WAIMAKARIRI
DISTRICT COUNCIL

Land and Water Committee

Agenda

Thursday 12 December 2019

9.30am

Waimakariri District Council Chambers
215 High Street
Rangiora

Members:

Cr Sandra Stewart (Chairperson)
Cr Neville Atkinson
Cr Kirstyn Barnett
Cr Al Blackie
Cr Niki Mealings
Cr Paul Williams

The Chairperson and Members
LAND AND WATER COMMITTEE

A Meeting of the **LAND AND WATER COMMITTEE** will be held in the **COUNCIL CHAMBERS, 215 HIGH STREET, RANGIORA** on **THURSDAY 12 DECEMBER 2019** to commence at **9.30am.**

Adrienne Smith
Governance Coordinator

Recommendations in reports are not to be construed as Council policy until adopted by the Council

BUSINESS

Page No

1 APOLOGIES

2 CONFLICTS OF INTEREST

Conflicts of interest (if any) to be reported for minuting.

3 RECEIPT OF MINUTES

3.1 Minutes of a meeting of the Land and Water Working Group held on Thursday 26 September 2019

RECOMMENDATION *5-9*

THAT the Land and Water Committee:

(a) **Receives** for information the circulated minutes of a meeting of the Land and Water Working Group held on 26 September 2019.

4 MATTERS ARISING

5 DEPUTATION

6 REPORTS

6.1 Stormwater Network Discharge Consents Issues and Implications – Janet Fraser (Utilities Planner)

RECOMMENDATION *10-16*

THAT the Land and Water Committee:

(a) **Receives** report No. 191128167199.

(b) **Notes** the ongoing lodgement and processing of stormwater network consent applications, including applications for Kaiapoi and Oxford to be submitted by 20 December 2019, introducing new regulation of urban stormwater quality and stormwater quantity.

7 REPORTS FOR INFORMATION

7.1 **Urban Stormwater water quality baseline results and issues identified – Sophie Allen (Water Environment Advisor)** - *(Report from the Utilities and Roading Committee meeting 19 November)*

17-190

7.2 **Cam River floodgate automation for saline intrusion prevention – Gerard Cleary (Manager Utilities and Roading)** – *(Report from the Utilities and Roading meeting 19 November 2019)*

191-207

7.3 **ZIPA Implementation – Update - Sophie Allen (Water Environment Advisor)** *(Report from the CWMS Waimakariri Zone Committee meeting 2 December 2019)*

208-212

Staff will provide an update on item 7.3

RECOMMENDATION

THAT Items 7.1 – 7.3 be received for information.

8 QUESTIONS

9 URGENT GENERAL BUSINESS

NEXT MEETING

The next meeting of the Land and Water Committee is scheduled for 9:30am, Thursday 13 February 2020 in the Council Chambers.

Briefing

Waimakariri Irrigation – Biodiversity project briefing – Dan Cameron (Project Lead, Dan Cameron Landscape Architecture) and Paul Reese (Waimakariri Irrigation Environmental Manager, Water Strategies Ltd)

As part of its freshwater solutions package, Waimakariri Irrigation Ltd is progressing a scheme-wide project to undertake the protection and enhancement of Biodiversity values and freshwater in partnership with its shareholders. With increasing activity in this area from multiple players, this is an opportunity to brief the Land & Water Committee on the project in order to keep members informed as to what they have done to date, where they are currently focussing on their efforts, and where they are heading. Through this discussion they hope to identify opportunities to share information and resources that help achieve the relevant outcomes we all want for our district.

MINUTES OF THE SECOND MEETING OF THE LAND AND WATER WORKING GROUP HELD IN THE COUNCIL CHAMBER, 215 HIGH STREET, RANGIORA AT 2PM ON THURSDAY 26 SEPTEMBER 2019

Attendees:

Councillor Robbie Brine, Councillor Kirstyn Barnett, Councillor Al Blackie, Geoff Meadows (Policy Manager), Councillor Paul Williams, Councillor Sandra Stewart, Sophie Allen (Water Environment Advisor), Grant MacLeod (Greenspace Manager), Gerard Cleary (Manager Utilities and Roading), Paula Douglas (Minutes Secretary)

1. APOLOGIES

Chris Brown, Kalley Simpson

Moved by Clr. Barnett
Seconded by Clr. Stewart **Carried**

2. CONFLICTS OF INTEREST

None.

3. CONFIRMATION OF PREVIOUS MINUTES

Moved by Clr. Stewart
Seconded by Clr. Williams **Carried**

4. PRESENTATIONS / DEPUTATIONS

4.1 Next Generation Farmers Trust – Victoria Trayner

(a) Victoria Trayner, Grant Edmonson, and Scott Evans were introduced to the group.
(b) Victoria is a Board Member, Grant is their Lawyer / Mentor, and Scott is the Chair of the Trust.
(c) Victoria gave background information on the Trust;
- It was set up 18mth – 2yrs ago in response to the ZIPA. Gives farmers a voice.
- Trust has formalised with 7 Trustees and a Board meeting once per month.
- Membership base of over 150 farmers, also business owners and rural sector business owners.

(d) The Trust helps highlight changes that have come about from the ZIPA, and helps people make submissions as individuals and as enterprises.
(e) Scott noted that the Trust's main motto is to bridge the gap between local authorities and farmers; facilitating understanding, not in confrontation, but in consultation.
(f) Victoria explained that the Trust's first step was to "nurture our own back yard", and to get Primary Industries on board. They have input from a range of industry stakeholders including Fonterra, Synlait, and Waimakariri Irrigation Limited.
(g) Next step for the Trust is to get the wider community involved, and to understand what they can actually do.
(h) Scott suggested a few ways in which the Council could help the Trust;
- Provide clear guidelines around what is beneficial to plant along waterways.
- Facilitate access to funds.
- Help to navigate through the consent process.
- Assistance with planning so don't end up with legacy issues.

(i) Victoria queried what sort of measuring and monitoring the Council will do. The Trust has members that are willing to open their gates to get measuring and monitoring happening on their farms. All types of farms are represented in the Trust, including arable farms, and even some lifestyle blocks.
(j) Clr. Stewart noted that measuring and monitoring will be part of parcel of the changes and required in consenting conditions.
(k) Grant shared his experience in helping put the Trust together, and highlighted that he is impressed with the leadership of the Trust. They are wanting to take the lead on data and data sharing, consistency of data, and transparency in reporting, and would like to see this permeate to a national level.
(l) Scott noted that the Trust will be able to engage with farmers easier than Council, and that although there will be farmers that don't want to partake in measuring and monitoring, there will be a lot more who will.
(m) Clr. Brine queried if the Trust has finances to put in a submission to the Government to respond to the NPS – Freshwater Management and Essential Freshwater package. The Trust would love to submit, but they are self-funded. PC7 was Waimakariri-specific and they had an RMA lawyer and a planner help with their PC7 submission. The NPS-FM is national. They interlink a lot, but the Trust won't be lobbying Central Government.
(n) Clr. Barnett queried if the Trust has plans to tell their story to urban representatives. This will be part of the Trust's next step. Currently the Trust has a Facebook page, and is looking to get more visible.
(o) There are a lot of farmers who are scared of losing their farms, and they want to know what they can do to ensure that this doesn't happen.
(p) To keep in touch, Sophie will remain the Trust's main point of contact, and minutes etc. from this Working Group's meetings will be circulated to the Trust.

Action: Paula to send the Working Group's Terms of Reference to the Trust.
Action: Paula to add Victoria to the circulation list.

4.2 <u>'Action for Healthy Waterways/ Essential Freshwater' presentation and discussion on the WDC submission. Geoff Meadows – Policy Manager</u>

(a) At the DPR briefing, three national directions were looked at. We have submissions underway for two of them (NPS for Highly Productive Land, NPS for Urban Development) and are still working on the Essential Freshwater package – this has both a draft NPS for Freshwater Management and a proposed NES for Freshwater.
(b) Geoff noted that there are no Canterbury catchments in the Schedule of Catchments for nitrogen load management.
(c) Discussed ECan's Plan Change 7 (PC7) vs theMfE Essential Freshwater Package;
- There is a difficulty for ECan in that things are changing so quickly. Policy parameters keep changing and by the time PC7 changes are implemented, they will be needing to change again.
- Intensification rules have already taken place in Plan Changes 1 through 6. PC7 intensification rules are not fully implemented, MfE haven't decided if they will accept PC7 intensification rules; as they are notified, but not operative. Deliberations are yet to take place.
- Because it was a publically consulted process, it is expected that PC7 will proceed.
- Gerard mentioned that he was at the LGNZ Freshwater Forum earlier in the week and discussed this with ECan staff. They were unsure how the Essential Freshwater Package would fit in terms of PC7.

- Essential Freshwater package is not law, just a proposal, so will ECan react on the basis of what's been proposed, or what is actually a policy statement? It will be their call if they proceed with PC7.

(d) Discussed the Report that will be going to Council on 1st October;
- Recommends approval of the main points of a submission, and authorises the Mayor and CE to approve a submission before 11th October.
- Clr. Barnett noted that this means the main points will effectively be approved 'sight unseen'.
- Clr. Blackie commented on the stock exclusion policies, and brought up a recent Press article on a 4yr study done by Cawthron Institute on fencing & riparian planting that showed these measures made little or no difference to the ecological life of the stream.
- Geoff noted that PC7 has more stringent stock exclusion policies.
- Sophie has further information on the article / study which can be circulated.

(e) Discussed the 'hierarchy of values';
- Difficult for Local Government as we already have the 4 Well-beings in the Local Government Act which are treated equally.
- The Hierarchy puts human health and social/economic health below ecological health.
- Gerard commented that the direction and intention of the Hierarchy is good, however some of the targets could be counter-productive. eg. Putting resources into trying to achieve a DIN of 1 will distract from other things that would be better to try to achieve.

(f) Discussed the regulatory impact potential shortage of Farm Environment Plan auditors;
- The National Environmental Standard – Freshwater (part of the Essential Freshwater Package) requires farm plans to be mandatory, and they are required to be put together by "suitably qualified and experienced" professionals.
- There is currently a recruitment drive on for Farm Environment Plan auditors.
- Clr. Barnett queried the definition of a farm, and if smaller farms will be included in auditing. Potential for farms under 5ha to be missed.

(g) The timeframe for some of these changes will be a 'generation'. Regional Council Plans are to operative up by 1st December 2025, and although they may seem unattainable now, there will be changes to technology and best practice by then.

Action: Sophie to send Cawthron study information to Paula for circulation.

4.3 Verbal Update: Kaiapoi River Rehabilitation. Sophie Allen – Water Environment Advisor

(a) Terrestrial and tidal planting will be funded by WDC for 2019-20. ECan contribution will be for Willow control.
(b) Dredging work is 2/3 complete due to a delay in starting.
(c) The important dredging work around the pontoons was prioritised and the remaining work of high points in the channel down from the town centre will be finished next winter.
(d) The suction dredge method worked well.

4.4 Verbal Update: Cam River Enhancement. Sophie Allen – Water Environment Advisor

(a) There has been less progress on this work.
(b) Some sediment traps have been put in in the Tuahiwi Stream.

(c) Beca (Vicky Clarke) has done the design work for almost all works requiring designs, and will be relocating to Tauranga shortly
(d) Next steps are to continue to working on getting the district-wide Resource Consent, which includes minor works in waterways, and signed agreement from landowners for works to be carried out on private land.

4.5 'Maintenance and Minor Works of Waterway beds and margins' – Presentation on the application for a global consent to undertake drainage, biodiversity, and other minor works in waterways. Simon Collin – Infrastructure Strategy Manager

(a) Waimakariri has a significant network of small waterways, only some of which Council maintains;
- Urban waterways are maintained by contract with Delta
- Rural waterways are maintained by contract with Sicon

(b) We have operated this way for a long time without a consent. ECan haven't been chasing us to apply for one, but we thought it was appropriate that we do.
(c) It will be a district-wide consent, but won't apply to the major waterways as they are maintained by ECan.
(d) Simon outlined the general maintenance works done in urban and rural waterways.
(e) Rural waterways also require minor works such as utilities and structures, small diversion, and damming.
(f) The consent will help to enable the work that Sophie and Janet are looking at doing for the Kaiapoi River Rehabilitation and Cam River Enhancement projects.
(g) Have received feedback from stakeholders;
- MKT want to know what the definition of 'streams that contain eels' is
- Doc would like an additional clause re culvert fish passage
- Fish & Game requested that any vegetation cut or managed during waterway maintenance is kept out of streams

(h) Simon covered some of the high level conditions;
- Minor works must be notified to ECan and Ngāi Tūāhuriri
- Minimise disturbances
- Must not impede the flow path
- Maximum depth of excavation

(i) Simon noted that prior to the consent application, Aquatic Ecology Ltd did a fish survey across the whole district and worked out spawning periods. Work can't be done in stream beds or banks during those periods. A new survey will need to be done every 5yrs to ensure it remains current.
(j) Council have been asked to supply additional material, namely the Management Plan, as part of the consent application. This usually isn't provided until after a consent has been granted
(k) It is expected we will have the consent before Christmas.

5. REPORTS

5.1 Memorandum of Understanding for ZIPA Implementation between Environment Canterbury - WDC (Sophie Allen – Water Environment Advisor)

THAT the Land and Water Working Group recommends:
THAT the Council:

(a) **Receives** report No. 190903122953.
(b) **Notes** the intention of Environment Canterbury and Waimakariri District Council Chief Executives to sign a Memorandum of Understanding for the Zone Implementation

Programme Addendum, to provide clarity of roles, responsibilities, and priorities for implementation.

Moved by: Clr. Barnett
Seconded by: Clr. Blackie **Carried**

5.1.1 Discussion on the MOU between ECan and WDC

(a) Clr. Stewart noted that this is part and parcel of the ZIPA recommendation that was approved in January – to work together with ECan, who is going to do what and when.
(b) Sophie commented that ECan are still in the process of filling out the table in Schedule 1 of the MOU.
(c) Gerard clarified that the recommendation is to receive the report and note the intention that the MOU will be signed off by Jim.
(d) Clr. Barnett queried if there will be updates going forward to evaluate how it is working. Sophie explained that it is proposed there will be quarterly and annual reporting with the first report coming in December.

5.2 Capex projects for 2019-20 for ZIPA Implementation (Sophie Allen – Water Environment Advisor)

THAT the Land and Water Working Group:

(a) **Receives** report No. 190718101047.
(b) **Approves** the proposed 2019-20 Waimakariri District Council capital expenditure work programme based on the Zone Implementation Programme Addendum (ZIPA) recommendations.
(c) **Circulates** this report to Council, Community Boards, the Waimakariri Water Zone Committee and Taranaki Stream Advisory Group for their information.

Moved by: Clr. Stewart
Seconded by: Clr. Barnett **Carried**

5.2.1 Discussion on the Capex Projects

(a) There was $300,000 approved for ZIPA implementation;
- $100,000 Capital that will go toward new structures / facilities such as fish passage projects, amenity improvements, and inanga spawning areas
- $200,000 Operational (includes hiring a Biodiversity Officer)

(b) Clr. Stewart queried what "rough loop tracks and tracks through" will be like. Sophie will talk to Greenspace for clarification.
(c) Clr. Brine mentioned that he's noticed that Taranaki Stream of Beach Road looks weed-infested at the moment.

Action: Sophie to clarify with Greenspace what the "rough loop tracks and tracks through" will be like.
Action: Sophie to investigate regarding and observation that the lower Taranaki Stream project will also require weed control.

Meeting closed 3:33pm

6. NEXT MEETING:

TBC – if the Working Group continues in the new Council term.

WAIMAKARIRI DISTRICT COUNCIL

REPORT FOR INFORMATION

FILE NO and TRIM NO:	DRA-21 /191128167199
REPORT TO:	Land and Water Committee
DATE OF MEETING:	12 December 2019
FROM:	Janet Fraser, Utilities Planner
SUBJECT:	Stormwater Network Discharge Consents Issues and Implications
SIGNED BY: **(for Reports to Council, Committees or Boards)**	Department Manager / Chief Executive

1. SUMMARY

1.1 This report updates the Land and Water Committee on progress preparing and lodging the district's stormwater network discharge consent applications.

1.2 The Rangiora and Woodend stormwater network consent applications are lodged and currently being processed by Environment Canterbury. The Kaiapoi and Oxford applications are currently being finalised. These should be lodged by 20 December 2019, subject to receipt of cultural advice on each application.

1.3 There are various issues and implications of the pending consents for management of water quantity and water quality in the district affecting existing and future urban stormwater network discharges. These are discussed in detail in this report.

2. RECOMMENDATION

THAT the Land and Water Committee:

(a) **Receives** report No. 191128167199.

(b) **Notes** the ongoing lodgement and processing of stormwater network consent applications, including applications for Kaiapoi and Oxford to be submitted by 20 December 2019, introducing new regulation of urban stormwater quality and stormwater quantity.

3. BACKGROUND

3.1 The district stormwater consent applications are a requirement of the Canterbury Land and Water Regional Plan (CLWRP). The CLWRP requires the Council as network operator to obtain consent for all its urban reticulated stormwater network discharges into the receiving environment (land and water) in the District.

3.2 The consenting of existing and future discharges has implications for the Council as network operator, for residents and businesses discharging stormwater and for the receiving environment.

3.3 The Council is seeking stormwater network discharge consents for a term of 35 years. A shorter term of consent may however be confirmed at the discretion of Environment Canterbury.

3.4 All applications must be lodged with Environment Canterbury by 30 June 2018 or later date as agreed between Environment Canterbury and the Waimakariri District Council (the current lodgement extension timeframe is until 20 December 2019).

3.5 The Rangiora stormwater network consent application was lodged in May 2018 and the Woodend application lodged in June 2019. Processing of the Rangiora application by Environment Canterbury is now almost complete with draft conditions to be available shortly for Waimakariri District Council review (expected in December 2019).

4. ISSUES AND OPTIONS

Stormwater Quality

4.1. During the period from 2020 to 2025 the Council will develop a comprehensive stormwater management plan to replace the current interim stormwater management plans. These will include a water quality strategy which will set out how the Council will improve the quality of the stormwater discharges.

4.2. This strategy will also determine how the Council will achieve CLWRP water quality standards for all the district's urban stormwater network discharges by or before 2040.

4.3. This strategy will include mitigation projects that are developed following review of results from a comprehensive stormwater monitoring programme. The programme proposes to take multiple samples/ surveys of the following:

- surface water quality from selected major network outlets and receiving streams or drains
- stormwater basin sediment toxicity accumulation
- stream bed sediment toxicity
- stream bed fine sediment depth and % cover
- ecological surveys in receiving streams

4.4. This data is to be gathered and analysed in the period 2020 to 2025. The monitoring programme from 2025 onwards will have a revised focus of tracking progress from implementing the physical stormwater quality improvements toward achieving the targets.

4.5. Baseline sampling from 2014 to 2016 has indicated particular urban sub-catchments now known to be generating exceedances of CLWRP standards. Hot spots indicated in the baseline will now be verified through more comprehensive sampling and potential future solutions investigated.

4.6. The monitoring programme will inform the prioritisation within towns and between towns of where the expenditure is best allocated to achieve the CLWRP standards. This will take into account where the expenditure would have the greatest benefit in reducing the discharge of the urban contaminants, thereby improving the stream water quality and protecting the aquatic habitat.

4.7. The Council's target is to ensure all urban network discharges comply with all applicable plan standards by or before 2040.

Stormwater Quantity

4.8 In each of its consent applications the Council undertakes to provide a 5 yearly localised flood model update to Environment Canterbury for each town. This will demonstrate changes over time to its peak network discharges at the major outlets from any future

increase in urban hardstand area. The flood models show interaction between up-gradient catchment rural runoff and urban runoff from hardstand areas.

4.9 It is the responsibility of Council as network operator to ensure there is no increase in modelled peak stormwater network discharges over the term of consent resulting from any urban development activity which the Council controls. It achieves this role through its existing District Plan and resource consent functions.

4.10 It is not anticipated that these model updates will show any increase in discharges as a result of any increase in any urban hardstand between each 5 yearly review period. This is because the model presents a *full development scenario* for every urban zone. The model assumes that all existing urban zones are fully developed, including that maximum permitted hardstand area and site coverage are achieved for every lot. Therefore any increase in peak network discharge would be from other factors such as non-complying urban infill or unapproved rural drainage diversion.

4.11 If the 5 yearly model update did show an increase in hardstand that had occurred within existing District Plan zone rules that increased peak discharges, then the Council would need to explain how the increase had occurred and may need to address downstream effects (if any identified).

4.12 Any proposed District Plan zone change or resource consent application for development or increased urban infill would have effects assessed via that process. All developments are required to provide attenuation to match pre-development flows.

4.13 The Council could require mitigation to be provided by any person undertaking any non-complying activity that affects urban stormwater drainage conveyance via its Stormwater Drainage and Watercourse Protection Bylaw.

4.14 It is uncertain whether rising groundwater which will increasingly inundate the Kaiapoi stormwater network over time will be captured in the future Kaiapoi flood hazard model. It is also uncertain whether this would be linked to any future consent mitigation requirements.

Stormwater Management Plans

4.15 An interim stormwater management plan has been prepared and lodged with each application. Key proposals include:

- Investigating source control options for identified contaminants.
- Investigate low impact design options to improve treatment at a sub-catchment level.
- Where practicable, incorporating measures to improve stormwater treatment as part of the capital works programme.
- Phase in use of pollution prevention plans through the district towns to manage discharges from medium risk premises.
- Phase in a new Council approval process for stormwater discharges from high risk sites by 1 January 2025. At this time the Council will assume responsibility for managing quality of discharges from these sites into and from its network.

General Implications

4.16 Achievement of Canterbury Land and Water Regional Plan standards will likely require a combination of at source controls and new sub-catchment treatment systems to capture diffuse contaminant discharges of zinc, copper and sediment.

4.17 A significant increase in drainage team workload is anticipated for approving on-site pre-treatment systems for high risk sites and approving medium risk site pollution prevention plans.

4.18 Review of the Stormwater Drainage and Watercourse Protection Bylaw will be required before 1 January 2025, to include a new process for the Council to approve discharges from high risk sites into the stormwater networks.

4.19 A significant increase in drainage team and water unit workload will be required for implementation of the stormwater monitoring programme.

4.20 Development of a basic contaminant load model will be undertaken to estimate and identify diffuse source/s of each contaminant.

4.21 A review and upgrade on the current water quality management database functionality is required – potentially from MS Access to something like Water Outlook or the ECan Water 2020 based on Hilltop with improvements.

4.22 Additional costs associated with investigation and design of new stormwater treatment will be incurred.

4.23 Stormwater baseline sampling indicates potential wastewater overflows or wastewater cross connections occurring in Kaiapoi, Oxford, Rangiora and Woodend. Additional targeted sampling is proposed to identify and verify the actual sources of contamination.

4.24 Note that developers in other districts are awaiting issue of network consents to enable their future stormwater discharges to be approved by the relevant territorial local authority and accepted through the network consent. There is an assumed reduction of costs and simplification of requirements for developers. This should not be the case as the same environmental outcomes still need to be met.

4.25 There is a need to encourage central Government to “lead” on certain issues, including:

- reduction of copper discharges from the stormwater networks, by introducing a national ban on use of copper brake pads in vehicles
- introduce a national “behaviour change” website and other promotional material to inform communities of necessary changes

4.26 The Management Team have reviewed this report and support the recommendations.

5. COMMUNITY VIEWS

5.1. Groups and Organisations

5.1.1. The network consent applications have been consulted with the Waimakariri Water Management Zone Committee. Other committees (e.g. Cam River Enhancement Subcommittee, Drainage Advisory Committees) and organisations (e.g. Fish and Game, Canterbury District Health Board) are aware of the network consent programmes via various ongoing communications on related issues with the Council drainage team.

5.1.2 This report was presented to the Waimakariri Water Management Zone Committee on 2 December 2019.

5.2. **Wider Community**

5.2.1. Each application includes a summary of public consultation on stormwater management as a component of previous Long Term Plan and Annual Plans. These plans have indicated a growing community aspiration in recent years for work to be undertaken toward improving quality of water in district waterways. However affordability is an ongoing concern.

5.2.2 A public communications plan will be developed in line with implementation of the stormwater monitoring programme. This will advise urban communities of actions to be taken to improve the quality of the stormwater discharges.

5.2.3 Public education and behaviour change is a significant component of the consent applications. The Canterbury Regional Stormwater Forum at its most recent meeting agreed it would request the Ministry for the Environment to lead the development of a new national public "behaviour change" website to address topical 3 water's issues. These include promoting actions the public can take to improve stormwater quality and reduce discharges of contaminants from private property into the stormwater systems.

6. IMPLICATIONS AND RISKS

6.1. **Financial Implications**

6.1.1. There is an existing budget of $65,000 per annum for environmental monitoring which will be used to undertake the district stormwater monitoring programme. This budget may need to be revised following the first completed year of monitoring, once actual costs are confirmed. The Council will need to ensure its programme is sufficiently resourced to enable it to meet the pending Environment Canterbury consent conditions for each network (yet to be issued).

6.1.2. Staff are currently working with Environment Canterbury on the detail of each application, seeking that conditions will be reasonable and achievable. It is noted additional resources will be required given the pending scale of the monitoring programme and associated improvement works required.

6.1.3 There is a preliminary budget of $20 million to be funded across the district urban drainage schemes to improve stormwater quality in the period 2025 to 2035. This budget has a preliminary allocation between Rangiora ($7.98 million), Kaiapoi ($7.7 million), Woodend ($2.6 million), and Oxford ($1.72million). The budget is indicative, with actual costs likely to vary in accordance with consent conditions.

6.1.4 There is no additional future budget to meet any water quantity requirements in the pending consent conditions. At this stage it is assumed that the Council will meet its consent requirements for water quantity management by ensuring there are no increases in peak network discharges as a result of future urban development, subdivision or infill. This is considered to be adequately managed via existing processes and will be demonstrated in the stormwater model updates provided 5 yearly to Environment Canterbury via the 35 year term of consent.

6.1.5 These are preliminary budgets, subject to confirmation once the stormwater consents are issued and when more comprehensive stormwater quality data is available. The data will better inform the locations, nature and scale of the improvements required.

6.2. **Community Implications**

6.2.1. There are implications for residents in the major urban towns associated with implementation of the consents. These include requirements for businesses and households to manage activities on their properties to avoid discharge of contaminants into the Council stormwater networks.

6.2.2. These actions will be measured via the proposed monitoring programme and consent compliance conditions (to be determined). Actions taken by the public will support the Council to achieve, over time, the discharge standards that will apply at the point of discharge or in the receiving waterway. The costs of the actions will be borne by urban communities, either through improving on-site stormwater management at the individual property level, or in drainage rates which will fund sub-catchment level stormwater treatment.

6.2.3 Residents will ultimately benefit from these requirements and actions which should result in future improvements in receiving water quality in urban streams with flow on improvements in the downstream environment. Over time there is anticipated to be improved recreation opportunities for residents including improved fishing, amenity, mahinga kai and safer recreational contact with water in local waterways.

6.3. **Risk Management**

6.3.1. There is a risk that water quality standards will not be achieved by the Council's target of 2040. There is a risk that the actual costs will exceed estimates, or that actions will be required that have not yet been identified.

6.3.2 There is a further risk that climate change affecting capacity and conveyance of the Kaiapoi stormwater network will result in uncertain outcomes for that town.

6.3.3 Staff will continue to report on likely outcomes and implications of the consenting process as consent conditions are confirmed in coming months.

6.4. **Health and Safety**

The network consents will target improvements to the health and safety of stormwater discharges including improving safety of: a) mahinga kai harvested from streams; b) human contact with waterways downstream of the stormwater outlets.

This will be achieved by developing mitigation strategies to reduce common contaminants found in stormwater such as bacteria, nutrients, metals and hydrocarbons. The Council will work toward reducing contamination from a wide variety of urban activities including wastewater overflows, urban construction discharge of sediment, fertiliser use on parks & gardens, runoff from manufacturing or storage yards, discharges of refrigerants or cleaning products, paints, detergents, oil or any other substances conveyed into streams from the stormwater networks.

7. CONTEXT

7.1. **Policy**

7.1.1. This matter is not a matter of significance in terms of the Council's Significance and Engagement Policy.

7.1.2 The actions to be undertaken to improve water quality which are required by the stormwater network discharge consents will assist the District to meet pending new national freshwater policies and standards. These are being introduced via

the Action for Healthy Waterways programme currently being consulted by the Ministry for the Environment. The programme includes a proposed new Draft National Policy Statement for Freshwater Management and proposed new National Environmental Standards for Freshwater.

7.2. Legislation

7.2.1. Consents are required under the Canterbury Land and Water Regional Plan (CLWRP), outlining requirements for water quality and water quantity to be met by the Council as the stormwater network operator.

7.2.2. The CLWRP is a requirement of the *Resource Management Act 1991*.

7.3. Community Outcomes

7.3.1. There is a healthy and sustainable environment for all.

7.3.2 Harm to the environment from the impacts of land use, use of water resources and air emissions is minimised.

7.3.3 Cultural values relating to water are acknowledged and respected.

7.4. Delegations

7.4.1. The Council holds the authority to allocate budget to implement the stormwater network discharge consent requirements in the Annual Plan.

WAIMAKARIRI DISTRICT COUNCIL

REPORT FOR INFORMATION

FILE NO and TRIM NO:	DRA-02-04 / 190618085491[v02]
REPORT TO:	Utilities and Roading Committee
DATE OF MEETING:	19 November 2019
FROM:	Sophie Allen – Water Environment Advisor
SUBJECT:	Urban stormwater water quality baseline results and issues identified

SIGNED BY:
(for Reports to Council, Committees or Boards)

Department Manager

Chief Executive

1. SUMMARY

1.1 This report summarises baseline water quality data for urban stormwater areas of Rangiora, Woodend, Kaiapoi, and Oxford, and raises issues identified. Comparison was made to exceedance levels in Schedule 5 of the Canterbury Land and Water Regional Plan, (LWRP), or the ANZECC Water Quality Guidelines for Fresh and Marine Water Quality, (2000).

1.2 Waimakariri District Council undertook baseline water quality sampling in 2014 (Rangiora) and 2016 (Woodend, Kaiapoi, Oxford) to inform network stormwater discharge consent applications.

1.3 It should be noted that water quality sampling carried out by Waimakariri District Council was for a limited time period (either 2014 or 2016), therefore results should be noted with caution that they may not be representative of the current state. WDC stormwater monitoring programmes, which are a condition of the comprehensive network discharge consents, will provide more information on general water quality and the source of contaminants.

1.4 In general, a number of the contaminants are sourced rurally and the guidelines are exceeded prior to entering an urban area. However for some contaminants there was an increase in concentration through the urban area, indicating that the urban discharges also contain these contaminants.

1.5 It is recommended that contaminants such as *E. coli*, and phosphorus should be investigated further by Environment Canterbury within the rural part of each catchment. It is also recommended that Environment Canterbury consider investigating nitrogen contamination sources in the rural areas as rural catchments consistently exceed the ANZECC guidelines for Total Nitrogen.

1.6 As expected, moderate rain events (such as a 'first flush' event) were when exceedances of contaminants were often measured.

1.7 The draft National Policy Statement for Freshwater Management (NPS-FM, 2019) proposes a more stringent National Bottom Line for Dissolved Inorganic Nitrogen (1.0 mg/l) than the exceedance levels for receiving environments that are 'spring-fed – plains – urban' currently in the Canterbury Land and Water Regional Plan (1.50 mg/l). Water quality

standards in Stormwater Network Discharge Consents may be updated, when the Land and Water Regional Plan incorporates changes from a finalised NPS-FM.

1.8 Environment Canterbury also undertakes regular water quality sampling in some of the downstream receiving environments, which has also been summarised in this report where applicable, with data sourced from the Land and Water Aotearoa website. In general, Environment Canterbury data shows that Total Nitrogen levels and trends are of concern in monitored waterways downstream of urban areas. Environment Canterbury does not sample for contaminants commonly from urban environments, such as copper and zinc.

1.9 Specific issues identified from the WDC baseline water quality results include:

Rangiora

1.1.1. Most exceedances of contaminants occurred during a moderate wet weather event (in May), which was much larger than a first flush rainfall event.

1.1.2. The Middle Brook catchment, in particular, was identified by WDC staff to require further investigation into sources of zinc.

Woodend

1.1.3. Most of the contaminants tested exceeded the guidelines in at least one of the sample rounds. Most exceedances of contaminants levels (as per the LWRP) occurred in a first flush rainfall event (December 2016), which was the largest rainfall event captured during the sampling period. Phosphorus and *E. coli* were found to be urban and rural-sourced in Woodend.

Kaiapoi

1.1.4. Most of the contaminants tested exceeded the guidelines in at least one of the sample rounds. Most exceedances occurred from a first flush rainfall event, (December 2016 sampling round), which was the largest rainfall event captured during the sampling period.

Oxford

1.1.5. Most of the contaminants tested exceeded the guidelines in at least one of the sample rounds. Most exceedances occurred from a first flush rainfall event, (December 2016 sampling round), which was the largest rainfall event captured during the sampling period. Some exceedances were also during a minor wet weather event in August 2016.

1.1.6. Exceedances of zinc and copper, possibly from a rural overland flow that enters the Findleys Drain, has been identified by WDC staff as a 'hot spot' for follow-up investigations in conjunction with Environment Canterbury staff.

Attachments:

i. Rangiora Stormwater Quality Monitoring Baseline Programme (Trim 140728079529)
ii. Woodend Stormwater Quality Monitoring Baseline Report (Trim 180822095021)
iii. Kaiapoi Stormwater Network Quality Baseline Monitoring 2016 Report (190709096637)

Note: the Oxford Stormwater Network Quality Baseline Monitoring Report is yet to be completed

2. RECOMMENDATION

THAT the Utilities and Roading Committee:

(a) **Receives** report No. 190618085491.

(b) **Notes** the issues raised in stormwater quality baseline monitoring reports, summarised in this report, for;

i. Rangiora (TRIM 140728079529);

ii. Woodend (TRIM 180822095021);

iii. Kaiapoi (TRIM 190709096637); and

iv. Oxford (report to be completed).

(c) **Notes** that WDC staff are investigating some issues raised by the stormwater quality baseline monitoring results, in conjunction with Environment Canterbury staff where appropriate.

(d) **Notes** that a report on the progress on the stormwater network discharge consent applications, associated monitoring programmes, and proposal for data management will be presented to the Utilities and Roading Committee in early 2020.

(e) **Notes** that budget allocation for urban stormwater quality improvements is included in the current budgets from 2025/26 onwards.

(f) **Circulates** this report to the Waimakariri Water Zone Committee, Land and Water Committee, and Community Boards.

3. BACKGROUND

3.1. Environment Canterbury requires each of the Territorial Authorities within the Canterbury region to submit comprehensive urban stormwater network discharge consents for all major towns in each district. The Rangiora urban stormwater discharge consent application, was the first to be lodged in the Waimakariri District in May 2018. Woodend was lodged in June 2019, with Kaiapoi and Oxford soon to follow by the end of 2019. Consent application requires the Waimakariri District Council (WDC) to propose a stormwater monitoring programmes for each urban area. The monitoring programmes focus on the urban stormwater discharge impact on the waterway, however also includes stream health water sampling and stream ecological surveys to characterise the receiving environment.

3.2. As a condition of the stormwater network discharge consents, more comprehensive stormwater quality will be carried out from 2020-2025. The results of this monitoring will be the basis for allocation of $20 million that has been budgeted for stormwater improvements in 2025-2035 (see Figure 1).

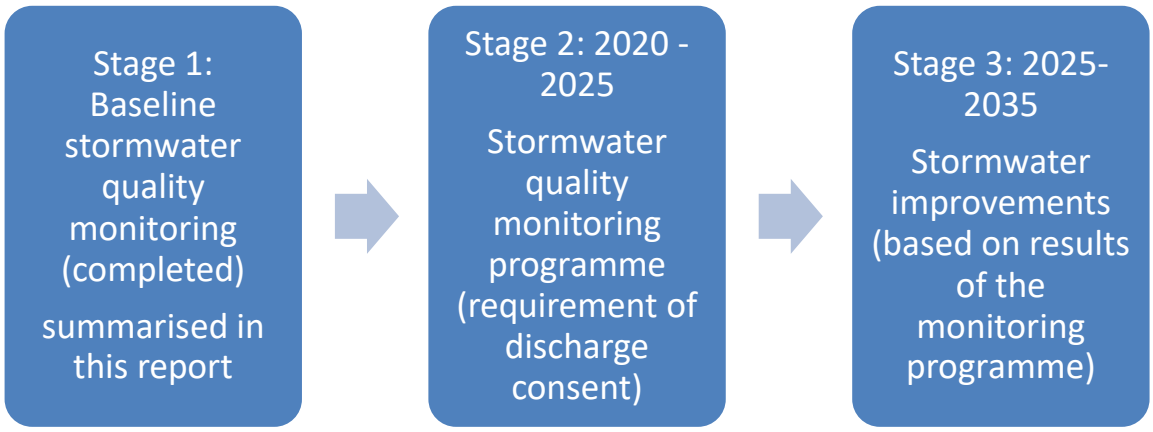

Figure 1: Stages for stormwater quality monitoring and improvements

3.3. WDC has undertaken baseline sampling programme, with the purpose of identifying the source of the waterway contaminants (see Table 1) and the current health of the waterways. Four sample rounds were completed, in both wet (including first flush) and dry conditions for each urban area.

3.3.1. In Rangiora, eight sites were sampled for Rangiora in the North Drain, North Brook, Middle Brook and South Brook.

3.3.2. In Kaiapoi, twelve sites were sampled for the baseline sampling programme in following waterways, Silverstream, Kaiapoi River, Kaikanui Stream, Cam River, Courtenay Stream and the McIntosh Drain.

3.3.3. In Woodend, seven sites were sampled in the Taranaki Stream, Waiora Stream, McIntosh Drain, Box Drain and a channel adjacent to the state highway at the south of Woodend

3.3.4. In Oxford, seven sites were sampled in the Findleys Drain, Main Drain, Pearsons Drain and Flannigans Drain.

3.4. Oxford differ from the other town centres (Rangiora, Woodend and Kaiapoi), in that it has some drains with hill-fed runoff, as well as some plains runoff and spring-fed flows. The drains in Rangiora, Woodend and Kaiapoi primarily receive plains runoff with a spring-fed baseflow. Hill-fed waterways have different exceedance values to plains-fed in Schedule 5 of the LWRP.

3.5. From 2009-2014, WDC undertook water quality sampling in the Taranaki Stream and Greigs Drain. These results have not been presented in this report.

Sources of contaminants

Table 1: Sources of common urban contaminants.

Contaminant	Major Contributing Activities (within Urban Limits)

Total Suspended Solids (TSS)	Sediment distributed via roads Earthworks and construction Residential gardening/soil disturbance Break down of organic material (e.g. leaf litter) in the kerb and channel Airborne particulates Sewage overflows
Dissolved zinc	Commercial and residential roofs (unpainted/ deteriorating galvanised) Vehicle use on roads – including vehicle tyre wear
Dissolved copper	Vehicle brake pads Industrial machinery operations and construction Exterior building surfaces (facades, down pipes, spouting)
E.coli	Wastewater overflows – human urban source Avian (bird droppings into open drains or urban properties) – natural urban/rural source Canine or feline (dog or cat faecal matter) – largely urban source Ruminant (cattle/sheep/deer droppings) – rural source
Hazardous substances	Industrial activities – various chemicals, risk of spills and leaks Residential activities (disposal of oil and paint residues, fuel leaks etc.) Hydrocarbons from vehicle use on roads and driveways
Dissolved lead	Dissolved lead primary sources include but are not limited to road runoff (auto parts) and construction wastes (paints).
Nitrogen (i.e. nitrate, nitrite, ammonical – N, and Total Kjeldahl Nitrogen)	Nitrogen primary sources include but are not limited to fertilizers and sewerage. Note: Total Nitrogen is the sum of TKN + Nitrate-N + Nitrite-N and DIN is the sum of Total Ammoniacal-N + Nitrate-N + Nitrite-N.
Phosphorus	Phosphorus primary sources include but are not limited to fertilisers and sewage. Phosphorus tends to attach to soil particles and moves into surface-water bodies from runoff.

4. ISSUES AND OPTIONS

4.1. WDC staff have assessed what will be addressed as a rural and/or urban contaminant for each of the network stormwater discharge consent applications (Table 2). WDC could be challenged to meet guideline levels of phosphorus and *E.coli*, if the guideline values are used as a consent condition, due to the significant rural contributions of phosphorus and *E. coli*.

Table 2: Definition by WDC staff of rural and/or urban primary contaminant sources for WDC network stormwater discharge consent applications. (Note: this classification is based on limited sampling, and includes assumptions made by WDC staff).

	TSS	**Dissolved zinc**	**Dissolved copper**	***E.coli***	**Dissolved Reactive Phosphorous**	**DIN**	**Total Ammoniacal Nitrogen**
Rangiora	Urban/ Rural	Urban	Urban	(Urban) / Rural	(Urban) / Rural	Rural	Rural
Kaiapoi	Urban/ Rural	Urban	Urban	(Urban) / Rural	(Urban) / Rural	Rural	Rural
Woodend	Urban/ Rural	Urban	Urban	(Urban) / Rural	(Urban) / Rural	Rural	Rural
Oxford	Rural	Urban	Urban	(Urban) / Rural	(Urban) / Rural	Rural	Rural

4.2. Lead and Total Hydrocarbon levels were far below guideline values in surface water samples. Therefore they are not considered priority contaminants for future surface water sampling, but will be sampled in stream bed sediments and stormwater basins where they may potentially accumulate.

4.3. Management of WDC water quality data is recommended to be improved with automation of data management processes, and an examination of what database will be fit for purpose with increased water quality monitoring for urban stormwater network consent compliance.

4.4. ***Rangiora***

4.4.1. It was found that the bulk of the contaminants are sourced rurally and the guidelines are exceeded prior to the township. However for some contaminants there was an increase in concentration through the township, indicating that the urban area discharges these contaminants also, but in smaller quantities.

4.4.2. The concentrations of contaminants discharging from springs sometimes exceeded the guidelines, particularly for nutrients in the Middle Brook. These springs source groundwater from rural recharge areas.

4.4.3. The baseline monitoring has shown that the rural areas have a significant impact on the health of the Rangiora waterways, and possibly others in the district. It is recommended that Environment Canterbury undertakes monitoring upstream of the townships to identify the source of these containments as many contaminant concentrations are exceeded prior to the urban limits.

4.4.4. Generally the TSS concentrations were below the LWRP guideline value, though they are increasing through the township, indicating that the township is contributing suspended solids to the waterways. The North Brook is the exception, where higher TSS concentrations seemed to be discharging from a water race.

This water race has now been closed. As TSS concentrations were not elevated, TSS is not predicted to be adversely affecting aquatic life.

4.4.5. Generally the dissolved copper concentrations increased within the township; although it is also noted that the rural runoff appears to have copper concentrations higher than the guideline values. Dissolved copper is a proven urban contaminant and the 2014 WDC baseline programme has shown that the concentrations can exceed the guidelines in high runoff events.

4.4.6. The LWRP guideline for zinc (0.015mg/L) was exceeded in many of the wet weather sample rounds. In the dry weather sample round the dissolved zinc concentrations did not exceeded the guideline value. Generally the dissolved zinc concentrations increase within the township; although it is also noted that the rural runoff appears to have zinc concentrations higher than the guideline values. The Middle Brook catchment, in particular, was identified by WDC staff to require further investigation into sources of zinc. Conclusions are that the zinc is likely to be discharging from older housing and unfiltered road runoff from busy roads.

4.4.7. The ANZECC guideline for Total Nitrogen (0.614mg/L) was exceeded generally in both the dry and wet weather samples. For Dissolved Inorganic Nitrogen the LWRP guideline (1.5mg/L) was generally exceeded in both the dry weather sample (June) and the wet weather sample (May). Results indicated that nitrogen is not an urban contaminant. The nitrogen levels in the North Brook and South Brook are higher in the dry weather flow sample round than the wet weather samples. This indicates that spring heads are potentially contributing nitrogen to the Brooks.

4.4.8. The ANZECC guideline for Total Phosphorus (0.033mg/L) and the LWRP guideline for Dissolved Reactive Phosphorus (0.016mg/L), were exceeded generally in the wet weather samples. Results indicated that phosphorus can be an urban contaminant. An increase in concentrations of phosphorus through the township are thought to be caused by spring inflow and mobilising of the bed sediments in high runoff conditions.

4.4.9. Results suggest that rural runoff is a main contributor of *E.coli*, but also urban run-off to some degree, with concentrations of *E.coli* increasing through the urban area. During dry weather days there are generally very low levels of *E.coli* in the waterways, indicating that the springs do not contribute *E.coli* to the waterways. It is recommended that Environment Canterbury undertakes further monitoring of the rural catchments to locate the sources of *E.coli*.

4.4.10. Downstream of the Rangiora urban area, Environment Canterbury regularly monitors water quality of the South Brook, North Brook, and Cam River at Marshs Road, and the Cam River at Bramleys Road. Total Nitrogen is generally at levels that place the Cam River and its tributaries in the worst 50% compared to similar waterways in Canterbury, and showing a likely trend of degrading (except the South Brook with no trend found). Total Phosphorus and Dissolved Reactive Phosphorus have generally been showing significant trends of improving, except at the Cam River at Bramleys Road where there is no significant trend. Turbidity and *E.coli* are showing mixed trends in the different tributaries.

4.4.11. Downstream of the Rangiora urban area, Environment Canterbury regularly monitors water quality in the Taranaki Stream at Gressons Road, which is also upstream of the Woodend urban area. *E.coli* and Total Nitrogen are both of concern, with levels that place the waterway in the worst 25% of similar waterways, and degrading trends. Turbidity and Dissolved Reactive Phosphorus levels are also very likely to be degrading, however the waterway is placed in the top 50% of similar waterways. There is no trend for Total Phosphorus.

4.5. ***Woodend***

4.5.1. It is recommended that contaminants such as *E. coli*, and phosphorus should be investigated further by Environment Canterbury within the rural catchment. Both of these contaminants exceed the LWRP guidelines in the rural zones, upstream of the urban limits.

4.5.2. Phosphorus was found to be more of an issue in Woodend's waterways than nitrogen. In contrast to the distribution of nitrogen, it is the urban-fed waterways that demonstrate higher levels of phosphorus than the rural waterways, which may indicate wastewater overflows or wastewater to stormwater cross connection. The majority of phosphorus in the samples is in the form of Dissolved Reactive Phosphorus (DRP), the more readily bioavailable form, rather than particulate or organic forms. This indicates the majority of phosphorus entering the stream is in a form which could readily contribute to eutrophication. TSS levels have a strong linear correlation with DRP and a noticeably weaker correlation with Total Phosphorus suggesting entrainment of sediment is not the main contributor to elevated levels of phosphorus.

4.5.3. There was a spike in zinc concentration in a minor rain event (August 2016), west of Rangiora Woodend Road (Box Drain). This is thought by WDC staff that it could be related to the low base flow (i.e. stagnant water) in this drain.

4.5.4. A 'hot spot' area for Total Phosphorus, Dissolved Reactive Phosphorus, and Dissolved Zinc was found during a moderate rainfall event (December 2016) at the corner of Woodend Beach and Main North Road. This is thought by WDC staff to possibly be due to vehicle traffic on State Highway 1, including potential disbursal of soil by truck wheels moving on and off nearby major roads. However, test results to-date cannot definitively confirm the cause.

4.5.5. The concentrations of *E. coli* in the 2016 samples exceed the guideline values in 24% of the samples captured. Exceedances were particularly prevalent in the first flush event seen in December. Aside from the December event, the smaller October rain event was the only other event to result in an exceedance of the guideline value. The sites sampled during the minor wet weather event in August and dry weather event in September both demonstrated levels of *E. coli* comfortably below the guideline value.

4.5.6. Although less than half the guideline value, it is worth noting that the two sites in the Taranaki Stream demonstrated the highest and most consistent base levels of *E. coli* levels observed during dry events. This is likely to be the result of consistent contamination upstream from rural areas. The urban areas generally exhibited low to no *E. coli* during dry weather events with extremely high levels after the first flush event in December.

4.5.7. Downstream of the Woodend urban area, Environment Canterbury monitors water quality in the Taranaki Stream at Preeces Road. Total Nitrogen is showing a degrading trend and the stream is in the worst 50% when compared to similar waterways. *E. coli*, Ammoniacal- Nitrogen and Turbidity trends are significantly improving, however the stream is also in the worst 50% when compared to similar waterways for these attributes. Total Phosphorus and Dissolved Reactive Phosphorus trends are significantly improving.

4.6. ***Kaiapoi***

4.6.1. Total suspended solids tended to be relatively low in Kaiapoi waterways, except for sites that are possibly influenced by tidal and/or tailwater from the Waimakariri River during high flows. Results showed that TSS is mainly an urban contaminant.

4.6.2. Copper was only detected almost exclusively in the first flush (December 2016) event. The results suggest inflows from Woodend (via McIntoshs Drain) and runoff from the State Highway One are contributing copper to Kaiapoi waterways. The Oaks Reserve site, the only sample site to show detectable levels outside of the first flush (December 2016) event, is directly downstream of a Kaiapoi industrial area and is downstream of State Highway 1 roadside drainage. The results show that copper is mainly an urban contaminant.

4.6.3. Dissolved Zinc is present in the majority of the urban-fed waterways however at relatively low concentrations at most of these sites. The notable exception to this is at the Oaks Reserve site on the Kaikanui Stream which significantly exceeded the guideline during both the wet weather events (August and December 2016). The results show that zinc is mainly an urban contaminant.

4.6.4. Dissolved Inorganic Nitrogen and Total Nitrogen shows elevated levels in the rural-sourced waterways such as Silverstream, Kaiapoi River and Courtenay Stream.

4.6.5. Phosphorus levels were highest in the first flush event (December 2016). Urban-fed waterways demonstrated higher levels of phosphorus (Total Phosphorus and Dissolved Reactive Phosphorus) than the rural waterways. Sample sites in Silversteam and upper site on the Cam River returned TP and DRP levels below the guideline levels whereas the urban fed waterways all demonstrated phosphorus levels in exceedance of the guidelines.

4.6.6. Environment Canterbury monitors water quality in the Silverstream (Kaiapoi River) at Island Road, which passes through the suburb of Silverstream, but is upstream of the majority of the Kaiapoi township. *E.coli* and Total Nitrogen are both of concern, with levels that place the waterway in the worst 25% of similar waterways, and degrading trends. Turbidity and Total Phosphorus trends are significantly improving. There is limited water quality monitoring in the Kaiapoi River downstream of Kaiapoi, due to the tidal nature of the waterway (only recreational monitoring of *E.coli* each summer).

4.7. ***Oxford***

4.7.1. Oxford had a higher level of exceedances for particular contaminants than for the other town centres, particularly for Total Suspended Solids, Total Phosphorus, zinc and copper. This is thought to possibly be due to issues such as point source contamination from private land uses and / or wastewater entering the stormwater network, such as through a cross-connection.

4.7.2. Most of the contaminants tested exceeded the guidelines in at least one of the sample rounds (for example Total Nitrogen, Ammoniacal-Nitrogen, *E.coli*, Total Phosphorus, Zinc and Total Suspended Solids). Most exceedances occurred from a first flush rainfall event, (December 2016 sampling round), which was the largest rainfall event captured during the sampling period. Some exceedances were also during a minor wet weather event in August 2016.

4.7.3. There is no Environment Canterbury water quality monitoring downstream of the Oxford urban area. There is an aquatic ecology health site that monitors macroinvertebrates on the Cust River at Tippings Road. This monitoring shows that the health of the waterway is fair, however there is trend that this health is likely degrading.

Pegasus

4.8. A comprehensive stormwater network discharge consent is already in place for the Pegasus urban area, therefore baseline water quality sampling has not been not carried

out. Due to the design standards used for Pegasus, it is not anticipated that there would be any significant stormwater discharge issues. Potentially fertiliser application could be contaminating stormwater. However, this has not been investigated.

Next Steps

4.9. Next steps for WDC staff is to complete lodgement of the Kaiapoi and Oxford stormwater network discharge consents, and continue working on any point source issues identified from the sampling. A future report to the Utilities and Roading Committee, to be drafted early in 2020, will examine budget allocation in the Long Term Plan for stormwater improvements. These improvements are anticipated to be implemented from 2025-2035.

4.10. Reallocation of staff time, or additional staff resourcing is anticipated at this early stage to be able to lead the stormwater monitoring programmes, and implement stormwater improvement work for issues identified. As a recognition of the increasing resourcing needed for stormwater resourcing, the Stormwater Engineer position was created within the 3 Waters team in 2019.

4.11. The Management Team have reviewed this report and support the recommendations.

5. COMMUNITY VIEWS

5.1. Groups and Organisations

5.1.1. This report will be circulated to the Waimakariri Water Zone Committee and Community Boards for their information and feedback.

5.2. Wider Community

5.2.1. There has been no consultation to-date for the wider community regarding the results and implications of baseline stormwater quality monitoring results. WDC has contacted one landowner of a property that has been identified as potential point sources of contaminants, with a few other individual potential point sources to be followed-up.

5.2.2. Contaminant reductions will require future widespread community behaviour change and public support. The stormwater network discharge consent applications propose that modelling is undertaken of sources of diffuse contaminant discharges prior to 2025. This will inform future actions needed to reduce the diffuse contaminant discharges.

5.2.3. A further role for widespread community response is in reduction of urban sources of sediment and other common household or business contaminants such as litter, detergents or other waste substances discharging into waterways. Proposals are being developed to address these various discharges with reductions implemented via consent conditions and education programmes. Many of these required changes can be most effectively led at a national level.

6. IMPLICATIONS AND RISKS

6.1. Financial Implications

6.1.1. There will be significant costs in order to meet water quality standards in Network Stormwater Discharge Consents, therefore $20 million has been allocated in the Long Term Plan for 2025-2035. These costs could increase, for example if National Bottom Lines in the National Policy Statement for Freshwater Management set more stringent levels, such as proposed for Dissolved Inorganic

Nitrogen. The actual cost implications of the NPS-FM will become more apparent over time.

6.1.2. The financial implications of the Network Stormwater Discharge Consent monitoring programmes, investigations and stormwater improvements will be presented to the Utilities and Roading Committee in a report in early 2020. This report is for information only.

6.2. **Community Implications**

6.2.1. The baseline stormwater water quality monitoring programme has highlighted that there are exceedances of guideline values. This will have an impact for the community; both for ratepayers to fund stormwater improvements to meet consent conditions, and also through behaviour changes/ changes to private land use that can improve stormwater quality.

6.3. **Risk Management**

6.3.1. The baseline network stormwater consent monitoring has successfully informed monitoring programmes proposed in the consent applications, by providing a basis to assess contaminants that are an likely to exceed guideline values, and assess whether contaminants have rural and/or urban contaminant sources.

6.4. **Health and Safety**

6.4.1. There are no health and safety considerations arising from this report.

7. CONTEXT

7.1. **Policy**

7.1.1. This matter is not a matter of significance in terms of the Council's Significance and Engagement Policy.

7.2. **Legislation**

7.2.1. (Resource Management Act 1991) – WDC has applied for comprehensive network stormwater discharge consents to meet Section 15 of the RMA, and rules in the Canterbury Land and Water Regional Plan.

7.3. **Community Outcomes**

7.3.1. There is a healthy and sustainable environment for all

7.3.2. Harm to the environment from the impacts of land use, use of water resources and air emissions is minimised.

7.3.3. Cultural values relating to water are acknowledged and respected.

7.3.4. Harm to the environment from the spread of contaminants into ground water and surface water is minimised.

7.4. **Delegations**

7.4.1. This report is for information only.

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Rangiora Comprehensive Stormwater Consent:

Stormwater Quality Monitoring Baseline Programme

Prepared by the Project Delivery Unit
September 2014

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1. SUMMARY

1.1. INTRODUCTION

The Rangiora Stormwater Consent, the first of such in the Waimakariri District, will be prepared in conjunction with a stormwater management plan (SMP). This requires the Waimakariri District Council (WDC) to produce a stormwater monitoring programme. This monitoring programme focuses on the urban stormwater discharge impact on the waterways, as opposed to general stream health.

Ecan requested that the WDC undertakes a baseline sampling programme before defining the parameters of the monitoring programme to demonstrate to all parties the source of the waterway contaminants and to gauge the current health of the Rangiora waterways. The purpose of this report is to present the findings from this baseline sampling programme and recommend the parameters that should be carried forward to the ongoing stormwater monitoring programme.

Four sample rounds have been completed, in both wet and dry conditions, at 8 sites in the North Drain, North Brook, Middle Brook and South Brook. The results from each of these rounds has been summarised along with suggested potential sources of each contaminant.

1.2. BACKGROUND

The stormwater monitoring programme has been designed to identify potential areas of urban stormwater impact on the Rangiora receiving waters. The trends formed from the monitoring programme analysis can be used to direct stormwater treatment activities, within the Rangiora urban limits.

The current stormwater monitoring programme has four sections; visual inspections, urban stormwater impact, stormwater basin monitoring and stream health monitoring.

Visual inspections, urban stormwater impact and stormwater basin monitoring will all form part of the Rangiora comprehensive stormwater discharge consent, with consent management objectives seeking to address any exceeded values.

The stream health monitoring will be included within the comprehensive stormwater discharge consent, however the parameters will not have consent management objectives associated with them, i.e. this information will be utilised for other Council projects, such as stream enhancement programmes, as these additional parameters are not considered to be primarily contributed by urban stormwater discharge.

This investigation looks at water quality samples, which will only affect the urban impact and stream health sections of this monitoring programme.

1.3. METHODOLOGY

Four water sampling rounds were undertaken by the WDC Water Unit and analysed by the WDC Project Delivery Unit. The sampling occurred approximately monthly from February to June 2014.

The samples were collected using best practice methods and delivered directly to the laboratory after collection. The sample testing was undertaken by Hill Laboratories in Hamilton.

The Rangiora waterways were sampled at the following sites:

RRND012: North Drain, Coldstream Road (capturing solely urban contaminants).
RRNB017: North Brook, on the Northern side of Boys Road
RRNB036: North Brook, Lilybrook Park
RRNB055: North Brook, at Aspen Street Park
RRMB019: Middle Brook, on the Northern side of Denchs Road

RRMB029: Middle Brook, on the Western side of Bush Street
RRSB030: South Brook, on the West side of Railway Road
RRSB048: South Brook, on the East side of Townsend Road

The laboratory test included Total suspended solids, Dissolved copper, Dissolved lead, Dissolved zinc, Total Ammoniacal-N, Nitrate-N + Nitrite, Total Kjeldahl Nitrogen (TKN), Dissolved Reactive Phosphorus, Total phosphorous, E. coli and Total petroleum hydrocarbons. The portable probe measurements included Dissolved Oxygen, pH, Temperature and Conductivity.

1.4. RESULTS SUMMARY

The results concluded that the some of the contaminants can be removed from the monitoring programme, and some added. Table 1 summarises the recommended changes to the monitoring programme.

Table 1: Summary of contaminants recommended to be changed in the monitoring programme

Contaminant	Source	Current Monitoring Programme Section	Recommended Monitoring Programme Section	Reason Section for Change
Total Suspended Solids	Urban	Urban Impact	Urban Impact	
Dissolved Copper	Urban	Urban Impact	Urban Impact	
Dissolved Lead	-	Urban Impact	-	Very Low Concentrations, therefore recommended to remove it from the programme
Dissolved Zinc	Urban	Urban Impact	Urban Impact	
Total Nitrogen	Rural	Stream Health	-	DIN is in the LWRP, therefore it is recommended that we replace TN with DIN
Dissolved Inorganic Nitrogen	Rural	-	Stream Health	
Total Phosphorus	Mainly Rural	Stream Health	-	DRP is in the LWRP, therefore it is recommended that we replace TP with DRP
Dissolved Reactive Phosphorus	Mainly Rural	-	Stream Health	
E.Coli	Mainly Rural	Stream Health	Stream Health	This was proven to be mainly a rural contaminant and be a contaminant that is monitored as part of the Wastewater Management plan.
Total Hydrocarbons	-	Urban Impact	-	Very Low Concentrations therefore recommended removing it from the programme. Total Hydrocarbons will remain in the basin sediment monitoring.
Dissolved Oxygen	Rural	Stream Health	Stream Health	
pH	Rural	Stream Health	Stream Health	
Temperature	Rural	Stream Health	Stream Health	
Conductivity	-	Stream Health	Stream Health	
Hardness	Rural or Urban	-	Stream Health	Initial one off sample recommended as overall indicator of contaminants.

All of the contaminants were found to be in the appropriate monitoring programme category. Dissolved Lead and Total Hydrocarbons are recommended to be removed from the programme as they were consistently measured to be well below the guideline values.

It is recommended that Total Nitrogen and Total Phosphorus should be replaced with Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen as these are specified in the LWRP.

It was recommended by Ecan water quality specialists that the waterway hardness is measured once or twice to characterise the waterway. This will enable the WDC to get site specific trigger values for metals.

It was found that the bulk of the contaminants are sourced rurally and the guidelines are exceeded prior to the township. However for some contaminants there was an increase in concentration through the township, indicating that the urban area discharges these contaminants also, but in smaller quantities.

The concentrations of contaminants discharging from the springs exceed the guidelines, particularly in the Middlebrook. These springs source water from rurally sourced undercurrent and resurgence.

This study has shown that the rural areas have a significant impact on the health of the Rangiora waterways, and possibly others in the district. It is recommended that Ecan undertakes monitoring upstream of the townships to identify the source of these containments as many contaminant concentrations are exceeded prior to the urban limits.

1.5. CONCLUSION

The following conclusions were made in this investigation:

- Most of the contaminants tested exceeded the guidelines in at least one of the sample rounds. However most exceedances occurred in the May, a moderate wet weather event, which was much larger than a first flush rainfall event.

- It was found that generally the contaminants were present in both rural and urban environments, however the rural area was found to have a larger impact than the urban area and the guidelines were often exceeded prior to reaching the urban discharge points.

The following changes are recommended to the Stormwater Monitoring Programme:

- It is recommended that the contaminants are left in their proposed monitoring programme section. All of the contaminants were found to be in the appropriate monitoring programme section.

- It is recommended that Lead and Total Hydrocarbons are removed from the ‘urban impact’ section of the Stormwater Monitoring Programme, as the results indicated that the concentrations were consistently far below the guidelines.

- It is recommended that Total Nitrogen and Total Phosphorus should be replaced with Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen as these are specified in the LWRP.

- It is recommended that many contaminants such as E.Coli, Nitrogen and Phosphorus should be investigated further by Ecan within the rural catchment. These were significantly exceeding the LWRP guidelines in the rural zones, upstream of the urban limits.

After discussions with Ecan and MKT the Stormwater Monitoring Programme will be updated.

2. INTRODUCTION

Environment Canterbury (Ecan) has requested each of the Territorial authorities within the Canterbury region submit Global Stormwater Consents for all major towns in each district. The Rangiora Stormwater Consent, the first of such in the Waimakariri District, will be prepared in conjunction with a stormwater management plan (SMP). This requires the Waimakariri District Council (WDC) to produce a stormwater monitoring programme. This monitoring programme focuses on the urban stormwater discharge impact on the waterway, as opposed to general stream health.

During the steering group meeting with Mahaanui Kurataiao Limited (MKT) and Ecan, in November 2013, a recommendation was suggested for the WDC to undertake a baseline sampling programme. The purpose of this was to demonstrate to all parties, the source of the waterway contaminants and the current health of the waterways.

Four sample rounds have been completed, in both wet and dry conditions, at 8 sites in the North Drain, North Brook, Middle Brook and South Brook. This report summarises the results from the study and suggests potential sources of the contaminants.

3. BACKGROUND

The stormwater monitoring programme has been designed to identify potential areas of urban stormwater impact on the Rangiora receiving waters. The trends formed from the monitoring programme analysis can be used to direct stormwater treatment activities, within the Rangiora urban limits.

Ecan has recommended that the WDC includes faecal coliform and portable probe measurements (such as dissolved oxygen, pH, temperature, specific conductance) to the urban stormwater impact monitoring, proposed to be sampled biannually.

If the WDC agrees to include these parameters, this would potentially raise the following issues:

1. Some of the sample parameters would be outside of the stormwater discharge consent scope, as they enter the network primarily from rural sources.
2. The cost of increased sampling; including collection, laboratory tests and results analysis.
3. Responsibility and resources for treating rural source contaminants are transferred to urban ratepayers, reducing the pressure from regulators applied to rural properties to mitigate their own adverse effects, and reducing available funding from urban ratepayers for proven urban contaminants such as copper or zinc.
4. The subsequent implications for other future urban consents within the Waimakariri District.

Therefore it was recommended that a 6 month baseline investigation be undertaken, and results used to assist determine the source of the contaminants and associated consent conditions.

3.1. MKT AND ECAN INVOLVEMENT WITH THE COMPREHENSIVE CONSENT

The WDC is working with MKT and Ecan to produce a comprehensive stormwater consent for discharge from the Rangiora urban stormwater network into the receiving waters. The WDC will be applying to Ecan for the consent, however currently MKT and Ecan are playing an advisory role recommending improvements on initiatives relating to the consent.

3.2. RANGIORA AREA

Rural land surrounds Rangiora Township. There is a high potential for the waterways within the urban limit to be impacted by rural activities.

Within the Rangiora urban limits there are three main receiving waters which receive urban stormwater; North Brook, Middle Brook and South Brook. These waterways have annual baseflow sourced from

springs and irrigation channels. These springs and irrigation channels source water from the upstream rural catchment.
The springs in Rangiora are a product of undercurrent and resurgence from the west of Rangiora. This is apparent through observations of the prevalent southeast direction of groundwater flow. These undercurrents are sourced from the upstream rural catchments, which can discharge rural contaminants within the urban area.

Figure 1 presents the WDC land zones surrounding Rangiora.

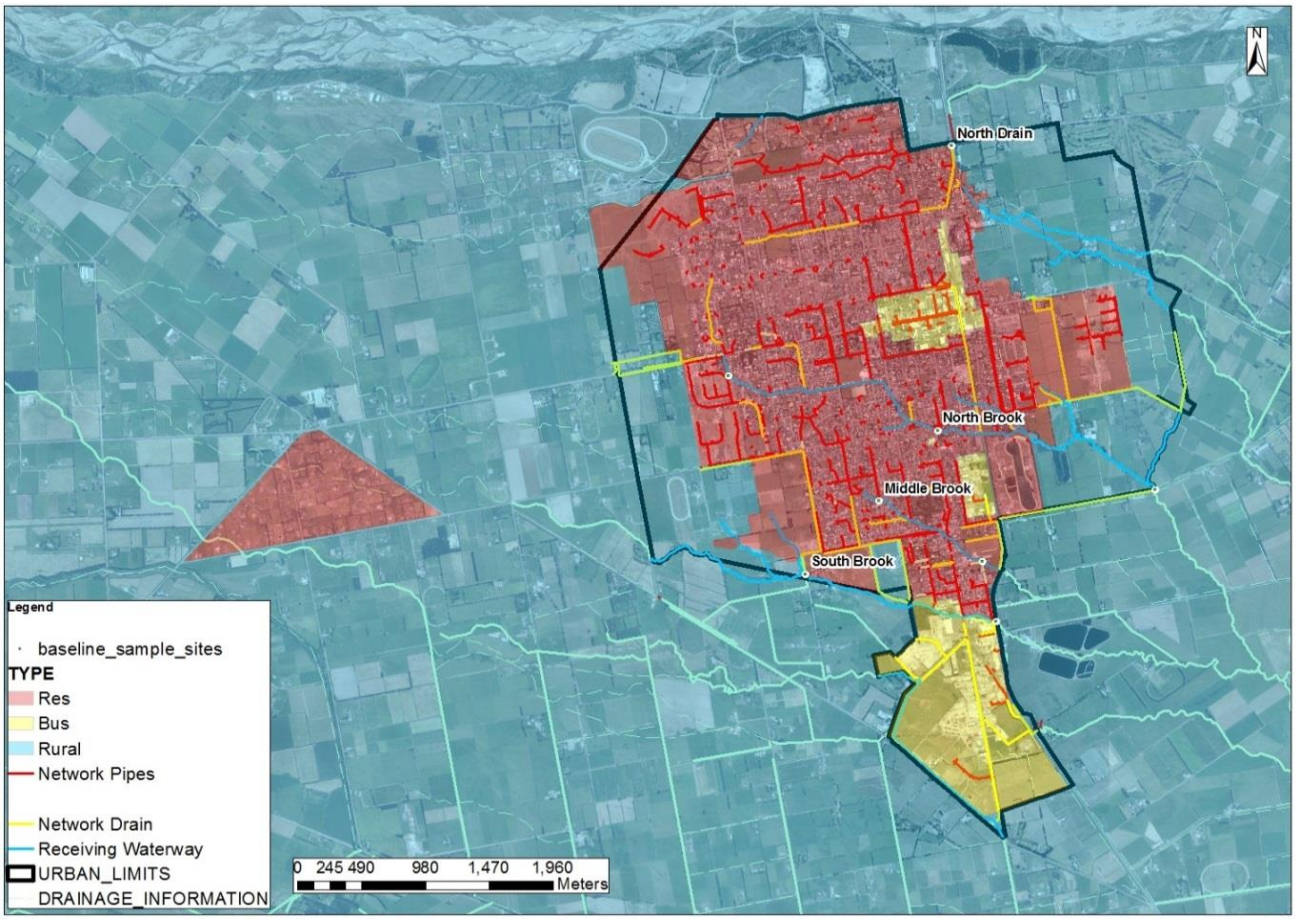


Figure 1: WDC Zonings surrounding Rangiora

The North Drain collects stormwater from the north Rangiora urban catchment. This waterway is ephemeral and therefore was only in flow in the wet weather baseline sampling rounds.

The North Brook originates from a rural irrigation channel and further is supplemented by several springs along the course.

The Middle Brook is sourced from springs originating within the Rangiora Township. The waterway flow is augmented by a pump, pumping spring water into the upstream end, so that there is always baseflow in this waterway. The Middle Brook is further supplemented by several other springs along the course.

The South Brook originates from three spring heads within the rural area. The waterway is also fed by several spring fed roadside drains and an irrigation channel.

Figure 2is a map showing the known spring locations within the Rangiora urban limits, sourced from the Ecan database.

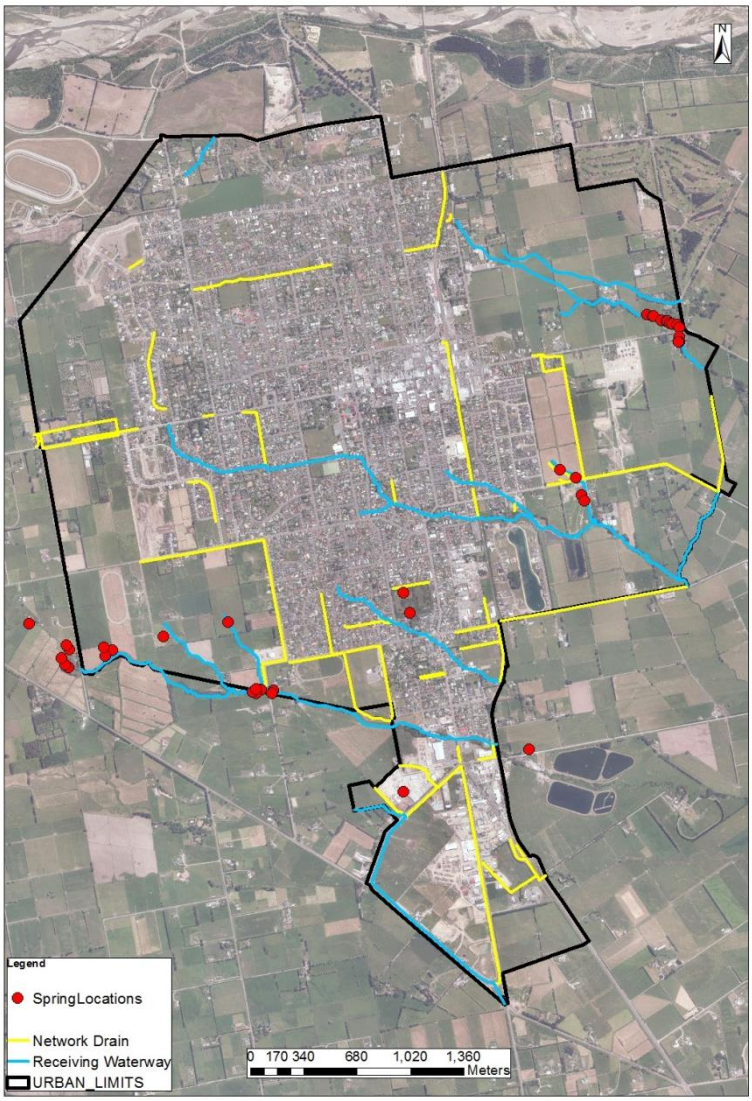


Figure 2: Known spring locations, sourced from the Ecan data base.

Figure 1 and Figure 2 show that all of the Brooks are sourced mainly from springs and urban runoff. It is noted that there are many springs that are not detailed in the Ecan data base, however these are difficult to locate as they emerge from many locations within the Brooks.

3.3. CURRENT PROPOSED STORMWATER MONITORING PROGRAMME

The stormwater monitoring programme has been designed to identify potential areas of urban stormwater impact on the Rangiora receiving waters. The trends formed from the analysis can be used to direct stormwater treatment activities, within the Rangiora urban limits.

Stormwater monitoring programme updates are recommended in this report.

This stormwater monitoring programme report specifies the following:

- Sample Locations
- Sample Parameters
- Sample Frequency

Based on the Canterbury Land and Water Regional Plan (LWRP), the WDC had proposed, prior to undertaking its baseline water quality survey, that the Rangiora stormwater monitoring programme include the following water quality monitoring parameters and frequency:

Table 2: Stormwater Monitoring Programme Overview

	Visual Discharge Inspection	Urban Stormwater Impact Monitoring	Stormwater Basin Monitoring	Stream Health Monitoring
Description	Visual inspection of the major discharge points into the receiving waters.	Water Sampling within the receiving waters and laboratory testing of Urban Stormwater Contaminants, which will be compared to the water quality Guidelines.	Soil or Sediment sampling of the Stormwater Basins.	Stream Health sampling of the receiving waters for a variety of ecological factors, including water quality testing, sediment sampling and ecological surveys.
Location	Major stormwater network discharge points.	Selected receiving waters sampling points.	Dry and Wet Stormwater Basins.	Selected receiving waters sampling points.
Parameters	Water clarity, visual contaminants.	Total suspended solids; Dissolved Copper, Lead and Zinc; Total petroleum hydrocarbons.	Total Copper, Lead and Zinc; Total Petroleum Hydrocarbons.	Dissolved Oxygen, pH, Temperature, Specific Conductance, Total Phosphorous, Total Nitrogen, Ammonia, E. coli
Frequency	Quarterly	Biannually	Every 5 years	Water Quality - Annually Sediment and Ecology Samples - Every 5 years
Weather Conditions	Wet Weather	Ideally First Flush Conditions	Any	Dry Weather Conditions

Visual inspections, urban stormwater impact and stormwater basin monitoring will all form part of the Rangiora comprehensive stormwater discharge consent, with consent management objectives applied to seek to address any exceeded values.

The stream health monitoring will be included within the comprehensive stormwater discharge consent, however the parameters will not have consent management objectives associated with them, i.e. this information will be utilised for other Council projects, such as stream enhancement programmes outside the scope of the consent, as these parameters are not considered to be primarily contributed by stormwater discharge.

This investigation looks at water quality samples, which will only affect the urban impact and stream health sections of this monitoring programme.

3.4. GUIDELINE VALUES

Water quality guidelines are used to identify if the WDC waterways are in a healthy condition. The guidelines have defined Trigger Levels for many different waterway contaminants.

The guidelines that are used to analyse the data are sourced from the following resources:

1. Canterbury Land and Water Regional Plan (2012) *(LWRP, Section 16, Schedule 5)*
2. ANZECC Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC, 2000)

The LWRP gives a guideline to the level to which a '*spring fed – plains urban'* Catchment should be striving to meet. However this guideline is quite brief, there are several contaminants that were sampled that are not in the LWRP. Therefore, although the LWRP will be the main guideline source the ANZECC guidelines will be used if LWRP does not provide a guideline value for any parameter considered essential to the consent.

The guidelines that are being compared to the contaminant concentration are specified.

4. METHODOLOGY

The proposed baseline study aimed to confirm whether the parameters outlined in the proposed monitoring programme are from primarily rural or urban sources.

Four water sampling rounds were undertaken by the WDC Water Unit and analysed by the WDC Project Delivery Unit. The sampling occurred approximately monthly from February to June 2014.

The samples were collected using best practice methods and delivered directly to the laboratory after collection. The sample testing was undertaken by Hill Laboratories in Hamilton.

4.1. SAMPLE LOCATIONS

To assess baseflow (DWF) contaminant concentrations and runoff contaminant concentrations (WWF), sample sites have been selected to be within the receiving waters.

To make this baseline sample programme more efficient and affordable for the WDC, 8 sites were sampled; 3 in the North Brook, 2 in the Middle Brook, 2 in the South Brook and 1 on the North Drain. These sites were selected from the urban stormwater impact sites, so that the data is comparable in the future.

The proposed sample points were situated at either the upstream edge of the urban limits (or at the stream source), and the downstream edge of the urban limits. The change in concentration of contaminants in the receiving waters will enable the WDC to assess the contaminants contributed by the urban area.

The sample locations are as follows; the site number relates to Figure 3:

RRND012: North Drain, Coldstream Road (capturing solely urban contaminants).
RRNB017: North Brook, on the Northern side of Boys Road
RRNB036: North Brook, Lilybrook Park
RRNB055: North Brook, at Aspen Street Park
RRMB019: Middle Brook, on the Northern side of Denchs Road
RRMB029: Middle Brook, on the Western side of Bush Street
RRSB030: South Brook, on the West side of Railway Road
RRSB048: South Brook, on the East side of Townsend Road

See Appendix A for more information on the sample locations; including descriptions, GPS locations and sampling location photographs.

Figure 3 presents a map of the proposed baseline sample sites.

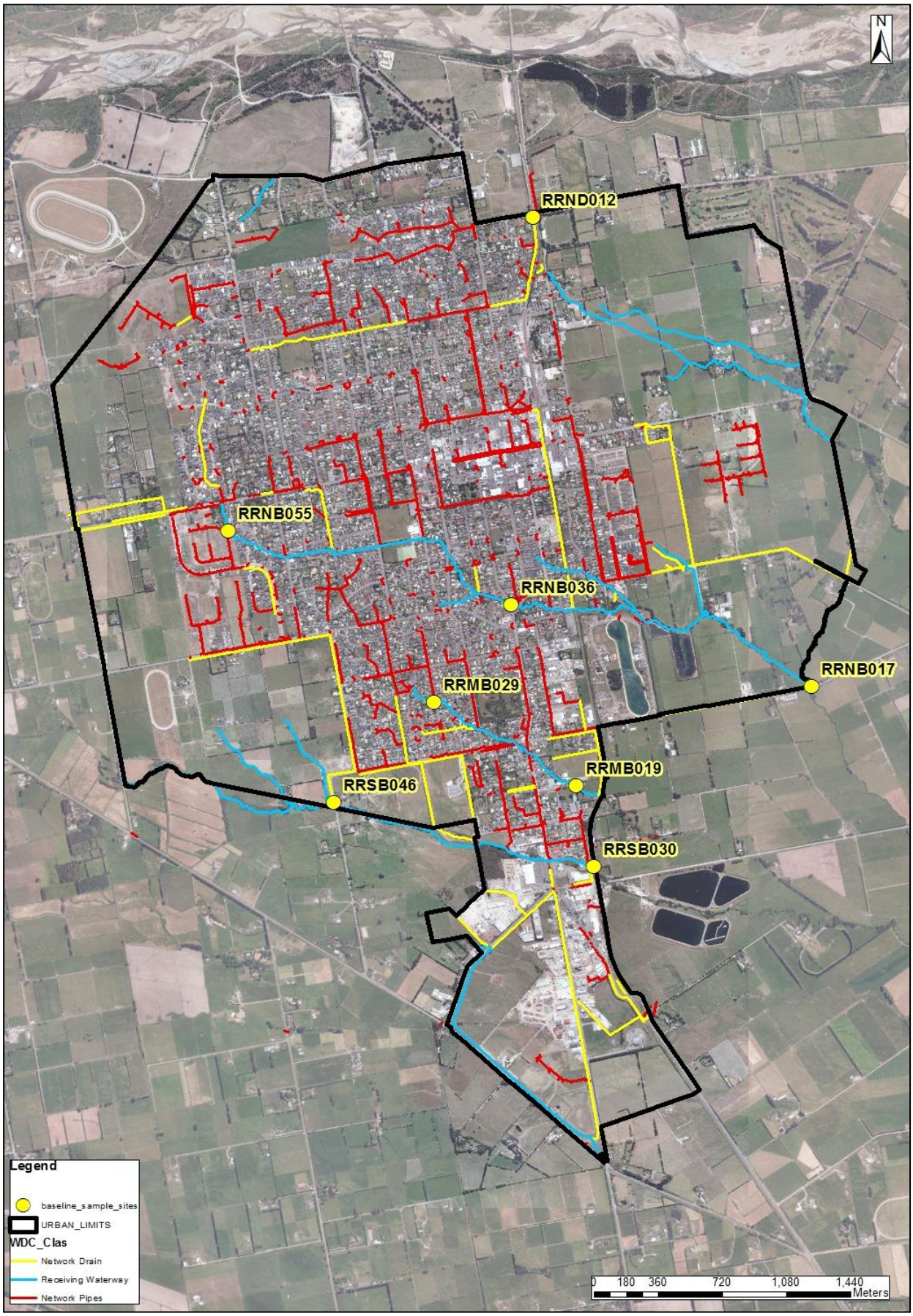


Figure 3: Sample sites for the Baseline Monitoring Programme.

4.2. SAMPLE PARAMETERS

The water quality parameters that were sampled as part of this baseline study are as follows:

Laboratory tests

- Total suspended solids
- Dissolved copper
- Dissolved lead
- Dissolved zinc
- Total Ammoniacal-N
- Nitrate-N + Nitrite
- Total Kjeldahl Nitrogen (TKN)
- Dissolved Reactive Phosphorus
- Total phosphorous
- E. coli
- Total petroleum hydrocarbons

Portable probe measurements

- Dissolved oxygen
- pH
- Temperature
- Conductivity

Dissolved oxygen, pH, temperature and specific conductance can be sampled using portable water quality devices. The WDC water unit currently has access to an YSI multi-probe used in past stormwater monitoring exercises.

4.3. FREQUENCY

The samples were retrieved approximately every month, so that four sample rounds are undertaken before June 2014. Wet and dry weather days were selected so the source of the contaminants could be separated into spring discharge and/or runoff contaminants.

The following list presents the selected sampling days;

1. February 13th 2014, sampling commenced at 9:00am
2. March 26th 2014, sampling commenced at 9:00am
3. May 14th 2014, sampling commenced at 9:00am
4. June 4th 2014, sampling commenced at 1:00pm

5. RESULTS

5.1. SAMPLING WEATHER CONDITIONS

First flush events give the best measure of runoff contaminants. As first flush events are statistically infrequent, getting a first flush event within the baseline monitoring programme period was predicted to be difficult. Therefore samples were retrieved in dry conditions and wet conditions; although the sample round in February fitted the first flush parameters.

Table 3 presents a summary of the rainfall prior to the water quality sampling; the rainfall data was taken from the Ayres Street, Rangiora WDC rainfall gauge.

Table 3: Presents a description of the conditions on each of the Baseline sampling days

Date	Weather Conditions	Event Description
February 13th	Dry weather when sampling, 22 mm of rain in the 24 hours before the sample, no rainfall 72 hours prior to that rainfall	* First flush event
March 26th	Dry weather whilst sampling, 13 mm of rain in the 24 hours before the sample, 0.8 mm rainfall 72 hours prior to the sampling	Minor wet weather event
May 14th	Wet weather whilst sampling, 41 mm of rain in the 24 hours before the sample, 0.2 mm rainfall 72 hours prior to the sampling	Moderate wet weather event, 1 year return period
June 4th	Dry weather whilst sampling, 0 mm of rain in the 24 hours before the sample, 0 mm rainfall 72 hours prior to the sampling	Dry weather event

** First flush conditions are defined as a rainfall event with rainfall no less than 10 mm and no greater than 25 mm, over 24 hours (CCC, waterways wetlands and drainage guide). Antecedent precipitation conditions should be considered, where a first flush storm needs to have a period of at least 72 hours of no measurable precipitation (Otago Regional Council).*

See Appendix B for rainfall hydrographs of the sampled events.

5.2. RESULTS SUMMARY

There were several parameter concentrations that were below detectable limits in the samples given to Hills Laboratory; for simplicity these were recorded as zero in this investigation.

Due to the North Drain being ephemeral there was flow in the May sample round only. February, March and June samples for the North Drain were collected but the results considered invalid as the samples were retrieved from stagnant water.

It is also noted that most guidelines specify that the sampling should be undertaken in a first flush event. The May samples generally produced higher concentrations than the other samples, however this event was much larger than a first flush event.

The following sections of this report look at each of the tested contaminants separately, to discuss the source of the contaminant and proposed changes to the current stormwater monitoring programme.

See Appendix C for a summary of the laboratory results summary for each of the sample rounds.

5.2.1. Total Suspended Solids

Total suspended solids (TSS) include all particles suspended in water which will not pass through a filter. Suspended solids are mainly non-point source pollutants such as soil erosion from agricultural and construction sites.

Figure 4 presents the TSS concentration laboratory results from the North Drain, North Brook, Middle Brook and South Brook.

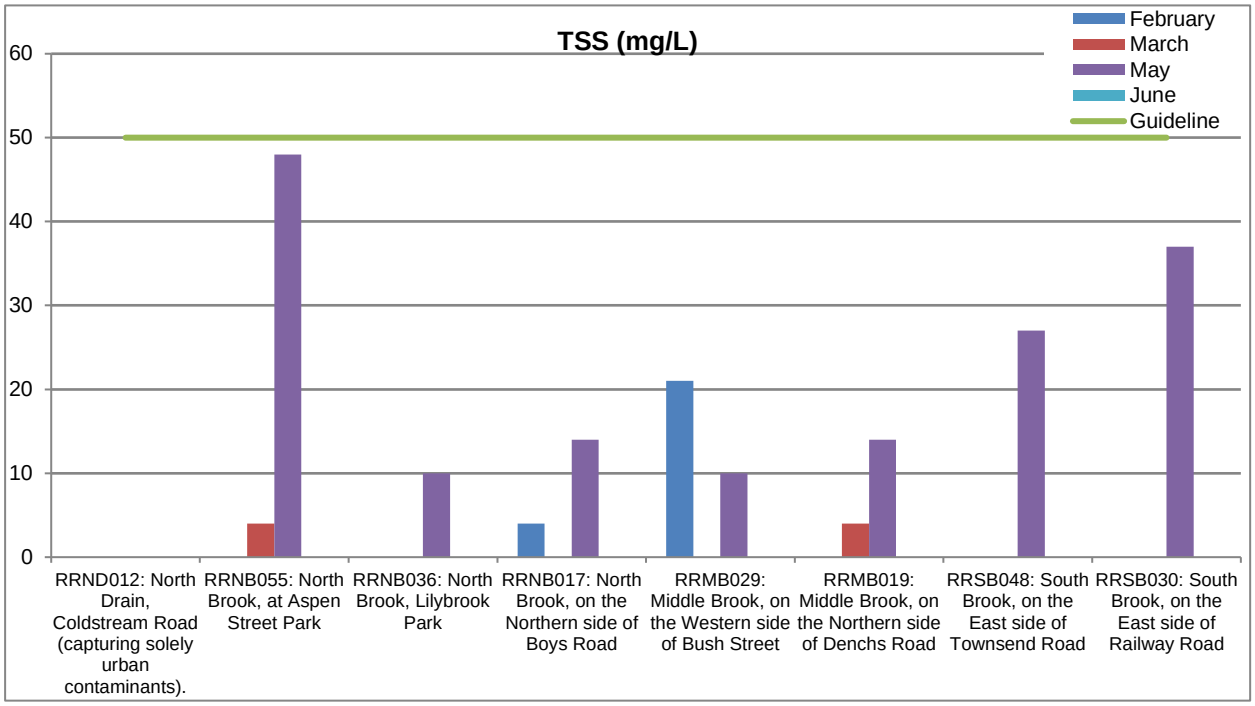


Figure 4: TSS concentrations in the North Drain, North Brook, Middle Brook and South Brook

Some sites had TSS concentrations below the detectable limit (3mg/L) in all events. The LWRP guideline, 50mg/L, is not exceeded in any of the sampling rounds. This indicates that TSS concentrations are not elevated, and are therefore not predicted to adversely affect aquatic life.

Flow in the north drain only occurred in the May sample, where the TSS concentrations were under the detectable limit and are therefore not shown in the Figure 4.

In the May sample round, the moderate wet weather event, the TSS concentrations were higher than in the other events. This is simply because there was more runoff in a larger rainfall event, therefore higher velocities, and greater particle movement is expected.

Generally the TSS concentrations are increasing through the township, indicating that the township is contributing suspended solids to the waterways. The North Brook is the exception, where higher TSS concentrations seem to be discharging from the irrigation channel.

In most of the sample rounds a trend and the source of the TSS was not clear. Therefore it is recommended that TSS remains in the urban impact monitoring programme, as it is standard practice to report against this parameter.

5.2.2. Dissolved Copper

Dissolved copper primary sources include but are not limited to, vehicle brake pad wear and plumbing uses such as copper spouting.

Figure 5 presents the dissolved copper concentration laboratory results from the North Drain, North Brook, Middle Brook and South Brook.

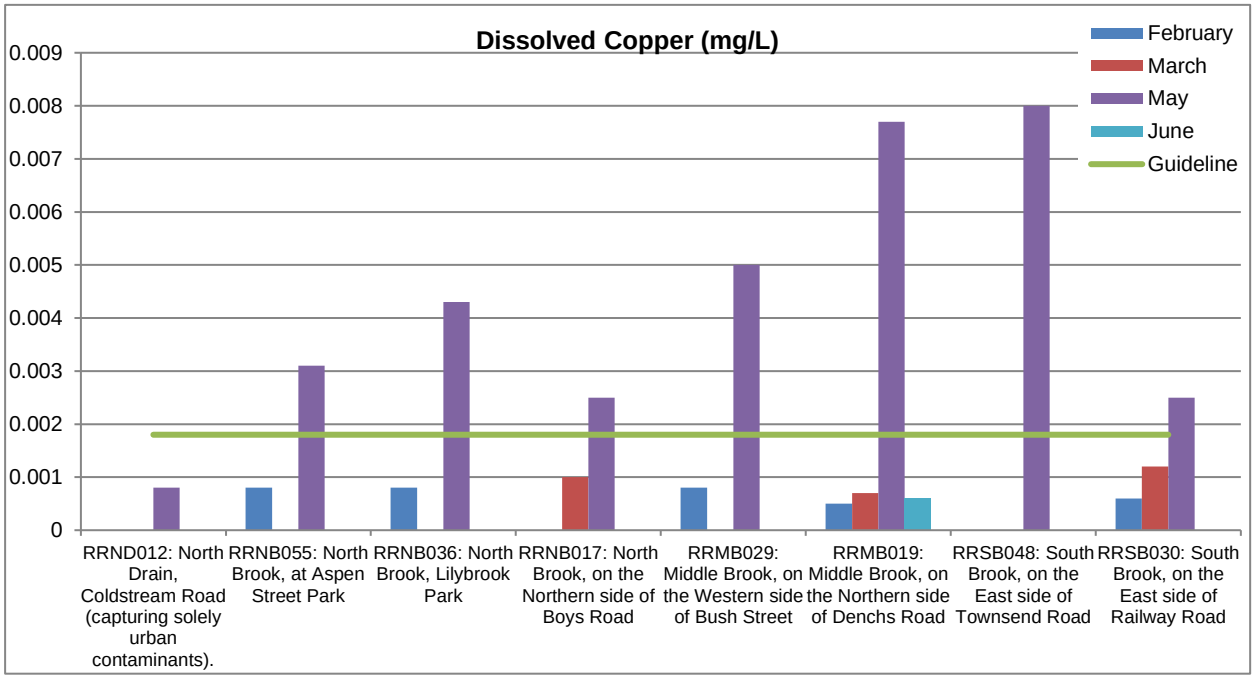


Figure 5: Dissolved Copper concentrations in the North Drain, North Brook, Middle Brook and South Brook

The LWRP guideline, 0.0018mg/L, is exceeded in the May, wet weather sample round. In low runoff or dry weather flow conditions the dissolved copper guideline is not exceeded. There are sites with concentrations below the detectable limit (0.0005 mg/L) particularly in the dry weather sample in June.

- North Drain – flow in the north drain only occurred in the May sample, where the dissolved copper concentrations were below the guideline value.
- North Brook – the copper concentrations are highest in the centre of the township. However it is noted that the copper concentration exceeds the guideline prior to the township also. The copper concentration at the Boys Road site is lower than the others, indicating that it is being diluted and/or the North Brook stormwater pond is operating effectively.
- Middle Brook – the copper concentrations are high near the start of the catchment, and increase in concentration through the township.
- South Brook – the copper concentrations were highest before entering the township, in the May sample. This seems to be an anomaly, as the other events do not follow the same trend.

Generally the dissolved copper concentrations increase within the township; although it is also noted that the rural runoff appears to have copper concentrations higher than the guideline values.

As dissolved copper is a proven urban contaminant and the baseline programme has shown that the concentrations can exceed the guidelines in high runoff events, it is recommended that dissolved copper remains in the ‘urban impact’ section of the monitoring programme.

5.2.3. Dissolved Lead

Dissolved lead primary sources include but are not limited to road runoff (auto parts) and construction wastes (paints).

Error! Reference source not found. Figure 5 presents the dissolved lead concentration laboratory r esults from the North Drain, North Brook, Middle Brook and South Brook.

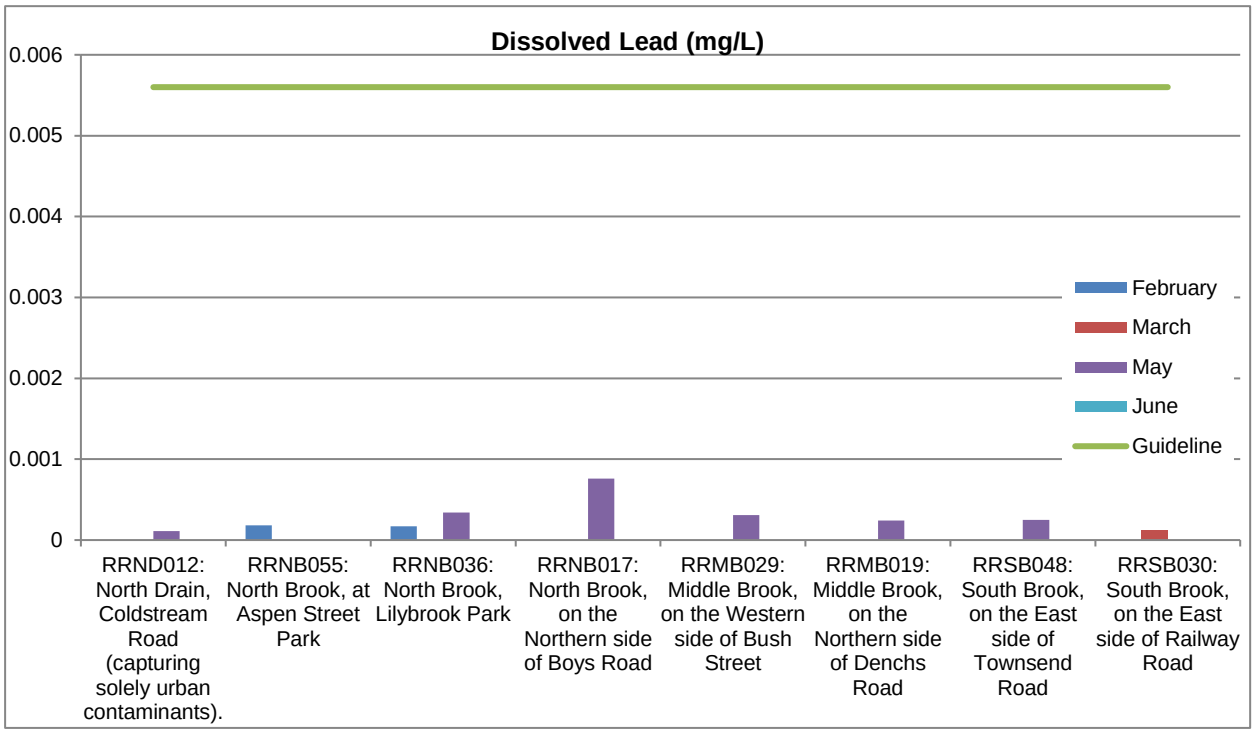


Figure 6: Dissolved Lead concentrations in the North Drain, North Brook, Middle Brook and South Brook

The LWRP guideline, 0.0056mg/L, is not exceeded in any of the sampling rounds. This indicates that dissolved lead concentrations are not predicted to adversely affect aquatic life in the Rangiora waterways. For many of the samples the concentrations were below the detectable limit (0.0005 mg/L).

Generally concentrations do not change significantly through the township. There are also minor lead concentrations prior to the township sourced from rural runoff.

Therefore it is recommended that dissolved lead is removed from the urban impact monitoring programme as recorded levels are extremely low and do not appear to be approaching the guideline level in any sample.

5.2.4. Dissolved Zinc

Dissolved zinc primary sources include but are not limited to, unpainted galvanized roofs and vehicle tyre wear.

Figure 7 presents the dissolved zinc concentration laboratory results from the North Drain, North Brook, Middle Brook and South Brook.

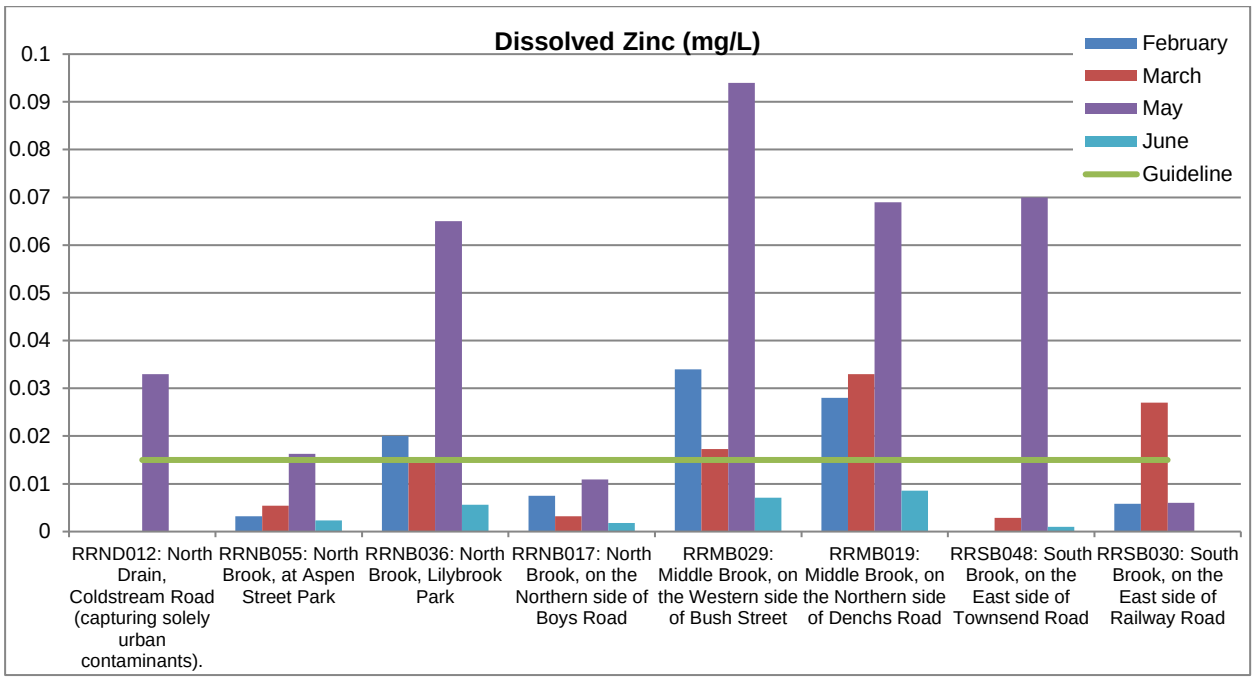


Figure 7: Dissolved zinc concentrations in the North Drain, North Brook, Middle Brook and South Brook

The LWRP guideline, 0.015mg/L, is exceeded in many of the wet weather sample rounds. In the dry weather sample round the dissolved zinc concentrations did not exceeded the guideline value.

- North Drain – flow in the north drain only occurred in the May sample, where the dissolved zinc concentrations exceeded the guideline values.
- North Brook – the zinc concentrations are highest in the centre of the township. However it is noted that the zinc concentration also exceeds the guideline prior to the township. The zinc concentration at the Boys Road site is lower than the others, indicating that it is being diluted and/or the North Brook stormwater pond is operating effectively.
- Middle Brook – the zinc concentrations are generally higher near the start of the catchment. All wet weather samples exceeded the guideline at both Middle Brook sites.
- South Brook – the zinc concentrations were highest before entering the township, in the May sample. This seems to be an anomaly, as the other events do not follow the same trend.

Generally the dissolved zinc concentrations increase within the township; although it is also noted that the rural runoff appears to have zinc concentrations higher than the guideline values.

As dissolved zinc is a proven urban contaminant and the baseline programme has shown that the concentrations can exceed the guidelines in high runoff events, it is recommended that dissolved zinc remains in the 'urban impact' section of the monitoring programme.

5.2.5. Nitrogen

Nitrogen primary sources include but are not limited to fertilizers and sewerage. It is noted that Total Nitrogen is the sum of TKN + Nitrate-N + Nitrite-N and DIN is the sum of Total Ammoniacal-N + Nitrate-N + Nitrite-N.

Figure 8 and Figure 9 present the Total Nitrogen (TN) and Dissolved Inorganic Nitrogen (DIN) concentrations from laboratory results from the North Drain, North Brook, Middle Brook and South Brook.

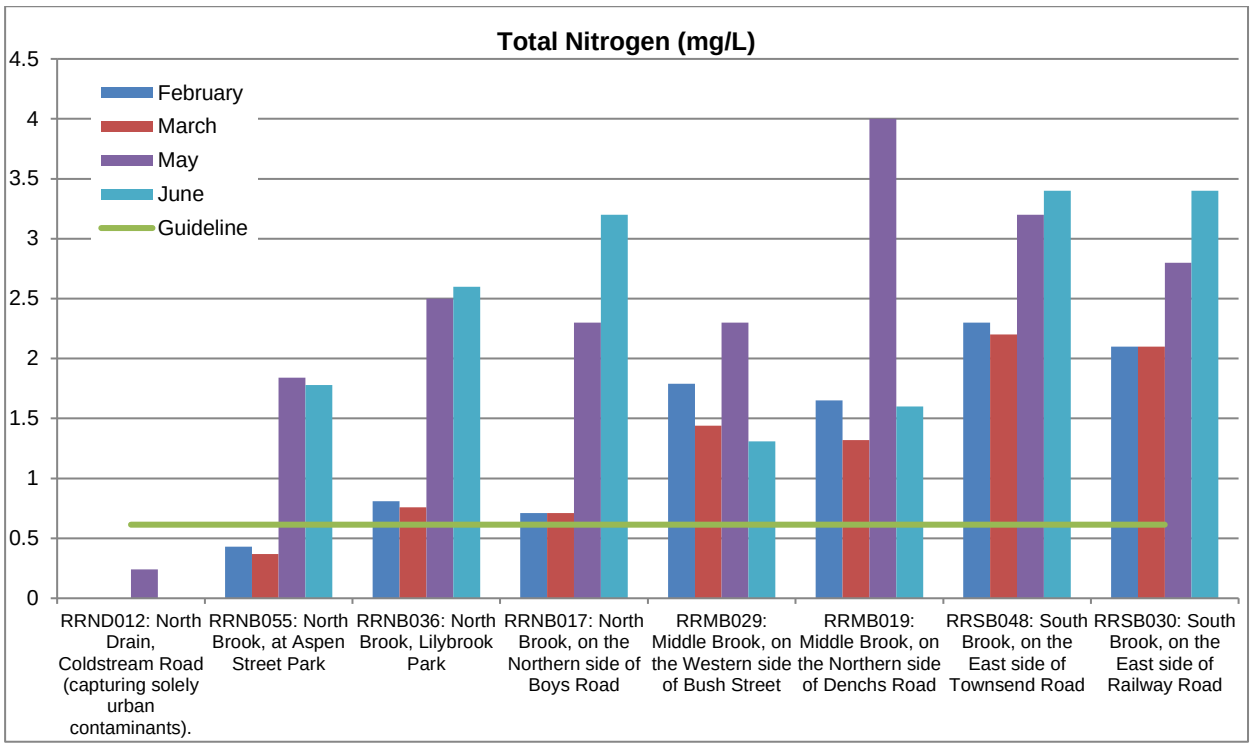


Figure 8: Total Nitrogen concentrations in the North Drain, North Brook, Middle Brook and South Brook

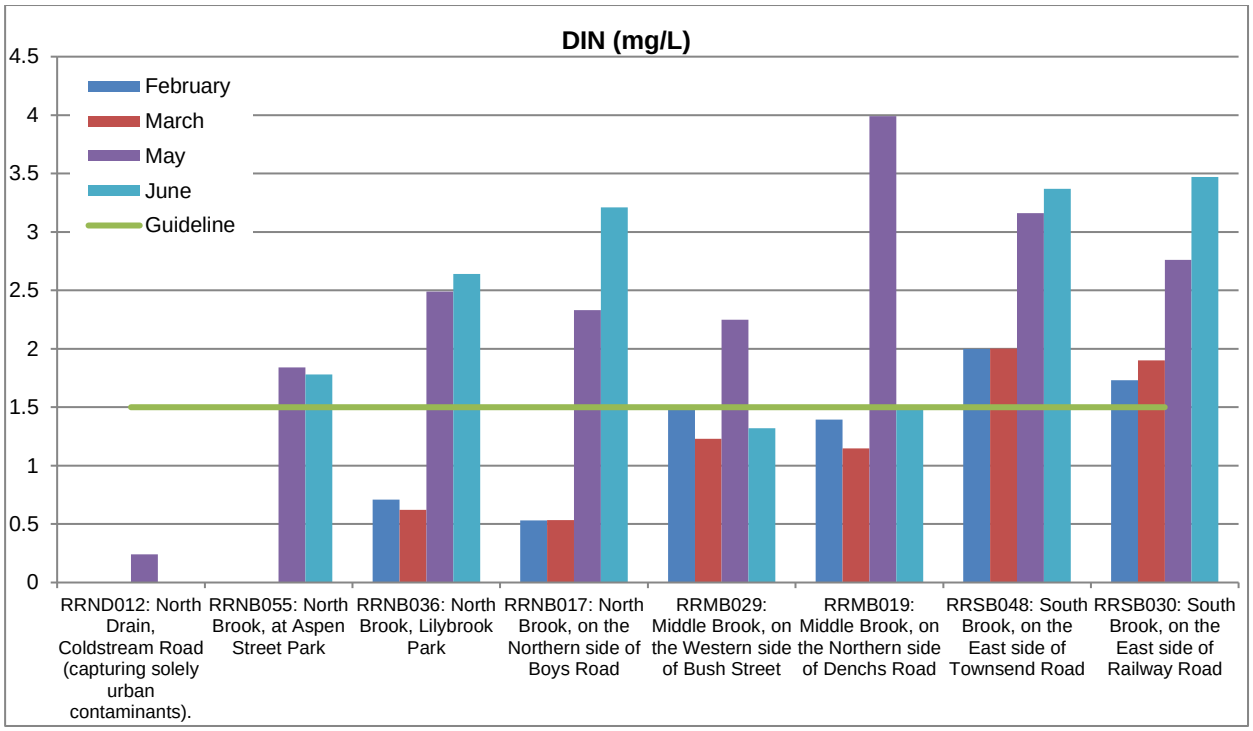


Figure 9: Dissolved Inorganic Nitrogen concentrations in the North Drain, North Brook, Middle Brook and South Brook

The ANZECC guideline for Total Nitrogen, 0.614mg/L, is exceeded generally in both the dry and wet weather samples. For DIN the LWRP guideline is 1.5mg/L, this is generally exceeded in both the dry weather sample (June) and the most wet weather sample (May).

The flow in the north drain only occurred in the May sample, where the nitrogen concentrations did not exceeded the guideline values; indicating that nitrogen is not an urban contaminant.

The nitrogen levels in the North and South Brooks are higher in the dry weather flow sample round than the wet weather samples. This indicates that the irrigation channels and spring heads are contributing nitrogen to the Brooks.

The nitrogen concentrations in moderate wet weather event (May) are also quite high, and generally decreasing through town. This indicates that when rural runoff is high, like in the May rainfall event, nitrogen levels are high.

In the February and March events the nitrogen concentrations were lower than the dry weather flow sample. In these events the runoff was low in the rural catchments, and infiltration was high. It appears that the urban discharge diluted the nitrogen concentrations from the springs and irrigations channels.

DIN is stated as an urban indicator in the LWRP. It is recommended that the WDC places this into the stream health section of the monitoring programme instead of the urban impact section as it is clearly demonstrated through these results to be a rural contaminant. DIN generally gives a better indication of highly bioavailable inorganic forms of nitrogen, for example fertilizers.

Therefore it is recommended that TN is replaced with DIN and remains in the stream health monitoring programme, as concentrations clearly correlate with spring flows and rural runoff, rather than urban discharges.

5.2.6. Phosphorus

Phosphorus primary sources include but are not limited to fertilizers and sewerage. Phosphorus tends to attach to soil particles and moves into surface-water bodies from runoff.

Figure 10 and Figure 11 present the Total Phosphorus (TP) and Dissolved Reactive Phosphorus (DRP) concentrations from laboratory results from the North Drain, North Brook, Middle Brook and South Brook.

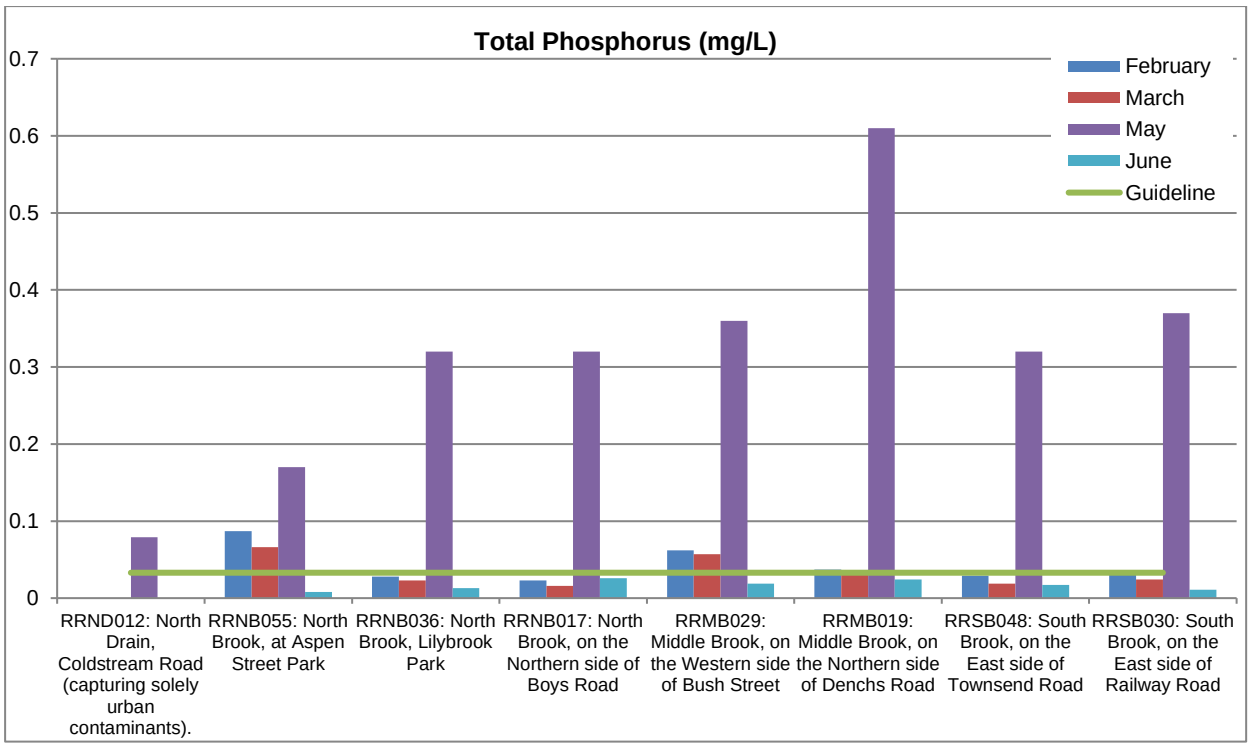


Figure 10: Total Phosphorus concentrations in the North Drain, North Brook, Middle Brook and South Brook

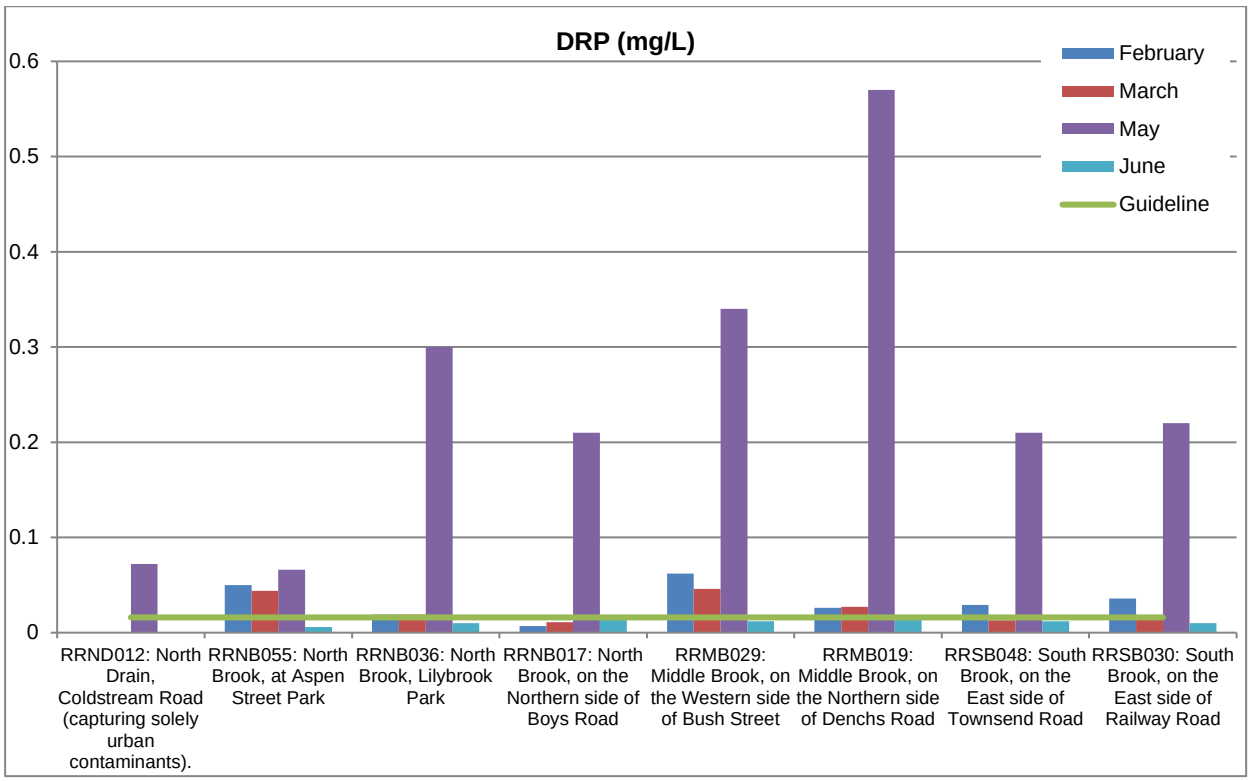


Figure 11: Dissolved Reactive Phosphorus concentrations in the North Drain, North Brook, Middle Brook and South Brook

The ANZECC guideline for TP (0.033mg/L) and the LWRP guideline for DRP (0.016mg/L), are exceeded generally in the wet weather samples.

The flow in the north drain only occurred in the May sample, where the phosphorus concentrations exceeded the guideline values; indicating that phosphorus can be an urban contaminant.

The dry weather samples for phosphorus were all below the guideline values. It is noted that the concentrations are generally increasing through the urban area in the dry weather sample, indicating that the springs could be contributing phosphorus along the course of the waterway.

Phosphorus concentrations decrease through the urban area in the February and March events. This indicates that the phosphorus concentrations are being diluted by the urban runoff, and therefore are being sourced rurally.

During the May sample round, the moderate wet weather event, the concentration increases through the township and the concentrations are higher than in the other events. This is simply because there is more runoff in a larger rainfall event, therefore higher velocities, and greater particle movement is expected.

As DRP is stated as the applicable indicator for stormwater quality in the LWRP, it is recommended that it replaces the TP in the current monitoring programme.

It is concluded that the increase in concentrations of phosphorus through the township are caused by the springs and mobilizing of the bed sediments in high runoff conditions. Therefore it is recommended that TP is replaced with DRP and kept in the ‘stream health’ section of the monitoring programme, as it is a rural contaminant.

5.2.7. E.Coli

E.Coli is used as an indicator of possible sewage contamination as E.Coli is commonly found in human and animal feces.

Figure 12 presents the E.Coli concentrations from laboratory results for the North Drain, North Brook, Middle Brook and South Brook.

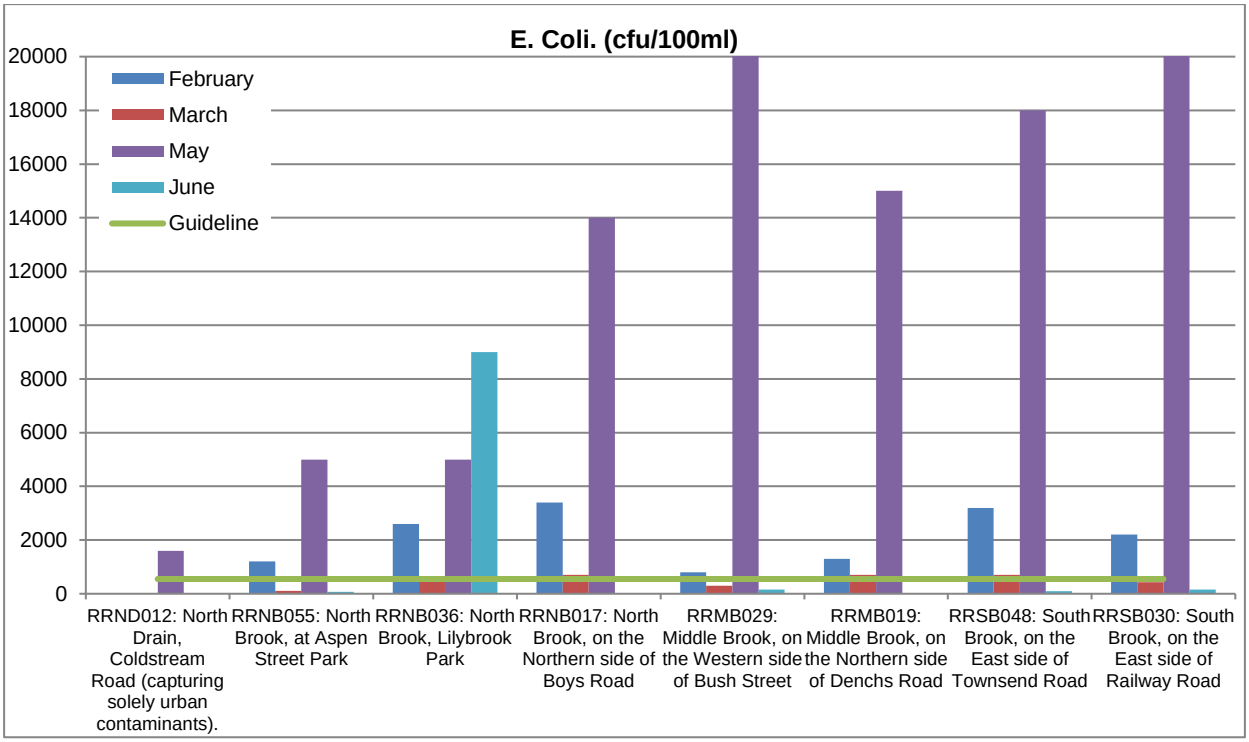


Figure 12: E.Coli concentrations in the North Drain, North Brook, Middle Brook and South Brook

The concentrations of E.Coli in these samples frequently exceeded the guideline LWRP (550 E.Coli per 100ml) values, particularly in the February and May wet weather samples.

The flow in the north drain only occurred in the May sample, where the E.Coli concentrations exceeded the guideline values; indicating that E.Coli can be an urban contaminant.

The runoff from the rural catchments has high concentrations of E.Coli prior to entering the urban area. This is seen in the upstream sample sites of the waterways.

It appears that the rural runoff is the main contributor of E.Coli, as during the DWF days there are generally very low levels of E.Coli in the waterways, indicating that the springs do not contribute E.Coli to the waterways. The exception being in the June sample at Lilybrook, the dry weather E.Coli concentration exceeds the wet weather samples. This is a clear outlier, and is therefore disregarded.

As the concentrations of E.Coli are increasing through the urban area, in some of the samples, the potential sources were investigated further. The main sources of E.coli include, but are not limited to:

- Urban animal sewerage such as dogs, cats and birds
- Agricultural sewerage
- Human sewerage

To investigate the rural and animal sources of E.Coli, Figure 13 presents the Rangiora stormwater network, rural zones and parks surrounding the three Brooks.

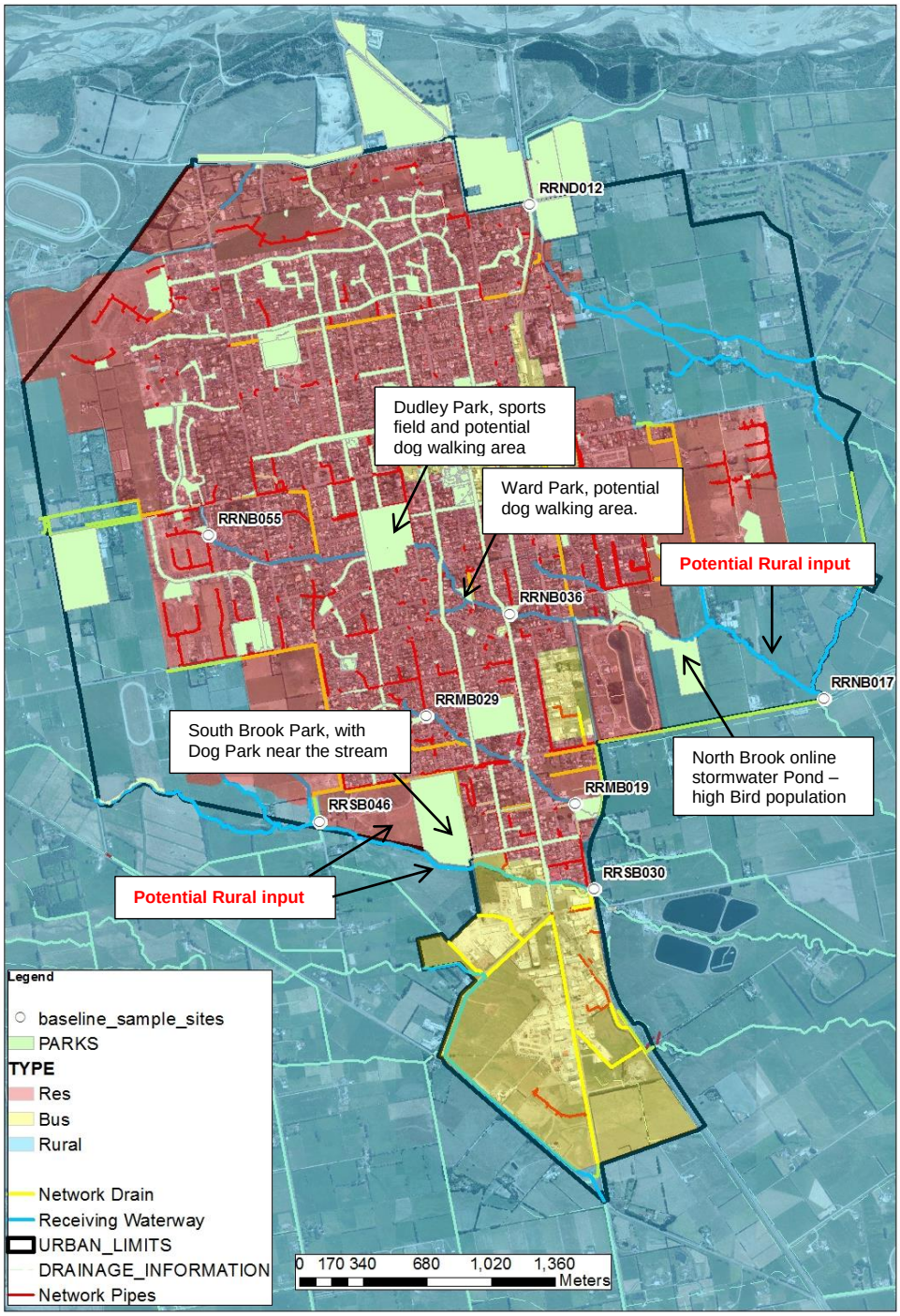


Figure 13: Map of Rangiora showing Zones and Parks surrounding the Brooks.

It is feasible that the North Brook stormwater pond dense bird population may be causing a spike in E.Coli concentrations at the RRNB017 sample point. However the urban animal sewerage generally seems an improbable conclusion. It is difficult to believe that dog parks (where most people pick up their dog waste) and bird guano on roofs can cause very elevated levels of E.Coli as observed in the wet weather samples.

As the E.Coli concentrations are elevated prior to entering the urban limits, it is concluded that the majority of the E.Coil is rurally sourced.

The May rainfall event, which caused the highest concentrations of E.Coli was run through the Rangiora Sewer Network Hydraulic Model, to see if this rainfall event caused any sewer overflows. The analysis concluded that the moderate event in May did not cause sewer overflows.

As modelling information is only a representation of the sewer network it is accepted that there may be sewerage overflow sites that are not appearing in the model. However it is also acknowledged that these overflows are being managed separately through the Wastewater Management Plan process. A number of wastewater capacity upgrades are currently programmed to reduce wastewater overflows and further improvements will be identified through the planning process and incorporated in future Long Term Plans.

Therefore it is recommended that Ecan undertakes further monitoring of the rural catchments to locate the source of E.Coli, as it appears to be mainly rurally sourced.

5.2.8. Total Hydrocarbons

Total Hydrocarbon primary sources include but are not limited to road asphalts, manufacturing facilities and fuelling depots, as these areas frequently experience oil spillages.

There is no consistency between guidelines for hydrocarbons; Ecan is in the process of investigating and stating a guideline.

For all samples the results indicated that the total hydrocarbon concentrations for C7 - C9, C10 - C14 and C15 - C36 were all below the detectable limits. Therefore it was concluded that the Rangiora urban and rural catchments do not have an issue with hydrocarbons.

It is recommended the hydrocarbons should be removed from the urban impact section of the monitoring programme, however the total hydrocarbon concentration should be kept in the ‘sediment sampling’ section of the monitoring programme, until it has been investigated further.

5.2.9. Dissolved Oxygen

Several factors affect the amount of oxygen dissolved in the water in waterways. Colder water usually has more oxygen, because gasses dissolve better in cold temperatures. Water motion also helps mix oxygen into the water. Eutrophication can deplete the oxygen concentration in the waterways.

Figure 14 presents the dissolved oxygen concentration portable probe results for the North Drain, North Brook, Middle Brook and South Brook. It is noted that a dissolved oxygen reading was not retrieved in the February event.

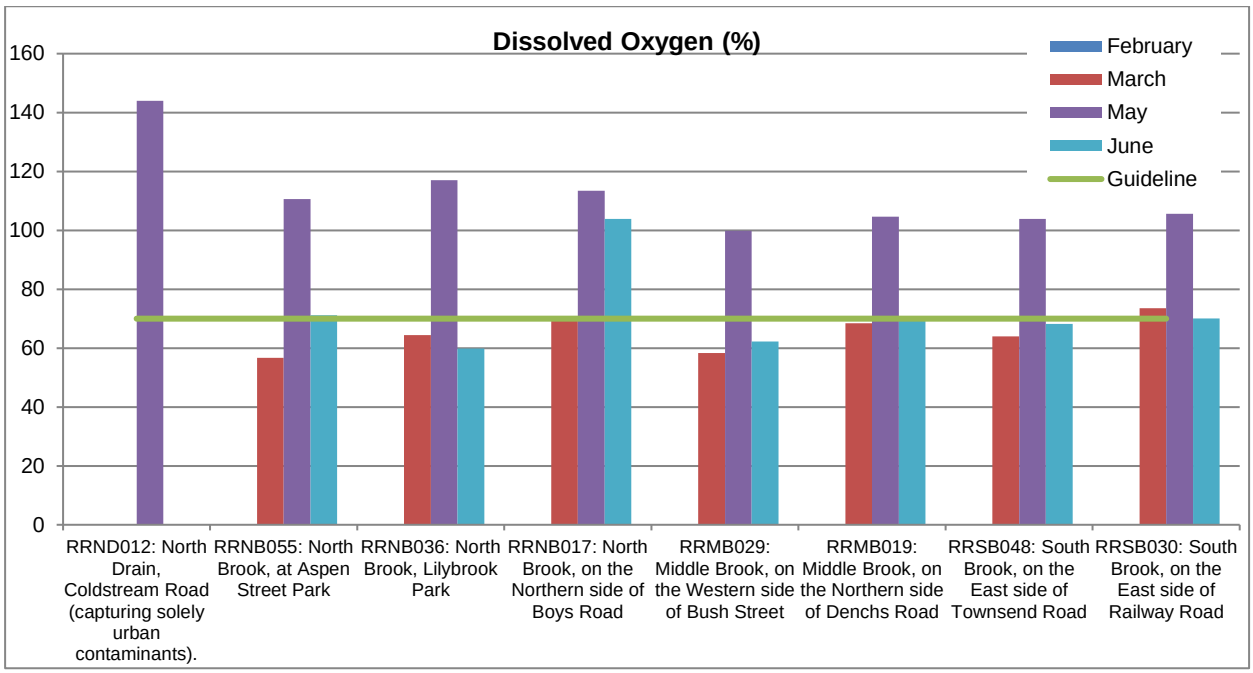


Figure 14: Dissolved Oxygen concentrations in the North Drain, North Brook, Middle Brook and South Brook

The LWRP guideline states that the dissolved oxygen saturation minimum is 70%. Most of the readings were recorded to be below this guideline. More water movement tends to result in more oxygen in the water, the data supports this, where in May the oxygen saturation levels are higher than the other events.

Oxygen saturation percentages are low in the dry weather event (June) and the minor wet weather event (March). This demonstrates that urban runoff does not have any significant effect on the dissolved oxygen saturation.

Therefore it is recommended that dissolved oxygen is kept in the 'stream health' section of the monitoring programme, as it is not negatively impacted by urban stormwater discharges.

5.2.10. pH

Low pH (acidic) is caused by high organic acids, such as some wetland waters or where mineral acidity occurs naturally. High pH (basic) is caused by highly eutrophic waters, where eutrophication occurs.
pH differences can also occur by water draining certain rock and soil types and industrial wastes.

Figure 15 presents the pH portable probe results from the North Drain, North Brook, Middle Brook and South Brook. It is noted that pH reading was not retrieved in the February event.

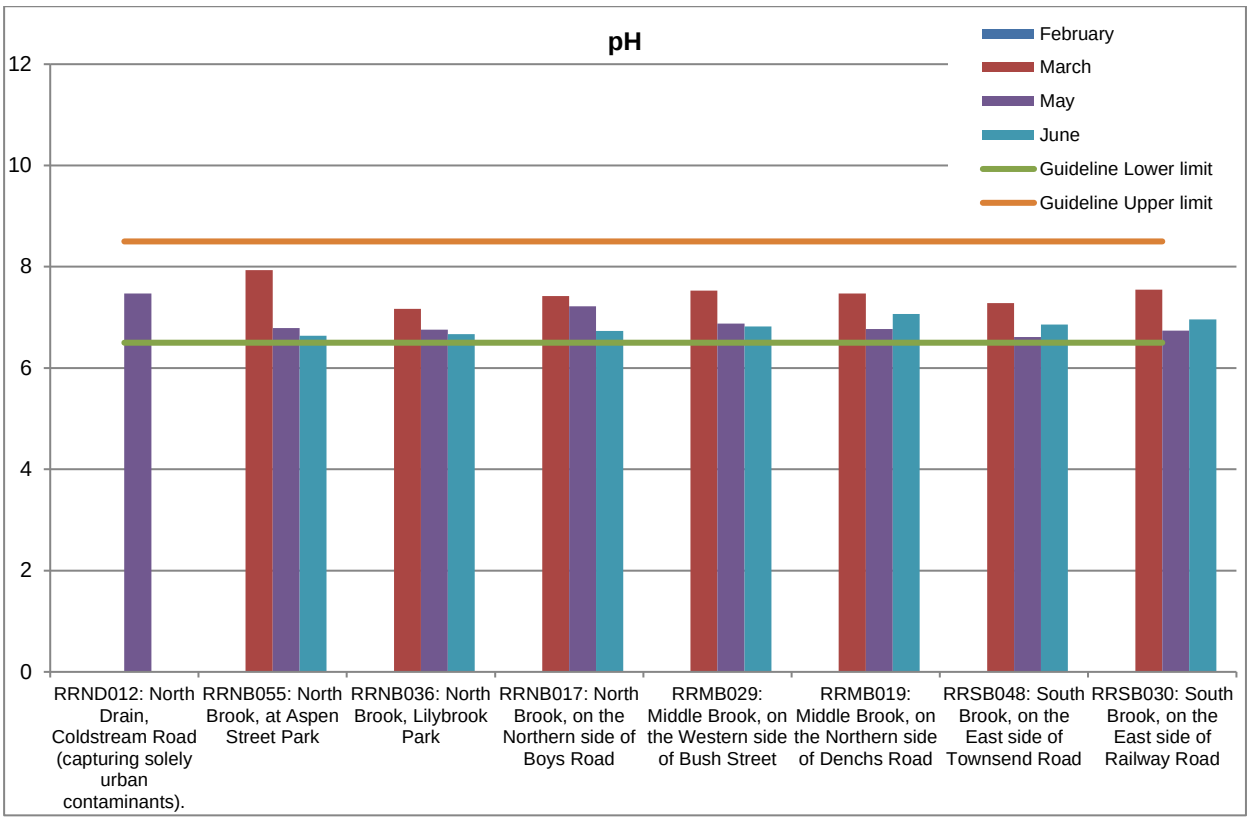


Figure 15: pH in the North Drain, North Brook, Middle Brook and South Brook

The LWRP guideline states that the pH should be within a range 6.5 to 8.5. All readings were with in this range, maybe slightly on the acidic side of the scale. The pH levels do not change significantly between the wet and dry samples.

Therefore it is recommended that pH is kept in the ‘stream health’ section of the monitoring programme, as it is not proven to be affected by the urban discharges.

5.2.11. Temperature

Temperature fluctuations can be caused by the change in runoff temperature off street/field surface temperatures.

Figure 16 presents the temperature portable probe results from the North Drain, North Brook, Middle Brook and South Brook. It is noted that pH reading was not retrieved in the February event.

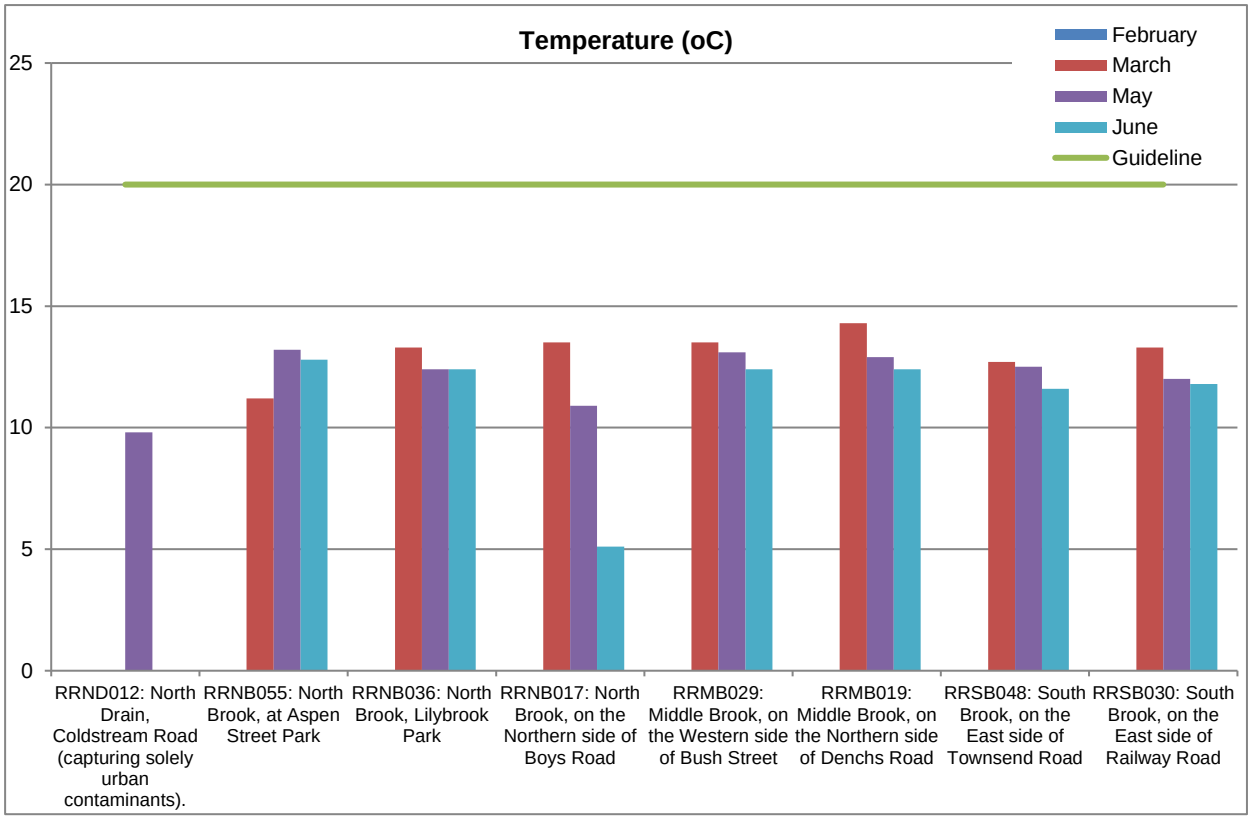


Figure 16: Temperature in the North Drain, North Brook, Middle Brook and South Brook

The LWRP guideline states that the stream temperatures should not exceed 20 degrees Celsius. All readings were below this guideline. Generally in the warmer months the waterway temperatures were higher than in the winter months. There is no evidence to suggest that stormwater runoff is altering the natural temperature of the stream, as the temperatures of the dry (June) and wet (May) weather events are similar.

Therefore it is recommended that temperature is kept in the 'stream health' section of the monitoring programme, as it is not proven to be affected by the urban discharges.

5.2.12. Conductivity

Conductivity measurements can be used to estimate ion concentrations in solution. It doesn't identify the specific ions in the water. However, significant increases in conductivity may be an indicator that polluting discharges have entered the water.

A conductivity guideline is not specified in the LWRP or ANZECC guidelines, the WDC has decided to include it in the stream health monitoring programme as it is a portable probe measurement, therefore easily retrieved with the other probe measurements.

Figure 17 presents the conductivity portable probe results from the North Drain, North Brook, Middle Brook and South Brook. It is noted that pH reading was not retrieved in the February event.

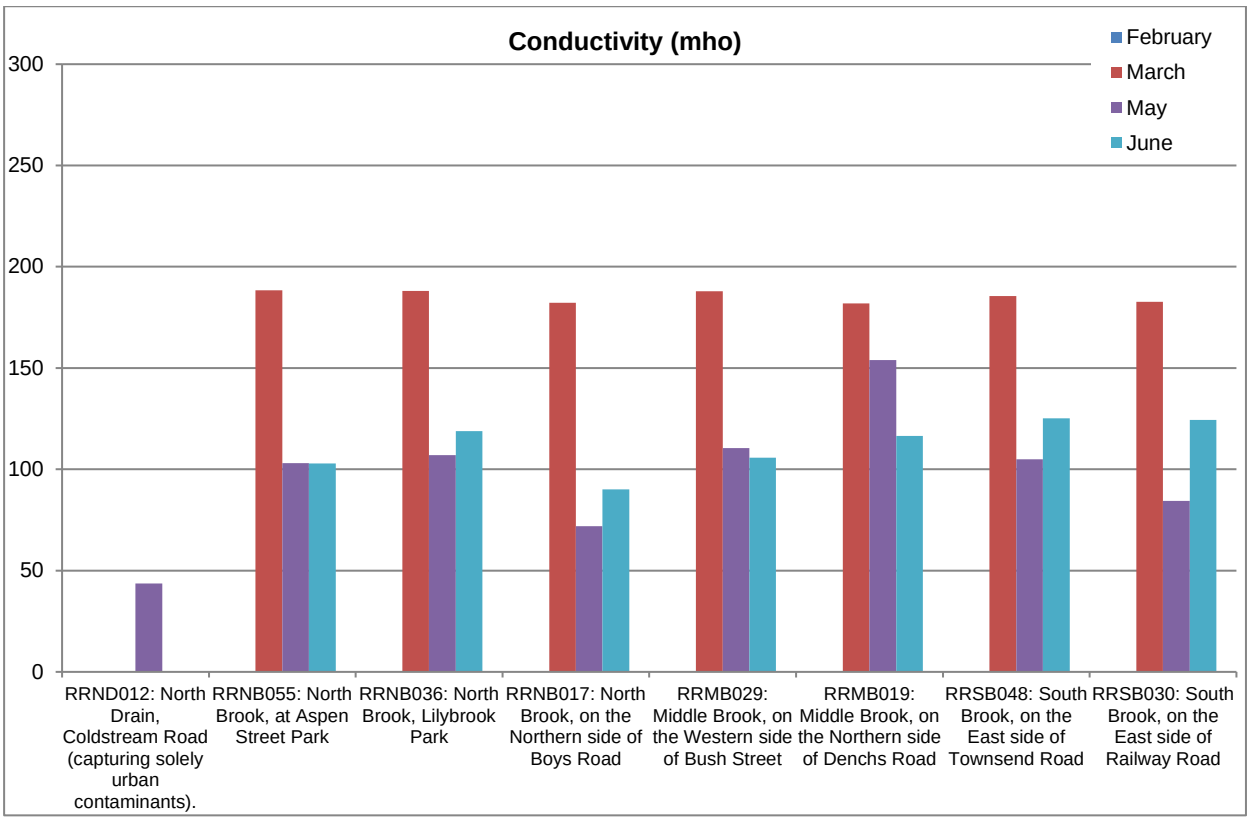


Figure 17: Temperature in the North Drain, North Brook, Middle Brook and South Brook

Although there are no guidelines for conductivity, it is recommended that conductivity is kept in the 'stream health' section of the monitoring programme, as it can be easily retrieved and recorded. Sharp changes in conductivity will indicated a change in discharge pollutant quantity and quality.

6. DISCUSSION

Four sample rounds were completed, in both wet and dry conditions, at 8 sites on the North Drain, North Brook, Middle Brook and South Brook. The results concluded that the some of the contaminants can be removed from the monitoring programme, and some added. Table 4 summarises the changes to the monitoring programme.

Table 4: Summary of contaminants recommended to be changed in the monitoring programme

Contaminant	Source	Current Monitoring Programme Section	Recommended Monitoring Programme Section	Reason Section for Change
Total Suspended Solids	Urban	Urban Impact	Urban Impact	
Dissolved Copper	Urban	Urban Impact	Urban Impact	
Dissolved Lead	-	Urban Impact	-	Very Low Concentrations, therefore recommended to remove it from the programme
Dissolved Zinc	Urban	Urban Impact	Urban Impact	
Total Nitrogen	Rural	Stream Health	-	DIN is in the LWRP, therefore it is recommended that we replace TN with DIN
Dissolved Inorganic Nitrogen	Rural	-	Stream Health	
Total Phosphorus	Mainly Rural	Stream Health	-	DRP is in the LWRP, therefore it is recommended that we replace TP with DRP
Dissolved Reactive Phosphorus	Mainly Rural	-	Stream Health	
E.Coli	Mainly Rural	Stream Health	Stream Health	This was proven to be mainly a rural contaminant and be a contaminant that is monitored as part of the Wastewater Management plan.
Total Hydrocarbons	-	Urban Impact	-	Very Low Concentrations therefore recommended removing it from the programme. Total Hydrocarbons will remain in the basin sediment monitoring.
Dissolved Oxygen	Rural	Stream Health	Stream Health	
pH	Rural	Stream Health	Stream Health	
Temperature	Rural	Stream Health	Stream Health	
Conductivity	-	Stream Health	Stream Health	
Hardness	Rural or Urban	-	Stream Health	Initial one off sample recommended as overall indicator of contaminants.

All of the contaminants were found to be in the appropriate monitoring programme category. Dissolved Lead and Total Hydrocarbons are recommended to be removed from the programme as they were consistently measured to be well below the guideline values.

Total Nitrogen and Total Phosphorus should be replaced with Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen as these are specified in the LWRP.

It was recommended by Ecan water quality specialists that the waterway hardness is measured once or twice to characterise the waterway. This will enable the WDC to get site specific trigger values for metals.

It was found that the bulk of the contaminants are sourced rurally and the guidelines are exceeded prior to the township. However for some contaminants there was an increase in concentration through the township, indicating that the urban area discharges these contaminants also, but in smaller quantities.

The concentrations of contaminants discharging from the springs exceed the guidelines, particularly in the Middlebrook. These springs source water from rurally sourced undercurrent and resurgence.

This study has shown that the rural areas have a significant impact on the health of the Rangiora waterways, and possibly others in the district. It is recommended that Ecan undertakes monitoring upstream of the townships as many contaminant concentrations are exceeded prior to the urban limits.

Table 5 presents the recommended Stormwater Monitoring Programme overview updated using the results from this baseline investigation.

Table 5: Recommended Updated Stormwater Monitoring Programme Overview

	Visual Discharge Inspection	**Urban Stormwater Impact Monitoring**	**Stormwater Basin Monitoring**	**Stream Health Monitoring**
Description	Visual inspection of the major discharge points into the receiving waters.	Water Sampling within the receiving waters and laboratory testing of Urban Stormwater Contaminants, which will be compared to the water quality Guidelines.	Soil or Sediment sampling of the Stormwater Basins.	Stream Health sampling of the receiving waters for a variety of ecological factors, including water quality testing, sediment sampling and ecological surveys.
Location	Major stormwater network discharge points.	Selected receiving waters sampling points.	Dry and Wet Stormwater Basins.	Selected receiving waters sampling points.
Parameters	Water clarity, visual contaminants.	Total Suspended Solids; Dissolved Copper and Zinc.	Total Copper, Lead and Zinc; Total Petroleum Hydrocarbons.	Dissolved Oxygen, pH, Temperature, Conductivity, Dissolved Reactive Phosphorus, Dissolved Inorganic Nitrogen, E.Coli, hardness (initial samples only)
Frequency	Quarterly	Biannually	Every 5 years	Water Quality - Annually Sediment and Ecology Samples - Every 5 years
Weather Conditions	Wet Weather	Ideally First Flush Conditions	Any	Dry Weather Conditions

7. CONCLUSION

During the steering group meeting MKT and Ecan, in November 2013, recommended the WDC undertakes a baseline sampling programme. The purpose of this was to demonstrate to all parties, the source of the waterway contaminants and the current health of the waterways.

Four sample rounds have been completed, in both wet and dry conditions, at 8 sites on the North Drain, North Brook, Middle Brook and South Brook. The report summarised the results from the investigation and suggested potential sources of the contaminants.

The following conclusions were made in this investigation:

- Most of the contaminants tested exceeded the guidelines in at least one of the sample rounds. However most exceedances occurred in the May, a moderate wet weather event, which was much larger than a first flush rainfall event.

- It was found that generally the contaminants were present in both rural and urban environments, however the rural area was found to have a larger impact than the urban area and the guidelines were often exceeded prior to reaching the urban discharge points.

The following changes are recommended to the Stormwater Monitoring Programme:

- It is recommended that the contaminants are left in their proposed monitoring programme section. All of the contaminants were found to be in the appropriate monitoring programme section.

- It is recommended that Lead and Total Hydrocarbons are removed from the 'urban impact' section of the Stormwater Monitoring Programme, as the results indicated that the concentrations were consistently far below the guidelines.

- It is recommended that Total Nitrogen and Total Phosphorus should be replaced with Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen as these are specified in the LWRP.

- It is recommended that many contaminants such as E.Coli, Nitrogen and Phosphorus should be investigated further by Ecan within the rural catchment. These were significantly exceeding the LWRP guidelines in the rural zones, upstream of the urban limits.

After discussions with Ecan and MKT the Stormwater Monitoring Programme will be updated.

8. APPENDIX

APPENDIX A: EXTRA BASELINE SAMPLING INFORMATION

Sampling kits should be ordered in advance to prepare for unpredicted sampling times. The kits should contain a STER, UP1L, NWU100 and a TPH250 from Hill Laboratory. The sample kits should be labelled in the following way:

SITE DESCRIPTIONS:

Site: RRND012
GPS location: X-Coordinate: 1567351; Y-Coordinate: 5206731
Site Description: In the North Drain near Coldstream Road. Sample to be retrieved upstream of Coldstream Road, in the deepest section of the stream.
Site Photo:

Site: RRNB017
GPS location: X-Coordinate: 1568918; Y-Coordinate: 5204096
Site Description: In the North Brook, on the Northern side of Boys Road. Sample to be retrieved between culverts under Boys Road, in the deepest section of the stream.
Site Photo:

Site: RRNB036
GPS location: X-Coordinate: 1567230; Y-Coordinate: 5204552
Site Description: In the North Brook, in Lilybrook Park. Sample to be retrieved near the high level overflow rock structure, in the deepest section of the stream.
Site Photo:

Site: RRNB055
GPS location: X-Coordinate: 1565640; Y-Coordinate: 5204966
Site Description: In the North Brook, at Aspen Street Park. Sample to be retrieved near the large flax in the centre of the park, in the deepest section of the stream.
Site Photo:

Site: RRMB019
GPS location: X-Coordinate: 1567595; Y-Coordinate: 5203538
Site Description: In the Middle Brook, on the Northern side of Denchs Road . Sample to be retrieved between the culverts on the west side of the bridge, in the deepest section of the stream.
Site Photo:

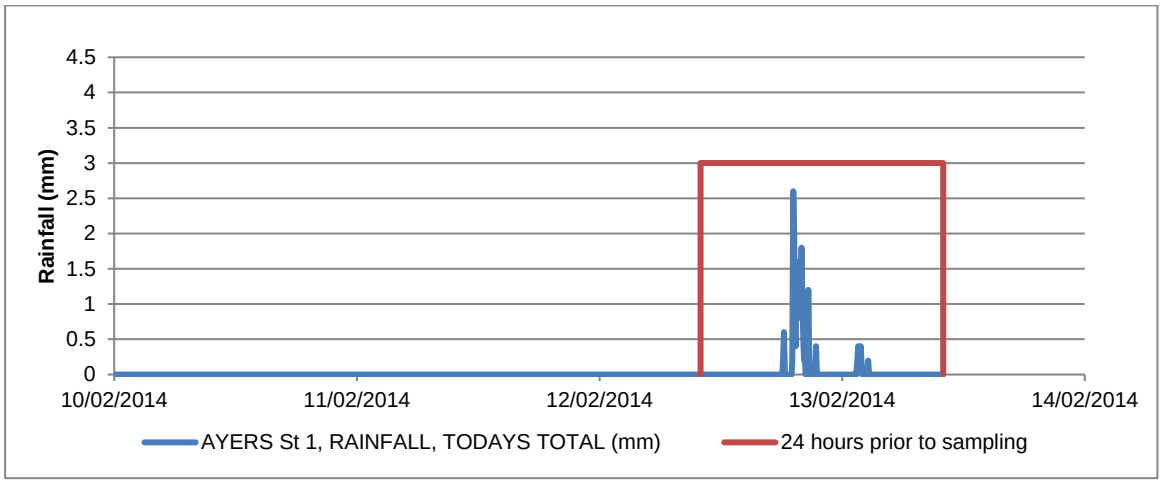
Site: RRMB029
GPS location: X-Coordinate: 1567595; Y-Coordinate: 5204004
Site Description: In the Middle Brook, on the Western side of Bush Street. Sample to be retrieved by the footpath, before the culvert, in the deepest section of the stream.
Site Photo:

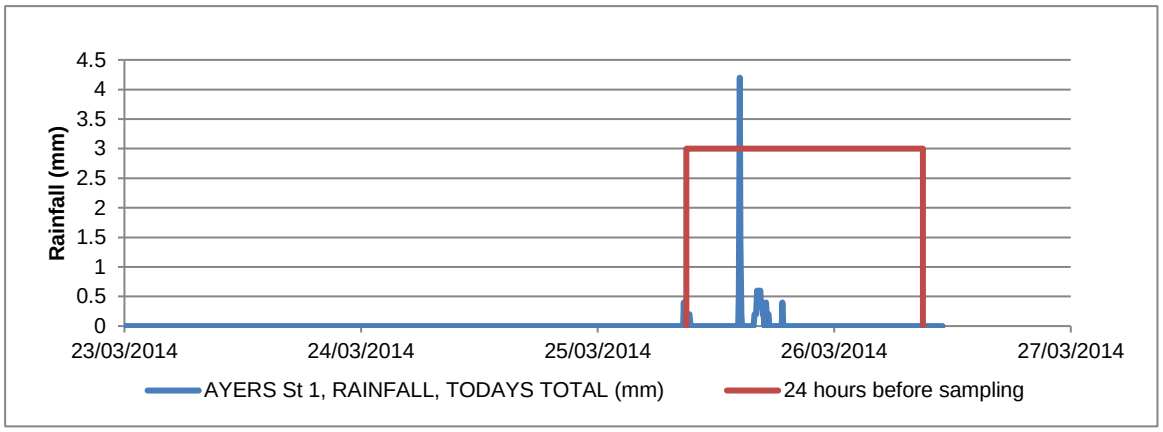
Site: RRSB030
GPS location: X-Coordinate: 1567664; Y-Coordinate: 5203074
Site Description: In the South Brook, on the west side of Railway Road. Sample to be retrieved from the stream bank, before the culvert, in the deepest section of the stream.
Site Photo:

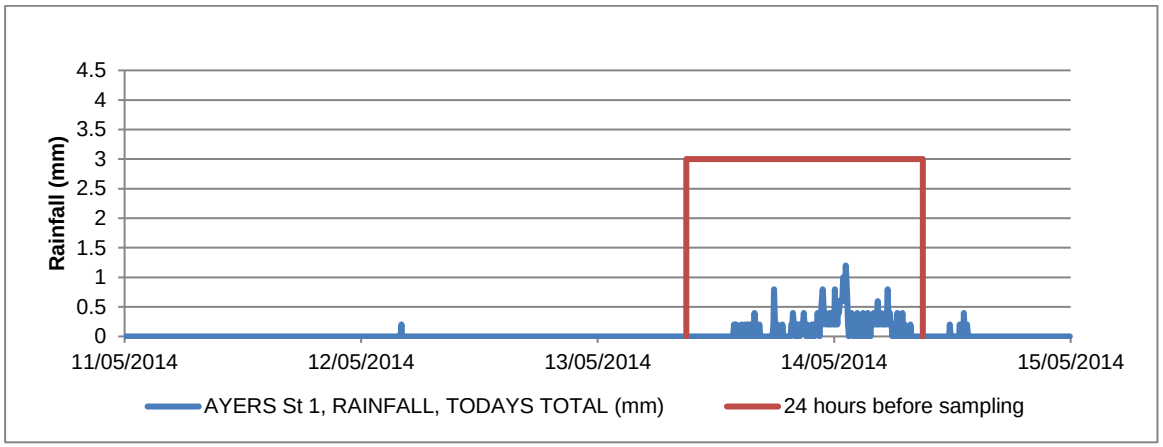
Site: RRSB048
GPS location: X-Coordinate: 1567664; Y-Coordinate: 5203074
Site Description: In the South Brook, on the East side of Townsend Road. Sample to be retrieved from the stream bank, under the bridge, in the deepest section of the stream.
Site Photo:

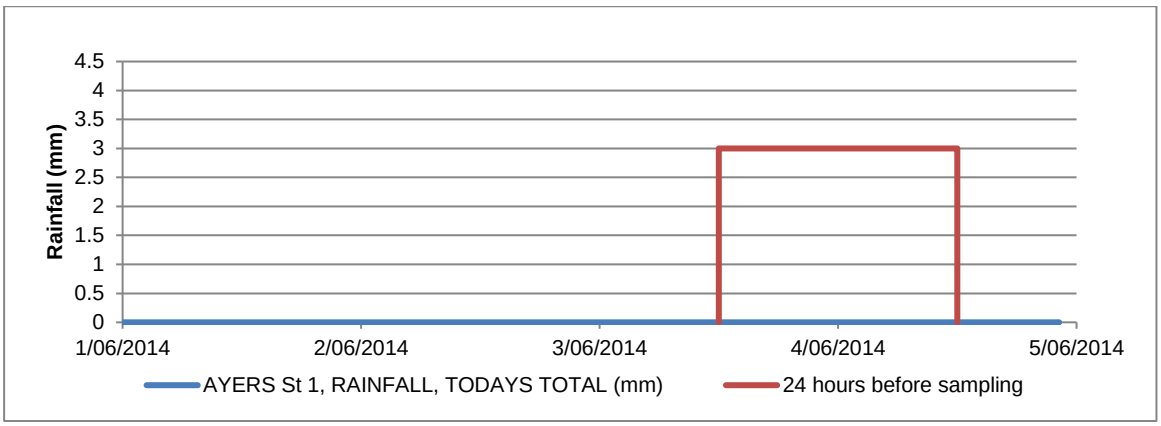
APPENDIX B: RAINFALL EVENT HYDROGRAPHS

Ayres Street, Rangiora Rainfall data; 24 hour period prior to the rainfall event is shown in red.








4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Rainfall (mm)
1/06/2014
2/06/2014
3/06/2014
4/06/2014
5/06/2014
AYERS St 1, RAINFALL, TODAYS TOTAL (mm)
24 hours before sampling

APPENDIX C: LABORATORY RESULTS SUMMARY

Red highlighting is exceedance of the guidelines

February sample round results

February	Guideline Value	RRND012: North Drain, Coldstream Road (capturing solely urban contaminants).	RRNB055: North Brook, at Aspen Street Park	RRNB036: North Brook, Lilybrook Park	RRNB017: North Brook, on the Northern side of Boys Road	RRMB029: Middle Brook, on the Western side of Bush Street	RRMB019: Middle Brook, on the Northern side of Denchs Road	RRSB048: South Brook, on the East side of Townsend Road	RRSB030: South Brook, on the East side of Railway Road
Total Suspended Solids g/m3	50		< 3	< 3	4	21	< 3	< 3	< 3
Dissolved Copper g/m3	0.0018		0.0008	0.0008	< 0.0005	0.0008	0.0005	< 0.0005	0.0006
Dissolved Lead g/m3	0.0056		0.00018	0.00017	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dissolved Zinc g/m3	0.015		0.0032	0.02	0.0075	0.034	0.028	< 0.0010	0.0058
Total Nitrogen g/m3	0.614		0.43	0.81	0.71	1.79	1.65	2.3	2.1
Total Ammoniacal-N g/m3	0.021		< 0.010	0.019	0.012	0.012	0.014	< 0.010	< 0.010
Nitrate-N + Nitrite-N g/m3	0.444		0.004	0.69	0.52	1.49	1.38	2	1.73
Total Kjeldahl Nitrogen (TKN) g/m3	0.17		0.42	0.12	0.19	0.3	0.28	0.28	0.35
Dissolved Inorganic Nitrogen (DIN)	1.5		0.004	0.709	0.532	1.502	1.394	2	1.73
Dissolved Reactive Phosphorus g/m3	0.016		0.05	0.019	0.007	0.062	0.026	0.029	0.036
Total Phosphorus g/m3	0.033		0.087	0.028	0.023	0.062	0.037	0.029	0.036
Escherichia coli cfu / 100mL	550		1200	2600	3400	800	1300	3200	2200
C7 - C9 g/m3			< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14 g/m3			< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36 g/m3			< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36) g/m3			0	0	0	0	0	0	0
Dissolved Oxygen (%)	70								
pH	6.5								
Temperature (°C)	20								
Conductivity (mho or µS/cm)	500								

March sample round results

March	Guideline Value	RRND012: North Drain, Coldstream Road (capturing solely urban contaminants).	RRNB055: North Brook, at Aspen Street Park	RRNB036: North Brook, Lilybrook Park	RRNB017: North Brook, on the Northern side of Boys Road	RRMB029: Middle Brook, on the Western side of Bush Street	RRMB019: Middle Brook, on the Northern side of Denchs Road	RRSB048: South Brook, on the East side of Townsend Road	RRSB030: South Brook, on the East side of Railway Road
Total Suspended Solids g/m3	50		4	< 3	< 3	< 3	4	< 3	< 3
Dissolved Copper g/m3	0.0018		< 0.0005	< 0.0005	0.001	< 0.0005	0.0007	< 0.0005	0.0012
Dissolved Lead g/m3	0.0056		< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	0.00012
Dissolved Zinc g/m3	0.015		0.0054	0.0144	0.0032	0.0173	0.033	0.0029	0.027
Total Nitrogen g/m3	0.614		0.37	0.76	0.71	1.44	1.32	2.2	2.1
Total Ammoniacal-N g/m3	0.021		< 0.010	0.011	0.013	0.031	0.017	0.013	0.011
Nitrate-N + Nitrite-N g/m3	0.444		0.004	0.61	0.52	1.2	1.13	1.99	1.89
Total Kjeldahl Nitrogen (TKN) g/m3	0.17		0.36	0.15	0.19	0.24	0.18	0.23	0.19
Dissolved Inorganic Nitrogen (DIN)	1.5		0.004	0.621	0.533	1.231	1.147	2.003	1.901
Dissolved Reactive Phosphorus g/m3	0.016		0.044	0.019	0.011	0.046	0.027	0.013	0.017
Total Phosphorus g/m3	0.033		0.066	0.023	0.016	0.057	0.032	0.019	0.024
Escherichia coli cfu / 100mL	550		110	540	700	300	700	700	430
C7 - C9 g/m3			< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14 g/m3			< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36 g/m3			< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36) g/m3			0	0	0	0	0	0	0
Dissolved Oxygen (%)	70		56.7	64.4	70.2	58.3	68.4	64	73.5
pH	6.5 - 8.5		7.93	7.17	7.42	7.53	7.47	7.28	7.55
Temperature (°C)	20		11.2	13.3	13.5	13.5	14.3	12.7	13.3
Conductivity (mho or µS/cm)	500		188.4	188	182.2	187.9	181.9	185.6	182.7

May sample round results

May	Guideline Value	RRND012: North Drain, Coldstream Road (capturing solely urban contaminants).	RRNB017: North Brook, on the Northern side of Boys Road	RRNB036: North Brook, Lilybrook Park	RRNB055: North Brook, at Aspen Street Park	RRMB019: Middle Brook, on the Northern side of Denchs Road	RRMB029: Middle Brook, on the Western side of Bush Street	RRSB030: South Brook, on the East side of Railway Road	RRSB048: South Brook, on the East side of Townsend Road
Total Suspended Solids g/m3	50	< 3	48	10	14	10	14	27	37
Dissolved Copper g/m3	0.0018	0.0008	0.0031	0.0043	0.0025	0.005	0.0077	0.008	0.0025
Dissolved Lead g/m3	0.0056	0.00011	< 0.00010	0.00034	0.00076	0.00031	0.00024	0.00025	< 0.00010
Dissolved Zinc g/m3	0.015	0.033	0.0163	0.065	0.0109	0.094	0.069	0.07	0.006
Total Nitrogen g/m3	0.614	0.24	1.84	2.5	2.3	2.3	4	3.2	2.8
Total Ammoniacal-N g/m3	0.021	< 0.010	0.05	0.034	0.023	0.051	0.032	0.107	0.103
Nitrate-N + Nitrite-N g/m3	0.444	0.071	1.03	1.73	1.4	1.5	2.6	1.45	1.03
Total Kjeldahl Nitrogen (TKN) g/m3	0.17	0.17	0.81	0.76	0.93	0.75	1.39	1.71	1.73
Dissolved Inorganic Nitrogen (DIN)	1.5	0.241	1.84	2.49	2.33	2.25	3.99	3.16	2.76
Dissolved Reactive Phosphorus g/m3	0.016	0.072	0.066	0.3	0.21	0.34	0.57	0.21	0.22
Total Phosphorus g/m3	0.033	0.079	0.17	0.32	0.32	0.36	0.61	0.32	0.37
Escherichia coli cfu / 100mL	550	1600	5000	5000	14000	34000	15000	18000	34000
C7 - C9 g/m3		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14 g/m3		< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36 g/m3		< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36) g/m3		0	0	0	0	0	0	0	0
Dissolved Oxygen (%)	70	144	110.6	117	113.4	99.9	104.6	103.9	105.6
pH	6.5 - 8.5	7.47	6.79	6.76	7.22	6.88	6.77	6.61	6.74
Temperature (°C)	Change of 2 °C	9.8	13.2	12.4	10.9	13.1	12.9	12.5	12
Consuctivity (mho or µS/cm)	2200	43.6	103	107	71.9	110.5	154	104.9	84.4

June sample round results

June	Guideline Value	RRND012: North Drain, Coldstream Road (capturing solely urban contaminants).	RRNB017: North Brook, on the Northern side of Boys Road	RRNB036: North Brook, Lilybrook Park	RRNB055: North Brook, at Aspen Street Park	RRMB019: Middle Brook, on the Northern side of Denchs Road	RRMB029: Middle Brook, on the Western side of Bush Street	RRSB030: South Brook, on the East side of Railway Road	RRSB048: South Brook, on the East side of Townsend Road
Total Suspended Solids g/m3	50		< 3	< 3	< 3	< 3	< 3	< 3	< 3
Dissolved Copper g/m3	0.0018		< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0006	< 0.0005	< 0.0005
Dissolved Lead g/m3	0.0056		< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010	< 0.00010
Dissolved Zinc g/m3	0.015		0.0023	0.0056	0.0018	0.0071	0.0086	0.001	< 0.0010
Total Nitrogen g/m3	0.614		1.78	2.6	3.2	1.31	1.6	3.4	3.4
Total Ammoniacal-N g/m3	0.021		0.01	0.013	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Nitrate-N + Nitrite-N g/m3	0.444		1.64	2.5	2.9	1.18	1.51	3.2	3.3
Total Kjeldahl Nitrogen (TKN) g/m3	0.17		0.14	0.14	0.31	0.14	0	0.17	0.17
Dissolved Inorganic Nitrogen (DIN)	1.5		1.78	2.64	3.21	1.32	1.51	3.37	3.47
Dissolved Reactive Phosphorus g/m3	0.016		0.006	0.01	0.016	0.012	0.016	0.012	0.01
Total Phosphorus g/m3	0.033		0.008	0.013	0.026	0.019	0.024	0.017	0.011
Escherichia coli cfu / 100mL	550		70	9000	10	160	10	90	150
C7 - C9 g/m3			< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14 g/m3			< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36 g/m3			< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36) g/m3			0	0	0	0	0	0	0
Dissolved Oxygen (%)	70		71.2	59.9	103.9	62.2	70	68.2	70.1
pH	6.5 - 8.5		6.64	6.67	6.73	6.82	7.07	6.86	6.96
Temperature (°C)	Change of 2 °C		12.8	12.4	5.1	12.4	12.4	11.6	11.8
Consuctivity (mho or µS/cm)	2200		102.9	118.8	90.1	105.7	116.5	125.1	124.4

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Woodend Stormwater Network Consent:

Stormwater Quality Monitoring Baseline Programme

Prepared by the Project Delivery Unit
November 2018

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1. EXECUTIVE SUMMARY

1.1. INTRODUCTION

The Woodend Stormwater Discharge Consent, the second of such in the Waimakariri District, will be prepared in conjunction with a stormwater management plan (SMP) and consent application. This requires the Waimakariri District Council (WDC) to produce a stormwater monitoring programme. This monitoring programme focuses on the urban stormwater discharge impact on the waterways, as opposed to general stream health.

The focus of this report is on stormwater quality entering and within the Woodend urban area.

ECan requested that the WDC undertakes a baseline sampling programme before defining the parameters of the monitoring programme to demonstrate to all parties the source of the waterway contaminants and to gauge the current health of Woodend's waterways. The purpose of this report is to present the findings from this baseline sampling programme and recommend the parameters that should be carried forward to the ongoing stormwater monitoring programme.

Four sample rounds have been completed, in both wet and dry conditions, at seven sites spread over the Taranaki Stream, Waiora Stream, McIntosh Drain, Box Drain and a channel adjacent to the state highway at the south of Woodend. The results from each of these sampling rounds has been summarised along with suggested potential sources of each contaminant.

1.2. BACKGROUND

The stormwater monitoring programme will be designed to identify potential areas of urban stormwater impact on the Woodend receiving waters. The trends formed from the monitoring programme analysis can be used to direct stormwater treatment activities, within the Woodend urban limits.

The Woodend stormwater monitoring programme will be modelled off the Rangiora Stormwater Monitoring Programme, with some modifications for the Woodend contaminants, informed by this investigation. Generally speaking the urban impact would be measured by monitoring urban contaminants through discharge point inspections, receiving surface water testing, stormwater basin testing and stream sediment surveys will all form part of the Woodend stormwater network discharge consent, with consent management objectives seeking to address any exceeded values.

The stream health monitoring will be included within the stormwater network discharge consent, however the parameters will not have consent management objectives associated with them, i.e. this information will be utilised for other Council projects, such as stream enhancement programmes, as these additional parameters are not considered to be primarily contributed by urban stormwater discharge.

This investigation looks at water quality samples, which will only affect the urban impact and stream health sections for the Woodend monitoring programme.

1.3. METHODOLOGY

Four water sampling rounds were undertaken by the WDC Water Unit and analysed by the WDC Project Delivery Unit. The sampling occurred approximately monthly from August to December 2016.

The samples were collected using best practice methods and delivered directly to the laboratory after collection. The sample testing was undertaken by Hill Laboratories in Hamilton.

The Woodend waterways were sampled at the following sites:

WDSH024	SH1 Drain, Woodend Beach - Main North Road Intersection
WDBD005	Box Drain, West of Rangiora Woodend Road - School Road Intersection

WDTS075	Taranaki Stream, Gatehouse Lane
WDTS066	Taranaki Stream, Chinnerys Road, Opposite Nursery
WDTS053	Taranaki Stream, East of Main North Road (SH1) – Pegasus Boulevard Roundabout
WDWS005	Waiora Stream, East of SH1
WDMD078	McIntosh Drain, before East Woodend Pond, Petries Road

The laboratory test included:

- Total suspended solids
- Dissolved copper
- Dissolved lead
- Dissolved zinc
- Total Ammoniacal-N
- Nitrate-N + Nitrite
- Total Kjeldahl Nitrogen (TKN)
- Total Nitrogen
- Dissolved Reactive Phosphorus
- Total phosphorus
- *E. coli*
- Petroleum hydrocarbons C_7-C_9, C_{10}-C_{14}, C_{15}-C_{34}
- Total Petroleum Hydrocarbons.

The portable probe measurements captured were Dissolved Oxygen, pH, Temperature and Conductivity.

1.4. RESULTS SUMMARY

The results concluded that the some of the contaminants are better suited to the urban impact section of the monitoring programme and others to the stream health section. Table 1 summarises the recommended changes to the monitoring programme.

Table 1: Summary of contaminants recommended to be changed in the monitoring programme

Contaminant	Source	Rangiora's Monitoring Programme Section	Woodend's Recommended Monitoring Programme Section	Reason Section for Change
Total Suspended Solids	Urban	Urban Impact	Urban Impact	
Dissolved Copper	Urban	Urban Impact	Urban Impact	
Dissolved Lead	Urban	Urban Impact	Urban Impact	Very Low Concentrations, therefore recommended to remove it from the programme
Dissolved Zinc	Urban	Urban Impact	Urban Impact	
Total Nitrogen	Rural	Stream Health	-	DIN is in the Land and Water Regional Plan (LWRP), therefore it is recommended that we replace TN with DIN
Dissolved Inorganic Nitrogen (DIN)	Rural	-	Stream Health	
Total Phosphorus	Mainly Urban	Stream Health	-	DRP is in the LWRP therefore it is recommended that TP is replaced with DRP. It appears DRP may be from both rural and urban sources. It is recommended further consideration is given to include DRP in the Urban Impact section of the monitoring programme.
Dissolved Reactive Phosphorus (DRP)	Mainly Urban	-	Urban Impact	
E. coli	Urban & Rural	Stream Health	Urban Impact	E. coli was found to be from both rural and possibly urban sources. It is a contaminant that is monitored as part of the Wastewater Management plan. It is recommended further consideration is given to including E. coli in the Urban Impact section of the monitoring programme.
Total Hydrocarbons	-	Urban Impact	-	Very Low Concentrations therefore recommended removing it from the programme. Total Hydrocarbons will remain in the basin sediment monitoring.
Dissolved Oxygen	Rural	Stream Health	Stream Health	
pH	Rural	Stream Health	Stream Health	
Temperature	Rural	Stream Health	Stream Health	
Conductivity	-	Stream Health	Stream Health	
Hardness	Mainly Rural	-	Urban Impact	Initial one off sample recommended as overall indicator of contaminants.

The contaminants that differed from the Rangiora Stormwater Monitoring Programme were Phosphorus and *E. coli*, these were found to be urban and rural sourced in Woodend and mainly rurally sources in Rangiora. Total Hydrocarbons are recommended to be removed from the programme as they were consistently measured to be well below the guideline values.

It is recommended that Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen should be used in the monitoring programme as these are specified in the LWRP.

It was recommended by ECan water quality specialists that the waterway hardness is measured once or twice to characterise the waterway. This will enable the WDC to get site specific trigger values for metals. This would be undertaken as part of the monitoring programme, as the sample sites would not be the same as in this baseline programme.

It was found that a number of the contaminants are sourced rurally and the guidelines are exceeded prior to the township. However for some contaminants there was an increase in concentration through the township, indicating that the urban area discharges these contaminants also, but in smaller quantities.

This study has demonstrated that the rural areas have a significant impact on the health of the Woodend waterways, and possibly others in the district. It is recommended that ECan undertakes monitoring upstream of the townships to identify the source of these containments as some contaminant concentrations exceed the guideline values prior to the urban limits.

1.5. CONCLUSION

The following conclusions were made in this investigation:

- Most of the contaminants tested exceeded the guidelines in at least one of the sample rounds. Most exceedances occurred in the December, a first flush rainfall event, which was the largest rainfall event captured during the sampling period.

- It was found that generally the contaminants were present in both rural and urban environments, however in some cases the rural area was found to have a larger impact than the urban area and the guideline concentrations were at times exceeded prior to reaching the urban discharge points.

The following changes are recommended to the Rangiora Stormwater Monitoring Programme for Woodend:

- It is recommended that further thought is put into placing *E. coli* and phosphorus to the urban impact section of the monitoring programme, as WDC shouldn't be trying to meet a guideline level which is near exceedance, due to the significant rural contributions of *E. coli* and phosphorus.

- It is recommended that Lead and Total Hydrocarbons are removed from the 'urban impact' section of the Stormwater Monitoring Programme, as the results indicated that the concentrations were consistently far below the guidelines.

- It is recommended that Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen should be used in the monitoring programme as these are specified in the LWRP.

- It is recommended that contaminants such as *E. coli*, and phosphorus should be investigated further by ECan within the rural catchment. Both of these contaminants exceed the LWRP guidelines in the rural zones, upstream of the urban limits. It is also suggested that ECan consider investigating nitrogen contaminates in the rural areas as rural catchments consistently exceed the ANZECC guidelines for TN however, as it stands they currently fall below the guideline levels provided in the LWRP for DIN.

These conclusions will be used to develop the Woodend Stormwater Monitoring Programme.

2. INTRODUCTION

Environment Canterbury (ECan) has requested each of the Territorial authorities within the Canterbury region submit Global Stormwater Consents for all major towns in each district. The Woodend Stormwater Discharge Consent, the second of such in the Waimakariri District, will be prepared in conjunction with a stormwater management plan (SMP) and consent application. This requires the Waimakariri District Council (WDC) to produce a stormwater monitoring programme. This monitoring programme focuses on the urban stormwater discharge impact on the waterways, as opposed to general stream health.

During the steering group meeting with Mahaanui Kurataiao Limited (MKT) and ECan, in November 2013, a recommendation was suggested for the WDC to undertake a baseline sampling programme. The purpose of this was to demonstrate to all parties, the source of the waterway contaminants and the current health of the waterways. Following on from the Waimakariri District's Urban Stormwater Consent: Baseline Monitoring Report (TRIM 160128006568) a baseline sampling programme has been undertaken for Woodend. The purpose of this sampling programme was to collect data which could then be use to demonstrate to all parties the source of the water contaminants and the current health of the waterways.

Four sample rounds have been completed, in both wet and dry conditions, at seven sites spread over the Taranaki Stream, Waiora Stream, McIntosh Drain, Box Drain and a channel adjacent to the state highway at the south of Woodend. The results from each of these sampling rounds has been summarised along with suggested potential sources of each contaminant.

The purpose of this report is to present the findings from this baseline sampling programme and recommend the parameters that should be carried forward to the ongoing stormwater monitoring programme.

3. BACKGROUND

The stormwater monitoring programme has been designed to identify potential areas of urban stormwater impact on the Woodend receiving waters. The trends formed from the monitoring programme analysis can be used to direct stormwater treatment activities within the Woodend urban limits.

The WDC would only agree to sample contaminants which have been proven to be urban sourced. The main consequences of accepting parameters which are rurally sourced are as follows;

1. Some of the sample parameters would be outside of the stormwater discharge consent scope, as they enter the network primarily from rural sources.
2. The cost of increased sampling; including collection, laboratory tests and results analysis.
3. Responsibility and resources for treating rural source contaminants are transferred to urban ratepayers, reducing the pressure from regulators applied to rural properties to mitigate their own adverse effects, and reducing available funding from urban ratepayers for proven urban contaminants such as copper or zinc.
4. The subsequent implications for other future urban consents within the Waimakariri District.

Therefore it was recommended that a 6 month baseline investigation be undertaken, and results used to assist determining the source of the contaminants and associated consent conditions.

3.1. MKT AND ECAN INVOLVEMENT WITH THE STORMWATER NETWORK CONSENTS

The WDC worked closely with MKT and ECan to produce the Rangiora stormwater network consent. The WDC will be applying to ECan for the Woodend network discharge consent. WDC will be sending the application and monitoring programme to MKT and ECan to provide advice before formally submitting the consent application.

3.2. WOODEND AREA

Rural land surrounds Woodend Township. There is a high potential for the waterways within the urban limit to be impacted by rural activities. Within the Woodend urban limits there are three main receiving waters which receive urban stormwater; the Taranaki Stream, Waiora Stream and the McIntosh Drain (downstream of the East Woodend stormwater management area). The drains to the south ultimately discharge into the Kaiapoi River.

ECan's known spring database does not identify any springs feeding into local waterways in or near Woodend.

Figure 1 represents the WDC land zones surrounding Woodend.

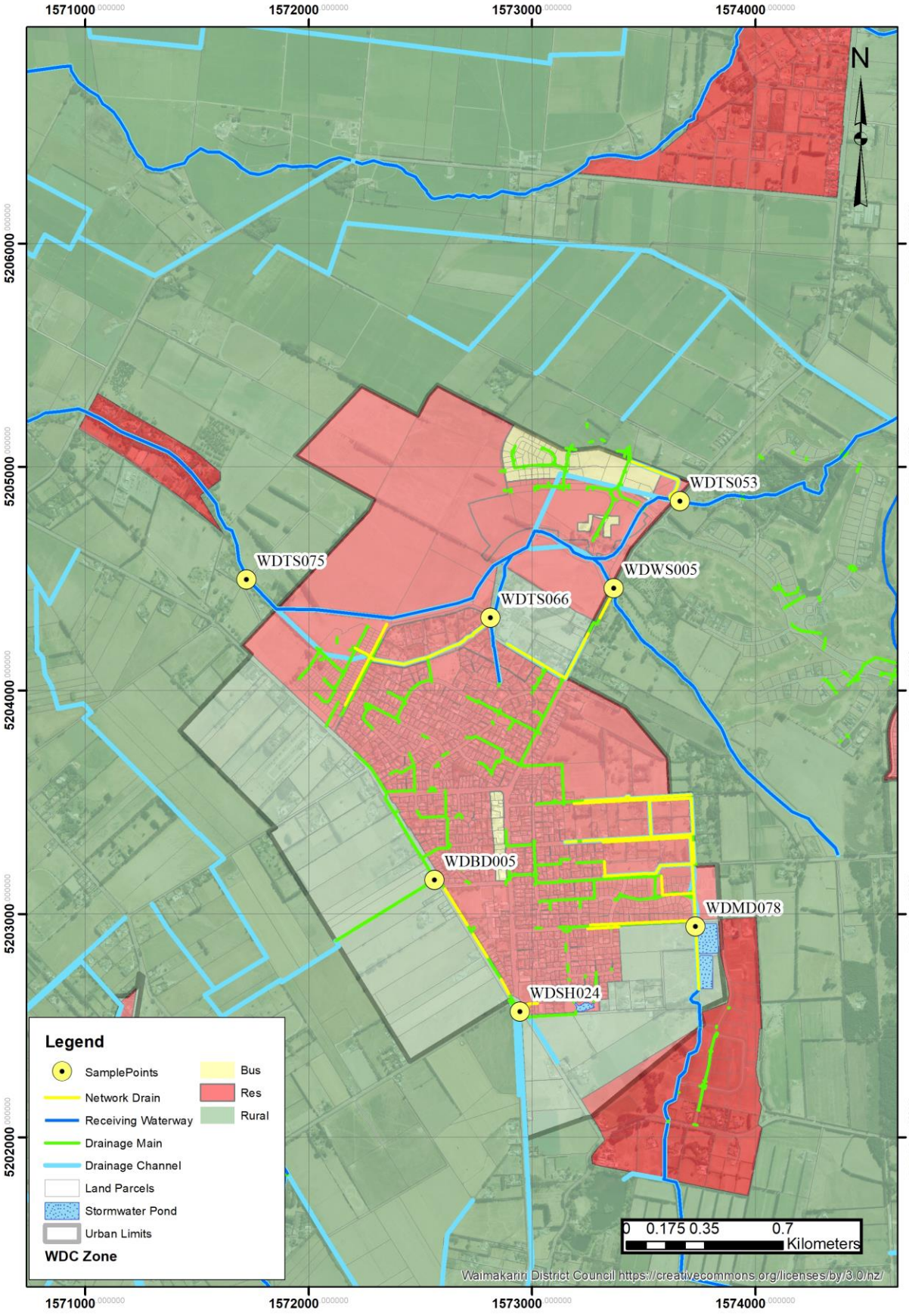


Figure 1: Land use zones in the greater Woodend area

Woodend township is split over three main catchments: the Waimakariri River, Taranaki Stream and Saltwater Creek catchments. Taranaki Stream discharges into the Ashley River and the other two discharge into the Waimakariri River. Figure 2 presents the catchments that the Woodend Township discharges to.

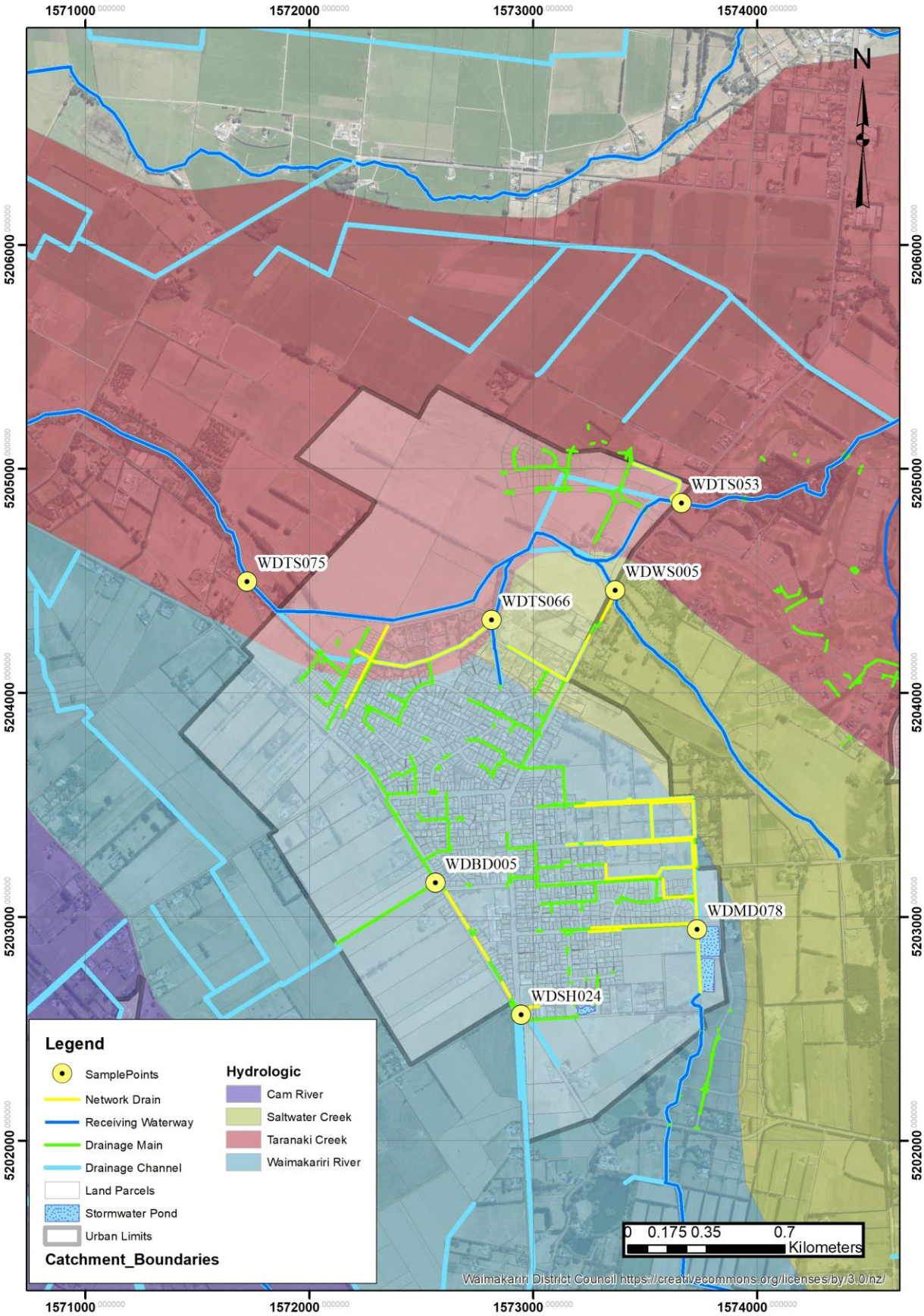


Figure 2: Woodend is split by three main catchments.

Woodend can be subdivided into sub-catchments as illustrated in Figure 3.

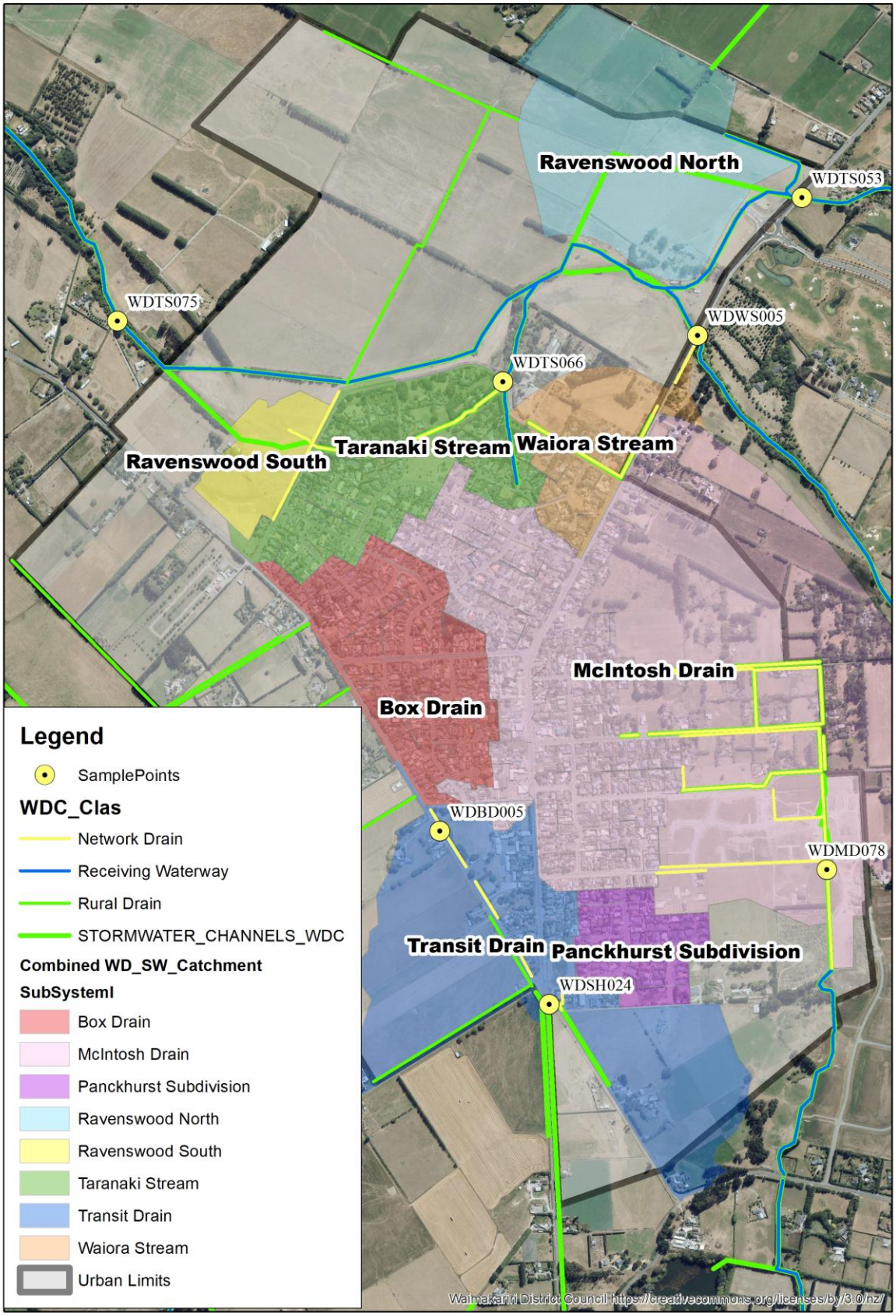


Figure 3: Woodend Stormwater Sub Catchments and Sample Points

The Taranaki collects water from the East of Woodend. This waterway is composed of both urban and rural areas. It should be noted that development is occurring to the north of Woodend (the Ravenswood

development) which will extend the urban limits to the northern boundary shown in Figure 3 and will significantly modify this part of the catchment.

The Waiora Stream Catchment is composed of a combination of urban and rural land.

The McIntosh Drain is fed by the south-eastern urban area of Woodend and rural land to the east of this. It is Woodend's largest urban subcatchment.

Located on the western side of Woodend the Box Drain subcatchment is composed of an approximately 50% split of rural and urban residential land.

The Transit Drain subcatchment is composed of an approximately 50% split of rural and urban residential land. This catchment discharges into the Cam River.

The Panckhurst Drive subcatchment is urban residential.

3.3. RANGIORA STORMWATER MONITORING PROGRAMME

The Rangiora stormwater monitoring programme was developed in 2014 and has been gradually improved upon since. The Woodend stormwater monitoring programme will be modelled off the Rangiora Stormwater Monitoring Programme, with some modifications for the Woodend contaminants, informed by this investigation.

Generally the Rangiora stormwater monitoring programme report specifies the following:

- Sample Locations
- Sample Parameters
- Sample Frequency

The Rangiora stormwater monitoring programme includes the following water quality monitoring parameters and frequency:

Table 2: Rangiora Stormwater Monitoring Programme Overview

	Urban Impact Monitoring (part of consent)				**Stream Health Monitoring (not part of consent)**	
	Discharge Point Inspection	**Receiving Surface Water**	**Stormwater Basin**	**Stream Sediment**	**Surface Water**	**Ecological**
Description	Inspection of the major discharge points into the receiving waters	Water quality testing	Soil or Sediment sampling of the Stormwater Basins	Sediment sampling of the stream beds	Water quality testing	Ecological surveys
Location	Downstream of major discharge points in receiving waterways	Selected receiving waters sampling points	Dry and Wet Stormwater Basins	Stream beds (sites to be confirmed)	Selected receiving waters sampling points	Stream beds

Parameters	Water clarity, visual contaminants and erosion	Dissolved Copper, Dissolved Zinc and Polycyclic Aromatic Hydrocarbons	Total Copper, Total Lead, Total Zinc and Polycyclic Aromatic Hydrocarbons	Sediment Survey; Total Copper, Lead, Zinc and Polycyclic Aromatic Hydrocarbons	Dissolved Oxygen pH Temperature Specific Conductance Total Phosphorous Total Nitrogen, Ammonia, *E. coli*, TSS	Periphyton Fish species Macrophytes QMCI
Frequency	Quarterly	Biannually	Every 5 years	Every 5 years	Annually	Every 5 years
Weather Conditions	Wet Weather	Ideally First Flush	Dry Weather	Dry Weather	Dry Weather	Dry Weather

Generally speaking the urban impact would be measured by monitoring urban contaminants through discharge point inspections, receiving surface water testing, stormwater basin testing and stream sediment surveys. These tests would form part of the Woodend stormwater network discharge consent, with consent management objectives applied to seek to address any exceeded values.

Similar to the Rangiora Consent, the stream health monitoring would be included within the Woodend stormwater network discharge consent, however the parameters will not have consent management objectives associated with them, i.e. this information will be utilised for other Council projects, such as stream enhancement programmes outside the scope of the consent, as these parameters are not considered to be primarily contributed by stormwater discharge.

This investigation looks at water quality samples, which would only affect the urban impact and stream health sections of this monitoring programme.

3.4. GUIDELINE VALUES

Water quality guidelines are used to identify if the WDC waterways are in a healthy condition. The guidelines have defined Trigger Levels or maximum allowable values (MAVs) for many different waterway contaminants. In some cases such as dissolved oxygen and pH there are also minimum allowable values (denoted Min AV).

The guidelines that are used to analyse our data are sourced from the following resources:

1. Canterbury Land and Water Regional Plan (2012) *(LWRP, Section 16, Schedule 5)*
2. ANZECC Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC, 2000)

The LWRP gives a guideline to the level to which a '*spring fed – plains urban'* catchment should be striving to meet. However this guideline is quite brief, there are several contaminants sampled that are not in the LWRP. Therefore, although the LWRP will be the main guideline source, the ANZECC guidelines will be used if LWRP does not provide a guideline value for any parameter considered essential to the consent. In these cases the 90 % level of protection (LOP) trigger value has been used. For a number of contaminants the LWRP guideline value is equal to the ANZECC guideline value.

The guidelines that are being compared to the contaminant concentration are specified.

4. METHODOLOGY

The proposed baseline study aimed to confirm whether the common water quality parameters are from primarily rural or urban sources.

Four water sampling rounds were undertaken by the WDC Water Unit and analysed by the WDC Project Delivery Unit. The sampling occurred approximately monthly from August to December 2016.

The samples were collected using best practice methods and delivered directly to the laboratory after collection. The sample testing was undertaken by Hill Laboratories in Hamilton.

4.1. SAMPLE LOCATIONS

To assess baseflow (DWF) contaminant concentrations and runoff contaminant concentrations (WWF), sample sites have been selected to be within the receiving waters.

Seven sites were sampled for the baseline sampling programme; three in the Taranaki Stream (WDTS065, WDTS066, WDTS053), one in the Waiora Stream (WDWS005), one in the Box Drain (WDBD005), one downstream of the Transit Drain (WDSH024) and one in the McIntosh Drain (WDMD078). These sites were selected from the urban stormwater impact sites, so that the data is comparable in the future.

The proposed sample points were situated at either the upstream edge of the urban limits (or at the stream source), and the downstream edge of the urban limits. The change in concentration of contaminants in the receiving waters will enable the WDC to assess the contaminants contributed by the urban area.

The sample locations are as follows:

WDBD005	Box Drain, West of Rangiora Woodend Road - School Road Intersection
WDTS075	Taranaki Stream, Gatehouse Lane
WDTS066	Taranaki Stream, West of Chinnerys Road Opposite Nursery
WDTS053	Taranaki Stream, East of Main North Road (SH1) – Pegasus Boulevard Roundabout
WDWS005	Waiora Stream, East of SH1
WDMD078	McIntosh Drain, before East Woodend Pond, Petries Road
WDSH024	SH1 Drain, Woodend Beach - Main North Road Intersection

Figure 4 presents a map of the baseline sample sites. See Appendix A for more information on the sample locations; including descriptions, GPS locations and photographs.

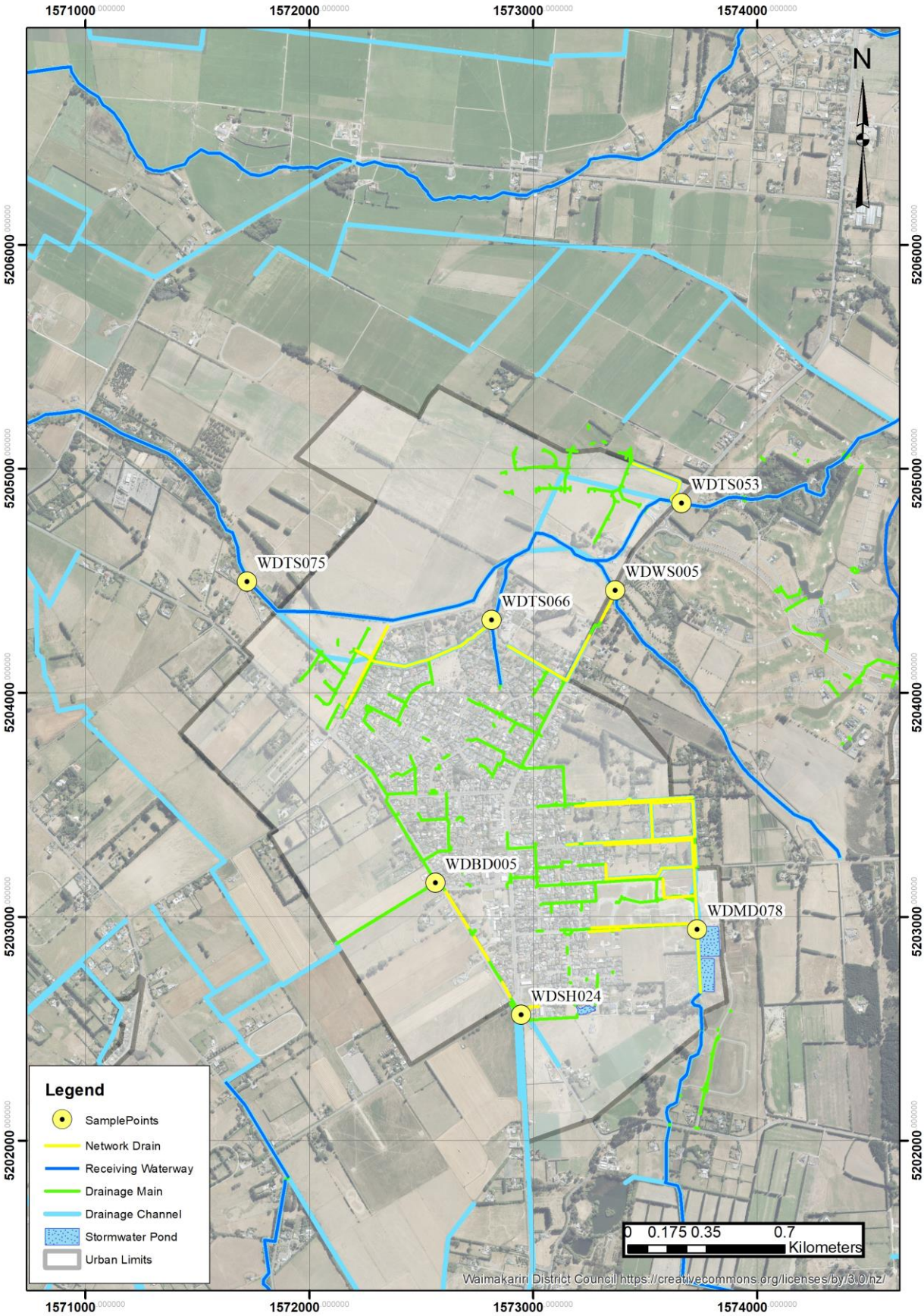


Figure 4: Woodend sample sites for the Baseline Monitoring Programme.

4.2. SAMPLE PARAMETERS

The water quality parameters that were sampled as part of this baseline study are as follows:

Laboratory tests

- Total suspended solids
- Dissolved copper
- Dissolved lead
- Dissolved zinc
- Total Ammoniacal-N
- Nitrate-N + Nitrite
- Total Kjeldahl Nitrogen (TKN)
- Dissolved Reactive Phosphorus
- Total phosphorus
- *E. coli*
- Total petroleum hydrocarbons

YSI multi-probe portable probe measurements

- Dissolved oxygen
- pH
- Temperature
- Conductivity

4.3. FREQUENCY

The samples were retrieved approximately every month, so that four sample rounds were undertaken. Wet and dry weather days were selected so the source of the contaminants could be separated into spring discharge and/or runoff contaminants.

The following list presents the selected sampling days;

1. August 4th 2016, sampling commenced at 3:00 pm
2. September 19th 2016, sampling commenced at 3:00 pm
3. October 13th 2016, sampling commenced at 2:00 pm
4. December 12th 2016, sampling commenced at 3:00pm

The plan for sampling was to be in the wet and dry conditions (and ideally across seasons). Weather conditions were not quite right in November, hence this month was missed.

5. RESULTS

5.1. SAMPLING WEATHER CONDITIONS

First flush events give the best measure of runoff contaminants. As first flush events are statistically infrequent, getting a first flush event within the baseline monitoring programme period was predicted to be difficult. Therefore samples were retrieved in dry conditions and wet conditions.

Table 3 presents a summary of the rainfall prior to the water quality sampling; the rainfall data was taken from the Ayres Street, Woodend WDC rainfall gauge.

Table 3: Presents a description of the conditions on each of the baseline sampling days in 2016

Date	Weather Conditions	Event Description
4th August 2016	Dry weather when sampling, 2 mm of rain in the 24 hours before sampling, 4 mm of rainfall 72 hours prior to the sampling	Minor wet weather event.
19th September 2016	Dry weather while sampling, 0 mm of rain in the 24 hours before sampling, 0 mm rainfall 72 hours prior to the sampling	Dry weather event.
13th October 2016	Dry weather while sampling, 0 mm of rain in the 24 hours before sampling, 4.4 mm rainfall 72 hours prior to the sampling	Dry weather event.
12th December 2016	Dry weather while sampling, 12.4 mm of rain in the 24 hours before the sample, 36.4 mm rainfall 72 hours prior to the sampling	Moderate wet weather event, 2.6 year return period for 1 hour interval. *First flush event.

** First flush conditions are defined as a rainfall event with rainfall no less than 10 mm and no greater than 25 mm, over 24 hours (CCC, waterways wetlands and drainage guide). Antecedent precipitation conditions should be considered, where a first flush storm needs to have a period of at least 72 hours of no measurable precipitation (Otago Regional Council).*

See Appendix B for rainfall hydrographs of the sampled events.

5.2. RESULTS SUMMARY

There were several parameter concentrations that were below detectable limits in the samples given to Hills Laboratory; for simplicity these were recorded as zero in this investigation.

There was flow in sampling point on the state highway near the State Highway Drain (WDSH024) during only one of the four events. As a result there were no samples taken from this point during the sampling rounds in August, September and October. Similarly the sample obtained from Box Drain (WDBD005) during the September sampling round was noted to be from still stagnant water so the results obtained from this sample are not necessarily representative of stormwater runoff.

It is also noted that most guidelines specify that the sampling should be undertaken in a first flush event. The sampling round completed in the December event was the closest event to a first flush rainfall event, although there was rainfall recorded in the days leading up to this event.

The following sections of this report look at each of the tested contaminants separately, to discuss the source of the contaminant and proposed changes to the current stormwater monitoring programme.

See Appendix C for a summary of the laboratory results summary for each of the sample rounds.

5.2.1. Total Suspended Solids

Total suspended solids (TSS) include all particles suspended in water which will not pass through a filter. Suspended solids are mainly non-point source pollutants such as soil erosion from agricultural and construction sites.

TSS as measured coming in and going out of Woodend are shown in Figure 5. The LWRP provides a guideline TSS value of 50 mg/L. It is acknnolodged that this is a measure at the discharge point, hoever it is the only relevant guideline of TSS to compare the results to.

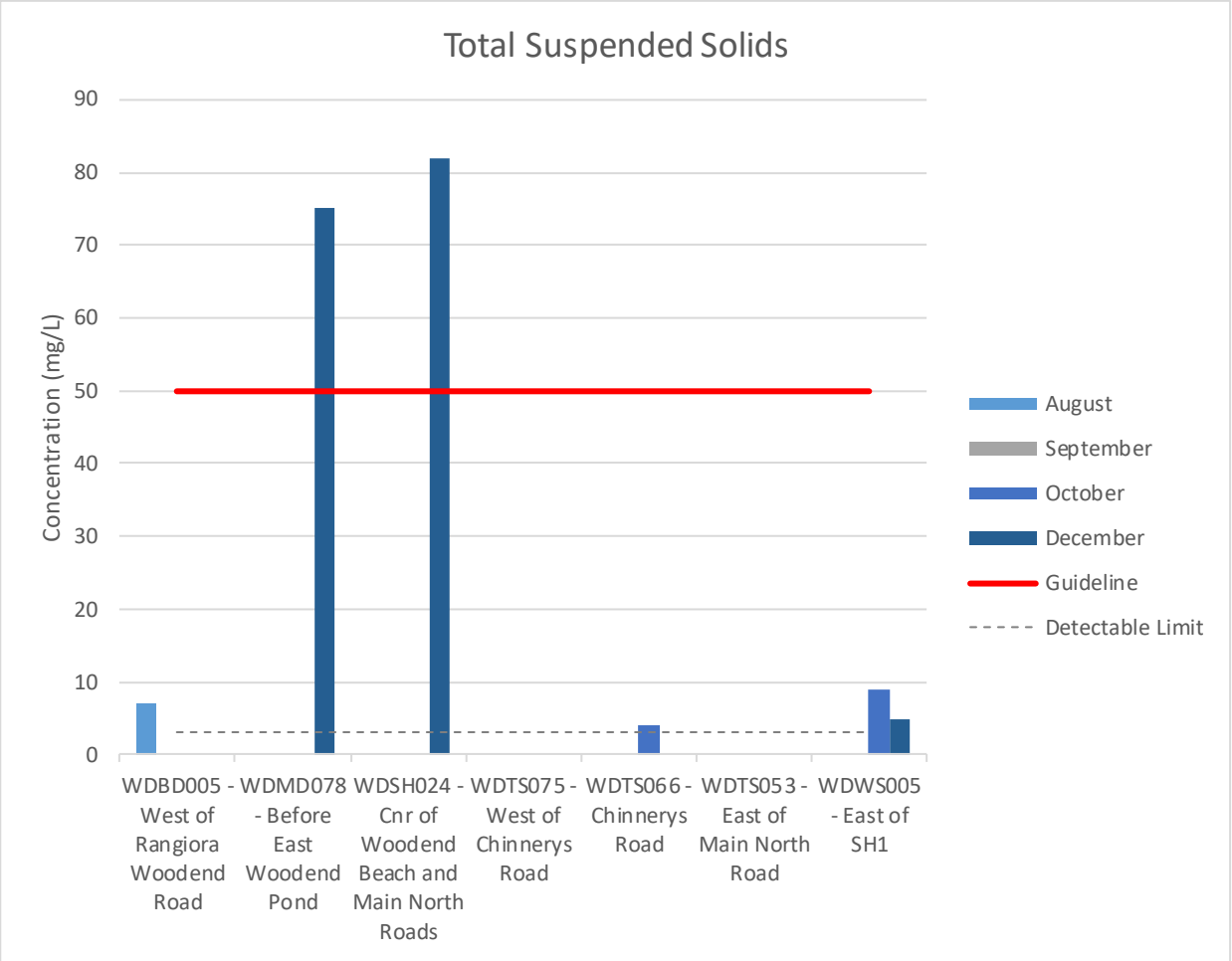


Figure 5: Total suspended solids as measured in the Taranaki Stream, Waiora Stream, McIntosh Drain and Box Drain and Transit Drain.

Total suspended solids were generally low or below detectable limit. The only significant exception to this was the large December event which resulted in total suspended solids above the guideline levels at two sites, one in the McIntosh Drain (WDMD078) and on the Transit Drain (State Highway 1, WDSH024). Samples taken from waterways entering Woodend from rural areas demonstrated levels just above the detectable limit, even in the December event.

The results show that TSS is mainly an urban contaminant and should be monitored as part of the stormwater network discharge consent.

5.2.2. Dissolved Copper

Primary sources for dissolved copper (Cu) include but are not limited to vehicle brake pad wear, plumbing uses such as copper spouting and soil disturbance from historic horticultural sites.

The 90% LOP trigger value for copper provided in both the LWRP and ANZECC guidelines is 0.0018 mg/L. Dissolved copper levels are shown in Figure 6.

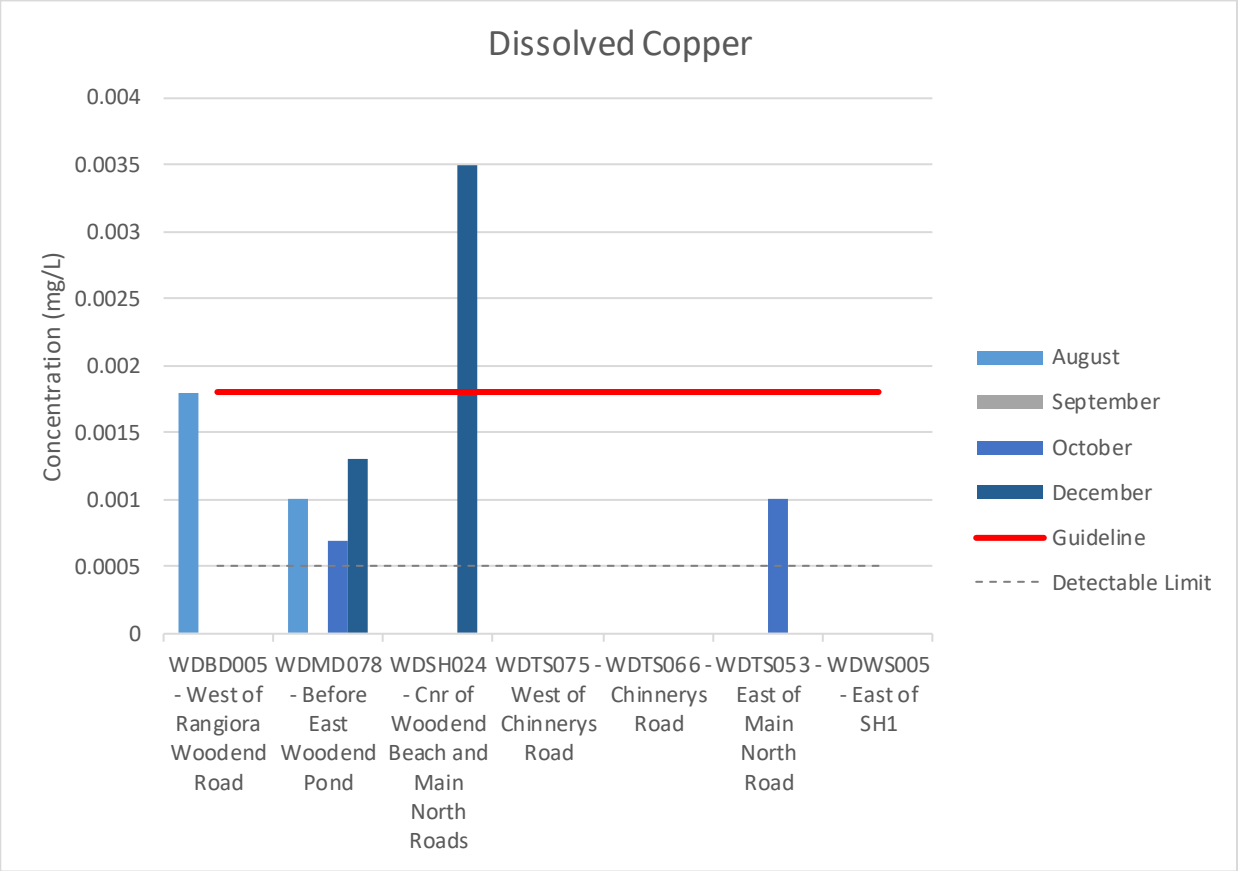


Figure 6: Dissolved copper levels in Woodend waterways.

A summary of the results by waterway is presented below.

Taranaki Stream (WDTS075, WDTS066 and WDTS053) – only detected in the sample taken at the site downstream of the highway.
McIntosh Drain (WDMD078) – detected in most samples.
Box Drain (WDBD005) – second highest reading recorded during the sampling, but only detected at this site in the August event.
Waiora Stream (WDWS005) – not detected.
State highway WDSH024) – exceeded allowable levels in the first flush event. Possibly due to surface runoff from the adjacent highway.

Based on the results the main sources of copper are from urban runoff such as state highways. It was detected at four out of the seven sample sites but was generally below the guideline value. Levels exceeded the guideline in only one sample, in the first flush event in December at WDSH024 adjacent to the state highway. Interestingly the McIntosh Drain sampling site (WDMD078) was the only site where copper was observed on more than occasion. Hence the McIntosh Drain catchment appears to be the most heavily influenced by copper - likely from a combination of road (the state highway is immediately upstream) and residential runoff.

The results suggest Woodend and the state highway are contributing dissolved copper to the local waterways. The rural catchments upstream of Woodend do not appear to be leading to increased dissolved copper levels.

The results show that copper is mainly an urban contaminant and it is recommended that dissolved copper is included in the 'urban impact' section of the monitoring programme.

5.2.3. Dissolved Lead

The recorded levels of dissolved lead are shown in Figure 7.

Primary sources of dissolved lead (Pb) include but are not limited to road runoff (from automobile parts), and degrading construction components such as paint and roof flashings. The 90% trigger level guideline provided by ANZECC for dissolved lead is 5.6 µg/L.

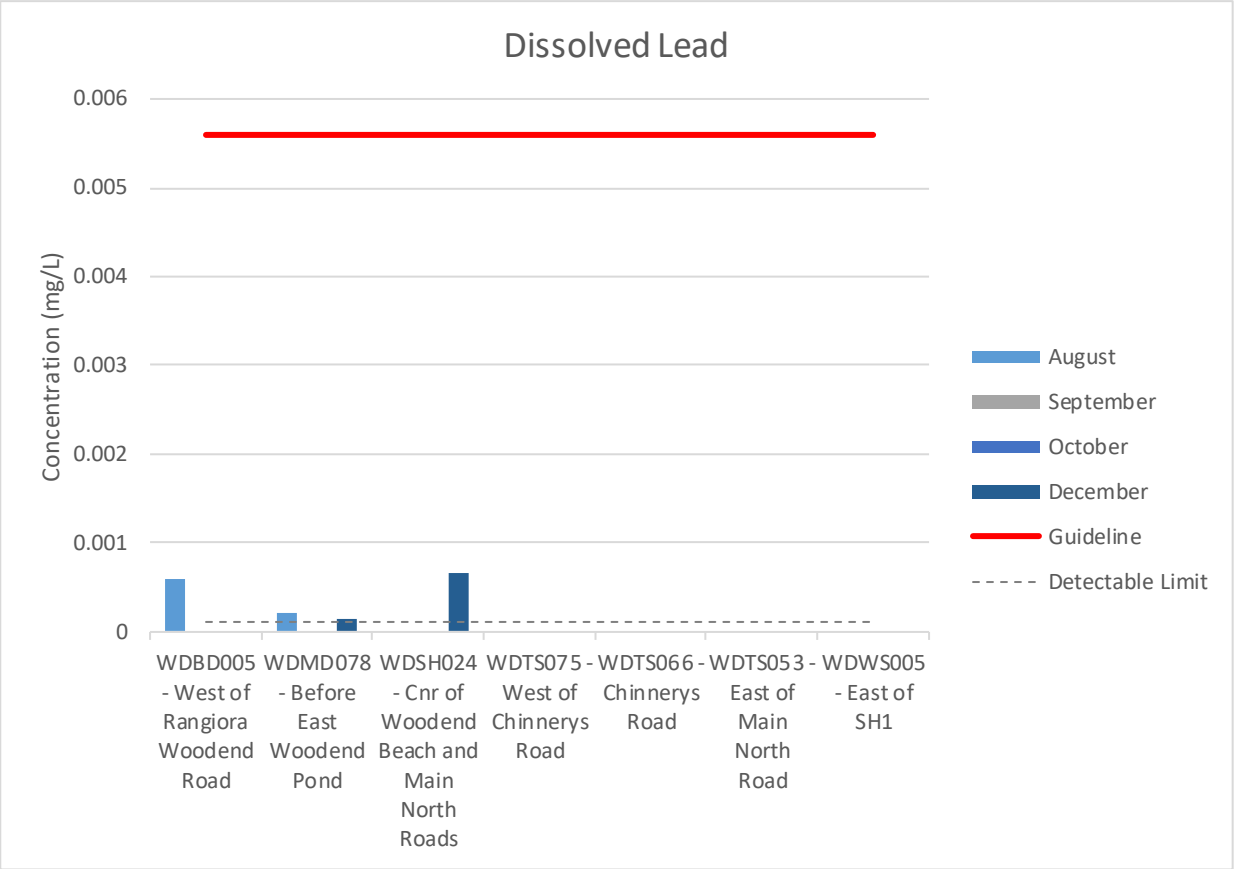


Figure 7: Dissolved lead levels recorded in Woodend's waterways.

Dissolved lead was detected in four samples spread over three samples sites. Similar to the dissolved copper results, the highest recorded result was from the state highway site (WDSH024) during the first flush event and the second highest result was recorded in the box drain (WDBD005), following the minor wet weather event in August. Lead was not detected in any of the predominantly rural fed waterways.

There was no lead present in any samples taken during either of the dry weather periods, it was only detected during the wet weather events in August and December 2016.

The results show that lead is predominantly an urban contaminant. Recorded levels of lead are low and do not appear to be approaching the guideline values level in any of Woodend's samples. This is consistent with findings in Rangiora.

Therefore it is recommended that dissolved lead is removed from the urban impact monitoring programme of the guideline.

5.2.4. Dissolved Zinc

Sources of dissolved zinc (Zn) are commonly from anti-corrosion agents used in the galvanisation of iron and steel. It is found in metal roofs, metal fences, lampposts, car bodies, anticorrosion paint used on exterior steel, in rubber vehicle tyres to protect against UV degradation, and some herbicides.

The LWRP and ANZECC provide a 90% guideline value of 15µg/L of dissolved zinc.

The recorded levels of zinc are presented in Figure 8.

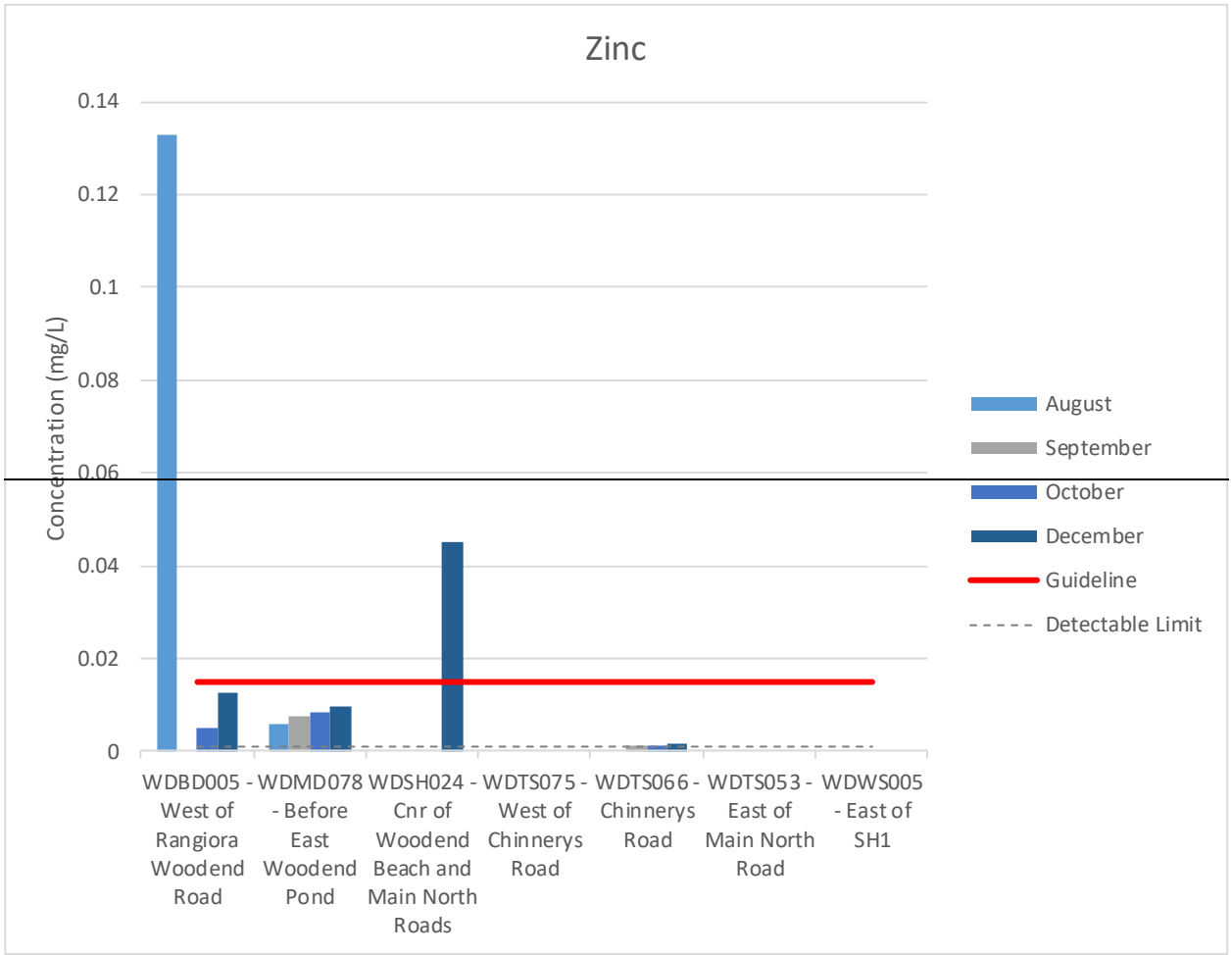


Figure 8: Dissolved concentrations of zinc in the samples captured at Woodend

Dissolved zinc is present in the three main urban fed catchments however only exceeds the guideline in the box drain (WDBD005) and adjacent to the state highway (WDSH024). Similar to the other heavy metals lead and copper, the highest dissolved zinc levels are recorded in the box drain (WDBD005) during the minor wet weather event in August and in the first flush event in December in the box drain and state highway drain respectively. The August Box Drain sampling event may have involved sampling in relatively stagnant water (as noted with the September sample). Further sampling at this site is required to determine whether the elevated contaminants observed at the Box Drain in the August sampling round were an anomaly or a result of unusual water retention / drainage occurring at this site.

Interestingly the amount of dissolved zinc is considerably higher in the Box Drain than on the State Highway, which stands in contrast to the levels observed for copper. This could be a reflection of the greater amount of zinc coming from galvanised roofs in the sub-catchment.

The results show that zinc is mainly an urban contaminant and it is recommended that dissolved zinc is included in the 'urban impact' section of the monitoring programme.

5.2.5. Nitrogen

Nitrogen primary sources include but are not limited to fertilizers and sewerage. It is noted that Total Nitrogen is the sum of TKN + Nitrate-N + Nitrite-N and DIN is the sum of Total Ammoniacal-N + Nitrate-N + Nitrite-N.

Figure 9 and Figure 10 present the Total Nitrogen (TN) and Dissolved Inorganic Nitrogen (DIN) concentrations from laboratory results from waterways in the Woodend area, respectively. The ANZECC guideline for total nitrogen is 0.614 mg/L. The LWRP guideline of 1.5 mg/L has been applied for DIN (the bioavailable portion). It is worth noting that the LWRP does not specify a guideline value for TN so the guideline value applied from the ANZECC guidelines for TN is more stringent as it is actually less than the value for DIN.

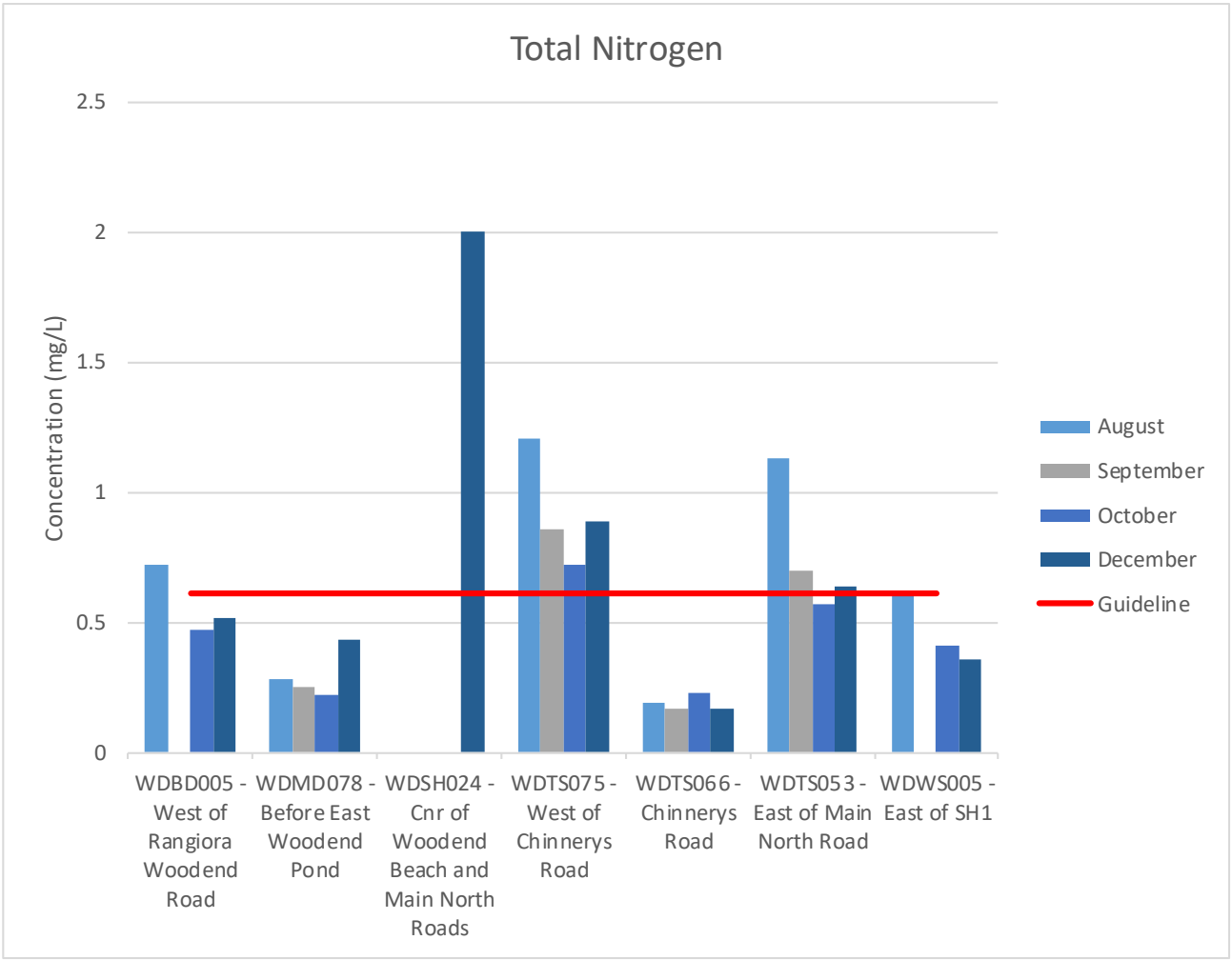


Figure 9: Recorded levels of Total Nitrogen in the Woodend area.

The guideline for TN, 0.614 mg/l, is exceeded in nine of the 24 samples. This is especially noticeable in the predominantly rurally sourced waterways such as the Taranaki (WDTS075 and WDTS053) and Waiora Stream (WDWS005). TN levels are also high in the Box Drain (WDBD005). The highest level recorded was during the December first flush event at site WDSH024 (adjacent to the state highway). It is worth noting this was the only sample taken from this site as it was dry during the other sampling rounds.

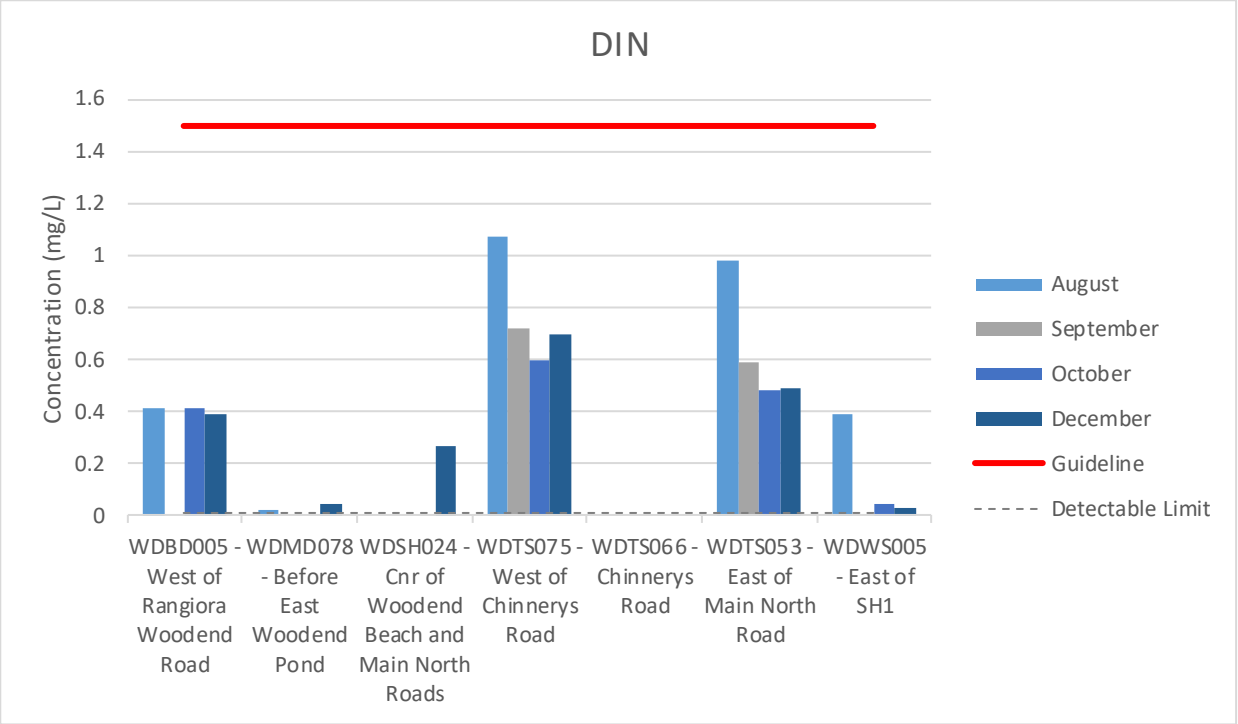


Figure 10: Recorded levels of dissolved inorganic nitrogen for the Woodend area.

All samples had DIN levels below the LWRP guideline. Interestingly the DIN level recorded for the December event at site WDSH024 were far below the guideline value and relatively inconspicuous amongst the other sites (i.e. TN>> DIN at this site).This suggests the forms of TN entering this water way, although in relatively high concentrations, are not readily bioavailable. The main flow of the Taranaki Stream (WDTS075 and WDTS053) demonstrates the highest levels of DIN of all the sites and in all captured events the stream DIN levels exhibit a decrease moving downstream through Woodend. This suggests that the Taranaki Stream is strongly influenced by upstream land use (predominantly agricultural) and the urban areas of Woodend have a dilutive effect on DIN levels.

The sample site WDTS066 (located in the middle stretch of the original Taranaki Stream channel) demonstrates very low TN levels and DIN below the detectable limit of 0.01 mg/l. This reinforces the idea that although the site ID has the prefix WDTS and is in the Taranaki Stream it is not carrying water from the upstream Taranaki Stream catchment. Just below sample site WDTS075 the water is diverted out of the historic channel and now flows along the manmade channel to the north. Elevated levels of urban contaminants such as zinc and copper at WDTS066 that are not picked up at the upstream or downstream sites support this. It is worth noting the sample site always contained flow during sampling so appears to have a reliable source from within this subcatchment to maintain this baseflow.

It is recommended that TN is replaced with DIN, as this is the value provided in the LWRP, in the stream health monitoring programme. It is recommended this contaminant stays in the stream health monitoring section of the programme as the results show that concentrations are more closely linked to rural runoff than urban.

5.2.6. Phosphorus

Primary sources of phosphorus include but are not limited to fertilisers (both agricultural and residential), sewerage and some detergents. Phosphorus has a tendency to bind to soil particles and can be transported into waterways with sediment runoff.

Figure 11 and Figure 12 present the recorded levels of Total Phosphorus (TP) and Dissolved Reactive Phosphorus (DRP) respectively. Similar to nitrogen the LWRP does not provide a guideline value for TP

so the 90% ANZECC guideline value of 0.033 mg/L has been used. The LWRP provides a guideline value of 0.016 mg/L for DRP.

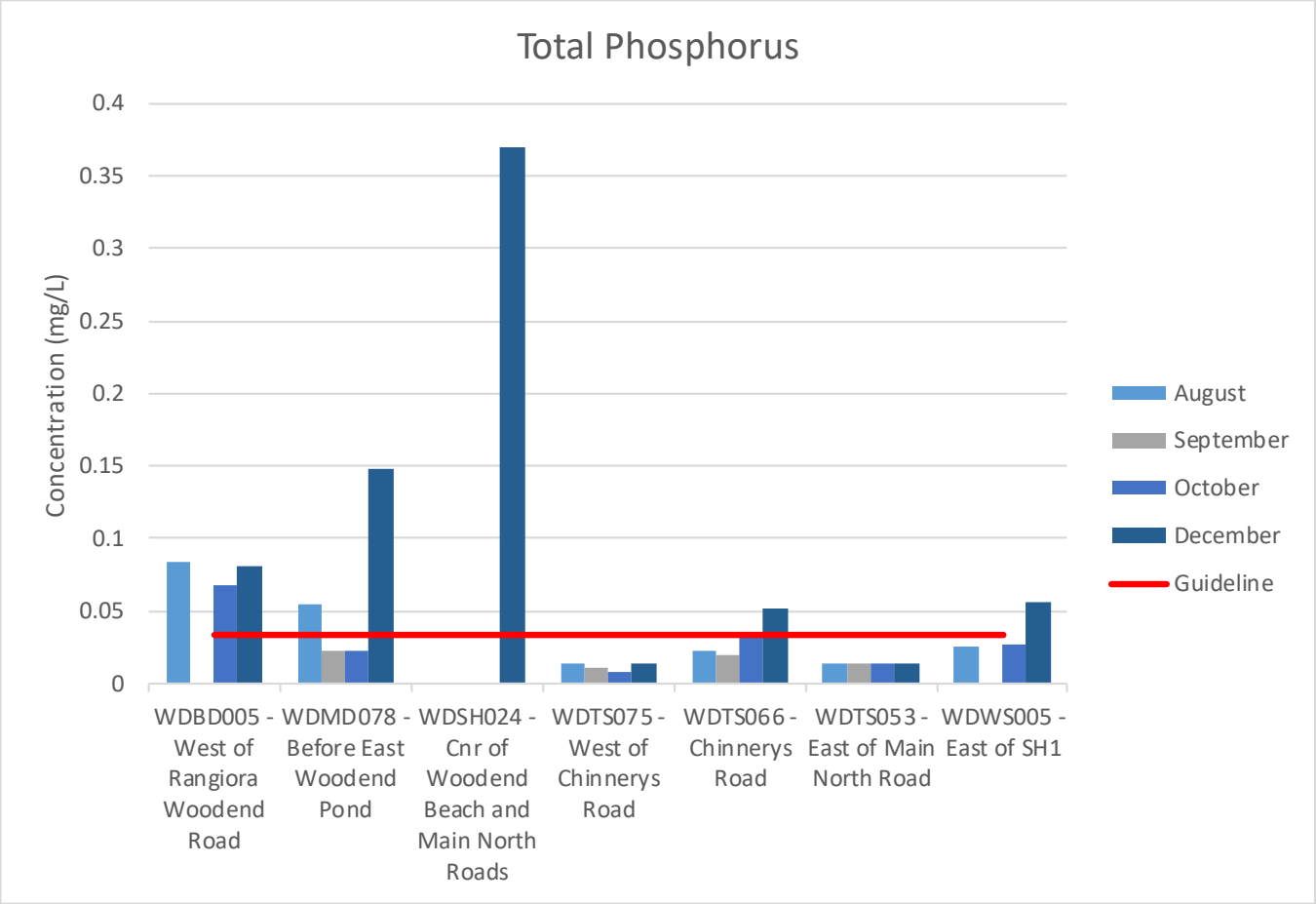


Figure 11: Total Phosphorus levels in Woodend's waterways.

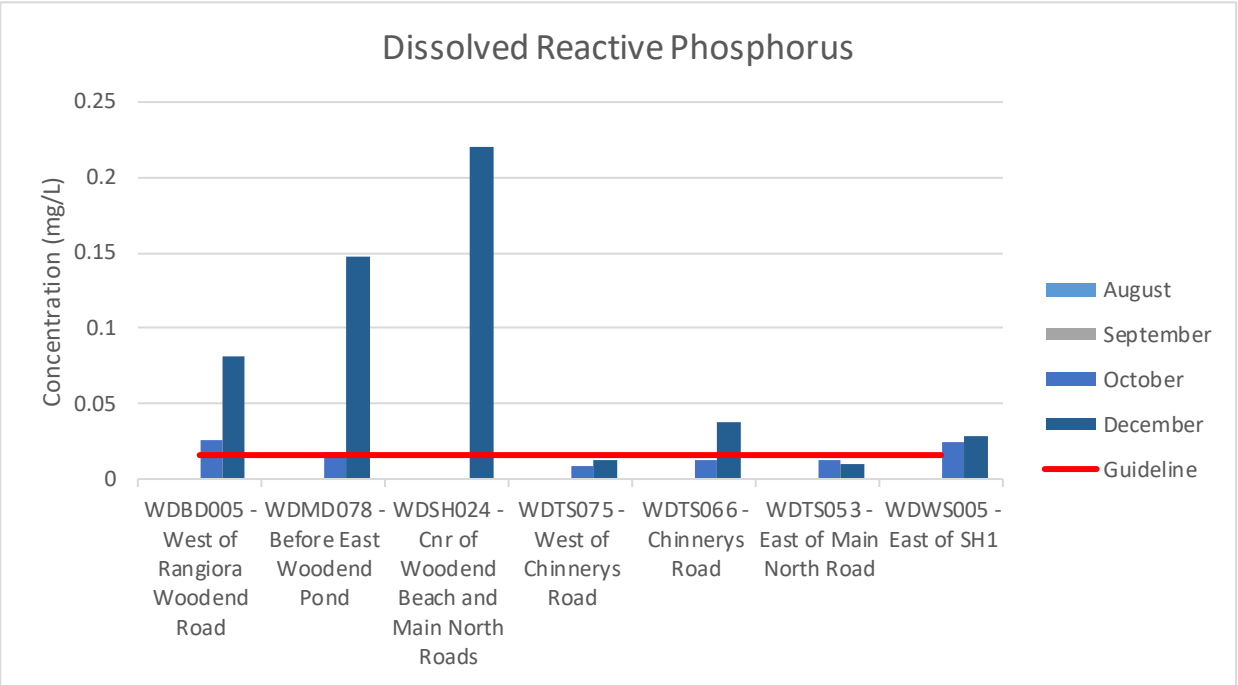


Figure 12: Dissolved Reactive Phosphorus in Woodend's waterways

Based on the levels observed it is apparent phosphorus is more of an issue in Woodend's waterways than nitrogen. In contrast to the distribution of nitrogen, it is the urban fed waterways that demonstrate higher levels of phosphorus than the rural waterways. Both of the sample sites in the main flow of the Taranaki Steam (WDTS075 and WDTS053) returned TP and DRP levels below the guideline levels whereas the urban fed waterways all demonstrated phosphorus levels in exceedance of the guidelines.

The majority of phosphorus in the samples is in the form of DRP (the more readily bioavailable form) rather than particulate or organic forms. This indicates the majority of phosphorus entering the stream is in a form which could readily contribute to eutrophication.

It is noted however that it the phosphorus concentrations are elevated to near or above guideline levels at all sample sited. It would be unfair to say phosphorus is only urban sourced.

At all sample sites phosphorus levels were highest in the first flush event in December. Initially it was suspected this was likely to be a result of greater entrainment of suspended solids due to the higher velocities experienced during the larger rain event. However, as illustrated in Figure 13 TSS levels have a strong linear correlation with DRP and a noticeably weaker correlation with TP suggesting entrainment of sediment is not the main contributor to elevated levels of phosphorus.

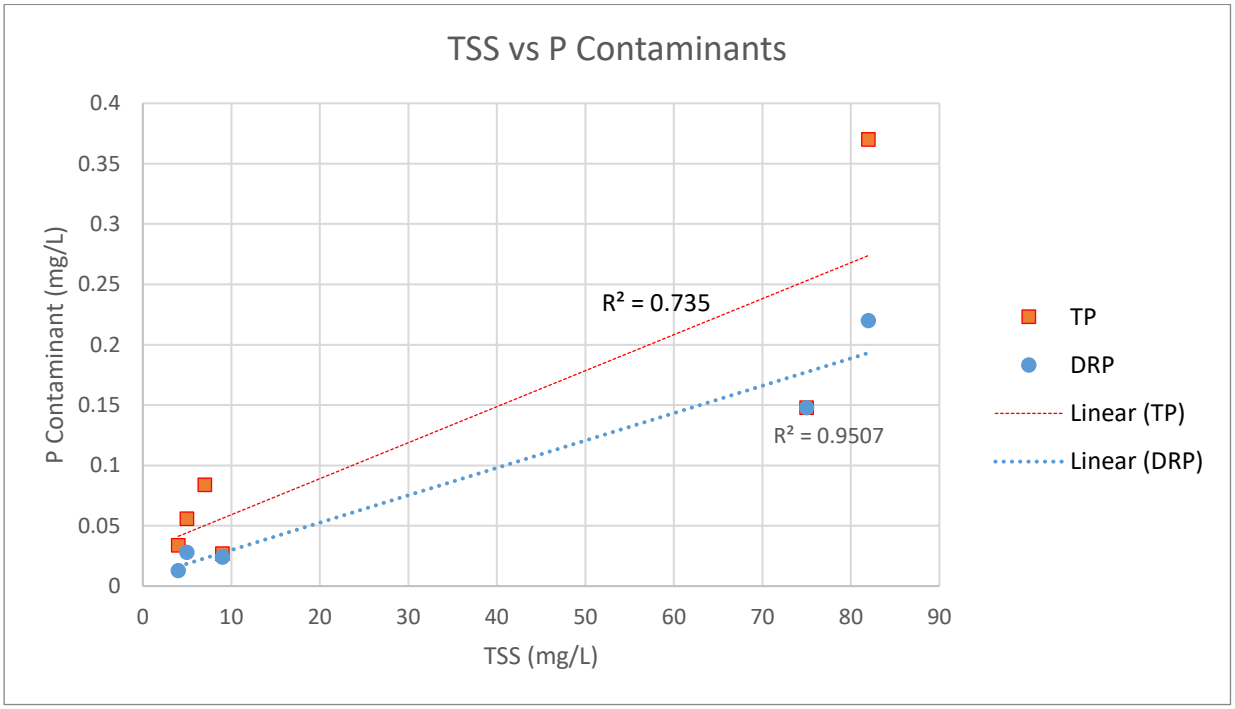


Figure 13: Figure plotting total phosphorus and dissolved reactive phosphorus against total suspended solids.

As DRP is stated as the applicable indicator for of phosphate in the LWRP, it is recommended that it replaces TP in the monitoring programme. The results show that phosphorus has both urban and rural sources. It is recommended that further thought is put into placing this contaminant into the urban impact section of the monitoring programme. As it stands WDC would face significant challenges to meet a guideline level which is near or above exceedance due to the significant rural contributions of phosphorus.

5.2.7. E. coli

Escherichia coli (*E. coli*) is used as an indicator of possible sewage contamination as *E. coli* is commonly found in human and animal feces. The LWRP provides a guideline of 550 CFU/100 mL of *E. coli* and requires 95% of samples to be below this value.

Figure 14 shows the recorded levels of *E. coli* in Woodend's waterways.

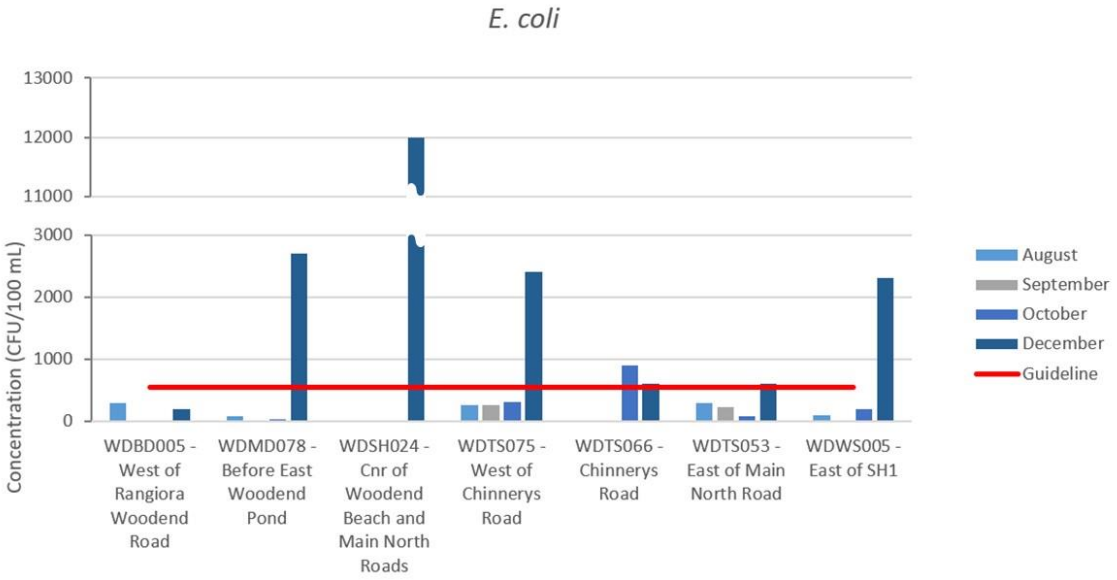


Figure 14: *E. coli* levels in Woodend's waterways.

The concentrations of *E. coli* in these samples exceed the guideline values in seven instances, or 24% of the samples captured. Exceedances were particularly prevalent in the first flush event seen in December. Aside from the December event, the smaller October rain event was the only other event to result in an exceedance of the guideline value. The sites sampled during the minor wet weather event in August and dry weather event in September both demonstrated levels of *E. coli* comfortably below the guideline value.

Although less than half the guideline value, it is worth noting that the two sites in the Taranaki stream demonstrated the highest and most consistent base levels of *E. coli* levels observed during dry events. This is likely to be the result of consistent contamination upstream in the rural land areas. The urban areas generally exhibited low to no *E. coli* during dry weather events with extremely high levels after the first flush event in December.

As the concentrations of *E. coli* are increasing in urban areas the potential sources have been investigated further. The main suspected sources of *E. coli* include:

- Fecal matter from urban animals such as dogs, cats, and birds
- Agricultural fecal matter
- Human fecal matter

The locations of Woodend's public parks, which could be common dog walking areas, are presented in Figure 15. These are areas that have higher concentrations of domestic animal fecal matter. There does not appear to be a strong obvious link between *E. coli* levels and the locations of public parks.

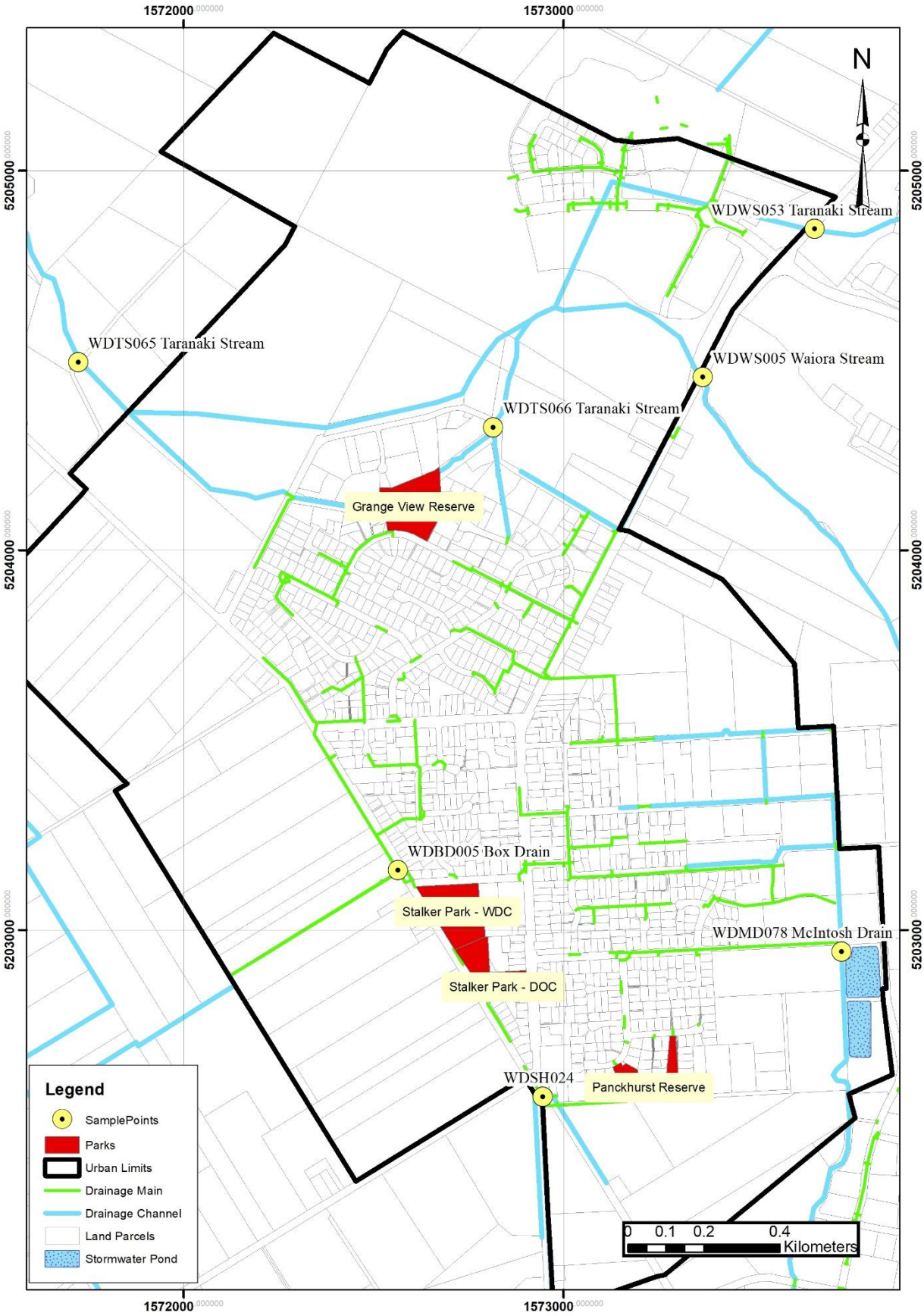


Figure 15: Map of public park areas in Woodend that may be sources of point sources of *E. coli*.

Overflows are managed separately through the Wastewater Management Plan process. There may be sewerage overflows occurring within the wastewater network contributing to the issue. However, modelling

completed for the Woodend Network in 2014 indicated that overflows should not occur during a 1 in 5 year storm event.

The results show that *E. coli* appears to have urban sources and elevated levels in the urban catchments are seen during rainfall events. However the results also show that significant levels of *E. coli* are entering the township from rural areas. Therefore it is recommended that further thought is put into placing this contaminant to the urban impact section of the monitoring programme.

Further investigation is required to identify whether there are any significant urban sources of E.coli contributing to the above exceedances, particularly at/into the State Highway 1 Drain. The Drain appears to have a solely urban sub-catchment and the high level of E.coli observed is not easily explained.

WDC should not be trying to meet a guideline level which is near exceedance, if there are found to be significant rural contributions of *E. coli* affecting results.

5.2.8. Total Hydrocarbons

Total Hydrocarbon primary sources include but are not limited to road asphalts, manufacturing facilities and fuelling depots, as these areas frequently experience oil spillages.

There is no consistency between guidelines for hydrocarbons; ECan is in the process of investigating and stating a guideline.

For all samples the results indicated that the total hydrocarbon concentrations for C7 - C9, C10 - C14 and C15 - C36 were all below the detectable limits. Therefore it was concluded that the Woodend urban and rural catchments do not have an issue with hydrocarbons.

It is recommended the hydrocarbons should be removed from the urban impact section of the monitoring programme, however the total hydrocarbon concentration should be kept in the 'sediment sampling' section of the monitoring programme, until it has been investigated further.

5.2.9. Dissolved Oxygen

Several factors affect the amount of oxygen dissolved in the water in waterways. Colder water usually has more oxygen, because gasses dissolve more readily in cold water. Water motion also helps mix oxygen into the water. Eutrophication can result in the depletion of oxygen concentration in the waterways as resulting organic matter respires and breakdowns.

Figure 16 and Figure 17 show the DO levels recorded by portable probe during the sampling rounds.

The ANZECC guidelines provide a relatively narrow DO guideline range of between 98% (min) and 105% (max). The absolute levels of DO, can also be used to gauge the general health of a waterway. For optimum fish health the minimum DO level suggested by NIWA is 5 mg/L.

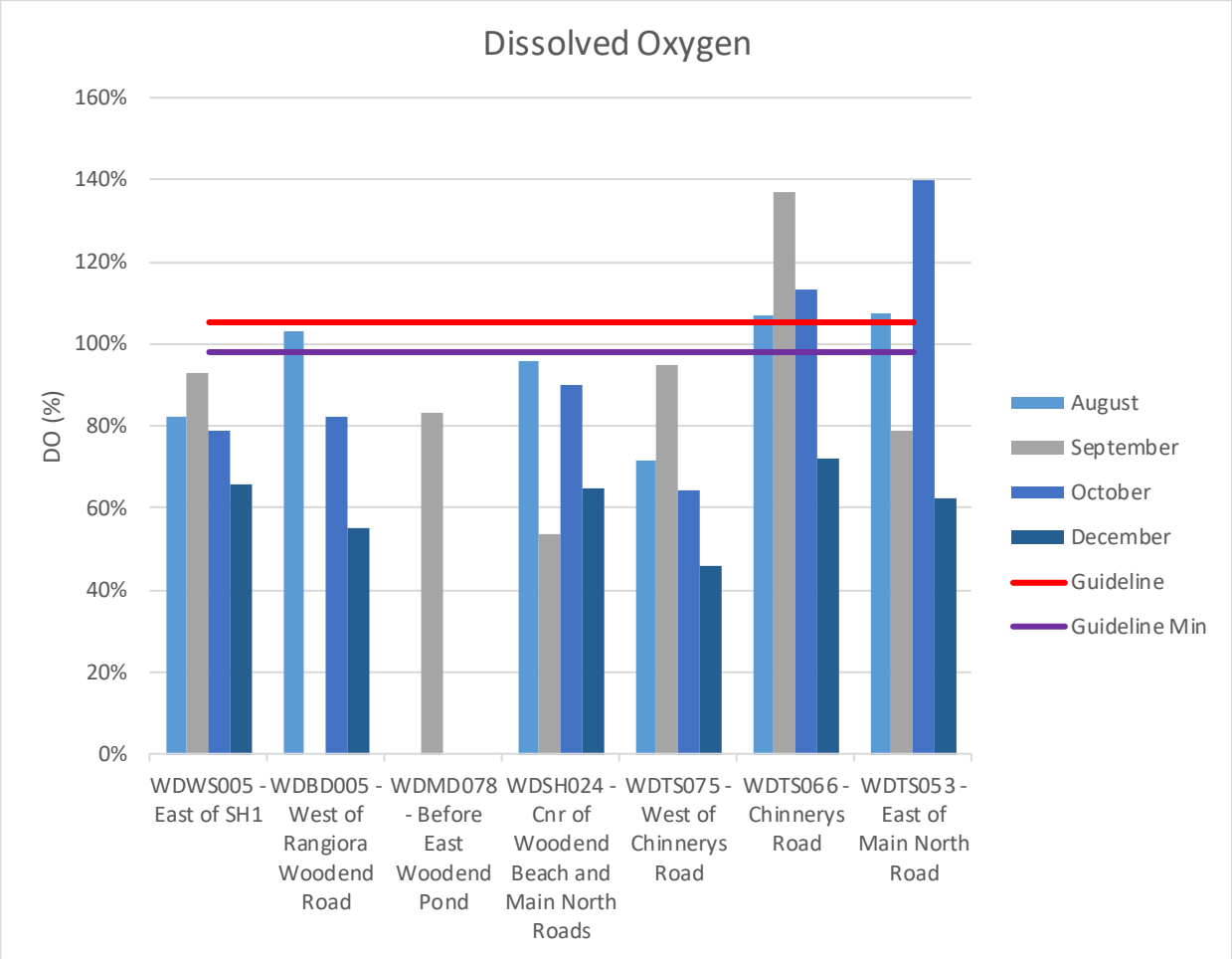


Figure 16: DO levels observed in Woodend's waterways as a percentage of saturation.

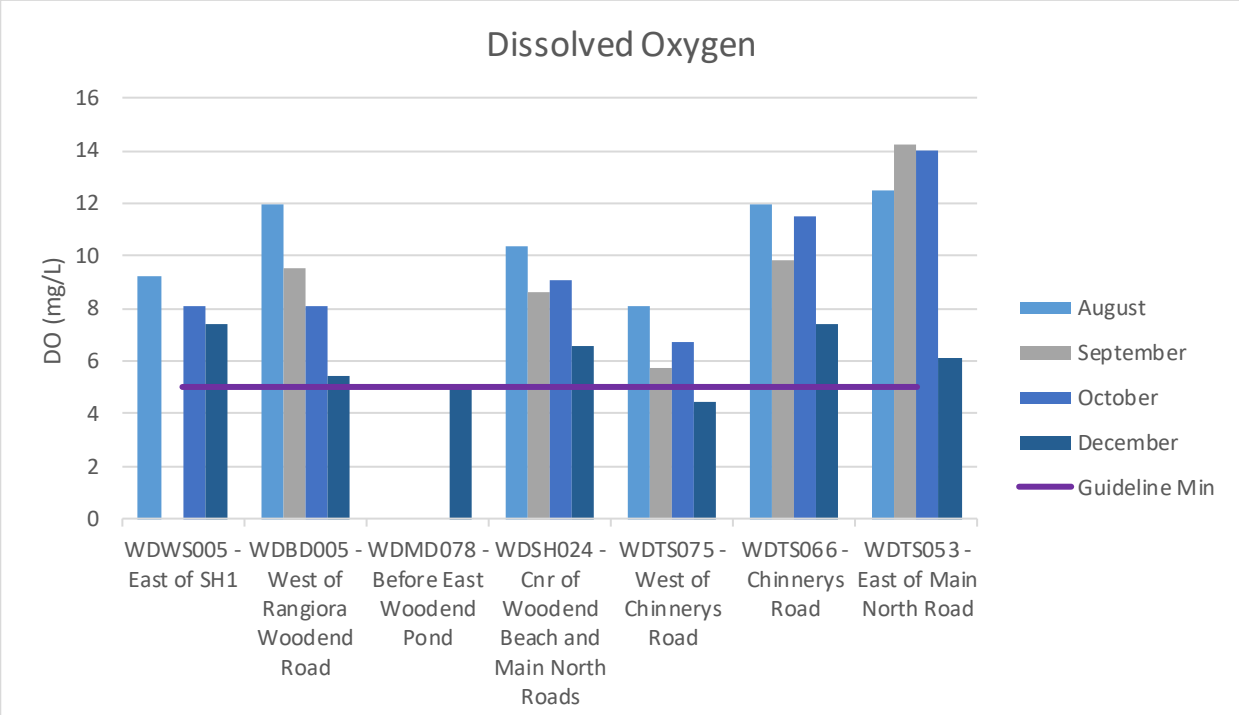


Figure 17: DO levels in observed in Woodend's waterways as an absolute value.

It is clear from the recorded DO levels that there is significant variation in Woodend's waterways. Although some variation is to be expected the DO fluctuates considerably between sites even within the same water body - for instance in the August event the Taranaki Stream goes from a DO level of 64% at site WDTS075 to 140% 2.2 km downstream at site WDTS053. This trend is not consistent between events and could suggest the DO readings are somewhat unreliable. The DO percentage saturation is a combination of two field measurements, the absolute DO level and the temperature. If both meter readings are not well calibrated then it is possible to produce compounding errors.

Figure 26 shows the absolute DO level exceeds the guideline minimum of 5 mg/L in all but one sample, which was captured in the first flush event in December. Interestingly the December event samples generally had the lowest levels of absolute DO at each site. This is appears to be a direct result of the warmer water in summer resulting in lower solubility of oxygen as saturated oxygen percentage (Figure 16) and temperature (Figure 19) are both relatively high.

The results suggests the waterways were not suffering from the low DO effects that can result from eutrophication at the time of sampling. However, it is expected waterways would have higher than usual DO levels after rain events due to raindrops having a large surface area to volume ratio to absorb oxygen while falling and additional mixing in the waterway created by increased turbulence and the resulting aeration. Low flow periods during warm summer periods are a more likely time to observe signs of eutrophication.

It is recommended that DO is monitored as part of the stream health in the monitoring programme, as it is a portable probe measurement and would not cost WDC much to monitor.

5.2.10. pH

Low pH (acidic) is caused by high organic acids, such as some wetland waters or where mineral acidity occurs naturally. High pH (basic) is caused by highly eutrophic waters, where eutrophication occurs.
pH differences can also occur by water draining certain rock, soil types and industrial wastes.

Figure 18 represents the pH portable probe results from the sampled waterways in and around Woodend. The LWRP provides a guideline from pH 6.5 to pH 8.5.

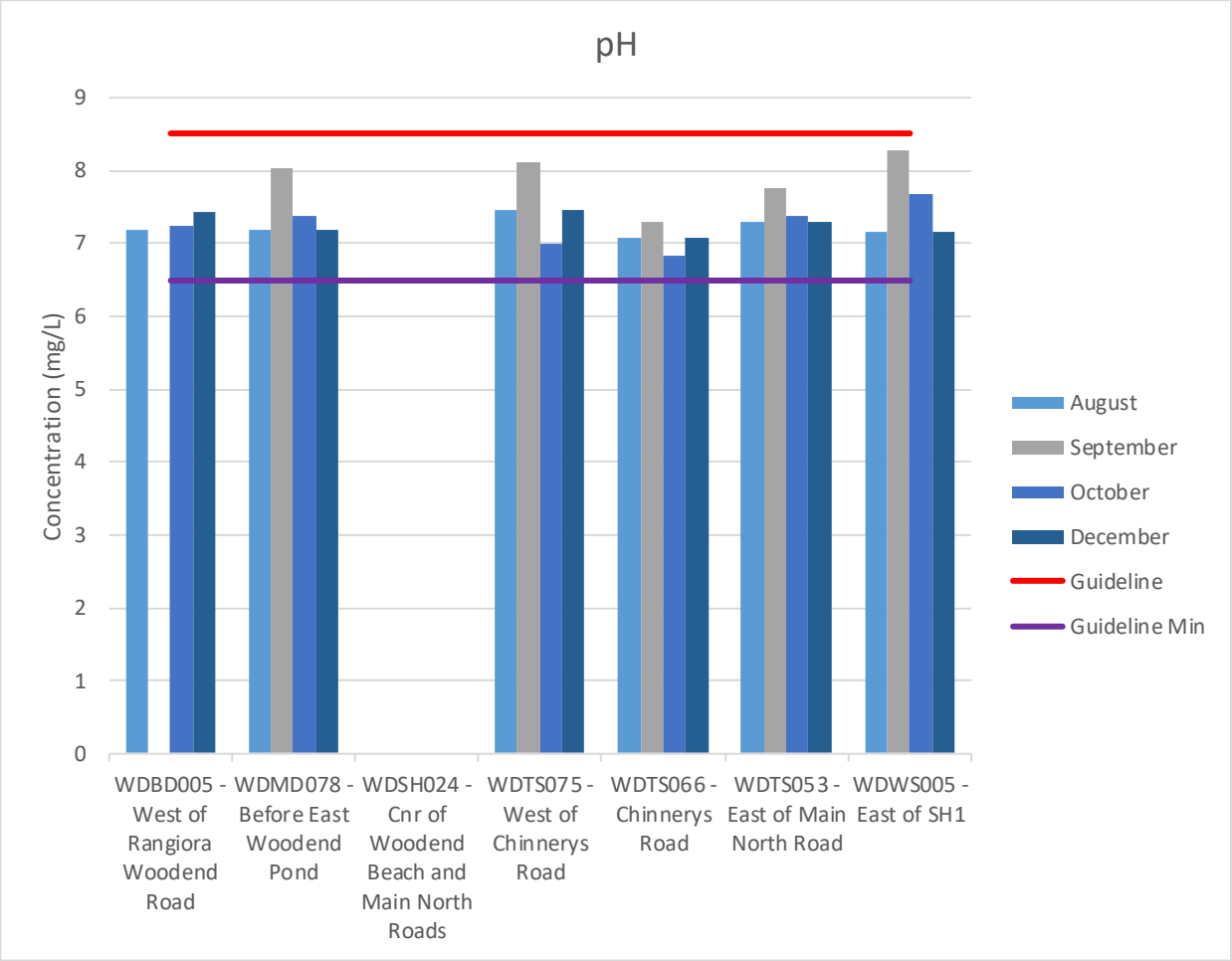


Figure 18: pH readings captured by portable probe in Woodend's waterways.

The recorded results are all within the guideline range. In general the samples tend to be slightly basic. The dry October event is the only event to demonstrate consistently elevated pH levels. There are three samples in the October and December rounds that demonstrate pH levels slightly below neutral.

The pH levels recorded are comfortably within the LWRP guidelines and don't indicate eutrophication or other problems indicated by pH changes.

It is recommended that pH is monitored as part of the 'stream health' section of the monitoring programme, as it is not proven to be affected by the urban discharges. As it is a portable probe measurement it would not cost WDC much to monitor.

5.2.11. Temperature

Temperature of waterways can be affected by the air temperature during a rain event, the temperature of surfaces contributing runoff entering waterways and the temperature of the baseflow. Seasonal temperature fluctuations play a major role.

The LWRP provides a guideline of a maximum temperature of 20 °C for lowland rivers.

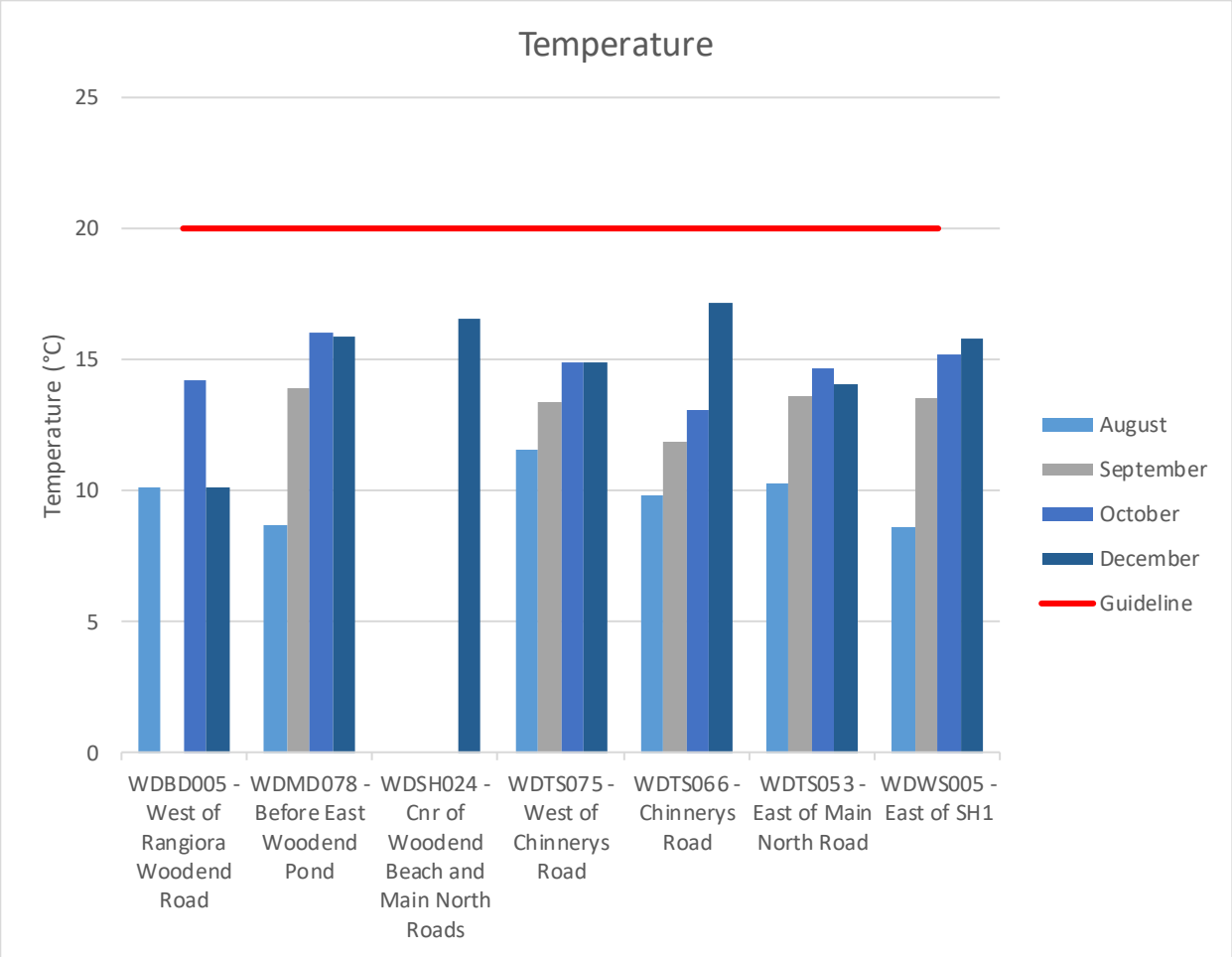


Figure 19: Temperature as captured by portable probe over the Woodend area.

The recorded results follow the trend of warmer temperatures in warmer periods of the year. The waterways reached a maximum temperature of 17 °C, observed in the December event. There is no evidence to suggest that stormwater is altering the temperature of Woodend's waterways. Additional measurements collected at the same time of the year during wet and dry events would be needed to confirm this observation.

It is recommended that temperature is monitored as part of the stream health in the monitoring programme, as it is a portable probe measurement and would not cost WDC much to monitor.

5.2.12. Conductivity

Water Conductivity is a measure of the total ionic strength of the water and is widely used as a quick indication of the level of enrichment of the water. The measurement does not distinguish between nutrient and non-nutrient ions so although it can signal a potential issue it requires additional information to

determine what the source of the ions is. There is no specific guideline for water conductivity provided by ANZECC or the LWRP.

Figure 20 presents the conductivity results recorded by portable probe.

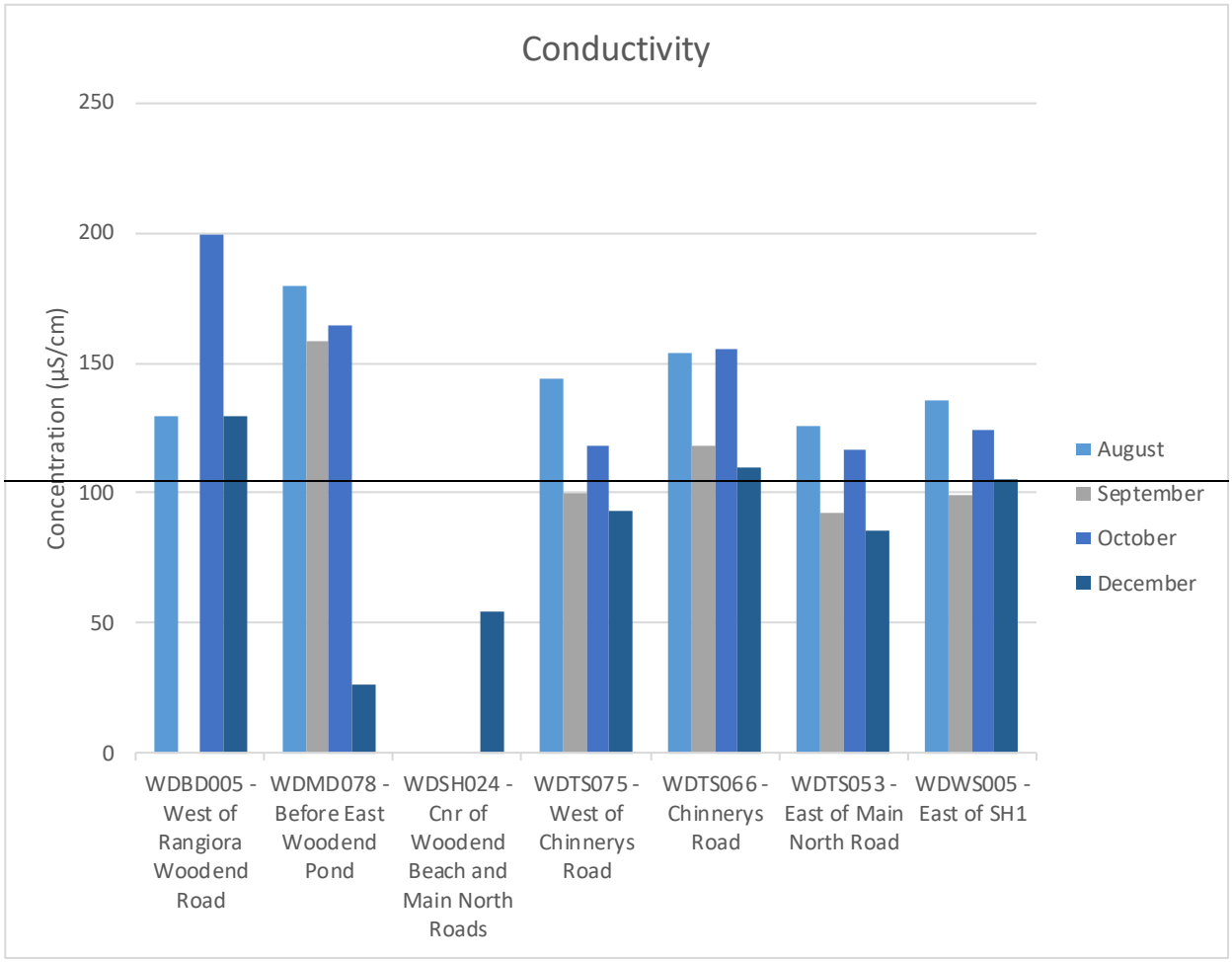


Figure 20: Conductivity results for Woodend.

Samples captured in the minor wet weather event in August and dry weather event in October events demonstrate the highest conductivity levels at each site. Samples captured during the first flush December event tend to demonstrate the lowest conductivity observed at each site. As the December event tended to demonstrate the highest levels of conducting nutrients such as DRP, and reasonably high levels of DIN, it appears the elevated conductivity observed in the August and October events is not from nutrients but from non-nutrient ions present in the water.

Although there are no guidelines for conductivity, it is recommended that conductivity is kept in the 'stream health' section of the monitoring programme, as it can be easily retrieved and recorded. Sharp changes in conductivity indicate a change in anion or ion concentration which is linked to contaminant quantity and quality.

6. DISCUSSION

Four sample rounds were completed, in both wet and dry conditions, at seven sites spread over the Taranaki Stream, Waiora Stream, Box Drain, Transit Drain, and the McIntosh Drain. The results concluded that basing Woodend's monitoring programme on the programme approved for Rangiora that some of the contaminants can be removed and some added. Table 4 summarises the proposed changes to the Rangiora monitoring programme for Woodend's programme.

Table 4: Summary of contaminants from Rangiora's monitoring programme recommended to be changed for application to Woodend.

Contaminant	Source	Rangiora's Monitoring Programme Section	Woodend's Recommended Monitoring Programme Section	Reason Section for Change
Total Suspended Solids	Urban	Urban Impact	Urban Impact	
Dissolved Copper	Urban	Urban Impact	Urban Impact	
Dissolved Lead	Urban	Urban Impact	Urban Impact	Very Low Concentrations, therefore recommended to remove it from the programme
Dissolved Zinc	Urban	Urban Impact	Urban Impact	
Total Nitrogen	Rural	Stream Health	-	DIN is in the Land and Water Regional Plan (LWRP), therefore it is recommended that we replace TN with DIN
Dissolved Inorganic Nitrogen (DIN)	Rural	-	Stream Health	
Total Phosphorus	Mainly Urban	Stream Health	-	DRP is in the LWRP therefore it is recommended that TP is replaced with DRP. It appears DRP may be from both rural and urban sources. It is recommended further consideration is given to include DRP in the Urban Impact section of the monitoring programme.
Dissolved Reactive Phosphorus (DRP)	Mainly Urban	-	Urban Impact	
E. coli	Urban & Rural	Stream Health	Urban Impact	*E. coli* was found to be from both rural and possibly urban sources. It is a contaminant that is monitored as part of the Wastewater Management plan. It is recommended further consideration is given to including *E. coli* in the Urban Impact section of the monitoring programme.
Total Hydrocarbons	-	Urban Impact	-	Very Low Concentrations therefore recommended removing it from the programme. Total Hydrocarbons will remain in the basin sediment monitoring.
Dissolved Oxygen	Rural	Stream Health	Stream Health	
pH	Rural	Stream Health	Stream Health	
Temperature	Rural	Stream Health	Stream Health	
Conductivity	-	Stream Health	Stream Health	
Hardness	Mainly Rural	-	Urban Impact	Initial one off sample recommended as overall indicator of contaminants.

The contaminants that differed from the Rangiora Stormwater Monitoring Programme were Phosphorus and *E. coli*, these were found to be urban and rural sourced in Woodend and mainly rurally sources in Rangiora. Total Hydrocarbons are recommended to be removed from the programme as they were consistently measured to be well below the guideline values.

It is recommended that Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen should be used in the monitoring programme as these are specified in the LWRP.

It was recommended by ECan water quality specialists that the waterway hardness is measured once or twice to characterise the waterway. This will enable the WDC to get site specific trigger values for metals. This would be undertaken as part of the monitoring programme, as the sample sites would not be the same as in this baseline programme.

It was found that a number of the contaminants are sourced rurally and the relevant guidelines are exceeded prior to entering the township. For some of these contaminants there was an increase in concentration through the township, indicating that the urban area discharges these contaminants also, but in smaller quantities.

There are no known contaminants discharging from springs.

This study has demonstrated that the rural areas have a significant impact on the health of the Woodend waterways, and possibly others in the district. It is recommended that ECan undertakes monitoring upstream of the townships as contaminant concentrations are exceeded prior to the urban limits.

Table 5 presents the recommended Stormwater Monitoring Programme overview updated using the results from this baseline investigation.

Table 5: Recommended Updated Stormwater Monitoring Programme Overview

	Urban Impact Monitoring (part of consent)				**Stream Health Monitoring (not part of consent)**	
	Discharge Point Inspection	**Receiving Surface Water**	**Stormwater Basin**	**Stream Sediment**	**Surface Water**	**Ecological**
Description	Inspection of the major discharge points into the receiving waters	Water quality testing	Soil or Sediment sampling of the Stormwater Basins	Sediment sampling of the stream beds	Water quality testing	Ecological surveys
Location	Downstream of major discharge points in receiving waterways	Selected receiving waters sampling points	Dry and Wet Stormwater Basins	Stream beds (sites to be confirmed)	Selected receiving waters sampling points	Stream beds
Parameters	Water clarity, visual contaminants and erosion	Dissolved Copper, Dissolved Zinc TSS, Dissolved Reactive Phosphorous and *E. coli*	Total Copper, Total Lead, Total Zinc and Polycyclic Aromatic Hydrocarbons	Sediment Survey; Total Copper, Lead, Zinc, and Polycyclic Aromatic Hydrocarbons,	Dissolved Oxygen pH Temperature Specific Conductance Dissolved Inorganic Nitrogen, Ammonia, Lead,	Periphyton Fish species Macrophytes QMCI

					Polycyclic Aromatic Hydrocarbons,	
Frequency	Quarterly	Biannually	Every 5 years	Every 5 years	Annually	Every 5 years
Weather Conditions	Wet Weather	Ideally First Flush	Dry Weather	Dry Weather	Dry Weather	Dry Weather

It should be noted that although applied here in this report in the absence of LWRP guidelines, the ANZECC (2000) guidelines do not provide water quality standards in the traditional sense (i.e. fixed standards that should not be exceeded). Rather, ANZECC (2000) states that the uncertainty in the derivation and application of such standards led them to develop trigger values that indicate a potential environmental problem if they are exceeded. Hence, ANZECC (2000) trigger values are not intended to be applied in an absolute fashion. If a trigger value is exceeded, further investigation is required.

7. CONCLUSION

The following conclusions were made in this investigation:

- Most of the contaminants tested exceeded the guidelines in at least one of the sample rounds. Most exceedances occurred in the December, a first flush rainfall event, which was the largest rainfall event captured during the sampling period.

- It was found that generally the contaminants were present in both rural and urban environments, however in some cases the rural area was found to have a larger impact than the urban area and the guideline concentrations were at times exceeded prior to reaching the urban discharge points.

The following changes are recommended to the Rangiora Stormwater Monitoring Programme for Woodend:

- It is recommended that further thought is put into placing *E. coli* and phosphorus to the urban impact section of the monitoring programme, as WDC shouldn't be trying to meet a guideline level which is near exceedance, due to the significant rural contributions of *E. coli* and phosphorus.

- It is recommended that Lead and Total Hydrocarbons are removed from the 'urban impact' section of the Stormwater Monitoring Programme, as the results indicated that the concentrations were consistently far below the guidelines.

- It is recommended that Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen should be used in the monitoring programme as these are specified in the LWRP.

- It is recommended that contaminants such as *E. coli*, phosphorus and nitrogen should be investigated further by ECan within the rural catchment. Both *E. coli* and phosphorus levels exceed the LWRP guidelines in the rural zones, upstream of the urban limits. Nitrogen contaminates in the rural areas as rural catchments consistently exceed the ANZECC guidelines for TN however currently fall below the guideline levels provided in the LWRP for DIN.

These conclusions will be used to develop the Woodend Stormwater Monitoring Programme. After discussions with ECan and MKT the Stormwater Monitoring Programme will be updated.

8. APPENDIX

APPENDIX A: EXTRA BASELINE SAMPLING INFORMATION

Sampling kits should be ordered in advance to prepare for unpredicted sampling times. The kits should contain a STER, UP1L, NWU100 and a TPH250 from Hill Laboratory. The sample kits should be labelled in the following way:

SITE DESCRIPTIONS:

Site: WDBD005

GPS location: X-Coordinate: 1572557; Y-Coordinate: 5203147

Site Description: Box Drain, West side of Rangiora Woodend Road.

Site Photo:

Site: WDMD078

GPS location: X-Coordinate: 1573732; Y-Coordinate: 5202953

Site Description: McIntosh Drain, before East Woodend Pond

Site Photo:

Site: WDSH024
GPS location: X-Coordinate: 1572942; Y-Coordinate: 5202558
Site Description: SH 1 Drain, Cr Woodend Beach & Main North Rd.
Site Photo:

Site: WDTS075
GPS location: X-Coordinate: 1571721; Y-Coordinate: 5204507
Site Description: Gatehouse Lane.
Site Photo: nil

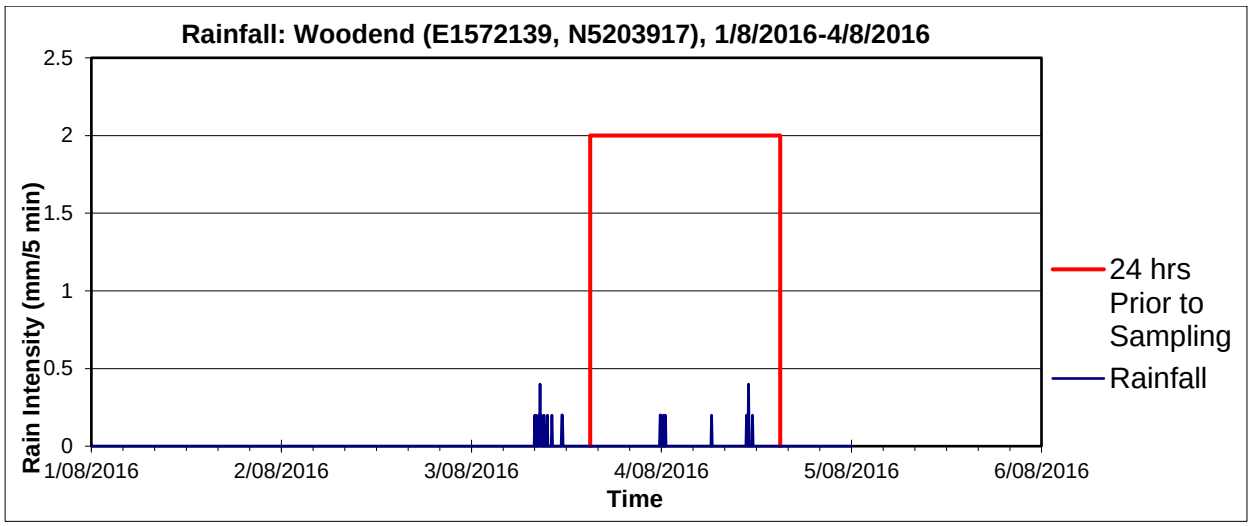
Site: WDTS066
GPS location: X-Coordinate: 1572812; Y-Coordinate: 5204321
Site Description: Taranaki Stream, East side of Chinnerys Road
Site Photo:

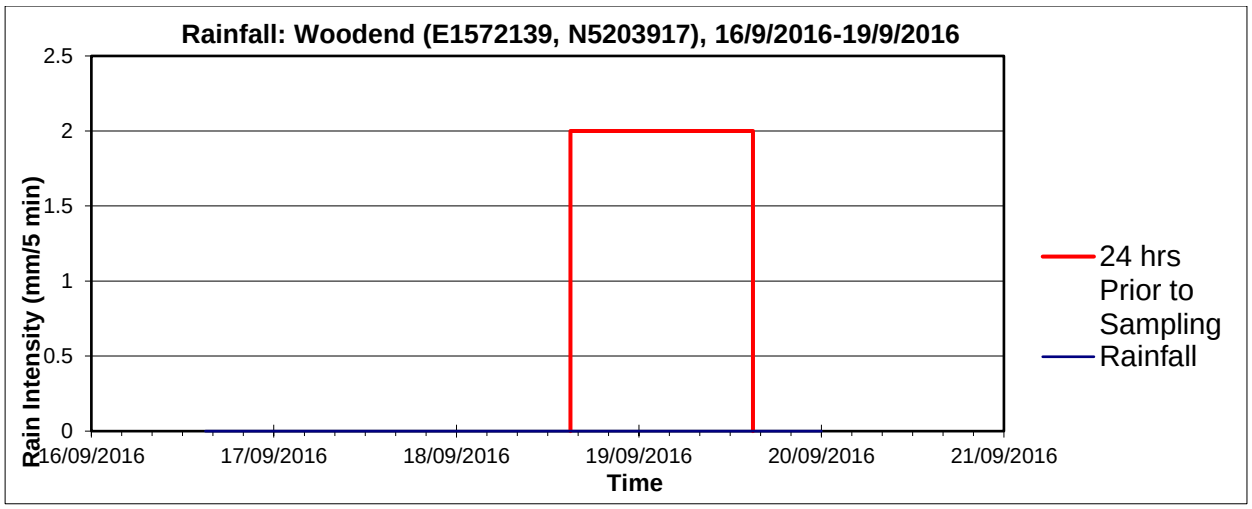
Site: WDTS053
GPS location: X-Coordinate: 1573660; Y-Coordinate: 5204832
Site Description: East side of the SH crossing, north of the roundabout.
Site Photo: nil

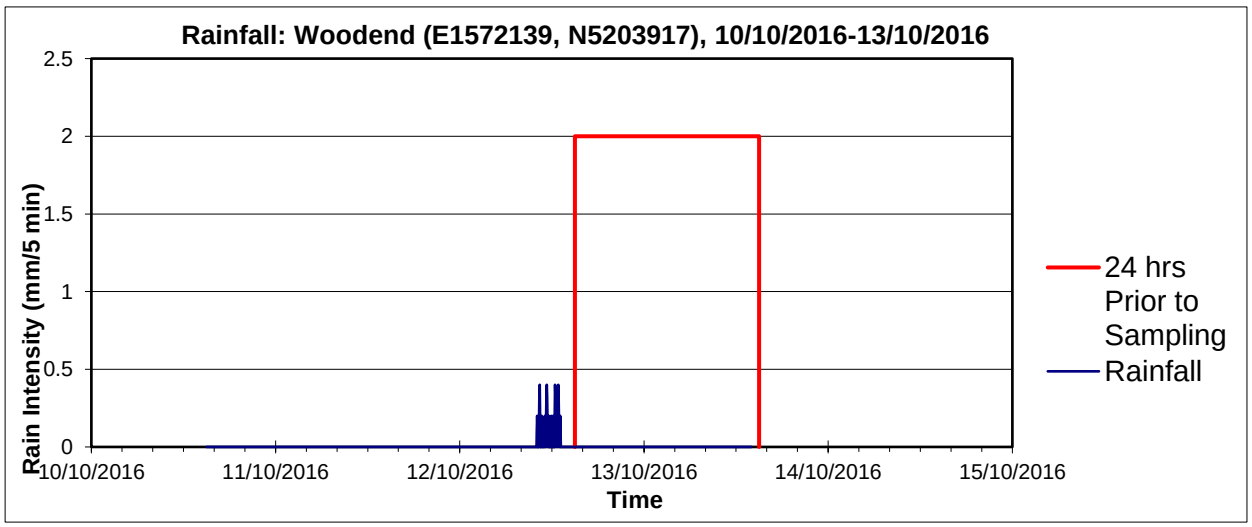
Site: WDWS005
GPS location: X-Coordinate: 1573371; Y-Coordinate: 5204448
Site Description: Waiora Stream crossing, east of the state highway
Site Photo: nil

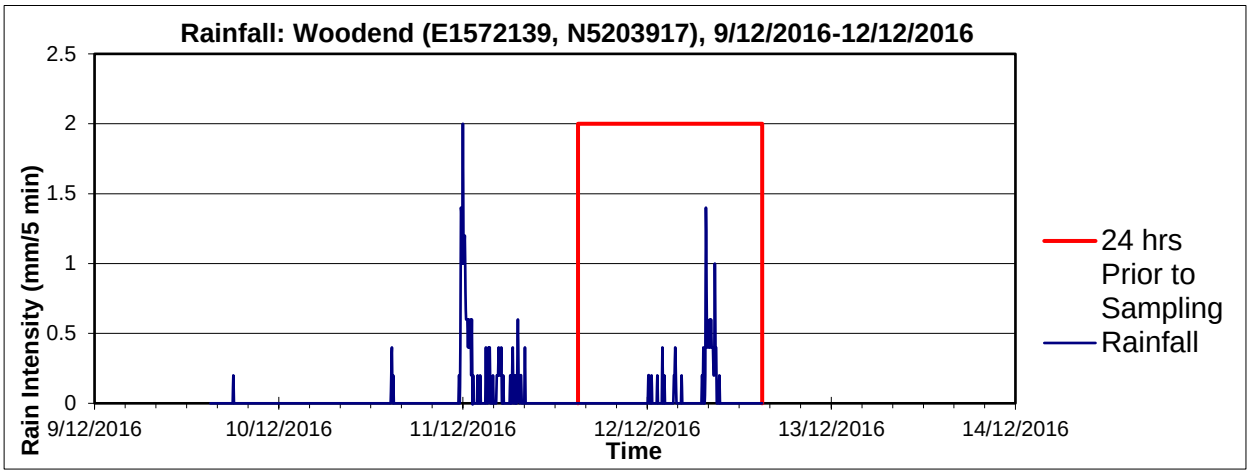
APPENDIX B: RAINFALL EVENT HYDROGRAPHS

Chinnerys Road, Woodend Rainfall data; 24 hour period prior to the rainfall event is shown in red.








Rainfall: Woodend (E1572139, N5203917), 9/12/2016-12/12/2016
Rain Intensity (mm/5 min)
2.5
2
1.5
1
0.5
0
9/12/2016
10/12/2016
11/12/2016
12/12/2016
13/12/2016
14/12/2016
Time
24 hrs Prior to Sampling Rainfall

APPENDIX C: LABORATORY RESULTS SUMMARY

Green and white highlighting marks acceptable values and red highlighting indicates exceedance of the guidelines

August sample round results

August	Guideline Value	WDBD005 - West of Rangiora Woodend Road	WDMD078 - After East Woodend Pond	WDSH024 - Cnr of Woodend Beach and Main North Roads	WDTS075 - West of Chinnerys Road	WDTS066 - Chinnerys Road	WDTS053 - East of Main North Road	WDWS005 - East of SH1
Total Suspended Solids (g/m^3)	50	7	<3	SAMPLE SITE DRY	<3	<3	<3	<3
Dissolved Copper (g/m^3)	0.0018	0.0018	0.001		<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Zinc (g/m^3)	0.015	0.133	0.0057		<0.0010	<0.0010	<0.0010	<0.0010
Dissolve Lead (g/m^3)	0.00056	0.00059	0.00022		<0.00010	<0.00010	<0.00010	<0.00010
Total Nitrogen (g/m^3)	0.614	0.72	0.28		1.21	0.19	1.13	0.61
Total Ammoniacal-N (g/m^3)	0.0018	0.27	<0.010		<0.010	<0.010	<0.010	<0.010
Nitrate-N and Nitrite-N (g/m^3)	0.015	0.144	0.022		1.07	<0.002	0.98	0.39
Total Kjeldahl Nitrogen (g/m^3)	0.17	0.58	0.26		0.14	0.19	0.15	0.22
Dissolved Inorganic Nitrogen (g/m^3)	1.5	0.414	0.022		1.07		0.98	0.39
Dissolved Reactive Phosphorus (g/m^3)	0.016							
Total Phosphorus (g/m^3)	0.033	0.084	0.055		0.014	0.023	0.013	0.026
E. Coli (cfu/100mL)	550	290	85		260	5	300	100
C7-C9# (g/m^3)	-		<0.10		<0.10	<0.10	<0.10	<0.10
C10-C14# (g/m^3)	-		<0.2		<0.2	<0.2	<0.2	<0.2
C15-C36# (g/m3)	-		<0.4		<0.4	<0.4	<0.4	<0.4
Total Hydrocarbons (g/m^3)	-		<0.7		<0.7	<0.7	<0.7	<0.7
DO (mg/L)	5	9.25	11.96		10.4	8.09	12	12.5
pH	8.5	7.18	7.19		7.45	7.08	7.3	7.17
Temperature (°C)	20	10.1	8.7		11.6	9.8	10.3	8.6
Conductivity (µS/cm)	500	129.8	179.3		144	154	125.7	136

September sample round results

September	Guideline Value	WDBD005 - West of Rangiora Woodend Road	WDMD078 - After East Woodend Pond	WDSH024 - Cnr of Woodend Beach and Main North Roads	WDTS075 -West of Chinnerys Road	WDTS066 - Chinnerys Road	WDTS053 - East of Main North Road	WDWS005 - East of SH1
Total Suspended Solids (g/m^3)	50	NO FLOW - STAGNANT WATER. NOT SAMPLED	<3	SAMPLE SITE DRY	<3	<3	<3	LAB TEST RESULTS NOT RETURNED
Dissolved Copper (g/m^3)	0.0018		<0.0005		<0.0005	<0.0005	<0.0005	
Dissolved Zinc (g/m^3)	0.015		0.0076		<0.0010	0.001	<0.0010	
Dissolve Lead (g/m^3)	0.00056		<0.00010		<0.00010	<0.00010	<0.00010	
Total Nitrogen (g/m^3)	0.614		0.25		0.86	0.17	0.7	
Total Ammoniacal-N (g/m^3)	0.0018		<0.010		<0.010	<0.010	<0.010	
Nitrate-N and Nitrite-N (g/m^3)	0.015		<0.002		0.72	<0.002	0.59	
Total Kjeldahl Nitrogen (g/m^3)	0.17		0.25		0.14	0.17	0.11	
Dissolved Inorganic Nitrogen (g/m^3)	1.5		0		0.72		0.59	
Dissolved Reactive Phosphorus (g/m^3)	0.016		0.014		0.008	0.006	0.009	
Total Phosphorus (g/m^3)	0.033		0.022		0.01	0.019	0.013	
E. Coli (cfu/100mL)	550		4		260	5	230	
C7-C9# (g/m^3)	-		<0.10		<0.10	<0.10	<0.10	
C10-C14# (g/m^3)	-		<0.2		<0.2	<0.2	<0.2	
C15-C36# (g/m3)	-		<0.4		<0.4	<0.4	<0.4	
Total Hydrocarbons (g/m^3)	-		<0.7		<0.7	<0.7	<0.7	
DO (mg/L)	5		9.57		8.66	5.76	9.86	14.26
pH	8.5		8.04		8.11	7.29	7.75	8.28
Temperature (°C)	20		13.9		13.4	11.9	13.6	13.5
Conductivity (µS/cm)	500		158.2		99.9	117.8	92	98.9

October sample round results

October	Guideline Value	WDBD005 - West of Rangiora Woodend Road	WDMD078 - After East Woodend Pond	WDSH024 - Cnr of Woodend Beach and Main North Roads	WDTS075 - West of Chinnerys Road	WDTS066 - Chinnerys Road	WDTS053 - East of Main North Road	WDWS005 - East of SH1
Total Suspended Solids (g/m^3)	50	<3	<3	SAMPLE SITE DRY	<3	4	<3	9
Dissolved Copper (g/m^3)	0.0018	<0.0005	0.0007		<0.0005	<0.0005	0.001	<0.0005
Dissolved Zinc (g/m^3)	0.015	0.0051	0.0085		<0.0010	0.0014	<0.0024	<0.0010
Dissolve Lead (g/m^3)	0.00056	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010
Total Nitrogen (g/m^3)	0.614	0.47	0.22		0.72	0.23	0.57	0.41
Total Ammoniacal-N (g/m^3)	0.0018	0.33	<0.010		<0.010	<0.010	<0.010	<0.010
Nitrate-N and Nitrite-N (g/m^3)	0.015	0.08	<0.002		0.6	<0.002	0.48	0.042
Total Kjeldahl Nitrogen (g/m^3)	0.17	0.39	0.21		0.11	0.23	<0.10	0.37
Dissolved Inorganic Nitrogen (g/m^3)	1.5	0.41			0.6		0.48	0.042
Dissolved Reactive Phosphorus (g/m^3)	0.016	0.025	0.017		0.009	0.013	0.013	0.024
Total Phosphorus (g/m^3)	0.033	0.068	0.023		0.008	0.034	0.014	0.027
E. Coli (cfu/100mL)	550	6	39		320	900	90	200
C7-C9# (g/m^3)	-	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10
C10-C14# (g/m^3)	-	<0.2	<0.2		<0.2	<0.2	<0.2	<0.2
C15-C36# (g/m3)	-	<0.4	<0.4		<0.4	<0.4	<0.4	<0.4
Total Hydrocarbons (g/m^3)	-	<0.7	<0.7		<0.7	<0.7	<0.7	<0.7
DO (mg/L)	5	8.1	8.11		9.09	6.74	11.48	14.01
pH	8.5	7.25	7.37		7.01	6.82	7.37	7.68
Temperature (°C)	20	14.2	16		14.9	13.1	14.7	15.2
Conductivity (µS/cm)	500	199.6	164.8		117.9	155.1	116.3	124.5

December sample round results

December	Guideline Value	WDBD005 - West of Rangiora Woodend Road	WDMD078 - After East Woodend Pond	WDSH024 - Cnr of Woodend Beach and Main North Roads	WDTS075 - West of Chinnerys Road	WDTS066 - Chinnerys Road	WDTS053 - East of Main North Road	WDWS005 - East of SH1
Total Suspended Solids (g/m^3)	50	<3	75	82	<3	<3	<3	5
Dissolved Copper (g/m^3)	0.0018	<0.0005	0.0013	0.0035	<0.0005	<0.0005	<0.0005	<0.0005
Dissolved Zinc (g/m^3)	0.015	0.0124	0.0097	0.045	>0.0010	0.0018	<0.0010	<0.0010
Dissolve Lead (g/m^3)	0.00056	<0.00010	0.00014	0.00065	<0.00010	<0.00010	<0.00010	<0.00010
Total Nitrogen (g/m^3)	0.614	0.52	0.43	2	0.89	0.17	0.64	0.36
Total Ammoniacal-N (g/m^3)	0.0018	0.23	<0.010	0.021	<0.010	<0.010	<0.010	0.016
Nitrate-N and Nitrite-N (g/m^3)	0.015	0.16	0.044	0.25	0.7	<0.002	0.49	0.016
Total Kjeldahl Nitrogen (g/m^3)	0.17	0.36	0.38	1.78	0.19	0.17	0.15	0.35
Dissolved Inorganic Nitrogen (g/m^3)	1.5	0.39	0.044	0.271	0.7		0.49	0.032
Dissolved Reactive Phosphorus (g/m^3)	0.016	0.081	0.148	0.22	0.013	0.038	0.01	0.028
Total Phosphorus (g/m^3)	0.033	0.081	0.148	0.37	0.013	0.052	0.014	0.056
E. Coli (cfu/100mL)	550	200	2700	12000	2400	600	600	2300
C7-C9# (g/m^3)	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
C10-C14# (g/m^3)	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
C15-C36# (g/m3)	-	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Total Hydrocarbons (g/m^3)	-	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
DO (mg/L)	5	7.42	5.44	5.04	6.56	4.42	7.41	6.15
pH	8.5	7.43	7.19		7.45	7.08	7.3	7.17
Temperature (^oC)	20	10.1	15.9	16.6	14.9	17.2	14.1	15.8
Conductivity (µS/cm)	500	129.8	26.1	54.1	93.5	109.7	85.3	105.4

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Kaiapoi Stormwater Network Consent:

Stormwater Quality Monitoring Baseline Programme

Prepared by the Project Delivery Unit
August 2019

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1. EXECUTIVE SUMMARY

1.1. INTRODUCTION

The Kaiapoi Stormwater Network Discharge Consent, the third of such in the Waimakariri District (following Rangiora and Woodend), will be prepared in conjunction with an Interim stormwater management plan (SMP) and consent application. This requires the Waimakariri District Council (WDC) to produce a stormwater monitoring programme. This monitoring programme focuses on the urban stormwater discharge impact on the waterways, as opposed to general stream health.

The focus of this report is on stormwater quality entering and within the Kaiapoi urban area.

ECan requested that the WDC undertakes a baseline sampling programme for each town before defining the parameters of the monitoring programme. This will demonstrate to all parties the source of the waterway contaminants and to gauge the current health of Kaiapoi's waterways. The purpose of this baseline report is to present the findings from this baseline sampling programme and recommend parameters that should be carried forward to the ongoing stormwater monitoring programme.

Four sample rounds have been completed, in both wet and dry conditions, at twelve sites spread over the McIntosh Drain, Cam River, Kaiapoi River, Silver Stream, Kaikanui Stream and Courtenay Stream. The results from each of these sampling rounds has been summarised along with suggested potential sources of each contaminant.

1.2. BACKGROUND

The stormwater monitoring programme will be designed to identify potential areas of urban stormwater impact on the Kaiapoi receiving waters. The trends formed from the monitoring programme analysis can be used to direct stormwater treatment activities, within the Kaiapoi urban limits.

The Kaiapoi stormwater monitoring programme will be modelled off the Rangiora Stormwater Monitoring Programme, with some modifications for the Kaiapoi contaminants, informed by this investigation. Generally speaking the urban impact would be measured by monitoring urban contaminants through discharge point inspections and selected discharge point testing, receiving surface water testing, stormwater basin testing and stream sediment surveys. All these components will form part of the Kaiapoi stormwater network discharge consent, with consent management objectives seeking to address any exceeded values.

The stream health monitoring will be included within the stormwater network discharge consent, however the parameters will not have consent management objectives associated with them, i.e. this information will be utilised for other Council projects, such as stream enhancement programmes. These additional parameters are not considered to be primarily influenced by urban stormwater discharge.

This investigation looks at water quality samples, which will only affect the urban impact and stream health sections for the Kaiapoi monitoring programme.

1.3. METHODOLOGY

Four water sampling rounds were undertaken by the WDC Water Unit and analysed by the WDC Project Delivery Unit. The sampling occurred approximately monthly from August to December 2016.

The samples were collected using best practice methods and delivered directly to the laboratory after collection. The sample testing was undertaken by Hill Laboratories in Hamilton.

The Kaiapoi waterways were sampled at the following sites:

KASS002	Silver Stream, South side of Island Road
KAKS027	Kaikanui Stream, North side of Neeves Road
KAKS003	Kaikanui Stream, The Oaks Reserve
KACS003	Courtenay Stream, Courtenay Drive Reserve
KASS012	Silver Stream, North side of bridge
KACR001	Cam River, South of Smith Street
KACR022	Cam River, SH1 West side of road
KAMD010	McIntosh Drain, South side of Beach Road
KACS012	Courtenay Stream, On walkway in reserve
KAMD057	McIntosh Drain, South of Fullers Road
KAKR037	Kaiapoi River, South of motorway bridge
KAKR005	Kaiapoi River, Hall Street

The laboratory test included:

- Total suspended solids
- Dissolved copper
- Dissolved lead
- Dissolved zinc
- Total Ammoniacal-N
- Nitrate-N + Nitrite
- Total Kjeldahl Nitrogen (TKN)
- Total Nitrogen
- Dissolved Reactive Phosphorus
- Total phosphorus
- *E. coli*
- Petroleum hydrocarbons C_7-C_9, C_{10}-C_{14}, C_{15}-C_{34}
- Total Petroleum Hydrocarbons.

The portable probe measurements captured were Dissolved Oxygen, pH, Temperature and Conductivity.

1.4. RESULTS SUMMARY

The results concluded that the some of the contaminants are better suited to the urban impact section of the monitoring programme and others to the stream health section. Table 1 summarises the recommended changes to the monitoring programme.

Table 1: Summary of contaminants recommended to be changed in the monitoring programme

Contaminant	Source	Baseline Monitoring Programme Inclusion	Recommended Ongoing Monitoring Programme Section	Reason Section for Change
Total Suspended Solids	Urban	Included	Urban Impact	
Dissolved Copper	Urban	Included	Urban Impact	
Dissolved Lead	Urban	Included	-	Very low concentrations, therefore recommended to remove it from the programme.
Dissolved Zinc	Urban	Included	Urban Impact	
Total Nitrogen (TN)	Rural	Included	-	

Contaminant	Source	Baseline Monitoring Programme Inclusion	Recommended Ongoing Monitoring Programme Section	Reason Section for Change
Dissolved Inorganic Nitrogen (DIN)	Rural & Urban	-	Stream Health	DIN is in the Land and Water Regional Plan (LWRP), therefore it is recommended that we replace TN with DIN
Total Ammoniacal Nitrogen (TAN)	Urban & Rural	Included	Stream Health	
Total Phosphorus	Mainly Urban	Included	-	DRP is in the LWRP therefore it is recommended that TP is replaced with DRP.
Dissolved Reactive Phosphorus (DRP)	Mainly urban	Included	Urban Impact	It appears DRP may be from both rural and urban sources. DRP as a component of wastewater overflows is a known issue for Kaiapoi and is being separately addressed via a wastewater capacity upgrade (refer consent application for details). The inclusion of DRP in the urban impact sampling programme will provide ongoing data that will enable any reduction of overflows entering streams over time to be measured and reported.
E. coli	Urban & Rural	Included	Urban Impact	*E. coli* was found to be from both rural and likely urban sources. It is a contaminant that is monitored as part of the Wastewater Management plan. E.coli as a component of wastewater overflows is a known issue for Kaiapoi and is being separately addressed via a wastewater capacity upgrade (refer consent application for details). The inclusion of E.coli in the urban impact sampling programme will provide ongoing data that will enable any reduction of overflows entering streams over time to be measured and reported.
Total Hydrocarbons	Urban	Included	-	Very low concentrations therefore recommended removing it from the programme. Total Hydrocarbons will remain in the basin sediment monitoring.
Dissolved Oxygen (DO)	-	Included	Stream Health	
pH	-	Included	Urban Impact	Can be used for guideline value adjustment.
Temperature	-	Included	Stream Health	
Electrical Conductivity	-	Included	Stream Health	Lab sample useful for determining salinity of water sample and potential mixing of fresh and salt water.
Hardness	-	-	Urban Impact -occasional	Initial one off sample to establish value for hardness adjustment and then occasional sampling recommended to monitor the character of the water way.
Dissolved Organic Carbon	Mainly Rural	-	Urban Impact - occasional	Initial one off sample to establish value for guideline adjustment and then occasional sampling recommended to monitor the character of the water way.

Total hydrocarbons and lead are recommended to be removed from the programme as they consistently demonstrated levels well below their guideline values.

It is recommended that Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen should be used in the monitoring programme as these are specified in the LWRP. It is also recommended that electrical conductivity (in the form of specific conductance) is captured by the lab for any samples as a backstop to check if there has been any mixing of the waterway water with tidal saline waters.

It was recommended by ECan water quality specialists that the waterway hardness, pH and dissolved organic carbon are measured once or twice to characterise the waterway. This will also enable the WDC to get site specific trigger values for metals. This would be undertaken as part of the future monitoring programme, as the sample sites will not be the same as in this baseline programme.

It was found that a number of the contaminants are sourced rurally and the relevant guidelines are exceeded prior to entering the township. For some of these contaminants there was an increase in concentration through the township. This indicates that the urban area discharges these contaminants also, but in smaller quantities.

There are no known contaminants discharging from springs within Kaiapoi.

This study has demonstrated that the rural areas have a significant impact on the health of the Kaiapoi waterways. It is recommended that ECan undertakes monitoring upstream of the townships as contaminant concentration guidelines are exceeded in some waterways prior to entering the urban limits.

It should be noted that although applied here in this report in the absence of LWRP guidelines, the ANZECC (2000) guidelines do not provide water quality standards in the traditional sense (i.e. fixed standards that should not be exceeded). Rather, ANZECC (2000) states that the uncertainty in the derivation and application of such standards led them to develop trigger values that indicate a potential environmental problem if they are exceeded. Hence, ANZECC (2000) trigger values are not intended to be applied in an absolute fashion. If a trigger value is exceeded, further investigation is required.

1.5. CONCLUSION

The following conclusions were made in this investigation:

- Most of the contaminants tested exceeded the guidelines in at least one of the sample rounds. Many exceedances occurred in the December sampling period which was a first flush rainfall event, and the largest rainfall event captured during the sampling period.

- It was found that generally the majority of contaminants were present in both rural and urban environments, however in some cases the rural area was found to have a larger impact than the urban area and the guideline concentrations were at times exceeded prior to reaching the urban discharge points.

The following factors are recommended for consideration in the ongoing Stormwater Quality Monitoring Programme for Kaiapoi:

- It is recommended that Lead and Total Hydrocarbons are removed from the ‘urban impact’ section of the Stormwater Monitoring Programme, as the results indicate that the concentrations were consistently far below the guidelines.

- It is recommended that Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen should be used in the monitoring programme as these are specified in the LWRP.

- It is recommended that *E. coli* and DRP are monitored regularly in the ongoing programme as there is some evidence to suggest the urban area is a contributing source of these contaminants.

- It is recommended that contaminants such as *E. coli*, phosphorus and nitrogen be investigated further by ECan within the rural catchments. Particularly in the largest wet weather event *E. coli* and phosphorus levels exceeded the LWRP guidelines in the rural zones, upstream of the urban limits. Nitrogen contaminants in the rural catchments were a prevalent issue across all four sampling events. The results show the ANZECC guidelines for DIN - at five of the twelve sites were significantly exceeded in all weather events, specifically in the Silverstream, Upper Kaiapoi River and Courtenay Stream.

- It is recommended that electrical conductivity is measured in future lab samples to indicate the salinity of the captured sample. This lab measurement can then be checked against the portable probe measurement to if there was saline stratification of the sampled layer of the waterbody at the time of sampling.

- It is recommended that dissolved copper and dissolved zinc sampling from selected major network discharge outlets (e.g. major pipes and open drains) is undertaken for several years from the main urban sub-catchments, to determine a baseline within the WDC stormwater network. Once a baseline is determined, improvement targets can be identified and progressed over the remaining term of consent. This baseline study shows that the Schedule 5 LWRP standards are not useful in assessing effects of discharges in tidal waterways or in spring fed rural streams. These strong flowing/ tidal streams, such as the Courtenay Stream, Kaiapoi River or lower Cam River, have significant volumes through Kaiapoi, diluting the main urban contaminants. This study showed the effects of the urban contaminants are only measurable in the shallow low volume streams or open drains.

These conclusions will be used to develop the Kaiapoi Stormwater Monitoring Programme. After discussions with ECan and MKT the Stormwater Monitoring Programme will be updated.

2. INTRODUCTION

Environment Canterbury (ECan) has requested each of the Territorial authorities within the Canterbury region submit Global Stormwater Consents for all major towns in each district. The Kaiapoi Stormwater Discharge Consent, the third of such in the Waimakariri District, will be prepared in conjunction with a stormwater management plan (SMP) and consent application. This requires the Waimakariri District Council (WDC) to produce a stormwater monitoring programme. This monitoring programme focuses on the urban stormwater discharge impact on the waterways, as opposed to general stream health.

During the steering group meeting with Mahaanui Kurataiao Limited (MKT) and ECan, in November 2013, a recommendation was suggested for the WDC to undertake a baseline sampling programme for each town. The purpose of this was to demonstrate to all parties, the source of the waterway contaminants and the current health of the waterways. Following this recommendation, a baseline sampling programme has been undertaken for Kaiapoi, along with the other main towns in the District.

Four sample rounds have been completed, in both wet and dry conditions, at twelve sites spread over the McIntosh Drain, Cam River, Kaiapoi River, Silver Stream, Kaikanui Stream and Courtenay Stream. The results from each of these sampling rounds has been summarised along with suggested potential sources of each contaminant.

The purpose of this report is to present the findings from this baseline sampling programme and recommend the parameters that should be carried forward to the ongoing stormwater monitoring programme.

3. BACKGROUND

The stormwater monitoring programme has been designed to identify potential areas of urban stormwater impact on the Kaiapoi receiving waters. The trends formed from the monitoring programme analysis can be used to direct stormwater treatment activities within the Kaiapoi urban limits.

Following review of the baseline study, the WDC will commit to ongoing sampling of contaminants which are proven to have an urban source, to help develop its water quality mitigations programme which will be implemented from 2025. The main consequences of accepting parameters which are rurally sourced are as follows;

1. Some of the sample parameters would be outside of the stormwater discharge consent scope, as they enter the network primarily from rural sources.
2. The cost of increased sampling; including collection, laboratory tests and results analysis.
3. Responsibility and resources for treating rural source contaminants are transferred to urban ratepayers, reducing the pressure from regulators applied to rural properties to mitigate their own adverse effects, and reducing available funding from urban ratepayers for proven urban contaminants such as copper or zinc.
4. The subsequent implications for other future urban consents within the Waimakariri District.

Therefore it was recommended that a 6 month baseline investigation be undertaken, and results used to assist determining the source of the contaminants and associated consent conditions which will apply to implementing the ongoing monitoring programme.

3.1. MKT AND ECAN INVOLVEMENT WITH THE STORMWATER NETWORK CONSENTS

The WDC worked closely with MKT and ECan to produce the Rangiora stormwater network consent, which forms a template for all of the towns in terms of the proposed management approach. The WDC will be shortly applying to ECan for the Kaiapoi network discharge consent. WDC will be sending the application and monitoring programme to MKT and ECan to provide advice before formally submitting the consent application.

3.2. KAIAPOI AREA

Rural land surrounds Kaiapoi Township. There is a high potential for the waterways within the urban limit to be impacted by rural activities. Within the Kaiapoi urban limits there are six main receiving waters which receive urban stormwater; the McIntosh Drain, Cam River, Kaiapoi River, Silver Stream, Kaikanui Stream and Courtenay Stream. All discharges from the stormwater network ultimately discharge into the Kaiapoi River, sometimes via one its tributaries.

ECan's spring database (Canterbury maps) does not identify any springs feeding directly into local waterways in Kaiapoi's urban area. There are clusters of seven total known springs outside of the urban area approximately 1 km to the west of Kaiapoi's urban boundary. These springs feed into the Kaiapoi River catchment.

The land use zones in Kaiapoi of the Kaiapoi area are presented in Figure 1.

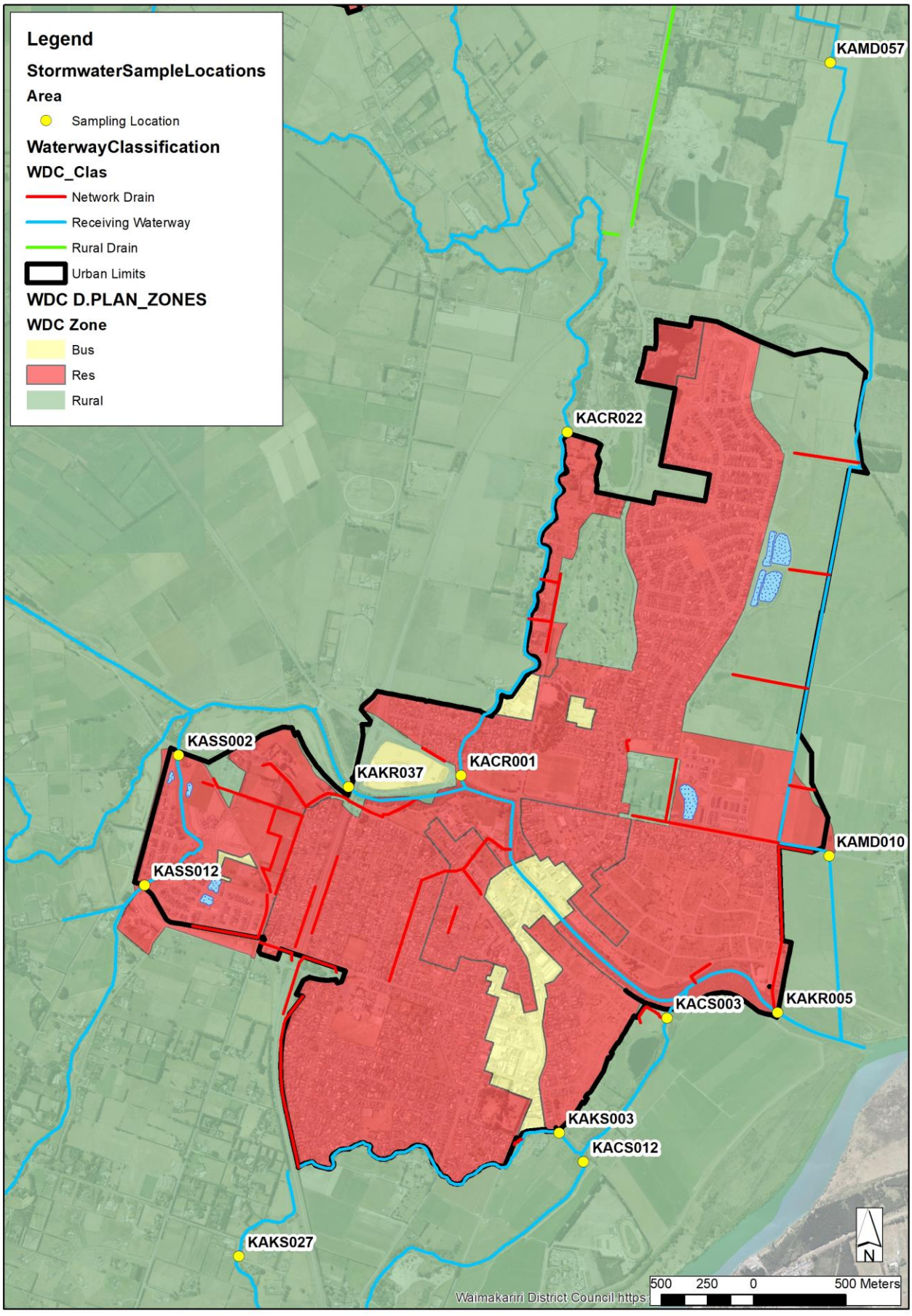


Figure 1: Land use zones in the greater Kaiapoi area

Kaiapoi township is split over four main catchments: the Cam River, Kaiapoi River, Courtenay Stream, and the Waimakariri River catchments. The Cust River and Ohoka Stream join the Kaiapoi River near to the western urban boundary and are outside the scope of this consent. Figure 2 presents the catchments that the Kaiapoi Township discharges to.

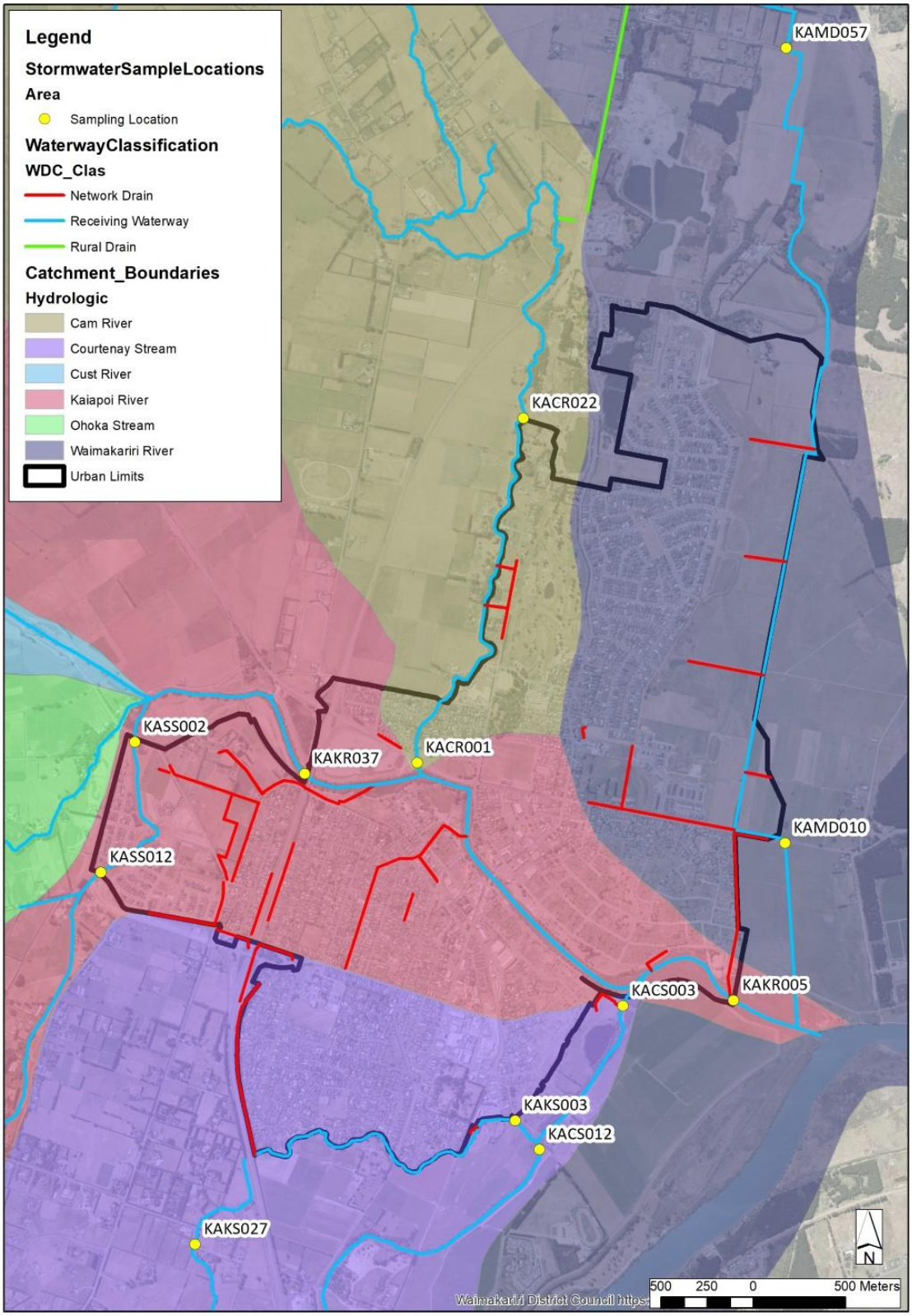


Figure 2: Kaiapoi is split by four main catchments.

Kaiapoi is subdivided into drainage sub-catchments, each having either one major, or multiple separate stormwater discharge points, as illustrated in Figure 3.

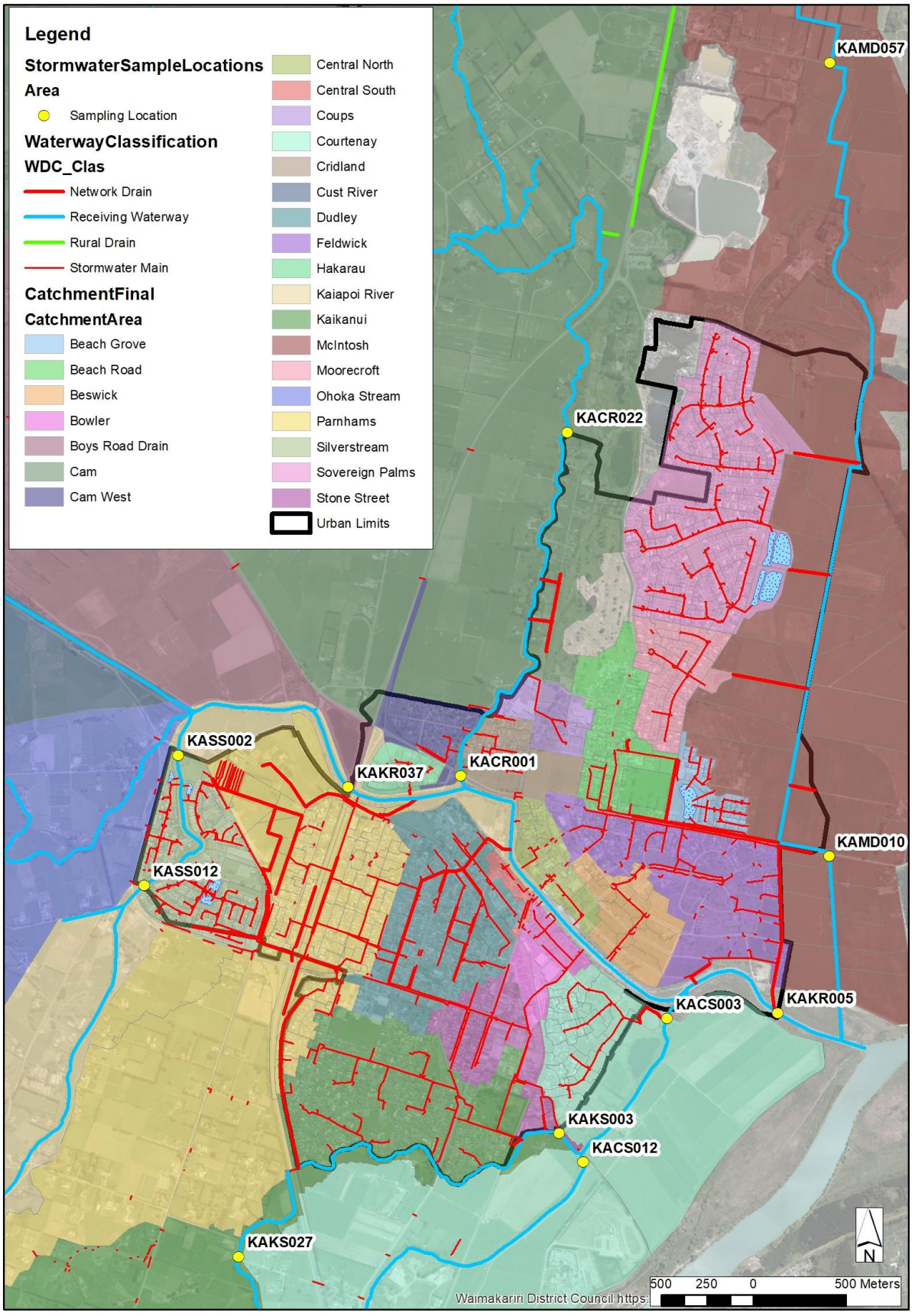


Figure 3: Kaiapoi stormwater sub catchments and sample points

All of Kaiapoi's main catchments (see Figure 2) are composed principally of rural areas. As a result the netflow from Kaiapoi's contributing urban areas is relatively insignificant when compared to the rural contributions. The greater contributions from rural areas and high spring flows and runoff flowing into the Kaiapoi waterways effectively create a significant dilutive effect for Kaiapoi's stormwater discharges into these waterways.

The Cam River is fed by the area to the north of Kaiapoi and a portion of Kaiapoi's northern urban area. So the Cam catchment is mainly rural with a minor urban contribution in the lower reaches. It also receives most of the urban Rangiora stormwater surface discharges.

The Kaiapoi River catchment is fed from the area to the west of Kaiapoi. It includes the Cust and Ohoka catchments. The Kaiapoi River catchment is a significant catchment composed of mainly rural land with reasonably sized but proportionately small contributing area of the west and centre of urban Kaiapoi. The Kaiapoi River catchment includes the Silver Stream which is heavily rurally influenced.

The Courtenay Stream catchment is composed of mostly rural land to the southwest of Kaiapoi and includes the southern portion of Kaiapoi's urban area.

The Waimakariri catchment, as shown in Figure 2, includes all of Kaiapoi's urban area to the east of the catchments previously mentioned. The catchment is composed of the McIntosh Drain catchment, which originates in Woodend, and carries a significant proportion of Woodend's stormwater runoff. Downstream of Woodend the McIntosh Catchment includes a corridor of rural area and eventually enters Kaiapoi picking up the majority of the northern urban area of Kaiapoi's stormwater runoff via the Sovereign Palms, Sovereign Lakes and Moorecroft Catchments, which feed into the drain from the west. In summary the McIntosh Drain originates in the Woodend urban area, travels through and services a reasonably large rural area before flowing through a proportionately small area of urban Kaiapoi.

3.3. RANGIORA STORMWATER MONITORING PROGRAMME

The Rangiora stormwater monitoring programme was developed in 2014 and has been gradually improved upon since. The Kaiapoi stormwater monitoring programme will be modelled off the Rangiora Stormwater Monitoring Programme which was supported by four years of water quality data collection (for Rangiora). Some modifications for the Kaiapoi contaminants have been added, informed by this investigation.

Generally the Rangiora stormwater monitoring programme report specifies the following:

- Sample Locations
- Sample Parameters
- Sample Frequency

Generally speaking the urban impact will be measured by monitoring urban contaminants through visual checks of discharge point inspections, lab testing at selected urban discharge points, receiving surface water testing, stormwater basin testing and stream bed sediment surveys. These tests would form part of the Kaiapoi stormwater network discharge consent, with consent management objectives applied to address any exceeded values.

Other water quality testing and ecological surveys will be undertaken for stream health assessment purposes. Compliance requirements for the consent will not apply. This information will be used to support other Council work programmes.

This investigation looks at water quality samples, which would only affect the urban impact and stream health (surface water testing) sections of this monitoring programme.

3.4. GUIDELINE VALUES

Water quality guidelines are used to identify if the WDC waterways are in a healthy condition. The guidelines have defined Trigger Levels or maximum allowable values (MAVs) for many different waterway contaminants. In some cases such as dissolved oxygen and pH there are also minimum allowable values (denoted Min AV).

The guidelines that are used to analyse our data are sourced from the following resources:

1. Canterbury Land and Water Regional Plan (2012) *(LWRP, Section 16, Schedule 5)*
2. ANZECC Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC, 2000)

The LWRP gives a guideline to the level to which a '*spring fed – plains urban'* catchment should be striving to meet. Although the LWRP will be the main guideline source, the ANZECC guidelines will be used if LWRP does not provide a guideline value for any parameter considered essential to the consent. In these cases the 90 % level of protection (LOP) trigger value has been used. For a number of contaminants the LWRP guideline value is equal to the ANZECC guideline value.

The guidelines that are being compared to the contaminant concentration are specified.

4. METHODOLOGY

The proposed baseline study aimed to confirm whether the common water quality parameters are from primarily rural or urban sources.

Four water sampling rounds were undertaken by the WDC Water Unit and analysed by the WDC Project Delivery Unit. The sampling occurred approximately monthly from August to December 2016.

The samples were collected using best practice methods and delivered directly to the laboratory after collection. The sample testing was undertaken by Hill Laboratories in Hamilton.

4.1. SAMPLE LOCATIONS

To assess both dry weather baseflow (DWF) contaminant concentrations and wet weather flow (WWF) runoff contaminant concentrations, sample sites have been selected to be within the receiving waters.

Twelve sites were sampled for the baseline sampling programme; two in each of the following waterways: Silver Stream (KASS012 and KASS002), Kaiapoi River (KAKR037 and KAKR005), Cam River (KACR022 and KACR001), Courtenay Stream (KACS012 and KACS003) and the McIntosh Drain (KAMD057 and KAMD010). These sites were selected to indicate water quality both upstream and downstream of the urban stormwater discharge locations, and during a range of weather events. It is anticipated that similar sites would be used in the future sampling programme so that the data is comparable in the future.

The proposed sample points were primarily situated at either the upstream edge of the urban limits (or at the stream source location with available road access), and the downstream edge of the urban limits. A couple of sites were positioned within the urban area at or above key confluences to capture quality prior to merging with a separate catchment. The change in concentration of contaminants in the receiving waters as they pass through Kaiapoi will enable the WDC to assess the contaminants contributed by the urban area.

The sample locations are as follows:

Site ID	Site Description
KASS012	Silver Stream, North side of bridge
KASS002	Silver Stream, South side of Island Road

Site ID	Site Description
KAKR037	Kaiapoi River, South of motorway bridge
KACR022	Cam River, SH1 West side of road
KACR001	Cam River, South of Smith Street
KAKS027	Kaikanui Stream, North side of Neeves Road
KAKS003	Kaikanui Stream, The Oaks Reserve
KACS012	Courtenay Stream, On walkway in reserve
KACS003	Courtenay Stream, Courtenay Drive Reserve
KAMD057	McIntosh Drain, South of Fullers Road
KAKR005	Kaiapoi River, Hall Street
KAMD010	McIntosh Drain, South side of Beach Road

Figure 4 presents a map of the baseline sample sites. See Appendix A for more information on the sample locations; including descriptions, GPS locations and photographs.

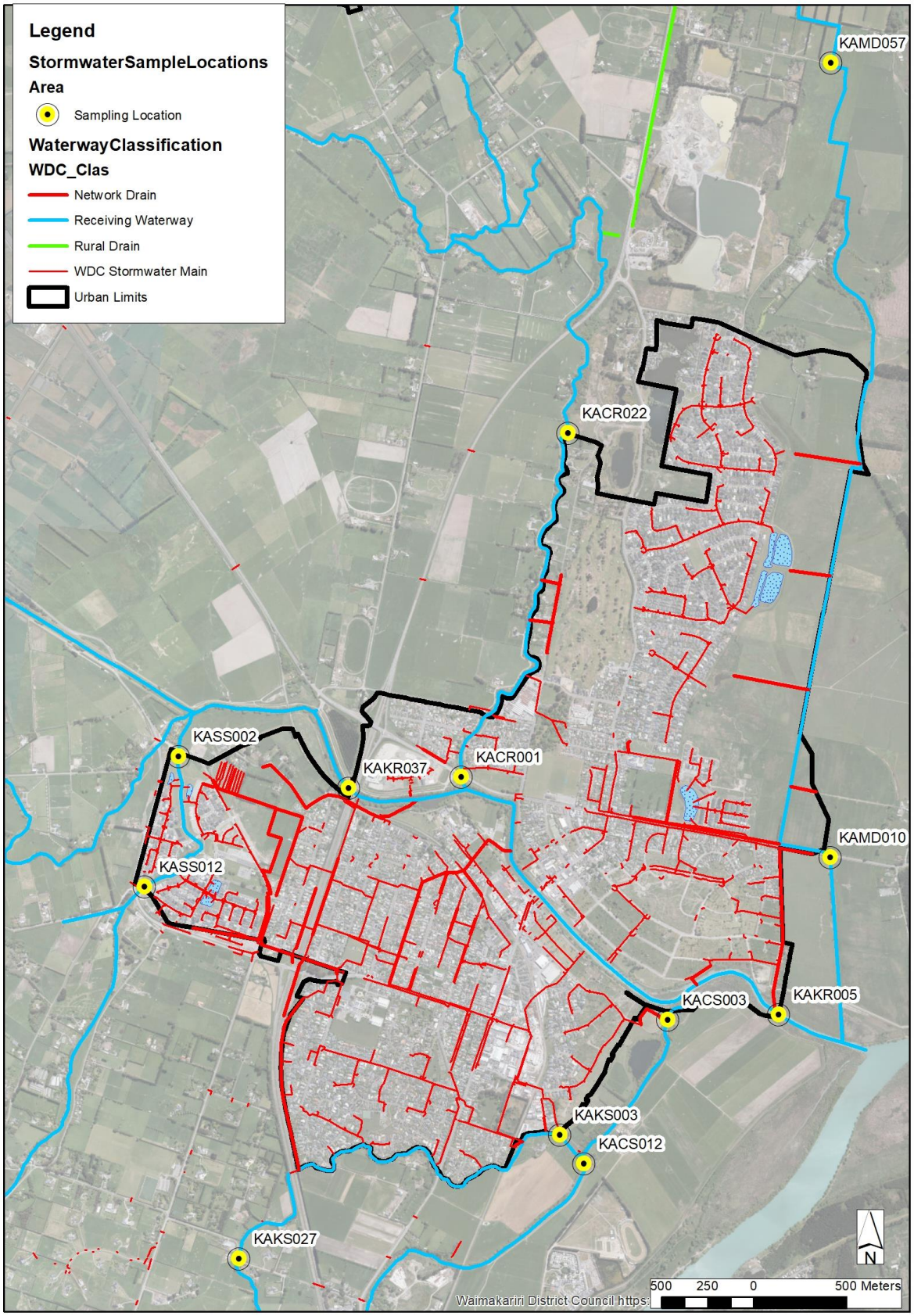


Figure 4: Kaiapoi sample sites used in the Baseline Monitoring Programme.

4.2. SAMPLE PARAMETERS

The water quality parameters that were sampled as part of this baseline study are as follows:

Laboratory tests

- Total suspended solids
- Dissolved copper
- Dissolved lead
- Dissolved zinc
- Total Ammoniacal-N
- Nitrate-N + Nitrite
- Total Kjeldahl Nitrogen (TKN)
- Dissolved Reactive Phosphorus
- Total phosphorus
- *E. coli*
- Total petroleum hydrocarbons

YSI multi-probe portable probe measurements

- Dissolved oxygen
- pH
- Temperature
- Conductivity

4.3. FREQUENCY

The samples were retrieved approximately every month, so that four sample rounds were undertaken. Wet and dry weather days were selected so the source of the contaminants could be separated into spring discharge and/or runoff contaminants.

The following list presents the selected sampling days;

1. August 4th 2016, sampling commenced at 11:00 am
2. September 19th 2016, sampling commenced at 12:00 pm
3. October 13th 2016, sampling commenced at 11:00 am
4. December 12th 2016, sampling commenced at 11:30 am

The plan for sampling was to be in the wet and dry conditions (and ideally across seasons). Weather conditions were not quite right in November, hence this month was missed.

5. RESULTS

5.1. SAMPLING WEATHER CONDITIONS

First flush events give the best measure of runoff contaminants. As first flush events are statistically infrequent, getting a first flush event within the baseline monitoring programme period was predicted to be difficult. Therefore samples were retrieved in dry conditions and wet conditions.

Table 2 presents a summary of the rainfall prior to the water quality sampling; the rainfall data was taken from the WDC Woodend rainfall gauge located at Chinnerys Road 7.2 km to the north of Kaiapoi.

Table 2: The weather conditions on each of the baseline sampling days in 2016

Date	Weather Conditions	Event Description
4th August 2016	Dry weather when sampling, 2 mm of rain in the 24 hours before sampling, 4 mm of rainfall 72 hours prior to the sampling	Minor wet weather event.
19th September 2016	Dry weather while sampling, 0 mm of rain in the 24 hours before sampling, 0 mm rainfall 72 hours prior to the sampling	Dry weather event.
13th October 2016	Dry weather while sampling, 0 mm of rain in the 24 hours before sampling, 4.4 mm rainfall 72 hours prior to the sampling	Dry weather event.
12th December 2016	Dry weather while sampling, 12.4 mm of rain in the 24 hours before the sample, 36.4 mm rainfall 72 hours prior to the sampling	Moderate wet weather event, 2.6 year return period for 1 hour interval. *First flush event.

** First flush conditions are defined as a rainfall event with rainfall no less than 10 mm and no greater than 25 mm, over 24 hours (CCC, waterways wetlands and drainage guide). Antecedent precipitation conditions should be considered, where a first flush storm needs to have a period of at least 72 hours of no measurable precipitation (Otago Regional Council).*

See Appendix B for rainfall hydrographs of the sampled events.

5.2. SAMPLING TIDAL CONDITIONS

Kaiapoi is low lying and is positioned immediately adjacent to the coast. As a result the lower reaches of Kaiapoi's waterways are affected by oceanic tidal movements. This likely means Kaiapoi's waterways will behave quite differently to the waterways in the other urban areas in the district. In addition to backflow of freshwater upstream there is potential for mixing of fresh and sea waters, stratification between fresh and brackish waters, and even bidirectional flow between stratified layers during an incoming (or flood) tide. Table 3 presents the tidal state during each of the sampling periods.

Table 3: The tidal state during each of the baseline sampling periods in 2016.

Date	Sampling Times	Tidal Conditions	Tidal Flow Direction
4th August 2016	11:00 to 14:30	Low tide when sampling commenced, flood tide during sampling.	Incoming
19th September 2016	12:00 to 14:30	Dead low when sampling commenced, flood tide during sampling.	Incoming
13th October 2016	11:00 to 14:00	Half-tide when sampling commenced, sampling occurred over the latter half of the flood tide. Last sample taken shortly before high tide.	Incoming
12th December 2016	11:30 to 14:30	Shortly before half-tide when sampling commenced last sample taken approx. 1 hour before high tide.	Incoming

The tide was rising during each of the sampling periods which means backflows from downstream contaminant sources, and even backflows from larger downstream waterways must to be considered during the assessment of contaminants at each site, particularly at the downstream most sites.

See Appendix C for tidal charts for the Kaiapoi area during the sampled events.

5.3. RESULTS SUMMARY

There were several parameter concentrations that were below detectable limits in the samples given to Hills Laboratory; for simplicity these were recorded as zero in this investigation.

There was flow at the upper McIntosh drain site south of Fullers Road (KAMD057) at only one of the sample rounds during first flush event in December. As a result there were no samples taken from this point during the sampling rounds in August, September and October.

It is also noted that most guidelines specify that the sampling should be undertaken in a first flush event. The sampling round completed in the December event was the closest event to a first flush rainfall event, although there was rainfall recorded in the days leading up to this event.

The following sections of this report look at each of the tested contaminants separately, to discuss the source of the contaminant and proposed changes to the current stormwater monitoring programme.

See Appendix D for a summary of the laboratory results summary for each of the sample rounds.

5.3.1. Total Suspended Solids

Total suspended solids (TSS) include all particles suspended in water which will not pass through a filter. Suspended solids are mainly non-point source pollutants such as soil erosion from agricultural and construction sites.

TSS as measured coming in and going out of Kaiapoi are shown in Figure 5. The LWRP provides a guideline TSS value of 50 mg/L. It is acknowledged that this is a measure at the discharge point, however it is the best known relevant guideline of TSS to compare the results against.

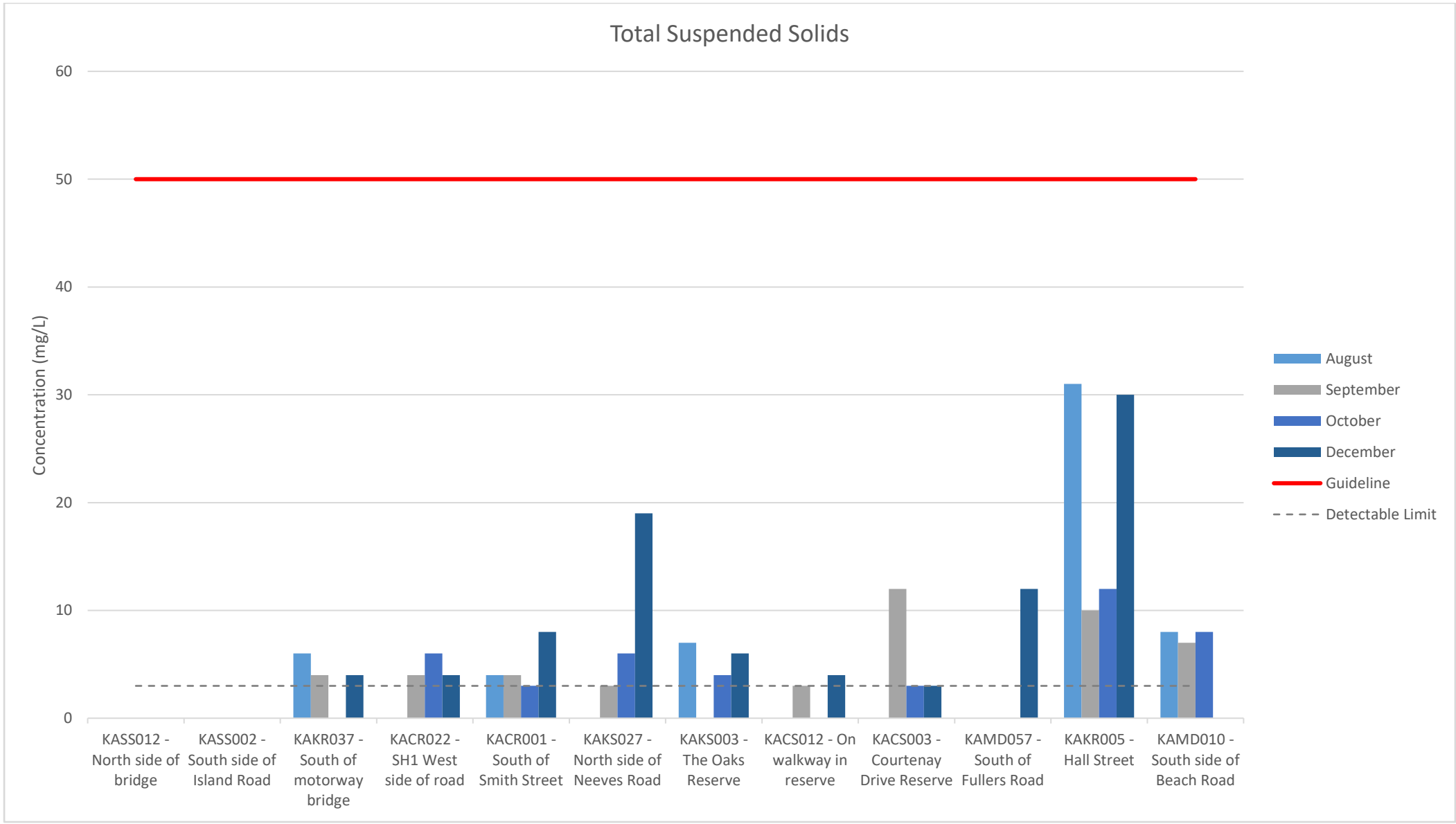


Figure 5: Total suspended solids as measured in the Kaiapoi River

The results demonstrate total suspended solids tend to be relatively low in Kaiapoi's waterways except for the lowest sites on the Kaiapoi River (KAKR005) and the McIntosh Drain (KAMD010). Considering their low elevations and proximity to the river mouth these sites are likely to be tidally influenced and the elevated TSS could be from entrained estuarine sediments.

Cross referencing the most downstream sites shows the lower McIntosh Drain sample consistently exhibited elevated conductivity which suggests brackish water was sampled.

Conversely the elevated TSS levels at site KAKR005 do not have corresponding elevated electrical conductivity levels demonstrating that the sampled water was not brackish at this point. It is possible that sediment laden backflow from the Waimakariri River has caused this spike in TSS in the lower Kaiapoi River and lower McIntosh Drain, however further information would be required to confirm this.

Kaiapoi does not have any exceedances for TSS. The vast majority of sites had consistent detectable but low concentrations and both of the monitored sites in the Silver Stream did not contain detectable levels in any of the four events. The results show total suspended solids tend to be relatively low in Kaiapoi's waterways except for the lower lying reaches of the McIntosh Drain and Kaiapoi River which are known to be tidally influenced.

It is recommended that TSS should continue to be monitored as part of the stormwater network discharge consent as it is a key indicator of the overall quality of a waterway. It is suggested that future monitoring include TSS levels taken from selected major stormwater discharge outlets, as well as a receiving waterway TSS baseline as in 2016.

5.3.2. Dissolved Copper

Primary sources for dissolved copper (Cu) include but are not limited to vehicle brake pad wear, plumbing uses such as copper spouting and soil disturbance from historic horticultural sites.

The 90% LOP trigger value for copper provided in both the LWRP and ANZECC guidelines is 0.0018 mg/L. Dissolved copper levels are shown in Figure 6.

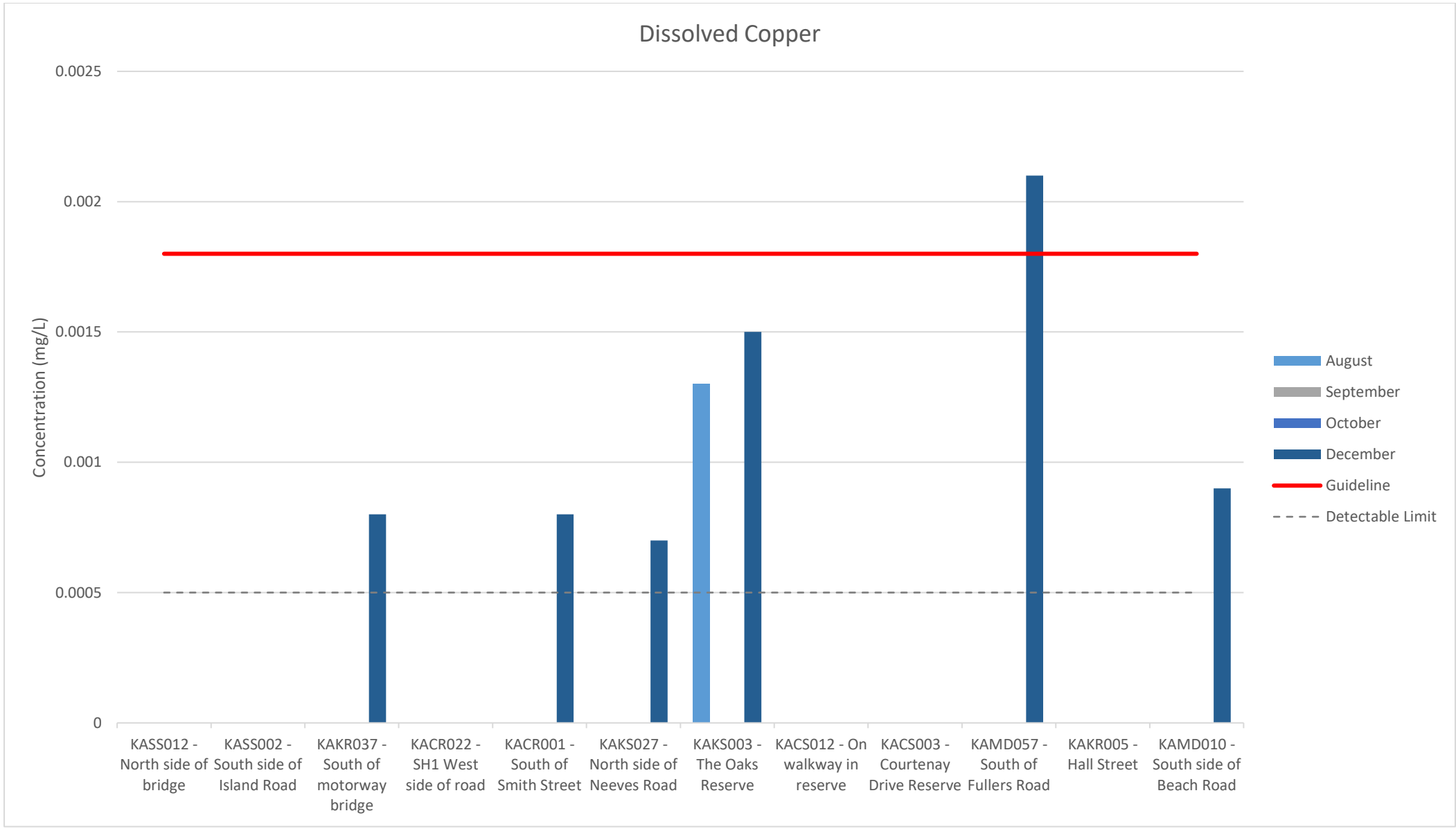


Figure 6: Dissolved copper levels in Kaiapoi waterways.

Copper was only detected at six of the twelve sites and almost exclusively in the first flush December event. The only site to demonstrate elevated levels across multiple events was at the Oaks Reserve site in the lower Kaikanui Stream, (KAKS003) which also showed a detectable level in the minor wet weather event in August. The sites exhibiting elevated levels in the December event tend to be located adjacent to or directly downstream of the highway.

The exception to being located near to the highway is both sites in the McIntosh Drain with the upper site exhibiting the highest level recorded and the only exceedance above the guideline value. The upper McIntosh Drain exceedance is likely to come from State Highway road runoff from Woodend. Also seemingly separate from the highway runoff are the sample sites in the Kaikanui Stream, notably the upper site (KAKS027) which is significantly upstream of the highway.

The results suggest inflows into Kaiapoi from the State Highway on the western side of Kaiapoi and through Woodend are contributing copper to Kaiapoi's waterways. The Silver Stream, upper Cam and Courtenay Stream with their significant spring flows and rural catchments do not have detectable levels of copper. The Oaks Reserve site (KAKS003) in the Kaikanui Stream is the only sample site to show detectable levels outside of the December first flush event. This site is located directly downstream of Kaiapoi's main industrial area and also conveys flows from State Highway 1 which drains to the head of the Kaikanui Stream, and from an older residential area in south Kaiapoi.

The results show that copper is mainly an urban contaminant and it is recommended that dissolved copper is included in the 'urban impact' section of the monitoring programme.

5.3.3. Dissolved Lead

The recorded levels of dissolved lead are shown in Figure 7.

Primary sources of dissolved lead (Pb) include but are not limited to road runoff (from automobile parts), and degrading construction components such as paint and roof flashings. The 90% trigger level guideline provided by ANZECC for dissolved lead is 5.6 µg/L.

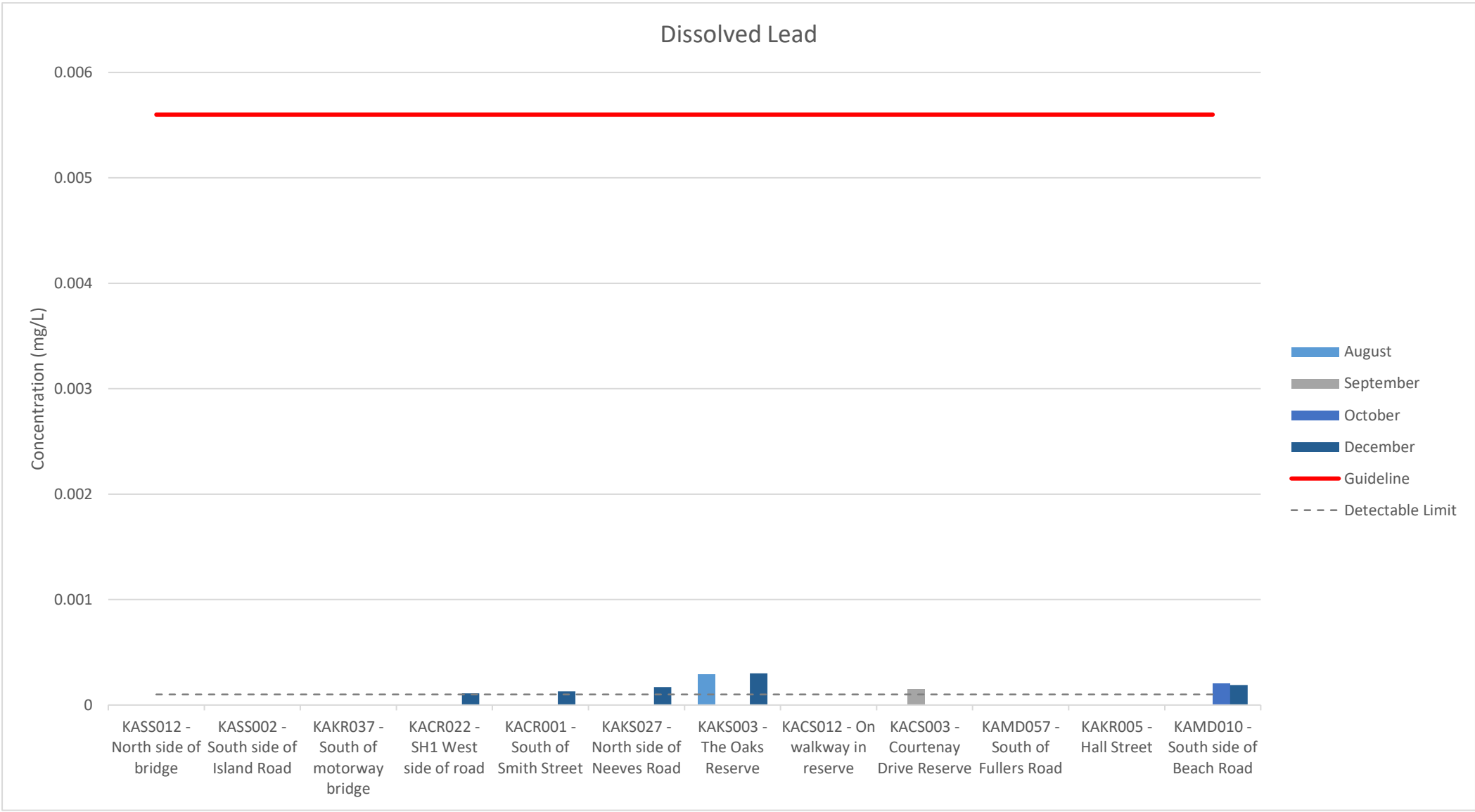


Figure 7: Dissolved lead levels recorded in Kaiapoi's waterways.

Dissolved lead was detected in eight samples spread over six samples sites. Similar to the dissolved copper results, the highest recorded results were from the lower McIntosh Drain site (KAMD010) and the Oaks Reserve site on the lower Kaikanui Stream (KAKS003). Lead was not detected in any of the predominantly rural fed waterways.

With one exception there was no lead present in any samples taken during the two sampled dry weather events, it was mainly detected during the wet weather events in August and December 2016. Lead was detected across all of the four events but the majority of the samples showing traces of dissolved lead were in the first flush event in December.

The results show that lead is predominantly an urban contaminant. Recorded levels of lead are barely detectable and hence far below the guideline values level in any of Kaiapoi's samples. This is consistent with findings in Rangiora and Woodend.

As the sampling result show lead is an insignificant contaminant in Kaiapoi's urban area it is recommended that dissolved lead is removed from the urban impact monitoring programme of the guideline.

5.3.4. Dissolved Zinc

Sources of dissolved zinc (Zn) are commonly from anti-corrosion agents used in the galvanisation of iron and steel. It is found in metal roofs, metal fences, lampposts, car bodies, anticorrosion paint used on exterior steel, in rubber vehicle tyres to protect against UV degradation, and some herbicides.

The LWRP and ANZECC provide a 90% guideline value of 15µg/L of dissolved zinc.

The recorded levels of zinc are presented in Figure 8.

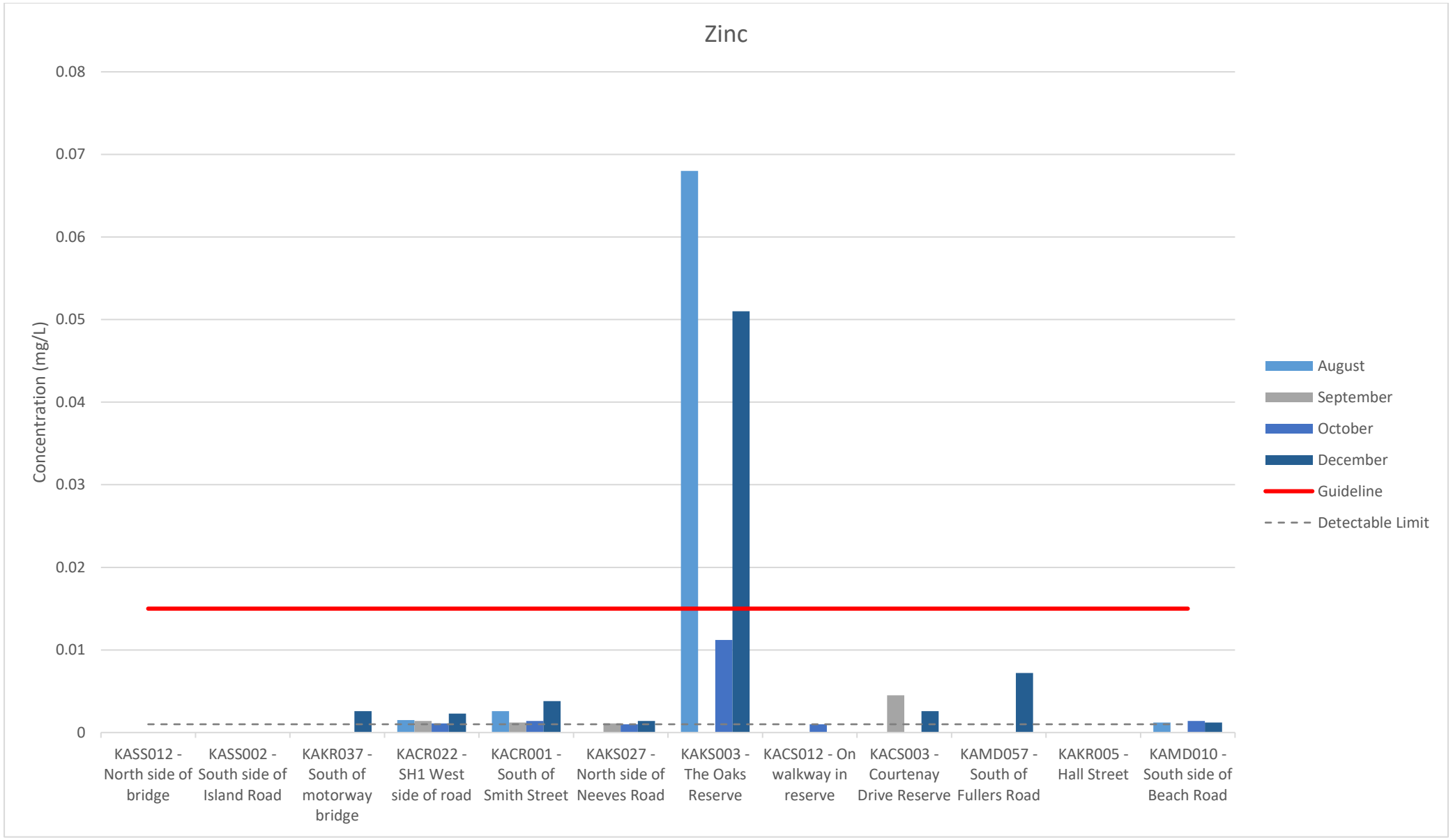


Figure 8: Dissolved concentrations of zinc in the samples captured at Kaiapoi

Dissolved zinc is present in the majority of the urban fed waterways however at low concentrations at the vast majority of sites. The notable exception to this is at the lower Kaikanui Stream Oaks Reserve site (KAKS003) which significantly exceeded the guideline during both the August and December wet weather events and demonstrated a high level in October (note this same site also demonstrated elevated levels of copper and lead).

This site measures discharges from the Kaiapoi Stone Street/Ohoka Road main industrial area, and also from a large older residential catchment in southern Kaiapoi. Either industrial activities or older residential roofing could be the cause of the zinc exceedance recorded at this site. Another possible source is road runoff from State Highway 1 which discharges into the head of the Kaikanui Stream via a roadside drain. Actual zinc sources will need to be further investigated. Additional monitoring sites on the Kaikanui Stream are proposed to be added to the monitoring programme to try to isolate the catchment source of the zinc.

The upper and lower McIntosh drain both show detectable levels of zinc with the upper site (KAMD057) demonstrating the second highest reading after the Oaks reserve site. The zinc in the McIntosh Drain is likely to have a Woodend based source.

The results show that zinc is mainly an urban contaminant and it is recommended that dissolved zinc is included in the ‘urban impact’ section of the monitoring programme.

5.3.5. Nitrogen

Nitrogen primary sources include but are not limited to fertilizers and sewerage. It is noted that Total Nitrogen is the sum of TKN + Nitrate-N + Nitrite-N and DIN is the sum of Total Ammoniacal-N + Nitrate-N + Nitrite-N.

Figure 9 presents the Total Nitrogen (TN) and Dissolved Inorganic Nitrogen (DIN) concentrations from laboratory results from waterways in the Kaiapoi area, respectively. The ANZECC guideline for total nitrogen is 0.614 mg/L. The DIN values presented in Figure 10 have been deduced from the laboratory results. The LWRP guideline of 1.5 mg/L has been applied for DIN (the bioavailable portion). It is worth noting that the LWRP does not specify a guideline value for TN. The guideline value applied from the ANZECC guidelines for TN is more stringent as it is actually less than the LWRP guideline value for DIN.

Figure 11 presents the total ammoniacal nitrogen (TAN), a component of DIN, which includes the forms of nitrogen: ammonia and ammonium. Ammoniacal nitrogen is commonly sourced from animal waste (from farmed animals and human). Total ammoniacal nitrogen provides an indication of relatively ‘fresh’ nitrogen contamination that has not yet been nitrified by microorganisms into nitrates. The ANZECC guideline for total ammoniacal nitrogen is modified based on the pH of the sample. pH values ranged from 6.6 to 8.0 in the collected results, giving a range of 2380 to 900 mg/L as total ammonia-N. In the interests of simplicity the average pH across the entire sample set (pH 7.3) was used in the adjustment method provided in ANZECC Guidelines to give a guideline value of 1.88 mg/L. It is noted this exceeds both the TN and DIN guideline values.

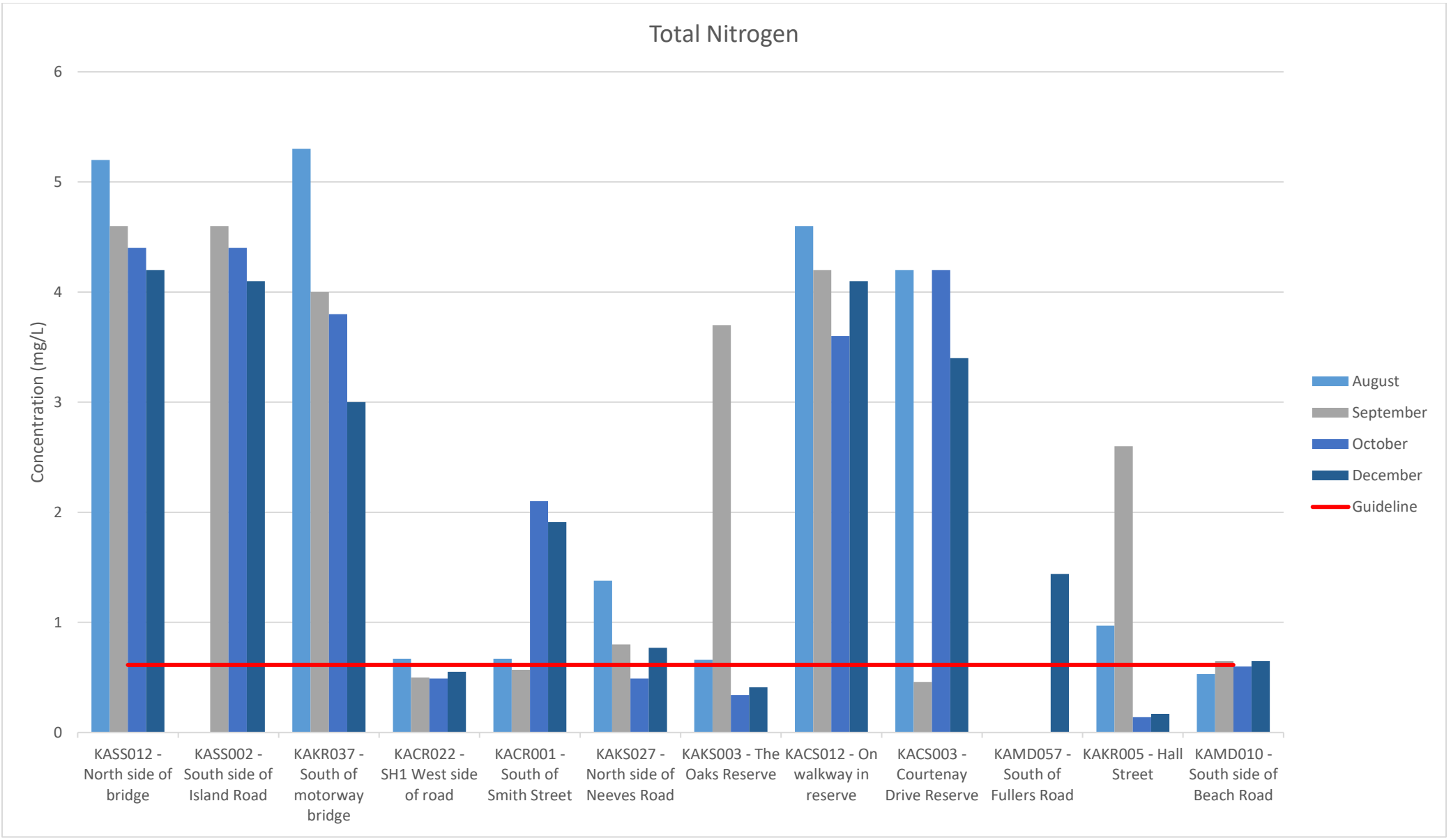


Figure 9: Recorded levels of Total Nitrogen in the Kaiapoi area.

The guideline for TN, 0.614 mg/l, is exceeded at the vast majority of the sites. This is especially noticeable in the predominantly rurally sourced waterways such as the Silver Stream (KASS012, KASS002), the Kaiapoi River (KAKR037) and Courtenay Stream (KACS012 KACS003).

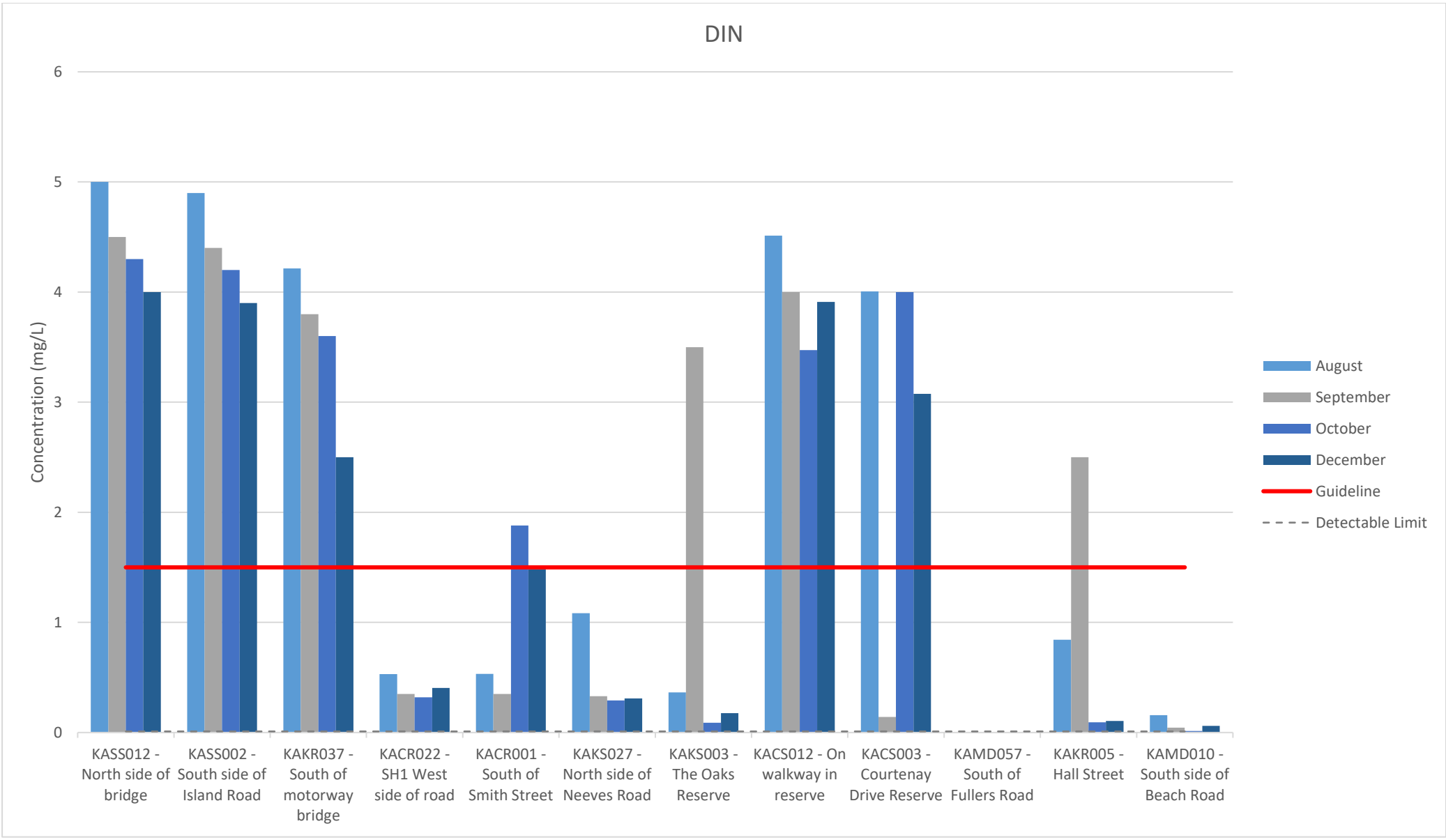


Figure 10: Recorded levels of dissolved inorganic nitrogen for the Kaiapoi area.

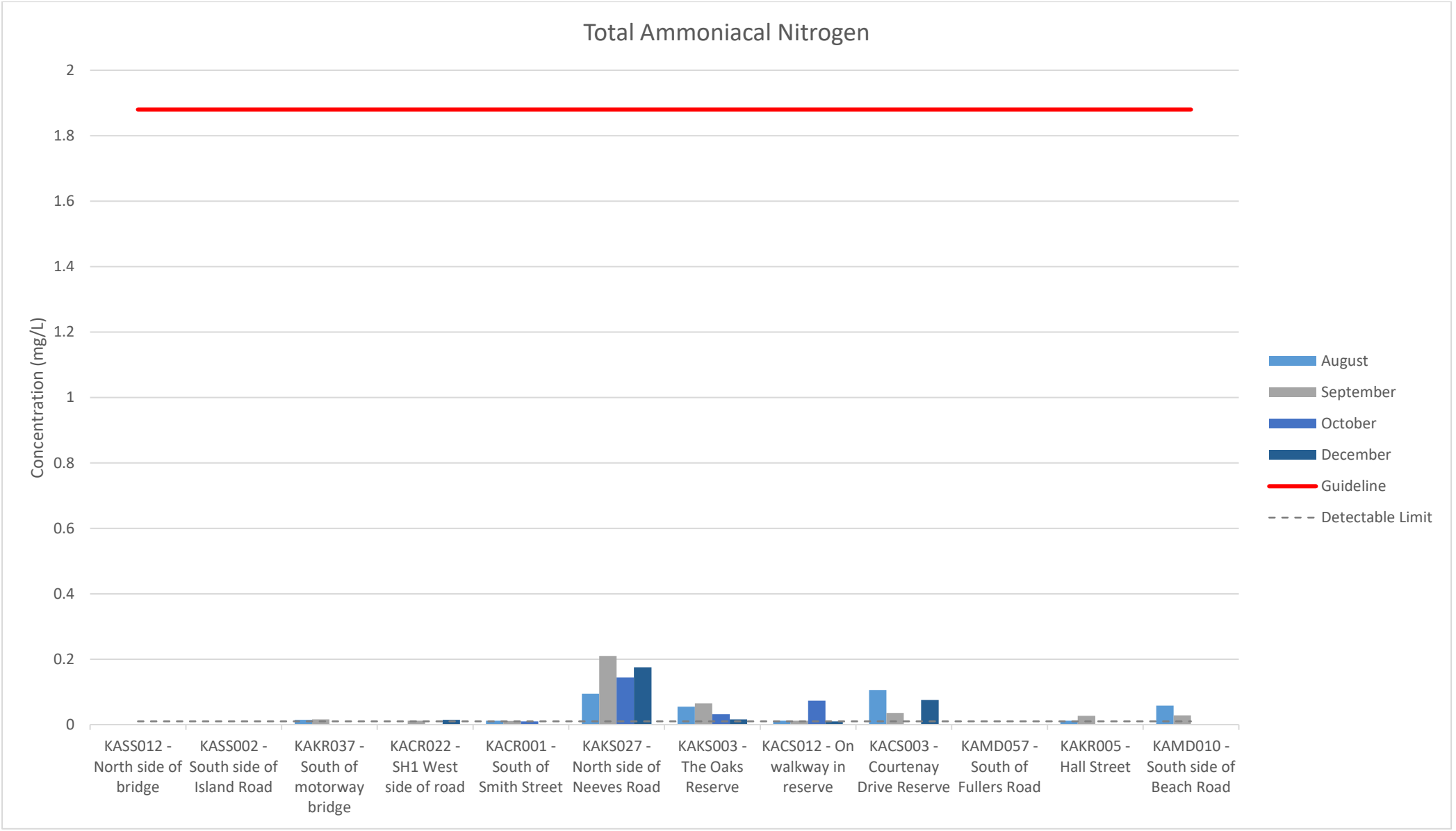


Figure 11: Recorded levels of total ammoniacal nitrogen for the Kaiapoi area.

DIN similarly to TN shows elevated levels in the rural sourced waterways such as Silver Stream, Kaiapoi River and Courtenay Stream. Generally urban sources do not appear to contribute to elevating nitrogen levels and in some waterways (such as the Silver Stream and, excepting the September results, in the Kaikanui Stream) there is a noticeable decrease in nitrogen levels at the downstream urban sample site.

The Cam River is an exception as it demonstrated low levels at the upper sampling point (KACR022) and in two of the four sampling events demonstrated significantly elevated levels at the downstream site (KACR001). However this may be caused by the incoming tide affecting nitrogen levels at the lower Cam site. The nitrogen at this site may represent backflow from another source, such as from the lower Kaiapoi River or from the Courtenay Stream, discharging upstream on the incoming tide.

The increase in TN and DIN levels observed in the Cam River could also be from runoff from the Kaiapoi Golf Course on the east side of the Cam, the neighbouring farm runoff to the west of this stretch of the Cam River, or possibly from avian sources in or around the Kaiapoi Lakes. *E. coli* levels at the two Cam River sites (consistent in October and high in December, similar to other sites) do not follow the same distribution trend suggesting the source of the nitrogen contamination is not derived from avian faecal matter.

The Courtenay River, Silver Stream and Kaiapoi River all demonstrate consistent exceedances of the guideline for TN, with the majority of these samples at these sites demonstrating levels more than double the guideline values. The results suggest the TN in these rivers is rurally sourced.

Kaiapoi has no clear predominantly urban sourced waterways. The upper McIntosh Drain site (KAMD057) is comprised of a combination of urban runoff from Woodend, rural runoff from the east of Woodend, runoff from rural land between Woodend and Kaiapoi, and resurgent groundwater discharging from tile drains from Woodend. The McIntosh Drain sampling demonstrates the overall lowest DIN levels of all sites sampled.

TAN indicates the presence of relatively ‘fresh’ nitrogen contamination. The levels observed show a markedly different distribution to that illustrated in the TN and DIN levels (both of which showed relatively consistent contaminant trends for each site). Generally the concentrations of TAN are well below the guideline values. The upper Kaikanui Stream site (KAKS027) generally demonstrated the highest levels. Further downstream The Oaks Reserve sample site (KAKS003) in the lower Kaikanui Stream demonstrated elevated TAN levels noticeably above background levels seen in other waterways. The Courtenay Stream and lower McIntosh Drain also demonstrated slightly increased levels. The distribution of TAN suggests that there could be localised sources of this nitrogen contaminant seeping into the waterways that are not from the same sources as the TN and DIN. It is unclear if this is from rural or urban sources.

It is recommended that TN is replaced with DIN, as this is the value provided in the LWRP, in the stream health monitoring programme. It is recommended this contaminant stays in the stream health monitoring section of the programme as the results show that concentrations are more closely linked to rural runoff than urban stormwater.

Although TAN levels are well below the guideline concentration it is recommended it is considered for inclusion in the stormwater programme as it provides information on the proximity of any sources of nitrogen contamination near the urban network.

5.3.6. Phosphorus

Primary sources of phosphorus include but are not limited to fertilisers (both agricultural and residential), sewerage and some detergents. Phosphorus has a tendency to bind to soil particles and can be transported into waterways with sediment runoff.

Figure 12 and Figure 13 present the recorded levels of Total Phosphorus (TP) and Dissolved Reactive Phosphorus (DRP) respectively. Similar to nitrogen the LWRP does not provide a guideline value for TP so the 90% ANZECC guideline value of 0.033 mg/L has been used. The LWRP provides a guideline value of 0.016 mg/L for DRP.

It should be noted that DRP results were not provided by the lab for the samples captured during the August event. DRP levels were recorded for the other three events.

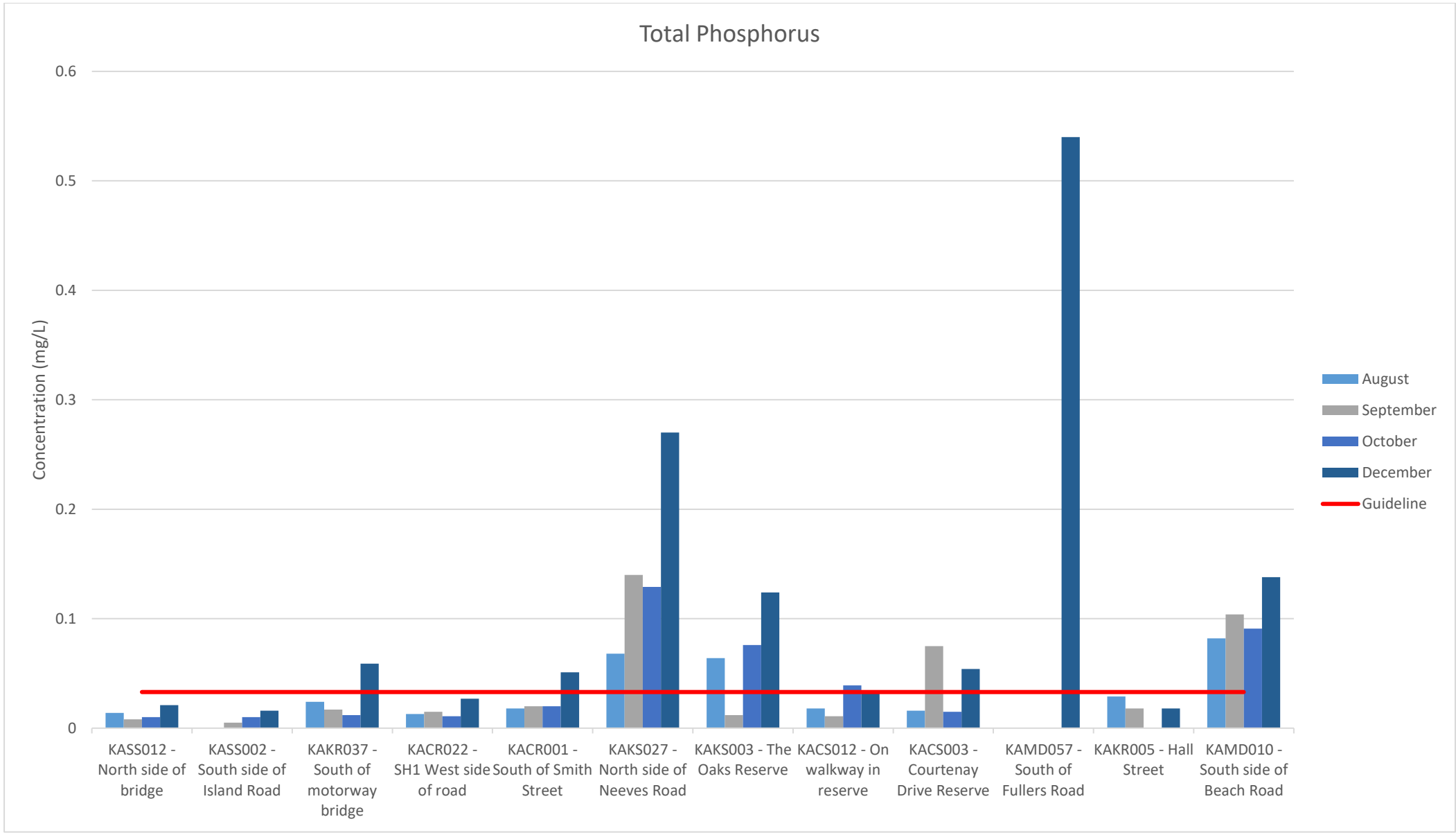


Figure 12: Total Phosphorus levels in Kaiapoi's waterways.

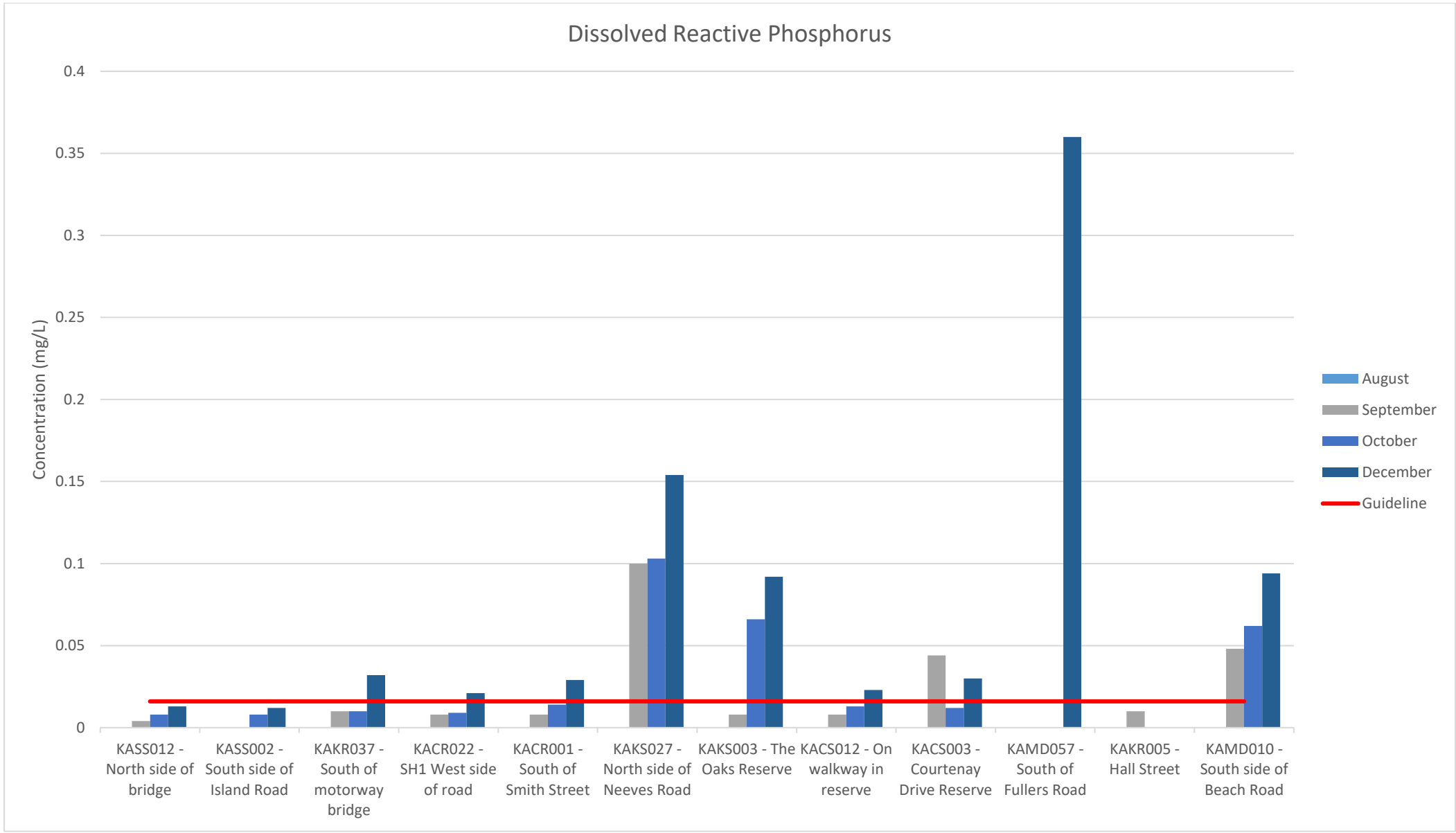


Figure 13: Dissolved Reactive Phosphorus in Kaiapoi's waterways

Based on the levels observed it is apparent phosphorus is less consistently an issue in Kaiapoi's waterways than nitrogen. In contrast to the distribution of nitrogen, the results demonstrate the shallower or ephemeral Kaiapoi waterways (Kaikanui Stream, McIntosh Drain) with less volume and lower flow rates have more frequent and higher elevated levels of phosphorus. Both of the sample sites in Silversteam (KASS012 and KASS002) and upper site on the Cam River (KACR022) returned TP and DRP levels below the guideline levels. Conversely the lower volume waterways all demonstrated phosphorus levels in exceedance of the guidelines, particularly in the first flush event in December.

At all sample sites phosphorus levels were highest in the first flush event in December with the exception of the lower Kaiapoi River site (KAKR005). The majority of phosphorus in the samples is in the form of DRP (the more readily bioavailable form) rather than particulate or organic forms. This indicates the majority of phosphorus entering the streams is in a form which could readily contribute to eutrophication.

It is noted that phosphorus concentrations are elevated above the guideline value in the December first flush at all sample sites but the two located in the Silver Stream. Rural source waterways with large spring fed catchments such as the Silver Stream do not show any exceedances above the guideline level, despite this waterway consistently demonstrating the highest levels of TN recorded during each event.

As DRP is stated as the applicable indicator of phosphate in the LWRP, it is recommended that it replaces TP in the urban impact section of the monitoring programme. The results show that phosphorus has both urban and rural sources. Wastewater overflows are a known urban cause of high phosphorous in waterways and are also a known issue for Kaiapoi. Wastewater overflows will be separately managed through a major wastewater network capacity upgrade for Kaiapoi programmed from 2023 to 2033.

5.3.7. E. coli

Escherichia coli (*E. coli*) is used as an indicator of possible sewage contamination as *E. coli* is commonly found in human and animal feces. The LWRP provides a guideline of 550 CFU/100 mL of *E. coli* and requires 95% of samples to be below this value.

Figure 14 shows the recorded levels of *E. coli* in Kaiapoi's waterways.

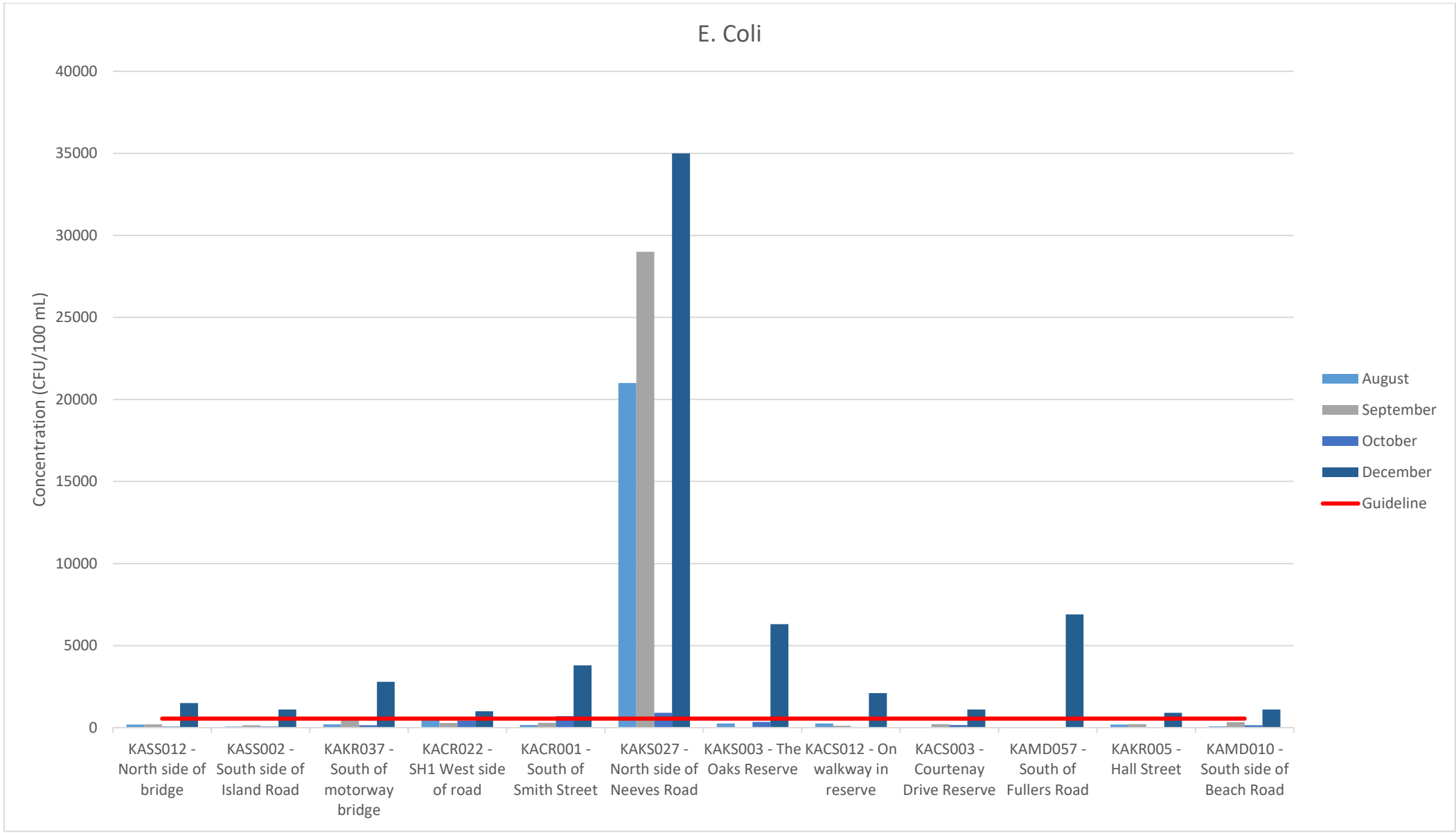


Figure 14: *E. coli* levels in Kaiapoi's waterways.

The concentrations of *E. coli* in these samples exceed the guideline values in fourteen instances of the 43, (42% total) of the samples captured. Exceedances were ubiquitous in the first flush event in December. The upper Kaikanui, (KAKS027) was the only site to demonstrate exceedances outside of the December event and demonstrated values above the 550 CFY/100 mL for all four samples. The sites sampled during the minor wet weather event in August and dry weather event in September typically both demonstrated levels of *E. coli* comfortably below the guideline value.

The ongoing elevated levels at the site in the upper Kaikanui Stream site (KAKS027) are likely to be the result of consistent contamination in the upstream rural land areas in combination with low flow, and possibly even stagnant, water. As a result of these conditions the *E. coli* result is not particularly meaningful.

The upper McIntosh Drain site (KAMD057) demonstrates the second highest *E. coli* concentrations of any site in December at 6900 CFU/100 mLs. KAMD057 is upstream of Kaiapoi's urban boundary and above tidal effects – the elevated levels at this site could be due to contamination upstream or possibly the lack of flow through this section of the channel leading to a build-up of bacteria which is being flushed out in the larger first flush event.

KAMD078 (sampled as part of Woodend's programme at 3:40 pm - approximately an hour after KAMD057) recorded an *E. coli* level of 2700 CFU/100 mLs. This shows that although elevated in Woodend the level of *E. coli* in this waterway increased further between two sites. It is noted that the *E. coli* recorded downstream at KAMD010 is significantly lower at 1100 CFU/100 mLs. However as discussed in section 5.3.12 "Electrical Conductivity", this site appears to be brackish. This indicates freshwater at this site has been diluted with seawater which is neutralising bacteria in the lower drain.

At just a little below the levels seen at KAMD057 the lower site on the Kaikanui (KAKS003), on the southern side of Kaiapoi, demonstrates the third highest *E. coli* level of all of the sites. KAKS003 is downstream of significant urban areas and is fed by both residential and commercial-industrial land use catchments. Possible explanations for the elevated *E. coli* levels at this site include:

- *E. coli* contamination washed down from further upstream. KAKS027 showed extremely high *E. coli* levels.
- Overflows from the urban wastewater network.
- Runoff from the industrial area to the north (see Figure 1) and possibly seepage from historic and known contaminated areas such as Kaiapoi's historic freezing works site. It is known that a considerable amount of waste was disposed of in slit trenches to the SE of the freezing works.
- Contaminated runoff from the farming area to the south of the Kaikanui Stream.
- Animal faecal matter runoff from urban greenspaces. The site is downstream of the Hinemoa Park Reserve and the Jim Brydon Reserve - neither are specific dog parks but both allow dog access. A cemetery area is also in this catchment but is unlikely to be a source of animal faecal matter.
- Backflow from avian sources in the downstream pond at the lower Courtenay Stream (unlikely as the Courtenay Stream has tide gates and if they were ineffective and there was backflow elevated *E. coli* levels would be expected at site KACS012 - this was not the case).

The locations of these possible sources is presented in Figure 15. Further investigation is needed to determine the actual sources of the *E. coli* particularly along the McIntosh Drain and Kaikanui Stream. Additional sampling could be undertaken along the Kaikanui to assist with narrowing down the source of this contamination.

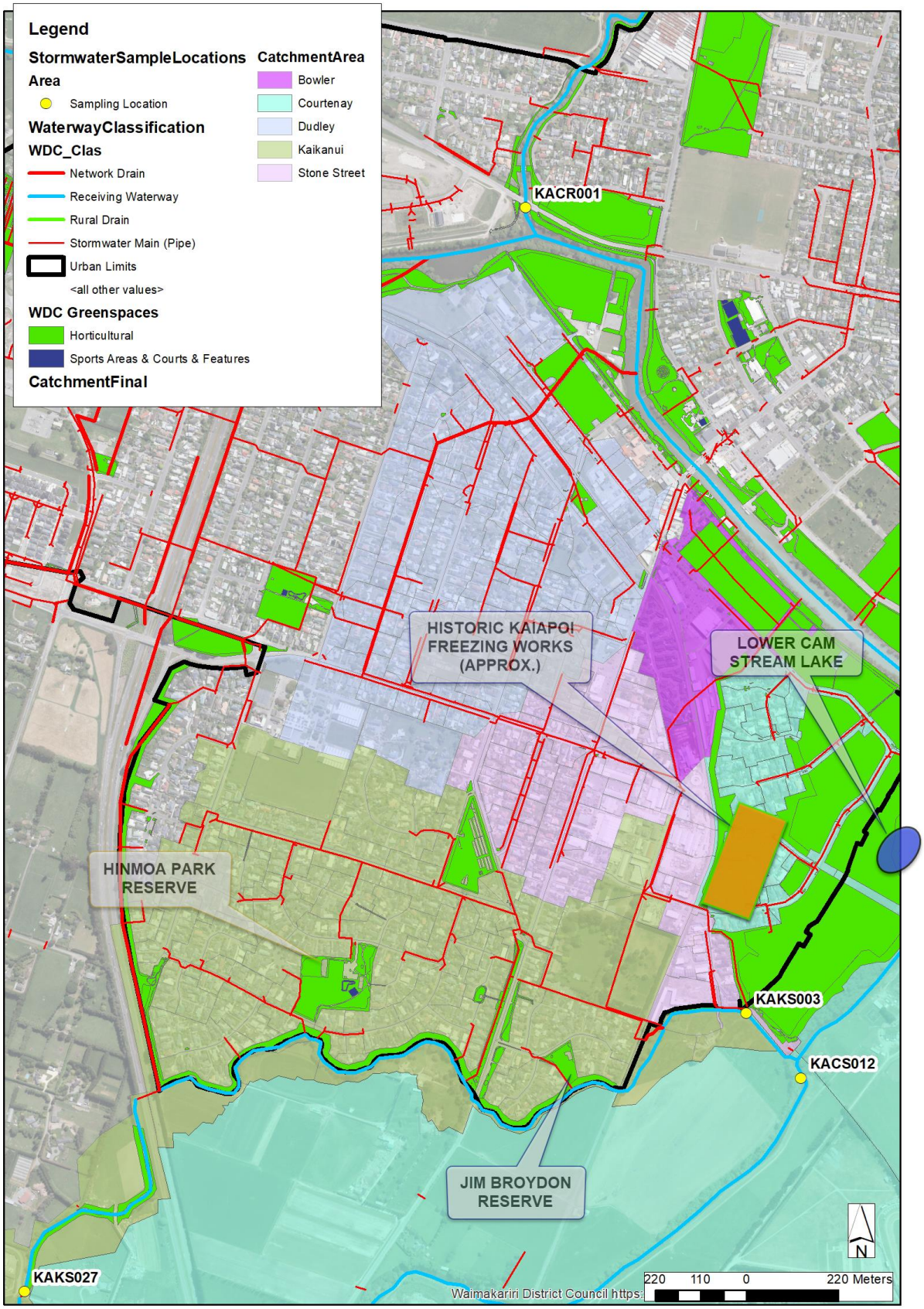


Figure 15: Possible sources of elevated *E. coli* at urban sample site KAKS003.

5.3.8. Total Hydrocarbons

Total Hydrocarbon primary sources include but are not limited to road asphalts, manufacturing facilities and fuelling depots, as these areas frequently experience oil spillages.

There is no consistency between guidelines for hydrocarbons; ECan is in the process of investigating and stating a guideline.

For all samples the results indicated that the total hydrocarbon concentrations for C7 - C9, C10 - C14 and C15 - C36 were all below the detectable limits. Therefore it was concluded that the Kaiapoi urban and rural catchments do not have an issue with hydrocarbons.

It is recommended the hydrocarbons should be removed from the urban impact section of the monitoring programme. However the total hydrocarbon concentration should be kept in the 'sediment sampling' section of the monitoring programme, until it has been investigated further.

5.3.9. Dissolved Oxygen

Several factors affect the amount of oxygen dissolved in the water in waterways. Colder water usually has more oxygen, because gasses dissolve more readily in cold water. Water motion also helps mix oxygen into the water. Eutrophication can result in the depletion of oxygen concentration in the waterways as resulting organic matter respires and breaks down.

Figure 16 and Figure 17 show the DO levels recorded by portable probe during the sampling rounds.

The ANZECC guidelines provide a relatively narrow DO guideline range of between 98% (min) and 105% (max). The absolute levels of DO, can also be used to gauge the general health of a waterway. For optimum fish health the minimum DO level suggested by NIWA is 5 mg/L.

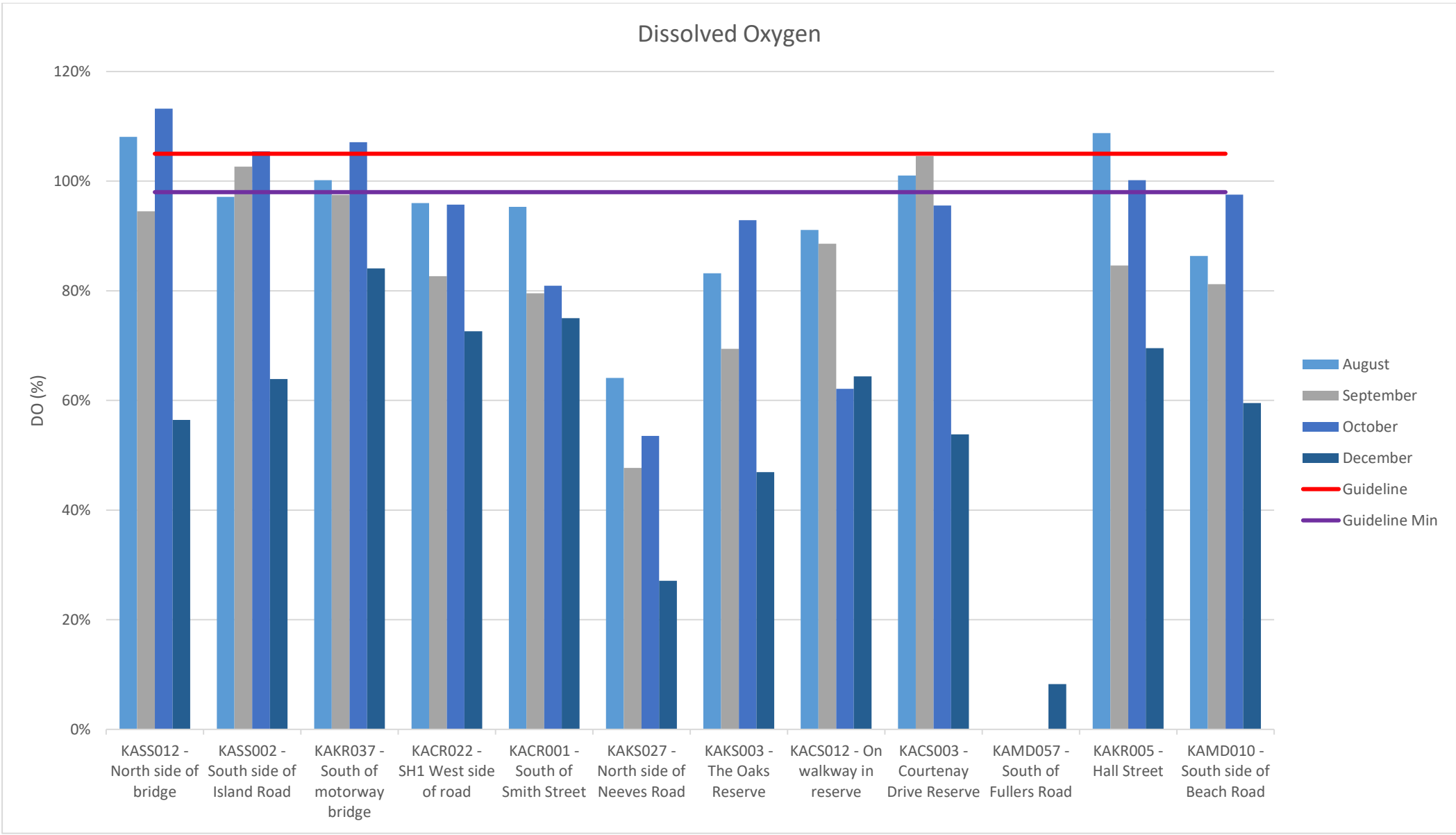


Figure 16: DO levels observed in Kaiapoi's waterways as a percentage of saturation.

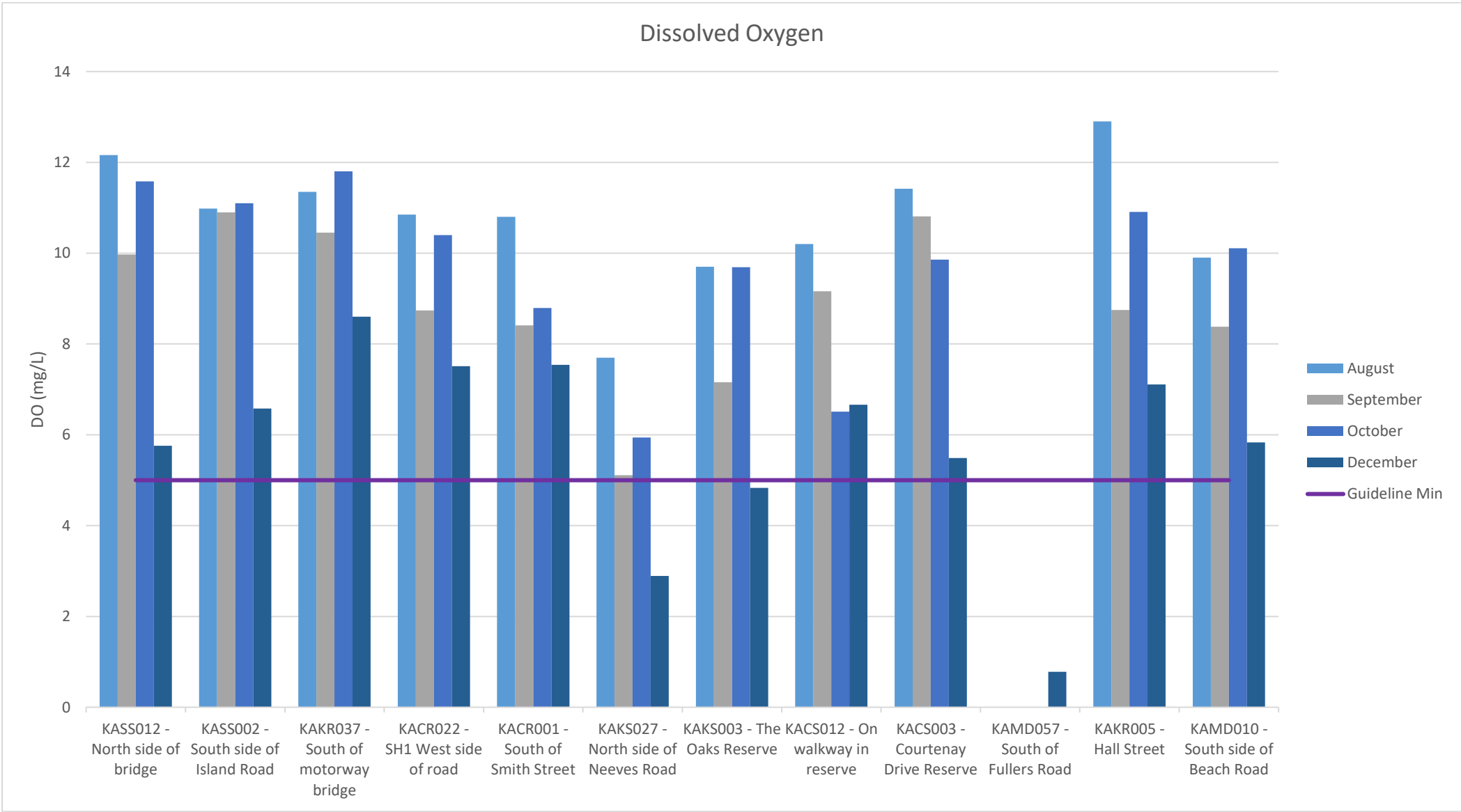


Figure 17: DO levels in observed in Kaiapoi's waterways as an absolute value.

It is clear from the recorded DO levels that there is significant variation in Kaiapoi's waterways. Although some variation is to be expected the DO fluctuates considerably between sites even within the same water body - for instance in the October event the Kaikanui Stream goes from a DO level of 54% at site KAKS027 to 94% 2.4 km downstream at site KAKS003. This trend is not consistent between events and could suggest the DO readings are somewhat unreliable. The DO percentage saturation (Figure 16) is a combination of two field measurements, the absolute DO level and the temperature. If both meter readings are not well calibrated then it is possible to produce compounding errors.

Figure 17 shows the absolute DO level exceeds the guideline minimum of 5 mg/L in all but three samples, which were captured in the first flush event in December. The only measurement taken in the upper McIntosh Drain at sample site KAMD057 showed a low DO reading of 0.78 mg/L, suggesting a near anoxic waterbody (<0.5 mg/L) at the time of sampling. Interestingly the December event samples generally had the lowest levels of absolute DO at each site. This is consistent with the results witnessed in previously assessed urban areas and appears to be a direct result of the warmer water in summer resulting in lower solubility of oxygen as saturated oxygen percentage (Figure 16) and temperature (Figure 19) are both relatively high.

The results suggests the waterways (with the exception of the upper McIntosh Drain) were not suffering from the low DO effects that can result from eutrophication at the time of sampling. However, it is expected waterways would have higher than usual DO levels after rain events due to raindrops having a large surface area to volume ratio to absorb oxygen while falling and additional mixing in the waterway created by increased turbulence and the resulting aeration. Low flow periods during warm summer periods are a more likely time to observe signs of eutrophication.

It is recommended that DO is monitored as part of the stream health in the monitoring programme, as it is a portable probe measurement and would not cost WDC much to monitor.

5.3.10. pH

Low pH (acidic) is caused by high organic acids, such as some wetland waters or where mineral acidity occurs naturally. High pH (basic) is caused by highly eutrophic waters, where eutrophication occurs.
pH differences can also occur by water draining certain rock, soil types and industrial wastes.

Figure 18 represents the pH portable probe results from the sampled waterways in and around Kaiapoi. The LWRP provides a guideline from pH 6.5 to pH 8.5.

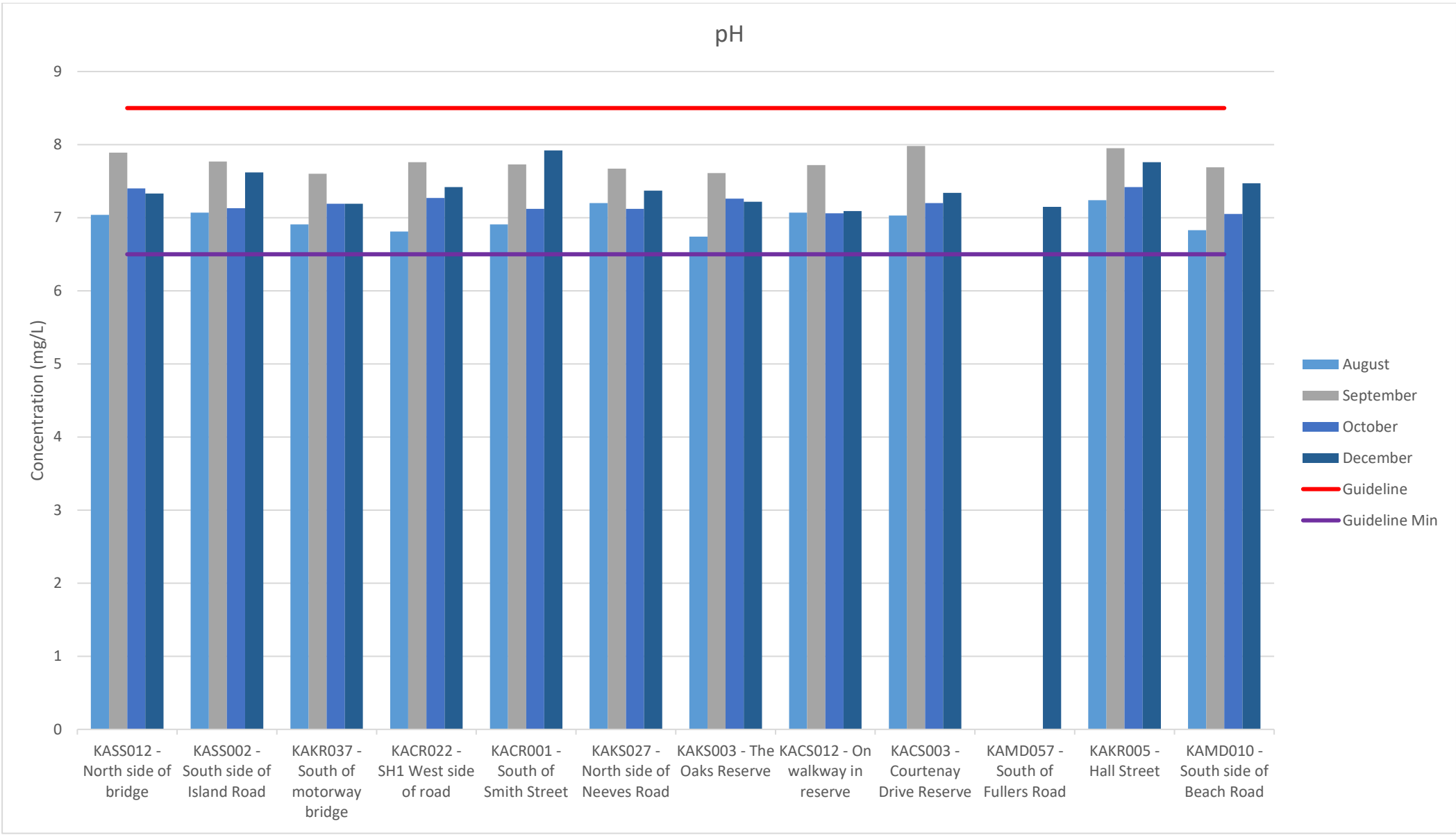


Figure 18: pH readings captured by portable probe in Kaiapoi's waterways.

The recorded results are all within the guideline range. In general the samples tend to be slightly basic. The dry August event is the only event to demonstrate near acidic pH levels, which occurred across the majority of the sites. There were no sites in the following three sampling periods that demonstrated acidic pH levels on the acidic side of neutral (below a pH of 7.0). September demonstrated the highest pH levels at all of the sites except one.

The pH levels recorded are comfortably within the LWRP guidelines and don't indicate eutrophication or other problems indicated by pH changes. The high pH levels in September could be due to the dry spell prior to this event (the longest of the four events).

It is recommended that pH is monitored as part of the 'stream health' section of the monitoring programme, as it is not proven to be affected by the urban discharges. As it is a portable probe measurement it would not cost WDC much to monitor.

5.3.11. Temperature

Temperature of waterways can be affected by the air temperature during a rain event, the temperature of surfaces contributing runoff entering waterways and the temperature of the baseflow. Seasonal temperature fluctuations play a major role.

The LWRP provides a guideline of a maximum temperature of 20 ^{o}C for lowland rivers.

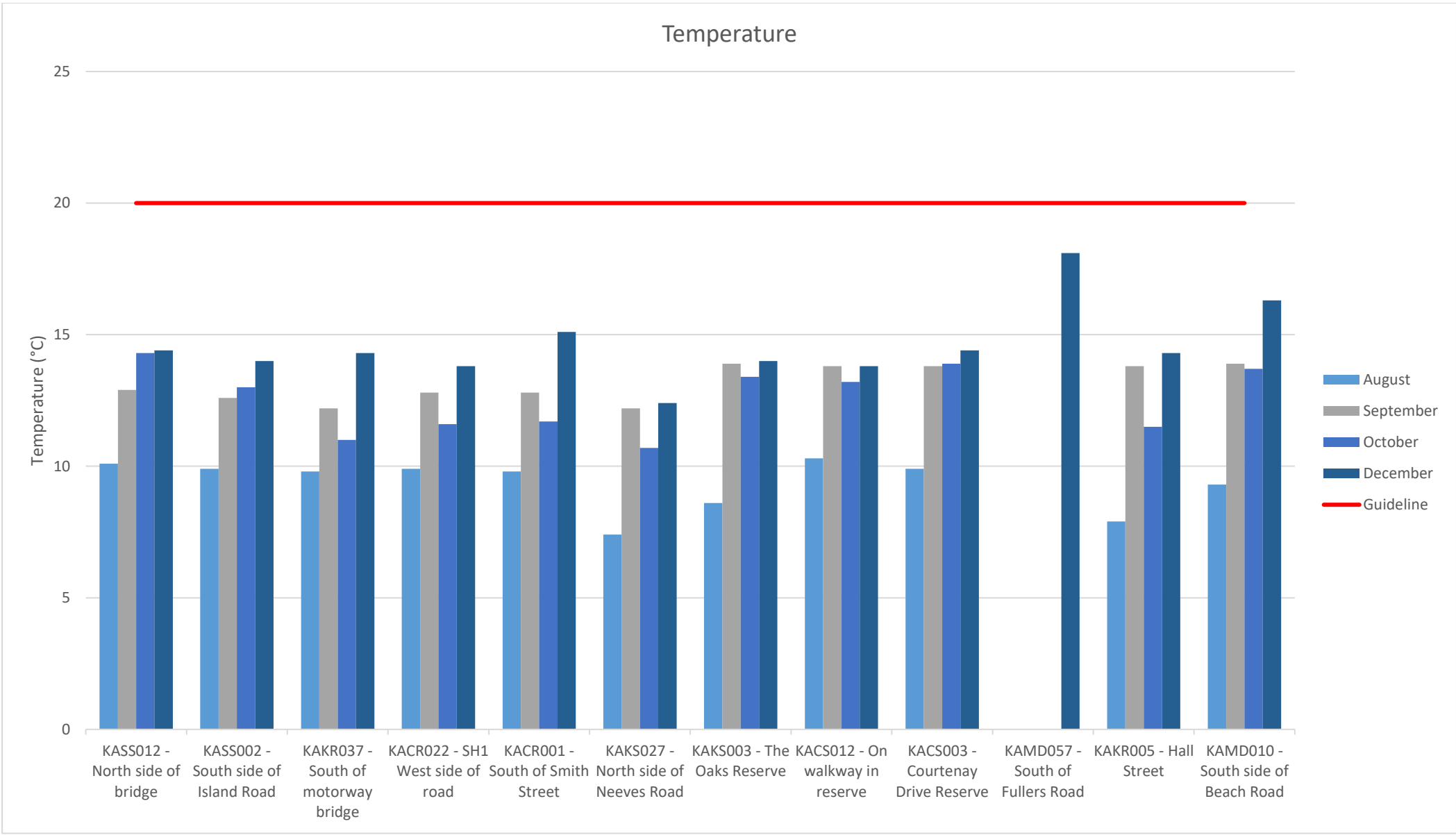


Figure 19: Temperature as captured by portable probe over the Kaiapoi area.

The recorded results follow the trend of warmer temperatures in warmer periods of the year. The waterways reached a maximum temperature of 18 ^{o}C, observed in the December event. There is no evidence to suggest that stormwater is altering the temperature of Kaiapoi's waterways. Additional measurements collected at the same time of the year during wet and dry events would be needed to confirm this observation.

It is recommended that temperature is monitored as part of the stream health in the monitoring programme, as it is a portable probe measurement and would not cost WDC much to monitor.

5.3.12. Electrical Conductivity

Water Electrical Conductivity is a measure of the total ionic strength of the water and is widely used as a quick indication of the level of enrichment of the water. The measurement does not distinguish between nutrient and non-nutrient ions so although it can signal a potential issue it requires additional information to determine what the source of the ions is. There is no specific guideline for water conductivity provided by ANZECC or the LWRP. Typical drinking water has a range of between 50-500 µS/cm while sea water is about 54,000 µS/cm.

Figure 20 presents Kaiapoi conductivity results as recorded by portable probe in the waterway.

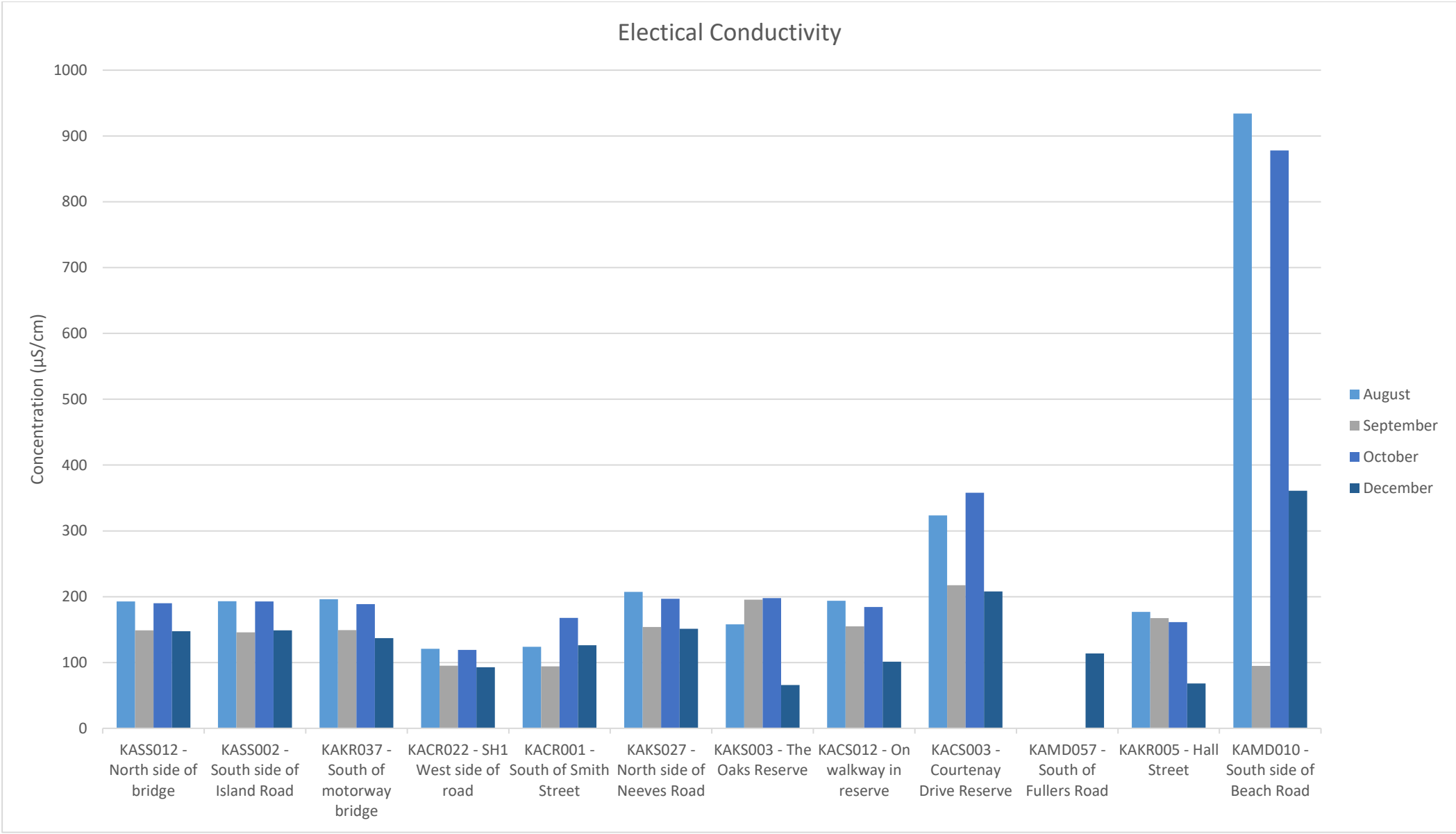


Figure 20: Conductivity results for Kaiapoi.

Samples captured in the minor wet weather event in August and dry weather event in October demonstrate the highest conductivity levels at each site. Samples captured during the first flush December event tend to demonstrate the lowest conductivity observed at each site. As the December event tended to demonstrate the highest levels of conducting nutrients such as DRP, and reasonably high levels of DIN, it appears the elevated conductivity observed in the August and October events is not from nutrients but from non-nutrient ions present in the water. There is a clear jump in conductivity levels at two of the lowest lying sites KACS003 and KAMD010. Considering both sites have low elevation and close proximity to the river estuary it appears there is some saltwater mixing at these sites.

Although there are no guidelines for conductivity, it is recommended that conductivity is kept in the 'stream health' section of the monitoring programme, as it can be easily retrieved and recorded. Sharp changes in conductivity indicate a change in anion or ion concentration which is linked to contaminant quantity and quality and particularly in the lower areas of Kaiapoi's waterways gives an indication of the salinity of the tested water.

It should be noted that at the low elevation sites the waterways could be stratified with saline sea water positioned deeper down in the waterbody. This potential stratification adds a layer of complexity to both sampling and interpretation. It is possible that the surface probe only measured the electrical conductivity of the very surface which might differ from the bottled sample if the sample container was filled any deeper than the probe was positioned, or the action of filling the sample bottle disturbed an interface between fresh and salty water.

In the future the sample source could be verified by having the electrical conductivity of the sample tested at the laboratory. This could then be checked during the quality analysis to verify it is approximately the same as the EC recorded by the portable probe. Any mismatches would indicate stratification of the waterway and show samples that have measured and captured different layers. The possibility of backflows up the river due to the rising tide should also be considered. By continuing to capture the time the measurement and sample were taken the state of the tide can then be considered and used to check if the sample was captured on an incoming or outgoing tide - this can then be used to inform if there may have been resulting backflow up the waterway.

Further investigation into the effect tidal flow has on the different waterways should be investigated, in the following areas:

- the reach of saltwater upstream in Kaiapoi's waterways
- the tidal influence on freshwater causing backflow upstream
- presence of stratification (haloclines) of Kaiapoi's waterways during rising tides
- if stratification is occurring in Kaiapoi's waterways during a flood tide (rising sea) are there bidirectional flows of distinct layers of freshwater downstream and saline water upstream?

6. DISCUSSION

Four sample rounds were completed, in both wet and dry conditions, at 12 sites spread over the Silver Stream, Kaiapoi River, Cam River, Kaiapoi Stream, Courtenay Stream and McIntosh Drain.

Due to its proximity to the sea and exposure to tides Kaiapoi presents a unique set of challenges when sampling and analysing the stormwater quality of its waterways. During the baseline sampling all of the sampling occurred during rising tides meaning that there is likely to have been backflows up the lower elevation waterways. There is clear evidence of brackish water at two of the twelve sites and it is possible there were backflows of freshwater upstream at some of the other sites, such as in the lower Cam River. Further investigation is required to determine the type and full extent of the tidal influence in Kaiapoi.

In addition to an investigation into tidal effects it is suggested that electrical conductivity or Total Dissolved Solids (TDS) is captured in the lab sample to verify the portable probe is measuring the same water as the sample captured for the lab – this would confirm the sample isn't coming from a sub-surface saline layer if there is stratification in the water body. To minimise potential contamination from backflows samples would ideally be captured during the latter half of an outgoing tide or at low tide, to allow any mixed back flowed water opportunity to be flushed downstream.

The results concluded that for Kaiapoi's ongoing monitoring programme some contaminants can be removed and some added. Table 4 summarises the suggested changes from the baseline monitoring programme for Kaiapoi's ongoing monitoring programme.

Table 4: Summary of contaminants from baseline monitoring programme recommended to be changed for ongoing monitoring programme application to Kaiapoi.

Contaminant	Source	Baseline Monitoring Programme Inclusion	Recommended Ongoing Monitoring Programme Section	Reason Section for Change
Total Suspended Solids	Urban	Included	Urban Impact	
Dissolved Copper	Urban	Included	Urban Impact	
Dissolved Lead	Urban	Included	-	Very low concentrations, therefore recommended to remove it from the programme.
Dissolved Zinc	Urban	Included	Urban Impact	
Total Nitrogen (TN)	Rural	Included	-	DIN is in the Land and Water Regional Plan (LWRP), therefore it is recommended that we replace TN with DIN
Dissolved Inorganic Nitrogen (DIN)	Rural & Urban	-	Stream Health	
Total Ammoniacal Nitrogen (TAN)	Urban & Rural	Included	Stream Health	
Total Phosphorus	Mainly Urban	Included	-	DRP is in the LWRP therefore it is recommended that TP is replaced with DRP.
Dissolved Reactive Phosphorus (DRP)	Mainly urban	Included	Urban Impact	DRP was found to be from rural and possibly urban sources. DRP is a component of wastewater overflows and it is recommended that it is monitored in Kaiapoi's water ways on an ongoing basis.

Contaminant	Source	Baseline Monitoring Programme Inclusion	Recommended Ongoing Monitoring Programme Section	Reason Section for Change
				The inclusion of DRP in the urban impact sampling programme will provide ongoing data that will enable any reduction of overflows entering streams over time to be measured and reported.
E. coli	Urban & Rural	Included	Urban Impact	E. coli was found to be from rural and possibly urban sources. E.coli is a component of wastewater overflows and it is recommended that it is monitored in Kaiapoi's water ways on an ongoing basis. The inclusion of E.coli in the urban impact sampling programme will provide ongoing data that will enable any reduction of overflows entering streams over time to be measured and reported.
Total Hydrocarbons	Urban	Included	-	Very low concentrations therefore recommended removing it from the programme. Total Hydrocarbons will remain in the basin sediment monitoring.
Dissolved Oxygen (DO)	-	Included	Stream Health	
pH	-	Included	Urban Impact	Can be used for guideline value adjustment.
Temperature	-	Included	Stream Health	
Electrical Conductivity	-	Included	Stream Health	Lab sample useful for determining salinity of water sample and potential mixing of fresh and salt water.
Hardness	-	-	Urban Impact -occasional	Initial one off sample to establish value for hardness adjustment and then occasional sampling recommended to monitor the character of the water way.
Dissolved Organic Carbon	Mainly Rural	-	Urban Impact - occasional	Initial one off sample to establish value for guideline adjustment and then occasional sampling recommended to monitor the character of the water way.

Total hydrocarbons and lead are recommended to be removed from the programme as they consistently demonstrated levels well below their guideline values.

It is recommended that Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen should be used in the monitoring programme as these are specified in the LWRP. It is also recommended that electrical conductivity (in the form of specific conductance) is captured by the lab for any samples as a backstop to check if there has been any mixing of the waterway water with tidal saline waters.

It was recommended by ECan water quality specialists that the waterway hardness and dissolved organic carbon are measured once or twice to characterise the waterway. This will enable the WDC to get site specific trigger values for metals. This would be undertaken as part of the monitoring programme, as the future monitoring programme sample sites would not be the same as in this baseline programme.

It is recommended that the monitoring programme for Kaiapoi be amended to include more sample points at additional locations in the urban stream reaches. This includes additional sample sites downstream of

more of the major urban discharge outlets, particularly in the Kaikanui Stream which has the most significant levels of urban contaminants identified to date.

The Council will also undertake dissolved copper and zinc sampling from selected major network discharge outlets (e.g. major pipes and open drains). It is recommended that sampling of dissolved metals from pipe outlets is undertaken for several years from the main sub-catchment pipes or drains, to determine a baseline. Once a baseline is determined, improvement targets can be identified and progressed over the remaining term of consent. This is a different monitoring approach from that proposed for Woodend or Rangiora. This is because the Schedule 5 standards in the LWRP are not relevant or useful in assessing effects of discharges in tidal waterways or in spring fed rural streams. These strong flowing rural streams, such as the Courtenay Stream or Cam River, flow with significant volumes through Kaiapoi, diluting contaminants which are only readily measurable in the lower volume shallower streams and open drains.

It was found that a number of the contaminants are sourced rurally and the relevant guidelines are exceeded prior to entering the township. For some of these contaminants there was an increase in concentration through the township, indicating that the urban area discharges these contaminants also, but in smaller quantities.

It is possible that nitrogen laden water is discharging into the Silverstream and Courtenay Stream from rural springs or overland flows upgradient of Kaiapoi. There are no mapped springs within urban Kaiapoi and so, no effect on springs from the urban stormwater discharges.

This study has demonstrated that the rural areas have a significant impact on the health of the Kaiapoi waterways. It is recommended that ECan undertakes monitoring upstream of the townships as contaminant concentration guidelines are exceeded in some waterways prior to entering the urban limits.

It should be noted that although applied here in this report in the absence of LWRP guidelines, the ANZECC (2000) guidelines do not provide water quality standards in the traditional sense (i.e. fixed standards that should not be exceeded). Rather, ANZECC (2000) states that the uncertainty in the derivation and application of such standards led them to develop trigger values that indicate a potential environmental problem if they are exceeded. Hence, ANZECC (2000) trigger values are not intended to be applied in an absolute fashion. If a trigger value is exceeded, further investigation is required.

7. CONCLUSION

The following conclusions were made in this investigation:

- Most of the contaminants tested exceeded the guidelines in at least one of the sample rounds. Many exceedances occurred in the December sampling period which was a first flush rainfall event, which was the largest rainfall event captured during the sampling period.

- It was found that generally the majority of contaminants were present in both rural and urban environments, however in some cases the rural area was found to have a larger impact than the urban area and the guideline concentrations were at times exceeded prior to reaching the urban discharge points.

The following factors are recommended for consideration in the ongoing Kaiapoi stormwater quality monitoring programme:

- It is recommended that Lead and Total Hydrocarbons are removed from the 'urban impact' section of the Stormwater Monitoring Programme, as the results indicated that the concentrations were consistently far below the guidelines.

- It is recommended that Dissolved Reactive Phosphorus and Dissolved Inorganic Nitrogen should be used in the monitoring programme as these are specified in the LWRP.

- It is recommended that *E. coli* and DRP are monitored regularly in the ongoing programme as there is some evidence to suggest the urban area is a contributing source of these contaminants.

- It is recommended that contaminants such as *E. coli*, phosphorus and nitrogen be investigated further by ECan within the rural catchments. Particularly in the largest wet weather event *E. coli* and phosphorus levels exceeded the LWRP guidelines in the rural zones, upstream of the urban limits. Nitrogen contaminants in the rural areas of rural catchments were a prevalent issue across all four sampling events. The results demonstrate significant exceedances of the guideline levels provided in the LWRP for DIN at five of the twelve sites sampled particularly in the Silverstream and Courtenay Stream.

- It is recommended that electrical conductivity is measured in future lab samples to indicate the salinity of the captured sample. This lab measurement can then be checked against the portable probe measurement and verify if there was saline stratification of the sampled layer of the waterbody at the time of sampling.

- It is recommended that dissolved copper and zinc sampling from selected major network discharge outlets (e.g. major pipes and open drains) is undertaken for several years from the main urban sub-catchments, to determine a baseline. Once a baseline is determined, improvement targets can be identified and progressed over the remaining term of consent. The Schedule 5 LWRP standards are not useful in assessing effects of discharges in tidal waterways or in spring fed rural streams. These strong flowing/ tidal streams, such as the Courtenay Stream, Kaiapoi River or lower Cam River, have significant volumes through Kaiapoi, diluting the main urban contaminants which are only measurable in shallow streams or open drains.

These conclusions will be used to develop the Kaiapoi Stormwater Monitoring Programme. After discussions with ECan and MKT the Stormwater Monitoring Programme will be updated.

8. APPENDIX

APPENDIX A: EXTRA BASELINE SAMPLING INFORMATION

Sampling kits should be ordered in advance to prepare for unpredicted sampling times. The kits should contain a STER, UP1L, NWU100 and a TPH250 from Hill Laboratory. The sample kits should be labelled in the following way:

SITE DESCRIPTIONS:

Site: KASS012
GPS location: X-Coordinate: 1570132; Y-Coordinate: 5196675
Site Description: Silver Stream, North side of bridge.
Site Photo:

Site: KASS002
GPS location: X-Coordinate: 1570316; Y-Coordinate: 5197379
Site Description: Silver Stream, South side of Island Road
Site Photo:

Site: KAKR037
GPS location: X-Coordinate: 1571237; Y-Coordinate: 5197207
Site Description: Kaiapoi River, South of motorway bridge.
Site Photo: nil.

Site: KACR022
GPS location: X-Coordinate: 1572421; Y-Coordinate: 5199128
Site Description: Cam River, SH1 West side of road.
Site Photo: nil.

Site: KACR001
GPS location: X-Coordinate: 1571845; Y-Coordinate: 5197268
Site Description: Taranaki Stream, East side of Chinnerys Road
Site Photo:

Site: KAKS027

GPS location: X-Coordinate: 1570642; Y-Coordinate: 5194664

Site Description: Kaikanui Stream, North side of Neeves Road

Site Photo:

Site: KAKS003

GPS location: X-Coordinate: 1572377; Y-Coordinate: 5195333

Site Description: Kaikanui Stream, The Oaks Reserve

Site Photo:

Site: KACS012
GPS location: X-Coordinate: 1572508; Y-Coordinate: 5195177
Site Description: Courtenay Stream, on walkway in reserve
Site Photo: nil.

Site: KACS003
GPS location: X-Coordinate: 1572960; Y-Coordinate: 5195954
Site Description: Courtenay Stream, Courtenay Drive Reserve
Site Photo:

Site: KAMD057
GPS location: X-Coordinate: 1573844; Y-Coordinate: 5201130
Site Description: McIntosh Drain, South of Fullers Road
Site Photo: nil.

Site: KAKR005
GPS location: X-Coordinate: 1573560; Y-Coordinate: 5195984
Site Description: Kaiapoi River, Hall Street
Site Photo: nil.

Site: KAMD010

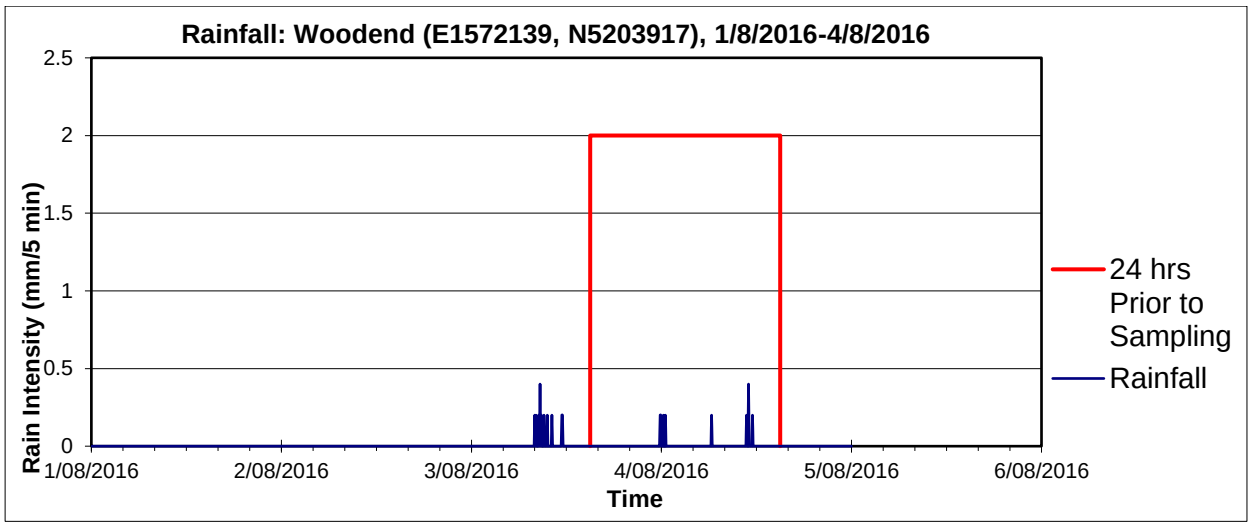
GPS location: X-Coordinate: 1573840; Y-Coordinate: 5196834

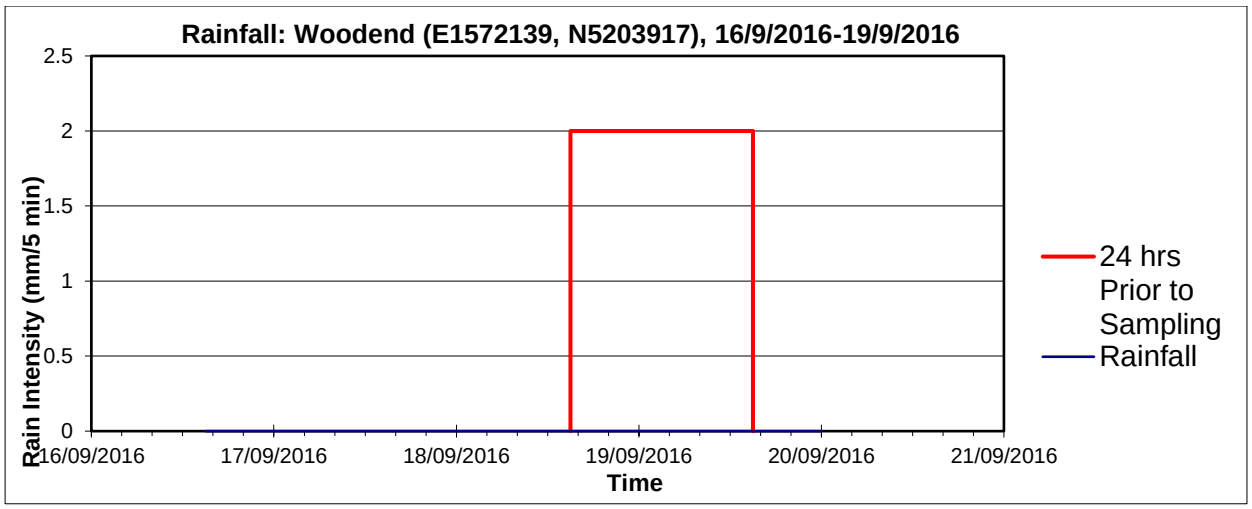
Site Description: McIntosh Drain, South side of Beach Road

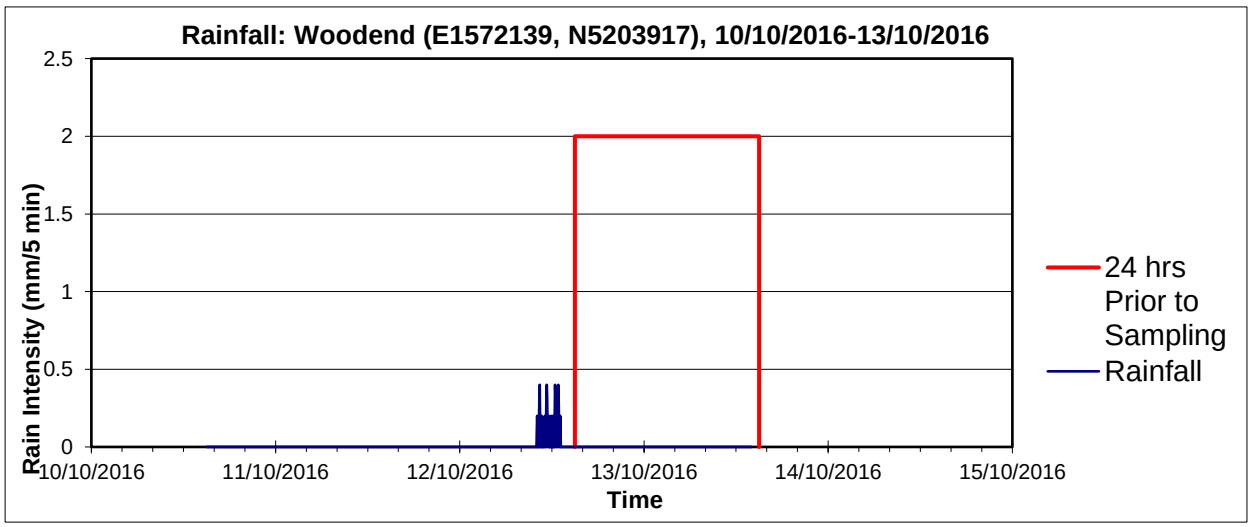
Site Photo:

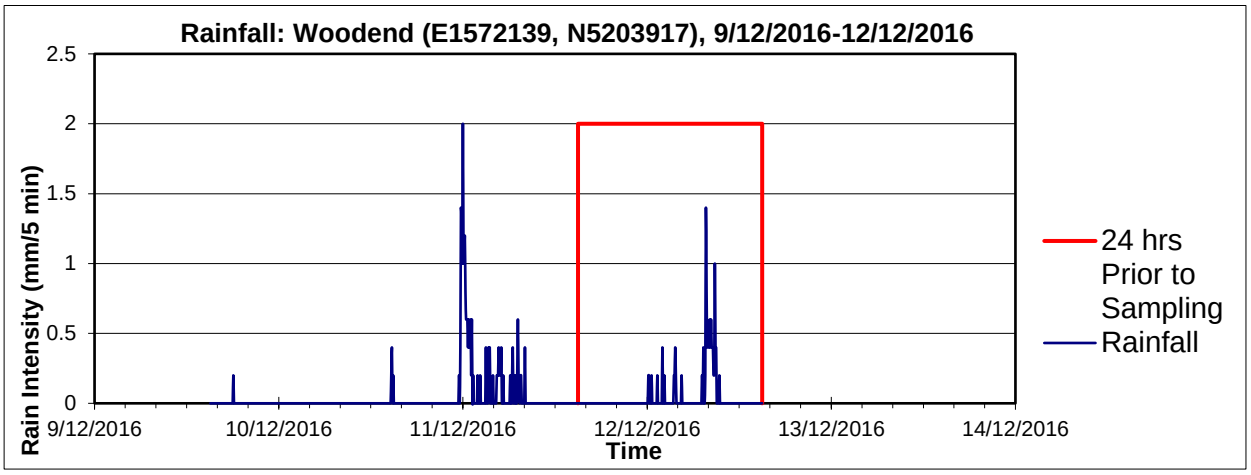
APPENDIX B: RAINFALL EVENT HYDROGRAPHS

Chinnerys Road, Woodend Rainfall data; 24 hour period prior to the rainfall event is shown in red.








Rainfall: Woodend (E1572139, N5203917), 9/12/2016-12/12/2016
Rain Intensity (mm/5 min)
2.5
2
1.5
1
0.5
0
9/12/2016
10/12/2016
11/12/2016
12/12/2016
13/12/2016
14/12/2016
Time
24 hrs Prior to Sampling Rainfall

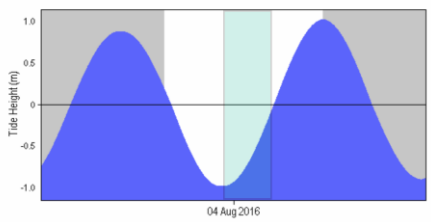
APPENDIX C: TIDAL INFORMATION

Source:	NIWA Tide forecaster		Latitude:	43 22 55.7 S	
	https://www.niwa.co.nz/node/26820/results		Longitude:	172 42 45.2 E	

Date		4/08/2016
Sampling	Start	11:00
	End	14:30
	Duration	3:30
Tidal State		*Flood Tide*

Date	Time	Tide Height (m)
4/08/2016	5:00	0.87
4/08/2016	11:09	-0.98
4/08/2016	17:29	1.02
4/08/2016	23:45	-0.9
5/08/2016	5:50	0.84
5/08/2016	11:59	-0.93

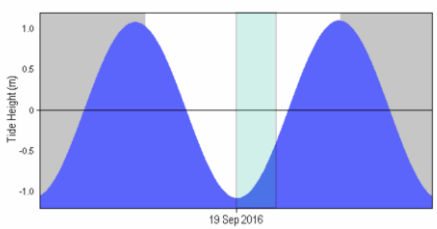
Graph



Date		19/09/2016
Sampling	Start	12:00
	End	14:30
	Duration	2:30
Tidal State		*Flood Tide*

Date	Time	Tide Height (m)
19/09/2016	5:48	1.07
19/09/2016	12:01	-1.08
19/09/2016	18:16	1.09
20/09/2016	0:30	-1.1
20/09/2016	6:46	1.09
20/09/2016	13:00	-1.07

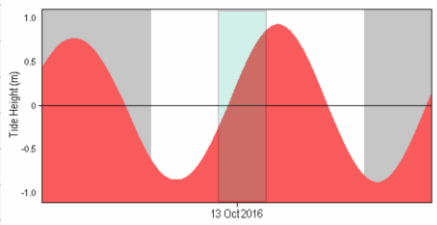
Graph



Date		13/10/2016
Sampling	Start	11:00
	End	14:00
	Duration	3:00
Tidal State		*Flood Tide*

Date	Time	Tide Height (m)
13/10/2016	2:01	0.76
13/10/2016	8:10	-0.85
13/10/2016	14:27	0.92
13/10/2016	20:42	-0.88
14/10/2016	2:51	0.86
14/10/2016	9:01	-0.93

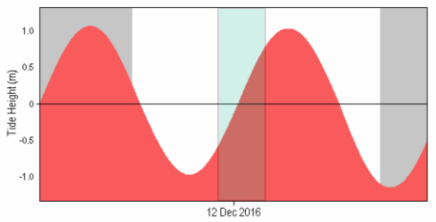
Graph



Date		12/12/2016
Sampling	Start	11:30
	End	14:30
	Duration	3:00
Tidal State		*Flood Tide*

Date	Time	Tide Height (m)
12/12/2016	3:04	1.06
12/12/2016	9:16	-0.98
12/12/2016	15:24	1.02
12/12/2016	21:40	-1.15
13/12/2016	4:01	1.15
13/12/2016	10:14	-1.03

Graph



APPENDIX D: LABORATORY RESULTS SUMMARY

Green and white highlighting marks acceptable values and red highlighting indicates exceedance of the guidelines

August sample round results

August	Guideline Value	KASS012 - North side of bridge	KASS002 - South side of Island Road	KAKR037 - South of motorway bridge	KACR022 - SH1 West side of road	KACR001 - South of Smith Street	KAKS027 - North side of Neeves Road	KAKS003 - The Oaks Reserve	KACS012 - On walkway in reserve	KACS003 - Courtenay Drive Reserve	KAMD057 - South of Fullers Road	KAKR005 - Hall Street	KAMD010 - South side of Beach Road
Total Suspended Solids (g/m^3)	50	<3	<3	6	<3	4	<3	7	<3	<3	SAMPLE SITE DRY	31	8
Dissolved Copper (g/m^3)	0.0018	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0013	<0.0005	<0.0005		<0.0005	<0.0005
Dissolved Zinc (g/m^3)	0.015	<0.0010	<0.0010	<0.0010	0.0015	0.0026	<0.0010	0.068	<0.0010	<0.0010		<0.0010	0.0012
Dissolve Lead (g/m^3)	0.00056	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00029	<0.00010	<0.00010		<0.00010	<0.00010
Total Nitrogen (g/m^3)	0.614	5.2	5.1	5.3	0.67	0.67	1.38	0.66	4.6	4.2		0.97	0.53
Total Ammoniacal-N (g/m^3)	1.88	<0.010	<0.010	0.015	<0.010	0.012	0.094	0.055	0.012	0.106		0.012	0.058
Nitrate-N and Nitrite-N (g/m^3)	0.444	5	4.9	4.2	0.53	0.52	0.99	0.31	4.5	3.9		0.83	0.1
Total Kjeldahl Nitrogen (g/m^3)	0.17	0.16	0.18	1.07	0.14	0.15	0.4	0.35	0.13	0.25		0.14	0.43
Dissolved Inorganic Nitrogen (g/m^3)	1.5	5	4.9	4.215	0.53	0.532	1.084	0.365	4.512	4.006		0.842	0.158
Dissolved Reactive Phosphorus (g/m^3)	0.016												
Total Phosphorus (g/m^3)	0.033	0.014	0.009	0.024	0.013	0.018	0.068	0.064	0.018	0.016		0.029	0.082
E. Coli (cfu/100mL)	550	180	70	200	520	160	21000	260	260	20		180	80
C7-C9# (g/m^3)	-	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10
C10-C14# (g/m^3)	-	<0.2	<0.2		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2		<0.2	<0.2
C15-C36# (g/m3)	-	<0.4	<0.4		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4		<0.4	<0.4
Total Hydrocarbons (g/m^3)	-	<0.7	<0.7		<0.7	<0.7	<0.7	<0.7	<0.7	<0.7		<0.7	<0.7
DO (mg/L)	5	12.2	11.0	11.4	10.9	10.8	7.7	9.7	10.2	11.4		12.9	9.9
pH	8.5	7.04	7.07	6.91	6.81	6.91	7.2	6.74	7.07	7.03		7.24	6.83
Temperature (°C)	20	10.1	9.9	9.8	9.9	9.8	7.4	8.6	10.3	9.9		7.9	9.3
Conductivity (µS/cm)	500	193	193	196	121	124	207	158	194	324		177	934

September sample round results

September	Guideline Value	KASS012 - North side of bridge	KASS002 - South side of Island Road	KAKR037 - South of motorway bridge	KACR022 - SH1 West side of road	KACR001 - South of Smith Street	KAKS027 - North side of Neeves Road	KAKS003 - The Oaks Reserve	KACS012 - On walkway in reserve	KACS003 - Courtenay Drive Reserve	KAMD057 - South of Fullers Road	KAKR005 - Hall Street	KAMD010 - South side of Beach Road
Total Suspended Solids (g/m^3)	50	<3	<3	4	4	4	3	<3	3	12	SAMPLE SITE DRY	10	7
Dissolved Copper (g/m^3)	0.0018	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005		<0.0005	<0.0005
Dissolved Zinc (g/m^3)	0.015	<0.0010	<0.0010	<0.0010	0.0014	0.0012	0.0011	<0.0010	<0.0010	0.0045		<0.0010	<0.0010
Dissolve Lead (g/m^3)	0.00056	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00015		<0.00010	<0.00010
Total Nitrogen (g/m^3)	0.614	4.6	4.6	4	0.5	0.57	0.8	3.7	4.2	0.46		2.6	0.65
Total Ammoniacal-N (g/m^3)	1.88	<0.010	<0.010	0.016	0.012	0.011	0.21	0.065	0.012	0.036		0.027	0.028
Nitrate-N and Nitrite-N (g/m^3)	0.444	4.5	4.4	3.8	0.35	0.35	0.33	3.5	4	0.141		2.5	0.044
Total Kjeldahl Nitrogen (g/m^3)	0.17	0.12	0.16	0.2	0.14	0.22	0.47	0.2	0.13	0.32		0.13	0.6
Dissolved Inorganic Nitrogen (g/m^3)	1.5	4.5	4.4	3.816	0.362	0.361	0.54	3.565	4.012	0.177		2.527	0.072
Dissolved Reactive Phosphorus (g/m^3)	0.016	0.004	<0.004	0.01	0.008	0.008	0.1	0.008	0.008	0.044		0.01	0.048
Total Phosphorus (g/m^3)	0.033	0.008	0.005	0.017	0.015	0.02	0.14	0.012	0.011	0.075		0.018	0.104
E. Coli (cfu/100mL)	550	200	140	510	280	290	29000	40	120	220		210	330
C7-C9# (g/m^3)	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10
C10-C14# (g/m^3)	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2		<0.2	<0.2
C15-C36# (g/m3)	-	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4		<0.4	<0.4
Total Hydrocarbons (g/m^3)	-	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7		<0.7	<0.7
DO (mg/L)	5	10.0	10.9	10.5	8.7	8.4	5.1	7.2	9.2	10.8		8.8	8.4
pH	8.5	7.89	7.77	7.6	7.76	7.73	7.67	7.61	7.72	7.98		7.95	7.69
Temperature (°C)	20	12.9	12.6	12.2	12.8	12.8	12.2	13.9	13.8	13.8		13.8	13.9
Conductivity (µS/cm)	500	149	146	149	95	94	154	196	155	217		168	95

October sample round results

October	Guideline Value	KASS012 - North side of bridge	KASS002 - South side of Island Road	KAKR037 - South of motorway bridge	KACR022 - SH1 West side of road	KACR001 - South of Smith Street	KAKS027 - North side of Neeves Road	KAKS003 - The Oaks Reserve	KACS012 - On walkway in reserve	KACS003 - Courtenay Drive Reserve	KAMD057 - South of Fullers Road	KAKR005 - Hall Street	KAMD010 - South side of Beach Road
Total Suspended Solids (g/m^3)	50	<3	<3	<3	6	3	6	4	<3	3	SAMPLE SITE DRY	12	8
Dissolved Copper (g/m^3)	0.0018	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005		<0.0005	<0.0005
Dissolved Zinc (g/m^3)	0.015	<0.0010	<0.0010	<0.0010	0.0011	0.0014	0.001	0.0112	0.001	<0.0010		<0.0010	0.0014
Dissolve Lead (g/m^3)	0.00056	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	0.0002
Total Nitrogen (g/m^3)	0.614	4.4	4.4	3.8	0.49	2.1	0.49	0.34	3.6	4.2		0.14	0.6
Total Ammoniacal-N (g/m^3)	1.88	<0.010	<0.010	<0.010	<0.010	0.01	0.144	0.032	0.073	<0.010		<0.010	<0.010
Nitrate-N and Nitrite-N (g/m^3)	0.444	4.3	4.2	3.6	0.32	1.87	0.148	0.056	3.4	4		0.092	0.013
Total Kjeldahl Nitrogen (g/m^3)	0.17	0.13	0.15	0.24	0.17	0.24	0.34	0.29	0.25	0.14		<0.10	0.59
Dissolved Inorganic Nitrogen (g/m^3)	1.5	4.3	4.2	3.6	0.32	1.88	0.292	0.088	3.473	4		0.092	0.013
Dissolved Reactive Phosphorus (g/m^3)	0.016	0.008	0.008	0.01	0.009	0.014	0.103	0.066	0.013	0.012		<0.004	0.062
Total Phosphorus (g/m^3)	0.033	0.01	0.01	0.012	0.011	0.02	0.129	0.076	0.039	0.015		<0.004	0.091
E. Coli (cfu/100mL)	550	63	70	150	410	700	900	350	32	160		17	150
C7-C9# (g/m^3)	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10
C10-C14# (g/m^3)	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2		<0.2	<0.2
C15-C36# (g/m3)	-	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4		<0.4	<0.4
Total Hydrocarbons (g/m^3)	-	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7		<0.7	<0.7
DO (mg/L)	5	11.6	11.1	11.8	10.4	8.8	5.9	9.7	6.5	9.9		10.9	10.1
pH	8.5	7.4	7.13	7.19	7.27	7.12	7.12	7.26	7.06	7.2		7.42	7.05
Temperature (°C)	20	14.3	13	11	11.6	11.7	10.7	13.4	13.2	13.9		11.5	13.7
Conductivity (µS/cm)	500	190	193	189	119	168	197	198	184	358		161	878

December sample round results

December	Guideline Value	KASS012 - North side of bridge	KASS002 - South side of Island Road	KAKR037 - South of motorway bridge	KACR022 - SH1 West side of road	KACR001 - South of Smith Street	KAKS027 - North side of Neeves Road	KAKS003 - The Oaks Reserve	KACS012 - On walkway in reserve	KACS003 - Courtenay Drive Reserve	KAMD057 - South of Fullers Road	KAKR005 - Hall Street	KAMD010 - South side of Beach Road
Total Suspended Solids (g/m^3)	50	<3	<3	4	4	8	19	6	4	3	12	30	<3
Dissolved Copper (g/m^3)	0.0018	<0.0005	<0.0005	0.0008	<0.0005	0.0008	0.0007	0.0015	<0.0005	<0.0005	0.0021	<0.0005	0.0009
Dissolved Zinc (g/m^3)	0.015	<0.0010	<0.0010	0.0026	0.0023	0.0038	0.0014	0.051	<0.0010	0.0026	0.0072	<0.0010	0.0012
Dissolve Lead (g/m^3)	0.00056	<0.00010	<0.00010	<0.00010	0.00011	0.00013	0.00017	0.0003	<0.00010	<0.00010	<0.00010	<0.00010	0.00019
Total Nitrogen (g/m^3)	0.614	4.2	4.1	3	0.55	1.91	0.77	0.41	4.1	3.4	1.44	0.17	0.65
Total Ammoniacal-N (g/m^3)	1.88	<0.010	<0.010	<0.010	0.015	<0.010	0.175	0.016	0.01	0.075	<0.010	<0.010	<0.010
Nitrate-N and Nitrite-N (g/m^3)	0.444	4	3.9	2.5	0.39	1.48	0.134	0.159	3.9	3	0.003	0.105	0.061
Total Kjeldahl Nitrogen (g/m^3)	0.17	0.23	0.19	0.55	0.16	0.43	0.63	0.25	0.19	0.41	1.44	<0.10	0.59
Dissolved Inorganic Nitrogen (g/m^3)	1.5	4	3.9	2.5	0.405	1.48	0.309	0.175	3.91	3.075	0.003	0.105	0.061
Dissolved Reactive Phosphorus (g/m^3)	0.016	0.013	0.012	0.032	0.021	0.029	0.154	0.092	0.023	0.03	0.36	<0.004	0.094
Total Phosphorus (g/m^3)	0.033	0.021	0.016	0.059	0.027	0.051	0.27	0.124	0.034	0.054	0.54	0.018	0.138
E. Coli (cfu/100mL)	550	1500	1100	2800	1000	3800	35000	6300	2100	1100	6900	900	1100
C7-C9# (g/m^3)	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
C10-C14# (g/m^3)	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
C15-C36# (g/m3)	-	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Total Hydrocarbons (g/m^3)	-	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
DO (mg/L)	5	5.8	6.6	8.6	7.5	7.5	2.9	4.8	6.7	5.5	0.8	7.1	5.8
pH	8.5	7.33	7.62	7.19	7.42	7.92	7.37	7.22	7.09	7.34	7.15	7.76	7.47
Temperature (°C)	20	14.4	14	14.3	13.8	15.1	12.4	14	13.8	14.4	18.1	14.3	16.3
Conductivity (µS/cm)	500	148	149	137	93	126	151	66	101	208	114	68	361

WAIMAKARIRI DISTRICT COUNCIL

REPORT FOR DECISION

FILE NO and TRIM NO:	DRA-19 / 191017145159
REPORT TO:	Utilities and Roading Committee
DATE OF MEETING:	19 November 2019
FROM:	Gerard Cleary – Manager Utilities and Roading, on behalf of the Kaiapoi River Rehabilitation Working Party
SUBJECT:	Cam River floodgate automation for saline intrusion prevention

SIGNED BY:
(for Reports to Council, Committees or Boards)

Department Manager | Chief Executive

1. SUMMARY

1.1 This report details a proposal from the Kaiapoi River Rehabilitation Working Party to investigate the feasibility for automation of the Cam River Floodgate to become a tidegate, for prevention of saline incursions upstream.

1.2 This reports seeks consideration of a $15,000 budget in 2020-21 to investigate the feasibility of this proposal, such as producing a concept design, detail of required resource consents and permissions, as well as preliminary consultation with Te Ngāi Tūāhuriri Rūnanga. As this is a generalised expenditure that could benefit a range of users, it is proposed for the budget to come from the general rate.

1.3 The intent of the automated floodgate operation is to avoid or limit saline intrusion into the lower Cam River during times when there is high salinity on the incoming tide. This would retain a freshwater environment in the lower Cam River, with possible complex benefits. However, there are also multiple possible disadvantages for ecological species and the local community.

1.4 The Cam River Floodgate is an Environment Canterbury asset, therefore any modifications would require their approval.

Attachments:

i. Kaiapoi River Rehabilitation Working Party meeting minutes 25 September 2019 (191029150331)

2. RECOMMENDATION

THAT the Utilities and Roading Committee recommends:

THAT the Council:

(a) **Receives** report No. 191017145159.

(b) **Considers** inclusion of a budget of $15,000 in the Draft Annual Plan from the general rate for 2020-21 to scope feasibility of automating the Cam River Floodgate, to be used as a tidegate against saline incursions.

(c) **Notes** that a report summarising findings from the feasibility study will be presented to the Utilities and Roading Committee and Environment Canterbury in early 2021, for a decision whether to proceed, and costings in order to obtain required consents / permissions and construct the design.

(d) **Notes** that any modifications to the Cam River floodgate would require the approval of Environment Canterbury as the asset owner.

(e) **Circulates** this report to the Kaiapoi-Tuahiwi Community Board and Waimakariri Water Zone Committee.

3. BACKGROUND

3.1 The Kaiapoi River Rehabilitiation Working Party has proposed that the Cam River floodgate could be modified to be used approximately up to four months of the year as a tidegate, for prevention of saline water from progressing upstream during a high tide. Environment Canterbury has conducted preliminary investigations that confirmed that automation of the Cam River Floodgate is possible, however with many required considerations.

3.2 The Kaiapoi River Rehabilitation Working Party has fully allocated a budget of $105,000 for 2019-20, and 2020-21 to projects in the Kaiapoi River (sediment trap construction, planting and river bank realignment), therefore there is no unallocated funding currently at the discretion of the Working party to allocate.

3.3 The Cam River Floodgates were designed and built in 1971/72 to prevent floodwater from the Waimakariri River overtopping the stopbanks upstream of the Floodgates. The Cam River Floodgates are an Environment Canterbury – owned and managed asset. When the water level at the Waimakariri River Gorge gauge reaches 3.5m the floodgates are lowered manually. Once the flood levels have receded the floodgates are raised again. The floodgates were designed for rare, temporary flooding.

3.4 A report into the cause of saline incursion by Adrian Meredith at Environment Canterbury, entitled ‘Assessment of the state of a tidal waterway – the Lower Kaiapoi River’ (March 2018), concluded that observed changes were mostly likely due to increasing episodes of saline water intrusion flowing into the lower Kaiapoi River. This conclusion is supported by salinity measurements taken by Environment Canterbury.

3.5 The saline intrusions are thought to be a result of bed level changes following the 2010-11 Canterbury earthquakes. Saline intrusion episodes in the lower Kaiapoi River are also hypothesised by Meredith (2018) to result from low flows in the Waimakariri River, generally in summer and autumn, allowing saltwater to penetrate further up the mouth of the Kaiapoi and Cam Rivers, with flow data supporting this hypothesis.

3.6 A report on the ecological and wider implications of saline incursions in the Kaiapoi River, including the Cam River catchment was presented to the Utilties and Roading Committee in April 2019 (190115003326[v2]). An agreed response strategy to the increasing saline incursions, such as to protect against (for example with a tidegates), or to accommodate (for example with provisions in the District Plan), has not been decided upon by the Waimakariri District Council. The saline incursions will likely be exacerbated by sea level rise, and modelled decreasing flows in the Waimakariri River in the summer time.

3.7 Environment Canterbury is continuing to undertake salinity monitoring during summer months in the Kaiapoi River, to assess when saline incursions occur, and further assess the level of relationship of saline incursions in the Kaiapoi and Cam Rivers to the minimum flow levels in the Waimakariri River.

4. ISSUES AND OPTIONS

Options

4.1. Options that have been discussed by the Kaiapoi River Rehabilitation Working Party include:

(1) Maintaining the status quo, with use of the floodgates only during floods in the Waimakariri River, with manual operation.

(2) Using the flood gate as a tide gate during periods of saline incursion, with manual operation, as and when there are low flows in the Waimakariri River. Manual operation however is labour intensive

(3) Modifying the flood gate for automated use as a tide gate for periods of saline incursions (i.e. low flow in the Waimakariri River). Automated salinity meters downstream of the floodgate, would transmit information of saline incursions occurrences via telemetry. This is the option recommended by the Kaiapoi River Rehabilitation Working Party, and therefore has been detailed further in this report.

4.2. Other combinations of the options are also possible, as such automated salinity meters downstream, however to retain the manual operation of the floodgate.

4.3. As Environment Canterbury is the asset-owner, any decisions for design and budget allocation for modification of the floodgate would need to be in consultation with Environment Canterbury.

Issues for automation of the Cam River Floodgate

4.4. The adaption of the floodgate to be used as a tidegate has many engineering, economic, ecological and cultural considerations.

Engineering and hydrology

4.4.1. The floodgate would be required to be modified to enable ease of opening and closing, to withstand corrosion from saline water, and to be submerged for longer periods. Winch motors have been proposed to be installed by Environment Canterbury as an opening and closing mechanism, with a modification to the lifting mechanism.

4.4.2. A power supply to the floodgate would be required to be installed for automation of the gate. Saline telemetry meters could operate off a mains, battery or solar supply.

4.4.3. Back-up power would need to be considered, as well as the increased cost of on-going maintenance, due to salinity exposure, increased use and more components.

4.4.4. Telemetry would need to be installed for the salinity meters, with a party, such as Environment Canterbury or Waimakariri District Council, who would receive and monitor the information. The telemetry meters would need to be carefully placed to ensure that salinity changes were detected within appropriate timeframes.

4.4.5. Security of the tidegate and salinity meters from vandalism or any activities that could endanger the public would need to be considered.

4.4.6. An assessment of the hydraulic and capacity effects on the Cam River and other waterbodies, such as the Kaiapoi River would need to be carried out. This should specifically examine what the effect of a fresh or flood in the Cam River would

have if the tidegate was closed, whether there would be sufficient flushing flows to clear built-up sediment behind the tidegate when opened, and salinity effects for the Kaiapoi River. Potentially the mechanism for the tidegate could be designed to have an override function to be open if floodwater needed to drain downstream, to not flood properties upstream of the Cam River Tidegate.

4.4.7. Hydrological investigations should consider the potential effect of raised groundwater levels upstream of a Cam River Tidegate. Investigations should also consider the effect of a Cam River tidegate for consequential effects on flood conveyance of the lower Ohoka Stream, lower Cust River and Silverstream and associated flood risk for properties adjoining the lower reaches of these waterways with higher tidal inflow as a consequence of less upstream conveyance into the Cam River system.

Economic

4.4.8. There is potential that preventing saline incursions with a tidegate would protect an area of productive land or with infrastructure upstream of the tidegate from saline effects in the medium term, but potentially not in the longer term, due to sea level rise. It had not been investigated in this report how substantial this area could be.

4.4.9. There is an opportunity cost to pursuing a feasibility study for automating the floodgate i.e. the budget could possibly be allocated to other projects to achieve the intended benefits, however a wider scope of potential options has not been carried out.

Ecology

4.4.10. Some species, such as the introduced Canadian oxygen weed (*Elodea Canadensis*) do not tolerate prolonged periods of saline water. Therefore these species would benefit from prevention of saline incursions through the operation of the tidegate. However many species, often thought of as freshwater species, such as brown trout, īnanga and eels, also inhabit saline estuarine environments. Freshwater mussels (*Echyridella menziesii*), that are known to be present in the Kaiapoi river above the mouth of the Cam River, and therefore potentially also around the Cam River Floodgate, are saline tolerant to some degree. Saline tolerant weedbed species, such as the native plant *Ruppia megacarpa* would naturally establish from seed source nearby if a tidegate was not in operation.

4.4.11. The tidegate would likely create a fish passage barrier that could prevent migratory fish (both introduced and native species) from completing their lifecycle. However, to what severity the tidegate would be a barrier requires further investigation of the time of year and length of time that the tidegate would be operating. A fish passage facility, such as a ‘window’, as that designed for the Taranaki Floodgate, could be a potential solution to enable fish passage. However, it should be noted that the Taranaki Floodgate ‘window’ is a novel design, yet to be monitored for results.

4.4.12. The tidegate, by changing the location of the saltwater wedge, where freshwater overlays saline water, would likely change the location of īnanga spawning habitat, located in 2019 by Aquatic Ecology Ltd for around the confluence of the Cam River with the Kaiapoi River. It would recommended, and potentially a consent condition, to monitor the new location(s) of the spawning habitat, and ensure that an appropriate vegetation cover of grasses, with low shading is provided at these locations.

4.4.13. One of the hypothetical benefits of a tidegate is reducing inflow of high suspended sediment backwash from the Waimakariri River flowing into the Cam River system, where it removes habitat for invertebrates and fish species that use interstitial spaces on and around rocks.

4.4.14. Potentially the current ecosystem and species present have already adapted to the saline incursions due to the length of time that they have been occurring.

Cultural

4.4.15. There are potential effects to mahinga kai, such as changes in the abundances of species that are available for harvest.

4.4.16. There are potential effects on silent files areas, such as the changes to water levels behind the Floodgate location, upstream of the Cam River.

Social

4.4.17. The social benefits, of maintaining a freshwater environment versus allowing an increasing estuarine environment to establish, have not been assessed with the local community. The preference for a freshwater environment or tidal / estuarine is a subjective question that would likely have a range of views.

4.5. The feasibility studies that are proposed to be carried out with the budget request of $15,000 are:

4.5.1. Assessment / advice on all consents and permissions that would be required to undertake the modification to a tidegate, with status of each proposed activity in each plan (i.e. permitted, restricted discretionary, controlled activity).

4.5.2. A concept design and costing of the works by a suitably - qualified engineer.

4.5.3. Preliminary consultation with Te Rūnanga Ngāi Tūāhuriri (potentially via Mahaanuai Kura Taiao Ltd and/or directly).

4.6. The Management Team have reviewed this report and support the recommendations.

5. COMMUNITY VIEWS

5.1. Groups and Organisations

5.1.1. Kaiapoi River Rehabilitation Working Party

The Working Party agreed with a motion at a meeting on the 25 September 2019 that it would request funding for a formal investigation and engineering options and implications report into future floodgate automation, with funding to be sought for this from the WDC annual plan budget.

5.2. Wider Community

5.2.1. The wider community has not been consulted on the proposal to automate the Cam River Floodgate. Individual members of the community have raised the idea with the Kaiapoi River Rehabilitation Working Party and Waimakariri District Council.

6. IMPLICATIONS AND RISKS

6.1. Financial Implications

6.1.1. It should be noted that this report requesting $15,000 is for a feasibility study only. This is recommended to come from the District-wide rate.

6.1.2. Environment Canterbury estimates the cost of full automation of the floodgate, including link to an electronic salinity sensor is approximately $45,000 to $50,000. An additional cost is the resource consents to approve the changed floodgate operation, estimated at $30,000, project management fees, and project contingencies. These estimates include costs of the investigations needed to support the consent processing (see Table 1).

6.1.3. A cost-sharing agreement with Environment Canterbury is recommended to be discussed, particularly if the project proceeded to construction stage.

Estimate of Costs for Full Automation (provided by Environment Canterbury) Note these estimates are a high level first approximation. Costs for investigations and consenting could be quite different, and excludes the on-going increased cost of maintenance.

Investigation/Design – Mechanical/Electronics/Safety/Security	$10,000
Downstream Salinity Meters/Data Loggers/Telemetry	$5,000
Power to downstream Salinity Meter – 240V/Battery/or potentially solar	$3,000
Upstream Salinity Meter/Data Logger/water level recorder/Telemetry	$5,000
Power to upstream Salinity Meter and Cam Floodgates	$6,000
Power winches (2)	$2,000
Fitting and modification – lifting mechanisms	$5,000
Fish Passage modifications	$3,000
Over-ride systems and back-up power	$5,000
Electronics	$3,000
Investigations for Consenting	$15,000
Consents for converting to a tidegate as well as for Salinity Meters	$15,000
Professional fees for project management	$30,000
Contingencies (30%)	$32,000
Total	**$139,000**

Table 1: Estimate of costs to automate the Cam River Floodgate

6.2. **Community Implications**

6.2.1. The implications for community members would be varied, with advantages and disadvantages depending on;

6.2.1.1. The subjective preference for freshwater or estuarine environments;

6.2.1.2. The degree of environmental effects (yet to be established in an Assessment of Environmental Effects), such as the level of saline inundation prevented, and effect on local ecology, flooding and sedimentation for the Cam River and surrounding waterways.

6.3. **Risk Management**

6.3.1. It is recommended to lead a wide community discussion with our coastal communities in the District regarding response strategies for increasingly saline environments from sea level rise, and for any advocacy to change minimum flows set for the Waimakariri River. Otherwise, there is a risk that budget could be allocated to conflicting response strategies, such as to protect the lower Cam River freshwater environment from saline incursions with a tidegate, or

encouraging saline-tolerant weedbeds to establish, which could provide coastal erosion protection in the future.

6.3.2. In the longer term, it cannot be assumed that a tidegate would be sufficient to maintain a freshwater environment, with increasing sea level, and potential saltwater inundation of groundwater along the coast. There is a risk that installation of a tidegate would incorrectly signal to the community that a freshwater environment could be maintained into the future.

6.4. **Health and Safety**

6.4.1. A health and safety risk assessment to the public of more regular opening and closing of the floodgate, as a tidegate, would be included as part of the feasibility study.

6.4.2. Assessment of Environmental Effects of the automated tidegate proposal would require a contractor conducting fieldwork to meet health and safety requirements.

7. CONTEXT

7.1. **Policy**

7.1.1. This matter is not a matter of significance in terms of the Council's Significance and Engagement Policy.

7.2. **Legislation**

7.2.1. Consents would be required under the Canterbury Land and Water Regional Plan, District Plan (under the Resource Management Act 1991). These could potentially be notified or non-notified consent applications.

7.2.2. Permission to obstruct fish passage would be required under the Freshwater Fishery Regulations 1983 (Part 6).

7.2.3. Additional consents and permits would likely be required, such as signalled by the proposed National Policy Statement– Freshwater Management from the Ministry for the Environment regarding fish passage.

7.3. **Community Outcomes**

7.3.1. Our district has the capacity and resilience to quickly recover from natural disasters and adapt to the effects of climate change.

7.3.2. There is a healthy and sustainable environment for all

7.3.3. Harm to the environment from the impacts of land use, use of water resources and air emissions is minimised.

7.3.4. Cultural values relating to water are acknowledged and respected.

7.4. **Delegations**

7.4.1. The Council holds the authority to allocate budget in the Annual Plan.

MINUTES JOINT WORKING PARTY
KAIAPOI RIVER REHABILITATION PROJECT

ENVIRONMENT CANTERBURY AND WAIMAKARIRI DISTRICT COUNCIL

MEETING IN THE KAIAPOI SERVICE CENTRE COUNCIL CHAMBERS
176 Williams Street, Kaiapoi
Wednesday 25 September 2019 at 4:00pm – 5:30pm

Purpose	Oversee the work required to scope in-stream proposals for improving water quality, navigability, flood hazard management, amenity and recreation in the Kaiapoi River.	
Working Party Members	Neville Atkinson (apologies for lateness); Claire McKay (Environment Canterbury); Michael Blackwell (Waimakariri Zone Committee); Kevin Felstead (Waimakariri Deputy Mayor – Chair of this Meeting); Sandra Stewart (Kaiapoi-Tuahiwi Community Board).	
Staff Advisors (as required)	Adrian Meredith; Andrew Arps; Brian McIndoe (Environment Canterbury) Grant McLeod, Sophie Allen, Duncan Roxborough, Janet Fraser, Gerard Cleary (Waimakariri District Council)	
Apologies	Position vacant (Mahaanui Kurataiao Ltd); Position vacant (Te Ngāi Tūāhuriri Rūnanga). Owen Davies, Chris Brown (Waimakariri District Council)	
Attachments	Finalised Comprehensive Planting Plan	Prepared by Tori Stableford
	Notes: Cam River Floodgates to Tidegates	Prepared by Brian McIndoe

Key Objective for the Working Party:

Oversee preparation of a report, initially for consideration by the Kaiapoi Community Board, and then by Environment Canterbury and Waimakariri District Council, setting out a possible costed programme of work that would be required to meet the water quality objectives, navigability requirements, flood hazard management, amenity and recreation imperatives for the Kaiapoi River.

Business

1. Welcome and Apologies

Cr. Kevin Felstead chaired the meeting. Also present were Michael Blackwell (Waimakariri Water Management Zone Committee), Sandra Stewart (Kaiapoi Tuahiwi Community Board), Neville Atkinson (Kaiapoi Tuahiwi Community Board – apologies for lateness), Claire McKay (Environment Canterbury).

Apologies were received from Jason Eden on behalf of Ngāi Tūāhuriri and Mahaanui Kurataiao Ltd.

Moved: Sandra Stewart Seconded: Kevin Felstead

CARRIED

2. Confirmation of Minutes

Minutes of a meeting of the Kaiapoi River Rehabilitation Working Party held on Wednesday 20 March 2019

RECOMMENDATION

That the Working Party:

(a) **Confirms** as a true and correct record the minutes of a meeting of the Working Party held on Wednesday 20 March 2019.

Moved: Sandra Stewart Seconded: Kevin Felstead

CARRIED

3. Review of Comprehensive Planting Plan

Janet provided an overview of the plan to the Working Party. During the meeting the plan was workshopped and its provisions were generally agreed among all present.

Brian confirmed that ECan will undertake willow control through the Kaiapoi River between the Coastguard and the Askeaton Reserve in January and February 2020. Dead trees will be removed and damaged trees will be pruned. Stumps will be left in the lower banks to stabilise them.

Brian noted the risk of wave lap erosion destabilising the river stopbanks in the areas where the willows are removed.

It is intended that the WDC terrestrial and wetted edge planting programme will provide infill around the areas where willows have been removed later in 2020, as shown in the plans.

For placement of plantings, Brian notes that flax and other “heavier” plants and shrubs need to be at a distance of 1m from the toe of the stopbank to maintain their stability. Other lighter/smaller plants including grasses can be planted up to the toe of the stopbank. No plants should be placed directly on the side of the stopbanks.

Andrew noted that Riverside Nurseries (Natural Habitat Landscapes) have a large number of low cost wetland plants that will need to be planted out shortly.

Action: Sophie to follow up with Riverside Nurseries regarding the suitability of these plants for the Kaiapoi River planting and for other pending WDC wetland planting projects.

Note: the plant list was subsequently reviewed by Sophie and was not considered suitable for the pending Kaiapoi aquatic or terrestrial plantings.

An updated version of the planting plan will be recirculated to all participants following the meeting.

The plan is a "live" document, intended for ongoing update as a working document.

Note that the programme outlined in Section 7 includes funding to implement much of the comprehensive planting plan in 2019/20 and 2020/21. Note that some decisions on shrub/tree removal will however be referred to the Kaiapoi – Tuahiwi Community Board for decision.

4. Ongoing Plant Maintenance & Weed Control

The Working Party agreed to recommend that an ongoing plant maintenance programme be established which will undertake:

a) Ongoing removal of juvenile exotic trees (including juvenile willows) and weeds, including ivy and yellow flag iris, inside the stopbanks
b) Infill planting as required to fill gaps and replace dead plants
c) Promote viability of existing terrestrial native plantings
d) Remove raupo cages from the previous year aquatic wetland plantings

Note that ongoing willow control is a function of Environment Canterbury and will not be included in the proposed Waimakariri District Council plant maintenance programme, other than for growth of juvenile plants.

It is suggested the Working Party recommend that the Waimakariri District Council include an ongoing budget of approximately $2,000 per annum commencing in 2020/21. The budget will be revised once detailed cost estimates from Delta Parks Contractors are received and an appropriate budget is recommended to be included to cover this work.

This programme would continue for a period of at least 4 years and be used for ongoing maintenance inside the stopbanks. This is intended to protect the viability of the newly establishing native plants, continue infill planting as required and provide ongoing removal of noxious or other problem weeds.

Action: Grant to include budget in 2020/21 Annual Plan.

Note: subsequent to the meeting Delta declined to undertake the proposed plant maintenance works. Therefore Wai-Ora Landscapes (or similar ecological restoration company) will now be approached to undertake the works. The works will be funded from the Greenspace Account and rated district wide as a component of the Parks Maintenance Programme.

5. Option to use Dredged Spoil to Widen Stopbanks

There is an option to utilise some of the dredged river spoil to widen stopbanks. To date the marina basin dredging has excavated material that is approximately half gravelly sand and half fine silts. The gravel/sand material is sitting in stockpiles adjacent to the dewatering basin and is ready for further reuse. The silty material remains within the basin to further dry before it will be extracted and stockpiled.

Brian advises that the area between Hall Street and the Corcoran Basin is suitable and desirable for stopbank widening. The compaction and stopbank design would involve

commencing a bench at 1m below the top of the current stopbank (e.g. the bench highest point at approximately 3mRL), with a 3:1 side batter from the existing stopbank to the newly formed outer bank toe. The bench would be in the form of a wider ramp extending from the landward side of the existing stopbanks.

However there is a stormwater asset traversing the toe of the stopbank for the full distance between Hall Street and the Corcoran Basin.

Action: Janet will follow up with the drainage team about potential use of the dredged spoil to widen this area of stopbank.

Other possible uses of the dredged spoil are:

- Build-up of slumped land at the Askeaton Reserve
- Wetland in-fill in the Kaiapoi wastewater treatment plant
- Build up other low lying land in the Regeneration Zone

The reuse of material for any of the above options is subject to pending contamination and salinity testing which will determine suitable future land uses.

A further factor is spoil composition. This will determine whether the material is able to be suitably compacted for reuse in widened stopbanks or other types of land use.

If no particular areas are identified for stopbank widening, then a default option for use of the balance of spoil not required for other purposes is for it to be bulldozed into the side of the stopbanks along Charles Street. Any material incorporated into the stopbanks will be suitably compacted.

6. Updates

Adrian Meredith – Update on salinity monitoring in Kaiapoi River

Adrian noted the salinity probes are now being put back in the Kaiapoi River to record saline incursions this summer. These will show any effects of the dredging on degree of saline intrusion affecting the river as a result of the deepened river bed contours.

Sophie Allen – Waimakariri District Council views on salinity report/ pigeon control options

Kaiapoi River salinity - Sophie commented on the discussion among the Utilities and Roading Committee about the considerations raised in Adrian's report on increasing salinity in the Kaiapoi River. The uncertainties concerning future effects were recognised. The Committee did not take a position on preferred response strategies at this stage. However it acknowledged that the future Council/ community response will likely involve a need for local adaption to the new conditions in the river including adapting to potential effects in the lower tributaries which are also affected by ongoing saline intrusion.

Pigeon control – The Roading department is seeking a price from SICON to implement the potential options to prevent pigeons from nesting beneath the Williams Street Bridge. The investigations are in progress but the pigeon removal operation may not be undertaken this financial year.

The options include blocking nesting locations with mesh wiring or with solid inserts. Various design options to block the pigeon access are being considered by the Roading team. The trapping of pigeons is required in advance/ in conjunction with the works so the colony does not immediately relocate to an alternative location. The accumulated faecal matter beneath the bridge will also need to be removed before the barriers are installed.

Andrew Arps – Update on Environment Canterbury terrestrial planting

Andrew is awaiting an update from Park Ranger Greg Stanley who undertook the river terrestrial planting over the previous year. Once provided this update will be circulated to the Working Party. Information on any further terrestrial planting to be undertaken by ECan along the Kaiapoi River will also be provided.

Grant McLeod - War Memorial Redevelopment

Grant described the proposal for the War Memorial area is likely to be in the form of an investigation paper or concept design presented to the Kaiapoi Community Board for consideration.

Specific feedback during the meeting was provided about the existing shrubbery surrounding the War Memorial. This area was noted to be providing current habitat for Tui and other native birdlife. It also provides shelter for people walking along the river during easterly winds. A design proposal or discussion document will be taken by Grant to the Kaiapoi Tuahiwi Community Board in the 2019/20 financial year. This could include the following considerations:

- Protecting currently established bird habitat
- Establishing view shafts over the river if/ where appropriate
- Consultation with the Kaiapoi RSA
- Retaining pedestrian shelter from easterly winds
- Opening up the existing walkway through the existing shrubs down to the water's edge

Brian McIndoe – Willow removal and automating the operation of the Cam Floodgate

Willow Removal – Brian noted the ECan willow control will be undertaken in January and February 2020 between the Coastguard Ramp and the Askeaton Reserve.

Cam Floodgate- ECan staff have identified that it is technically possible to fully automate the Cam floodgate. The gate could be electronically linked to a salinity gauge that could automatically lower the gate into the river during times of saline incursion.

Brian estimates the cost of full automation of the flood gate including link to an electronic salinity sensor is approximately $45,000 to $50,000. An additional cost is the resource consents to approve the changed floodgate operation, estimated at $30,000. These estimates include costs of the investigations needed to support the consent processing. A further update paper was provided by Brian subsequent to the meeting and is attached to these minutes, for information.

The intent of the automated floodgate operation is to avoid or limit saline intrusion into the lower Cam River during times when there is high salinity on the incoming tide. This would retain a freshwater environment in the lower Cam River for longer periods and minimise effects on its freshwater species. The gate automation would improve habitat for freshwater species such as freshwater mussels.

A further benefit is reducing inflow of high suspended sediment backwash from the Waimakariri River flowing into the Cam River system, where it then sloshes back and forth with the tide.

Some implications of the floodgate operation that would need to be assessed through the Environment Canterbury consent process are:

- The requirement to obtain Environment Canterbury (and Department of Conservation) resource consent/ approval to block fish passage
- Design of a suitable fish bypass, ensuring fish passage into the Cam River system whilst minimising saline encroachment
- Maintain freshes and outflow / conveyance from the Cam River during wet weather in the foothills catchment, which can assist to flush sediment and weeds from the system
- Consequential effects on salinity in the Kaiapoi River mainstem and upstream tributaries, if saline water is pushed further upstream in the Kaiapoi River

- Consequential effects on flood conveyance of the lower Ohoka Stream, lower Cust River and Silverstream and associated flood risk for properties adjoining the lower reaches of these waterways with higher tidal inflow as a consequence of less upstream conveyance into the Cam River system

The Working Party agreed that it will request funding for a formal investigation and engineering options and implications report into future floodgate automation. Funding will be sought from the WDC annual plan budget.

Action: Sophie to work with Brian McIndoe to draft a report to the Utilities and Roading Committee, then to Council requesting budget for the 2020/21 annual plan to formally investigate engineering options and implications of automating the Cam River floodgate for saline incursion response.

Duncan Roxborough – Kaiapoi River Dredging

The dredging of the marina basin is near complete, with the Riverview Pontoon installed and a deep berthing pocket established for vessels berthing at the pontoon. The pontoon can be used now, but its full construction will be complete once its services (lights and power) are installed.

A small pocket of dredging adjacent to the wharf was not completed and final dredge depths in the marina basin have not yet been reached.

The dredging will recommence next year in the period from 1 June to 15 August. During this time the Council will complete the balance of the marina basin berthing dredging and will excavate the navigation channel from the Coastguard to the Kaiapoi / Waimakariri confluence.

Navigation dredge channel volumes are less than originally anticipated. The minimal channel dimensions (10m wide flat bottom channel at -2.5mRL) could potentially be widened further from the original channel design plans, within the existing contracted extraction allowance.

Janet Fraser – Alternative Backhoe Dredge Consents

The Council is discussing consent conditions with Environment Canterbury for alternative backhoe dredging consents. These will be needed to dredge small pockets (with a long reach digger on a barge) where larger boulders and gravels in the river cannot be sucked into the suction pump hose and pumped to the dewatering basin. This will enable the Council to complete all of the intended dredging next winter.

7. General Business

7.1 Proposed Forward Work Programme for Waimakariri District Council

It is proposed to continue to implement the previously scoped Kaiapoi River Rehabilitation Projects. The identified projects and updated proposed implementation dates (and indicative budgets) are outlined in the following table.

Combining available Kaiapoi River aquatic planting budgets, the Waimakariri District Council currently has approximately $18,000 budget available in 2019/20 to continue aquatic planting, terrestrial planting and weed control works between the Mafeking Bridge and the Courtenay Confluence.

A further site visit of the planting trial area is proposed with the Working Party in November 2019. This will be held prior to commencing the summer planting and weed control programme and will finalise the 2019/20 aquatic and terrestrial planting locations.

The following locations and activities are currently proposed:

Table 7.1: Summary Proposed Kaiapoi River Rehabilitation Programme

Activity	Description	Year			
		2018/19	2019/20	2020/21	2021/22
Extend aquatic planting to Courtenay Confluence Augment existing terrestrial planting	Extend aquatic planting from Mafeking Bridge to Courtenay Confluence Augment previously successful planting trial areas with additional plantings Weed and willow control to ensure available light wells Yellow flag iris control Augment existing terrestrial planting with new native planting on lower river banks	-	$18,000*	$20,000*	-
Kaiapoi River Navigation Dredging	Complete navigation channel safety component of Kaiapoi River dredging	$350,000		-	-
Gravel Beach/Wetland	On raised shelf at corner of Charles and Smith Street adjacent to fishing hole	-	-	$10,000	-
Sediment trap at Mafeking Bridge	Create a slow flow channel and major sediment trap with central planted island	-	-	-	$50,000
Realign River Bend at Smith/Charles St Corner	Requires earthworks and further consultation with Fish & Game and Ngāi Tūāhuriri.	-	-	-	$25,000
Total			**$368,000**	**$30,000**	**$75,000**

*Includes $10,000 per annum from Waimakariri Water Management Zone biodiversity funds, with the balance from the Kaiapoi urban drainage account.

The proposed funding allocation is indicative. It is likely that funding for some projects may exceed the above estimates and for other projects may be less than estimated.

The Working Party has progressed proposals on the basis that a 50% cost share will be provided by the Waimakariri District Council and Environment Canterbury for each project. The programme above is currently budgeted by Waimakariri District Council, including underwriting the requested 50% Environment Canterbury cost share to enable the works to proceed.

The $10,000 per annum allocated from Waimakariri Water Management Zone biodiversity funds are a Waimakariri District Council contribution to the Zone Committee work programme. These are not Environment Canterbury Immediate Steps funds.

The Working Party may wish to reiterate its previous request to Environment Canterbury to provide a 50% cost share to contribute to the continuation of the river rehabilitation programme (see previous meeting minutes).

8. Recommendations

THAT the Working Party:

(a) **Endorses** the continuation of the Kaiapoi River Rehabilitation programme as outlined in Table 7.1.

(b) **Notes** the proposed funding in Table 7.1 is indicative, and final allocations may differ among the recommended projects following more detailed planning with the project contractor/s.

(c) **Recommends** the Waimakariri District Council includes an ongoing inner stopbank maintenance programme potentially with Wai-Ora Landscapes or other selected contractor, estimated at $2,000 per annum or other price as agreed with the selected contractor, and be ongoing for at least four years. This programme is to cover weed removal, provide for infill planting as required and protect the viability of existing plants.

(d) **Recommends** that Environment Canterbury consider through its Annual Plan process provision of a $25,000 budget in 2021/22 to contribute to the cost of establishment of the slow flow channel, central-island and major sediment trap formation upstream of the Mafeking footbridge.

(e) **Requests** Waimakariri District Council staff prepare a report that requests Annual Plan 2020/21 budget provision from the Waimakariri District Council to cover investigation of issues and options to automate the Cam River floodgate, electronically connected to a salinity sensor.

(f) **Notes** recommendation (e) would seek in kind support from Environment Canterbury of specialist advice regarding the automation of the floodgate.

(g) **Notes** a Working Party site visit will be arranged in November 2019, to review specific sites for Waimakariri District Council aquatic and terrestrial planting in the 2019/20 year.

Moved: Neville Atkinson **Seconded: Sandra Stewart**
CARRIED

9. Other General Business

Sandra queried how the Waimakariri River minimum flow allocation is currently measured and restrictions applied. For instance, how is the 41 cumecs cut off point for abstractions measured and how are the in-river flow gauge devices calibrated. Environment Canterbury staff have agreed to provide an explanation report on this process to the next meeting of the Waimakariri Water Management Zone Committee.

10. Closing and Next Meeting Date and Time

It was raised that this meeting may potentially be the last meeting of the Kaiapoi River Rehabilitation Working Party, with a proposal to incorporate the Party into the WDC Land and Water Working Group – to be discussed by the newly-elected Council. Gerard Cleary thanked the Party for their hard work over many years.

AGENDA ITEM NO: 3	**SUBJECT:** ZIPA Implementation – Update
REPORT TO: Waimakariri Water Zone Committee	**MEETING DATE:** 2 December 2019
REPORT BY: S Allen, WDC Water Environment Advisor & Murray Griffin, CWMS Facilitator – Waimakariri, ECan	

Waimakariri Land & Water Solutions Programme – Update

Background

The Zone Implementation Programme Addendum (ZIPA) for the Waimakariri Water Zone was adopted by Waimakariri District Council and Environment Canterbury in December 2018. This report outlines progress on implementation of ZIPA recommendations up until the 21 November 2019.

Summary of key progress

Waimakariri District Council

- Stormwater Network Discharge Consent monitoring programmes have been drafted, with Rangiora and Woodend monitoring programmes lodged with Environment Canterbury. Oxford and Kaiapoi at to be lodged by the end of 2019. These programmes are due to commence mid-2020. (ZIPA Rec. 1.4-J)

- Stormwater quality baseline sampling from 2014 and 2016 has been summarised in a 19 November 2019 Utilities and Roading Committee report (circulated to WWZC for information). (ZIPA Rec. 1.4-J)

- Forestry overspray and sedimentation incident at the WDC-owned Forrestdale Wetland investigated. Advice provided by Environment Canterbury. Remediation response undertaken by forestry company to replant and create 10m planting buffer. (ZIPA Rec. 1.5)

- Drainage review report of WDC drainage management scoped in a memo to Drainage Asset Manager. Review scheduled Dec 2019 – Feb 2020. $20K allocated. (ZIPA Rec. 1.7, incl. 1.7 a & b)

- Fish survey work undertaken November 2019 to establish fish passage issues and design requirements for remediation at Plasketts Road (No. 3 Drain) and Cust Main Drain. (ZIPA Rec. 1.8c)

- ‘Drain shading’ pilot proposed by WDC drainage team i.e. native planting along problematic drains with the purpose of reducing high cleaning frequency. Pilot drains yet to be decided. $20K allocated in 2019-20. (ZIPA Rec. 1.14)

- WDC-managed drains are included in the Drainage Review (Rec 1.7), which includes a discussion of mahinga kai, wāhi tapu and wāhi taonga. (ZIPA Rec. 1.20)

- Below the Ashley Rakahuri gorge is proposed to be listed at a Significant Amenity Landscape, and Te Aka Aka as an Outstanding Natural Feature in the District Plan – Boffa Miskell report. (ZIPA Rec. 1.22)

- Upper Catchment of the Ashley Rakahuri (Puketeraki Ranges above the gorge, excluding the plain) recommended to be an Outstanding Natural Landscape in the District Plan – Boffa Miskell report. (ZIPA Rec. 1.24)

- $20K allocated in 2019-20 towards public education and awareness campaigns aimed at improving the water quality and health of urban waterways. To be scoped. (ZIPA Rec. 1.25)

- Native planting and public amenity projects in the South Brook and Taranaki Stream Weeding work commenced in November 2019. Culvert installation, planting, and path construction to be completed by 30 June 2019. $70K allocated in 2019-20. (ZIPA Rec 1.26)

- Cam River Enhancement Fund:
    - Three minor sediment traps have been installed on Tuahiwi Stream, and bank stabilisation works have been carried out. Waiting for a district-wide 'Maintenance and Minor Works in Waterways' consent to undertake further works. This consent application is being processed by Environment Canterbury. (ZIPA Rec. 1.27)
    - $10K allocated in 2019-20 for Kaiapoi River tidal plantings with wetland plants, to narrow the channel and create greater flushing flows. A project brief has been written, and plant list prepared for a planting in February 2020 by contractors. (ZIPA Rec. 1.27)

- WDC has created a new full-time role of Ecologist – Biodiversity. This role has been recruited, with a projected start date of the successful candidate in mid-January. (ZIPA Rec. 2.2c). Ecologist-Biodiversity will work with the Water Environment Advisor to support landowners. (ZIPA Rec. 1.18)

- $10K has been allocated in 2019-20 towards climate change and sea level rise impacts on indigenous biodiversity in the Waimakariri Water Zone. To be scoped. (ZIPA Rec. 2.4)

- $10K has been allocated in 2019-20 for ecological survey work of ecological values (on an as-required basis), that can inform Council planning and operational activities. Survey work was carried out for the North Brook wai kōura population in September 2019 by Wildlands Ltd, which showed positive news; that no trout were present above the protective weir. (ZIPA Rec. 2.5)

- On-going discussions with WDC planners for the District Plan, such as rates rebates and a draft policy on awarding 'transferable development lot' rights (an ability to subdivision and sell a lot) in exchange for biodiversity protection. (ZIPA Rec. 2.10)

- Inanga spawning area improvements have been scoped for Taranaki Stream, McIntosh Drain and Courtenay Stream. Pampas, gorse and willow removal due to

be carried out in late-November at McIntosh and Courtenay Stream, with native re-planting after 1 June, due to no disturbance of the sites during the inanga spawning window. Taranaki Stream will be undergo improvements in 2020-21, when a consent is in place for bank regrading. Environment Canterbury has supported WDC inanga spawning area improvements with funding from the Regional Fish Habitat Improvement Fund. (ZIPA Rec. 2.11)

- WDC has allocated $10K in 2019-20 towards the testing of private drinking wells. WDC has contacted landowners of 20 wells for the pilot nitrate study in Cust and Eyreton and is obtaining final permission letters. Sampling is due to take place in late-November. (ZIPA Rec. 3.16a)

- WDC has distributed information about nitrate health impacts to landowners in the nitrate study. (ZIPA Rec. 3.16b)

- WDC has drafted a pamphlet with guidance on well depth and well-head security, in collaboration with ECan Groundwater. This will be independently reviewed and formatted by a graphic designer in 2020. $5K allocated towards this in 2019-20. (ZIPA Rec. 3.17)

- Management structure of the Land and Water Committee created within Council in November 2019. Memorandum of Understanding drafted between ECan and WDC for ZIPA Implementation at the staff-level. (ZIPA Rec. 3.25)

- **Cam River Floodgate Report** – This report details a proposal from the Kaiapoi River Rehabilitation Working Party to investigate the feasibility for automation of the Cam River Floodgate to become a tidegate, for prevention of saline incursions upstream. This report is provided as **agenda item 3.1**.

- **Urban Stormwater Water Quality Baseline Results and Issues Report** – This report summarises baseline water quality data for urban stormwater areas of Rangiora, Woodend, Kaiapoi, and Oxford, and raises issues identified. Comparison was made to exceedance levels in Schedule 5 of the Canterbury Land and Water Regional Plan, (LWRP), or the ANZECC Water Quality Guidelines for Fresh and Marine Water Quality, (2000). This report is provided as **agenda item 3.2**.

Environment Canterbury

Science

- Counter-weight levers have been installed on the Courtenay and Kairaki Creek floodgates. This is to promote extended opening times and fish passage on the low tide. Monitoring of gate opening durations prior to fixes were undertaken by a summer student. This will be followed up in due course to measure the effectiveness of the levers.

- A new floodgate has been built to replace the existing Taranaki Creek floodgate. The new floodgate is designed with an adjustable aperture near the top. Once installed, this will allow improved passage of inanga on the surface during all tidal cycles.

Limited fish monitoring was undertaken upstream of the gate in early 2019. Fish passage efficiency will be monitored on the new gate.

- Scoping the feasibility, benefits/detriments, and requirements for converting the Cam River Flood gate into an electrically operated Tide gate.

- Commissioned inanga spawning surveys in lower Kaiapoi Catchment to inform WDC inanga spawning habitat improvements.

- Initial discussions and planning around connecting of Kairaki Creek with Pines Beach Wetlands to promote habitat connection held in November.

- Commission trout spawning surveys in the Kaiapoi River catchment, specifically the Cust River fishery.

- Community education – Lincoln University student field trip, led by Environment Canterbury, focused on awareness of aquatic and mahinga kai values, and issues in the Waimakariri Zone. Visits to Ashley River / Rakahuri – Saltwater Creek Estuary, Taranaki Creek and lower Ashley River / Rakahuri.

- Additional recreational water quality monitoring site picked up at Ashley River / Rakahuri at SH1.

- Ongoing salinity monitoring of Kaiapoi River to increase the database to enable a model/relationship between salinity intrusion and Kaiapoi River Flows/Waimakariri River flows/ and High tide height.

- Continuous Nitrate data logger re-established on the upper Silverstream catchment.

- Age tracer data for streams, and modelled particle tracking for drinking water supplies, have been completed in support of Plan Change 7. This monitoring addressed lag times between land use and nitrate concentration changes in wells and spring-fed streams and transport pathways towards key receptors such as spring-fed streams, community water supply wells, and the Christchurch aquifer system. Link to this report: https://api.ecan.govt.nz/TrimPublicAPI/documents/download/3626251

- Members of the ECan Science team continue to work with WIL on the infiltration trial at Silverstream.

Zone Delivery

- **Ashley Rakahuri River**

Currently developing a landscape scale conservation, recreation and mahinga kai lead “On the ground Action Plan” to protect and revitalise the Ashley Rakahuri river and educate and activate others with regard to its importance as a source of health, happiness and heritage. The preparation of this will be completed in the first quarter of 2020 with on the ground work commencing in the second quarter.

As a subset of this work the following initial recommended actions have been made.

SITE NAME & ECOSYSTEM TYPE	VALUES	RECOMMENDED ACTIONS
Ashley River – Saltwater Creek Estuary Taranaki Stream • Estuary • Wetlands • Stream Land tenure - mixed	The site includes the river, the river mouth and estuary as well as the key tributaries Saltwater Creek and Taranaki Stream The Saltwater Creek Estuary is a wetland of international significance. Inanga spawning, populations **References:** FENZ IBA Rivers, Estuaries, Lagoons – 2016	Weed control. Enhance Inanga spawning habitat through fencing and restoration of riparian vegetation. Fish passage and control of non-native fish Pest control Weed control Protect/enhance nesting sites through island creation where appropriate Support the work of the River care group

- **Clean and Green Silverstream**

Riparian and Forrest planting projects are progressing well at Giles Road Reserve and the connecting land between Waimakariri Regional park and Silverstream reserve. Combined with existing planting this creates 85% uninterrupted planting and setback for the first 9 kilometres on Silverstream through to the Silverstream sub Division. More planting of larger species will take place in Autumn 2020 and then the maintenance programme will commence.

- **Caring for the Cam**

A copy of the Top 10 Tips brochure for managing sediment in the Ruataniwha / Cam River is provided as **agenda item 3-3**.

- **Education**

In addition to on farm Business as Usual engagement, a series of monthly Drop-In sessions have arranged to assist landowners with GMP and Education.

A copy of the Lifestyle Block Good Management Practice factsheet is provided as **agenda item 3-4**.

- **Fish Screen Report**

An update report is provided as **agenda item 3-5** on work undertaken to date, our new approach to fish screens, and our 5-year plan to address the current state of non-compliance across the region.