Before the Commissioner / Hearing Panel appointed by Canterbury Regional Council

IN THE MATTER OF	The Resource Management Act 1991
AND	
IN THE MATTER OF	Application CRC120223 by Christchurch City Council for a discharge permit to discharge contaminants (being stormwater) onto and into land and into water associated with the South West Area of Christchurch City.

Section 42A Officer's Report

Date of Hearing: 14 November 2011

Report of Lisa Caryn Scott

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INTRODUCTION

1. The Christchurch City Council (CCC) has applied for a resource consent (CRC120223) to discharge stormwater from the present and future CCC-managed stormwater network to land and water in the South-West Christchurch Area. The application and supporting information have been submitted to Environment Canterbury in the form of a report titled “Resource Consent Application & Assessment of the Environmental Effects for South-West Christchurch” (the “AEE”) prepared for the CCC by their consultants Golder Associates (NZ) and dated August 2011.

2. My report will provide information and advice related to the effects of the proposed discharges to land on groundwater quality, which is within my field of expertise.

3. This report is supplementary to the overview Section 42A report prepared by Brent Hamilton, for the resource consent application. Full details of the consent application by the CCC are provided in that report.

4. I am employed by Environment Canterbury as a Groundwater Quality Scientist, a position I have held since October 2010. My work with Environment Canterbury includes investigating, monitoring, and reporting on the chemical and microbiological quality of groundwater in the region.

5. I hold a Master of Science degree in environmental geochemistry and a PhD in geology, both from the University of Cape Town in South Africa. I have been employed as a groundwater scientist since 1996, specialising in geochemistry and groundwater quality. Prior to my employment at Environment Canterbury, I worked as a research scientist in Canada and a scientist in South Africa.

6. Previously I have been involved in several research and consulting projects relating to the evaluation and protection of groundwater quality, including two projects involving stormwater management for the City of Cape Town, South Africa. These projects have allowed me to develop knowledge and skills in assessing the sources and fate of contaminants in groundwater.

7. I have read the Code of Conduct for Expert Witnesses in giving evidence to the Environment Court. I agree to comply with that code when giving evidence to the Hearing Panel in this matter. All my evidence is within my expertise and I have considered and stated all material facts known to me which might alter or qualify the opinions I express.

SUMMARY OF APPLICATION

8. The CCC proposes to manage stormwater discharges from a variety of land uses under a Stormwater Management Plan (the "SMP", presented as Appendix B of the AEE). Under the SMP, the preferred stormwater disposal option is soakage to ground where possible. The SMP advocates the use of soil adsorption basins, where suitable soakage conditions exist, i.e. permeable strata and sufficient depth to groundwater. Where soakage is not feasible, sedimentation basins, followed by wetlands (or wet ponds) will be used to treat stormwater before discharge to surface water systems. The SMP design principles avoid the use of pipes and concrete channels, preferring a 'natural' system.

9. According to the design approach described in Section 5.3.3 of the SMP, the soil adsorption basins will be designed to allow 80% of the average annual stormwater volume to be treated by filtration (slow infiltration through the soil media bed) prior to disposal to ground and the remaining 20% of the volume to receive some treatment via sedimentation prior to disposal to ground via rapid soakage (chambers or trenches).

10. This report comments on the possible groundwater quality effects of stormwater infiltration (soakage to ground) through soil adsorption basins, rapid soakage chambers and trenches and unlined channels in the stormwater network, which will allow stormwater to reach the unconfined groundwater. Infiltrated stormwater, especially stormwater infiltrated by rapid soakage, has the potential to affect groundwater quality because stormwater runoff contains dissolved contaminants that can be transported into the groundwater.

11. The main contaminants of concern for groundwater are those that are present in high concentrations in stormwater and are not readily adsorbed to the soil media or filtered out during infiltration through the unsaturated zone to the water table. These may include salts, nutrients, microorganisms and some heavy metals, hydrocarbons and pesticides. The AEE focuses on nutrients, microorganisms and heavy metals. The groundwater beneath South-West Christchurch is used as a supply of mostly untreated drinking water for the city and the surrounding area, and it also discharges to spring-fed streams such as the Heathcote River and the Halswell River. Contaminants infiltrated with stormwater could pose a threat to the untreated drinking-water supplies or stream ecosystems.

12. The stormwater to be discharged includes stormwater from roofs, residential hard-stand areas, development (construction) areas which are less than 1 hectare on the Port Hills and less than 5 hectares in other areas and existing and future industrial sites, as described in Section 2.1 of the AEE. Residential stormwater generally contains different types of contaminants than stormwater from industrial areas.

13. The AEE recognises the risk posed by industrial stormwater and proposes in Section 2.2.2 of the AEE that a programme of auditing high risk industrial sites be developed. Sites with unacceptable risk will be removed from the consent.

14. The additional risk of contamination associated with stormwater discharges from contaminated sites is also recognised in Section 2.2.3 of the AEE. To manage this risk, the applicant has excluded discharges of stormwater from development areas (construction phase) on known contaminated sites from their application. Stormwater treatment systems (soil adsorption or sedimentation basins and wetlands) will also not be constructed on known contaminated land, unless it has been accepted by Environment Canterbury as being remediated.

15. The AEE acknowledges that "*groundwater quality may change as a result of contaminants entrained in naturally and planned infiltrated stormwater from urban sources*", but concludes, mainly from the evidence of groundwater quality modelling, that the "*overall changes to general groundwater quality are slight and considered to be no more than minor*". I agree with this overall assessment that the risk to groundwater quality is low, provided that enforceable measures can be put in place to protect both stormwater and groundwater quality.

16. In my opinion, the AEE provided an acceptable review of the potential adverse effects on groundwater quality with evidence provided in the report and appendices to support the applicant's conclusions.

DESCRIPTION OF RECEIVING ENVIRONMENT

17. A description of the groundwater quality in the South-West Christchurch area is presented in Section 4.4.2 of the AEE, with more detailed information in "Technical Report No. 5 Water Quality Assessment" (Appendix F of the AEE). The Groundwater Quality Assessment draws largely on two reports by Pattle Delamore Partners Ltd (PDP), "Groundwater Quality Assessment for South-West Christchurch", dated December 2006 ('PDP 2006') and "Localised and Residual Impacts on Groundwater", dated July 2007 ('PDP 2007') for a description of the groundwater quality in the area.

18. The information presented in the AEE and its appendices is consistent with my understanding of the state of groundwater quality in South-West Christchurch. The shallow groundwater beneath South-West Christchurch has been affected by a range of contaminants, including nitrate, bacteria, and hydrocarbons (BTEX, PAH and chlorinated solvents). Some high groundwater nitrate nitrogen concentrations have been found at Islington and Wentworth Park while hydrocarbon contamination has been detected in groundwater beneath the area from Hornby and Oaklands across to Sydenham and Waltham.

19. In some cases, the concentrations of contaminants have exceeded drinking-water standards, but at most monitored sites in the area, contaminant concentrations have decreased since the late 1980s and early 1990s. Beneath a depth of about 50 to 60 metres below ground surface, the groundwater shows little or no effect of anthropogenic contamination. These conclusions are supported by Environment Canterbury groundwater quality reports by Hayward (2002) and Barber et al. (2005) and data stored in Environment Canterbury's Squalarc water quality database.

20. The proposed stormwater discharges to soil adsorption basins will largely occur over areas in South-West Christchurch where the aquifer is unconfined. These discharges could be a potential source of contaminants which may travel downwards and eastwards with the groundwater flow, moving under the confining layers into the deeper aquifers (Barber *et al.* 2005).

CONTAMINANTS OF CONCERN

21. Environment Canterbury's Natural Resources Regional Plan (the "NRRP") lists "*sediment, microorganisms, heavy metals, for example zinc and copper, hydrocarbons, pesticides and litter*" as contaminants found in stormwater (NRRP, Chapter 4 Water Quality, page 4-17). The main stormwater contaminants listed in the AEE are bacteria and viruses (microorganisms); nitrogen and phosphorus (nutrients); heavy metals, especially copper, zinc and lead; polynuclear aromatic hydrocarbons (PAHs), petroleum hydrocarbons; and suspended sediment. The assessment of groundwater quality effects is based primarily on the expected fate of nitrate nitrogen,

phosphorus, faecal coliform bacteria, zinc, lead and copper from modelling calculations. I will discuss the modelling in the following section of my report.

22. I agree that the applicants have considered most of the important contaminants of concern, with the possible exception some hydrocarbons and heavy metals. Pitt *et al.* (1996) conducted a comprehensive review of the impact of stormwater on groundwater quality from nearly 100 case studies in several countries, which provides a good summary overview of the range of possible risks to groundwater. These reviewers list several hydrocarbon compounds commonly found in urban runoff from residential and industrial areas, including chlorinated solvents, phthalate esters, PAHs, benzene, toluene, ethylbenzene and xylene (BTEX), phenols and polychlorinated biphenyls (PCBs). Hydrocarbon contamination of groundwater is mentioned in several places in the AEE as a potential hazard of stormwater infiltration, but no detailed assessment of the possible magnitude of the effect is offered.

23. Pesticides in stormwater have also not been considered in any detail in the application, other than to comment that the loading of pesticides applied to land is likely to decrease, along with nutrients as land use changes from rural to urban (on page 86, Appendix F of the AEE). Pitt *et al.* (1996) point out that urban pesticide contamination of groundwater can result from municipal and household use of pesticides for pest control and nitrate can leach from fertilizers applied to golf courses, parks and home lawns.

24. The AEE considers the potential fate of zinc, lead and copper in groundwater originating from the stormwater discharges, but does not address the fate of any other metals. Pitt *et al.* (1996) also list aluminium, arsenic, cadmium, chromium, iron, mercury and nickel as other heavy metals and inorganic compounds in stormwater that are of most environmental concern from a groundwater pollution standpoint. Although trace metals are not monitored regularly, there are instances where lead, cadmium and chromium have exceeded the New Zealand Drinking-Water Standard in groundwater samples from the Christchurch area (Hayward 2002). With the exception of zinc, most heavy metals are associated with solid particulates and should be largely removed by filtration or sedimentation if discharged to soil adsorption basins rather than directly to ground.

25. High volumes of suspended sediments in stormwater are typically not a serious concern for groundwater quality, but construction phase discharges, allowed under the proposed consent, could cause short-term increases in the loading of hydrocarbons and heavy metals from earthwork vehicles and machinery.

26. Stormwater contains a variety of microorganisms, some of which are infectious to humans. Faeces from domestic animals and wild birds are probably the main sources of microorganisms in stormwater in sewered catchments. The levels of faecal indicator bacteria in stormwater are highly variable but are generally lower in commercial or industrial areas than in residential catchments (Williams 1993). Faecal coliforms were chosen to represent contamination by microorganisms for the groundwater quality modelling calculations in the AEE.

27. Some contaminants in stormwater are removed by various processes before reaching the groundwater. These processes include adsorption to soil media, chemical precipitation and adsorption to particulates (which are filtered out during infiltration), degradation and microorganism die-off. The construction of stormwater treatment systems, such as the proposed soil adsorption basins, is intended to enhance these processes. Pitt *et al.* (1996) concluded that most stormwater contaminants pose only

a low to moderate threat to groundwater quality. This is especially true if the stormwater discharge is via surface percolation (soil infiltration) rather than sub-surface injection. The contaminants with the highest risk to groundwater were pathogens, particularly enteroviruses and soluble nutrients, such nitrate, if these were present in stormwater at high concentrations.

MODELLING PREDICTIONS

28. The conclusion that the effects on groundwater quality from the proposed stormwater discharges will be minor is largely based on modelling calculations carried out by PDP which are described in PDP 2006 and PDP 2007 and summarised in the AEE.

29. For assessing localised effects, PDP 2006 employed a line source model. The line source model relies on estimated groundwater flow parameters and estimated source concentrations of a particular contaminant. Analytical equations are then used to describe groundwater flow and contaminant dispersion to predict patterns of contaminant concentrations with time and distance from the source. To look at large-scale effects of future development, PDP 2007 employed mass balance estimates. These were based on a water balance for the unconfined portion of the aquifer in the South-West Christchurch study area, existing groundwater concentrations and estimated contaminant concentrations in stormwater recharge for a proposed land use scenario (Development Scenario 2).

30. The results of the line source modelling suggested that proposed discharge will not increase concentrations of nitrate, zinc or lead to levels that would cause concern, but that faecal coliform bacteria counts could exceed drinking-water standards up to 500 metres down-gradient of discharge points for roughly five days after a discharge event. The mass balance calculations suggested very small changes in contaminant concentrations including very slight increases in zinc, copper and phosphorus and a potential slight decrease in nitrate nitrogen for the portion of the aquifer considered. Overall contaminant concentrations in groundwater were estimated by the large-scale modelling to be below drinking-water standards.

31. The input concentration of faecal coliform bacteria in PDP's line source model is 8,000 cfu/100 ml after soil treatment and infiltration (PDP 2006). This value is consistent with the expected median concentration (EMC Value) for bacteria in New Zealand urban runoff recommended by Williams (1993) and was considered by PDP to be a conservative estimate. I am, however, sceptical about modelling the transport of micro-organisms in groundwater because there are many uncertainties with regard to die-off and adsorption rates, particularly in the complex sand and gravel sediments that underlie Christchurch and the Canterbury Plains.

32. It was assumed that 90% of the zinc and lead would be removed in the soil prior to the discharge reaching groundwater. The figure of 90% is somewhat arbitrary, justified only by the statement "*Infiltration has been demonstrated to effectively reduce the levels of metals*". Table 3 on page 12 of the PDP 2006 report gives removal ranges for metals of 50 to 100%. The removal rate is roughly consistent with figures published in a review by Pitt *et al.* (1996), which indicate a "*filterable fraction*" of less than 20% (giving a removal of greater than 80%) for both copper and lead.

33. The modelling calculations are reported to consider a '*worst case scenario*' by using the discharge after treatment from the largest '*first flush basin'* (as far as I can tell this was later relabelled '*soil adsorption basin*'). What the modelling does not consider is that the soil lined part of the basin has a limited capacity and that stormwater flows in excess of this capacity (typically a 5 to 10 year event volume) will discharge to

another soil lined detention basin and, if this is exceeded, directly to groundwater via a rapid soakage chamber. Such large storm events are likely to lead to dilution of contaminants in the stormwater, but will also bypass the treatment capacity of the soils.

34. I agree with the general findings of the modelling, that large-scale, persistent high concentrations of contaminants downgradient of the soil adsorption basins are not likely. I caution against accepting the quantitative model outputs as true "*predictions*", rather than indicative estimates. Numerous assumptions have been used in setting up the models, such as input contaminant concentrations, pore velocities, dispersivities and soil removal factors. While these assumptions mostly seem reasonable to me, they are still sources of uncertainty that will affect the modelling results.

35. My main criticism of the modelling exercises, and one shared by URS Limited who reviewed PDP's groundwater quality reports that have remained unchanged for this application, is that there is no sensitivity analysis of the modelling and no discussion of the model uncertainties in the PDP reports. The modelling presents only one outcome, rather than a range of possible outcomes that might give a better picture of reality. In some cases, the authors have also failed to provide their data sources, particularly for data describing the groundwater system such as pore velocities and dispersivities, used as inputs for the calculations.

ASSESSMENT OF ACTUAL AND POTENTIAL EFFECTS

36. The AEE reports that groundwater contamination may occur as a result of natural and planned infiltration of contaminated stormwater and that groundwater contamination is particularly significant when groundwater is used for human consumption. However, the AEE anticipates that the effects of contamination are likely to be "*limited to shallow groundwater localised around soil absorption basins*". Most of the public supply wells in Christchurch draw water from deeper aquifers, but there are many that are less than 60 metres deep. Because the overall changes in groundwater quality are expected to be slight, the effects on groundwater quality are considered in the AEE to be "*no more than minor*". I agree with this assessment, provided adequate treatment systems are built into the network and hazardous and toxic chemicals and heavy metals from industrial areas can be kept out of the stormwater.

37. The SMP recognises the loss of drinking-water supplies and the degradation of spring-fed streams as potential adverse effects in the objectives for the groundwater receiving environment (listed on page 50 of the SMP in Appendix B of the AEE). To protect drinking-water supplies, mitigation (in the form of soil adsorption basins) and the establishment of separation zones between discharge areas and existing and future shallow (less than 60 m deep) public drinking wells are recommended in the AEE. The effect on spring-fed streams is not addressed in detail. I will discuss these issues further in the following sections.

Community Drinking-Water Wells and Separation Zones

38. Section 7.7.1.2 of the AEE suggests applying a separation distance of 1,000 metres between a soil adsorption basin and future down-gradient public drinking-water supply wells less than 60 metres deep. This separation distance appears to be a conservative approach taken in response to the PDP's modelling. The modelling calculations suggest that faecal coliform concentrations greater than 1 cfu/100 ml (which exceeds the drinking-water standard) can occur at distances up to 500 m from the downgradient edge of the basins (PDP 2006).

39. The 1,000-metre separation distance is consistent with the NRRP requirements for a community drinking-water supply well where the top of the first screen is less than 30 metres deep, and more conservative than the 500-metre separation distance required for wells a minimum screen depth of 30 to 70 metres (NRRP Chapter 4, Schedule WQL2). The proposed upgradient and cross-gradient separation distance of 200 metres is consistent with the NRRP.

40. I endorse the adoption of the more conservative 1,000-metre separation distance to protect down-gradient wells from pathogens and other contaminants that might be infiltrated from the proposed stormwater basins. While stormwater is likely to have lower concentrations of pathogens than sewage effluent, tracer studies at Burnham and Templeton (Martin and Noonan, 1997; Sinton *et al.*, 1997) found that bacteria from flood-irrigated sewage effluent could travel over 900 metres in groundwater down-gradient of the discharge. A large separation distance also provides better protection against viruses. Even though concentrations of viruses in stormwater might not be expected to be very high, viruses are smaller (less easily removed by filtration), have longer survival rates in the environment (allowing them to be transported greater distances) and are infective in smaller doses than bacteria. Moore *et al.* (2010) suggest viruses may travel greater distances than bacteria in Canterbury's gravel aquifers.

41. I have noticed that separation zones for the protection of public supply wells are recommended in the PDP groundwater quality report (PDP 2006) and discussed in the AEE, but they are not written into the consent conditions. Instead, the Monitoring Programme, which will be attached to and form part of the consent if granted, makes provision for a downgradient zone of 1,000 m for the identification of at-risk private domestic wells in Section 2.3. While this provision captures some of the original intentions of a separation zone, it does not provide the same level of protection, especially for public supply wells. Under the current proposal, existing public supply wells less than 1,000 m downgradient of the discharges and new wells (public or private) installed within this zone after the commissioning of the soil adsorption basins will have no monitoring requirement, which leaves these wells at risk that any adverse effect from the discharges would not be detected or mitigated.

Private Drinking-Water Wells

42. The potential effect on private drinking-water wells is a significant groundwater quality issue arising from the proposed stormwater discharges. This is an opinion shared with some of the submitters, including Canterbury District Health Board (CDHB) and McFarlane Family Trust.

43. In Section 3.6 of the PDP 2007 report, 38 private domestic wells of less than 60 metres deep and 12 wells of unknown depth were identified within 1,000 metres down-gradient of the soil adsorption basin locations proposed at that time. Figure 18 of that report (included in Appendix F of the AEE) shows the locations of these wells, based on the currently planned basin locations. However, the basin locations will not be fixed by the consent if granted and the number and location of potentially affected wells is likely to change.

44. The AEE states that "*these private domestic wells are unlikely to be used when a reticulated water supply becomes available, and therefore effects on these wells are not considered any further*". However, there is no indication of when a reticulated supply is to be made available and the CDHB submission points out that "*there is no acknowledgement that the owner may not wish or be able to afford to do this"* [connect to the reticulated supply].

45. An attempt has been made to address the concerns about private drinking-water supplies in '"Version 1.0 Monitoring Programme for South-West Christchurch Stormwater Management Plan", dated 17 October 2011 (the "Monitoring Programme"). The Monitoring Programme proposes a pre-commissioning survey to identify at-risk private drinking-water wells prior to commissioning of any soil adsorption basin and quarterly sampling of the high risk wells for *E. coli* indicator bacteria. I endorse the monitoring of private drinking-water wells, although I suggest that the monitoring should be more comprehensive. I will discuss this issue further in the section of this report that deals with monitoring.

Baseflow to Spring-Fed Streams

46. As stated in the Executive Summary of the SMP, the "*water quality of springs contributing to surface waterway base and low flows is not expected to change significantly*". The soil adsorption basins are not proposed for locations close to springs. Although not explicitly stated in the AEE, it appears to me that the groundwater quality effect on spring-fed streams has been considered to be minor, based on an anticipated small overall change in groundwater quality.

47. The small overall changes to groundwater quality are supported by a mass balance calculation by PDP (PDP 2007) in which the contribution of rainfall recharge is relatively small (less than 10%) when compared to the volume of groundwater through-flow. I do not have sufficient knowledge of groundwater recharge and flow volumes for South-West Christchurch to comment on this matter. The water balance component of this modelling is being reviewed by Paul Goff.

48. Although I do not know what the effects of recharge from the stormwater basins will be on the quality of groundwater discharging to the spring-fed streams, I am of the opinion that stormwater discharges to infiltration basins will likely lead to better water quality in spring-fed streams than stormwater discharges directly to the streams. For this reason, I support the option of stormwater infiltration upgradient of the spring discharge zone.

PROPOSED CONSENT CONDITIONS

49. The AEE proposed consent conditions in Section 12. These conditions have been revised in Attachment 1 of a letter from CCC in response to a request for further information to Stephen Timms, Principal Consents Planner, Environment Canterbury dated 17 October 2011 (the "Revised Conditions"). In terms of groundwater quality effects, the key components of the Revised Conditions are:

- Condition 3: prohibiting discharges from contaminated land used for development
- Conditions 5, 6 and 15: auditing of high risk industrial sites and removal of sites with unacceptable risk from the consent.
- Conditions 11 and 12: monitoring in accordance with an agreed Monitoring Programme to investigate the effects of stormwater discharges on groundwater quality and soil quality, amongst other effects.
- Condition 16: annual reporting of monitoring results

50. The AEE recognises that industrial stormwater and stormwater discharged from or to contaminated land poses the greatest threat to groundwater quality. The scope of the

consent excludes discharges from construction areas on sites categorised as contaminated on Environment Canterbury's Listed Land Use Register (LLUR) and no stormwater treatment systems are to be constructed on sites categorised as contaminated. (refer Condition 3 that limits the scope of the consent). I support the exclusion of stormwater from known contaminated sites from the scope of the consent. Such activities should be required to go through a separate discharge consent process involving site-specific assessments of the contaminant types and concentrations to establish the risks and mitigation required for the protection of groundwater and surface water quality.

51. An audit of industrial sites is proposed to be undertaken by CCC over the next 10 years, beginning with the development of a programme for auditing high risk sites within one year, should the consent be granted. The audit will focus on, amongst other things, "*site environmental practices, including spill prevention/control, minimisation or elimination of contaminants at source*" Site management is not within my area of expertise so I will not comment on the details of the proposed audit, but I do support the need for good site management to prevent hazardous and toxic chemicals from entering the stormwater system. Measures should be in place at each site to prevent spills wherever possible and to contain all releases that do occur, and minimise hazardous substances being entrained in stormwater from poor site practices and inappropriate storage. The aim is to prevent on-going chronic and high concentrations of hazardous chemicals entering the CCC stormwater network and eventually entering the soil adsorption basin facilities where they may percolate to the groundwater.

52. Industries that present an unacceptable risk will be removed from the consent (Condition 5 (iv)). According to the AEE (page 11), the removal of an industry connection is considered "*an action of last resort*" to be imposed where "*site owners (or occupiers) cannot meet the required standards for discharge into the network*". Neither the AEE nor the SMP specify what the "required standard" for discharge will be and I suggest that this needs clarification for this consent condition to be enforced effectively. Brett Mongillo discusses this in more detail in his s42A report.

MONITORING PROGRAMME

53. A Monitoring Programme for the proposed stormwater discharges has been developed. Groundwater quality monitoring is addressed in Section 2.3 of the Monitoring Programme.

54. The stated purpose of the Monitoring Programme (Section 1.2 of the Monitoring Programme) is to determine if the receiving environment objectives are being met. The groundwater receiving environment objectives listed on page 50 of the SMP are to "*meet NRRP groundwater quality standards at public drinking wells and springs*"; "*maintain a high quality groundwater resource*", "*design soil adsorption basins and soakage systems to avoid contamination of deep confined aquifers*" and "*protect the water quality of springs that contribute to waterway baseflows*." The proposed groundwater quality monitoring involves only quarterly sampling of one water quality parameter in shallow private wells. In my opinion, this is not going to be effective in determining whether any of the groundwater receiving environment objectives are being met.

55. I accept that it would be a very costly exercise to monitor absolute compliance with all the groundwater quality objectives. For example, NRRP quality standards make reference to all health-based and aesthetic parameters in the New Zealand Drinking-Water Standards, which would require analysis of over 150 parameters in each

sample from public supply wells and springs downgradient of the discharges. I suggest that the list of parameters be scaled back to a few indicator parameters, similar to those proposed for surface water monitoring.

56. My preference for monitoring groundwater quality impacts is to sample from a dedicated network of closely-spaced, purpose-designed monitoring wells sampling at the water table along the downgradient boundary each discharge site. Properly sited, single-purpose wells would help to avoid questions of possible alternative contaminations sources, if contamination is detected.

57. The next, and less expensive, option is to monitor at the point of greatest possible adverse effect. In my opinion, the proposed monitoring of high risk private drinking-water wells would meet this criterion. I support the proposed monitoring of *E. coli* bacteria in high risk drinking-water wells as a minimum requirement for groundwater quality monitoring.

58. The Monitoring Programme includes provisions for follow-up sampling of lower-risk wells in the event that *E. coli* bacteria are detected in a high-risk private drinking-water well, which I think is a good idea. However, the document is vague about what options are available if detections keep recurring. There is also no provision for notifying the well owners if *E. coli* are detected in their wells or offering them alternatives. At this stage no details have been given on how the level of risk to each well will be decided, other than that this will be done "*in consultation with Environment Canterbury*".

59. The Monitoring Programme proposes identifying private domestic wells downgradient of new soil adsorption basins prior to commissioning, but makes no provision for those wells downgradient of existing basins. For example, a part of the largest of the soil adsorption basins described in the preliminary Stormwater Management Scheme (SWMS) in the SMP, the Awatea Road North Facility in Wigram (Figure 30 of the SMP), has recently been constructed and may well be commissioned. I recommend that if the CCC has not done so, they confirm with the occupiers and owners within the 1,000 m downgradient separation zone from this, and any other existing facilities, that they are on reticulated supply and not using shallow wells for domestic supply. If shallow domestic wells are in use in the separation zone, these should also be monitored to mitigate the risk to the well users.

60. I think that microbial contamination may pose the greatest threat to shallow groundwater users, particularly from residential stormwater. However, monitoring only bacterial contamination does not reflect the range of threats that the proposed stormwater discharges from industrial sites could pose to groundwater quality. The perceived low risk of localised groundwater contamination by lead and zinc are based on model calculations using several assumptions with no sensitivity analysis. Hydrocarbon contamination was not modelled at all.

61. Given the uncertainty in the modelling predictions and the range of contaminants of concern discussed in an earlier section of this report, I advise that additional parameters should be monitored in the groundwater, at least until it can be confirmed that the risk to groundwater quality is low. My suggested parameters include conductivity, selected heavy metals (copper, lead, zinc, cadmium and chromium) and hydrocarbons (BTEX, PAH and chlorinated solvents). I advise monitoring these parameters in all potentially-affected shallow drinking-water wells (public and private) within the 1,000 m downgradient separation zone of stormwater infiltration facilities receiving industrial stormwater discharges. Monitoring of E.coli bacteria in at-risk drinking-water wells should be sufficient for infiltration facilities receiving only

residential stormwater, although any shallow public supply wells should be included in the monitoring, in addition to private wells.

62. The Monitoring Programme also sets out monitoring requirements for soil quality (although only for one basin in the South-West Christchurch area) and soil infiltration rates (Section 6). These are also relevant for the protection of groundwater quality. Monitoring the soil adsorption basins is important for ensuring that contaminant removal processes are working properly and that soil degradation and the formation of preferential flow channels, which could allow stormwater infiltration with little or no soil treatment, are not occurring. Brett Mongillo has reviewed the soil adsorption basin monitoring.

CONCLUSIONS

63. I generally agree with the conclusions of the AEE with respect to the effects on groundwater quality. In my opinion, as long as the proposed stormwater discharge occurs via soil adsorption basins rather than directly to soak holes (except for roof water) and high concentrations of toxic and hazardous chemicals from industries and contaminated sites can be excluded, the effects on groundwater quality are unlikely to be more than minor.

64. I endorse the adoption of measures to protect both stormwater and groundwater quality. These include management of discharges from industries and contaminated sites, soil adsorption basins, and separation distances.

65. I emphasize the threat that hazardous and toxic chemicals from industries could pose to groundwater quality should these substances enter the CCC stormwater network. Industrial sites need additional site management to ensure that contaminant loads to stormwater are acceptable. I support measures such as the auditing of industrial sites to educate problem sites to use best practices to minimise their impact on stormwater quality and, if unsuccessful, the removal of unacceptable industrial discharges from the consent.

66. Soil adsorption basins provide an important method for mitigating possible adverse effects on groundwater quality. Soil adsorption basins will need to be sited, designed, constructed, maintained and monitored to ensure they operate efficiently. I support the condition that soil adsorption basins are not to be constructed on known contaminated land (unless remediated) and the receiving environment objective that adsorption basins and soakage systems be designed to avoid contamination of deep confined aquifers.

67. I also support the proposed 1,000-metre separation distance between soil adsorption basins and down-gradient public drinking-water supply wells less than 60 metres deep. Although separation distances for public supply wells were proposed in the AEE, monitoring of existing or future shallow public wells within this zone has not been included in the Monitoring Programme. I recommend that the Monitoring Programme be revised to address the risk to these wells.

68. Several private drinking-water wells are likely to fall within the 1,000-metre separation distance from existing or future soil adsorption basins. Monitoring the quality of drinking-water supplies, especially the potential for bacteria contamination, in all wells that continue to be used for drinking-water should be a priority for groundwater quality monitoring. I support a door-to-door survey to identify current and future at-risk private-drinking wells and a minimum of quarterly monitoring for *E.coli* bacteria in samples from high risk wells.

69. Because of the range of contaminants of concern in industrial stormwater, I advise that additional parameters, such as conductivity, selected heavy metals and hydrocarbons, also be included for groundwater quality monitoring for all drinking-water wells within 1,000 m downgradient of facilities receiving industrial stormwater.

70. Monitoring shallow-drinking water wells as proposed could be a useful means of identifying possible adverse impacts of the proposed stormwater discharges on down-gradient groundwater users. However, uncertainties could later arise when trying to link any detected contamination directly to the stormwater discharges. In my opinion, installing closely-spaced, dedicated monitoring wells near the down-gradient boundary of each soil adsorption basin receiving industrial stormwater and monitoring these for a range of contaminants of concern would be a more effective means of monitoring the impact on groundwater quality from the proposed stormwater discharges.

Signed: ____________________ Date: 31 October 2011

Lisa C Scott
Groundwater Quality Scientist, Environment Canterbury

Reviewed by:

Signed: ____________________ Date: 31 October 2011

Carl R Hanson
Groundwater Quality Team Leader, Environment Canterbury

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