Resource consent application WGN130103: Water quality and aquatic ecology technical review

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Summary of key points

1. The applicant has undertaken a significant amount of work in attempting to understand the potential effects of the River Recharge with Groundwater (RRwGW) proposal. However, I believe that there is still considerable uncertainty around the potential effects on the Waikanae River and the various small streams that might be impacted by the proposal. Further, I disagree with some of the conclusions made in relation to the assessments/experiments undertaken and presented in the technical reports that informed the AEE. Given this uncertainty and the high aquatic ecological values of the Waikanae River, I believe a precautionary approach is required by Greater Wellington Regional Council (GWRC) when processing this application.

2. The most notable gap in the AEE methodology is that there is no overview of the ecological values of the various small stream that may be affected or a proposal to collect new project-specific data on the small streams within the area of potential impact (from borefield drawdown). The effects of stream depletion caused by borefield drawdown on the aquatic ecosystems of these small streams have not been adequately addressed and requires further assessment.

3. Monitoring of groundwater bores undertaken so far has been insufficient to accurately characterise the water quality of these bores and hence to fully inform my review. Further water quality monitoring of these bores is required. This should occur prior to the discharge of any groundwater to the Waikanae River and would enable the bore hierarchy to be developed based on accurate and robust information.

4. Thresholds for what are acceptable changes in water quality, periphyton growth/cover and other ecosystem indicators (eg, macroinvertebrates and fish) need to developed/proposed and these need to recognise the high ecological and recreational values of the Waikanae River and the small streams considered to be most at risk. Given the uncertainty of the effects and the high values of the river, a comprehensive monitoring plan needs to be developed in consultation with GWRC that incorporates these thresholds and includes suitable mitigation options.

5. If an adaptive management approach is decided as an appropriate way forward, the applicant must first provide significantly more information on the proposed monitoring, thresholds and mitigation.
A  Introduction

1. Kapiti Coast District Council (the applicant) has applied for resource consents to increase abstraction the Waikanae River and from their public water supply borefield as well as authorise the discharge of groundwater to the Waikanae River (just downstream of the existing water supply abstraction point). The consents are required as a part of a proposed medium term (50-year) solution to securing a reliable potable water supply for the communities of Waikanae, Raumati and Paraparaumu. The application was lodged in November 2012.

2. The duration sought for the consents is 35 years.

3. This technical report is one of four that serves to support the GWRC section 42a officer’s report and therefore a full description of the proposed activities and the planning aspects relevant to the applications will not be repeated here.

B  Scope of this report

4. This report focuses on the technical aspects of the proposed river recharge activities in relation to water quality and aquatic ecology. The report includes:

   (a) a brief overview of the existing water quality and ecology of the Waikanae River and small coastal streams on the Kapiti Coast (including the ecological values of these systems);

   (b) a brief description of the river recharge proposal followed by comment on the adequacy of assessment methods and information provided;

   (c) an evaluation of the applicant’s Assessment of Environmental Effects (AEE);

   (d) a brief summary and evaluation of matters raised by submitters in relation to water quality and ecology;

   (e) an evaluation of proposed monitoring and options for adaptive management; and

   (f) recommendations, should consent be granted, on draft consent conditions that provide a regulatory framework for managing and monitoring the effects of the proposed activities.

6. The reports directly relating to the application that I have consulted in whole or part to prepare this report include:

   • Suren A, Wech J and Gadd J. 2011. The effects of groundwater discharge on the algal, invertebrate and fish communities of the Waikanae River. Prepared for Kapiti Coast District Council by NIWA (including the review by Dr Death contained within Appendix A, which is referred to in this report as Death 2011).


• Beca 2012. Memorandum dated 5 November 2012 to GWRC. Subject: GWRC comments on the draft KCDC application (including the accompanying material from NIWA).


• Beca 2013b. *Draft monitoring plan*. Summary tables prepared by Beca (Beca reference#NZ1-7149772-4 0.4), dated 13 March 2013.

5. Other reports and material consulted in the preparation of this report are cited in the text and listed in the references section at the end of the report.

6. Comments in this report are limited to river and stream water quality and ecology. Technical material relating to hydrology, groundwater hydrology, wetland ecology and hydrology has been reviewed by Thompson (2013), Mzila (2013) and Myers (2013), respectively.

C Summary of the proposal

7. The overall concepts and operational details of the river recharge proposal are described in detail in GWRC’s section 42a officer’s report and Chapter 3 of the AEE and are not repeated here. However the following paragraphs summarise the features most pertinent to the review contained in this report.

8. At present, when the Waikanae River recedes to extreme low flows, community water supply needs cannot be fully met and groundwater from the KCDC borefield is used instead. This activity occurs under existing resource consents held by the applicant for abstraction of river water and groundwater. Due to the undesirable nature of the groundwater (for potable supply), the applicant has sought to ‘exchange’ it on a litre-by-litre basis for river water, thereby allowing an exclusive (and secure) river water supply, even during the most extreme drought scenarios.

9. Characterising the proposed activity (ie, likely frequency of river recharge in the future) has been based largely on applying future water demand estimates to a historical river flow record to generate a number of scenarios for effects assessment. The worst case scenario represents a combination of predicted demand in the year 2060 and a 1-in-50 year drought low flow in the Waikanae River. Assessments of the effects of the proposal (primarily under the worst case scenario) has focussed on two main areas: modelling the likely groundwater drawdowns associated with increased abstraction from the existing borefield and predicting the instream consequences of discharging bore water to the Waikanae River.

10. The applicant has acknowledged difficulties in fully assessing the likely impacts of the proposal. They have proposed to deal with these limitations by undertaking targeted monitoring within an adaptive management framework.
D Description of the environment

11. This section provides a brief description of the water quality and aquatic ecological health/values of the Waikanae River and small streams that may be affected by the applicant’s proposal. Recreational values are also briefly described where appropriate. For descriptions of the hydrological, hydrogeological (including groundwater-surface water interactions) and wetland environments, refer to peer review reports of Thompson (2013), Mzila (2013) and Myers (2013), respectively.

Waikanae River

12. The Waikanae River is a gravel bed river with a catchment area of about 149 km$^2$, draining the southwest Tararua Range. The catchment is dominated by indigenous forest (~66%). However, there are significant areas of exotic forestry and pasture. There is also an urban component, although proportionally this is very small (~1%)$^1$.

13. The Waikanae River is considered to have some of the highest indigenous fish values in the Wellington region. The river, along with several of its tributaries, is listed in Appendix 3 of Greater Wellington Regional Council’s (GWRC) Regional Freshwater Plan (RFP) (WRC 1999) as having nationally threatened fish species recorded in the catchment. The Waikanae River is also identified in GWRC’s Regional Policy Statement (RPS) (GWRC 2013) as a river with a significant indigenous ecosystem: high macroinvertebrate health (above and including the Reikorangi Stream), habitat for threatened indigenous fish species, habitat for six or more migratory fish species, and inanga spawning habitat.

14. In addition to high indigenous aquatic ecological values, the Waikanae River is also identified in Appendices 4 and 5 of GWRC’s RFP as a water body with important trout habitat (including spawning habitat) and as having regionally important recreational values (swimming and angling), respectively.

15. As part of its Rivers State of Environment (RSoE) monitoring programme, GWRC undertakes monthly water quality monitoring and annual assessments of aquatic ecosystem health at two sites on the Waikanae River (Waikanae River at Mangaone Walkway and Waikanae River at Greenaway Road). Results from recent analysis of this data undertaken in Perrie et al. (2012) are summarised in paragraphs 16 to 19.

16. Based on the application of a water quality index using monthly data collected over a three–year period (July 2008 to June 2011), water quality at Waikanae River at Mangaone Walkway and Waikanae River at Greenaway Road were classed as ‘good’ and ‘excellent’, respectively. Both sites had high water clarity, low counts of faecal indicator bacteria and generally recorded low concentrations of nutrients$^2$.

17. Analysis of monthly observations of periphyton cover and annual assessments of periphyton biomass over the same three–year period indicated that nuisance periphyton growths are not common and during the three–year period examined, both monitoring sites were classed as ‘excellent’ (ie, low periphyton growth).

18. Application of the Macroinvertebrate Community Index (MCI) to data collected over this period classed the Waikanae River at Mangaone Walkway and Waikanae River at Greenaway Road as ‘excellent’ and ‘good’, respectively. Of the 55 river and stream sites monitored by

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$^1$ These catchment landcover proportions are based on the catchment upstream of the Waikanae River at Greenaway Road but are generally indicative of landcover proportions for the entire catchment.

$^2$ The site located in the upper catchment, Waikanae River at Mangaone Walkway, slightly exceeds the ANZECC (2000) lowland trigger value of 0.01 mg/L but this is thought to reflect the underlying geology of the catchment (Perrie et al. 2012; Ausseil 2011).
GWRC, it is worth noting that the Waikanae River at Mangaone Walkway recorded the third highest MCI score over the period examined (140.9).

19. Overall, the monitoring undertaken by GWRC indicates that the Waikanae River has high water quality and aquatic ecological health and it generally ranks as one of the better rivers assessed in the region (eg, Perrie et al. 2012).

20. In terms of recreational water quality, a recent analysis by Greenfield et al. (2012) reported Suitability for Recreation Grades (SRFGs) of ‘fair’ for swimming sites located at State Highway 1 and Jim Cook Park. However, while microbiological contamination is generally low, both sites are at times affected by growths of potentially toxic cyanobacteria, specifically *Phormidium sp*. Moderate growth of cyanobacteria has been reported from at least one of these monitoring sites every year since monitoring commenced in 2006/07 (Greenfield et al. 2012). Although no cyanobacteria linked dog deaths or human health issues have been reported in the Waikanae River in recent years, there is anecdotal evidence that dog deaths recorded in the Waikanae River area in 1998 were related to consumption of toxic cyanobacteria.

**Small streams on the coastal plain**

21. The only stream site on the coastal plain that is currently monitored under GWRC’s RSoE programme, and that may be adversely affected by this proposal, is the Ngarara Stream (the monitoring site is located at Field Way). Water quality data from this site classes it as ‘poor’ and it doesn’t meet guidelines for dissolved oxygen, faecal indicator bacteria, dissolved reactive phosphorus and nitrite-nitrate nitrogen. MCI scores are also indicative of degraded ecosystem health (Perrie et al. 2012).

22. Historical GWRC data are available for additional sites on the Ngarara Stream (located on the Kakariki Stream) and these data are also indicative of poor water quality and ecological health (Perrie 2007). However, Perrie (2007) did note some improvements to water quality and ecosystem health at sites monitored. These improvements were attributed to rehabilitation of the riparian margins of section of this stream.

23. While the limited available water quality and macroinvertebrate monitoring data indicate poor water quality and ecological health in coastal streams on the Kapiti Coast, these streams are known to have high indigenous fish values (eg, Joy et al. 2013; Perrie et al. 2012). For example, in 2011 Joy et al. (2013) recorded eels, giant kokopu, banded kokopu, inanga, common bully, giant bully, redfin bully and koura (freshwater crayfish) in a section of the Ngarara Stream. Based on indigenous fish criteria, GWRC’s RPS (GWRC 2013) lists several Kapiti coastal streams as having significant indigenous ecosystems (eg, Mangaone Stream, Waimeha Stream, Whareroa Stream and the Whareroa Stream), indicating the potential high value of these coastal stream systems.
E Adequacy and completeness of information

Overall comment
24. The applicant has undertaken a significant amount of work in attempting to understand the potential effects of the RRwGW proposal. However, I believe that there is still considerable uncertainty around the potential effects on the Waikanae River and other water bodies in the area from the RRwGW. Further, I disagree with some of the conclusions made in relation to the assessments/experiments undertaken and presented in the technical reports that informed the AEE. Given this uncertainty and the high aquatic ecological values of the Waikanae River (and other potentially affected water bodies), I believe a precautionary approach is required by GWRC when processing this application.

Gaps/limitations of the AEE
25. The most notable gap in the AEE is that there is no overview of the ecological values of the various small stream that may be affected or a proposal to collect new project-specific data on the small streams within the area of potential impact (from borefield drawdown). Given the known or potential significant values of these stream ecosystems I would have expected a description of these values as well as an assessment of potential effects. This should have included additional surveys of aquatic values as well as hydrological surveys to provide an understanding of the relationships between ecological values and flow. Thompson (2013) and Mzila (2013) also highlight limitations in their reviews of the hydrological and hydrogeological components of assessing the effects of RRwGW on small streams (these are not discussed in detail in this report).

26. Additional gaps or limitations in the AEE include:
   a) A lack of water quality monitoring data from some bores for key variables such as dissolved reactive phosphorus;
   b) Experimental methodology/design and interpretation of some results;
   c) Insufficient detail on how fish passage will be maintained over the weir located in at water take for the water treatment plant; and,
   d) No assessment of the potential effects on trout populations in the Waikanae River;

27. The above limitations/gaps are discussed in more detail in Section F.

28. Lastly, the applicant has not defined or proposed any ‘thresholds’ of what they consider might be appropriate or acceptable change in either water quality or measures of ecosystem health other than stating that where a change may occur it may be acceptable. I consider thresholds need to be established that clearly define when an effect has occurred and set in motion appropriate mitigation. This is discussed further in subsequent sections of this report.

F Assessment of environmental effects (AEE)

Waikanae River
Water quality – general
29. As stated in the AEE, the RRwGW option will result in a significant change in downstream water quality and, depending on the amount of groundwater being discharged, will shift from that characteristic of surface water to that more characteristic of groundwater (eg, higher mineral content with conductivity potentially increasing from around 100 µS/cm to 1,000 µS/cm). Other variables, such as concentrations of nutrients and metals, may also change
significantly as a result of the RRwGW (where relevant these are discussed in more detail below).

30. The RRwGW may also result in a change in water temperature in the Waikanae River and this could breach water quality guideline A8.2 (2) listed in Appendix 8 of the RFP (WRC 1999). This guideline states that the natural temperature of the water shall not be changed by more than 3°C. Wech (2012) shows that during autumn/winter the groundwater may warm the river by around 3°C (see Table 3.1 and Figure 3.1 in Wech 2012). The opposite may happen in summer (eg, groundwater might cool the river), which could be argued as beneficial. However, this would still constitute a breach of this guideline.

31. The RRwGW may also breach water quality guideline A8.2 (5) of Appendix 8 in the RFP which states that there shall be no undesirable biological growths as result of any discharge of a contaminant to water. The AEE states that the RRwGW will likely cause an increase in periphyton growth. An increase in periphyton growth above natural levels would generally be considered undesirable (increased periphyton growth is discussed further below). If this consent is to be granted the inability of the RRwGW to comply with these water quality guidelines listed in GWRC’s RFP needs to be considered.

32. The AEE states that the groundwater is of acceptable quality to be discharged to the Waikanae River, and that the resulting effects of the groundwater discharge will either be minor or can be mitigated. While significant effort has been invested in determining what effects will be, the complexities of riverine ecosystems, along with some of the experimental methodology employed means that it is difficult to investigate and quantify all potential effects (eg, effects on fish eggs and larvae, micro-organisms, etc.). As such, a significant amount of uncertainty remains around the effects and whether the bore water is of an ‘acceptable’ quality to be discharged. Further, and as mentioned above, the RRwGW may breach water quality guidelines listed in GWRC’s RFP that provide guidance for effects assessments (WRC 1999).

Bore water quality

33. The quality of the groundwater to be used in the RRwGW option has yet to be adequately characterised. For example, in some bores nutrient concentration data are not available at all and for some other bores it is limited to one or two sampling occasions. While groundwater quality is generally considered to exhibit less seasonal variability than surface water quality, especially in deeper aquifers such as those to be used in the RRwGW, the sampling effort to date can not be considered sufficient to characterise the water quality in these bores. Via the s92 further information response, the applicant has stated that further water quality sampling is not required because previous results have been fairly consistent. I disagree with this statement because for the 11 bores where data are presented (via S92 response), ten of them have had water samples analysed for dissolved reactive phosphorus (DRP) on only two occasions or less. Further, variation in water quality in some bores is apparent. For example, the two total phosphorus results recorded against bore S2 were 0.061 and 0.111 mg/L (although the difference in these results may also reflect how the bore was sampled (different depths, etc.). The two sample results (but collected from different depths) further indicates that sampling so far has not been adequate for bore water characterisation.

34. To further illustrate that the sampling to date is inadequate to characterise the water quality of the bores to be used in the RRwGW and to show that water quality in deep bores can vary seasonally (or temporally), concentrations of DRP against time for two deep bores monitored under GWRC’s Groundwater Quality State of Environment (GQSoE) programme are plotted in Figure 1 (Bore R25-5135 is located on the Kapiti Coast and is 93 m deep and bore S27-0602 is located in the southern Wairarapa and is 61 m deep. Both bores show reasonable variation for time period presented (and at times between consecutive samples) with maximum values
recorded around two and four times greater than minimum values recorded for bores R25-5135 and S27-0602, respectively.

![Figure 1: Dissolved reactive phosphorus concentrations for bores R25-5135 (Left, Kapiti Coast, 93 m deep) and S27-0602 (South Wairarapa, 61 m deep), based on data collected quarterly by GWRC for the period 2005 to 2011. Note different scales on the y-axis.](image)

35. Accurate characterisation of the water quality of each bore is not only important for assessing what the effects on the ecosystem will be (eg, what nutrient concentrations can we really expect from some of these bores) but also to accurately inform the development of a bore hierarchy which will help mitigate any effects. Better characterisation of the bore water quality was also a recommendation made in one of the AEE background reports (Suren et al. 2010). If this consent is to be granted, adequate water quality monitoring of all bores (undertaken to the satisfaction of GWRC) should occur prior to any groundwater being discharged into the Waikanae River. An on-going water quality monitoring programme will also need to be developed.

**Nutrient concentrations in bore water compared with background concentrations in the Waikanae River**

36. The AEE and supporting documents indicate that a significant increase in DRP is likely to occur in the Waikanae River as a result of RRwGW. However, at least based on the limited monitoring data from some bores, concentrations of soluble inorganic nitrogen (SIN) may also increase. This has not been acknowledged in the AEE or in its supporting documents that assessed the effects of the RRwGW. The AEE states that the RRwGW will “likely lower concentrations of soluble inorganic nitrogen” (AEE, P53). Based on the data supplied (via s92 further information request), concentrations of soluble SIN in some bores are twice that likely to be present in the Waikanae River during the low flow periods in which the RRwGW may be in operation. As such there is the potential that the RRwGW will lead to an increase in both DRP and SIN concentrations in the Waikanae River.

37. An additional difficulty, as noted above in paragraphs 33 to 35, is that the concentrations of nutrients in bore water to be used in the RRwGW have not been adequately characterised.

**Toxicants**

38. As with nutrients, concentrations of toxicants (eg, heavy metals and metalloids) in each bore have not been adequately characterised due to limited sampling to date. Data presented for nine bores in the AEE indicate water samples have been analysed for dissolved metals on four occasions in one bore, two occasions in three bores and five occasions in the remaining five bores. The AEE also indicates that in some bores measured concentrations of dissolved copper and zinc exceeded ANZECC (2000) guidelines for 90% level of protection. While some dilution of bore water and associated toxicants will clearly occur in the river, accurately
determining what concentrations are present is the critical first step to fully assessing the potential effects of heavy metal discharged from the groundwater to the river.

Bore hierarchy
39. I support the development of a bore hierarchy in attempt to minimise potential effects on the Waikanae River (eg, use the bores with highest water quality and most similar to the river first). However, in addition to using concentrations of DRP to determine this hierarchy, consideration should also be given to:

- Bores with chemical signatures more similar to the river water quality;
- Concentrations of SIN; and
- Concentrations of toxicants.

40. To accurately inform the bore hierarchy the water quality of each bore will need to be adequately characterised. If this consent is to be granted, adequate monitoring of all bores should occur prior to any groundwater being discharged into the Waikanae River.

Waikanae River – periphyton
41. The Waikanae River is recognised by GWRC as being significant for contact recreation and as having significant aquatic ecological values (eg, RFP and RPS). Increases in concentrations of nutrients (DRP and SIN) due to the RRwGW are likely to lead to an increase in periphyton growth and this may negatively impact on both the recreational and ecological values of the Waikanae River.

42. The AEE acknowledges this (although note that the AEE and its supporting documents do not acknowledge that SIN may increase as part of the RRwGW) and states that there will likely be an increase in periphyton growth but that this increase will likely be acceptable from both an ecological and public health perspective. However, ‘acceptable’ has not been defined and no threshold to measure what is acceptable has been proposed. It is important to discuss and attempt to set thresholds for which an increase above and beyond that of the current state becomes unacceptable (and trigger appropriate mitigation, etc.). These thresholds should be included in consent conditions.

43. Statements in the AEE supporting information, such as “…the river naturally exceeds the MfE (2000) guideline values in the absence of RRwGW” (NIWA’s response in BECA’s memo dated 5 November 2012) are not helpful. These statements do not indicate/conclude that any effects associated with the recharge are acceptable. Increases in soluble nutrient concentrations as a result of the RRwGW could lead to more frequent breaches of MfE (2000) and/or MoH/MfE (2009) guideline values or further exacerbate the situation when environmental conditions are favourable for periphyton growth (ie, in the absence of the RRwGW, guidelines might be breached but with the addition of extra nutrients caused by the RRwGW, higher periphyton cover/biomass may occur above that which would normally occur. This may have further adverse effects on recreation and aquatic ecosystem values).

44. It is worth noting that while monitoring undertaken by GWRC does show that on occasion the Waikanae River does exceed some MfE (2000) and/or MoH/MfE (2009) guideline values, when compared with other rivers in the region, issues with the occurrence of nuisance growths of periphyton in the Waikanae River and associated breaches of guidelines are relatively infrequent (eg, see Perrie et al. 2012 and Greenfield et al. 2012).
45. Given that the concentrations of nutrients currently measured in water samples collected from the Waikanae River are relatively low (Perrie et al. 2012; s92 further information response) and that there is some indication of nutrient limitation of periphyton growth occurring in the Waikanae River (Ausseil 2011), the increase in concentrations of DRP and SIN could lead to an increase in the frequency of breaches of MfE (2000) and/or MoH/MfE (2009) guidelines.

46. The effects of this increased periphyton growth on the aquatic ecosystem (eg, invertebrates and fish) are not fully addressed in the AEE and this requires some discussion/clarification by the applicant. When setting appropriate thresholds for what is an acceptable increase in periphyton growth, consideration also needs to be given to setting thresholds for what is an acceptable change in other measures of ecosystem health (that might be adversely affected by increased periphyton growth). For example, QMCI scores should not deviate from 20% between sites located upstream and downstream of the RRwGW discharge point.

47. While the applicant’s experiments to date have concluded that the RRwGW is unlikely to lead to an increase in potentially toxic cyanobacteria, these conclusions should be treated with caution. Firstly, the experiment undertaken by Suren et al. (2011) was hampered by differences between control and impact sites and this may have affected the validity of the results. The interpretation of these results – that the RRwGW did not lead to increase in periphyton (including potentially cyanobacteria species) – were also disputed in a review undertaken by Death (2011). Secondly, the experiment was undertaken along the edge of the river and in my experience cyanobacteria is unlikely to (at least at the beginning) proliferate along the rivers edge (eg, Figure 2). This may indicate that habitat in both the control and experimental channel is not the preferred habitat for cyanobacteria.

Figure 2: Proliferation of benthic cyanobacteria in the middle of the channel in the Waipoua River. Note that the cyanobacteria mats are not growing along the edge of the river channel (December 2011).

48. As a result of the uncertainty of the results presented in Suren et al. (2011), a second set of experiments was undertaken (Wech 2012). Wech (2012) concluded that the RRwGW would
lead to increase in periphyton growth but that this was unlikely to be benthic cyanobacteria. While I agree with the interpretation of results presented in Wech (2012), caution is still required because:

a) The experiments undertaken by Wech (2012) used artificial channels, and while extremely useful, there is always some uncertainty around how the validity of these results would apply to an actual river;

b) The role of DRP and SIN (absolute concentrations as well as SIN and DRP ratios) in promoting cyanobacteria growth/blooms is not completely understood in rivers in New Zealand and subject to further on-going research (eg, Heath et al. 2012; Greenfield pers. comm. 2013); and

c) The water quality (including concentrations of DRP and SIN) of the groundwater bores has yet to be adequately characterised and increases in SIN were not considered in the AEE, Suren et al. (2011) or Wech (2012) when evaluating the potential effects of the RRwGW.

Mitigation of increased periphyton growth – flushing flows generated by water treatment plant

49. I consider the effectiveness of the proposed mitigation measures to reduce periphyton cover/biomass to be highly questionable.

50. The AEE states that a flushing discharge generated from the Water Treatment Plant can increase the flow in the river from around 600 L/s to around 950 L/s and that this has the potential to mitigate and remedy any algal proliferation (although it does state that the success of this flush in removing periphyton is unknown and will depend on species present, etc). In my opinion this small increase in flow will likely cause a negligible reduction in periphyton cover. Biggs and Close (1989) indicate that at least an increase of six times the preceding baseflow is required before any removal of periphyton is likely to occur. Despite further discussion in the s92 response, I still believe that the effectiveness of this proposal will be minimal in reducing periphyton cover/biomass.

51. Similarly, mitigation actions such as raking of the substrate are probably not feasible given the length of river bed that would likely require raking.

52. If the RRwGW led to an unacceptable increase in periphyton growth it is unlikely that there are any feasible options available for the applicant for removing excessive periphyton growth. More appropriate mitigation/offsetting might be indirect measures such as developing a bore hierarchy and habitat enhancement (eg, riparian fencing, planting, remediation of fish passage issues etc.) elsewhere in the catchment.

Waikanae River – fish

53. The Waikanae River is recognised in both GWRC’s RFP and RPS as having significant indigenous fish values. Sixteen indigenous species have been recorded within the Waikanae catchment, ten of which are classified as threatened species with populations that are considered to be at risk or declining (Allibone et al. 2010). Koura (freshwater crayfish) are also recorded in the catchment and are classified as a threatened species (Hitchmough et al. 2007) Based on my observations/surveys, the Waikanae River also appears to have higher numbers of lamprey ammocoetes than other rivers in the Wellington region; indicating that is a potential ‘stronghold’ for this threatened species.

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3 Summer Greenfield, Senior Environmental Scientist, Greater Wellington Regional Council.
4 NIWA’s National Freshwater Fish Database (NZFFD) accessed in February 2013. Brown trout (introduced species) are also recorded in the NZFFD.
54. The AEE states that the "NIWA investigations concluded that RRwGW will have no adverse effect on fish survival or growth" (AEE, p56). However, in his review of Suren et al. (2011), Joy (2011) highlighted a number of limitations of the investigations undertaken that dispute this conclusion or at least indicate that it should be interpreted with caution. These limitations include:

a) The control and impact sites were not similar;  
b) Overtopping of the impact channel by floods/freshes;  
c) Sample sizes of fish used in experiments (tanks and cages) were not sufficient to show a statistical robust response;  
d) Only three of 16 fish species recorded in the catchment were used in the experiments;  
e) Growth rates cannot be adequately assessed over such a short period using adult fish and individual fish were not tagged; and  
f) The effect on migrating fish was not assessed.  

55. Dr Joy also disagreed with some of the interpretation of the data and states that the smaller increase in fish density over the duration of the study in the impact channel vs. the control channel\(^5\) reveals a potential impact from the RRwGW. Overall Dr Joy concluded that the overall conclusion in Suren et al. (2011) "the RRwGW option is thus highly unlikely to have any effects on fish communities in the Waikanae River" (p57) is not justified by the data.  

56. Overall, I generally agree with the limitations of the experimental design documented in Joy (2011). Additionally, I add that Suren et al. 2011 did not examine all potential effects, such as effects on micro-organisms which are the food source for lamprey ammocoetes (and other fish larvae/fry) or effects on survival and growth of key life stages such as fish eggs and larvae/fry. However, I also acknowledge that there are resource constraints in undertaking these types of investigations (eg, having adequate sample sizes, examining the effects on all fish species, etc.) and that the applicant has invested substantial effort in an attempt to understand the potential effects of the RRwGW on fish populations in the Waikanae River. Nonetheless, considerable uncertainty remains around some potential effects from RRwGW on the high indigenous fish values of the Waikanae River and I do not agree with the definitive conclusion in the AEE that there will be no effects on the growth and survival of fish.  

57. The AEE recognises that the change in the chemical signature of the river water due to the RRwGW may discourage migratory native fish from entering the Waikanae River mouth. Suren et al. 2011a states that while some upstream migration occurs in early summer that there is less in late summer/autumn when the RRwGW option is likely to occur. However, this statement overlooks that while less fish may be entering the river mouth during late summer/autumn, it is likely that considerable numbers of fish will be in the river system and may encounter the RRwGW bore discharge as they progress further upstream during this period (ie, fish may enter the river mouth during spring/early summer prior to operation of the RRwGW but may encounter the groundwater signature as they move up the main stem of the Waikanae River later in the year). The effects of the RRwGW on upstream migration are unknown (eg, if the groundwater signature is 'unattractive' this could lead to a decline in fish in habitat upstream of the RRwGW discharge point).  

\(^5\) The increases in fish densities that were recorded in both the impact and the control channel were thought to relate to seasonal migrations (eg, redfin bullies moving upstream).
Trout

58. To date the effects of the RRwGW option on trout do not appear to have been examined or considered in the AEE. GWRC’s RFP recognises the Waikanae River as being significant for trout habitat (including spawning habitat) and for angling. Trout are generally considered to be more sensitive to changes or deterioration in water quality than indigenous species and the effects on trout should have been examined. Upstream migrations of mature trout to suitable spawning habitat occur in autumn/early winter and so there is the potential that the RRwGW will coincide with this key life history period. Potential effects on trout should be discussed in consultation with Fish and Game.

Fish passage past the weir

59. Apart from assurances in the AEE that fish passage will be maintained over the weir, an assessment by a freshwater ecologist does not appear to have been undertaken or if it has the details are not provided. Given that the RRwGW will occur during summer and autumn and that this period coincides with upstream migrations of indigenous fish and trout, an assessment of the suitability for the weir to provide/maintain fish passage is required. This should be undertaken by a suitably qualified freshwater ecologist and needs to take into account the reduction in flow over the weir that will occur due to the RRwGW option.

Small stream flow depletion from aquifer drawdown

60. Depletion or drawdown of water levels and flows in small streams within the RRwGW footprint are likely to occur. In some cases the depletion of these small streams may be significant and can be considered a high level of hydrological alteration (see Thompson (2013) for further details). However, the effects on the ecological values of these small streams were not examined in the AEE, nor have the ecological values of these small streams been characterised in any way. At least some small Kapiti Coast streams, including some of those that may be affected, are known to have high ecological values – especially in regards to indigenous fish communities.

61. Given that the values of these small streams have not been characterised and that no assessment of the effects of the RRwGW on the values has been undertaken in the AEE, I can provide no comment on whether I think the effects have been accurately assessed other than to say that this is a significant gap in the application. Relationships between shallow groundwater and stream flows need to be developed and this needs to occur in conjunction with an assessment of how known ecological values may be affected by stream depletion caused by the RRwGW. If this consent is to be granted a comprehensive monitoring plan looking at establishing the baseline ecological values of these streams needs to be implemented. This monitoring programme would need to provide an understanding of how these ecological values will respond to changes in flow.

G Comment on submissions

62. I have reviewed the summary of submissions. My comments on aspects of the submissions that relate to river and stream water quality and ecology follow.

63. A recurring theme in comments from submitters was about the general risk of negative impacts from the scheme on the ecological and recreational values of the Waikanae River. The concerns relate mainly to the change in water chemistry in the river due to the bore water discharge (ie, addition of nutrients), and in particular concern about whether this will promote more algae growth (including blooms of potentially toxic cyanobacteria), and/or compromise ecological and fishery values. Several submitters state that not enough research has been undertaken and/or that considerable uncertainty remains in regards to the potential effects. I consider these
concerns generally valid in that there remains considerable uncertainty about the impact of changes in water chemistry at low flows on ecological and recreational values.

64. In some cases, submitters state that their concerns may be addressed through rigorous monitoring and by setting thresholds or standards that protect the high ecological and recreational values of the Waikanae River. I generally agree that a rigorous monitoring programme accompanied by appropriately designed and defined water quality and ecological thresholds/standards may help alleviate some of the existing uncertainty that remains around the effects of this proposal (see Sections H and I).

65. At least two submitters commented on a lack of information about the potential effect of groundwater drawdown on surface water features as well as sensitive, high value environments that are hydraulically connected to these features. I agree that this is a valid concern and consistent with my comments in paragraphs 60 and 61 and addressed further in Mr Thompson’s hydrology technical review of this application (Thompson 2013).

H Draft monitoring plan and proposed consent conditions

Draft monitoring plan

66. Overall the draft monitoring plan lacks sufficient detail to enable a comprehensive review. I have therefore outlined the following comments and/or questions that should be given further consideration or require clarification. Given the uncertainty of the effects of the RRwGW on the aquatic ecology of the Waikanae River and various small streams, the monitoring plan will need to be comprehensive and its development will require significant consultation with GWRC and stakeholders.

Bore water quality and development of bore hierarchy

67. Further sampling is required to characterise the water quality of each bore and this programme of further sampling needs to be designed in consultation with GWRC. This should occur prior to the discharge of any groundwater to the Waikanae River and would enable the bore hierarchy to be developed using both DRP and DIN (and other variables deemed critical, eg, see Paragraphs 39 and 40). If through this characterisation process water quality appears to be significantly different (eg, higher concentrations of nutrients) from that presented in the AEE, the potential effects of the RRwGW option may need to be reassessed.

68. Weekly testing of the blended bore water should include both ammoniacal nitrogen and nitrite-nitrate nitrogen (at the moment just SIN is indicated, although I note SIN is the addition of ammoniacal nitrogen and nitrite-nitrate nitrogen concentrations so I am just seeking clarification of what is proposed).

69. A trigger for a response could include re-examination of the bore hierarchy if nutrient concentrations breach a certain threshold (eg, there should be thresholds for the maximum concentrations of SIN and DRP in the discharge). Similarly thresholds for toxicants could also be included in the trigger framework.

Water levels in wetlands

70. It is stated that baseline monitoring of wetlands is required to establish the existing condition of wetlands to monitor any future trends. I assume these trends will be related to the water level monitoring and ongoing assessment of potential effects. This should also include assessing and establishing baselines for the ecological values of these wetlands. However, no details on this are provided. Myers (2013) also notes the lack of information on wetland fauna in the AEE and I agree with her recommendations for additional monitoring.
Water quality monitoring – Waikanae River

71. Sampling frequency of water quality in the Waikanae River should increase to weekly at least two weeks prior to when the discharge of groundwater is expected to take place.

72. Two sites upstream of the discharge point may not be required but I need to see the applicant’s justification. I agree that at minimum two sites downstream of the discharge are required. Information on the locations of the downstream sites is needed.

73. In addition to DRP, water samples should also be analysed for ammoniacal nitrogen and nitrite-nitrate nitrogen. Triggers to analyse additional variables in the Waikanae River could relate to the previous week’s results in the blended bore water (eg, if a concentration of a metal was above a threshold then this could trigger monitoring the following week in the river if the discharge is continuing).

Periphyton

74. I generally agree with (the little) detail is provided. However, during periods of recharge monitoring should be weekly.

75. Further information is required on what baseline monitoring will occur to establish relationships between periphyton cover/biomass at upstream and downstream monitoring sites prior to any recharge occurring.

76. Thresholds and triggers need to be stated/defined that detail what increase is or is not acceptable and what mitigation will occur when these thresholds are breached.

Macroinvertebrates

77. Monitoring of aquatic macroinvertebrates in the Waikanae River should also occur to complement water quality and periphyton monitoring. This needs to include monitoring to establish baseline information for sites above and below the groundwater discharge point and on-going monitoring that could be triggered to occur after so many days of groundwater discharge. Macroinvertebrate monitoring should also be triggered when periphyton thresholds are breached.

Fish

78. Very little detail has been provided. Given the high values and uncertainty of effects significant baseline information to characterise the diversity and abundance of a range of indigenous fish species and brown trout will be required. This may require monitoring of sites on the main stem of the Waikanae River upstream and downstream of the discharge point but also on tributaries located upstream and downstream of this point. Monitoring sites and survey methods that target high value or sensitive species (or life stages of) should be considered.

79. Given that there is uncertainty around the effects on recruitment, some discussion around the appropriateness of sites located on a ‘control’ river may also be warranted.

Depletion of small streams (eg, Ngarara) and wetlands

80. Given that depletion of small streams and wetlands is likely to occur and that the effects on these ecosystems have not been adequately addressed, baseline monitoring of water levels/flows and assessments of ecological values will be required – at least at those sites considered most at risk and/or that have high ecological values. These baseline assessments can then be used to help interpret any effects of the RRwGW if consent is granted. The minimum requirements of these baseline assessments need to be agreed to in consultation with GWRC.
Proposed conditions of consent

81. The following comments relate to what I believe would be required as conditions if this application is to be granted. I have read the proposed conditions by the applicant (Appendix 4, AEE) but given the lack of detail, especially around the monitoring plan and associated conditions, I have therefore just stated the ‘intent’ of what I would expect to be captured by consent conditions. Details around monitoring conditions and suitable methodology require significantly more work by the applicant and need to be agreed to in consultation with GWRC.

Further baseline type monitoring

82. The water quality of bores needs to be properly characterised. This should include a minimum of at least four sampling occasions prior to the RRwGW and include the full suite of key variables (agreed to in advance with GWRC). On-going monitoring requirements (variables and frequency) of all bores will also need to be developed and conditioned.

83. The bore hierarchy needs to be developed on appropriate information and needs to consider more than just concentrations of DRP (eg, see paragraphs 39 and 40). The bore hierarchy will need to be reviewed annually to account for any trends in bores etc.

84. Baseline aquatic ecological values of small streams at risk from draw down need to be established. This would include a desktop exercise and probably additional field work depending on gaps. This condition will need to link in with hydrological components detailed in Thompson (2013).

85. A condition will be required that specifies work that will need to be undertaken to establish baseline levels of periphyton (cover and biomass) and macroinvertebrates, and relationships between sites located upstream and downstream of the RRwGW discharge.

86. Baselines of fish communities using appropriate methodology for selected sites in the river and tributaries that focus on high value and sensitive species will need to be specified as a condition. Consideration also needs to be given to a monitoring site outside of the catchment given that there is uncertainty around the effects of the RRwGW on the recruitment of diadromous species into the Waikanae River.

On-going monitoring

87. As mentioned in paragraph 35, an ongoing monitoring programme of all bores to be used in the RRwGW will need to be a condition (including the frequency and variables). Note the monitoring condition provided by applicant seems to be a copy/paste mistake from the river monitoring condition.

88. Monitoring of the quality of the RRwGW discharge needs to be at least weekly and needs to include more than analysis for just DRP as is currently proposed (eg, needs to include DIN, toxicants etc.). Given that water from more than one bore may be mixed prior to discharge to the Waikanae River, continuous conductivity monitoring of the discharge should also occur.

89. Linked in with the above discharge monitoring (ie, weekly), monitoring of water quality upstream and downstream of the RRwGW discharge should also occur at sites agreed in consultation with GWRC. The downstream sites should also include continuous measurements of conductivity to provide an indication of mixing over time.

90. A condition is required that periphyton cover (and possibly biomass) is measured upstream and downstream of discharge. At least two sites below, maybe three. This should occur at least weekly during the potential discharge period for the first few years and should always occur when a RRwGW discharge is occurring. If baseline levels are established between upstream
and downstream monitoring sites, fortnightly monitoring might be appropriate when the RRwGW is not discharging. Assessment methodology and sites needs to be agreed with GWRC.

91. Macroinvertebrates – Ongoing monitoring of macroinvertebrates to complement water quality and periphyton monitoring at sites located upstream and downstream of the discharge. Refer to paragraphs 77 and 98 for further detail.

92. Fish – every three years might be appropriate as proposed but this might depend on how the baseline is established. Annual monitoring would be best at the beginning and also refer to Paragraphs 78, 79 and 86 for more detail.

93. Fish passage – I have yet to see any details on how this will be maintained past the weir and as such monitoring to make sure fish are getting past may be required. This should include annual assessments of the weir for the first few years of operation by a suitably qualified and experienced freshwater ecologist and a flow level trigger to make sure that fish passage is maintained under low flow situations.

94. Small stream monitoring – this depends on the outcomes of baseline monitoring but I would expect some ongoing ecological monitoring linked in with levels/flows.

Thresholds that need to be detailed in conditions

95. Given the uncertainty around the proposal, a threshold should be considered for how much groundwater (ratio to river water and total days?) can be discharged in the first few years while further data are gathered (eg, not make more than 10% of river flow, etc).

96. Water quality – thresholds are needed for concentrations of nutrients and toxicants that are not to be exceeded in the discharge and downstream in the river. This could be a concentration limit or a percentage change from upstream river water quality.

97. Periphyton – a threshold for what is acceptable needs to be established (eg, periphyton cover and/or biomass does not increase by more than 10% compared with sites upstream of the discharge – this would need to incorporate any natural difference between these sites hence good baseline data are required). If this threshold is exceeded it could trigger macroinvertebrate monitoring and/or mitigation. I note again that the applicant’s current proposed mitigation for increased periphyton growth is unsatisfactory.

98. Fish – need to define what would be unacceptable and what this would trigger (eg, a decline in abundance of a species by 20% and what this would trigger, ie, mitigation etc.).

99. Water level and ecological trigger thresholds for streams (and wetlands) that may experience draw down. This should also include triggers for ecosystem health (eg, macroinvertebrate and fish communities).

Other conditions required

100. Weir – fish passage should be maintained at all times of the year. An appropriate flow over the weir should be a condition of consent (to be determined by a suitably qualified and experienced freshwater ecologist).

101. Exclusion period of RRwGW operation to protect migratory fish – given the uncertainty around the effects of the RRwGW on migratory fish a condition that stipulates no (or has limits on the amount of) recharge to occur between August and December (inclusive) might be appropriate.
However, note that this does not protect fish migrating upstream during summer when the RRwGW might be in operation.

102. An exclusion period for when instream works cannot occur to protect fish migrations (native and trout) is also appropriate.

103. Fish screens may be required to prevent fish colonising the created discharge channel. (although this would depend on the outflow). Alternatively a condition detailing how ‘fish rescue’ will be carried in this channel (when it is dewatered) could be appropriate.

I Conclusions and recommendations

104. Due to information gaps in the AEE and the significant uncertainty that remains around some of the potential effects, I recommend that if this application is to be granted, that it is subject to appropriate conditions that stipulate the collection of further information and allow for an adaptive management approach. However, such conditions (as indicated in Section H) would require significant further information to be gathered prior to the operation of the RRwGW and during the first few years of operation.

105. Conditions would also need to define a number of thresholds setting out acceptable changes in ecological values in both the Waikanae River and the small streams that might be adversely affected. Given the uncertainty around some of the effects, these thresholds would need to be relatively stringent in the first few years to ensure that adverse effects do not occur while further information on the potential effects of this proposal are being gathered. Furthermore, exceedance of these thresholds would need to clearly trigger appropriate mitigation (and/or off-setting) and set out steps to avoid further adverse effects (e.g., cease using a particular bore if is contributing to the drawdown of a particular stream or bore water discharge should not exceed 10% river flow volume, etc.). It is worth noting that appropriate mitigation (and/or off-setting) may come at significant cost to the applicant (e.g., developing additional bores, fencing and riparian rehabilitation, sourcing alternative water supply, etc.).

106. An adaptive management approach in this instance may be appropriate given that the full potential impact of the scheme is unlikely to occur in the early years of any consent term. This provides some opportunity to establish baselines and further assess potential effects. An appropriate adaptive management plan should ensure that the aquatic ecological values of the Waikanae River and various small streams will not be impacted to an unacceptable degree, but caution is required to ensure that such an approach adequately compensates for the current lack of information about effects. Agreement on an appropriately designed monitoring programme is key to an adaptive management process and there should be sufficient flexibility in the RRwGW operation to respond quickly and meaningfully if trigger levels are breached. As mentioned above, it is also worth noting that there can be additional risks/costs for the applicant associated with an adaptive management approach.

107. If an adaptive management approach is decided as an appropriate way forward, the applicant must first provide more information on proposed monitoring, thresholds and mitigation. This needs to include detail on monitoring sites, methods, variables and frequency.

J References


