Resource consent application WGN130103: Hydrology technical review

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Summary of key points

1. The general approach to hydrology, yield and demand modelling for the Waikanae River seems reasonable. It seems unlikely that the proposed activity will result in significant changes to the Waikanae River flow regime (over and above effects that are already occurring under the existing borefield and river abstraction consents). However, I have some reservations about the lack of account for climate change and think there needs to be a fuller discussion from the applicant about the basis and justification for this; a discussion that should be in the context of overall planning principles adopted by the applicant across a range of projects.

2. Although some effort has been made by the applicant to characterise small stream hydrology and the likely impacts of the proposed river recharge (RRwGW) scheme on these systems, considerable uncertainty remains. The uncertainty relates both to groundwater model limitations (with respect to calibration data) and a lack of sufficiently detailed information on the hydrology and ecology of the streams. As a result I cannot form an overall view on whether the scheme impacts on stream hydrology will be more or less than minor.

3. It appears that five streams in the area of maximum predicted drawdown may be affected to a potentially significant degree; the Muaupoko Stream, Kakariki Stream, Ngarara Creek, Waimeha Stream and Kowhai Stream. Drawdown-induced depletion rates in these streams (and/or water level declines in the Holocene sands around them) are predicted to be high relative to what is estimated to be ‘normal’ background summer state. Furthermore, given the overall uncertainty in the magnitude of predicted drawdowns it seems plausible that a noticeable effect in the streams mentioned above might be associated with drawdowns that occur more frequently than in the modelled worst case scenario. Whether or not such a noticeable effect occurs and is ecologically meaningful depends on the physical characteristics of the streams and their sensitivity to water level declines and flow depletions – information we have not been provided.

4. Notwithstanding the uncertainty around likely scale and consequence of streamflow depletion it is noted that the full potential impact of the scheme is unlikely to occur in the early years of any consent term (since headroom for demand growth is built into the maximum abstraction rate applied for). This provides some opportunity to establish ‘normal borefield operation’ hydrology baselines (albeit with, potentially, a creeping increase in abstraction and abstractive effect to deal with).

5. While I think it is possible to take an adaptive management approach to ensure that small stream hydrology is not impacted to an unacceptable degree, caution is needed to ensure such an approach adequately compensates for the current lack of information about effects. I note that there is no detail yet in the draft monitoring plan on small streams. Agreement on an appropriately designed monitoring programme is needed and there should be sufficient flexibility in the borefield operation to respond quickly and meaningfully if trigger levels are breached.

6. Overall, I conclude that there are significant inadequacies in the AEE relating to a lack of information and potential environmental effects, and valid concerns expressed by some submitters. However, I think that these inadequancies and concerns can potentially be satisfactorily addressed early in a consent term. I
recommend that, if the application is granted, it is subject to some stringent conditions regarding further baseline investigation, ongoing monitoring and adaptive management. I have made recommendations for such conditions of consent in Section H of this report. I note that there is no guarantee that further baseline investigations, and the determination of management criteria from these, will not compromise the overall viability of the proposed scheme; a risk the applicant will need to bear. I finally note that my recommendations on the overall consent application and conditions of consent are made on the basis of perceived impacts on river and stream hydrology only.
A Introduction

7. Kapiti Coast District Council (the applicant) has applied for resource consents to increase abstraction from 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 community; a solution hereafter referred to as RRwGW. The application was lodged in November 2012.

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

9. This technical report serves to support the Greater Wellington Regional Council’s (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

10. This report focuses on the technical aspects of the proposed RRwGW activities in relation to surface water hydrology. The report includes:

(a) a brief overview of the existing hydrological environment,

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

(c) an evaluation of the applicant’s assessment of effects;

(d) a brief summary and evaluation of matters raised by submitters in relation to the surface water hydrology,

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

(f) recommendations on granting the consent applications and draft consent conditions that provide a regulatory framework for managing and monitoring the effects of the activity

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


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


12. 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.

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

C Summary of the proposal

14. The overall concepts and operational details of the RRwGW proposal are described in detail in GWRC 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.

15. 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.

16. 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 river.

17. The applicant has acknowledged difficulties in fully assessing the likely impacts of the proposal. With regard to hydrology, this is due primarily to uncertainty in the groundwater modelling results and inadequacies in the information on ground-surface water interactions. They have proposed to deal with these limitations by undertaking targeted monitoring within an adaptive management framework.
D Description of the hydrological environment

18. This section provides a brief description of the hydrological environment of the project area (Figure 1), focusing on the Waikanae River and small streams closest to the borefield. For descriptions of the hydrogeological (including groundwater-surface water interactions), wetland and ecological environments, refer to technical review reports of Mzila (2013), Myers (2013) and Perrie (2013), respectively.

![Figure 1: Waterways closest to the project 'impact' area](image)

**Waikanae River**

19. The Waikanae River (Figure 1) is a gravel bed river with a catchment area of about 149 km$^2$, draining the southwest Tararua Range. The river has four main tributaries: Maungakotukutuku Stream, Reikorangi Stream, Rangiora River, and Ngatiawa River. The upper Waikanae catchment is covered in natural vegetation, but large areas of the Ngatiawa and Maungakotukutuku valleys are pasture.

20. The Waikanae Water Treatment Plant, operated by KCDC, is located downstream of the confluence with the Maungakotukutuku Stream. Downstream of the Water Treatment Plant, the Waikanae River flows across the coastal plain, losing a significant amount of flow to groundwater initially and then regaining some of this flow before discharging to the sea (Figure 2).
21. The 7-day duration mean annual low flow (7dMALF) of the Waikanae River is 1.050 m$^3$/sec (or 1,050 litres/sec as measured at the GWRC continuous flow monitoring site located just upstream of the KCDC abstraction – see Figure 1). Beyond the normal inter-annual variability that is expected, the magnitude, frequency and overall pattern of low flow occurrence has not shown any systematic change over the past 35 years (duration of available record).

22. The Waikanae catchment is considered by GWRC to be over allocated under current Regional Freshwater Plan (RFP) policies; the existing core allocation limit in the RFP for the Waikanae River is 0.290 m$^3$/sec while current surface water allocation is 0.463 m$^3$/sec (the KCDC take). In addition to the KCDC river take there are five consented groundwater takes in the riparian gravels below the Water Treatment Plant that are considered to have a direct hydraulic connection to the river. These groundwater consents have a combined maximum rate of take of about 0.025 m$^3$/sec (or about 2.5% of the 7dMALF at the Water Treatment Plant).

23. At flows of around 7dMALF (1.050 m$^3$/sec), total flow alteration can be up to 0.300 m$^3$/sec or 30% of 7dMALF in the Water Treatment Plant reach (according to the sliding scale of removal allowed for under the current consent). However, the proportional level of alteration increases in the lower reaches (e.g., near Jim Cooke Park reach) – perhaps to as much as 70% of natural 7dMALF – because of the significant additional natural flow loss to groundwater as well as additional depletion effect associated with groundwater abstractions. These levels of flow alteration are classified as high based on criteria proposed in draft guidelines for determining ecological flows (Beca 2008). At the maximum rate of consented take (463 m$^3$/sec), which can only occur at natural flows in excess of 1.4 m$^3$/sec in the Water Treatment Plant reach, the level of alteration increases a little more (to about 33% in the Water Treatment Plant and around 80% in the Jim Cooke Park reach.

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**Figure 2: Concurrent gauging results for Waikanae River showing flow loss (at low flows) between the Water Treatment Plant and Jim Cooke Park reaches**
Small streams on the coastal plain

24. GWRC hold little information on the hydrology of the small streams that occupy the coastal plain in the direct vicinity of the KCDC borefield. Very few flow gaugings have been undertaken in the past and only short term (months to a few years) of continuous water level or flow monitoring data is available for two sites (one on the Waimeha Stream and one on the Ngarara Creek). Consequently, little is known about the natural seasonal variation in water levels and flows, the spatial (reach by reach) variation in flow regime and hydraulics (eg channel wetted perimeters and flow velocities) or the extent of any groundwater dependencies these streams have.

25. As a general observation, the streams highlighted in Figure 1 rise at the base of the Tararua Range foothills and have small, low gradient catchments. They have low summer base flows, although water can pond to a reasonable depth in some of the lowest reaches, even at low flows. The Waimeha Stream is an exception; it flows relatively vigourously at low flows as a result of more direct hydraulic connection with the Waikanae River. Recent conceptualisation of groundwater-surface water interactions on the Kapiti Coast by GWRC (as part of the development of a groundwater model) has drawn on what little information is available for small streams in the project area and relevant aspects of this are described further in Section D of the hydrogeology/groundwater review (Mzila 2013).

26. There is no existing consented abstraction directly from the small streams in the borefield area and they do not have allocation limits specified in the existing Regional Freshwater Plan.
E Adequacy and completeness of information

Overall comments

27. The general approach taken by the applicant to modelling proposal effects has been to assume that, with respect to natural climate cycles and patterns and magnitude of hydrological variability on the Kapiti Coast, the near-future (next 50 years) will not differ markedly to a similar period of the most recent observed past. Starting from this base assumption, modelling has used the historic Waikanae River flow record (36 years) as a template for designing future demand scenarios and making predictions about how often river recharge will be required. Effects assessments flow on from this analysis. In my view the base assumption is generally a reasonable one although I have some reservations about the lack of account for climate change (which I discuss more in paragraph 34).

28. The most notable gap in the methodology is that no attempt was made to collect new project-specific data on the small streams within the area of potential impact (from borefield drawdown). In my view, given the scarcity of existing hydrological information, it would have been prudent to at least conduct a descriptive survey of the existing small stream environment to provide a sense of spatial variability in features such as channel morphology, depth to stream bed and likely wetland and groundwater interactions. While this would not have established a hydrology baseline, it would have provided some general characterisation from which subsequent inferences about vulnerability to groundwater drawdown could be made. I note that the applicant provided additional material on stream hydrology as part of their S92 response to our initial concerns on this matter, and I comment on this in paragraph 36.

Demand modelling

29. The approach taken to demand modelling seems generally reasonable although I am not particularly familiar with industry standard practice in this area (see paragraph 30). I cannot comment on how realistic the specified targets for demand reduction are but assumptions and model input conditions relating to climate and flow generally appear to have erred towards being conservative (a good approach). Notwithstanding the imperfect nature of the model, the comparison of outputs with actual demand data (in Section 2.2 of the demand modelling report) indicates that the relatively large differences during peak periods in both demand areas (Waikanae and Paraparaumu-Raumati), are all over-predictions. In my view this provides some confidence that the demand forecasts used as input to the wider scheme assessment are less likely to fall short of actual future demand requirements (especially with the contingency headroom built in).

30. I note review comments from Alastair McCarthy (Engineer, GWRC Bulk Water Department) on the demand modelling did not raise any significant concerns (McCarthy 2013).

Hydrology and yield modelling

31. The hydrology and yield modelling report provides analyses of the Waikanae River flow for the purpose of characterising the operational requirements of the proposed river recharge activity. Analyses relating to understanding the likely drawdown impacts on the hydrology of the Waikanae River and other streams within the
project area are not provided, although references to these aspects are made in the *Aquifer and groundwater modelling report* and supplementary information that was provided, both of which I comment on later.

32. The low flow review and analysis (Section 2) seems adequate and the estimated 50 year 1-day MALF of 0.603 m³/sec is, in my view, reasonable. The report states that the applicant’s estimate differs somewhat from that provided on the GWRC website (0.517 m³/sec). I note that GWRC has recently revised up its own estimate to 0.559 m³/sec as part of a routine review. The GWRC and applicant estimates differ now by 7% (as a result of using slightly different statistical fitting techniques). This margin is comparable to a standard maximum flow gauging error, and would probably result in a flow differential that would not be noticeable to a river bank observer.

33. The general premise of using the historical Waikanae River flow record to predict future hydrology and yield scenarios seems reasonable. As noted in paragraph 21, the magnitude, frequency and overall pattern of low flow occurrence has not shown any systematic change over the past 35 years (beyond the normal inter-annual variability that is expected). More specifically, recent analysis by GWRC (Keenan et al 2012) found no statistically significant trends in two indicators of low flow for the Waikanae River at the Water Treatment Plant site over the period 1980–2010.

34. Notwithstanding comments in the previous paragraph, I have some reservation that no account for climate change has been incorporated in the hydrology and yield scenarios. The applicant has stated (page 7 of the *Hydrology and yield modelling report*) that “it is not anticipated that climate change will result in a significant increase in the severity or duration of low flow events on the Waikanae River in the next fifty years”. While I accept that there remains a good deal of ambiguity in how any influence of climate change may play out (mainly due to the uncertain nature of how one effect such as reduced total seasonal rainfall may be offset by another effect such as increased frequency of rainfall events), I am not convinced that this is sufficient reason to not incorporate some ‘what if?’ scenarios in the effects assessment.

35. I note that the applicants reliance (in part) on projected rainfall changes for Paraparaumu (Table 2.3 of the *Hydrology and yield modelling report*) may not adequately represent likely rainfall changes in the headwaters of the Waikanae River; modelling results in Ministry for the Environment (2008) indicate more severe decreases in summer seasonal rainfall in the Tararua Range than the adjacent coastal plain. While I accept that the most severe baseflow recessions in the Waikanae River have historically occurred in late summer/autumn (and may not therefore be exacerbated by reductions in summer rainfall), I also see no reason why the seasonality of extreme recessions could not shift under a future climate scenario.

Small stream hydrology

36. To partially address the gap noted in paragraph 28, the applicant was asked (via S92 request) to provide information the hydrology of individual streams in the

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1 The two indicators are: Annual 7day duration low flow and annual number of days with flow below the 90th percentile low flow (Q₉₀)
model area, including estimates of baseflows and typical summer water levels in potentially critical reaches. The applicant’s response was largely in the form of a supplementary technical memo titled *Low flow statistics for Kapiti Coast watercourses* (Michael Law, Beca). In this memo brief descriptions of the main identified streams are given and low flow statistics estimated from flow duration curves based on a combination of measured flow record, spot gauging data, paired catchment analysis (scaled area) and modelled data from the NIWA Water Resources Explorer NZ (WRENZ) tool. The flow estimates are based on standard accepted desktop techniques and I am satisfied that best use has been made of readily available, existing information. However, small stream hydrology has by no means been adequately characterised, due mainly to a lack of project specific data with which to calibrate estimates and comment on spatial variation in hydraulic parameters.

Modelling of flow depletion effects
37. The likely extent of flow depletion in the lower reaches of the Waikanae River has been modelled for various groundwater abstraction scenarios. Water level changes in the shallow aquifers beneath, and surrounding, small streams in the project area were also modelled (although no modelling of the rate of flow depletion in these streams was undertaken). The modelling methodology has been reviewed by Mzila (2013) as part of the groundwater assessment and no further comment is provided here. I note that GWRC generated a set of flow depletion figures for the small streams by running the applicants worst case scenario through a recently developed (GWRC) numerical model; my understanding is that these figures were accepted by the applicant as indicative (in the absence of other information).

F Assessment of environmental effects
38. There are two main (but related) issues regarding hydrology impacts of the proposed river recharge activity; potential flow depletion effects on the lower Waikanae River and potential flow depletion effects on smaller streams. These are dealt with separately in this section followed by points of note on some other aspects of the effects assessment.

Waikanae River flow depletion from aquifer drawdown
39. On page 32 of the *Aquifer testing and groundwater modelling report*, the applicant states that the largest net decrease in Waikanae River flow (caused by groundwater abstraction under the 1 in 50 year drought and high demand scenario) is predicted to be about 0.018 m³/sec (and Figure 12a in the same report shows that more frequently occurring, less extreme abstractive effects are likely to cause flow losses from the river of between 0.005 and 0.012 m³/sec). The applicant goes on to say the worst case scenario flow loss (0.018 m³/sec) represents about 3% of river flow in a 50 year drought and considers the effect to be minor.

40. In my view, the applicant has not assessed the full abstractive effect on the river. The maximum induced loss of 0.018 m³/sec has presumably been compared to the estimated 50 year drought flow of 0.600 m³/sec at the Water Treatment Plant (to get the stated 3% effect). However, Figure 2 in this report shows that when the Water Treatment Plant is flowing at 0.600 m³/sec, flow at the Jim Cooke Park reach
downstream is likely to be only around 0.150–0.200 m$^3$/sec$^2$. In order to assess the full potential impact of the abstraction, it is necessary to compare the estimated maximum flow decrease (0.018 m$^3$/sec) to the Jim Cooke Park drought flow; when this is done, the worst case scenario abstractive effect represents a loss of 9–12% of river flow (rather than 3%).

41. While there are no universally accepted numbers to define the significance of impact, in general terms, once the abstractive effect of a single activity exceeds the maximum standard error in a flow gauging (±7%) then, in theory, the effect becomes of measurable significance. Therefore, in a drought situation, it could be inferred that the maximum abstractive impact on river flow of the proposed activity (9–12%) is likely to be more than minor. However, determining whether the predicted flow loss will actually cause a more than minor effect requires consideration of a number of additional site specific factors; including the length (and values) of the affected reach and the frequency and duration of impact. I deal with each of these aspects in turn in the following paragraphs (42 to 44) before coming to a conclusion in paragraph 45.

42. While flows are lowest at the Jim Cooke Park reach, Figure 2 shows that flows are only marginally higher at the gauging sites upstream (Nimmo Ave East) and downstream (Riverbank Reserve). In my view, the length of river in which abstractive effects at extreme low flows may be considered potentially more than minor (ie where induced flow loss as a proportion of natural low flows becomes measureable) therefore extends from Nimmo Ave East to Riverbank Reserve; this is a total channel length of about 1.5 km. This reach has high community values (eg, aesthetic, recreational) while the Waikanae River as a whole is also highly regarded for its native fish and trout communities.

43. Since the applicant assessed the proportional flow loss to be minor, no attempt has been made to quantify how the flow loss might modify instream values. However, I have reviewed historic habitat assessment reports for the Waikanae River (Watts 2003 and Harkness 2003) that include surveys conducted in both the Water Treatment Plant and Jim Cooke Park reaches. I have also reviewed historic gauging cross sectional data from the Jim Cooke Park reach. Together, these sources of information indicate to me that, even with a higher degree of abstraction-induced flow loss (9–12%) than proposed by the applicant, the reductions in habitat availability in the Jim Cooke Park reach (for a variety of native fish and trout life stages) will be in the order of only a few percent. It appears that flows in the Jim Cooke Park reach need to fall to about 0.1 m$^3$/sec, or lower, before habitat availability begins to rapidly diminish towards zero; this is consistent with the spot gauging undertaken by GWRC in late April 2003 when flow at Jim Cooke Park was only 0.200 m$^3$/sec but a reasonable width and depth of flowing channel remained.

44. The maximum rate of induced flow-loss (0.018 m$^3$/sec) will only eventuate if there is a 1 in 50 year drought coinciding with a peak demand scenario. It is therefore reasonable to anticipate that such a situation would not occur more than once between now and 2060 (although in reality, it could occur several times if there were back-to-back extreme droughts towards the end of the design period).

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2 The flow gauging data in Figure 2 for 27 April 2003 were collected towards the end of a very significant recession (and the same one that the applicant chose to extend into the 50 year design event) and are therefore considered to offer a very useful indication of likely 50 year drought flow conditions through the length of the lower Waikanae River.
Modelling by the applicant (page 16, Hydroplogy and yield modelling report) indicates that, in such an event, the borefield may be operating at high to full capacity for about a month and a half and presumably the maximum abstractive effect on the river would occur for more or less the same period. From Figure 12a in the Aquifer testing and groundwater modelling report it seems that there are about four other events in the 36 year predictive record where the abstraction-induced flow loss exceeds 0.010 m$^3$/sec and therefore could represent more than 7% of natural flow (assuming flow in the Nimmo Ave East to Riverbank Reserve reach is down to 0.15–0.2 m$^3$/sec on each occasion). It is not apparent from Figure 12a or other information for what duration the borefield may be operating at high to full capacity in these more frequent events, although it is clearly less than for the worst case event.

45. Overall, it seems likely that drawdown caused by increased groundwater pumping will further exacerbate extreme low flows in the Waikanae River in the vicinity of Jim Cooke Park, and to a larger degree than stated by the applicant. However, when the likely magnitude, frequency, and duration of the flow depletion episodes are considered together, I come to the view that the net effect on river hydrology will probably be one of only minor consequence. Based on the historical distribution of flows for the Waikanae River, the amount of time that river flows are low enough for the predicted abstractive effect to become potentially significant (<0.750 m$^3$/sec at Water Treatment Plant or <0.30 m$^3$/sec in the Jim Cooke Park reach) is around 1%. During these times, habitat for fish species with high flow demands will already be severely limited and I expect only small incremental reductions in remaining habitat will occur as flow reduces to the 1 in 50 year flow minus flow loss as a result of the predicted abstractive effect. While I cannot comment specifically on how other flow-dependent instream values might be effected by additional flow depletion, I would intuitively not expect the effect to be of a greater scale than that I have inferred for habitat changes.

46. Notwithstanding my comments in the previous paragraphs, I think it would be prudent for the applicant to demonstrate via consent monitoring that, during times of high or maximum continuous groundwater abstraction, there is no unanticipated significant decline in flow/levels in the lower Waikanae River. I have reiterated this suggestion later in the section reviewing proposed monitoring conditions (paragraphs 66 and 76).

Small stream flow depletion from aquifer drawdown

47. Unlike the Waikanae River, estimated flow depletion rates have not been provided in the AEE for smaller streams in the project area. However, subsequent to the AEE being issued, further analysis of the worst case river recharge pumping scenario with respect to stream flow depletion was undertaken (see paragraph 29). Results indicate that, relative to estimated base flows (defined here by Q95 flows – the flow that is exceeded 95% of the time), the most significantly depleted waterways are likely to be the Kakariki Stream (with depletion equating to 15% of the Q95 flow), Waimeha Stream (25% of Q95), Kowhai Stream (100% of Q95) and Ngarara Creek (500% of Q95). These rates of depletion will be even higher when assessed (as is more conventional) against mean annual low flow (MALF). MALFs have not been estimated in this case due to an absence of suitable data. For context, depletion of a low baseflow regime by more than 25% of MALF (in a system where there is a
moderate risk of deleterious effect) is generally considered to be a high level of hydrological alteration (Beca, 2008).

48. Shallow groundwater drawdowns in the vicinity of some of the streams have been predicted to vary between 50mm (near the Waimeha Stream) and up to 400mm (sections of the Kakariki and Muapoko Streams) under the worst case scenario. In shallow stream reaches that have high hydraulic connectivity with underlying aquifers, such a reduction could prove significant.

49. The extent to which the predicted worst case flow/level depletions (as well as more frequently occurring but lesser magnitude depletions) will actually affect the streams in question has not been assessed and the applicant acknowledges insufficient information is available to do this. Without a better understanding of water level/flow-dependent ecological values and likely changes in flow regime and hydraulics (e.g. velocities, critical reach width and depth etc), any comment regarding the likelihood and scale of impact is speculative and I cannot conclude whether effects are likely to be minor or not.

50. With respect to developing a better understanding of cause and effect, I agree with the applicant that “it may prove difficult to separate out any effects due directly to increased pumping from the bore field over and above what occurs naturally during a drought”\(^3\). However, I also further agree with the applicant\(^3\) that there is merit in collecting baseline flow and shallow groundwater data in and around the streams of interest. This should help refine the understanding of groundwater dependency and allow (1) more informed inferences regarding cause and effect to be made and (2) appropriate reference criteria/trigger levels to be formed. The collection of any such data should be informed by a reach survey of stream character and values.

51. I have made further comments and suggestions about small stream monitoring in Section H (Proposed monitoring and consent conditions) in paragraph 69 in particular.

Hydrological neutrality – Waikanae River

52. One of the key principles (advocated for by the applicant) of the proposed scheme is that low flows in the Waikanae River will not be affected (over and above the existing operation of water supply consent – eg, see statement in Table 17 in Section 5 of the AEE). I generally agree that this principle is fulfilled – on the basis that the existing and proposed river abstraction operation graphs in the AEE show only a very minor change in net flow within the consent flow bands – and am satisfied that the proposal will have no substantial impact on the rate of flow in the river. However, I do not believe that the scheme will be entirely neutral with respect to Waikanae River flows and following paragraphs expand on this comment.

53. The groundwater drawdown associated with additional borefield abstraction will induce further flow loss in the lower reaches of the Waikanae River (relative to the existing borefield operation). This effect was discussed in detail earlier (paragraphs 39 to 46).

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\(^3\)Memo from Michael Law (Beca reference#NZ1-7171059-7 0.7) dated 20 March 2013 on ‘Response to S92 questions relating to hydrology’
54. Concept designs for the groundwater discharge channel are discussed on page 32 of the AEE. No mention is made of potential channel losses through bed seepage; ie, it is assumed that the river receives the entire volume that enters the channel (which looks about 300–400 m in length). The applicant has subsequently (via S92 process) responded that this issue could be dealt with at the detailed design stage although they also state that any impermeable channel design could potentially be undesirable from the point of view of “naturalising” the groundwater. I agree this is a design matter but think it remains important to understand what the magnitude of such losses might be (pre-design phase), however minor or short-lived, as they will occur when the river is very low. Any discrepancy in water accounting (i.e. between what is removed from the river and replaced with groundwater) at these times in particular may be of heightened concern; and such concerns need to be weighed against the benefits of naturalising the groundwater.

55. The applicant has stated on page 16 of the AEE that the “best endeavours” approach they currently take to maintain a minimum flow of 0.850 m$^3$/sec at the Water Treatment Plant gauge is not going to be a feature of their future operation (under river recharge proposals). They intend to revert to the legally binding 0.750 m$^3$/sec minimum flow. I accept that this minimum flow has been set by GWRC and the applicant is under no obligation to justify its merits but simply note here that there will be a net reduction in low flows in the future compared with under the present consent (rather than the hydrologically neutral outcome implied in the AEE). I also note that the applicant has applied to take up to 0.355 m$^3$/sec when natural flow has fallen below 1.4 m$^3$/sec; this is an increase of 0.005 m$^3$/sec from the existing 0.350 m$^3$/sec limit. While probably inconsequential it represents an increase in abstraction in what is already considered an over-allocated catchment (refer to paragraph 22).

**Flushing flows – Waikanae River**

56. On pages 54 and 55 of the AEE, the applicant describes potential mitigation of algae proliferation by manually initiating “flushing” flows using bore water. In addition to the concerns about potential water quality impacts raised by Perrie (2013), I would also question the flushing value of the flows described. Increasing flow from 0.600 m$^3$/sec to 0.950 m$^3$/sec (the example given for a 50 year drought scenario) will lead to only very small changes in overall river flow velocity (other than immediately downstream of the discharge pipes) and certainly would not replicate the disturbance characteristics of a natural flushing flow as claimed on page 55. Normally, flows of two to three times natural median (or six times the preceding baseflow) are considered necessary to properly disturb algae.

57. The subsequent S92 response from the applicant (Question 20) does not, in my view, resolve the issue raised above satisfactorily. In the first two paragraphs of the response the applicant accepts that it is not practical to generate a true flushing flow and that the proposed flows will “provide flow variability” rather than true flushing effect. But in the last paragraph they have returned to describing the proposed flows as having flushing capability and being part of a mitigation strategy relating to periphyton removal. I would be surprised if any significant periphyton removal could be achieved with the proposed flows and therefore find the proposal misleading. Either more evidence of likely effect is needed or the weighting given to perceived benefits should be downscaled.
Summary of key points - assessment of effects

58. While I do not consider that the potential effect on the lower Waikanae River (relating to flow depletion from aquifer drawdown) has been fully characterised, I do not think this inadequacy unduly effects the overall conclusions reached by the applicant. Taking into consideration the additional analysis of flow depletion in critical reaches of the river (described in paragraphs 40–47), I do not expect the effect to be more than minor.

59. Despite additional effort by the applicant to characterise small stream hydrology, and the likely impacts of the river recharge scheme on these systems, considerable uncertainty remains. The uncertainty relates both to groundwater model limitations (with respect to calibration data) and a lack of sufficiently detailed information on the hydrology and ecology of the streams. As a result I cannot form an overall view on whether the scheme impacts on stream hydrology will be more or less than minor.

G Comment on submissions

60. I have reviewed the summary of submissions. My comments on aspects of the submissions that relate to river and stream hydrology follow.

61. A recurring theme in comments from submitters was about the general risk of negative impact from the scheme on the Waikanae River, and specific concern about compromised ecological and angling values in the Waikanae River and algae proliferation. The concerns appear to relate to potential changes in water quality as a result of the bore water discharge, rather than changes in the instantaneous flow rate per se. However, there are references to the ‘taking of more river water’ in conjunction with ‘adding more nutrients’ and particular concern about whether this will promote more algae growth or compromise fishery values. As I understand the proposal, the additional water that will be taken from the river relates to adopting the 0.750 m$^3$/sec minimum flow (rather than “best endeavours” approach currently taken to cease take at 0.850 m$^3$/sec), the increase in rate of take from 0.350 m$^3$/sec (below natural flows of 1.4 m$^3$/sec) to 0.355 m$^3$/sec and the additional flow depletion of up to around 0.02 m$^3$/sec in the lower river caused by groundwater drawdown. In my view, this change in flow regime alone would be unlikely to lead to significant changes in algae growth characteristics or fish habitat quality. However, concerns from submitters are generally valid in that there remains considerable uncertainty about the impact of changes in water chemistry at low flows.

62. At least one submitter commented on the poor understanding of the cumulative hydrological effects of the proposed bore field project and the Kapiti Coast Expressway. I cannot comment on overall cumulative effects, but with regard to river and stream flow rates I do not consider there to be a need for one project to explicitly consider the other. Effects from the expressway project on low flow regimes of rivers and streams are expected to be negligible.

63. 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 (eg, QEII covenanted land with heritage trees) that are hydrologically connected to these features. I agree that this is a valid concern and
consistent with my comments in paragraphs 47 to 51. Several of my recommendations for monitoring and management conditions relate to addressing the information deficiencies highlighted by these submitters.

64. One submitter has raised concern about the lack of account for climate change possibilities in the assessment of effects. I agree this is a valid concern, about which I have previously commented (in paragraphs 27, 34 and 35). The same submitter has pointed to at least one unrelated planning document where the applicant has accepted the likelihood of an increased propensity for drought on the Kapiti Coast (placing pressure on water resources) and the submitter has noted that this appears inconsistent with the applicant’s stance in the current AEE. I think there needs to be a fuller discussion from the applicant about the basis and justification for opting not to account for climate change, and this discussion should be in the context of overall planning principles.

H Proposed monitoring and consent conditions

Draft monitoring plan

Waikanae River - flow

65. The monitoring proposed to ensure the 0.750 m$^3$/sec residual flow (or natural flow below that) is maintained seems sensible. My only comment relates back to paragraph 54 in this memo; it will be important to characterise any potential flow loss from the groundwater discharge subsequent to it being measured at the Water Treatment Plant but before it reaches the river. I doubt whether ongoing monitoring of this potential loss component would be needed (as I expect it would be minimal) but it should still be quantified in the early stages of the scheme – see later suggestion for additional monitoring condition.

66. I think it would be prudent for the applicant to also periodically monitor the flow in the Waikanae River in the reach between Nimmo Ave East and Riverbank Reserve (ie where flows are lowest). Such monitoring should focus on times of extreme low flow when groundwater is being abstracted at high to maximum capacity on a continuous basis. The purpose of such monitoring would be to demonstrate (in accordance with predictions) that the low flow regime is not significantly changed by induced depletion. Concurrent gauging results to date suggest the pattern/magnitude of flow loss and gain in the Waikanae River is very stable over time so it should identifying large departures from this should be possible with correctly timed monitoring.

Waikanae River - quality

67. Depending on which locations are agreed to sample water quality and periphyton, it may be appropriate that spot flow gaugings are also undertaken on each sample occasion. The further any sample sites are from the Water Treatment Plant flow gauge site (especially downstream), the less representative the record from this flow site will be. While general comparisons of flow conditions between sample days could rely on the Water Treatment Plant record, any flow-adjustment of water quality data will require more site-specific flow measurements.
Small streams (including spring heads)

68. Currently the only reference to monitoring potential depletion effects in small streams occurs in the ‘Response’ section of the ‘Groundwater Level’ monitoring plan and states:

“Increased monitoring may include flow/instream monitoring of small streams other than the Waikanae River if considered appropriate by the Adaptive Management Committee. Based on current information and assessment an initial baseline monitoring focus on the Waimeha Stream, Kakariki Stream and Ngarara Creek (being those small streams to the north most likely to be influenced by the project over and above natural drought conditions) could be carried out over the first few years of the project”

While I generally agree with the sentiment of this approach, the small streams require a dedicated comprehensive monitoring plan with much more specific detail. I recommend that such a plan is a requirement/condition of any granted consent.

69. Since commenting on details (such as determining management trigger values relating to the small streams) cannot be done at this stage due to an absence of relevant information, my suggestions are constrained to what I think will be key requirements of a monitoring plan. These are:

- A fuller characterisation (than has to date been provided) of the small streams is needed with (a) reach by reach descriptions of stream values and physical properties and (b) a conceptualisation of how the streams relate to shallow groundwater, one another and other connected water bodies and sensitive areas (e.g. wetlands). This first step should include mapping of important spring heads.

- Development of a targeted baseline monitoring schedule of sites and variables, focussing on stream and groundwater levels and flow (based on the findings of the characterisation work). Hydrological baseline monitoring for three full years should provide sufficient data with which to make informed inferences about variability as well as extrapolations about the likely response of surface water features to extreme events.

- Determine management response triggers relating to departures from ‘normal’ water levels and flows.

70. Should the consent be granted, I would expect some monitoring to continue beyond the baseline assessment period, although it may well be appropriate to focus on a reduced set of key indicator sites/variables. In addition to the streams listed above by the applicant (paragraph 68), the Kowhai and Muapoko Streams should also be considered in scope (at least initially) since they too are likely to be within the higher impact area. Streams may well be discarded from any subsequent monitoring programme but I would expect there to be an agreed line of reasoning for this.
Proposed conditions of consent

71. The following are my comments on the conditions of consent proposed by the applicant (Appendix Four, AEE), including recommendations for alternative or additional conditions.

Water take and use – Waikanae borefield

72. There is no reference to small streams in the proposed conditions around operation of the borefield and nothing to reflect the intent in the draft monitoring plan. I suggest proposed monitoring condition 14 (a) be amended to (bolded text is mine):

   Monitoring of water levels in the shallow aquifer, selected small streams (as agreed between GWRC and the applicant) and wetlands as specified in the Boffa Miskell Wetlands report. This shall include monitoring of selected streams and wetlands prior to the implementation of stage 1 to establish baseline monitoring information.

73. Subsequent points under proposed condition 14 (mainly e and f) are not specific about what trigger levels are being referred to; I assume they are water levels in shallow aquifers and wetlands (and streams) but this may need to be spelled out.

Water take and use – Waikanae River

74. GWRC is likely to move to a notification system whereby an ‘authoritative’ set of mean daily flow values for all monitored rivers will be published on the GWRC website every day. It will be these numbers that should be used in future by applicants for managing abstraction rates. The same numbers will be used by GWRC to assess compliance. It is hoped that by working from a single set of published numbers any doubt or confusion relating to the effect of GWRC site rating changes on day to day abstraction management will be reduced. It may be appropriate, as consent conditions are developed further, to reflect this procedure (probably under proposed operational condition 5).

Groundwater recharge discharge to the Waikanae River

75. In reference to my earlier comments (eg, paragraph 65), I think there should be an additional monitoring condition that requires the applicant to demonstrate in Stage 1 of the scheme implementation that the rate of groundwater discharged to the river (as opposed to what is measured at the Water Treatment Plant) matches the rate of water abstracted from the river below the 0.750 m³/sec limit (to within acceptable margins of error). This would then allow us to be confident that operational condition 4 can be met by monitoring river flow at the gauge and river flow abstraction and groundwater recharge discharge at the Water Treatment Plant. The need for such a condition is dependent on the final design of the groundwater discharge channel.

76. I think a condition should be added requiring the applicant to periodically monitor the flow in the Waikanae River in the reach between Nimmo Ave East and Riverbank Reserve (ie where flows are lowest). Such monitoring should focus on times of extreme low flow when groundwater is being abstracted at high to maximum capacity on a continuous basis. Refer to paragraph 66.
I Recommendations

77. Overall, I conclude that there are significant inadequacies in the AEE relating to a lack of information and potential environmental effects, and valid concerns expressed by some submitters. However, I think that these inadequacies and concerns can potentially be satisfactorily addressed early in any granted consent term. I recommend that, if the application is granted, it is subject to some stringent conditions regarding further baseline investigation, ongoing monitoring and adaptive management. I note that my recommendations on the overall consent application and conditions of consent are made on the basis of perceived impacts on river and stream hydrology only.

78. My recommendation for conditional approval is largely based on the fact that the full potential impact of the scheme is unlikely to occur in the early years of any consent term (since headroom for demand growth is built into the maximum abstraction rate applied for). This provides some opportunity to establish ‘normal borefield operation’ hydrology baselines (albeit with, potentially, a creeping increase in abstraction and abstractive effect to deal with) where such baselines are currently undetermined. While I think it is possible to take an adaptive management approach to ensure that hydrology is not impacted to an unacceptable degree, caution is needed to ensure such an approach adequately compensates for the current lack of information about effects. I think this can be achieved through appropriately worded consent conditions. Agreement on an appropriately designed monitoring programme is needed and the applicant should be required to respond quickly and meaningfully if trigger levels are breached. I have made recommendations for such conditions of consent in Section H of this report.

79. The main outstanding area of concern for me relates to the uncertainty of potential impacts on the small streams, and any sensitive environments that are hydrologically connected to these streams. I recommend that attention is focussed on this area (through conditions) as a matter of priority should the consent be granted. I further recommend that baseline monitoring to characterise small streams and establish management trigger levels should occur for a period of at least three full years.

80. I note that there is no guarantee (nor should there be an expectation) that further baseline investigations, and the determination of management criteria from these, will not compromise the overall viability of the proposed scheme; a risk the applicant will need to bear.
References


