Report

Annual Waikanae River and River Recharge Report 2014/15 (Consents WGN130103 [33251] and [33252])

Prepared for Greater Wellington Regional Council

On behalf of Kāpiti Coast District Council

Prepared by CH2M Beca Ltd

22 September 2015

Revision History

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Document Acceptance

Action			
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on behalf of	CH2M Beca Ltd		

Highlights

This 2014/15 annual report has been prepared for Kāpiti Coast District Council as part of the consenting requirements for the River Recharge with Groundwater scheme. It reports on operational aspects and monitoring undertaken in relation to the Council's water take from the Waikanae River during the year 1 July 2014 to 30 June 2015. In line with the requirements of the resource consents, the discharge of groundwater to the Waikanae River for river recharge did not take place during this year.

During the year the river intake for the Waikanae water treatment plant was upgraded with new screens and pumps. The infrastructure needed for river recharge was also completed so that river recharge can commence next summer (within the limits of the consent) if the Waikanae River flow gets to be low enough for it to be required.

The flow in the Waikanae River reached low levels in March and April 2015 which meant that the Waikanae Borefield was used at times to supplement the water supply. The Council's take from the Waikanae River during these times of low flow, as well as throughout the rest of the year, were within the requirements of the consent, except for one 15 minute instance during pump testing when the 355 L/s allowable abstraction rate was exceeded by 12 L/s.

There was a comprehensive programme of monitoring in the Waikanae River during the months of December to April at sites upstream and downstream of the water treatment plant. The monitoring involved regular water quality measurements and assessments of the numbers and types of algae and insects in the river, as well as fish surveys. This monitoring will continue for a further two summers and the data collected over the three years will be used to develop a longer term monitoring programme and triggers with a series of actions in case of potential adverse effects from the groundwater discharge to the river.

Some changes to the current monitoring programme have been recommended based on the observations to date. These recommended changes are generally to improve the reliability of data collected, or in some cases it has been recognised that sufficient data has been gathered and further data collection is not necessary.

The Adaptive Management Group which comprises representatives of the Council, Greater Wellington Regional Council and Te Āti Awa ki Whakarongotai met in August 2015 to discuss this report, alongside representatives of key stakeholder groups. Recommendations from the Adaptive Management Group included:

- An alternative method for sampling algae (periphyton) in the river using ceramic tiles attached to a wire for retrieval from the river bank. The new methodology is to be compared against the original method (sampling from boulders on the bed of the river) for the first sample of the coming summer to see if there are any discrepancies. Also discontinue manual water velocity and in-situ depth measures in the river at the periphyton monitoring sites.
- Insect (macroinvertebrate) surveys in the river to only occur when there is medium high or high levels of periphyton present. This is a change to the current methodology as sufficient data have been already been collected for low to medium periphyton levels from this year of monitoring.
- Monthly baseline monitoring reports are no longer required as these are not being reviewed by the Regional Council. Seasonal reports are to be appended to the annual report rather than submitted to the Regional Council separately.

Executive Summary

This annual report for the Waikanae River take and river recharge has been prepared on behalf of Kāpiti Coast District Council (Council) in accordance with Condition 24 of consent WGN130103 [33251] and Condition 26 of consent WGN130103 [33252]. This is the second annual Waikanae River and River Recharge report, and covers the period from 1 July 2014 to 30 June 2015. The report includes recommendations of the Adaptive Management Group, which met on 26 August 2015 to discuss this annual report.

In accordance with Conditions 4 and 18 of consent WGN130103 [33252] river recharge did not occur during the 2014/15 reporting period. Construction of the required infrastructure for river recharge is now complete and, subject to the necessary approvals, Council expects to be able to commence river recharge next summer (2015/16) if required.

The maximum daily abstraction from the Waikanae River was 20,527 m^3/day on 14 February 2015, while the average daily abstraction volume was 11,946 m^3/day. These daily abstraction volumes are lower than the volumes reported in last year's report. The maximum instantaneous abstraction rate was 367 L/s (on 13 February 2013 for no more than 15 minutes). This short duration high flow occurred on a day that upgrading works were being carried out on the river intake wet well and pumps. Typically the instantaneous abstraction rate was less than 250 L/s.

Council ceased abstraction from the river on three occasions during the months of February to April due to low river flows, which necessitated the use of the Waikanae Borefield to supplement the public water supply. The requirements of the consent for minimum flow in the Waikanae River downstream of the WTP were complied with.

During the year modifications to the intake structure for new screens and a new control gate were completed and the raw water pumps were replaced. Other than these construction works for the WTP upgrade and the low river flows that occurred during February to April, no other unusual events were noted by Council in relation to the river take.

Baseline monitoring of the Waikanae River was carried out during the period December 2014 to April 2015 in in accordance with the certified Waikanae River Baseline Monitoring Plan (River BMP), and the results of this monitoring are documented in the report in Appendix B. The baseline monitoring data collected during 2014/15 is part of a three-year programme of monitoring and adds to the data collected in March and April 2014. This data includes water quality, periphyton measures, macroinvertebrate samples and fish surveys. Algae growths have not yet been seen above a low-medium bed cover. The macroinvertebrate communities represent a good quality, relatively sensitive array of species. This year a minor response in the macroinvertebrate community to the mild increase in matting algae and filamentous algae in March was measured.

As there was no river recharge during the 2014/15 year, the interim trigger levels for the Waikanae River did not apply.

Further river baseline monitoring will be carried out over the 2015/16 summer in accordance with the River BMP. Boffa Miskell has recommended some changes for next year's river baseline monitoring programme. These changes are: an alternative methodology for visual assessment of periphyton using in-river ceramic tiles, discontinuation of the water velocity and in-situ depth measures at the periphyton monitoring sites, macroinvertebrate data collection only if high algae levels occur, and changing the methodology for investigating fish migration.

Looking ahead to the coming year (2015/16), there is no additional mitigation or adaptive management that is anticipated at this stage, other than the proposed changes to the River BMP.

Subject to the necessary approvals from GWRC, river recharge may be used next summer (2015/16) if required due to low flows in the Waikanae River. Initially river recharge will be limited to no more than 20% of the downstream river flow in accordance with Condition 18 of consent WGN130103 [33252]. The recharge will be undertaken in accordance with the approved Bore Preference Hierarchy Plan.

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1 Introduction

The Kāpiti Coast District Council (Council) holds resource consents WGN130103 [33251] and [33252] to take water from the Waikanae River for public water supply and to discharge groundwater to the Waikanae River for the purpose of river recharge.

This is the second annual Waikanae River and River Recharge report to Greater Wellington Regional Council (GWRC), and covers the period from 1 July 2014 through to 30 June 2015. This report is required by Condition 24 of consent WGN130103 [33251] and Condition 26 of consent WGN130103 [33252]. The requirements of these conditions are listed in the tables below (Table 1 and Table 2) with cross-references to the relevant section in this report.

In accordance with Condition 4 of consent WGN130103 [33252] the discharge of groundwater for the purpose of river recharge did not occur during the 2014/15 reporting period. Construction of the required infrastructure for river recharge is complete and was officially opened on 27 May 2015. Subject to the necessary approvals from GWRC, Council expects to be able to commence river recharge next summer (2015/16) if it is required due to low flows in the Waikanae River. Initially river recharge will be limited to no more than 20% of the downstream river flow in accordance with Condition 18 of consent WGN130103 [33252].

Table 1: Requirements for Annual Waikanae River report

Condition 24 of consent WGN130103 [33251]		Section in this annual report
The consent holder shall, by 30th August each year, submit an Annual Waikanae River report to the Manager, or by another date as agreed with the Manager. The annual Waikanae River report shall report on the year 1 July to 30 June inclusive, and include the following information:		
a)	Records of the instantaneous rate of take (L/s), and total daily volumes (m^3);	Section 2.1.2
b)	Flow and river recharge information to demonstrate compliance with Condition 6 (Waikanae River low flow);	Section 2.1
c)	Provide information to demonstrate compliance with Condition 18 of this consent	Sections 2.1 and 2.2
d)	Results of all monitoring undertaken that year required by Conditions 19, 20 and 21 of this consent (if applicable), including a comprehensive analysis of the monitoring results, assessment against any relevant guidelines and comparison with previous years' results (i.e. trend analysis);	Section 3
e)	Details of any trigger levels or compliance limits that were reached (if occurred that year);	Section 3.1
f)	Details of any actions and/or mitigation/adaptive management taken in response to trigger levels or compliance limits being reached, including an assessment of the effectiveness of these actions and/or mitigation/adaptive management;	Section 3
g)	Any recommendations for changes to the Waikanae River Baseline Monitoring Plan or the On-going Mitigation Plan (as relevant), including triggers, compliance limits or actions and/or mitigation measures or changes to the operations and	Section 3.3, Section 2.3 and Section 5

Condition 24 of consent WGN130103 [33251]		Section in this annual report
	maintenance manual, including recommendations of the Adaptive Management Group (referred to in Condition 26 of this consent);	
h)	A discussion on any mitigation/adaptive management that may be required in the coming year;	Section 4
i)	Summary of any maintenance undertaken.	Section 2.2
The annual Waikanae River report can be combined with the annual River Recharge report required by the conditions of discharge permit WGN130103 [33252]. The annual Waikanae River report shall be made available to the public on the Kāpiti Coast District Council website no later than 30th August each year, or by another date as agreed with the Manager. *Note: The consent holder is only required to report on the listed requirements of this condition if they have occurred during that compliance year (1 July to 30 June inclusive).* *Note: The consent holder may request, with the Manager's approval, an extension of time to submit the annual report to the Manager and make it available to the public on the website, if the Adaptive Management Group requires more time to consider the draft annual report and provide their recommendations as required by part (g) of this condition.*		Refer www.kapiticoast.govt.nz

Table 2: Requirements for Annual River Recharge report

Condition 26 of consent WGN130103 [33252]		Section in this annual report
The consent holder shall, no later than 30th August each year that a discharge to the River occurs, submit an annual River Recharge report to the Manager, or by another date as agreed with the Manager. The annual River Recharge report shall report on the year 1 July to 30 June inclusive, and include the following information:		
a)	Records of the instantaneous rate of discharge (L/s), and total daily volumes (m^3) of discharge	Section 2.1.3 Not applicable for 2014/15
b)	Dates, times and duration of discharge	Section 2.1.3 Not applicable for 2014/15
c)	Information to demonstrate compliance with the rate of discharge specified in Condition 5	Section 2.1.3 Not applicable for 2014/15
d)	Flow and river recharge information to demonstrate compliance with the Waikanae River low flow specified in Condition 12 of this consent	Section 2.1.3 Not applicable for 2014/15
e)	Results of all monitoring undertaken that year required by Conditions 22 or 23 of this consent (if applicable), including a comprehensive analysis of the monitoring results, assessment against any relevant guidelines and comparison with previous years' results (i.e. trend analysis)	Section 3
f)	Details of any trigger levels or compliance limits that were reached (if occurred that year)	Section 3.1
g)	Details of any actions and/or mitigation/adaptive management taken in response to trigger levels or compliance limits being reached, including an assessment of the effectiveness of these actions	Section 3

Condition 26 of consent WGN130103 [33252]		Section in this annual report
	and/or mitigation/adaptive management	
h)	Any recommendations for changes to the Waikanae River Baseline Monitoring Plan or the On-going Mitigation Plan as relevant), including triggers, compliance limits or actions and/or mitigation measures or changes to the operations and maintenance manual, required by Condition 17 to be discussed with the Adaptive Management Group (as required by Condition 27 of this consent)	Section 3.3 and Section 2.3
i)	A discussion on any mitigation/adaptive management that may be required in the coming year	Section 4
j)	Summary of any maintenance undertaken	Section 2.2
The annual River Recharge report may be combined with the annual Waikanae River report required by consent WGN130103 [33251]. The annual River Recharge River report shall be made available to the public on the Kāpiti Coast District Council website by 30 August each year, or by another date as agreed with the Manager. *Note: The consent holder may request, with the Manager's approval, an extension of time to submit the annual report to the Manager and make it available to the public on the website, if the Adaptive Management Group requires more time to consider the draft annual report and provide their recommendations as required by part (g) of this condition.*		Refer www.kapiticoast.govt.nz

There are a number of plans and manuals required by the RRwGW suite of consents and various reports have been produced from the 2014/15 monitoring. These documents are set out in the following figure (Figure 1).

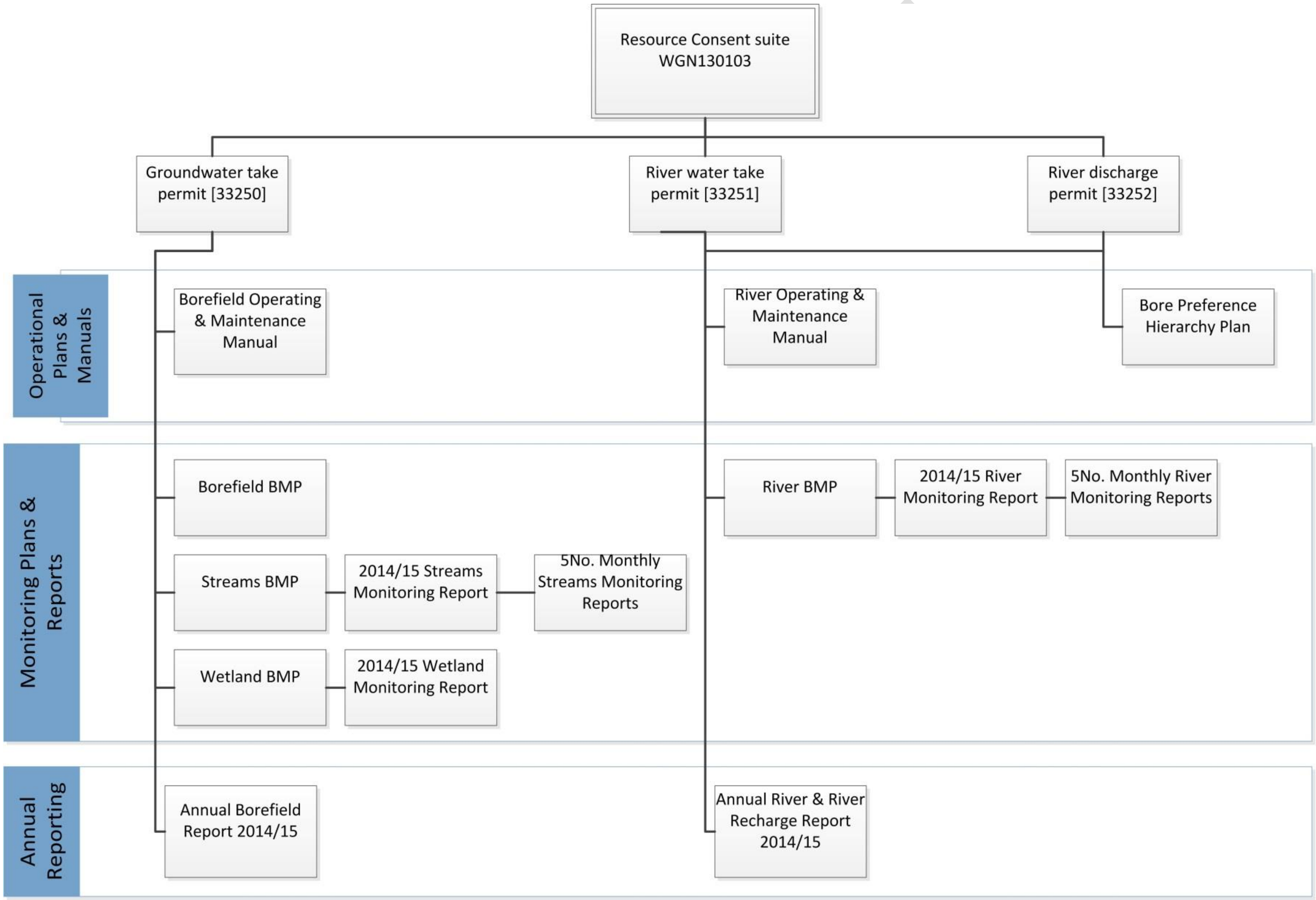

Figure 1: Key documents for RRwGW consents and 2014/15 monitoring

2 Operation of River Take and River Recharge

2.1 River Flows, Abstraction and Recharge

2.1.1 Waikanae River Flows

The Waikanae River flow is monitored by GWRC at a gauging station approximately 200 m upstream of the Waikanae Water Treatment Plant (WTP) intake. Rainfall is also measured by GWRC at this site. River flow data, recorded at 15 minute intervals, for the reporting period is presented in Figure 2 together with weekly rainfall depths.

Since December 2014 Council's SCADA system has been receiving river flow data from GWRC's SCADA system on an approximately hourly basis. The river flow data received and stored by Council is used for managing the water supply abstraction and, unlike GWRC's river flow database, this data is not back-corrected if GWRC subsequently updates the rating curve for the gauging station. GWRC gauged the river in late February and the rating curve was updated in early March, which can be seen in Figure 2 as the step down in river flow. The river flow data for the period 1 July 2014 to 30 November 2014 was supplied by GWRC[1], whilst the river flow data for the period 1 December 2014 to 30 June 2015 was extracted from Council's SCADA system. The rainfall data for the whole 2014/15 year was supplied by GWRC[1].

Low rainfall through August to October kept river flows below 2,000 L/s until late in October. Rainfall through November and December raised flows to a peak flow of more than 200,000 L/s on 10 December. Rainfall in the week ending 23 December delayed the start of the summer flow recession, which commenced in the last week of December. Rainfall was generally low through January, February and March, with river flows dropping steadily to 810 L/s in early March (after GWRC re-rated the river). 37 mm of rainfall in the week ending 10 March pushed flows up to 10,000 L/s, but flows then dropped back to a low of 734 L/s on 21/22 March (ie. it naturally dropped below the river's consented minimum flow of 750 L/s). From mid-April onwards, heavy rainfall raised flows above threshold levels.

Further commentary is included in Section 2.1.4 in relation to the low flows in the river from February to April 2015.

[1] Data supplied by GWRC on 28 May and 30 June 2015.

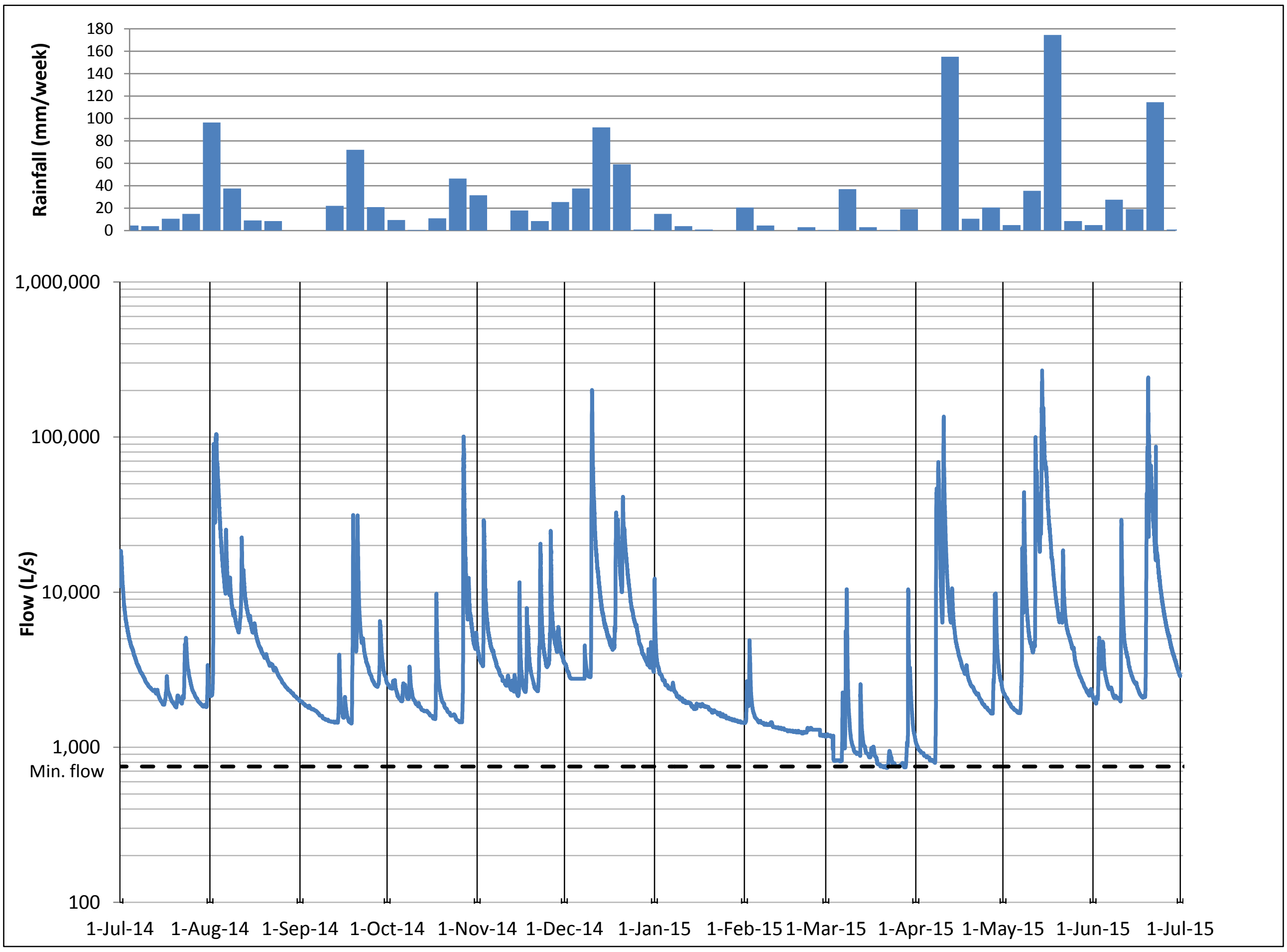

Figure 2: Waikanae River Flow and Rainfall at Water Treatment Plant (July 2014 – June 2015)

2.1.2 River Abstraction

Council measures and records the rates and volumes of water abstracted from the Waikanae River by way of a flow meter at the WTP intake. Council regularly submits its river abstraction records to GWRC as per Condition 13 of consent WGN130103 [33251]. Following the upgrade to the WTP's SCADA system, Council is now able to automatically submit river abstraction records direct from Council's SCADA to GWRC's Water Use Data Management System (Hydrotel). A summary of the abstraction data is provided below.

The daily abstraction volumes for the reporting period are summarised in Figure 3. The maximum daily abstraction was 20,527 m^3/day on 14 February 2015. This is less than the maximum allowable daily volume of 30,700 m^3/day specified by Condition 5 of consent WGN130103 [33251]. The total volume abstracted in the period 1 July 2014 to 30 June 2015 was 4,360,189 m^3. This is equivalent to an average daily abstraction of 11,946 m^3/day. The maximum and average daily abstraction volumes for 2014/15 are less than the volumes reported in last year's (2013/14) annual report.

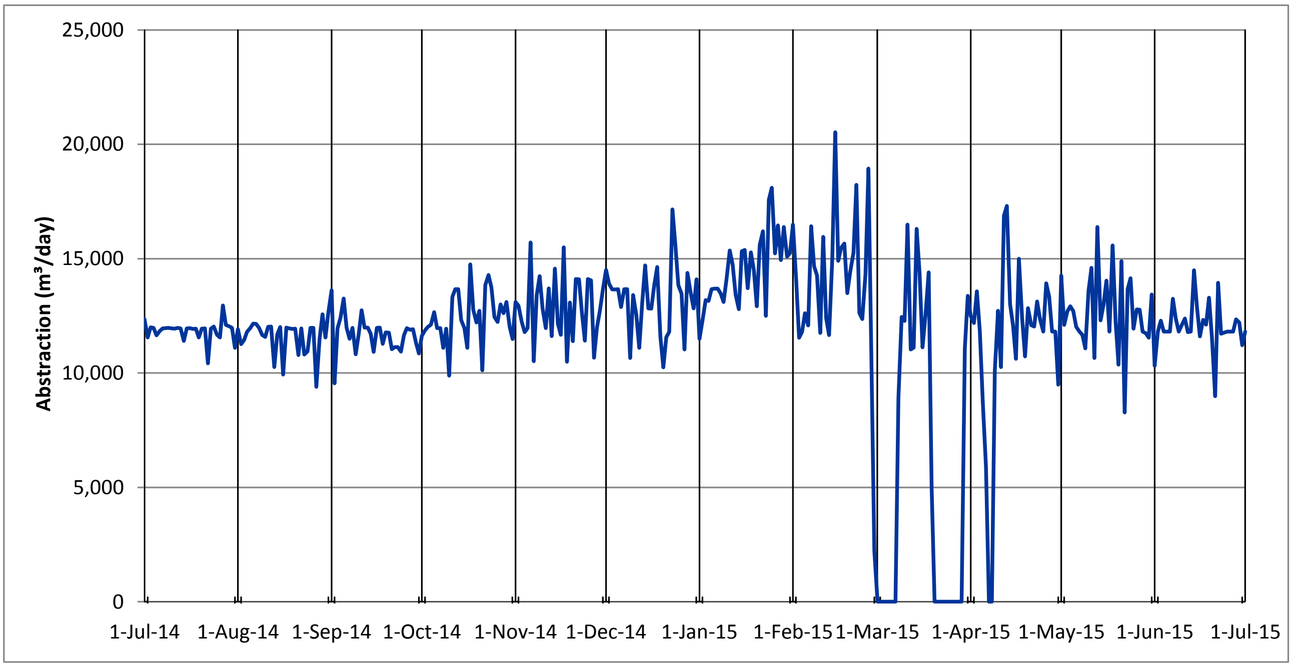

Figure 3: Waikanae WTP River Abstraction Volumes (m3/day)

The instantaneous rates of abstraction (recorded at 15 minute intervals) for the reporting period are shown in Figure 4. The maximum abstraction rate was 367 L/s on 13 February 2015. This peak rate was for no more than 15 minutes duration and was due to testing of the raw water pumps. The river flow at this time was 1,340 L/s, which means that the maximum allowable pumping rate given by Condition 5 of consent WGN130103 [33251] was exceeded by 12 L/s during this 15 minute period. The effects of this short term spike in the abstraction rate would be negligible, as the 15-minute preceding and subsequent abstraction rates were 229 L/s and 199 L/s respectively, and the average abstraction was 177 L/s on this particular date. Modifications to the Waikanae WTP SCADA system for the river recharge project included setting limits on the new raw water pumps to match the requirements of Condition 5 of consent WGN130103 [33251]. The instantaneous abstraction rate was less than 310 L/s at all other times during 2014/15 and the average instantaneous abstraction rate over the reporting period was 142 L/s.

The reduced rates of abstraction by Council during the months of March and April are due to the low river flows that occurred at this time which necessitated the use of the Waikanae Borefield for supplementary supply. Refer to section 2.1.4 for further analysis of this period.

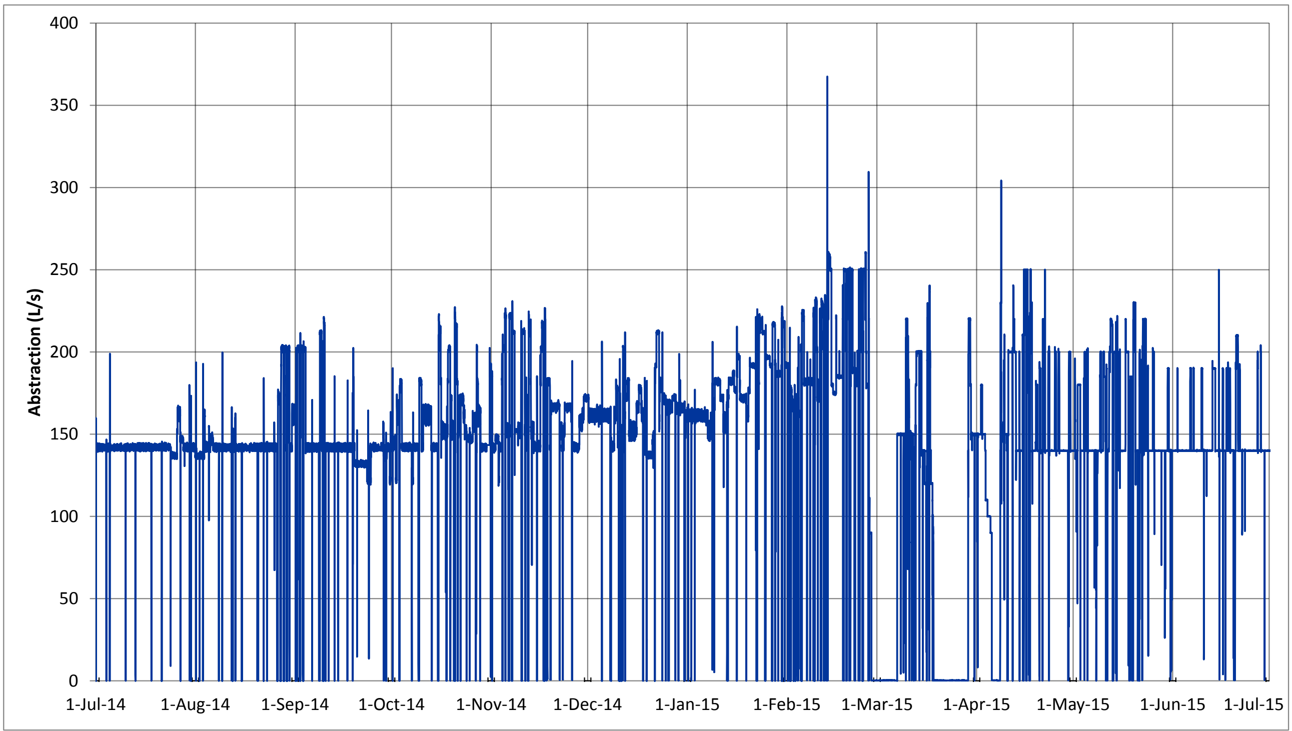

Figure 4: Waikanae WTP River Abstraction Rates (L/s)

2.1.3 River Recharge

There was no discharge of groundwater to the Waikanae River for the purpose of river recharge during the reporting period.

Short duration discharges (of a few hours) of groundwater to the Waikanae River via the swale have taken place twice in the past six months: once on 20 March for the purposes of commissioning the swale (and which allowed a blessing by Iwi in a welcoming of the water ceremony), and once on 27 May for the purposes of testing the boulder placement at the base of the recharge outlet (and facilitated demonstration of the swale during the opening ceremony). Both of these discharges were undertaken outside of the requirements of the consents suite WGN130103 and were approved by GWRC as a permitted activity due to the effects of the discharge being *de minimis*.

2.1.4 River Low Flow Periods

The flow of the Waikanae River was low enough during March and early April 2015 that Council had to reduce abstraction from the Waikanae River and use the Waikanae Borefield as a supplementary source for water supply. The Borefield was used for supplementary supply for a total of 29 days. Due to low river flows abstraction from the river ceased for the periods 27 February to 7 March 2015, 18 to 29 March 2015 and 5 to 8 April 2015, and during these times the Borefield provided all water for public supply.

Figure 5 shows the river flow at the GWRC gauging site upstream of the WTP (blue line) and the WTP abstraction (purple line; these are both as 15-minute readings taken from Council's SCADA), and the resulting calculated flow immediately downstream of the WTP (green dotted line) during the period of low river flows in summer and autumn 2014/15. Overlaid on this graph is the river flow from GWRC's website recorded each morning by the WTP operators (blue dots in Figure 5) and the corresponding WTP abstraction set points (orange dashes). The green dots in Figure 5 represent the downstream flow calculated from the website published river flow and the WTP abstraction set point. Although the green dotted line drops below 750 L/s on a couple of occasions in mid March, this is not the basis of compliance. The only time the re-calculated downstream flow (compliance basis shown by the green dots) goes below 750 L/s (20-28 March 2015) is when there is no abstraction from the river occurring and so the river has fallen naturally below 750 L/s. This demonstrates compliance with Condition 12 of consent WGN130103 [33251].

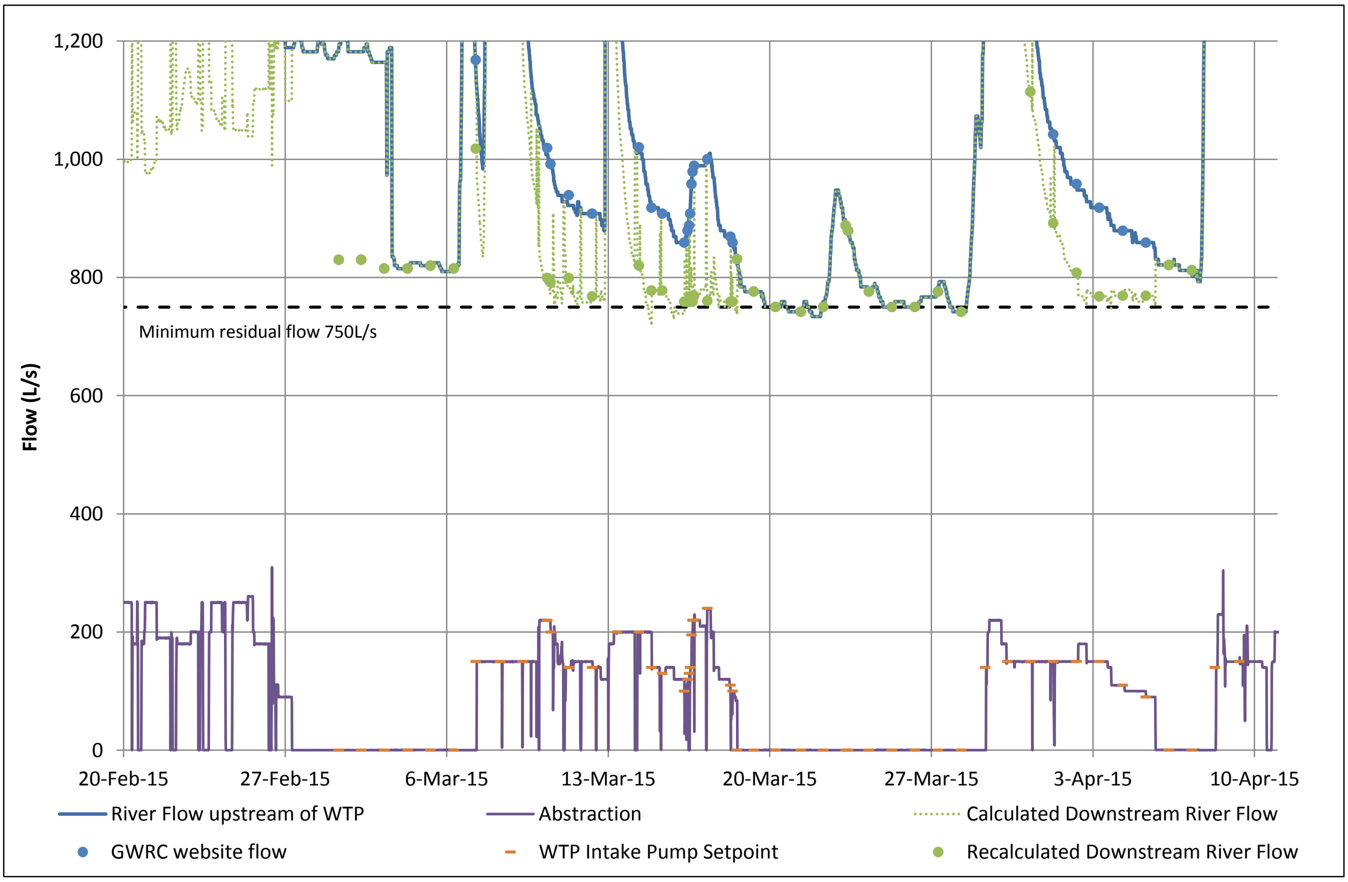

Figure 5: River flow upstream and downstream of WTP during low flow periods

A minimum flow of 200 L/s was maintained over the weir downstream of the abstraction point at all times in accordance with Condition 16 of consent WGN130103 [33251].

2.2 Operations Log and Maintenance Undertaken

Council has confirmed that its upgraded SCADA system together with the NCS system are an 'electronic data management system' which records and stores the information required by Condition 18 of consent WGN130103 [33251]. Council are also currently implementing a new system (WaterOutlook) to store and report data and operational information relating to the Waikanae River take and recharge.

As part of the SCADA system upgrade Council has worked with the GWRC to enable river abstraction records to be submitted automatically from Council's SCADA to GWRC's Water Use Data Management System (Hydrotel).

Excerpts from the Council’s WTP operations log that relate to maintenance of the intake are included in Appendix A. Additionally the WTP operators carry out an inspection of the intake every day and clear accumulated debris from the intake screens, such as leaves and twigs, as required.

Modifications to the intake structure for new screens and a new control gate were completed and the raw water pumps were replaced during the year. There were a number of temporary shutdowns to the intake and wet well during the construction works to facilitate these modifications. The outlet for river recharge was also constructed within the river bank immediately downstream of the intake.

Other than the construction works associated with the upgrade to the intake and raw water pumps, and ceasing abstraction for three periods during February to April on account of low river flow, no other unusual events were noted by Council in relation to the river take.

2.3 Operations and Maintenance Manual

The Waikanae River Take Operations and Maintenance Manual (ROMM) was submitted to GWRC for approval on 2 April 2015, in accordance with Condition 17 of consent WGN130103 [33251]. Prior to completion of the ROMM, Council continued to use the operations and maintenance manual from the previous water permit WGN050024 [31767].

There are no recommended changes to the ROMM at this time.

3 River Monitoring

3.1 Aquatic Monitoring

Baseline monitoring of the Waikanae River was carried out during the period December 2014 to April 2015 in accordance with the certified Waikanae River Baseline Monitoring Plan (River BMP). The results of this monitoring are documented in the report “Waikanae River Aquatic Baseline Monitoring Data” by Boffa Miskell, which is included as Appendix B.

The river baseline monitoring generally involved collection of periphyton data, macroinvertebrate samples, water quality measurements and velocity measurements at two sites upstream of the Waikanae WTP and three downstream sites. Fish surveys at these same sites as well as in upper tributaries of the Otaki and Waikanae Rivers were also completed. Algae growths have not yet been seen above a low-medium bed cover. The macroinvertebrate communities represent a good quality, relatively sensitive array of species. This year a minor response in the macroinvertebrate community to the mild increase in matting algae and filamentous algae in March was measured.

The baseline monitoring data collected during the 2014/15 summer/autumn adds to the data collected in March and April 2014. The data collected over the 3-year baseline monitoring period will be used to develop an on-going monitoring regime for the Waikanae River and inform the development of management trigger levels and cease abstraction compliance limits as part of the On-going Mitigation Plan for the Waikanae River.

The hydrological conditions in 2014/15 are considered to be not atypical, as defined by the consent WGN130103 [33251]. The river flow was consistently low, with no freshes or floods over 10 m^3/s, for more than 30 days during the summer/autumn period of 2 January to 7 March 2015 (65 days).

As there was no river recharge during the 2014/15 year, the interim trigger levels for the Waikanae River did not apply.

3.2 Bore Water Quality Monitoring

The Bore Preference Hierarchy Plan, which is required by Condition 16 of consent WGN130103 [33252], was submitted to GWRC for approval on 26 March 2015. This plan included full water quality results for the production bores Kb4, K4, K5 and K6 from monthly sampling carried out between October 2013 and January 2015. Monthly sampling of these bores continued through February and March 2015. Additional sampling of bores Kb4, K4 and K5 was carried out in early April when these bores were turned on for supplementary supply and a second April sample was collected from bore K4 as it was operated for more than 3 days. This is a requirement of Condition 27(j) of the groundwater take permit WGN130103 [33250].

Sampling for the remaining production bores, K10, Kb7, K12 and N2, commenced in May 2015 following the installation of bore pumps and headworks piping. The Bore Preference Hierarchy Plan will be updated once a year of sampling has been completed for these four bores. This means that, subject to GWRC's approval of the current Bore Preference Hierarchy Plan, only bores Kb4, K4, K5 and K6 will be used for river recharge in the first instance. The proposed hierarchy for these bores from first to fourth preference is: 1st Kb4, 2nd K4, 3rd K5 and 4th K6. Kb4 is the most preferred bore as it has the lowest dissolved reactive phosphorus concentration and a chemical signature more similar to the Waikanae River, based on major ion chemistry, than the other three bores.

A summary of the bore water quality sampling results obtained during the reporting period is included in Appendix C.

As required by the River BMP, a summary of the river water quality results from the 2014/15 baseline monitoring is included in Appendix C for comparison with the bore water quality.

There has been no monitoring of blended bore water. Blended bore water quality monitoring will be carried out in accordance with the River BMP when river recharge commences.

3.3 Changes to River Baseline Monitoring Plan

The Waikanae River monitoring report for 2014/15 (Appendix B) includes recommendations relating to changes to the baseline monitoring programme. These are summarised below; refer to Appendix B for further detail.

1. An alternative methodology for the visual assessment of periphyton is proposed. This involves the use of ten in-river ceramic tiles at each monitoring site, which are attached by a wire to a waratah on the river bank. This would overcome issues with the current methodology which is impractical when visibility in the river is poor or if river flows are high and it is not safe to enter the river. As well as improved safety for the field work team, the proposed method will also provide a more reliable and less subjective measurement of algae development through the monitoring season.

2. Discontinuation of the water velocity and in situ depth measures at each periphyton visual assessment quadrat is proposed. The measures to date have allowed a better understanding of the microhabitats instream but they are not considered to be related to periphyton abundance.

3. 150 macroinvertebrate samples representing low and medium-low periphyton levels have been collected to date. However it is the response in macroinvertebrate community to high periphyton levels that is of most interest. Therefore it is proposed that future baseline data collection for macroinvertebrates focus on gathering data only at high algae levels.

4. The fish surveys in the upper tributaries of the Waikanae and Otaki Rivers are not considered to provide a reliable indicator as to whether the RRwGW scheme is affecting fish migration in the Waikanae River. Instead of these surveys, whitebait and elver trapping above the water treatment plant intake is proposed as better test of identifying passage issues than the current programme.

These proposals will be discussed and agreed between Council's and GWRC's ecologists, and any changes will be incorporated into a revised BMP that will be submitted to GWRC for approval prior to the commencement of next summer's monitoring.

4 Mitigation/Adaptive Management in the Coming Year

Looking ahead to the coming year (2015/16), there is no additional mitigation or adaptive management that is anticipated at this stage, other than the proposed changes to the River BMP as outlined in Section 3.3 above.

Further river baseline monitoring will be carried out over the 2015/16 summer in accordance with the certified River BMP.

Subject to the necessary approvals from GWRC, river recharge may be used next summer (2015/16) if required due to low flows in the Waikanae River. Initially river recharge will be limited to no more than 20% of the downstream river flow in accordance with Condition 18 of consent WGN130103 [33252]. The recharge will be undertaken in accordance with the approved Bore Preference Hierarchy Plan.

5 Recommendations of the Adaptive Management Group

The Adaptive Management Group (AMG) for the RRwGW scheme comprises three members who are representatives of GWRC, Council and Te Āti Awa ki Whakarongotai. Figure 6 shows the stages of AMG and key stakeholder involvement in the lead up to the submission of this annual report to GWRC.

Council held a briefing session with the AMG and key stakeholders on 28 May 2015. Representatives of Wellington Fish and Game Council, Royal Forest and Bird Protection Society of New Zealand, The Kapiti Fly Fishing Club, Friends of the Waikanae River and Regional Public Health were present at the briefing. The purpose of this briefing session was to discuss the observations from the baseline monitoring undertaken to date as well as any observations of the AMG and key stakeholders, and to make an early start in the process of considering the potential for adaptive management in regards to these observations ahead of the AMG meeting in August 2015 on the annual reports.

The AMG met on 26 August 2015 to discuss the draft version of this annual report, as well as the annual Waikanae Borefield report. Representatives from the following key stakeholders also attended this meeting: Wellington Fish and Game Council, Royal Forest and Bird Protection Society of New Zealand, The Kapiti Fly Fishing Club, Friends of the Waikanae River and Regional Public Health.

Recommendations received from the AMG are presented in the table below:

Table 3: Recommendations of the Adaptive Management Group

Adaptive Management Observations & Opportunities	Consideration with AMG recommendation
Periphyton monitoring methodology ▪ Current method is not practical following rainfall events which increase the suspended solids in the river, i.e. the water becomes cloudy. High river levels can also mean that the river is unsafe to enter to undertake the sampling/observations. The current method also has an element of subjectivity between individuals undertaking the monitoring. ▪ Water velocity and in-situ depth measures have allowed a better understanding of microhabitat instream however they are not considered to be related to peripyton abundance.	▪ Consider alternative proposed methodology - use of a tile on a wire. Benefits include improved safety for the team undertaking the field work and the ability to produce more accurate results. AMG agreed. Note: the first survey of the summer is to be undertaken using both methodologies so results between methodologies can be compared. ▪ Consider discontinuing water velocity and in-situ depth measures. AMG agreed.
Fish surveys ▪ Fish surveys have been undertaken in upper tributaries of the Waikanae and Otaki Rivers. However, the types and numbers of fish present are such that this is not considered to provide a reliable indicator as to whether the RRwGW scheme is affecting fish migration in the Waikanae River.	▪ Consider alternative methodology for fish surveys in the Waikanae River to survey whitebait and elver (baby eel) populations upstream of the WTP intake when it is known fish are running. AMG requested that an understanding of the submitter's requirements for these surveys be investigated and reported on before a recommendation can be made.
Macroinvertebrate sampling ▪ Macroinvertebrate samples have been gathered for low and medium-low periphyton levels to date. However it is the response in macroinvertebrate community to high periphyton levels that is now of most interest.	▪ Consider focusing future macroinvertebrate baseline data collection on high algae levels only going forward. AMG agreed. Change to methodology to allow macroinvertebrate surveys to only occur when there is medium high or high levels of periphyton present going forward.
Monthly and Seasonal Reports ▪ The Baseline Monitoring Plans (BMPs) for the Small Coastal Streams and Waikanae River note that monthly and seasonal reports will be provided to GWRC outlining the data collected during each month and at the end of each season respectively, over the monitoring period set out in the BMP's	▪ Consider the value and practicality of these monthly and seasonal reports when the data is assessed and presented in the annual report. AMG agreed that monthly reports are no longer required and seasonal reports are to be submitted to GWRC appended to the relevant annual report.

Other AMG recommendations:

- It was agreed that the consents' submission date for the annual reports be updated via a section 127 application to the end of September each year to allow for the AMG review period.
- It was agreed an amendment to the consent should be submitted via a section 127 application to make allowance for the river intake pump ramp up as the environmental impact of a very short duration of the slightly higher than consented instantaneous pump rates was considered to be '*de minimis*'.

Note that recommendations made by the AMG and included in the final annual reports still require the approval of GWRC before implementation.

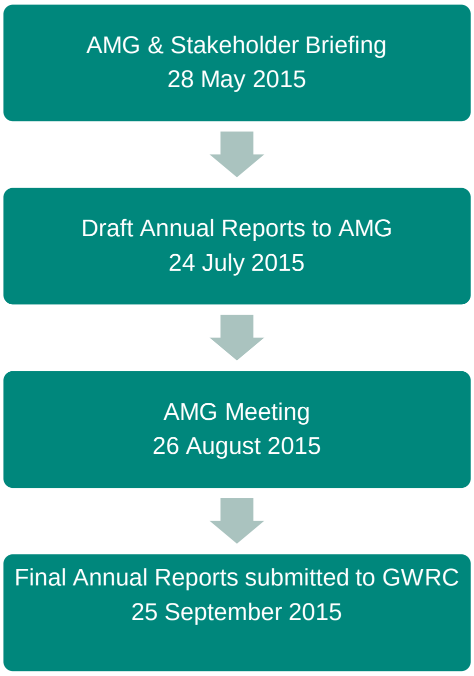

Figure 6: AMG activities associated with this year's annual report

Appendix A

Operations Log

Water Treatment Plant Operations Log

Date	Action
28 July 2014	Cleaned the leaf rack, run mono pumps
	Check intake screen
	Ran #2 pump for 5 minutes
9 August 2014	Clear leaf rack
	Clear intake – logs, small tree
13 November 2014	Cleared leaf rack
	Cleared intake, removed branch from intake gate
	Reset raw water # 1 pump, power cut
15 November 2014	Cleared leaf rack
	Checked intake
	C10 Waikanae WTP, Raw Water pump failed on #1 at 0529 and #2 at 0551, came in to plant to check, reset ok
12 December 2014	Cleared leaf rack x4
	Checked intake. Informed downers that lifting structure at intake is damaged
13 December 2014	Cleared leaf rack
	Cleared intake – lots of stones in intake weir
15 December 2014	Cleared leaf rack
	Cleared stones from intake
27 January 2015	Clean leaf rack
	Clear intake
	0915 Raw pumps off
	1155 Raw pumps on
5 February 2015	Cleared leaf rack
	Checked intake
	Rang Chris A about Kb4 comms, Bill said new radio ordered, will be here next week
	Plant shut down at 1000am for Raw Water #2 pump removal, bypassed plant while process water was disconnected (bypassed 127m^3
7 February 2015	Checked intake, closed gate
	Cleared leaf rack
9 February 2015	GWRC data from river had no change. Rang Jon Marks @ 9am.
	Clean leaf rack
	Clear intake
	Shut down plant for gibault replacement and raw water #2 fitting at 1000am
10 February 2015	Clean leaf rack and ran Mono's in manual
	Clean intake screen, lower gate, lots of leaves
	Replace inlet fitting on CL17 (water leak) Waikanae retic monitor

	2 x induction for wedge wire intake screen install
11 February 2015	Clear leaf rack
	Clear intake
	Raw water pump shut down – working being carried out in intake
	Test low water alarm/shut down in intake with pump 1 running (FAIL) TA and AC
	1730 Raw water pump 1 back on – all systems go!
12 February 2015	Clear leaf rack
	Clear intake
	1010hrs Pump 1 RW off for divers
	Raw water flow control set point now controlled by (SCADA 2) need to be logged
13 February 2015	0840hrs – Turn raw water pump off – turn drive to manual and lockout at MCC
	0845 – Divers able to enter raw water intake well
	Clear leaf rack
	0947hrs – Restart raw water pump 1
18 February 2015	Check intake
	Clean leaf rack
	Contractor's working on intake
	Plant off at 1000hrs
	Plant back on at 1630hrs
19 February 2015	Clear leaf rack
	Clear intake
	0815hrs plant off for work on intake gate
	1717hrs plant back on
21 February 2015	Clear leaf rack
	Check intake
	Contractors working on the intake gate
23 February 2015	Raw pump 2 trip
	0600hrs main bore field on for sample
	Clear leaf rack
	Check intake
	1030hrs turn off bores
	1100hrs turn off Waikanae plant for intake work
	Turn on plant 1645hrs
24 February 2015	Clear leaf rack
	Check intake
	1000hrs turn off Waikanae plant – raw pump one replacement
26 February 2015	Cleared leaf rack
	Check intake
	Test ran new # 1 pump 332l/s and 43Hz

	Tested no water switch for bearings on raw water pumps
7 March 2015	Turned off bores at 0520am, river flow 1201l/s, pumps wouldn't run, low flow on bearing water sensor switch, turned valve on a bit more to get flow, put pH probes into retic water to being reading down! (Can't change set pts)
	Cleared leaf rack
	Checked intake
9 March 2015	#2 pump flow switch failed again!
	Reset low flow switch, poly pumps and low alum flow 0640
	Cleared leaf rack
	Checked intake
	Turned valve on full for bearing flow switch on raw water pumps, failed for 3rd time
11 March 2015	Clear lead rack
	Clear intake screen - open and close gate
	Alistair – Discovered raw water pump issues when pumping between 153l/s and 180l/s pump/s oscillate between 150 and 200l/s with possible likelihood of breeching resource consent during low flows. Email to Gerry, BN, DB and operations
14 March 2015	Clean leaf rack
	Clean intake, open and close gate
19 March 2015	Clear leaf rack
	Check intake – work being down on gate
	Lock the lid to raw well
	V Notch 1 ratio 0.4 to 0.5
	V Notch 2 ratio 0.6 to 0.7
20 March 2015	Clear leaf rack
	Check intake – work being done on gate
21 March 2015	Clear leaf rack
	Check intake – contractors left bridge down
23 March 2015	Clean leaf rack
	Check intake
	John Ray plunge pool work
1 April 2015	Raw water pump gland switch kept tripping
	Open gate to clear leaves from intake
	Clean leaf rack
7 April 2015	Cleaned leaf rack
	K6 high temp cabinet alam
	Turned off K6 at 1235
	Opened up intake gate at 1720, river flow starting to come up
8 April 2015	K5 and Kb4 off at 0800hrs
	Turn off K4 bore 0918hrs – BN and DB to take samples

	Clear leaf rack
	Check intake, logs need to be removed
	1530hrs Ramp raw water pump up and down to allow pump manufacturer to observe efficiency of new pumps
	1800hrs Raw pumps set at 150l/s
	1805hrs filters not happy after ramping R/W pumps up and down. Will watch over next few hours
9 April 2015	0653 Filter inlet valve 1 failed to close (ALARM)
	Check intake – several branches and logs in race
	Clear leaf rack
	Remove logs from the intake
	Clear small logs/sticks from intake shute TA/BB
	Run off raw water pump 2 as this pump has scade supply water connected to it, until MAXTARR completes installation of pump 1
	Huge caustic spike into raw water (pre pit) dosing as a result of Brown Bros – testing efficiency flow's at different levels off raw water pump 1. Ramping up and down effected dosing while on alum and pre-caustic
17 April 2015	0815hrs Waikanae plant off for intake work
	Clean leaf rack
	Check intake
29 April 2015	Cleared leaf rack
	Air sparged intake
	Shut down raw water pumps for new pipework connection for scan. Restarted at 1500
	Changed raw water pump duty to #1
2 May 2015	C10 WTP #2 wetting core high level 0105. Check valve had blockage, back feeding from main removed valve and cleared. Raw water pump had also tripped on gland flow switch sample at depot
	Glad flow switch on #1 raw water pump failed again 0820, changed
	Checked leaf rack
14 May 2015	Took all readings of dosing pumps and raw water pumps for 140, 190 and 220l/s
	C10 WTP borefield K6 comm failed, acknowledged
	C10 WTP river flow analogue fail 0200, acknowledged
	C10 WWTP #2 raw water pump flow confirmation fault, reset and ran, took a long time to get up to speed. Increased flow to 200l/s 0510
18 May 2015	Shut down #2 pump for scan pipework correction by MAXTARR
10 June 2015	Changed raw water to pump #1

Appendix B

Aquatic Monitoring Report

Waikanae River Aquatic Baseline Monitoring Data

A report on 2014/2015 aquatic data collection for water permits
WGN130103 [33251] & [33252]
Prepared for Kapiti Coast District Council
9 July 2015

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Cover photograph: Periphyton measure in the Waikanae River © BML 2015

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1.0 Introduction

Resource consent conditions 19 (Consent WGN130103 [33251]) and 21 (Consent WGN130103 [33252] for Kapiti Coast District Council's River Recharge with Groundwater Project (RRwGW Project) requires the preparation of a '*Waikanae River Baseline Monitoring Plan*' (Waikanae River BMP). That plan (as prepared by BML (2014[1]) and certified by GWRC) requires the collection of:

- periphyton data - including visual cover and community composition assessments, algal biomass (AFDM) and chlorophyll-a over summer periods at frequencies that depend on the river's flow;
- macroinvertebrate samples that are dependent on periphyton levels (i.e. sample periods target each of a low, medium and high periphyton period);
- water quality samples for a base set of water quality per fortnight (or, flow depending, weekly); and
- a set of velocity measures taken at each periphyton visual cover estimation.

These data are collected from two upstream "control" and three downstream "receiving" monitoring sites on the Waikanae River. Manual water flow (gauging) measures are also required on a small number of occasions downstream of the State highway 1 bridge (near Jim Cooke Reserve).

Full details of the consent conditions and the parameters and requirements for monitoring can be found in the BML report "Waikanae River Baseline Aquatic Monitoring Plan" dated 23 February 2014[1] (prepared for KCDC).

This report presents the findings of five months data collection spanning December 2014 through April 2015. This data adds to a previous data set collected in March and April 2014. All data collected to date are prior to the introduction of bore water to the Waikanae River and is part of a three year monitoring programme, as described in the Waikanae River BMP (BML 2014).

This current report:

- Presents the findings of five months of data collection, December 2014 through April 2015, as part of the baseline sampling, prior to introduction of any bore water recharge to the Waikanae River;
- Presents the summary data and basic analyses of the metrics that may be used in the future to track potential effects of the groundwater discharge to the Waikanae River. Raw data has been given in the previous monthly reports and is not presented again in this report; and
- Concludes with any lessons learnt on collection of the data and observations as to the usefulness of the data to predict responses to the potential effects of bore water addition.

This baseline monitoring data will be part of the data set which informs the development of ongoing trigger levels. This report presents a brief summary of methodologies (Section 2.0), the full details of which are provided in the Waikanae River BMP (BML 2014). Sections 3.0 and 4.0 present background data such as river flows, rainfall, shade and substrate quantity. The monitoring results are reported in Section 5.0, examining the metrics of water quality measured over time for each site. Fish survey results (examining galaxiid migration potential) are reported in Section 6.0, and flow gauging results are presented in 7.0. Lastly (Section 8.0), this report summarises the results and discusses the

[1] Boffa Miskell Limited 2014. Waikanae River Baseline Aquatic Monitoring Plan: Kāpiti Water Supply RRwGW Scheme. Report prepared by Boffa Miskell Limited for Kāpiti Coast District Council.

monitoring to date, the parameters measured and makes recommendations as to the value of the information collected and if any changes to the monitoring regime are required.

2.0 Methods

2.1 Monitoring sites

The monitoring locations have been determined in the Waikanae River BMP, and in summary consist of:

- Two 'control' sites, (C1 and C2) located upstream of the Waikanae Water Treatment Plant (WTP); and
- Three 'receiving' sites, located at predetermined intervals downstream of the Waikanae WTP (R1, R2 and R3).

The locations of these sites are described in full in the Waikanae River BMP (BML 2014) and shown in Map 1. At each site, a wooden stake was driven into the bank so that the site location (in addition to GPS location) can be resampled over time. The stakes driven in in 2014 have been removed or the river has removed them, nevertheless the GPS location and site photos and sampler familiarity has allowed an accurate transect location each measurement time.

Currently, and for the purpose of this report, the control and receiving sites are simply replicate data sites until such time as bore water is introduced. Following that time, the upper sites (C1 and C2) become control sites to examine the effects of bore water on the parameters measured.

Part of the initial monitoring results and analysis is to determine if C1 and C2 (the control sites) are sufficiently similar in the monitored metrics as to be good control sites.

The flow gauging was under taken by NIWA at two of the previously used sites (NIWA 1 and 3 on Map 1).

Map 1 – Waikanae River Monitoring locations (C1, C2, R1, R2, R3). Note that the NIWA sites are those at which river gauging was undertaken; One gauging site (NIWA 1) was used for the 2015 measure.

The following photographs give a general indication of the conditions at each monitoring site.

Figure 1: 'Receiving' Site R1: looking upstream from and showing the location of the first transect.

Figure 2: 'Receiving' Site R2: under pylon, looking downstream.

Figure 3: 'Receiving' Site R3: below SH1 looking downstream from riffle to run.

Figure 4: 'Control' Site C1: looking upstream.


Figure 5: 'Control' Site C2: looking downstream from upper transect.

2.2 Monitoring methods

At each of the two control and three receiving sites the following was measured, generally during fine weather and low-flow conditions (i.e., post-raised or flushing flow events). Full methods for this sampling programme are provided in Waikanae River BMP (BML 2014). In summary, the following parameters are required to be measured at each site in a set timetable which is flow related.

1. Water chemistry and temperature:
   - pH;
   - Temperature (˚C);
   - Conductivity (μS/cm);
   - Dissolved reactive phosphorus (DRP, g/m^3);
   - Total phosphorus (TP, g/m^3);
   - Soluble inorganic Nitrogen (SIN, g/m^3);
   - Total nitrogen (TN, g/m^3);
   - Total ammonia (NH_4, g/m^3); and
   - Dissolved calcium (g/m^3).
2. Periphyton:
   - Visual observations of percent cover of periphyton at each site according to the Rapid assessment method (RAM) 1 & 2 methods of Biggs and Kilroy[2] (2000); and

[2] Biggs, B.J.; Kilroy, C. (2000). *Stream Periphyton Monitoring Manual*. Prepared by NIWA for the New Zealand Ministry for the Environment.

- Periphyton biomass, based on both chlorophyll-*a* and ash-free dry mass (AFDM) measurements (Biggs and Kilroy (2000)), from multiple rock scrapings collected from each site.

3. Velocity:
   - At each periphyton quadrat the water velocity was measured by either "the ruler method" (Harding et al 2009[3], Drost 1963[4]), or (more frequently) using a water velocity meter (GLWFP2311 Flow probe).
4. Benthic macroinvertebrates:
   - The macroinvertebrate community was sampled (at times relating to periphyton abundance) at each site following the Ministry for the Environment sampling 'Protocol C3 – Hard-bottomed, Quantitative', where five replicate Surber samples were collected from riffle habitat at each site; and
   - Six biotic metrics were calculated for each Surber sample: total abundance, taxonomic richness, Ephemeroptera, Plecoptera, Trichoptera [ETP] richness, EPT abundance, Macroinvertebrate Community Index [MCI], and the Quantitative Macroinvertebrate Community Index [QMCI]).
5. Freshwater fish:
   - Local resident fish by EFM of the monitoring sites in February; and
   - For migration success measures – a t two sites, one in the Otaki (control site) and one in the upper Waikanae, measured reaches are sampled by multi-pass EFM to catch and estimate the local fish taxa, size distribution and abundance.
6. Flow gauging
   - Standard river gauging (following the BMP methodology) was undertaken on two occasions (12/2/2015 and 10/3/2015) below SH1 near Jim Cooke Park (site NIWA 1 on Map 1).

In addition some basic substrate data, in terms of hard bottom cover available for periphyton was assessed, as was the proportion of river shaded to assist in understanding the periphyton results.

Table 1 sets out the monitoring activities by period for the 2014-2015 monitoring season.

Table 1. Sample activity by period for the current 2014-2015 Annual Report. Note samples are fortnightly unless flows < 1100L/S, macroinvertebrates are triggered by periphyton biomass and periphyton lab samples are not regular.

Period	Water Quality	Visual periphyton	velocity & depth	periphyton lab	Macroinvertebrates
Week 1 December 2014	✓	✓	✓	✓	✓
Week 2 December 2014	Not required	Not required	Not required	Not required	Not required
Week 3 December 2014	✓	✓	✓	✓	Not required
Week 4 December 2014	Not required	Not required	Not required	Not required	Not required
Week 1 January 2015	✓	✓	✓	Not required	Not required
Week 2 January 2015	Not required	Not required	Not required	Not required	Not required

[3] Jon Harding, Joanne Clapcott, John Quinn, John Hayes, Mike Joy, Richard Storey, Hamish Greig, Joe Hay, Trevor James, Mary Beech, Rachael Ozane, Adrian Meredith, Ian Boothroyd 2009. Stream Habitat assessment protocol for wadable rivers and streams in New Zealand. School of Biological Sciences, University of Canterbury, New Zealand.
[4] Drost, H. (1963). Velocity head rod for measuring stream flow. J. Hydrol. (New Zealand) 2: 7–11.

Period	Water Quality	Visual periphyton	velocity & depth	periphyton lab	Macroinvertebrates
Week 3 January 2015	✓	✓	✓	✓	Not required
Week 4 January 2015	Not required	Not required	Not required	Not required	Not required
Week 1 February 2015	✓	✓	✓	✓	✓
Week 2 February 2015	Not required	Not required	Not required	Not required	Not required
Week 3 February 2015	✓	✓	✓	✓	✓
Week 4 February 2015	Not required	Not required	Not required	Not required	Not required
Week 1 March 2015	✓	✓	✓	Not required	Not required
Week 2 March 2015	✓	✓	✓	Not required	Not required
Week 3 March 2015	✓	✓	✓	✓	✓
Week 4 March 2015	✓	✓	✓	Not required	Not required
Week 1 April 2015	✓	✓	✓	✓	Not required
Week 2 April 2015	Not required	Not required	Not required	Not required	Not required
Week 3 April 2015	✓	✓	✓	✓	Not required
Week 4 April 2015	✓	✓	✓	Not required	Not required

2.3 Data analyses

Tables and charts (graphic plots) were prepared to examine the differences in water quality, periphyton and macroinvertebrate results between sites and over time (monitoring period). In addition, the Excel(©) analysis function "correlation" was used to examine the correlation between water quality parameters, periphyton parameters, and water velocity at each site over time. Pearson Correlation (Excel 2013) was undertaken to ascertain significant (alpha 0.05) positive and negative correlations. The correlation coefficient is a measure of the extent to which two measurement variables "vary together".

A non-metric multidimensional scaling (or NMDS) ordination[5] with 1000 random permutations, using abundance data, was used to determine if the macroinvertebrate community was similar among the five survey sites (C1, C2, R1, R2, R3), and particularly between the sampling periods. NMDS ordinations rank sites such that distance in ordination space represents community dissimilarity (in this case using the Bray-Curtis metric). Therefore, an ordination score (i.e. an x and a y value) for the entire macroinvertebrate community found at any site can be presented on an x-y scatterplot to graphically show how similar (or dissimilar) the community at a site is from that found at another site. Ordination scores that are closest together are more similar in macroinvertebrate community composition, than those further apart (Quinn and Keough 2002[6]).

An analysis of similarities (ANOSIM), with 100 permutations, was then used to test for significant differences in macroinvertebrate community composition between particular dates. It is helpful to view ANOSIM results when interpreting an NMDS ordination. An NMDS ordination may show that communities appear to be quite distinct (i.e. when shown graphically sites could be quite distinct from

[5] Goodness-of-fit of the NMDS ordination was assessed by the magnitude of the associated 'stress' value. A stress value of 0 indicates perfect fit (i.e. the configuration of points on the ordination diagram is a good representation of actual community dissimilarities). It is acceptable to have a stress value of up to 0.2, indicating an ordination with a stress value of <0.2 corresponds to a good ordination with no real prospect of misleading interpretation (Quinn & Keough 2002)[6].

6 Quinn, G.P., Keough, M.J. (2002) *Experimental design and data analysis for biologists.* Cambridge University Press, Cambridge

one another in ordination space), but ANOSIM results show whether these differences are in fact statistically significantly different[7].

If ANOSIM revealed significant differences in macroinvertebrate community composition (i.e. $R \neq 0$ and $P \leq 0.05$) between the two baseline sampling occasions, similarity percentages (SIMPER) were calculated[8] to show which macroinvertebrate taxa were driving these differences.

NMDS, ANOSIM and SIMPER analyses were performed in PRIMER version 6.1.

3.0 Water Quantity through the Monitoring Period

3.1 Flow effect on baseline monitoring

The Waikanae River BMP specifies the frequency of summer sampling relative to the 7-day average flow for the Waikanae River. Fortnightly sampling is undertaken when the 7-day average flow is above 1100 L/s, whereas weekly sampling is required when the 7-day average flow is below 1100 L/s.

While data collection is fortnightly or weekly (flow dependent), as flows rise, the ability to visually monitor periphyton reduces, so that only scrape samples and water quality data may be collected. Where flows increase such that sampler safety is placed at risk sampling is then abandoned. Therefore, there are gaps in the data sets related to flow conditions.

3.2 Rainfall and river flow

Weekly rainfall depths and average flow data during the summer of 2014-2015, which includes the monitoring period of March and April 2015, is summarised in Table 2 and Figure 6. The river flow data presented in this section is the updated data from GWRC following re-gauging of the river.

Table 2. Background Waikanae Rainfall and River flow records (data from GWRC) 1st October 2014 to 2 June 2015

Week ending	7-day Rainfall (mm)	7-day average flow (L/s)	Week ending	7-day Rainfall (mm)	7-day average flow (L/s)
7/10/2014	0.0	2164	10/02/2015	4.5	1135
14/10/2014	0.5	1778	17/02/2015	0.0	952
21/10/2014	11.0	2098	24/02/2015	3.0	964
28/10/2014	46.5	17379	3/03/2015	0.5	817
4/11/2014	31.5	8224	10/03/2015	37.0	2939
11/11/2014	0.0	2746	17/03/2015	3.0	913
18/11/2014	18.0	2906	24/03/2015	0.5	826
25/11/2014	8.5	6307	31/03/2015	19.0	2587

[7] ANOSIM is a non-parametric permutation procedure applied to the rank similarity matrix underlying the NMDS ordination and compares the degree of separation among and within groups (i.e. sites or years) using the test statistic, R. When R equals 0 there is no distinguishable difference in community composition, whereas an R-value of 1 indicates completely distinct communities (Quinn & Keough 2002).

[8] The SIMPER routine computes the percentage contribution of each macroinvertebrate taxon to the dissimilarities between all pairs of sites among groups.

Week ending	7-day Rainfall (mm)	7-day average flow (L/s)
2/12/2014	25.5	3625
9/12/2014	37.5	3386
16/12/2014	92.0	7249
23/12/2014	59.0	20746
30/12/2014	1.0	4084
6/01/2015	15.0	2767
13/01/2015	4.0	2044
20/01/2015	1.0	1733
27/01/2015	0.0	1350
3/02/2015	20.5	2048

Week ending	7-day Rainfall (mm)	7-day average flow (L/s)
7/04/2015	0.0	838
14/04/2015	155.0	8611
21/04/2015	10.5	2603
28/04/2015	20.5	1873
5/05/2015	5.0	1855
12/05/2015	35.5	4704
19/05/2015	174.5	18136
26/05/2015	8.5	4446
2/06/2015	8.5	3156

Low rainfall through October kept river flows below 2,000 L/s until late in the month. Rainfall through November and December raised flows to a peak daily mean flow of more than 200,000 L/s on 10 December. Rainfall in the week ending 23 December post delayed the start of the summer flow recession, which commenced in the last week of December.

Rainfall was generally low through January, February and March, with flows dropping steadily to 782 L/s in early March. 37 mm of rainfall in the week ending 10 March pushed flows up to 10,000 L/s, flows dropped back to around 800 L/s later in the month. From mid-April onwards, heavy rainfall raised flows above threshold levels.

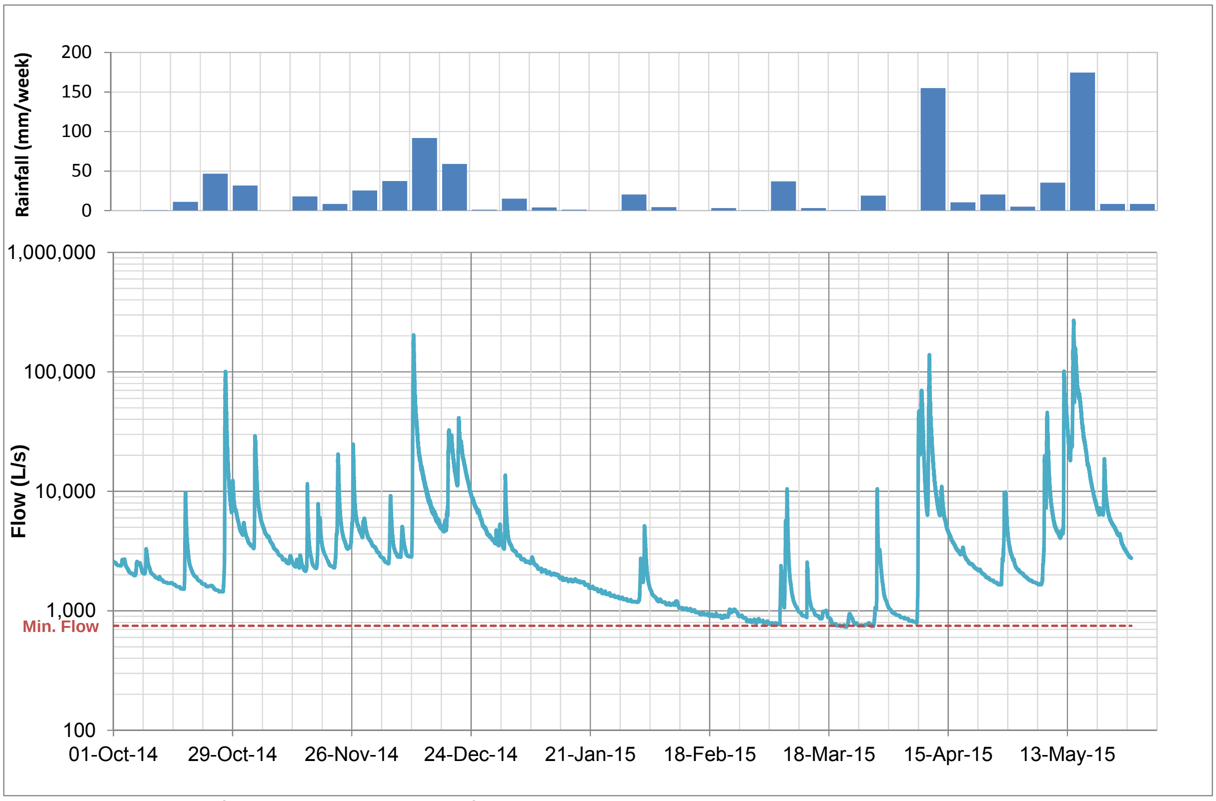

Figure 6: Weekly rainfall depths and recorded flow at the Waikanae WTP

Flow gaugings were carried out by NIWA at two locations downstream of the water treatment plant on 12 February and 10 March. These are reported in Section 7.0.

3.3 Abstraction

Figure 7 shows daily average abstraction from the beginning of October 2014 to 22 May 2015. During this period, the average abstraction was 11,983 m^3/day (139 L/s daily average), with a peak of 20,527 m^3/day (238 L/s). The peak abstraction occurred on 15 February 2015. Due to low river flows, abstraction from the river was reduced to zero during the periods of:

- 1 to 7 March 2015
- 20 to 29 March 2015
- 7 to 8 April 2015

GWRC re-gauged the river and adjusted the rating curve during the summer. However, the water treatment plant abstraction was operated such that the downstream flow was above or at 750 L/s based on the flow rating in use at the time. However, the river flow data presented in this section is the updated data from GWRC following re-gauging of the river.

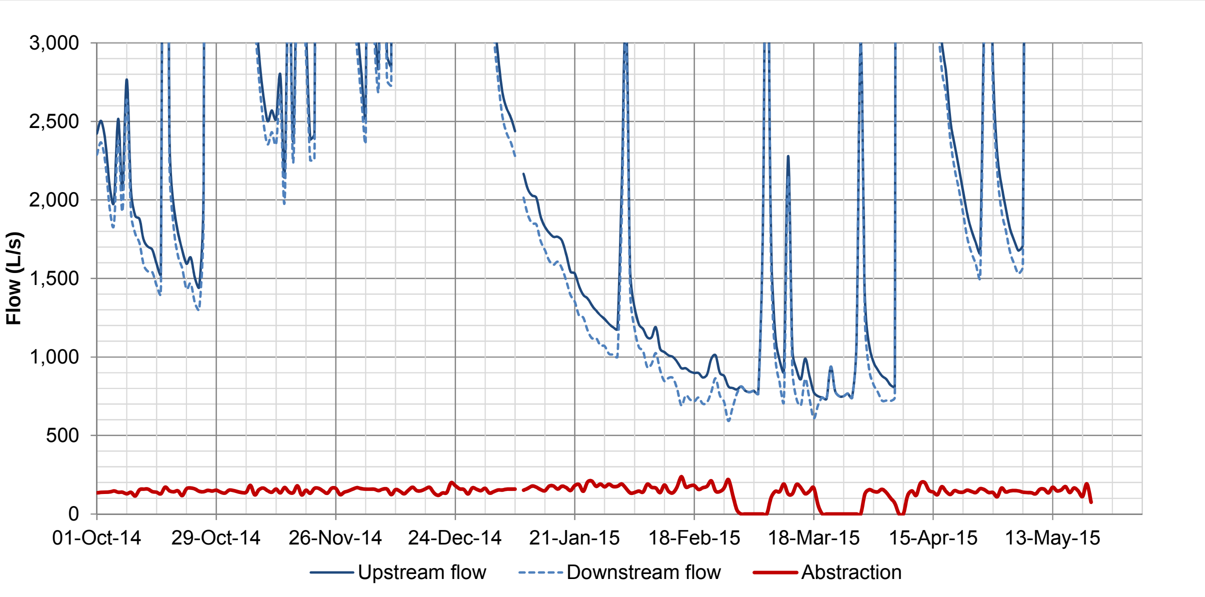

Figure 7: Waikanae River daily abstraction and calculated downstream flow (calculated from upstream flow at GWRC gauging station minus daily average abstraction).

3.4 Water temperature

The water temperature of the Waikanae River is recorded by GWRC at the water treatment plant. However, as shown in Figure 8, there is no data after 19 December 2015. This means that is has not been possible to review the relationship between water temperature and river flow during the summer flow recession using these data. There are however, the weekly or fortnightly sampling measures and while not continuous these provide a window into water temperatures across the monitoring season and so the broad pattern. It is these data that are used in correlations later in this report.

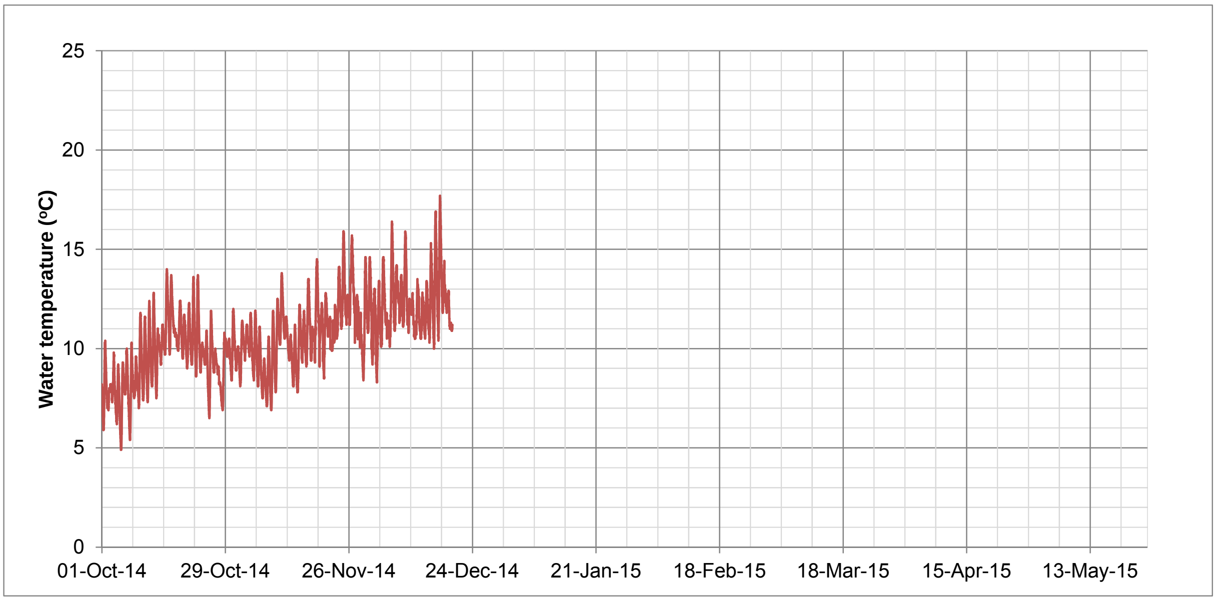

Figure 8: Waikanae River recorded water temperature

4.0 Shade & Substrate Quantity

This year (2014-2015) around 65% of the substrate within each 1m^2 quadrate along each of the five site transects were of sufficient size and hardness to support attaching periphyton. The other 35% of the substrate was generally sands. This is an average decrease of 15% in the quantum of suitable algae attachment substrate in a quadrate in the 2013-2014 measures.

Shading is as it was last season (no change), being largely absent at all monitoring sites. Despite there being native (and exotic) shrub and forest generally near the river, most tall vegetation is set back from the active water channel sufficiently so that no actual direct shade is provided except in early morning and late evening (Table 3).

Table 3: Shade estimates

Transects	Shading (%)	Wetted width (m)
Control 1 (C1)		
Riffle 1	10	10.5
Riffle2	12.5	12.6
Run 1	10	13.1
Run 2	10	12.7
Control 2 (C2)		
Riffle 1	0	10.2
Riffle 2	0	10.6
Run 1	0	13.1
Run 2	0	12.6
Site 1 (R1)		
Run 1	0	15
Run2	0	17.5
Riffle 1	0	23.2
Riffle 2	0	21
Site 2 (R2)		
Riffle	0	11
Riffle 2	5	12.5
Run 1	0	10.2
Run 2	0	11.6
Site 3 (R3)		
Riffle 1	0	10
Riffle 2	0	10
Run1	0	20.3
Run 2	0	18.5

5.0 Results

Throughout this report the sites are labelled as C1, C2, R1, R2 and R3. Reference to the Map 1 may be required, but it should be remembered that C1 is the control site closest to the water treatment plant and C2 the upstream control site. R1, R2 and R3 are the sequence of downstream effect sites.

The monthly reports are appended to this report and through those individual reports the month's data completeness can be viewed. Not all months contained all data because of a range of weather, water condition, and equipment issues.

5.1 Water chemistry and temperature

Summary plots of water quality data are contained within the following sub-sections. Note the data are not continuous, they are one point in time measures, and plots are generally given as bar graphs.

5.1.1 pH

A raised spike in pH was recorded in January (Figure 9). The cause for this is unknown and we can only speculate that a very localised geological erosion input had occurred. There are no discharging side streams, instream rubbish or other obvious source for change. Generally the values are within (even considering the raised values) "normal" levels and the two outliers are not so drastic as to result in species death. The remainder of the data show a relatively stable pH at around 7.6.

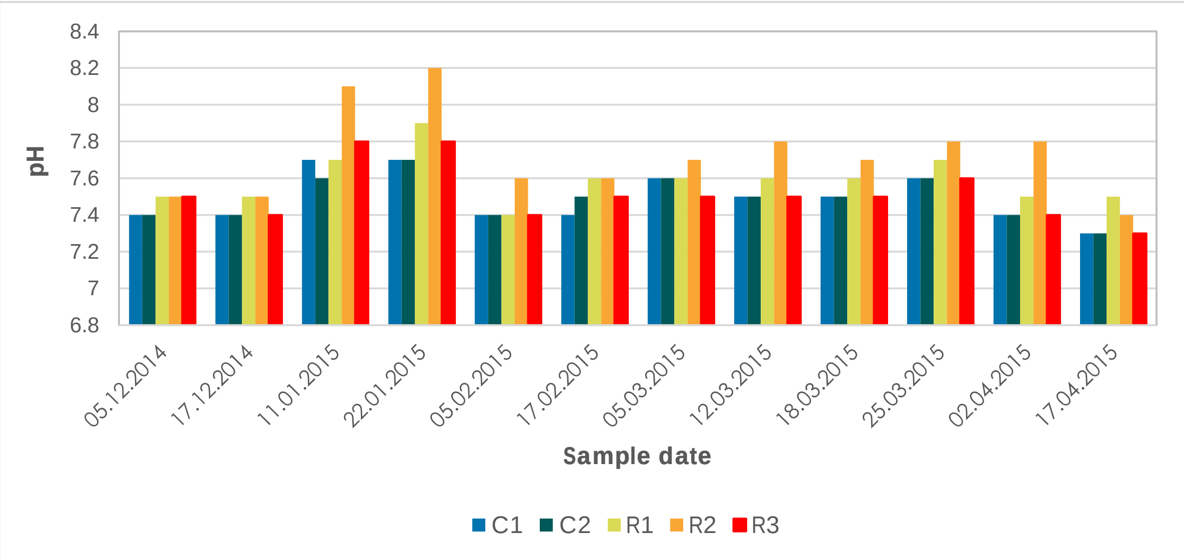

Figure 9: pH (Lab) measures across monitoring sites at successive dates through December 2014 to May 2015 in the Waikanae River

5.1.2 Temperature

Water temperature varies throughout the day but the averaged trend from December through to April shows February to be the warmest month, at around an average of 20°C (Figure 10).

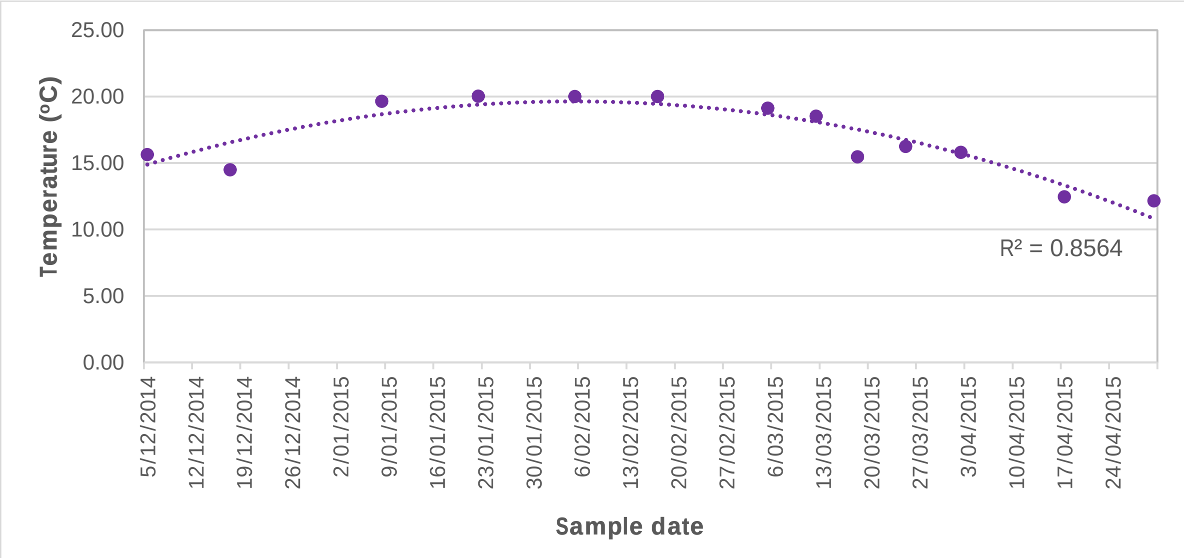

Figure 10: Average day time spot temperatures measured across all monitoring sites through December 2014 to April 2015 in the Waikanae River.

5.1.3 Conductivity

Conductivity had several abnormal measures in early March, but was otherwise low and stable (Figure 11). The spike at around the 12/3/2015 we believe was a meter error. The data gaps are due to equipment failure.

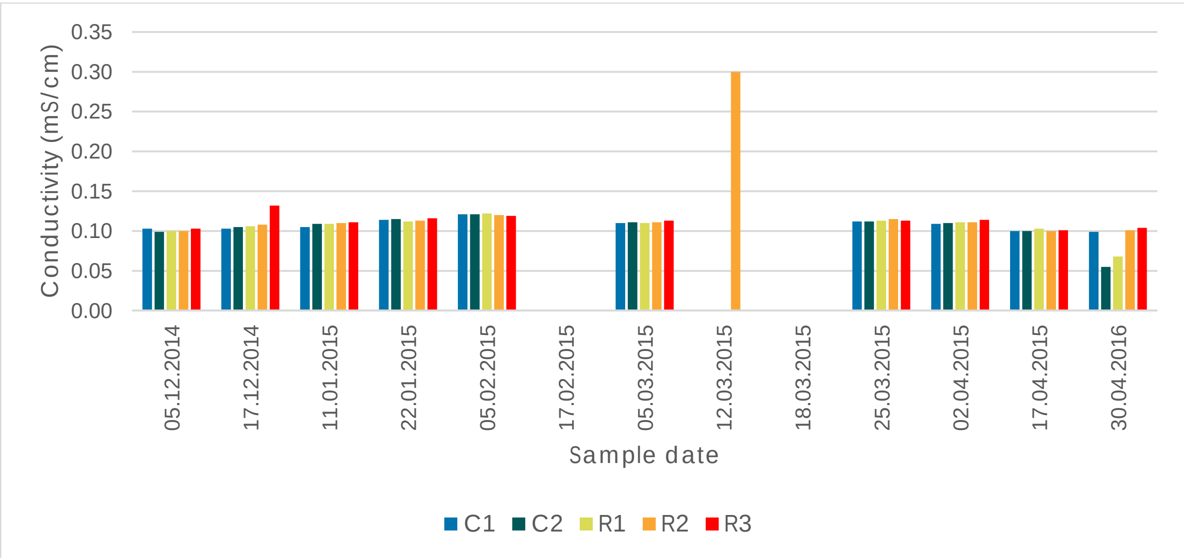

Figure 11: Conductivity (spot) measures across monitoring sites at successive dates through December 2014 to April 2015 in the Waikanae River

5.1.4 Total phosphorus

Total phosphorus was relatively low and stable at around 0.0125 g/m^3 throughout the monitoring period (Figure 12). A spike is seen in March and this is a random effect of one off spot sampling (a grab of the water column that held some organic matter, or faeces for example). The April and late December lift might relate to increasing river flow and discharge in connection with on land seasonal (farming) practices (i.e. fertiliser spreading to promote summer or pre-winter grass growth).

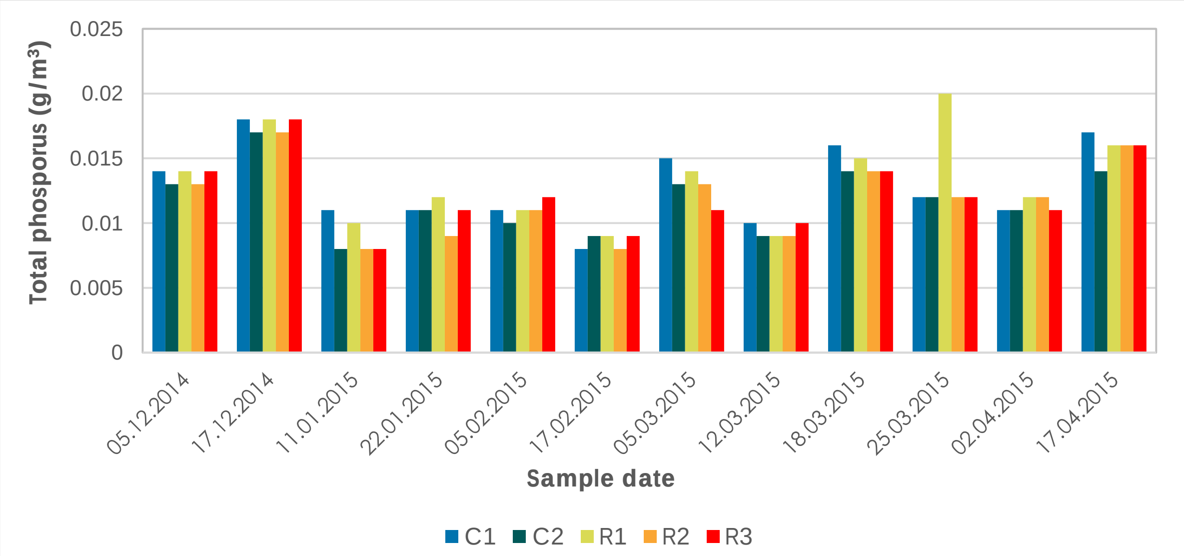

Figure 12: Total phosphorus measures across monitoring sites at successive dates through December 2014 to April 2015 in the Waikanae River.

5.1.5 Dissolved reactive phosphorus (DRP)

DRP trended down from its highest point in December (Figure 13) although it rose again later in early autumn (perhaps due to land use activities and run off). The levels in general are relatively high (for example ECAN[9] recommends an upper limit of 0.006 g/m^{-3}).

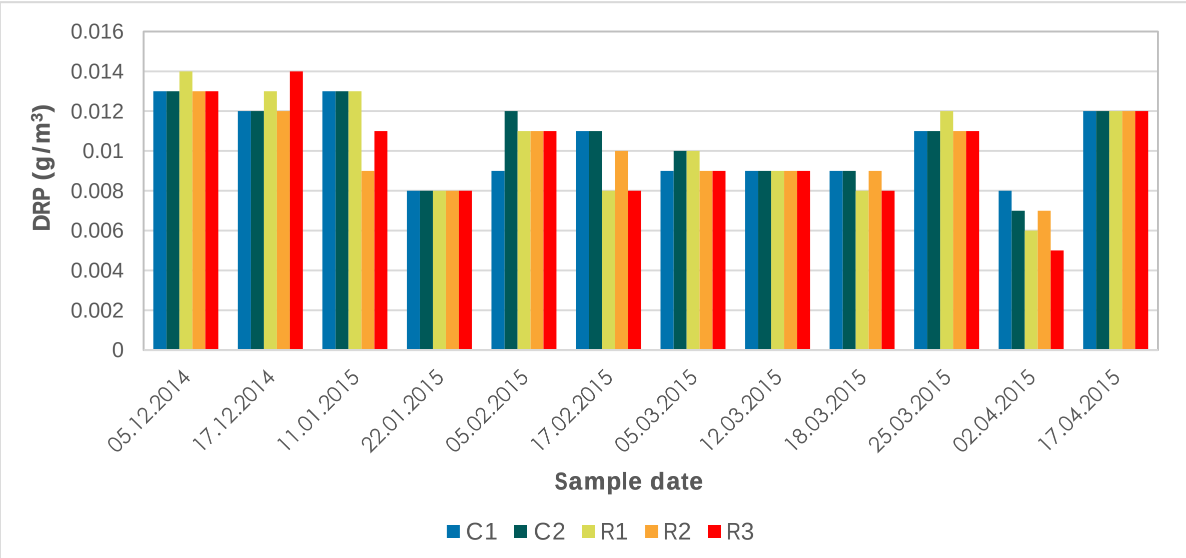

Figure 13: Dissolved reactive phosphorus (DRP) measures across monitoring sites at successive dates through December 2014 to April 2015 in the Waikanae River

[9] ECAN 2012: Proposed Canterbury Land and Water Regional Plan, Vol 1

5.1.6 Total Nitrogen

Total nitrogen was relatively stable and low, with one anomalous reading in December (Site R3) (Figure 14). That one reading likely being a sample contamination (e.g. faeces). There was a noticeable increase in the April measures, again likely due to seasonally changing land uses.

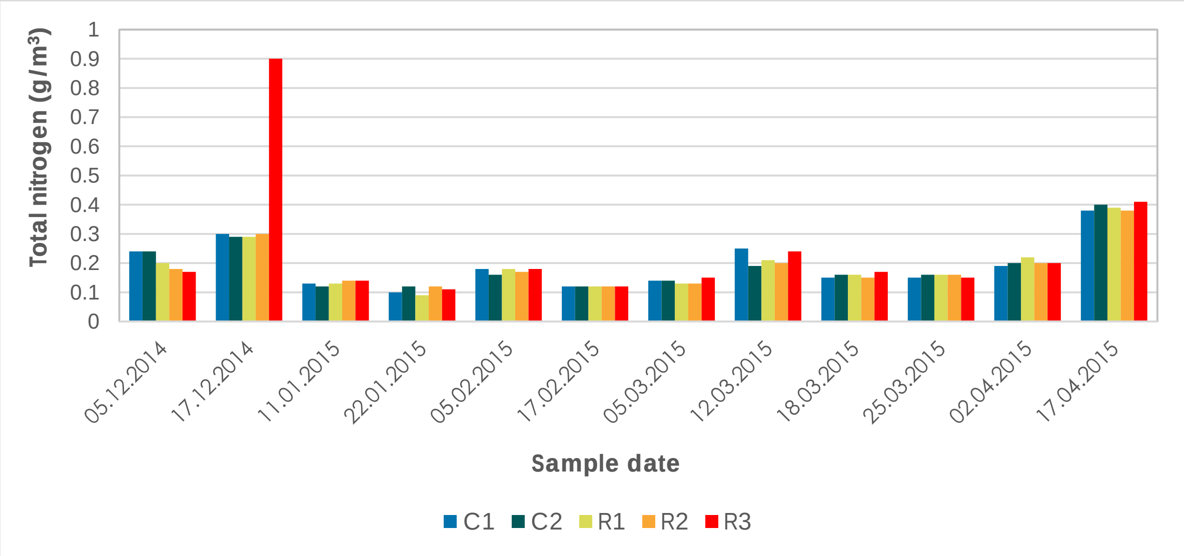

Figure 14: Total Nitrogen measures across monitoring sites at successive dates through December 2014 to April 2015 in the Waikanae River.

5.1.7 Nitrite/Nitrate Nitrogen

As with total nitrogen, a stable low level of nitrite-nitrate nitrogen was measured, with a small rise in the last (April) monitoring occurrence (Figure 15). There was one anomalous reading in December at site R3.

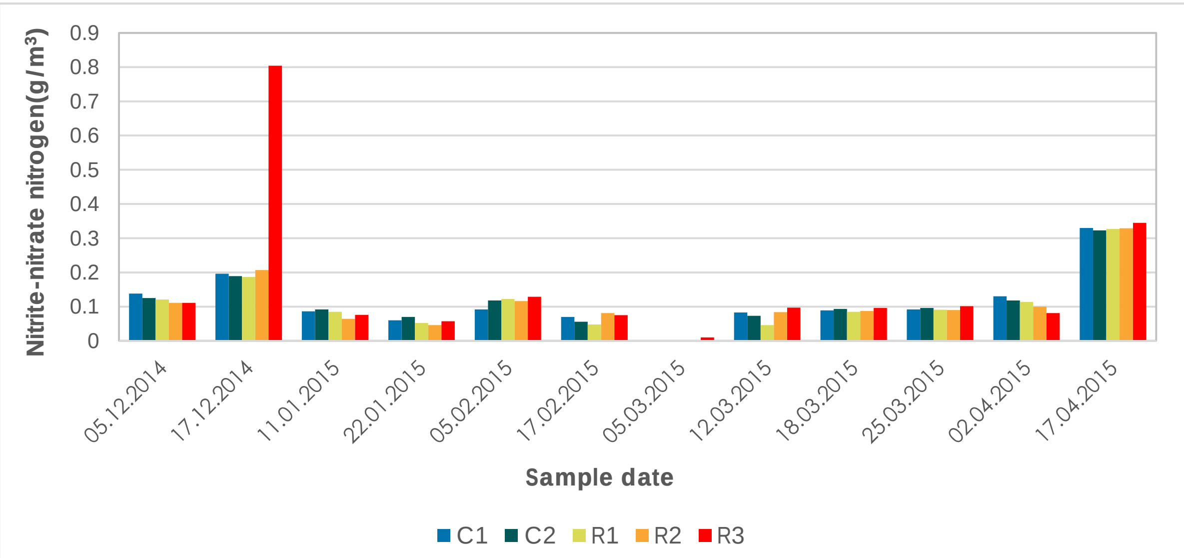

Figure 15: Nitrite/Nitrate measures across monitoring sites at successive dates through December 2014 to April 2015 in the Waikanae River.

5.1.8 Soluble Inorganic Nitrogen

Soluble inorganic nitrogen also followed the same pattern as total nitrogen, with an anomalous reading in December and a small rise in the last (April) monitoring session (Figure 16).

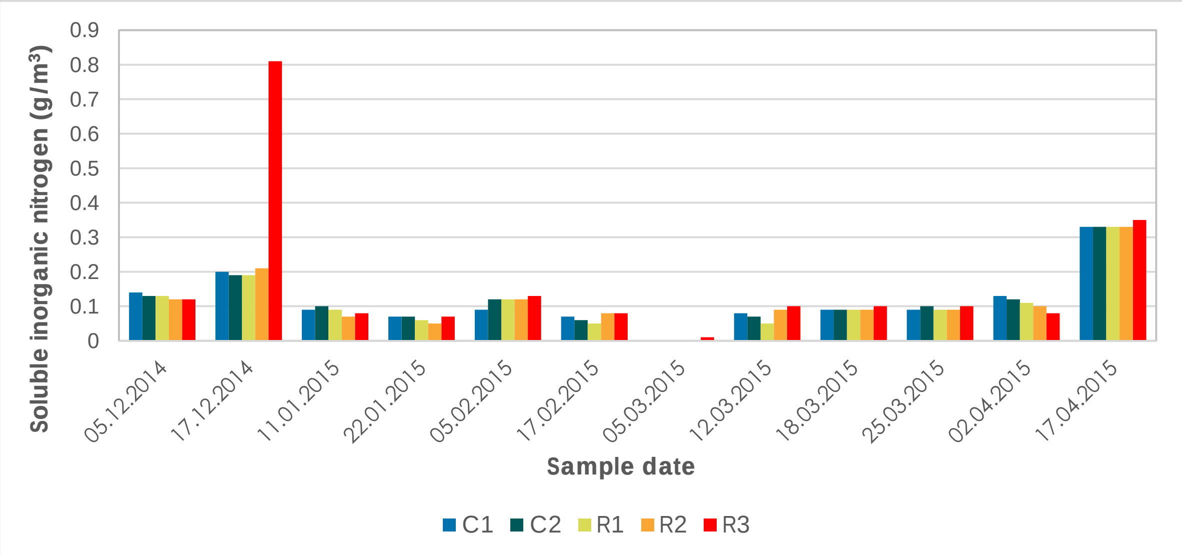

Figure 16: Soluble inorganic nitrogen measures across monitoring sites at successive dates through December 2014 to April 2015 in the Waikanae River.

5.1.9 Ammonia-Nitrogen

All measurements of ammonia nitrogen were <0.01, below both the laboratory detection level.

5.1.10 Dissolved Calcium

Dissolved calcium was relatively stable throughout the monitoring period at around 5.5 g/m^3 (Figure 17).

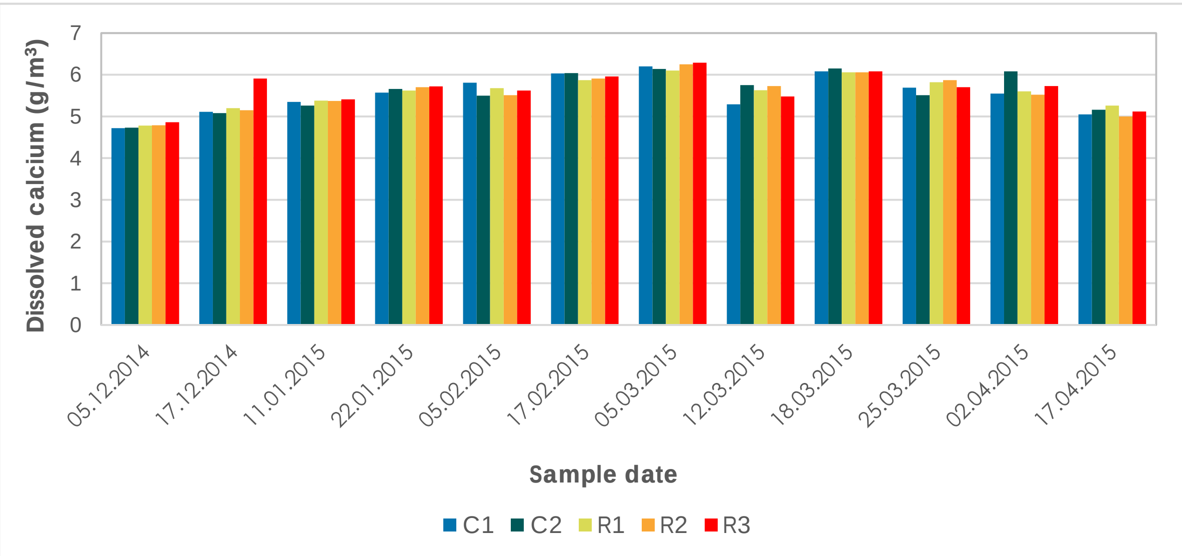

Figure 17: Dissolved calcium measures across monitoring sites at successive dates through December 2014 to April 2015 in the Waikanae River.

5.1.11 Summary

Water chemistry across the sites is remarkably similar and follow small but visible oscillations across the five months of monitoring. In particular, there was a rise in some nutrients in the mid-April measure at the end of the monitoring session. Measures on the 17th December 2014 had anomalies for nitrogen products, but no other raised measure. There was generally little difference between the “receiving” and “control’ sites. The rise at the end of the measurement period (April) is not sufficient (in time or extent) to affect the general trend. If we see the same pattern again (next monitoring season (noting we did not see it last year)) then we may be able to say something about a seasonal trend.

5.2 Periphyton

5.2.1 Visual Assessments of Periphyton at Fixed Positions

Visual periphyton cover measures were taken from four across-river transects (in two runs and two riffles) and five quadrats per transect at each monitoring visit. The percentage cover on the hard substrate available to periphyton was generally around 65% of the bed and so the cover reported in the following graphs is the cover of that hard substrate, not the total bed.

Three graphs are presented: the first is the averaged cover from runs and riffles of the thin matting periphyton (Figure 18), the second is the averaged medium matting periphyton (Figure 19) and the third is the averaged filamentous periphyton (Figure *20*). Technically the data points on these graphs should not be joined by lines; a line implies there is a value between the points. We technically only have the points measured and make no assumption about what the values are in-between times. However, a line does help the reader identify possible trends, so a line has been included for viewer ease. There were few occasions, and very limited cover, of thick periphyton over the five months of monitoring and as such that data is too few to plot.

A slight trend in time can be seen with increasing medium mat cover through the monitoring period (Figure 19). There is a possible trend in the thin cover (one that follows the water temperature trend) but that trend is not ecologically important because the cover of thin algae is consistently high at around 60-70%. In terms of filamentous periphyton, two peaks are evident, although both small. The early autumn peak was seen only in large cobble riffles, and was short lived. Isolated peaks (as seen in Figure 19) are not uncommon in such data as the survey may randomly encounter a small patch of high growth in the river even where the majority of the river has only a low level of algae.

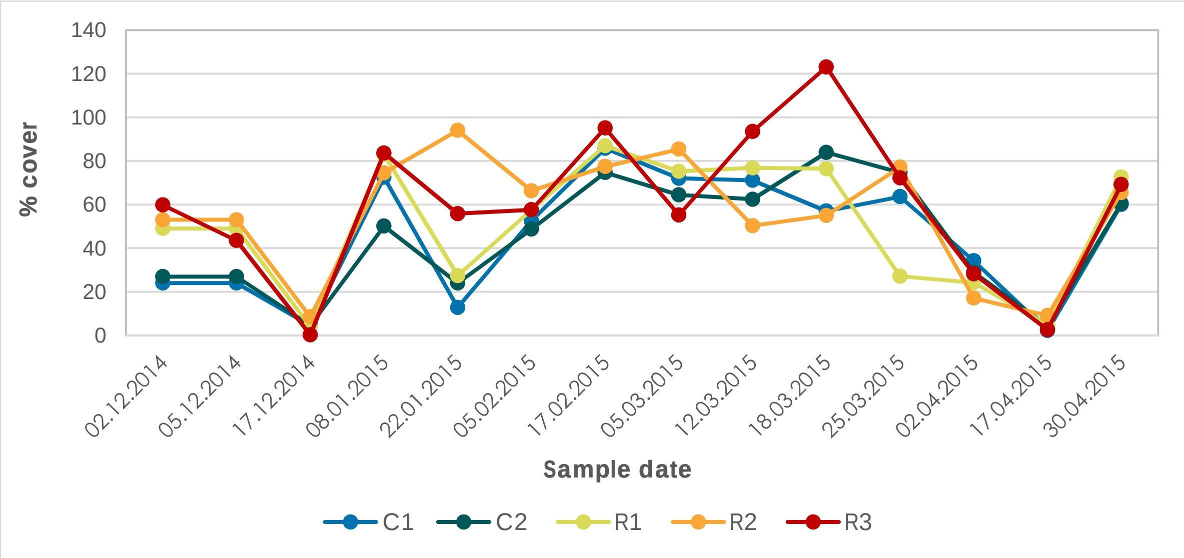

Figure 18: Average (n=20) thin matting periphyton cover across monitoring sites on the Waikanae River.

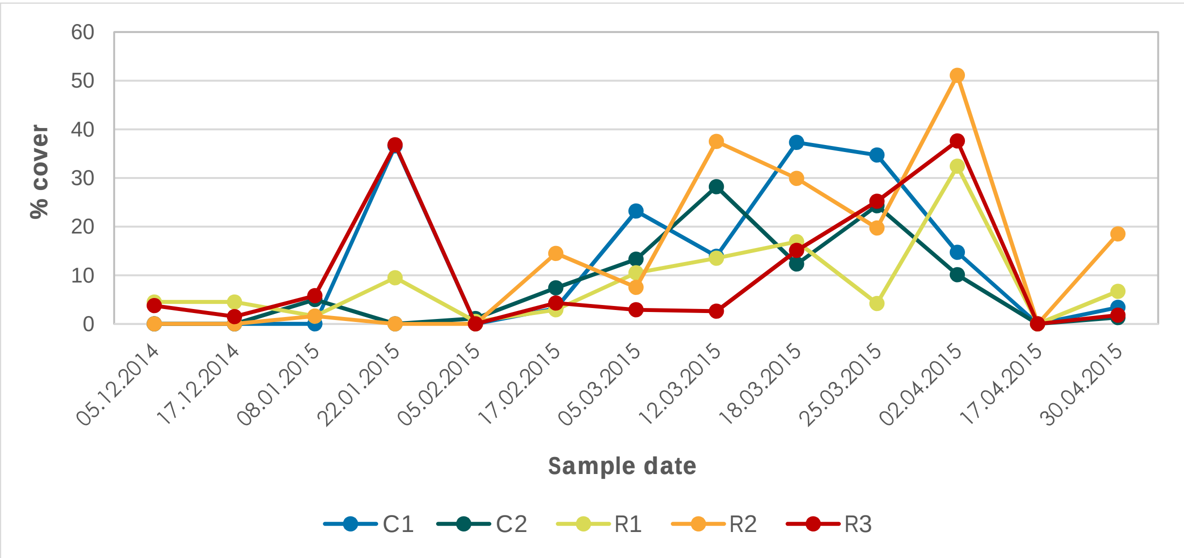

Figure 19: Average (n=20) medium matting periphyton cover across monitoring sites on the Waikanae River.

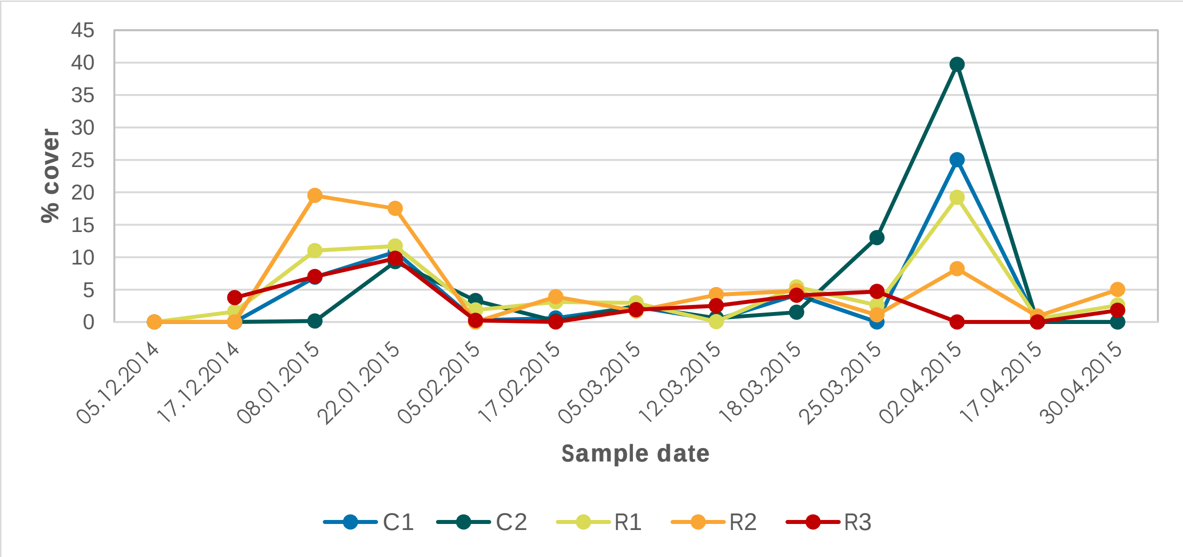

Figure 20: Average (n=20) filamentous matting periphyton cover across monitoring sites on the Waikanae River.

Figure *20* shows that at two times in the season the abundance of long green filamentous algae begins to develop. At each time, however, that abundance is reduced soon after rain caused floods. If no flood rains came then that LGF should have persisted into the next measurement and before long problem levels could have been recorded. This season that did not happen. The data tells us that LGF in the Waikanae may be of issue in later summer seasons, depending on year to year rain / flood events.

5.2.2 Velocity at Measurement Plots

Velocities at each quadrat ranged between approximately 0.2 to 1.4 ms^{-1} in the riffles (Figure 21), with an average velocity of 0.69 ms^{-1}. In comparison, the runs included slower velocity areas which generally ranged between approximately 0.1 to 1.2 ms^{-1} but with several very fast measures (Figure 22), and an overall average of 0.63 ms^{-1}.

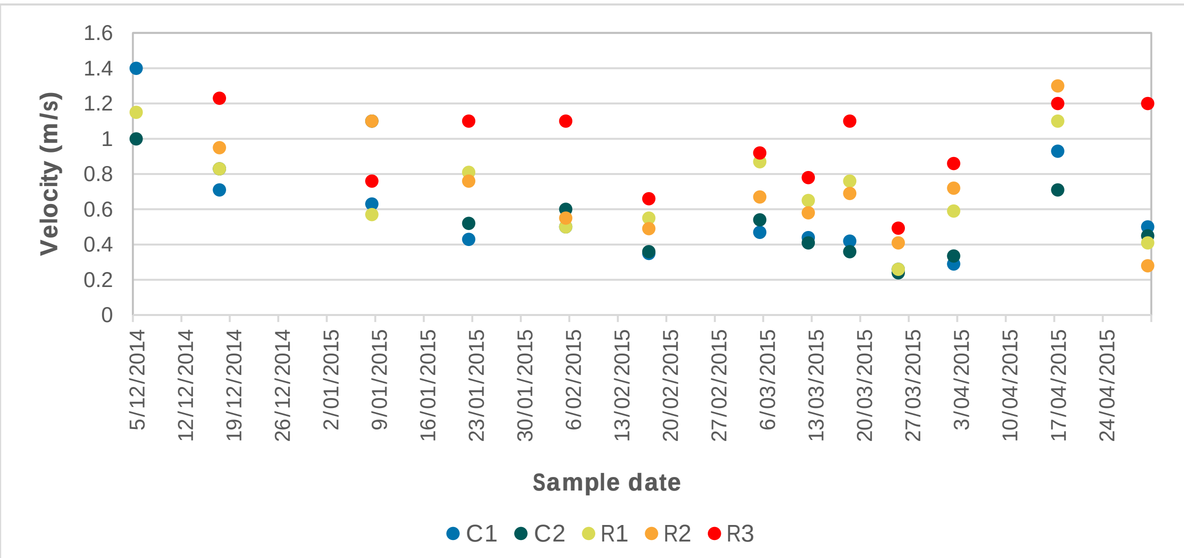

Figure 21: Average (n= 20) water velocity (riffles) across periphyton monitoring locations at each site over the monitoring period on the Waikanae River.

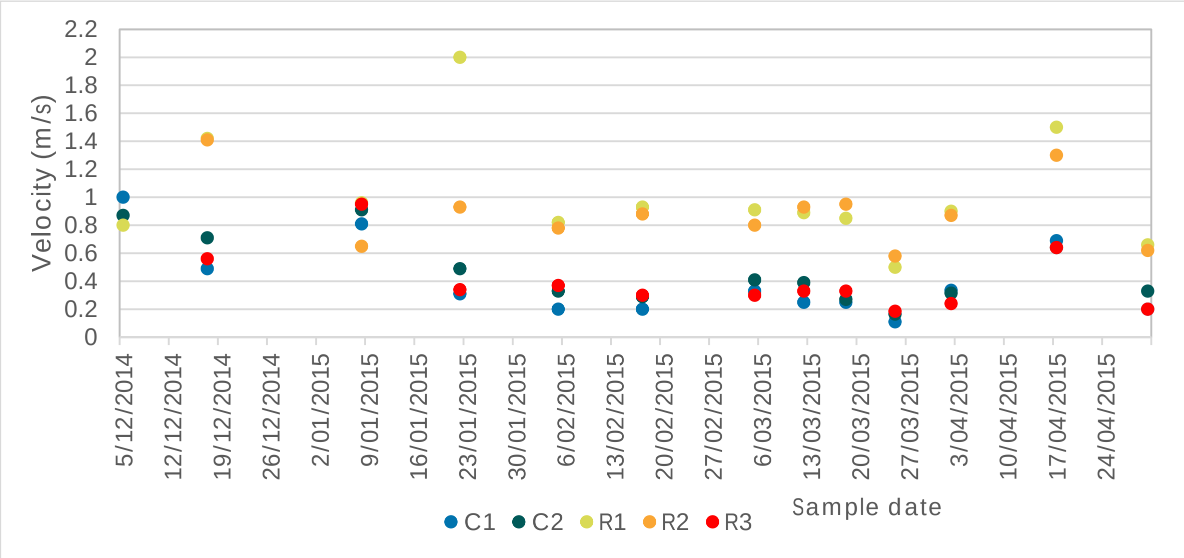

Figure 22: Average (n= 20) water velocity (runs) across periphyton monitoring locations at each site over the monitoring period on the Waikanae River.

There was an observable in-river velocity and periphyton pattern, with the shallow riffle areas generally having a greater abundance of filamentous algae, when it was present. This pattern also relates to the locations of boulder weirs and cascades which are also areas of higher velocity. There were no useful correlations or insight from this measure other than that the velocities loosely vary with flow and are generally least in the central measurement seasons as flows declined. The change in velocity spot measures are not found to be related to algae abundance.

There were two significant and one lesser flushing flows during the monitoring period: 10th December recorded nearly 200 cumecs, 9-10th April recorded 130 cumecs, and the largest (a 10 year flood) was recorded on 15th May, which was upward of 250 cumecs. These flushes generally caused the periphyton to be removed through high velocities and the entrained sediments (acting as “sand paper”).

5.2.3 Quantitative Periphyton Measures

The measures of periphyton attained through the season suggest that the Waikanae River, at these points of measure (Figure 23), is between generally oligotrophic and sometimes briefly mesotrophic in terms of the Biggs (2000) guide (that is chlorophyll-a bounds of 60mg/m^2 and 200 mg/m^2 to delimit oligotrophic, and eutrophic streams (after Dodds et al. 1998, referenced in Biggs 2000)).

The values over the monitoring period generally fall below National guideline chlorophyll-a “alert” levels for the protection of benthic biodiversity (Biggs 2000). There was one raised period (22nd January 2014; see Figure 23), but that level was only a third of the lower “alert” level and cannot be considered a high periphyton level. Of interest is that level is only around two weeks after the 200 cumec “flood” on the 10th December (2014).

Average Ash Free Dry Matter (AFDM) follows the same pattern as chlorophyll-a, with a peak in late January and a small rise again in early April (Figure 24).

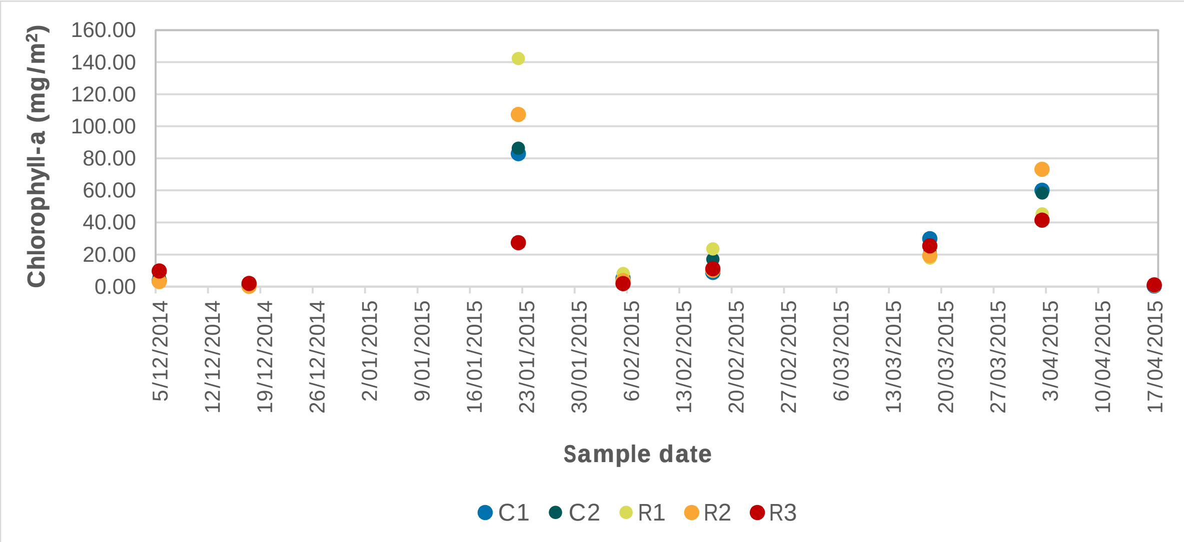

Figure 23: Average chlorophyll-a (mg/m^2) monitored from each Waikanae River site

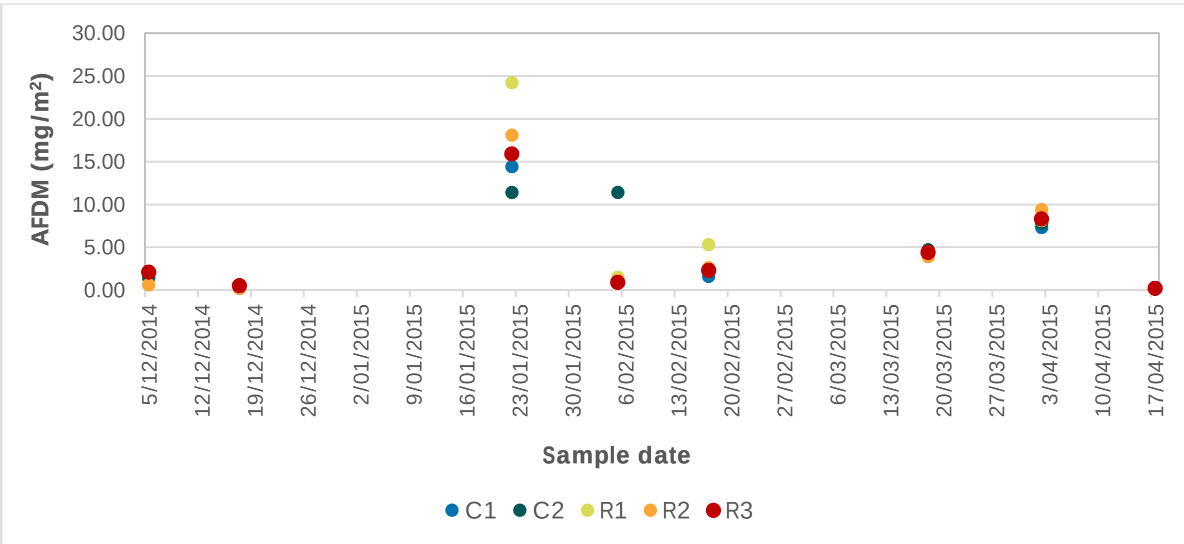

Figure 24: Average Ash Free Dry Matter (AFDM) (mg/m^2) monitored from each Waikanae River site

5.2.4 Periphyton Species Richness & Community Composition

Both the number of taxa making up the periphyton community and relative abundances were lower in early February (Figure 25) compared to early April (Figure 26). In the February samples (Figure 25), there was a subtle difference in the periphyton community between the control (C) sites and the receiving (R) sites. The control sites had more filamentous green algae (*Microspora, Mougeolia, Ulothrix, Stigeoclonium, Melosira*) while the "receiving" sites had more diatom (matting) algae. Ulothrix was the most prominent algae taxon present.

Data from the April samples (Figure 26) show that across the sites, the composition change in terms of species was minimal. Also, taxa were relatively frequently sampled across the sites but Gomphoneis (a diatom) was most abundant.

The periphyton which cause most human and animal health issues (cyanobacteria) were represented in the Waikanae River at the monitoring sites by one taxa (*Anabaena*) and this was infrequently sampled (see Figure 25 and Figure 26).

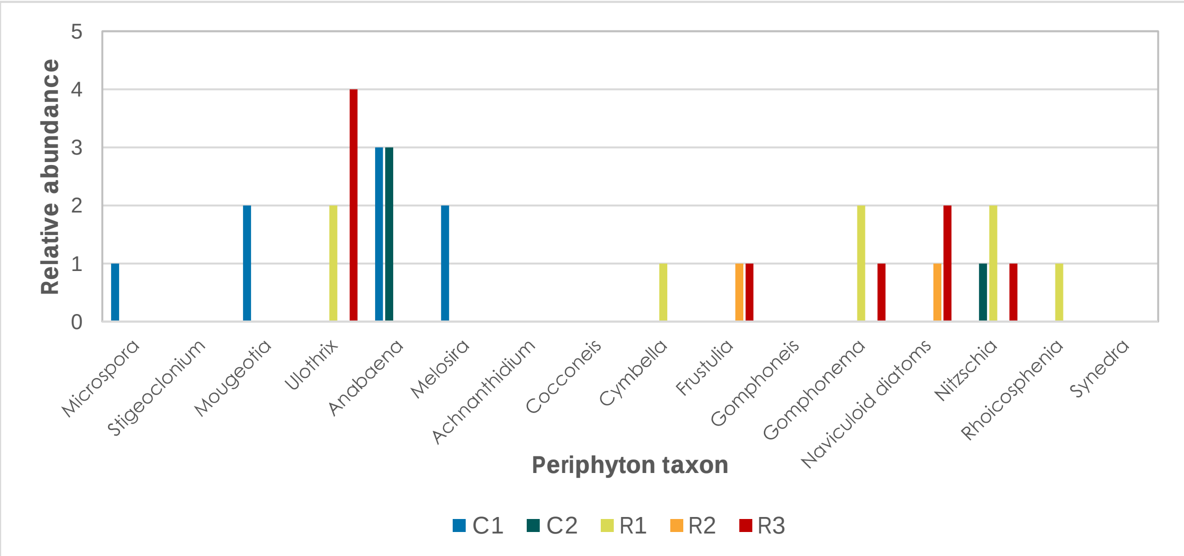

Figure 25: Periphyton taxa across the sites in the Waikanae River in early February 2015

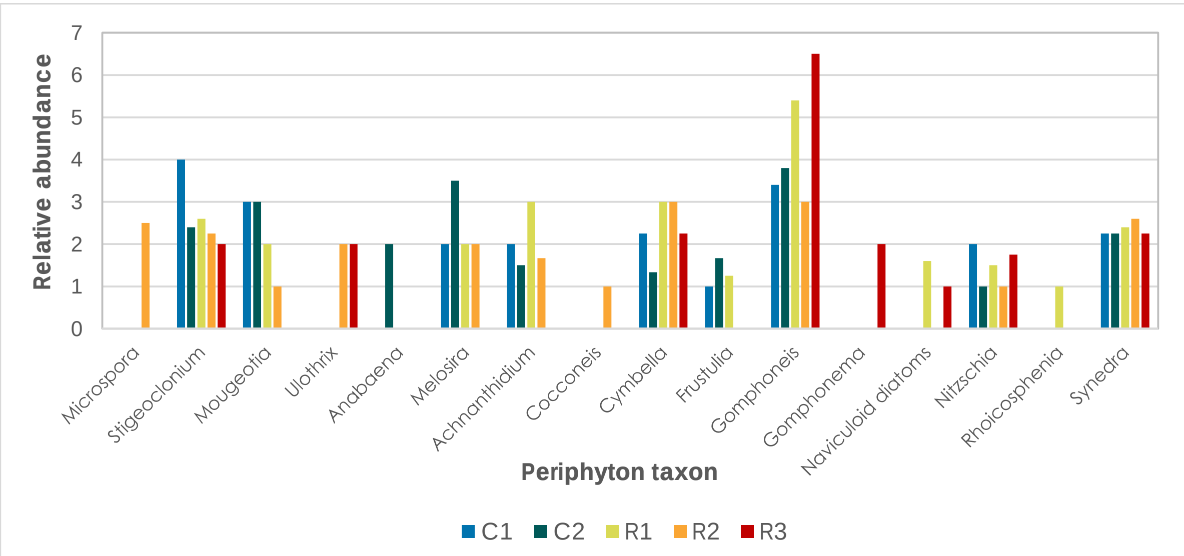

Figure 26: Periphyton community compositions in Waikanae River in early April 2015

5.3 Correlations

The Pearson correlations co-efficients between water quality parameters, periphyton parameters and velocity are provided in Appendix 1. Each table presents a correlation co-efficient for each possible pair of measurement variables for each site. A correlation coefficient of ≥0.5 suggests a significant positive correlation, whereas correlation coefficient of ≤-0.5 suggest a significant negative correlation.

The matrices in Appendix 1 show varied correlations across the variables and sites, but with no lasting patterns. There were no notable correlations with water velocity and few with water temperature.

Of particular importance for this monitoring programme is the determination of correlations between chlorophyll-a, and biomass (AFDM), visual cover estimation and DRP (a factor often related to algae blooms). These results have been taken from Appendix 1 and are summarised in Table 4.

There was typically no correlation between chlorophyll-a, and visual cover measures (i.e. correlation co-efficient between 0.5 and -0.5; orange cells in Table 4). This is not surprising given the thin matting cover was relatively constant while there were few occasions of medium and thick matting over the monitoring period.

As expected the biomass (AFDM) and chlorophyll-a measures were very tightly correlated (i.e. correlation co-efficient ≥0.5; green cells in Table 4). Of interest is that DRP was not, or only negatively (i.e. correlation co-efficient ≤-0.5; red cells in Table 4), correlated with periphyton abundance. This too is not unexpected in the absence of any substantive algae growths (i.e. the correlation is not biologically meaningful in the absence of either periphyton abundance change or DRP change).

Table 4: Correlation coefficients for chosen metrics related to Chlorophyll-a. (Green ≥0.5; orange 0.5 - -0.5; red ≤-0.5)

Site	Chlorophyll-a & AFDM	Chlorophyll-a & visual cover	Chlorophyll-a & DRP
Site R1	0.99	-0.09	-0.21
Site R2	0.98	0.35	-0.28
Site R3	0.76	0.3	-0.4
Site C1	0.98	0.79	-0.7
Site C2	0.67	0.008	-0.2

5.4 Macroinvertebrates

The objective of this monitoring was to sample benthic macroinvertebrates at times and in locations with increasing benthic periphyton. The Waikanae River BMP proposes either: (a) in a sequence after a flushing flood, or (b) throughout the summer-autumn period at three difference stages (levels of development) of periphyton growth (low, moderate and high).

The 2015 season could not achieve the above. This is because there were no “high” periphyton biomass times in which to measure macroinvertebrate community responses. As noted in Section 5.2.2, two floods occurred during the monitoring period (10th December and 9-10th April) and one outside of the monitoring period (15th May). The December event did not change the already low periphyton level (a macroinvertebrate sample had been taken on in the first week of December representing low periphyton). The second flood occurred in April 10th, also during a low-medium periphyton period. At no time during the monitoring period did the visual periphyton measures indicate a medium or high periphyton level. The chlorophyll-a results show that there was one period of “medium” periphyton (results of the 22nd of January), but that this level did not last to the next sampling period (5th February), at which time the visual measures did not indicate a medium or high periphyton level.

Four macroinvertebrate samples were undertaken during the monitoring period with the aim of capturing varying periphyton levels (Table 5). In essence there was little periphyton growth variance throughout the monitoring period and therefore little chance to reflect macroinvertebrate changes related to this factor. That said a pattern in fauna was observed as discussed below.

Table 5: Dates of macroinvertebrate sampling and associated flow and periphyton levels

Sample date	Flow (cumecs)	Periphyton level
1/12/2014	3.4	Low
5/02/2015	1.3	Low
18/02/2015	12	Low
15/03/2015	0.91	Low-medium

5.4.1 Macroinvertebrate Community Indices & Indicator Metrics

Six metrics are used to describe and compare the macroinvertebrate communities sampled. Each sampling occasion involved five replicate samples per site and so represent a good spatial representation of each habitat type and are sufficient for reasonable statistical requirements. The following graphs present the averaged or summary data for the six parameters required to be reported (abundance, taxa richness, EPT taxa richness, EPT taxa ratio, MCI and QMCI).

5.4.1.1 Average Abundance of all macroinvertebrates

Averaged abundances were more variable than any other metric and rose slightly through the monitoring season (Figure 27).

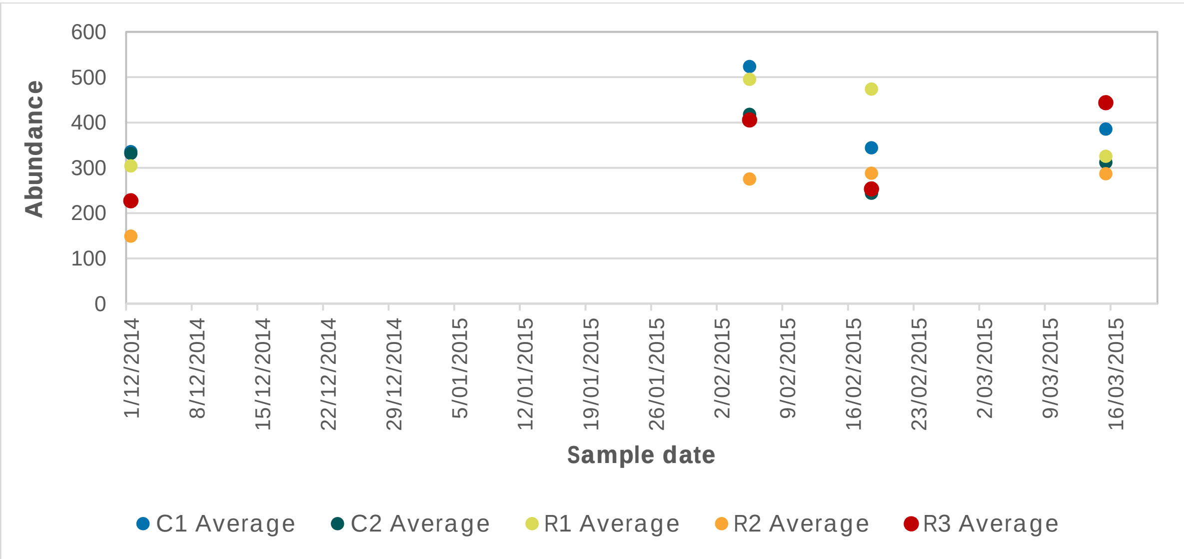

Figure 27: Averaged abundances from all samples in the Waikanae River.

5.4.1.2 Taxa Richness

Taxa richness increased slightly through the monitoring season (Figure 28).

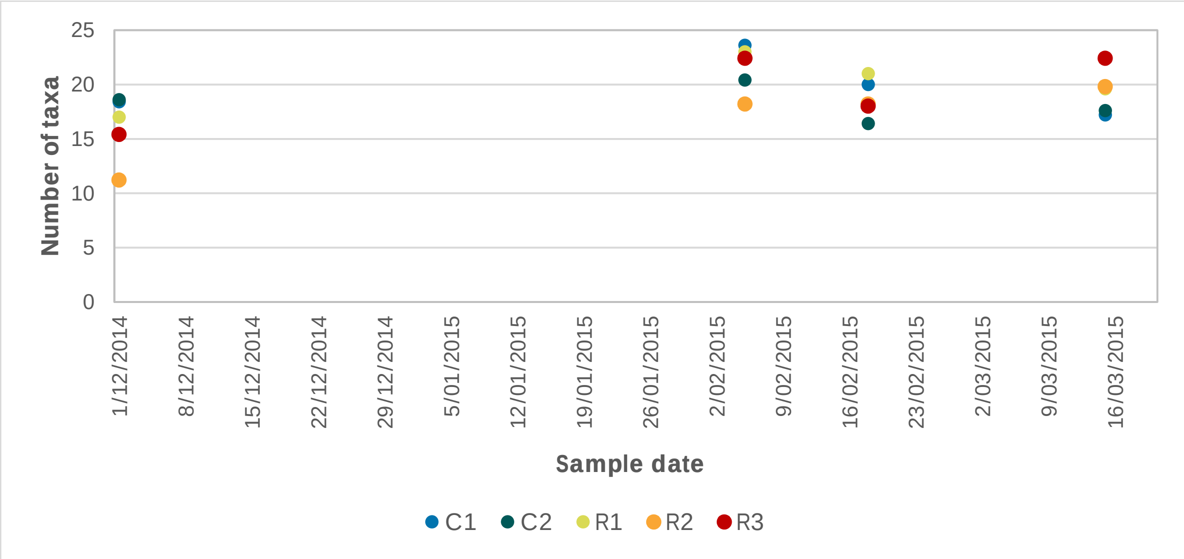

Figure 28: Taxa richness from all samples in the Waikanae River.

5.4.1.3 EPT Taxa Richness

The EPT taxa richness was stable but minor variations were seen, especially at site R2 (Figure 29).

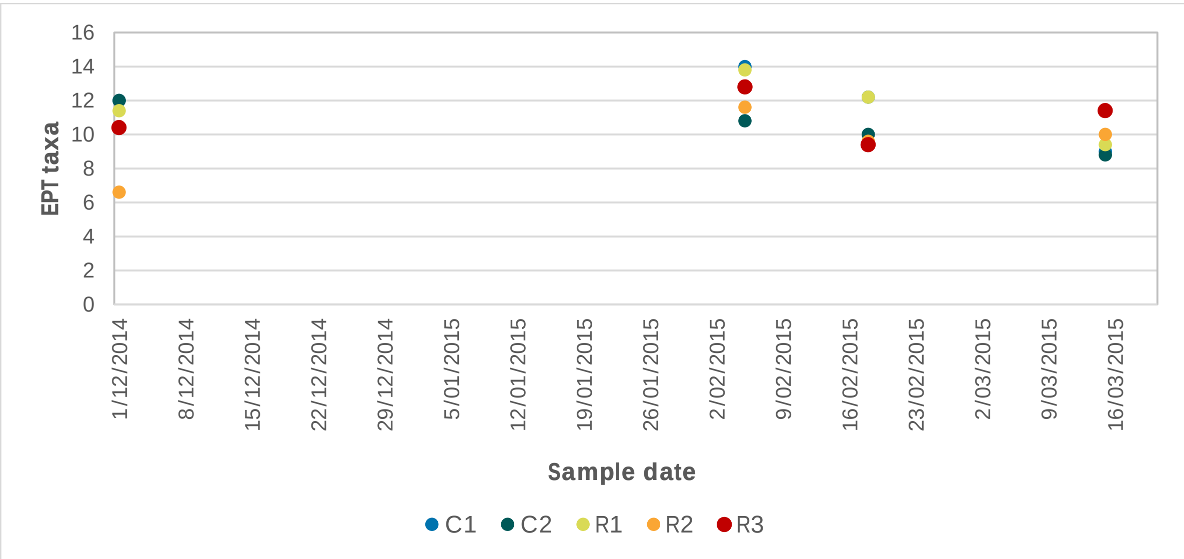

Figure 29: Average number of EPT taxa from all samples in the Waikanae River.

5.4.1.4 EPT Taxa Ratio

The average EPT ratio declined through the monitoring period (Figure 30), being lowest in the March measure which coincided with when matting algae was at its thickest and filamentous algae was also “peaking” (refer to Figure 19 and Figure *20*).

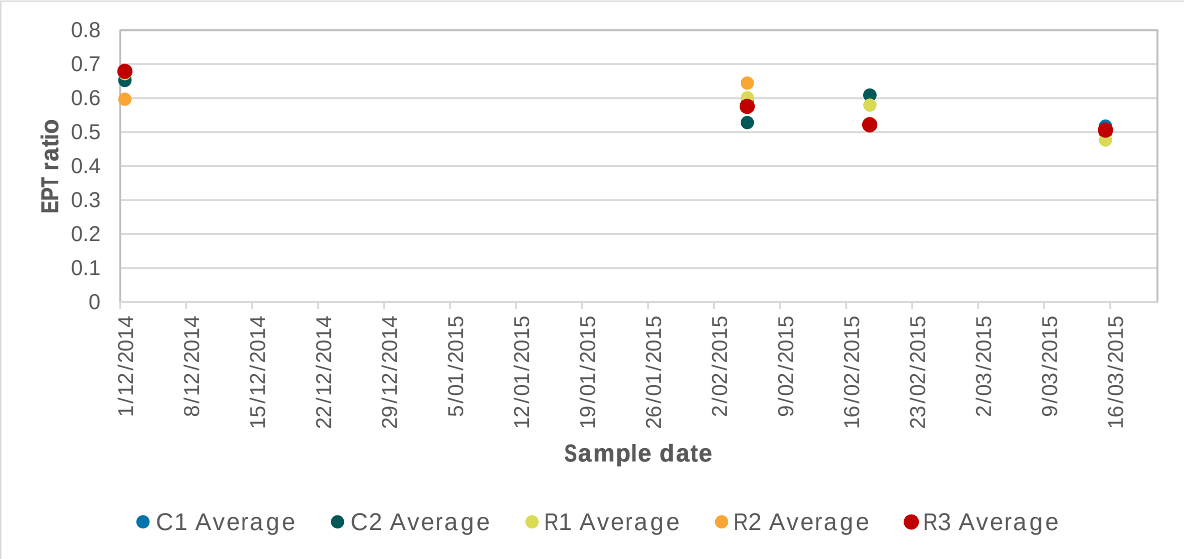

Figure 30: Averaged EPT taxa ratio from all samples in the Waikanae River.

5.4.1.5 MCI

The MCI values throughout are relatively high and generally fall into the accepted "Excellent" water quality category (Stark & Maxted 2007[10]). A relatively stable, but slightly decreasing, MCI measure was recorded over the monitoring period (Figure 31).

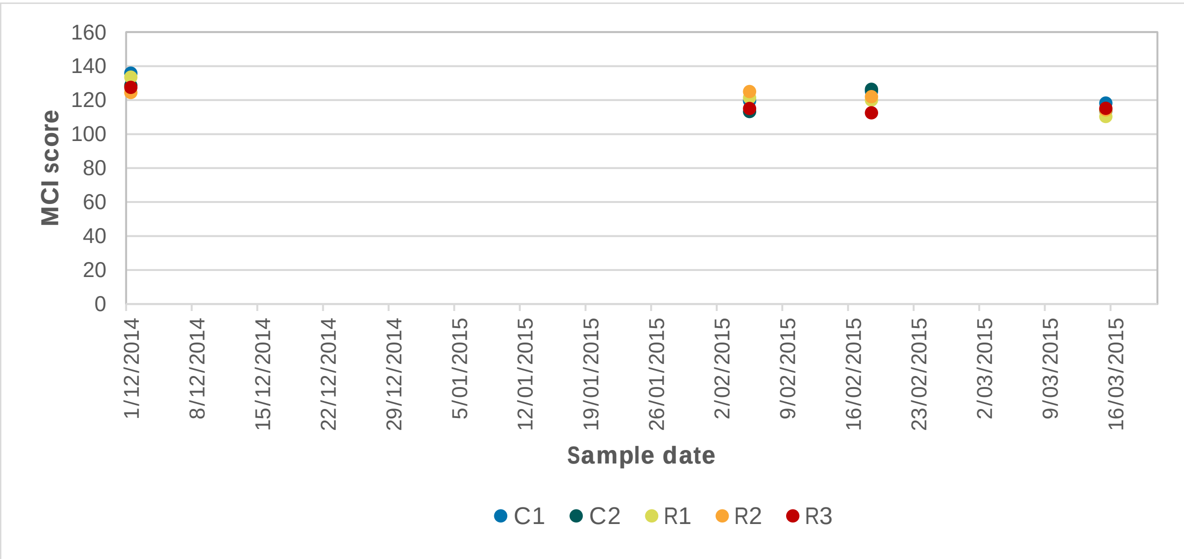

Figure 31: Averaged MCI from all samples in the Waikanae River.

5.4.1.6 QMCI

As with the MCI, the QMCI indices scores are generally high and suggest a healthy community and "excellent" water quality. A notable decrease in QMCI was recorded near the end of the monitoring period (Figure 32), potentially related to a subtle shift in the communities make-up (see Section 5.4.2 below).

[10] Stark, J; Maxted, J. 2007. A user guide for the macroinvertebrate community index. Prepared for the Ministry for the Environment. Cawthron Report No.166. 58p.

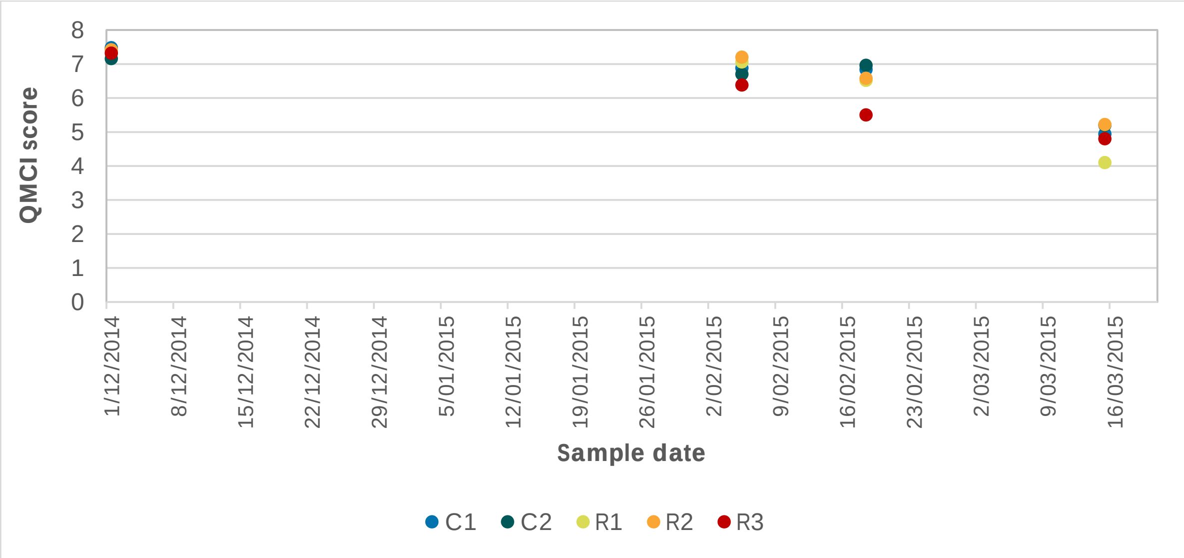

Figure 32: Averaged QMCI from all samples in the Waikanae River in 2015.

5.4.2 Macroinvertebrate Community Composition

The following analysis looks first at the differences between the sites monitored and then at the times of samples (noting that no time represented a medium of high periphyton condition).

The NMDS ordination and ANOSIM results comparing the fauna across the sites showed that there were significant, albeit weak, differences among the macroinvertebrate communities found at the five sampling locations. That is, all the same species are present, but in different abundances and it is that difference on which the statistical analysis is operating on. There may not be a meaningful, biological difference, only a statistical one. The data show there were subtle changes in community composition along the Waikanae River (Figure 33; ANOSIM: $R = 0.056$, $P = 0.004$). The differences are subtle in that they relate to the abundances of a few specific taxa and not to differences in the total taxa present at a site. For example the difference between the two control sites rests on a 40% difference in the number of Orthoclad (fly) larvae (42 as opposed to 26), or as between site C1 and site R1, a 44% difference in riffle beetles (Beraoptera). See Appendix 2 Table 10 for the SIMPER analysis outcomes pertaining to site and macroinvertebrate fauna.

The NMDS ordination and ANOSIM results comparing the sites' fauna across the sample dates showed that there were significant, albeit weak, differences among the macroinvertebrate communities found during the four sampling occasions (time) i.e. there were subtle changes in community composition through time (Figure 34; ANOSIM: $R = 0.452$, $P = 0.001$). Those differences again are subtle and relate to variations in abundances of the same taxa, not in different community compositions. See Appendix 2 Table 11 for the SIMPER analysis outcomes pertaining to sampling time and macroinvertebrate fauna. These results show that the abundance of Deleatidium is a strong driver between December and March (for example), while Orthodclad abundances were much higher in March. In some respects the March data resembles more an algae river community whereas the December- February fauna better resemble a low periphyton community condition.

The changes in EPT, most prominently the decline in Deleatidium and the increase in Orthodclad flies, signals, and is a response to, the mild but measured increase in matting algae and filamentous algae in March. Periphyton abundance and thickness is often associated with changes in algae grazer communities, with changes in abundance that often favour some fly and beetle taxa over mayfly and stonefly taxa.

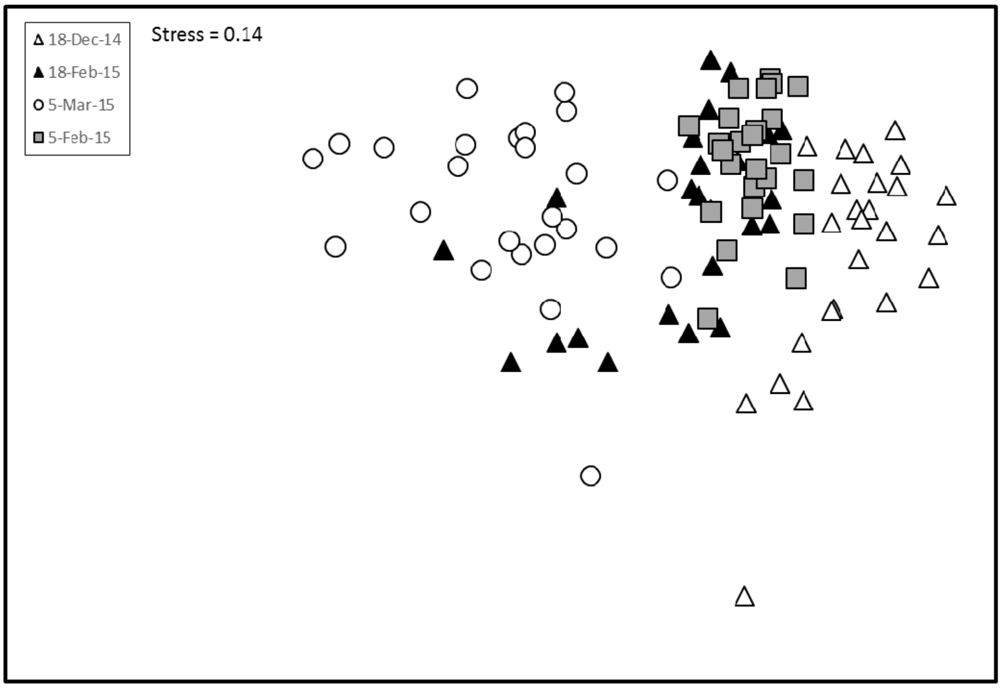

*Figure 33**:** Non-metric multidimensional scaling (NMDS) ordination based on a Bray-Curtis matrix of dissimilarities calculated from macroinvertebrate abundance data collected in kick-net samples at 5 sites on each of 4 different dates. Note the NMDS gave a good representation of the actual community dissimilarities among the five sampling locations. Axes are identically scaled so that the sites closest together are more similar in community composition than those further apart.*

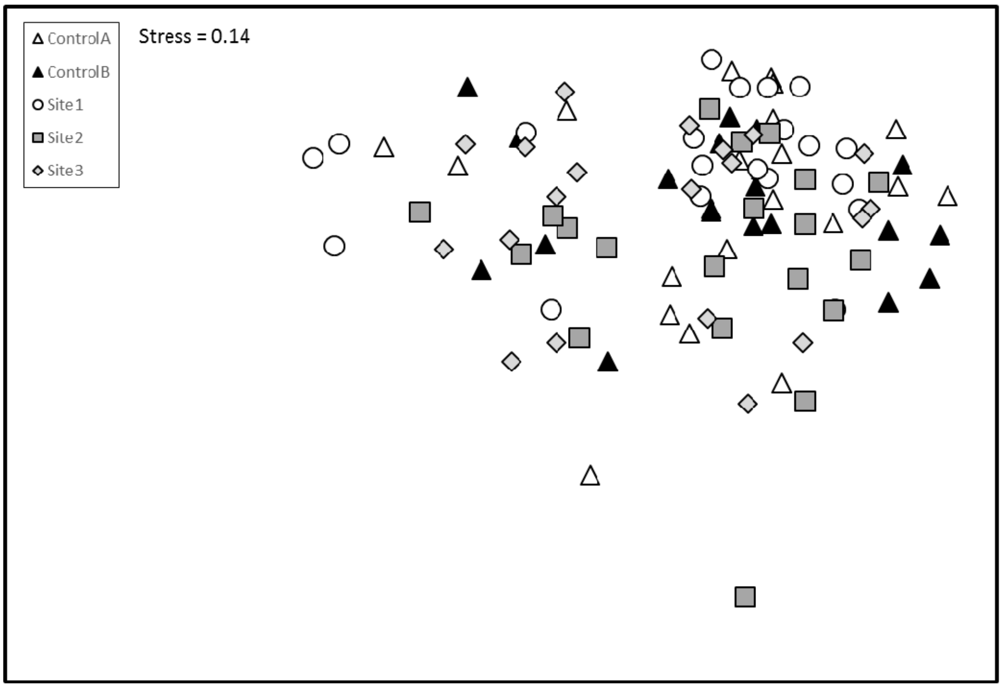

*Figure 34**:** Non-metric multidimensional scaling (NMDS) ordination based on a Bray-Curtis matrix of dissimilarities calculated from macroinvertebrate abundance data collected in kick-net samples at 5 sites on each of 4 different dates. Note the NMDS gave a good representation of the actual community dissimilarities among the four sampling occasions*

(dates) (two-dimensional stress = 0.14). Axes are identically scaled so that the sites closest together are more similar in community composition than those further apart.

5.5 Resident Waikanae Fish

An EFM survey was undertaken in February (as required by the BMP Section 4.4.3 for the initial baseline survey year) to attempt to establish the local fish presence. Each riffle and run of each site was sampled as per the BMP method. The results are presented below in Table 6.

Table 6. Fish taxa from February EFM sampling of the Waikanae River sites 2015.

Species	C1	C2	R1	R2	R3
Torrent Fish	2	4	6	5	5
Common Bully			3	4	6
Red Fin Bully	1	2			
Elva		4	6	1	4
Short fin eel	2	1	1		1
Inanga					2
Long fin eel		3			1
Brown trout		1			
Total number over 150m	5	15	16	10	19

Note size class data are not presented here, but are stored in spreadsheets of raw data.

The BMP anticipated one survey in the “control” and “receiving” sites and while one was done last year, this 2015 survey completes what is technically the first full year of baseline monitoring.

Given the fish survey effort is over 150m the data in Table 6 show very low numbers of fish. No common bully were recorded in the upstream control sites and no red fin bully in the downstream effect sites. Only torrent fish were present throughout, although in low numbers when compared to other (M2PP) surveys carried out downstream (below Jim Cooke Park). The results indicate that either by the method (EFM) or because the river is sparse in fish at the sample locations, fish measures at these locations are poor as an indicator of change.

6.0 Fish Population Surveys

The purpose of an electric fishing (EFM) survey is to attempt to attain a repeatable estimation of a local migrant fish population, specifically the density and age structure of that population over time. This may be through measurement of one or several species, typically of *galaxiid* and eel.

6.1 Monitoring Location

The location of the EFM survey had to be one in which there was a high probability of resident galaxiids of various ages; a stable habitat in terms of physical environment (bank, bed and riparian condition), accessible (to both upward migrating fish and research) and fishable.

Two stable inland distance tributary sites were required to investigate evidence of galaxiid migration; one upstream site within the Waikanae River and one control site outside of the Waikanae River. The Otaki River was identified as an appropriate control site given that its comparable size to the Waikanae River and on the same coast.

The following two sites were located with suitable aquatic and riparian features matching the above criteria:

1. A site on the Ngatiawa River, a main upper tributary of the Waikanae River, at around altitude 140m above sea level, above farmland at the end of Ngatiawa Road; and
2. The Pukeatua Stream at around 110-120m above sea level, off the Otaki Gorge Road in the upper Otaki River catchment.

Both survey locations have been selected on the basis of catchment size, river size similarity, access, and presence of migrant fish populations. The 2015 survey located a new and better site to represent the Waikanae River than was used in the 2014 survey (Figure 35).

Figure 35: Otaki and Waikanae River Tributary survey locations for 2014 and 2015.

6.2 Results

6.2.1 Waikanae (Ngatiawa River) Tributary

The conditions of substrate, riparian vegetation and upper catchment land-use appear conducive to native fish populations. The reach surveyed was on average 6m wide, 20cm deep, had a riffle-cascade system, the cascades made by large boulder-cobble weirs separated by 5-9m of fast run or riffle. The reach surveyed contained 10m of run habitat, 30m of riffle habitat, 5m of pool habitat and 15m of cascade habitat.

An identifiable and accessible 60m of the tributary was fished using an electric fishing machine. The 6m wide reach was fished up both sides covering in total 4m of the 6m width, using standard stop net and 3m survey sections, with multiple (4) passes. The results are presented in Table 7. Five species of fish (including eel) were identified, with an average of 0.1 fish / m^2.

Table 7: Fish records from the 100m reach survey of the chosen Waikanae River tributary

Fish species	Threat classification[11]	Length (mm) of each fish	Habitat
Korao	*At Risk - Declining*	110, 100, 60, 50, 30	Cascades (lower)
Common bully	*Not Threatened*	50, 50	Runs
Redfin bully	*At Risk - Declining*	80, 70, 50, 90, 90, 80, 70, 70, 70, 100, 110, 60	Riffle-runs
Longfin eel	*At Risk - Declining*	280, 160, 140	Cascade and run
Elva	-	120,100	Runs
Brown trout	*Introduced*	200	Upper run

6.2.2 Otaki (Pukeatua Stream) Tributary

The sample area comprises a boulder stream with cascades and runs. The average width was 4.5m and average depth ranging from 30-40cm. The 50m sampled reach was fished using an electric fishing machine. The results are presented in Table 8. Four species of fish (including eel) were identified, with an average of 0.05 fish / m^2.

Table 8: Fish records from the 100m reach survey of the chosen Otaki River tributary

Fish species	Threat classification[11]	Length of each fish (mm)	Habitat
Torrent fish	*At Risk - Declining*	90, 90, 80	riffle
Koaro	*At Risk - Declining*	70, 140, 120	cascade
Redfin bully	*At Risk - Declining*	50	riffle
Longfin eel	*At Risk - Declining*	200, 160, 300	runs
Elva	-	150	run

6.3 Fish Monitoring Conclusion

The data show recruitment (passage) has occurred in both the Otaki and the Waikanae River sites. There were a small number of young eel and bully both at least in theory requiring a migration stage to

[11] Goodman et al (2014). Conservation status of New Zealand freshwater fish, 2013. *New Zealand Threat Classification Series 7*. Department of Conservation, Wellington.

their life cycles. The juvenile koaro are less indicative as this species does not always require a migration stage.

7.0 Flow gauging

The aims of the hydrological monitoring are to:

- Identify/confirm and monitor the relationship between river flows, river abstraction rates and groundwater pumping in the river downstream of the water treatment plant. This is to identify whether additional groundwater pumping reduces flows in the Waikanae River downstream of the treatment plant due to increased losses through the bed of the river as a result of lowered groundwater levels.
- Confirm river flows at the periphyton and water quality monitoring locations to allow correlation of monitoring and effects.

Two sets of flow gauging were conducted by NIWA during the summer of 2014/2015 at the locations specified in River BMP; just downstream of SH1 and alongside Jim Cooke Park. The results are summarised in Table 9, which also shows the results of two sets of gaugings carried out during the 2013/2014 summer. The gaugings carried out by NIWA are plotted in Figure 36, which also shows the results of 12 sets of gaugings carried out between 1993 and 2008 by GWRC at the same locations.

The 2014/2015 gaugings undertaken by NIWA indicate:

- Net gains of 261 L/s and 58 L/s between the water treatment plant and the gauging location just downstream of SH1. The greater gain occurred when upstream river flows were higher.
- Net losses of 297 L/s and 237 L/s between SH1 and Jim Cooke Park, with the greater loss occurring when river flows (as recorded at the water treatment plant) were slightly higher.

Table 9: Gauging on the Waikanae River

Date	Water treatment plant			Site	Flow (L/s)	Area (m^2)	Velocity (m/s)	Time (NZST)
	Upstream flow (L/s)	Abstraction (L/s)	Downstream flow (L/s)					
11/3/14	850	87	763	Below SH1	850	3.18	0.268	13:45
				Jim Cooke Park	564	2.49	0.227	15:08
10/4/14	799	52	747	Below SH1	719	2.62	0.275	11:10
				Jim Cooke Park	536	2.55	0.210	12:30
12/2/15	1010	144	866	Below SH1	1127	6.36	0.177	10:45
				Jim Cooke Park	830	2.98	0.278	12:16
10/3/15	979	142	837	Below SH1	895	8.56	0.105	10:25
				Jim Cooke Park	658	2.6	0.253	12:45

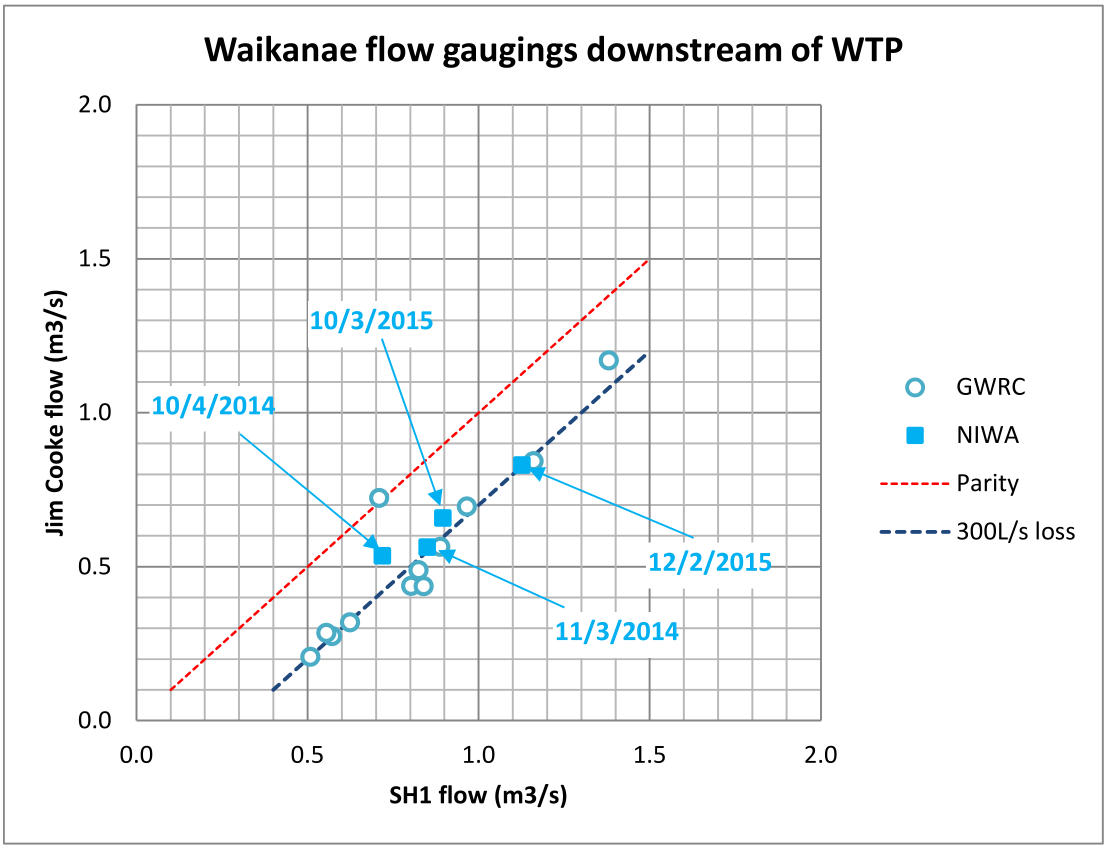

Figure 36: Waikanae River flow gaugings

8.0 Summary and Recommendations

8.1 Summary

This report, builds on the previous two months of 2013-2014 late summer data[12]. To date, there are now seven months in total of pre-activity aquatic monitoring data. There are a number of interesting points this monitoring data raises in terms of the stability and condition of the current Waikanae Rivers water quality.

The data and the correlations reported here, as well as the early analysis indicate that the Waikanae River, by and large, has a stable water quality, with a small but seasonally predictable temperature regime. Nutrient status can be described as generally between oligotrophic and mesotrophic (i.e. a medium nutrient status, with DRP being the higher nutrient). Algae growths are generally minor and not yet seen above a low-medium bed cover. The algae communities do develop throughout summer, doubling in taxa richness, but there are few "problem" (cyano-bacteria) species. The bed itself, being only 60-80% suitable for algae attachments, also limits algae presence.

The macroinvertebrate communities, while subtly different along the river, are relatively similar and generally stable through time. The fauna represent a good quality, relatively sensitive (to water quality)

[12] BML 2014 (July). Waikanae River Aquatic Baseline Monitoring Data. Prepared for KCDC.

array of species with a high EPT ratio. This year we did measure a minor algae response in the macroinvertebrate community.

8.2 Recommendations

8.2.1 Periphyton Measures

The visual periphyton measures do not result in a good and differentiated set of data. This is because the bed is generally always covered in a high (but thin) matting of diatom algae and a visual measure is sufficiently approximate that subtle differences cannot be recorded. The measure of medium and thick algae is infrequent and the abundances generally minor but a trend in that cover was seen in the 2015 data. The system of measure is also reliant on clear water and good visibility, as well as an ability to safely wade across and stand in the entire river width. On occasions when flows are high and water turbidity raised, these data cannot be collected.

The chlorophyll-a measure is a more accurate and quantitative measures and can be collected under more difficult field conditions. In terms of analysis, the data show that chlorophyll-a is very tightly correlated with the AFDM and that both measures are not needed where the quantum of algae is the dominant requirement. Taxonomic relative abundances and chlorophyll-a provide the best, clearest and most often collectable data for the Waikanae River for this project.

The down side of using only chlorophyll-a measures is that sometimes a lengthy period from collection to a result can occur, depending on the processing lab. Therefore, some form of immediate visual assessment is beneficial, especially where "effect" based outcomes are required in a short timeframe.

We suggest that a better, safer and more reliable system to estimate immediate periphyton development is the use of in-river ceramic tiles (e.g. unglazed ceramic tiles[13]). The deployment of tiles (of a measured area), into the river centrally and at one (true right) edge at five locations (ten tiles in total per site) will provide, through observation of the tile surface, a more reliable and less subjective measurement of algae development (the tile being photographable). The tile should be attached by a wire to a warratah on the bank. The tile can therefore be extracted from the river even at difficult flows and at raised turbidity. In such difficult water periods it may be difficult to return the tile, but at worst it can be thrown back into the stream. This system would allow a more frequently attained accurate visual instant measure of algae species and cover and thickness from which to assess the presence of algae issues.

8.2.2 Water Quality Measures

As discussed last year, water velocity and *in situ* depth measures at each periphyton visual assessment quadrat are one-off measures and show no pattern or predicting ability for periphyton abundance. The measures have allowed a better understanding of the micro-habitats instream and the river in general but provide no predictive ability in regard to adverse effects associated with the introduction of bore water. As such, these measures need not be continued.

[13] Examples include: "Jacobson et al (2008). Algal growth response in two Illinois Rivers receiving sewage effluent. Journal of Freshwater Ecology 23"; "Stevenson et.al Chapter 6, Rapid Bio-assessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic. In Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. "Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition, EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

8.2.3 Macroinvertebrate Measures

To date, the macroinvertebrate data show a relatively stable community (albeit there are weak statistical differences down the river) but there are as yet no strong periphyton growth-community related data as there have been no "high periphyton periods". There are, in effect, 150 macroinvertebrate samples representing low periphyton levels – even the 2013-2014 "medium" levels were relatively low (perhaps medium for the Waikanae River). That said, the March 2015 data, with decreasing Deleatidium and increasing fly larvae, do show the direction of response in the community relating to increasing filamentous and matting algae. As such, future baseline data collection should focus on gathering only high algae level data; no more low and medium-low levels as there is now sufficient low periphyton community data collected. If no high events occur then that is inactive of the Rivers normal condition.

8.2.4 Fish Migration Passage

In terms of the fish passage, the interpretation of the results of a limited (in time) set of measurements of fish absence/presence in a tributary in the Otaki (as a control) and in the upper Waikanae River, has substantive difficulties in attributing the absence of small fish to anything other than chance. It is our opinion that there is sufficient seasonal whitebaiting activity in the Waikanae River that lower river whitebait runs and timing can be identified and that whitebait and elva trapping above the water treatment plant intake could be successfully undertaken each year, with a much greater chance of identifying passage issues than the current program. This we propose would be a better test of passage maintenance.

Appendix 1: Water quality data correlations

Red squares are negative significant correlations (i.e. ≤-0.5), green squares are positive significant correlations (i.e. ≥0.5).

Site C1	*Velocity*	*Periphyton cover*	*Temperature*	*Conductivity*	*pH*	*TP*	*DRP*	*TN*	*DC*	*N-N*	*SIN*	*AFDM*	*Chloro a*
Velocity	1												
Periphyton cover	-0.57896698	1											
Temperature	-0.46599196	0.321758889	1										
Conductivity	0.10136488	-0.281498055	0.102217834	1									
pH	-0.2884945	0.626042347	-0.09552135	-0.14106592	1								
TP	0.39717844	-0.088787519	-0.502255338	-0.41385559	-0.11439161	1							
DRP	0.72145796	-0.709868962	-0.408692463	0.117518033	-0.54129955	0.2763868	1						
TN	0.4834038	-0.31424979	-0.826791268	0.068530713	-0.24434959	0.5903399	0.385706	1					
DC	-0.77713252	0.532723664	0.628018962	-0.30616873	0.42821394	-0.2643656	-0.5905444	-0.6859401	1				
N-N	0.48294631	-0.429708894	-0.789908061	0.015422878	-0.33115674	0.5412911	0.4602393	0.882973	-0.647805	1			
SIN	0.49665727	-0.428114787	-0.77722405	0.019710616	-0.33725585	0.5547375	0.4619898	0.8761038	-0.6531151	0.9990221	1		
AFDM	-0.37229041	0.734526782	0.884818446	0.075857879	0.32329259	-0.3747686	-0.7321306	-0.6093862	0.2375346	-0.4918295	-0.4652763	1	
Chloro a	-0.43433289	0.793917024	0.854002449	0.016944318	0.26047414	-0.3710492	-0.7953055	-0.5909946	0.286487	-0.4669188	-0.4450358	0.9767392	1

Site C2	*Velocity*	*Periphyton cover*	*Temperature*	*conductivity*	*pH*	*TP*	*DRP*	*TN*	*DC*	*N-N*	*SIN*	*AFDM*	*Chloro a*
Velocity	1												
Periphyton cover	-0.58372168	1											
Temperature	-0.0667158	0.399440665	1										
Conductivity	0.27833875	-0.481548493	0.034747504	1									
pH	-0.60985317	0.398473814	0.027515644	-0.32170417	1								
TP	0.12556019	-0.426151253	-0.602922772	0.027941855	-0.11579484	1							

Site C2	*Velocity*	*Periphyton cover*	*Temperature*	*conductivity*	*pH*	*TP*	*DRP*	*TN*	*DC*	*N-N*	*SIN*	*AFDM*	*Chloro a*
DRP	0.64718542	-0.17556692	-0.27524864	0.317283869	-0.40480841	0.1018607	1						
TN	0.33546891	-0.704159798	-0.808610304	0.034497011	-0.14147168	0.6186199	0.2914574	1					
DC	-0.77242597	0.627429124	0.413235662	-0.3490069	0.43714782	-0.261969	-0.7471565	-0.5412144	1				
N-N	0.34405967	-0.701156	-0.781706799	0.136130529	-0.25657651	0.4697153	0.3535288	0.9204784	-0.5748643	1			
SIN	0.36174866	-0.703023739	-0.77472852	0.16518284	-0.26790708	0.4596347	0.3768451	0.9174527	-0.5860775	0.9991051	1		
AFDM	-0.50725925	0.203007046	0.871739587	0.227246511	0.37160896	-0.591129	-0.5537679	-0.6516165	0.4213088	-0.5234226	-0.5290443	1	
Chloro a	-0.40176026	0.008760782	0.8693439	0.132902363	0.25163418	-0.4021338	-0.8657497	-0.5342015	0.4867701	-0.4936101	-0.4980219	0.667772	1

Site R1	*Velocity*	*Periphyton cover*	*Temperature*	*Conductivity*	*pH*	*TP*	*DRP*	*TN*	*DC*	*N-N*	*SIN*	*AFDM*	*Chloro a*
Velocity	1												
Periphyton cover	-0.46387265	1											
Temperature	-0.11523855	0.660618013	1										
Conductivity	0.14764262	-0.475557042	-0.039686142	1									
pH	-0.13224642	0.137980565	-0.000853087	-0.25514626	1								
TP	0.00872985	-0.647809798	-0.515615447	0.217855958	0.0146672	1							
DRP	-0.00790859	-0.202993122	-0.249057326	0.345893032	-0.3700541	0.4168706	1						
TN	0.27820095	-0.63777853	-0.921886381	0.008168089	-0.13214825	0.3922783	0.3249139	1					
DC	-0.34213222	0.450301076	0.459065642	-0.28611257	0.3908222	-0.1049965	-0.6393249	-0.5049843	1				
N-N	0.20755617	-0.430832789	-0.68763926	0.145976314	0.07915782	0.1858022	0.2196736	0.6910771	-0.3779657	1			
SIN	0.39899173	-0.692038394	-0.885751519	0.209085906	-0.21764478	0.4276742	0.426629	0.9037065	-0.5774595	0.8286564	1		
AFDM	0.51392636	-0.038730796	0.871691562	0.106983337	0.16615237	-0.3748759	-0.5862175	-0.6173584	0.3232522	-0.3378639	-0.519781	1	
Choro a	0.54239543	-0.089129756	0.861230553	0.157724366	0.14248263	-0.3528517	-0.5447166	-0.5880484	0.2696736	-0.3172905	-0.487248	0.9976008	1

Site R2	*Velocity*	*Periphyton cover*	*Temperature*	*Conductivity*	*pH*	*TP*	*DRP*	*TN*	*DC*	*N-N*	*SIN*	*AFDM*	*Chloro a*
Velocity	1												
Periphyton cover	-0.46564212	1											

Site R2	*Velocity*	*Periphyton cover*	*Temperature*	*Conductivity*	*pH*	*TP*	*DRP*	*TN*	*DC*	*N-N*	*SIN*	*AFDM*	*Chloro a*
Temperature	-0.44480467	0.743301944	1										
Conductivity	-0.01612308	0.005546114	0.402064486	1									
pH	0.01811377	0.29800551	-0.007551021	0.140339729	1								
TP	0.33108276	-0.687596049	-0.895586262	-0.44571258	-0.23431826	1							
DRP	-0.16755915	-0.282874851	-0.472466401	-0.09814701	-0.47237645	0.5059374	1						
TN	0.57064164	-0.871059781	-0.77108824	0.061956471	-0.27903024	0.7161393	0.4949645	1					
DC	0.04122683	0.587125399	0.289253474	-0.0161205	0.65887353	-0.3393059	-0.6109327	-0.6288892	1				
N-N	0.51730427	-0.793253015	-0.804145233	-0.08854146	-0.27238186	0.6464645	0.5872877	0.9498109	-0.6646908	1			
SIN	0.50569212	-0.793106892	-0.793743832	-0.08163874	-0.28848808	0.6490168	0.5990436	0.9521777	-0.6813362	0.9994058	1		
AFDM	0.02760581	0.467435343	0.738174748	0.119855217	0.49229834	-0.5292099	-0.7886318	-0.4779428	0.4140063	-0.5575944	-0.5632868	1	
Chloro a	0.02676135	0.353816413	0.71568489	0.164139113	0.47494409	-0.4801128	-0.821025	-0.421798	0.358779	-0.5243872	-0.531037	0.986577	

Site R3	*Velocity*	*Periphyton cover*	*Temperature*	*conductivity*	*pH*	*TP*	*DRP*	*TN*	*DC*	*N-N*	*SIN*	*AFDM*	*Chloro a*
Velocity	1												
Periphyton cover	-0.1758805	1											
Temperature	-0.38037171	0.238625269	1										
conductivity	0.02885081	-0.681523196	0.292121292	1									
pH	-0.26618131	-0.210847483	-0.22968823	-0.07899202	1								
TP	0.10259938	-0.608739479	-0.654605201	-0.10534693	0.49409405	1							
DRP	0.10141952	-0.412208112	-0.236254455	0.292846528	-0.11762062	0.5725964	1						
TN	0.4081222	-0.638048661	-0.591046705	0.25648003	0.25459211	0.7656015	0.5600259	1					
DC	0.19383562	0.301478292	-0.129341634	-0.20775826	0.4215159	-0.1347421	-0.4554021	0.0210695	1				
N-N	0.40868262	-0.634793099	-0.579122116	0.249888622	0.23421097	0.7866937	0.6179143	0.9868284	-0.0281259	1			
SIN	0.40752757	-0.634571219	-0.569043573	0.248754453	0.2344869	0.7876548	0.6202701	0.9854621	-0.0342603	0.9998246	1		
AFDM	-0.06901473	0.167763866	0.749096657	0.025800283	0.1566794	-0.4797218	-0.6258116	-0.4282597	0.2245222	-0.4517053	-0.4442327	1	
Chloro a	-0.22864882	0.299585453	0.411388848	-0.27427593	-0.14063494	-0.4925648	-0.8694256	-0.46154	0.3353325	-0.5275213	-0.5291551	0.7551867	1

Appendix 2: Simper analysis outcomes

Table 10: Simper analysis outcomes for site – fauna comparisons

Groups C1 & C2						
Average dissimilarity = 51.14						
	Group C1	Group C2				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	156.15	130.4	13.61	1.41	26.62	26.62
Elmidae	47.35	64.6	7.61	1.23	14.87	41.5
Orthocladiinae	42	26.35	7.28	0.66	14.24	55.74
Beraeoptera	24.55	18.95	4.05	0.88	7.93	63.67
Aoteapsyche	33.8	14.9	3.91	0.86	7.64	71.3
Pycnocentrodes	13.85	20.05	3.43	0.88	6.71	78.01
Tanytarsini	11.6	4	1.59	0.68	3.11	81.12
Zelandoperla	11.6	6.4	1.33	0.98	2.6	83.72
Coloburiscus	8.95	2.6	1.14	0.89	2.23	85.94
Olinga	6.2	4.4	0.85	1.13	1.65	87.59
Aphrophila	7.65	3.75	0.76	1.27	1.49	89.08
Potamopyrgus	2.75	5.15	0.74	0.69	1.46	90.54

Groups C1 & Site R1						
Average dissimilarity = 51.90						
	Group C1	Group Site R1				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	156.15	181.5	16.14	1.41	31.1	31.1
Orthocladiinae	42	40.1	8.14	0.74	15.69	46.79
Elmidae	47.35	76.9	7.47	1.32	14.4	61.19
Aoteapsyche	33.8	22.95	4.02	0.95	7.74	68.93
Beraeoptera	24.55	10.8	2.88	0.72	5.56	74.49
Pycnocentrodes	13.85	7.85	1.92	0.87	3.69	78.18
Tanytarsini	11.6	9.25	1.87	0.85	3.6	81.78
Zelandoperla	11.6	1.45	1.43	0.99	2.76	84.54
Coloburiscus	8.95	2.45	1.04	0.87	2.01	86.55
Austrosimulium	5.6	5.4	0.74	1.16	1.43	87.98
Olinga	6.2	4.95	0.73	1.11	1.4	89.38
Aphrophila	7.65	6.1	0.7	1.23	1.35	90.73

Groups C2 & Site R1						
Average dissimilarity = 48.41						
	Group C2	Group Site R1				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	130.4	181.5	16.24	1.49	33.54	33.54

Elmidae	64.6	76.9	7.24	1.34	14.95	48.48
Orthocladiinae	26.35	40.1	6.95	0.77	14.35	62.84
Pycnocentrodes	20.05	7.85	2.88	0.85	5.96	68.79
Beraeoptera	18.95	10.8	2.79	0.83	5.76	74.56
Aoteapsyche	14.9	22.95	2.7	1.14	5.57	80.13
Tanytarsini	4	9.25	1.27	0.95	2.63	82.76
Zelandoperla	6.4	1.45	0.79	1.14	1.63	84.39
Potamopyrgus	5.15	2.8	0.75	0.74	1.54	85.93
Maoridiamesa	1.35	4.15	0.71	0.61	1.48	87.4
Olinga	4.4	4.95	0.69	1.11	1.43	88.83
Austrosimulium	2.6	5.4	0.65	1.1	1.34	90.17

Groups C1 & Site R2

Average dissimilarity = 53.35

	Group C1	Group Site R2				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	156.15	117.7	15.32	1.36	28.72	28.72
Orthocladiinae	42	14.9	6.79	0.61	12.73	41.45
Elmidae	47.35	37.95	6.17	1.17	11.57	53.02
Aoteapsyche	33.8	22.35	5.62	0.99	10.54	63.56
Beraeoptera	24.55	3.6	3.47	0.71	6.51	70.07
Pycnocentrodes	13.85	4.4	2.36	0.82	4.42	74.49
Tanytarsini	11.6	8.8	2.31	0.74	4.32	78.82
Zelandoperla	11.6	3.6	1.66	0.95	3.11	81.92
Coloburiscus	8.95	2.3	1.37	0.9	2.57	84.49
Aphrophila	7.65	2.55	0.94	1.28	1.77	86.26
Austrosimulium	5.6	3.75	0.87	1.01	1.64	87.9
Potamopyrgus	2.75	5.6	0.86	0.92	1.61	89.5
Olinga	6.2	2.45	0.83	1.09	1.55	91.05

Groups C2 & Site R2

Average dissimilarity = 50.33

	Group C2	Group Site R2				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	130.4	117.7	14.58	1.39	28.97	28.97
Elmidae	64.6	37.95	8.73	1.24	17.34	46.31
Orthocladiinae	26.35	14.9	5.33	0.69	10.58	56.89
Aoteapsyche	14.9	22.35	3.7	0.96	7.36	64.25
Pycnocentrodes	20.05	4.4	3.66	0.82	7.26	71.51
Beraeoptera	18.95	3.6	3.22	0.75	6.41	77.91
Tanytarsini	4	8.8	1.71	0.73	3.4	81.31
Potamopyrgus	5.15	5.6	1.16	0.87	2.31	83.63
Zelandoperla	6.4	3.6	0.91	1.1	1.81	85.43
Hydrobiosis	5.95	4.1	0.85	1.4	1.68	87.11

Helicopsyche	3.8	0.95	0.73	0.4	1.46	88.57
Olinga	4.4	2.45	0.7	0.93	1.38	89.95
Austrosimulium	2.6	3.75	0.64	0.81	1.28	91.23

Groups Site R1 & Site R2

Average dissimilarity = 52.37

	Group Site R1	Group Site R2				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	181.5	117.7	18.8	1.49	35.9	35.9
Elmidae	76.9	37.95	8.57	1.39	16.37	52.27
Orthocladiinae	40.1	14.9	6.79	0.72	12.97	65.24
Aoteapsyche	22.95	22.35	4.27	1.06	8.15	73.39
Tanytarsini	9.25	8.8	2.02	0.91	3.85	77.24
Pycnocentrodes	7.85	4.4	1.52	0.96	2.91	80.15
Beraeoptera	10.8	3.6	1.47	0.71	2.82	82.97
Maoridiamesa	4.15	3.1	0.97	0.69	1.85	84.82
Austrosimulium	5.4	3.75	0.88	1.04	1.69	86.51
Potamopyrgus	2.8	5.6	0.85	0.96	1.62	88.12
Hydrobiosis	5.85	4.1	0.77	1.28	1.47	89.6
Aphrophila	6.1	2.55	0.7	1.25	1.33	90.93

Groups C1 & Site R3

Average dissimilarity = 54.02

	Group C1	Group Site R3				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	156.15	108.6	13.61	1.32	25.19	25.19
Orthocladiinae	42	27.05	7.07	0.71	13.08	38.27
Elmidae	47.35	50.9	6.24	1.21	11.55	49.82
Aoteapsyche	33.8	25.05	4.4	0.95	8.14	57.96
Tanytarsini	11.6	31.6	4.33	0.78	8.01	65.97
Beraeoptera	24.55	9	3.04	0.71	5.63	71.6
Pycnocentrodes	13.85	13.25	2.6	0.89	4.81	76.41
Zelandoperla	11.6	0.75	1.63	1	3.02	79.43
Potamopyrgus	2.75	12	1.62	0.59	3	82.42
Coloburiscus	8.95	2.9	1.15	0.88	2.14	84.56
Tanypodinae	0.25	7.2	1.08	0.45	2.01	86.57
Hydrobiosis	4.75	8.25	0.87	1.19	1.61	88.18
Olinga	6.2	5.8	0.86	1.16	1.59	89.77
Aphrophila	7.65	6.25	0.82	1.2	1.52	91.29

Groups C2 & Site R3

Average dissimilarity = 51.39

	Group C2	Group Site R3				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%

Deleatidium	130.4	108.6	13.09	1.38	25.47	25.47
Elmidae	64.6	50.9	7.6	1.22	14.78	40.26
Orthocladiinae	26.35	27.05	5.65	0.8	10.99	51.25
Tanytarsini	4	31.6	4.09	0.73	7.96	59.2
Pycnocentrodes	20.05	13.25	3.55	0.88	6.91	66.11
Aoteapsyche	14.9	25.05	3.05	1.18	5.93	72.04
Beraeoptera	18.95	9	2.96	0.82	5.75	77.79
Potamopyrgus	5.15	12	1.9	0.69	3.7	81.5
Tanypodinae	0	7.2	1.13	0.46	2.21	83.7
Zelandoperla	6.4	0.75	0.89	1.16	1.74	85.44
Hydrobiosis	5.95	8.25	0.88	1.32	1.7	87.15
Olinga	4.4	5.8	0.83	1.18	1.62	88.77
Aphrophila	3.75	6.25	0.68	1.15	1.32	90.09

Groups Site R1 & Site R3

Average dissimilarity = 52.02

	Group Site1	Group Site3				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	181.5	108.6	17.11	1.44	32.89	32.89
Elmidae	76.9	50.9	7.58	1.32	14.57	47.46
Orthocladiinae	40.1	27.05	6.55	0.79	12.59	60.04
Tanytarsini	9.25	31.6	3.97	0.79	7.63	67.67
Aoteapsyche	22.95	25.05	3.36	1.19	6.47	74.14
Pycnocentrodes	7.85	13.25	1.89	0.85	3.63	77.77
Potamopyrgus	2.8	12	1.58	0.6	3.04	80.81
Beraeoptera	10.8	9	1.42	0.75	2.74	83.54
Tanypodinae	1.1	7.2	1.07	0.48	2.06	85.6
Hydrobiosis	5.85	8.25	0.83	1.27	1.6	87.2
Maoridiamesa	4.15	1.7	0.74	0.6	1.42	88.62
Olinga	4.95	5.8	0.71	1.18	1.36	89.98
Austrosimulium	5.4	3.7	0.7	1.23	1.35	91.32

Groups Site R2 & Site R3

Average dissimilarity = 52.61

	Group Site R2	Group Site R3				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	117.7	108.6	14.14	1.25	26.88	26.88
Elmidae	37.95	50.9	7.1	1.25	13.49	40.37
Tanytarsini	8.8	31.6	5.03	0.81	9.56	49.93
Orthocladiinae	14.9	27.05	4.91	0.98	9.34	59.27
Aoteapsyche	22.35	25.05	4.89	1.12	9.29	68.56
Pycnocentrodes	4.4	13.25	2.44	0.84	4.64	73.19
Potamopyrgus	5.6	12	2.16	0.7	4.11	77.31
Beraeoptera	3.6	9	1.44	0.97	2.73	80.03

Tanypodinae	0.3	7.2	1.31	0.46	2.5	82.53
Hydrobiosis	4.1	8.25	1.12	1.32	2.12	84.66
Aphrophila	2.55	6.25	0.87	1.1	1.66	86.31
Austrosimulium	3.75	3.7	0.8	0.94	1.52	87.83
Olinga	2.45	5.8	0.8	1.08	1.52	89.36
Maoridiamesa	3.1	1.7	0.65	0.7	1.23	90.59

Table 11: Simper analysis outcomes for time – fauna comparisons

Groups 18-Dec-14 & 18-Feb-15

Average dissimilarity = 54.82

	Group 18-Dec-14	Group 18-Feb-15				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	145.16	134.24	15.7	1.37	28.64	28.64
Elmidae	19.56	61.68	8.45	1.22	15.42	44.06
Aoteapsyche	2.68	40.68	6.26	1.17	11.41	55.47
Pycnocentrodes	33.48	1.6	5.35	1.42	9.75	65.23
Beraeoptera	31.6	3.16	4.61	0.92	8.41	73.64
Orthocladiinae	1.24	10.64	1.75	0.79	3.2	76.84
Potamopyrgus	0.96	9.2	1.59	0.55	2.9	79.73
Zelandoperla	3.64	7.64	1.42	0.84	2.59	82.32
Coloburiscus	4	6.72	1.17	0.85	2.13	84.46
Tanypodinae	0	5.44	0.96	0.37	1.76	86.21
Tanytarsini	0.28	5.96	0.95	0.96	1.74	87.96
Helicopsyche	5.84	0.16	0.94	0.61	1.71	89.67
Aphrophila	5.6	5.04	0.82	1.22	1.49	91.16

Groups 18-Dec-14 & 5-Mar-15

Average dissimilarity = 68.18

	Group 18-Dec-14	Group 5-Mar-15				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	145.16	60.6	15.68	1.46	23.01	23.01
Orthocladiinae	1.24	98.96	15.03	1.35	22.05	45.06
Elmidae	19.56	54.48	7.17	1.27	10.51	55.57
Tanytarsini	0.28	40.24	5.99	1.07	8.78	64.35
Pycnocentrodes	33.48	4.2	4.94	1.4	7.25	71.6
Beraeoptera	31.6	7	4.21	0.92	6.18	77.78
Aoteapsyche	2.68	25.68	4.04	0.96	5.92	83.7
Maoridiamesa	0.12	7.2	1.26	0.88	1.85	85.55
Austrosimulium	1.64	7.56	1.06	1.12	1.56	87.12
Hydrobiosis	2.64	7.8	0.98	1.37	1.44	88.55
Olinga	4.24	6.6	0.97	1.25	1.42	89.97
Potamopyrgus	0.96	5.64	0.93	0.77	1.36	91.33

Groups 18-Feb-15 & 5-Mar-15

Average dissimilarity = 55.82

	Group 18-Feb-15	Group 5-Mar-15				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	134.24	60.6	13.1	1.43	23.46	23.46
Orthocladiinae	10.64	98.96	12.91	1.22	23.13	46.59
Elmidae	61.68	54.48	6.6	1.24	11.83	58.42
Tanytarsini	5.96	40.24	5.13	0.99	9.19	67.61
Aoteapsyche	40.68	25.68	4.77	1.02	8.54	76.15
Potamopyrgus	9.2	5.64	1.55	0.64	2.77	78.93
Zelandoperla	7.64	3.64	1.21	0.88	2.16	81.09
Maoridiamesa	0.92	7.2	1.14	0.89	2.03	83.12
Austrosimulium	4.48	7.56	0.99	1.2	1.77	84.89
Beraeoptera	3.16	7	0.92	0.86	1.65	86.55
Coloburiscus	6.72	1.32	0.91	0.72	1.63	88.18
Tanypodinae	5.44	0.44	0.87	0.39	1.55	89.73
Olinga	4.4	6.6	0.86	1.25	1.53	91.26

Groups 18-Dec-14 & 5-Feb-15

Average dissimilarity = 48.11

	Group 18-Dec-14	Group 5-Feb-15				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	145.16	215.48	15.42	1.29	32.06	32.06
Elmidae	19.56	86.44	10.1	1.58	20.98	53.04
Pycnocentrodes	33.48	8.24	3.93	1.26	8.17	61.21
Beraeoptera	31.6	11.76	3.83	0.98	7.95	69.16
Aoteapsyche	2.68	26.2	3.55	1.32	7.38	76.54
Orthocladiinae	1.24	9.48	1.17	1.16	2.43	78.97
Potamopyrgus	0.96	6.84	0.98	0.76	2.04	81.01
Hydrobiosis	2.64	7.84	0.94	1.18	1.95	82.95
Helicopsyche	5.84	0.24	0.79	0.59	1.63	84.59
Aphrophila	5.6	6.72	0.78	1.19	1.61	86.2
Tanytarsini	0.28	5.72	0.75	0.62	1.55	87.75
Zelandoperla	3.64	4.12	0.68	1.04	1.41	89.16
Olinga	4.24	3.8	0.63	1.03	1.31	90.47

Groups 18-Feb-15 & 5-Feb-15

Average dissimilarity = 42.65

	Group 18-Feb-15	Group 5-Feb-15				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	134.24	215.48	16.26	1.4	38.13	38.13
Elmidae	61.68	86.44	7.48	1.35	17.55	55.67
Aoteapsyche	40.68	26.2	4.03	1.06	9.44	65.12
Orthocladiinae	10.64	9.48	1.54	1.07	3.62	68.74
Potamopyrgus	9.2	6.84	1.43	0.64	3.36	72.09

Beraeoptera	3.16	11.76	1.36	0.98	3.19	75.28
Zelandoperla	7.64	4.12	1.02	0.88	2.39	77.67
Pycnocentrodes	1.6	8.24	0.98	0.96	2.29	79.96
Tanytarsini	5.96	5.72	0.93	0.84	2.19	82.15
Coloburiscus	6.72	3.32	0.87	0.83	2.04	84.19
Tanypodinae	5.44	1.2	0.84	0.43	1.96	86.15
Hydrobiosis	4.84	7.84	0.8	1.21	1.88	88.03
Aphrophila	5.04	6.72	0.68	1.19	1.59	89.62
Olinga	4.4	3.8	0.56	1	1.32	90.94

Groups 5-Mar-15 & 5-Feb-15

Average dissimilarity = 57.81

	Group 5-Mar-15	Group 5-Feb-15				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Deleatidium	60.6	215.48	20.41	1.97	35.31	35.31
Orthocladiinae	98.96	9.48	11.22	1.2	19.4	54.71
Elmidae	54.48	86.44	6.91	1.35	11.96	66.67
Tanytarsini	40.24	5.72	4.54	0.99	7.85	74.52
Aoteapsyche	25.68	26.2	2.92	1	5.06	79.58
Beraeoptera	7	11.76	1.31	1.04	2.27	81.84
Pycnocentrodes	4.2	8.24	1.1	0.89	1.9	83.74
Potamopyrgus	5.64	6.84	0.96	0.77	1.67	85.41
Maoridiamesa	7.2	0.84	0.94	0.89	1.63	87.04
Hydrobiosis	7.8	7.84	0.8	1.28	1.38	88.42
Austrosimulium	7.56	3.16	0.78	1.1	1.36	89.78
Olinga	6.6	3.8	0.72	1.23	1.24	91.02

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W14039/340_KCDC_Baseline_Monthly_Monitoring_Report_December_2014

1.0 Introduction

The Waikanae River Baseline Aquatic Monitoring Monthly Report – December 2014 is prepared in general accordance with the Waikanae River Baseline Aquatic Monitoring Plan (River BMP) prepared for Kapiti Coast District Council by Boffa Miskell (BML), dated 23 February 2014. As per the River BMP, this report presents "*the results of periphyton visual cover, depth, velocity and flows over the month via a spread sheet, noting any exceedance or trend relevant to triggering macroinvertebrate sampling and a comment on the periphyton trends at each site. Water quality and macroinvertebrate data will be delivered as part of this report via a spread sheet and, as appropriate, the hydrological gauging results*" for the Waikanae River monitoring for December 2014.

2.0 Monitoring

Sampling included three downstream (receiving) and two upstream (control) monitoring sites as per resource consent WGN130103 permit [33251] condition 19 and permit [33252] condition 21. Monitoring locations are provided in **Figure 1** below.

Water quality monitoring, periphyton visual assessment transects and periphyton sampling were undertaken by suitably qualified ecologists on the 5th and 17th of December 2014. Following a large rain event on 10th December 2014, low-growth macroinvertebrate sampling was undertaken on the 17th of December 2014. Macroinvertebrate samples were preserved in ethanol and sent to Ryder Consulting Limited (RCL) for identification on 19 January 2015. Periphyton samples were frozen and sent in a chilli-bin with ice to RCL for identification on 8 December 2014 and 15 January 2015. Water quality samples were sent in a chilli-bin with ice to Eurofins ELS Limited on the 8th and 18th December 2014.

Field water quality readings were taken using a calibrated Horiba U-50 water quality meter and velocity data was collected using a FP111 Flow Probe. Velocity data was not recorded at Site 2 (R2) and Site 3 (R3) on the 5th December 2014 due to equipment failure. No water depth measurements were taken during December 2014.

No anomalous field observations (sheens, odours, high turbidity etc) were noted during December 2014.

Please note, because this is baseline monitoring, no exceedance trigger or relevant trend to trigger macroinvertebrate sampling is reported. Macroinvertebrate sampling is undertaken to reflect low, medium and high levels of periphyton growth. In addition, no periphyton trends are identifiable.

No hydrological gauging was undertaken in December 2014.

Raw data and results are provided in the following appendices:

- **Appendix 1:** Field water quality data.
- **Appendix 2:** Laboratory water quality results.
- **Appendix 3:** Periphyton visual cover data and water velocity data.
- **Appendix 4:** Periphyton sampling results**.**
- **Appendix 5:** Macroinvertebrate sampling results. Please note, an excel version of the macroinvertebrate sampling results is available and supplied separately.

3.0 References

Boffa Miskell (2014). Waikanae River Baseline Aquatic Monitoring Plan. Kapiti Water Supply RRwGW Scheme, prepared by Boffa Miskell Limited for Kapiti Coast District Council, dated 23 February 2014.

Appendix 1: Field Water Quality Data

5-Dec-14

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	9:31	11:15	12:50	15:19	16:04
Temperature (˚C)	12.60	13.80	15.76	17.20	18.80
pH	7.53	7.32	7.54	6.09	6.92
Conductivity (ms/cm)	0.10	0.10	0.10	0.10	0.10
Dissolved Oxygen (mg/L)	22.10	12.63	19.38	11.40	14.70
Dissolved Oxygen (%)	214.90	126.10	201.70	120.00	160.60
TDS (g/L)	0.07	0.06	0.07	0.07	0.67
NTU	2.70	5.70	1.30	1.70	1.10

17-Dec-14

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	14:57	13:52	16:03	12.18	11:00
Temperature (˚C)	15.38	14.88	14.39	14.01	13.78
pH	5.9	5.61	5.74	5.50	7.90
Conductivity (ms/cm)	0.103	0.105	0.106	0.108	0.132
Dissolved Oxygen (mg/L)	17.61	0.00	12.51	10.45	25.89
Dissolved Oxygen (%)	181	17.09	128.00	104.00	258.30
TDS (g/L)	0.067	174.50	0.069	0.07	0.086
NTU	0.7	0.07	0.00	0.50	0.70

Appendix 2: Laboratory Water Quality Results

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Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
Wellington
6142

Attention: Barbara Risi

Report Number: 14/37918
Issue: 1
05 January 2015

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
14/37918-01	Miscellaneous Sample		17/12/2014 16:05	18/12/2014 12:25	0

Notes: Waik Site 1

	Test	Result	Units	Signatory
0001	pH	7.5		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.19	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.187	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.20	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.018	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.013	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.29	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
14/37918-02	Miscellaneous Sample		17/12/2014 14:45	18/12/2014 12:25	0

Notes: Waik Control B

	Test	Result	Units	Signatory
0001	pH	7.4		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.19	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.189	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.08	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.017	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.012	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.29	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
14/37918-03	Miscellaneous Sample		17/12/2014 12:18	18/12/2014 12:25	0

Notes: Waik Site 2

	Test	Result	Units	Signatory
0001	pH	7.5		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.21	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.207	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.15	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.017	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.012	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.30	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
14/37918-04	Miscellaneous Sample		17/12/2014 10:30	18/12/2014 12:25	0

Notes: Waik Site 3

	Test	Result	Units	Signatory
0001	pH	7.4		Marylou Cabral KTP

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Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
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6142

Attention: Stephen Fuller/Barbara Risi

Report Number: 14/36566
Issue: 1
24 December 2014

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
14/36566-01	Miscellaneous Sample		05/12/2014 09:30	08/12/2014 13:40	0

Notes: W14012, Control A

	Test	Result	Units	Signatory
0001	pH	7.4		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.14	g/m³	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.138	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	4.72	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.014	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.013	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.24	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
14/36566-02	Miscellaneous Sample		05/12/2014 11:15	08/12/2014 13:40	0

Notes: W14012, Control B

	Test	Result	Units	Signatory
0001	pH	7.4		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.13	g/m³	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.125	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	4.73	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.013	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.013	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.21	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
14/36566-03	Miscellaneous Sample		05/12/2014 12:50	08/12/2014 13:40	0

Notes: W14012, Site 1

	Test	Result	Units	Signatory
0001	pH	7.5		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.13	g/m³	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.121	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	4.78	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.014	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.014	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.20	g/m³	Divina Lagazon KTP

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Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
14/36566-04	Miscellaneous Sample		05/12/2014 14:50	08/12/2014 13:40	0

Notes: W14012, Site 2

	Test	Result	Units	Signatory
0001	pH	7.5		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.12	g/m³	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.111	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	4.79	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.013	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.013	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.18	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
14/36566-05	Miscellaneous Sample		05/12/2014 16:00	08/12/2014 13:40	0

Notes: W14012, Site 3

	Test	Result	Units	Signatory
0001	pH	7.5		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.12	g/m³	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.111	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	4.86	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.014	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.013	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.17	g/m³	Divina Lagazon KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m³
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m³
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m³
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m³
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m³
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m³
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m³

"<" means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m3 is the equivalent to mg/L and ppm.

Samples will be retained for a period of time, in suitable conditions appropriate to the analyses requested.

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Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
14/37918-04	Miscellaneous Sample		17/12/2014 10:30	18/12/2014 12:25	0

Notes: Waik Site 3

	Test	Result	Units	Signatory
0125	Inorganic Nitrogen	0.81	g/m³	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.804	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	5.91	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.018	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.014	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.90	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
14/37918-05	Miscellaneous Sample		17/12/2014 15:30	18/12/2014 12:25	0

Notes: Waik Control A

	Test	Result	Units	Signatory
0001	pH	7.4		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.20	g/m³	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.196	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	5.11	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.018	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.012	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.30	g/m³	Divina Lagazon KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m³
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m³
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m³
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m³
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m³
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m³
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m³

"<" means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m3 is the equivalent to mg/L and ppm.

Samples will be retained for a period of time, in suitable conditions appropriate to the analyses requested.

All test methods and confidence limits are available on request. This report must not be reproduced except in full, without the written consent of the laboratory.

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Appendix 3: Periphyton Visual Cover Data and Water Velocity Data

Periphyton Cover - Field Survey Results
Date 2 December 2014

		R1																			
		Riffle 1					Riffle 2					Run 1					Run 2				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
thin mat/film	Green	40	20												**5**						
	Light Brown	60	30	60	80	80		90	90	35	20	10	5	0	10	80	80	60	30	5	90
	Dark Brown/ Black																				
Medium mat	Green				1		40														
	Light Brown																				
	Dark Brown/ Black						50														
Thick mat	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short	green																				
	brown reddish																				
Filaments, long	green																				
	brown reddish																				
	Potential	70	40	50	80	90	90	70	80	70	80	60	60	30	60	90	60	50	60	30	60

		R 2																			
		Riffle 1					Riffle 2					Run 1					Run 2				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
thin mat/film	Green					80															
	Light Brown	50	40	30	10		80	80	60	50	60	10	40	50	60	50	50	70	70	40	40
	Dark Brown/ Black	20					10						5	5							
Medium mat	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short	green																				
	brown reddish																				
Filaments, long	green																				
	brown reddish																				
	Potential	70	50	60	40	50	100	100	80	70	100	60	50	80	85	40	50	60	70	50	60

		R 3																			
		Riffle 1					Riffle 2					Run 1					Run 2				
		1 (left)	**2**	**3**	**4**	**5 (right)**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
thin mat/film	Green						10					40	60	5	50	60					
	Light Brown	60	30	40	40	5	40	50	30	70	60	10	30	100	30	45	50	70	30	50	90
	Dark Brown/ Black			10	20			10													
Medium mat	Green					60		5	10												
	Light Brown																				
	Dark Brown/ Black																				
Thick mat	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short	green																				
	brown reddish																				
Filaments, long	green																				
	brown reddish																				
	Potential	80	60	90	80	90	60	70	75	50	80	40	60	5	50	60	70	80	60	10	60

		Control A C1																			
		Riffle 1					Riffle 2					Run 1					Run 2				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4***	**5***	**1**	**2**	**3**	***4**	***5**	**1**	**2**	**3**	**4**	**5**
thin mat/film	Green											30					30				
	Light Brown	20	20	10	40		60	10	10			20	70	50				20	20	40	20
	Dark Brown/ Black				10																
Medium mat	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short	green																				
	brown reddish																				
Filaments, long	green																				
	brown reddish																				
	Potential	80	70	60	60		90	60	50			40	50	20			70	70	80	60	50

*Too deep

		Control B C2																			
		Riffle 1					Riffle 2					Run 1					Run 2				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
thin mat/film	Green	P													**5**	20					
	Light Brown	10	20	30	P	50	50	30	10	5	60	5	25	5	20	60	5	10	5	50	60
	Dark Brown/ Black						P														
Medium mat	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short	green																				
	brown reddish																				
Filaments, long	green																				
	brown reddish																				
	Potential	80	80	60	60	80	90	100	70	50	70	90	60	50	70	100	90	70	40	70	80

5-Dec-14

		SITE 1 (R1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green	40	20												**5**						
	Light Brown	60	30	60	80	80		90	90	35	20	10	5	0	10	80	80	60	30	5	90
	Dark Brown/ Black																				
Medium mat (%)	Green						40														
	Light Brown																				
	Dark Brown/ Black						50														
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	70	40	50	80	90	90	70	80	70	80	60	60	30	60	90	60	50	60	30	60
	Velocity (m/s)	0.8	1.1	1.3	1	1.4	0.8	1.5	1.2	1.4	1	1.3	1.2	0.7	0.5	0.3	1	1.2	0.8	0.7	0.3

SITE 2 (R2)

Periphyton Class		Riffle 1					Riffle 2					Run 1					Run 2				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green					80															
	Light Brown	50	40	30	10		80	80	60	50	60	10	40	50	60	50	50	70	70	40	40
	Dark Brown/ Black	20						10						5	5						
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	70	50	60	40	50	100	100	80	70	100	60	50	80	85	40	50	60	70	50	60
	Velocity (m/s)	**Data not recorded**																			

SITE 3 (R3)

Periphyton Class		Riffle 1					Riffle 2					Run 1					Run 2				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green						10														
	Light Brown	5	40	40	30	60	40	50	30	30	60	10	30	95	30	45	50	70	30	50	55
	Dark Brown/ Black							10													
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black			10	20																
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green	60						5	10												
	Brown reddish																				
	Potential Cover (%)	90	80	90	60	80	60	70	75	50	80	40	60	95	50	60	70	80	60	70	60
	Velocity (m/s)	**Data not recorded**																			

CONTROL A (C1)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	*4	*5	1	2	3	4	5
Thin mat/film (%)	Green					Too deep/ rough to survey				Too deep/ rough to survey		30			Too deep/ rough to survey		30				
	Light Brown	20	20	10	40		60	10	10			20	70	50				20	20	40	20
	Dark Brown/ Black				10																
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	80	70	60	60		90	60	50			40	50	20			70	70	80	60	50
	Velocity (m/s)	0.4	1	1.7	1.9	1.6	0.7	1.7	2.1			0.9	2.9	9	0.8	0.6	0.8	1.1	1	0.9	0.6

CONTROL B (C2)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green	1													**5**	20					
	Light Brown	10	20	30	1	50	50	30	10	5	60	5	25	5	20	60	5	10	5	50	60
	Dark Brown/ Black						1														
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	80	80	60	60	80	90	100	70	50	70	90	60	50	70	100	90	70	40	70	80
	Velocity (m/s)	0.2	1.3	1.6	1	0.6	0.8	1.2	1.5	1.3	0.6	0.8	1.6	1.3	0.8	0.1	1	1.3	1.2	0.5	0.1

17-Dec-14

		SITE 1 (R1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green	No periphyton observed				No perpihyton observed			No periphyton observed									No perpihyton observed		No perpihyton observed	
	Light Brown		20	10	5		25										10		10		
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green				1			30													
	Brown reddish																				
	Potential Cover (%)	70	80	70	80	100	95	90	80	60	70	60	60	50	40	50	90	60	50	40	50
	Velocity (m/s)	0.6	1	1.1	1.2	0.9	0.9	1.2	1.6	2	1.3	0.8	0.9	1.1	0.6	0.4	0.5	0.9	1.1	0.6	0.2

		SITE 2 (R2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green	No periphyton observed							No periphyton observed					No periphyton observed		No periphyton observed					
	Light Brown						80	20			30	30	5		5						
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	100	90	90	90	80	90	80	70	50	90	40	50	40	50	60	80	10	10	40	70
	Velocity (m/s)	1.2	1.7	2	1.5	1.1	0.6	1.5	1.6	1.8	1	0.7	0.5	0.3	0.6	1.4	0.4	0.7	0.4	0.8	1.5

		SITE 3 (R3)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1 (left)**	**2**	**3**	**4**	**5 (right)**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green																				
	Light Brown										5										
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green	**No periphyton observed**										**No periphyton observed**									
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	100	90	90	80	100	100	70	80	90	100	100	70	60	90	80	80	100	100	100	90
	Velocity (m/s)	0.5	1	1.8	1.6	1.6	0.9	1.2	1.6	1.1	0.1	0.3	0.5	0.7	0.5	0.6	0.2	0.7	0.7	0.9	0.6

		CONTROL A (C1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	***4**	***5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green																				
	Light Brown			10	5		40	5		10	20										
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green	**No periphyton observed**				**No periphyton observed**			**No periphyton observed**			**No periphyton observed**									
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	90	90	70	90	100	80	90	100	90	90	100	80	70	50	80	70	50	50	70	40
	Velocity (m/s)	0.5	0.9	1.2	1.5	1.3	0.8	1.6	1.5	1.8	0.9	0.3	0.4	0.6	0.7	0.6	0.2	0.4	0.6	0.6	0.6

		CONTROL B (C2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green	**No periphyton observed**					**No periphyton observed**				**No periphyton observed**										
	Light Brown			10	15	5		15	30	15											
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	40	70	60	90	70	90	70	60	60	80	50	80	10	50	60	100	20	50	90	70
	Velocity (m/s)	0.5	0.4	1.1	1.2	0.9	0.5	1.1	1.2	1.1	1.2	0.4	0.8	0.8	1.2	0.5	0.1	1.2	1.6	1	0.3

Appendix 4: Periphyton Sampling Results

Periphyton substrate scrap sample analysis

Date	Site	Sample	Chlorophyll *a* (mg per m^2)	AFDM (g per m^2)	Autotrophic Index (AFDM in mg/m^2 : chlorophyll *a* in mg/m^2)
5 December 2014	**Site 1**	**Pooled x10**	3.4	0.6	166.6
	Site 2	**Pooled x10**	3.0	0.6	204.8
	Site 3	**Pooled x10**	9.6	2.1	219.9
	Control 1	**Pooled x10**	3.6	1.4	376.9
	Control 2	**Pooled x10**	6.0	1.5	245.1

Species assemblage and relative proportional abundances

	Site 1	Site 2	Site 3	Control 1	Control 2
Filamentous green algae					
Microspora	1				
Mougeotia	2				
Ulothrix			2		4
Cyanobacteria					
Anabaena	3	3			
Filamentous diatoms					
Melosira	2				
Diatoms					
Cymbella			1		
Frustulia				1	1
Gomphonema			2		1
Naviculoid diatoms		1		1	2
Nitzschia			2		1
Rhoicosphenia			1		

Appendix 5: Macroinvertebrate Sampling Results

Please note, an excel version of the macroinvertebrate sampling results is available and was supplied with this report at the time of issue.

Low periphyton	Site & sample replicate	Control A,1	Control A,2	Control A,3	Control A,4	Control A,5	Control B,1	Control B,2	Control B,3	Control B,4	Control B,5
	Total abundance	528	375	388	102	284	429	253	290	230	456
17-Dec-14	Number of taxa	25	14	17	13	23	18	18	14	18	25
	EPT taxa richness	15	10	11	8	16	12	14	8	13	13
	MCI	124.8	141.4	137.6	136.9	138.3	133.3	142.2	118.6	131.1	117.6
	QMCI	7.4	7.6	7.5	7.5	7.4	7.2	7.3	7	7.2	7.1
OLIGOCHAETA									3		4
Elmidae		26	5	24	9	19	17	5	19	9	35
Hydraenidae		1		2							
Paracalliope				2			1			1	
Aphrophila		5	5	4		10	2	4	3	5	11
Austrosimulium		3	5	3		1	5			1	2
Eriopterini					1	1					1
Maoridiamesa		1									
Mischoderus											1
Orthocladiinae		4			2	3			1	2	1
Tanytarsini		1					1				1
Ameletopsis											
Coloburiscus		9	8	1		18	4	2	1	2	17
Deleatidium		273	160	173	60	152	208	104	144	87	97
Ichthybotus						1		1			
Neozephlebia		1									
Nesameletus		1					2				1
Archicauliodes		6	4	6	1	2	4	2	1		3
Latia											5
Potamopyrgus		2			2	3		1			14
PLATYHELMINTHES		1							1		1
Austroperla						1					
Spaniocerca						1					
Stenoperla								1			
Zelandiobius		1									
Zelandoperla		11	24	12	3	5	3	4	4	12	6
Aoteapsyche		1	6	1	1	4	8	1	2	5	12

Beraeoptera		60	103	109	6	14	89	57	41	45	72
Costachorema			1	3		2		2			2
Helicopsyche		15	2	1	6	3	2	8	2	5	57
Hydrobiosella											
Hydrobiosis		5		6		3	8	3	7	1	4
Neurochorema							1	1		1	1
Olinga		17	1	6	1	13	2	1		1	19
Oxyethira											
Plectrocnemia		1	1			1				1	
Psilochorema		3		1		1	2			1	
Pycnocentria		1			1	1		1		3	1
Pycnocentrodes		79	50	34	9	25	70	55	61	48	88
		Site 1,A	Site 1,B	Site 1,C	Site 1,D	Site 1,E	Site 2,A	Site 2,B	Site 2,C	Site 2,D	Site 2,E
	Total abundance	426	426	139	276	253	198	153	28	267	99
17 Dec 2014	Number of taxa	20	22	14	14	15	10	14	6	15	11
	EPT taxa richness	15	13	9	9	11	6	8	4	9	6
	MCI	136	120.9	134.3	140	136	130	115.7	130	122.7	123.6
	QMCI	7.3	7.1	7.5	7.6	7.5	7.5	7.3	7.5	7.7	7.1
OLIGOCHAETA											
Elmidae		75	84	11	34	10	15	13	1	7	7
Hydraenidae			1	1	1						
Hydrophilidae							1				
Staphylinidae				1							
Paracalliope								1			
Aphrophila		12	15	3	1	5	4	1		4	2
Austrosimulium		1	4	1		3		1		5	1
Eriopterini											
Maoridiamesa			1						1		
Mischoderus											
Orthocladiinae		1	3		2	4		1		1	1
Polypedilum										1	
Tanytarsini			1								

Ameletopsis					1					
Coloburiscus	6	4	1	1	5		1		4	1
Deleatidium	211	241	102	208	179	134	95	16	214	51
Ichthybotus	1									
Nesameletus	1									
Archicauliodes	1	2		1					2	2
Potamopyrgus						1	1			
PLATYHELMINTHES		1								
Zelandiobius	1	1								
Zelandoperla	1	2			1					1
Aoteapsyche	1	5			2		2		1	
Beraeoptera	66	23	5	3	12	8	8	6	4	12
Costachorema	1	1					1			
Helicopsyche	3		1	4	2	10	5		4	
Hydrobiosella			1							
Hydrobiosis	3	5		1	1	1	1		1	1
Neurochorema										
Olinga	3	4	1	4	9	1		1	6	
Oxyethira			1							
Plectrocnemia	1	1		1	1					
Psilochorema	1	1		1					1	
Pycnocentria		1	1							
Pycnocentrodes	36	25	9	14	18	23	22	3	12	20

		Site 3,A	Site 3,B	Site 3,C	Site 3,D	Site 3,E
	Total abundance	125	407	290	82	231
17-Dec-14	Number of taxa	14	17	15	12	19
	EPT taxa richness	9	11	10	9	13
	MCI	110	127.1	129.3	135	135.8
	QMCI	7.3	7.1	7.2	7.4	7.6
OLIGOCHAETA		1				
Elmidae		4	33	13	5	9
Hydraenidae						1

Aphrophila	8	19	10	4	3
Austrosimulium			3	1	1
Eriopterini					1
Orthocladiinae	2	2	1		
Polypedilum					1
Tabanidae		1			
Tanytarsini	2	1			
Acanthophlebia	1				
Coloburiscus	7	4	2		2
Deleatidium	82	238	171	55	174
Nesameletus		1			
Archicauliodes		5	2		
Zelandiobius					1
Zelandoperla				1	1
Aoteapsyche	3	3	4	4	1
Beraeoptera	1	18	20	2	6
Costachorema		1			1
Helicopsyche		6	8	1	1
Hydrobiosis		7	3	2	3
Neurochorema					
Olinga	6	3	2	2	3
Oxyethira	1				
Plectrocnemia			1		
Psilochorema	2	1	4	2	3
Pycnocentria					1
Pycnocentrodes	5	64	46	3	18

Waikanae River Baseline Aquatic Monitoring Monthly Report – January 2015

Kāpiti Water Supply RRwGW Scheme

Prepared for Kapiti Coast District Council

Document Quality Assurance

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Reviewed by:	Dr Vaughan Keesing Senior Principal / Ecologist Boffa Miskell Limited	
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1.0 Introduction

The Waikanae River Baseline Aquatic Monitoring Monthly Report – January 2015 is prepared in general accordance with the Waikanae River Baseline Aquatic Monitoring Plan (River BMP) prepared for Kapiti Coast District Council by Boffa Miskell (BML), dated 23 February 2014. As per the River BMP, this report presents "*the results of periphyton visual cover, depth, velocity and flows over the month via a spread sheet, noting any exceedance or trend relevant to triggering macroinvertebrate sampling and a comment on the periphyton trends at each site. Water quality and macroinvertebrate data will be delivered as part of this report via a spread sheet and, as appropriate, the hydrological gauging results*" for the Waikanae River monitoring for January 2015.

2.0 Monitoring

Sampling included three downstream (receiving) and two upstream (control) monitoring sites as per resource consent WGN130103 permit [33251] condition 19 and permit [33252] condition 21. Monitoring locations are provided in **Figure 1** below.

Periphyton visual assessment transects were undertaken by suitably qualified ecologists on the 8th and 22nd of January 2015. Water quality sampling was undertaken on the 11th and 22nd of January 2015, and periphyton scrape sampling was undertaken on 22 January 2015. Periphyton samples were frozen and sent in a chilli-bin with ice to Ryder Consulting Limited (RCL) for identification on 29th January 2015. Water quality samples were sent in a chilli-bin with ice to Eurofins ELS Limited on the 12th and 26th January 2015.

Field water quality readings were taken using a calibrated Horiba U-50 water quality meter and velocity data was collected using a combination of the 'ruler method' and a FP111 Flow Probe.

pH data was not recorded at Site 2 (R2) and Site 3 (R3) on 22 January 2015 due to equipment failure. In addition, no periphyton visual data was recorded at Transect 1 of Riffle 2 at Site 2. Stream depth was not recorded during the 22 January 2015 survey.

Please note, because this is baseline monitoring, no exceedance trigger or relevant trend to trigger macroinvertebrate sampling is reported. Macroinvertebrate sampling is undertaken to reflect low, medium and high levels of periphyton growth. In addition, no obvious periphyton trends are identifiable.

No hydrological gauging or macroinvertebrate sampling were required to be undertaken in January 2015.

No anomalous field observations (sheens, odours, high turbidity etc) were noted during January 2015.

Raw data and results are provided in the following appendices:

- **Appendix 1:** Field water quality data.
- **Appendix 2:** Laboratory water quality results.
- **Appendix 3:** Periphyton visual cover data and water velocity data.
- **Appendix 4:** Periphyton sampling results**.**

3.0 References

Boffa Miskell (2014). Waikanae River Baseline Aquatic Monitoring Plan. Kapiti Water Supply RRwGW Scheme, prepared by Boffa Miskell Limited for Kapiti Coast District Council, dated 23 February 2014.

Appendix 1: Field Water Quality Data

8 January 2015

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	15:30	16:15	13:15	14:30	12:01
Temperature (˚C)	20.48	20.19	19.32	20.28	17.90
pH	5.29	5.49	5.06	5.50	4.22
Conductivity (ms/cm)	0.11	0.11	0.11	0.11	0.11
Dissolved Oxygen (mg/L)	13.00	12.10	14.42	13.20	13.70
Dissolved Oxygen (%)	145.00	134.60	157.00	148.00	153.00
TDS (g/L)	0.07	0.07	0.07	0.07	0.07
NTU	0.00	0.00	0.00	0.00	0.00

22 January 2015

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	14:07	-	-	15:15	13:32
Temperature (˚C)	20.29	20.56	19.87	18.69	20.70
pH	7.53	7.59	7.33	-	-
Conductivity (ms/cm)	0.114	0.115	0.112	0.113	0.116
Dissolved Oxygen (mg/L)	14.31	12.02	15.29	15.37	13.43
Dissolved Oxygen (%)	162.70	137.30	175.00	169.70	152.10
TDS (g/L)	0.074	0.075	0.073	0.073	0.076
NTU	0.80	1.30	0.90	0.90	1.10

Appendix 2: Laboratory Water Quality Results

eurofins ELS

Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
Wellington
6142

Attention: Stephen Fuller

Report Number: 15/865
Issue: 1
16 January 2015

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/865-01	Miscellaneous Sample		11/01/2015 14:30	12/01/2015 10:30	0

Notes: Waikanae River, Control Site 1

	Test	Result	Units	Signatory
0001	pH	7.7		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.09	g/m^3	Shanel Kumar .
0515	Nitrite Nitrate Nitrogen	0.086	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.35	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.013	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.13	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/865-02	Miscellaneous Sample		11/01/2015 15:30	12/01/2015 10:30	0

Notes: Waikanae River, Control Site 2

	Test	Result	Units	Signatory
0001	pH	7.6		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.10	g/m^3	Shanel Kumar .
0515	Nitrite Nitrate Nitrogen	0.092	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.26	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.008	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.013	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.12	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/865-03	Miscellaneous Sample		11/01/2015 12:30	12/01/2015 10:30	0

Notes: Waikanae River, Effect Site 1

	Test	Result	Units	Signatory
0001	pH	7.7		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.09	g/m^3	Shanel Kumar .
0515	Nitrite Nitrate Nitrogen	0.085	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.38	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.010	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.013	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.13	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/865-04	Miscellaneous Sample		11/01/2015 13:30	12/01/2015 10:30	0

Notes: Waikanae River, Effect Site 2

	Test	Result	Units	Signatory
0001	pH	8.1		Gordon McArthur KTP

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Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/865-04	Miscellaneous Sample		11/01/2015 13:30	12/01/2015 10:30	0

Notes: Waikanae River, Effect Site 2

	Test	Result	Units	Signatory
0125	Inorganic Nitrogen	0.07	g/m³	Shanel Kumar .
0515	Nitrite Nitrate Nitrogen	0.064	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	5.37	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.008	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.14	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/865-05	Miscellaneous Sample		11/01/2015 11:00	12/01/2015 10:30	0

Notes: Waikanae River, Effect Site 3

	Test	Result	Units	Signatory
0001	pH	7.8		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.08	g/m³	Shanel Kumar .
0515	Nitrite Nitrate Nitrogen	0.076	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	5.41	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.008	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.011	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.14	g/m³	Divina Lagazon KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m³
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m³
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m³
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m³
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m³
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m³
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m³

"<" means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m3 is the equivalent to mg/L and ppm.

Samples will be retained for a period of time, in suitable conditions appropriate to the analyses requested.

All test methods and confidence limits are available on request. This report must not be reproduced except in full, without the written consent of the laboratory.

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Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
Wellington
6142
Attention: Barbara Risi

Report Number: 15/2493
Issue: 1
04 February 2015

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/2493-01	Miscellaneous Sample		22/01/2015 14:32	26/01/2015 09:45	0

Notes: Site 1

	Test	Result	Units	Signatory
0001	pH	7.9		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.06	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.052	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.62	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.012	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.008	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.09	g/m³	Tracy Morrison KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/2493-02	Miscellaneous Sample		22/01/2015 12:50	26/01/2015 09:45	0

Notes: Site 2

	Test	Result	Units	Signatory
0001	pH	8.2		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.05	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.046	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.70	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.009	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.008	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.12	g/m³	Tracy Morrison KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/2493-03	Miscellaneous Sample		23/01/2015 14:10	26/01/2015 09:45	0

Notes: Site 3

	Test	Result	Units	Signatory
0001	pH	7.8		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.07	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.057	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.72	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.011	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.008	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.11	g/m³	Tracy Morrison KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/2493-04	Miscellaneous Sample		22/01/2015 15:30	26/01/2015 09:45	0

Notes: Control A

	Test	Result	Units	Signatory
0001	pH	7.7		Gordon McArthur KTP

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Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/2493-04	Miscellaneous Sample		22/01/2015 15:30	26/01/2015 09:45	0

Notes: Control A

	Test	Result	Units	Signatory
0125	Inorganic Nitrogen	0.07	g/m^3	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.060	g/m^3	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Tracy Morrison KTP
1810	Calcium - Dissolved	5.57	g/m^3	Wayne Edgerley KTP
2080	Total Phosphorus	0.011	g/m^3	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.008	g/m^3	Tracy Morrison KTP
2127	Total Nitrogen	0.10	g/m^3	Tracy Morrison KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/2493-05	Miscellaneous Sample		22/01/2015 13:30	26/01/2015 09:45	0

Notes: Control B

	Test	Result	Units	Signatory
0001	pH	7.7		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.07	g/m^3	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.070	g/m^3	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Tracy Morrison KTP
1810	Calcium - Dissolved	5.66	g/m^3	Wayne Edgerley KTP
2080	Total Phosphorus	0.011	g/m^3	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.008	g/m^3	Tracy Morrison KTP
2127	Total Nitrogen	0.12	g/m^3	Tracy Morrison KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m^3
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m^3
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m^3
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m^3
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m^3
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m^3
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m^3

"<" means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m3 is the equivalent to mg/L and ppm.

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Appendix 3: Periphyton Visual Cover Data and Water Velocity Data

Periphyton Cover - Field Survey Results

8-Jan-15

SITE 1 (R1)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	95	95	90	90	95	90	90	90	50	90	40	80	70	90	60	70	80	95	90	90
	Dark Brown/ Black									15								5			
Medium mat (%)	Green																				
	Light Brown		1				5	5	10	10											
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green						5										20				
	Brown reddish																				
Filaments, long (%)	Green				20	10	1	10	50	60	10	1				1		15	1	5	10
	Brown reddish																				
	Potential Cover (%)	100	100	90	70	90	100	100	90	90	90	80	50	40	40	60	70	90	95	90	100
	Velocity (m/s)	0.4	0.5	0.7	0.8	0.4	0.3	0.7	0.8	1.2	1.0	0.7	0.2	0.7	0.7	0.4	0.8	0.8	1.5	1.5	1.0
	Depth (cm)	22.0	29.0	49.0	49.5	29.0	17.0	24.0	33.0	32.0	39.0	24.0	-	54.0	47.0	38.0	21.0	31.0	24.0	43.0	37.0

SITE 2 (R2)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	40	20	60	30	40	60	70	95	70	85	95	100	80	70	90	80	80	85	20	30
	Dark Brown/ Black	25	60	25	60					15	5										
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown	30														1					
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green		20	25	70	60		5	5	30	15	5			5	5	1		15	90	30
	Brown reddish																				
	Potential Cover (%)	50	80	90	75	50	50	70	95	95	75	75	60	80	75	75	90	60	80	30	80
	Velocity (m/s)	1.4	1.7	1.0	1.0	1.0	0.7	0.4	0.6	0.8	1.0	0.8	0.8	0.9	1.2	1.0	0.0	0.3	0.7	0.9	0.9
	Depth (cm)	36.0	33.0	40.0	31.0	33.0	16.0	23.0	26.0	31.0	46.0	23.0	36.0	37.0	41.0	50.0	14.0	33.0	41.5	45.0	45.0

SITE 3 (R3)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	90	100	95	35	75	95	95	100	95	100	95	70	60	80	90	90	95	90	40	80
	Dark Brown/ Black							1													
Medium mat (%)	Green																				
	Light Brown					5			15	10	1						5	5	5	40	30
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	5	2	1			1			1		1									
	Brown reddish																				
Filaments, long (%)	Green				1	5		45	20		5		2	2	1	1	1	1	10	10	25
	Brown reddish																				
	Potential Cover (%)	85	60	90	100	100	80	100	90	100	100	70	90	50	60	95	90	60	70	60	80
	Velocity (m/s)	0.6	0.9	0.8	0.9	0.8	0.5	0.9	0.8	1.1	0.8	-	0.7	0.8	0.6	0.5	0.9	1.2	1.4	1.3	0.7
	Depth (cm)	18.0	26.0	23.5	32.5	15.5	28.0	41.0	40.5	47.0	31.5	18.0	20.0	23.5	15.5	15.5	22.5	40.0	48.5	45.5	36.0

CONTROL A (C1)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	60	80	90	90	90	70	30	80	60	80	75	70	50	90	60	95	80	60	50	80
	Dark Brown/ Black								10												
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown						30	50	10	10	1	25		10	1						
	Dark Brown/ Black																				
Filaments, short (%)	Green				5	1															
	Brown reddish																				
Filaments, long (%)	Green							20	15	10	1		10	30	15	1					
	Brown reddish																				
	Potential Cover (%)	90	90	95	70	80	85	70	90	50	60	80	80	90	60	85	100	90	90	40	50
	Velocity (m/s)	0.3	0.3	0.4	0.5	0.5	0.4	0.7	0.8	0.9	1.1	0.4	0.8	0.8	0.9	1.2	0.5	0.9	0.6	0.9	1.2
	Depth (cm)	10.5	15.5	11.5	13.0	21.0	12.5	19.0	27.0	37.0	42.0	8.0	27.5	36.0	44.5	48.0	15.5	13.0	39.0	43.5	47.0

CONTROL B (C2)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	40	20	30	30	70	50	50	40	70	50	70	50	50	40	50	80	80	50	30	50
	Dark Brown/ Black											1				1					
Medium mat (%)	Green																				
	Light Brown		40	40	20																
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green		1		1																
	Brown reddish																				
Filaments, long (%)	Green									1											
	Brown reddish																				
	Potential Cover (%)	95	95	60	95	50	60	50	50	70	60	90	90	90	95	70	95	90	60	50	90
	Velocity (m/s)	0.9	1.2	1.6	1.7	1.7	0.6	1.0	1.4	1.3	1.1	0.8	0.7	0.8	0.6	0.8	0.8	0.8	0.6	0.8	0.7
	Depth (cm)	10.5	27.0	27.0	29.0	40.0	33.0	28.0	30.0	34.0	28.0	21.5	22.0	21.0	20.5	25.0	37.0	52.0	58.0	43.0	30.0

Periphyton Cover - Field Survey Results

22-Jan-15

SITE 1 (R1)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	20	25	10	20	10	20	30	20	30	30	20	20	30	10	20	20	20	30	20	20
	Dark Brown/ Black	5	5	10	10	10	10	5	30	5	5	5	10				5			5	2
Medium mat (%)	Green																				
	Light Brown	5	5		10	10	30	10	10	10	5	10	10	20	5	10	10	5	15	5	5
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	10	20	25	20	20	30	20	40	10	10	2	5	5		5	5	5		1	
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	75	80	90	80	90	80	80	90	70	70	70	80	90	80	90	70	60	80	80	80
	Velocity (m/s)	1.2	1	1.5	0.3	0.7	0.3	0.7	1.1	1.3	2	0.2	0.5	0.5	0.3	0.2	0.4	0.3	0.6	0.2	0.4

SITE 2 (R2)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green						No Data Recorded														
	Light Brown	60	100	100	60	100		20	10	10		90	40	90	90	70	30	70	50	100	90
	Dark Brown/ Black	25			30			80	70	90		10	60	20	10	20	70	30	50	30	10
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	40	10	40		20		10		20	20	15	10	10		10	10	30	60	25	20
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	90	100	80	70	60		80	90	90	90	100	80	100	80	90	100	100	100	80	90
	Velocity (m/s)	0.9	0.8	1.1	0.9	0.4		1.1	1	0.8	0.3	0.2	0.6	0.6	0.5	0.3	0.3	0.7	0.6	0.6	0.4

SITE 3 (R3)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green	10	10	20	30	10															
	Light Brown	70	40	80	80	60	90			100	50			100		10	50	20	90	50	70
	Dark Brown/ Black			20	20		10	10	10						10				10		30
Medium mat (%)	Green																				
	Light Brown		40					50			50	100	100		100	80	50	80		50	
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green						20	50	5	10	10	20	5	10	5		15	20	15	10	
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	90	100	100	90	80	100	90	80	70	90	100	100	90	90	80	80	95	70	70	80
	Velocity (m/s)	0.5	0.5	0.6	0.6	0.5	0.6	0.4	0.7	0.7	0.6	0.3	0.4	0.4	0.4	0.2	0.3	0.3	0.4	0.3	0.3

CONTROL A (C1)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	*4	*5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	15	5	10	10	20	20	20	20	10	10	10	10	10	5	10	15	5	10	10	20
	Dark Brown/ Black							2	10			5		2							
Medium mat (%)	Green																				
	Light Brown	40	50	40	60	40	60	20	40	60	50	20	10	5	10	20	40	50	40	60	40
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	2	10	20	10		30	40	10	20	10	2		5	5	10	2	10	20	10	
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	0.3	0.6	0.9	0.9	0.6	90	100	80	70	70	80	70	70	70	70	80	70	70	70	70
	Velocity (m/s)	1	1.1	1.1	12	1.2	1.2	0.9	1.3	1.4	1.3	0.5	0.4	0.4	0.5	0.4	0.3	0.6	0.9	0.9	0.6

CONTROL B (C2)

		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	40	30	10	10	10	5	20		10	10	20	30	30	30	10	20	40	10	30	10
	Dark Brown/ Black	1				5	30	10	30	5	10				5	5				5	10
Medium mat (%)	Green																				
	Light Brown	30	20	20	20	30	20	40	10	40	30	30	20	20	30	20	30	10	50	20	30
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	5	10	40	20	20	10	5	20	20	20	1					2	1	10	2	
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	90	70	60	70	70	90	80	70	80	90	90	80	70	70	30	80	70	70	50	60
	Velocity (m/s)	0.5	0.6	1	1.2	1.1	0.8	0.7	1.4	1.2	1	0.1	0.2	0.3	0.4	0.5	0.2	0.3	0.5	0.6	0.6

Appendix 4: Periphyton Sampling Results

Periphyton substrate scrap sample analysis

Date	Site	Sample	Chlorophyll *a* (mg per m^2)	AFDM (g per m^2)	Autotrophic Index (AFDM in mg/m^2 : chlorophyll *a* in mg/m^2)
22 January 2015	**Site 1**	**Pooled x10**	142.2	24.2	169.8
	Site 2	**Pooled x10**	107.3	18.1	168.5
	Site 3	**Pooled x10**	27.3	15.9	581.4
	Control 1	**Pooled x10**	82.8	14.4	173.8
	Control 2	**Pooled x10**	86.3	11.4	131.6

Waikanae River Baseline Aquatic Monitoring Monthly Report – February 2015

Kāpiti Water Supply RRwGW Scheme
Prepared for Kapiti Coast District Council

Document Quality Assurance

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Prepared by:	Tony Payne Ecologist Boffa Miskell Limited	
Reviewed by:	Dr Vaughan Keesing Senior Principal / Ecologist Boffa Miskell Limited	
Status: FINAL	Revision / version: B	Issue date: 20 May 2015

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Photograph. Waikanae River © BML 2015

1.0 Introduction

The Waikanae River Baseline Aquatic Monitoring Monthly Report – February 2015 is prepared in general accordance with the Waikanae River Baseline Aquatic Monitoring Plan (River BMP) prepared for Kapiti Coast District Council by Boffa Miskell (BML), dated 23 February 2014. As per the River BMP, this report presents "*the results of periphyton visual cover, depth, velocity and flows over the month via a spread sheet, noting any exceedance or trend relevant to triggering macroinvertebrate sampling and a comment on the periphyton trends at each site. Water quality and macroinvertebrate data will be delivered as part of this report via a spread sheet and, as appropriate, the hydrological gauging results*" for the Waikanae River monitoring for February 2015.

2.0 Monitoring

Sampling included three downstream (receiving) and two upstream (control) monitoring sites as per resource consent WGN130103 permit [33251] condition 19 and permit [33252]condition 21. Monitoring locations are provided in **Figure 1** below.

All monitoring was undertaken by suitably qualified ecologists in general accordance with the Waikanae River RBMP. Periphyton visual assessment transects, periphyton sampling, macroinvertebrate sampling, and water quality sampling were undertaken on the 5th and 17th of February 2015. An electric fishing survey (EFM) was undertaken on 5 February 2015. Macroinvertebrate samples were preserved in ethanol and sent to Ryder Consulting Limited (RCL) for identification on 13 February 2015 and 5 March 2015. Periphyton samples were frozen and sent in a chilli-bin with ice to RCL for identification on 12 February 2015 and 11 March 2015. Water quality samples were sent in a chilli-bin with ice to Eurofins ELS Limited on the 11th and 19th February 2015. Hydrological gauging was undertaken at Site 2 and Site 3 by NIWA on 12 February 2015

Field water quality readings were taken using a calibrated Horiba U-50 water quality meter and velocity data was collected using a FP111 Flow Probe. Stream depth was not recorded during the February 2015 surveys.

No anomalous field observations (sheens, odours, high turbidity etc) were noted during February 2015.

Please note, because this is baseline monitoring, no exceedance trigger or relevant trend to trigger macroinvertebrate sampling is reported. Macroinvertebrate sampling is undertaken to reflect low, medium and high levels of periphyton growth. In addition, no periphyton trends are identifiable.

Raw data and results are provided in the following appendices:

- **Appendix 1:** Field water quality data and hydrological gauging results
- **Appendix 2:** Laboratory water quality results.
- **Appendix 3:** Periphyton visual cover data and water velocity data.
- **Appendix 4:** Periphyton sampling results**.**
- **Appendix 5:** Macroinvertebrate sampling results. Please note, an excel version of the macroinvertebrate sampling results is available and can be supplied upon request.
- **Appendix 6:** EFM survey results

3.0 References

Boffa Miskell (2014). Waikanae River Baseline Aquatic Monitoring Plan. Kapiti Water Supply RRwGW Scheme, prepared by Boffa Miskell Limited for Kapiti Coast District Council, dated 23 February 2014.

Appendix 1: Field Water Quality Data and Hydrological Gauging Results

Field Water Quality Data

5-Feb-15

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	No Data - Equipment Failure				-
Temperature (˚C)					18.18
pH					6.92
pH (mV)					-
Conductivity (ms/cm)					0.103
Dissolved Oxygen (mg/L)					14.7
Dissolved Oxygen (%)					160.6
TDS (g/L)					0.07
NTU					1.1

17-Feb-15

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	No Data - Equipment Failure				-
Temperature (˚C)					17.73
pH					6.58
pH (mV)					-
Conductivity (ms/cm)					0.11
Dissolved Oxygen (mg/L)					10.74
Dissolved Oxygen (%)					116.30
TDS (g/L)					0.07
NTU					0.50

Hydrological Gauging Results

12-Feb-15

Site	Time	Area (m^2)	Velocity (mm/s)	Flow (L/s)
Site 2	10:45 a.m.	6.36	177	1127
Site 3	12:16 p.m.	2.98	278	830

Appendix 2: Laboratory Water Quality Results

Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
Wellington
6142

Attention: Stephen Fuller

Report Number: 15/4416
Issue: 1
25 February 2015

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/4416-01	Miscellaneous Sample		05/02/2015 15:30	11/02/2015 08:00	0

Notes: Control A

	Test	Result	Units	Signatory
0001	pH	7.4		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.09	g/m^3	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.092	g/m^3	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Tracy Morrison KTP
1810	Calcium - Dissolved	5.81	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m^3	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m^3	Tracy Morrison KTP
2127	Total Nitrogen	0.18	g/m^3	Tracy Morrison KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/4416-02	Miscellaneous Sample		05/02/2015 14:00	11/02/2015 08:00	0

Notes: Control b

	Test	Result	Units	Signatory
0001	pH	7.4		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.12	g/m^3	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.118	g/m^3	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Tracy Morrison KTP
1810	Calcium - Dissolved	5.50	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.010	g/m^3	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.012	g/m^3	Tracy Morrison KTP
2127	Total Nitrogen	0.16	g/m^3	Tracy Morrison KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/4416-03	Miscellaneous Sample		05/02/2015 12:36	11/02/2015 08:00	0

Notes: Site 1

	Test	Result	Units	Signatory
0001	pH	7.4		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.12	g/m^3	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.122	g/m^3	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Tracy Morrison KTP
1810	Calcium - Dissolved	5.68	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m^3	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.011	g/m^3	Tracy Morrison KTP
2127	Total Nitrogen	0.18	g/m^3	Tracy Morrison KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/4416-04	Miscellaneous Sample		04/02/2015 13:00	11/02/2015 08:00	0

Notes: Site 2

	Test	Result	Units	Signatory
0001	pH	7.6		Gordon McArthur KTP

85 Port Road Seaview
Lower Hutt 5045 New Zealand
Phone: (04) 576 5016 Fax: (04) 576 5017
Email: mailto:reports@els.co.nz Website: http://www.els.co.nz

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/4416-04	Miscellaneous Sample		04/02/2015 13:00	11/02/2015 08:00	0

Notes: Site 2

	Test	Result	Units	Signatory
0125	Inorganic Nitrogen	0.12	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.116	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.51	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.011	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.17	g/m³	Tracy Morrison KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/4416-05	Miscellaneous Sample		04/02/2015 16:00	11/02/2015 08:00	0

Notes: Site 3

	Test	Result	Units	Signatory
0001	pH	7.4		Gordon McArthur KTP
0125	Inorganic Nitrogen	0.13	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.129	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.62	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.012	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.011	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.18	g/m³	Tracy Morrison KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m³
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m³
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m³
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m³
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m³
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m³
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m³

"<" means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m3 is the equivalent to mg/L and ppm.

Samples will be retained for a period of time, in suitable conditions appropriate to the analyses requested.

All test methods and confidence limits are available on request. This report must not be reproduced except in full, without the written consent of the laboratory.

Report Released By

Rob Deacon

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Appendix 3: Periphyton Visual Cover Data and Water Velocity Data

Periphyton Cover - Field Survey Results
5-Feb-15

		SITE 1 (R1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green				90			60							5						
	Light Brown	15	90	80		45	30	10	80	60	80	60	40	30	60	40	50	80	60	20	40
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown								10												
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green		5				5	5	2	15	5										
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	60	70	90	80	70	90	80	95	80	70	80	70	60	60	80	70	90	80	60	70
	Velocity (m/s)	0.2	0.5	0.8	0.6	0.2	0.5	0.8	0.6	1	1.1	0.3	0.5	0.5	0.2	0.1	0.2	0.3	0.7	0.2	0.1

		SITE 2 (R2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green	20	20	40	30	30		80	100	100	100	80	10				40				
	Light Brown	80	60	30	40	10	80	20						90	60	10	50	40	30	50	40
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	60	100	70	60	90	100	100	100	80	70	100	90	90	80	50	100	60	50	60	70
	Velocity (m/s)	NOT RECORDED																			

		SITE 3 (R3)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green			70	50		70							10							
	Light Brown	70	60			30	60	60	70	60	60	80	60	30	15	100	70	50	40	30	60
	Dark Brown/ Black		20																		
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																5				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	80	80	100	80	100	100	90	90	80	90	70	100	70	40	80	80	70	50	60	70
	Velocity (m/s)	NOT RECORDED																			

		CONTROL A (C1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green			60		30		70													
	Light Brown	50	80	30	100	60	40	30	60	60	60	60	35				50	30	40	20	40
	Dark Brown/ Black								5	30											
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green								5												
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	70	50	100	90	80	80	90	70	100	80	80	60	20	50	20	70	60	80	50	60
	Velocity (m/s)	0.6	0.5	1	0.8	0.5	0.3	0.7	1	0.8	0.3	0.1	0.4	0.4	0.5	0.2	0.2	0.3	0.5	0.6	0.5

		CONTROL B (C2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	60	40		80		60	80	70	80	65	70	50	60	30	20	10	30	80	50	30
	Dark Brown/ Black														20						
Medium mat (%)	Green																				
	Light Brown					20															
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green					60															
	Brown reddish																				
Filaments, long (%)	Green						5														
	Brown reddish																				
	Potential Cover (%)	80	50	80	100	90	70	70	60	75	50	40	60	50	70	80	60	50	70	60	80
	Velocity (m/s)	0.6	0.6	1	0.7	1.2	0.6	0.6	1	1.6	1.3	0.2	0.7	0.9	0.5	0.2	0.3	0.9	0.9	0.4	0.2

Periphyton Cover - Field Survey Results
17-Feb-15

		SITE 1 (R1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	40	100	100	100	100	60	100	100	80	90	90	100	50	70	80	95	90	100	60	100
	Dark Brown/ Black				1			5													
Medium mat (%)	Green														**20**			1			
	Light Brown					10															
	Dark Brown/ Black						5			15							5	5			
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	10																			
	Brown reddish																				
Filaments, long (%)	Green		10	1	5	2	5	7	15	5	1										
	Brown reddish																				
	Potential Cover (%)	60	90	100	80	90	100	90	100	100	100	80	80	90	80	100	80	95	85	100	100
	Velocity (m/s)	0.5	0.3	0.7	0.7	0.8	0.4	0.9	0.9	0.8	0.4	0.3	0.4	0.2	0.1	0.1	0.1	0.3	0.5	0.2	0.1

		SITE 2 (R2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																		100		
	Light Brown	100	80	100	50	80	100	80		100	50	100	30	30	30	100	100	90		100	
	Dark Brown/ Black		20		5				50					60	5			10			
Medium mat (%)	Green												**70**								
	Light Brown																				80
	Dark Brown/ Black				5		5					50			70						
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green		40	20																	
	Brown reddish																				
Filaments, long (%)	Green					5								5	5	2					
	Brown reddish																				
	Potential Cover (%)	100	95	70	90	70	100	100	60	60	90	100	80	70	80	90	100	100	70	95	90
	Velocity (m/s)	0.2	1.3	1.5	0.9	0.5	0.7	1	1.2	0.4	0.1	0.4	0.6	0.8	0.4	0.3	0.2	0.5	0.5	0.4	0.1

		SITE 3 (R3)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	100	100	100	80	100	100	90	100	90	100	90	100	100	70	100	100	100	100	100	60
	Dark Brown/ Black				2			5		10	10										
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green	10	7		10	10		5	15	10			1				7		5	5	
	Brown reddish																				
	Potential Cover (%)	100	100	70	80	90	95	100	100	90	100	100	100	100	80	90	100	100	100	80	70
	Velocity (m/s)	0.2	0.5	1.1	0.9	0.4	0.4	0.9	1.2	0.9	0.4	0.15	0.3	0.2	0.2	0.1	0.2	0.05	0.5	0.5	0.2

		CONTROL A (C1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	*4	*5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	100	30	100	40	90	80	60	60	100	90	70	100	100	100	50	80	100	100	50	100
	Dark Brown/ Black		50		60		20														
Medium mat (%)	Green		10						5							5					
	Light Brown								40												
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green			10				2													
	Brown reddish																				
	Potential Cover (%)	80	80	100	100	90	60	80	95	90	80	95	70	60	100	100	100	60	50	90	80
	Velocity (m/s)	0.4	0.9	1.5	0.5	0.8	0.3	0.6	0.6	0.9	1.2	0.1	0.1	0.2	0.5	0.3	0.1	0.2	0.3	0.5	0.3

		CONTROL B (C2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				70
	Light Brown		90	40	60	100	60	90	95	30	50	80	100	50	100	100	20	100	100	100	
	Dark Brown/ Black									40	5										
Medium mat (%)	Green			30			2														
	Light Brown	100																			
	Dark Brown/ Black		5						5												
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green	1						2													
	Brown reddish																				
	Potential Cover (%)	100	90	90	90	80	100	95	70	85	90	90	100	60	80	60	95	95	70	60	10
	Velocity (m/s)	0.3	0.9	0.7	0.8	0.3	0.3	0.6	0.9	1	0.5	0.1	0.2	0.5	0.4	0.1	0.2	0.4	0.3	0.4	0.2

Appendix 4: Periphyton Sampling Results

Date	Site	Sample	Chlorophyll *a* (mg per m^2)	AFDM (g per m^2)	Autotrophic Index (AFDM in mg/ m^2 : chlorophyll *a* in mg/ m^2)
5 February 2015	Site 1	a	3.7	0.8	225.8
		b	5.0	1.4	273.1
		c	22.6	2.1	93.9
		d	2.7	0.7	251.2
		e	6.6	2.4	354.6
	Site 2	a	5.3	1.1	213.6
		b	2.8	0.9	322.1
		c	0.8	0.5	697.8
		d	5.2	1.7	324.6
		e	4.0	1.0	245.2
	Site 3	a	0.7	0.7	1046.8
		b	1.3	0.9	697.8
		c	1.9	1.6	862.0
		d	1.4	0.6	429.4
		e	3.0	0.6	199.4
	Control 1	a	3.0	0.9	299.1
		b	6.7	0.9	135.1
		c	5.3	1.0	185.1
		d	1.4	1.0	697.8
		e	8.3	2.7	330.6
	Control 2	a	1.6	0.5	279.1
		b	6.7	51.6	7642.4
		c	6.3	1.8	288.8
		d	13.5	2.4	180.1
		e	1.7	0.8	436.1

Date	Site	Sample	Chlorophyll *a* (mg per m^2)	AFDM (g per m^2)	Autotrophic Index (AFDM in mg/ m^2 : chlorophyll *a* in mg/ m^2)
17 February 2015	Site 1	Pooled x10	23.4	5.3	224.4
	Site 2	Pooled x10	10.0	2.6	263.0
	Site 3	Pooled x10	11.0	2.3	212.1
	Control 1	Pooled x10	8.7	1.6	186.2
	Control 2	Pooled x10	17.8	2.2	124.9

Appendix 5: Macroinvertebrate Sampling Results

Macroinvertebrate Data - 5 February 2015

Group	Species	Control A a	Control A b	Control A c	Control A d	Control A e	Control B a	Control B b	Control B c	Control B d	Control B e	Site 1 a	Site 1 b	Site 1 c	Site 1 d	Site 1 e	Site 2 a	Site 2 b	Site 2 c	Site 2 d	Site 2 e	Site 3 a	Site 3 b	Site 3 c	Site 3 d	Site 3 e
	1 Total abundance	718	706	435	229	529	467	520	301	273	528	579	564	343	615	375	421	290	222	163	280	536	172	398	455	466
	2 Number of taxa	27	26	21	20	24	22	21	18	21	20	26	25	21	21	22	21	19	19	17	15	21	15	22	26	28
	3 Number of EPT taxa	15	14	13	12	16	14	10	9	10	11	15	15	12	13	14	11	14	11	11	11	13	9	12	14	16
	4 MCI score	123	121.5	115.2	116	122.5	128.2	108.6	105.6	104.8	119	116.9	123.2	116.2	117.1	133.6	111.4	127.4	124.2	125.9	136	113.3	116	111.8	108.5	125.7
	5 QMCI	6.8	6.8	7	6.8	7	6.5	6.7	6.9	6.6	6.8	7.1	7.1	7.1	7	7	6.7	7.5	7.5	7.4	6.9	6	6.5	6.6	6.3	6.5
ANNELIDA	OLIGOCHAETA	5	6	2	1			1	5	2		2	3						1			4		4	8	8
Coleoptera	Elmidae	185	150	49	33	91	134	125	77	103	78	106	161	54	102	73	125	38	29	18	43	136	21	132	51	47
Coleoptera	Hydraenidae	2										2	2	3		1			2	1						1
CRUSTACEA	Ostracoda																								1	
CRUSTACEA	Paracalliope								1																	
Diptera	Aphrophila	22	12	12	4	18	6	6	1	2	8	10	5	5	4	6	7	1	1	1	5	16	5	5	2	4
Diptera	Austrosimulium	5	5	5	1	4	2	11	3	4	4	4	1	3	10		2	2				5	3	4	1	
Diptera	Empididae										1															
Diptera	Eriopterini	5	1					1		1														1		2
Diptera	Maoridiamesa		1	1		1	5	1		1	2			2	1	1								1	3	1
Diptera	Muscidae																7									
Diptera	Orthocladiinae	16	15	7	2	2	24	24	4	5	15	19	4	16	23	5	7	1	2	1		11	3	7	18	6
Diptera	Polypedilum	1								2		1														
Diptera	Tabanidae																1									
Diptera	Tanypodinae	2	3									4	4	1					1						3	12
Diptera	Tanytarsini	8	13	4	1	1	3	5	2	1	7	5	1	1	8	1	10					48	3	7	7	7
Ephemeroptera	Ameletopsis																									1
Ephemeroptera	Austroclima					1																				
Ephemeroptera	Coloburiscus	11	3	2	6	8	2	4	3		5	5	2		6	1		1	1	1	5	1	1		9	6
Ephemeroptera	Deleatidium	309	340	236	105	276	201	268	169	118	264	362	319	199	384	197	202	207	159	118	152	164	61	166	203	208
Ephemeroptera	Neozephlebia																								1	
Ephemeroptera	Nesameletus	4	4	4	2	5	1					1	1			2		1				5	2			6
Megaloptera	Archicauliodes	5	9	9	4	8	1	1	1		3	5	2	1	3	3	4	1	3	1	10	3		3	4	6
MOLLUSCA	Physa									1																
MOLLUSCA	Potamopyrgus	13	6		3	7	3	2	6	1	9	4	7		2	7	5		6	5	3	6	1	6	25	44
MOLLUSCA	Sphaeriidae																1									
PLATYHELMINTHES	PLATYHELMINTHES		1					2																	3	4
Plecoptera	Austroperla												1		2				1		1					
Plecoptera	Megaleptoperla															1					1					1
Plecoptera	Stenoperla	1			1					1	1					1										
Plecoptera	Zelandoperla	12	5	4	5	8	4	8	3	2	12	3	1	8	6	2	1	2	6	1	4		1	2	2	1
Trichoptera	Aoteapsyche	27	28	36	33	51	36	32	9	10	41	5	11	11	28	25	15	8	3	4	47	53	17	19	64	42
Trichoptera	Beraeoptera	39	35	30	10	16	9	3	5	4	23	7	4	16	9	18	4	1	1	1		9	23	17	6	4
Trichoptera	Costachorema	2	4	6	6	4	4			4	6	1		7	5	6	1	1		4	1	1		1	2	
Trichoptera	Helicopsyche	1	1				1						2													1
Trichoptera	Hydrobiosella						1																			
Trichoptera	Hydrobiosis	14	11	3	1	4	11	12	5		12	7	4	2	7	11	15	8	2	2		20	8	4	12	21
Trichoptera	Neurochorema	1				1				1		4	3	3	2		2	1				14	10	5	9	3
Trichoptera	Olinga	7	10	4		1	2	5			2	9	8	3	4	2	2	7	1	2	1	5		2	3	15
Trichoptera	Oxyethira	2		1	2	1		2	1	5		4	3	1	2			1	1	1	2	1		1	2	1
Trichoptera	Plectrocnemia		1			3						3	5	1		1	2	1	1			2		1	3	3
Trichoptera	Psilochorema	8	10	8	3	4	5	1	4	4	3	2	5	2	2	5	4	7	1	1	4	12		3	5	7
Trichoptera	Pycnocentria		1	1		1	1					1														
Trichoptera	Pycnocentrodes	11	31	11	6	13	11	6	2	1	32	3	5	4	5	6	4	1		1	1	20	13	7	8	4

Macroinvertebrate Data - 17 February 2015

Group	Species	Control A a	Control A b	Control A c	Control A d	Control A e	Control B a	Control B b	Control B c	Control B d	Control B e	Site 1 a	Site 1 b	Site 1 c	Site 1 d	Site 1 e	Site 2 a	Site 2 b	Site 2 c	Site 2 d	Site 2 e	Site 3 a	Site 3 b	Site 3 c	Site 3 d	Site 3 e
	1 Total abundance	615	370	152	152	432	259	333	268	235	124	775	469	391	414	320	552	157	129	188	413	391	144	104	281	346
	2 Number of taxa	23	17	17	19	24	15	17	17	17	16	25	21	21	16	22	24	17	16	17	17	21	15	14	17	23
	3 Number of EPT taxa	14	10	10	12	15	9	11	10	11	9	15	12	12	9	13	13	9	7	9	10	12	7	7	10	11
	4 MCI score	127.8	121.2	120	126.3	130	124	130.6	117.6	128.2	131.2	118.4	117.1	110.5	121.2	132.7	118.3	118.8	115	122.4	135.3	123.8	105.3	105.7	120	107.8
	5 QMCI	6.2	7.1	6.7	7.1	7.1	7	7.2	6.8	7.2	6.6	6.5	6.3	6.4	6.9	6.5	6.4	5.8	6.9	6.7	7.1	6.1	5.6	5.4	5	5.4
ANNELIDA	OLIGOCHAETA			1								3		2			1									1
Coleoptera	Elmidae	48	28	20	17	55	35	72	110	46	70	139	135	97	155	78	67	11	16	37	103	32	14	38	42	77
Coleoptera	Hydraenidae	1				1					1				2	1	2		2	1	1	2				
Diptera	Aphrophila	18	6	5	5	10	1	3	1	5	3	16	7	2	6	7	8	1	1	1	4		2	2	5	7
Diptera	Austrosimulium	18	3		2	6	2	1		2		18	10	2			11	4		3	4	2	2	6	10	6
Diptera	Empididae				1								1													1
Diptera	Eriopterini										1					1										
Diptera	Harrisius																									1
Diptera	Hexatomini											1														
Diptera	Maoridiamesa					1					1		2	5			8	5	1							
Diptera	Orthocladiinae	12	3	1	5	2			1	1		28	35	28	2	3	16	16	4	3		7	10	11	42	36
Diptera	Polypedilum	7																								
Diptera	Tabanidae				1				1							2			1			1		1		1
Diptera	Tanypodinae											8			2		3				1	19	5	1	56	41
Diptera	Tanytarsini	13	1	4		7	3	1	1			23	15	18		5	13	2	1	3		14	12	5	3	5
Ephemeroptera	Acanthophlebia					1																				
Ephemeroptera	Austroclima	1				3											2									
Ephemeroptera	Coloburiscus	32	34	4	1	22	2	4		2	1	13	1			3	26			1	2	4			12	4
Ephemeroptera	Deleatidium	204	158	64	62	174	146	196	117	138	33	378	193	175	206	128	228	49	76	97	240	144	38	21	30	61
Ephemeroptera	Nesameletus	3			2	5			1	1			2			1		1				1				
Ephemeroptera	Zephlebia	1	1																							
Megaloptera	Archicauliodes	5	4	1	2	9	9	4	2	1	2	9	5	2	5	5	3	1	3	1	5	8	3			4
MOLLUSCA	Potamopyrgus	1	6	2		2	29	4	1	3	1	12	3	1	7	2	26	1	5	13	8	84	16		2	1
Plecoptera	Austroperla				1							2	1			1										
Plecoptera	Megaleptoperla					1																				
Plecoptera	Zelandiobius	1																								
Plecoptera	Zelandoperla	32	31	10	20	34	10	5	6	2		2		2		1	15	10	1	2	4				2	2
Trichoptera	Aoteapsyche	192	72	29	18	64	9	21	15	13	1	76	23	17	16	62	102	47	12	15	25	33	25	9	57	64
Trichoptera	Beraeoptera	7	7	1	5	5		1	1	5	2	4	2	10	5	3	1	1				4	5	1	4	5
Trichoptera	Costachorema	1			4	3	1		3	1	2	1	1	3		1	1	4	2	2	3				2	2
Trichoptera	Helicopsyche											1		1								2				
Trichoptera	Hydrobiosella							1													1					
Trichoptera	Hydrobiosis	8	7	2	1	4	6	6	5	4	1	14	10	7	2	2	4	1	1	1	5	8	2	5	8	7
Trichoptera	Neurochorema			1					1			1	4	3	1		4			1		3			1	9
Trichoptera	Olinga	4	7	4	3	19	2	10		4	2	8	1	1	1	3	7	2	2	2	3	14	7	1	1	2
Trichoptera	Oxyethira											2		1									1			1
Trichoptera	Plectrocnemia	1				1		1								1					1	3				
Trichoptera	Psilochorema	5	1	2	1	1	3	2	1	4	2	8	11	6	2	9	2	1	1	5	3	3	2	1	4	8
Trichoptera	Pycnocentria			1								2			1		1									
Trichoptera	Pycnocentrodes		1		1	2	1	1	1	3	1	6	7	8	1	1	1					3		2		

Appendix 6: EFM Survey Results

Electric Fishing (EFM) Survey
5-Feb-15

Site 1 (R1)					
	Riffle 1	**Riffle 2**	**Riffle 3**	**Riffle 4**	**Run 1**
Pass 1	Nil	Nil	Nil	CB - 40 mm	Elver - 150 mm
Pass 2	TF - 70 mm, Elver - 180 mm	Nil	Nil	Elver - 150 mm	Nil
Pass 3	Nil	CB - 50 mm	Nil	Nil	Nil
Pass 4	TF - 90 mm, CB - 40 mm	Bully (unidentified) observed	Nil	Nil	SF Eel - 280 mm, TF - 80 mm
Pass 5	Nil	-	Nil	Elver - 220, 170, 150 mm, TF - 60, 112, 80 mm	-

Site 2 (R2)				
	Riffle 1	**Riffle 2**	**Run 1**	**Run 2**
Pass 1	TF - 110 mm, CB - 60 mm	Nil	Nil	-
Pass 2	TF - 88 mm	CB - 50 mm, Eel (unidentified) -180 mm	Nil	-
Pass 3	CB - 65 mm	TF - 60 mm	Nil	-
Pass 4	CB - 70 mm	Nil	Nil	-
Pass 5	-	TF - 70, 60 mm, Eel (unidentified) - 180 mm	-	-

Site 3 (R3)					Comments
	Riffle 1	**Riffle 2**	**Run 1**	**Run 2**	School of inanga observed in a side branch
Pass 1	CB - 35, 40 mm	Nil	Inanga - 30 mm	Eel (unidentified) - 800 mm	
Pass 2	Nil	LF Eel - 400 mm	Inanga - 70 mm	SF Eel - 700 mm	
Pass 3	CB - 40 mm	Nil	Nil	Nil	
Pass 4	CB - 50, 70 mm	Nil	Nil	Nil	
Pass 5	Nil	-	Nil	-	
Pass 6	CB - 50 mm, Elver - 110 mm	-	Nil	-	
Pass 7	TF - 110, 70, 60 mm, Elver - 150 mm	-	Nil	-	
Pass 8	TF - 100 mm	-	-	-	
Pass 9	TF - 90 mm, Elver 100 mm	-	-	-	

Control A (C1)					Comments
	Riffle 1	**Riffle 2**	**Run 1**	**Run 2**	Trout 300 mm observed in a pool
Pass 1	Nil	-	-	-	
Pass 2	Nil	-	-	-	
Pass 3	Nil	-	-	-	
Pass 4	TF - 80, 70 mm	-	-	-	
Pass 5	Nil	-	-	-	
Pass 6	RF bully - 55 mm	-	-	-	
Pass 7	Nil	-	-	-	
Pass 8	Nil	-	-	-	
Pass 9	Eel (unidentified) - 300, 300 mm	-	-	-	

Control B (C2)				
	Riffle 1	**Riffle 2**	**Run 1**	**Run 2**
Pass 1	Nil	-	SF Eel - 200 mm, Eel (unidentified) - 230 mm	-
Pass 2	RF bully - 75 mm, Elver - 100 mm	-	Nil	-
Pass 3	BT - 120 mm, LF Eel 220, 180 mm	-	Nil	-
Pass 4	TF - 120 mm	-	Nil	-
Pass 5	Nil	-	Nil	-
Pass 6	Nil	-	LF Eel - 350 mm	-
Pass 7	Elver - 200 mm	-	Eel (unidentified) - 450 mm	-
Pass 8	Eel (unidentified) - 300 mm, RF bully - 70 mm	-	Nil	-
Pass 9	TF - 95, 90, 60 mm	-	Nil	-

Notes:
CB - denotes common bully - *Gobio cotidanus*
RF bully - redfin bully - *Gobiomorphus huttoni*
TF - denotes torrent fish *Cheimarrichthys fosteri*
SF Eel - denotes shortfin eel - *Anguilla australis*
LF Eel - denotes longfin eel - *Australis dieffenbachii*
BT - denotes brown trout - *Salmo trutta*
Inanga - denotes *Galaxiid sp.*
Nil - denotes no fish caught
- denotes no fishing conducted, unsuitable fishing conditions

Total Common Bully: 11
Total Redfin Bully: 2
Total Torrentfish: 20
Total Eel: 23
Total Inanga: 2
Total Brown Trout: 1

Waikanae River Baseline Aquatic Monitoring Monthly Report – March 2015

Kāpiti Water Supply RRwGW Scheme

Prepared for Kapiti Coast District Council

Document Quality Assurance

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Prepared by:	Tony Payne Ecologist Boffa Miskell Limited	
Reviewed by:	Dr Vaughan Keesing Senior Principal / Ecologist Boffa Miskell Limited	
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1.0 Introduction

The Waikanae River Baseline Aquatic Monitoring Monthly Report – March 2015 is prepared in general accordance with the Waikanae River Baseline Aquatic Monitoring Plan (River BMP) prepared for Kapiti Coast District Council by Boffa Miskell (BML), dated 23 February 2014. As per the River BMP, this report presents "*the results of periphyton visual cover, depth, velocity and flows over the month via a spread sheet, noting any exceedance or trend relevant to triggering macroinvertebrate sampling and a comment on the periphyton trends at each site. Water quality and macroinvertebrate data will be delivered as part of this report via a spread sheet and, as appropriate, the hydrological gauging results*" for the Waikanae River monitoring for March 2015.

2.0 Monitoring

Sampling included three downstream (receiving) and two upstream (control) monitoring sites as per resource consent WGN130103 permit [33251] condition 19 and permit [33252] condition 21. Monitoring locations are provided in **Figure 1** below.

All monitoring was undertaken by suitably qualified ecologists in general accordance with the Waikanae River RBMP. Periphyton visual assessment transects and water quality sampling were undertaken on the 5th, 12th, 18th and 25th of March 2015. Periphyton sampling was undertaken on the 5th and 18th March 2015 and macroinvertebrate sampling was undertaken on the 5th March 2015. Macroinvertebrate samples were preserved in ethanol and sent to Ryder Consulting Limited (RCL) for identification on 10th March 2015. Periphyton samples were frozen and sent in a chilli-bin with ice to RCL for identification on 5th March 2015 and 12th March 2015. Water quality samples were sent in a chilli-bin with ice to Eurofins ELS Limited on the 9th, 13th, 18th, and 25th March 2015. Hydrological gauging was undertaken at Site 2 and Site 3 by NIWA on 10 March 2015

Field water quality readings were taken using a calibrated Horiba U-50 water quality meter and velocity data was collected using a FP111 Flow Probe. Stream depth was only recorded during the 25th March 2015 survey.

On 25th March 2015, periphyton visual assessments at Site 1 were inhibited by high turbidity due to construction works being conducted upstream at the KCDC water treatment plant. No other anomalous field observations (sheens, odours, high turbidity etc) were noted during March 2015.

Please note, because this is baseline monitoring, no exceedance trigger or relevant trend to trigger macroinvertebrate sampling is reported. Macroinvertebrate sampling is undertaken to reflect low, medium and high levels of periphyton growth. In addition, no periphyton trends are identifiable.

Raw data and results are provided in the following appendices:

- **Appendix 1:** Field water quality data and hydrological gauging results
- **Appendix 2:** Laboratory water quality results.
- **Appendix 3:** Periphyton visual cover data and water velocity data.
- **Appendix 4:** Periphyton sampling results**.**
- **Appendix 5:** Macroinvertebrate sampling results. Please note, an excel version of the macroinvertebrate sampling results is available and can be supplied upon request.

3.0 References

Boffa Miskell (2014). Waikanae River Baseline Aquatic Monitoring Plan. Kapiti Water Supply RRwGW Scheme, prepared by Boffa Miskell Limited for Kapiti Coast District Council, dated 23 February 2014.

Appendix 1: Field Water Quality Data and Hydrological Gauging Results

Field Water Quality Data

5-Mar-15

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	14:30	15:35	13:15	11:30	10:00
Temperature (˚C)	20.09	20.58	19.43	18.28	17.21
pH	7.79	7.7	7.75	7.80	7.81
ORP (mV)	226.00	230	215.00	240.00	174.00
Conductivity (ms/cm)	0.11	0.111	0.11	0.11	0.11
Dissolved Oxygen (mg/L)	10.07	9.8	20.22	9.56	16.66
TDS (g/L)	0.072	0.072	0.072	0.072	0.074
NTU	0.00	0	0.00	0.50	0.00

12-Mar-15

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	No data due to equipment failure	13:02	12:18	11:21	No data due to equipment failure
Temperature (˚C)		18.87	17.95	18.74	
pH		7.71	7.50	7.68	
ORP (mV)		221.00	222.00	216	
Conductivity (ms/cm)		0.00	0.00	0.3	
Dissolved Oxygen (mg/L)		0.111	0.111	0.117	
TDS (g/L)		96.00	101.10	113.8	
NTU		0.072	0.072	0.076	

18-Mar-15

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	12:45	11:45	13:30	10:45	9:40
Temperature (˚C)	16.50	15.29	16.48	14.90	14.14
pH	7.48	7.58	7.53	7.54	7.57
ORP (mV)	195.00	215	220.00	250.00	182.00
Conductivity (ms/cm)	0.00	0	0.00	0.00	0.00
Dissolved Oxygen (mg/L)	0.11	0.111	0.11	0.11	0.13
TDS (g/L)	89.80	121.3	102.10	107.7	188.40
NTU	0.073	0.072	0.072	0.073	0.081

25-Mar-15

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	11:55	11:30	12:30	10:35	10:00
Temperature (˚C)	16.4	16.2	16.8	16.0	15.8
pH	7.1	7.3	7.5	7.3	7.2
Conductivity (ms/cm)	0.112	0.112	0.113	0.115	0.113
Dissolved Oxygen (mg/L)	14.70	16.05	14.10	22.60	12.60
TDS (g/L)	0.073	0.073	0.074	0.075	0.073
NTU	1.0	0.8	21.6	2.6	1.9

Hydrological Gauging Results

10-Mar-15

Site	Time	Area (m^2)	Velocity (mm/s)	Flow (L/s)
Site 2	10:25 a.m.	8.56	105	895
Site 3	12:45 p.m.	2.60	253	658

Appendix 2: Laboratory Water Quality Results

Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
Wellington
6142

Attention: Tony Payne

Report Number: 15/7935
Issue: 1
27 March 2015

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/7935-01	Surface Water		05/03/2015 00:00	09/03/2015 13:50	0

Notes: Site 1

	Test	Result	Units	Signatory
0001	pH	7.6		Marylou Cabral KTP
0055	Conductivity at 25°C	12.1	mS/m	Vinia Buntoro KTP
0125	Inorganic Nitrogen	< 0.01	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	< 0.005	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	6.10	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.014	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.010	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.13	g/m³	Tracy Morrison KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/7935-02	Surface Water		05/03/2015 00:00	09/03/2015 13:50	0

Notes: Site 2

	Test	Result	Units	Signatory
0001	pH	7.7		Marylou Cabral KTP
0055	Conductivity at 25°C	12.1	mS/m	Vinia Buntoro KTP
0125	Inorganic Nitrogen	< 0.01	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	< 0.005	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	6.25	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.013	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.13	g/m³	Tracy Morrison KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/7935-03	Surface Water		05/03/2015 00:00	09/03/2015 13:50	0

Notes: Site 3

	Test	Result	Units	Signatory
0001	pH	7.5		Marylou Cabral KTP
0055	Conductivity at 25°C	12.2	mS/m	Vinia Buntoro KTP
0125	Inorganic Nitrogen	0.01	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.010	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	6.29	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m³	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.15	g/m³	Tracy Morrison KTP

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Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/7935-04	Surface Water		05/03/2015 00:00	09/03/2015 13:50	0
Notes: Site A					

	Test	Result	Units	Signatory
0001	pH	7.6		Marylou Cabral KTP
0055	Conductivity at 25°C	12.0	mS/m	Vinia Buntoro KTP
0125	Inorganic Nitrogen	< 0.01	g/m^3	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	< 0.005	g/m^3	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Tracy Morrison KTP
1810	Calcium - Dissolved	6.20	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.015	g/m^3	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m^3	Tracy Morrison KTP
2127	Total Nitrogen	0.14	g/m^3	Tracy Morrison KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/7935-05	Surface Water		05/03/2015 00:00	09/03/2015 13:50	0
Notes: Site B					

	Test	Result	Units	Signatory
0001	pH	7.6		Marylou Cabral KTP
0055	Conductivity at 25°C	11.9	mS/m	Vinia Buntoro KTP
0125	Inorganic Nitrogen	< 0.01	g/m^3	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	< 0.005	g/m^3	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Tracy Morrison KTP
1810	Calcium - Dissolved	6.14	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.013	g/m^3	Tracy Morrison KTP
2088	Dissolved Reactive Phosphorus	0.010	g/m^3	Tracy Morrison KTP
2127	Total Nitrogen	0.14	g/m^3	Tracy Morrison KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Conductivity at 25°C	APHA 22nd Edition Method 2510 B.	0.1 mS/m
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m^3
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m^3
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m^3
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m^3
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m^3
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m^3
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m^3

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Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
Wellington
6142

Attention: Tony Payne

Report Number: 15/8714
Issue: 1
08 April 2015

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/8714-01	Surface Water		12/03/2015 00:00	13/03/2015 16:10	0

Notes: Site 1, Waikanae River, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.6		Vinia Buntoro KTP
0125	Inorganic Nitrogen	0.05	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.046	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.63	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.009	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.21	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/8714-02	Surface Water		12/03/2015 00:00	13/03/2015 16:10	0

Notes: Site 2, Waikanae River, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.8		Vinia Buntoro KTP
0125	Inorganic Nitrogen	0.09	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.084	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.73	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.009	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.20	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/8714-03	Surface Water		12/03/2015 00:00	13/03/2015 16:10	0

Notes: Site 3, Waikanae River, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.5		Vinia Buntoro KTP
0125	Inorganic Nitrogen	0.10	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.097	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.48	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.010	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.24	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/8714-04	Surface Water		12/03/2015 00:00	13/03/2015 16:10	0

Notes: Control A, Waikanae River, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.5		Vinia Buntoro KTP

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Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/8714-04	Surface Water		12/03/2015 00:00	13/03/2015 16:10	0

Notes: Control A, Waikanae River, W14039.340

	Test	Result	Units	Signatory
0125	Inorganic Nitrogen	0.08	g/m^3	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.083	g/m^3	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Tracy Morrison KTP
1810	Calcium - Dissolved	5.29	g/m^3	Wayne Edgerley KTP
2080	Total Phosphorus	0.010	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m^3	Tracy Morrison KTP
2127	Total Nitrogen	0.25	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/8714-05	Surface Water		12/03/2015 00:00	13/03/2015 16:10	0

Notes: Control B, Waikanae River, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.5		Vinia Buntoro KTP
0125	Inorganic Nitrogen	0.07	g/m^3	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.073	g/m^3	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Tracy Morrison KTP
1810	Calcium - Dissolved	5.75	g/m^3	Wayne Edgerley KTP
2080	Total Phosphorus	0.009	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m^3	Tracy Morrison KTP
2127	Total Nitrogen	0.19	g/m^3	Divina Lagazon KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m^3
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m^3
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m^3
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m^3
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m^3
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m^3
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m^3

"<" means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m3 is the equivalent to mg/L and ppm.

Samples will be retained for a period of time, in suitable conditions appropriate to the analyses requested.

Report Released By

Sunita Raju

Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
Wellington
6142

Attention: Tony Payne

Report Number: 15/9129
Issue: 1
08 April 2015

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9129-01	Surface Water		18/03/2015 13:30	18/03/2015 16:00	0

Notes: Site 1 W14039.340

	Test	Result	Units	Signatory
0001	pH	7.6		Vinia Buntoro KTP
0125	Inorganic Nitrogen	0.09	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.085	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	6.06	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.015	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.008	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.16	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9129-02	Surface Water		18/03/2015 10:45	18/03/2015 16:00	0

Notes: Site 2 W14039.340

	Test	Result	Units	Signatory
0001	pH	7.7		Vinia Buntoro KTP
0125	Inorganic Nitrogen	0.09	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.087	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	6.06	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.014	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.15	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9129-03	Surface Water		18/03/2015 09:15	18/03/2015 16:00	0

Notes: Site 3 W14039.340

	Test	Result	Units	Signatory
0001	pH	7.5		Vinia Buntoro KTP
0125	Inorganic Nitrogen	0.10	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.096	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	6.08	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.014	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.008	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.17	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9129-04	Surface Water		18/03/2015 12:40	18/03/2015 16:00	0

Notes: Control A W14039.340

	Test	Result	Units	Signatory
0001	pH	7.5		Vinia Buntoro KTP

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Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9129-04	Surface Water		18/03/2015 12:40	18/03/2015 16:00	0

Notes: Control A W14039.340

	Test	Result	Units	Signatory
0125	Inorganic Nitrogen	0.09	g/m^3	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.089	g/m^3	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Tracy Morrison KTP
1810	Calcium - Dissolved	6.08	g/m^3	Wayne Edgerley KTP
2080	Total Phosphorus	0.016	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m^3	Tracy Morrison KTP
2127	Total Nitrogen	0.15	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9129-05	Surface Water		18/03/2015 11:45	18/03/2015 16:00	0

Notes: Control B W14039.340

	Test	Result	Units	Signatory
0001	pH	7.5		Vinia Buntoro KTP
0125	Inorganic Nitrogen	0.09	g/m^3	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.093	g/m^3	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Tracy Morrison KTP
1810	Calcium - Dissolved	6.15	g/m^3	Wayne Edgerley KTP
2080	Total Phosphorus	0.014	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.009	g/m^3	Tracy Morrison KTP
2127	Total Nitrogen	0.16	g/m^3	Divina Lagazon KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m^3
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m^3
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m^3
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m^3
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m^3
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m^3
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m^3

"<" means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m3 is the equivalent to mg/L and ppm.

Samples will be retained for a period of time, in suitable conditions appropriate to the analyses requested.

Report Released By
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Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
Wellington
6142

Attention: Tony Payne

Report Number: 15/9858
Issue: 1
08 April 2015

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9858-01	Surface Water		25/03/2015 12:30	25/03/2015 15:35	0

Notes: Site 1, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.7		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.09	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.091	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.82	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.020	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.012	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.16	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9858-02	Surface Water		25/03/2015 10:35	25/03/2015 15:35	0

Notes: Site 2, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.8		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.09	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.090	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.87	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.012	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.011	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.16	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9858-03	Surface Water		25/03/2015 11:00	25/03/2015 15:35	0

Notes: Site 3, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.6		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.10	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.101	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.70	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.012	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.011	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.15	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9858-04	Surface Water		25/03/2015 11:55	25/03/2015 15:35	0

Notes: Control A, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.6		Marylou Cabral KTP

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Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9858-04	Surface Water		25/03/2015 11:55	25/03/2015 15:35	0

Notes: Control A, W14039.340

	Test	Result	Units	Signatory
0125	Inorganic Nitrogen	0.09	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.092	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.69	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.012	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.011	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.15	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/9858-05	Surface Water		25/03/2015 11:30	25/03/2015 15:35	0

Notes: Control B, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.6		Marylou Cabral KTP
0125	Inorganic Nitrogen	0.10	g/m³	Tracy Morrison .
0515	Nitrite Nitrate Nitrogen	0.096	g/m³	Tracy Morrison KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Tracy Morrison KTP
1810	Calcium - Dissolved	5.51	g/m³	Wayne Edgerley KTP
2080	Total Phosphorus	0.012	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.011	g/m³	Tracy Morrison KTP
2127	Total Nitrogen	0.16	g/m³	Divina Lagazon KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m³
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m³
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m³
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m³
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m³
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m³
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m³

"<" means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m3 is the equivalent to mg/L and ppm.

Samples will be retained for a period of time, in suitable conditions appropriate to the analyses requested.

All test methods and confidence limits are available on request. This report must not be reproduced except in full, without the written consent of the laboratory.

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Appendix 3: Periphyton Visual Cover Data and Water Velocity Data

Periphyton Cover - Field Survey Results
5-Mar-15

		SITE 1 (R1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green																				
	Light Brown	80	80	75	60	65	80	75	50	70	85	90	90	100	90	95	65	70	50	50	60
	Dark Brown/ Black							5	2	15	5						2				
Medium mat (%)	Green																				
	Light Brown	15	10	10	25	30	10	15	35	10	5	10	10		5						
	Dark Brown/ Black		5	5	10																
Thick mat (%)		15	15	15	35	30		15	35	10	5	10	10	0	5	0	0	0	0	0	0
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	2	2	10	2	5	5	1	10	5	5				1	3	2		1		5
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	100	95	100	95	100	90	95	100	100	100	100	100	85	85	95	100	100	95	85	70
	Velocity (m/s)	0.6	0.8	1	0.6	0.8	0.6	0.8	0.6	1	0.8	0.2	0.2	0.5	0.4	0.3	0.5	0.5	0.7	0.4	0.2

		SITE 2 (R2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green																				
	Light Brown	50	70	85	70	85	85	85	75	75	80	70	85	95	100	90	95	85	95	90	95
	Dark Brown/ Black	2	15	5		3		10			5					8					
Medium mat (%)	Green																				
	Light Brown	20	10	5	15	10	5		15	10	10	20	10	2				10		5	
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	2		1		1	5	2	5	8	1	1	1			1		1	1	3	1
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	80	100	100	100	100	100	100	100	95	100	95	90	85	100	100	90	95	90	100	100
	Velocity (m/s)	1	1.3	1	0.6	0.5	0.7	0.7	0.9	0.9	0.8	0.3	0.5	0.5	0.5	0.2	0.2	0.3	0.5	0.4	0.2

		SITE 3 (R3)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green																				
	Light Brown	55	50	60	60	35	75	80	70	80	45	65	65	50	30	30	40	70	45	60	35
	Dark Brown/ Black		1	2				10	10												
Medium mat (%)	Green																				
	Light Brown	5	2		2	5	5	5	5	2	10	5	5				5		5		
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green		2	5	10		1	5	1	1				1	1		1	5		5	1
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	100	100	100	100	90	95	70	100	85	95	95	90	100	100	100	95	100	95	100	100
	Velocity (m/s)	0.9	0.7	0.6	0.9	1	0.5	0.8	0.9	0.8	0.7	0.2	0.4	0.6	0.3	0.2	0.4	0.5	0.8	0.6	0.5

		CONTROL A (C1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	***4**	***5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green				1	1				5								1			
	Light Brown	80	85	75	75	70	50	40	45	70	15	80	95	85	80	95	85	85	85	45	70
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	15	10	15	10	15	50	60	50	20	60	5	5	10	15	5	15	10	40	55	25
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green		5	8	10	10				2	5				1			2	1	2	1
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	85	100	100	100	100	80	100	95	100	95	100	65	70	60	95	50	100	45	90	80
	Velocity (m/s)	0.5	0.6	0.8	0.8	0.7	0.3	0.5	0.8	0.6	1.4	0.2	0.2	0.3	0.4	0.4	0.3	0.4	0.5	0.4	0.3

		CONTROL B (C2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green	5	2	10	5	5	8	15		2				10	5						5
	Light Brown	60	75	40	25	20	60	40	35	70	80	70	70	50	60	40	90	85	95	80	75
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	15	10	5	10	2	10	10	5		5	20	25	35	20	60		10	5	5	10
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	1	5	8	2				2	5	2	1	1	2	5		1			10	5
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	100	65	100	90	90	60	85	90	95	100	100	100	95	100	90	70	65	85	95	100
	Velocity (m/s)	0.8	1.5	1.5	1.3	0.9	0.7	0.8	1.2	1.2	1	0.3	0.5	0.6	0.6	0.6	0.2	0.5	0.7	0.6	0.5

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		SITE 1 (R1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Green																				
Thin mat/film (%)	Light Brown	90	80	40	40	80	95	80	50	65	50	95	90	75	90	100	100	95	80	80	80
	Dark Brown/ Black																				
	Green																				
Medium mat (%)	Light Brown	5	2	40	50	10	1	10	5	10	30	2	5	20	10				10	5	5
	Dark Brown/ Black	1			2					15	10		2	5						2	
	Green																				
Thick mat (%)	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green		1	1	5	1	1	1	2	2	5	1		1						1	1
	Brown reddish																				
Filaments, long (%)	Green											1									
	Brown reddish																				
	Potential Cover (%)	100	100	95	95	90	100	100	100	100	90	100	90	85	70	60	95	90	100	80	80
	Velocity (m/s)	0.8	0.8	1.2	0.5	0.5	0.9	1.3	1	1	0.8	0.1	0.4	0.4	0.2	0.2	0.2	0.3	0.3	0.5	0.2

		SITE 2 (R2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Green																				
Thin mat/film (%)	Light Brown	55	70	75	40	50	50	40	30	5		70	60	30	35	80	70	20	60	70	85
	Dark Brown/ Black		5			5															
	Green																				
Medium mat (%)	Light Brown	30	10	15	30	30	15	50	50	75	60	20	30	60	60	15	5	70	15	15	10
	Dark Brown/ Black	10		5	2				10	10	10	5	5	5	1						
	Green																				
Thick mat (%)	Light Brown																				
	Dark Brown/ Black							5													
Filaments, short (%)	Green	5	10	5		10	2	2	10	10	20	2	1	5	1		1				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	100	70	70	90	100	95	95	80	100	100	85	95	90	70	80	95	60	80	90	100
	Velocity (m/s)	0.4	0.5	0.8	0.8	0.6	0.5	0.8	0.7	1.1	1	0.3	0.6	0.8	0.6	0.3	0.1	0.5	0.6	0.6	0.5

		SITE 3 (R3)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Green									10	20										
Thin mat/film (%)	Light Brown	90	80	100	100	80	80	100	100	100	60	100	100	100	90	100	100	100	60	100	80
	Dark Brown/ Black																				
	Green																				
Medium mat (%)	Light Brown					10													30		10
	Dark Brown/ Black																				
	Green																				
Thick mat (%)	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	2	10		5	10	5								5			1			
	Brown reddish																				
Filaments, long (%)	Green			5				1					5	1							
	Brown reddish																				
	Potential Cover (%)	95	95	100	100	100	100	80	70	100	90	90	100	85	70	70	100	100	100	80	90
	Velocity (m/s)	0.2	0.8	1.2	1	0.6	0.4	0.7	0.9	0.9	0.1	0.3	0.5	0.4	0.4	0.1	0.4	0.1	0.6	0.4	0.3

		CONTROL A (C1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Green	40				30															
Thin mat/film (%)	Light Brown	30	70	60	80	80	80	100	100	100	40	60	100	90	50	50	80	30	60	40	60
	Dark Brown/ Black																				
	Green																				
Medium mat (%)	Light Brown		30	40	60						60										
	Dark Brown/ Black	30					20			10									30		
	Green																				
Thick mat (%)	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green						5		2												
	Brown reddish																				
	Potential Cover (%)	80	100	95	100	100	100	80	90	80	95	90	100	80	70	60	20	70	60	90	90
	Velocity (m/s)	0.5	0.8	1	0.6	0.1	0.5	0.9	0.9	0.8	0.5	0	0.1	0.3	0.5	0.4	0.2	0.5	0.5	0.3	0.1

		CONTROL B (C2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Green																				
Thin mat/film (%)	Light Brown	50	60	80	50	40	68	40	60	40	50	60	80	75	70	75	40	60	85	80	80
	Dark Brown/ Black		1									10									
	Green																				
Medium mat (%)	Light Brown	15	10	10	30	20	30	50	30	50	30	20	15	10	20	20	60	20	10	10	15
	Dark Brown/ Black	5		15	10	2	2	2		5	10	5	5	5	5			10	2	5	5
	Green																				
Thick mat (%)	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	1		2	2			2	2					1		1		1			
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	100	95	100	95	100	100	95	95	90	85	95	80	50	100	100	80	60	90	100	100
	Velocity (m/s)	0.8	0.9	1	0.8	0.6	1.1	1.2	0.9	1	0.6	0.6	0.4	0.2	0.6	0.4	0.2	0.3	0.4	0.5	0.5

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		SITE 1 (R1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	53	85	45	55	65	68	45	75	65	69	100	98	95	94	89	90	100	73	63	93
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	40	10	30	30	20	25	50	10	20	15			5	5	5	5		15	30	5
	Dark Brown/ Black	2					5									5	5		10	5	
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	5	5	25	15	15	2	5	5	10	10		2		1	1				2	2
	Brown reddish																				
Filaments, long (%)	Green										1								2		
	Brown reddish																				
	Potential Cover (%)		90	95	100	100	100	100	90	85	100	100	90	95	90	85	100	100	85	80	90
	Velocity (m/s)	1.4	1.2	0.8	0.6	0.7	0.9	1.2	1.1	0.6	5	0.2	0.5	0.4	0.2	0.1	0.3	0.4	0.5	0.4	0.1

		SITE 2 (R2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green											100	95				70				
	Light Brown	80	40	60	20	20	70	65	50	30	80		5	90	20	70	10	20	30	40	50
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	20	60	15	50	60	20	30	20	60	20			5	60	5		50	30	15	30
	Dark Brown/ Black			5	5	2		2	10										2	2	10
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	2	2	15	15	10	5	5	15	10	2				2	5		1	2		
	Brown reddish																				
Filaments, long (%)	Green															5					
	Brown reddish																				
	Potential Cover (%)	90	90	80	70	95	100	50	95	100	100	80	70	80	95	90	80	60	75	95	95
	Velocity (m/s)	0.4	0.5	0.9	0.8	0.8	0.5	0.7	0.9	0.5	0.6	0.1	0.1	0.3	0.5	0.2	0.1	0.3	0.4	0.3	0.3

		SITE 3 (R3)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	80	70	60	75	90	75	70	885	80	75	95	40	70	85	100	95	90	88	94	95
	Dark Brown/ Black	2																			
Medium mat (%)	Green																				
	Light Brown	5	20	30	5	5	10	20	10	15	15		60	30	10		5	10	10	5	5
	Dark Brown/ Black		5	5	5	5		2	2										2		
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																		Q		
Filaments, short (%)	Green	15	5	5	10	2	15	5	2	5	10				2					1	
	Brown reddish																				
Filaments, long (%)	Green	2						2													
	Brown reddish																				
	Potential Cover (%)	95	95	100	80	95	95	95	85	100	100	60	75	95	100	100	65	75	100	100	100
	Velocity (m/s)	0.3	0.7	0.7	0.7	0.6	0.5	0.5	0.5	0.8	0.5	0.2	0.3	0.5	0.5	0.1	0.2	0.2	0.3	0.3	0.2

		CONTROL A (C1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	5	10	15	45	45	25	10		30	55	54	79	90	95	90	90	95	85	95	95
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	80	80	80	40	50	60	70	65	50	30	45	20	5	5	10	10	5	15	5	5
	Dark Brown/ Black	2			1	5	5	5	10	5	5			5							
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	10	5	5	2		5	10	25	10	5	1	1								
	Brown reddish																				
Filaments, long (%)	Green						5														
	Brown reddish																				
	Potential Cover (%)		75	90	95	90	100	90	95	90	90	95	70	60	70	85	90	70	60	80	90
	Velocity (m/s)	1.2	0.6	0.9	0.7	0.3	1	0.8	1.4	0.9	0.8	0.5	0.4	0.4	0.5	0.2	0.3	0.3	0.3	0.3	0.2

		CONTROL B (C2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	80	80	60	75	80	70	90	80	70	90	90	90	80	85	80	74	80	89	89	98
	Dark Brown/ Black			10		10										10		5			
Medium mat (%)	Green																				
	Light Brown	5	5	20	15	5	10	10	5	10	5	10	5	5	5	5	25	10	5	5	2
	Dark Brown/ Black		5		5	5		2	5	15	1	5	2	5	10	5		2	5	5	
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green		2	2	5				2	1	1	2	5		2	1	1	2	1	1	
	Brown reddish																				
Filaments, long (%)	Green												2								
	Brown reddish																				
	Potential Cover (%)	60	90	75	95	95		90	85	90	100	85	95	70	100	100	100	85	95	90	100
	Velocity (m/s)	0.7	0.6	1.3	1.1	0.7	0.9	1.3	1.1	0.4	0.4	0.3	0.7	0.4	0.5	0.5	0.5	0.4	0.5	0.3	0.3

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		SITE 1 (R1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	50	35							75	65	95					94				100
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	30	50																		
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown									15	30						5				
	Dark Brown/ Black											5									
Filaments, short (%)		0	0	0	0	0		0	0	15	30	5	0	0	0	0	5	0	0	0	0
	Green									10	5						1				
	Brown reddish																				
Filaments, long (%)	Green	20	15																		
	Brown reddish																				
	Potential Cover (%)	100	100							95	100	100									85
	Velocity (m/s)	0.1	0.2	0.6	0.8	0.5	0.9	0.4	0.8	0.2	0.2	0.1	0.2	0.3	0.2	0.1	0.2	0.3	0.4	0.1	0.1
	Depth (cm)	18	13	17	18	12	12	17	16	9	11.5	12.5	29	40	37	13	15.5	24	34	30	10

		SITE 2 (R2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	85	68	85	70	40	88	65	55	60	15	100	100	89	89	100	70	80	95	100	100
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	15	20	10	15	40	10	30	40	30	60			10	10		30	15	5	10	
	Dark Brown/ Black		5		10	5	1				10							5			
Thick mat (%)	Green																				
	Light Brown										10										
	Dark Brown/ Black									10											
Filaments, short (%)		0	0	0	0	0		0	0	10	10	0	0	0	0	0	0	0	0	0	0
	Green	1	2	5	5	10	1	5	5		5			1	1						
	Brown reddish																				
Filaments, long (%)	Green		5			5															
	Brown reddish																				
	Potential Cover (%)	90	95	70	90	90	80	95	80	70	90	40	60	80	85	60	50	70	100	100	80
	Velocity (m/s)	0.05	0.2	0.4	0.3	0.3	0.1	0.2	0.4	0.8	0.6	0.01	0.05	0.3	0.2	0.05	0.05	0.1	0.2	0.2	0.1
	Depth (cm)	10	20	32	24	20	6	15	24	26.5	24	5	40.5	50.5	28	31.5	9.5	15	33	51.5	19

		SITE 3 (R3)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	75	78	58	68	80	75	70	80	80	50	100	15	20	100	94	100	85	80	39	100
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	25	15	30	15	15	20	20	15	15	50		80	70		5		15	20	60	
	Dark Brown/ Black		5	5	2	5		5		1			5								
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	2	2	5	5	1	5	5	5	5	1		1	1		1				1	
	Brown reddish													5							
Filaments, long (%)	Green	2		2																	
	Brown reddish																				
	Potential Cover (%)	95	95	100	95	100	100	95	100	95	100	70	70	100	90	100	60	95	100	100	100
	Velocity (m/s)	0.05	0.5	0.4	0.9	0.2	0.3	0.4	0.6	0.4	0.4	0.1	0.4	0.4	0.3	0.1	0.1	0.2	0.2	0.2	0.1
	Depth (cm)	15	17	26	22	20	17	24	24	15	8	5.5	18.5	24	20	11.5	9.5	17	31	36	25

		CONTROL A (C1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	10	48	20	25	83	20	35	25	25	15	100	100	90	100	100	90	84	69	90	100
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	90	50	60	70	15	70	60	70	50	70			10			10	15	30	10	
	Dark Brown/ Black			10		10				15	15										
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green		2	5	5			5	5	10								1	2		
	Brown reddish																				
Filaments, long (%)	Green			5		2	10														
	Brown reddish																				
	Potential Cover (%)	95	70	90	90	95	100	100	90	90	95	60	50	70	95	80	60	80	70	80	95
	Velocity (m/s)	0.1	0.5	0.4	0.3	0.2	0.5	0.8	0.5	1.1	0.6	0.2	0.2	0.2	0.1	0	0.2	0.1	0.3	0.2	0.05
	Depth (cm)	12	27	31	16	10	14	18	26	20	13.5	49	41.5	33	21.5	4	33.5	37	33	24	11.5

		CONTROL B (C2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green																				
	Light Brown	74	63	73	85	85	90	85	29	60	89	40	78	35	84	90	100	85	64	100	100
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	20	30	10	5		10	10	60	30	10	60	10	55	5	10		15	20		
	Dark Brown/ Black	5	2	15	10	15		5	10	5			10	5	10	5			15		
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green	1	5	2					1	5	1	2	2	5	1				1		
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	95	80	85	95	100	60	95	90	80	100		80	90	95	100	95	50	90	100	100
	Velocity (m/s)	0.4	0.5	0.6	0.3	0.3	0.8	0.9	0.8	0.6	0.03	0.1	0.5	0.5	0.1	0.2	0.1	0.3	0.3	0.4	0.2
	Depth (cm)	17	21.5	19.5	6	14.5	40.5	21	20	19.5	10	6	23	23	21	15.5	10	25.5	26	19.5	17

Appendix 4: Periphyton Sampling Results

Date	Site	Sample	Chlorophyll *a* (mg per m^2)	AFDM (g per m^2)	Autotrophic Index (AFDM in mg/m^2 : chlorophyll *a* in mg/m^2)
5 March 2015	**Site 1**	**a**	14.8	4.1	277.1
		b	9.9	3.4	345.1
		c	8.4	2.8	335.3
		d	22.2	6.4	287.3
		e	14.9	3.2	213.9
	Site 2	**a**	6.2	2.3	377.7
		b	20.1	5.6	279.6
		c	32.4	5.6	172.1
		d	9.7	2.2	225.6
		e	15.8	2.4	153.7
	Site 3	**a**	30.4	5.1	168.2
		b	*2.6*	*0.8*	*310.1*
		c	13.5	3.4	250.2
		d	*3.4*	*0.9*	*267.3*
		e	12.0	4.2	348.9
	Control 1	**a**	23.1	3.5	150.5
		b	9.8	2.5	253.3
		c	31.2	4.0	128.2
		d	62.3	9.0	144.0
		e	34.2	5.9	173.3
	Control 2	**a**	32.8	4.6	140.5
		b	97.1	14.8	152.6
		c	17.9	4.2	231.7
		d	97.8	17.7	181.2
		e	83.6	7.1	84.8

Please note that values in italics indicate samples that may have leaked prior to laboratory analysis, and should be interpreted with caution.

5 March 2015 – Algal community composition (relative abundance).

	Site 1					Site 2					Site 3					Control 1					Control 2				
	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
Filamentous green algae																									
Microspora	4		4			3		2	2	3	3	4	3		3	3	3	3	3						2
Mougeotia	3		2	4	2	4	4	3			3	3	4		3	3	3								
Stigeoclonium	2		3		1		2	4			3	2		3	2			3	2			2	2	2	3
Cyanobacteria																									
Oscillatoria/ Phormidium		2		1	2			2	1				1	1			1	1		6	3	2	2	2	
Rivularia																				2				3	
Filamentous diatoms																									
Melosira	2	3	3	3	3	2		3	3	5	2	5	3	3	3	3		1		3					
Diatoms																									
Achnanthidium	1		3	3	1	1		1						2	1				1			1			3
Cocconeis										1							1		1			2		2	1
Cymbella	2		1	3	3	2	2	1			1	2			2	2	1		1	2	1		1		2
Gomphoneis	3	2	3	4	3	2	2	4	2	2	3	2	3	1	2				4	2		4	2		
Gyrosigma																			1						
Naviculoid diatoms	2	1	1	1	1	2		2		1		2	2			1		1		2		1		2	3
Nitzschia	1	1	1	1	1				1	1			1	1				1	1			2		1	
Pinnularia										1			1	1						1		1	1		1
Synedra				2	1				1	1				1								1	1	1	2

Date	Site	Sample	Chlorophyll *a* (mg per m2)	AFDM (g per m2)	Autotrophic Index (AFDM in mg/m2 : chlorophyll *a* in mg/m2)
18 March 2015	**Site 1**	**Pooled x10**	17.8	4.4	249.4
	Site 2	**Pooled x10**	19.2	3.9	201.6
	Site 3	**Pooled x10**	25.3	4.4	173.5
	Control 1	**Pooled x10**	29.8	4.1	137.3
	Control 2	**Pooled x10**	21.5	4.7	218.6

Appendix 5: Macroinvertebrate Sampling Results

Macroinvertebrate Data - 5 March 2015

Group	Species	Control A a	Control A b	Control A c	Control A d	Control A e	Control B a	Control B b	Control B c	Control B d	Control B e	Site 1 a	Site 1 b	Site 1 c	Site 1 d	Site 1 e	Site 2 a	Site 2 b	Site 2 c	Site 2 d	Site 2 e	Site 3 a	Site 3 b	Site 3 c	Site 3 d	Site 3 e
	1 Total abundance	484	608	541	60	234	349	520	238	227	225	157	537	182	319	431	267	209	235	326	398	503	393	275	500	547
	2 Number of taxa	20	21	19	11	15	18	20	15	17	18	18	24	17	16	23	23	15	17	24	20	25	23	18	21	25
	3 Number of EPT taxa	11	11	10	5	8	9	11	7	9	8	10	12	7	7	11	11	8	8	12	11	14	11	8	11	13
	4 MCI score	122	114.3	115.8	110.9	128	115.6	121	109.3	114.1	108.9	114.4	121.7	96.5	108.8	110.4	108.7	114.7	114.1	113.3	120	114.4	119.1	113.3	115.2	113.6
	5 QMCI	4.1	4.7	3.5	6.2	6.2	6.3	4.5	4.6	5.4	5.2	5.3	4.8	3.7	3.3	3.4	5.4	5.5	5.8	5	4.4	4.3	5.3	4.9	4.6	4.9
ACARINA	ACARINA	1								1	1		3				1			2	1	6	2	1	3	3
ANNELIDA	OLIGOCHAETA		1							2				2			1		1	1						
CNIDARIA	Hydra															1										
Coleoptera	Elmidae	30	101	24	3	30	93	74	28	68	94	20	113	24	30	37	57	74	56	26	16	73	89	28	91	83
Coleoptera	Hydraenidae	1		1		1		1					1			1				2			1			
Diptera	Aphrophila	4	2	1	2	8	2	2	2		8	2	6	2	5	3	2		1	1	6	10	9	2	4	8
Diptera	Austrosimulium	10	15	15	1	10	4	4	5	1	1	5	14	5	12	15	8		2	5	27	7	9	7	7	
Diptera	Empididae	1	1	1							2		2	1		1		2				1				1
Diptera	Eriopterini															1							1	1		1
Diptera	Maoridiamesa			15	1		1	5	11			2	10	17	27	15	5	3	20	12	7	8	4	5	10	2
Diptera	Muscidae																1									
Diptera	Orthocladiinae	246	211	300	9		39	240	94	45	31	37	147	61	153	231	59	22	29	66	69	123	54	59	109	40
Diptera	Pelecorhyncidae										1															
Diptera	Tabanidae		1				1										1						1			3
Diptera	Tanypodinae											1	1		1					1		1			1	5
Diptera	Tanytarsini	37	71	71			3	10	9	15	18	9	47	13	16	22	13	38	4	33	59	142	67	46	107	156
Ephemeroptera	Austroclima					2		1																		
Ephemeroptera	Coloburiscus	11	5			4	3					1									3	3	2		1	
Ephemeroptera	Deleatidium	76	129	70	25	77	133	93	48	44		45	80	6	4	13	65	48	74	80	49	57	84	53	79	83
Ephemeroptera	Nesameletus		1			1							1									1				1
Megaloptera	Archicauliodes	8	12	6	6	3	3	8	4	6	10	1	4	1	2	4	2	3	8	8	5	2	1	2	1	11
MOLLUSCA	Latia					8								1												
MOLLUSCA	Potamopyrgus		5			3	7	3	9	2	8		7		4		3	1	13	19	2	2	7	3	4	39
PLATYHELMINTHES	PLATYHELMINTHES															1										
Plecoptera	Austroperla												1			1			2						1	
Plecoptera	Megaleptoperla												1							1						
Plecoptera	Stenoperla												1						1							
Plecoptera	Zelandoperla	8	3	2	3		6	23	11	3	4						6	4	4	3	8	2		1		
Trichoptera	Aoteapsyche	22	16	11	8	56	21	28	9	9	16	11	43	36	44	43	6		7	35	118	25	12	30	26	10
Trichoptera	Beraeoptera	6	5	10	1	22	2	1	1	5	13	2	10	4	4	9	7			9	9	4	8	24	12	7
Trichoptera	Costachorema	1		2				3						1	1	2	1					1				
Trichoptera	Helicopsyche									1													1			1
Trichoptera	Hudsonema																									1
Trichoptera	Hydrobiosis	6	11	2	1	6	13	10	3	5	3	3	12	6	8	12	11	4	7	9	8	10	8	3	19	15
Trichoptera	Neurochorema		1	1								2	1	1			3	1		2	6	4	3	3	2	1
Trichoptera	Olinga	9	13	5			14	9	2	9	4	7	19		4	8	6	1	1	3	1	10	13	5	6	16
Trichoptera	Oxyethira										1					1				1		1				1
Trichoptera	Plectrocnemia																1			1	1					
Trichoptera	Psilochorema	1	3	3		3	3	2			2	2	10	1	4	2	4	4	5	2	2	3	6		3	2
Trichoptera	Pycnocentria	3	1				1	2		2		2	3			4	4	3		4	1	4	6		6	3
Trichoptera	Pycnocentrodes	3		1				1	2	9	8	5				4						3	5	2	8	54
Trichoptera	Triplectides																	1								

Waikanae River Baseline Aquatic Monitoring Monthly Report – April 2015

Kāpiti Water Supply RRwGW Scheme
Prepared for Kapiti Coast District Council

Document Quality Assurance

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1.0 Introduction

The Waikanae River Baseline Aquatic Monitoring Monthly Report – April 2015 is prepared in general accordance with the Waikanae River Baseline Aquatic Monitoring Plan (River BMP) prepared for Kapiti Coast District Council by Boffa Miskell (BML), dated 23 February 2014. As per the River BMP, this report presents "*the results of periphyton visual cover, depth, velocity and flows over the month via a spread sheet, noting any exceedance or trend relevant to triggering macroinvertebrate sampling and a comment on the periphyton trends at each site. Water quality and macroinvertebrate data will be delivered as part of this report via a spread sheet and, as appropriate, the hydrological gauging results*" for the Waikanae River monitoring for April 2015.

2.0 Monitoring

Sampling included three downstream (receiving) and two upstream (control) monitoring sites as per resource consent WGN130103 permit [33251] condition 19 and permit [33252] condition 21. Monitoring locations are provided in **Figure 1** below.

All monitoring was undertaken by suitably qualified ecologists in general accordance with the Waikanae River RBMP. Periphyton visual assessment transects and water quality sampling were undertaken on the 2nd, 17th, and 30th of March 2015. Periphyton sampling was undertaken on the

2nd and 17th March 2015. Periphyton samples were frozen and sent in a chilli-bin with ice to RCL for identification on 3rd and 21st April 2015. Water quality samples were sent in a chilli-bin with ice to Eurofins ELS Limited on the 2nd and 21st April 2015 and 4th May 2015. No macroinvertebrate sampling was required during April 2015, as there was no periphyton condition that required such sampling. No hydrological gauging was required during April 2015.

Field water quality readings were taken using a calibrated Horiba U-50 water quality meter and velocity data was collected using a FP111 Flow Probe.

No anomalous field observations (sheens, odours, high turbidity etc) were noted during March 2015.

Please note, because this is baseline monitoring, no exceedance trigger or relevant trend to trigger macroinvertebrate sampling is reported.

Raw data and results are provided in the following appendices:

- **Appendix 1:** Field water quality data.
- **Appendix 2:** Laboratory water quality results.
- **Appendix 3:** Periphyton visual cover data and water velocity data.
- **Appendix 4:** Periphyton sampling results**.**

3.0 References

Boffa Miskell (2014). Waikanae River Baseline Aquatic Monitoring Plan. Kapiti Water Supply RRwGW Scheme, prepared by Boffa Miskell Limited for Kapiti Coast District Council, dated 23 February 2014.

Appendix 1: Field Water Quality Data

2-Apr-15

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	11:55	12:41	13:44	14:23	19:00
Temperature (˚C)	15.8	15.3	15.6	16.0	16.3
pH	6.8	6.8	6.8	7.6	7.1
Conductivity (ms/cm)	0.109	0.110	0.111	0.111	0.114
Dissolved Oxygen (mg/L)	9.67	13.52	13.16	10.12	15.45
TDS (g/L)	0.071	0.071	0.072	0.072	0.074
NTU	0.6	0.6	0.7	0.6	0.6

17-Apr-15

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	9.57	9.27	10.28	11.21	11.53
Temperature (˚C)	12.3	12.2	12.4	12.7	12.8
pH	7.3	6.9	7.3	7.2	7.2
Conductivity (ms/cm)	0.1	0.100	0.103	0.100	0.101
Dissolved Oxygen (mg/L)	25.220	11.21	11.94	18.92	10.71
TDS (g/L)	0.065	0.065	0.067	0.065	0.066
NTU	1.6	0.4	2.1	1.7	1.6

30-Apr-15

Site	Control A	Control B	Site 1	Site 2	Site 3
Time	11	10.29	11.29	9.06	8.26
Temperature (˚C)	12.58	12.03	12.36	11.67	12.08
pH	7.58	7.68	7.36	7.47	7.36
Conductivity (ms/cm)	0.055	0.099	0.068	0.101	0.104
Dissolved Oxygen (mg/L)	49.01	23.35	36.53	19.31	26.16
TDS (g/L)	0.023	0.064	0.042	0.065	0.068
NTU	27.5	1.6	25.9	1.8	1.3

Appendix 2: Laboratory Water Quality Results

Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
Wellington
6142

Attention: Tony Payne

Report Number: 15/10969
Issue: 1
15 April 2015

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/10969-01	Surface Water		02/04/2015 12:10	07/04/2015 10:00	0

Notes: Control A, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.4		Marylou Cabral KTP
0055	Conductivity at 25°C	11.7	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.13	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.130	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.55	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.008	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.19	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/10969-02	Surface Water		02/04/2015 11:45	07/04/2015 10:00	0

Notes: Control B, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.4		Marylou Cabral KTP
0055	Conductivity at 25°C	11.7	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.12	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.118	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	6.08	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.007	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.20	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/10969-03	Surface Water		02/04/2015 13:20	07/04/2015 10:00	0

Notes: Site 1, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.5		Marylou Cabral KTP
0055	Conductivity at 25°C	11.7	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.11	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.114	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.60	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.012	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.006	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.22	g/m^3	Divina Lagazon KTP

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Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/10969-04	Surface Water		02/04/2015 14:20	07/04/2015 10:00	0

Notes: Site 2, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.8		Marylou Cabral KTP
0055	Conductivity at 25°C	11.7	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.10	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.100	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.52	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.012	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.007	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.20	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/10969-05	Surface Water		02/04/2015 18:00	07/04/2015 10:00	0

Notes: Site 3, W14039.340

	Test	Result	Units	Signatory
0001	pH	7.4		Marylou Cabral KTP
0055	Conductivity at 25°C	11.8	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.08	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.081	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.73	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.005	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.20	g/m^3	Divina Lagazon KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Conductivity at 25°C	APHA 22nd Edition Method 2510 B.	0.1 mS/m
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m^3
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m^3
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m^3
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m^3
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m^3
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m^3
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m^3

"<" means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m3 is the equivalent to mg/L and ppm.

Samples will be retained for a period of time, in suitable conditions appropriate to the analyses requested.

All test methods and confidence limits are available on request. This report must not be reproduced except in full, without the written consent of the laboratory.

Report Released By
Rob Deacon

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Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
Wellington
6142
Attention: Tony Payne

Report Number: 15/12994
Issue: 1
07 May 2015

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/12994-01	Surface Water		17/04/2015 09:20	21/04/2015 16:20	0

Notes: Control B, W14039

	Test	Result	Units	Signatory
0001	pH	7.3		Gordon McArthur KTP
0055	Conductivity at 25°C	10.5	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.33	g/m³	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.323	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	5.16	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.014	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.012	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.40	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/12994-02	Surface Water		17/04/2015 10:00	21/04/2015 16:20	0

Notes: Control A, W14039

	Test	Result	Units	Signatory
0001	pH	7.3		Gordon McArthur KTP
0055	Conductivity at 25°C	10.6	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.33	g/m³	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.330	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	5.05	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.017	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.012	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.38	g/m³	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/12994-03	Surface Water		17/04/2015 10:25	21/04/2015 16:20	0

Notes: Site 1, W14039

	Test	Result	Units	Signatory
0001	pH	7.5		Gordon McArthur KTP
0055	Conductivity at 25°C	10.7	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.33	g/m³	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.327	g/m³	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m³	Divina Lagazon KTP
1810	Calcium - Dissolved	5.26	g/m³	Shanel Kumar KTP
2080	Total Phosphorus	0.016	g/m³	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.012	g/m³	Divina Lagazon KTP
2127	Total Nitrogen	0.39	g/m³	Divina Lagazon KTP

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Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/12994-04	Surface Water		17/04/2015 11:25	21/04/2015 16:20	0

Notes: Site 2, W14039

	Test	Result	Units	Signatory
0001	pH	7.4		Gordon McArthur KTP
0055	Conductivity at 25°C	10.6	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.33	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.329	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.00	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.016	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.012	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.38	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/12994-05	Surface Water		17/04/2015 12:00	21/04/2015 16:20	0

Notes: Site 3, W14039

	Test	Result	Units	Signatory
0001	pH	7.3		Gordon McArthur KTP
0055	Conductivity at 25°C	10.8	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.35	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.345	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.12	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.016	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.012	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.41	g/m^3	Divina Lagazon KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Conductivity at 25°C	APHA 22nd Edition Method 2510 B.	0.1 mS/m
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m^3
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m^3
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m^3
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m^3
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m^3
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m^3
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m^3

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Eurofins ELS Limited

Analytical Report

Boffa Miskell
PO Box 11-340
Wellington
6142

Attention: Tony Payne

Report Number: 15/14190
Issue: 1
12 May 2015

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/14190-01	Surface Water		30/04/2015 11:00	04/05/2015 14:35	0

Notes: W14039.340 Control A

	Test	Result	Units	Signatory
0001	pH	7.4		Marylou Cabral KTP
0055	Conductivity at 25°C	10.7	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.19	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.184	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.48	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.008	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.28	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/14190-02	Surface Water		30/04/2015 10:30	04/05/2015 14:35	0

Notes: W14039.340 Control B

	Test	Result	Units	Signatory
0001	pH	7.4		Marylou Cabral KTP
0055	Conductivity at 25°C	10.7	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.18	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.180	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.26	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.007	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.29	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/14190-03	Surface Water		30/04/2015 11:30	04/05/2015 14:35	0

Notes: W14039.340 Site 1

	Test	Result	Units	Signatory
0001	pH	7.5		Marylou Cabral KTP
0055	Conductivity at 25°C	10.7	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.18	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.184	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.15	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.012	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.008	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.27	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/14190-04	Surface Water		30/04/2015 09:30	04/05/2015 14:35	0

Notes: W14039.340 Site 2

	Test	Result	Units	Signatory
0001	pH	7.5		Marylou Cabral KTP
0055	Conductivity at 25°C	10.8	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.19	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.189	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.41	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.008	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.29	g/m^3	Divina Lagazon KTP

Sample	Site	Map Ref.	Date Sampled	Date Received	Order No.
15/14190-05	Surface Water		30/04/2015 08:30	04/05/2015 14:35	0

Notes: W14039.340 Site 3

	Test	Result	Units	Signatory
0001	pH	7.4		Marylou Cabral KTP
0055	Conductivity at 25°C	11.1	mS/m	Gordon McArthur KTP
0125	Inorganic Nitrogen	0.23	g/m^3	Divina Lagazon .
0515	Nitrite Nitrate Nitrogen	0.225	g/m^3	Divina Lagazon KTP
0760	Ammonia Nitrogen	< 0.01	g/m^3	Divina Lagazon KTP
1810	Calcium - Dissolved	5.63	g/m^3	Shanel Kumar KTP
2080	Total Phosphorus	0.011	g/m^3	Divina Lagazon KTP
2088	Dissolved Reactive Phosphorus	0.006	g/m^3	Divina Lagazon KTP
2127	Total Nitrogen	0.38	g/m^3	Divina Lagazon KTP

Comments:

Sampled by customer using ELS approved containers.

Test Methodology:

Test	Methodology	Detection Limit
pH	Dedicated pH meter following APHA 22nd Edition Method 4500 H.	0.1
Conductivity at 25°C	APHA 22nd Edition Method 2510 B.	0.1 mS/m
Inorganic Nitrogen	By Calculation - NNN plus Ammonia	0.01 g/m^3
Nitrite Nitrate Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I.	0.005 g/m^3
Ammonia Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500 NH3-H.	0.01 g/m^3
Calcium - Dissolved	ICP-OES following APHA 22nd Edition Method 3120 B (modified).	0.01 g/m^3
Total Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G. Persulphate digestion follows APHA 22nd Edition 4500-P B.	0.005 g/m^3
Dissolved Reactive Phosphorus	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-P G.	0.005 g/m^3
Total Nitrogen	Flow Injection Autoanalyser following APHA 22nd Edition Method 4500-NO3 I. Persulphate digestion follows APHA 22nd Edition 4500-N C.	0.05 g/m^3

"<" means that no analyte was found in the sample at the level of detection shown. Detection limits are based on a clean matrix and may vary according to individual sample.

g/m3 is the equivalent to mg/L and ppm.

Samples will be retained for a period of time, in suitable conditions appropriate to the analyses requested.

All test methods and confidence limits are available on request. This report must not be reproduced except in full, without the written consent of the laboratory.

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Appendix 3: Periphyton Visual Cover Data and Water Velocity Data

Periphyton Cover - Field Survey Results
2-Apr-15

		SITE 1 (R1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green																				
	Light Brown	10	20	10	20	10	10	5	5	10	20	40	60	40	20	60	40	30	20	10	30
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	10	5	20	30	20	25	30	50	40	30			5	20	20	30	20	40	50	40
	Dark Brown/ Black	5	5	20	5	20	5	40	20	30	10										
Thick mat (%)	Green	10	10		20																
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green			20	5	5		5	10	5	5	5						5		5	5
	Brown reddish	50	60	30		30	60	10	5	5	10	10	20	30	30	5		10	10	20	30
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	90	80	100	95	90	80	90	80	75	80	90	70	60	70	80	75	80	70	60	70
	Velocity (m/s)	0.3	0.4	0.6	1.2	1.0	0.3	1.0	1.2	1.4	1.2	0.2	0.5	0.3	0.3	1.0	0.2	0.2	0.3	0.4	0.4
	Depth (cm)	13.0	17.0	16.0	22.0	31.0	10.0	16.0	20.0	17.0	26.0	30.0	36.0	34.0	30.0	12.0	13.0	21.0	31.0	35.0	27.0

		SITE 2 (R2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green																				
	Light Brown	40	20	10	15	5	10	5	10	5	5	10	10		30	30	50	30	10	20	20
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	30	40	50	50	60	40	60	70	70	50	40	50	70	40	40	10	30	80	60	30
	Dark Brown/ Black	5	5						5		5	5	5					5	5		
Thick mat (%)	Green	10				10	5	10			5										
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green		5	10	5	5	5		5	5	10	5	5	5	10		5				10
	Brown reddish		10	10	20	10	20	5		10	20	30	10	10	5	10		5			
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	80	80	80	90	80	90	90	70	80	90	70	80	90	70	80	60	75	70	60	50
	Velocity (m/s)	0.4	0.6	0.7	0.8	0.5	1.0	0.9	1.2	0.6	0.5	0.3	0.2	0.5	0.4	0.2	0.3	0.3	0.3	0.3	0.2
	Depth (cm)	16.0	14.0	27.0	29.0	31.0	20.0	18.0	32.0	27.0	17.0	46.0	50.0	47.0	36.0	18.0	39.0	44.0	45.0	42.0	22.0

		SITE 3 (R3)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green																				
	Light Brown	15	10	20	20	35	20	20	25	40	20	30	20	10	40	40	30	40	30	50	40
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	60	20	50	40	40	50	30	40	25	40	30	80	30	60	50	20	20	20	25	10
	Dark Brown/ Black	5	5				5	5			10										
Thick mat (%)	Green						5	10	5	10	5		5					5			
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish	5	10	10	20	10	20	10	10	5						5	5				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	80	90	80	75	75	80	80	90	95	90	40	30	40	50	70	70	75	50	60	60
	Velocity (m/s)	0.4	0.6	0.6	0.8	0.9	0.5	0.8	0.6	0.6	0.5	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.2
	Depth (cm)	12.0	21.0	27.0	29.0	31.0	18.0	33.0	30.0	27.0	25.0	31.0	56.0	70.0	67.0	51.0	21.0	35.0	37.0	29.0	23.0

		CONTROL A (C1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green																				
	Light Brown	10	15	5	20	10	20	25	10	20	15	80	70	80	70	70	70	20	10	20	30
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	10	10		10	20	30	10	5	5	10					10	5	20	30	5	
	Dark Brown/ Black	10	20	25	20	20	10	5	10	10	10										
Thick mat (%)	Green						**2**			**10**	20										
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green		10	5	5																
	Brown reddish	40	40	50	40	30	30	40	50	30	20		5		10		5	5	20	40	50
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	90	90	80	90	90	95	90	80	90	90	95	80	90	90	80	90	80	70	60	80
	Velocity (m/s)	0.5	0.8	0.9	1.0	1.1	0.1	0.6	0.9	0.9	1.1	0.1	0.1	0.1	0.3	0.3	0.2	0.3	0.3	0.3	0.3
	Depth (cm)	12.0	17.0	25.0	24.5	28.0	15.0	17.0	20.0	27.0	34.0	12.0	16.0	28.0	36.0	44.0	20.0	32.0	38.0	51.0	53.0

		CONTROL B (C2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Thin mat/film (%)	Green	10																			
	Light Brown			50	20	10	50	40	20	30	30	40	50	70	30	40	30	20	20	20	20
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black	40		10	25	20	10	10	20	10	5			5		2	10	10	10	10	5
Thick mat (%)	Green																				
	Light Brown																		20	10	5
	Dark Brown/ Black																				
Filaments, short (%)	Green			2	5	15	2		5		20								5	5	5
	Brown reddish	40		30	40	50	40	50	40	60	50	20	10	5	60	50	60	50	70	30	40
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	90	90	90	80	90	100	90	80	80	90	95	80	60	20	70	70	50	80	70	75
	Velocity (m/s)	0.8	1.1	1.2	1.2	1.2	0.6	0.6	0.9	0.8	1.0	0.3	0.4	0.5	0.3	0.4	0.5	0.6	0.7	0.6	0.2
	Depth (m)	9.0	12.0	21.0	28.0	30.5	9.0	12.0	17.0	21.5	24.5	15.5	31.0	32.0	36.0	24.5	13.0	32.0	32.0	31.0	16.5

Periphyton Cover - Field Survey Results
17-Apr-15

		SITE 1 (R1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Potential Cover (%)	100	80	90	80	90	80	95	80	80	70	80	60	60	80	60	50	70	30	75	75
	Velocity (m/s)	1.0	1.3	1.2	1.1	0.9	1.1	1.4	1.4	1.1	0.7	0.6	1.0	0.8	0.8	0.7	0.3	0.5	0.6	0.8	0.7
	Depth (cm)	26.0	51.0	53.0	38.0	18.0	34.0	35.5	39.0	45.0	17.0	17.5	23.0	52.0	55.0	30.0	38.0	61.0	56.0	52.0	26.0
Thin mat/film (%)	Green																				
	Light Brown	10	20	15	5		20	5	10	10				5	10	2				2	
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish		5						5												
Filaments, long (%)	Green																				
	Brown reddish																				

		SITE 2 (R2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Potential Cover (%)	90	80	80	75	90	90	80	90	100	80	70	60	80	75	80	90	80	90	75	60
	Velocity (m/s)	0.8	0.9	1.4	2.0	1.4	1.6	1.3	1.3	0.9	1.0	0.6	0.7	1.0	1.0	1.0	0.9	1.3	1.2	0.7	0.6
	Depth (cm)	27.0	40.0	45.0	41.0	44.0	49.0	49.0	42.0	33.0	26.0	22.0	32.0	40.0	51.0	43.0	44.0	50.0	52.0	39.0	22.0
Thin mat/film (%)	Green									5						5					
	Light Brown	5	5	10	10	5	10	15	10	15	10		2	5	10	10	20	10	10	5	5
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish				5		2		5										5		
Filaments, long (%)	Green																				
	Brown reddish																				

		SITE 3 (R3)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Potential Cover (%)	90	90	80	70	75	100	90	80	90	80	100	90	95	80	60	80	75	70	60	90
	Velocity (m/s)	1.0	1.3	1.5	1.7	1.5	1.1	1.3	1.2	1.3	1.1	0.7	0.6	0.7	1.0	0.6	0.8	0.8	0.6	0.3	0.2
	Depth (cm)	16.0	15.0	26.0	34.0	35.0	27.0	32.0	35.0	20.0	34.0	34.0	50.0	47.0	41.0	31.0	52.0	51.0	34.0	18.0	15.0
Thin mat/film (%)	Green							5													
	Light Brown	5					5	10	5			5		5	10				5		
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				

		CONTROL A (C1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Potential Cover (%)	70	90	90	80	80	90	80	80	90	100	90	80	90	90	100	90	75	80	75	0
	Velocity (m/s)	1.1	1.3	1.5	1.5	1.5	1.3	1.2	1.4	1.4	1.3	0.4	0.7	0.7	0.9	0.8	0.3	0.4	0.6	0.6	0.9
	Depth (cm)	27.0	29.0	38.0	39.0	47.0	22.0	27.0	29.0	49.0	27.0	27.0	42.0	50.0	59.0	57.0	26.0	42.0	47.0	70.0	78.0
Thin mat/film (%)	Green																				
	Light Brown			5		5	10		1		10	5						5		10	
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				

		CONTROL B (C2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Thin mat/film (%)	Green		10	5	5																
	Light Brown	5	5	10	5			15		5		10						5	2	2	
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				
	Potential Cover (%)	90	90	100	80	80	90	80	75	8	80	70	70	60	60	80	90	80	60	75	90
	Velocity (m/s)	0.2	1.8	1.3	1.6	1.4	1.3	1.4	1.4	1.3	1.5	0.4	0.7	1.2	1.2	0.8	0.7	0.3	0.8	0.9	0.7
	Depth (m)	26.0	30.0	35.0	33.0	41.5	32.0	30.0	27.0	30.0	32.0	19.0	31.0	36.0	27.0	17.0	15.0	29.0	25.0	31.0	20.0

Periphyton Cover - Field Survey Results
30-Apr-15

		SITE 1 (R1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Velocity (m/s)	0.7	0.5	1.0	1.2	0.3	0.4	0.8	1.6	0.7	0.4	0.2	0.4	0.7	0.6	0.2	0.3	0.5	0.7	0.6	0.2
	Depth (cm)	25.0	21.0	31.0	23.0	38.0	16.0	25.0	24.0	31.0	53.0	27.0	45.0	53.0	42.0	25.0	26.0	26.0	45.0	52.0	34.0
	Potential Cover (%)	90	90	70	80	100	90	80	80	95	80	70	50	70	30	100	90	40	70	80	50
Thin mat/film (%)	Green																				
	Light Brown	85	60	80	50	90	90	40	70	10	70	90	80	100	90	90	80	60	60	94	80
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	10	10	5				30	20		10	1	20						10	1	10
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green											1								5	
	Brown reddish																				
Filaments, long (%)	Green	1	10	5				30													
	Brown reddish																				

		SITE 2 (R2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Velocity (m/s)	0.2	0.3	0.5	0.6	0.1	0.2	0.3	0.4	0.5	0.3	0.2	0.3	0.4	0.6	0.2	0.1	0.2	0.7	0.5	0.3
	Depth (cm)	14.0	36.0	40.0	45.0	28.0	12.0	28.0	37.0	46.0	38.0	12.0	26.0	36.0	60.0	28.0	9.0	16.0	44.0	61.0	34.0
	Potential Cover (%)	95	70	70	80	80	80	70	70	50	70	20	30	50	20	80	10	50	70	20	90
Thin mat/film (%)	Green																				
	Light Brown	80	95	60	60	60	60	85	10	50	30	90	90	80	50	75	70	90	90	10	70
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown	10	5	20	30	10		10	10	50	60			5	40	5			5	90	1
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green			20	5			2	70						2						
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				

		SITE 3 (R3)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Velocity (m/s)	0.2	0.4	0.5	0.5	0.3	0.2	0.5	0.6	0.6	0.2	0.1	0.2	0.3	0.3	0.2	0.1	0.6	0.5	0.5	0.2
	Depth (cm)	14.0	36.0	50.0	43.0	17.0	12.0	35.0	46.0	43.0	17.0	16.0	40.5	65.0	74.0	21.0	13.0	42.0	42.0	38.0	19.0
	Potential Cover (%)	80	70	30	50	80	80	90	80	70	80	40	60	20	90	90	40	40	60	100	90
Thin mat/film (%)	Green																				
	Light Brown	90	95	60	80	50	80	70	20	60	70	30	80	60	50	90	70	90	80	90	80
	Dark Brown/ Black																				
		90	95	60	80	50		70	20	60	70	30	80	60	50	90	70	90	80	90	80
Medium mat (%)	Green		5																		
	Light Brown							10	10		10										
	Dark Brown/ Black																				
		0	5	0	0	0		10	10	0	10	0	0	0	0	0	0	0	0	0	0
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)		0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green			20	10			20	50	10											
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				

		CONTROL A (C1)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Velocity (m/s)	0.3	0.6	0.5	0.8	0.3	0.1	0.4	0.6	0.6	0.3	0.1	0.3	0.5	0.5	0.3	0.2	0.3	0.5	0.3	0.2
	Depth (cm)	11.0	17.0	37.0	40.0	24.0	14.0	30.0	47.0	53.0	40.0	16.0	34.0	47.0	67.0	82.0	22.0	50.0	72.0	91.0	97.0
	Potential Cover (%)	90	90	95	60	80	95	90	90	80	90	90	90	90	90	90	100	100	90	80	80
Thin mat/film (%)	Green																				
	Light Brown	80	65	90	60	80	80	70	85	70	50	80	70	60	40	10	70	50	30	30	50
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown		20	10	30				5												
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green		20	1	5																
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				

		CONTROL B (C2)																			
		Riffle 1					Riffle 2					Run 1					Run 2				
Periphyton Class		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	Velocity (m/s)	0.5	0.4	0.4	0.6	0.3	0.6	0.5	0.5	8.0	0.2	0.2	0.1	0.3	..2	0.1	0.2	0.3	0.2	0.2	0.3
	Depth (cm)	30.0	17.0	23.0	31.0	14.0	45.0	26.0	24.0	22.0	10.0	79.0	5.0	28.0	32.0	12.0	18.0	51.0	68.0	41.0	71.0
	Potential Cover (%)	90	90	60	90	90	90	80	80	60	90	50	20	40	50	90	85	80	0	0	5
Thin mat/film (%)	Green																				
	Light Brown	80	70	70	90	90	80	80	100	80	80	10	50	80	70	70	60	70			
	Dark Brown/ Black																				
Medium mat (%)	Green																				
	Light Brown			5	10					10											
	Dark Brown/ Black																				
Thick mat (%)	Green																				
	Light Brown																				
	Dark Brown/ Black																				
Filaments, short (%)	Green																				
	Brown reddish																				
Filaments, long (%)	Green																				
	Brown reddish																				

Appendix 4: Periphyton Sampling Results

Date	Site	Sample	Chlorophyll *a* (mg per m^2)	AFDM (g per m^2)	Autotrophic Index (AFDM in mg/m^2 : chlorophyll *a* in mg/m^2)
2 April 2015	**Site 1**	**a**	36.2	7.0	192.4
		b	62.1	8.4	135.3
		c	63.0	12.8	203.6
		d	43.4	8.2	189.0
		e	21.6	4.2	194.9
	Site 2	**a**	231.7	23.5	101.3
		b	32.9	4.1	125.7
		c	25.8	3.7	142.5
		d	43.1	8.3	193.6
		e	32.1	7.4	229.2
	Site 3	**a**	41.8	6.3	150.2
		b	61.7	10.3	167.5
		c	39.0	9.3	239.2
		d	33.0	8.1	244.8
		e	30.8	7.6	246.3
	Control 1	**a**	98.7	8.4	84.7
		b	57.1	7.2	125.5
		c	75.6	9.1	120.4
		d	19.7	3.7	188.1
		e	48.6	8.1	165.5
	Control 2	**a**	34.6	4.8	138.8
		b	81.6	11.1	136.5
		c	29.7	7.5	251.9
		d	110.6	10.8	97.2
		e	35.2	4.7	133.1

Date	Site	Sample	Chlorophyll *a* (mg per m^2)	AFDM (g per m^2)	Autotrophic Index (AFDM in mg/m^2 : chlorophyll *a* in mg/m^2)
17 April 2015	**Site 1**	**Pooled x10**	0.1	0.2	1240.6
	Site 2	**Pooled x10**	0.4	0.2	373.8
	Site 3	**Pooled x10**	1.0	0.2	228.8
	Control 1	**Pooled x10**	0.3	0.2	450.2
	Control 2	**Pooled x10**	0.1	0.1	610.6

Appendix C

Bore and River Water Quality Summary

Comments on following tables

Laboratory detection limits, resource consent condition and water quality guideline values have been added to the following tables.

Note the ANZECC (2000) Guidelines are applicable to the receiving body of water (in this case the Waikanae River) rather than the bore water discharge. Although the bore water exceeds the guideline values for some parameters, once the groundwater enters the river and is diluted it is expected that the concentrations in the river will be acceptable.

The water from all bores meets the Drinking-water Guidelines for New Zealand 2005 (revised 2008) maximum acceptable values.

Table C.1: Summary of Bore Water Quality Sampling Results (July 2014 to June 2015) and River Water Quality Sampling Results (December 2014 to April 2015)

Bore		Temperature (field) (°C)	pH (field) -	pH (lab) -	Conductivity (field) mS/m	Conductivity (lab, @25°C) mS/m	Dissolved Oxygen (field) mg/l	Dissolved Oxygen (lab) g O_2/m^3	Total (NP) Organic Carbon g/m^3	Alkalinity - Total g $CaCO_3$/m^3	Total Dissolved Solids g/m^3	Bicarbonate g $CaCO_3$/m^3	Free CO_2 g CO_2/m^3	Anion Sum meq/l	Cation Sum meq/l	Ion Balance %	Fluoride g/m^3
Laboratory detection limit				0.1		0.1		1	0.5	0.3	1	1	1	1	0.001	0.001	0.01
Resource consent WGN130103 [33252] condition 7		n/a	7.0 - 8.8	7.0 - 8.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Drinking-water Standards for New Zealand 2005 (revised 2008)		n/a	7.0-8.5 (GV)	7.0-8.5 (GV)	n/a	n/a	n/a	n/a	n/a	n/a	1000 (GV)	n/a	n/a	n/a	n/a	n/a	1.5
ANZECC 2000 Guidelines	99% protection	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	95% protection	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
KB4	Maximum	16.7	7.7	7.8	104.2	122	0.46	1.2	0.5	204	673	203	40	11.0	10.6	14.3	0.04
	Minimum	14.8	7.2	7	87.5	107	0.08	<0.5	<0.3	187	589	186	6	7.3	9.72	0.3	0.03
	Average	15.3	7.5	7.7	92.8	113	0.20	0.8	0.3	194	619	193	11	9.6	10.1	3.61	0.03
	Number of Samples	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
K4	Maximum	15.3	7.6	7.6	60.1	63	0.24	1.4	1.2	127	346	127	9	5.4	6.01	7.24	0.26
	Minimum	14.5	7.0	7.4	47.2	47	0.07	<0.5	0.7	102	261	102	6	4.2	4.15	0.98	0.17
	Average	14.8	7.4	7.5	55.4	58	0.14	0.9	0.8	109	317	109	7	4.9	5.2	2.82	0.21
	Number of Samples	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
K5	Maximum	15.5	8.0	8.1	100	107	0.40	8.8	0.7	248	589	245	6	9.64	11.2	11.5	0.11
	Minimum	15.4	7.6	7.9	70.4	101	0.05	0.6	<0.3	194	554	192	4	8.4	9.2	0.34	0.04
	Average	15.5	7.9	8.0	90.8	104	0.17	1.5	0.5	223	573	220	4	9.0	9.6	3.25	0.06
	Number of Samples	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
K6	Maximum	15.9	7.6	7.7	103.5	111	1.39	1.2	0.5	277	612	276	52	10	11.9	11.8	0.05
	Minimum	15.2	7.2	7	91.9	109	0.06	0.6	<0.3	251	597	249	9	8.8	9.9	0.45	0.03
	Average	15.3	7.5	7.6	97.3	110	0.35	0.81	0.3	262	606	261	16	9.6	10.4	4.23	0.04
	Number of Samples	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
K10	Maximum	15.1	7.4	7.7	63.4	80.5	0.65	1.1	0.3	208	443	207	11	6.75	7.59	6.02	0.03
	Minimum	14.8	7.4	7.6	61.3	80.2	0.09	0.9	0.3	205	441	204	9	6.7	7.5	5.07	0.03
	Average	15.0	7.4	7.7	62.4	80	0.37	1.00	0.3	207	442	206	10	6.7	7.5	5.55	0.03
	Number of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Kb7	Maximum	15.1	7.7	7.8	55.4	62.3	0.15	1	0.1	91	343	91	3	5.28	5.64	4.27	0.07
	Minimum	15.1	7.7	7.8	54.9	61.1	0.15	0.9	0.1	90	336	90	3	5.2	5.5	2.13	0.07
	Average	15.1	7.7	7.8	55.2	62	0.15	0.95	0.1	91	340	91	3	5.2	5.6	3.20	0.07
	Number of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
K12	Maximum	14.8	7.8	7.9	44.7	50.4	0.73	0.9	0.2	84	277	84	2	4.18	4.48	3.46	0.08
	Minimum	14.7	7.8	7.8	44	50.3	0.24	0.9	0.1	82	277	81	2	4.2	4.4	2.8	0.08
	Average	14.8	7.8	7.9	44.4	50	0.49	0.90	0.2	83	277	83	2	4.2	4.4	3.13	0.08
	Number of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
N2	Maximum	14.5	7.4	7.5	38.1	42.9	0.46	0.9	0.4	70	236	70	5	3.62	4.04	7.74	0.16
	Minimum	14.3	7.3	7.4	37.2	42.9	0.3	0.7	0.2	70	236	70	4	3.5	3.8	2.53	0.15
	Average	14.4	7.3	7.5	37.7	43	0.38	0.80	0.3	70	236	70	5	3.5	3.9	5.14	0.16
	Number of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
River Sampling Dec 2014 to Apr 2015 (5 sites)	Maximum	20.70	7.90	8.2	30.0		49.0										
	Minimum	11.67	4.22	7.3	0.0		0.00										
	Average	16.3	7.02	7.6	9.5		14.4										
	Number of Samples	50	48	60	50		50										

Bore		Chloride	Nitrite - Nitrogen	Bromide	Nitrate - Nitrogen	Sulphate	Ammonia Nitrogen	Total Hardness	Boron - Dissolved	Calcium - Dissolved	Iron - Dissolved	Magnesium - Dissolved	Manganese - Dissolved	Potassium - Dissolved	Sodium - Dissolved	Total Phosphorus	Dissolved Reactive Phosphorus
		g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	$gCaCO_3/m^3$	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3
Laboratory detection limit		0.02	0.01	0.02	0.01	0.02	0.01	1	0.005	0.01	0.005	0.01	0.005	0.01	0.02	0.005	0.005
Resource consent WGN130103 [33252] condition 7		n/a	n/a	n/a	n/a	n/a	2	n/a	0.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Drinking-water Standards for New Zealand 2005 (revised 2008)		250 (GV)	0.06	n/a	11.3	250 (GV)	n/a	200 (GV)	1.4	n/a	0.2 (GV)	n/a	0.4	n/a	200 (GV)	n/a	n/a
ANZECC (2000) Guidelines	99% protection	n/a	n/a	n/a	4.9	n/a	0.32	n/a	0.09	n/a	n/a	n/a	1.2	n/a	n/a	n/a	n/a
	95% protection	n/a	n/a	n/a	7.2	n/a	0.9	n/a	0.37	n/a	n/a	n/a	1.9	n/a	n/a	n/a	n/a
KB4	Maximum	275	0.06	1.07	<0.01	2.15	0.06	147	0.268	38.7	0.005	12.3	0.030	7.07	176	0.037	0.041
	Minimum	149	<0.01	0.8	<0.01	1.08	0.04	123	0.233	31.0	<0.005	10.9	0.018	6.01	157	0.029	0.028
	Average	227	0.01	0.90	<0.01	1.469	0.05	136	0.249	34.9	<0.005	11.8	0.024	6.39	165.4	0.033	0.036
	Number of Samples	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
K4	Maximum	113	<0.01	0.42	<0.01	19.10	0.02	38	0.105	5.5	0.02	6.0	0.183	2.01	121	0.105	0.104
	Minimum	75	<0.01	0.14	<0.01	12.9	<0.01	25	0.063	3.7	<0.005	3.9	0.128	1.67	82.9	0.092	0.074
	Average	99	<0.01	0.35	<0.01	16.16	0.01	32	0.095	4.6	0.011	5.1	0.161	1.81	102.5	0.098	0.093
	Number of Samples	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
K5	Maximum	201	0.04	1.01	<0.01	0.67	0.32	136	0.53	31.9	0.04	13.7	0.080	8.56	195	0.128	0.136
	Minimum	181	<0.01	0.52	<0.01	0.33	0.13	100	0.319	22.6	0.007	10.5	0.052	6.74	151	0.094	0.085
	Average	190	<0.01	0.73	<0.01	0.49	0.28	122	0.423	27.8	0.025	12.6	0.061	7.42	160	0.109	0.109
	Number of Samples	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
K6	Maximum	196	0.03	0.78	<0.01	0.84	0.4	148	0.683	35.2	0.005	15.3	0.1	9.51	202	0.08	0.073
	Minimum	163	<0.01	0.58	<0.01	0.34	0.33	137	0.58	31.1	<0.005	14.3	0.07	8.35	156	0.064	0.054
	Average	186	<0.01	0.72	<0.01	0.55	0.37	143	0.627	33.1	<0.005	14.6	0.078	9.10	168	0.074	0.066
	Number of Samples	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
K10	Maximum	119	<0.01	0.51	<0.01	<0.02	0.22	182	0.202	49.9	0.011	13.8	0.187	7.40	90.5	0.057	0.037
	Minimum	119	<0.01	0.46	<0.01	<0.02	0.21	167	0.141	46.3	0.009	12.4	0.157	7.27	86.4	0.05	0.035
	Average	119	<0.01	0.49	<0.01	<0.02	0.22	175	0.172	48.1	0.01	13.1	0.172	7.34	88	0.054	0.036
	Number of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Kb7	Maximum	122	<0.01	0.4	<0.01	14.5	<0.01	65	0.555	13.1	0.024	7.8	0.015	2.64	98.3	0.03	0.034
	Minimum	119	<0.01	0.36	<0.01	14.10	<0.01	62	0.519	12.7	0.022	7.31	0.015	2.58	96.7	0.03	0.026
	Average	121	<0.01	0.38	<0.01	14.30	<0.01	64	0.537	12.9	0.023	7.6	0.015	2.61	98	0.030	0.030
	Number of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
K12	Maximum	88.7	<0.01	0.29	<0.01	15.3	0.01	78	0.427	18	<0.005	8.31	0.052	1.96	65.9	0.042	0.048
	Minimum	86.3	<0.01	0.27	<0.01	15.00	0.01	78	0.396	17.6	<0.005	7.92	0.049	1.92	64.4	0.042	0.044
	Average	88	<0.01	0.28	<0.01	15.15	0.01	78	0.412	17.8	<0.005	8.1	0.051	1.94	65	0.042	0.046
	Number of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
N2	Maximum	72.6	<0.01	0.24	<0.01	20.2	0.05	100	0.095	28.5	0.005	7.7	0.098	3.12	43.6	0.122	0.124
	Minimum	67.3	<0.01	0.22	<0.01	19.50	0.05	96	0.059	26.7	<0.005	7.21	0.088	2.9	41.5	0.119	0.124
	Average	70	<0.01	0.23	<0.01	19.85	0.05	98	0.077	27.6	<0.005	7.5	0.093	3.01	43	0.121	0.124
	Number of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

River Sampling Dec 2014 to Apr 2015 (5 sites)	Maximum						<0.01			6.29						0.020	0.014
	Minimum						<0.01			4.72						0.008	0.005
	Average						<0.01			5.59						0.012	0.010
	Number of Samples						60			60						60	60

Bore		Total Nitrogen g/m^3	Arsenic - Dissolved g/m^3	Cadmium - Dissolved g/m^3	Chromium - Dissolved g/m^3	Copper - Dissolved g/m^3	Lead - Dissolved g/m^3	Nickel - Dissolved g/m^3	Zinc - Dissolved g/m^3
Laboratory detection limit		0.05	0.001	0.0002	0.001	0.0005	0.0005	0.0005	0.002
Resource consent WGN130103 [33252] condition 7		n/a	0.03	0.0005	0.0022	0.0033	n/a	n/a	0.018
Drinking-water Standards for New Zealand 2005 (revised 2008)		n/a	0.01	0.004	0.05	2	0.01	0.08	1.5 (GV)
ANZECC 2000 Guidelines	99% protection	n/a	0.001 (As III) 0.0008 (As V)	0.00006	0.00001	0.001	0.001	0.008	0.0024
	95% protection	n/a	0.024 (As III) 0.013 (As V)	0.0002	0.001	0.0014	0.0034	0.011	0.008
KB4	Maximum	0.08	<0.001	<0.0002	<0.001	0.0025	<0.0005	<0.0005	0.010
	Minimum	<0.05	<0.001	<0.0002	<0.001	<0.0005	<0.0005	<0.0005	0.004
	Average	0.06	<0.001	<0.0002	<0.001	0.0009	<0.0005	<0.0005	0.006
	Number of Samples	10	10	10	10	10	10	10	10
K4	Maximum	0.06	0.007	<0.0002	0.002	0.0025	<0.0005	<0.0005	0.010
	Minimum	<0.05	<0.001	<0.0002	<0.001	<0.0005	<0.0005	<0.0005	0.003
	Average	<0.05	<0.001	<0.0002	0.0006	0.0008	<0.0005	<0.0005	0.006
	Number of Samples	11	11	11	11	11	11	11	11
K5	Maximum	0.34	0.001	0.0001	<0.001	0.0025	<0.0005	<0.0005	0.007
	Minimum	0.26	<0.001	<0.0002	<0.001	<0.0005	<0.0005	<0.0005	<0.002
	Average	0.31	0.001	<0.0002	<0.001	0.0007	<0.0005	<0.0005	0.002
	Number of Samples	10	10	10	10	10	10	10	10
K6	Maximum	0.43	0.001	<0.0002	<0.001	0.0053	<0.0005	0.0011	0.018
	Minimum	0.33	<0.001	<0.0002	<0.001	<0.0005	<0.0005	<0.0005	<0.002
	Average	0.387	<0.001	<0.0002	<0.001	0.0018	<0.0005	<0.0005	0.009
	Number of Samples	9	9	9	9	9	9	9	9
K10	Maximum	0.23	0.001	<0.0002	<0.0002	0.0119	<0.0005	<0.0005	0.028
	Minimum	0.22	0.001	<0.0002	<0.0002	0.002	<0.0005	<0.0005	0.01
	Average	0.225	0.001	<0.0002	<0.0002	0.0070	<0.0005	<0.0005	0.019
	Number of Samples	2	2	2	2	2	2	2	2
Kb7	Maximum	<0.05	<0.001	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	0.005
	Minimum	<0.05	<0.001	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	0.002
	Average	<0.05	<0.001	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	0.004
	Number of Samples	2	2	2	2	2	2	2	2
K12	Maximum	<0.05	<0.001	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	0.004
	Minimum	<0.05	<0.001	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	0.003
	Average	<0.05	<0.001	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	0.004
	Number of Samples	2	2	2	2	2	2	2	2

River Sampling Dec 2014 to Apr 2015 (5 sites)	Maximum	0.9							
	Minimum	0.09							
	Average	0.20							
	Number of Samples	60							