WAIMAKARIRI
DISTRICT COUNCIL

Council Agenda

Tuesday 24 October 2017

Commencing at 1.00pm

Waimakariri District Council Chamber
215 High Street
Rangiora

Members:

Mayor David Ayers
Deputy Mayor Kevin Felstead
Councillor Neville Atkinson
Councillor Al Blackie
Councillor Robbie Brine
Councillor Wendy Doody
Councillor Dan Gordon
Councillor John Meyer
Councillor Sandra Stewart
Councillor Paul Williams

The Mayor and Councillors

WAIMAKARIRI DISTRICT COUNCIL

A meeting of the **WAIMAKARIRI DISTRICT COUNCIL** will be held in the **COUNCIL CHAMBERS, 215 HIGH STREET, RANGIORA** on **TUESDAY 24 OCTOBER 2017** at **1.00PM.**

Sarah Nichols
GOVERNANCE MANAGER

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. REPORTS

3.1. Adoption of the Annual Report for the year ended 30 June 2017 – Jeff Millward (Manager Finance and Business Support)

6 - 10

RECOMMENDATION

THAT the Council:

(a) **Receives** report No. 171018112616.

(b) **Adopts** the Annual Report for the year ended 30 June 2017 (TRIM 170731080695).

(c) **Approves** the Annual Report Summary for the year ended 30 June 2017 (TRIM 170817089048).

(d) **Notes** the Net Surplus before taxation of $28.5m for the Council includes vested assets of $14.3m and $15.2m comprising primarily of development contributions and assets transferred to council ownership as a result of subdivisions.

(e) **Authorises** the Manager Finance and Business Support, in conjunction with the Chief Executive to make necessary minor edits and corrections to the Annual Report prior to printing.

NOTE: Attachments to be circulated separately

3.2. **Appointment of a Chairperson, Deputy Chair, Councillor and Commissioner to the Waimakariri District Licensing Committee – Malcolm Johnston (Environmental Services Manager)**

11 - 14

RECOMMENDATION

THAT the Council:

(a) **Receives** report 170928104745

(b) **Appoints** Councillor Neville Atkinson as Chairperson of the Waimakariri District Licensing Committee.

(c) **Appoints** Commissioner Jim Gerard as the Deputy-Chair of the Waimakariri District Licensing Committee.

(d) **Appoints** Councillor ……..as a member of the Waimakariri District Licensing Committee.

(e) **Appoints** Mr Al Lawn to the Waimakariri District Licensing Committee as a Commissioner until 31 December 2018.

3.3. **Road Safety Action Plan – Kathy Graham (Journey Planner/Road Safety Coordinator)**

15 - 42

RECOMMENDATION

THAT the Council:

(a) **Receives** report No. 171004107285.

(b) **Notes** the Road Safety Action Plan 2016-17 activity results (Doc 171005107719)

(c) **Endorses** the 2017– 2018 Action Plan (Doc 171005107741)

(d) **Circulates** this report to the Community Boards

3.4. **Stormwater Drainage Bylaw Review 2017/18 – Janet Fraser (Utilities Planner) and Owen Davies (Drainage Asset Manager)**

43 - 81

RECOMMENDATION

THAT the Council:

(a) **Receives** report No. 170907097266.

(b) **Approves** the attached proposed Stormwater Drainage Bylaw 2018 and Statement of Proposal for public consultation using the Special Consultative Procedure outlined in the *Local Government Act 2002.*

(c) **Appoints** Councillor Sandra Stewart (Drainage and Stockwater Portfolio Holder), together with Councillor…….. and Councillor…… to hear submissions on the proposal and to recommend decisions to the Council.

(d) **Notes** the proposed hearing / submissions deliberations date is Tuesday 27 February 2018 [time TBC].

(e) **Notes** that upon adoption, the bylaw will be renamed the Stormwater Drainage Bylaw 2018 to reflect the date of its last review.

(f) **Notes** that, once adopted, the Stormwater Drainage Bylaw 2018 will not be required to be formally reviewed for another 10 years.

(g) **Refers** this report to the Community Boards for their information.

3.5. **Cam River Enhancement Allocation of Funding – Janet Fraser (Utilities Planner) and Owen Davies (Drainage Asset Manager)**

82 - 207

RECOMMENDATION

THAT the Council:

(a) **Receives** report No. 170925103162.

(b) **Adopts** the "*Scoping Strategy for the Three Brooks and Channel Enhancements in the Middle Cam River and Tuahiwi Stream"* report by Dr Henry Hudson published in August 2017.

(c) **Notes** the "*Scoping Strategy*" provides a basis for allocating funding from the Cam River Enhancement Fund.

(d) **Notes** the allocation of the Cam River Enhancement Fund among prioritised projects was confirmed by the Cam River Enhancement Fund Subcommittee at its 24 August 2017 meeting.

(e) **Notes** that a further report on the future role of the Cam River Enhancement Fund Subcommittee will be bought to Council following completion of all of the physical works which are undertaken through the fund.

(f) **Circulates** this report and its attachments to the Kaiapoi-Tuahiwi, Rangiora-Ashley and Woodend-Sefton Community Boards.

3.6. **CAREX Report on Glyphosate – Greg Bennett (Land Drainage Engineer)**

208 - 229

RECOMMENDATION

THAT the Council:

(a) **Receives** report No. 171012110892.

(b) **Notes** that CAREX study did not detect any short term effect of glyphosate on freshwater invertebrates and fish following spraying of waterways.

(c) **Notes** that a follow up report on the wider use of glyphosate by Council and future maintenance provisions will be presented to Council as part of the LTP process.

(d) **Circulates** this report to the Community Boards, Drainage Advisory Groups and the Waimakariri Water Zone Committee for their information.

3.7. Electoral Voting System – Sarah Nichols (Governance Manager)

230 - 233

RECOMMENDATION

THAT the Council:

(a) **Receives** report No. 171013110952.

(b) **Retains** the First Past the Post (FPP) voting system for the 2022 and 2025 local authority elections.

OR

(c) **Approves** staff to consult with the community on preferred voting process of using First Past the Post or Single Transferable Vote method.

4. QUESTIONS

(under Standing Orders)

5. URGENT GENERAL BUSINESS

(under Standing Orders)

6. NEXT MEETING

The next scheduled meeting of the Council is on Tuesday 7 November 2017 commencing at 1.00pm.

WAIMAKARIRI DISTRICT COUNCIL

REPORT

FILE NO:	FIN-12-02 / 171018112616
REPORT TO:	Council
DATE OF MEETING:	24 October 2017
FROM:	Jeff Millward, Manager Finance & Business Support
SUBJECT:	Adoption of the Annual Report for the Year Ended 30 June 2017
SIGNED BY: (for Reports to Council or Committees)	Department Manager / Chief Executive

1. SUMMARY

1.1. The purpose of this report is to present the Annual Report for the year ended 30 June 2017 to the Council for adoption.

1.2. Overall, the year-end accounts show the Council is in a relatively sound position. The Net Operating Surplus, before taxation & other gains, for the year ended 30 June 2017 was $28.5m compared with a budgeted net operating surplus of $18.2m.

1.3. The net operating surplus, before taxation of $28.5m, after allowing capital related revenues & other gains that are required by accounting standards to be shown within the Income Statement, is generally aligned to the budget that Council adopted when setting its Annual Plan. The net surplus of $28.5m includes $14.3m assets transferred to council ownership as a result of subdivisions and $15.2m of Development contributions. A summary of main variances to budget is provided in section 3.2 and within note 31 of the Annual Report.

1.4. Borrowings have increased $5m over the last financial year from $95m to $100m, compared to the $125m budgeted. This is primarily lower due to delayed Earthquake recovery work that has been reforecast within the 2017/18 Annual Plan.

1.5. Sixty-five percent of the non-financial performance measures were met or exceeded the measure, with nineteen percent almost meeting the measure. Sixteen percent of the measures or scheduled work was behind schedule.

1.6. Seventy-two percent of capital projects (190 of the 265) were completed. There were a number of projects that are to be completed over two financial years and some relating to the Earthquake recovery and regeneration that have been delayed.

1.7. As with the previous year, the Annual Report provides an overview at the front of each significant activity, with the intention to provide the reader a better understanding of the scope of the work that has been undertaken throughout the year.

1.8. The Annual Report also contains the financial benchmarking section, as required by the Local Government (Financial Reporting Prudence) Regulations 2014. This is the second year of reporting against the 2015-2025 Long Term Plan forecasts.

1.9. An Annual Report Summary has been completed, as required by the Act and Standards. This has also been audited by Audit New Zealand and provides the reader with a snapshot of the key information provided within the Annual Report.

1.10. At the time of preparing this report, it is expected that the Auditors report will provide unmodified opinion.

Attachments:

i. Annual Report for the year ended 30 June 2017 (Trim 170731080695)
ii. Annual Report Summary for the year ended 30 June 2017 (Trim 170817089048)
ii. The audit opinion and letter of representation for the year ended 30 June 2017 (is to be tabled by the Auditors)

2. RECOMMENDATION

THAT the Council:

(a) **Receives** report No. 171018112616.

(b) **Adopts** the Annual Report for the year ended 30 June 2017 (TRIM 170731080695).

(c) **Approves** the Annual Report Summary for the year ended 30 June 2017 (TRIM 170817089048).

(d) **Notes** the Net Surplus before taxation of $28.5m for the Council includes vested assets of $14.3m and $15.2m comprising primarily of development contributions and assets transferred to council ownership as a result of subdivisions.

(e) **Authorises** the Manager Finance and Business Support, in conjunction with the Chief Executive to make necessary minor edits and corrections to the Annual Report prior to printing.

3. ISSUES AND OPTIONS

3.1 The Net Surplus after Vested Assets and before Taxation for the year ended 30 June 2017 totalled $28.5m. This compared with the budget for the year of $18.2m.

Consolidated Income Statement for the Council Parent ($000s)

Income Statement	***Budget 2017***	***Actual 2017***	***Difference***
	(Parent)	***(Parent)***	***(unfavourable)***
Income	**$'000's**	**$'000's**	**$'000's**
Rates	52,533	53,037	504
Interest	639	282	(357)
Subsidies and grants	6,367	6,389	22
Other revenue	16,668	19,289	2,621
Development and other Contributions	9,899	15,282	5,383
Earthquake Recoveries - Government	2,700	1,747	(953)
Vested Assets	12,479	14,323	1,844
Total Income	**101,285**	**110,349**	**9,064**
Operating Expenditure by Activity			
Governance	2,145	2,094	51
District Development	5,022	4,914	108
Roads and Footpaths	16,996	16,996	-
Water Supply and Stockwater	6,518	7,729	(1,211)
Sewerage and the Treatment and Disposal of Sewage	8,781	9,102	(321)
Stormwater Drainage	3,787	4,356	(569)
Solid Waste	6,836	6,577	259
Libraries and Museums	4,749	4,202	547
Recreation	14,861	15,906	(1,045)
Community Protection	7,231	7,074	157
Community Development	1,890	1,794	96
Property Management	732	846	(114)
Earthquake Recovery	1,704	1,529	175
Non-Significant Activities	1,820	2,396	(576)

Income Statement	*Budget 2017*	*Actual 2017*	*Difference*
Total Expenditure	**83,072**	**85,515**	**(2,443)**
Other gains	-	3,654	3,654
Operating Surplus before Taxation	**18,213**	**28,488**	**10,275**

Comparison with the Budgeted Net Surplus

3.2 The largest differences were as follows:

Income

- Other revenue was $2.6m over budget due to increased rates penalties, recoveries of private works, more than budgeted connection fees/lump sum contributions to connect to Council's infrastructural facilities, cash settlement from URS/OCEL for the Ocean Outfall claim and increased liquor licensing/food premises revenue.;
- Development Contributions received were more than budgeted by $5.4m. Significant subdivisions were completed in Woodend, Kaiapoi and Rangiora;
- Earthquake recoveries from Government agencies were under budget by $1.0m due to delays in the recovery programme. Council received $7.8m from Civic Assurance for its above ground infrastructural and buildings in Feb and Apr 16. No insurance proceeds (earthquake related) were received this year;
- Assets vested into Council ownership were $1.8m over budget mainly due to significant subdivisions completed in Woodend, Kaiapoi and Rangiora;
- Other gains of $3.7m contains valuation gains of Council's interest rate swaps, forestry assets and investment properties, which were not budgeted;

Expenditure

- Water Supply - Actual expenditure was $1.2m more than budget mainly due to unbudgeted asset deletion costs from the capital renewal programme and capital expensed from capital projects. The well establishment costs at Oxford Rural No.1 scheme were expensed as the well was dry. In addition, rates remissions and remissions on rates penalties were over budget;
- Stormwater Drainage - Actual expenditure was $0.6m more than budget due to unbudgeted asset deletion costs from the capital renewal programme and capital expensed from capital projects;
- Recreation - Expenditure was over budget by $1.0m. Assets deletions due to the capital renewal programme were not budgeted. Depreciation expenses were more than budgeted due to revaluation of reserve/building assets at 30 June 16. Revaluation loss on airfield properties was not budgeted. Rates remissions and remissions on rates penalties were over budget;
- Libraries and Museums - Expenditure was under budget by $0.5m as no payments for the Canterbury Museum Redevelopment Levy were required.
- Non-Significant Activities - Expenditure was over budget by $0.6m. This is mainly due to increased payroll costs and costs incurred on the Silverstream subdivision investigations. In addition, contributions to Local Authority Protection Programme for the disaster fund were more than what were budgeted.

Financial limits

A brief summary of treasury policy limits are provided as follow:

Measure	Limit	Actual 2016	Actual 2017
Gross interest paid on term debt will not exceed 15% of gross operating revenue	15%	5.2%	5.1%
Net cash inflow from operating activities exceeds gross annual interest expense by two times	>2 times	6.9 times	7.5 times

Measure	Limit	Actual 2016	Actual 2017
Local Government Funding Agency. Interest as a maximum of 25% of rates revenue	25%	9%	8%
Net debt as percentage of operating revenue shall not exceed 175% or if WDC obtains a Standard and Poor's long term credit rating of 'A+' or better 250%	250%	110%	124%
Liquidity ratio of greater than 110%	110%	174%	143%

Non-financial performance measures and levels of service

3.3 There are 81 performance measures across the organisation including those for the Council Controlled Organisations (CCO's). Of these, 53 (65%) Achieved, 15 (19%) were nearly achieved, 13 (16%) were not achieved.

Capital Expenditure

3.4 Cash spent on capital works for the year ended 30 June 2017 totalled $42.1m, compared to a budget of $54.5m. Of 265 capital projects 190 (72%) have been completed. The full status of the projects was reported to the Audit Committee meeting on 19th September.

Balance Sheet

3.5 Ratepayer Equity as at 30 June 2017 is $1,554m (2016: $1,422m). This is a $132m (9.3%) increase over that in 2016 and generally reflects movements in the additional capital and assets vested in Council. The increase in equity for the previous period ended 30 June 2016 was 4.4%. Both years increases reflect the growth that is occurring in the district.

3.6 Public debt is $100m compared with a budget of $125m and $5m more than in 2016.

Annual Report Summary

3.7 Under section 67, 98 & 99 of the Local Government Act 2002, the Council is required to make publicly available a summary of its Annual Report. The summary is required to be audited. A copy of the draft summary is attached. It comprises:

- The Mayor's report
- A summary of the Financial Statements
- Key performance measures from the LTP
- Summary of Activity

Letter of Representation

3.8 As at the time of preparing this report, the audit is approaching completion. It is anticipated that the audit will have been completed and clearance from the Auditors to issue the Auditors report and the Council to adopt by the time Council meets on 24 October.

3.9 There are two disclosures made within post balance events to the Annual Report. An events after balance date has been made for the transfer of the Rural Fire assets to Fire & Emergency New Zealand and the passing of Councillor Allen.

3.10 The Mayors report makes special mention of the passing of Board Member Karen Eastwood and Councillor Peter Allen and, noting the contributions that both have provided to the respective Boards and District represented.

3.11 It is standard practice for the Mayor and the Chief Executive to sign a letter of representation relating to the audit.

The letter covers a large number of matters, but the essence is that the Mayor and Chief Executive believe the financial statements are correct and that they are not aware of any financial irregularities. The letter also states that Management consider the organisation to be a going concern.

3.12 Options

The Council could:

- Adopt the Annual Report for the Year Ended 30 June 2017; OR
- Request that modifications be made to the Annual Report for the year ended 30 June 2017; OR
- Hold a further meeting for the purpose of adopting the Annual Report. If the meeting is not held prior to the 31 October this would not meet the statutory timeframes as set out in the Local Government Act 2002.

3.13 The Management Team and Chief Executive have reviewed this report and support the recommendations.

3.14 Audit New Zealand is currently completing its audit of the Annual Report and is expected to have been completed by 24 October. The Audit report is expected to be an unmodified report.

4. COMMUNITY VIEWS

4.1. Not sought specially in relation to the report, but form part of the results and measures within the Annual Report.

5. FINANCIAL IMPLICATIONS AND RISKS

5.1. A number of steps are taken to mitigate the risk of an error in the external financial statements. These include internal review and external audit.

5.2. Financial information is contained within the report.

5.3. At the time of preparing the report, the audit field work was completed and being provided to the technical review group. The opinion will be subject to this review.

6. CONTEXT

6.1. These issues are not matters of significance in terms of the Council's Significance Policy.

6.2. The production of the Annual Report contributes to the outcome that "Public organisations make information about their plans and activities readily available".

6.3. Section 98(1) of the Local Government Act 2002 requires that "a local authority must prepare and adopt in respect of each financial year an annual report ….".

6.4. Section 98(3) of the Local Government Act 2002 requires that "The annual report must be completed and adopted by resolution within 4 months of the end of the financial year to which it relates".

6.5. Section 98(4) provides that "A local authority must, within 1 month after the adoption of its annual report, make publicly available – (a) its annual report; and (b) a summary of the information contained in its annual report".

6.6. The Local Government (Financial Reporting and Prudence) Regulations 2014 requires Council to disclose performance in relation to benchmarks in the annual plan, annual report and long-term plan.

Jeff Millward
Manager Finance & Business Support

WAIMAKARIRI DISTRICT COUNCIL

REPORT

FILE NO and TRIM NO: ENV-04-08 / 170928104745

REPORT TO: The Council

DATE OF MEETING: 24 October 2017

FROM: Malcolm Johnston, Environmental Services Manager

SUBJECT: Appointment of a Chairperson, Deputy Chair, Councillor and Commissioner to the Waimakariri District Licensing Committee.

Department Manager | Chief Executive

1. SUMMARY

The *Sale and Supply of Liquor Act 2012* outlines the requirement for all Territorial Authorities to form District Licensing Committees (DLCs). DLCs are responsible for decisions on applications for alcohol licences and managers certificates. The DLC is a committee made up of Councillors, Commissioners or a mixture of both. The Waimakariri DLC was initially established by Council in 2013. The DLC was re-constituted in November 2016 following the local body elections with its members being Chair Councillor Peter Allen, and Councillors Neville Atkinson, Wendy Doody and John Meyer, along with Commissioner Jim Gerard. With the sad passing of Councillor Allen, Council now should formally appoint a new Chairperson and Deputy-Chair. Two further DLC Committee members are also proposed to ensure sufficient numbers are available to make up a hearing panel when required.

This report would usually first be made to the District Planning and Regulation Committee which has delegation for matters relating to liquor licencing and the Committee would make its recommendation about the DLC appointments to the Council. The 17 October scheduled meeting of this Committee was cancelled and, as it is expected that there will be a DLC Hearing before the end of the year, it's important to formalise the constitution of the DLC beforehand.

The purpose of this report is to seek to appoint Councillor Neville Atkinson as the new DLC Chairperson. It also seeks to appoint current Commissioner Jim Gerard as the Deputy Chairperson. Both Councillor Atkinson and Commissioner Gerard have had a lot of experience having been members of the Waimakariri DLC since its inception in 2013. The report also seeks to appoint a further Councillor as a member of the DLC. This appointment confirms Council's commitment to invest in its members - mentoring, training and providing valuable experience, all of which ensures a continuity of competent and experienced members available to contribute to licencing hearings.

This report also seeks to appoint Mr Al Lawn, of West Melton, as a Commissioner with the Waimakariri DLC for a period until 31 December 2018. Mr Lawn is currently a Commissioner with the Christchurch City Council DLC and a Commissioner with Selwyn and Ashburton DLCs. He is a vastly experienced Commissioner and previously spent a number of years as a Police Sergeant in charge of the Licensing Section at Christchurch, responsible for alcohol licencing reporting across Canterbury. Mr Lawn is available until the end of next year should the Council consider that he could assist as a Commissioner.

2. RECOMMENDATION

THAT the Council:

(a) **Receives** report 170928104745

(b) **Appoints** Councillor Neville Atkinson as Chairperson of the Waimakariri District Licensing Committee.

(c) **Appoints** Commissioner Jim Gerard as the Deputy-Chair of the Waimakariri District Licensing Committee.

(d) **Appoints** Councillor ……..as a member of the Waimakariri District Licensing Committee.

(e) **Appoints** Mr. Al Lawn to the Waimakariri District Licensing Committee as a Commissioner until 31 December 2018.

3. ISSUES AND OPTIONS

3.1 General

The *Sale and Supply of Liquor Act 2012* (the Act) was enacted on 18 December 2012 and the Waimakariri District Licensing Committee came into effect on 18 December 2013.

3.2 The District Licensing Committee's functions are specified in the Act as follows:

- To consider and determine applications for renewal of licences and manager's certificates;
- To consider and determine applications for temporary authority to carry on the sale and supply of alcohol in accordance with section 136;
- To consider and determine applications for the variation, suspension, or cancellation of special licences;
- To consider and determine applications for the variation of licences (other than special licences)
- With the leave of the Chairperson for the licensing authority, to refer applications to the licensing authority;
- To conduct enquiries and make reports as may be required of it by the licensing authority;
- Any other functions conferred on licensing committees by or under the Act or any other enactment.

3.3 Operation of District Licensing Committees

Each Territorial Authority must appoint one or more licensing committees to deal with licencing matters in their District.

The DLC has the same powers as a Commission of Enquiry under the *Commission of Enquiry Act 1908*. This provides powers that include the issuing of summonses requiring the attendance of witnesses, and the power to require the production of documents.

The Act provides that each hearing committee must comprise of three members. Unopposed applications may be approved on the papers by the Chairperson following reports from the Inspector, and where applicable, reports from the Police and Medical Officer of Health. Having the DLC Chairperson attend and assess unopposed applications on a weekly basis has worked well and it is recommended this arrangement is continued.

3.4 Composition of District Licensing Committees

The hearing committee would comprise three members being the Chairperson and two members off the "list" established by each Territorial Authority.

The "list" of licensing committee members may include elected representatives. It may also include appointed Commissioners.

3.5 Appointment of Members of District Licensing Committees

Both the Chairperson and Deputy Chairperson can be either an elected member or a Commissioner appointed to the committee.

The Chief Executive may (on the recommendation of the Council) appoint a person as a Commissioner if that person is of good standing in the community and has the necessary knowledge, skill and experience relating to matters that are likely to come before the committee.

The restrictions regarding potential conflicts of interest and other matters which apply to elected members also apply to Commissioners.

A Territorial Authority must not approve a person to be included on the list unless that person has experience relevant to District Licensing matters.

A person cannot be included on the list if:

- The Territorial Authority believes that person has, directly or by virtue of his or her relationship with another person, such an involvement or appearance of involvement with the alcohol industry that he or she could not perform his or her duties without actual bias or the appearance of bias; or
- The person is a Constable, a Medical Officer of Health, an Inspector or an employee of the Territorial Authority.

All members of DLCs hold office for up to five years or by Council resolution. At the conclusion of that period, they may be re-appointed.

4 OPTIONS

Council must appoint a District Licensing Committee. The only options available to Council are the selection processes and membership of the Committee. Having a sufficient number of competent, experienced and skilled members is critical to enable the Council to maintain a sustainable, operationally sound, District Licensing Committee.

A recommendation is made to appoint Councillor Neville Atkinson as Committee Chairperson. Councillor Atkinson has significant experience having been the DLC Deputy-Chair since the inception of the DLC in 2013 and sitting on a number of committee hearings covering a range of different licence applications. He has regularly stood in for the Chairperson assessing and making decisions on numerous licence and manager certificate applications. He has also had experience chairing a full DLC Hearing in June 2017.

A recommendation is made to appoint Commissioner Jim Gerard as Committee Deputy-Chair. Commissioner Gerard has been a member of the DLC since 2013 and gained valuable experience sitting on a number of DLC hearings. Commissioner Gerard is a current Community Board member, previous Mayor, a previous Councillor, and has considerable experience with Waimakariri District. Commissioner Gerard has also stood in for the DLC Chairperson assessing and making decisions on licence and manager certificate applications.

A recommendation is made to appoint a further Councillor as a member of the Waimakariri DLC. This recommendation looks to ensure Council continues to invest in new DLC members, providing mentoring and training opportunities along with gaining experience attending and observing hearings. This continuity planning future proofs the DLC by ensuring competent and experienced members are always available to 'step up' to participate in licensing hearings.

A recommendation is made to appoint Mr Al Lawn as a Commissioner of the Waimakariri DLC for the period to the end of 2018. Mr Lawn has considerable experience as a DLC Commissioner and gained experience as Chairperson overseeing numerous DLC hearings. He is currently a Commissioner with the Christchurch City Council DLC and a Commissioner with both Selwyn and Ashburton DLCs. He is vastly experienced in the alcohol licensing arena and previously spent a number of years as the Police Sergeant in charge of the Alcohol Licensing Section for Canterbury Police. The period to the end of 2018, accommodates Mr Lawn's projected availability.

If these recommendations are accepted the DLC would comprise of:

- Councillors Neville Atkinson (Chairperson), Wendy Doody, John Meyer and one other Councillor.
- Commissioners Jim Gerard (Deputy Chair) and Al Lawn.

Given the frequency of DLC hearings and the workload associated with that, having six members available forms a good base that provides for continuity of experience and competency while still retaining capacity to meet hearing schedules so applications can be decided in a timely manner.

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

5 COMMUNITY VIEWS

This report has been prepared from observations of the structure, processes and procedures of the current DLC as well as other Council DLCs across Canterbury. No community views have been sought.

6 FINANCIAL IMPLICATIONS AND RISKS

The legislation intends that the costs associated with licencing are recovered as far as possible.

6.1 Fees and Allowances for Members of District Licensing Committees

The Act provides that DLC members are entitled to remuneration. Remuneration rates are determined by the Minister of Justice, and are currently set at $78 per hour for Chairpersons and $51 per hour for members.

6.2 Licence Fees

The Act sets out the expectation of a self-funded risk-based fee structure. Fees are expected to cover licensing system costs - such as the operation of DLCs, Inspectors and compliance activities.

7 Context

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

7.2 Legislation: *The Sale and Supply of Alcohol Act 2012*

7.3 Community Outcomes:

There is a safe environment for all

WAIMAKARIRI DISTRICT COUNCIL

REPORT

FILE NO:	CMS 06 03/171004107285
REPORT TO:	Council
DATE OF MEETING:	24 October 2017
FROM:	Kathy Graham – Journey Planner/Road Safety Coordinator
SUBJECT:	Road Safety Action Plan
SIGNED BY: (for Reports to Council or Committees)	Department Manager / Chief Executive

1. SUMMARY

1.1. The purpose of this report is to present results from the Waimakariri Road Safety Action Plan (RSAP) 2016-17 activities and to seek Council's endorsement for the 2017-18 Road Safety Action Plan.

1.2. The RSAP target areas, goals and activities for the 2017-2018 RSAP remain largely unchanged from 2016-17 as the work and activities required to achieve a safe road system increasingly free of death and serious injury demands a consistent and long-term approach.

1.3. The 2017–2018 Action Plan has been developed and approved by the Road Safety Coordinating Committee. The plan outlines the road safety activities that will be carried out in the District for the coming year. It provides a focus for the work of the agencies and organisations that have a responsibility for improving road safety in the District

1.4. The plan focuses on the high risk issues in the District that have been identified by analysing local crash data and from feedback from the NZTA, the Police, the community and other relevant stakeholders. The plan is aligned to the Governments "Safer Journey's" Strategy to 2020 and follows the principles of the "Safe System" approach.

Attachments:

i. Road Safety Action Plan 2016-17 activity results report (Doc 171005107719)
ii. Road Safety Action Plan for 2017–2018 (Doc 171005107741)

2. RECOMMENDATION

THAT the Council:

(a) **Receives** report No. 171004107285

(b) **Notes** the Road Safety Action Plan 2016-17 activity results (Doc 171005107719)

(c) **Endorses** the 2017– 2018 Action Plan (Doc 171005107741)

(d) **Circulates** this report to the Community Boards

3. ISSUES AND OPTIONS

3.1. In 2006 the National Road Safety Committee agreed that Road Safety Action Plans (RSAP) should be the primary mechanism for coordination of education, engineering, and enforcement approaches to road safety at a district and sub-regional level. Local Government are best placed to lead RSAP's as they own and maintain the land transport infrastructure assets and have statutory objectives to promote community wellbeing and improve the performance of the land transport system.

3.2. RSAP's have proven to be a useful tool to bring together the Councils road safety partners into one plan. Reporting on the key focus areas at each road safety committee meeting provides an opportunity for discussion and monitoring of the issues affecting our district. Having an effective RSAP is considered a key element in maintaining a low crash record for our District.

3.3. The RSAP target areas, goals and activities for the 2017-2018 RSAP remain largely unchanged from 2016-17 as the work and activities required to achieve a safe road system increasingly free of death and serious injury demands a consistent and long-term approach.

3.4. The Management Team has reviewed this report and supports the recommendations.

4. COMMUNITY VIEWS

4.1. A RSAP gives effect to local road safety issues. The plan is focused on coordinating the delivery of enforcement, education and engineering activities to best manage key local road safety risks.

4.2. Road safety partners identify problems by evaluating information and intelligence such as local crash data provided by the New Zealand Transport Agency, local Police information, ACC statistics as well as public feedback and reports.

4.3. The Council has a number of partners who work collaboratively to implement the plan, including: Environment Canterbury, New Zealand Police, New Zealand Transport Agency, AA New Zealand, NZ Trucking Association, New Zealand Road Transport Association, ACC and SADD.

5. FINANCIAL IMPLICATIONS AND RISKS

5.1. There is a risk that in preparing an action plan that the wrong issues will be identified and targeted, however the Road Safety Committee membership is made up of the appropriate local and regional organisations so the district needs have been recognised.

5.2. The Council funds their own activities under the Road Safety Action Plan from the Road Safety and Minor Improvements programmes. Stakeholders and partners activities in the Road Safety Action Plan are funded by their respective organisations.

6. CONTEXT

6.1. Legislation

This RSAP supports the implementation of New Zealand's road safety strategy, Safer Journeys, by outlining actions for the District that will also address and progress the national road safety actions. This includes a range of local road safety works, road safety programmes, enforcement and local initiatives and campaigns.

6.2 Community Outcomes

The Action Plan gives effect to the following community outcomes

- There is a safe environment for all
- Crime, injury and road crashes are minimised
- Transport is accessible, convenient, reliable, affordable and sustainable

Kathy Graham
Journey Planner/Road Safety Coordinator

Road Safety Action Plan Education & Promotion Report 2016/17

Programme Reports

This report contains an overview of some of the road safety education and promotion activities funded from the Waimakariri Road Safety funding for the 2016/17 year in the RSAP target areas.

Various channels were utilised to promote road safety messaging, including social media, web, print and video advertising as well as direct interaction with target audiences.

Crash statistics (as at 4/10/17) for the district are included at the conclusion of this report.

Alongside scheduled/planned campaigns, various road safety messages have been disseminated throughout the year as appropriate related to concerns raised at the time about driver behaviour, weather conditions, or feedback from staff or the public.

Social media continues to be an excellent tool to share information and the council Facebook page currently has just over 8,200 followers.

In addition, a number of road safety related council website articles were picked up by local news media and published in print and online furthering the reach of several of our road safety messages.

Collaboration with partner Councils and NZTA have enabled a wider reach of key road safety messages.

YOUNG DRIVERS:

Road safety education days – Kaiapoi High School – 26 June
Oxford Area School – 13 September

The purpose of Road Safety Education Day is to encourage young people to look beyond the choices they make around driving, the impact those choices can have not only on them but also on others. The day also provide awareness of what is involved in road crashes, gives an insight into the role of emergency services and provides some education around staying safe on the roads.

- Simulated road crash scene with all emergency service personnel participating and MC commentating;
- Workshops from St John, Fire Service, Serious Crash Unit, Police (Drink/Drug driving and truck safety with assistance from CVIU, NZ Trucking Assoc. and Fonterra)
- Presentation from Brain Injury Trust speaker and Attitudes

U–Drive Programme – Oxford Community Trust - Funding for U-Drive young driver mentoring scheme – Oxford Community Trust – 2 new mentors trained; (32 students on the programme since Jan 2015, 19 (up from 13 in 2016) have gained their Restricted and we have 6 who are in training at the moment – as at 3/7/17)

SADD – 4 Oxford Area Schools supported to attend SADD Conference, Christchurch

Kaiapoi School Road Safety Education Day
Evaluation 2017

Male 67

Which parts of the program did you find interesting? Please tick on the scale

	Good	Ok	Not so interesting
Crash Scene	76%	24%	0%
First Aid at scene of a crash - workshop	52%	48%	0%
Physics of a car crash - workshop	72%	28%	0%
Truck safety -workshop	46%	49%	5%
Fire Service - workshop	58%	40%	2%
Breath Testing - workshop	46%	46%	8%
Brain Injury Assn presentation	57%	43%	0%
Attitudes	76%	24%	0%

What is something you learnt/heard that you think will help you next time you are in a car with your friends?	Make sure everyone is wearing a seatbelt	Don't be a distraction to the driver	speak up and say you don't feel safe	don't give into peer pressure	Don't be on the phone
What part of the day had the most impact on you?	Attitudes presentation	Photos	The car crash scene	Fire Service	Physics

Female 70

Which parts of the program did you find interesting? Please tick on the scale

	Good	Ok	Not so interesting
Crash Scene	84%	14%	2%
First Aid at scene of a crash - workshop	50%	47%	3%
Physics of a car crash - workshop	64%	34%	2%
Truck safety -workshop	30%	51%	19%
Fire Service - workshop	66%	33%	1%
Breath Testing - workshop	36%	56%	8%
Brain Injury Assn presentation	79%	21%	0%
Attitudes	77%	20%	3%

What is something you learnt/heard that you think will help you next time you are in a car with your friends?	Make sure everyone is wearing a seatbelt	Don't be a distraction to the driver	Even if you are not involved an crash can still affect you	don't give into peer pressure	Don't be on the phone	speak up and say you don't feel safe	make sure the driver is OK to drive
What part of the day had the most impact on you?	The speeches	Photos	The car crash scene	Fire Service	Physics	Brain injury survivor	

Oxford Area School Road Safety Education Day
Evaluation 2017

Male/Female 42

Which parts of the program did you find interesting? Please tick on the scale

	Good	Ok	Not so interesting
Crash Scene	88%	12%	
First Aid at scene of a crash - workshop	81%	19%	
Physics of a car crash - workshop	83%	17%	
Truck safety -workshop	67%	24%	7%
Fire Service Workshop	79%	19%	2%
Breath Testing - workshop	83%	14%	
Brain Injury Assn presentation	79%	19%	2%
Attitudes	93%	5%	2%

What is something you learnt/heard today that you think will help you next time you are in a car with your friends?
"Take a stand for doing the right thing"; I learnt to always think twice and to make the right decision when driving, not be distracted"; "Experiencing other people's stories makes you realise what could happen"; "Speak up"; "To help the driver make smart decisions"; If you are in the car crash the 'ripple effect' that happens, how many people are actually involved"; "Get rid of distractions"; "I think it helped me understand risks more".

What part of the day do you think you will remember the most?
"I will remember the crash scene and the Attitude talk knowing that it has a big impact on you and your family"; "The mock crash and the brain injury talk"; "The crash scene – it was really harrowing and showed me what an actual crash was like";

RURAL ROAD LOSS OF CONTROL/HEAD ON (INCL. SPEED)

Winter Driving – Drive to the conditions:

Social media and print advertising using the attached posters and videos

Winter driving campaign media and promotion through various channels - social media, print, and collateral distributed;

Social media campaign - Is 100 OK? Facebook page related publicity and promotion - winter driving and drive to the conditions videos shared ;

Cinema advertising – videos

- Cinema advertising – Speed – Sept/Dec 2016, Winter Driving May-August 2017.
- Social media/print advertising – winter driving advertising
- Is 100 OK Rural Canterbury Road Safety Facebook page – promotion of various road safety messages –
- 6 x NZTA Restraint billboards erected in district
- Winter driving campaign – ice scrapers/cloths giveaway at service centres/social media promotion
- Social media advertising/website articles – ice/grit/lights/speed
- Billboards "Check your Speed" throughout district

https://www.waimakariri.govt.nz/your-council/media-and-news/2017/07/wandering-stock-on-roads
https://www.waimakariri.govt.nz/your-council/media-and-news/2017/09/motorists-urged-to-slow-down
https://www.facebook.com/is100kOK/videos/890894797632542/
https://www.facebook.com/is100kOK/videos/1021692877886066/
https://www.waimakariri.govt.nz/your-council/media-and-news/2017/06/driving-to-the-conditions
https://www.waimakariri.govt.nz/your-council/media-and-news/2017/07/warning-of-possible-hazardous-road-conditions

INTERSECTIONS – rural and urban

- Campaign ran during April –key message – Check and Check again at intersections – run in conjunction with Selwyn, Timaru & Ashburton using same collateral;
- Competition alongside campaign and advertising in newspapers, posters, social media, promoted via radio by police;
- Competition postcards distributed to service centres – 4 questions to answer to go in draw to win 1 of 2 x $50 MTA voucher and 1 x $250 MTA voucher;
- Facebook post reached over 20000 – shared by Canterbury Police & 12 others
- Cinema advertising Jan/Feb/Mar/April – 'watch for stop sign jumpers'
- Police campaign targeting intersections two weeks during 10th to the 23rd April.
    - During that time 73 drivers received infringement notices (compared to 112 over similar period in 2016) – 72 for failing to stop at a stop sign and one for failing to give way when turning right.
    - Ohoka/Island 16 ions
    - Johns Percival 9
    - Johns Plaskett 6
    - Williams Smith 5
    - Pineacres 5
    - Beach Williams 3
    - Charles Smith 3

https://www.waimakariri.govt.nz/your-council/media-and-news/2017/04/check-and-check-again-at-intersections
https://www.waimakariri.govt.nz/your-council/media-and-news/2017/05/intersection-safety-message-not-getting-through
https://www.waimakariri.govt.nz/your-council/media-and-news/2017/08/choo-choo-choose-rail-safety!
https://www.facebook.com/is100kOK/videos/884392944949394/

MOTORCYCLES

Collaborated with Christchurch City Council and Selwyn District Council on the Kick-Start motorcycle riders event for 2016 event.
Promoting and supporting ACC Ride Forever training with local Waimakariri trainers
(13 riders funded for Ride Forever training)

https://www.waimakariri.govt.nz/your-council/media-and-news/2017/09/motorcycle-riders-event-2017

OLDER DRIVERS

Confident Driving for Mature Drivers Course

Funded by Council - Presented by Age Concern Canterbury

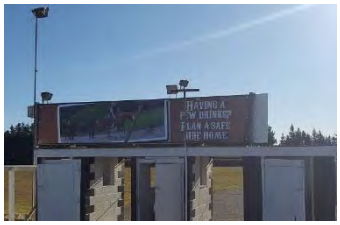
5 x Older Driver Courses funded and miscellaneous collateral supplied (e.g. intersection safety cards/ice scrapers) – facilitated by Age Concern
Total Attendance = 88:
Oxford – 25; Woodend – 13, Rangiora – 19, Kaiapoi – 13, Rangiora (2nd course) – 18

https://www.waimakariri.govt.nz/your-council/media-and-news/2017/03/keeping-up-to-date-with-road-rules-and-skills-important-for-all-ages

General feedback from particpants:

- More should attend. More publicity. Charge more.
- Great day. Thanks.
- I feel I would have benefitted by attending another course.
- Very good catering. Excellent value. Thought provoking. Highlight awareness of different aspects.
- A very worthwhile way to spend a day! Great for the confidence and I'm sure I'll have a few more years of safe driving
- Much food for thought and a lot of bedtime reading! Most grateful for the opportunity to attend
- Enjoyed course thoroughly cheers
- Please keep up the good work
- This course will definitely improve my confidence and enable me to drive into Christchurch more

DRINK/DRUG DRIVING



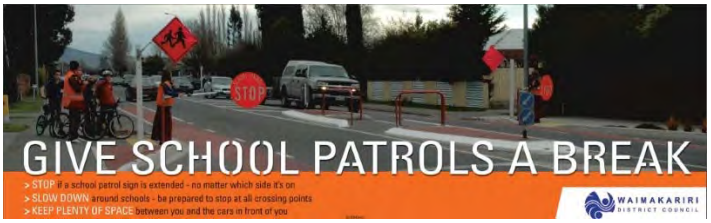
Social media/general promotion of drink/drug free driving message
Billboards in district over Christmas period promoting 'sober driver' message
Funded free bus for 2 x events in Rangiora where alcohol available to reinforce drink/drug free driving
https://www.waimakariri.govt.nz/your-council/media-and-news/2017/03/council-providing-free-bus-service-to-eats-and-beats
Support for Drive Sober North Canterbury –Repeat drink driver programme
Police Breath Testing Bus attendance at Road Safety Education days – Kaiapoi & Oxford Schools

VULNERABLE ROAD USERS

Involvement and support in local schools road safety intiatives – Woodend Safe School Team – campaign to reduce speed on Rangiora/Woodend Road;
Presentation at Pegasus School for Road Safety week
Social media, print and news articles shared re sharing the road with:

- Cyclists
- Horse riders

https://www.waimakariri.govt.nz/your-council/media-and-news/2017/01/back-to-school-safety-reminder
https://www.waimakariri.govt.nz/your-council/media-and-news/2017/05/a-bright-outlook-on-road-safety
https://www.waimakariri.govt.nz/your-council/media-and-news/2017/05/national-ride-for-road-safety



Pool party evening at Dudley Pool provided for school road patrol students to say thank you for their work during the year. Funded and supported by Council and supported by Constable Ken Terry, School Education Officer.

Crash List: WMK F&SI ALL CRASHES

Overall Crash Statistics

Crash Severity	Number	%	Social cost ($m)
Fatal	23	16	106.24
Serious	119	84	124.58
Minor Injury	0	0	0
Non-injury	0	0	0
	142	100	230.83

Overall Casualty Statistics

Injury Severity	Number	% all casualties
Death	25	11
Serious Injury	146	64
Minor Injury	56	25
	227	100

Crash Numbers

Year	Fatal	Serious	Minor	Non-inj
2013	8	22	0	0
2014	4	22	0	0
2015	4	22	0	0
2016	1	20	0	0
2017	3	18	0	0
TOTAL	20	104	0	0
Percent	16	84	0	0

Note: Last 5 years of crashes shown

Casualty Numbers

Year	Fatal	Serious	Minor
2013	8	25	11
2014	4	26	11
2015	4	29	10
2016	2	22	8
2017	4	20	1
TOTAL	22	122	41
Percent	12	66	22

Note: Last 5 years of casualties shown

Crash Type and Cause Statistics

Crash Type	All crashes	% All crashes
Overtaking Crashes	7	5
Straight Road Lost Control/Head On	33	23
Bend - Lost Control/Head On	34	24
Rear End/Obstruction	28	20
Crossing/Turning	29	20
Pedestrian Crashes	8	6
Miscellaneous Crashes	3	2
TOTAL	142	100

Crash factors (*)	All crashes	% All crashes
Alcohol	34	24
Too fast	22	15
Failed Give way/Stop	29	20
Failed Keep Left	7	5
Overtaking	4	3
Incorrect Lane/posn	17	12
Poor handling	42	30
Poor Observation	54	38
Poor judgement	13	9
Fatigue	6	4
Disabled/old/ill	7	5
Pedestrian factors	7	5
Vehicle factors	6	4
Road factors	23	16
Weather	3	2
Other	16	11
TOTAL	290	203
Crashes with a:		
Driver factor	235	165
Environmental factor	26	18

(*) factors are counted once against a crash - ie two fatigued drivers count as one fatigue crash factor.

Note: Driver/vehicle factors are not available for non-injury crashes for Northland, Auckland, Waikato and Bay of Plenty before 2007. This will influence numbers and percentages.

Note: % represents the % of crashes in which the cause factor appears

Number of parties in crash	All crashes	% All crashes
Single party	67	47
Multiple party	75	53
TOTAL	142	100

Driver and Vehicle Statistics

Note: Driver information is not computerised for non-injury crashes

Drivers at fault or part fault in injury crashes

Age	Male	%	Female	%	Total	%
15-19	19	21	3	7	22	17
20-24	11	12	8	19	19	15
25-29	7	8	6	14	13	10
30-39	12	13	3	7	15	11
40-49	16	18	8	19	24	18
50-59	13	15	5	12	18	14
60-69	7	8	1	2	8	6
70+	4	4	8	19	12	9
TOTAL	89	100	42	100	131	100

Drivers at fault or part fault in injury crashes

Licence	Male	Female	Total	%
Full	55	26	81	61
Learner	5	4	9	7
Restricted	16	6	22	17
Never licensed	0	2	2	2
Disqualified	4	0	4	3
Overseas	1	1	2	2
Expired	2	0	2	2
Other/Unknown	7	3	10	8
TOTAL	90	42	132	100

Vehicles involved in injury crashes

	No.of vehicles	% Injury crashes
SUV	34	23
Car/Stn Wagon	114	67
Motor Cycle	28	20
Other	2	1
Bicycle	9	6
Truck	10	7
Van Or Utility	26	18
TOTAL	223	142

Note: % represents the % of injury crashes in which the vehicle appears

Crash List: WMK F&SI ALL CRASHES

Road Environment Statistics

Road Type	Local road	%	State highway	%	Total	%
Urban	27	19	2	1	29	20
Open Road	87	61	26	18	113	80
TOTAL	114	80	28	20	142	100

Conditions	Injury	Non-injury	Total	%
Light/overcast	94	0	94	66
Dark/twilight	47	0	47	33
TOTAL	141	0	141	99

Conditions	Injury	Non-injury	Total	%
Dry	124	0	124	87
Wet	14	0	14	10
Ice/snow	3	0	3	2
TOTAL	141	0	141	99

Intersection/mid-block	All crashes	% All crashes
Intersection	42	30
Midblock	100	70
TOTAL	142	100

Objects Struck	Injury crashes	%	Non-injury crashes	%
Crashes w/obj.struck	59	42	0	0

Object Struck	Injury crashes	%	Non-injury crashes	%
Bridge	3	2	0	0
Cliff Bank	3	2	0	0
Over Bank	1	1	0	0
Fence	11	8	0	0
Guard Rail	7	5	0	0
Traffic Island	1	1	0	0
Phone Box Etc.	1	1	0	0
Kerb	2	1	0	0
Slip Or Flood	1	1	0	0
Parked Vehicle	3	2	0	0
Train	1	1	0	0
Post Or Pole	13	9	0	0
Vehicle	1	1	0	0
Traffic Sign	4	3	0	0
Tree	14	10	0	0
Ditch	7	5	0	0
Stray Animal	2	1	0	0
Other	3	2	0	0
Water/River	2	1	0	0
TOTAL	80		0	

Note: % represents the % of crashes in which the object is struck

Time Period Statistics

Day/Period	All crashes	% All crashes
Weekday	95	67
Weekend	47	33
TOTAL	142	100

Day/ Period	0000-0259	0300-0559	0600-0859	0900-1159	1200-1459	1500-1759	1800-2059	2100-2400	Total
Weekday	5	4	10	9	20	19	18	9	94
Weekend	4	2	5	9	6	10	7	4	47
TOTAL	9	6	15	18	26	29	25	13	141

Note: Weekend runs from 6 pm on Friday to 6 am on Monday

Day/ Period	0000-0259	0300-0559	0600-0859	0900-1159	1200-1459	1500-1759	1800-2059	2100-2400	Total
Mon	1	1	0	2	7	4	2	0	17
Tue	1	0	3	2	2	4	5	1	18
Wed	0	1	3	1	3	0	3	3	14
Thu	0	1	3	1	4	5	1	2	17
Fri	3	1	1	3	4	6	7	3	28
Sat	3	1	4	4	3	5	2	3	25
Sun	1	1	1	5	3	5	5	1	22
TOTAL	9	6	15	18	26	29	25	13	141

Month	Injury	%	Non-injury	%	Total	%
Jan	12	8	0	0	12	8
Feb	6	4	0	0	6	4
Mar	14	10	0	0	14	10
Apr	14	10	0	0	14	10
May	17	12	0	0	17	12
Jun	9	6	0	0	9	6
Jul	11	8	0	0	11	8
Aug	9	6	0	0	9	6
Sep	16	11	0	0	16	11
Oct	13	9	0	0	13	9
Nov	9	6	0	0	9	6
Dec	12	8	0	0	12	8
TOTAL	142	100	0	0	142	100

AN OPERATIONAL ROAD SAFETY ACTION PLAN

WAIMAKARIRI DISTRICT C

2017 - 2018

BACKGROUND

In 2010 the New Zealand Government launched Safer Journeys.

Safer Journeys is a strategy designed to guide New Zealand's efforts to improve road safety from 2010–2020. Its vision is for:

"A safe road system increasingly free of death and serious injury"

To achieve this it takes a Safe System approach, looking across the entire road system to improve safety by creating safer roads and roadsides, safer speeds, safer vehicles and safer road use. Within these categories, it sets a number of areas of concern where action is needed.

The Safe System approach recognises that people make mistakes and are vulnerable in a crash. It reduces the price paid for a mistake so crashes don't result in death or serious injuries.

The Safer Journeys strategy was developed by the National Road Safety Committee (NRSC).

Following the release of the Safer Journeys strategy, the NRSC released the Safer Journeys Action Plan 2011 - 2012 which set out the actions to be taken over this time to address the areas of concern. In March 2013 the NRSC released the second Safer Journeys Action Plan 2013-2015. In early 2016, the last Safer Journeys Action Plan 2016-2020 was released.

Significant progress has been made under the two previous Action Plans across all key areas of the Safe System. This includes initiatives such as:

- raising public awareness through advertising campaigns
- lowering blood and breath alcohol levels
- making our high risk roads safer through rumble strips and median barriers
- mandating electronic stability control for light vehicles.

Many initiatives will continue as a core part of the policies and decision making of various agencies.

While the Safer Journey's Action Plan has key areas of national focus, local Road Safety Action Plans are the primary mechanism for coordination of education, engineering and enforcement approaches to road safety problems at sub-regional levels.

WAIMAKARIRI ROAD SAFETY ACTION PLAN - INTRODUCTION

The Waimakariri Road Safety Action Plan sets out the priority areas, actions, measures and responsibilities in regard to road safety in the Waimakariri District for the 2017-18 year.

The action plan has been developed in collaboration with various road safety partners who comes together as part of the Waimakariri District Road Safety Co-ordinating Committee, (RSCC) which is a working party for the Council's Utilities and Roading Committee.

The membership of the RSCC consists of Waimakariri District Councillors, Council staff, Police, Transport Agency, ACC and other road safety partners and stakeholders.

The purpose of the Committee is to improve road safety in the district by coordinating the work of all the agencies that have district road safety functions to ensure a safe systems approach is followed as envisaged by New Zealand's road safety strategy, Safer Journeys.

This includes the integration of education, enforcement and engineering programmes and initiatives.

VISION

The Waimakariri District has a safe road system that is increasingly free of death and serious injury.

The Waimakariri Road Safety Action Plan uses the Safer Journeys Safe System approach to guide and influence the actions.

Four key principles underline the Safe System approach.

- People make mistakes - We need to recognise that people make mistakes and some crashes are inevitable.
- People are vulnerable - Our bodies have a limited ability to withstand crash forces without being seriously injured or killed.
- We need to share responsibility - Those who design the road system and those who use the roads must all share responsibility for creating a road system where crash forces don't result in death or serious injury.
- We need to strengthen all parts of the system - We need to improve the safety of all parts of the system - roads and roadsides, speeds, vehicles, and road use - so that if one part fails, other parts will still protect the people involved.

The key components of the Safe System are the four pillars:

The Safe System approach requires the designers, managers and operators of the land transport system to consider:

- **safe roads and roadsides** that are predictable, promote safe behaviour and are forgiving of human error
- **safe speeds** that suit the function and level of safety of the road, the skill of the driver and the safety of the vehicle
- **safe vehicles** that incorporate emerging collision avoidance technologies and modern warning systems, and are well maintained to help prevent crashes and protect road users from crash forces, and
- **safe use** by having drivers, motorcyclists, cyclists and pedestrians who are skilled and competent, proactive in managing hazards, predictable, alert, unimpaired, compliant and make safe choices.

Purpose of the Action Plan

Each stakeholder or partner involved in road safety in the Waimakariri may have a different function, or role to play within the Safe System, however, the collaborative approach and guidance provided under the Road Safety Action Plan ensures all activities focus on achieving the same outcome – a road system increasingly free of death and injury.

This is enabled under the RSAP which :

- Informs and guides co-ordination of various road safety activities within the District and enables outcomes to be monitored and measured;
- Allows the community to see and understand the focus for road safety activates in the District allowing them opportunity to be actively involved in creating a safe road system;
- Supports applications for road safety activities under the National Land Transport Fund.

Footnote: *While there are specific target areas and topics of concern highlighted in this Action Plan, all aspects affecting road safety and minimizing injury to road users will be included in the various target areas. Of particular note in this regard is* ***'speed' and 'restraint use'*** *which are key components of many of the target areas to be addressed.*

Target Areas in our District

Young Drivers

Rural Road Loss of Control/Head-On (incl. Speed)

Intersections - Rural and Urban

Motorcyclists

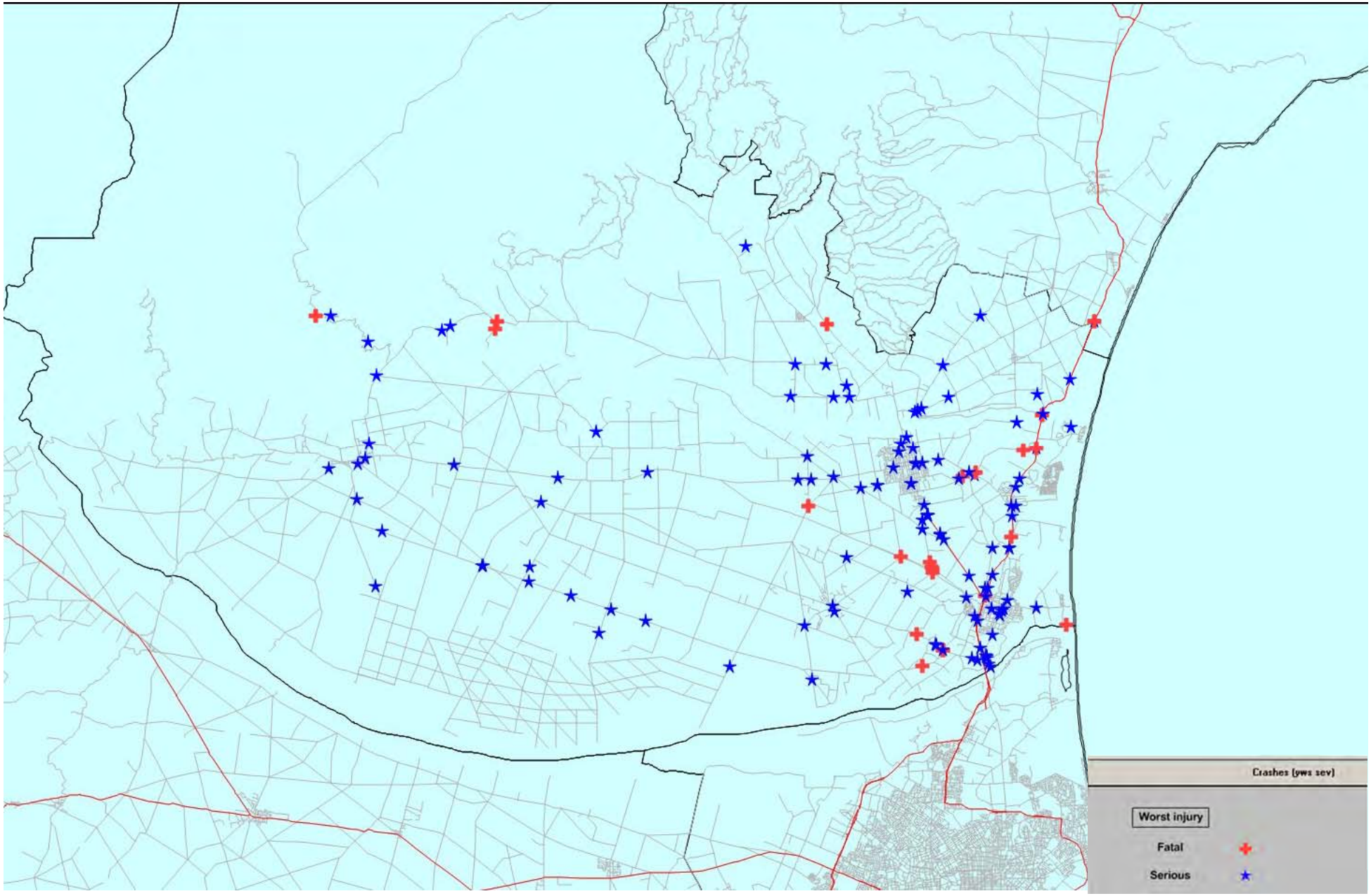
Older Road Users

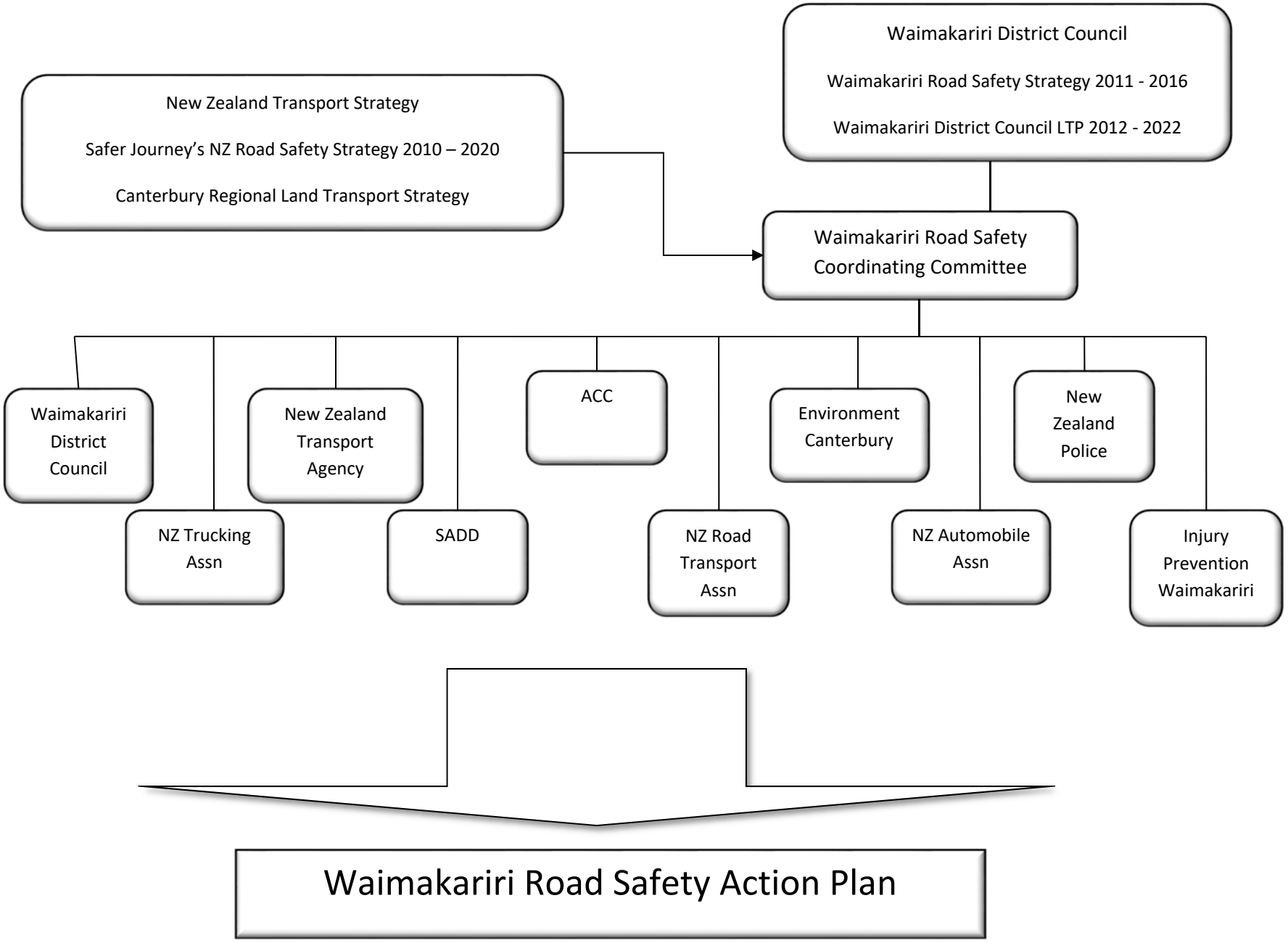
Of Concern

Vulnerable Road Users

Drink/Drug Driving

Waimakariri District Fatal & Injury Crashes Map 2012-2017




Waimakariri District Council
Waimakariri Road Safety Strategy 2011 - 2016
Waimakariri District Council LTP 2012 - 2022
New Zealand Transport Strategy
Safer Journey's NZ Road Safety Strategy 2010 – 2020
Canterbury Regional Land Transport Strategy
Waimakariri Road Safety Coordinating Committee
Waimakariri District Council
NZ Trucking Assn
New Zealand Transport Agency
SADD
ACC
NZ Road Transport Assn
Environment Canterbury
NZ Automobile Assn
New Zealand Police
Injury Prevention Waimakariri
Waimakariri Road Safety Action Plan

SUMMARY	Waimakariri 2012-2017
Fatal & Serious Injury Crashes	142
Deaths	23

33% of crashes - young drivers were at fault or part fault

YOUNG DRIVERS (16-24 yrs)

- Safer Journeys Strategy 2010-2020 – Increasing the safety of young drivers;
- Briefing Notes Crash Analysis - Locally this issue is of concern due to the number of deaths/and or serious casualties resulting from these crashes which reflects a high level of collective risk and also when viewed against the local road use (VKT) which reflects a high personal risk.
- District Road Risk Profile (June 2015) – Top 5 Road Risk Factor #2; 30% of all fatal and serious crashes in the Canterbury District have young drivers as a factor & 44% of all fatal and serious crashes in the SH1 North Journey have Young Drivers as a factor
- Police Data Summary - Of relevance to Waimakariri is the identified high risk journey of State Highway 1 north of Christchurch. The highest three risk factors on this journey are young drivers, rural intersections and urban intersections.

KEY TRENDS	GOALS	SAFE SYSTEM FOUR PILLARS	ACTIVITIES – may relate to more than one pillar	LEAD AGENCY	
Total Fatal & Serious Injury Crashes (2012-17) where young drivers at fault or part fault in injury crashes - 132 • Deaths 10 • Serious injuries 31 ***Why:*** • Poor observation 13% • Poor handling 15% • Too fast 10% • Alcohol 10% ***Where:*** • Urban road - 31% • Open road – 69% ***Licence Status:*** • Full – 26% • Learner – 20% • Restricted – 34% • Other – 20%	Reduce fatal and serious crashes involving young drivers Encourage increased uptake in training by young drivers	Safe Speeds Safe Road Users Safe roads and roadsides Safe vehicles	Police enforcement focus on the fatal five offences (alcohol/drugs, speed, restraints, dangerous and careless driving and high risk drivers) in addition to other trauma promoting offences. Promote uptake of https://drive.govt.nz/ and support community programmes that improve young driver skills Support Oxford Community Trust U-Drive young driver mentoring programme Work with schools, emergency services and groups such as SADD to deliver a programme and/or campaign to upskill and educate young drivers Utilise social media and other media channels to engage with young drivers, parents and caregivers to promote skills training & safe vehicles Collaborate with partner agencies and Councils on initiatives targeting young drivers Encourage integration of road safety into school curriculum and promote https://education.nzta.govt.nz/ Identify through analysis any problematic corridors/intersections where young drivers feature highly in fatal & serious crashes Provide education and information to both young drivers and parents/caregivers about safe vehicle choice utilizing http://rightcar.govt.nz/ and ANCAP ratings	Police WMK WMK/NZTA NZTA/WMK	

RURAL ROAD LOSS OF CONTROL/HEAD ON (incl. Speed)

SUMMARY	Waimakariri 2012-2017
Fatal & Serious Injury Crashes	142
Deaths	23

67% of crashes involved lost control/head on crash factors

- Safer Journeys Strategy 2010- 2020
- Safer Journeys Action Plan 2016-2020 – Action 3 - Ensure roads and roadsides support safer travel
- Briefing Notes Crash Analysis - Locally rural road loss of control/head on crashes are of concern due to the number of deaths and/or serious casualties resulting from these crashes which reflects a high level of collective risk.
- District Road Risk Profile (June 2015) – Top 5 Road Risk Factor #3; 25% of all fatal and serious crashes in the Canterbury district have rural roads as a factor

KEY TRENDS	GOALS	SAFE SYSTEM FOUR PILLARS	ACTIVITIES – may relate to more than one pillar	LEAD AGENCY	
• Total Fatal & Serious Injury Crashes (2012-17) on 80km/h plus roads - 113 • Deaths 23 • Serious Injuries 90 ***Highest rated factors were:*** • Poor observation 35% • Poor handling 34% • Too fast 17% • Alcohol 25% • Poor judgement 10% **At Fault:** • 15-24 years - 33% • 25-40 years – 20% • 40-49 years - 18% • 50-59 years – 14% • 60-69 years - 7% • 70 plus – 8% ***Licence status***: • Full – 62% • Learner – 7% • Restricted 18%	Reduce the number of fatal and serious crashes on rural roads in the Waimakariri District, with particular reference to loss of control/head on crashes Achieve a reduction in average speeds across the district	Safe speeds Safe road users Safe roads and roadsides Safe vehicles	Police enforcement is to focus on the fatal five offences (alcohol/drugs, speed, restraints, dangerous and careless driving and high risk drivers) in addition to other trauma promoting offences. Regular monitoring & reporting on speed data to maximize ongoing enforcement and speed management and inform education & advertising opportunities, particularly where speed limit changes occur; Utilise data gathering to monitor and analyse average speeds in the district on nominated routes and resources such as Urban KiwiRap and High Risk Rural Roads guide to ensure roads and roadsides adhere to best practice Education via Cinema Advertising – Speed – Sept-Dec; Winter Driving – May-Aug Education campaign specifically targeting 'driving to the conditions' (e.g. Winter driving); restraints, distraction etc; Develop education campaigns to inform and improve driver skills in rural road environments and highlight speed and restraint use as key factors. Reference to the 2016 Speed Management Guide where applicable to ensure consistency and best practice adhered to. Regular network inspections & maintenance work is carried out on roads & roadsides Establish liaison with Main Power regarding power pole placement Provide education and information to drivers about safe vehicle choice utilizing http://rightcar.govt.nz/ and ANCAP ratings	Police WMK/NZTA WMK WMK NZTA/WMK	

INTERSECTIONS – RURAL AND URBAN

SUMMARY Waimakariri 2012-2017
Fatal & Serious Injury Crashes 142
Deaths 23
29% of crashes involved crossing/turning movements

- Safer Journeys Strategy 2010 – 2020
- District Road Risk Profile (June 2015) – 31% of all fatal and serious crashes in Canterbury District have urban intersections as a factor;
- District Road Risk Profile (June 2015) – Top 5 Road Risk Factor #1 – Urban Intersections; 30% of all fatal and serious crashes in the SH1 North Journey have Rural Intersections as a factor; 18% of all fatal and serious crashes in the SH1 North Journey have Urban Intersections as a factor.
- Police Rural Intersection Crash Analysis for Canterbury – significant increase in number of serious injury and fatal crashes at rural intersections in late 2014 and early 2015 & highest rate of fatal and serious injury crashes at rural intersections for past decade;
- Police Data Summary - Of relevance to Waimakariri is the identified high risk journey of State Highway 1 north of Christchurch. The highest three risk factors on this journey are young drivers, rural intersections and urban intersections.

KEY TRENDS	GOALS	SAFE SYSTEM FOUR PILLARS	ACTIVITIES – may relate to more than one pillar	LEAD AGENCY	
Total Fatal & Serious Injury Crashes (2012-2017) involving intersections– 42 Deaths – 7 Serious injuries – 43 ***Who:*** Of the 36 DSI crashes (2011-2016) drivers at fault or part fault • 32% were aged 15-24 years of age • 22% were aged 70 plus years of age • 45% were aged 25-70 years of age ***Where:*** • Urban Road - 36% • Open Road - 64% ***Why:*** • Poor observation – 26% • Failed to giveway/stop – 25% • Alcohol – 12% • Poor handling – 12%	Reduce the number of fatal and serious crashes at Waimakariri intersections	Safe speeds Safe road users Safe roads and roadsides Safe vehicles	Police enforcement is to focus on the fatal five offences (alcohol/drugs, speed, restraints, dangerous and careless driving and high risk drivers) in addition to other trauma promoting offences. Develop campaign to target high risk users e.g. enforcement and education campaigns incl. Cinema Advertising – Jan- April 2017 Support and promote Age Concern Older Drivers courses in the District reinforcing intersection safety/speed judgement, etc Explore ways to influence road user behaviour at intersections Proactively consider engineering treatments at problematic locations and routes, utilizing guides such as Urban KiwiRap & High Risk Intersection Guide; Regular network inspection and maintenance is carried out at intersections Provide education and information to drivers about safe vehicle choice utilizing http://rightcar.govt.nz/ and ANCAP ratings and encourage vehicles fit for purpose;	POLICE WMK WMK/NZTA NZTA/WMK	

MOTORCYCLISTS

SUMMARY	Waimakariri 2012-2017
Fatal & Serious Injury Crashes	142
Deaths	23

20% of crashes involved motorcyclists

- Safer Journeys Strategy 2010-2020
- Safer Journeys Action Plan 2016-2020 Action 2 – Make Motorcycling Safer
- District Road Risk Profile (June 2015) – Top 5 Road Risk Factor #4;
- Canterbury ACC claims cost per annum - $9.3m (10% of total motorcycle ACC claims)

KEY TRENDS	GOALS	SAFE SYSTEM FOUR PILLARS	ACTIVITIES – may relate to more than one pillar	LEAD AGENCY	
Total Fatal & Serious Injury Crashes (2012-2017) involving motorcyclists– 28 Deaths – 5 Serious injuries – 24 ***Who:*** Of the 21 DSI crashes (2011-2016) drivers at fault or part fault • 22% were aged 15-24 years of age • 45% were aged 25-49 years of age • 34% were aged 50 plus ***Where:*** • Urban Road - 21% • Open Road - 79% ***Why:*** Poor handling – 43% Poor observation – 36% Alcohol – 32% Failed to giveway/stop – 25% Poor judgement – 18%	Reduce the number of fatal and serious injury crashes involving Waimakariri riders	Safe speeds Safe road users Safe roads and roadsides Safe vehicles	Police enforcement is to focus on the fatal five offences (alcohol/drugs, speed, restraints, dangerous and careless driving and high risk drivers) in addition to other trauma promoting offences. Motorcycle events – Ride Forever will be promoted at large key events in Canterbury and the West Coast by the contracted Ride Forever trainers Utilise media channels to engage with & promote and educate re rider upskilling & equipment and to educate vehicle drivers re motorcyclists vulnerability/visibility; Consider financial support for localised RideForever training Support annual Kick-Start Motorcycle event – joint safety campaign with CCC, Selwyn & Ride Forever trainers Develop and/or support education campaigns that encourage training and promote safe rider behavior; Promote uptake of ACC RideForever training (Ride Forever – Subsidised motorcycle training for riders at all levels will be delivered in all T.A's by x 2 contractors. (growth in training by 30% on previous year across Canterbury)) Apply NZTA 'Safer Journeys for motorcycling on NZ roads guide recommendations to local roads and roadsides and encourage uptake of "Making roads motorcycle friendly" by contractors and maintenance crews. Promote safety benefits of new bikes & safety technology particularly for young and/or returning riders	POLICE ACC/WMK WMK WMK ACC/WMK	

Older Road Users

- Safer Journeys Strategy 2010-2020
- District Road Risk Profile (June 2015) Emerging Risk; SH1 North Journey #5 Road Risk Factor
- Communities at Risk Register 2015 – emerging strategic priority

SUMMARY Waimakariri 2012-2017
Fatal & Serious Injury Crashes 142
Deaths 23
15% of crashes involved older drivers (60 plus) at fault or part-fault

KEY TRENDS	GOALS	SAFE SYSTEM FOUR PILLARS	ACTIVITIES – may relate to more than one pillar	LEAD AGENCY	
Total Fatal & Serious Injury Crashes (2012-2017) where older road users (60 plus) involved – 37 crashes Fatal 8 Serious injury – 38 ***Who:*** • 60-69 – 22% • 70+ - 33% ***Where:*** • Urban Road 24% • Open Road 76% ***Why:*** Poor observation 19% Failed Giveway/Stop 12% Alcohol 6% Road factors 6%	Reduce the number of fatal and serious crashes involving older road users	Safe speeds Safe road users Safe roads and roadsides Safe vehicles	Police enforcement is to focus on the fatal five offences (alcohol/drugs, speed, restraints, dangerous and careless driving and high risk drivers) in addition to other trauma promoting offences. Engage with local health providers regarding licensing of older drivers Consider supporting progammes targeting correct vehicle use, e.g. 'carfit programmes' Support Older Driver Education Courses Promote and support information and education targeting older drivers Provide information/education to support increased tolerance & understanding of older drivers Consider engineering treatments at problematic locations and routes, utilizing Urban KiwiRap & High Risk Intersection Guide Provide education and information to drivers about safe vehicle choice utilizing http://rightcar.govt.nz/ and ANCAP ratings and encourage vehicles fit for purpose;	POLICE WMK WMK NZTA/WMK	

OF CONCERN

Drink/Drug Driving

- Safer Journeys Strategy 2010-2020
- District Road Risk Profile (June 2015) – Top 5 Road Risk Factor #5 Alcohol & Drugs;

SUMMARY	Waimakariri 2012-2017
Fatal & Serious Injury Crashes	142
Deaths	23
24% of crashes involved alcohol	

KEY TRENDS	GOALS	SAFE SYSTEM FOUR PILLARS	ACTIVITIES – may relate to more than one pillar	LEAD AGENCY	
Total Fatal & Serious Injury Crashes (2012-2017) where drugs/alcohol involved– 34 Deaths – 7 Serious injuries – 34 ***Who:*** Of the 22 DSI crashes (2011-2016) drivers at fault or part fault • 25% were aged 15-24 years of age • 61% were aged 25-49 years of age • 12% were aged 50-69 years of age • 3% were aged 70 plus ***Where:*** • Urban Road - 15 % • Open Road - 85% ***Why:*** Alcohol plus: Poor observation –33% Poor handling – 33% Too fast – 33% Failed to keep left – 15% Incorrect lane/position –8%	Reduce the number of fatal and serious crashes involving drunk or drugged drivers	Safe speeds Safe road users Safe roads and roadsides Safe vehicles	Police enforcement is to focus on the fatal five offences (alcohol/drugs, speed, restraints, dangerous and careless driving and high risk drivers) in addition to other trauma promoting offences; Conduct community campaign engaging with publicans, staff and public to encourage use of sober driver/courtesy vans; Support Wellbeing North Canterbury Drive Sober Course; Develop and/or support education campaigns that encourage and promote sober driver use/hospitality courtesy van use; Support and promote national advertising campaigns targeted at drink/drug driving; Utilise resources such as Urban KiwiRap and High Risk Rural Roads guide to ensure roads and roadsides adhere to best practice Provide education and information to drivers about safe vehicle choice utilizing http://rightcar.govt.nz/ and ANCAP ratings	POLICE WMK WMK NZTA/WMK	

Vulnerable Road Users

- Safer Journeys Strategy 2010-2020 area of medium concern
- Accreditation as International Safe Community

SUMMARY Waimakariri 2012-2017
Fatal & Serious Injury Crashes 142
Deaths 23
6% of crashes involved vulnerable road users

KEY TRENDS	GOALS	SAFE SYSTEM FOUR PILLARS	ACTIVITIES – may relate to more than one pillar	LEAD AGENCY	
Total Fatal & Serious Injury Crashes (2012-2017) where vulnerable road users involved – 18 Fatal - 3 Serious injury – 15 ***Where:*** • Urban Road 67% • Open Road 33%	Reduce the number of fatal and serious crashes involving vulnerable road users	Safe speeds Safe road users Safe roads and roadsides Safe vehicles	Police enforcement is to focus on the fatal five offences (alcohol/drugs, speed, restraints, dangerous and careless driving and high risk drivers) in addition to other trauma promoting offences; Support national initiatives such as "Share the Road" and 'Restraints' campaigns with local safety campaigns; Investigate Bikes in Schools programme & similar initiatives to increase cycle skills education amongst children; Work with the Waimakariri Access Group to increase awareness/promote best practice for disabled/sight impaired; Support education and promotional programs that increase awareness of vulnerable road users; Support heavy transport operators with education and awareness programs for both HT drivers and vulnerable road users; Ensure the vision and priorities of the Waimakariri Walking & Cycling Strategy are implemented Conduct an audit of school safety signage/environment to maximise safety; Promote vehicles with safety technologies designed to protect vulnerable road users.	POLICE WMK WMK NZTA/WMK	

MEASURES & EVALUATION

In order to assess the success of our Road Safety Action Plan, various measures and evaluation methods will be considered in regard to each programme of work, campaign or education initiative undertaken.

A number of the measures and evaluations can be captured through related existing programmes of work such as regular road maintenance and audit procedures and the following quantitative measures.

- Road crash statistics relating to death and serious injury will be sourced from CAS and a crash statistics relating to the specific areas of concern monitored and reported on;
- Data relating to the seriousness of injuries will be sourced where possible through ACC and a reduction in the severity of injuries measured;
- Police statistics/reporting on alcohol/drugs, speed, restraints, dangerous and careless driving and high risk drivers
- Uptake of training programmes in the District, e.g. Ride Forever motorcycle training, Oxford Trust U-Drive programme

Qualitative Measures:
Educational and promotional campaigns will utilize a variety of methodology to establish base-lines where possible and record the reach and impact of individual campaigns, where possible.

Establishing base-line data relating to road safety knowledge, understanding, satisfaction and perceptions will be sought through miscellaneous road safety surveys. This will assist to establish any changes in public knowledge of road safety initiatives undertaken in the District and understanding of road safety issues over the 2017/18 period.

WAIMAKARIRI DISTRICT COUNCIL
REPORT

FILE NO and TRIM NO:	DRA-21 / 170907097266
REPORT TO:	Council
DATE OF MEETING:	24 October 2017
FROM:	Janet Fraser, Utilities Planner Owen Davies, Drainage Asset Manager
SUBJECT:	Stormwater Drainage Bylaw Review 2017/18
SIGNED BY: **(for Reports to Council or Committees)**	Department Manager / Chief Executive

1. SUMMARY

1.1. The purpose of this report is to seek approval from the Council to publicly consult the Stormwater Drainage Bylaw 2017/2018 using the Special Consultative Procedure.

1.2. The draft revised bylaw proposed by staff is substantially amended from the existing 2011 version. Some key proposed changes in the revised version include:

- Extending the existing bylaw to cover land drainage systems (rural drainage areas) as well as urban reticulated stormwater systems
- Provisions for acceptance of stormwater and land drainage water into a Council system
- Extending provisions for pollution prevention plans throughout the district to better manage discharge of contaminants into Council systems from medium risk activities / sites, at or from source
- Clarify that consenting responsibilities for discharges into Council systems from high risk activities / sites should remain with Environment Canterbury
- Some provisions of the bylaw extend to private systems and activities on private properties
- Provisions to prevent interference with Council systems
- Provisions to avoid damage from excessive use of herbicide, or from stock or vehicle access to watercourses managed by the Council
- Requirement for private owners/occupiers to maintain watercourses, overland flow paths, floodplains or stop banks in an operational state

1.3 The bylaw has been drafted to seek to respond to common issues experienced during the ongoing operation and maintenance of the Council's stormwater and land drainage systems. These include avoiding activities which interfere with Council systems or watercourses managed by the Council, including vehicle or stock damage or excess spraying of open drains. Some provisions are to avoid nuisance associated with operating private stormwater systems.

1.4 The proposals within the draft bylaw are intended to assist the Council to implement its stormwater network discharge consents which it is required to obtain under provisions of the Canterbury Land and Water Regional Plan (CLWRP). Consent applications for existing stormwater discharges from the district's urban reticulated stormwater systems are currently being prepared and are required to be lodged with Environment Canterbury by 30 June 2018.

1.5 It is anticipated that enforcement to give effect to the stormwater network discharge consent conditions will be undertaken through applying the Stormwater Drainage Bylaw. The bylaw and consents will therefore operate together to assist the district achieve the objectives and policies of the National Policy Statement for Freshwater Management (2014) (NPSFM). They are intended to improve water quality outcomes in the district, over time, by improving the quality of the urban stormwater discharges.

Attachments:

i. Draft Stormwater Drainage Bylaw 2017/2018 for public consultation (TRIM 171003106407).
ii. Statement of Proposal to adopt the Stormwater Drainage Bylaw 2017/2018 for public consultation (TRIM 171003106598).
iii. Stormwater Bylaw 2011 (operative since 1 October 2011) (TRIM 110927043815).

2. RECOMMENDATION

THAT the Council:

(a) **Receives** report No. 170907097266.

(b) **Approves** the attached proposed Stormwater Drainage Bylaw 2018 and Statement of Proposal for public consultation using the Special Consultative Procedure outlined in the *Local Government Act 2002.*

(c) **Appoints** Councillor Sandra Stewart (Drainage and Stockwater Portfolio Holder), together with Councillor…….. and Councillor…… to hear submissions on the proposal and to recommend decisions to the Council.

(d) **Notes** the proposed hearing / submissions deliberations date is Tuesday 27 February 2018 [time TBC].

(e) **Notes** that upon adoption, the bylaw will be renamed the Stormwater Drainage Bylaw 2018 to reflect the date of its last review.

(f) **Notes** that, once adopted, the Stormwater Drainage Bylaw 2018 will not be required to be formally reviewed for another 10 years.

(g) **Refers** this report to the Community Boards for their information.

3. ISSUES AND OPTIONS

3.1. Introduction

3.2. The purpose of this report is to seek approval of the Council to publicly consult the Stormwater Drainage Bylaw 2017/2018 using the Special Consultative Procedure. The *Local Government Act 2002,* section 160, provides for the use of the Special Consultative Procedure outlined in section 83 to review and amend the bylaw.

3.3. The bylaw will be finalised in 2018, following public consultation. Once it is in force it will replace the Stormwater Bylaw 2011.

3.4. Prior to the establishment of the Stormwater Bylaw in 2011 there was no local legislation in place to control the quality of stormwater discharges into the Council's reticulation or receiving environment. The bylaw has been developed for the primary purpose of protecting public health and safety, and improving the quality of the environment.

3.5. The proposed revisions will protect the public infrastructure investment by controlling access to reticulation and facilities and requiring approval for any works on or interference with Council systems. In addition, the bylaw protects the public from flood hazard through preventing interference with watercourses, stop banks, overland flow paths or flood plains. It protects the environment by specifying provisions to avoid contaminants from discharging into or from the stormwater or land drainage systems.

3.6. The draft bylaw, following consultation and receipt of submissions, will be forwarded to a hearing panel for consideration. The hearing panel will consider and hear submissions and then make recommendations about the bylaw for approval by the Council.

3.7. The draft bylaw that is proposed by staff is substantially revised from the existing 2011 version. Some key proposed changes shown in the revised version include:

- Extending the existing bylaw to cover land drainage systems (rural drainage areas) as well as urban reticulated stormwater systems
- Provisions for acceptance of stormwater and land drainage water into a Council system
- Extending provisions for pollution prevention plans throughout the district to better manage discharge of contaminants into Council systems from medium risk activities / sites, at or from source
- Clarify that consenting responsibilities for discharges into Council systems from high risk activities / sites should remain with Environment Canterbury
- Some provisions of the bylaw extend to private systems and activities on private property
- Provisions to prevent interference with Council systems
- Provisions to avoid damage from excessive use of herbicide, or from stock or vehicle access to watercourses managed by the Council
- Requirement for private owners/occupiers to maintain watercourses, overland flow paths, floodplains or stop banks in an operational state

3.8 The bylaw has been drafted to seek to respond to common issues experienced during the ongoing operation and maintenance of the Council's stormwater and land drainage systems. These include avoiding activities which interfere with Council systems or watercourses managed by the Council, such as vehicle or stock damage or excess

spraying of open drains. Some provisions are to avoid nuisance associated with operating private stormwater systems.

3.9 The bylaw is also intended to address some of the effects of managing private stormwater or land drainage systems. This is so that the bylaw can support the role of the Council in resolving situations where the actions of one party affect other properties and downstream Council systems or the receiving environment.

3.10 Policy 4.16A of the Canterbury Land and Water Regional Plan requires the Council to account for and assume responsibility for the quality and quantity of all stormwater discharged from its reticulated stormwater systems by 2025. This includes management of discharges into the Council stormwater systems from high risk activities or sites. This bylaw gives effect to the policy, in part, by providing avenues for the Council to assume responsibility for medium risk activity / site discharges into its networks.

3.11 However the Council prefers that Environment Canterbury retain the responsibility for consenting high risk discharges, whether into Council stormwater systems or directly into the receiving environment. The bylaw continues to refer the regulation and management of these discharges to Environment Canterbury. This is discussed further in Section 6 and is an issue currently being addressed through the Canterbury Regional Stormwater Forum.

3.12 The *Local Government Act 2002*, section 158, requires the first review of a bylaw made under the Act to be undertaken no later than five years after the bylaw was made, if the bylaw was made after 1 July 2003. The review date for the Stormwater Bylaw 2011 (in force from 1 October 2011) is therefore 1 October 2016. Any bylaw that is not reviewed within the specified timeframe is revoked two years after the last date on which it should have been reviewed. The Stormwater Bylaw 2011 will therefore be revoked on 1 October 2018, if not reviewed prior to this date.

3.13 Following this 2017/18 review, a subsequent review is required to be carried out no later than ten years after the last review date.

3.14 Rationale for Bylaw and Local Government Act Assessment – Section 155

3.15 In carrying out the review of its 2011 bylaw, the *Local Government Act 2002,* section 155 requires the Council to determine whether the bylaw is still the most appropriate way of addressing the perceived problem, whether it is the most appropriate form of bylaw and whether it gives rise to any implications under the *New Zealand Bill of Rights Act 1990.*

3.16 The Council has the option of revoking the Stormwater Bylaw 2011 and relying on other legislation to manage the quality and quantity of stormwater and land drainage discharges in the district. However, the bylaw has been developed in order to protect Council infrastructure, public health and safety and the environment. It achieves this by clearly specifying the requirements and obligations of all parties, and the rules and conditions to be met by each activity or person generating a discharge into a Council system.

3.17 Adopting the Stormwater Drainage Bylaw 2018 means the Council does not have to rely on the cooperation of the customer to ensure either: (a) the acceptable quality of stormwater and land drainage discharges into its systems; or (b) that it can avoid the adverse effects of flood flows that may result from harmful or damaging private activities.

3.18 It means the Council can make the public aware of the requirements by publishing its bylaw and providing enforcement in circumstances where a customer does not voluntarily agree to meet the requirements. It provides the Council with an enforcement option for circumstances when a customer intentionally or repeatedly ignores the bylaw provisions.

3.19 The bylaw is therefore the appropriate mechanism to protect public health and the network infrastructure from damage or misuse. The bylaw is still considered to be the most appropriate mechanism for managing the quality and quantity of discharges into and from the Council's systems and into the receiving environment. It provides an open and transparent process for the community to provide input into the preparation and adoption of the rules that will be applied.

3.20 The existing form of the bylaw in force from 2011 is no longer considered to be appropriate. The 2011 version does not cover all of the operating situations encountered by the Council in managing its systems. It also does not enable the Council to provide sufficient direction to the community in order to implement the stormwater discharge network consents which it is required to obtain under the CLWRP. The consents will require the Council to, over time, achieve the water quality standards of the CLWRP, as they apply within the district. Proposals which outline how the Council will achieve these standards must be included in applications to be lodged with Environment Canterbury by 30 June 2018.

3.21 The current form of bylaw is also not consistent with the form of the Councils other bylaws, nor is it consistent with bylaws in surrounding districts. The bylaw has therefore been subject to extensive review in order for it to: a) meet operating needs of the activity managers; and b) as a future tool to implement the stormwater network discharge consents and help the district achieve the CLWRP water quality and quantity standards. The bylaw has been reviewed by Council asset managers, engineering and policy staff and compared with the bylaws of Auckland City, the Christchurch City Council and the Hurunui District Council. The bylaw has been reviewed by the Council's legal advisors Corcoran and French and their advice is included in the attached draft. The revised version is considered to provide greater consistency with bylaws of other councils, with the Waimakariri District Council's own bylaws and is drafted in anticipation of meeting requirements of the CLWRP as far as is practicable.

3.22 Bylaw Enforcement

3.23 The Council is currently only able to legally enforce this bylaw through court action. At present it can seek to improve water quality in the district or protect flood management infrastructure by proceeding with court prosecutions in the case of bylaw offences.

3.24 In cases of intentional minor non-compliance (e.g. paint or oil discarded into the stormwater system from private property) the Council can prosecute through the courts. This has an estimated cost to Council of $10,000 to $15,000 per prosecution and average processing times of at least 6 months per offence. This seems unreasonable in the case of minor offences. It is ineffective in preventing point source contaminants generated on private property from being discharged into the stormwater network.

3.25 The Council can continue to refer minor pollution issues to Environment Canterbury to enforce directly via its own infringements system, if the discharge contravenes Section 15 of the *Resource Management Act 1991.* The Council can refer complaints about point source contaminant discharges to Environment Canterbury for enforcement if it is not otherwise required to manage these discharges itself to comply with its stormwater network discharge consent conditions.

3.26 The infringement process applied by Environment Canterbury directly under Section 15 of the *Resource Management Act 1991* is complex and not able to be applied readily by the Waimakariri District Council's warranted enforcement officers. The Council also cannot issue small instant fines in the case of offences against the Stormwater Drainage Bylaw. However, the Council will be required to take responsibility for the quality of discharges into its networks from private activities and manage these appropriately, so that it can meet

the rules of the CLWRP as they apply to the quality of discharges from the stormwater networks into the receiving environment.

3.27 These requirements will be applied by Environment Canterbury through the stormwater network discharge consents. The Waimakariri District Council could in future face enforcement action from Environment Canterbury if it is unable to prevent contaminants from private properties and private activities from entering into and discharging from the stormwater networks.

3.28 Following adoption of the bylaw, staff will seek a legal avenue to issue infringement fines of up to $1,000 per offence under the revised bylaw provisions, as an alternative to court prosecution. This could be achieved through a change to Section 259 of the *Local Government Act 2002* (see Section 6). Alternately it could be achieved through development of new regulations made by Order in Council by the Governor-General which specify particular infringement offences and fines which can be levied under the bylaw. Mayor Keating made an earlier request to Government for similar enforcement powers to be granted to the Council in 2010 (see TRIM 100618020742) which was subsequently declined by Government at the time.

3.29 A further option may be available to issue infringement fines of up to $400 per offence under provisions of the *Litter Act 1979.* Advice from Corcoran French lawyers indicates the definition of "litter" within the Act includes contaminated substances in liquid form, such as spilled oil. Staff will now investigate more widely the possible use of the *Litter Act* in terms of future Stormwater Drainage Bylaw enforcement for discharges of various types of contaminants into the Council systems, including discharge of liquid contaminants and suspended sediment. A definition of substances defined as "litter" under the *Litter Act* is included in Section 6, for reference.

3.30 The Council will pursue the above enforcement options and investigations as a necessary step toward implementing the NPSFM at a local level. The Council will seek to initiate lobbying for the changes sought in section 3.28 from the Canterbury Mayoral Forum and Canterbury Regional Stormwater Forum.

3.31 The Management Team has reviewed this report and supports the recommendations.

4. COMMUNITY VIEWS

4.1 The following table summarises the consultation proposal for the review of the Stormwater Drainage Bylaw 2011.

Tuesday 24 October 2017	The Council approves the draft bylaw for consultation
Saturday 28 October 2017	Public submission period opens (first public notice)
Monday 30 October 2017	Notification letters sent to key agencies and organisations
Friday 15 December 2017	Submission period closes
Tuesday 27 February 2018	Hearings and deliberations *Time to be confirmed*
April 2018	Hearings panel recommendations to full Council Bylaw comes into force

4.2 The bylaw review will be discussed at a regular liaison meeting between Te Ngai Tuahuriri Runanga and WDC representatives.

4.3 Notification of agencies and organisations will include letters sent to each of the following:

- Contractors responsible for operating the stormwater drainage network
- Adjoining local authorities and Environment Canterbury
- Community and Public Health Canterbury office
- Waimakariri Zone Water Management Committee.

4.4 Consultation will include the following steps:

- Public notices/advertisements in newspapers, on the Council's website and via social media (including Facebook)
- Statement of proposal and draft bylaw available to view on the Council's website and in service centres and libraries.

5 FINANCIAL IMPLICATIONS AND RISKS

5.1 The review of the Stormwater Bylaw 2011 will be carried out using existing staff resources. Any associated advertising costs can be met from existing budgets.

5.2 There will be operating cost increases to the Council over time as a result of implementing the Stormwater Drainage Bylaw 2018. These will be required in order to:

- Roll out a process to assess, approve and review pollution prevention plans throughout the district
- Provide approvals for the activities which can now be managed under new provisions of Section 12 of the proposed bylaw
- Increased monitoring and assessment of activities now covered by the bylaw provisions
- The bylaw is a key monitoring and enforcement tool for the implementation of pending Stormwater Network Discharge Consents for each major town in the district. These are required to be lodged with Environment Canterbury by 30 June 2018 and will also incur additional costs for implementation.

5.3 The Council will introduce user charges in the future to cover the costs of providing these assessments and approvals under Section 18 of the proposed bylaw, as practicable. These fees and charges would be introduced through the Annual Plan consultation process at a later date.

5.4 The increased operating costs incurred as noted in Section 5.2 of this report for implementing the bylaw (and stormwater network consents) are for the purpose of better managing the quality of stormwater and land drainage discharges into the receiving environment.

5.5 It is anticipated that full operating costs could be in the order of an additional $100,000 per year, including salary costs. These costs will not come into full effect until 2025 and are

subject to the outcome on the role territorial authorities will play in terms of consenting discharges from high risk sites and construction phase discharges.

5.6 The draft bylaw has been subject to review by Corcoran French Lawyers. The results of that review have been incorporated into the attached draft.

6 CONTEXT

6.1 Policy

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

The bylaw will assist the Council over time to meet the recently amended policy direction of the Canterbury Land and Water Regional Plan introduced through Plan Change 4.

For instance, Policy 4.16A *states "Operators of reticulated stormwater systems implement methods to manage the quantity and quality of all stormwater directed to and conveyed by the reticulated stormwater system, and from 1 January 2025 network operators account for and are responsible for the quality and quantity of all stormwater discharged from that reticulated stormwater system*."

The bylaw, through its provisions for management of contaminants and introduction of pollution prevention plans for medium risk activities / sites, could be considered to give effect to this policy. However, the bylaw refers the regulation of high risk activities / sites to Environment Canterbury to continue its consenting function for these activities. This may not be considered to meet the policy intent in that regard.

The bylaw will also assist the Council to meet provisions of Policy 4.16 (c) and (e) of the CLWRP, as set out below.

For instance, policy 4.16 states:

"Any reticulated stormwater system for any urban area is managed in accordance with a stormwater management plan that addresses the following matters:

(c) *How any discharge of stormwater, treated or untreated, into water or into land where it may enter water meets or will meet, the water quality outcomes and standards and limits for that waterbody set out in Table 1, Schedules 5 and 8 and Sections 6 to 15 (whichever applies); and*

(d) The management of the discharge of stormwater from sites involving the use, storage or disposal of hazardous substances; and

(e) Where the discharge is from an existing local authority network, demonstration of a commitment to progressively improve the quality of the discharge to meet condition (c) as soon as practicable but no later than 2025.

The Council previously opposed assuming the management of the discharge of stormwater from sites involving the use, storage or disposal of hazardous substances through its appeal to the Environment Canterbury decision on Plan Change 4. Therefore the proposed bylaw may not be considered to be consistent with Policy 4.16(d) of the CLWRP, as the consenting of discharges from sites using these substances is intended to continue to be referred to Environment Canterbury.

Staff are of the view that Environment Canterbury should continue to perform its current consenting function, issuing discharge permits for stormwater on sites using hazardous substances into the

stormwater networks and receiving environment. The content of its bylaw would not provide for the Council to assume or enforce that function.

This is a matter currently being addressed through the Canterbury Regional Stormwater Forum, in terms of the role territorial authorities will play in consenting and enforcing construction and high risk site discharges. Reference has been made to a shared services model between Councils although this has not got any traction at this stage with Environment Canterbury.

The bylaw will assist the Council to give effect to Policy 4.17 of the CLWRP. The Policy states:

4.17 *Stormwater run-off volumes and peak flows are managed so that they do not cause or exacerbate the risk of inundation, erosion or damage to property or infrastructure downstream or risks to human safety.*

The bylaw gives effect to the policy by introducing provisions that will prevent interference with Council stormwater or land drainage infrastructure, or to any publicly managed watercourse. These are some of the potential causes of the issues stated in the above policy.

The proposals within the draft bylaw are also intended to assist the Council to implement the stormwater discharge consents it is currently preparing under provisions of the Canterbury Land and Water Regional Plan (CLWRP).

The implementation and enforcement of these consents can, in part, be undertaken through some of the new provisions of the Stormwater Drainage Bylaw. The bylaw and consents will therefore, over time, form one of the local mechanisms to assist the district to achieve the objectives and policies of the National Policy Statement for Freshwater Management (2014) (NPSFM) under the *Resource Management Act 1991*.

The NPSFM directs regional councils, in consultation with their communities, to set objectives for the state of fresh water bodies in their regions and to set limits on resource use (e.g. how much of a contaminant can be discharged) to meet these objectives over time. The NPSFM seeks to safeguard the health of people who come into contact with fresh water and to safeguard fresh water's life supporting capacity, ecosystem processes and indigenous species, among other objectives. In terms of regional implementation, the CLWRP provides water quality outcomes and standards that the Council, through stormwater network consents and other methods such as practical initiatives, will be required to achieve (over time).

The discharge of contaminants into and from the Council systems and into the receiving environment can be reduced through the implementation of the proposed revised bylaw. This will assist the Council to improve water quality in the district. It will provide local progress toward the Government's target to make 90% of rivers and lakes swimmable by 2040 by improving quality of discharges from Council systems into the local rivers.

6.2 Legislation

Consultation Requirements

The Stormwater Drainage Bylaw (originally known as the Stormwater Bylaw) was established under Section 145 and 146 of the *Local Government Act 2002* and is being consulted through this review under Sections 82, 83, 86, and 156.

The Stormwater Drainage Bylaw assists the Council to align its activity management with the purpose and intent of the *Health Act 1956* and the *Resource Management Act 1991.* This is in terms of assisting the Council to improve its management of contaminated discharges into the

stormwater and land drainage systems and downstream receiving environment, and in so doing improve health and safety for people and the quality of the environment.

Bill of Rights Act 1990

The Council is required, under Section 155 of the *Local Government Act 2002*, to determine whether the bylaw gives rise to any implication under the *New Zealand Bill of Rights Act 1990* and that it is not inconsistent with that Act. The latter Act establishes certain fundamental human rights as well as rights in relation to offences and other matters.

A review by Council staff of all the relevant provisions of the Act does not give rise to any concerns. For instance, the *New Zealand Bill of Rights Act 1990* states in section 5, justified limitations, *'Subject to section 4, the rights and freedoms contained in this Bill of Rights may be subject only to such reasonable limits prescribed by law as can be demonstrably justified in a free and democratic society.'*

It is believed that the bylaw is justified as it contributes to public health and safety by addressing the risks associated with harmful or contaminated discharges into Council stormwater or land drainage systems, which may enter the receiving environment.

It also protects against inadequate management of stormwater or drainage runoff volumes and peak flows resulting from inappropriate private activities. This includes protecting against interference with public systems or flood management infrastructure.

In addition to this, the bylaw is being reviewed using a democratic process which gives all interested people an opportunity to participate.

This includes publicly notifying the proposal, receiving and hearing submissions and using elected Councillors to make the final decision. For these reasons the proposed Stormwater Drainage Bylaw is not considered to be inconsistent with the *New Zealand Bill of Rights Act 1990*.

Section 259 – Local Government Act 2002

Section 259 is the *Local Government Act 2002* requirement for infringement notices for enforcement of local authority bylaws to be authorised through Regulations (via an Order in Council made by the Governor-General on the recommendation of the Minister of Local Government).

259 Regulations

(1) The Governor-General may, by Order in Council made on the recommendation of the Minister, make regulations for 1 or more of the following purposes:

(a) Prescribing breaches of bylaws that are infringement offences under this Act:

(b) Prescribing infringement fees (not exceeding $1,000) for infringement offences:

(c) Prescribing infringement notice forms:

This process has in the past proven very difficult for any individual Council to initiate in order to implement any one bylaw. The approach is also administratively burdensome to the Department of Internal Affairs, whom is required to implement it.

Therefore a review of this approach would be required to be supported by effective regional lobbying, as explained in section 3 of this report.

Litter Act 1979

The definition of litter under the *Litter Act 1979* is as follows:

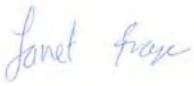
Litter *includes any refuse, rubbish, animal remains, glass, metal, garbage, debris, dirt, filth, rubble, ballast, stones, earth or waste matter, or any other thing of a like nature.*

Staff will investigate use of this definition to issue infringement fines in accordance with the *Litter Act 1979* infringement provisions for situations where contaminants which align with the above definition are discharging into the Council stormwater or land drainage systems.

6.3 Community Outcomes

The review of the Stormwater Bylaw 2011 promotes the following community outcomes:

- There is sufficient clean water to meet the needs of communities and ecosystems
- Core utility services are provided in a timely, sustainable and affordable manner



Owen Davies
Drainage Asset Manager

Janet Fraser
Utilities Planner

STORMWATER DRAINAGE BYLAW 2018

Draft Bylaw for Public Notification

WAIMAKARIRI DISTRICT COUNCIL

24 October 2017

WAIMAKARIRI DISTRICT COUNCIL
STORMWATER DRAINAGE BYLAW 2018

1 TITLE, AUTHORITY AND COMMENCEMENT

1.1 This bylaw shall be known as the *Waimakariri District Council Stormwater Drainage Bylaw 2018*.

1.2 This bylaw shall come into force on the 1st day of [insert Month] 2018.

1.3 This Bylaw supersedes and revokes the Stormwater Bylaw 2011.

1.4 The Council resolved to review the Stormwater Bylaw 2011 on 24 October 2017. This Bylaw was confirmed following a special consultative procedure by resolution at a meeting on [insert date].

2 INTRODUCTION

2.1 This bylaw is made by the Waimakariri District Council in exercise of the powers and authority vested in the Council by Section 146 of the *Local Government Act 2002*.

2.2 This bylaw applies and operates throughout the Waimakariri District.

2.3 This bylaw applies to the following:

- Council or private stormwater systems
- Council or private land drainage systems
- Private activities affecting watercourses, flood plains, overland flow paths or the receiving environment.

2.4 This bylaw does not derogate from the Building Act 2004, the Hazardous Substances and New Organisms Act 1996, the Health Act 1956 and the Resource Management Act 1991 and any of those Acts' subsequent amendments or applicable Regulations.

Explanatory Note: This bylaw interacts with the Waimakariri District Council Wastewater Bylaw in seeking to reduce wastewater overflows. The Wastewater Bylaw seeks to prevent stormwater inflow into the wastewater systems by addressing defects in the wastewater reticulation, non-complying wastewater or stormwater connections and poorly designed gully traps. These steps all assist to prevent wastewater overflows that can adversely affect the receiving environment.

The Stormwater Drainage Bylaw supports these provisions by requiring effective operation and maintenance of Council and private stormwater and land drainage systems and separate operation of the stormwater and wastewater systems.

3 OBJECTIVES

3.1 The purpose of the bylaw is to provide a mechanism to assist the Council to achieve the following key objectives:

a. Control the discharge of contaminants into any Council stormwater system or land drainage system;

b. Prevent the unauthorised discharge of stormwater into any Council stormwater or land drainage system;

c. Enable the Council to meet relevant objectives, policies and standards for discharges from any Council stormwater system into the receiving environment;

d. To protect the land, structures and infrastructure of Council and private stormwater and land drainage systems;

e. To define the obligations and responsibilities of the Council, private property owners and occupiers and the public in matters related to the discharge of stormwater and land drainage water, and the management of stormwater systems and land drainage systems.

4 INTERPRETATION

a. In this bylaw:

i. "**Approval or approved"** means approval or approved in writing by Waimakariri District Council either by resolution of Council or by a Council officer.

ii. **"Best practicable option"** means the best method for preventing or minimising the adverse effects of any stormwater discharge on the environment, as determined by the Council, having regard to:

a. the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and

b. the financial implications of an option compared with other options.

iii. **"Catchment Management Plan"** is a plan providing an overview of the stormwater system(s) and water quality issues within a catchment to provide a framework for future stormwater management.

iv. **"Connection"** means an approved discharge from a premises of stormwater into a Council stormwater system or land drainage water into a Council land drainage system that is subject to Council's approved and applicable rates and charges.

v. **"Construction activities"** means any activities involving the disturbance of the surface of any land but excludes farming and forestry activities.

vi. **"Contaminant"** includes any substance (including gases, odorous compounds, liquids, solids, and micro-organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy or heat:

a. when discharged into water, changes, or is likely to change the physical, chemical, or biological condition of the water into which it is discharged, or

b. when discharged onto or into land or into air, changes or is likely to change the physical, chemical or biological condition of the land or air onto or into which it is discharged.

vii. **"Council"** means the Waimakariri District Council.

viii. **"Council system"** means a land drainage or stormwater system which is under the control of the Council. For the purposes of the bylaw, drains within

New Zealand Transport Agency, Kiwirail or Environment Canterbury owned land are deemed to be part of a Council system.

ix. **"Customer"** means the person discharging stormwater or land drainage water into the Council system.

x. **"District Plan"** means the Waimakariri District Plan.

xi. **"District"** means the Waimakariri District.

xii. **"Environment Canterbury"** means the Canterbury Regional Council.

xiii. **"Erosion and Sediment Control Plan"** means a plan that has been prepared in accordance with the Environment Canterbury Erosion and Sediment Control Guidelines.

xiv. **"Flood plain"** means an area which is predicted to flood in a storm event.

xv. **"Ground soakage system"** means a system that provides for stormwater to soak into the ground.

xvi. **"High Risk Activities"** are those activities defined as High Risk in Schedule 1 of this Bylaw.

xvii. **"Land drainage system**" means any combination of surface or subsurface pipes, channels, drains or canal systems that have been constructed for the primary purpose of collecting or draining water from agricultural or rural land and ancillary structures; or controlling or permanently lowering the water table; and which conveys and discharges that water to the receiving environment.

xviii. **"Land drainage water"** means water arising from the drainage of water from the soil profile, or excess surface water from agricultural or rural land. It excludes stormwater, which is separately defined.

xix. **"Medium Risk Activities"** are those activities defined as Medium Risk in Schedule 1 of this bylaw.

xx. **"Natural servitude"** means a state where low-lying land is obliged to receive surface water which drains naturally from land situated at a higher gradient (surface water includes all naturally occurring water which results from rainfall or water flowing onto the site, including percolating water).

xxi. **"Nuisance"** has the same meaning as Section 29 of the *Health Act 1956*, and includes a person, thing, or circumstance causing stress or annoyance or unreasonable interference. In the context of this bylaw the term nuisance includes, but is not limited to:

a. Danger to life;

b. Danger to public health;

c. Flooding of any building floor or sub-floor, or public roadway;

d. Damage to property;

e. An effect on the efficient operation of a stormwater or land drainage system;

f. Damage to any facet of a stormwater or land drainage system;

g. Erosion or subsidence of land;

h. Long or short term adverse effects on the environment; or

i. Adverse loss of riparian vegetation; or

j. Wastewater overflow to land or water; or

k. Anything that causes a breach of any stormwater discharge consent condition binding Council.

xxii. **"Offence"** includes any act or omission in relation to this bylaw or any part thereof for which any person can be prosecuted.

xxiii. **"Owner/occupier"** means any persons acting in general management or control of the land, or any plant or machinery on that land.

xxiv. **"Overland flow path"** means any secondary flow path that is:

a. illustrated in a catchment management plan or on any Council drainage plan or record; or

b. the overland route taken by any concentration of, or significant sheet flow of stormwater or land drainage water on its way to a flood plain, stormwater system, land drainage system or watercourse.

xxv. **"Person"** includes an individual person (corporation sole) and also a body of persons, whether corporate, incorporate or non-corporate.

xxvi. **"Point of connection"** means the point on the Council system that marks the boundary of responsibility between the customer and the Council, at which the customer(s) private system connects to and discharges stormwater or land drainage water into the Council system.

xxvii. **"Pollution Prevention Plan"** means a Council approved plan which identifies actual or potential risks relating to the discharge of contaminants from a specific site or operation, and the management strategies implemented or proposed to mitigate these risks.

xxviii. **"Premises"** means either:

a. A property or allotment which is held under a separate certificate of title or for which a separate certificate of title may be issued and in respect to which a building consent has been or may be issued, or

b. A building that has been defined as an individual unit by a cross-lease, unit title or company lease and for which a certificate of title is available, or

c. Land held in public ownership (e.g. reserve) for a particular purpose.

d. Individual units in a building which are separately occupied and/or leased.

xxix. **"Private system"** means any land drainage system or stormwater system that drains water from a privately owned premises to a receiving environment or up to the point of connection with a Council system.

xxx. **"Receiving environment"** means any surface water body or land into which stormwater or land drainage water is conveyed.

xxxi. **"Stopbank"** means an embankment to prevent flooding**.**

xxxii. **"Stormwater"** means runoff that has been channelled, diverted, intensified or accelerated by human modification of the land surface or rainfall runoff from the external surface of any structure as a result of precipitation, and excludes land drainage water, which is separately defined.

xxxiii. **"Stormwater system"** means the system provided by the Council or private property owner/occupier for the management of stormwater runoff, which includes any combination of open channels, drains, underground pipes and basins, ponds, wetlands, kerb, channel and swales up to and including the point of discharge, but excluding the receiving environment.

xxxiv. **"Stormwater Management Plan"** is a plan to improve the management of water quality and water quantity in a defined area.

xxxv. **"The Act"** means the *Local Government Act 2002* and its amendments.

xxxvi. **"Watercourse"** means every open river, stream, creek, floodway, culvert, channel and open drain through which stormwater or land drainage water commonly flows, whether continuously or not, and which may be either publicly or privately managed.

xxxvii. **"WDC"** means the Waimakariri District Council.

b. Terms and expressions defined in the Act shall, when used in this bylaw, have the same meanings as those in the Act, unless they are alternatively defined in this bylaw.

c. If any requirement in relation to any person or activity specified in this bylaw differs from a requirement in any other legislation, regulation, consent condition, standard or Regional or District Plan provision then the more stringent requirement shall apply.

PART 1: ACCEPTANCE, DESIGN AND CONNECTIONS

5 ACCEPTANCE OF STORMWATER

5.1 Every premises shall be entitled to have its stormwater or land drainage water accepted by the Council subject to:

a. The premises being located within a drainage rated area (designated in accordance with the *Local Government Act 2002*) which is serviced by a Council stormwater or land drainage system;
b. The owner of the premises has prior written approval from the Council for the additional new connection(s);
c. There being sufficient capacity within the Council system to accommodate the additional connection(s);
d. The additional connection(s) must be at least cost neutral to the existing scheme members and annual rates generated from the additional connection(s) must be sufficient to cover the life cycle costs of the new assets and the variable costs of the service;
e. Fulfillment of the requirements of this bylaw, including obtaining any relevant consent, implementing any pollution prevention plan that the customer is required to obtain, and meeting all requirements of the *Resource Management Act 1991*, *Building Act 2004* or any other acts or regulations;
f. Payment of the appropriate fees and charges applicable to the connection(s).

Explanatory Note: A premises within a drainage rated area will either have a direct connection to a council system, or will have a private system that discharges to a council system within the drainage rated area. The customer is required to maintain the private system prior to the point of connection to the Council system.

In the areas outside of drainage rated areas, the principles of natural servitude apply and stormwater and land drainage water that discharge to a private system or receiving environment are subject to the applicable clauses within section 16 and to the Building Code.

5.2 If an application to connect to a Council system does not meet the requirements of clauses 5.1 (c), (d) or (e) then the Council may:

a. Require an upgrade to the system at the cost of the customer(s); or
b. Require that an alternative stormwater or land drainage system is provided within the premises in accordance with section 6; or
c. Decline the application and advise the customer(s) of the reason(s) why the application was declined.

6 DESIGN AND VESTING

6.1 Any proposed new stormwater or land drainage system and any proposed alteration to any existing system must be designed, constructed and operated in accordance with:

a. Council's Engineering Code of Practice;
b. Any relevant Catchment Management Plan prepared by Environment Canterbury or Waimakariri District Council;
c. Any relevant Stormwater Management Plan prepared and approved by the Waimakariri District Council;

d. The Waimakariri District Plan;
e. The Canterbury Land and Water Regional Plan;
f. The Regional Coastal Environment Plan for the Canterbury Region;
g. The Environment Canterbury Erosion and Sediment Control Guidelines;
h. Any resource, building or other consents relevant to the proposed works;
i. Any written conditions imposed by Council when approving the works;
j. Waimakariri District Council standard construction specifications.

6.2 As-built plans showing details of all new or altered systems must be provided to Council within the timeframe specified in Council's written approval or Engineering Code of Practice.

6.3 For sites being re-developed, Council may require retrofit stormwater mitigation and/or implementation of site specific management plans or practices to treat and/or retain stormwater runoff from all or some part of existing impervious areas.

6.4 The Council may specify areas in the District, or may impose controls on any premises, whereby stormwater disposal must be by ground soakage, unless site conditions prevent it.

7 POINT OF CONNECTION

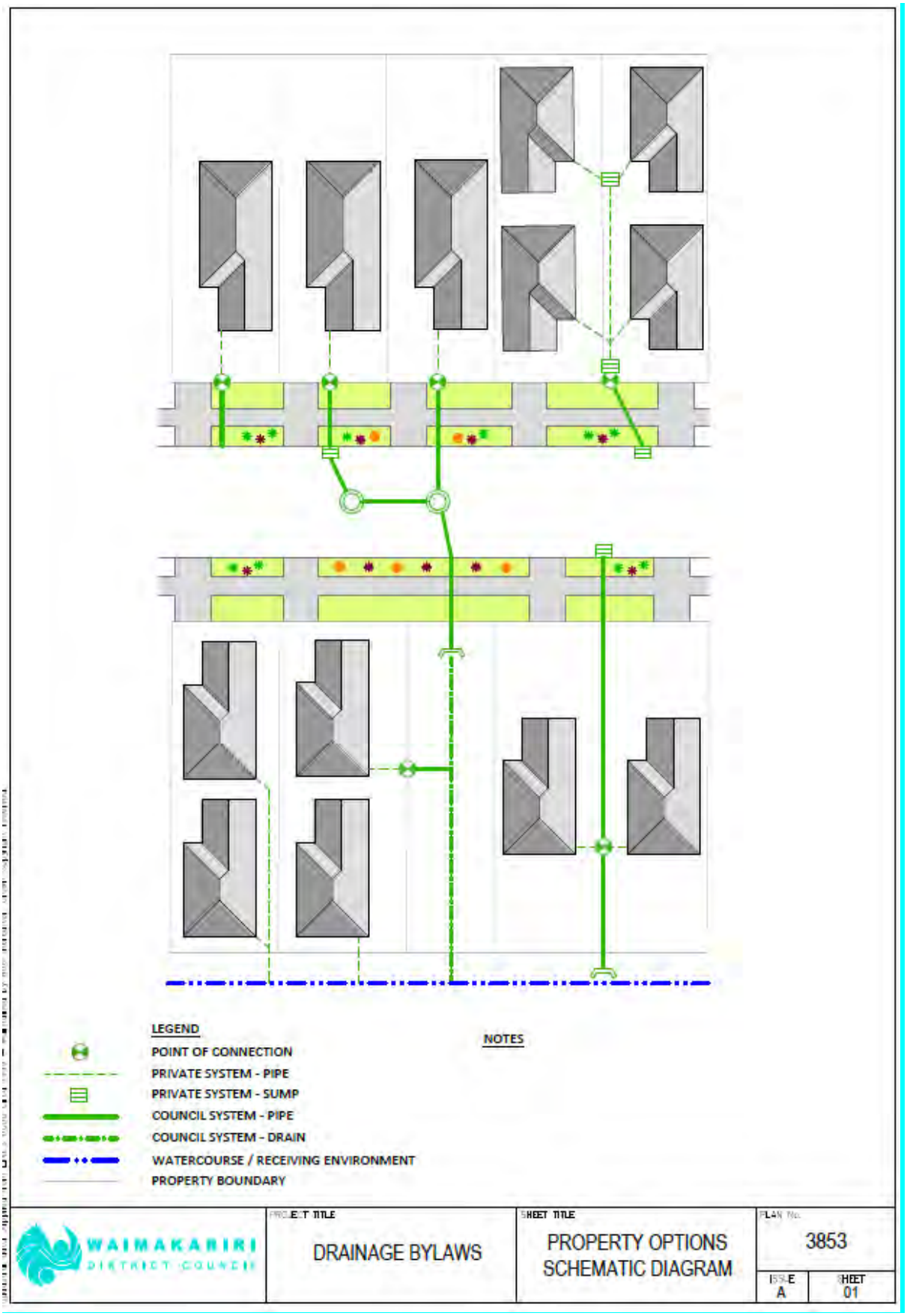
7.1 The Council owns and is responsible for the maintenance of any Council system, including any pipe and fittings up to the point of connection.

7.2 The customer owns and shall be responsible for all repairs to the private stormwater or private land drainage system within the customer's property and on the customer's side of the point of connection. Except where the private system is within public land, the following applies:

a. the Council is responsible for any damage to the system caused by a Council contractor or a Council asset (such as a street tree);
b. the customer is responsible for clearing of blockages or repairing damage from trees or other customer assets on the customer's own property up to the point of connection.

7.3 There may be only one point of connection for each premises unless prior written agreement is provided by the Council.

Figure 1: Stormwater Drainage Point of Connection Examples



PART 2: MANAGEMENT OF CONTAMINANTS

8 DISCHARGE OF CONTAMINANTS

8.1 No person or premises may discharge directly or indirectly a contaminant into a Council system, including by way of private system to a Council system, if the discharge is likely to cause nuisance or adversely affect the operation of the system or receiving environment, including having an adverse effect on aquatic life, unless the discharge is approved by the Council or is expressly authorised by an operative resource consent.

Explanatory note: Contaminants as defined in Section 4 of this bylaw include (but are not limited to) sediment, concrete, cement slurry, sewage, effluent, solvents, soap, detergents, dissolved metal, hazardous material, fungicide, insecticide, litter and green waste.

8.2 The Council may require premises that do not comply with clause 8.1 to implement the following controls:

a. The modification of the premises to reduce or avoid the discharge of the contaminant;
b. The installation and use of treatment and mitigation measures or devices;
c. The proactive maintenance of the private system, including the provision of and compliance with a site specific management plan approved by Council.

8.3 Any owner, occupier or person who is present on a premises subject to a control made under clause 8.2 must comply with that control.

9 MEDIUM RISK ACTIVITIES / SITES

9.1 The owner/occupier undertaking any new medium risk activity on any site as defined in Schedule 1 that connects to a Council system shall prepare and implement a site specific Pollution Prevention Plan. This plan shall be submitted to and approved by the Council and fully implemented prior to connecting into the Council system.

9.2 The owner/occupier undertaking any existing medium risk activity on any site as defined in Schedule 1 and that connects to a Council system shall prepare and implement a site specific Pollution Prevention Plan. This plan shall be submitted for Council approval no later than 6 months after being requested by the Council, or such later date as agreed with Council. The plan shall be fully implemented within 6 months of being approved by the Council.

9.3 The Pollution Prevention Plan if required under 9.1 or 9.2 above shall include:

9.3.1 A site assessment identifying all actual and potential sources of contaminant discharge, including surface coatings;

9.3.2 Suitably scaled plans showing the site layout, boundaries, all stormwater, land drainage and wastewater drainage including the point of connection or discharge to the Council stormwater, land drainage or wastewater systems, and relevant buildings and outdoor spaces (including identification of their use);

9.3.3 Identification and installation requirements of the best practicable options proposed to ensure that potential contamination of all discharges are minimised. The application of current, nationally accepted standards, such as the Auckland Regional Council's Guidelines TP10, the Christchurch Waterways and Wetlands Drainage Guide or Environment Canterbury's Erosion and Sediment Control Guidelines will be taken into account by the Council when assessing pollution prevention plans;

9.3.4 Site specific spill prevention and spill response procedures;

9.3.5 A description of the maintenance procedures proposed, actions to be taken and/or infrastructure to be developed.

9.4 Evidence of ongoing compliance with any Pollution Prevention Plan shall be provided to the Council upon request.

9.5 Any Pollution Prevention Plan prepared pursuant to this section shall be reviewed by the owner/occupier or operator of the activity to which the plan relates, at three yearly intervals after implementation. The review shall identify any changes to the matters covered in clause 9.3, and with a timeframe of action. The reviewed pollution prevention plan shall be forwarded to the Council for approval within its three yearly review timeframe. The Council may include further terms and conditions within the revised Pollution Prevention Plan to ensure the activity is being undertaken in accordance with clauses 9.3 and 8.1. Once approved, the plan shall become binding.

9.6 Notwithstanding clause 9.5, the Council may require that any Pollution Prevention Plan shall be revised where there have been significant changes to an activity or failure to meet any requirement of clause 8.1.

10 HIGH RISK ACTIVITIES / SITES

10.1 The owner/occupier undertaking any new high risk activity on any site as defined in Schedule 1 shall apply for and obtain any necessary resource consent from Environment Canterbury for a discharge into any Council or private stormwater or land drainage system.

10.2 The owner/occupier undertaking an existing high risk activity on any site as defined in Schedule 1 shall apply for and obtain any necessary resource consent from Environment Canterbury for a discharge into any Council or private stormwater or land drainage system, no later than 6 months after being requested by the Council, or such a later date as agreed with Council.

10.3 Any consented discharge under clauses 10.1 and 10.2 shall also comply with the requirements of this bylaw except for the need to submit a Pollution Prevention Plan.

11 CONSTRUCTION ACTIVITIES

11.1 An Erosion and Sediment Control Plan must be prepared and implemented by the owner/occupier of any premises where construction activities are occurring where there is a discharge, either directly or indirectly, into any Council system.

11.2 The Erosion and Sediment Control Plan required under clause 11.1 must be prepared and implemented in accordance with the current version of the Environment Canterbury Erosion and Sediment Control Guidelines.

PART 3: PROTECTION OF SYSTEMS AND WATERCOURSES

12 RESTRICTED ACTIVITIES

12.1 Approval in writing must be obtained from the Council before any of the following occur:

12.1.1 Any works on a Council system or a watercourse managed by the Council;

12.1.2 Any alteration, interference with or obstruction of any Council system;

12.1.3 The erection of any new vehicle or stock crossing over a watercourse managed by the Council;

12.1.4 Allowing any stock or vehicles to do anything that damages or is likely to cause damage to any Council system or watercourse managed by the Council;

12.1.5 Any modification to a bank structure, including widening, deepening, damming, diverting or planting or removing any vegetation from any part of a Council system or from the banks of any watercourse managed by the Council, including use of herbicide in such a way as to alter the flow of water or destabilise the bank structure; or

12.1.6 The erection of a structure, or placement of any material or planting of any vegetation (e.g. tree or hedge) where these impede access by machinery or apparatus used to clean, maintain or improve any part of a proposed or existing Council system.

13 WORKS IN PROXIMITY TO SYSTEMS

13.1 Any person who proposes to undertake any works or activities that may result in damage to any part of a Council system, including excavation works, must obtain Council's approval before beginning such works.

13.2 The person undertaking the works or activities is responsible for locating any buried services.

13.3 Any person who damages or causes disruption to any Council system is liable for the full costs of any repairs and associated costs incurred as a result of the damage or disruption. Any possible damage or disruption to any Council system must be reported to the Council immediately.

13.4 Following any works in proximity to a Council system, bedding and backfill must be reinstated in accordance with the Engineering Code of Practice.

PART 4: ACCESS, MAINTENANCE AND MONITORING

14 SYSTEM ACCESS

14.1 An owner/occupier shall allow Council access to and about all facets of all Council systems for the purposes of monitoring, testing and maintenance in accordance with Sections 171-173 and 182 of the Local Government Act 2002 (or other such notice as otherwise arranged with any owner/occupier).

14.2 In emergency conditions, or for the purpose of ascertaining whether a stormwater or land drainage system is being misused or this bylaw is not being complied with, an owner/occupier shall allow Council access to and about all facets of the system in accordance with sections 171-173 and 182 of the Local Government Act 2002.

15 WATER QUALITY MONITORING

15.1 Council may independently monitor, sample and analyse discharged stormwater or land drainage water and recover costs from the property owner/occupier, where failure to comply with any Pollution Prevention Plan relating to the property is evident.

15.2 Where it is suspected that any discharge within the district is in breach of any part of sections 8 to 11, the Council may independently monitor, sample and analyse discharged stormwater or land drainage water, and where an offence is proven, may recover the costs of investigating, sampling and analysing the discharge, from the property owner/occupier.

PART 5: PRIVATE SYSTEMS

16 PRIVATE SYSTEM MAINTENANCE

16.1 All private systems must be designed, constructed, managed and maintained by the owner/occupier, at the owner/occupier's expense or by some other arrangement acceptable to the Council.

16.2 The owner/occupier of a private system must ensure that the system:

a. is maintained in good operating condition; and
b. does not cause or contribute to nuisance.

16.3 The owner/ occupier of a premises on which there is a watercourse, stop bank, overland flow path or flood plain must maintain that watercourse, stop bank, overland flow path or flood plain in an operational state which ensures the free flow of water.

PART 6: OFFENCES, PENALTIES AND ENFORCEMENT

17 OFFENCES

17.1 Every person who breaches this bylaw commits an offence and is liable on summary conviction to a fine not exceeding $20,000.00 as set out in section 242 of the Local Government Act 2002.

18 FEES AND CHARGES

18.1 The Council may in accordance with the Local Government Act 1974 and Local Government Act 2002 set charges or fees to recover the cost of any of the following:

a. Processing the assessment of Pollution Prevention Plans, their review, approvals and monitoring of compliance with the plans;

b. Processing the assessment of any other approval, consent, or any other monitoring, investigation, sampling or analysis charge that is required under any part of this bylaw;

c. Processing the assessment, approval or monitoring of any Erosion and Sediment Control Plan required under this bylaw.

19 REMEDIES

19.1 In the event of a breach of statutory or other legal requirements including this bylaw, the Council may serve notice on the owner/occupier advising the nature of the breach and the steps to be taken within a specified period to remedy it. If after the specified period, the owner/occupier has not remedied the breach, the Council may charge a re-inspection fee.

19.2 At any time after the specified period in 19.1 has elapsed, the Council may carry out any remedial work required in order to make good the breach, and recover from the owner/occupier all reasonable costs incurred in connection or associated with the remedial work together with any resulting damages.

19.3 If however the breach is such that public health or safety considerations or nuisance, or risk of consequential damage to council assets is such that delay would create or be likely to create unacceptable results, the Council may take immediate action to rectify the defect, and recover all reasonable costs and damages from the owner/occupier.

SCHEDULE 1 – MEDIUM AND HIGH RISK ACTIVITIES AND SITES

A) High Risk activities and sites include any of the following:

i) Any activity listed in the Canterbury Land and Water Regional Plan Schedule 3 "Hazardous Industries and Activities List"; or

ii) Any site on the Canterbury Listed Land Use Register; or

iii) Any new development site, or re-development of an existing site, that is not permitted under the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011;

unless any such activity or site is specifically identified as a "medium risk" as defined below.

B) Medium Risk activities and sites include any of the following:

i Aggregate and material storage/stockpiled yards which are subject to erosion and/or leaching of contaminants,

ii. Commercial analytical laboratory sites,

iii. Construction and maintenance depots (that exclude areas used for refueling or bulk storage of hazardous substances),

iv. Demolition yards that exclude hazardous wastes,

v. Dry cleaning premises,

vi. Engineering workshops with metal fabrication,

vii. Engine reconditioning workshops,

viii. Food and beverage manufacturers,

ix. Motor vehicle workshops,

x. Any other activity or premises that has failed to meet the requirements of Section 8, unless that activity or site is otherwise defined as a "high risk" in Schedule 1(a).

STATEMENT OF PROPOSAL TO REVOKE THE WAIMAKARIRI DISTRICT COUNCIL STORMWATER BYLAW 2011 AND CREATE THE

STORMWATER DRAINAGE BYLAW 2018

Introduction

This Statement of Proposal is prepared for the proposed *Waimakariri District Council Stormwater Drainage Bylaw 2018,* and is made under sections 83, 86, 145, 146 and 156 of the *Local Government Act 2002* (the Act).

The documents relating to this proposal are attached to this Statement of Proposal. Copies of the Statement of Proposal are also available on the Council's website at waimakariri.govt.nz and at all Council Service Centres and district libraries during the consultation period which runs from 28 October to 8 December 2017.

Consultation will include notification of a number of affected organisations, public notices in local newspapers and information about the review on the Council's website.

Any questions can be referred to Janet Fraser on 0800 965 468.

You can forward your submissions to the Council at:

Stormwater Drainage Bylaw Submissions
Waimakariri District Council
Private Bag 1005
Rangiora 7440

Attention: Janet Fraser, Utilities Planner

Or email them to: records@wmk.govt.nz.

We need to receive your submission no later than **Friday 15 December 2017.**

All submitters have the opportunity to present their views to the hearing panel of Councillors in person. The likely hearing date is Tuesday 27 February 2018 (time to be confirmed).

Nature of Proposal

The Council proposes to revoke the current *Stormwater Bylaw 2011* and replace it with an amended bylaw called the *Stormwater Drainage Bylaw 2018* (being publicly consulted in 2017). As part of this bylaw making process the Council invites members of the public to comment on the draft 2018 amended bylaw.

The proposal to make this bylaw is made under the provisions of the *Local Government Act 2002*:

Section 145 – "*A territorial authority may make bylaws for its district for 1 or more of the following purposes:*

a) protecting the public from nuisance:

b) protecting, promoting, and maintaining public health and safety:

c) *minimising the potential for offensive behaviour in public places."*

Section 146 - *"Without limiting section 145, a territorial authority may make bylaws for its district for the purposes-*

b) of managing, regulating against, or protecting from, damage, misuse, or loss, or for preventing the use of, the land, structures, or infrastructure associated with 1 or more of the following:

(iii) wastewater, drainage, and sanitation:

(iv) land drainage:

The *Stormwater Bylaw 2011* was prepared to provide a mechanism to control the discharge of contaminants into public drains. The bylaw was developed to ensure that the Council could maintain the aquatic health of its drains, and meet the appropriate standards relating to its discharges from communal stormwater systems. The 2011 bylaw included provisions for managing discharges of contaminants into drains, and managing discharge of sediment into the stormwater systems from construction activities. It also introduced the use of Pollution Prevention Plans within the Southbrook Outline Development Plan area for medium risk activities.

The above provisions of the 2011 bylaw are consistent with the purpose of the *Resource Management Act 1991* in terms of seeking to maintain and enhance the quality of the environment by reducing discharges into the receiving environment of harmful contaminants.

The discharge of contaminants into the environment will continue to be reduced or prevented by the implementation of the 2018 version. The 2018 version covers more of the operating situations encountered by the Council in managing its systems and offers more protection against damage to the receiving environment. For example, the revised 2018 bylaw extends Pollution Prevention Plan requirements throughout the whole district to better address the quality of discharges into the networks from medium risk activities / sites.

It also includes new provisions to enable the Council to provide sufficient direction to the community in order to implement the stormwater discharge network consents which it is required to obtain under the Canterbury Land and Water Regional Plan (CLWRP). These consents will form part of the local approach to progressing the objectives and policies of the National Policy Statement for Freshwater Management (NPSFM) 2014.

The 2018 version also controls activities which interfere with Council systems and requires maintenance of privately managed flood protection infrastructure. It seeks to reduce common issues such as vehicle or stock damage to watercourses or excess spraying that damages open drains.

The bylaw is also intended to address some of the effects of managing private stormwater or land drainage systems. This is so that the bylaw can support the role of the Council in resolving situations where the actions of one party affect other properties and downstream Council systems or the receiving environment.

Reasons for this Proposal

Under section 158 of The Act, the Council is required to review its bylaws at five and then ten yearly intervals. The 5 year interval for the WDC Stormwater Bylaw 2011 is 1 October 2016, but under section 160A, a bylaw remains in force for a further two years, at which point it lapses. Council must therefore timetable its review in time to enable an amended bylaw to be adopted by Council before 1 October 2018.

Section 156 of The Act requires a Council to consult the public using a special consultative procedure if (1) (ii) *"the local authority considers that there is, or is likely to be, a significant impact on the public due to the proposed bylaw or changes to the bylaw".*

The proposed revised 2018 bylaw is significantly changed in content and provisions from the previous 2011 version. The Council has therefore decided to use the special consultative procedure to provide opportunity for public input.

The reason for developing this bylaw is to avoid nuisance from operating stormwater and land drainage systems, protect Council infrastructure, public health and safety and the quality of the environment. The provisions of the 2011 bylaw have been significantly expanded to include a wider range of requirements as set out in the 2018 version. These will enable the Council to better respond to common issues arising whilst it is managing the quality and quantity of stormwater discharges and resolving common operating issues. The changes are summarised in the "Proposed Changes" section of this Statement, below.

Section 155 Report

The Council is required to determine whether a bylaw is the most appropriate way of addressing the perceived problem, and if so, whether the proposed bylaw is the most appropriate form of bylaw and whether it gives rise to any implications under the *New Zealand Bill of Rights Act 1990.*

Determination of whether the Bylaw is appropriate

The Council considers a bylaw to still be the most appropriate mechanism for controlling nuisance and protecting public health and safety resulting from the discharge of stormwater or land drainage water, and other associated matters, for the following reasons:

- The bylaw provides an administratively simple way of specifying the rules and conditions to be met by each activity or person generating a stormwater or land drainage discharge
- A bylaw will help to ensure the health and safety of the public, Council contractors and employees, through preventing or reducing the discharge of contaminants, preventing interference with Council systems and requiring suitable maintenance of private systems
- It means the Council can make the public aware of the requirements by publishing its bylaw and providing enforcement in circumstances where a customer does not voluntarily agree to meet the requirements
- The bylaw provides an open and transparent process for the community to provide input into the preparation and adoption of the rules that will be applied
- The bylaw means the Council does not have to solely rely on the cooperation of the customer to ensure either: (a) the acceptable quality of stormwater and land drainage discharges into its systems; or (b) that it can avoid adverse effects of flood flows that may result from inappropriate private activities. This is because the bylaw sets out the conditions and rules that will apply in each of these circumstances, with enforcement as an option if necessary
- The bylaw provides the Council with a specific and focused method of enforcement in terms of managing activities in a way that will improve the quality of discharges into and from its systems
- Despite the need for a formal process, bylaws can be amended relatively easily to meet changing circumstances in the future

Form of the Bylaw

The form of the 2011 bylaw needs to be significantly amended as it is no longer appropriate or effective in addressing all of the circumstances and requirements of managing the stormwater drainage activity.

The 2011 version does not cover all of the operating situations encountered by the Council in managing its systems. It also does not enable the Council to provide sufficient direction to the community in order to implement the stormwater discharge network consents which it is required to obtain under the CLWRP.

The consents will require the Council to, over time, achieve the water quality standards of the CLWRP, as they apply within the district. The bylaw will provide a key method in the district to assist the Council to achieve these water quality standards.

The current form of bylaw is also not consistent with the form of the Council's other bylaws, nor is it consistent with bylaws in surrounding districts. The bylaw has therefore been subject to extensive review in order for it to: a) meet operating needs of the activity managers; and b) as a future tool to implement the stormwater network discharge consents and help the district achieve the CLWRP water quality and quantity standards.

The bylaw has been reviewed by Council asset managers, engineering and policy staff and compared with the bylaws of Auckland City, the Christchurch City Council and the Hurunui District Council. It has been subject to review by Corcoran French Lawyers and their recommendations are included in the draft bylaw for consultation.

The revised version is considered to provide greater consistency with bylaws of other councils, with the Waimakariri District Council's own bylaws and is drafted in anticipation of meeting requirements of the CLWRP as far as is practicable.

New Zealand Bill of Rights Act 1990

The Council must determine whether the bylaw gives rise to any implication under the *New Zealand Bill of Rights Act 1990* and that it is not inconsistent with that Act.

The Act establishes certain fundamental human rights as well as rights in relation to offences and other matters. A review by the Council of all of the relevant provisions of the Act does not give rise to any concerns.

For instance, the *New Zealand Bill of Rights Act 1990* states:

Section 5: *Justified Limitations*

"Subject to section 4, the rights and freedoms contained in this Bill of Rights may be subject only to such reasonable limits prescribed by law as can be demonstrably justified in a free and democratic society."

It is believed that the bylaw is justified and reasonable as it contributes to public health and safety by reducing the risk of harmful or contaminated substances discharging into Council stormwater or land drainage systems, which may then enter the receiving environment and affect downstream properties and health of aquatic ecosystems.

It also protects against inadequate management of stormwater or drainage runoff volumes and peak flows resulting from inappropriate private activities. This includes protecting against interference with public systems and requiring maintenance of privately owned flood management infrastructure to protect wider public safety and avoid nuisance.

The bylaw will require restrictions on individual behaviour that are currently already understood and accepted by the majority of citizens because of the collective benefits they generate. Some examples of how the community will benefit from this bylaw will be in avoiding discharge of contaminants into the environment, improving quality of freshwater in local streams and rivers and protecting flood control infrastructure from interference and ensuring adequate private maintenance so as to reduce or avoid flood risk and damage to downstream properties.

The bylaw will be made using a democratic process including publicly notifying the proposal, receiving and hearing submissions giving all interested people an opportunity to participate, with the final decision determined by elected Councillors.

<u>Options available to the Council</u>

The Council could either adopt the draft bylaw as proposed, amend the bylaw following public consultation, or it could choose instead to seek to meet its objectives in undertaking the stormwater drainage activity without the use of a bylaw to regulate public and private behaviour.

Since the adoption of the *2011 Stormwater Bylaw* the Council has continued to use a combination of education, guidelines and advocacy to the general public, in working towards improving the quality of the stormwater and land drainage discharges and in avoiding or reducing flood risks associated with the activity. The existence of the bylaw has enabled more insistence on compliant behaviour in cases where softer approaches have not have the desired effect.

The continued existence of a bylaw provides the appropriate legal tool to control organisations and individuals that choose to dispose of waste into the stormwater system or otherwise damage infrastructure in a way that can create a risk to public health or safety.

Proposed Changes

The draft bylaw that is proposed by staff is substantially revised from the existing 2011 version. Some key proposed changes shown in the revised 2018 version include:

- Extending the existing 2011 bylaw to cover land drainage systems (rural drainage areas) as well as urban reticulated stormwater systems
- Provision for the acceptance of stormwater and land drainage water into a Council system
- Extending provisions for pollution prevention plans throughout the district to better manage discharge of pollutants from medium risk activities / sites, at source
- Clarifying that consenting responsibilities for discharges into Council systems from high risk activities / sites should remain with Environment Canterbury
- Some provisions of the bylaw will extend to private systems and activities on private property
- Provisions to prevent interference with Council systems
- Provisions to avoid damage from excessive use of herbicides, or from stock or vehicle access to watercourses managed by the Council
- Requirement for private owners/occupiers to maintain any aspect of a flood defence system in an operational state

Related Documents

- Waimakariri District Council Stormwater Bylaw 2011 (TRIM 110927043815)
- Proposed Waimakariri District Council Stormwater Drainage Bylaw 2018 (TRIM 171003106407)
- Officer Report Titled “Stormwater Drainage Bylaw Review” (TRIM 170907097266)

STORMWATER BYLAW 2011

This Stormwater Bylaw 2011
was adopted at a Council meeting held on
6 September 2011

WAIMAKARIRI DISTRICT COUNCIL
THE COMMON SEAL OF

Chief Executive

Administration Manager

WAIMAKARIRI
DISTRICT COUNCIL

September 2011

WAIMAKARIRI DISTRICT COUNCIL
STORMWATER BYLAW 2011

1 TITLE, AUTHORITY AND COMMENCEMENT

1.1 This bylaw shall be known as the Waimakariri District Stormwater Bylaw 2011.

1.2 This bylaw shall come into force on the 1st day of October 2011.

2 INTRODUCTION

2.1 This bylaw is made by the Waimakariri District Council in exercise of the powers and authority vested in the Council by Section 146 of the Local Government Act 2002.

2.2 Except for Sections 7, 8, and 9 which apply only to the Southbrook outlying development area, this Bylaw applies and operates throughout the Waimakariri District.

3 OBJECTIVES

3.1 The objective of this Bylaw is to provide a mechanism to control the discharge of contaminants into public drains.

3.2 The bylaw is needed to ensure that the Council can maintain the aquatic health of its drains, and meet the appropriate standards relating to its discharges from communal stormwater systems.

4 INTERPRETATION

1) In this bylaw:

i. "Best practicable option" (BPO) means the best method for preventing or minimising the adverse effects of any stormwater discharge on the environment, as determined by the Manager Utilities and Roading, having regard to:

a. the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and

b. the financial implications of an option compared with other options; and

c. the effects on the environment; and

d. the current state of technical knowledge as in the Auckland Regional Council's guidelines TP10 or Environment Canterbury's Erosion and Sediment Control Guideline 2007, and the likelihood that the option can be successfully applied.

ii. "Construction activities" means any activities involving the disturbance of the surface of any land but excludes farming and forestry activities.

iii. "Contaminant" includes any substance (including gases, odorous compounds, liquids, solids, and micro-organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy or heat:

a. when discharged into water, changes, or is likely to change the physical, chemical, or biological condition of the water into which it is discharged, or

b. when discharged on to or into land or into air, changes or is likely to change the physical, chemical or biological condition of the land or air on to or into which it is discharged.

iv. "Council" means the Waimakariri District Council.

v. "Development" in relation to any land means altering the stormwater runoff characteristics of that land including by stormwater drainage works, building work, subdivision or change of use.

vi. "District Plan" means the Waimakariri District Plan.

vii. "Environment Canterbury" means the Canterbury Regional Council.

viii. "Industrial or trade process" are businesses or activities included in Schedule 1 or listed in Schedule WQL9 of the PNRRP.

ix. "Manager Utilities and Roading" means the person employed as the Manager Utilities and Roading by the Council or any person authorised to exercise the powers and duties of the said person.

x. "NRRP" shall mean the Natural Resources Regional Plan prepared by Environment Canterbury

xi. "Owner/occupier" means any persons acting in general management or control of the land, or any plant or machinery on that land.

xii. "Person" includes a Corporation Sole and also a body of persons, whether corporate or unincorporate.

xiii. "Public drain" means any passage, channel, or pipe on, over, or under the ground by which stormwater is conveyed and which is under the control of the Council. For the purposes of this bylaw, drains within New Zealand Transport Agency owned land are deemed to be Public drains.

xiv. "Stormwater" means runoff that has been channelled, diverted, intensified or accelerated by human modification of the land surface or rainfall runoff from the external surface of any structure as a result of precipitation.

xv. "Southbrook ODP area" means the Southbrook Business 2 Zone as currently defined in the Waimakariri District planning map 154.

xvi. "The Act" means the Local Government Act 2002 and its amendments.

xvii. "WDC" means the Waimakariri District Council.

2) Terms and expressions defined in the Act shall, when used in this by-law, have the same meanings as those in the Act, unless they are alternatively defined in this bylaw.

5 CONSTRUCTION ACTIVITIES

5.1 Any person who carries out any earthworks as defined in the District Plan related to either construction activity or development, which may lead to stormwater run-off into public drains, and which is contaminated with soil particles or causes water to scour the soil, shall ensure that erosion and sedimentation control activities are implemented in accordance with good practice as described in Environment Canterbury's Erosion and Sediment Control Guideline 2007.

6 MINIMUM STORMWATER QUALITY STANDARD

6.1 The owner/occupier of any land or any person causing a discharge to the Council's stormwater system, including any discharge from a private drain or private common drain that in turn discharges to a public drain, shall ensure that it does not;

a. contain any chemicals in quantities sufficient to be toxic to plants and animals, paint, oil, grease, pesticides, fertiliser, tannins, detergent, grass clippings, rubbish, litter, or heavy metals, or

b. cause the production of conspicuous oil or grease films, scums or foams, or floatable material, or

c. cause a conspicuous change of colour or visual clarity, at that point which is 30 times the receiving drain channel's width downstream from the point of discharge into the public drain , or

d. cause an emission of objectionable odour, or

e. cause adverse effects on aquatic life, or

f. contain suspended solid concentrations in excess of 100mg/litre at that point which is 30 times the receiving drain channel's width downstream from the point of discharge into the public drain, or

g. contain any hazardous substances, waste water or trade wastes.

except where the discharge:

h. is a discharge of dye or tracer material for investigative purposes, or

i. is a discharge of water from the testing or emptying of pipelines, tanks or bunds where potable or stream water has been used, and no welding residues, disinfection chemicals or other chemical contaminants contained within the pipeline will be discharged to the receiving water body, or

j. is a discharge of overflow bore water to surface water bodies, if the rate of discharge is no more than five litres per second and the discharge has not been contaminated prior to discharge, or

k. is a discharge from a swimming pool (excluding swimming pool filter backwash water) which is free of chemicals, algae, leaves, dirt or other debris. (Any discharge with these contaminants must be discharged to the sewerage system.) Swimming pool water is considered free of chemical contaminants when a pool has been left open to sunlight for 14 days, the level of chlorine does not register on any home testing kit, and no smell of chlorine remains, or

l. is a specific discharge which is authorised to be permitted under specific resource consent, or

m. is from an activity for which the best practicable option is already in place, or

n. is from a moderate risk industrial or trade process (as defined in schedule 1) and complies with an approved pollution prevention plan, or is from a high risk activity (as defined in schedule 1) and complies with a Resource Consent which has been obtained from Environment Canterbury.

7 POLLUTION PREVENTION PLANS – SOUTHBROOK OUTLINE DEVELOPMENT PLAN AREA

7.1 Prior to discharging to any Public drain, the owner/occupier of land with any new moderate risk industrial or trade processes in the Southbrook outline development plan (ODP) area, shall prepare a site or operation specific pollution prevention plan and submit this plan and obtain approval for it from the Manager Utilities and Roading. The owner/occupier shall ensure the process shall is fully compliant before discharging to the Public drain.

7.2 For existing moderate risk industrial or trade processes a Pollution Prevention Plan shall be provided by the owner/occupier no later than 6 months after being requested by the Manager Utilities and Roading, or such later date as the Manager Utilities and Roading might agree. Within 6 months of the pollution prevention plan being approved by the Manager Utilities and Roading or such later date as agreed, the owner/occupier shall ensure the process is fully compliant with the requirements of the approved pollution prevention plan.

7.3 The pollution prevention plan, required under 7.1 above, shall include:-

a. A site assessment identifying all actual and potential sources of stormwater pollution,

b. Suitably scaled plans showing the site layout, boundaries, all stormwater and sewer drainage, and relevant buildings and outdoor spaces (including identification of their use),

c. Identification and installation requirements of the best practicable options proposed to ensure that potential contamination of stormwater discharges are minimised, The application of current, nationally accepted standards, such as the Auckland Regional Council's guidelines TP10 or Environment Canterbury's Erosion and Sediment Control Guideline 2007, will be taken into account by the Manager Utilities and Roading when assessing pollution prevention plans.

d. Site specific spill prevention and spill response procedures,

e. A description of the maintenance procedures proposed, actions to be taken and/or infrastructure to be developed.

8 REVIEW OF POLLUTION PREVENTION PLANS

8.1 Any pollution prevention plan prepared pursuant to clause 7 shall be reviewed by the occupier or operator of the activity to which the plan relates, no later than three years after implementation and thereafter at three yearly intervals. The review shall identify any changes to the matters covered in clause 7.3, and with a timeframe of action. The reviewed pollution plan shall be forwarded to the Manager, Utilities and Roading for his approval, and the approved reviewed plan shall become binding.

8.2 Not withstanding clause 8.1 above, the Manager Utilities and Roading may require that any pollution prevention plan shall be revised where he considers that there have been significant changes in the facility concerned or its operational procedures.

9 STORMWATER DISCHARGE RESOURCE CONSENTS

9.1 The owner/occupier of any land with high risk activity as defined in Schedule 1 within the Southbrook ODP area shall apply for and obtain any necessary resource consent from Environment Canterbury for stormwater discharges into Public Drains. Any such consented discharge shall also comply with the requirements of this bylaw except for the need to submit a pollution prevention plan.

10 MONITORING OF STORMWATER DISCHARGES

10.1 Council may independently monitor, sample and analyse discharged stormwater and recover costs from the property owner/occupier, where failure to comply with the pollution prevention plan relating to the property is evidenced.

10.2 Where it is suspected that a discharge within the district is in breach of clause 6 the Council may independently monitor, sample and analyse discharged stormwater, and where an offence is proven, may recover the costs of investigating, sampling and analyzing the discharge, from the property owner/occupier.

11 OFFENCES

11.1 Unless a resource consent allows otherwise, or it is a permitted activity under the District Plan, every person who discharges or causes the discharge of stormwater to a public drain in contravention of Clause 5 or 6 hereof, commits an offence against this bylaw and on summary conviction is liable to a fine not exceeding $20,000 as per section 242(4) of the Act.

11.2 Any owner/occupier within the Southbrook ODP area, who fails to adhere to or comply with an approved pollution prevention plan, or any owner/occupier of land with moderate risk operations in that area who fails to adhere to or comply with clause 7, commits an offence against this bylaw and on summary conviction is liable to a fine not exceeding $20,000 as per section 242(4) of the Act.

11.3 Any owner/occupier of land with high risk operations in that area who fails to adhere to or comply with clause 9, commits an offence against this bylaw and on summary conviction is liable to a fine not exceeding $20,000 as per section 242(4) of the Act.

11.4 Any other breaches of this bylaw not referred to in Section 11.1 or 11.2 shall be an offence under the bylaw.

12 FEES AND CHARGES

12.1 The Council may as part of its Annual Plan process set charges to recover the cost of processing the assessment of pollution prevention plans, their review and monitoring of compliance with the plans.

13 REMEDIES

13.1 In the event of a breach of statutory or other legal requirements including this bylaw, the Council may serve a defect notice on the owner/occupier advising the nature of the breach and the steps to be taken within a specified period to remedy it. If after the specified period, the owner/occupier has not remedied the breach, the Council may charge a re-inspection fee.

13.2 At any time after the specified period in 13.1 has elapsed, the Council may carry out any remedial work required in order to make good the breach, and recover from the owner/occupier all reasonable costs incurred in connection or associated with the remedial work together with any resulting damages.

13.3 If however the breach is such that public health or safety considerations or risk of consequential damage to council assets is such that delay would create or be likely to create unacceptable results, the Council may take immediate action to rectify the defect, and recover all reasonable costs and damages from the owner/occupier.

SCHEDULE 1 – HIGH AND MODERATE RISK INDUSTRIAL OR TRADE PROCESSES

A **High risk** industrial and trade processes (high risk activities) shall be those activities listed in NRRP schedule WQL9.

B **Moderate risk** industrial and trade processes includes, but is not limited to:

a. Any other activity or premises nominated by the Manager Utilities and Roading that has failed to meet the minimum stormwater quality standards as specified in Clause 6.1.

b. Any other business identified by the Manager Utilities and Roading as of particular concern relating to the quality of its stormwater discharges, with regard to achieving minimum stormwater quality standards as specified in Clause 6.1.

c. The following industrial and trade processes:

i. aggregate and material storage/stockpiled yards which are subject to erosion and/or leaching of contaminants,
ii. boat building and repair facilities,
iii. construction and maintenance depots,
iv. demolition activities,
v. food and beverage manufacturers,
vi. liquid waste removal contractors,
vii. operations where water used to wash buildings uses detergents and chemicals and liquid waste removal contractors,
viii. retail service stations, truck stops, oil terminals and depots and lubricating oil blending and grease manufacturing plants,
ix. recycling and waste centres,
x. spray painting, panel beaters and sign writers workshops,
xi. transport depots,
xii. vehicle and mechanical engineering workshops,
xiii. vehicle recyclers,
xiv. wood and paper product and furniture manufacturers.

WAIMAKARIRI DISTRICT COUNCIL

REPORT

FILE NO and TRIM NO:	DRA-19 / 170925103162
REPORT TO:	Council
DATE OF MEETING:	24 October 2017
FROM:	Janet Fraser, Utilities Planner Owen Davies, Drainage Asset Manager
SUBJECT:	Cam River Enhancement Allocation of Funding

SIGNED BY: **(for Reports to Council or Committees)**	Department Manager	Chief Executive

1. SUMMARY

1.1. The purpose of this report is to update the Council on the allocation of funding from the Cam River Enhancement Fund (the Fund). The Fund was allocated during a recent meeting of the Cam River Enhancement Fund Subcommittee (the Subcommittee) on 24 August 2017.

1.2. The Cam River Enhancement Fund was allocated across a number of prioritised projects based on recommendations of Dr Henry Hudson within the "*Scoping Strategy for the Three Brooks and Channel Enhancements in the Middle Cam River and Tuahiwi Stream"* report dated August 2017 ("Scoping Strategy").

1.3 This report recommends the Council now adopt the Scoping Strategy, noting it is a basis for allocation of the Fund. The Scoping Strategy will also assist to identify ongoing projects which could be undertaken in future outside the immediate scope of the Fund.

1.4 The Fund was allocated among high priority sites for which physical works are recommended in the Scoping Strategy for the purposes of habitat restoration.

1.5 The approved allocations from the Fund include $114,000 for prioritised projects, $37,000 for works on the Tuahiwi Stream which have been scoped by Environment Canterbury and $50,000 for works below a spring head in the Fernside area at a tributary of the South Brook (still to be scoped). Section 3 contains further detail of these projects.

1.6 The report notes that a further report on the future role of the Cam River Enhancement Fund Subcommittee will be bought to Council following completion of all of the physical works which are undertaken through the fund.

1.7 The Subcommittee has expressed interest in the formation of a proposed future advisory group to oversee further district water quality and habitat improvements for lowland waterways. That group could be comprised of Councillors and representatives from key stakeholder groups. It could be supported as required by Environment Canterbury and Waimakariri District Council staff.

Attachments:

i. "*Scoping Strategy for the Three Brooks and Channel Enhancements in the Middle Cam River and Tuahiwi Stream, August 2017"*, report by Dr Henry Hudson of Environmental Management Associates (TRIM 170410035142[v2]) .
ii. Cam River Enhancement Fund Subcommittee Minutes of Meeting 24 August 2017 (TRIM 170825092351).
iii. Cam River Enhancement email record of consultation discussion with Department of Conservation (TRIM 171002106261).
iv. Cam River Enhancement Fund Approval Letter from North Canterbury Fish and Game Council 13 October 2017 (TRIM 171017112494).

2. RECOMMENDATION

THAT the Council:

a) **Receives** report No. 170925103162.

b) **Adopts** the "*Scoping Strategy for the Three Brooks and Channel Enhancements in the Middle Cam River and Tuahiwi Stream"* report by Dr Henry Hudson published in August 2017.

c) **Notes** the "*Scoping Strategy*" provides a basis for allocating funding from the Cam River Enhancement Fund.

d) **Notes** the allocation of the Cam River Enhancement Fund among prioritised projects was confirmed by the Cam River Enhancement Fund Subcommittee at its 24 August 2017 meeting.

e) **Notes** that a further report on the future role of the Cam River Enhancement Fund Subcommittee will be bought to Council following completion of all of the physical works which are undertaken through the fund.

f) **Circulates** this report and its attachments to the Kaiapoi-Tuahiwi, Rangiora-Ashley and Woodend-Sefton Community Boards.

3. ISSUES AND OPTIONS

3.1. The Cam River Enhancement Fund was set up as a result of the mediated resource consent agreement between the Council and several stakeholder groups regarding the discharge from the Rangiora Sewage Treatment Plant.

3.2. The consent required the Council, as consent holder, to "…*provide the amount of $25,000 per annum for five years, for habitat restoration in the Cam River system to be used as agreed between North Canterbury Fish and Game Council and the consent holder, in consultation with Department of Conservation*".

3.3. The Subcommittee was initially set up by the Utilities and Roading Committee in 2010. Due to the focus at that time on earthquake recovery works and limited staff availability progress did not immediately occur. Late in 2012 the subcommittee was reconvened, consisting of Councillors, a member of the Kaiapoi/Tuahiwi Community Board and WDC staff, together with representatives from North Canterbury Fish and Game Council, Department of Conservation, Environment Canterbury and Ngai Tuahuriri.

3.4. In 2015/16, Dr Henry Hudson was engaged by the Subcommittee to write a scoping strategy in order to assist the Subcommittee to allocate the Cam River Enhancement Fund. The Scoping Strategy summarises the present state of the three brooks leading into the Cam River. This strategy also proposes remedial measures aimed at restoring

the health of the three brooks and improving the Cam River. The Scoping Strategy has been reviewed by the Subcommittee during the 24 August meeting and is now being recommended to the Council for adoption.

3.5 The fund had reached a value of $208,437 which was available for allocation for habitat restoration in the Cam River system as at 3 August 2017. This has now been allocated in accordance with the Scoping Strategy recommendations. The Scoping Strategy proposes a variety of rehabilitation and enhancement works to be carried out in the tributaries and mainstem of the Cam River. This is consistent with a 'top down' approach aimed at trapping sediment before it reaches the main stem of the Cam.

3.6 The Cam River Enhancement Subcommittee met on 24 August 2017 and allocated the fund for expenditure among prioritised projects as summarised in the following table:

Project Description	**Method and Comment**	**Estimated Cost**
Sediment Traps	3 Sediment Traps on the Cam Mainstem	$8,700
	2 Sediment traps on the North Brook	$5,800
	1 Sediment trap on the South Brook	$2,900
	1 sediment trap on the South south Brook	$2,900
Fine Sediment Removal and Bed Raking	Fine sediment removal, followed by bed raking in heavily sedimented reaches on the following sites: • A tributary to the North Brook • North Brook between Boys and Marsh Road • South Brook around the spring head • South Brook downstream of Lehmans Road	$52,100
Drainage Wetlands	3 Drainage wetlands on the Cam Mainstem between Marsh Road and Power Road	$9,000
Bank Reshaping	3 bank reshaping sites on the Cam Mainstem at or downstream of Boys Road	$7,500
	3 bank reshaping sites on the North Brook	$7,500
	6 bank reshaping sites on the South Brook	$15,000
Remediate bed scour from localised discharges	1 site on the North Brook	$2,500
Total		**$113,900**

3.7 The approved allocations also include $37,000 for works on the Tuahiwi Stream which have been scoped by Environment Canterbury and $50,000 for works below a spring head in the Fernside area at a tributary of the South Brook (still to be scoped). More detail of these funding allocations is available in the staff report to the Subcommittee on "*Proposed Cam River Fund Allocation*" (see TRIM 170926103933).

3.8 Combined, the allocated projects have a total estimated value of $200,900. The unallocated $8,000 of funding could be used to meet any shortfall for any of the above high priority projects, or could be reallocated to one or more of the lower priority projects also described in the *"Proposed Cam River Fund Allocation"* report.

3.9 The following are the projects on the Tuahiwi stream scoped by Environment Canterbury that are approved for funding through the Cam River Enhancement Fund:

Project Description	Method and Comment	Estimated Cost
Pasture swale protection	Rehabilitate 7 pasture drainage swales near Rangiora Woodend Road, creating 7 small sediment traps in the pugged drains	$7,000
Sediment Traps	Expand and maintain 3 existing sediment traps at Greens Road and create one new sediment trap at Church Bush Road	$7,500
	Create a major sediment trap and wetland at the large pond at the south end of the stream. Includes fencing and planting alongside adjoining reaches of stream south of Church Bush Road and a reach north of Church Bush Road.	$20,000
Bank reshaping	Re-batter eroding banks and vegetate eroding site on Tuahiwi Stream near Te Pouapatuki Road	$2,500
Total		**$37,000**

3.10 The approach taken via the above allocations is to begin fine legacy sediment removal and bed raking in the heavily sedimented upper reaches of the North Brook and South Brook. This will be continued downstream and into the Cam mainstem as funding permits. The removal of legacy sediment and bed raking in the Middle Brook was not recommended in the Scoping Strategy as this reach is a part of the separate CAREX programme of works.

3.11 A comprehensive future approach to legacy sediment removal and bed raking is recommended in the upper reaches of the Cam mainstem. This work is outside the immediate Scoping Strategy recommendations and planned Fund expenditure. It will require more funding than is available from the Cam River Enhancement Fund and could become part of a future project for this catchment.

3.12 Some of the above projects now require detailed design and on-site investigations before realistic costs can be presented to the Subcommittee. Further investigations are being undertaken and detailed designs (where required) with any required cost adjustments will be further discussed with the Subcommittee prior to works commencing.

3.13 There are a number of lower priority projects identified in the "*Proposed Cam River Fund Allocation*" report which could be considered for future funding by the Council outside of the scope of the Cam River Enhancement Fund.

3.14 There are also a number of projects that were recommended in the Scoping Strategy that are being funded through the Waimakariri District Council flood response funds (in conjunction with flood mitigation works), or which could be funded in future by developers, Environment Canterbury or from other contestable funds.

3.15 The success of the Cam River enhancement works in restoring habitat in the Cam River system will depend on the preparedness of private property owners to limit sources of sediment from entering the Cam River system from their own activities.

3.16 The project implementation therefore requires cooperation between private property owners, Environment Canterbury and the Waimakariri District Council to identify complementary mitigations to prevent further sediment from private properties from entering the system.

3.17 Staff intend to coordinate and support a monitoring programme for the works undertaken through the Fund. Baseline monitoring for the Cam River system was undertaken through the Environment Canterbury streamwalk in 2016. This monitoring provided many useful inputs to the Scoping Strategy.

3.18 The ongoing monitoring of the project could include a further streamwalk in 5 years to monitor progress following completion of projects through the Cam Fund. The monitoring is intended to be undertaken collaboratively between Environment Canterbury, Ngai Tuahuriri and the University of Canterbury.

3.19 Cam River system monitoring could involve wider monitoring of the project outcomes from Tuahiwi youth on behalf of Ngai Tuahuriri, as a part of their kaitiakitanga (guardianship) responsibility for the Cam River system. Further, it could involve Canterbury University students undertaking freshwater ecology research together with those involved in the Canterbury Waterway Rehabilitation Experiment (CAREX) programme.

3.20 The Management Team has reviewed this report and supports the recommendations.

4 COMMUNITY VIEWS

4.1 The Subcommittee membership comprises the following:

- One Utilities and Roading Committee member
- The Waimakariri District Council Canterbury Water Management Strategy portfolio holder
- One member from the Waimakariri Water Management Zone Committee (Lowland Streams Subcommittee)
- One representative from the Kaiapoi/Tuahiwi Community Board
- One representative from Department of Conservation
- One representative from Environment Canterbury
- One representative from North Canterbury Fish and Game Council
- One representative from Te Ngāi Tūāhuriri Rūnanga Inc.

4.2 A further report on the future role of the Cam River Enhancement Fund Subcommittee will be bought to Council following completion of all of the physical works which are undertaken through the Fund.

4.3 The Subcommittee has expressed an interest in formation of a new district waterways advisory committee. This committee could take a wider view on initiatives to improve water quality in lowland streams in the district. That group would likely be comprised of Councillors and representatives from key stakeholder groups. It would be supported by Environment Canterbury and Waimakariri District Council staff.

4.4 This proposed new advisory committee, once formed, would be able to continue to use the Scoping Strategy as a basis to determine methods for ongoing rehabilitation projects for the Cam River system in future, outside the scope of the Fund expenditure.

4.5 The Subcommittee approved the vision for the Cam River catchment as outlined in the Scoping Strategy. The adopted vision is to "*rehabilitate the Three Brooks into a sustainable eco-geomorphological based exemplar that provides a broad range of ecosystem services and provides environmentally friendly, cost effective and hydraulically effective erosion and flood control required in a dynamic rural and urban landscape".*

4.6 The Scoping Strategy Appendix 1 includes a series of Vision Statements which are described as the "*key activities to provide these ecosystem services".* These statements can be viewed as aspirational reference points for the Cam River catchment. The proposed new advisory committee may consider further developing and recommending these vision statements to the Council in future for adoption, in consultation with the community.

4.7 The Council has received a written letter of approval of the proposed Fund allocation from the North Canterbury Fish and Game Council which is attached to this report (see attachment iv. TRIM 171017112494). A record of consultation undertaken with the Department of Conservation is also attached to the report in attachment iii (TRIM 171002106261). The Department did not always have a representative available to attend meetings, but have been invited to provide further feedback during the ongoing detailed project designs.

5 FINANCIAL IMPLICATIONS AND RISKS

5.1 The fund had a value of $208,437 as at 3 August 2017.

5.2 The Fund expenditure as allocated does not include any costs of detailed design required for specific projects. These additional costs will be met from existing drainage maintenance budgets.

5.3 The Cam River Enhancement Subcommittee will continue to reconvene as required to approve any final detailed designs and cost adjustments for the project and oversee completion of the physical works.

5.4 The Subcommittee could choose to disband following completion of all of the physical works which are being undertaken through the Fund.

5.5 Following completion of the Cam River enhancement projects, any ongoing maintenance requirements will be incorporated into the drainage maintenance activity. The associated increased costs incurred will be included in future annual plans.

6 CONTEXT

6.1 Policy

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

The Council is in the final stages of obtaining a global consent for maintenance and minor works in waterways that will allow a number of the projects identified in the Scoping Strategy to be undertaken (i.e. installation of sediment traps, bank reshaping and channel rehabilitation). This will broaden the number of works that can be undertaken in the Cam River catchment under the current consent (at present limited to just riparian planting, fencing and water troughs).

6.2 Legislation

The Council was required to establish the Enhancement Fund as part of the resource consents granted for the Rangiora Waste Water Treatment Plant, in 2001 (Clause 20 of

the Rangiora Sewerage Discharge Proceedings Environment Court decision 11 December 2001).

The purpose of the fund as noted in the Environment Court decision was to be used "*for habitat restoration in the Cam River system to be used as agreed between North Canterbury Fish and Game Council and the consent holder in consultation with the Department of Conservation*".

6.3 Community Outcomes

The progressing of works enhancing the Cam River will contribute to the following outcome:

There is sufficient clean water to meet the needs of communities and ecosystems.

Janet Fraser
Utilities Planner

Owen Davies
Drainage Asset Manager

Scoping strategy for the Three Brooks and channel enhancements in the middle Cam River and Tuahiwi Stream

Prepared for Waimakariri District Council
Prepared by Dr Henry R Hudson
Environmental Management Associates
Nelson
(+64) 027 284 4239
henry.hudson.nz@gmail.com

WAIMAKARIRI DISTRICT COUNCIL

Report 17-04
August 2017

EMA

Citation: Hudson, H.R. 2017. Scoping strategy for the Three Brooks and channel enhancements in the middle Cam River and Tuahiwi Stream. Environmental Management Associates Report 2017-04 for Waimakariri District Council. 112 pages.

Executive Summary

This report builds on previous investigations of issues and rehabilitation options for the whole Cam River catchment; but with a focus on the North, Middle and South brook headwater streams of the Cam River (the "Three Brooks"; entering the Cam at km 8.4); and Cam River upstream of Bramleys Road (river km 6.5). (Further downstream the Cam River is managed by ECan). Consideration is also given to sediment control from a major tributary sediment source (Tuahiwi Stream - previously called Maori Drain) which enters the Cam at km 4.8.

For the Three Brooks the scoping study provides context, reviews issues and options to enhance waterways; and examines works done to date, the effectiveness of these works, and what could or should be undertaken in the future to achieve the vision statement for the waterways.

In the middle and upper Cam River, in-stream sediment related issues are reviewed as background for concepts, options and suitable locations for the in-field technical advice that has been provided on sediment removal, creation of pools and riffles, sediment traps and bank stabilisation.

The context for in-field technical advice provided on sediment control in Tuahiwi Stream is outlined based on previous investigations of sediment issues, and issues and options for low impact residential development in the catchment.

The vision is to rehabilitate the Three Brooks into a sustainable eco-morphological based exemplar that provides a broad range of ecosystem services and provides cost effective and hydraulically effective erosion and flood control required in a dynamic rural and urban landscape. The vision is elaborated in the text and appendices.

ECan streamwalks, undertaken in the Three Brooks and Tuahiwi Stream, are a powerful tool to describe stream corridor condition. Coupled with other information, the streamwalks show instream habitat is degraded because of excessive fine sediments on and in the stream bed, contaminants, and limited instream and riparian habitat diversity. Further, the streamwalks identify critical source area (e.g. bank erosion; surface runoff areas; and livestock crossings); riparian habitat condition; and the extent of streamside fencing excluding livestock. The streamwalks are a significant contribution to identifying what could or should be undertaken in the future to achieve the vision statement for the waterways.

A major threat to stream rehabilitating is paralysis by analysis. It's the author's belief that enough is known about what is wrong with the system, and how to address the causes of these problems, to act now with a range of proven management measures at specific locations. However, it is important to recognise that the effectiveness of these measures will vary with local conditions, and continual refinement to optimize outcomes, are required. Hence, any works should be treated as experiments, with appropriate monitoring and reporting of successes and failures.

A second major threat is ad hoc rehabilitation efforts rather than systematic implementation of a management framework to facilitate an ecosystem approach that cuts across various roles and responsibilities, to provide direction for decisions and expenditures that lead to incremental and systematic

improvements in a coherent and cost effective way (e.g. sediment removal and bed raking as part of routine drainage maintenance).

Regarding paralysis by analysis, it is important to state what is known and what information is required before specific actions are undertaken. We know:

- Excessive sediment deposition on and within the bed, and flux of these sediments (and contaminants), continue to be major limitations to ecosystem health throughout these waterways;
- An integrated catchment management approach is required to achieve the Cam vision which includes controlling generation and delivery of sediment and contaminants from upland areas to waterways as well as the waterways themselves;
- Actions should start in the headwaters and move downstream otherwise upstream sediment and contaminants may overwhelm downstream rehabilitation;
- Critical source areas (hot spots or point sources) of sediment and contaminants can be managed at specific locations (e.g. controlling excessive bank erosion; stream crossings; tributary drain and tile drain outfalls);
- Correctly undertaken riparian planting can provide appropriate instream and terrestrial habitat; buffering from upland inputs of sediment and contaminants; and erosion control;
- Sediment and contaminants can be trapped and treated in and along waterways to stop downstream degradation and limit reaches requiring repeated rehabilitation;
- Excessive fine sediment deposits can be removed from waterways to enhance habitat quality;
- Bed reshaping can be used to remove fine sediment and enhance habitat diversity;
- Bank reshaping can be employed to control erosion and facilitate riparian planting;
- Bank reshaping may be undertaken at the same time as routine channel maintenance for drainage outfall; and
- Bank reshaping may be modified to provide a “two-stage” or compound channel;
- Two stage and compound channels (deviating from trapezoidal channels) are effective in maintaining a clean bed and trapping and treating sediment and contaminants; and facilitate riparian planting:
    - Narrower low flow channels can flush fine sediment;
    - Frequently flooded benches act as linear wetlands to trap and treat sediment and contaminants; and
    - Infrequently flooded stream margins trap and treat sediment and contaminants and buffer the stream from upland inputs.
- Many of these activities can be combined with routine drainage outfall maintenance, but this requires an integrated, and incremental approach, to waterway management.

While we know what can or should be done to achieve the vision for the Three Brooks, there are uncertainties about how exactly to go about proposed activities, site specific cost and effectiveness, and how activities can be refined.

- Protocols are required to cost effectively clean extensive reaches of legacy sediments in different situations. A combination of options may be utilised, depending on the fine sediment cover and bed characteristics, including:
    - Cleaning thick sediment drapes with an hydraulic excavator and conventional bucket (costs are well established from routine maintenance);
    - Using a “sand wand” vacuum system to remove veneers of fine sediment and interstitial fine sediment from the upper ~100 mm of stream bed gravel (cost estimates are based on experience in other lowland streams);
    - Using an hydraulic excavator with bucket teeth to rake the bed and wash out interstitial fine sediments to a depth of ~300 mm or more (costs are estimated from routine maintenance);
    - Using an hydraulic excavator to create habitat diversity such as pools and riffles with a sinuous course (costs are estimated from routine maintenance); and
    - Coupling these operations with a local downstream trap to control the downstream flux of released sediment (costs are estimated from routine maintenance).
- In terms of effectiveness:
    - Rapid progress can be made to remove fine surface material with an hydraulic excavator (kilometers of narrow channel per day);
    - A “sand wand” is proven effective in cleaning the upper ~100 mm of stream bed, but is relatively slow (~30 square metres of stream bed per hour);
    - Bed raking can dislodge deep interstitial fine sediments and create habitat diversity in waterways (i.e. a pool and riffle structure with a sinuous channel) but costs and effectiveness need to be rigorously quantified.
- Sediment traps are an essential component of instream rehabilitation but traps have to be designed to be fit for purpose, and the cost and effectiveness of unconventional designs, and ongoing maintenance costs, need to be rigorously quantified. Sediment traps can include:
    - Temporary structures (e.g. sand bag or straw bale dams for the duration of bed cleaning and bank wortks);
    - Enhancing natural sediment deposition areas to revitalize deposition; and
    - Larger, more permanent features that widen and deepen a watercourse and require periodic maintenance.
- Drainage outfall wetlands are an essential component of instream rehabilitation, but have to be designed to be fit for purpose, and the cost and effectiveness of unconventional designs, and ongoing maintenance costs, need to be rigorously quantified. Wetlands can include:
    - Enhancing existing stormwater “ponds”;

- Mini-wetlands (~80 m^2) excavated at the ends of tile drains; and
- Constructed wetlands for larger streams.

- Riparian planting has been undertaken with vigour and costs are well known locally. Internationally, benefits are well established. However, while there are clear aesthetic improvements, the ecological effectiveness of previous riparian management is uncertain because the design philosophy is uncertain and there is limited before and after information on stream corridor condition. This situation is improving with current research activities in Middle Brook.

While the Cam River Enhancement Fund can contribute in a meaningful way toward applying and verifying these ideas at specific locations – hence ticking the box for actions – there are two major considerations:

- The entire budget, or a large portion, could be spent on any one of these elements for the ~13 km Three Brooks (e.g. compound channel realignment ~$1,000 per linear metre (LM); bank reshaping ~$5 LM; riparian planting ~$8 to $20 LM), so choice of activities is critical; and
- The Three Brooks and Tuahiwi Stream are a microcosm of issues facing lowland streams regionally, and a coordinated, co-operative approach is required between WDC, ECan and other stakeholders, such as the University, to achieve the vision here and elsewhere, with various sources of funding.

In terms of bang for the buck, the greatest benefit for the vision is to control sediment and contaminants getting into and moving down waterways and removing excessive fine sediment that is already in the waterways. Habitat complexity, and compound channels can be created at the same time for a modest incremental cost. Specific activities at specific locations are recommended with indicative costings.

Table of Contents

List of Tables

List of Figures

1 Introduction

Waimakariri District Council (WDC) commissioned this report on behalf of the Cam River Enhancement Subcommittee. The Subcommittee is tasked with allocating the Cam River Enhancement Fund to projects that promote "habitat restoration" in the Cam River system". The project brief delineated three areas for further investigations in the Cam catchment to build on previous reports and Subcommittee deliberations (Figure 1):

- North, Middle and South Brook headwater streams of the Cam River (the "Three Brooks"; entering the Cam at km 8.4);
- Tuahiwi Stream (previously referred to as Maori Drain), a major tributary which enters the Cam at river km 4.8; and
- The mainstem of the Cam River between Marsh Road (km 9.4) and Bramleys Road (km 6.5).

The Three Brooks scoping strategy includes a vision statement, outlining potential improvement projects and a summary of works completed, underway or programmed by stakeholders on the Three Brooks from spring head to the confluence of each brook with the Cam River. The strategy also outlines benefit and potential budgets for each proposed option. The works to be considered include habitat restoration through measures such as stream enhancement, shading, habitat creation and bank stabilisation/reshaping projects, sediment traps and legacy sediment removal approaches, creation of riffles and pools and options for two stage channel formation. Other factors affecting water quality and in-stream habitat are also considered to provide context. The strategy will scope the potential for a "two stage channel design" for the Three Brooks and provide indicative costings.

Tuahiwi Stream in-stream sediment issues are reviewed as background for in-field technical advice that has been provided on design concepts, options and suitable locations for sediment traps and sediment removal. The sites chosen were based on previous investigations and work undertaken by WDC.

In the Marsh Road to Bramley Road reach of the Cam River in-stream sediment related issues are reviewed as context for concepts, options and suitable locations for the in-field technical advice provided on bed raking (for sediment removal), creation of pools and riffles, sediment traps and bank stabilisation.

Based on the in-field technical advice that has been provided, and this report, WDC staff will prepare the draft plans and designs for the proposed works, which will be reviewed by the consultant prior to being presented to the sub-committee for approval.

Elements of this report are based on previous investigations by Environmental Management Associates (EMA), which are referenced throughout. The Executive Summary and Recommendations from the lesser known Tuahiwi Stream (Maori Drain) report are appended.

2 A brief history

As discussed by Hudson (2010), prior to European settlement, the Cust River and Eyre River fed into flax and raupō swamps that extended over much of the area from present day Rangiora to the Waimakariri (Courtenay) River. Drainage of the swamp began in the 1850s; the Cust River was diverted into the Cust Main

drain circa 1880[1] (which flows into the present day Kaiapoi River); and in 1929 the Eyre River was diverted to the Waimakariri River. The lower Waimakariri River was channelized in the 1930s, removing a complex of islands and channels, and the remnant Waimakariri River North Branch became the Kaiapoi River thus establishing the present drainage pattern (Figure 1). Other drainage modifications include diversion of upper South-South Brook into Cust Main Drain (the date is uncertain) and continued development of the urban stormwater network.

Based on the stream channels defined by the ECan streamwalks, the Cam River above Bramleys Road has a ~35 km^2 catchment and flows about 13 km from north east of Rangiora to the Kaiapoi River (Figure 1).[2] The catchment area is difficult to accurately define because of the relatively level landscape, and rural and stormwater drains, culverts and road embankments modifying flow paths.

Cam River joins the Kaiapoi River 5.6 km from the sea and the Kaiapoi joins the Waimakariri River 2.6 km from the sea. The main tributaries (North Brook, Middle Brook, South Brook, South-South Brook and upper Cam/Coldstream) are spring-fed and also receive surface water runoff from the rural and urban catchment. Flows in the tributaries and the Cam River are thought to be influenced by groundwater from the Ashley River to the north.

Development of the Cam catchment has had profound effects on land use and biodiversity. Over about 150 years the catchment has been extensively modified and is now largely pasture and arable land that is virtually devoid of native vegetation. Recently land use has evolved from large rural holdings and small service centres to rapidly expanding urban centres with surrounding rural residential properties. The combination of the increased urban and rural population almost invariably has a negative impact on water quality and stream biota (e.g. Suren & Eliot 2004).

3 Vision

The vision is to rehabilitate the Three Brooks into a sustainable eco-geomorphological based exemplar that provides a broad range of ecosystem services and provides environmentally friendly, cost effective and hydraulically effective erosion and flood control required in a dynamic rural and urban landscape.

This vision statement is applicable to the Cam River and many other similar streams and rivers. “Sustainable” refers to intergenerational sustainability, with minimum continuing intervention over the long term. “Eco-geomorphological” refers to inking the physical form and processes of waterways with ecological response by adopting an ecosystem perspective (Hudson 2002).

“Ecosystem services” can be catagorised as provisioning (e.g. mahinga kai), regulating (e.g. waste treatment, buffer zones), supporting (such as primary production, nutrient cycles and pollination) and cultural (such as spiritual and recreational benefits).[3] These services and actions are fleshed out in Appendix 1 and include rehabilitating and promoting spring feed streams and providing the physical habitat and opportunity for ecosystem services in the stream corridor.

[1] www.legislation.govt.nz/act/local/1905/0037/latest/DLM30904.htm

[2] Gerard (2002) reports there are about 80 km of banks (40 km of waterways) in the Cam catchment.

[3] https://en.wikipedia.org/wiki/Ecosystem_services Accessed February 2017.

Underlying concepts include (Hudson 2002):

- Physical habitats have been lost or degraded;
- Sufficient water quality, physical habitat structures and abiotic processes are pre-requisite for re-establishing ecosystem services;
- Realistic goals and objectives are required;
- River corridor improvements are usually based on physical templates and processes; and
- Structural habitat improvements and restoration of flow regimes are necessary, but not necessarily sufficient, to restore particular species, because other factors may be equally, or even more, important.

Regarding goals and objectives, Hudson (2002) noted the goal of ecosystem management must be intergenerational sustainability, but objectives are conditioned by political, scientific, and economic realities, which often differ significantly from natural or reference conditions. This frequently precludes restoration, but there are a number of options:

Enhancement: "any improvement of a structural or functional attribute" (NRC, 1992), but the endpoint of that improvement is not to resemble the original state;

Rehabilitation: "… improvements of a visual nature to a natural resource; putting back into good condition or working order." (NRC, 1992). The direction of change is toward the original state; and

Restoration: "return of an ecosystem to a close approximation of its condition prior to disturbance … ensuring that ecosystem structure and function are recreated or repaired, and that natural dynamic ecosystem processes are operating effectively again." (NRC, 1992).

There are several guiding principles for stream habitat rehabilitation and enhancement that are discussed at length in Hudson (2002, 2005). These may be summarised as follows:

1. Prevent further degradation of existing relatively intact ecosystems;
2. Re-establish the structure, composition and natural processes to make rehabilitated ecosystems resilient and self-sustaining;
3. Use reference sites as models to guide rehabilitation and enhancement, and as a comparison for assessing the success of the project;
4. Use native species from the local area where possible;
5. Take a broad view of factors that influence the rehabilitation reach and receiving waters, and address ongoing causes of degradation;
6. Take a broad view of how the rehabilitation may impact local, upstream and downstream ecosystems;
7. Take a long term view of how the catchment may change to influence stream conditions;
8. Take a long term view of rehabilitation (e.g. riparian margin tree growth and vegetation succession);
9. Determine if passive rehabilitation (e.g. controlling causes of degradation; rewatering a wetland) will allow recovery in a reasonable timeframe;

10. Management approaches must be sensitive to local conditions and be adapted as necessary;
11. Systematic learning is required with activities treated as experiments using appropriate experimental designs, monitoring, and assessment and reporting;
12. Experiences, both successes and failures, should be shared;
13. A co-operative approach, between multiple stakeholders, is required;
14. Minimise risk by careful planning with a multi-disciplinary team; and
15. The project must be ecologically and practically feasible.

Feasibility is determined by physical, political, and economic realities (Hudson 2002, 2005). In the case of the Three Brooks and the Cam system, the objective is not restoration – as this would involve reverting the landscape back to an extensive raupō swamp. Also, the drainage network is required to control flooding and erosion, within a limited stream corridor (i.e. the stream channel, the stream margins/floodplain and the infrequently flooded upland fringe).

At best we can rehabilitate the highly modified waterways by naturalizing aspects of the stream corridor i.e. the direction of change is toward free flowing streams that would be found in a high quality lowland landscape. At worst, there are highly modified segments of the Three Brooks and Cam drainage network that are steep-sided ditches with no marginal strips. In these instances, limited enhancements might be possible. The tools chosen to address these issues depend on correctly defining the problems and the causes of these problems. This is undertaken in the next section.

4 Situation analysis

4.1 Introduction

For the Three Brooks the scoping study reviews issues and options to enhance the waterways and examines works done to date, the effectiveness of these works, and what could or should be undertaken in the future to achieve the vision statement for the waterways. There are clear overlaps with issues and actions on the Cam mainstem and Tuahiwi Stream.

To understand the effectiveness of completed works, as a platform to recommend further works, the ideal scenario is to treat each activity as an experiment and undertake before and after measures of stream corridor condition. This is the approach advocated for all habitat restorations (Hudson 2002) and in previous investigations in the Cam system (Hudson 2010); and is the approach taken in the CAREX experiments by the University of Canterbury.

Works recommended in the past were specifically undertaken to address issues in the system which are outlined below. The only way to evaluate the effectiveness of these works is to examine stream corridor condition before and after the works were undertaken using the existing surveys, long term ECan monitoring at a limited number of sites, and ECan streamwalks over the catchment.

To facilitate discussion, stream corridor issues are reviewed, the options that were acted upon are described, and the effectiveness of these actions are assessed in terms of changes in stream corridor condition. In addition, some preliminary results from the CAREX experiments are discussed.

4.2 Issues

Previous investigations, reported in Hudson (2010), showed that a combination of bacterial contamination, nutrient enrichment, loss of clarity and sedimentation lead to a degradation of the amenity value, and benthic invertebrate and fish habitat of the Cam River and tributaries. Numerous sites were sampled in detail (e.g. Figure 2 and Figure 3); but these investigations are dated (EOS 2005 and Golder Associates 2008); but have not been updated as recommended.

Regarding sediment, Golder Associates (2008) quantified composition of stream bed sediments at 16 sites in the Three Brooks (Figure 2). Many of the sites had gravel- sized sediments that could provide good quality habitat for invertebrates and trout spawning. Most of the South and Middle brook sites were dominantly gravel size whereas 4 of 8 North Brook sites had more than 50% fine sediment (<2 mm) (Figure 3). EOS Ecology (2005) also reported an abundance of relatively coarse, silt-free riverbed in the Three Brooks.

The lowest habitat quality occurs in Rangiora Township, with higher quality habitat both upstream and downstream on South Brook. North and Middle brook habit improves from the Township site downstream. Habitat quality is lower than other rural sites in the North Brook tributaries (N5 & N7) and near the confluence of the Three Brooks (N8 & N9) (Figure 2). With the exception of N8, which has ~10% fine sediment, the lower habitat quality rural sites assessed by Golder Associates (2008) are dominantly fine sediment. This is fundamentally important because many species have a low tolerance for fine sediment substrates.

Golder Associates (2008) followed the approach of EOS Ecology (2005) and ranked the Three Brooks based on benthic invertebrate indices, as well as fish taxa richness. The low ecological value sites were located in the uppermost reaches of the North and Middle brooks (N1, N2, M1 M2), and lower reaches of North Brook at the Cam confluence (N8 & N9; Figure 2).

A large decline in trout numbers was reported based on similar surveys in 1982 and 2005 in the Cam and tributaries. Taylor (2005) observed 38 trout during the 2005 survey compared with 323 trout in the 1982 survey; and 124 fully excavated trout redds in 2005 compared with more than 260 observations in 1982. Taylor (2005) reports some of the gravel reaches utilized by spawning trout in 1982 had silt deposits in the 2005 survey (e.g. North Brook upper reaches, North Brook tributary upstream of Boys Road, and Middle Brook). However, Taylor (2005) considered that "… silt depth is still considered sufficiently thin in most reaches for spawning to be re-established. Preventing, or at least reducing, further silt inputs may allow freshes to flush sediment from affected reaches." Taylor (2005) does not discus other limitations, but ECan long term monitoring would strongly suggest that stream water temperature is not limiting.

Hudson (2010) looked at patterns of ecological values with habitat suitability criteria (substrate, depth and velocity) and found some obvious relations such as N1 site at North Brook has unsuitable depth and velocity and 80% fine sediment cover which is unsuitable for high quality macroinvertebrates. In contrast, the 7 top ranked sites had depths ranging from 0.25 to 0.35 m and velocities of 0.80 to 1.00 m/s and ~5 to 15% fine sediment. The concluded these relations strongly suggest the most productive sites have riffle like characteristics with shallow fast flows over a clean gravel bed, a known characteristic of good benthic invertebrate habitat (e.g. Jowett et al. 2008).

More recent surveys of water quality and macroinvertebrates have been undertaken by ECan (Greer & Meredith 2016) at four sites in the Three Brooks

and Cam River (Figure 4). Details of the state and trends over the past five years are summarised in Appendix 2. Key points for the period 2011 to 2015 include:

- Invertebrate communities are in a degraded state in the Cam at Bramleys Road and South Brook at Marsh Road, consistently failing to meet Land and Water Regional Plan (LWRP) outcomes.
- Invertebrate community composition (QMCI scores are indicative of poor (South Brook) or fair water quality (Cam at Bramleys Road)[4] and degraded habitat.
- Spot measurements show some sites periodically meet the LWRP ≤20% fine sediment threshold, but others have not:
    - The Cam at Marsh Road had consistently high sediment cover (90 to 100%);
    - The Cam at Bramleys Road and North Brook at Marsh Road vary from 10 to 80% fine sediment cover; and
    - The South Brook at Marsh Road varies from 15 to 25% fine sediment cover.
- Recorded total suspended solid (TSS) concentrations are relatively low at the study sites (i.e. less than the 25 mg/L TSS threshold for onset of detrimental effects); but measurements were not taken during the rising stages of a flood when concentrations are expected to be greatest.
- Temperatures from all the spring-fed stream sites in the study area are low as expected (ranging from 13.3 to 15.8 ^{0}C; and the minimum recorded dissolved oxygen saturation exceeds LWRP outcomes.[5]
- Cam River at Marsh Road median dissolved reactive phosphorus (DRP) concentrations exceed the 70% probability of nuisance macrophyte growth; and the other study area sites median values were below the 30% probability of nuisance macrophyte growths. However, other factors are important because nuisance macrophyte growths have been regularly observed in most spring-fed streams.
- Plant available nutrient concentrations (DIN: dissolved inorganic nitrogen is composed of nitrate-nitrite nitrogen (NNN) and ammoniacal nitrogen (NH_4N)) were sufficiently high in all spring-fed streams in the Kaiapoi River catchment to allow macrophytes to proliferate. South Brook at Marsh Road was in the high range with median values exceeding the 90% probability of nuisance macrophyte growths. North Brook and the Cam River sites were usually below the 70% probability of nuisance macrophyte growths.
- Under the National Policy Statement for Freshwater Management (MFE 2014), national bottom lines for nitrate toxicity are not being met in the upper Kaiapoi River which requires better management of nutrient inputs to meet the C band requirement at Harpers Road. The Cam system sites are often around the A band; with a high degree of protection of

[4] Invertebrate communities were not monitored at the other sites of interest to this investigation

[5] This is consistent with previous investigations. Concentrations of dissolved oxygen were high enough and water temperatures low enough to be of no concern for aquatic life (ECan 2003). Dissolved oxygen at N2 (in Rangiora) was the only site below guideline values (74% against >80% saturation) in baseflow conditions. In high flows DO approached 100% saturation (Golder Associates 2008). Water temperatures were lower than guideline values in late November sampling at 17 sites (Golder Associates 2008). Water temperatures are expected to be relatively low in baseflow conditions in largely spring-fed streams.

biodiversity, the exception being South Brook at Marsh Road with is generally between the A and B bands (Figure A2: 1).

- Plant available nutrients (DIN) and dissolved reactive phosphorus (DRP) NNN concentrations are stable or downward trending at the study sites.
- All of the sites in the Kaiapoi catchment are above the alert level for *E.coli*. Most of the measurements for the Cam at Marsh Road and Bramleys Road exceed the threshold at which a site is considered unsuitable for contact recreation. Some exceedances also occur on the South Brook and North Brook, but the majority of measurements are between the alert level and unsuitable for contact recreation level. The Cam sites are trending up for unadjusted flows whereas the South and North brooks are trending down for the period of record (1999-2016).

ECan are developing and testing an advanced streamwalk protocol. While many of the attributes previously reported from the stream walks of Gerard (2002), are repeated, the scientific framework, and extensiveness of the protocols have been enhanced (Golder Associates 2015). ECan kindly undertook a "test run" in the Cam River system; and agreed to enhance the sediment cover protocol to include an assessment of dominant substrate (akin to that used in instream flow modelling). The streamwalks provide a fundamental basis for identifying hots spots to target remedial actions and provide context for evaluating the success or otherwise of different initiatives.

Key points from Gerard (2002) include:

- The quantity of material derived from bank erosion appears to be relatively small, and largely associated with stock access;
- About a third of the ~80 km length of stream bank in the Cam and major tributaries was accessible by livestock. As well, there was stock access to drains feeding into the Cam River;
- Cam River: "Heavy sedimentation" occurred upstream of the confluence of the Cam and South Brook which was attributed to low stream gradient with natural deposition (there is limited stock access to the waterway upstream);
- North Brook: High levels of bank damage occurred in the unfenced sections which comprised 40% of the stream bank length, and there was also natural bank erosion which was rare elsewhere in the Cam system. Several dairy crossings were identified which were thought to be likely to be the source of episodic plumes of sediment;
- Middle Brook: Significant bank damage in the unfenced reaches of Middle Brook (27% of the bank length of the 3.1 km stream) was observed, and several culverts in poor condition, contributed sediment to the stream, and there was a "considerable amount" of sediment deposited at the rail bridge "indicating that the urban area has been a significant contributor";
- South Brook: Stock access occurred over 34% of the stream bank length, and to springs and tributaries, causing bank instability and contributions to the sediment load. Stock crossings were also identified as a source of sediments and contaminants;[6]

[6] Gerard (2002) identified the Waste Water Treatment Plant (WWTP) as "… the prime issue… responsible for considerable discoloration, particularly by algae, and a number of contaminants. It is impossible to achieve high water quality in the Cam until this discharge ceases." The discharge ceased in 2006.

- South-South Brook: A “dirty little stream” with poor aquatic habitat and water quality resulting largely from stock access by deer causing significant damage in the springs and stream itself. Stormwater from the industrial area was identified as a potential issue;
- Tuahiwi Stream (Maori Drain): The drain was heavily sedimented for much of its length, with very poor aquatic habitat, which was attributed to poor riparian management with stock access to 30% of the stream bank length and to springs and drains; and
- There were limited reaches with high native biodiversity (e.g. the Holcroft reach of the Cam River); with most of the banks of the Cam waterways featuring grass and willow trees.

There has been no reporting at this stage of the latest ECan streamwalk, but ECan have very kindly provided the maps (Appendix 3) and photographs from the streamwalk. In summary these maps illustrate several key points:

- Fencing along both banks is more extensive than in 2002 (Appendix 3):
    - Cam River: There is no stock access on the Cam from Marsh to Bramleys Road (with ~750 m of stock access from Marsh to Boys Road);
    - North and Middle Brook: There is no stock access;
    - South Brook: <500 m of stock access;
    - South-South Brook: about half the reach has stock access from both banks; and
    - Tuahiwi Stream: ~1000 m has stock access from both banks.
- Fencing on one bank is similarly limited (Appendix 3):
    - Cam River Marsh Road to Bramleys Road: ~300 m;
    - North Brook ~500 m;
    - Middle Brook ~600 m;
    - South Brook: ~1100 m; and
    - Tuahiwi: ~800 m;
- Stock damage to stream banks ranges from no damage to severe (Appendix 3):
    - Cam River: no damage upstream of the Three Brooks, and on the right bank downstream to Bramleys Road; with minor damage on the left bank from the Three Brooks downstream to Bramleys Road;
    - North Brook: no damage:
    - Middle Brook: no damage;
    - South Brook: no damage (or not assessed for one tributary) for most of the Brook, with minor erosion over ~2000 m of one bank (including the oxidation pond reach that is described by Gerard as having ineffective fencing);
    - South-South Brook moderate bank damage over ~500 m (coinciding with a segment of unfenced reach);with no damage for ~2300 m; and
    - Tuahiwi Stream: ~200 m severe bank damage.

- Fine sediment cover exceeds the LWRP[7] outcome of <20% for extensive reaches of the waterways (Appendix 3):
    - Most of the Cam between Marsh and Bramleys Road exceeds the LWRP outcome (~600 m at the South-South Brook confluence meets the outcome);
    - About half of North Branch;
    - All but ~185 m of Middle Brook;
    - About 60% of South Brook (with <8% not assessed);
    - All of South-South Brook (a small reach was not assessed); and
    - All of Tuahiwi Stream.
- There are subtleties within the fine sediment patterns in a figure titled "Fine Sediment Cover" that was provided earlier by ECan. Cover is reported in 5 classes in Figure 5: 0-20%; 21-40%; 41-60%; 61-80% and 81-100%. This detail is useful in identifying reaches for remedial works or to prevent further downstream degradation with sediment traps (Figure 5). The location and rationale of the sediment traps is discussed in Section 7.1.1 In channel sediment traps.

  In addition, the five cover classes in Figure 5 are useful for indirectly assessing the effectiveness of rehabilitation actions. For example:
    - High sediment cover (41-60% cover) in the bed raking reach above the main CAREX sediment trap (M1) in Middle Brook strongly suggests cleaning had a temporary effect - the bed was cleaned in 2015 and inundated with sediment by 2017;
    - A clean bed below the main sediment trap (~200 m with <20% fine sediment cover) strongly suggests the M1 trap is effective in controlling downstream movement of fine sediment; and
    - Further downstream ~500 m of channel has 21-40% fine sediment cover. The upper portion of this section has three shallow CAREX traps (marked M2 in Figure 5). In low flow conditions the traps were observed to have edge deposits of fine sediments and exposed gravel in the shallow pools, which strongly suggests shallow traps are ineffective.
- Considerably more information is now available on vegetation, specifically riparian groundcover, understory and canopy vegetation and shading:
    - The waterways are dominated by exotic vegetation, with some mixed vegetation; with limited shading;
    - None of the Cam from Marsh to Bramleys Road is classed as native vegetation (The Holcroft reach (which is 50 m long) was identified as having a mixed, not native, riparian ground cover and canopy); and
    - The most extensive native vegetation reach is on the South Branch through town (~225 m); with smaller sections on upper North Branch and Tuahiwi Stream.

[7] http://files.ecan.govt.nz/public/lwrp/LWRP-Plan-Volume_1.pdf

In the Cam above Revells Road, Hudson (1999) found that in low flow conditions the main source of suspended solids is resuspension of sediment from the riverbed. In high flow conditions sediment concentrations and loads increased downstream, with erosion from farm land and sub-divisions identified as major sources. Extensive drapes of easily re-suspended sediment in Tuahiwi Stream contained high levels of caesium-137 and beryllium-7 radionuclide's which are indicative of surface erosion. Further downstream in the tidal reach, backwash and bank erosion were important additional sources of sediment. Sediment fingerprinting suggested that over half the material at the Cam mouth is probably derived from the upper catchment (i.e. above Revells Road). There was little evidence of significant contemporary bank and bed erosion.[8]

With respect to upland and stream bank erosion, the ECan streamwalk mapped and photographed critical source areas (Appendix 3):

- Overland flow paths (OLFP) were identified at several locations in the Three Brooks, one site in the Cam and seven sites on Tuahiwi Stream. The latter are to be addressed by ECan, with a possible option being very low cost – essentially spreading a mix of native plant seeds on the flow paths:[9]
    - The worst case scenario would be gullying or rilling, but no such sources of sediment were observed;
    - Some OFLPs were vegetated, acting as grassed waterways which would trap and treat sediment and contaminants (e.g. Figure 6);
- Of concern are exposed surface drains directly contributing sediment and contaminants to the waterways (e.g. Figure 7);
- Bank erosion was identified in three sites in the upper Cam, three sites on North Brook, one site on Middle Brook, six sites on South Brook and two sites in Tuahiwi Stream. Various type of bank erosion were observed, which require different management measures (Hudson 2005):
    - Bank trampling by stock (Figure 8);
    - Toe scour undermining banks and cause slumping (Figure 9);
    - Unvegetated over steepened banks contributing sediment by dry ravel and surface wash (e.g. Figure 10).

Sediment and contaminants from surface runoff and drains were identified as significant sources in the Cam (Hudson 1999); but subsurface drains may also be important sources (Figure 13), but were not mapped in the streamwalk.

4.3 Conclusions: situation analysis

While there are improvements since earlier investigations reported by Hudson (2010) specific issues remain:

- Excessive sediment and contaminants are still generated and delivered to waterways;

[8] Golder Associates (2008) examined bank erosion in the North, Middle and South brooks. They noted the stream channels at their sampling sites were typically incised, with steep banks. However, active bank erosion was relatively uncommon. Notable exceptions were site N7 in a tributary of North Brook which had active bank erosion along the entire reach, and M2 in the upper Middle Brook where bank slumping and erosion were prevalent. These sites no longer have active bank erosion (ECan maps A:2S).

[9] Jason Butt, ECan, pers. comm. 8 August 2017.

- Water quality guidelines are exceeded for faecal coliforms;
- Plant available nutrient concentrations allow macrophytes to proliferate. South Brook at Marsh Road was in the high range with median values exceeding the 90% probability of nuisance macrophyte growths. North Brook and the Cam River sites were usually below the 70% probability of nuisance macrophyte growths;
- In contrast to the wider Kaiapoi Catchment where national bottom lines for nitrate toxicity are exceeded, Cam system sites are often around the A band; with a high degree of protection of biodiversity, the exception being South Brook at Marsh Road with is generally between the A and B bands;
- Concentrations of dissolved oxygen continue to be high enough, and water temperatures low enough, to be of no concern for aquatic life;
- There are excessive sediments throughout the Three Brooks, Tuahiwi Stream and the upper Cam River, which has adverse effects on aquatic life, particularly trout spawning and benthic invertebrates; and
- Flushing of excessive fine sediments from the upper river put further stress on the lower river where tidal fluxes compound the issues.

5 Review of management measures

5.1 Introduction

The vision is to sustainably manage the waterways which requires moving from reactive management treating symptoms (e.g. removing fine sediment drapes) to proactive management addressing causes of problems (e.g. controlling sediment and contaminants before they become a problem in the waterways). The analogy is to move the ambulance from the bottom of the cliff to preventing problems at the top of the cliff.

Sometimes underlying causes of problems are not readily apparent or there are a combination of causes. For example, a decline in the trout fishery could be related to several limitations in the trout fishery, such as excessive stream temperatures, lack of dissolved oxygen, lack of physical habitat structures (e.g. spawning riffles), and degraded habitat (e.g. excessive fine sediment causing egg mortality).

Once limitation(s) have been identified (e.g. excessive fine sediment limiting spawning opportunity and success), then the cause can be addressed. For example, excessive fine sediment could be generated from farmland erosion, livestock trampling stream banks, or erosion of the channel. Each of these sources require different approaches (management measures) and methods (best management practices) to fix the problems (Table 1). Before rushing into action, some key decisions are required (Table 2).

This approach was employed to recommend management measures, and where possible specific actions (and costs), by Hudson (2010) for the Cam and tributaries. In addition, works were recommended for the residential/lifestyle development of the Tuahiwi catchment (Hudson 2013). The rationale was as follows:

- The first priority must be to avoid generating excessive runoff, soil erosion and contaminants through appropriate land management practices;

It is futile, and not cost effective, to attempt to rehabilitate the river itself by treating the symptoms (e.g. removing excessive fine sediment on the riverbed) without fixing the causes;

- The second priority is to control the transfer of sediment and contaminants between sources and waterways and treat sediment and contaminant problems (e.g. slow runoff through buffer strips and filter sediments and contaminants);

  While the emphasis is on avoidance, it is recognised that it is not feasible to completely control generation of sediment and contaminants at a catchment scale; and

- The third line of defence is to trap and treat sediment and contaminants in waterways with instream traps and wetlands.

  Waterways themselves are sources of sediment (e.g. bank erosion) and sometimes contaminants; and even with good catchment management, upland and inchannel legacy issues must be dealt with. The traps and wetlands will enhance water quality.

The position taken was that enough is known to recommend management measures to address the issues identified in the Cam catchment with confidence. However, some data gaps and uncertainties were also apparent. This is not perceived as an excuse for inaction, but an opportunity to be adaptive and fill the gaps and learn by treating the recommended management measure as experiments. It was thought that such an approach, and interim developments in knowledge and circumstances, may lead to an evolution in thinking and reassessment of priorities and actions with time. This has been the case as described in the next section.

5.2 Recommended actions

Key ideas, with updates, from the recommendations of Hudson (2010) are summarised.

1. Avoid excessive contributions of soil erosion & contaminants from urban stormwater & new subdivisions

In essence, the recommendation was to utilise low impact urban design principles in future development as part of normal operating procedures. It was thought that such activities would be governed by rules in the Waimakariri River Regional Plan (WRRP operative 11 June 2011), and would be designed and implemented without cost to the Cam River and Tributaries Enhancement Fund (the Enhancement Fund). However, rules for the Cam and Kaiapoi River are relatively lax (e.g. not suitable for contact recreation or cultural purposes). The WRRP has been superseded by the Land and Water Regional Plan (LWRP – operative in part in February 2016). LWRP guidelines have been referred to in the ECan streamwalk maps (Appendix 3).

2. Avoid excessive contributions of runoff, soil erosion & contaminants from farmland.

A major focus of ECans Living Streams initiative (and actions by the Cam River Working Party), is to identify sources and causes of contaminants and to implement control measures. This complements the WRRP and LWRP. There are a broad range of management measures that can be effectively implemented as part of modern farming practices which are vital to the success of the Cam River rehabilitation, that are not directly funded by the Enhancement Fund.

3. Avoid erosion & contamination from livestock access to waterways.

Control of livestock access to lowland spring fed streams is now required in the Environment Canterbury Natural Resources Regional Plan (NRRP) (cattle, farmed deer and farmed pigs).[10] The concern remains that exclusion should be extended to important spring fed waterways that are not identified in NRRP Planning Maps Series A. This should be considered in the Zone Committee review process. Livestock exclusion may be accomplished using the ECan (2013) drainage bylaw.[11] Provision should be made to allow selected riparian grazing by sheep for weed control.

4. Avoid erosion & contamination from uncontrolled stream crossings

Plumes of sediment and faecal contamination of waterways and bed disturbance occurs where livestock cross streams. Preventing livestock access to waterways, including stream crossings, is incompletely required in the NRRP, but is proposed in the Next Steps for Freshwater consultation document dated March 2016.[12] However, the Clean Water Package (2017) proposes exclusion of dairy cattle and pigs from most lakes, rivers and streams from 1 July 2017, and will continue to 2030 when cattle, pigs and deer will be excluded from waterways.[13]

The original recommendations remain - there may be some requirement for financial incentives to enhance stream crossings in particular non-delineated waterways (e.g. feeder drains) and to rehabilitate degraded waterways by the Enhancement Fund.

5. Control & treat runoff, soil erosion & contaminant movement into waterways with buffers, streamside planting & channel naturalisation

Updated stream surveys were recommended to identify priority reaches for stream stabilisation, buffers and riparian planting. An updated and enhanced ECan survey is reported here.

Use of the Enhancement Fund, in combination with the Biodiversity Fund, was recommended for riparian planting to provide multi-faceted benefits including control of runoff, sediment and contaminants entering waterways, bank erosion protection, provision of habitat and food supplies, improved amenity and cultural values, and improved aquatic habitat. Ad hoc planting, largely based on aesthetics, was a recurring risk when a range of planting options was required to address particular outcomes (Table 4 & Table 5).

Bank reshaping may be required to provide the required stability and conditions for riparian planting (Figure 11 & Figure 12). A logical extension is naturalisation of waterways to improve habitat quality and to trap and treat sediment and contaminants. These actions would be facilitated with a global consent, with the requirement to employ best management practices.

---

10 http://previous.ecan.govt.nz/advice/your-business/farming/Pages/what-farmers-need-to-know-and-do.aspx Effective June 2012

11 https://www.ecan.govt.nz/document/download/?uri=1758285 ECan Flood protection and drainage Bylaw 2013.

12 http://www.mfe.govt.nz/publications/fresh-water/next-steps-fresh-water-consultation-document (accessed March 2017)

13 http://www.mfe.govt.nz/fresh-water/freshwater-management-reforms/clean-water-package-2017 (accessed March 2017).

6. Control bank erosion

An assessment of bank erosion has been repeated by ECan and reported here. This confirms the quantity of material derived from bank erosion is probably relatively small, and often associated with livestock access. Detailed site assessments, to plan control measures that are tailored to address the type of erosion, are recommended. Bank reshaping, channel naturalization and riparian planting should be considered as a package with support from routine drainage works (Table 4 & Table 5; Figure 11 & Figure 12), the Enhancement Fund and Biodiversity Fund,

7. Control downstream spread of sediment with instream sediment traps

Construction of sediment traps in the riverbed will limit movement of sediment and contaminants from the upper catchment to the lower river. Further sites have been added and costs refined based on recent sediment trap construction and quantities trapped.

The recommendation for a global consent for small scale sediment traps on tributary streams using existing design guides has not been acted on. This consent would reduce cost and facilitate construction resulting in improved downstream bed conditions and limiting bed disturbance.

8. Control upstream tidal flux & sedimentation with the flood gates

Controlling upstream and downstream tidal fluxes of sediment with the Cam River floodgates has not been acted upon. It is not considered further in this investigation, because the floodgate is in the lower river.

9. Treat excessive sediment deposition by removal of fine sediment from within the gravel bed

Trials were recommended in the upper reaches because all such works should progress from upstream to downstream. The idea was to target a control reach and test reach that include a riffle, pool, riffle, pool, riffle sequence. Effectiveness would be quantified based on the before and after sediment sampling and before and after biological sampling.

Some investigations have been undertaken which have established costs and effectiveness of sand wand fine sediment removal. However, there is limited information on large scale bed raking to remove fine sediment from on and in the bed and to create habitat diversity. These trial are reviewed.

10. Quantification of sediment deposits

Benchmark surveys of fine sediment deposits on and in the bed were recommended to quantify the extent of rehabilitation activities to improve habitat and limit sediment resuspension, and to quantify the amount of sediment that may have to be removed. Also, a follow up survey was suggested to quantify the success of management measures. The recent ECan streamwalks provide useful information on bed material character, and fine sediment cover, but information on the depth of fine sediment is limited. Site inspections are recommended prior to sediment removal works being undertaken.

11. Quantification of stream health

To benchmark and evaluate rehabilitation it was recommended that periphyton, benthic invertebrates and fish are quantified at key locations in the Cam and major tributaries. The recent ECan streamwalk provides extensive comparative information on algae, macrophytes and benthic invertebrates and is reported

here. Information on fish is also required to evaluate the success or otherwise of management measures.

12. Management framework

Development of an ecosystem approach to catchment management was recommended to allocate appropriate resources, formalize priorities across jurisdictions, and ensure actions are consistent with an overriding strategy, policy and plans, leading to incremental and systematic improvements in a coherent and cost effective way. The objective was to move from somewhat ad hoc and reactive initiatives by WDC and ECan.

The WDC 2015 report "Cam River: Towards a whole of Catchment Strategy" reiterates some of the issues and opportunities discussed previously, but does not outline a locally relevant eco-systemic management framework to go forward.

13. Reshape the channel & floodway

Limited attention was given to creation of two-stage or compound waterways, because of the perception of the lack of opportunity in the confined waterways of the Cam and tributaries. Instream structures (large wood debris, spurs) were proposed as options. However, different approaches to two stage waterways have since been found, there is more information on costs and benefits, and some trials in the Cam tributaries have been undertaken and are reviewed.

Regarding the latter, Allibone & Hudson (2015) recommended a compound channel design requiring negligible to major bank reprofiling, and instream structural elements (e.g. pools-riffles, woody debris, boulder clusters and spurs) in Waituna Creek, Southland. Additionally, linear wetlands along the stream channel, and point source wetlands, were recommended to control sediment and contaminants from surface drains and tile drains (Figure 14).

6 Completed and proposed works

In terms of the recommendations of Hudson (2010 and 2013), and discussion above, the following works were started, have been undertaken or are planned in the Three Brooks, Cam and Tuahiwi Stream (Appendix 4):[14]

- In channel sediment traps;
- Wetland traps at surface and tile drains;
- Sediment removal from the stream channel;
- Bank stabilisation and reshaping;
- Two stage/compound channels;
- In channel habitat structures; and
- Riparian planting.

[14] Maps were kindly provided by Greg Bennett, Drainage Engineer, WDC.

7 Recommendations, costs and effectiveness

7.1 Trapping and treating sediment and contaminants

7.1.1 In channel sediment traps

In-channel sediment traps have been recommended for the Three Brooks, Tuahiwi Stream and Cam River. Key questions for this scooping study are:

- What are sediment traps;
- Why would you construct them;
- What would be constructed;
- Where should traps be located;
- How should traps be maintained; and
- What are the expected costs and benefits?

In-channel sediment traps are depressions in the stream bed designed to stop the downstream movement of coarse particles (sand and gravel) as well as varying proportions of fine sediments (fine sand, silt and clay that move in the flow rather than along the bed). Their widespread use is testament to their cost effectiveness and/or environmental benefit (Hudson 2002). This type of trap is often used in conjunction with wetlands.

Sediment traps have been recommended as a tool to trap and control spread of fine sediment deposits that limit stream life throughout the Three Brooks, Tuahiwi Stream and the Cam River. Linear wetlands in compound channels are also recommended to trap and treat very fine sediment and contaminants. The objective is to remove excessive sediment by trapping and excavation to achieve less than 20% cover of fine sediment (i.e. sediment less than 2 mm) on the stream bed (Clapott et al. 2011). This will benefit fish and macroinvertebrates that prefer relatively clean gravel beds (Figure 15).

Sediment trap guidelines were developed for Ministry of Agriculture and Fisheries (MAF) based on extensive, comprehensive, international experiences and well understood hydraulics (Hudson 2002). A “rule of thumb” best management practice was developed to facilitate sediment trap construction based on existing channel dimensions (Figure 16). In addition, two other types of sediment traps are recommended:

- Enhancing natural sediment deposition areas to revitalize deposition (e.g. inner bend and lee deposits, and deep pools); and
- Temporary structures (e.g. sand bags or straw bale dams) for the duration of channel works such as bed raking.

Sediment traps are proposed (green) or already exist in various forms (red) throughout the catchment (Figure 5). The sites identified consist of conventional sediment traps and enhancements to natural deposition areas along the edge of the channel (C9-Figure 17) and across the channel (M1-Middle Brook Figure 18 & Figure 19). Also stormwater retention ponds that already trap sediment effectively (N1- Northbrook; S9- Southbrook; Ss1-South-South Brook), or could be enhanced to be more effective (T2-Tuahiwi Stream), are identified (Figure 5).

Some of the existing traps are opportunistic, coinciding with drainage works (e.g. T1 - Tuahiwi Stream willow removal; N2 fish barrier into Crayfish Creek; proposed flood capacity along Lehmans Road – S2, S3 & S4). Others are to address a specific sediment problem (e.g. S6 - Fernside Road; and S8 north

bank tributary to South Brook), or control the downstream flux of sediment into clean or rehabilitated reaches. The latter, which are referred to as primary sediment traps, include:

- Cam mainstem near Boys Road (C1 in Figure 5), Marsh Road (C2), Three Brooks confluence (C5), above South-South Brook confluence (C6)' and below Bramelys Road above the tidal reach at C9. (Sediment trap-drainage wetlands are also proposed at major drains flowing into the Cam at C3, C4, C7 and C8);
- North Brook main tributary above Boys Road (N3) and mainstem at Marsh Road (N4);
- Middle Brook main CAREX trap (M1) and lower Middle Brook (M3) as a control of potential downstream sediment flux from proposed channel and bank works;
- South Brook mainstem at S1, S5, S7;
- South-South Brook mainstem at the Cam Confluence (SS2); and
- Tuahiwi Stream mainstem at T1 and T2.

Once primary reach sedimentation traps are constructed, it is proposed that the opportunistic element of sediment trap construction will become part of routine operations as an integrated approach to waterway management becomes embedded.

Temporary structures would be constructed as required for bed raking and other channel works to control sediment plumes and to facilitate removal of fines that were flushed downstream.

In terms of what to expect from conventional traps, a series of equations are provided in Hudson (2002) to calculate trap efficiency. For these equations we need to know:

- Trap dimensions;
- Design or effective streamflow; and
- Size distribution of inflow sediment.

Trap dimensions are proportional to the effective streamflow. The effective streamflow is the combination of magnitude and frequency of flow events that over the long term transport the most sediment. It may take a few years of record, or spot gauging's and flow regionalization, to adequately describe this flow range, hence traps are often sized based on a design flow or scaled from existing channel dimensions (i.e. the guideline trap).

The size distribution of incoming sediment is normally based on measurements of the total sediment load in a variety of flow events. The major consideration in the Three Brooks, Tuahiwi and Cam, is the transport of sand and finer material. Much of the former will move on or near the bed, and the latter in suspension. Sill plates should be employed if suspended sediment samplers are used to develop sediment rating curves. Turbidity metres (and conventional suspended sediment sampling) are unlikely to measure suspended sediment on or near the bed, which might be a significant portion of the total load.

Some idea of sediment load is required to determine the frequency of clean-out. In high load streams the trap may infill rapidly and become ineffective in preventing resuspension. Hence, the guideline trap is relatively deep (Figure 16). To refine the depth a design streamflow is required.

Often sediment traps are maintained with an hydraulic excavator using a conventional bucket to scoop sediment out. Alternatives include simple suction dredges (essentially a pipe connected to a centrifugal pump that sucks loose sediment off the bed and disposes through a pipe); and suction combined with mechanical loosening or the use of water jets (e.g. the "sand wand") to remove firmer surface material and interstitial fine sediment. This is discussed further in the section on sediment removal from stream channels.

Traps have to be designed to be fit for purpose, and the cost and effectiveness of unconventional designs, and ongoing maintenance costs, need to be rigorously quantified.

An indicative cost of excavation for within exiting channel small traps, from routine drainage maintenance, is \$1.60 /m^3 plus disposal (if required).[15] Transport of equipment to site is an additional cost for one off operations. This illustrates the need to integrate enhancement works into routine operations while a machine is in the vicinity of the trap or is undertaking other work at the trap site. Management costs have not been included here or elsewhere in the cost estimates. These costs include resource consent costs (this is where a global consent for rehabilitation activities would prove invaluable); organisation and supervision of the activities and monitoring and assessment.

Costs of conventional traps are proportional to channel size. For refining designs to be context sensitive, the recommendation is to produce relatively shallow (~750 mm) traps that are 1.5 times the stream width and 10 times the channel width in length. To provide indicative construction costing, the channel base is assumed to be 2.0 m, with a 1.5 m bank height. Increasing the depth by ~750 mm, increases the cross sectional area by ~6.6 m^2. A 20 m long trap requires removal of ~130 m^3 of sediment and edge planting of both banks (~80 m^2).

Fletcher & Hudson (2016) provide indicative construction costs for one off operations for large areas in the Kaiapoi River, with costs for the hypothetical trap as follows:

- Excavation: \$4.00 /m^3, ~130 m^3, ~\$520;
- Removal from stock pile and levelling on a nearby site \$2.00 /m^2, 130 m^3, ~\$260;
- Grassing of the infill ~\$1.00 m^2, assume ~250 mm depth, ~525 m^2, ~\$525; and
- Planting of banks ~\$5.50 to \$8.50 /m^2, 80 m^2, ~\$440-\$680.

For the hypothetical test traps (to establish rates of sediment infill), the estimated costs would probably range from ~\$1,000 for excavation, no cost disposal, and least cost bank planting to ~\$2,000 for excavation, off-site disposal, levelling and seeding, and high cost bank planting. If traps infill rapidly, then more frequent cleaning is required or deeper, more costly, traps are required.

To verify the efficiency of traps (particularly unconventional traps such as the edge trap or enhanced natural pool trap), the following information is required:

- The streamflow for the period of accumulation;
- The input sediment load;
- The amount of sediment that has accumulated;

[15] Greg Bennett, WDC Land Drainage Engineer, written com. 16 Feb 2017 "Cleaning of sediment traps: Based on standard drain cleaning rates \$1.60 per lineal m + disposal of spoil. This is how the two traps along Tuahiwi Stream (Maori Drain) were charged & we have only done this once per site so far."

- The output sediment load; and
- The size distribution of the outflow sediment

Rule of Thumb Sediment Trap (Hudson 2005)

As shown in Figure 16, for a rule of thumb trap:

- The traps should be in a straight section of channel, not a bend;
- The trap should be 1.5 times wider than the upstream channel;
- The trap should gradually widen downstream; and
- The depth (to provide freeboard to stop resuspension after a reasonable volume of trapping) should be 1.5 m deeper than the existing channel

CAREX constructed a sediment trap on the Middle Brook (CX-1-M1 in Figure 5). The trap is useful from a practical perspective because it trapped 4 m^3 of the target sediment; and because we can learn from its performance as an enhancement to a natural pool (i.e. a trap that is relatively shallow and contained within the existing banks at a bend) rather than as a conventional trap (see text box).

The CAREX main trap is an unconventional design – perhaps driven by the aim "… to develop an "ideal" sediment trap design." Nonetheless, based on the reported dimensions, and some assumptions, trapping efficiencies can be assessed (Figure 18 & Figure 19).

Trap dimensions are given as 2.5 m wide (the same as the stream channel upstream), 12 m long and up to 0.70 m deep. A theoretical trap efficiency of 95% for 125 µm sediment is cited, whereas CAREX report a trap efficiency of 60-70% over an 8- month period. It is unclear how the theoretical and reported trap efficiencies were calculated and how silt plates were used to calculated sediment loads.

At this stage no information is publically available for the CAREX trap on streamflow, the input and output sediment load or size distribution characteristics of the input and outputs (Figure 18-a).[16]

Based on the available information (Figure 18), there are uncertainties about the stream inflow which is critical in accurately determining trapping efficiency:[17]

- There is an apparent discontinuity in flow; and
- It is unclear if the reported velocities and depths refer to a random measurement, design discharge or flood discharge.

In terms of streamflow (see footnote 17) and trap efficiencies:

- To trap 95% of 125 µm sediment, the effective input flow would have to be about 100 L/s;
- If the effective input flow was 300 L/s, the trap efficiency would be about 60% for 125 µm sediment; and
- If the effective input flow was closer to 600 l/s, the trap efficiency would be about 40% for 125 µm sediment.

[16] Dr Febria Oabel, written com., 16 February 2017.

[17] The input and trap discharges should be the same because there is no loss or gain of water between the two points. However the schematic suggests the input discharge is ~560 L/s (a scaled depth of 0.45 m, reported width of 2.5 m and reported velocity of 0.5 m/s) and the mid trap discharge is 75 L/s (a scaled depth of 0.60 m, reported width of 2.5 m and reported velocity of 0.05 m/s). In response Professor Harding (written com. 13 Feb 2017) noted "I think the upstream depth is probably less than 0.45 m and the middle of the trap is certainly deeper than 0.60 m. It was at least 0.75 m when initially dug and cleaned." This doesn't make a material difference – for the reported flow velocity the input flow depth would have to be less than 0.10 m in order for the input and throughput flows to be equal.

The theoretical trapping efficiency (based on the effective sediment trap being ≤30 m^2 and effective flows less than ~300 L/s) can be compared with the observation that about two thirds of the trapped material was finer than 1.0 mm:

- Sediment larger than 0.5 mm is expected to be trapped;
- Perhaps 90% of 0.25 mm sediment is expected to be trapped;
- Perhaps 70% of 0.125 mm sediment is expected to be trapped; and
- Perhaps 25-30% of 0.0625 mm sediment is expected to be trapped.

With the above assumptions and assuming an equal proportion of these sizes in the incoming sediment load, the theoretical trapping efficiency for this mixed load is ~70%.

Additionally, when the bed level in the trap decreases to ~300 mm (the depth shown), at flows over ~350 L/s material finer than 1.0 mm is likely to be resuspended and flushed from the trap (Figure 19).This indicates the critical nature of a design flow to refine trap depth and trap storage capacity. Also, it shows the importance of trap depth – if it's too shallow there will be relatively little storage before resuspension occurs. In the event that the ability to excavate the bed is limited to ~700 mm, then relatively frequent cleaning is probably required. Given the importance of flood flows on sediment loads reported by Hudson (1999) in the Cam River, traps should be inspected, and cleaned if required, after each flood.

The expectation from extensive international research is that sediment traps will be a key tool to help control excessive fine sediment deposits in waterways. This contention is supported by the main sediment trap CX-1-M1 in Middle Brook which accumulated 4 m^3 of fine sediment in an 8 month period (Figure 18). This sediment was probably derived from upstream erosion and from the upstream channel itself (the bed ~150 m upstream of the trap contains 41-60% fine sediment cover).

The stream bed immediately downstream of the M1 main trap has a clean gravel bed (Figure 5 & Figure 21); but for a further ~500 m downstream the bed has 21-40% fine sediment cover although there are three shallow traps in the upper portion of this reach (M2 in Figure 5). These traps resembled shallow pools with no apparent channel widening, with fine sediment deposits along the edge and exposed gravel in the pool (Figure 20). The lack of fine sediment deposits in the pools, and the relatively consistent high sediment cover throughout the reach strongly suggests that the shallow traps are ineffective. This is likely to be a general problem with very shallow sediment traps – resuspension will occur with freshes when most of the sediment transport occurs

It is important to place the 4 m^3 from 8 months of trapping in M1 in Middle Brook in context. The CAREX estimates of sediment loads will be helpful in this regard by providing direct measurements at the site, but in the meantime available information is used.

Suspended sediment loads were estimated by Hudson (1999) who reported that a single large storm dominated the sediment flux over a three month survey period. Suspended sediment loads (excluding organics) were estimated at 73 tonnes at Youngs Road, more than 160 tonnes at Revells Road and 470 tonnes at the mouth of the Cam River. The dry weight of a cubic metre of fine alluvial sediment is roughly a tonne. Thus, it is likely that the trapped amount is a meaningful proportion of the expected sediment load in Middle Brook.

Once the overall integrated catchment management plan has been implemented, and measures are in place to avoid and control the generation and

delivery of sediments and contaminants to waterways, the importance of sediment traps will decline with time. This will be some years from now as the legacy sediments are cleaned up.

7.1.2 Drain wetlands

The role of open drains and tile drains in agricultural catchments as point sources of sediments and contaminants is recognised in Europe and the United States; and in New Zealand. Various configurations of natural, restored and constructed wetlands have been shown to be effective in reducing agricultural runoff impacts on receiving waters. However, diffuse runoff and associated contaminant loads are inherently variable, and it is difficult to directly transfer results because of differing climates, wetland vegetation, flow regimes and land use practices. Also, various parts of wetlands vary in effectiveness and with age. In this regard, to provide a guide to sizing wetlands, Rutherford & Wheeler (2011) report entire wetland maximum removal rates of ~250 mg N/m^2/day from various New Zealand studies.

In a simple, cost effective approach for tile drains, Petersen et al. (1992) excavated mini-wetland to expose tile drains and allow water to pass through vegetation before entering a waterway (Figure 14). They found small wetlands (8 m by 10 m wide) were effective with high trapping efficiencies reflecting local conditions. The expectation, for New Zealand plants and conditions, is that an 80 m^2 wetland would remove ~0.02 kg/day (7.3 kg/year) (based on Rutherford & Wheeler 2011); which would be beneficial, and cost effective, in the local and regional context:

- In the Canterbury Plains, CAREX quantified export of nitrate-nitrogen in small agricultural streams <2 m wide and tile drains (Goeller et al. 2016). They reported flux of nitrate-N from <1 to >50 kg/day from streams; with <0.01 to >5 kg/day for tile drain "hotspots;"
- The low end "hot spot" load of <0.01 kg/day equates to <3.7 kg/year which is about half the rate of removal from an 80 m^2 mini-wetland; and
- Therefore, it is likely that mini-wetlands would be effective in trapping and treating nutrients from many low end "hot spots" and other tile drains.

The generality of this finding can be further evaluated using ECan summary statistics of NNN concentrations from hundreds of measurements in lowland stream and rivers across the region:

- Lower quartile NNN concentrations are ~0.42 mg/L, median concentrations are ~1.3 mg/L, with upper quartile concentrations are ~3.4 mg/L (Meredith and Hayward 2002);
- For the Kaiapoi catchment, Greer & Meredith (2016) report median values over several years of 4 to ~8 mg/l for Kaiapoi River sites; 0.45 mg/L for North Brook at Marsh Road; 0.64 mg/L for Cam at Bramleys Road; 0.67 mg/L for Cam at Marsh Road and 1.47 for South Brook at Marsh Road (Figure A3: 1); and
- Kaiapoi River sites exceed the upper quartile of all of ECan's Canterbury lowland sites; South Brook is above the median; and North and Middle Brook are between the lower quartile and median.

This further supports the contention that, apart from South Branch, the Cam catchment is at the lower end of the spectrum of nutrient concentrations and mini-wetlands would probably be effective trapping and treating nutrients from tile drains and small waterways.

Indicative costs for hypothetical mini outfall wetlands (8 m wide and 10 m long with 1.5 m bank height) are based on Section 7.1.1 In channel sediment traps. Additional excavation of ~90 m^3 is required, with 80 m^2 of wetland base planting and 40 m^2 of bank planting. Costs would probably range from ~$1,000 for excavation, no cost disposal, and low cost planting to ~$1,900 for excavation, off-site disposal, levelling and seeding, and high cost planting. Cost could possibly be lower for wetlands created as part of routine drainage operations.

Locations of mini wetlands cannot be specified at this stage because the location of tile drains was not mapped by ECan, and is not reported in WDC drainage management plans. It is recommended that tile drain locations are mapped, and a rating of possible sediment and contaminant discharge is assigned, to identify several suitable drains for trialing drainage outfall wetlands.

The next question is whether larger wetlands or bioreactors would be cost effective in trapping and treating nutrients from larger streams and more nutrient rich sites. This requires information on nutrient loadings.

Based on reported median NNN concentrations, and estimates of catchment area and median flow,[18] ball park estimates of NNN loads were calculated:[19]

- Cam River at Marsh Road: 0.67 mg/L, ~360 ha, ~190 L/s, ~11 kg/day, ~3,900 kg/year;
- Cam River at Bramleys Road: 0.64 mg/L, ~2,700 ha, ~1,400 L/s, ~76 kg/day, ~28,000 kg/year;
- North Brook at Marsh Road: 0.45 mg/L, ~600 ha, ~310 L/s, ~12 kg/day, ~4,400 kg/year; and
- South Brook at Marsh Road (excluding Middle Brook; but extending to the Cam mouth): 1.47 mg/L, ~990 ha, ~510 L/s, ~65 kg/day, ~24,000 kg/year.

Tanner et al. (2010) provide guidelines of design and expected efficiencies for constructed wetlands (Figure 22 & Figure 23) based on New Zealand experience over several years. Titoki wetland, Northland, is particularly relevant, with the ~900 m^2 area being 1.6% of the 5.65 ha catchment; with a depth of ~1.0-1.5 m; and tall growing native sedges (40-50% cover), interspersed with sprawling emergent herbs and grasses (20-30% cover) and floating leaved and submergent plants and free floating plants. The embankments were planted in flax (Tanner & Sukias 2011).

For Titoki wetland the ground was excavated 1 to 1.5 m into low permeability clay subsoils. Original topsoil (50-200 mm depth) was returned to the base of the wetland as a growth medium and source of organic matter for denitrifying bacteria. The upper sediment trap water depth is 0.4 and 0.8 m; with an average wetland depth of 0.3 m (Tanner & Sukias 2011).

Nitrate-N loads (54-82 kg/ha) were reduced seasonally by a median of 68% for spring-summer and 49% for autumn and winter (Figure 24) which places the

[18] Tony Gray, ECan, kindly provided provisional flow data for 66409 Cam River at Youngs Road. For the period 16-06-2010 to 06-02-2017 the median flow was 1,322 L/s; the maximum 33.58 m^3/s, and minimum 641 L/s.

19 Reported NNN concentrations were combined with estimates of streamflow. The only site with several years of streamflow record is the Cam River at Youngs Road. Median flow values were estimated for the ECan water quality sites by prorating by catchment areas and the median flow for the period of record at Youngs Road. As noted in footnote 2 catchment area delineations are problematic in this type of environment.

Titoki constructed wetland at 1.6% of the catchment area at or above the upper performance band in Figure 23.

Annual nitrate-N loads at Titoki (54 to 82 kg/ha) are far in excess of the estimated yields from the Brooks and Cam River (Cam at Marsh Road ~11 kg/ha/year; Cam at Bramleys Road ~10.5 kg/ha/year; North Brook ~7.4 kg/ha/year and South Brook ~24 kg/ha/year).

Streamflow was highly variable in the irrigated Titoki catchment with dairying, but flow information is not available. As noted by Tanner & Sukias (2011) more attenuated and sustained flow rates will enhance treatment performance. Therefore the expectation is that with spring-fed streams, such as the Three Brooks and upper Cam, coupled with smaller input loads and relatively constant water temperatures, trapping and treating in constructed wetlands would reduce significantly nitrate-N loads.

For constructed wetlands the major issue is the drainage area size, hence wetland construction cost and lost opportunity cost for productive land. For example, South Brook is a critical source of nutrients of the Three Brooks and upper Cam River. To treat the whole of South Brook based on the Tanner et al. (2010) guidelines requires a ~260,000 m^2 wetland (~160 m wide and 1,200 m long). This is larger than the Rangiora water treatment plant, so is clearly impractical.

In order to target treatment areas, macrophytes were used as an indicator of excessive nutrients. Emergent macrophytes exceeded LWRP outcomes (with greater than 30% cover) in the upper South Brook and two tributaries (Appendix 3). The smaller tributary (at Townsend Road) has a catchment area of approximately 13.5 ha. A constructed wetland of 1% of the catchment area, has a footprint of 1,350 m^2. Lehmans Road tributary drain is significantly larger: ~70 ha (and ~1,350 m in length) for a 1% wetland footprint of ~7,000 m^2.

An elongated shape with inflow and outflow at opposite ends promotes even flow and avoids short circuiting or dead zones to maximize efficiency. Tanner et al. (2010) recommend a length to width ratio of 3:1 to 10:1 for small wetlands (<1,000 m^2) and 3:1 to 5:1 for large wetlands (>1,000 m^2). At a 5 times length to width ratio, the Townsend wetland would be ~16 m wide and ~85 m long; and Lehmans wetland ~37 m wide and 190 m long.

Construction would involve considerable excavation as the existing drains are relatively narrow (0.6 m to 2.5 m water surface) with moderate banks angles (31-60°) in the lower reaches. The estimated volume of removal is ~1,100 to ~1,600 m^3 for Townsend and ~6,500 to ~9,500 m^3 for Lehmans (depending on bank height). Based on estimates discussed in Section 7.1.1 In channel sediment traps, an indicative cost for the excavation and disposal is ~$8,000 to ~$11,000 for Townsend and ~$45,000 to ~$66,000 for Lehmans. Planting costs would add an estimated~ $7,500 to~ $11,500 for Townsend and ~$38,500 to ~$60,000 for Lehmans.

While these constructed tributary wetlands could probably significantly improve water quality in South Brook, spending this amount is not recommended for the following reasons:

- It would be more cost effective to address the cause of the problem; and
- Where the cause is not apparent, a more targeted approach is warranted.

In the case of Townsend Road tributary there is stock access from the right bank for ~300 m, and from both banks for ~200 m of the ~500 m long stream. Around 700 m of fencing is required to exclude stock. The recommended approach is as follows:

- Enforce the NRRP requirement for stock exclusion from designated waterways - Lehmans drain is identified in Planning Map A.[20]
- Fine sediment resuspension and dispersion downstream would be addressed with the recommended sediment trap at the mouth of Townsend tributary.

It is not clear what causes excessive macrophyte growth and excessive fine sediment cover in Lehmans Road drain. There is no stock access to the drain, but ECan mapped three tributary drains that flow into Lehmans Road drain. Further investigation is warranted to determine cause, and examine if small wetlands would be viable for the small tributary drains. Three potential locations are suggested based on the ECan minor tributary locations in the Lehmans Road drain (Figure 5).

The efficiency of the proposed Lehmans Road tributary drain constructed wetlands should be evaluated. A staged approach is suggested. As a first stage, the recommendation is to construct small wetlands based on Titoki, but scaled to the channel dimensions rather than the percent catchment area guide (Figure 23). Reasons include:

- The catchment areas are difficult to accurately determine;
- Drain sizes are proportional to design flows;
- Nutrient loads are probably much smaller than Titoki; and
- Efficiencies may be greater than Titoki because of the spring fed source.

As for Titoki (Figure 22), it is recommended to construct a sediment trap at the inflow to the wetland. Assuming a 1 m wide drain, for the sediment trap widen the channel to 1.5 m over a length of 10 m, and lower the bed ~750 mm. For the wetland, widen the channel to 5 m over a 25 m length, partially infill with topsoil as a growing medium, and constrict the downstream end to provide a low flow water depth of ~300 mm. Plant an assemblage on the edge of the sediment trap and wetland, and plant the wetland with sedges and other plants as for the Titoki wetland.

The cost would be relatively modest and will provide a learning experience for further small wetlands. The major costs are for planting the wetland (~$700-$1,000 for 125 m^2 of planting at $5.50 to $8.00 /$m^2$) and bank edge planting (~$200-$300 for 35 m of channel). Excavation of ~100 m^3 is possibly required at $4.00 /$m^3$ for excavation, $2.0 m^2 nearby spreading (~250 mm depth) and grassing (400 m^2 at $1.00). The total indicative cost is ~$1,300 for excavation and least cost planting, to ~$2,400 for excavation, off-site soil levelling and seeding and higher cost planting.

Seasonal monitoring of nutrient inputs and outputs would be required if this is to be learning experience. After a few years, once local performance is better understood, the applicability of small constructed wetlands should be reviewed for possible further installation.

7.1.3 Bioreactors

Bioreactors have been shown to be effective in stripping nutrients. For example, Robertson & Merkley (2009) placed wood chips under a gravel veneer in excavated stream channels in the Avon River, southern Ontario, Canada; and

[20] http://canterburymaps.govt.nz/maps-apps?q=%5bcategory%3aPlanning%5d&page=3&orderby=MostRecent Accessed March 2017.

Christianson et al. (2012) undertook long term tests of large off channel bioreactors in the US Midwest.

In the excavated Avon Stream channel the 40 m^3 reactor reduced mean nutrient loading (Nitrate-N) from 4.8 mg/L to 1.04 mg/L over a period of 1.5 years. Almost complete removal occurred when effluent temperature was >10°C with lower efficiencies at effluent temperatures as low as 2 to 4°C (with ice cover). Robertson & Merkley (2009) noted a decrease in dissolved oxygen downstream and fine sediment deposition limiting efficiency. They proposed staging reactors downstream if DO was an issue and incorporating a sediment trap. Costs are not cited, it was merely noted the costs were for excavation of the 40 m^3 reactor, the woodchips, and placement of gravel.

Nitrate N loading is similar in the Avon Stream to the upper quartile range of Canterbury lowland streams (Meredith and Hayward 2002); but the Avon flows are very small, with resulting reactor attenuation of only 66 kg N/year. This would suggest bioreactors would have to be much larger than 40 m^3 to significantly attenuate nutrient concentrations in the Three Brooks (e.g. North Brook 4,400 kg/year).

Experiments are being undertaken in lowland stream in Canterbury using untreated pine woodchips to provide long term denitrification in conventional bioreactors (CAREX Newsletters May and September 2015) and with bags of woodchips placed in four streams (December 2016). Costs and effectiveness have not been reported for the CAREX experiments.

7.1.4 Conclusions: trapping and treating

In channel sediment traps have proven performance and their wide spread use is recommended (Figure 5), at least until catchment management significantly improves and legacy sediment are removed from waterways. Several locations were recommended and more details on trap locations are provided in the next sections.

Costs of traps are proportional to channel size, with a hypothetical conventional but shallow trap (750 mm) design for a 2 m channel base and 1.5 m bank height. Indicative costs range from ~$1,000 for excavation, no cost disposal, and bank planting to ~$2,000 for excavation, off-site disposal, levelling and seeding, and bank planting. Shallow traps are recommended to limit construction costs while rates of infill are established. The traps may suffice, or require more frequent cleaning, or possibly enlarging. Time will tell.

It is probably cost effective to target tile drain outfalls for mini wetland treatment. Some of these mini wetlands could be created by minor excavation, bank reshaping and planting in the drain itself. Sites are suggested in Figure 5), but their use is considered experimental, with monitoring required to determine efficiencies. Costs would probably range from ~$1,000 for excavation, no cost disposal, and low cost planting to ~$1,300 for excavation, off-site disposal, levelling and seeding, and high cost planting. Cost could possibly be lower for wetlands created as part of routine drainage operations.

Large scale conventional constructed wetlands are expensive and are not recommended at this stage. It is far more effective to control excessive generation and delivery of contaminants than to construct treatment wetlands (1-2-5% of the catchment area) for larger streams. However, given the relatively low levels of nutrients and steady flows in the Three Brooks, smaller trial constructed wetlands are recommended in three Lehmans Road drains at an indicative cost of $1,300 to ~$2,400 each. After a few years, once local performance is better understood, the applicability of small constructed wetlands should be reviewed.

Simple bioreactors – channel excavations with woodchips and gravel overlays – can significantly reduce nutrient levels at low flow rates, but scale may be an issue. Local cost and performance information is required before they can be recommended. For the purpose of experiments with bioreactors, they could be placed at the downstream end of the sediment traps (Figure 5).

The use of bags of woodchips, as flow deflectors, would be a simple, relatively inexpensive, approach to remove nutrients and increase habitat diversity. These could be placed opportunistically in the upper South Brook where abundant macrophyte cover is indicative of high nutrient availability (Figure A3: 2G); but their performance with relatively large streamflow's is uncertain.

7.2 Sediment removal from the stream channel

Excessive fine sediment on and within the bed is recognised as a significant impediment to aquatic health (Clapcott *et al*. 2011). Therefore previous reports recommended cleaning legacy and contemporary fine sediment f(<2 mm particle size) from the surface of the bed and from within the bed itself (interstitial fines).

Three instream sediment removal techniques have been used in the Three Brooks, Cam and Tuahiwi Stream:

- Excavation;
- Sand wand ™; and
- Bed raking.

7.2.1 Excavation

For decades the conventional means of cleaning weeds and sediment from New Zealand drains is with an hydraulic excavator (Hudson & Harding 2004). A digging bucket (with teeth to penetrate hard soil and rock) is often the default, although a cleanup bucket (a digging bucket without teeth) may be used for soft or well loosened material (e.g. Figure 25 top). Excavation is often undertaken from the bank (sometimes with a long reach excavator), but for wider, or less accessible streams, excavation may be undertaken from within the channel (Figure 25-bottom). Sediment is often scooped out of the drain and spread adjacent to the bank; or temporarily stockpiled for dewatering prior to offsite use; or in some instances loaded into to dump trucks with liners (to contain the slurry of material) for offsite disposal.

As noted by Greg Bennett, WDC Land Drainage Engineer (footnote [15]), standard drain cleaning rates are $1.60 per linear metre, plus disposal if material can't be placed adjacent to the channel (e.g. Figure 25 top). This rate, or similar, would be applicable to a large portion of the Three Brooks, upper Cam and Tuahiwi Stream. The relatively low cost is related to long term, not one off, contracts.

Larger watercourse require long reach excavators, draglines, or work from within the channel to excavate bed material (e.g. Figure 25). Large scale excavation costs were estimated at $4.00 /m^3, plus $2.00 /m^3 to move and level on an adjacent site, and $1.00 m^2 for hydroseeding in the Kaiapoi River (Fletcher & Hudson 2016).

7.2.2 Sand wand

Gray (2013) undertook a comprehensive review of a new tool - the Sand Wand.™ He notes the wand uses a combination of water jet and suction to mobilise and suck up a slurry of fine sediments beneath an enclosed hood. Practitioners manually move the equipment across the stream bed using a rocking motion moving parallel to flow. The arrangement of pumps relative to the

hood depends on the topography of the stream. Slurry can be discharged to land or into sediment separating equipment. The setup is illustrated in Figure 28. It was noted that in two trials negative environmental effects can be mitigated and are not long lasting. Protocols are recommended for habitat restoration as a discretionary activity requiring resource consent.

In Middle Brook, the CAREX team used a sand wand to clean out the sediment traps and a 10 m section of 2.5 m wide stream. They reported the sand wand was effective at reducing fine sediment cover from ~40% to 10-20% cover from depositional environments (pools and the sediment trap), but not from shallow water (<20 cm deep i.e. riffles). They note the wand is labour intensive and the removed sediment needs to be disposed elsewhere. Time and cost is not reported.

Taylor & Marshall (2013) addressed the issue of shallow water by construction of a temporary sandbag weir. They report it took 2 operators 3 hours of instream time to clean thick liquefaction fine sediments over a 15 m length of the ~4 m wide Wairarapa Stream, Christchurch. 1,350 kg of wet silt (22 kg/m^2) was removed. They believe they could achieve cleaning of 60 m of 4 m wide stream in a day for a labour cost of ~$450 for three workers. Machine costs are not reported (e.g. hire, fuel, maintenance). This equates to ~$2.00 /m^2. Current labour costs are likely to be higher, so a ball park cost of $3.00 /m^2 is used.

Gray et al. (2013) report the sand wand is highly effective in removing fine sediment from the upper 10 cm of the stream bed in Otukaikina Creek (old South Branch, Waimakariri River) (Figure 29). Sediment cover decreased from ~70% to ~5% with the trial, but this was short lived as sediment was delivered into the trial reach and deposited. After 6 weeks the trail reach increased to ~45% fine sediment cover, but further downstream cover decreased.

The Otukaikina Creek trial emphasises several very important points:

- Bed restoration is futile if upstream sediment sources are not controlled;
- Sand wands can clean fine sediment from the bed;
- Removing fine sediment deposits can result in downstream fine sediment cover reductions;
- The sand wand is not very effective at deep cleaning (>100 mm); and
- The work is labour intensive, and slow, with the expectation of cleaning perhaps a couple of hundred square metres per day.

Gray et al (2013) noting the importance of clean substrate at depths greater than 100 mm note: “Potential improvements to stream restoration techniques which involve the removal of fine sediment from deeper substrates would be a suitable topic of further investigation.” In this regard, bed raking was proposed by Hudson (2010).

7.2.3 Bed raking

Bed raking was proposed by Hudson (2010) based on observations of hydraulic excavators cleaning drains and extracting sand and gravel from river beds (Figure 25). The proposition was that standard hydraulic excavator digging buckets with teeth could be used to push around gravel to create habitat diversity (pools and riffles) and in doing so promote the downstream flushing of fine material from within and on the stream bed.

This idea was encouraged by the availability of a modified land clearing rake for cleaning aquatic weeds in the District. The rake was constructed by a local contractor in collaboration with WDC (Figure 26). The rake is routinely used to clean weeds while allowing stream fauna to pass through with minimal bed

disturbance (Bennett 2012). It was thought that the rake could be used as a ripper to deeply penetrate the bed to release fine sediment and to push around gravel to create habitat diversity (pools and riffles).

Protocols need to be developed (as for the sand wand – Gray 2013), including:

- Effective operational procedures, for example:
    - Remove surficial fine material from the channel edges and mid channel using a digging bucket or suction dredge (if required);
    - Disturb the bed to remove interstitial fines by bed raking or water blasting with the sand wand (if required); and
    - If using a digger bucket or bed rake, push bed material around to create shallow pools and riffles (if required this could be undertaken as part of the bed disturbance above);
- Effective environmental controls (e.g. trapping disturbed fines further downstream behind a temporary silt barrier, straw bale or sand bag weir); and
- Appropriate disposal of fine sediment (e.g. spread on adjacent land as nutrient rich soil or stockpiled and disposed offsite).

Every operation would be site sensitive with the steps taken dependent on local conditions (e.g. the first steps of surface fine sediment removal may not be required). Initial removal of fine sediment drapes, could be undertaken with a digging bucket or suction dredge (essentially a pipe connected to a centrifugal pump that sucks loose sediment off the bed and disposes through a pipe). A sand wand (discussed above) could also be used, but there is no real need to utilise a water jet to mechanically loosen the fine sediment. Removal of material from the sediment trap may be undertaken with the digger, suction dredge or sand wand. This cleaning would probably occur immediately for temporary traps, but as part of routine drainage maintenance for permanent sediment traps.

Bed raking was undertaken in the Middle Brook CAREX reach for ~180 m upstream of the CX-1-M1 trap in 2015 (Figure 5; Appendix 4). In this reach ECan report a fine sediment cover of 41-60% in 2017. Some months later I found confined sections of the reach had exposed gravel, and the margins and weed beds had fine sediment drapes (Figure 27), whereas further upstream the bed has bank to bank fine sediment cover. As noted previously,this suggests bed raking was successful, but long term success requires control of upstream sediment inputs.

WDC undertook bed raking in upper South Brook ~300 to ~700 m downstream of Lehmans Road (Appendix 4). Results have not been reported, other than to state that the South Brook bed was hard. A heavier rake was required to penetrate the bed. The bed in this reach is described by ECan as “very fine” substrate with 80-100% fine sediment cover. More information is required to understand what was used, how it was used and what occurred with bed raking.

At this stage it is unclear where bed raking can be successfully undertaken and how to undertake bed raking (i.e. operating procedures for different conditions). There is also a lack of rigorous quantification of the effectiveness of bed raking (i.e. before-after-control-impact-paired differences (BACIP) and habitat creation:

- Experiments are required to develop protocols, and quantify the extent and depth of fine sediment surface cover and interstitial fine sediment content at various depths in the bed before and after treatment.

- Further, the optimum channel profile for pools and riffles has to be determined so that flushing of sediment occurs in freshes. Low flow pool depths of ~300 m, with riffle depths of ~100 mm would provide habitat diversity for many aquatic species.

What is known is that extensive reaches can be raked in a relatively short period, with apparent reductions in fine sediment cover, and possibly interstitial fine sediment. Costs are not reported, but would probably be in the range for routine drain cleaning (~$1.60 per linear metre for small waterways) to remove fine sediment drapes; with a similar additional cost to disturb the bed to release interstitial fines and create pools and riffles.

Given the potential to clean large reaches at relatively low cost in a short period, a rigorous appraisal of bed raking is warranted in conjunction with using bed raking to create habitat diversity (i.e. pools and riffles ~7-10 channel widths apart). Test reaches are suggested below.

7.2.4 Bed clearing locations and costs

Removal of fine sediment deposits from on and within the streambed would probably be beneficial at most locations in the Three Brooks, Cam and Tuahiwi Stream. However, it is considered futile, and not cost effective, to clean a reach only for the reach to be inundated by fine sediment from upstream. The preferred strategy to deal with this is relatively simple:

- First, stop the excessive contribution of fine sediment into waterways by controlling critical source areas such as bank erosion;
- Second, progressively clean the bed from spring head downstream; and
- In the event upstream bed cleaning is not possible, and/or if sediment delivery into the upstream waterway cannot be controlled, then the flux of material into the rehabilitation reach must be controlled with sediment traps at the head of the reach.

Indicative costs are based on excavation costs for drainage maintenance ($1.60 per linear metre for small drains)[15] and sand wand costs reported by Taylor & Marshall (2013) from Wairarapa Stream which are revised to $3.00 per square meter of stream bed to allow for increased labour costs and some equipment cost.

Sand wand removal of fine sediment on and in the bed is a one pass process. Removal of fine sediment drapes with a cleanup bucket or digging bucket is also a one pass process and is a prerequisite for bed raking. A second pass is required to rip the bed and create pools and riffles. A change in equipment for the hydraulic excavator is required – from a cleanup bucket to a digging bucket or rake. The second pass is expected to be a similar cost to the first pass for the hydraulic excavator. For larger streams, and for offsite disposal of fine sediment, costs are greater as noted earlier.

Fine sediment removal costs have to be verified as protocols are developed. It is assumed that a global consent is in effect that permits these activities following specific protocols. Options, and ball park costs (excluding management), include:

- Sand wand removal of surface and shallow subsurface fines (~100 mm) ~$3.00 /m^2;
- Hydraulic excavator removal of surface fine sediment ~$1.60 /Lm; and

- Hydraulic excavator disturbance of deep subsurface fine material (~300 mm) by ripping the bed and creating pools and riffles ~$1.60 /Lm in addition to the removal of surface fines of ~$1.60.

In terms of locations, the ideal place to start remediation of excessive fine sediment deposits is in the headwater streams of the Three Brooks, specifically North Brook and South Brook. For the time being, activities in Middle Brook should be avoided so as to not interfere with the CAREX research. South-South Brook is probably in the too hard basket – with limited opportunity for rehabilitation – hence for at least the medium term – emphasis should be on stopping downstream impacts with a mouth sediment trap - linear wetland (SS2 in Figure 5). Upstream inputs are controlled with a stormwater pond at SS1.

The upper part of North Brook from the water races west of Rangiora and spring heads within the upper portion of the town, were not surveyed by ECan. Periodic drain maintenance occurs in this reach and future works are proposed for stormwater management at Dudley Park (Appendix 4). Bed clearing should be undertaken opportunistically with routine maintenance and with the proposed stormwater management at Dudley Park. Temporary sediment traps should be employed to control downstream flux of fine sediment into Northbrook ponds.

Downstream of Northbrook ponds (N1 in Figure 5) to Boys Road, the bed has less than 20% fine sediment cover, but is potentially under threat from downstream flushing of fine sediment from Crayfish Creek which has 80-100% fine sediment cover. While it is tempting to remove extensive fine sediment from this headwater stream, it may be prudent to avoid interference (Table 2).

Crayfish Creek is managed by WDC as a high value site because of the presence of koura (freshwater crayfish). Removing excessive fine sediment deposits may not be helpful for koura – of overriding importance is cover, such as tree roots, undercut banks, leaf litter and wood, relatively shallow depth and low velocity pools (<0.4 m/s) (Jowett et al. 2008). Substrate is important between streams but not within streams, with young being associated with fine substrate and adults with cobbles.

The recommended action is to control downstream sediment flux from Crayfish Creek with a sediment trap (N2 in Figure 5). This has been accomplished to some degree with a fish barrier. Taylor & McCaughan (2012) noted fine sediment discharging into Crayfish Creek from North Brook road drain. A sediment trap is also recommended to control this influx if this flux has not already been controlled.

A tributary entering North Brook ~100 m upstream of Boys Road is largely 80-100% fine sediment covered, with the potential to flush into a clean segment of North Brook. The recommended action is to control downstream sediment flux from this tributary with a sediment trap (N3 in Figure 5) and to undertake sediment removal over the ~830 m spring head reach of the tributary. Also, to control surface erosion, the overland flow path shown in Figure 7 should be grassed (e.g. as in Figure 6) or seeded in native species and fenced.

This tributary varies in width. Above Northbrook Road the tributary is in the 0.6-1.5 m wetted width category; and downstream the wetted width of the lower ~400 m is generally in the 1.6-2.5 m wide category (Appendix 3).The surface area to be cleaned is approximately 1,250 m^2. Indicative costs for the three sediment removal options are as follows:

- Sand wand removal of surface and shallow subsurface fines (~100 mm) ~$3,750;
- Hydraulic excavator removal of surface fine sediment ~$1,350; and

- Hydraulic excavator disturbance of deep subsurface fine material (~300 mm) by ripping the bed and creating pools and riffles an additional $1,350.

Fine sediment removal is recommended over the ~1,000 m North Brook reach from Boys Road to Marsh Road where the bed cover is 61-80% fine sediment (Figure 5). Trout spawning is limited in this reach, because of fine sediment cover (Taylor 2005). The channel is in the ~2.6 to ~4 m category (Appendix 3), with wetted width measurements frequently at the top end of this range (Google Earth); hence the surface area is probably ~4,000 m^2. Ball park construction costs are:

- Sand wand ~4,000 m^2, ~$12,000;
- Excavator surface removal ~1,000 m, ~$1,600; and
- Excavator rip and contour an additional $1,600.

A sediment trap has been proposed for North Brook at Marsh Road which would control flux into the clean reach that extends to the confluence with South Brook (N4 in Figure 5). This trap would be cleaned as part of routine drainage maintenance.

Upper South Brook has patches of heavily sediment (80-100% fine sediment cover) to relatively clean bed (<20% fine sediment cover). The narrow, heavily sedimented, ~375 m spring head reach, requires further investigation. Sediment trap locations were described earlier. If cleanup is considered a priority, then ball park construction costs are:

- Sand wand ~600 m^2, ~$1,800;
- Excavator surface removal ~375 m. ~$600; and
- Excavator rip and contour an additional ~$600.

The remaining ~1,500 m of upper South Brook consists of 21-40% to 80-100% fine sediment cover, in a narrow channel (~1.5 m wetted width). Brown trout spawning was observed in this reach (Taylor 2005). It is recommended that tributary inputs are controlled with sediment traps and drainage wetlands as discussed earlier. Ball park construction costs are:

- Sand wand ~2,250 m^2, ~$6,750;
- Excavator surface removal ~1,500 m, $2,400 (but access may be limited in sections with trees); and
- Excavator rip and contour an additional $2,400.

WDC described bed raking with an old, light rake, was not very effective in the most heavily sedimented section of this reach where the bed was described as hard. The effectiveness of the sand wand and bed raking could be compared in upper South Brook with an objective being to develop operating procedures for difficult conditions. If half the reach were cleaned with the sand wand; and half with an excavator undertaking cleaning, ripping and contouring, the estimated cost is ~$6,000; plus supervision and reporting.

For the inchannel cleanup, temporary sediment traps are recommended. These temporary sediment traps could be constructed with overlapping silt fences or straw bales at a cost of ~$250 installed. The traps would be cleaned out at the completion of the channel clean up to stop downstream flux of fine sediment. Cleaning of the trapped sediment could be undertaken with the sand wand as part of the overall estimated cost of the channel works.

Lower South Brook, from below the water treatment plant, past Middle Brook and South Brook confluences to the junction with the Cam, is a distance of ~1,800 m. This reach is moderately sedimented (21-60% fine sediment cover - Figure 5). Taylor (2005) did not observe brown trout spawning in most of this reach, which may in part be attributed to lack of habitat diversity and fine sediment on and in the bed.

With channel width ranging from ~1.5 to ~5 m (median 3.0) (Google Earth), the bed area to be cleaned in lower South Brook is ~5,400 m^2. The cost for sediment removal probably increases from normal drainage cleaning rates because of the channel size. Cleaning rates are assumed to double. Ball park cost are:

- Sand wand ~5,400 m^2, ~$16,000;
- Excavator surface removal ~1,800 m, ~$5,800; and
- Excavator rip and contour an additional ~$5,800.

A sediment trap at the mouth of Middle Brook would control sediment coming into South Brook while CAREX operations are underway. Sediment from the bed disturbance in lower South Brook would be trapped at the confluence of the Three Brooks and Cam River (M3 in Figure 5). A trap and other works are proposed by CAREX.

For the Cam River mainstem, the focus of this review is the reach between Marsh Road (km 9.4) and Bramleys Road (km 6.5). However, context is important. In this regard, while the spring head reach is relatively clean, much of the Cam above the Three Brooks and Marsh Road has 81-100% fine sediment cover. Downstream of the Three Brooks to Bramleys Road there is a sub-equal mix of the 0-20% to 61-80% fine sediment cover (Figure 5).

To protect the higher quality reaches from upstream resuspension and transport of fine sediment, sediment traps are recommended on the Cam near Boys Road (C1), Marsh Road (C2), near the Three Brooks confluence (C4), and at the South-South Brook confluence (the latter combined with a wetland – Ss2). In addition, drainage wetlands are proposed at several sites (Figure 5).

In terms of fine sediment removal in the Cam mainstem, the preference would be to start in the spring fed headwaters. Failing that, fine sediment removal is recommended in the reach below the Marsh Road sediment trap to Bramleys Road.

From Marsh Road to the Three Brooks confluence, the Cam is narrow (1.6-2.5 m category Appendix 3). For an average wetted width of ~2 m, the ~950 m of channel has 80-100% fine sediment cover. For this reach, ball park estimates to remove fine sediment are:

- Sand wand ~2,000 m^2, ~$6,000;
- Excavator surface removal ~950 m, ~$1,500; and
- Excavator rip and contour an additional ~$1,500.

Below the Three Brooks to ~300 m above Youngs Road, the Cam is sub equally 21-40% and 41-60% fine sediment cover (Figure 5). This reach was utilised for trout spawning (Taylor 2005) therefore may be a lower priority for removal of fine sediment. The wetted width is classed as 4.1-7.0 m (Appendix 3); with aerial photographs often showing a wetted width of ~7.0 m (Google Earth).

Over the ~670 m reach, with an average width of ~7.0 m, an area of ~4,700 m^2 could be cleaned. A sediment trap is proposed at the lower end to control sediment flux into the clean bed reach (<20 fine sediment) that extends ~300 m

upstream and ~300 m downstream of Youngs Road (Figure 5). A ball park cost to clean this reach is based on triple the routine drain clearing rate because of channel size:

- Sand wand ~4,700 m^2, ~$14,000;
- Excavator surface removal ~670 m, ~$3,200; and
- Excavator rip and contour an additional ~$3,200.

The ~700 m reach from above Youngs Road to above Power Road has <20% fine sediment cover. Fine sediment removal is not required. The reach would be protected with the recommended sediment trap on the Cam River above Youngs Road, the South-South Brook sediment trap and the drain wetland on Youngs Road (Figure 5). The bed in this reach is relatively narrow (classed as 1.6-2.5 m in Appendix 3).

Immediately downstream of the clean bed reach around river km 7.13, the wetted width widens to 4.1-7.0 m (Appendix 3); averaging around 6.5 m (Google Earth). Here the bed has 61-80% fine sediment cover for the ~660 m reach to Bramleys Road, with 80-100% fine sediment cover beyond the study reach to Revells Road (Figure 5) (and further downstream through the tidal reach – Hudson 1999). A ball park cost to clean this reach is based on triple the routine drain clearing rate because of channel size:

- Sand wand ~4,600 m^2, ~$14,000;
- Excavator surface removal ~660 m, ~$3,200; and
- Excavator rip and contour an additional ~$3,200.

Enhancement of a natural inner bend sediment trap is proposed ~300 m downstream of Bramleys Road (km 6.54). This will trap some fine sediment entering the lower tidal reach (C9 in Figure 5; Figure 17). Upstream tidal flux appears to stop around Revells Road (river km 4.85).

A number of actions were proposed for Tuahiwi Stream, including fine sediment removal (Hudson 2013; Appendix 5). The bed is almost exclusively 100% covered in thick sediment drapes. Sediment traps are recommended to control flux into the Cam River at T1 and T2 in Figure 5, because the stream is a large contributor to the sediment load in the Cam (Hudson 1999). However, the minutes of the Cam River Enhancement Fund Subcommittee, dated 30 July 2015, note:

- The use of the fund for mahinga kai restoration in the Tuahiwi (Maori) Drain is not supported by Ngai Tuahuriri. This is because the establishment of new mahinga kai areas in this drain is unlikely to be effective given the extent of legacy sediment and degradation.
- The Runanga view is that enhancement of existing remnant mahinga kai populations (particularly koura) should be a priority. This includes: a) an area just upstream from the Revells Road bridge; b) the area along Cox Road; c) the area between Boys Road and Marsh Road; d) the side tributaries of the Middle Brook; and e) the Crayfish Creek tributary to the North Brook

Regarding the latter, the first two reaches are out of the study area; and Middle Brook is the CAREX test bed and was not considered further in this report. It was recommended that Crayfish Creek be protected from sediment inputs. A fish barrier has been installed by WDC. It was recommended that drapes of fine sediment are not removed from the bed of Crayfish Creek because of potential adverse effects on koura and requisite koura habitat.

7.2.5 Conclusions: sediment removal

Extensive drapes of fine sediment occur through the Three Brooks and Cam River. Surface deposits can be effectively removed with hydraulic excavators at low cost (~$1.60 per linear metre for drain and small streams). Surface fines and shallow (~100 mm) subsurface fines can be effectively removed with a sand wand at an estimated cost of ~$3.00 per square metre (excluding management costs). Bed raking (ripping the bed) has the potential to loosen and flush fine sediment from deeper in the bed (~300 mm) and to create habitat diversity (e.g. pools and riffles) for a similar cost to routine drain cleaning (an additional $1.60 /Lm for small streams). It is envisioned that bed raking-habit creation can be undertaken once surface sediment was removed.

Extensive removal of surface and subsurface fine sediments has been recommended, with indicative costs for selected reaches, for the three approaches:

- The least cost approach is to remove the surface deposits of fine sediments with an hydraulic excavator. This may be sufficient to improve habitat quality significantly, but this is not rigorously quantified. If this were the only approach used, the reach length of recommended cleaning is ~7,800 m; for a cost of ~$20,000. This is greater than the $1.60 /LM because some reaches are relatively wide and costs may increase by a factor of two or three;
- Sand wand fine sediment removal is effective in removing surface material and shallow subsurface fines (~100 mm). Improvements in habitat quality have been documented. If all the channels were cleaned by the sand wand (~7,800 m; ~25,000 m^2), the ball park cost is ~$75,000; and
- Bed raking is proposed as a two stage process. The first pass is to remove fine sediment surface deposits at a cost of $1.60 /Lm for much of the study area. The second pass would double the cost and would rip the bed to a depth of ~300 mm and push around bed material to release interstitial fines and create pools and riffles. If all the channels were treated, and an allowance is made for increased costs for wider channels, the ball park costs for cleaning and diversifying a ~7,800 m length of channel with an areas of ~25,000 m^2, a ball park estimate of the total cost is ~$40,000. Both stages may not be required.

There are three significant issues:

- There is a lack of rigorous quantification of the effectiveness of bed raking (ripping the bed) and no reporting of using hydraulic excavators to push around bed material to release interstitial fines and create pools and riffles;
- Recommended protocols need to be tested and refined as required; and
- A global resource consent, with appropriate resource consent conditions, is required to facilitate habitat rehabilitation.

As a way forward, and in the spirit of adaptive management and continual learning, the recommendation is to work with conventional excavator clearing, the sand wand and bed raking as site conditions determine. The first two are well understood. Bed raking is definitely experimental, and comprehensive trials of a two-step approach for fine sediment removal with an hydraulic excavator are recommended based on potential. This is considered a worthy investment because if bed raking proves to be effective environmentally and cost wise, it may be widely utilised in the Three Brook, Cam River and elsewhere.

7.3 Bank stabilisation, bed and bank reshaping

7.3.1 Bank stabilisation

Previous investigations noted there was little evidence of significant contemporary mainstem riverbank erosion in the Cam River catchment.[21] Hudson (1999) reported the major sediment sources were upland soil erosion (from farmland and subdivisions) and streambed erosion (re-suspension). Although the quantity of material derived from bank erosion may be of lesser importance than other sources, bank stabilisation is a prerequisite for successful control of bank erosion and riparian planting (Figure 11), and control of bank erosion will improve habitat by reducing local deposition of sediment in the channel.

ECan's mapping has identified places with conspicuous bank erosion (e.g. Figure 8, Figure 9 and Figure 10). These sites are discussed previously with respect to stock damage and stream bank erosion and overland flow paths (Appendix 3). Three sites were identified in the upper Cam, three sites on North Brook, one site on Middle Brook, six sites on South Brook and two sites in Tuahiwi Stream.

ECan kindly provided photographs of several of these sites which were useful in determining the magnitude of the erosion problem. These photographs documented a few additional and/or miscoded sites (prior to an ECan audit) such as bank collapse marked as an overland flow path for North Brook R5-R6 (Appendix 3).

The photographs and context (Google Earth) suggest localized scour is occurring, generally in bends, as expected. To determine the nature of the bank erosion, site inspections are required. But in terms of magnitude, at individual sites, bank collapse or scour is occurring over several metres, perhaps up to 20 or 30 metres; and the banks are generally quite low (1-2 m).

In terms of recent bank reshaping works, Greg Bennett, WDC, noted costs of $5.00 per linear metre for 1 m high banks with a 1:1 to 1:2 batter, plus disposal of material if adjacent uses could not be found.[15] Riparian planting costs were cited as $20 per linear metre or $8-$10 per linear metre for a single row of carex.

Assuming an average length of 20 linear metres, bank reshaping is estimated to cost ~$100 (plus transport to site and any disposal cost); and riparian planting ~$400. Therefore, the 15 identified sites could be reshaped and planted for ~$10,000 to $15,000.

Other bank reshaping and planting is discussed in section 7.5 Riparian planting - buffers.

7.3.2 Two stage/compound channels

A hierarchy of actions can be undertaken to enhance highly modified and artificial waterways (Hudson (2000) reviewed the rationale for these channel modifications):

- Reshaping the channel by removing fine sediment drapes and shifting bed material to create shallow pools and riffles (as discussed above);

[21] Golder Associates (2008) examined bank erosion in the North, Middle and South brooks. They noted the stream channels at their sampling sites were typically incised, with steep banks. However, active bank erosion was relatively uncommon. Notable exceptions were site N7 in a tributary of North Brook which had active bank erosion along the entire reach, and M2 in the upper Middle Brook where bank slumping and erosion were prevalent.

- Reshaping the channel from a flat-bed trapezoid to concentrate flow (to maintain a weed free corridor and flush fine sediments), and encourage trapping and treating of sediment and contaminants along the vegetated channel margins (Figure 30);
- Reshaping banks to create benches for wet edge and bank planting (Figure 31 & Figure 32); and
- Reshaping the bed and banks to create a "two-stage" channel to concentrate flow in a narrow low flow channel and trap and treat sediment and contaminates and provide more floodway capacity in the high flow channel (Figure 33).

The first option was discussed and costed in the previous section on removing sediment from waterways. The second option is a modification to this approach where the fine sediment is removed with a digging bucket, and gravel is pushed out of the channel onto the margins as part of creating shallow pools and riffles. This will deepen the channel (requiring resource consent unless a global consent is granted for this purpose) to concentrate flow and flush fine sediment from within the bed with the disturbance. To be conservative, and incremental cost of $1.60 per linear metre could be added to the stream cleaning cost discussed earlier.

Performance Standards

Hudson (2005) describes three drainage maintenance performance standards. In summary these are:

Hydraulic efficiency:

To maintain drainage outfall as cost effectively as possible, with a focus on how maintenance improves outfall to provide the required level of service, not how much drain was cleaned.

Agricultural productivity:

The value of various levels of hydraulic efficiency should be related to agricultural productivity, and maintenance geared to provide a cost effective level of drainage.

Environmental performance:

The focus is to meet sediment and water quality standards, conserve and protect flora and fauna, and manage for multiple purposes where appropriate.

On the channel margins fine sediment will over time accumulate as vegetation grows and trapping is enhanced. If sediment deposition reaches a point where channel capacity impacts the hydraulic **performance standards** (see text box), the sediment can be removed.

Reshaping banks to create a planting bench for (Figure 31) is discussed in section 7.5 Riparian planting - buffers. The ball park cost for excavation is ~$1.00 to $5.00 per linear metre (when undertaken with recommended sediment removal works), with a single row of carex secta costing ~$8-$10 per linear metre over short lengths.

Banks could be further reshaped by pushing material and vegetation into the existing channel ("bank sliding" in Figure 32). This would provide an edge buffer and constrict the stream. Marginal plants would be planted along the wet edge. Shrubs and trees would be planted upslope for erosion protection.

Bank sliding may be a viable option as part of the channel reshaping discussed earlier. The incremental cost of bank sliding is probably in the same ball park as drain cleaning ($1.60 per linear metre). Planting costs would have to be factored in. Wet edge planting is estimated to cost $5.50 to $8.50/m^2 for large areas (Fletcher & Hudson 2016).

As discussed in Hudson (2005), significant increases in channel capacity can be achieved by multi-stage (compound) channel designs in unconfined streams (Brookes 1989; Brookes & Shields 1996: RRC 2002) and in restricted corridors in urban areas (Ellis & House 1994). Increasing the high flow channel width increases channel capacity, while retaining a relatively narrow low flow channel is essential for aquatic fauna. Works can be undertaken on the floodplain with

minimal disturbance to the existing low flow channel (Brookes 1989). Similarly, bank reshaping can be used to increase channel capacity and to increase channel stability and suitability for vegetation control.

In the two stage channel illustrated in Figure 33, the overall channel corridor is somewhat widened (by about the bank height), upper bank slopes are steepened (if corridor width is limiting) and a bench is cut. As a result, the floodway capacity increases, which decreases the bank erosion potential of the waterway. The low flow channel supports aquatic life, and the shallow marginal bench accommodates flood flows and supports emergent and wetland plants in addition to providing locations for small linear ponds for habitat diversity and contaminant filtering.

Costs for significant works of this nature have not been estimated for a rural environment in New Zealand. However, in town, the Northbrook enhancement at Ward Park stream realignment, secondary channel benching and slope battering cost ~$250 per linear metre (WDC, written com.).

A multi-stage channel design was employed in Ritobäcken Brook, Finland, which is a similar size to the Cam River Bramleys Road reach. The Brook required frequent dredging, had very unstable banks causing erosion and sedimentation, had limited floodway capacity causing flooding and poor habitat (Restore 2013). The benefits were reduced flooding risk, bank stabilisation with vegetation, lower maintenance cost as dredging and vegetation management is no longer required, improved water quality and habitat. The cost for Ritobäcken Brook in 2010 was €15,000 with €2,500 planning cost for an 800 m length of channel. The extent of significant excavation is not specified. It is noted that the excavated bank material (2,500 m^3) was transported to nearby arable land to fill in the lowest areas. This equates to ~$30 per linear metre. Planting costs were not included.

7.3.3 Conclusions: bank stabilisation and reshaping

Bank stabilisation is recommended for the 15 eroding banks identified by ECan, with potentially a few other sites. Eroding banks are localized in extent. Assuming works are undertaken over an average 20 m length of bank, excavation and replanting could be undertaken for $10,000 to $15,000.

Extensive removal of surface and subsurface fine sediments has been recommended. If this were coupled with reshaping the channel from a flat-bed trapezoid to concentrate flow and create a frequently wetted edge, the incremental cost is estimated as $1.60 /Lm. For the 7,800 m of bed recommended for cleaning this would cost ~$12,500.

Bank sliding is an alternative approach to achieve a partial two-stage channel, with linear wetlands, but this has yet to be investigated in New Zealand. Uncertainties relate to bank stability following bank sliding and whether banks with revegetate naturally with desirable species or if planting is required. Testing is recommended. Excavator costs are estimated to be in the same ball park as drain cleaning ($1.60 per linear metre); with wet edge planting costs of $5.50 to $8.50/$m^2$. Several test reaches, each of 100 m length, would have a ball park cost of ~$1,000 per reach. If this proves cost effective and environmentally beneficial, the cost to undertake the remaining ~7,000 m of channel would be ~$70,000.

Costs for a fully developed two stage channel are uncertain and should be investigated. A showcase trial is recommended, such as continuing stream rehabilitation from Railway Road to below Marsh Road on South Brook (~175 m); and/or North Brook at Marsh Road (~75 m upstream and ~75 m downstream). At tentative budget of $50 per linear metre is suggested.

7.4 In channel habitat structures

The starting position is that the Three Brooks, upper Cam River and drains are highly modified, or artificial, and were designed to convey stormflow efficiently and to dewater extensive poorly drained soils usually in a flat bottom trapezoidal channel. Instream woody debris, logjams and snags are removed for hydraulic efficiency. As a result the waterways have very poor instream and riparian habitat.

As noted by Allibone & Hudson (2015), the objective is to create instream conditions that provide habitat for both the desired fish community, and also habitat for prey items for these species. This includes resting and feeding habitat, spawning habit for some native species and migrations requirements. Taylor & McCaughhan (2012) identify species of ecological importance, such as lamprey (clean gravels; marginal soft herbs in silt banks), longfin eel (bank refugia, overhead cover, clean gravel, pools and riffles), common smelt (no cover requirements), inanga (spawning occurs much further downstream), giant kokopu (logs, tree roots, overhanging vegetation), koura (soft sediment waterways with stable banks for burrows), and brown trout and Chinook salmon (spawning gravels).

In addition to the pools and riffles discussed previously, that will address many of these needs, there are a variety of instream and bank aquatic habitat structures that would add diversity to the waterways. Two of particular relevance are large wood debris (LWD) and flow deflection structures (Allibone & Hudson 2015).

The restoration of LWD has become common in North American and also in Australia. These actions also recognise that if restoration is left to natural process the colonisation and growth of trees to a size that will provide LWD to rivers and stream is a process that will take decades or longer. Therefore, typically riparian plantings are undertaken to re-establish the bank side vegetation and tree trunks and stumps with roots wads are placed in the waterway.

To prevent flood events removing the LWD, the logs are partially buried in the stream banks and anchored by partial burial or rope tie downs. ECan has considerable expertise in this area.

Flow deflection structures include boulder clusters placed in the waterway, and wood or rock groynes extending from the bank downstream to form an open ended V shape, and channel constrictions (Figure 34). These structure act as partial dams while still allowing fish passage, raise water levels and creates fast sections of flow and provide habitat and detritus. CAREX is investigating these structures in lowland streams and may provide estimates of cost and effectiveness.

It is recommended that these options are discussed by the Cam River Enhancement Subcommittee.

A significant element of the proposed rehabilitation is with habitat improvements in the riparian zone and the infall of plant material – leaves to whole trees to provide food and fish cover. This is discussed in the next section.

7.5 Riparian planting - buffers

Extensive riparian planting has been undertaken in lowland streams across Canterbury, and throughout New Zealand, with a broad range of purported

benefits.[22] Often however, benefits are incidental, because planting is often more aesthetically driven than focused on addressing particular issues or habitat requirements (Table 5).

As described in detail in Hudson (2005), plants should be selected based on the purpose of the planting (e.g. biodiversity, erosion control; contaminant trapping; shading), the bank shape (profiles) and how frequently the zones are flooded. This ranges from the "margins" that are continuously wet (they intercept the groundwater table and are flooded by streamflow), to frequently wet lower bank zones; to stopbanks and upland fringe zones that are flooded infrequently.

For the Kaiapoi River rehabilitation Hudson & Fletcher (2015) based recommendations on Landcare Research guides[23] and in consideration of the Mahaanui Iwi Management Plan (2013) that includes provision for the ongoing protection and restoration/enhancement of mahinga kai, source to sea fish passage, catchment management, and establishment and maintenance of indigenous planted riparian zones. The Christchurch City Council (2005) guide "Christchurch City and Lowland Canterbury Streamside Planting" (which is based on the advice of Dr Meurk), to specify plants for different parts of the river profile (Table 6). This approach is recommended for the Three Brooks and upper Cam.

Locally sourced, assemblages of plants are recommended. Streamside planting would be established along the edge of the channel and up the bank following the pattern illustrated in Figure 12 and Figure 35. The first priority is to establish ground cover on disturbed areas (e.g. hydro-seeding grass). In a short time the grass will provide a high degree of protection against streamflow and surface wash (rainsplash and runoff). The additional step is to establish marginal plants such as rushes, flax and toitoi; and shrubs and trees progressively further up the bank. Upland planting is also recommended to provide a bio-diverse stream corridor. Deep rooted plants may be required on benches and side slopes to control mass failure and provide additional erosion resistance in the event of channel migration.

Streamside planting has to be carefully planned to allow excavators to gain access to the creek and to be able to reach over or around planting to maintain the channel if required. However, the expectation is that the channel will be self-sustaining with minimal or no intervention required over the long term.

Environmental benefits of the selected plants were summarised from the Landcare factsheets and database by Hudson & Fletcher (2015). For example, *Schoenoplectus tabernaemontani* (Kāpūngāwhā, bulrush, club-rush) is a tall, spiky, sedge found in shallow, freshwater and estuarine habitats and on the margins of rivers and wetlands. Growth is seasonal with stems dying back over winter. The traditional use of the dried stems is for plaiting mats and baskets. Kāpūngāwhā is tolerant of pollutants, growing vigorously in nutrient-enriched water, and taking up and storing large quantities of nutrients, particularly nitrogen and phosphorus. These characteristics, and its ease of propagation, have made this plant popular for use in artificially constructed wetlands for treatment of sewerage and agricultural wastewater in New Zealand and overseas. Similarly, *Eleocharis acuta* (spike sedge) is a perennial spreading sedge with slender creeping rhizomes, and is an excellent nutrient stripper and soil stabiliser.

Streamside buffers have been proven effective in trapping sediment. Specifically, a steep decline in surface erosion and delivery is expected with

[22] http://www.doc.govt.nz/Documents/conservation/native-plants/Streamside-planting.pdf

[23] Dr Colin Meurk developed comprehensive guides which are widely used. http://natureservices.landcareresearch.co.nz/app/ (accessed April 2017)

increasing ground cover. This is illustrated in an application of the Universal Soil Loss Equation (USLE) where a river bank situation is simulated for default rainfall and soil characteristics, with a no till bank with a 1:4 slope (25%), 3 m long with 0 to 95% grass cover. Erosion decreases exponentially with grass cover increasing from 0 to 95%, with a 97% explanation (Figure 36).

CAREX has presented results of soil loss against percent ground cover for some lowland streams. There is a low degree of explanation (22%), a much flatter decline in sediment inputs to a stream, with a considerable amount of variance (several orders of magnitude) for 10% cover for 5 cases. The results are presented without detailed explanation.

In my opinion, two factors play a critical role in determining effectiveness of buffers:

- Considerably wider buffers are required as the rate of erosion from the contributing area increase (Table 4); and
- Different types of cover provide different degrees of buffering for different situations (Table 5).

Design of riparian buffers should take these factors into account.

To this point, as noted earlier, much of the riparian planting has been aesthetically driven, and attempting to do the right thing. Future planting should be more context driven and purpose driven. For example, experiments on shading by CAREX are useful regarding macrophytes, but results suggest shading may provide shelter that encourages growth. Further, shading for stream temperature moderation does not appear to be required in the spring fed Three Brooks and upper Cam based on reported stream temperatures which are relatively low and relatively steady.

A major issue facing the Cam Enhancement Subcommittee is related to the degree of support, and type of support, that can or should be offered to landowners or other stakeholders who could or should undertake riparian planting. The conundrum is that there is a paucity of native riparian planting but that riparian planting could consume the entire Can Enhancement budget.

Planting of wet edge and bank vegetation often requires bank shaping. Greg Bennett[15] indicated costs of ~$5.00 per linear metre of bank for Middle Brook (bank height of ~1.5 m). As discussed previously, planting costs range from ~$5.50 to $8.50 per square metre. For an hypothetical 1.5 m bank, for a 1:1 slope ~2.0 m^2 /Lm of planting is required and for a 1:2 slope ~3.4 m^2 /Lm of planting is required. The low end cost would be ~$16.50 and high end ~$34 /Lm. For each $10,000 about 300 m to 600 m of 1.5 m high bank could be reshaped and planted with an assemblage of appropriate species.

Recommendation areas follow:

- Provide non – financial support to landowners or other stakeholders who wish to plant (e.g. support applications to the Intermediate Steps and Biodiversity funds);
- Target financial support to otherwise unfundable sites and/or high profile sites (e.g. where public walkways or cycleways are intended);
- Fund, or co-fund, riparian planting for bank stabilisation works that have been identified earlier; and
- Fund, or co-fund, riparian planting for the two stage channel trial, which was discussed earlier.

8 Conclusions and recommendations

A review of issues and options provides the Cam River Enhancement Subcommittee with an opportunity to cherry pick through a range of management measures and specific actions to enhance the Three Brooks and upper Cam River. The actions, potential benefits, and indicative costs, have been outlined. Costs are for construction and do not include management costs such as resource consents, planning, supervision and monitoring and assessment.

Priorities remain:

- Avoid generating excessive runoff, soil erosion and contaminants through appropriate land management practices as a prerequisite;
- Control the transfer of sediment and contaminants between sources and waterways;
- Trap and treat sediment and contaminants in waterways to stop downstream transfer; and
- A regional or district global resource consent, with appropriate conditions, is required to facilitate habitat rehabilitation in stream corridors.

Some of the recommend actions are well established. Notably, a major issue is excessive fine sediments in and on the stream beds. This issue can be addressed by enforcement of livestock exclusion rules in problem areas, better land management, and more specific to the Cam Enhancement fund, trapping and treating sediments and contaminants and removing sediments from waterways. Specific actions and indicative costs are as follow (there is no provision for resource consent costs, organisation or supervision):

Trapping and treating sediment and contaminants:

- Sediment traps: 14 additional traps and enhancement of an existing pond, at an indicative cost of ~$1,000 to ~$2,000 each;
- Mini wetlands at tile drain outfalls: sites are to be identified, at an indicative cost of ~$1,000 to ~$1,900 each;
- Constructed wetlands: conventional constructed wetlands are prohibitive in terms of cost and land area – a trial of 3 smaller drainage wetlands is recommended at an indicative cost of ~$1,300 to ~$2,400 each; and
- Bioreactor trials are underway, with unknown cost and effectiveness in lowland streams with relatively high flows.

Sediment removal from the stream channel is recommended, using a combination of three approaches, starting in headwater streams where possible, and moving downstream:

- Removal of surface fine sediment from 7,800 m of waterway with excessive fine sediment cover with conventional drain cleaning by hydraulic excavator ~ $20,000;
- Removal of surface and shallow subsurface (~100 mm) fine sediment from 7,800 m of waterway (~25,000 m^2) with excessive fine sediment cover by sand wand ~$75,000; and
- Experiment with bed raking to remove surface and deep subsurface (~300 mm) fine sediment from 7,800 m of waterway with excessive fine sediment cover and create more habitat diversity (shallow pools and riffles) ~$40,000.

Bank stabilisation, bed and bank reshaping:

- Bank remediation, with reshaping and riparian planting, of 15 sites ~$10,000 to $15,000;
- Creation of pools and riffles with bed raking (above) coupled with reshaping the channel from a flat bottom trapezoid to concentrate flow in a V shaped channel over the 7,800 m reach ~$12,500;
- Bank reshaping opportunistically at ~$1.00 to $5.00 /Lm when undertaken with recommended sediment removal, with a single row of carex planting at $8-10 /Lm (over small lengths);
- Bank sliding trial to create a constricted low flow channel with linear wetlands, over several 100 m test reaches at an indicative cost of $1,000 per reach. If this is successful extend the trial to the remaining 7,000 m of channel where sediment removal is planned at an indicative cost of ~$70,000; and
- Two stage/compound channels, undertake two trials over ~ 175 m on South Brook and ~150 m on North Brook, at a tentative budget of $50 per linear metre (~$16,000).

In channel habitat structures:

- Trials are underway, with large woody debris and boulder clusters, with unknown cost and effectiveness in lowland streams.

Riparian planting is often more aesthetically driven than focused on addressing particular issues or habitat requirements. Specific recommendations are made regarding planting. There is a huge opportunity to improve riparian condition, but at a very large cost. For each $10,000 about 300 m to 600 m of 1.5 m high bank could be reshaped and planted with an assemblage of appropriate species. Direct funding might be directed to otherwise unfundable sites and/or high profile sites (e.g. where public walkways or cycleways are intended as discussed in the Vision Statement (appended).

An option for riparian rehabilitation that should be trialed, that may greatly reduce costs, is seeding rather than planting.

Once the overall integrated catchment management plan has been implemented, and measures are in place to avoid and control the generation and delivery of sediments and contaminants to waterways, the importance of sediment traps will decline with time. This will be some years from now as the legacy sediment are cleaned up. Removal of fine sediment legacy deposits should be one-off operations, unless something catastrophic occurs in the catchment.

9 Acknowledgements

The support and feedback from the Cam River Enhancement Subcommittee, and Waimakariri District Council (in particular Janet Fraser and Greg Bennett) is greatly appreciated. A major contribution to the understanding of river corridor condition in the Three Brooks and Tuahiwi Stream is the updated, and more sophisticated, “Stream walk” trial by ECan. I greatly appreciate discussions, and the collection and provision of this information, by Andrew Arps, Jarred Arthur, Duncan Gray, Anna Veltman, and other members of the team. Anna also kindly provided a number of helpful comments and corrections in the report. Janet and Greg, and Owen Davies and Kalley Simpson of WDC provided very useful discussion on the draft report.

10 References

Allibone RM, Hudson HR. 2015. Waituna Creek restoration options. Water Ways Consulting Ltd and Environmental Management Associates Ltd Report 11-2015 for Department of Conservation. 37 pages.

Bennett G. 2012. Low impact drainage maintenance in the Waimakariri District. Water New Zealand Stormwater Conference 2012. 12 pages.

Brookes A. 1989. Alternative channelization procedures. Pages 139-162 Gore JA, Petts GE, editors, Alternatives in Regulated River Management. CRC Press, Boca Raton, Florida.

Brookes A, Shields Jr. FD. 1996. Towards an approach to sustainable river restoration. Pages 385-402 in Brookes A, Shields Jr. FD, editors, River channel restoration: guiding principles for sustainable projects. John Wiley and Sons.

CCC. 2005. Christchurch City and Lowland Canterbury Streamside Planting. Christchurch City Council.

Christianson LE, Bhandari A, Helmers MJ, Kult KJ, Sutphin T, Wolf R. 2012. Performance evaluation of four field-scale agricultural drainage denitrification bioreactors in Iowa. Agricultural and Biosystems Engineering Publications. 307.

Clapcott JE, Young RG, Harding JS, Mathael CD, Quinn JM, Death RG. 2011. Sediment assessment methods. Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand. 108 pages.

ECan. 2003. The Cam River: an assessment of water quality and ecosystem health monitoring, 1992-2001. Environment Canterbury Report R03/17. (This report is referenced as Main MR & Lavender R. 2003 by Golder Associates).

Ellis JB, House MA. 1994. Integrated design approaches for urban river corridor management. Pages 311-323 in Kirby C, White WR, editors. Integrated river basin development. John Wiley & Sons, Chichester, UK.

EOS Ecology Ltd. 2005: Ecological assessment of Rangiora's Three Brooks. Prepared for Waimakariri District Council, December 2005.

FISRWG. 1998. Stream corridor restoration – principles, processes, and practices. Federal Interagency Stream Restoration Working Group, Natural Resource Conservation Service, United States Department of Agriculture, Washington, DC. 547p.

Fletcher DA, Hudson HR. 2016. “Kaiapoi River Rehabilitation Stage 1a - Sediment trap, bank reshaping and drainage wetland design concepts. Tonkin & Taylor Ltd and Environmental Management Associates Ltd Report 53720.001 for Waimakariri District Council | Kaiapoi River Rehabilitation Working Party.

Gerard, R. 2002. Cam River restoration project progress report April 2002. Unpublished report, Resource Care Section, Environment Canterbury. 65 pages.

Goeller B, Febria C, Warburton H, Devlin H, Harding J, McIntosh. A. 2016. Solving nutrient problems in Canterbury agricultural waterways. Abstract. Joint Conference of the Society for Ecological Restoration Australasia and the New Zealand Ecological Society. Hamilton, New Zealand.

Golder Associates. 2008. Rangiora ICMP stage one: Ecology of the Three Brooks. Report prepared by Golder Associates (New Zealand) Limited for Waimakariri District Council.

Golder Associates. 2015. Harts Creek: stream assessment. Golder Associates Report 1478110197-003 for Environment Canterbury. 84 pages.

Gray DP. 2013. Fine sediment removal from streams: environmental effects, protocols and a proposed rule. Environment Canterbury Report R13/95.

Gray DP, Taylor M, Moore E, Pohe S, Barbour S. 2013. A trial of fine sediment removal using the Sand Wand^{TM}: efficacy and impacts. Environment Canterbury Report R13/96.

Greer M, Meredith A. 2016. Waimakariri Zone water quality and ecology: State and trend. Environment Canterbury Report R12/68. 86 pages.

Harding J, Glenjarman NPC, Febria CM, Hogsden KL, McIntosh AR. Undated. CAREX: Trialling sediment traps and the sand wand to remove excessive fine sediments in agricultural waterways. CAREX Poster 2 sediment tools, School of Biological Sciences, University of Canterbury

Hewson D, Hudson HR. 2000. Guidelines for cleaning waterways. Environment Canterbury Information Sheet No. 6.

Hudson HR. 1999. Cam River sediment source investigation: an evaluation of diagnostic properties of sediment sources. Environmental Management Associates Report 99-04 for Canterbury Regional Council. 15 pages.

Hudson HR. 1999. Lower Cam River sediment sources. Environmental Management Associates Report 99-05 for Canterbury Regional Council. 53 pages.

Hudson HR. 2000. Naturalisation of drainage channels. Environmental Management Associates Report 200-14 for Environment Southland. 28 pages

Hudson HR. 2002. Linking the physical form and processes of rivers with ecological response (keynote paper). Pages 121-142 in Dyer FJ, Thoms MC, Olly JM, editors, The Structure, function and management implications of fluvial sedimentary systems. IAHS Publication 276. http://hydrologie.org/redbooks/a276/iahs_276_121.pdf

Hudson HR. 2002. Development of an in-channel coarse sediment trap best management practice. Environmental Management Associates Report 2002-10 for Ministry of Agriculture and Forestry Project FMP 500 Drainage Systems and Impacts.

Hudson HR. 2005. Sustainable drainage management field guide. New Zealand Water Environment Research Foundation, Wellington. 24 pages and appendices. www.wet.org.nz/wp-content/uploads/2012/03/**fieldguide**_final.pdf

Hudson HR. 2005. H20-DSS Hillslopes to Oceans: Decision Support System for sustainable drainage management. New Zealand Water Environment Research Foundation, Wellington

Hudson HR. 2010. Cam River rehabilitation issues and options. Environmental Management Associates, Christchurch. Report 2010-03 for Waimakariri District Council. 112 pages.

Hudson HR. 2013. Drainage rehabilitation and low impact development: issues and options for Maori Reserve 873. Environmental Management Associates, Christchurch, Report 2013-01 for Waimakariri District Council. 46 pages

Hudson HR, Harding JS. 2004. Drainage management in New Zealand: A review of existing activities and alternative management practices. *Science for Conservation 235*. 39 p. http://www.doc.govt.nz/upload/documents/science-and-technical/sfc235.pdf

Jowett IG, Parkyn SM, Richardson J. 2008. Habitat characteristic of crayfish (Paranephrops planifrons) in New Zealand streams using generalized additive models (GAMS). Hydrobiologia 596: 353-364.

Karssies LE, Prosser IP. 1999. Guidelines for riparian filter strips for Queensland irrigators. CSIRO Land and Water, Canberra. Technical Report 32/99. 39 pages.

Mahaanui Kurataiao Ltd. 2013. Mahaanui Iwi Management Plan. http://www.mkt.co.nz/iwi-management-plan/

Meredith AS, Hayward, SA. 2002 An overview of the water quality of the rivers and streams of the Canterbury region. Environment Canterbury Technical Report R02/25. 34 pages.

NRC (National Research Council). 1992. Restoration of aquatic ecosystems: science, technology and public policy. National Academy Press. Washington DC. 552 pages.

Petersen RC, Petersen LBM, Lacoursiere J. 1992. A building-block model for stream restoration. Pages 293-309 in Boon PJ, Calow P, GE. Petts GE, editors, River Conservation and Management. John Wiley & Sons Ltd.

Restore. 2013. Rivers by design. Partners of the Restore Project. Environment Agency, Bristol, UK. 44 pages.

Robertson WD, Merkley LC. 2009. In-stream bioreactor for agricultural nitrate treatment. Journal of Environmental Quality 38: 230-237.

RRC. 2002 Manual of river restoration techniques RRC web addition. River Restoration Centre, Silsoe, UK.

Rutherford K, Wheeler D. 2011. Wetland nitrogen removal modules in Overseer. http://flrc.massey.ac.nz/workshops/11/manuscripts/Rutherford_2011.pdf

Suren A, Elliot S. 2004. Impacts of urbanization on streams. Pages 35.1-35.17 in Harding J, Mosley P, Pearson C, Sorrell B. editors, Freshwaters of New Zealand. New Zealand Hydrological Society and New Zealand Limnological Society.

Tanner CC, Sukias JPS, Yates CR. 2010. New Zealand guidelines: Constructed wetland treatment of tile drainage. NIWA Information Series No. 75 National Institute of Water & Atmospheric Research Ltd.

Tanner CC, Sukias JPS. 2011. Multiyear nutrient removal performance of three constructed wetlands intercepting tile drain flows from grazed pastures. Journal of Environmental Quality 40: 620-633.

Taylor MJ. 2005. An update of trout spawning in the Cam River. Aquatic Ecology Limited, Christchurch, Report No. 33. 36 pages.

Taylor MJ, Marshall W. 2013. Silt removal trial from Wairarapa Stream: 12 April 2013. Environment Canterbury Report R13/117.

Taylor M, McCaughan H. 2012. Compilation of important ecological areas in the Waimakariri District. Aquatic Ecology Ltd. Report 99 for Waimakariri District Council. 38 pages.

11 Report limitations

The information in this report and any accompanying documentation is accurate to the best of the knowledge and belief of the Consultant acting on behalf of Waimakariri District Council (WDC). While the Consultant has exercised all reasonable skill and care in the preparation of information in this report, neither the Consultant nor WDC accept any liability in contract, tort or otherwise for any loss, damage, injury or expense, whether direct, indirect or consequential, arising out of the provision of information and advice in this report.

Tables

Table 1 Sediment related management measures and best management practices (Hudson 2005)

Problem	Management measure	Best management practice
Sediment build up in the channel	remove sediment deposit	• channel excavation • work windows • coarse sediment trap
Sediment movement downstream	control sediment transport	• grassed waterways • sediment traps • instream filters
Upland erosion	on-farm soil loss control	a large range of practices are available including: - cropping management practices: • conservation tillage • contour strip-cropping • conservation cropping sequence • cover control - stock management practices: • stock & waterways • rotational crazing - water and sediment control practices: • grassed waterways • interceptor drains • critical area planting • control basins • terraces
	off-farm loss control	• filter strips • field borders • wetlands
Bed erosion	grade stabilization	• drop structures – weirs • vanes • deflectors • placement of large organic debris
	bed stability	• stock & waterways • restricted access watering points • stream crossings
Bank erosion	lateral erosion protection	• streamside vegetation • bank reshaping • multi-stage floodways • anchored trees • rip rap • groynes • retards • flow deflectors
	bank stability protection	• streamside vegetation • bank reshaping • stock & waterways • vegetation (weed) control
	surface wash protection	• rehabilitating land • grassed waterways • stock & waterways • farm tracks

Table 2 Key questions in decision making (Hudson 2005)

Key questions in decision making

1. What is the problem?
   A clear identification of the particular problem(s) is a prerequisite to any management intervention.
2. What are the causes?
   There may be multiple causes of a particular problem. The sources, and magnitude and frequency of contribution to the problem must be identified to prioritise actions. Management should always try to address the causes of a problem. Treatment of effects without addressing the causes may result in expensive, repetitive actions that are unsustainable and unsuccessful.
3. What is the objective?
   Have a clear idea of what you have to achieve both locally (e.g. removing sediment) and at a reach (e.g. general channel instability) or perhaps catchment scale (e.g. changing land use). Check if these objectives are realistic and will bring a demonstrable benefit.
4. Is intervention required?
   In some cases indirect actions may solve the problem. E.g. local bank failures may stabilise and the blockage may be naturally removed by streamflow if livestock grazing on the banks is controlled.
5. What are the most appropriate methods to relieve effects and to achieve a long term solution?
   The choice of management practices and the location and timing of operations will determine the success of the project and likely impacts.
6. Is consultation and resource consent required?
   Early and extensive consultation with relevant regulatory authorities, interest groups and individuals is crucial. Obtain the required authorisations.
7. Are there negative local impacts?
   Think what other activities might be indirectly or inadvertently affected. E.g. riparian planting may prevent access for future drainage management; using heavy equipment to clear a channel may cause land disturbance and loss of farm productivity.
8. What effects might the works have elsewhere?
   Actions in part of a waterway may have impacts upstream (e.g. erosion with channel excavation), downstream (e.g. sediment plumes) or laterally (e.g. de-watering wetlands).
9. When is the best time to undertake work?
   Some emergency works have to be undertaken immediately. Routine maintenance should avoid sensitive times and places for fish and animals. Use the most effective period for weed management (which is often not when weeds are causing a problem). Flood or erosion risk should also be considered.
10. What are the chances of success and risks of failure of the proposed actions?
11. What are the risks of no intervention?
12. Is help or consultation required?

Table 3 Habitat characteristics of three Brook sampling site in base flow conditions (Golder Associates 2008b)

Site	Depth (m)	Width (m)	Velocity (m/s)	Shade (%)	Macrophyte cover (%)	Filamentous algae[1] (%)
North Brook						
N1	0.3	2.0	0.0	25	100	60
N2	0.75	0.1	0.2	70	1	10
N3	0.14	2.1	0.7	50	10	5
N4	0.35	3.3	0.8	70	40	5
N5	0.6	1.2		25	20	25
N6	0.3	3.1	1.0	30	40	0
N7	0.5	2.0	0.5	50	5	0
N8	0.4	4.3	0.6	0	65	0
N9	0.6	4.0	0.6	0	80	25
Middle Brook						
M1	0.08	1.8	0.6	60	0	0
M2	0.12	1.6	0.5	70	0	0
M3	0.1	2.0	0.3	40	20	70
South Brook						
S1	0.35	1.5	0.9	25	40	5
S2	0.3	1.8	0.9	10	10	0
S3	0.4	4.3	0.7	0	60	0
S4	0.28	1.9	0.8	30	10	0
S5	0.25	2.1	0.9	10	10	0

Comments: Velocity could not be measured at N5 due to sluggish flow and debris in the channel. % Filamentous algae is streambed cover with green filamentous algae >20 mm (i.e. nuisance growth).See Figure 2 for locations.

Table 4 Relationship between soil loss, slope and filter strip width for dispersed flow (from Hudson 2005, based on Karssies & Prosser 1999)

Soil loss (t/ha/y)	Filter strip slope (%) - filter width (m)									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
1	2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2	2
5	2	2	2	2	3	3	3	4	4	4
10	2	2	4	5	6	6	7	7	7	7
20	3	9	11	12	12	13	13	13	13	14
30	9	15	17	18	19	19	19	20	20	20
40	15	21	23	24	25	25	26	26	26	26
50	22	28	30	>30						
60	28	>30								
70	>30									

Table 5 Relative effectiveness of different buffer vegetation types in an agricultural setting (from Hudson 2005 based on Dosskey et al. (1997) and others)

Benefit	Vegetation type			
	Reeds	Grass	Shrub	Tree
Stabilise bank erosion	Low-High	Medium	High	High
Filter sediment	High	High	Low	Low
Filter nutrients, pesticides, microbes				
- Sediment bound	High	High	Low	Low
- Soluble	High	Medium	Low	Medium
Aquatic habitat (cover, food, shade)	High	Low*	Medium	High
Terrestrial habitat				
- Grassland species	Medium	High	Medium	Low
- Forest species	Low	Low	Medium	High
Visual diversity	High	Low	Medium	High
Flood attenuation	Low	Low	Medium	High
Economic products	Low	Medium	Low	Med-High

Table 6 Plants from Christchurch City and Lowland Canterbury streamside planting guide

Sedges, Rushes, Ferns and Ground Covers

		frost	sun	shade	wet	dry	wind	grazing (once established)	Aquatic Edge of stream Marsh	lower bank
pondweed	*Myriophyllum propinquum/triphyllum*	●	●	◗	●	◑	◑	●	A	
pondweed	*Potamogeton cheesemanii/ochreatus*	●	●	◗	●	◑	◑	●	A	
raupo	*Typha orientalis* (invades open water)	●	●	◑	●	◑	●	●	A E	
kapungawha, lake club rush	*Schoenoplectus validus/tabernaemontani*	●	●	◑	●	◑	●	●	A E	
spike sedge	*Eleocharis acuta*	●	●	◗	●	◑	●	●	A E M	
pukio, tussock sedge	*Carex secta/virgata*	●	●	◗	●	◑	●	◗	E M	■
makura	*Carex maorica/geminata*	●	●	◗	●	◑	●	●	E M	■
bog rush	*Schoenus pauciflorus*	●	●	◑	●	◑	●	●	E M	
swamp kiokio	*Blechnum minus*	◗	◗	●	●	◑	◗	●	E M	■
swamp nettle	*Urtica linearifolia*	◗	●	◗	●	◑	◑	●	E	■
puniu, prickly shield fern	*Polystichum vestitum*	◗	◗	●	●	◗	◗	◗	E M	■
harakeke, NZ flax	*Phormium tenax*	●	●	◑	●	◗	●	●	E M	■
tussock rushes, wiwi	*Juncus gregiflorus/pallidus/sarophorus*	●	●	◑	●	◗	●	●	E M	■
umbrella sedge, upoko-tangata	*Cyperus ustulatus*	●	●	◑	●	◗	●	◗	E	■
gully fern, pakauroharoha	*Pneumatopteris pennigera*	◑	◑	●	◗	●	◗	◗		■
nini	*Blechnum chambersii*	◑	◑	●	◗	◑	◑	●	E	
kiwakiwa	*Blechnum fluviatile*	◑	◑	●	◗	◑	◑	◗	E	
hen & chickens fern	*Asplenium bulbiferum*	◑	◑	●	◗	◑	◑	◑		
mata, water-fern	*Histiopteris incisa*	◑	◑	●	◗	◑	◑	●		■
rough pigfern	*Hypolepis ambigua*	◗	◗	●	●	◗	◗	●		■
toetoe grass, toetoe	*Cortaderia richardii*	●	●	◑	◗	●	●	◗		■
kakaha, bush lily	*Astelia fragrans*	◗	◗	●	◗	◗	◗	◑		■

Shrubs and Trees

		frost	sun	shade	wet	dry	wind	grazing (once established)	lower bank
mikimiki (shrub)	*Coprosma propinqua*	●	●	◗	●	●	●	●	■
cabbage tree, ti kouka	*Cordyline australis*	●	●	◗	●	●	●	◗	■
mikimiki (shrub)	*Coprosma pedicellata*	●	●	◗	●	◗	●	●	■
manuka, tea tree	*Leptospermum scoparium*	●	●	◑	●	●	●	●	■
kahikatea, white pine	*Dacrycarpus dacrydioides*	◗	●	◗	●	◑	◗	●	
pokaka	*Elaeocarpus hookerianus*	●	●	●	●	◑	●	●	
karamu	*Coprosma robusta*	◗	●	●	●	●	●	◑	
mikimiki (shrub)	*Coprosma* aff. *parviflora* (sp.t)	●	●	◑	●	◗	●	●	■
kohuhu, black matipo, tawhari	*Pittosporum tenuifolium*	●	●	◗	●	●	●	◗	
weeping mapou (shrub)	*Myrsine divaricata*	●	●	◗	●	◗	●	●	■

Figures

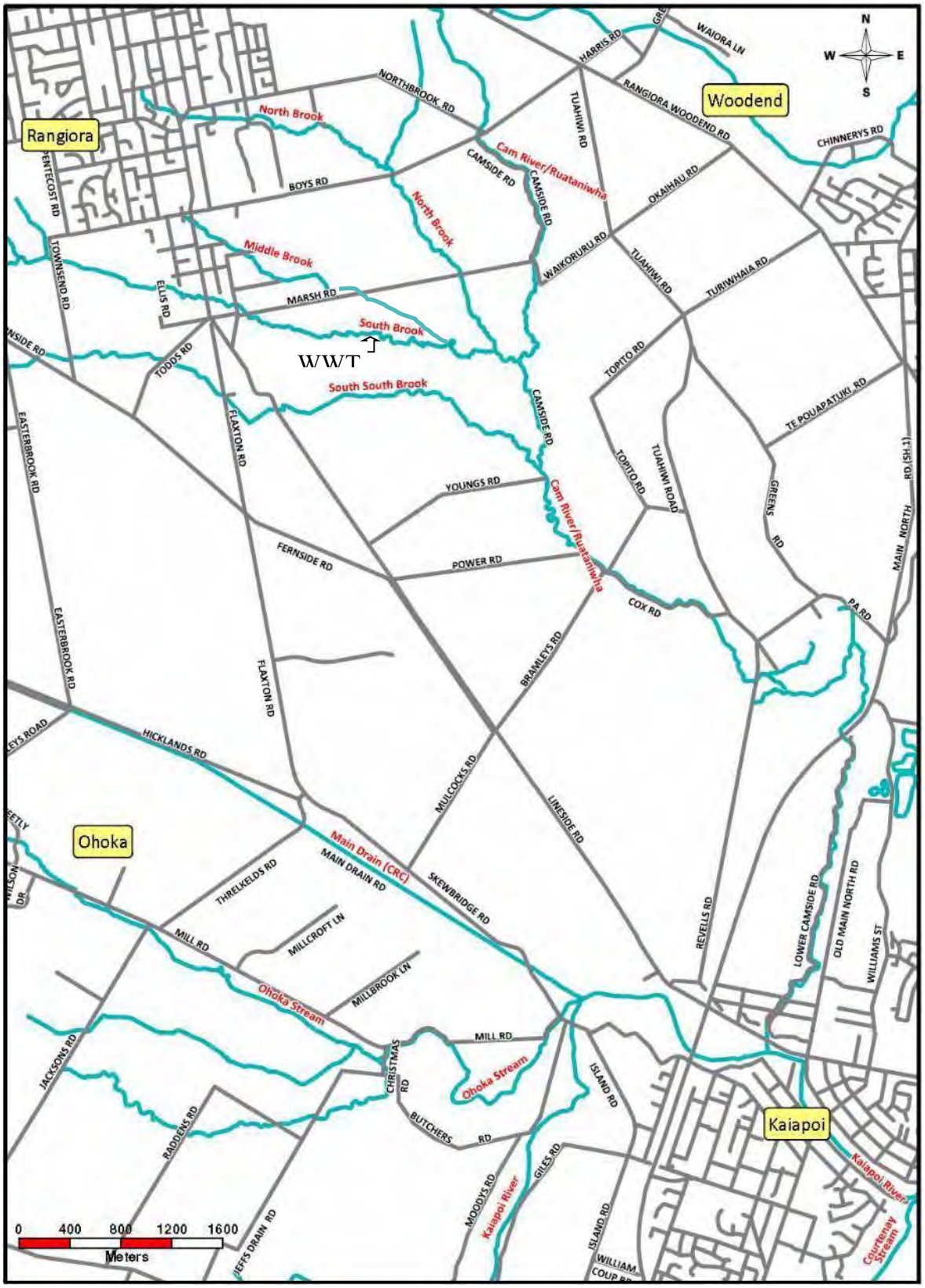


Figure 1 Geography of the Cam River catchment (WDC)

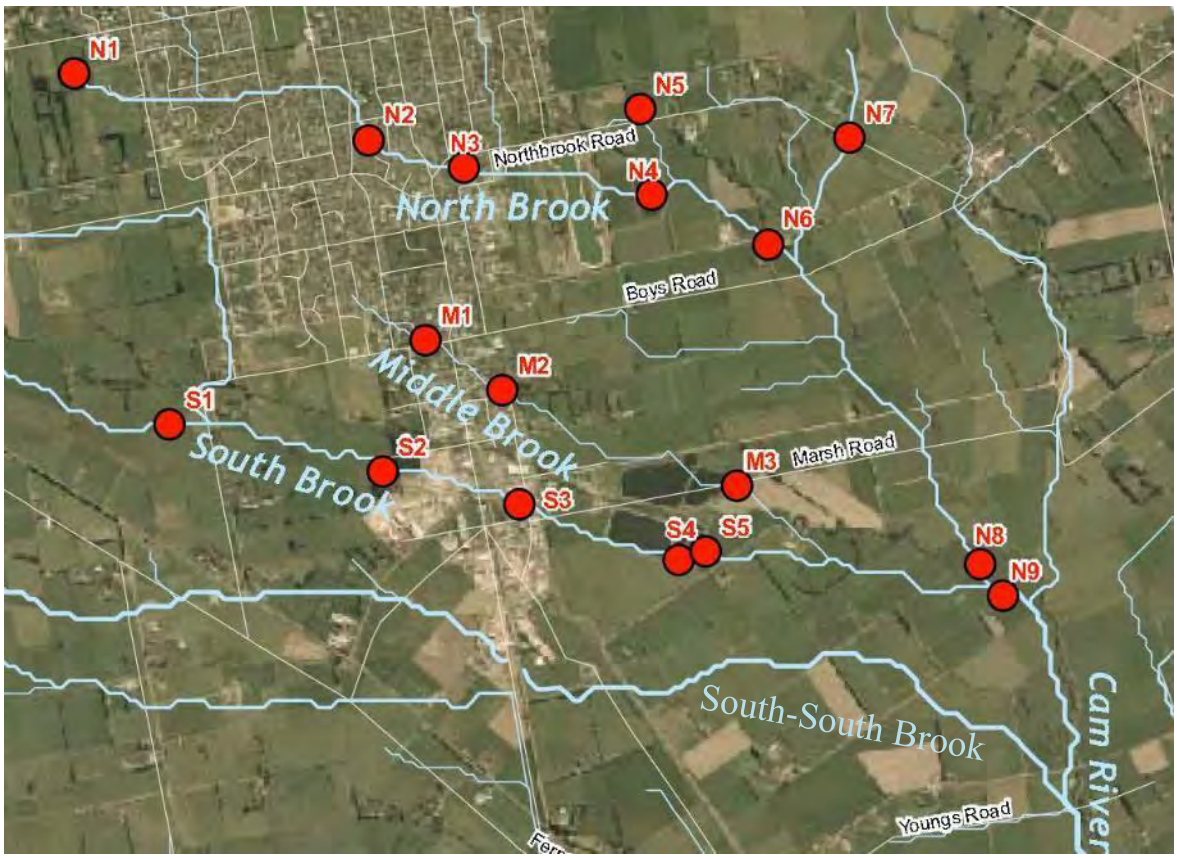


Figure 2 Three Brooks sampling sites (based on Golder Associates 2008)

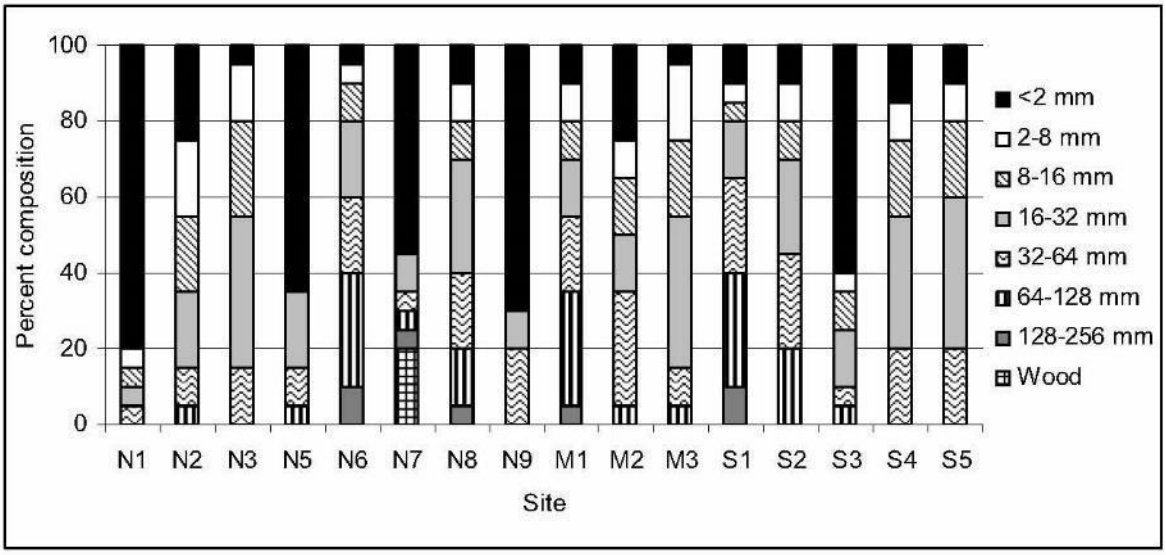


Figure 3 Composition of stream bed sediments in the Three Brooks (see Figure 2 for locations; Golder Associates 2008)

SQ34905 Cam River at Marsh Rd (CRM)

SQ30369 Cam River at Bramleys Road (CRB)

SQ34903 North Brook at Marsh Rd (NBM)

SQ30390 South Brook at Marsh Rd (SBM)

Figure 4 ECan sampling sites (based on Greer & Meredith 2016)

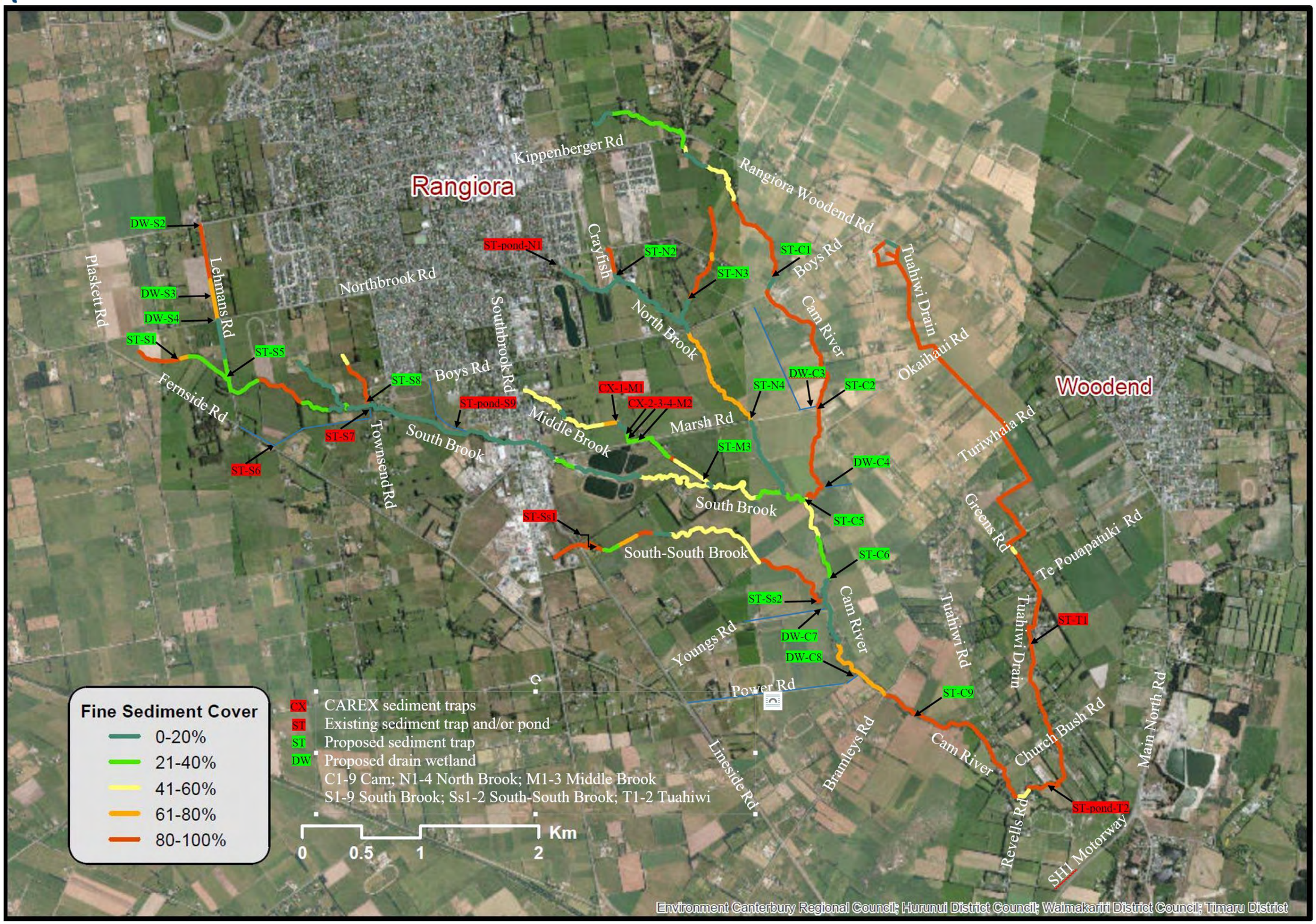


Figure 5 Fine sediment cover (map kindly provided by ECan) proposed & existing sediment traps & drain wetlands

Figure 6 Overland flow path for land surface drainage, North Brook tributary 1 at R1 in Figure A3: 2A (ECan streamwalk)

Figure 7 Overland flow path for land surface drainage, North Brook tributary 1 at R4 in Figure A3: 2A (ECan streamwalk)

Figure 8 Stock trampling bank collapse, view upstream Middle Brook above Dunlops Road at R15 (ECan streamwalk)

Figure 9 Toe scour and collapse, North Brook above Marsh Road at R4 in Figure A3: 2A (ECan streamwalk)

Figure 10 Over steepened banks can erode by dry ravel, South Brook above Buckleys Road at R22-23 (ECan streamwalk)

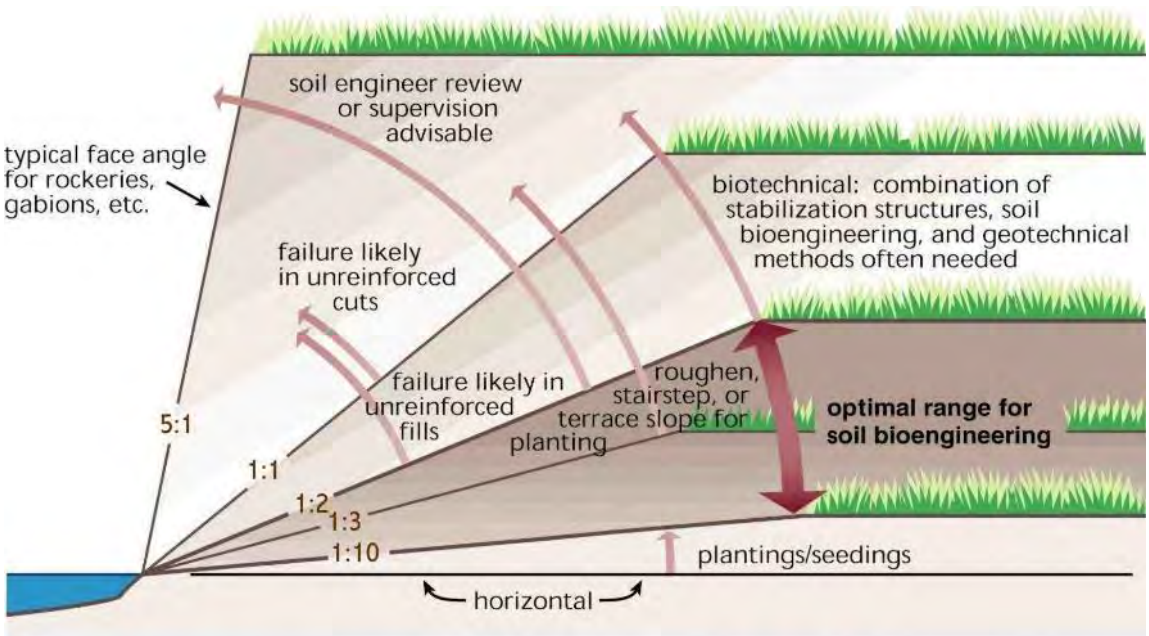


Figure 11 Bank reshaping: guideline (FISRWG 1998)

Comment Slope (rise/run), and bank height relative to rooting depth, are important factors in determining appropriate bank protection measures.

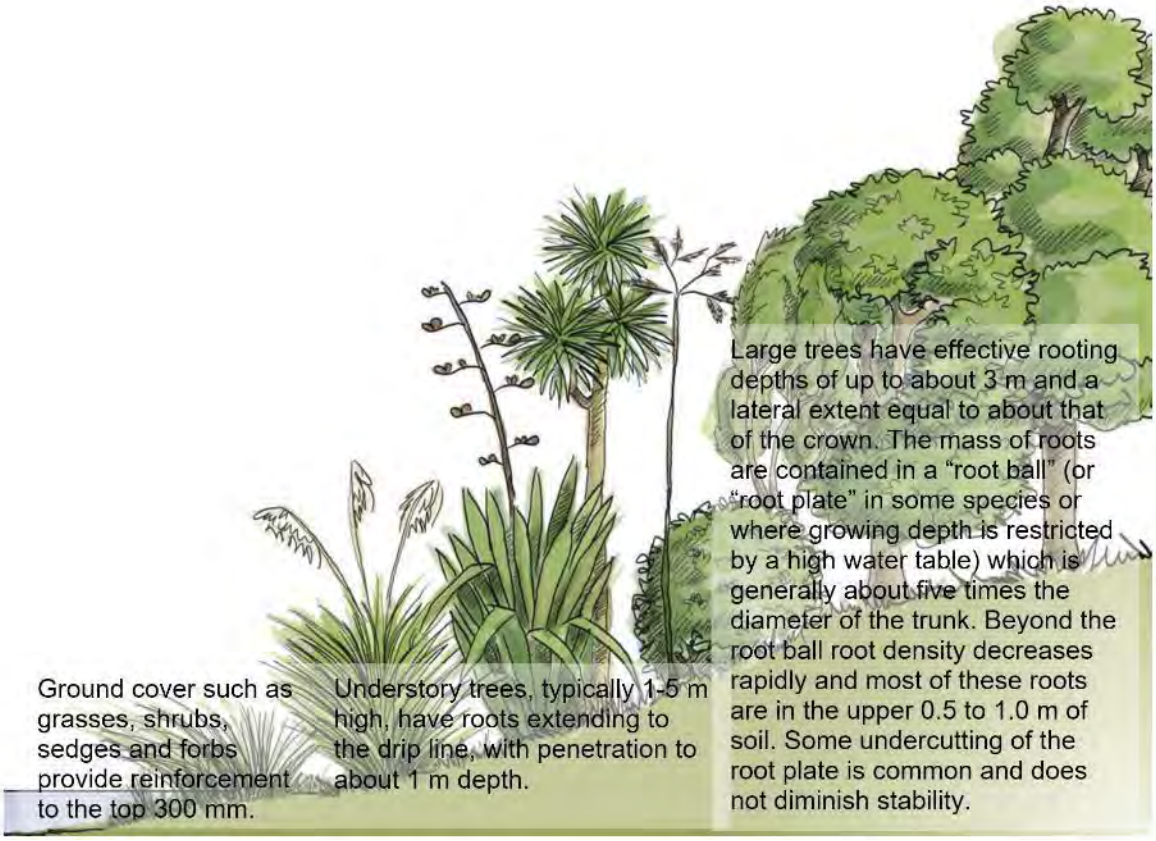


Figure 12 General guidelines for root protection (Hudson 2005 adopted from Greater Wellington Regional Council)

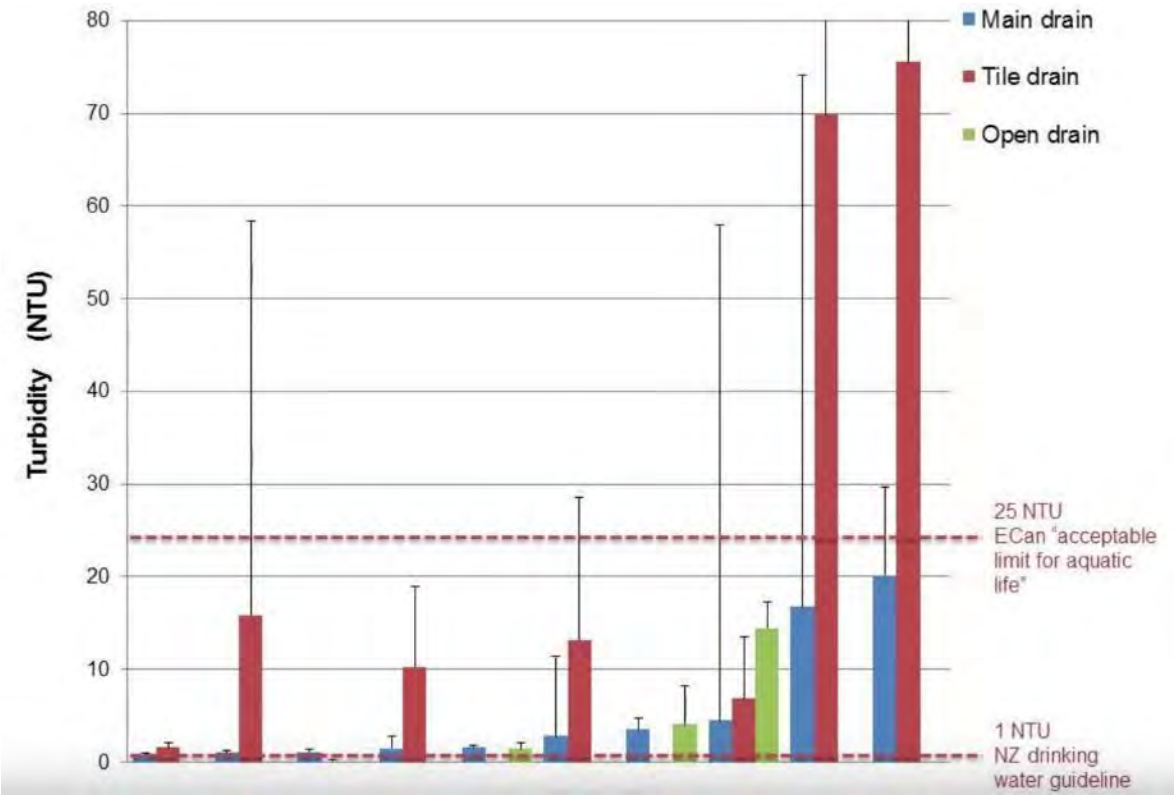


Figure 13 Tile drains may be a source of sediment (and contaminants) (source: McIntosh 2016)

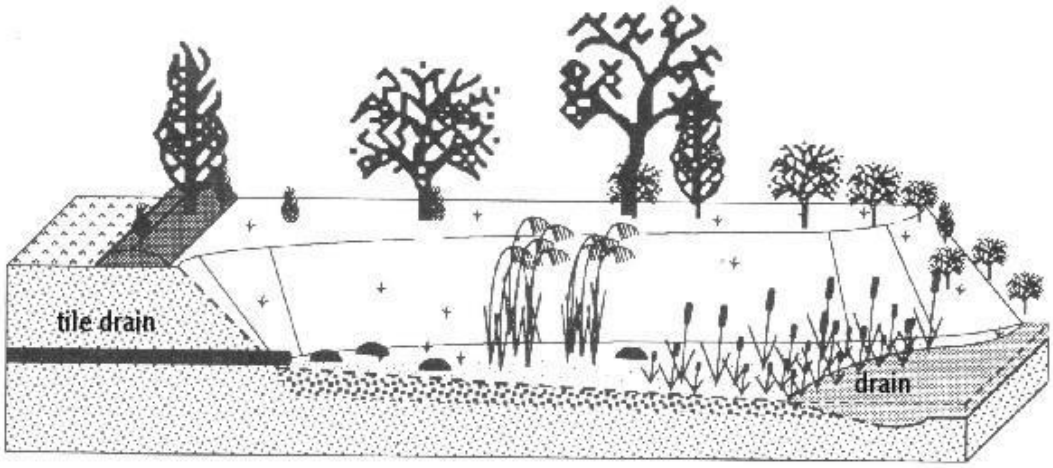


Figure 14 Schematic of a mini-wetland that receives water from tile drains and acts as a sediment and nutrient trap (adapted from Petersen et al. 1992)

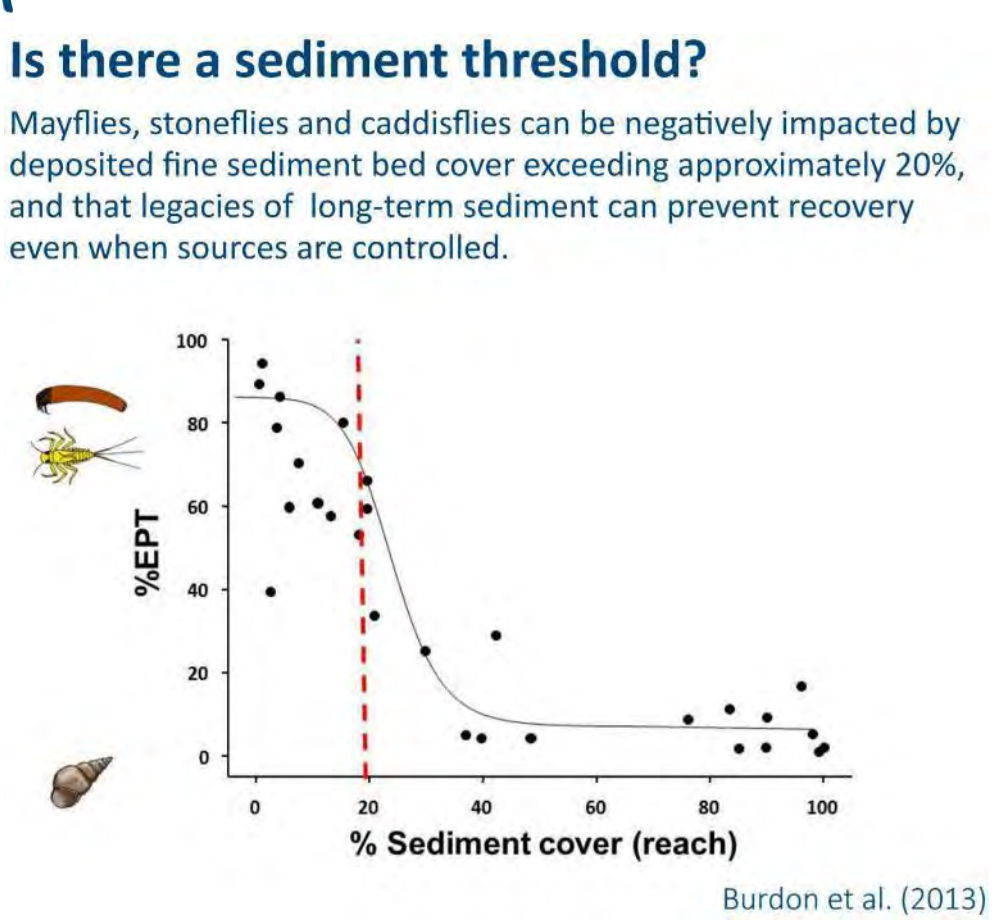


Figure 15 Fine sediment cover threshold (CAREX poster-2)

Comment: The recommended guideline for fine sediment (<2 mm) cover for macroinvertebrates and fish is 20% (Clapcott *et al*. 2011).

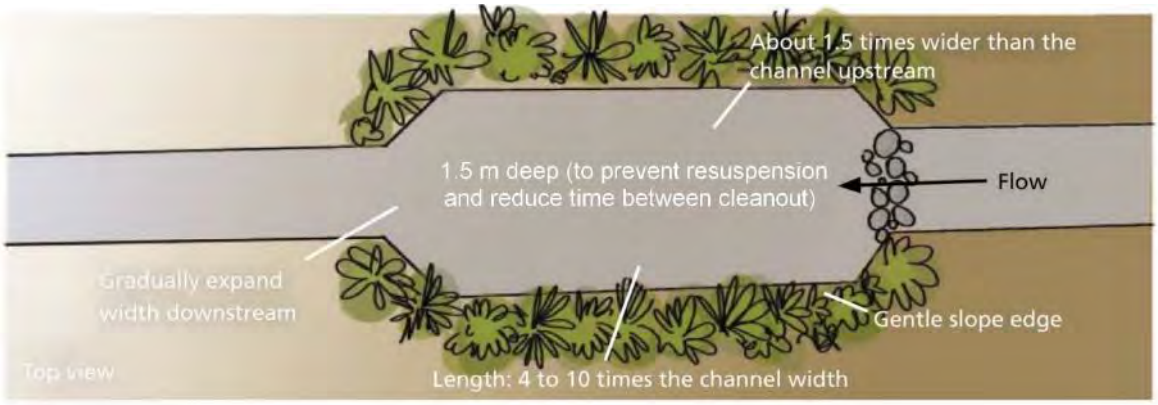
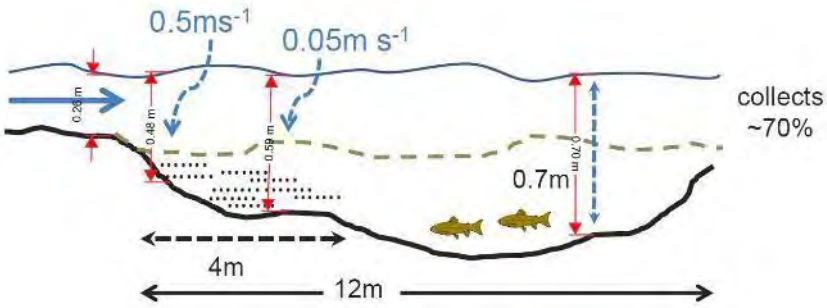


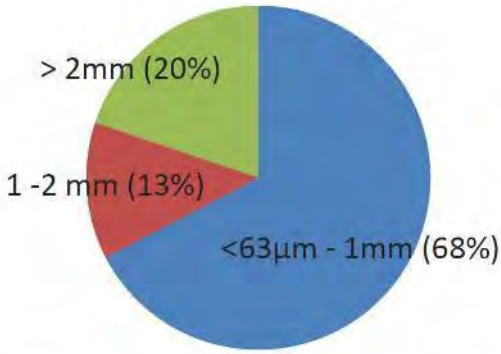
Figure 16 Conventional sediment trap rule of thumb design (after Hudson 2002)

Figure 17 Natural sediment deposition areas can be utilised as sediment traps by removing sediment to revitalise deposition (Cam River ~300 m below Bramleys Road)

More on the sediment traps

Recently, we used a digger to clean out our large (12m long and 0.7 m deep) sediment trap, which has been in place for 8 months. One of our students was monitoring the amount of sediment collected in the trap and we estimate it has captured about 60-70% of the fine sediment entering this length of stream. Over the 8 month period, the trap filled in to an average depth of ~35cm deep. During our cleaning we removed about 4m³ of sediment from the trap! The trap has proven to be very efficient and its success is due to it being long enough and deep enough to reduce the water velocity to less than 0.01ms⁻¹. This very slow water velocity is enough for very fine silt to drop out of the water column. We will continue to monitor this trap and several others over the next year. Our aim is to develop an "ideal" sediment trap design.





Most sediment collected in the trap was very fine.

The trap collected 60-70% of the fine sediment entering the reach over a 8-month period. The theoretical trap efficiency for this trap is about 95% for 125µm sediment based on Hudson (2002). .

Figure 18 CX-01 sediment trap (CAREX newsletter Sep 2015 (a - top); CAREX poster 2 (Harding et. al. undated) (b - bottom)

Comment: In the text the trap velocity is reported as less than 0.01 m/s; but the figure below has a trap velocity of 0.05 m/s and input velocity of 0.5 m/s. For the reported cross sectional area of 1.75 m³ (2.5 m width and 0.7 m depth), to achieve a 0.01 m/s mean velocity requires a streamflow of less than 20 L/s which is far less than expected (75 to 560 L/s - see footnote 17).There should be no gain or loss of flow.

Figure 19 Main CAREX sediment trap on the Middle Brook ~400 m upstream of Marsh Road (M1 in Figure 5)

Comment: The trap is largely infilled with fine sediment. Some trapping will continue within the vegetation, but this material is easily resuspended with agitation. View upstream.

Figure 20 CAREX shallow sediment trap on the Middle Brook ~240 m upstream of Marsh Road (M2 – CX3 - in Figure 5)

Comment: View upstream. Trapping occurs along the edge of the shallow trap (where silt plates are located), but the bed is largely exposed gravel indicating the trap is too shallow to be effective. It is unclear how edge silt plates are used to calculated sediment loads and trap efficiencies.

Figure 21 Middle Brook below the main CAREX sediment trap (M1 in Figure 5) is a clean gravel bed

Figure 22 A 900 m^2 interception wetland with a coarse sediment trap at the top end (right) draining 5.65 ha (revised) (Tanner et al. 2010; 2011)

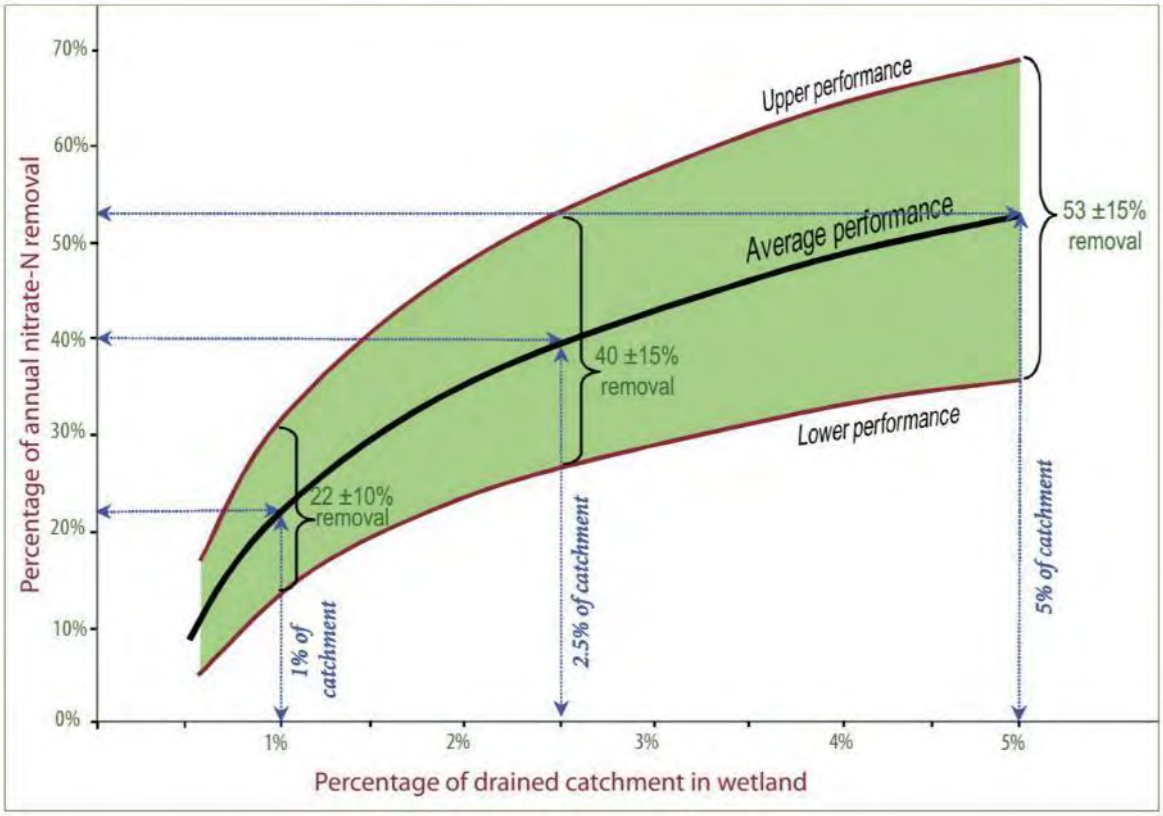


Figure 23 Constructed wetland size and performance (Tanner et al. 2010)

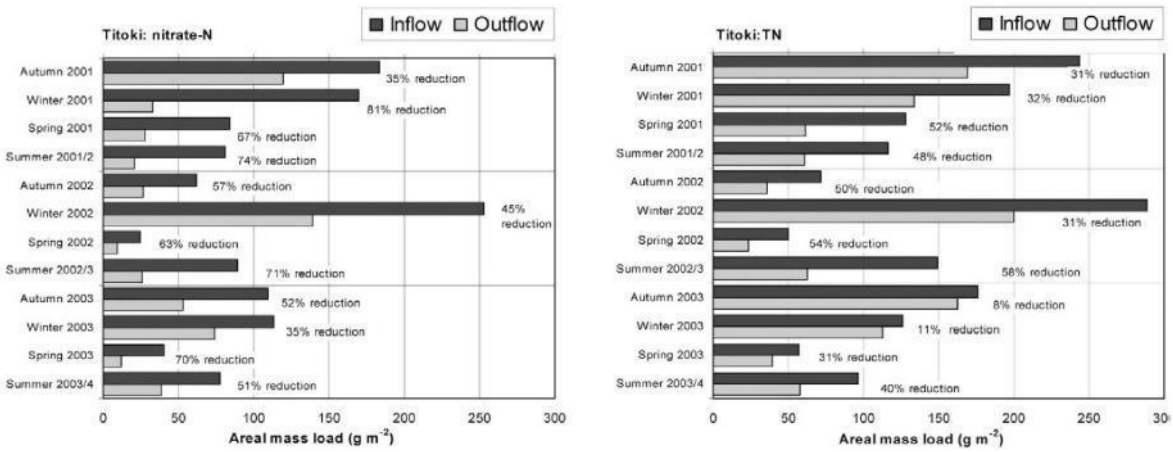


Figure 24 Titoki wetland performance (Tanner & Sukias 2011)

Figure 25 Hydraulic excavators are commonly used to remove sediment (and weeds) from the bank (Duck Creek) and inchannel (Avon River - Sunday Star Times 04 May 2014)

Figure 26 Rake bucket used in the Waimakariri District for aquatic weed removal

Figure 27 Exposed gravel with marginal fine sediment deposits in the bed raking reach Middle Brook above M1 in Figure 5

Sand wand trial

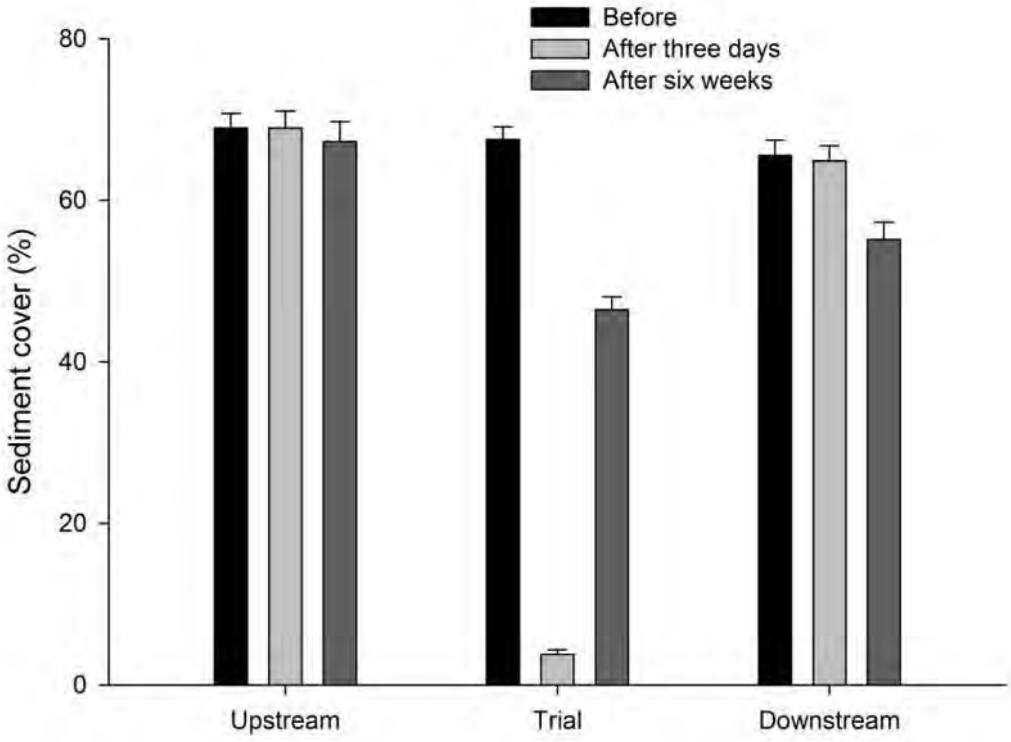
A Sand Wand™ (Streamside Environmental) was used to remove sediment from two sediment traps and three 10m reaches of a small waterway (approx. 2.5m wide).

Sand wanding resulted in a reduction of fine sediment cover from approximately 40% cover to 10-20% cover. The sand wand was effective at removing loose sediment from depositional habitats (e.g., a pool or sediment trap) but doesn't work well in shallow water (<20 cm deep). The wand is labour intensive and the removed sediment needs to be deposited elsewhere.

Sediment removed from the waterway using the sand wand was dispersed on an adjacent paddock.

Waterway bed substrate revealed and a lamprey that came to check out potential new habitat after sand wand was used.

Figure 28 Sand wand trials Middle Brook (Harding et al. poster 2 undated)



Mean (± 1SE) sediment cover within, upstream and downstream of the trial reach. Sediment cover was estimated using a stream bed viewer, n = 80. Differences ($p < 0.05$) between groups and occasions were derived from a two way ANOVA on ranked values

The initial removal of fine sediment, at least on the surface of the stream bed, was very successful with a significant removal of fine sediment. However, over time fine sediment has returned and deposited on the bed, almost reaching pre-trial levels of cover. The source of new sediment to the treatment reach may be deeper deposits within the reach itself or upstream reaches. The latter source appears more likely, particularly given the unusually high flows in the stream between sampling periods. However, despite the migration of fine sediment into the trial reach, sediment cover remained at a lower level than prior to the trial.

Figure 29 Sand wand trials Otukaikina Creek (Gray et al. 2013)

Figure 30 Partial drain clearing, leaving shallow vegetated margins, to concentrate flow to maintain a weed and sediment free narrower channel (Hewson & Hudson 2000)

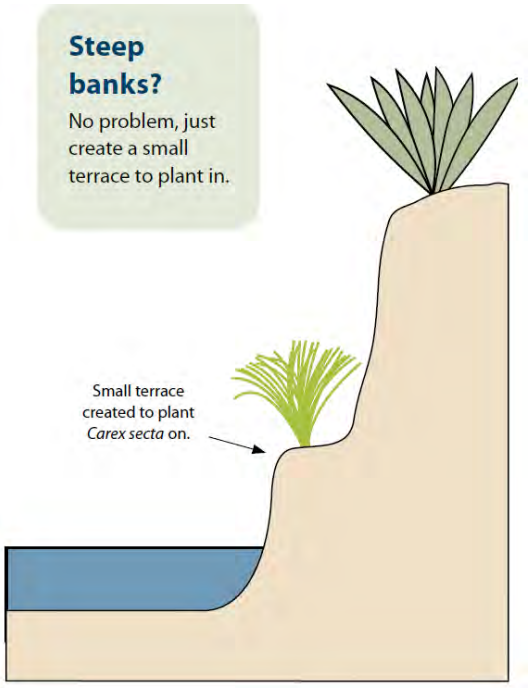
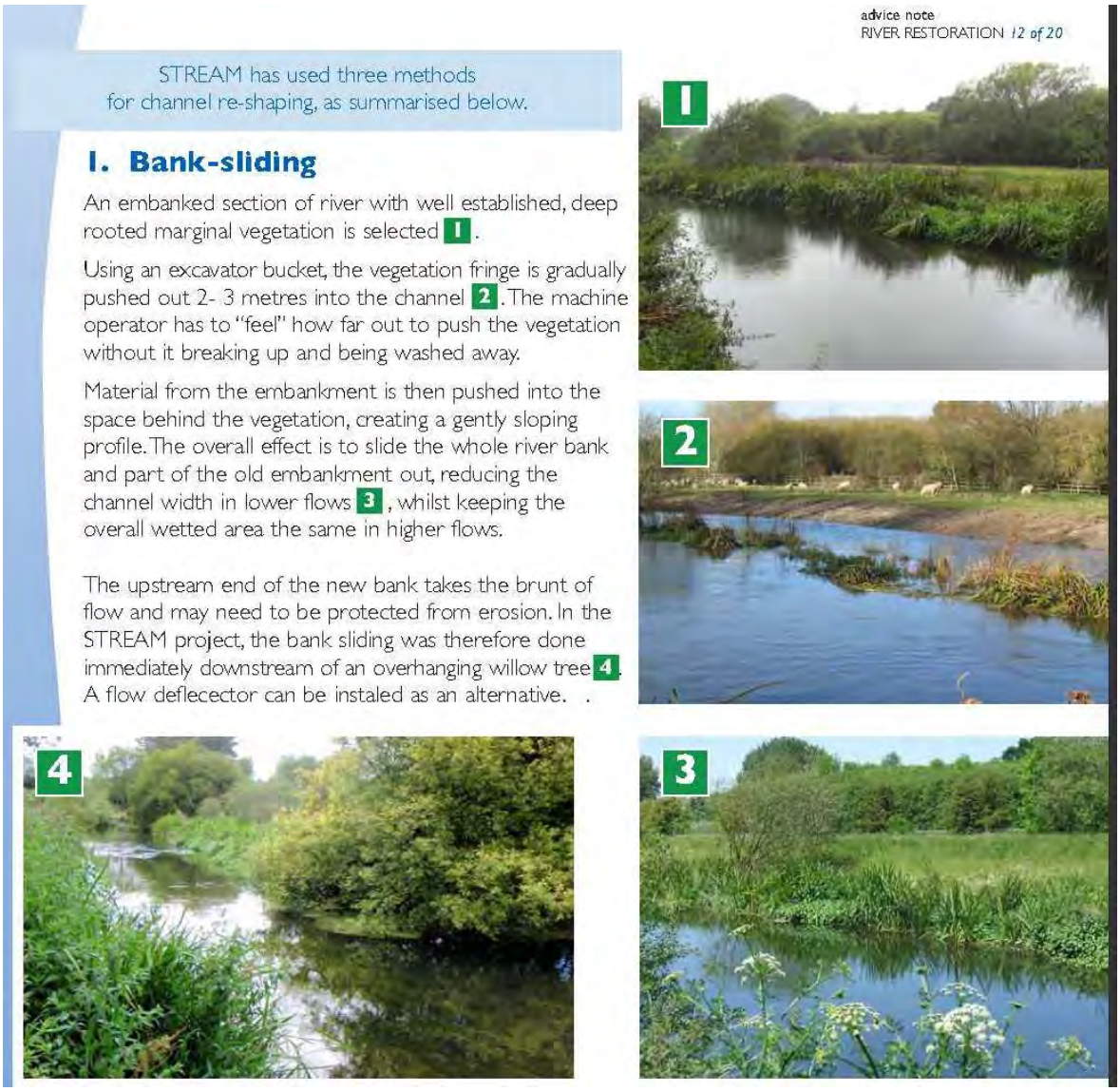


Figure 31 Benching steep banks to provide a planting platform (Environment Canterbury Living Streams Handbook Part 3: Planting and maintenance)



advice note
RIVER RESTORATION 12 of 20

STREAM has used three methods for channel re-shaping, as summarised below.

1. Bank-sliding

An embanked section of river with well established, deep rooted marginal vegetation is selected 1.

Using an excavator bucket, the vegetation fringe is gradually pushed out 2- 3 metres into the channel 2. The machine operator has to "feel" how far out to push the vegetation without it breaking up and being washed away.

Material from the embankment is then pushed into the space behind the vegetation, creating a gently sloping profile. The overall effect is to slide the whole river bank and part of the old embankment out, reducing the channel width in lower flows 3, whilst keeping the overall wetted area the same in higher flows.

The upstream end of the new bank takes the brunt of flow and may need to be protected from erosion. In the STREAM project, the bank sliding was therefore done immediately downstream of an overhanging willow tree 4. A flow deflecector can be instaled as an alternative. .

Figure 32 Bank sliding (Advice note River Restoration)

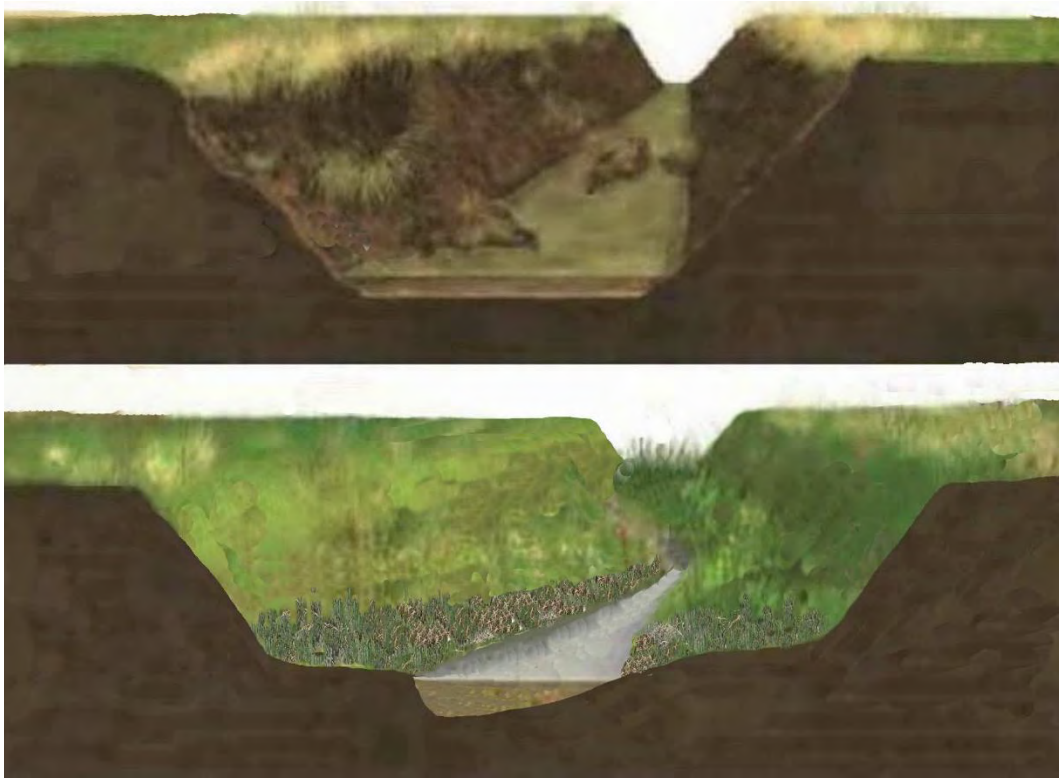


Figure 33 Two stage channel design providing a narrow low flow channel and periodically inundated vegetated high flow channel

Figure 34 Addition of boulder clusters and logs for habitat diversity (CAREX Newsletter May 2015)

Comment: CAREX Newsletter May 2015:

Natural boulders and wood logs have been added to one of our waterways to demonstrate the value of habitat for freshwater insects and fish. Many agricultural waterways lack important habitat for freshwater animals. Monitoring has shown this habitat is being used by insects to lay their eggs and fish are using them for cover. Our plan is to trial a larger-scale demonstration later this year.

Figure 35 Edge planting of raupō, carex secta (pukio/flax) and kiokio fern (Blechnum novaezelandiae) with cabbage tree (Cordyline australis) in the background

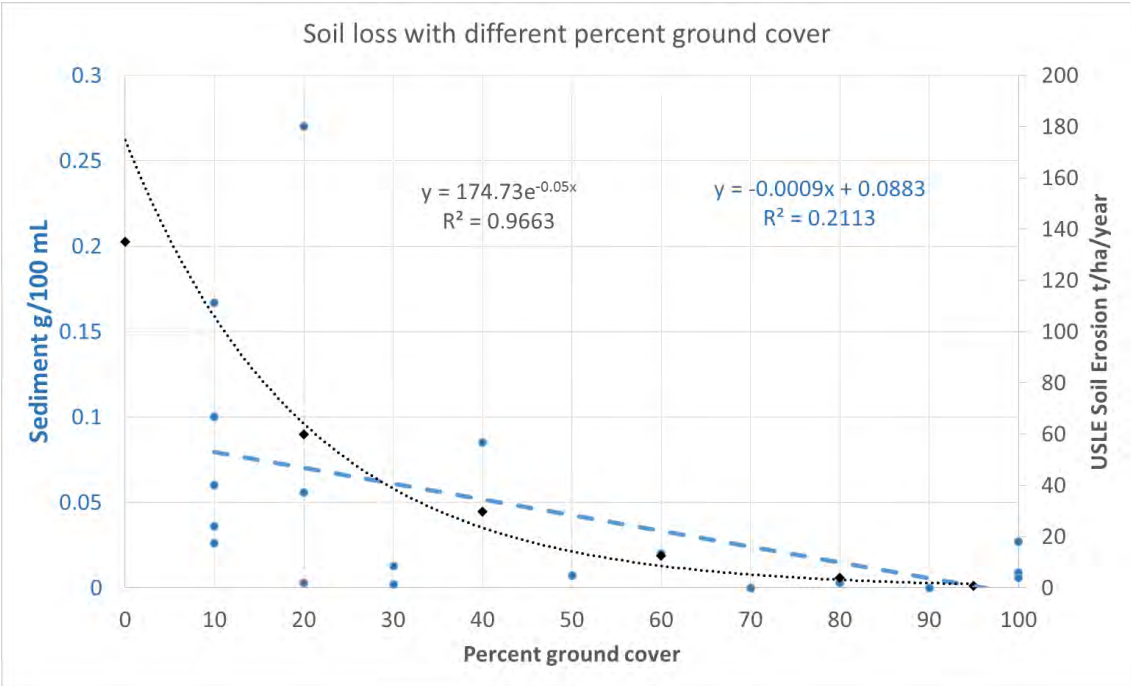


Figure 36 Graph of sediment loss with percent ground cover (CAREX poster 2) superimposed with predicted soil loss for a hypothetical drain bank

Comment: CAREX poster 2 (Harding et al. undated), showing a graph from Porter (2014), under the title “How can we reduce reducing fine sediment in waterways, states “maximising riparian vegetation cover e.g. >50% grass cover.”

The extreme variability at low ground cover is unexpected. Highest yields, and lowest yields, occur with 20% ground cover, with greater yields at 40% cover than 30% cover. The intuitive expectation, and prediction from the Universal Soil Loss Equation (for a hypothetical low steep drain bank, and default soil and rainfall), is that the greatest soil loss would occur with the least ground cover with a rapid decline in soil loss as cover increases.

Appendix 1: A Vision for the Three Brooks

The vision is to rehabilitate the Three Brooks into a sustainable eco-geomorphological based exemplar that provides a broad range of ecosystem services and provides environmentally friendly, cost effective and hydraulically effective erosion and flood control required in a dynamic rural and urban landscape.

This vision statement is applicable to the Cam River and many other similar streams and rivers. "Sustainable" refers to intergenerational sustainability, with minimum continuing intervention over the long term. "Eco-geomorphological" refers to inking the physical form and processes of waterways with ecological response by adopting an ecosystem perspective (Hudson 2002). "Ecosystem services" can be catagorised as provisioning (e.g. mahinga kai), regulating (e.g. waste treatment, buffer zones), supporting (such as primary production, nutrient cycles and pollination) and cultural (such as spiritual and recreational benefits).

Key activities to provide these ecosystem services are summarised, and adapted for the issues and options identified in the Three Brooks, based on a vision statement from the Styx River project. [24]

Vision 1: To achieve a sustainable spring-fed stream ecosystem

1. **Protect, maintain and restore natural drainage patterns and processes by:**
   - Understanding natural surface and subsurface drainage patterns and processing through research and monitoring
   - Ensuring that any development mitigates for stormwater quality and quantity and recognises and works with natural drainage patterns
   - Recognising natural variations due to storm events and seasonal changes and allowing sufficient space for these to occur through building setbacks, zoning and land protection
   - Avoiding filling and building within floodplains and ponding areas through education, working with landowners, regulation and enforcement
   - Maximise ground soakage through minimizing hard surfaces (i.e. low impact urban design)
   - Monitor water abstraction and impacts on waterways and wetlands
   - Recognise and plan for the long term effects of climate change and sea level rise
2. **Protect springs by:**
   - Identifying springheads
   - Ensuring that spring flow from the underlying aquifers is maintained
   - Preventing livestock access
3. **Protect and enhance water quality by:**
   - Controlling the generation and delivery of sediment and contaminants from the catchment
   - Control, and trap and treat sediment and contaminants in the waterways
   - Remove excessive fine sediment deposits from waterways
4. **Protect and monitor remnant indigenous vegetation and the effect of weed invasion**
5. **Identify and protect natural landforms**
6. **Undertake instream habitat enhancements such as fine sediment removal and creation of instream habitat structures (such as pool and riffles) and improve riparian habitat**
7. **Increase native bird species richness through:**
   - Protecting and restoring core habitat sites for wetland and bush bird species
   - Ensuring that there are adequate buffer zones along waterway and wetland margins

[24] http://www.thestyx.org.nz/new-zealand/visionone/ Accessed March 2017.

- Developing green corridor linkages
- Reintroduce native species.

8. **Undertake predator control as necessary**
9. **Monitor effects of land use change and land management practices**
    - Promote enforcement of applicable rules to avoid or mitigate effects
    - Encourage best management practices

Vision 2: To create a positive lowland stream experience

10. **Identify and protect:**
    - Suitable routes along the Three Brooks, Cam River and other tributary waterways (to be done in the spirit of partnership through negotiation with current landowners)
    - Provide improved road crossing facilities so that roads do not become barriers to pedestrians and cyclists
11. **Provide a range of experiences through the development of:**
    - Walkway routes and cycleways; and boating facilities on the Cam and ponds
    - A range of landscape experiences based on natural and cultural values
    - Innovative interpretative material
12. **Develop service nodes that will concentrate human activity and provide facilities for:**
    - Parking for cars and bicycle
    - Relaxation
    - Eating facilities
    - Learning activities
    - Recreation facilities
13. **Monitor and remedy the impact of people and recreational activities on ecological values through:**
    - Preventing or limiting access to core habitat or sensitive areas
    - Use of design elements to lessen the impact on wildlife if required (e.g. screening, moats, fences)
14. **Promote the lowland stream experience:**
    - The development of promotional material
    - On site interpretation, facilities, and learning experience

Vision 3: Adaptively manage - treat actions as experiments and learn

15. **Continue with the Cam River Enhancement Sub Committee to oversee development and implementation of the recommended actions, research and learning programme**
16. **Develop partnerships with:**
    - Operational and Planning units within Waimakariri District Council
    - Other organisations (for example Environment Canterbury, Department of Conservation, Ministry of Fisheries, Fish and Games Council)
    - Iwi
    - Research providers such as consultants, research institutes and educational institutions
    - Schools and service organisations
    - Community groups and volunteers such as the bio blitz on the Cam
17. **Develop joint projects:**
    - Internally, within Waimakariri District Council
    - Externally with Environment Canterbury and with other stakeholders in the Waimakariri Zone

- Externally with others outside the zone (e.g. Styx, Lake Ellesmere-Waihora)

18. Develop a website that:

- Promotes adaptive management
- Provides easy access to data and reports
- Encourages enquiry and discussion.

Vision 4: Make the Three Brooks and upper Cam a destination

19. Recognise, highlight and enhance the unique landscape character by:

- Improving public access, visibility and landscaping
- Promoting the Three Brooks and Cam as green corridors
- Promote stories of the land, its drainage and vegetation patterns, cultural patterns, cultural features and landmarks
- Allow people to express their relationship to the area through consultation and participation

20. Promote the locality through:

- Regular newsletters
- Media articles
- Publications
- Websites of the various organisations involved
- Videos, documentaries

21. Stage a series of events that will enhance this area as a destination

- Cross country run for schools
- Walkathon
- Training circuit.

Vision 5: Foster partnerships

22. Locally

- Work with private landowners in the development of the Vision while at the same time recognising:
  - private property rights
  - the need to use a range of protection methods to accomplish desired outcomes
  - the need to achieve win-win situations
- To work with a wide range of organisations and institutions to adaptively manage
- To work with private enterprise and community organisations in the development of the Three Brooks and Cam River as a destination (e.g. Kaiapoi the River Town)
- To work with private enterprise, landowners and community organisations in the development of the lowland stream experience (e.g. eco homestays)

23. Tangata Whenua

- Develop policies for mahinga kai (food gathering) specific values including habitat and species management
- Recognise and protect sites of significance and where appropriate, mark these by signs or events

24. Regionally

- Continue involvement in regional research initiatives, using the Three Brooks as a case study for adaptive management
- Develop joint projects to compare and contrast with other lowland ecosystems
- Promote information sharing to learn from successes and failures.

Appendix 2: ECan water quality and ecology (Greer Meredith 2016)

Citation: Greer M, Meredith A. 2016. Waimakariri Zone water quality and ecology: State and trend. Environment Canterbury Report R12/68. 86 pages.

From the Executive summary:

"What was done

Available water quality and ecology data for the Waimakariri CWMS zone were collated, and the results compared with current regional plan limits and objectives, and established guideline values from the literature. Current state was assessed from data collected over the past five years and trend analyses were undertaken across the entire data set where more than five years of data were available.

What was found and what it means

Many of the rivers in the Waimakariri CWMS Zone, particularly spring-fed streams, exhibit unhealthy ecological communities, poor habitat conditions and degraded water quality. This condition reflects the high intensity land use in many parts of the zone. Without appropriate catchment scale management of nutrient losses and sediment inputs these impacted streams will continue to exhibit unhealthy aquatic communities."

Cam River condition (summarised from the report)

Environment Canterbury (ECan) undertook an assessment of state and trends of water quality and ecology in the Waimakariri Zone, including sites in the Cam and Kaiapoi river system (Greer & Meredith 2016). The report is intended to inform the zone committee of current state, but also of the key drivers, of ecosystem health. Available water quality and ecology data collected over the past five years were collated, and results compared with current regional plan limits and objectives, and established guideline values from the literature. Current state and trends were assessed for selected sites, including the following, if data were available:

SQ34905 Cam River at Marsh Rd

SQ30369 Cam River at Bramleys Road

SQ34903 North Brook at Marsh Rd

SQ30390 South Brook at Marsh Rd

As discussed by Greer & Meredith (2016) the key drivers and indicators of water quality and ecosystem health include invertebrate community structure, fish, macrophytes, fine sediment cover, water temperature and dissolved oxygen, nutrients, total suspended solids, and E.coli. Fish are only discussed in general terms. Findings are summarised.

Invertebrate communities are in a degraded state in most spring-fed rivers of the Kaiapoi River catchment including the Cam and South Brook (Table A4: 1). Both these sites consistently fail to meet Land and Water Regional Plan (LWRP)

outcomes; and the composition QMCI score) is indicative of poor (South Brook) or fair water quality (Cam at Bramleys Road)[25] and degraded habitat.[26]

Table A2: 1 Minimum QMCI scores recorded from 2011 to 2015 in the Kaiapoi catchment. Highlighted values fail to meet the LWRP outcomes

	LWRP outcome	2011	2012	2013	2014	2015	Mean
Kaiapoi River @ Harpers Rd		5.0	4.3	4.4	4.9	5.6	4.9
Kaiapoi River @ Heywards Rd		6.1	6.6	5.3	5.6	5.0	5.7
Kaiapoi River @ Island Rd		N/A	4.5	2.8	4.5	4.1	4.0
Cust River @ Tippings Rd		5.3	7.1	5.2	3.8	3.8	5.0
Cust River @ Skewbridge Rd	**5**	4.1	3.3	4.0	3.4	4.8	3.9
Ohoka Stream @ Bradley's Rd		3.6	3.3	2.5	3.8	3.8	3.4
Ohoka River @ Island Rd		N/A	4.8	3.1	5.9	4.7	4.6
Cam River @ Bramleys Rd		4.9	4.2	4.7	3.3	5.0	4.4
South Brook @ Marsh Rd		3.1	2.5	3.1	2.8	4.1	3.1

It is considered by Greer & Meredith (2016) that total macrophyte cover is unlikely to be having significant ecological effects at the Cam River sites, or the South Brook (mean values range from 43 to 48% total macrophyte cover which is below the LWRP outcome of less than 50%). However, the North Brook at Marsh Road usually exceeds the LWRP outcome (mean of 70% cover). Also, emergent macrophytes are considered unlikely to have significant ecological effects in spring-fed rivers in the Kaiapoi River catchment with all sites regularly meeting the LWRP outcome. Benthic cyanobacteria does not appear to be a health risk in spring-fed streams in the Kaiapoi River catchment. All sites met the LWRP outcome for benthic cyanobacteria cover (50%) every year in which monitoring was conducted between 2011 and 2016.

"Fine sediment cover is also high across the Kaiapoi catchment, which is undoubtedly a key driver of poor ecosystem health" (Greer & Meredith 2016).[27] The recorded exceptions include the North Brook and South Brook at Marsh Road, where in three of the five years of record maximum fine sediment cover was less than the LWRP outcome of 20% (Table A4: 2).

Greer & Meredith (2016) do not discuss fine sediment trends, but trends are apparent at some of the study sites in the period 2011 to 2015 inclusive. The Cam River at Marsh Road has consistently high fine sediment cover (90 to 100%); the Cam at Bramleys Road has increased fine sediment cover, peaking at 80% in 2012; the South Brook at Marsh Road is below the LWRP outcomes

[25] Invertebrate communities were not monitored at the other sites of interest to this investigation

[26] Greer & Meredith (2016) note: "Generally, the higher the QMCI score the better the water and habitat quality. Invertebrate communities with a QMCI score below 4 are indicative of poor water quality, communities with a score between 4 and 5 are indicative of fair water quality, communities with a score between 5 and 6 are indicative of good water quality, and communities with a score above 6 are indicative of excellent water quality (Stark and Maxted, 2007). When these grades were established the key concern of the time was point source discharges of agricultural, industrial and urban wastes, and the grades were used as indicators of the level of organic pollution. Nowadays, point source discharges are less common in Canterbury, and the predominant drivers of stream heath are diffuse nutrient discharges, habitat degradation and abstraction for irrigation. Consequently, when considering the drivers behind low QMCI scores consideration must be given to a range of habitat and water quality parameters, not just traditional metrics of pollution such as nutrient and toxicant concentrations."

[27] It is noted that the one year of fine sediment data for the Kaiapoi River at Heywards Road has up to 90% cover (median around 20% cover), but has high QMCI scores indicating good to excellent water quality. The reported sediment cover may not reflect normal conditions.

for 3 of 5 years; and the North Brook at Marsh Road has increased fine sediment cover (from 10% to 80%) in the period of record.

Table A2: 2 Maximum fine sediment cover (%) recorded from 2011 to 2015 in the Kaiapoi catchment. Highlighted values fail to meet the LWRP outcomes

	LWRP outcome	2011	2012	2013	2014	2015	Mean
Kaiapoi River @ Harpers Road		N/A	90	N/A	65	80	78
Kaiapoi River @ Heywards Rd		N/A	90	N/A	N/A	N/A	90
Kaiapoi River @ Island Rd		15	100	80	95	95	77
Cust River @ Skewbridge Rd		15	10	60	20	30	27
Ohoka River @ Island Rd	**20**	30	5	60	20	30	29
Cam River @ Marsh Rd		90	100	100	95	100	97
Cam River @ Bramleys Road		10	15	40	80	40	37
South Brook @ Marsh Rd		20	25	25	15	20	21
North Brook @ Marsh Rd		10	10	15	40	80	31

Single monthly water temperature and dissolved oxygen measurements are recognised as not being representative samples; but might identify LWRP outcome exceedences. Temperatures from all the spring-fed stream sites in the study area are low as expected (ranging from 13.3 to 15.8 ^{0}C). For the study sites minimum recorded dissolved oxygen saturation exceeds LWRP outcomes. The limited data suggests that water temperature and low dissolved oxygen may not be a critical issue.

Plant available nutrient concentrations (DIN: dissolved inorganic nitrogen is composed of nitrate-nitrite nitrogen (NNN) and ammoniacal nitrogen (NH_4N)) were sufficiently high in all spring-fed streams in the Kaiapoi River catchment to allow macrophytes to proliferate. South Brook at Marsh Road was in the high range with median values exceeding the 90% probability of nuisance macrophyte growths. North Brook and the Cam River sites were usually below the 70% probability of nuisance macrophyte growths.

Dissolved reactive phosphorus (DRP) is the readily available component of phosphorus for plant uptake, and, as with DIN, the higher the DRP concentration the greater the risk of nuisance periphyton and macrophyte growths. Cam River at Marsh Road median DRP concentrations exceed the 70% probability of nuisance macrophyte growth; and the other study area sites median values were below the 30% probability of nuisance macrophyte growths.

It is noted by Greer & Meredith (2016) that "Nutrient availability is just one of a number of factors that influence macrophyte growth in spring-fed streams, and elevated DIN and DRP concentrations will not always result in nuisance macrophyte growths. However, as nuisance macrophyte growths **have been regularly observed** in most spring-fed streams in the Kaiapoi River catchment, it is apparent that factors such as light availability, flow conditions and rooting substrate are not limiting macrophyte growth, and current DIN and DRP concentrations are sufficient for nuisance growths in these streams."

There is a downward trend in plant available nutrients (DIN) and dissolved reactive phosphorus (DRP) for the Cam at Bramleys Road and South Brook at Marsh Road. Trends at North Brook are flow dependent (DIN -4% flow adjusted; 0% unadjusted; DRP +4% flow adjusted; -5% unadjusted). There is a negative trend for DIN (-1%) unadjusted flow for the Cam at Marsh Road, with no trend for DRP.

Nutrients may also be habitat limiting toxicants. Nitrate-nitrite nitrogen (NNN) concentrations were much lower in the Cam River catchment, than in the

Kaiapoi, Cust and Ohoka Rivers, and Greer & Meredith (2016) concluded it is unlikely that nitrate toxicity is having detrimental effects on ecosystem health in this system. Ammonia toxicity (NH_4N total ammoniacal nitrogen) concentrations are below the 99% threshold for biodiversity protection at all study sites apart from South Brook at Marsh Road, where most of the measurements are less than the 95% threshold for biodiversity protection. Therefore, there is a low risk of ammonia toxicity negatively affecting invertebrate communities.

NNN concentrations are stable or downward trending at the study sites. Under the NPS for freshwater management (MFE 2014) national bottom lines for nitrate toxicity are not being met in the upper Kaiapoi River which requires better management of nutrient inputs to meet the C band requirement at Harpers Road. Median values for Cam system sites are below the A band; with a high degree of protection of biodiversity (99%), the exception being South Brook at Marsh Road with is generally between the A and B bands (Figure A2: 1). The 95th percentile values (1.87 mg/L, 2.22 mg/L, 1.78 mg/L and 3.5 mg/L for the Cam at Marsh Road, Cam at Bramleys Road, North Brook at Marsh Road and South Brook at Marsh Road, respectively, exceed the threshold for 99% protection of biodiversity, but not the 95% protection level.

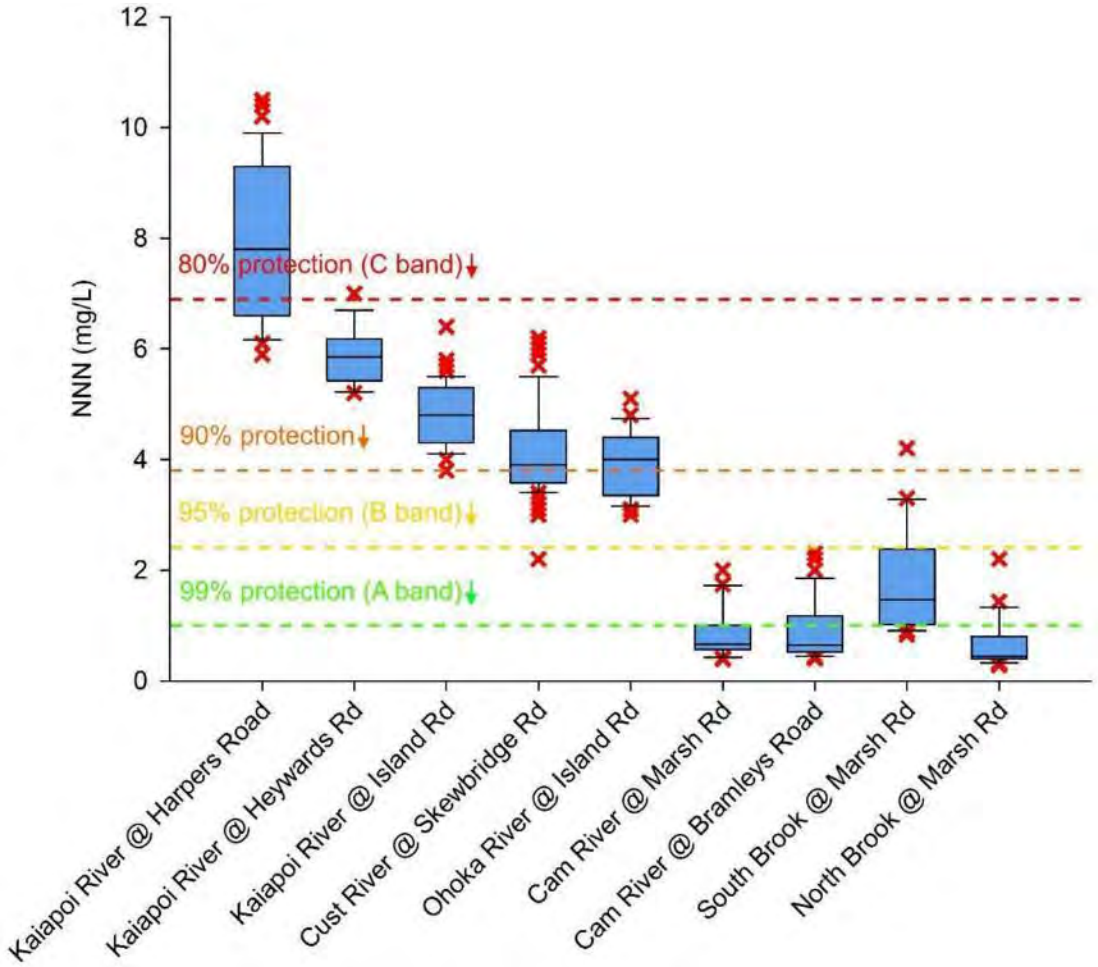


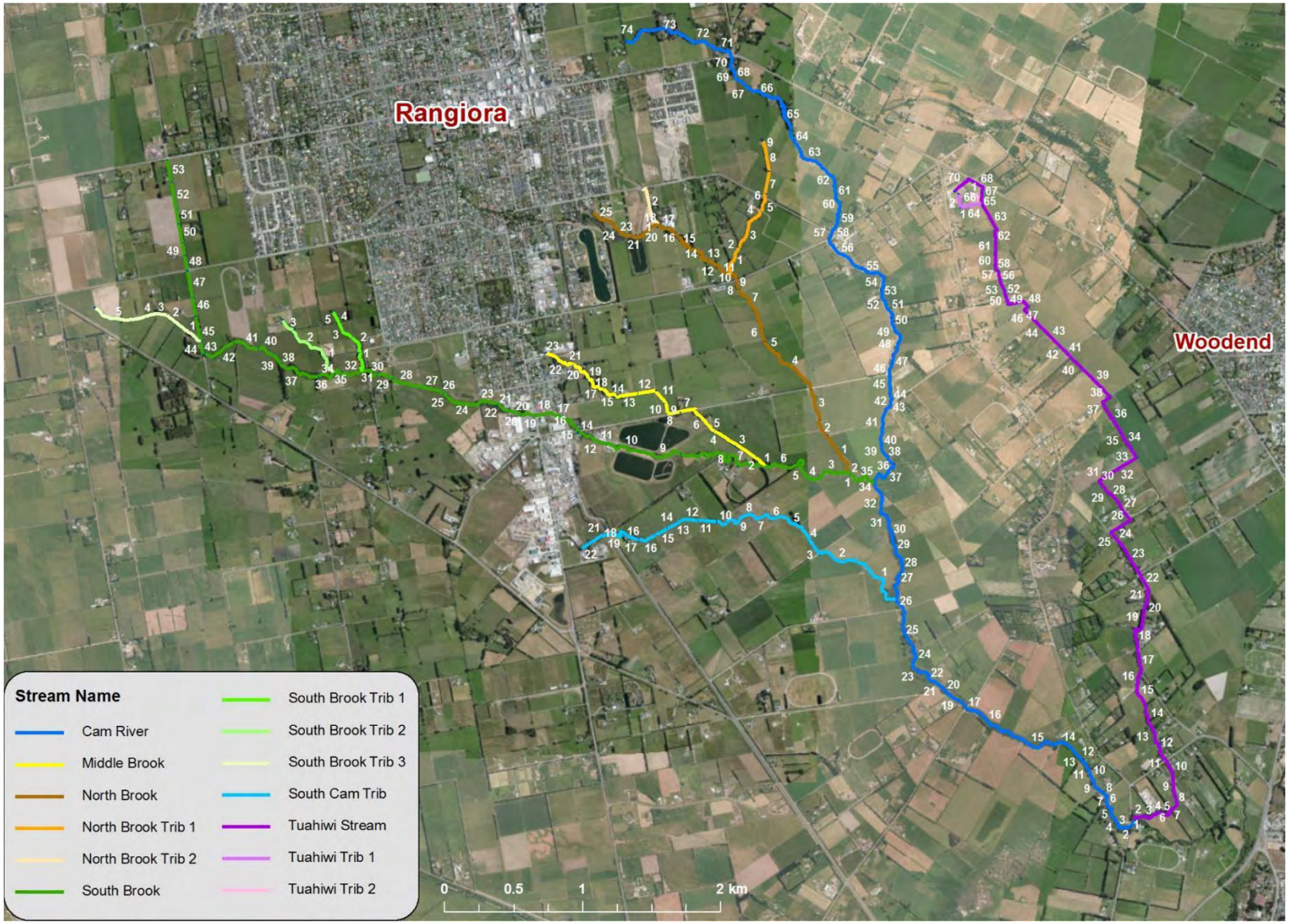
Figure A2: 1 Distribution of NNN concentrations, with thresholds for the protection of biodiversity from nitrate toxicity (Hickey 2013) and NPS (2014) bands.

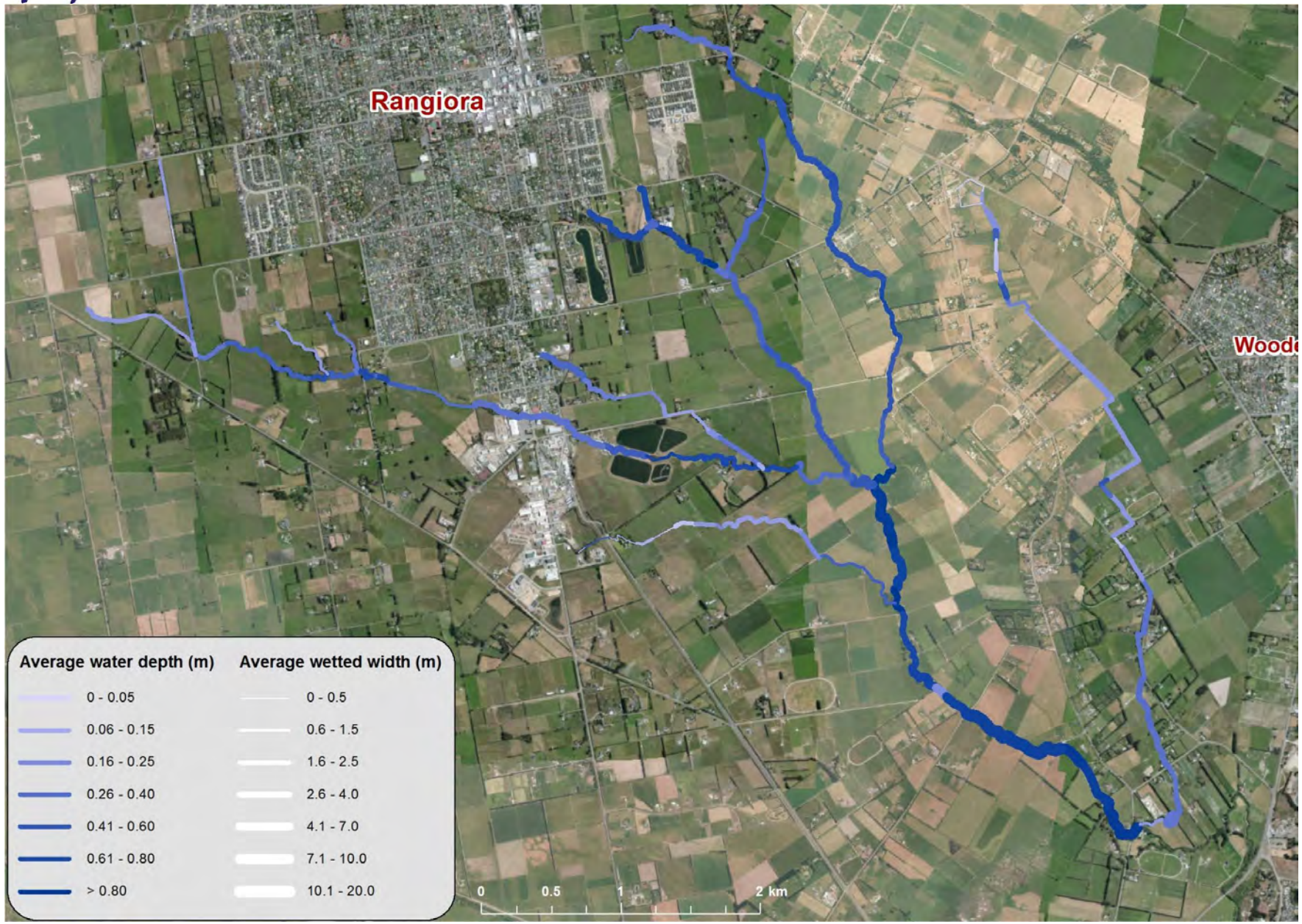
Recorded total suspended solid (TSS) concentrations are relatively low at the study sites (i.e. less than the 25 mg/L TSS threshold for onset of detrimental effects). However, it should be noted that it is likely that measurements were not taken during the rising stages of a flood when concentrations are expected to be greatest.

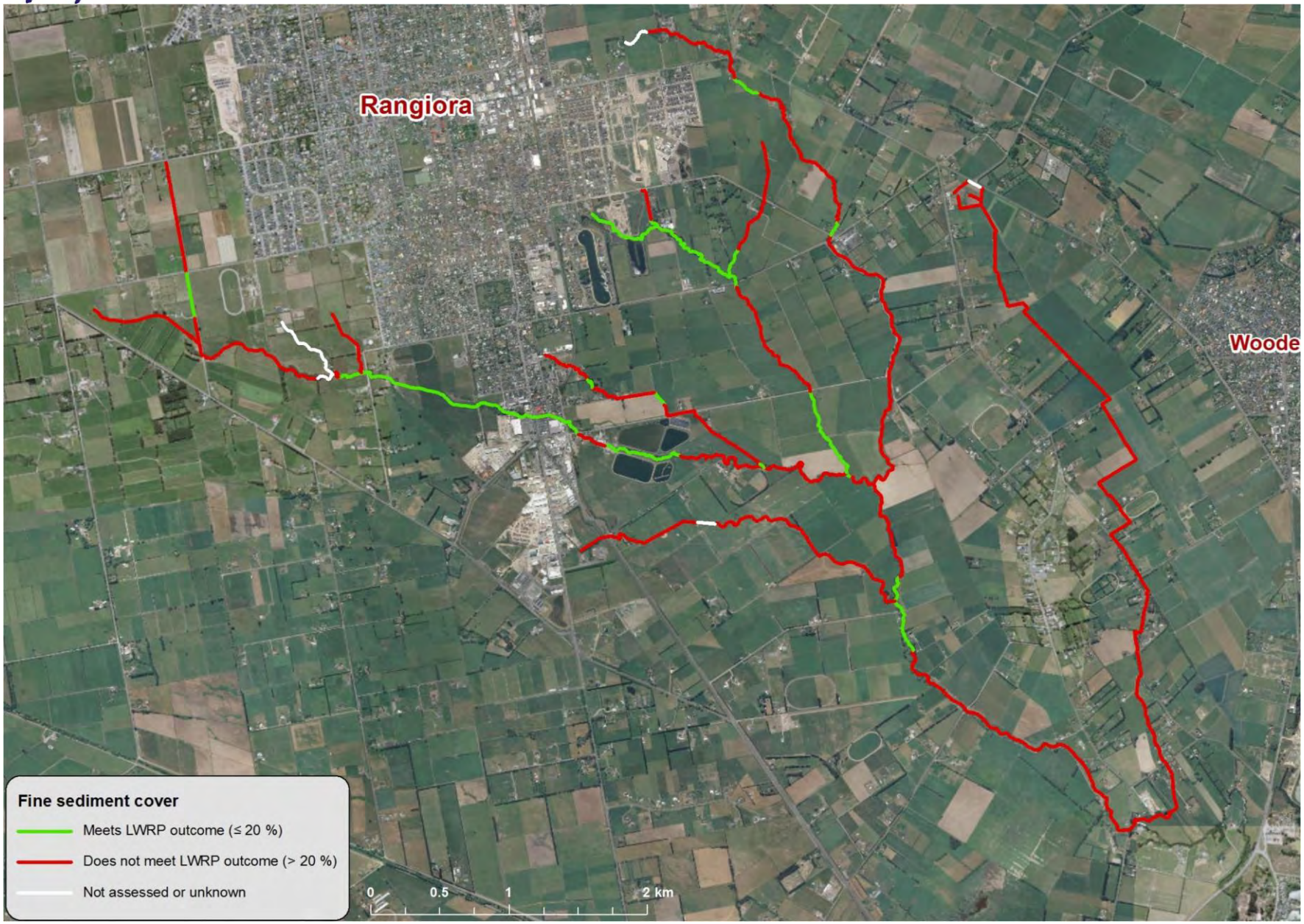
All of the sites in the Kaiapoi catchment are above the alert level for *E.coli*. Most of the measurements for the Cam at Marsh Road and Bramleys Road exceed the threshold at which a site is considered unsuitable for contact recreation. Some exceedances also occur on the South Brook and North Brook, but the majority of measurements are between the alert level and unsuitable for contact recreation level. The Cam sites are trending up for unadjusted flows whereas the South and North brooks are trending down for the period of record (1999-2016).

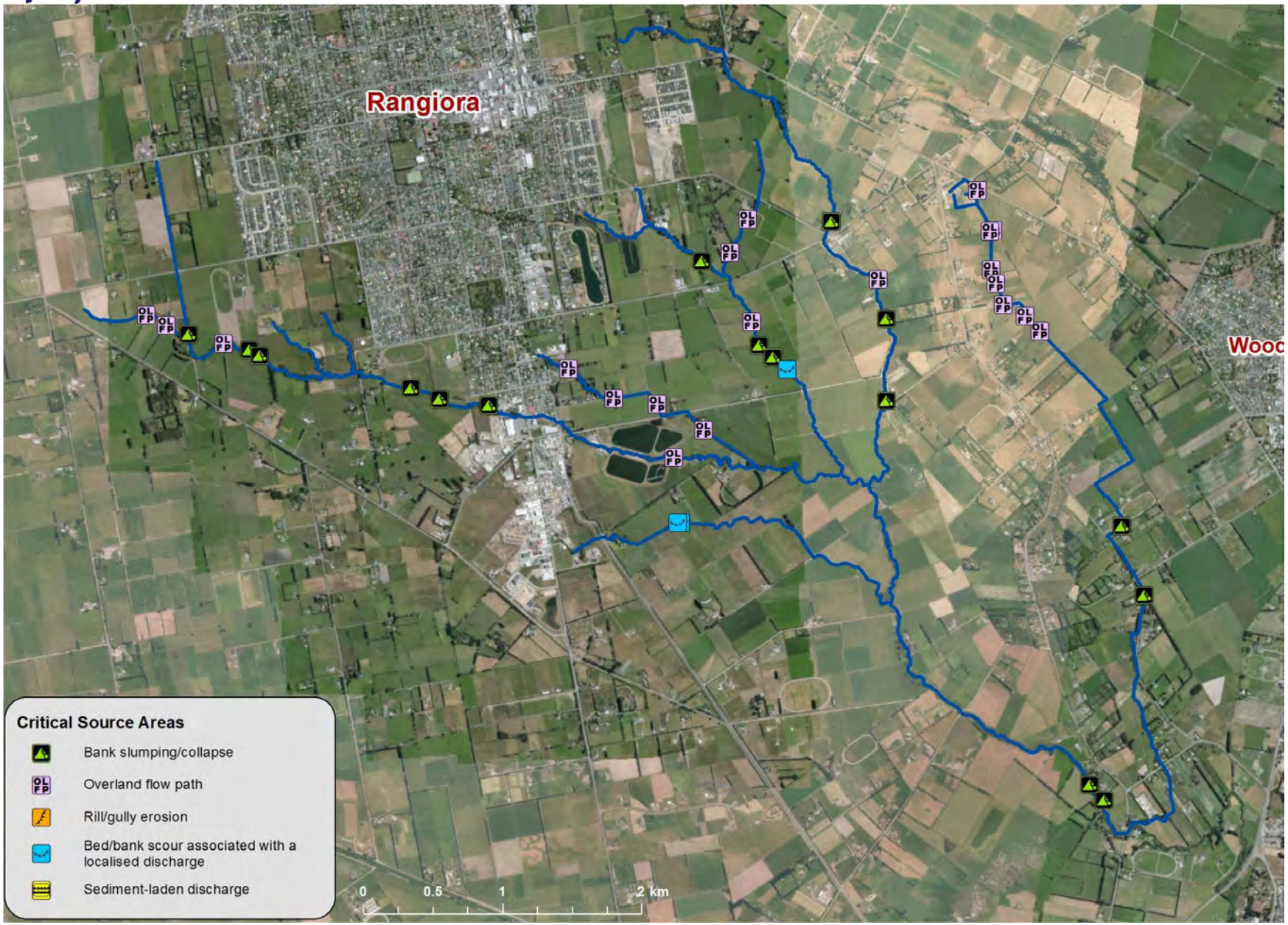
Greer & Meredith (2016) do not report on habitat grade; but Greer (2015) has done so in a memorandum to the Waimakariri Zone Committee. Only two sites in the study area were reported. The Cam River at Bramleys Road had an average grade of good and has been graded as fair or good for each of the last five years. For the same period, the South Brook at Marsh Road had an average grade of poor, ranging from fair to very poor.

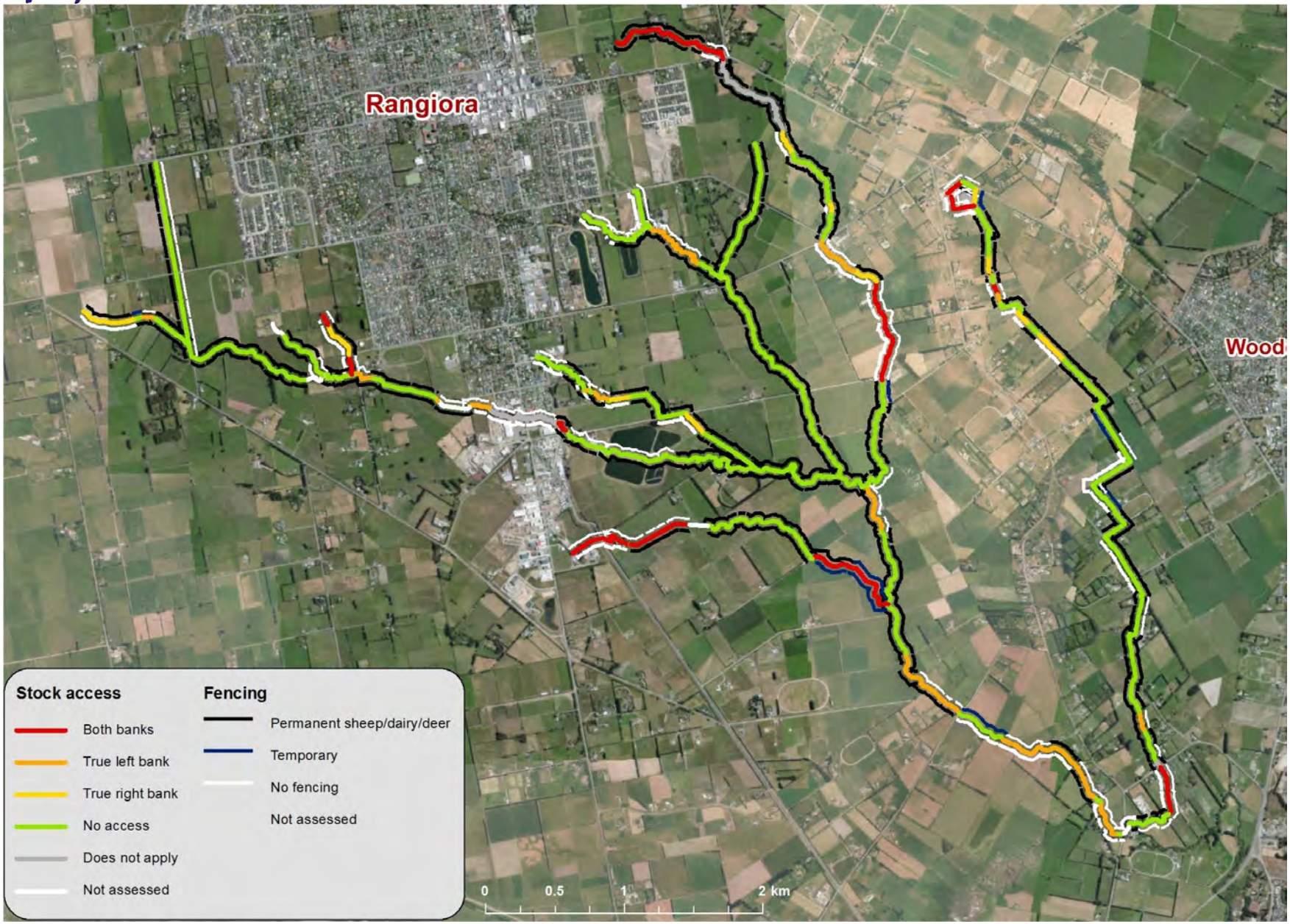
Appendix 3: ECan stream walk maps




Rangiora
Woode
Average water depth (m)
0 - 0.05
0.06 - 0.15
0.16 - 0.25
0.26 - 0.40
0.41 - 0.60
0.61 - 0.80
> 0.80
Average wetted width (m)
0 - 0.5
0.6 - 1.5
1.6 - 2.5
2.6 - 4.0
4.1 - 7.0
7.1 - 10.0
10.1 - 20.0
0
0.5
1
2 km


Rangiora
Woode
Fine sediment cover
Meets LWRP outcome (≤ 20 %)
Does not meet LWRP outcome (> 20 %)
Not assessed or unknown
0
0.5
1
2 km


Rangiora
Wood
Critical Source Areas
Bank slumping/collapse
Overland flow path
Rill/gully erosion
Bed/bank scour associated with a localised discharge
Sediment-laden discharge
0
0.5
1
2 km


Rangiora
Wood
Stock access
Both banks
True left bank
True right bank
No access
Does not apply
Not assessed
Fencing
Permanent sheep/dairy/deer
Temporary
No fencing
Not assessed
0
0.5
1
2 km


Rangiora
Woodend
Emergent Macrophyte Cover
≥30%
0-29%
0
0.5
1
2
Km

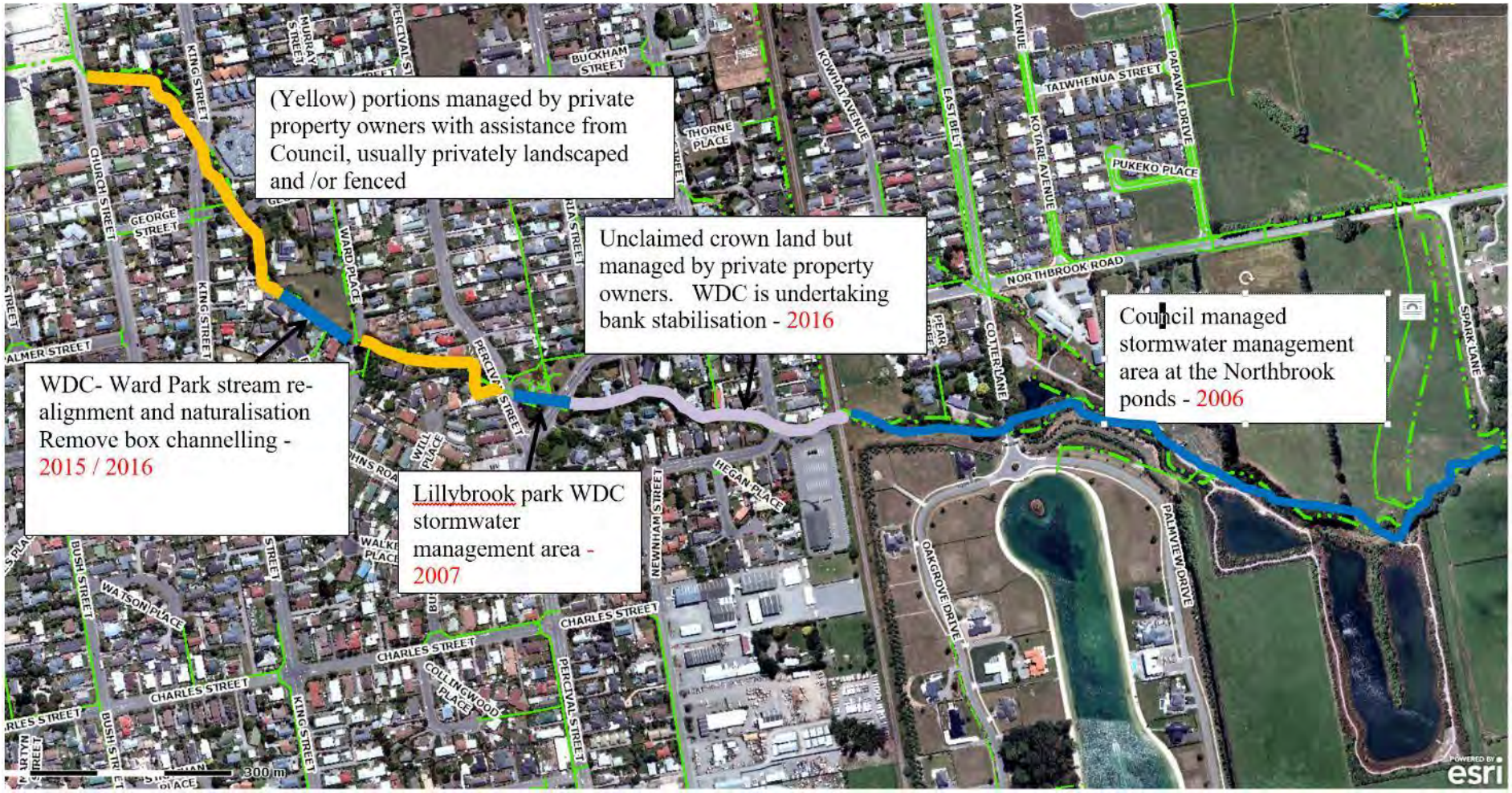
Appendix 4: WDC waterway work maps

North Brook (Spring Heads originating at North West of Town) to Dudley Park

Legend

- Sediment traps
- Bed raking
- Privately owned / maintained
- Council owned / maintained
- Feature riparian planting
- Bank reshaping

North Brook Dudley Park to Northbrook Ponds

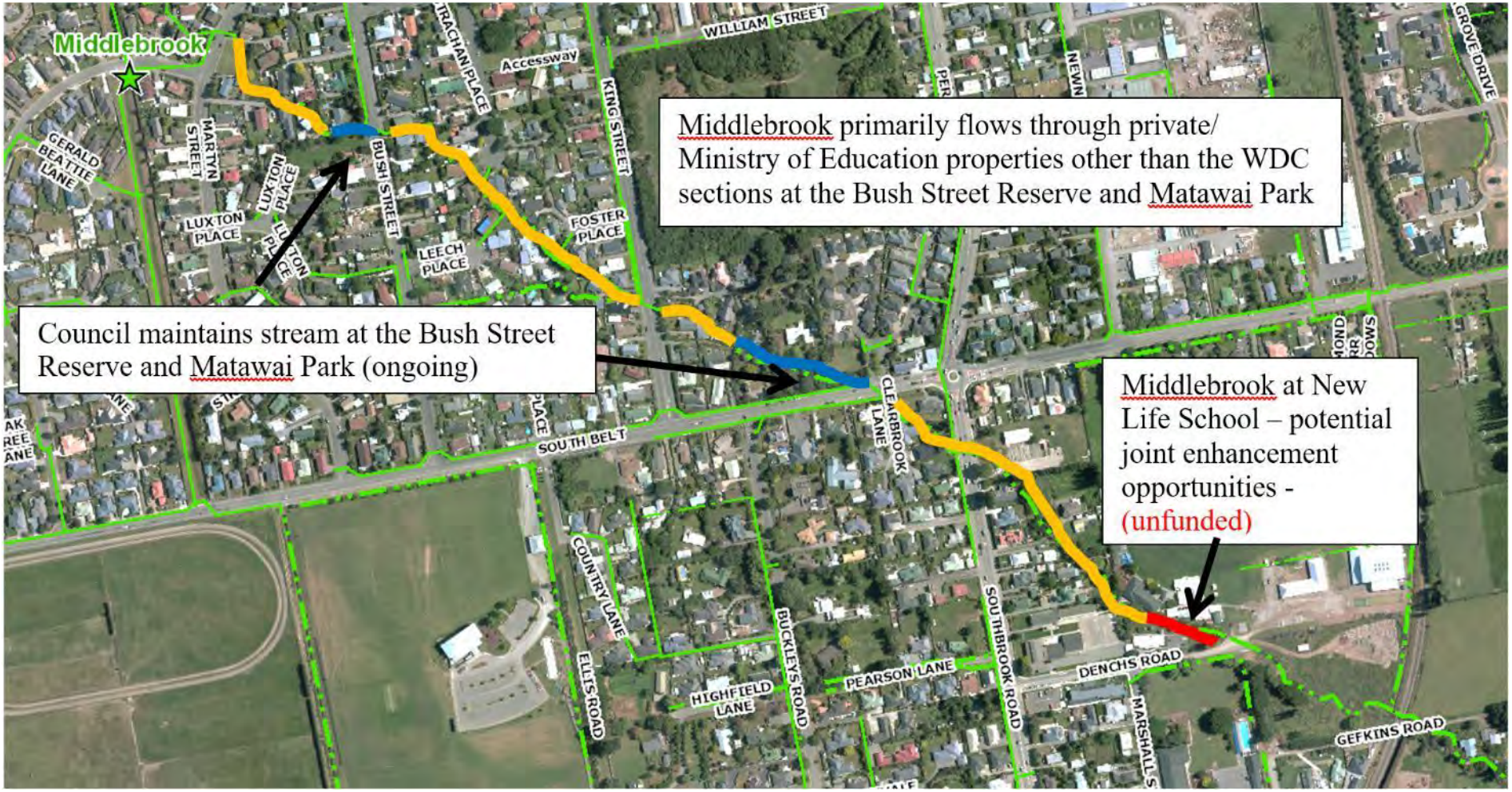


North Brook and Crayfish Creek tributary

Middle Brook

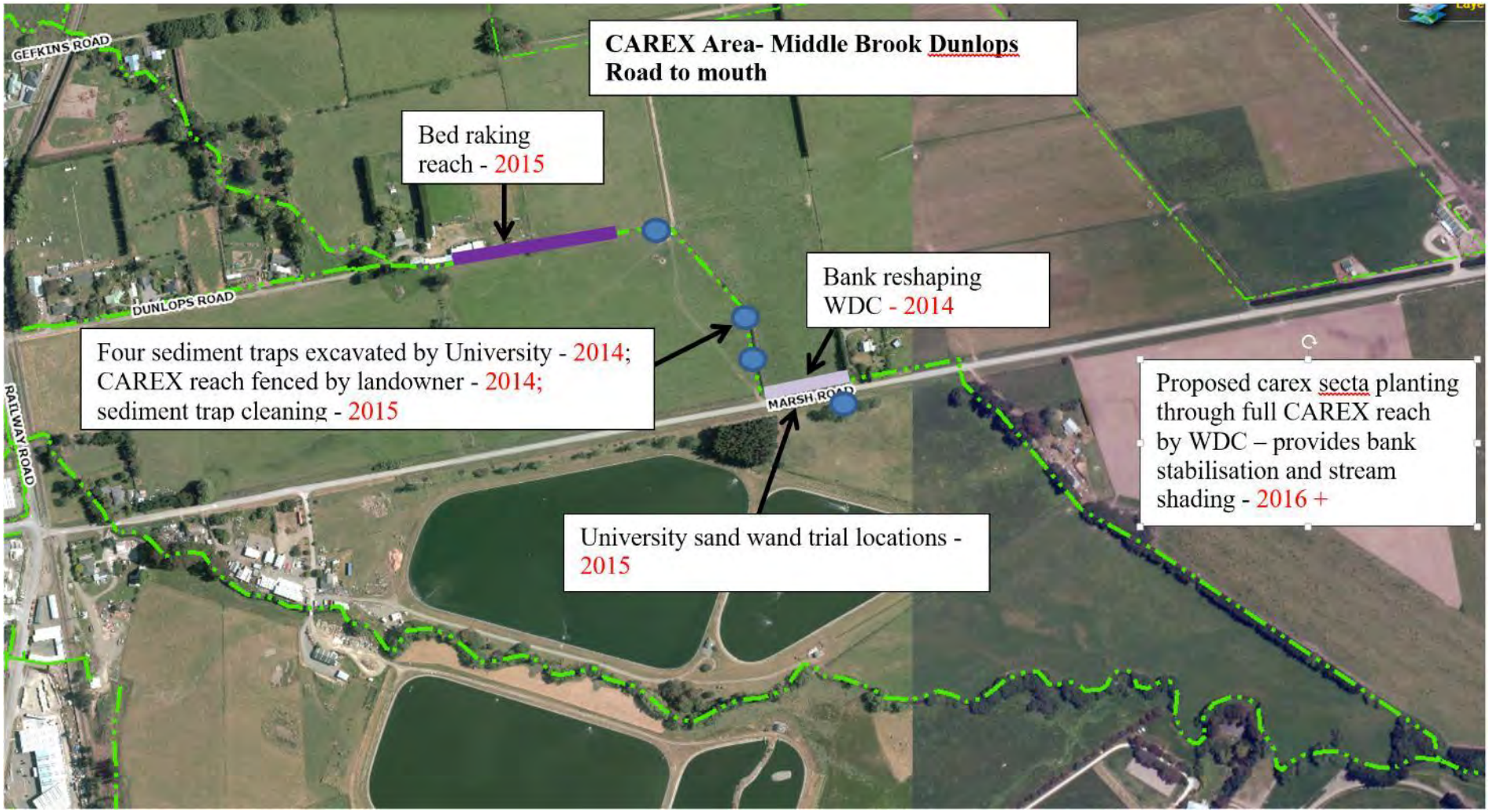
Legend

Sediment traps
Bed raking
Privately owned / maintained
Council owned / maintained
Feature riparian planting
Bank reshaping



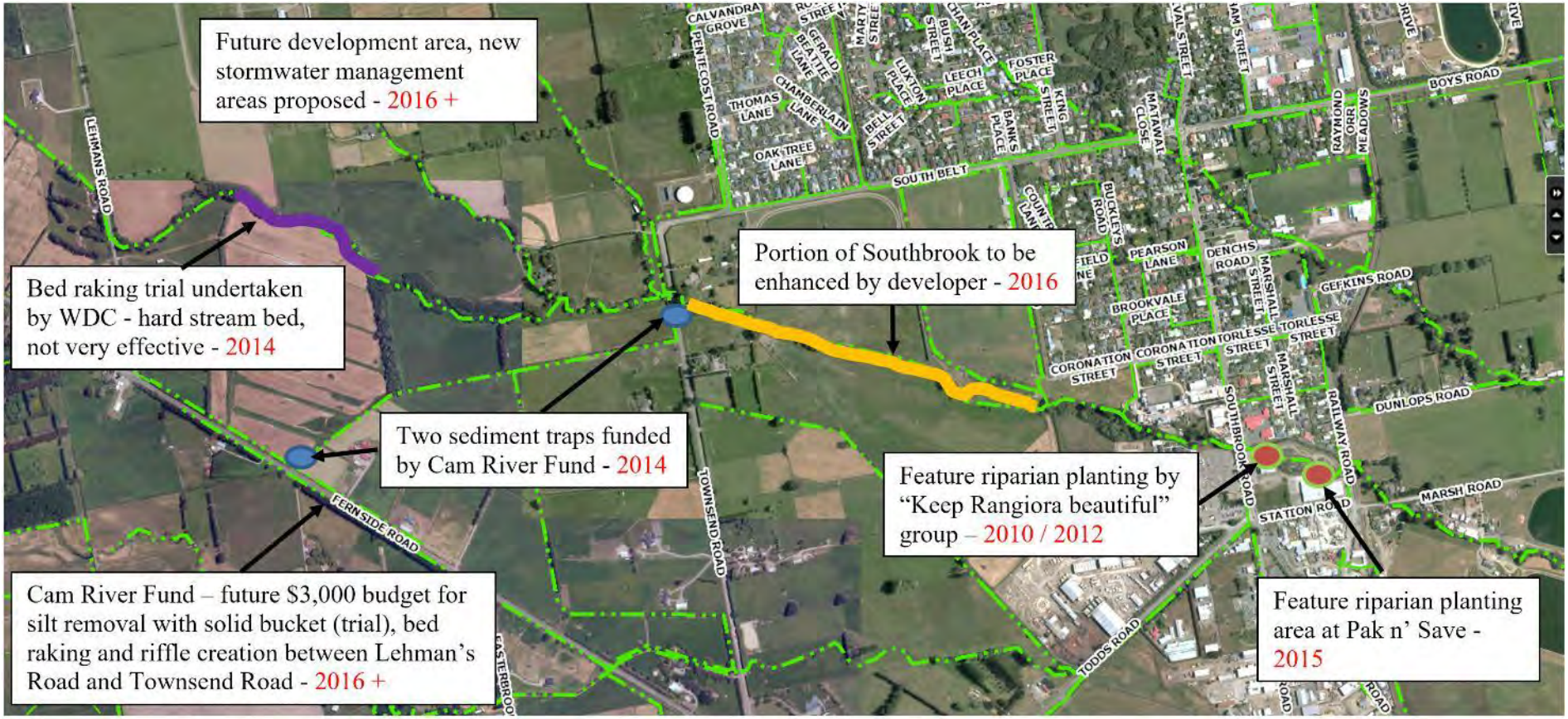
Middle Brook Denchs Road to above Dunlops Road

Middle Brook CAREX reach

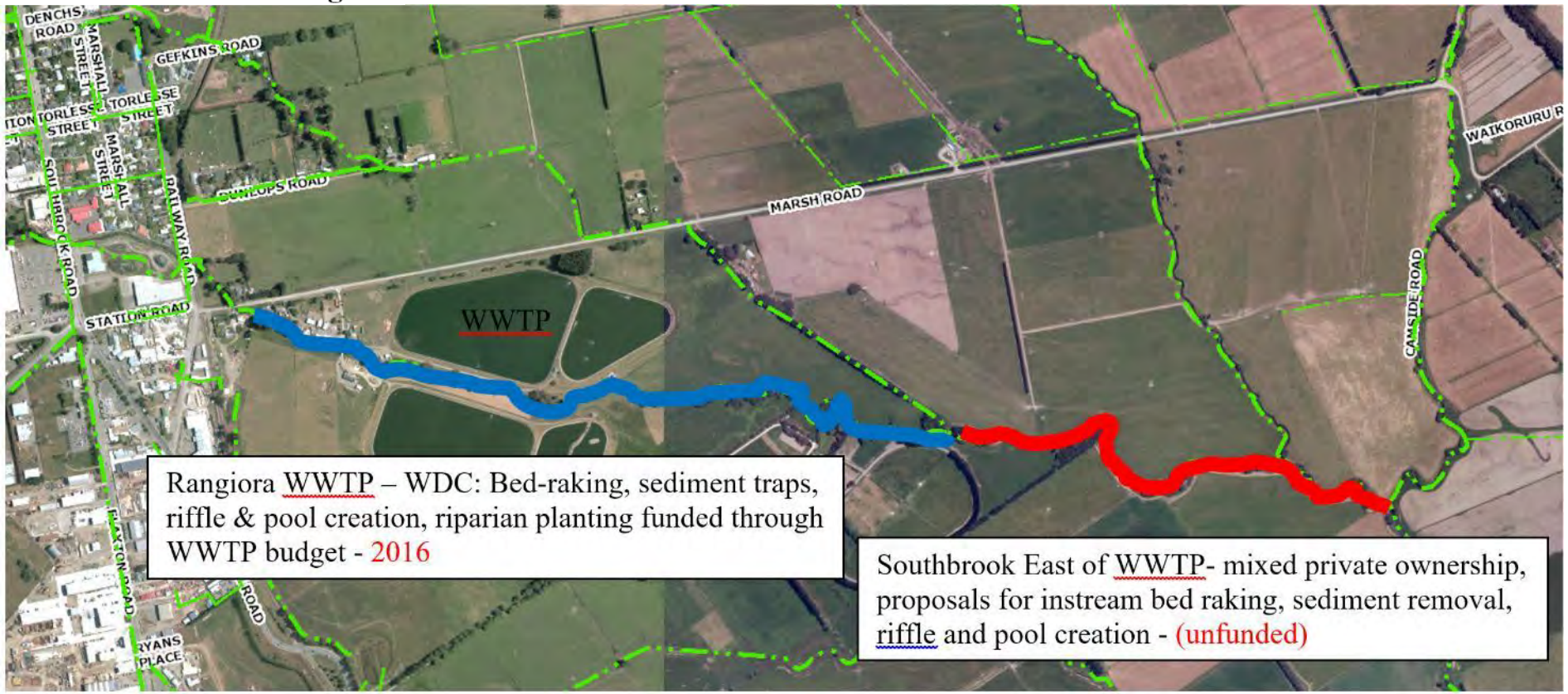


Southbrook West of Rangiora

Sediment traps
Bed raking
Privately owned / maintained
Council owned / maintained
Feature riparian planting
Bank reshaping

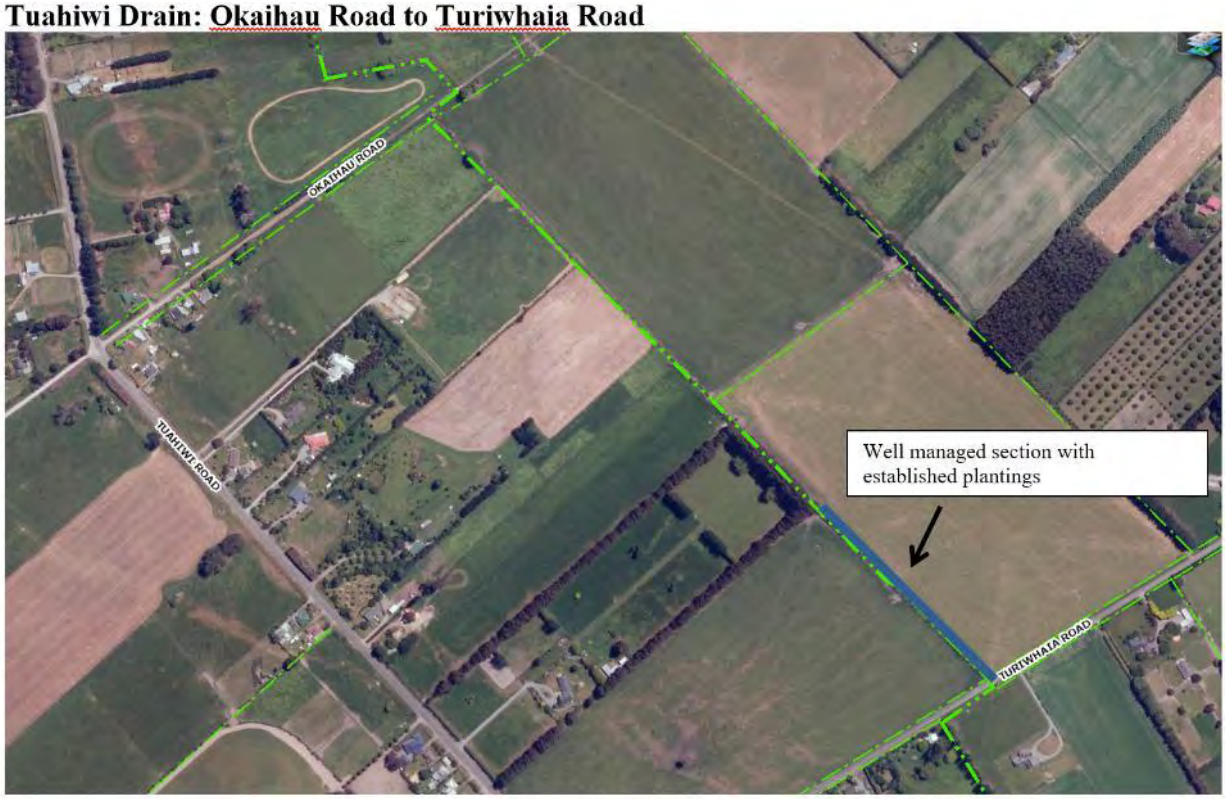


South Brook East of Rangiora



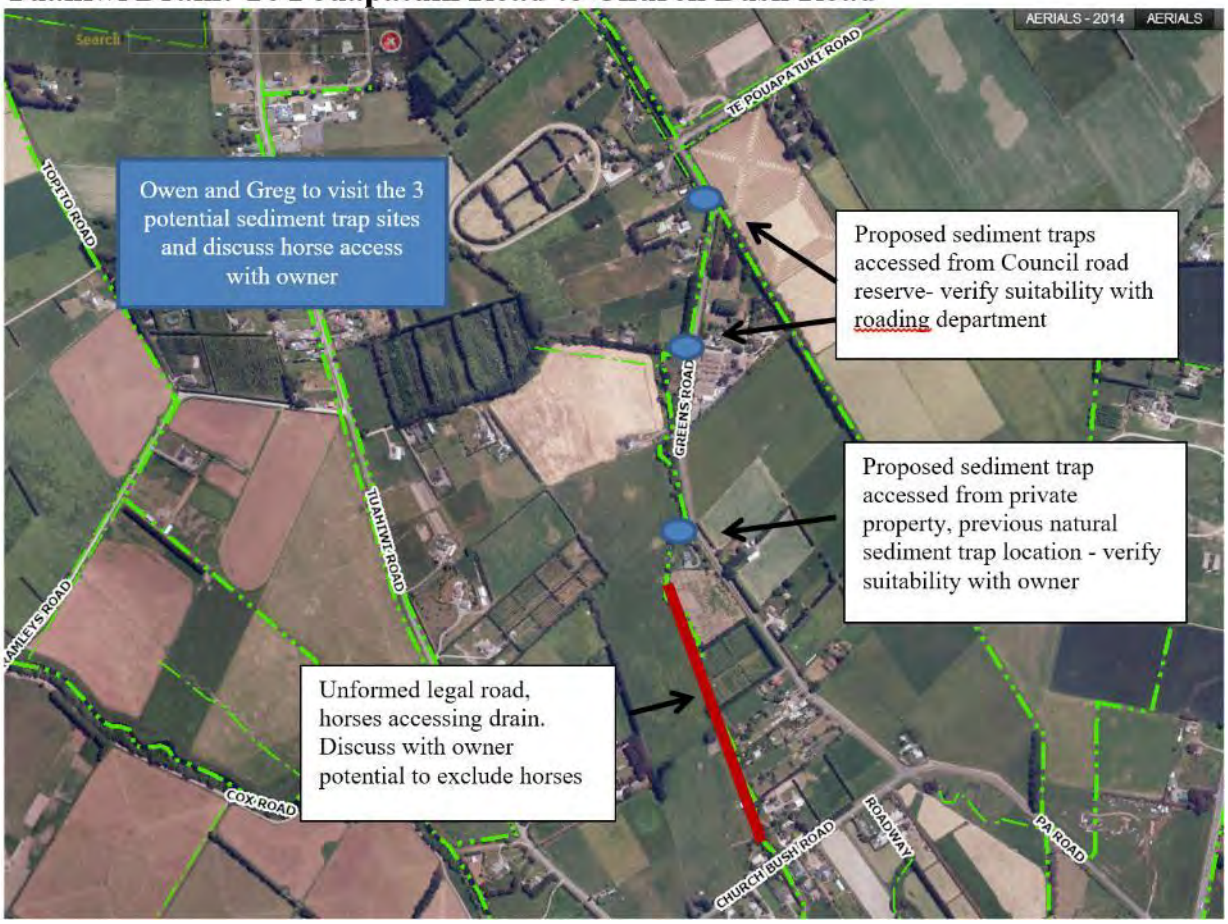
Tuahiwi Drain: Rangiora Woodend Road to Okaihau Road

Tuahiwi Drain: Okaihau Road to Turiwhaia Road

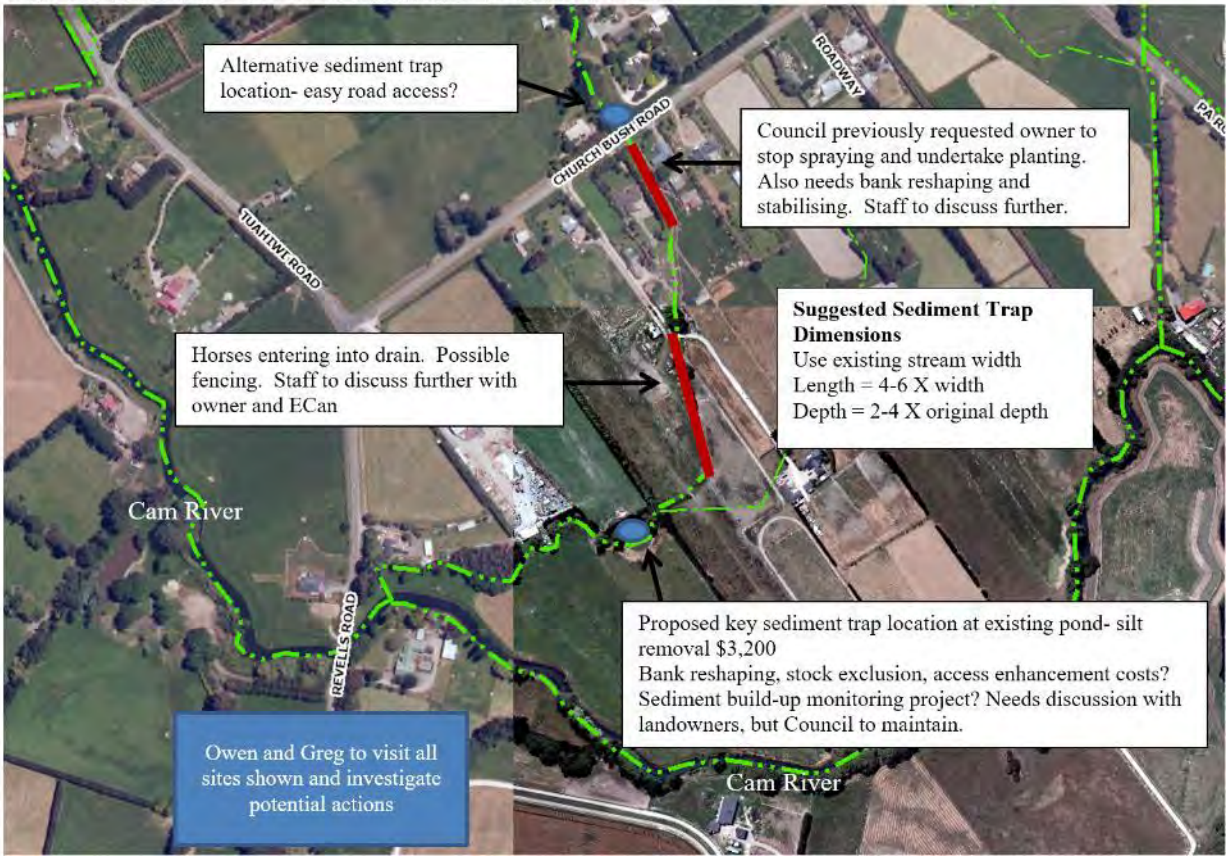


Tuahiwi Drain: Turiwhaia Road to Te Pouapatuki Road

Tuahiwi Drain: Te Pouapatuki Road to Church Bush Road



Tuahiwi Drain: Church Bush Road to Revells Road



Appendix 5: Tuahiwi Stream (Maori Drain)

Citation: Hudson, H.R. 2013. Drainage rehabilitation and low impact development: issues and options for Maori Reserve 873. Environmental Management Associates, Christchurch, Report 2013-01 for Waimakariri District Council. 112 pages.

Abstract

Waimakariri District Council (Council) is exploring options for a District Plan Change to provide the opportunity for additional housing and related living activities on Maori Reserve 873. As part of the proposed consultation and discussion, existing surface water drainage related issues of the 6.2 km Maori Drain are reviewed and management options are recommended.

Maori Drain is in a degraded state with limited aesthetic and ecological values. The objectives are to protect and enhance these values, while retaining drainage efficiency and lowering long term maintenance costs. Proposed measures are to control generation of sediment and contaminants from the catchment and channel, to trap and treat sediment and contaminants with buffers, bank reshaping and planting, and by removing excessive fine sediment deposits from the drain bed. Performance based management measures are required.

In addition, options to selectively rehabilitate elements of a natural watercourse are recommended, and management measures to protect the watercourse and receiving waters with future development of the 1068 ha Reserve are proposed. These measures include creating wetlands, green corridors and low impact development.

Maori Drain has been a notable source of sediment and contaminants; hence the measures proposed for the drain are an important element of the rehabilitation of the Cam and Kaiapoi rivers. These recommendations are also consistent with the Kainga-Nohoanga concept and scoping report for development of the Reserve and with the urban development strategy for greater Christchurch.

The greatest hurdles are not technical, but socio-economic. Clearly there are significant costs associated with extensive riparian planting, bank reshaping and channel works. The recommended actions may be at least partially funded through existing initiatives. However, the biggest hurdle may prove to be social. Maori Reserve 873 consists of multiple small holdings and owners and it may be difficult to achieve a common vision to enhance and rehabilitate the aquatic environment in a catchment context.

This report acknowledges the partnership Council has with Ngai Tuahuriri.

Conclusions and recommendations

Maori Drain is degraded because of excessive fine sediment and contaminants; and this situation is likely to continue unless further action is taken. It is futile to attempt to enhance or rehabilitate the drain unless inputs of sediment and contaminants are controlled. Specifically, to protect and enhance the existing drain the following are recommended:

1. **Catchment management:** Reduce inputs of sediment and contaminants from existing land uses by applying upland runoff, erosion and sediment control measures; and improved land use management practices.

2. **Riparian management**: Reduce inputs of sediment and contaminants with more extensive buffer strips; stabilise channel banks with reshaping and plantings; and control stock access to waterways (to prevent bank collapse and bed disturbance and prevent livestock defecation in watercourses).
   Site investigations are required to identify and prioritize critical sites for the establishment of riparian buffers, bank reshaping and streamside planting.

Even if inputs are significantly reduced, existing extensive fine sediment deposits will probably continue to limit aquatic habitat and amenity values for decades. Flushing flows are limited in this groundwater dominated drain, but bed disturbance and minor increases in flow cause plumes of sediment to be resuspended and move downstream. A continued management focus on weed control in the lower two thirds of Maori Drain will not in itself address these issues. To improve habitat and amenity values, and optimize drainage management, the following enhancements are recommended (once recommendations 1 and 2 have been given effect to and sediment inputs are under control):

3. **Sediment removal**: Remove excessive fine sediment deposits from Maori Drain.
4. **Drainage efficiency management**: Performance based management criteria should be developed to determine drainage outfall requirements, and work windows should be used to determine the most appropriate time for drainage maintenance.

Maori Drain was constructed to dewater extensive swamps, with a focus on hydraulic efficiency. The drain is typified by long straight sections, steep sides, a flat base and shallow slow moving water. Although the removal of fine sediment from the drain will be an enhancement (recommendation 3), there is an opportunity to rehabilitate aspects of a natural stream and trap and treat sediment and contaminants The objectives are to improve aeration and habitat, create threads of higher velocity to maintain a weed and fine sediment free corridor, and to trap and treat sediment and contaminants in selected areas to limit downstream spread. Specifically:

5. **Channel naturalisation**: Selectively create pool-riffle bed forms and a more asymmetric, sinuous channel pattern.
   At one end of the spectrum this may be an extension of the sediment removal recommended in 3, involving redistributing bed material with a weed rake within the existing channel corridor.
   A greater level of naturalisation would be construction of linear wetlands in two stage channels with linear wetlands to trap and treat sediment and contaminants in Maori Drain. These linear wetlands may be incorporated into the bank reshaping and riparian planting (recommendation 2).
   At the upper end of the spectrum a meandering channel could be constructed along the existing alignment or in a different position.
6. **In-channel trap and treatment:** Control downstream movement of sediment and contaminants with traps and filters. Deep pools can be constructed as sediment traps (as part of recommendation 5) and several existing pools can be enhanced and managed as sediment traps.
7. **Tributary wetlands**: Construct wetlands to trap and treat sediment and contaminants from tributary surface and subsurface drains.

The viability of any of these measures is dependent on controlling the generation of runoff and sediment and contaminants from the rural landscape and with urban development. These measures are central to low impact design. Creating a naturalised stream corridor of channels and wetlands would be an integral component of the green infrastructure connections for the built environment.

The proposed measures are an important element of the rehabilitation of the Cam and Kaiapoi rivers, and are consistent with the concepts underlying the Kainga-Nohoanga proposal for the Reserve and the urban development strategy for greater Christchurch.

Cam River Enhancement Fund Subcommittee

MINUTES OF MEETING

DATE: 24 August 2017, 4.00 pm
VENUE: Rangiora WDC, Committee Rooms
CHAIRPERSON: Clr. Sandra Stewart (Cam River Working Party),
ATTENDEES: Anna Veltman (Environment Canterbury), Andrew Arps (Ecan), Arapata Reuben (Ngai Tuahuriri), Grant Edge (Waimakariri Zone Committee), Clr. John Meyer (WDC Councillor), Clr. Kevin Felstead (WDC Councillor), Scott Pearson (Fish and Game), Owen Davies (WDC), Janet Fraser (WDC), Greg Bennett (WDC), Martin Pinkham (Kaiapoi-Tuahiwi Community Board), Denise Clark (Secretary WDC)
GUESTS: Jason Butt (Ecan) and Dr. Henry Hudson, Kalley Simpson (WDC)
APOLOGIES: None

Apologies accepted as true and correct

Moved: Clr. John Meyer ***Seconded : Clr. Sandra Stewart***

Carried

The minutes of the meeting of the Cam River Enhancement Fund Subcommittee held in the Rangiora Council Chambers on 26th May 2017 were confirmed as a true and correct record.

Moved: Clr. John Meyer ***Seconded: Clr. Sandra Stewart***

Carried

1. ***Update from Environment Canterbury staff on new Middle Brook Immediate Steps Application from CAREX***

   a) A copy of the Carex Report was tabled. Jason talked about rebattering a section of the Middle Brook, adding additional sediment traps with ongoing monitoring afterwards. Funding is sought to move fences and plant supply as well as to maintain plants. The cost is $102,000 in total.

DISCUSSION:

- Clr. Stewart said it should go directly to Immediate Steps and recommends we put this aside for consideration at a later date.
- Grant Edge agrees it should go to the Zone Committee first as he has concerns that it looks like we are redoing some straight sections of the stream. It doesn't solve the sediment issues.
- Scott Pearson raised some concerns over the removal of the Hawthorne's hedge as part of the project, as this may be a loss of Koura habitat.
- This group is supportive of intent of the project and will review at a later time after it has been considered by the Water Zone Committee.

Moved: Clr. Kevin Felstead ***Seconded: Clr. Sandra Stewart***

Carried

2. *Overview of Scoping Strategy by Henry Hudson*

DISCUSSION

- A good discussion was had on using lidar for the pond at the end of the Tuahiwi Stream – the development of this sediment trap would help reduce contamination coming into the Cam River from this point.
- 3 Waters are coordinating the allocation of funds and then the implementation of works that get approved. WDC are coordinating works and projects to benefit the Cam river restoration.
- A new Water Environment Advisor is being sought at Council to help with the coordination of these projects in the future.
- Kalley Simpson said this is the first cut of the budget being allocated today but will need to look at the budget again at the time of allocation. Scott Pearson said we need to make the prioritization a bit clearer.
- Kalley Simpson to provide more detailed costings of the work for the high priority projects as these are further scoped.
- Arapata Rueben has spoken to Tuahiwi Youth and they can help with the monitoring of the waterways.
- Another stream walk would be beneficial.
- Noted that Ecan are using tablet technology now.
- Dr. Hudson would like to see depth of sediment detail included in some of this information.
- The Water NZ Post Graduate Conference being held in November. WDC are tapping into this resource for future monitoring work.

3. *Report from WDC : Proposed Cam River Fund Allocation*

DISCUSSION

- Costing of detailed design is not included in the costs. Kalley Simpson said the design cost estimates in the report are adequate at this stage for some of the smaller sediment traps. WDC's drainage maintenance and minor works consents will cover some of the smaller design works proposed.
- Scott Pearson said 30% funding for expert design still needs to be allocated and take priority before any of these experimental projects.
- A further discussion will be required at a later date to include detailed design and construction costs in the Annual / Long Term Plan for projects which are not funded through the Cam River Fund, and for the detailed design of larger projects that is unable to be funded through the existing drainage budgets.
- Item K in the fund allocation needs to be clarified – to say 30% of total value of the works would be funded from existing drainage budgets.
- Arapata Reuben is in agreement with A, B, C and (E) – more than exceeded. Vision statement is too wordy. Bullet point 7 – Downstream of Bramleys Road is a shortsighted approach to cut it off at this point. (Arapata left at 5.20 pm)

JANET FRASER GAVE THE FOLLOWING OVERVIEW OF THE REPORT:

- Recommendation A - Approves expenditure from the Cam River Enhancement Fund for the following proposed high priority projects:

Project Description	Map Reference	Method and Comment	Estimated Cost
Sediment Traps	ST 1-3	3 Sediment Traps on the Cam Mainstem at / between Boys Road and confluence with the South Brook, at an estimated cost of $2,900 per trap	$8,700
	ST 6-7	2 Sediment traps on the North Brook, estimated cost $2,900 per trap	$5,800
	ST 9	1 Sediment trap on the South Brook, estimated cost $2,900	$2,900
	ST 13	1 sediment trap on the South south Brook, estimated cost $2,900	$2,900
Fine Sediment Removal	FSR 1-4	Fine sediment removal, followed by bed raking in heavily sedimented reaches, estimated cost of $20 per linear metre, at the following: -FSR 1 tributary to the North Brook -FSR 2 North Brook Boys to Marsh Road -FSR 3 South Brook spring head -FSR 4 South Brook downstream of Lehmans Road	$16,600 $20,000 $7,500 $8,000
Drainage Wetlands	DW 1, 3 & 4	3 Drainage wetlands on Cam Mainstem between Marsh Road and Power Road, estimated cost $3,000 each	$9,000
Bank Reshaping	BS 1-3	3 bank reshaping sites on the Cam Mainstem at or downstream of Boys Road, estimated each at 30m length at $85per linear metre (e.g. $2,500 each)	$7,500
	BS 6-8	3 bank reshaping sites on the North Brook ($2,500 each)	$7,500
	BS 9-14	6 bank reshaping sites on the South Brook ($2,500 each)	$15,000
Remediate bed scour from localised discharges	BDSC 1	1 site on the North Brook Cost of $2,500 per site (as for bank reshaping costs)	$2,500
Total			**$113,900**

- Recommendation B – Tuahiwi Stream - $7 ½ k for fencing and planting was out of the $20k not additional to. Reducing the total to $37,000 (see approved projects in following table):

- Recommendation B - *Approves projects currently being scoped by Environment Canterbury for the Tuahiwi Stream, including the following indicative projects and costs (noting a funding pre-allocation of up to $50,000 was previously approved by the Subcommittee) (note – table was updated by Environment Canterbury staff during meeting):*

Project Description	**Map Reference**	**Method and Comment**	**Estimated Cost**
Pasture swale protection	See information from ECan	Rehabilitate 7 pasture drainage swales in stream upper reaches near Rangiora Woodend Road, creating 7 small sediment traps in the pugged drains at the stream confluence, at $1,000 each	$7,000
Sediment Traps	See information from ECan	Expand and maintain 3 existing sediment traps at Greens Road ($1,500 each) and create one new sediment trap at Church Bush Road ($3,000). Work likely to be undertaken in partnership between Environment Canterbury and Waimakariri District Council.	$7,500
	ST 14	Create a major sediment trap and wetland at the large pond at the south end of the stream. Includes fencing and planting alongside adjoining reaches of stream south of Church Bush Road and a reach north of Church Bush Road.	$20,000
Bank reshaping	BS 16	Re-batter eroding banks and vegetate eroding site on Tuahiwi Stream near Te Pouapatuki Road at $2,500 estimate	$2,500
Total			**$37,000**

- Recommendation C - *Notes a pre-allocation of $50,000 is also provided from the Cam River Enhancement Fund for protection of springs in the Fernside area (note: further information may be provided on this proposed allocation by Environment Canterbury).*
- Recommendation C – Protection of springs in the Fernside Area – ECan have not yet begun this work and the Subcommittee note the need to work with the Van Beeks to develop solutions.

Meeting suggested with Ecan and WDC and Fish and Game to discuss a way forward with the landowners. Kalley to organize.

- Recommendation D – removed $7500 from the Tuahiwi Section –
- Recommendation E – Lower priority projects – over $100k of projects identified exceed the value of the Cam River Fund.
- Recommendation F – Beginning in the high priority heavily sedimented reaches of the North Brook and the South Brook.
- Recommendation G – Scope of works Henry covered from Marsh Road to Bramleys but downstream of Bramleys is excluded and also upstream of Marsh Road.
- Recommendation H – Projects in the view of staff to be funded by developers or other contestable funds, private owners or flood response budget.
- Scott Pearson queried when the bank changes are being made is there provision for planting in the budget? Greg uses coconut matting on exposed soils and you can later plant it with natives. The $85 per linear metre should cover planting which has been included in the budget.
- Replace recommendation I and J with new recommendation – Requests staff to bring back a report on the formation of a new Advisory Group, that group can confirm a vision going forward. Consider expanding the consent and focus of this new group out to the wider area of streams. Recommendation to approve A – L. Kalley Simpson to write a report to this committee and then send to Council for approval.

Moved: Clr. Sandra Stewart – Seconded: Clr. Kevin Felstead

Carried

4. ***General Business***

- Martin Pinkham has produced a report of the Cam River Enhancement Structure proposal – provided copies to committee members.
- Clr. Meyer and Clr. Stewart thanked the staff and committee members for their time and efforts put into the Cam River Rehabilitation project.
- Going forward Clr. Felstead would like to see a diverse group of people from key environments be included in the next group formed.
- Next meeting to be advised at a later date.

5. ***Meeting Closed 5.56 pm***

Adrienne Smith

From: Anita Spencer <aspencer@doc.govt.nz>
Sent: Thursday, 28 September 2017 3:32 PM
To: Janet Fraser
Subject: FW: Cam River Enhancement proposed funding allocations

Hi Janet,
Thanks for the opportunity to make comment on the Cam River Enhancement Funding allocations. I've cc'ed in Rachel Brown who is our RMA advisor just to keep her in the loop and so that you can also contact her if required.

It has been pretty difficult to comment on this at the end of the process without knowing the background. Unfortunately Robin Smith, who I think was the original DOC contact, is away at the moment so I haven't been able to talk to him about it. In order to understand the background more, It would be good to get a copy of the original Environment Court decision and how DOC was involved which has led to this consultation being needed…. so if you can help out with that it would be really appreciated. Has DOC been involved at all over the last 2 years?

I have read through the documents and can make the following broad comments:

- we support the approach taken to use the funding for instream works, rather than on riparian restoration which could be done as a second stage.
- support protection of the spring heads
- It is difficult to comment effectively as with the current information we don't know what freshwater values have been identified, or how the current work intends to protect and enhance them.
- Is there a plan for how you will protect fish at the sites where work is going to be undertaken, salvage, net off area and release upstream?
- Are you aware of the work that Carex (Canterbury University Freshwater Group) are doing which is work and research on second stage ditches? Also there is work down in the Waituna lagoon which is similar to what is planned.
- If we were to get our freshwater scientists to review this they would need more time to read the background documents and get familiar with the project and comment on the proposed works
- Suggest that some of the work may need to be prioritised if costs turn out to be more than suggested
- Suggest that landowners be seen as a valuable resource of how riparian restoration be actioned

Please let me know if you have any questions in regards to the above comments

Ngā mihi
Anita

Anita Spencer
Senior Ranger

Phone 03 341 9109 / 027 542 8056
Mahaanui Office/Department of Conservation/31 Nga Mahi Rd/Sockburn/Christchurch
PO Box 11089/Sockburn 8443/ Christchurch

Janet Fraser
Project Delivery Unit
Waimakariri District Council
Private Bag 1005, Rangiora 7440

13 October 2017

Dear Janet,

Fish and Game Approval of Cam River Enhancement Fund Expenditure

On behalf of the North Canterbury Fish and Game Council, I am pleased to provide Fish and Game approval for the proposed expenditure of funds from the Cam River Enhancement Fund.

A condition of the Environment Court decision was that Fish and Game provide its approval, therefore I have set out our broad reasons for support in this letter. I am also aware that the Department of Conservation has provided its support with some further suggestions for the project implementation phase.

My role as Environmental Advisor, has included membership of the Cam River Enhancement Committee since late 2012. During this time, I have actively participated in strategic and technical discussions, culminating in the Scoping Strategy investigation by Dr Henry Hudson.

I believe the Committee has been thorough in its assessment of the opportunities afforded by this fund and has gained sufficient technical information to adopt the scoping recommendations in Dr Hudson's report and the subsequent high priority projects list, as prepared by Waimakariri District Council staff.

There is some flexibility provided for the effective implementation of these projects, given that priorities and costs may be subject to change. Fish and Game's approval is on the basis that any major deviations from the current recommended projects will occur in close consultation with the Cam River Enhancement Committee.

I wish to thank Sandra Stewart for her excellent Chairing of the Committee and the efforts of fellow committee members and Waimarkariri District Council staff.

It will be very pleasing to see the Cam River and its tributaries receive some important rehabilitation work and I look forward to seeing the results.

Kind Regards

Scott Pearson
Environmental Advisor
North Canterbury Fish and Game

Statutory managers of freshwater sports fish, game birds and their habitats
North Canterbury Fish and Game
PO Box 50 Woodend 7641, North Canterbury, New Zealand
Telephone: (03) 313 5728 or 0800 347426 Email: northcanterbury@fishandgame.org.nz
www.fishandgame.org.nz

WAIMAKARIRI DISTRICT COUNCIL

REPORT

FILE NO and TRIM NO:	DRA-21 / 171012110892
REPORT TO:	Council
DATE OF MEETING:	24 October 2017
FROM:	Greg Bennett, Land Drainage Engineer
SUBJECT:	CAREX report on glyphosate
SIGNED BY: **(for Reports to Council or Committees)**	Department Manager / Chief Executive

1. SUMMARY

1.1. The purpose of this report is to present the CAREX report entitled "Persistence and ecological consequences of glyphosate to control aquatic weeds in Waimakariri lowland waterways".

1.2. The aims of this study were to investigate the persistence of glyphosate in the stream water and sediment following spraying and the effect of glyphosate on the freshwater invertebrates and fish in sprayed waterways.

1.3. The work found that glyphosate was present in the water column for 1-2 days following spraying, but quickly bound to sediment and broke down. It also found that Freshwater invertebrates and fish were not affected by the use of glyphosate to control emergent macrophytes.

Attachments:

i. Persistence and ecological consequences of glyphosate to control aquatic weeds in Waimakariri lowland waterways. TRIM 171011110252
ii. Environmental Protection Authority About Glyphosate Information Sheet TRIM 171012110889
iii. Glyphosate 510 Label TRIM 171012110888

2. RECOMMENDATION

THAT the Council:

(a) **Receives** report No. 171012110892.

(b) **Notes** that CAREX study did not detect any short term effect of glyphosate on freshwater invertebrates and fish following spraying of waterways.

(c) **Notes** that a follow up report on the wider use of glyphosate by Council and future maintenance provisions will be presented to Council as part of the LTP process.

(d) **Circulates** this report to the Community Boards, Drainage Advisory Groups and the Waimakariri Water Zone Committee for their information.

3. ISSUES AND OPTIONS

3.1. The Council at its meeting on the 6th of September 2016 (TRIM 160929100894) made the following resolutions:

THAT the Council:

(a) **Receives** report No. 160805077062.

CARRIED

(b) **Notes** the responses to a Council request for information on the effects of use of glyphosate on public health and the environment from the Environmental Protection Authority (TRIM 160812081280), Ministry of Health (see TRIM 160815081517) and Ministry for the Environment (160823085124).

CARRIED

Against Councillor Atkinson

(c) **Notes** the report by Dr Wayne Temple, commissioned by the Environmental Protection Authority on "*Review of the Evidence Relating to Glyphosate and Carcinogenicity, published August 2016"* concluded that **"***based on a weight of evidence approach, taking into account the quality and reliability of the available data – glyphosate is unlikely to be genotoxic or carcinogenic to humans and does not require classification under HSNO as a carcinogen or mutagen".*

CARRIED

Against Councillor Atkinson

(d) **Notes** that based on the information received to date, it is unlikely that the use of glyphosate by the Council would pose a risk to public health and the environment.

LOST

(e) **Notes** the CAREX study in the Cust Main Drain and tributary drains proposes to collect stream bed sediment and water chemistry samples and undertake fish and invertebrate population counts pre and post glyphosate spraying to assist to identify any effects of glyphosate on the distribution of aquatic species in the study reach.

CARRIED

(f) **Notes** that Council spraying programmes using glyphosate will continue at locations where this was previously used and the programme will be reviewed again pending receipt of further advice from the Parliamentary Commissioner for the Environment and results of the CAREX study.

CARRIED

Against Councillors Atkinson, Faass, Meyer

(g) **Requests** staff prepare a further report on the following: 1) results of the CAREX trial; 2) any further advice from the Parliamentary Commissioner for the Environment.

CARRIED

(h) **Circulates** this report to the Kaiapoi, Rangiora and Woodend-Ashley Community Boards and the Oxford Eyre Ward Advisory Board and the Waimakariri Water Zone Committee.

CARRIED

3.2. The CAREX report and this cover report is in response to the request (g) above.

3.3. The Parliamentary Commissioner for the Environment acknowledged the request for information regarding glyphosate but no other correspondence has been received.

3.4. In response to the Council's request on the 6th of September 2016 the Waimakariri District Council partnered the Canterbury Rehabilitation Waterway Experiment (CAREX) in a trial to understand the persistence of glyphosate in stream water and sediment and its short-term effects on freshwater invertebrates and fish following spraying of waterways.

3.5. The trial was conducted over the summer of 2016 – 2017 along five different waterways within the Waimakariri District. In each waterway an upstream reach was left as an unsprayed control and a downstream reach was sprayed. Water quality, macroinvertebrate and fish samples were collected in each reach before and after spraying. The CAREX Report presents the findings of this trial.

3.6. The work found that:

3.6.1. Glyphosate was present in the sediment before spraying had even started.

3.6.2. Glyphosate was present in the water column for 1-2 days following spraying, but quickly bound to sediment and broke down.

3.6.3. Freshwater invertebrates and fish were not affected by the use of glyphosate to control emergent macrophytes.

3.7. It was concluded that as these drains are highly modified environments, invertebrates and fish that continue to occupy them are tolerant of water quality in these systems.

3.8. A previous report titled; Professional Opinion on the Impact of Glyphosate on the Kaiapoi River was presented to Kaiapoi Community Board 20 June 2016 (TRIM 160608053721). This work concluded that it is unlikely that glyphosate has contributed to the die-off of aquatic plants observed in the Kaiapoi River over 2012-2016.

3.9. There have been other concerns regarding the risk of exposure to glyphosate on human health. These concerns are not specifically covered in this report.

3.10. Additional background information on glyphosate is provided as attachments ii and iii.

3.11. A follow up report on the wider use of glyphosate by Council and future maintenance provisions will be presented to Council as part of the LTP process.

3.12. The Management Team has reviewed this report and supports the recommendations.

4. COMMUNITY VIEWS

4.1. The Kaiapoi Community Board at its meeting on the 20th of June 2016 (TRIM 160620057958) recommended the following:

4.1.1. **Recommends** that Council approves the use of mechanical means, rather than spraying, to control weeds in the Council stormwater and roadside drains, and waterways. Notes that mechanical means, rather than spraying Council drains, is estimated to cost an additional $80,000 per year.

4.1.2. **Recommends** that Council declines support for a return to the use of spraying to control weeds in Council drains.

4.2. Kaiapoi resident Michael Bate has been vocal in his opposition to the use of glyphosate making several submissions to the Council and Water Zone Committee. He has distributed flyers and erected billboards.

5. FINANCIAL IMPLICATIONS AND RISKS

5.1. The chemical testing of water samples was funded using existing drainage budgets and cost $13,200.00

5.2. The spraying of the 5 reaches was funded using existing drainage maintenance budgets and cost $1356.60

5.3. The sampling and reporting carried out by CAREX did not incur any cost to the Council.

6. CONTEXT

6.1. Policy

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

6.2. Legislation

Resource Management Act 1991

Section 31

(1) Every territorial authority shall have the following functions for the purpose of giving effect to this Act in its district:

(e) the control of any actual or potential effects of activities in relation to the surface of water in rivers and lakes:

Section 35

i. Every local authority shall gather such information, and undertake or commission such research, as is necessary to carry out effectively its functions under this Act or regulations under this Act.

ii. Every local authority shall monitor (a) the state of the whole or any part of the environment in its region or district;

6.3. Community Outcomes

6.3.1. The air and land is healthy

6.3.2. Core utility services are provided in a timely, sustainable and affordable manner.

6.3.3. There is sufficient clean water to meet the needs of communities and ecosystems

CAREX Canterbury Waterway Rehabilitation Experiment

A project funded by the Mackenzie Charitable Foundation

UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND

Persistence and ecological consequences of glyphosate to control aquatic weeds in Waimakariri lowland waterways

Katie Collins , Jon S. Harding
Corresponding author: carex@canterbury.ac.nz

September 2017

Executive Summary

This study and report was undertaken by researchers from CAREX and no payment was received for this work. Waimakariri District Council paid for commercial analysis of glyphosate and AMPA. The purpose of this study was to understand the persistence of glyphosate in stream water and sediment and its short-term effects on freshwater invertebrates and fish following spraying of waterways.

From December 2016 – March 2017 five waterways near Rangiora were investigated to test the effect of glyphosate on aquatic weeds, stream invertebrates and fish. In each waterway an upstream reach was left as an unsprayed control and a downstream reach was sprayed. Samples were collected in each reach before and after spraying. Glyphosate and AMPA (the product of glyphosate) were already present in the sediment at both the control and spray reaches before spraying even started. This implies that parties other the Council are spraying waterways or nearby areas, and this makes determining the effects of spraying on animal life in these waterways difficult.

Glyphosate and AMPA were present in the water column for 1-2 days following spraying, but glyphosate quickly bound to sediment and broke down to AMPA. Glyphosate and AMPA were still present in the sediment at both the control and spray reaches 14 weeks after spraying. Weeds in the spray reaches were greatly reduced by glyphosate, being reduced from 90% cover to 20%, however 14 weeks after spraying weed cover in these reaches had returned to about 50%. We could not detect any effect of glyphosate on stream invertebrate species richness, metrics such as the MCI and SQMCI or fish. These waterways are highly modified environments, and invertebrates and fish that occupy them are tolerant of water quality in these systems. Given the small sample size (five waterways), the findings of the study are limited and add to our understanding of drain maintenance on aquatic systems.

1. Introduction

Excessive growth of aquatic macrophytes (weeds) is a significant problem in lowland agricultural waterways, including in the Waimakariri District. Management is undertaken by Councils to ensure drainage is maintained, most commonly using mechanical clearance, herbicide spray and hand weeding.

Glyphosate is one of the world's most effective and most frequently used herbicides. It is a non-selective, broad-spectrum herbicide commonly used on emergent (surface dwelling) and marginal (bankside) macrophytes, but following manufacturers instructions, spraying directly on the waterway should be minimised.

Concerns have been raised about the toxic effect of glyphosate on aquatic life. There are also concerns of secondary effects including depleted dissolved oxygen levels and release of nutrients from decomposing plants, and sudden changes in habitat influencing refugia and food sources for aquatic invertebrates and fish.

To respond to public concerns, an investigation was carried out by the University of Canterbury on behalf of the Waimakariri District Council on the use of glyphosate spray to control aquatic macrophytes. This investigation was undertaken between December 2016 and March 2017.

The aims of this study were to investigate:

- the persistence of glyphosate in the stream water and sediment following spraying
- the effect of glyphosate on the freshwater invertebrates and fish in sprayed waterways

2. Methods

2.1. Experimental design

The impact of glyphosate was tested in five waterways. In each waterway an upstream 200m reach was selected which was not sprayed (control reach) and a 200m reach downstream was sprayed (treatment reach). The five waterways were scheduled to be sprayed by the Waimakariri District Council as part of their annual weed control program. They were:

- Ashworths: Ashworths Road Drain, between Mill Road & Main Drain Road
- Ohoka: Ohoka Stream North Branch, between Mill Road & the first gate along the walkway
- Threlkelds: Threlkelds Road, upstream of Main Drain Road
- Easterbrook: Easterbrook Road, upstream of Hicklands Road
- Ashby's: No. 4 Drain, upstream of Hicklands Road

Figure 1: Location of the five waterways used in the spray trial.

A 200m stretch at the top of each reach was left unsprayed as a control reach. Macrophytes were sprayed from the 200m point downstream. Sampling of the control reach was undertaken 100m into the reach, and the spray reach was sampled at 400m (Fig 2).

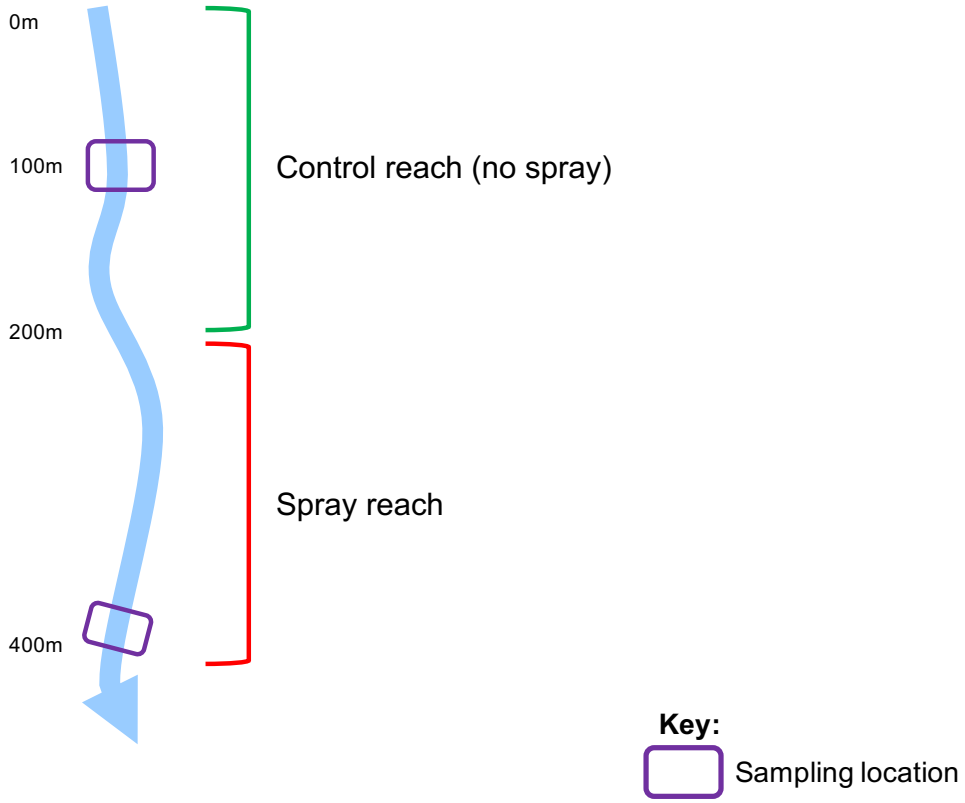


Figure 2: Spray trial experimental design used in all five waterways

Spraying was carried out by the Waimakariri District Council's contractor on 21 December 2016.

2.2. Weed monitoring

At each of the control (100m) and spray (400m) reaches, three macrophyte assessment cross-sections were set up. These cross-sections were measured before the spray trial (pre-spray), and 3, 6 and 14 weeks after spraying (post spray). On each cross-section, aquatic weed species and the height above the water surface were recorded every 10cm across the wetted width of waterway.

2.3. Glyphosate and AMPA sampling of water and sediment

When glyphosate contacts water, there are two major pathways of dissipation: binding to sediments, and microbiological breakdown. When sediments are present glyphosate rapidly binds to soil particles, bacteria and fungi in the water and sediment also breakdown glyphosate into aminomethylphosphonic acid (AMPA). AMPA can remain stable in sediments for some time. We measured both glyphosate and AMPA to better understand the persistence and breakdown time in these streams and sediments.

Glyphosate and AMPA samples of both stream water and stream bed sediment were collected and sent for analysis by AsureQuality (Wellington).

Water samples were collected pre-spray, the day of spraying (both control and spray reaches) and 1 and 5 days post spray (spray reaches only).

Samples of sediment were collected pre-spray (control and spray reaches) and 5 days, 3 weeks (spray reaches only) and 6 weeks post spray (control and spray reaches).

2.4. Aquatic invertebrates

Aquatic invertebrates were collected at both control and spray reaches pre spray, 5 days and 6 weeks after spraying. In each reach a single invertebrate kick-net sample (500 µm mesh) was collected from five representative micro-habitats within the reach using the standard New Zealand protocols (Stark et al 2001). Samples were labelled and stored in 70 % ethanol.

In the laboratory the samples were sieved (500 µm Endecott sieve), and all invertebrates identified to the lowest practicable level (usually genus) using identification guides (such as Winterbourn 2006). Coded abundances of taxa were recorded as described by Stark (1998).

We then calculated several stream health metrics to determine the impact of the spray trial on aquatic invertebrates. The Macroinvertebrate Community Index (MCI) uses the presence or absence of taxa and their tolerance to pollution to indicate stream health. The MCI ranges from 0 – 200, scores of less than 80 indicate a severely polluted system while scores over 120 are considered healthy (Table 1). A second metric called the Semi-Quantitative Macroinvertebrate Community Index (SQMCI) was calculated using the pollution tolerances of taxa present and the coded abundance data. SQMCI's range from 0 – 10. Values less than 4 indicate a severely polluted system while values more than 6 indicate health systems.

Table 1: Interpretation of MCI and SQMCI values.

Water quality	Description	MCI	SQMCI
Excellent	Clean water	> 119	> 5.99
Good	Doubtful quality or possible mild pollution	100 – 119	5.00 – 5.90
Fair	Probable moderate pollution	80 – 99	4.00 – 4.99
Poor	Probable severe pollution	< 80	< 4.00

2.5. Fish sampling

Freshwater fish were sampled with a portable (KAINGA EFM300) electric fishing machine by spot fishing in areas where aquatic weed cover was less than 40%. Electric fishing was undertaken at both control and spray reaches pre spraying and 3, 6 and 14 weeks post spray. However, this was problematic especially prior to spraying as weed cover was extensive and the high weed cover potentially confounded any results. Captured fish were identified to species level where

possible in the field. Very small fry (> 4 cm) were identified to family. Glass eels and elvers (Anguillidae) (>10 cm) were recorded as elvers.

Table 2: Timing of different sample collection over the experimental period.

Days since spraying	**Water samples**		**Sediment samples**		**Macrophyte transects**	**Aquatic Invertebrates**	**Fish**
	Control	**Spray**	**Control**	**Spray**	**Control & Spray**	**Control & Spray**	**Control & Spray**
Pre spray							
Day of spray							
Spray 1 day							
Spray 5 days							
Spray 3 weeks							
Spray 6 weeks							
Spray 14 weeks							

3. Results

3.1. Glyphosate and AMPA in water

Prior to spraying no glyphosate was detected in the water but AMPA was found in water in the control sites. No glyphosate or AMPA were present in the water on the day of spraying at any control (non-sprayed) reaches (Fig 3A & B) whereas both glyphosate and AMPA were present in the water on the day of spraying at all spray (treated) reaches. On the day after spraying, glyphosate was detected in the water at all spray reaches at low concentrations. AMPA was only detectable in the water at the Easterbrook spray reach (Fig 3A & B). Five days after spraying, glyphosate and AMPA were both virtually undetectable in the water at all spray reaches (Fig 3A & B).

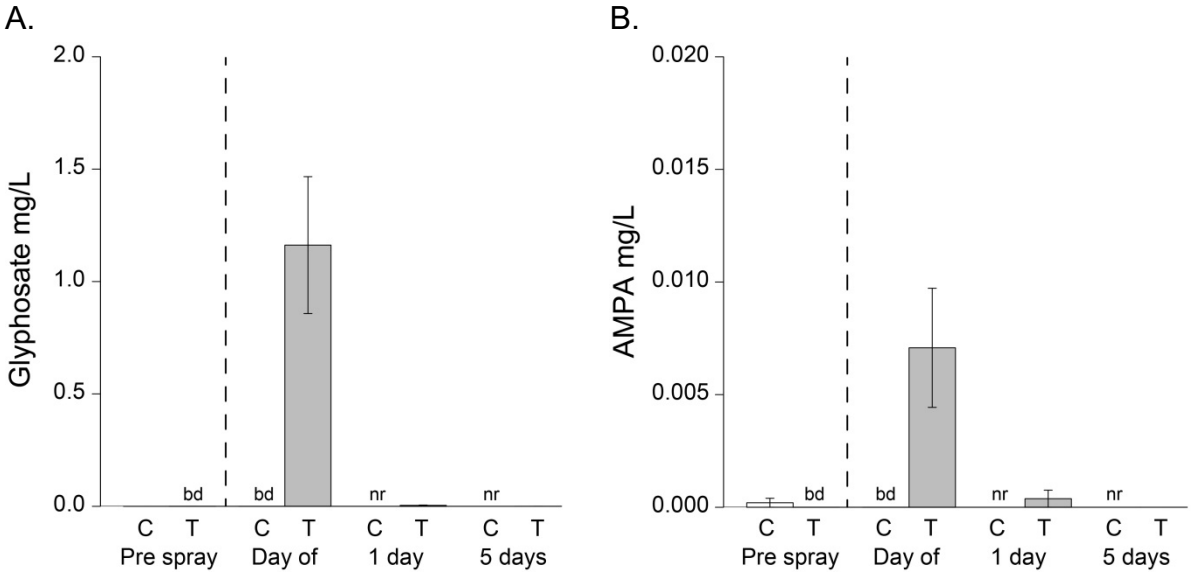


Figure 3: A. Mean glyphosate and B. Mean AMPA concentrations in water pre spraying, on the day of spraying, the day after spraying and 5 days after spraying. Control reaches are shown in white, treated (spray) treated reaches are shown in grey. Time of spraying is indicated by the dotted line. nr = sample not run, bd = sample result below detectable limit. Mean values are shown with ± 1 Standard error.

3.2. Glyphosate and AMPA in sediment

Pre spraying, glyphosate and AMPA were detected in the sediment in both control and spray reaches (Fig 4A & B). Six weeks after spraying, glyphosate and AMPA were still detectable in the sediment in both control and spray reaches (Fig 4A & B).

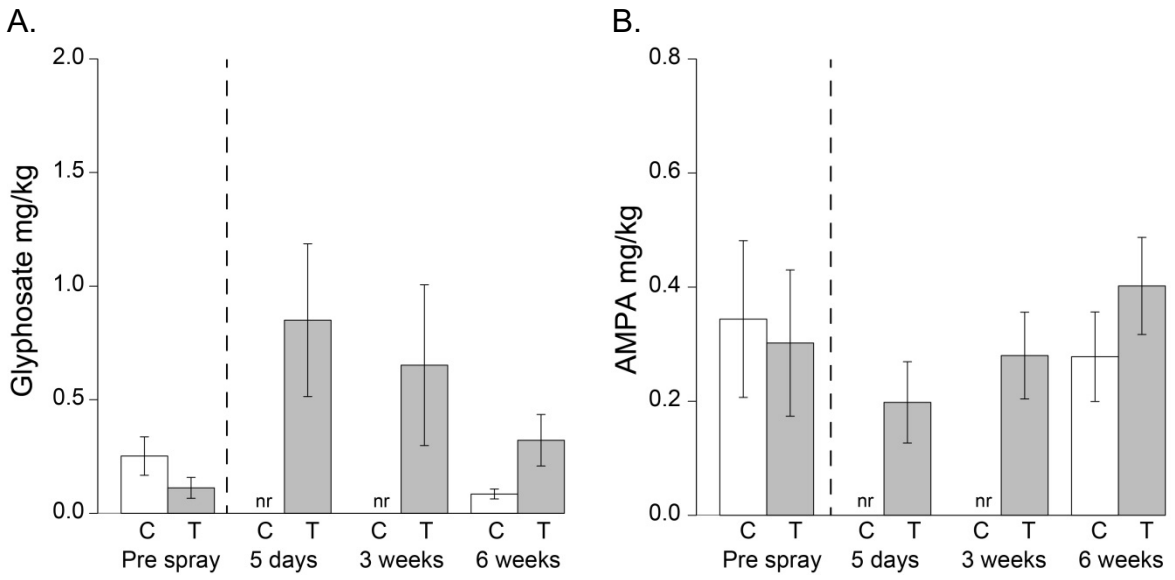


Figure 4: A. Mean glyphosate and B. Mean AMPA concentrations in sediment pre spraying, 5 days after spraying, 3 weeks and 6 weeks after spraying. Control reaches are shown in white, treated (spray) treated reaches are shown in grey. Time of spraying is indicated by the dotted line. nr = sample not run, bd = sample result below detectable limit. Mean values are shown with ± 1 Standard error.

3.3. Aquatic weed cover

Macrophyte cover was between 80 – 100 % pre spraying. Three weeks post spraying, macrophyte cover was greatly reduced in the spray reaches (Fig 5, Photos 1-3). Fourteen weeks post spraying, macrophytes were starting to grow back in sprayed reaches (Fig 5).

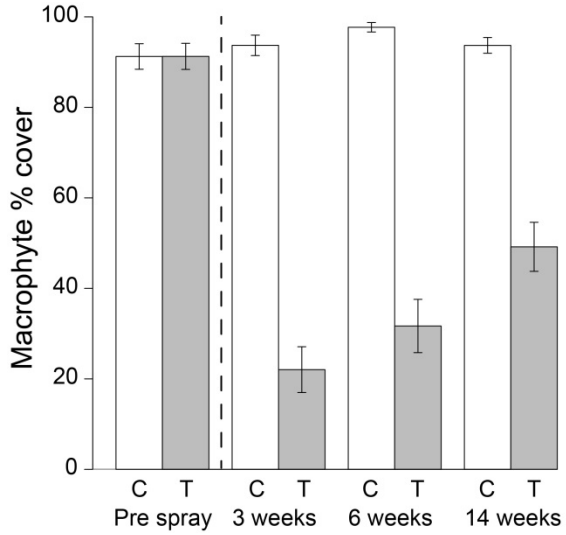


Figure 5: Mean macrophyte percent cover pre spraying, 3 weeks, 4 weeks and 14 weeks after spraying. Control reaches are shown in white, treated (spray) treated reaches are shown in grey. Time of spraying is indicated by the dotted line. Mean values are shown with ± 1 Standard error.

Photo 1: Threlkelds Road site pre spraying

Photo 2: Threlkelds Road control site 3 weeks after spraying

Photo 3: Threlkelds Road spray site 3 weeks after spraying

3.4. Invertebrate species richness, MCI and SQMCI

We compared mean values for invertebrate species richness, MCI and SQMCI and found no difference, suggesting these communities are not affected by the presence of glyphosate in the water or sediment (Fig 6A, B & C). MCI and SQMCI scores at all sites indicated probable moderate levels of pollution.

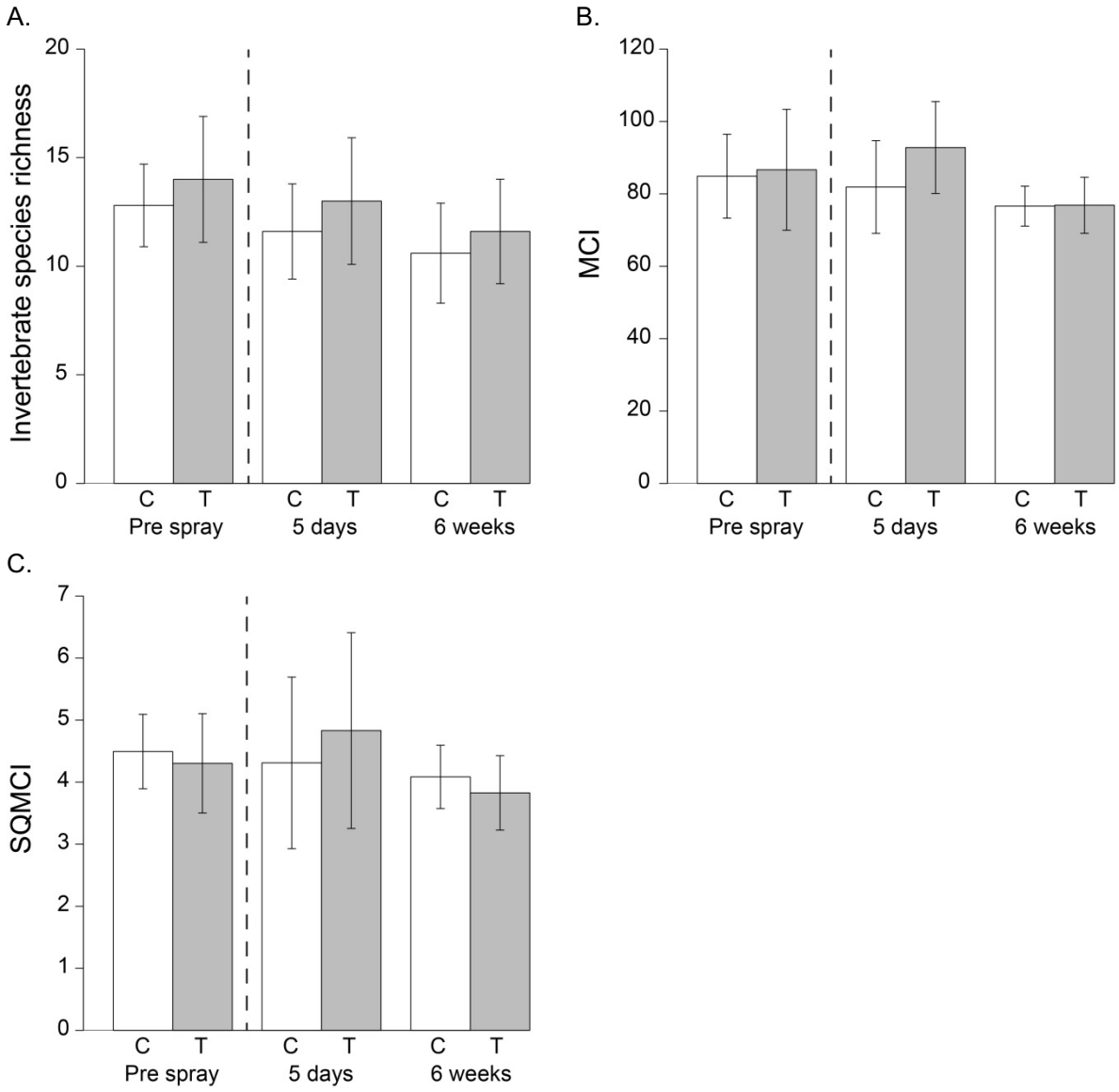


Figure 6: A. Mean invertebrate species richness, B. MCI and C. SQMCI pre spraying, 5 days and 6 weeks after spraying. Control reaches are shown in white, treated (spray) treated reaches are shown in grey. Time of spraying is indicated by the dotted line. Mean values are shown with ± 1 Standard error.

3.5. Fish species richness

Five fish species were observed in the five waterways, including: upland bullies (*Gobimorphus breviceps*), common bullies (*Gobimorphus cotidianus*), shortfin eels

(*Anguilla australis*), one longfin eel (*Anguilla dieffenbachii*) and juvenile brown trout (*Salmo trutta*).

Post spraying no differences were observed in fish species richness despite a declining trend. It seems unlikely individual fish species were directly impacted (Fig 7). Unfortunately, the high weed cover made accurate fish data difficult to collect.

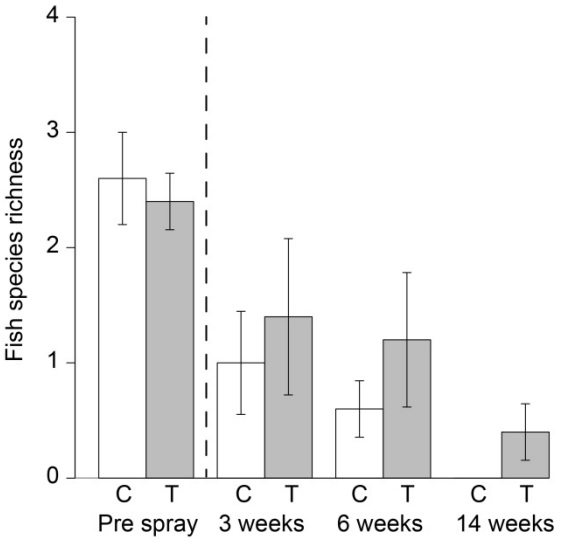


Figure 7: Mean fish species richness pre spraying, 3 weeks, 6 weeks and 14 weeks post spraying. Control reaches are shown in white, treated (spray) treated reaches are shown in grey. Time of spraying is indicated by the dotted line. Mean values are shown with ± 1 Standard error.

4. Final comments

- The purpose of this study was to understand the persistence of glyphosate in stream water and sediment and its short-term effects on freshwater invertebrates and fish following spraying of waterways.
- Glyphosate and AMPA were present in the water column for 1-2 days following spraying, but glyphosate quickly bound to sediment and broke down to AMPA
- Glyphosate and AMPA were already present in the sediment at both the control and spray reaches before spraying even started.
- Glyphosate and AMPA were still present in the sediment at both the control and spray reaches 14 weeks after spraying
- Spraying with glyphosate is an effective way to control aquatic weeds, however effectiveness is short lived and grow back is evident within three months
- Species richness of invertebrates and fish, MCI and SQMCI are not affected by the use of glyphosate to control emergent macrophytes. These drains are highly modified environments, and invertebrates and fish that continue to occupy them are tolerant of water quality in these systems.
- Glyphosate is commonly used for domestic purposes on lawns and gardens, and in agricultural landscapes. There are several ways it can enter waterways, including spray drift and direct runoff from sprayed land.
- This study was not designed to detect the sources of glyphosate in these stream systems. Our results show that either: glyphosate can persist in these systems between periods of drain maintenance, or the glyphosate in the system prior to commencement of this study was from other nearby sources.

5. Acknowledgements

This work would not have been possible without the field assistance of Hayley Devlin, Nicky Glenjarman, Will Keay, Alice West, Catherine Febria, Tina Clapham and Sarah and Nick Collins.
Thank you to Greg Bennett and the Waimakariri District Council for the support of this research, and to the District-appointed contractors who executed the spraying contract.
The glyphosate data presented here were paid for by the Waimakariri District Council.

Environmental Protection Authority
Te Mana Rauhī Taiao

INFORMATION SHEET

About glyphosate

Glyphosate is a chemical used to control weeds. It is a broad-spectrum herbicide that works by inhibiting an enzyme found in plants. Glyphosate-containing substances are perhaps the most common herbicides in New Zealand and world-wide, and are used commercially and around the home. The Environmental Protection Authority (EPA) has approved glyphosate for use in New Zealand.

The use of glyphosate in New Zealand

Glyphosate substances are used in a wide variety of settings, including orchards, vineyards, pastures, vegetable patches, roadways, parks, sports grounds and home gardens. Glyphosate has been used in New Zealand since 1976 and is currently sold under a large number of different brand names.

Under the Hazardous Substances and New Organisms (HSNO) Act 1996, all hazardous substances, such as glyphosate, require approval by the EPA before they can be used in New Zealand. The EPA has approved approximately 60 substances containing glyphosate under this Act.

The Ministry for Primary Industries' Agricultural Compounds and Veterinary Medicines (ACVM) Group had active registrations for 89 glyphosate products under the ACVM Act as of 1 June 2015. (Note: a single HSNO approval can cover more than one ACVM registered product.)

The safety of glyphosate

Based on the EPA's current assessment, people are advised that following the label instructions on all glyphosate products provides adequate protection for users. People should follow the use and safety instructions on all chemical product labels, as these are designed to reduce human exposure to the product and to protect the environment. If the label has been removed or damaged, you can search the manufacturer's website to find the relevant safety information.

How the EPA balances the risks and benefits of glyphosate

The EPA monitors international developments and the latest research available through a wide range of scientific media. In addition to deciding on applications under the HSNO Act to import and manufacture hazardous substances, the EPA also reassesses existing substances to take into account new information.

Reassessments may be initiated by the EPA or by external parties and anyone can apply to have a substance reassessed or reviewed. You can find further details about this on our website.

All glyphosate substances used in New Zealand have been through an approval process, which considers likely impacts on human health and the environment. To reduce the risks posed by glyphosate, we recommend you follow the advice below.

Protect yourself, others, and the environment

Many chemicals we use every day in New Zealand can pose a risk to people or the environment. You can protect yourself, others, and the environment by following the recommendations for using and storing glyphosate.

Using glyphosate safely

When using any chemical, you should start by reading the label. This will tell you the specific risks for the product, and how you can reduce these risks. There are some practices that you should follow any time you use glyphosate:

Before you spray

- Read all instructions on the label and follow them.
- Make sure you are using the right product for the job you are doing.
- Confirm your spray area is not close to water, such as streams, rivers, lakes or ponds.
- Check the weather forecast. Make sure no rain is predicted for at least 24 hours. Avoid spraying when it is windy.
- Clear children and pets from the area, and keep them well away.
- Follow the label advice on the need for protective clothing.

After spraying

- Wash your hands, face and clothing.
- Keep children and pets away until the spray has dried, or for the amount of time indicated on the label.
- Read the instructions on the label to help you safely dispose of any unused product.

Storing glyphosate safely

You should follow these simple recommendations to protect yourself, others, and the environment:

- Keep it locked up and out of reach of children and pets.
- Store the product in its original container.
- Make sure it is kept far away from food, including pet food.
- Dispose of empty herbicide containers and unused herbicides properly.
- Check the label instructions and use-by date before each re-use.

Where can I find out more about glyphosate?

If you need more information, please call 0800 HAZSUBS (0800 429 7827) or email: hazardous.substances@epa.govt.nz.

WARNING
KEEP OUT OF REACH OF CHILDREN
ECOTOXIC

AGPRO

GREEN GLYPHOSATE 510

NON-RESIDUAL HERBICIDE

Active Ingredient: 510g/litre glyphosate as the isopropylamine salt in the form of a soluble concentrate.

NET CONTENTS: 20 Litres
Batch No:
Date of Manufacture:
HSNO Approval number: HSR007811
Registered pursuant to the ACVM Act 1997 No. P5306
See www.nzfsa.govt.nz/acvm for registration conditions.

Registered to and distributed by:
AGPRO NZ LTD
PO BOX 58-963, GREENMOUNT
10 POLARIS PLACE, EAST TAMAKI
AUCKLAND
PH 0-9-273 3456
FAX 0-9-273 3457
Web: www.agpro.co.nz

PRECAUTIONS:

- Store in the original unopened container in a cool dry place, avoiding sunlight and away from foodstuffs and drink containers.
- Do not eat, drink or smoke while using.
- Remove protective clothing and wash hands and face thoroughly before meals and after work.
- Wash protective clothing after work.
- Avoid contamination of any water supply with chemical or empty container.
- Avoid contact with eyes and skin.
- Avoid inhalation of spray mist.
- Toxic to aquatic organisms.

FIRST AID:
• If swallowed do NOT induce vomiting.
• For advice contact National Poisons Centre (0800 POISON 764-766) or a doctor immediately
• If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water.
• If splashed in eyes, wash out immediately with water.

READ PRECAUTIONS BEFORE OPENING
READ THE DIRECTIONS FOR USE BEFORE USING THIS PRODUCT.

GENERAL INSTRUCTIONS
AGPRO GREEN GLYPHOSATE 510 is a non-selective herbicide. It is absorbed by plant foliage and greenstems and is translocated through the plant from point of contact into the root system. The effects of AGPRO GREEN GLYPHOSATE 510 may not be apparent for 4-7 days depending on weather conditions, weed species and the herbicide use rate. Some perennial weeds may not show effects for 10-20 days.
There is no withholding period for AGPRO GREEN GLYPHOSATE 510. Avoid grazing weeds after spraying for 3 days if treating annual weeds or 7-10 days if treating

perennial weeds, to allow translocation of this product through the weeds.

SPRAY DRIFT WARNING:

Beware: Apply this product carefully. Spray drift may cause serious damage to other desirable plants. Do not apply under weather or spraying conditions which would be expected to cause spray drift onto nearby crops and susceptible plants.

RECOMMENDED USES

Agricultural Areas: Used to control a wide range of annual and perennial weeds prior to sowing crops or pastures. See Weed Control Chart.

Asparagus: May be used to control weeds prior to planting or crop emergence and in established plantings provided herbicide contact with any part of the asparagus plant is avoided through the use of shielding or weed wiping equipment. See Weed Control Chart.

Aquatic Areas: May be used in drains and waterways. See Weed Control Chart.

Broad-acre Crops: Used to control a wide range of weeds prior to cultivation of barley, oats, peas, and wheat. For best results do not disturb sprayed weeds by cultivation for 3 days after spraying for annual weeds and 7 days after cultivation for perennial weeds. See Weed Control Chart.

Brushweeds: A wide range of brushweeds are controlled by this product. Always use AGPRO
Organosilicone when treating brushweeds. See Weed Control Chart.

Forestry: May be used to control a wide range of brushweeds and grasses. See Weed Control Chart.

General Weed Control: Used in a wide range of situations to control weeds. Use 1 litre in 100 litres of clean water and ensure the foliage is well covered. See Weed Control Chart.

Market Gardens: May be applied to control weeds before or after seeding, but prior to crop emergence. See Weed Control Chart.

Non-agricultural Areas: Used to control weeds. See Weed Control Chart.

Orchards: May be used for weed control in apple, pear, citrus, grape, stone and berryfruit growing provided any herbicide contact with the trees is avoided. See Weed Control Chart.

Pasture: Used as a spot application to control a wide range of weeds. See Weed Control Chart. Existing pasture may be treated with this product prior to the sowing of new pasture or crops.

Other Uses: May be used as a spot application to control weeds in lawns, parks, reserves and ornamentals.

MIXING PROCEDURES

Spray tanks should be free of any previous spray chemicals. A suitable tank cleaning agent is recommended. Half fill spray tank with clean water, add the required amount of AGPRO GREEN GLYPHOSATE 510 then fill with clean water. Add surfactant last. Agitate well before spraying. When tank mixing with other compatible chemicals add AGPRO GREEN GLYPHOSATE 510 after other water soluble products, but before flowables.

IMPORTANT

AGPRO GREEN GLYPHOSATE 510 should only be stored and applied in plastic or plastic lined containers, aluminium, brass, copper, stainless steel or fibreglass containers. The contact of AGPRO GREEN GLYPHOSATE 510 with unlined or galvanised steel may cause a highly flammable gas to form causing an explosion if ignited by an open flame etc.

SURFACTANT ADDITION
The addition of a surfactant is not generally needed with this product, except when water volumes exceed 50 litres/ha. In this case add a 100% non-ironic surfactant, such as AGPRO Wetter/Penetrant at label rates.

TANK MIXTURES
AGPRO GREEN GLYPHOSATE 510 can be tank mixed with DICAMBA 20% ai for improved control of clover. For knockdown and residual control AGPRO GREEN GLYPHOSATE 510 can be tank mixed with AGPRO SIMAZINE 500. Observe the Directions of Use Table and crops suitable on the respective label. Do not apply tank mix by air.

APPLICATION
A. BOOM SPRAY EQUIPMENT: A spray volume of 25-120 litres/ha is recommended. Ensure a double overlap of nozzle patterns at the top of the weed canopy.
NOTE: Fan nozzle equipment should be used at pressures in the range 240-280kPA.
B. AERIAL APPLICATION: AGPRO GREEN GLYPHOSATE 510 may be aerially applied in pasture or fallow situations prior to establishment of field crops or new pasture. Apply in spray volumes of 15-80 litres/ha. Increased spray volumes should be used in difficult situations such as mountainous areas and hilly terrains. This will ensure adequate crop coverage. DO NOT use in intensive horticultural areas.

APPLICATION PROCEDURE IN HOT CONDITIONS
It is recommended that when the temperature reaches 24-26 degrees C, increase water volume to at least 30-35 litres/ha and increase droplet size to at least 300 micron VMD. Aerial application is not recommended at temperatures above 32 degrees C.

WASHING AND CLEANING OF EQUIPMENT
Take careful precautions with regard to the washing of all spray equipment after each day of spraying. Spray tanks, pumps, lines and nozzles should be thoroughly rinsed with clean water following application to prevent corrosion. Aircraft should be thoroughly washed, especially landing gear, after each day of spraying.

CONTAINER DISPOSAL:
Triple rinse container and add residue to spray tank. Burn in an appropriate incinerator, if circumstances such as wind direction permit. Otherwise crush or puncture and bury in a suitable landfill, or if appropriate, recycle.

SHELF LIFE:
When stored appropriately, this product should show no significant degradation for two years from the date of manufacture. Contact your supplier for further information about the use of any product that is older than this.
COMPATIBILITY: Compatible with most commonly used herbicides.

CONDITIONS OF SALE:
The use of AGPRO GREEN GLYPHOSATE 510 being beyond the control of the manufacturer, no warranty expressed or implied is given by AGPRO NZ LTD regarding its suitability, fitness or efficiency for any purpose for which it is used by the buyer, whether in accordance with the directions or not and AGPRO NZ LTD accepts no responsibility for any consequence whatsoever resulting from the use of this product.

WEED CONTROL CHART - Application Rates

WEEDS	BOOMSPRAY Per HA	HANDGUN Per 100L	WATER KNAPSACK Per 15L WATER	CRITICAL COMMENT
Annual Weeds	700ml - 1.4L	140ml	20ml	Apply at the higher rate for larger weeds. May be tank mixed with AGPRO Simazine 500 for longer term control. Do not spray plants stressed due to low moisture levels, frost, waterlogged or covered with dust.
Australian Sedge	4.2L	700ml	110ml	Apply to actively growing weeds only, usually November to March. For aerial application increase the rate to 6.3L/ha. Dense growth should be burnt 12-18 months prior to treatment.
Barberry	—	700ml	110ml	Apply from flowering to late fruit stage, usually January to April. If bushes have been cut, regrowth should reach 1.5 before spraying
Barley Grass	700ml	140ml	20ml	Apply to actively growing weeds only.
Blackberry	6.3 - 14L	700ml - 1.1L	110 - 140ml	Should be applied between January-May ie from flowering to leaf fall. See that the plants are not under stress. Use of CDA equipment is not recommended. Complete spraying of foliage cover is essential for total control. Use the higher rate on old, dense infestations over 1.75m high.
Boxthorn	—	700ml	110ml	Do not spray in dry conditions. Complete spraying of the foliage cover is essential for total control. The use of CDA equipment is not recommended.
Bracken	6.3L	700ml	160ml	Bracken should be slashed in the winter or early spring. Then prior to frosts, apply in March- May to actively growing fronds. It may be necessary to repeat treatment in conjunction with pasture improvement for permanent control. Add AGPRO Organosilicone at 250ml per 100L of spray to achieve good control.
Broom	6.3L	700ml	110ml	Best results are obtained when plant is in full leaf. (Late spring to early summer). Add AGPRO Organisilicone at 250ml/100L (aerial application), 200ml/100L (Handgun), 20ml/15L (Knapsack) to achieve good control.
Browntop	2.1L	500ml	70ml	Apply at early head stage to actively growing plants.
Buddleia	6.3L	700ml	110ml	Apply to actively growing plants. Spray before the seedheads have formed (late spring to early summer) for best results.
Californian thistle	2.8L	700ml	110ml	Apply to actively growing plants after development of flower buds.
Couch	4.2L	700ml	110ml	Apply to actively growing plants at early head stage.
Dock	2.8—6.3L	700ml	110ml	Use the higher rate for larger plants. Apply to actively growing plants in full leaf. Dicamba 20% ai can be added at label rates to improve control.
Floating sweet grass & Reed sweet grass	6.3L	700ml	140ml	Apply to actively growing plants in late summer (Feb-March) and before the onset of frosts. Not more than one quarter of the plant should be submerged at the time of treatment.
Gorse	—	700ml	—	Handgun application only. Use AGPRO Organosilicone at 200ml/100L or poor results will occur. Spray plant to ensure complete coverage. Apply at any time of the year. Re-treat as required as regrowth may occur after 12 months.
Indian doab	6.3L	700ml	110ml	Apply to actively growing plant at early seedhead stage.
Johnson grass	4.2L	700ml	110ml	Apply at early head stage to actively growing plants
Kikuyu	4.2L	700ml	110ml	Apply to actively growing plants.
Mercer grass-aquatic	6.3L	1.1L	110ml	Apply to actively growing plants in late summer (Feb - March)
Mercer grass-non-aquatic	4.2L	700ml	75ml	No more than one quarter of the plant should be submerged at the time of treatment
Old Man's Beard	—	700ml- 1-4L	200ml	Use the higher rate on plants with stem diameters greater than 1cm. If it is not possible to obtain complete coverage, cut the plant in winter and spray when the plant is over 0.5 m long, using the higher rate. Apply November to March.
Pampas grass/Toetoe	—	700ml	110ml	Apply Spring to Autumn. Ensure complete coverage of the foliage. Do not spray while the plant is flowering.
Paspalum	4.2L	700ml	110ml	Apply to Paspalum at early head stage. Apply to actively growing plants.
Prairie grass	700ml - 1.4L	140ml	20ml	Apply to actively growing plants at seedhead stage.
Ragwort	4.2L	700ml	110ml	Apply to actively growing plants with sufficient leaf area for herbicide uptake,. Keep stock out until the treated plants brown-out.
Ring Fern	700ml - 2.1L	210ml	35ml	The higher rate should normally be used for control. Use 700ml-1.4L/ha only for Pasture Manipulation, increasing the rate to 2.1L/ha for dense infestations.
Ratstail	3.5L	—	—	Apply to actively growing plants at seedhead stage.
Rautahi (Cutty grass) & Rushes	4.2L	700ml	110ml	Apply to actively growing plants, usually January to March.
Ryegrass	1.1 - 2.1L	350ml	50ml	Use AGPRO Organo-silicone at 100ml/100L or poor results will occur. Apply when plants are actively growing. Use the lower rate from January to July before cultivation and the higher rate from August to December.
Tall fescue	4.2L	700ml	110ml	Apply to actively growing plants usually January to March.
Willow	6.3L	700ml	—	Apply to actively growing plants and spray to ensure the foliage is well covered.

WAIMAKARIRI DISTRICT COUNCIL

REPORT

FILE NO and TRIM NO:	GOV-26 / 171013110952
REPORT TO:	Council
DATE OF MEETING:	24 October 2017
FROM:	Sarah Nichols, Governance Manager
SUBJECT:	Electoral Voting System
SIGNED BY: (for Reports to Council or Committees)	Department Manager / Chief Executive

1. SUMMARY

1.1. The purpose of this report is to obtain Council approval for the method of voting to be used for the 2022 and 2025 Local Authority elections.

1.2. The Local Electoral Act 2001 offers a choice of two voting systems for the Council Elections. The currently used First Past the Post (FPP), or the Single Transferable Vote (STV).

2. RECOMMENDATION

THAT the Council:

(a) **Receives** report No. 171013110952.

(b) **Retains** the First Past the Post (FPP) voting system for the 2022 and 2025 local authority elections.

OR

(c) **Approves** staff to consult with the community on preferred voting process of using First Past the Post or Single Transferable Vote method.

3. ISSUES AND OPTIONS

3.1. In 2002 the Council resolved to consult with the community before making the decision to hold the 2004 and 2007 elections by using the First Past The Post (FPP) method as opposed to the Single Transferable Vote (STV) method. Information was sent out with the rates instalment notices and an advertisement was placed in the Northern Outlook. Of the responses received in 2002, 782 favoured retention of the FPP system and 277 favoured a change to STV.

3.2. In 2008, the Council resolved to retain the FPP system and advertised its intentions for public submission and did this again in 2011. No public feedback by way of demand of poll with the required voter percentage was received to change the voting system.

3.3. There is an opportunity for the community to poll for a change of method. The local authority must give public notice of the right of 5% of the electors to demand a poll on the future electoral system. Ninety days must be given following the public notice allowing electors to gather sufficient signatures to demand that a poll be held to change the

electoral system. After which time the local authority may resolve to undertake a poll of electors.

3.4. The Department of Internal Affairs website gives the following outline for both methods of voting:

Single Transferrable Vote

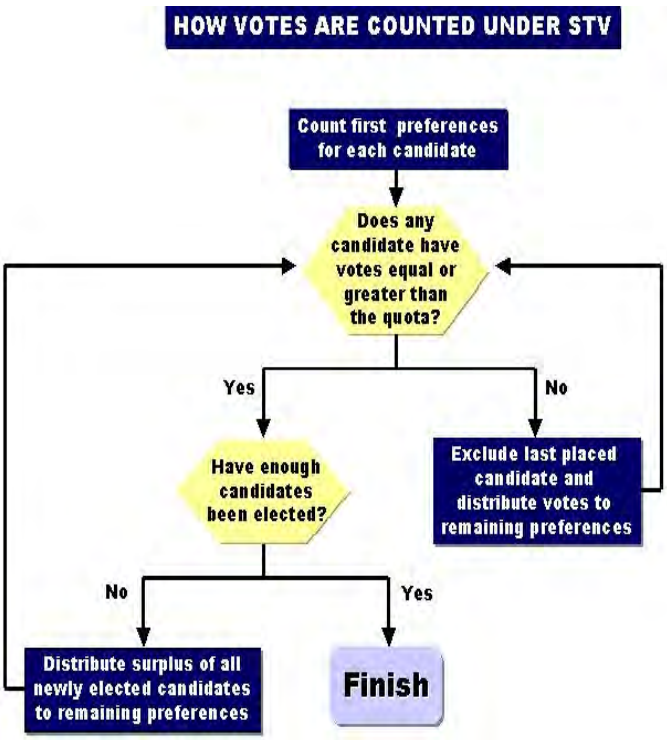
"Under a STV (Single-Transferable Vote) electoral system, voters rank candidates in their order of preference. A good example to consider is an election to select three councillors for a ward in a council election. Under STV, you would write "1" next to the name of your favourite candidate, "2" next to your second favourite candidate and so on.

STV means that you have one vote, but can indicate your preferences for all the candidates and it can be transferred if your most preferred candidate is so popular s/he doesn't need all their votes or is not popular at all with other voters. Under FPP, you would place ticks next to the names of up to three candidates, which means you would have three votes.

The number of vacancies and votes determines the quota a candidate must reach to be elected. The formula for deciding the quota is total number of valid votes, divided by the number of vacancies plus one. This process is illustrated in the following diagram:

Candidates must reach a set number (quota) of votes in order to be elected. By numbering your preferences you are saying:

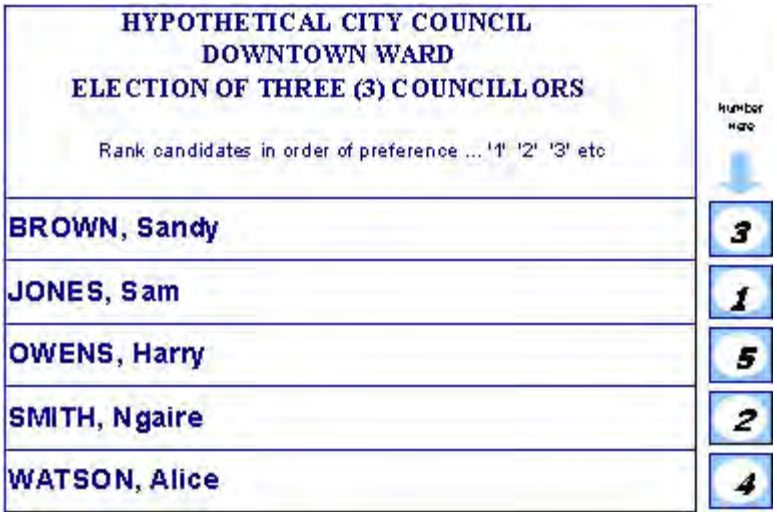
"The candidate I most want to represent me on the council is Sam Jones. He's my number one choice - but if he gets more votes than the quota, then part of my vote is to be transferred to my second choice, Ngaire Smith, and maybe this will help to get her elected. On the other hand, if Sam has so little support that he can't possibly be elected, transfer my vote to Ngaire..."



An animated demonstration of this process is on the www.stv.govt.nz site.

STV Voting Form

This is how a voting form might look for a local authority election held under the Single Transferable Vote method.



HYPOTHETICAL CITY COUNCIL
DOWNTOWN WARD
ELECTION OF THREE (3) COUNCILLORS

Rank candidates in order of preference ... '1' '2' '3' etc

	Number here
BROWN, Sandy	3
JONES, Sam	1
OWENS, Harry	5
SMITH, Ngaire	2
WATSON, Alice	4

There are three vacancies in this ward. Instead of a tick you rank candidates in the order you prefer – “1” beside your first choice, "2” beside your second choice, “3” beside your third choice and so on. You can rank as few or as many candidates as you wish.

First Past the Post (FPP)

Under the **FPP** (First Past the Post) electoral system, the candidate with the most votes wins. This is a very simple method of electing candidates and is widely used throughout the world. It was used in New Zealand for Parliamentary elections up until the introduction of MMP (Mixed Member Proportional) in the 1996 general election.

Although **FPP** is very simple, some people have argued that the results of an **FPP** election may not always reflect the wishes of the majority of voters. The following examples show how results of **FPP** elections may vary.

Where one candidate has a clear majority of votes, it can be seen that the majority of people did support the winning candidate.

	Number of Votes	Percentage of Votes
Candidate One	140	70%
Candidate Two	20	10%
Candidate Three	20	10%
Candidate Four	20	10%
	Total Votes = 200	Total = 100%

In this example, the winning candidate received 70% of the total votes
However, the winning candidate might receive more votes than any other one candidate, but receive fewer votes than the other candidates put together.

	Number of Votes	Percentage of Votes
Candidate One	80	40%

Candidate Two	60	30%
Candidate Three	40	20%
Candidate Four	20	10%
	Total Votes = 200	Total = 100%

In this case, the winning candidate got 40 of the total votes, the other candidates received 60 percent of votes. It could be said that the election result did not reflect the wishes of the majority. Some people have also argued that even when the winning candidate gets the majority of the votes, many people's votes are "wasted".

3.5. In 2002 the residents in the district were asked to indicate a preference between FPP and STV. Of the responses received, 782 favoured retention of the FPP system and 277 favoured a change to STV. It was subsequently resolved to use FPP.

3.6. In 2007 of the 85 local authorities in New Zealand 77 used FPP. Two Councils that used STV in 2004 changed back to FPP in 2007.

3.7. In the 2013 elections, seven councils used the STV system (Dunedin City, Kapiti Coast, Marlborough District, Porirua City, Wellington City, Greater Wellington and Palmerston North City Councils), with the rest (72 councils) using FPP. The Canterbury District Health Board uses the STV system. Anecdotal public feedback is that the STV system is confusing and cumbersome.

3.8. The Management Team has viewed this report.

4. COMMUNITY VIEWS

4.1. The public has an opportunity to express an opinion by way of seeking a poll after Council's decision is advertised. There is no evidence that the community has had a change of opinion since the survey undertaken in 2002.

4.2. Should the Council resolve to continue with the FPP system, advertising will be undertaken on 27 October 2017 of the proposal, noting the opportunity to demand a poll.

5. FINANCIAL IMPLICATIONS AND RISKS

5.1. The Council would be faced with the costs of a poll should one be demanded. Should the Council decide to use the STV method, as opposed to the FPP method, the actual costs of election might increase slightly by way of processing costs due to the greater complexity of the method. That exercise has not been investigated, but a report could be sought from the Returning Officer (Anthony Morton – electionz.com).

6. CONTEXT

6.1. Policy

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

6.2. Legislation

Section 27 of the Local Electoral Act 2001 is the appropriate legislation requiring this resolution and Sections 28 to 34 determine steps to follow.

6.3. Community Outcomes

There are wide ranging opportunities for people to contribute to the decision making by local, regional and national organisations that affects our District.