interpretation/analysis, numerical and analytical modelling and reporting. Carl has been involved in the preparation and management of Assessment of Environmental Effects (AEE) reports for consent applications and presenting evidence as an expert witness at hearings.

Project Experience

Ashburton District Council: Groundwater assessments associated with an ADC application to replace the Rakaia township shallow supply bores with a deeper groundwater supply.

Canterbury Regional Council (Environment Canterbury): Auditing of aquifer pumping tests carried out by various consultants for resource consent applications or compliance with consent conditions. Providing technical advice to council and reanalysis where required.

Canterbury Regional Council (Environment Canterbury): Technical assessment of effects associated with the removal of adaptive management conditions from a resource consent to abstract groundwater.

Christchurch City Council: Assessment of effects of an existing cemetery on the underlying groundwater quality.

Christchurch City Council: Hydrogeological investigation at proposed cemetery site at Canterbury Park

Christchurch City Council: Preparation of tender documents and management of drilling and testing investigation for the enhancement of stream flow at Kaputone Stream.

Christchurch City Council: Supervision of remedial works following the release of diesel into the environment as a result of overfilling an aboveground storage tank at a CCC pumping station.

Christchurch International Airport Limited: Assessments of potential groundwater issues and preparation and management of consent applications associated with the operation of the airports groundwater based air-conditioning systems.

Christchurch International Airport Limited: Assessments of deep groundwater supply options and preparation and management of consent application to replace existing airport shallow supply with a deep secure groundwater source.

Christchurch International Airport Limited: Well head security assessments on various airport supply wells.

Christchurch Ready Mix Concrete: Assessment of potential groundwater effects from expanding of existing quarry operations, including management of groundwater resource consenting issues.

Confidential Client: Hydrogeological investigations and numerical modelling of dewatering requirements and groundwater management issues associated with proposed open cast mine developments.

Elliot Sinclair and Partners Ltd: Modelling and reporting of the potential transport of bacteria through the unsaturated zone into groundwater resulting from changes to overflow discharges for stormwater disposal from a residential subdivision in Rolleston.

EnviroLink: Contribution to preparation of technical report: "New Zealand Guidelines for the Monitoring and Management of Sea Water Intrusion Risk on Groundwater" and accompanying saltwater intrusion analysis tools.

Gillman Wheelans Limited: Hydrogeological testing and assessments and preparation of resource consent application to take groundwater from a deep secure source for a new subdivision (including replacement of the existing township supply) at West Melton, including preparation and presentation of evidence at a resource consent hearing.

Golf Renovations and Shaping Specialists (Grass Ltd): Liquefaction assessment at Waimairi Beach Golf Club.

Mobil Oil New Zealand Ltd: Environmental site investigations for underground storage tank site closures and divestment sites in the South Island regions. Planning, implementing and supervising phase 2 investigation works at petroleum hydrocarbon storage sites.

Opus International Consultants: Hydrogeological assessments and recommendations with regard to determining a suitable groundwater source for a new Christchurch City Council water supply pumping station at Wilmers Road. Design and management of aquifer testing programme, aquifer testing analysis and reporting in support of a consent application by council to take groundwater for public supply.

Selwyn District Council: Development of a sampling protocol for re-commissioning of a public supply well.

Selwyn District Council: Investigation into deep groundwater public supply options.

St Andrews College: Hydrogeological assessments to support consent application for abstraction and re-injection of groundwater for a proposed air-conditioning system.

Taranaki Regional Council: Review of existing council State of the Environment groundwater monitoring and sampling programmes.

Tasman District Council: Contribution to analysis and reporting requirements involving groundwater quality issues at the Mapua FCC site at completion of the MCD soil remediation process.

University of Canterbury: Field testing and contribution to design and analysis of a de-watering re-injection system for construction of the university biosciences building.

Various Clients: Preparation of assessment of environmental effects (AEE) reports for groundwater take consent applications.

Various Clients: Assessments of potential well yields, interpretation and analysis of pumping test data, well interference and groundwater mounding assessments associated with groundwater takes and discharges, interaction of surface water and groundwater, groundwater quality assessments, sea water intrusion assessments, interpretation of groundwater level monitoring records, analytical and numerical modelling applications.

Various Clients: Supervision of field investigations including the drilling and installation of groundwater monitoring wells.

Waimakariri District Council: Preparation and management of a consent application to take groundwater for public water supply from deep bores in Kaiapoi to supply Rangiora township.

Whakatane District Council: Desktop assessment of potential for a groundwater supply source to Whakatane Township.

Appendix B

Figures referred to in the evidence of Carl Steffens

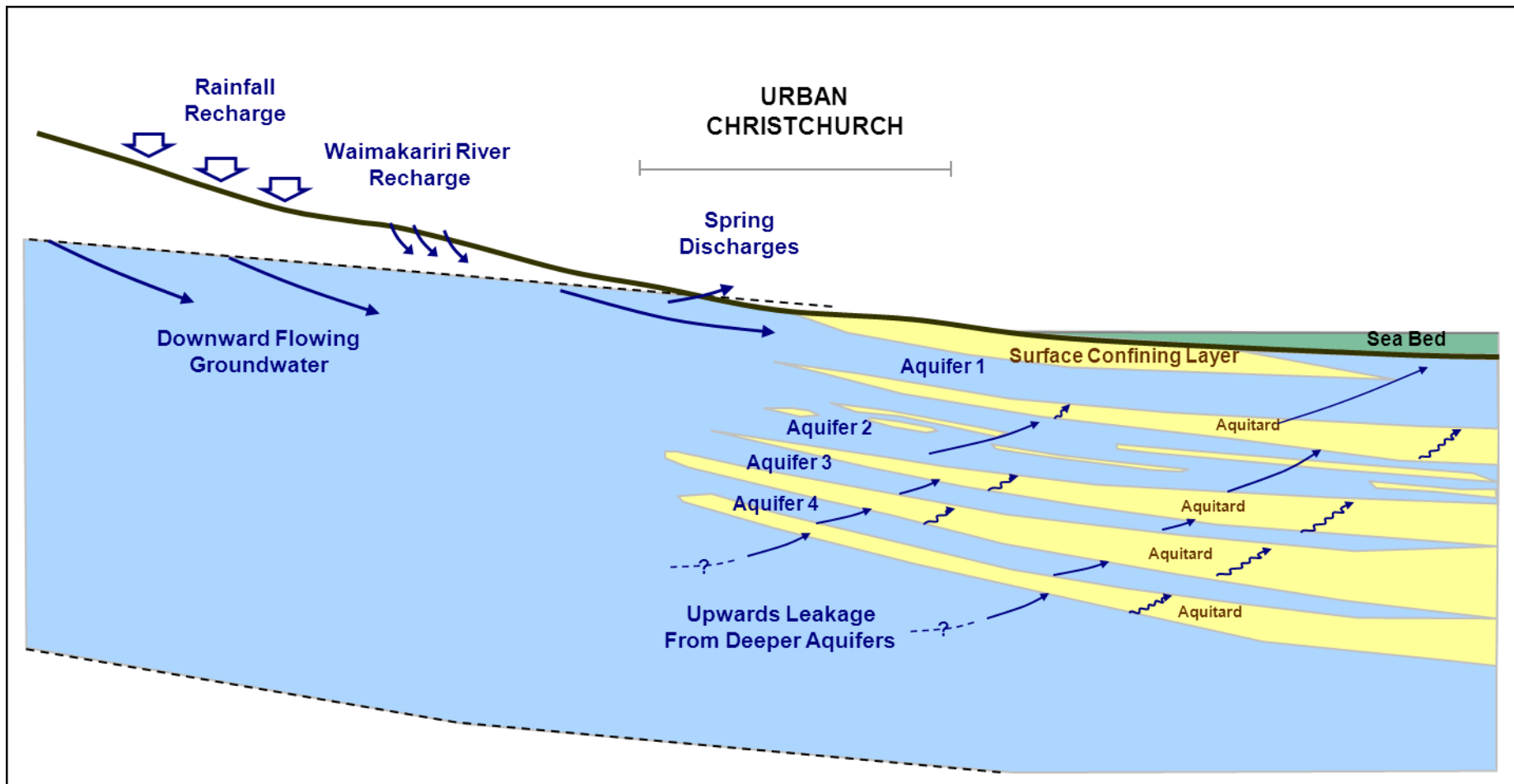


Figure 1. Diagrammatic Cross Section: Physical Model of the Christchurch Groundwater System - showing downwards hydraulic gradient in the west and upward gradient in the east

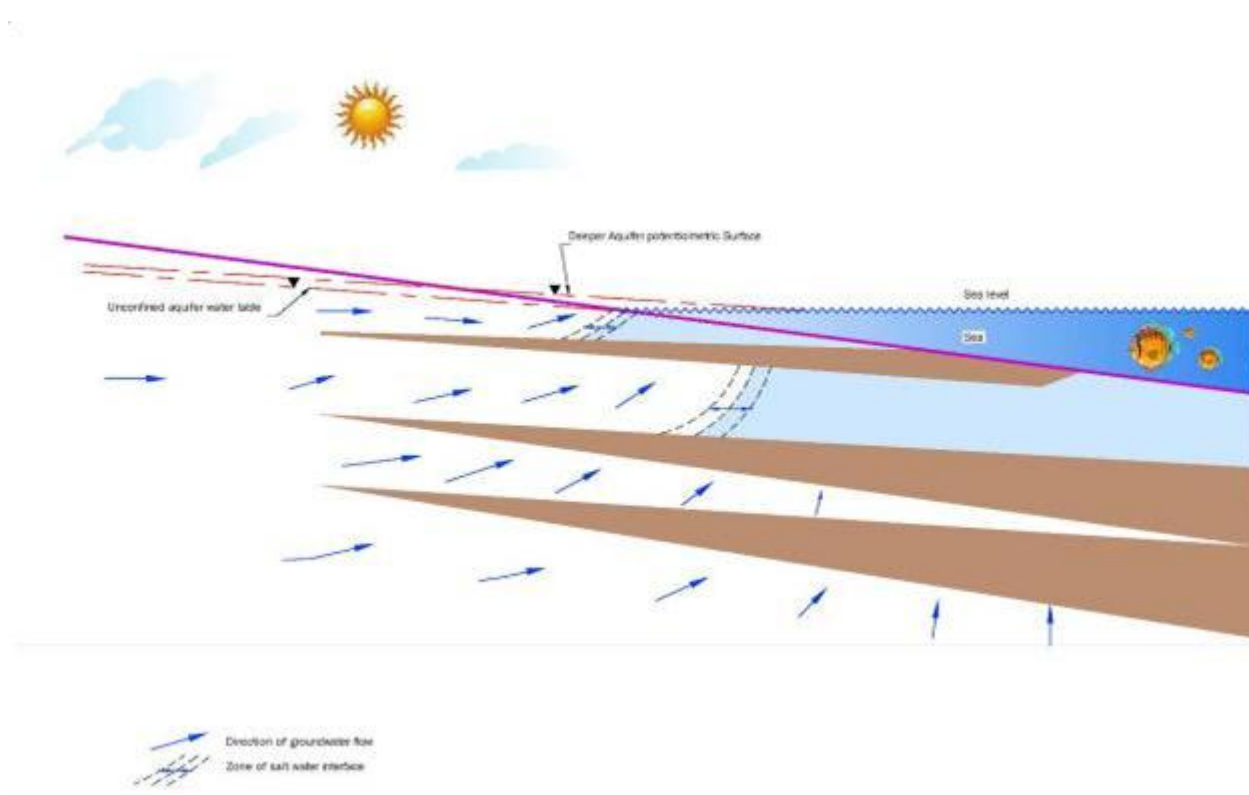


Figure 2: Schematic Diagram of Sea Water Interface

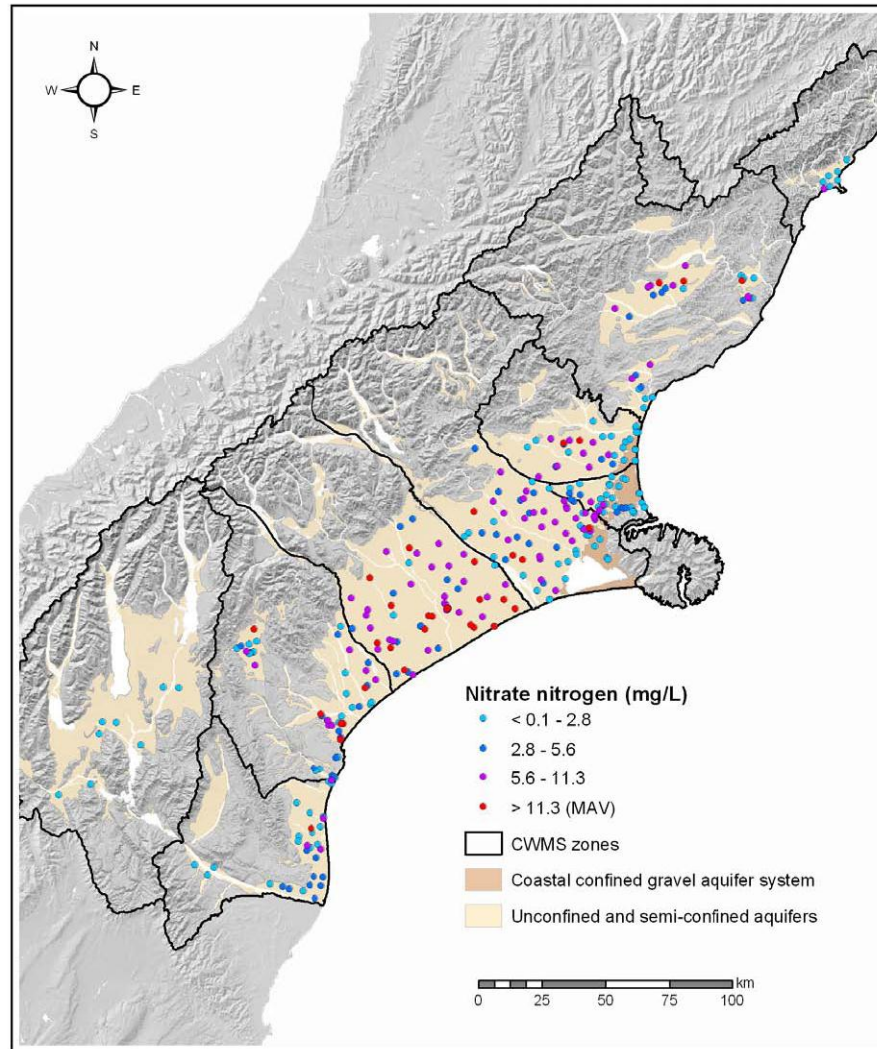


Figure 3: Nitrate nitrogen concentrations recorded in Environment Canterbury's 2010 annual survey.

APPENDIX C – SUGGESTED REWORDING

Page 2-5 2.10 Definitions, Translations and Abbreviations

Changed (in terms of Rules 5.42 to 5.45) means a change in land use, calculated on a per property basis that arises from either:

- 1. a resource consent to use, or increase the volume of, water for irrigation on a property; or*
- 2. for properties with a leaching loss of more than 20 kg/ha/yr as assessed via the look-up tables (Lilburne et al., 2010) or Overseer[®], an increase of more than 10% in the loss of nitrogen from land used for a farming activity above the average nitrogen loss from the same land for the period between 1 July 2011 and 30 June 2013. The amount of nitrogen loss shall be calculated using the Overseer[®] nutrient model for the 12 months preceding 1 July in any year and expressed as kilograms per hectare per year.*

Page 4.4 of the pLWRP- Table 1c

Management unit	Subunit	Appearance & Palatability	Health indicators				Groundwater pressure		Groundwater levels
		Guideline value for any aesthetic determinand [DWSNZ*]	Nitrate- nitrogen Concentration (mg/L)		Escherichia coli [median concentration of organisms per 100ml of water]	All other inorganic or organic determinands of health significance [DWSNZ 2005*] (% Maximum Acceptable Value)		Salt-water intrusion	
			Max	Average					
Coastal Confined Gravel Aquifer System		Water quality in each aquifer <u>that is used for abstraction or emerges in spring-fed streams</u> is maintained at least in the state recorded or reasonably deduced in the three years prior to 1 November 2010				The upwards hydraulic pressure gradient is maintained in all aquifers <u>Groundwater pressures in aquifers with an upward hydraulic pressure gradient should be managed to minimise the risk of near surface contaminants causing adverse effects in wells that utilise confined aquifers</u>	There is no landward movement of the salt-fresh water interface and saltwater contamination of fresh water aquifers is avoided <u>Groundwater pressures in coastal aquifers should be managed to minimise the risk of saltwater contamination of those areas where an aquifer is used for fresh water abstraction.</u>		
Unconfined gravel aquifers	Shallow groundwater predominantly recharged by soil drainage <u>that is used for abstraction or emerges in spring-fed streams</u>	Within the Guideline value, <u>where this has been met in the three years prior to 1 November 2010</u>	< 11.3	≤ 5.6	< 1	≤ 50% MAV		Long-term average groundwater water-levels, and the flow and levels in surface bodies is maintained	
	Deep groundwater predominantly recharged by rivers	Water quality is maintained at least in the state recorded or reasonably deduced in the three years prior to 1 November 2010							

Key: DWSNZ = Drinking Water Standards for New Zealand 2005

Pages 5-11 - Farming rule 5.39

- 1 *5.39 Prior to 1 July 2017, the use of land for any farming activity existing at 11 August 2012 and outside of the Lake Zone shown on the Planning Maps, is a permitted activity if the following condition is met: 1. A record of the annual amount of nitrogen loss from the land, for the period from 1 July in one year to 30 June in the following year, calculated using the OVERSEERTM nutrient model, is kept and is provided to the CRC upon request for farms leaching more than 20 kg/ha/yr. or, for farms leaching less than 20 kg/ha/yr as assessed via the look-up tables (Lilburne et al., 2010) or Overseer®, a record of*

stock type, stocking rates and fertiliser application is kept and recorded in a suitable format to enable use of the OVERSEER® nutrient model, if required.

Pages 5-12 - Farming rule 5.46

- 2 5.46 From 1 July 2017, the use of land for any farming activity, is a permitted activity if the following conditions are met... 2. The average annual loss of nitrogen does not exceed the rate for the relevant farming activity in Schedule 8, when this Schedule is available and has been incorporated into the Plan following a process including public notification, submissions and hearings; and 3. If the annual average loss of nitrogen, averaged over three consecutive years is less than 20 kilograms per hectare a record of the annual amount of nitrogen loss from the land, for the period from 1 July in one year to 30 June in the following year, calculated using the OVERSEER™ nutrient model, is kept and is provided to the CRC upon request; a record of stock type, stocking rates and fertiliser application is kept and recorded in a suitable format to enable use of the OVERSEER® nutrient model, if required.

Page 5-21 of the pLWRP- Rule number 5.88: the taking and using of water for a group or community water supply from groundwater or surface water (restricted discretionary)

- 3 5.88 The taking and using of water for a group or community water supply from groundwater or surface water is a restricted discretionary activity provided the following condition is complied with: 1. There is an operative Water Supply Strategy for water supplies that are subject to minimum flow or water level restrictions.

Recommended definition from Section 42A report for Community Water Supply:

- 4 ~~Water taken primarily~~ for group drinking water supply and includes group drinking water supply, and community drinking water supply but that may also be used for other purposes such as supply to institutional, industrial, processing, stockwater, or amenity irrigation use and fire-fighting

Page 9.2 of the pLWRP- Section 9 Christchurch-West Melton Sub Regional Area, Policy 9.4.1 (d)

- 5 9.4.1 *Protect the high quality, untreated groundwater sources available to Christchurch City as a potable water supply in the area shown on the Planning Maps as the Christchurch Groundwater Protection Zone by: (e) Ensuring any land uses, where there is a naturally occurring confining layer of 3 m or more, maintain an overlying confining layer above the aquifer of at least 3m thickness, or where this layer is removed or reduced, including as part of site construction or gravel or mineral extraction,*

Section 9.62 - restriction on Future Allocations in Christchurch - West Melton Zone

- ~~6 No additional water is to be allocated from the Christchurch West-Melton Groundwater Allocation Zone shown on the Planning Maps except for group or community water supply as set out in Rule 5.88.~~