Report

Kapiti Water Supply Project: Groundwater Quality

Prepared for Kapiti Coast District Council (Client)

By CH2M Beca Limited

3 October 2012

Revision History

Revision Nº	Prepared By	Description	Date
A	Kirsten Fraser	For Information	14 Sept 2012
B	Kirsten Fraser	Graph of ammonia nitrogen included	3 Oct 2012

Document Acceptance

Action	Name	Signed	Date
Prepared by	Kirsten Fraser		3 Oct 2012
Reviewed by	Andrew Watson		3 Oct 2012
Approved by	Andrew Watson		
on behalf of	CH2M Beca Limited		

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1 Introduction

This report provides a summary of the groundwater quality for the Waikanae borefield and the investigation bores drilled as part of the Kapiti Water Supply Project.

There are six production bores within the Waikanae borefield that are currently used for water supply (K13, K10, Kb4, K4, K5 and K6). All of these bores, with the exception of bore K13 (which will be decommissioned), have been sampled by Kapiti Coast District Council (KCDC) for chemical analyses of water quality on at least three occasions since 2010.

As part of the Kapiti Water Supply Project the Waikanae borefield will be extended to increase the groundwater yield. A new production bore has been drilled at site N2 and investigation bores have been drilled at sites N3, S1 and S2. The groundwater from bore N2 and these investigation bores has also been sampled and analysed. For the three investigation bores, samples were collected from two depths and it is between these two depths that water will likely be abstracted when a production bore is constructed at each of these locations in the future.

The extended borefield will also include the existing bores Kb7 and K12. These bores have not been tested recently as these bores are not fitted with pumps. These bores will be sampled when they are completed as production bores in about 2014. Sampling results from 2004 when these bores were constructed indicate that the water quality of these two bores is within the range of the other existing production bores.

Figure 1 shows the locations of the production and investigation bores.

The groundwater from the Waikanae Borefield is considered secure under the Drinking-water Standards for New Zealand 2005 (Revised 2008). Residence time testing of the bore water has demonstrated is not directly affected by surface or climatic influences and as such seasonal variation in the groundwater quality is not anticipated.

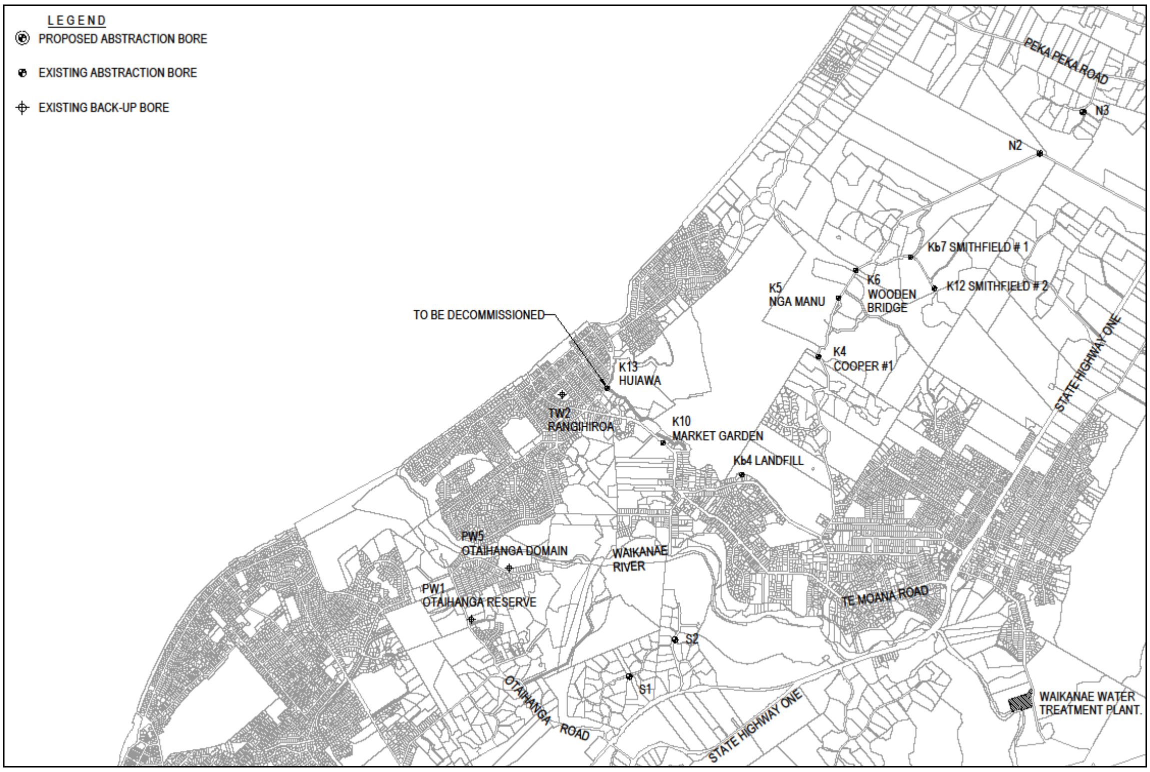


Figure 1: Locations of Production and Investigation Bores

2 Summary of Groundwater Chemistry

The results of recent groundwater quality analyses are summarised in the graphs below which show the median (shown as a cross) and range of water quality for each bore.

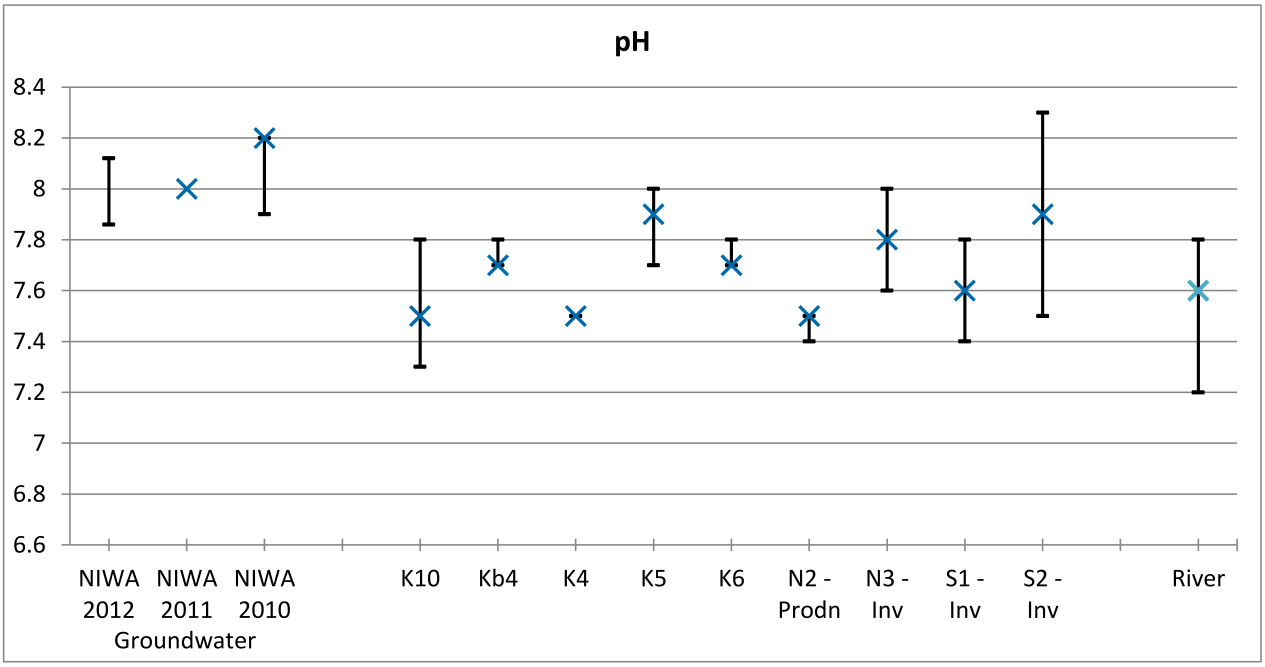
Also included in these graphs is:

- the chemistry of the groundwater discharges during NIWA's ecological investigations
  - 2010 (bores Kb4 and K4; range and median given)
  - 2011 (blend of bores K4 and K6; average given)
  - 2012 (bore K10; range given)
- the chemistry of the Waikanae River during NIWA's ecological investigations.

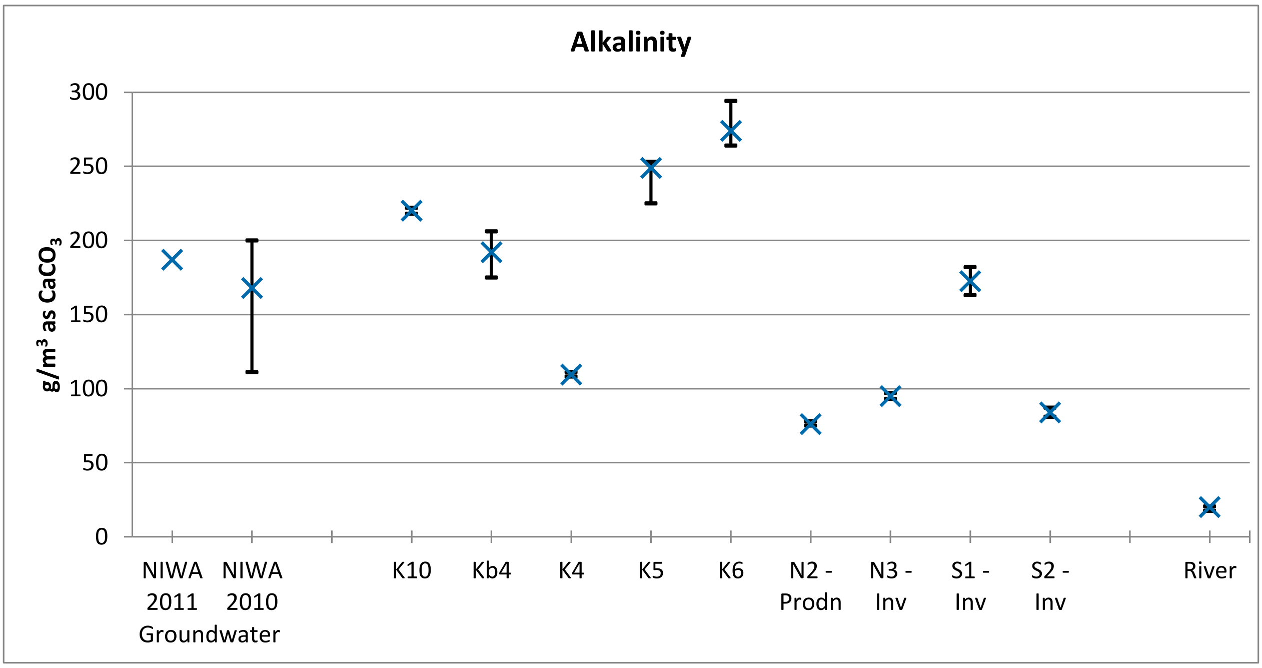
Other water quality data for the Waikanae River is available from GWRC's regular State of the Environment sampling and the "100 Rivers" study (Close & Davies-Colley, 1990). This data is generally consistent with the NIWA river water quality results.

Refer to the NIWA reports (2010, 2011 and 2012) for further information on water quality.

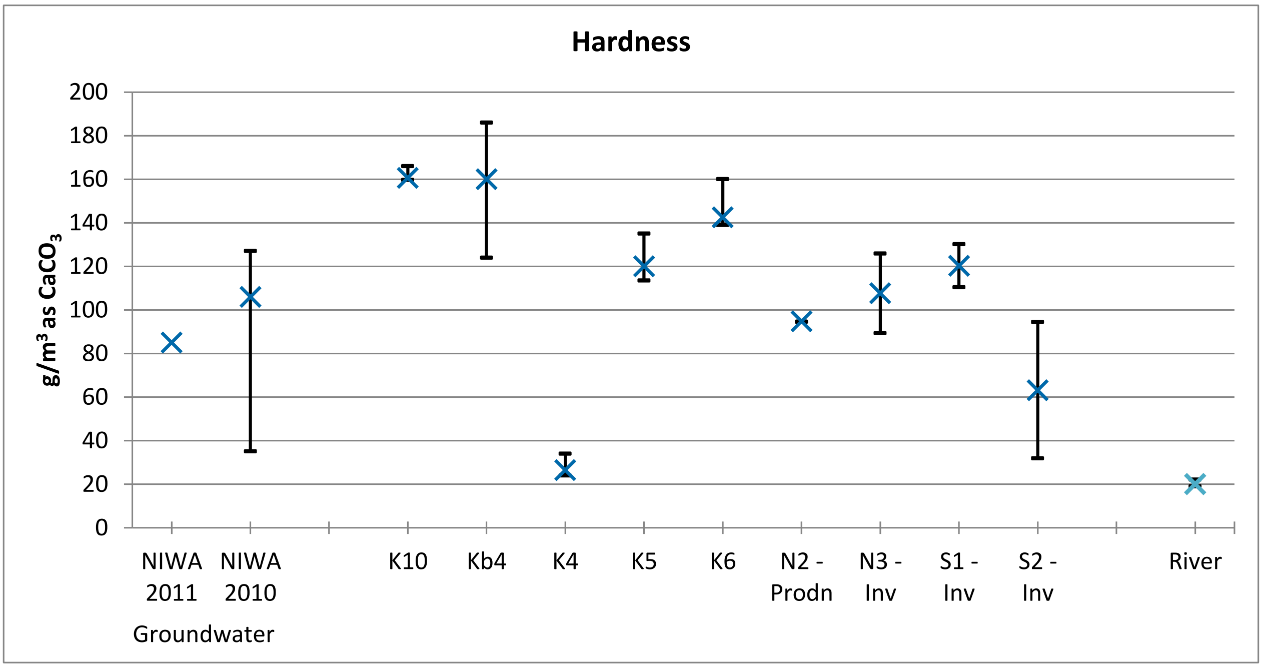
2.1 pH



2.2 Alkalinity

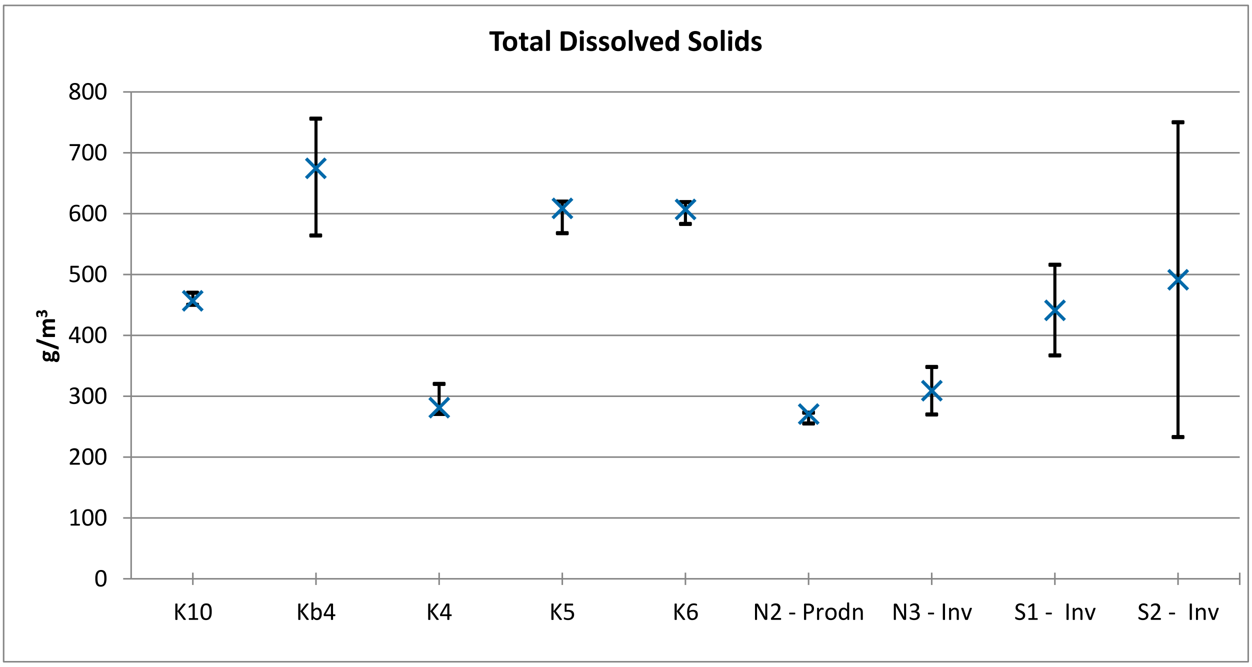


2.3 Hardness



Hardness is determined by the concentrations of calcium and magnesium ions in the water. The hardness of the water from bore K4 is lower than the other production bores and is more similar to the hardness of the river water. It is thought that this difference is because K4 is screened in the gravel layer within the Lower Pleistocene Sand Aquifer (the aquifer overlying the Waimea Aquifer), whereas the other production bores are screened in both the Lower Pleistocene Sand and Waimea Aquifers. The Pleistocene Sands appear to be "cleaner", containing fewer fine-grained soils (silts and clays), than the Waimea Aquifer and are therefore more consistently permeable (CH2M Beca, 2012).

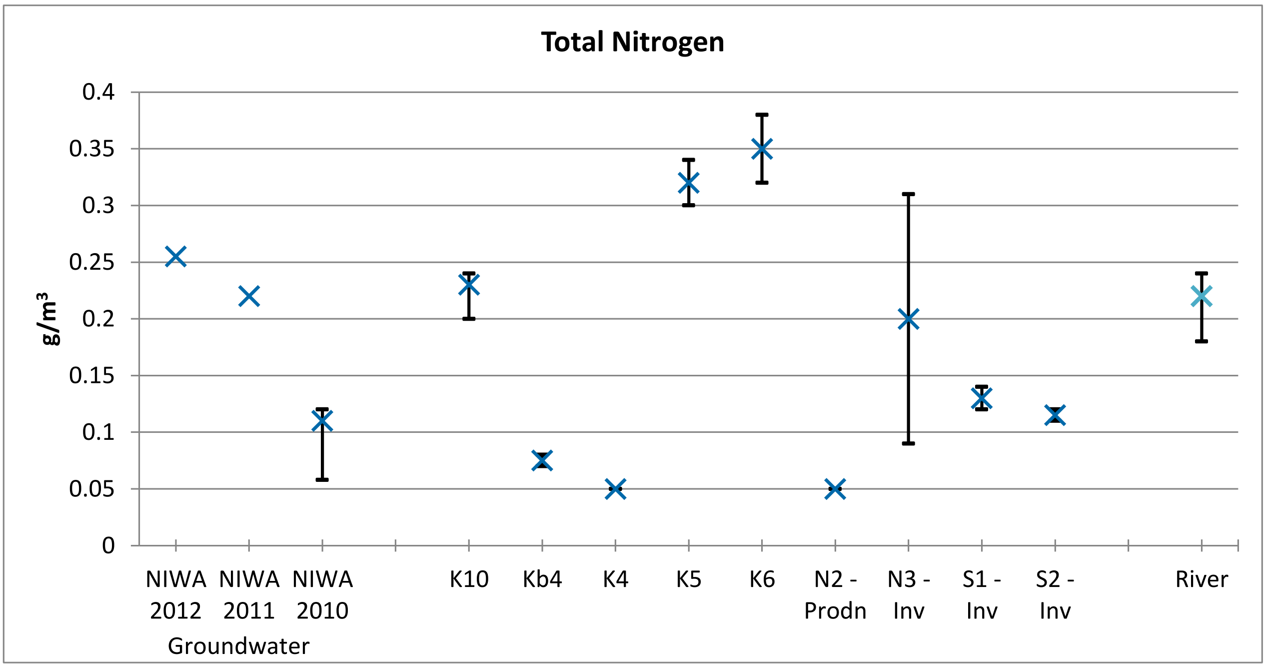
2.4 Total Dissolved Solids



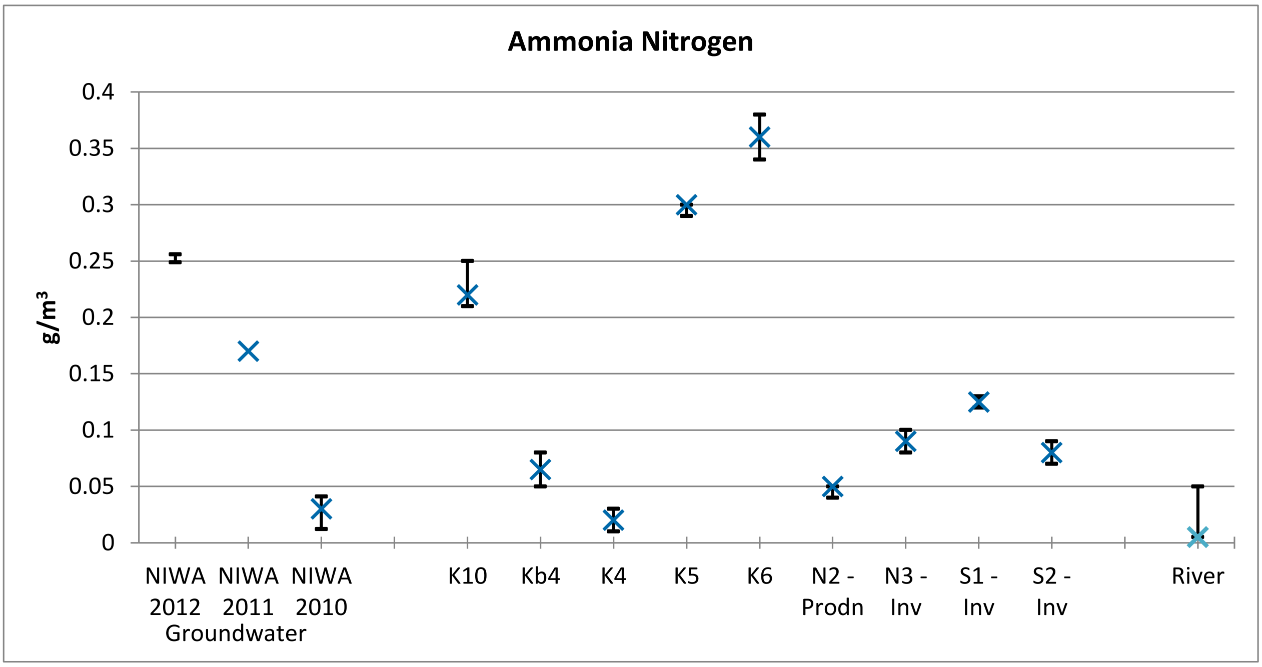
Total dissolved solids were not included in the NIWA analyses of groundwater and river water.

2.5 Total Nitrogen

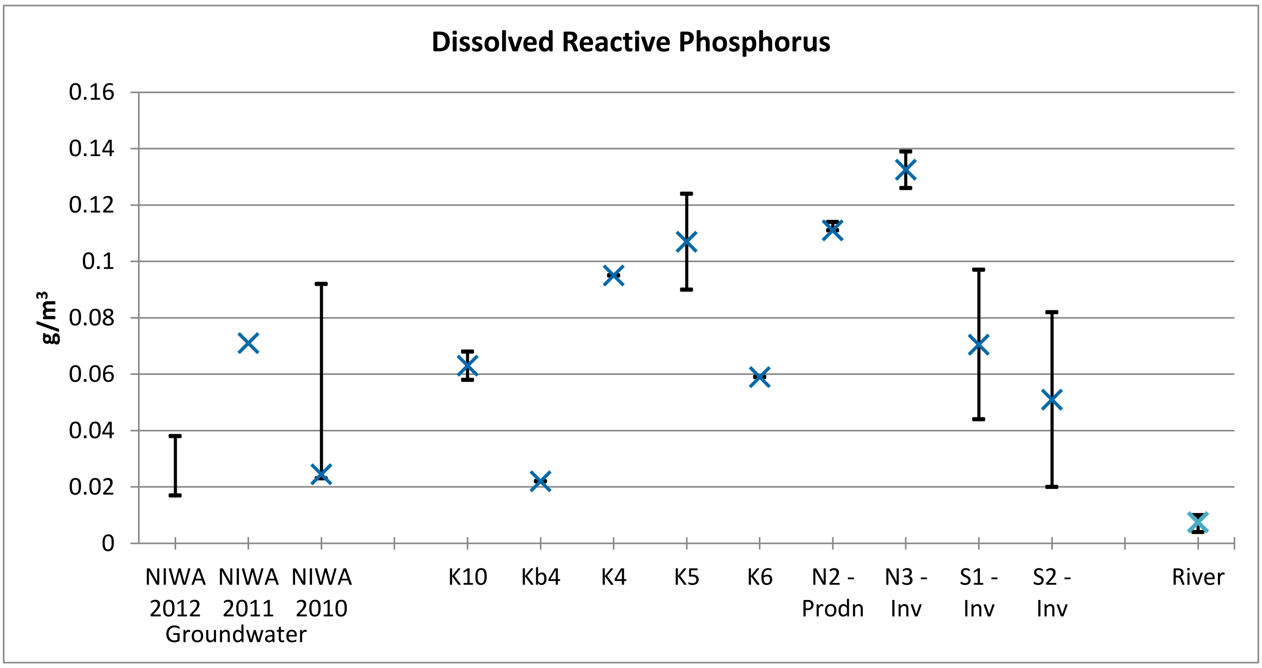
Note the NIWA 2010 and 2011 results are dissolved inorganic nitrogen rather than total nitrogen, and the NIWA 2012 result is the average soluble inorganic nitrogen concentration. Inorganic nitrogen includes nitrate, nitrate and ammonia. Total nitrogen includes both inorganic nitrogen and organic nitrogen.



2.6 Ammonia Nitrogen

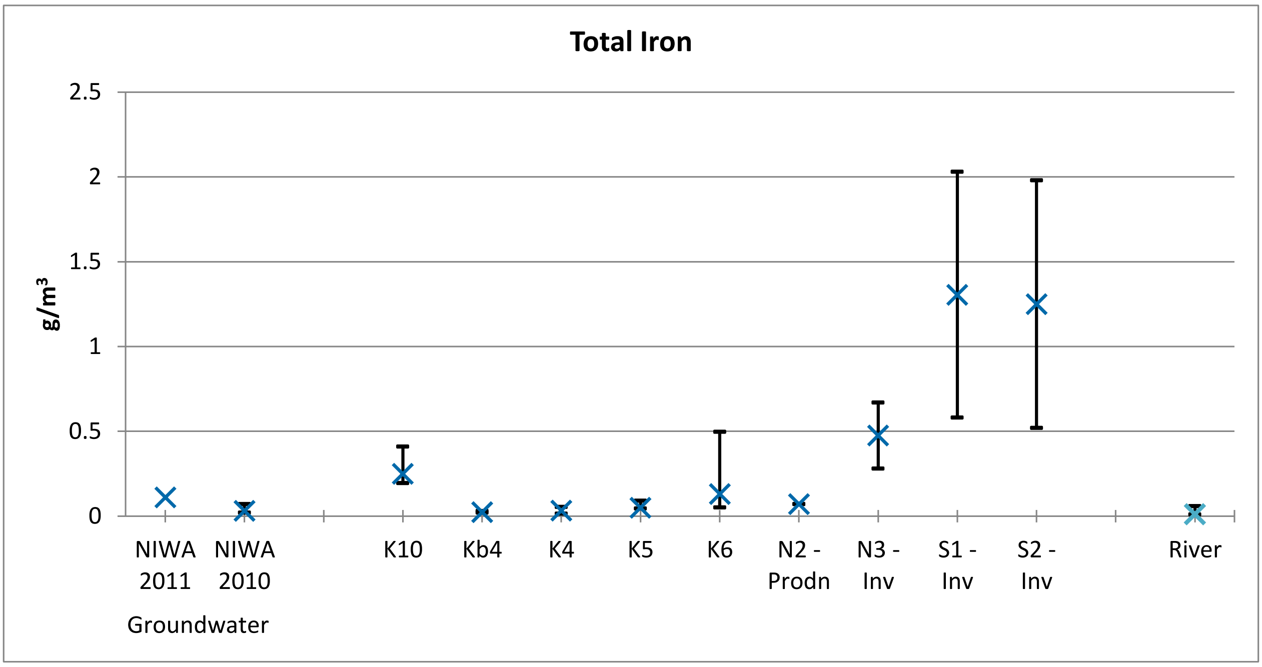


2.7 Dissolved Reactive Phosphorus

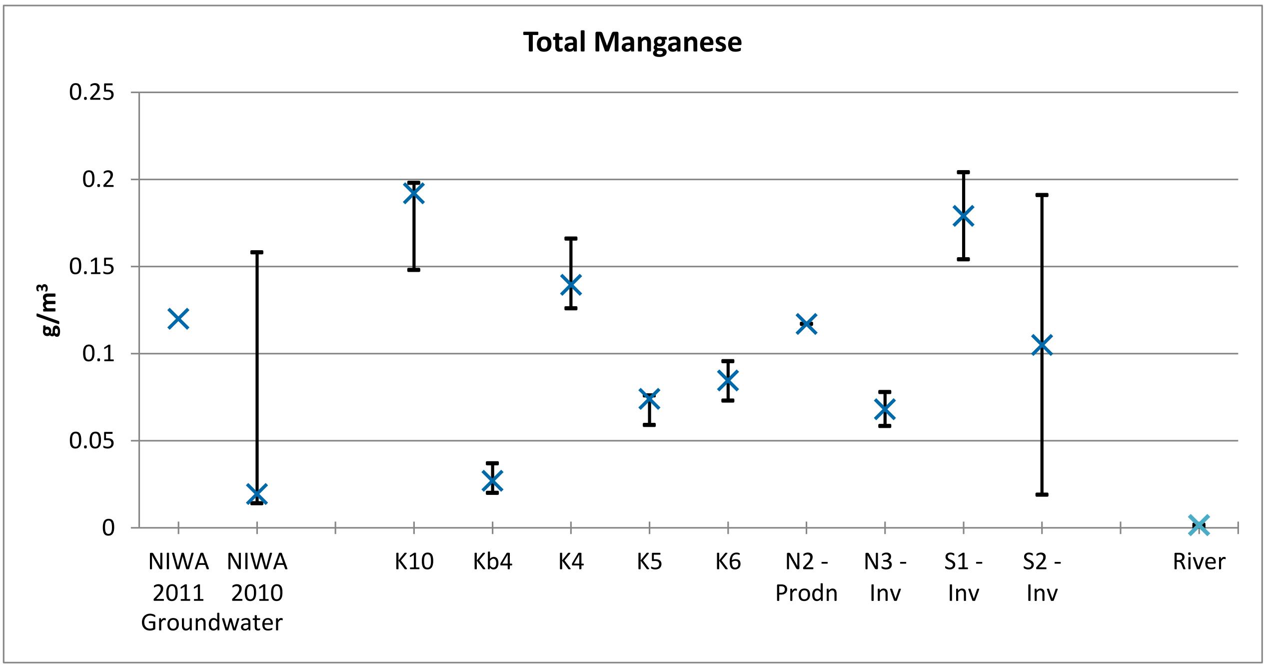


The flow weighted average dissolved reactive phosphorus (DRP) concentration for the groundwater discharge has been calculated for the ultimate RRwGW solution in 2060 using the median results and assuming each bore (existing and proposed) is pumping at its maximum estimated capacity. Bores Kb7 and K12 are not included in this calculation (because they have not been tested for DRP) but their contribution to the total flow is relatively small (<5%). The flow weighted average DRP concentration is 0.078 g/m^3, which is similar to that of the groundwater discharge during NIWA's 2011 investigations.

2.8 Iron



2.9 Manganese



Analyses of the bore water shows there is typically little difference between the dissolved and total manganese concentrations, which indicates that most of the manganese is in the dissolved form.

2.10 Trace Metals

For bores with more than one water quality sample, the concentration given is the maximum concentration measured. Results shown as "<" indicate that it was below the limit of detection. Results shown as "n/a" indicate that samples were not tested for this parameter.

Dissolved Metals Concentrations in Bore Water (g/m^3)

	K10	Kb4	K4	K5	K6	N2	N3-inv	S1-inv	S2-inv
No. of samples	1	1	1	1	1	4	2	2	2
Aluminium	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	0.024	0.004	<0.002
Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0005	<0.0005	<0.0005
Arsenic	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	0.009
Barium	0.025	0.025	0.007	0.018	0.034	0.016	0.023	0.045	0.021
Boron	0.140	0.206	0.057	0.429	0.572	0.070	0.192	0.211	0.215
Cadmium	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chromium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	<0.0005	0.0006	<0.0005	<0.0005	0.0006	<0.0005	0.0006	<0.0005	0.0022
Lead	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Mercury	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	n/a	n/a	n/a
Molybdenum	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	0.001	0.0008	<0.0005	0.0006
Nickel	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Selenium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.002	<0.002
Silver	n/a	n/a	n/a	n/a	n/a	<0.0005	<0.0005	<0.0005	<0.0005
Uranium	0.001	0.0011	<0.0002	<0.0002	0.0015	<0.0002	<0.0005	<0.0005	<0.0005
Zinc	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	0.026	0.015	0.028

The two samples from investigation bore N3 were taken at 61.9-70.9m depth and 73.2-79.5m depth.

The two samples from investigation bore S1 were taken at 57.4-66.4m depth and 72.8-81.8m depth.

The two samples from investigation bore S2 were taken at 33-39m depth and 62-66m depth.

3 Comparison with ANZECC Freshwater Trigger Values

A comparison has been undertaken between the water quality results from the production and investigation bores against the freshwater trigger values for toxicants in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000*. This shows that for all metals or metalloids and non-metallic organics included in the guidelines the dissolved concentrations present in the bore water are less than the values given for 99% level of protection (i.e. without mixing with river flow), except for the following:

- Arsenic (only total measured, rather than speciated), but total in 95-99% level of protection range.
- Boron, at least 95% level of protection, except for bores K5 and K6 that are in 90-95% level of protection range.
- Cadmium, at least 95% level of protection.
- Chromium, only chromium VI has a trigger value and this has not been specifically analysed for. Dissolved chromium is lower than detection limit of test (0.001 g/m^3), which indicates at least 95% level of protection.
- Copper, all bores at least 99% level of protection except for one sample from investigation bore S2 was in the 80-90% level of protection range (the other sample from this bore was lower than the detection limit of test (0.0005 g/m^3)).
- Mercury, lower than the detection limit of test (0.0005 g/m^3), but if assume it is present at close to detection limit then at least 95% level of protection.
- Silver, not tested in existing production bores, but as this is a sand and gravel aquifer likely to be at trace levels. Tested in N2 and investigation bores and lower than detection limit of test for all samples (0.0005 g/m^3), which indicates at least 80% level of protection.
- Zinc, at least 99% level of protection except for the three investigation bores in the 80-90% level of protection range.
- Total Ammonia Nitrogen, at least 99% level of protection for ammonia toxicity (at pH 8) except for bore K6 in 95-99% level of protection range.
- Cyanide, in 95-99% level of protection range.
- Hydrogen sulphide, detection limits have varied for the tests undertaken. If we assume that the concentration is less than the lowest detection limit (0.002 g/m^3) then at least 80 to 90% level of protection range.

While the concentration of the toxicants listed above may exceed the 99% protection level values, it is noted that the ANZECC Guidelines recommends the 95% protection level values for most slightly-moderately disturbed ecosystems. For toxicants such as silver and hydrogen sulphide the concentration in the bore water may well be less than the 95% level of protection but this is unknown as the limit of detection is greater than the trigger value.

Following mixing of the bore water with the river flow, the concentrations referred to above would reduce by at least a third. The concentrations may also be reduced following blending of groundwater from multiple bores. Furthermore, metals may combine with any bicarbonate present in the groundwater which will further reduce their ecological toxicity.

4 References

ANZECC & ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, The Guidelines.* Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

CH2M Beca (2012) *Kapiti Coast – Updated Aquifer Testing and Groundwater Modelling*. Prepared for Kapiti Coast District Council, September 2012

Close ME and Davies-Colley R J (1990) Baseflow water chemistry in New Zealand rivers. 1.Characterisation. *New Zealand Journal of Marine and Freshwater Research* 24, pp319–341.

Ministry of Health (2008) *Drinking-water Standards for New Zealand 2005 (Revised 2008)*.

NIWA (2012) *Effect of groundwater inputs on benthic algal biomass and species composition in the Waikanae River*. Prepared for Kapiti Coast District Council, August 2012

NIWA (2011) *The effects of groundwater discharge on the algal, invertebrate and fish communities of the Waikanae River.* Prepared for Kapiti Coast District Council, August 2011

NIWA (2010) *Technical memo summarising the effects to aquatic ecology of proposed water supply options for the Kapiti Coast*. Prepared for Beca, May 2010