Planning & Resources Department

Resource Investigations Section

WAIRARAPA DIVISION

Motuwaireka Stream Targeted Investigation Study Of Bacteriological Water Quality

October 1999 – July 2000

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PURPOSE 1

BACKGROUND 1

INTRODUCTION 1

METHODS 2

MONITORING SITES 2
LAND USE CHANGE 2
WATER QUALITY SAMPLING 2

RESULTS 4

LAND USE 4
WATER QUALITY 4
BOX AND WHISKER PLOTS AN EXPLANATION 4
BACTERIOLOGICAL RESULTS 5
Faecal Sterol Fingerprinting 7
GROUND WATER QUALITY 7

DISCUSSION 8

CONCLUSION 9

ACKNOWLEDGEMENTS 10

Purpose

This report summarises the findings of an intensive bacteriological water quality survey of the contributing tributaries of the Motuwaireka Stream catchment. The main purpose of this report is to identify areas within the catchment which have impaired water quality and to identify what possible sources of contamination contribute to this. Possible methods of improving water quality within the catchment are also identified.

Background

In 1995 Alison Morton reported that the water quality of the Motuwaireka Lagoon for the swimming season (19 January 1995 to 2 March 1995) was excellent.

Since 1996 the Motuwaireka Lagoon has had water quality which has been unsuitable for bathing (Stansfield, 1997, 1998, 1999, 2000). Percent salinity of the lagoon has been lower during these years and this may have contributed to higher bacteria counts in the lagoon.

On January 24 1996 a press release was made and on 26 January 1996 a sign warning of pollution was erected by the Masterton District council at this site.

On Thursday 4 February 1999 a meeting was held with members of the Riversdale Residents Association, staff from Wellington Regional Council, Masterton District Council and some Regional Councillors. The residents expressed their concern on the water quality of the Motuwaireka Lagoon and it was agreed that the Wellington Regional Council would pursue a sanitary survey of the catchment to determine what factors were contributing to the poor water quality of this lagoon.

Introduction

The Motuwaireka Stream is a 4^{th} order stream which has its headwaters located in the Ngaumu Forest and Riversdale areas. The stream follows a course which is predominantly surrounded by pastoral farming and discharges to sea at Riversdale (a popular beach resort located in the south eastern region of the north island). The lower reaches of the Motuwaireka Stream forms a lagoon which has historically been a popular bathing and fishing site for many people. The lagoon (commonly called Riversdale Lagoon) is a dynamic water body which often has variable salinity due to tides, closures at the mouth (caused by sea swells) and flooding.

The Riversdale Lagoon has suffered a history of neglect in terms of surrounding land use and wastewater disposal practices (see Appendix 1 for reported pollution response incidents). A water quality investigation conducted in 1985 (DSIR) indicated that seepage from septic tanks was occurring at some sites within the catchment area and that the local landfill would allow intrusion of leachates into a tributary of the lagoon. Groundwater monitoring conducted by the Wellington Regional Council in February 1998 indicates that there are still localised areas within the Riversdale area in which septic tank seepages are affecting groundwater quality (Morgan pers comm).

Since 1985 many waste water disposal facilities in the area have been upgraded. The local landfill has been closed and relocated to a site which has been a transfer station since October 1999. Despite these improvements, the Riversdale Lagoon continues to have water quality which is unsuitable for bathing.

Methods

Monitoring Sites

Much of the experimental design for this project had been undertaken in consultation with the local Riversdale community as it was thought that local knowledge would assist greatly in the determination of appropriate monitoring sites. A meeting with the Riversdale Ratepayers Association and a mail out to rural land owners helped determine 8 sites within the Motuwaireka Stream catchment which were suitable as monitoring sites. Initial results from the study led to the inclusion of 2 extra sites to the programme. The resulting 10 sampling sites are illustrated in the following table and map which follows. Appendix 2 shows photographs of the sites.

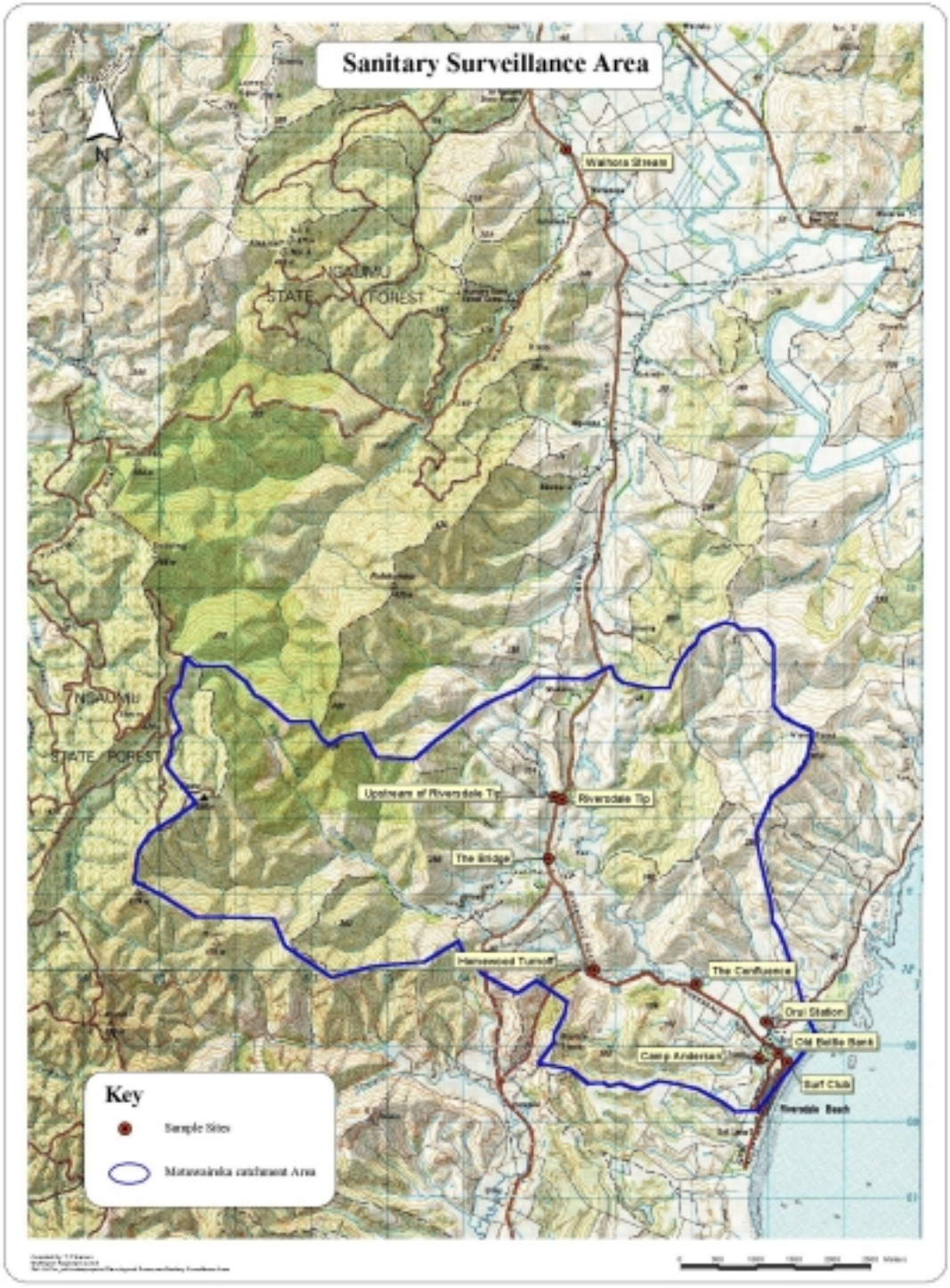
Site	Map Reference	Reason for inclusion
Upstream of Riversdale Tip	NZMS 260 T26 652122	Reference site for tip
Riversdale Tip	NZMS 260 T26 653122	Tip leachates, contributing tributary
The Bridge	NZMS 260 T26 651114	Agricultural runoff, contributing tributary
Homewood Turnoff	NZMS 260 T27 657099	Old Tip leachates
The Confluence	NZMS 260 T27 671097	Effects of combined tributaries
Orui Station	NZMS 260 T27 680093	Septic tank discharges
YMCA	NZMS 260 T27 679088	Septic tank seepage
Old Bottle Bank	NZMS 260 T27 681089	Disused disposal area
Surf Club	NZMS 260 T27 688091	Coastal monitoring site
Waihora Stream	NZMS 260 T26 653207	Reference site for study

Land Use Change

Past and present land use of the Motuwaireka Stream catchment was reviewed to see whether any major land uses may have contributed to the deterioration in water quality of the Riversdale Lagoon. This involved looking at aerial photographs taken in the 1943 and comparing these with more recent information extracted from the GIS (Geographic Information Systems) computer system.

Water Quality Sampling

Water sampling was undertaken following rainfall events as previous reports have found that high bacterial concentrations in the Motuwaireka Lagoon were observed following rainfall events (Stansfield 1999). 200 ml samples of water were extracted from the sampling sites of the Motuwaireka Stream and were transferred to a chilli bin with ice and delivered to the ESR laboratory in Christchurch within 24 hrs. These samples were analysed for *Total coliforms*, *Escherichi coliforms* (E.coli) and *Enterococci* bacteria.


Sanitary Surveillance Area
N
Waihora Stream
NGAUMU
STATE FOREST
NGAUMU
STATE FOREST
Upstream of Riversdale Tip
Riversdale Tip
The Bridge
Homewood Turnoff
The Confluence
Oral Station
Old Bellbird Bank
Camp Anderson
Surf Club
Riversdale Beach
Key
Sample Sites
Matawaiuka catchment Area

E.coli bacteria generally survive in water for shorter periods compared to *Enterococci* (Donnison1998). Sites with high *Enterococci : E.coli* ratios are therefore likely to represent sites which contribute a more continuous source of contamination to the streams water. The ratio of *Enterococci : E. coli* concentrations were therefore also examined to determine whether any sites had higher ratios.

On site measurements of Conductivity, Salinity, Temperature and Turbidity were made at each site during sampling. On one occasion water samples were also taken at four sites for the analysis of faecal sterols. The faecal sterol test is a new technique used to fingerprint whether the bacterial contamination is of human or animal origin.

Tracer dye (fluroscene) was added to two septic tank systems which are in close proximity to the lagoon to see if the disposal fields may be in the direction of the lagoon.

Results

Land Use

Table 1: Land Use In The Motuwaireka Stream Catchment

LANDUSE	1943		CURRENT	
	Hectares	%	Hectares	%
Exotic Forestry	15	0.4	345	11
Indigenous Vegetation	1627	49	876	27
Other (mostly pastoral)	1683	51	2004	62

Table 1 shows that there has been considerable changes to the land use and vegetation within the Motuwaireka Stream catchment since 1943. Most notable is the decline in indigenous vegetation cover. The maps which follow clearly illustrate the land use changes which have occurred since the 1943.

In 1943, approximately 49% of the Motuwaireka Stream Catchment was covered in indigenous vegetation (predominantly scrub). In several areas the indigenous vegetation extended down to the Motuwaireka Stream. Exotic forestry during the 1940s made up approximately 14 hectares of the entire catchment area. The remaining 1683 hectares of the catchment comprised of pasture and other land use cover.

In comparison, current aerial maps of the catchment show a distinct change in land use cover. Today indigenous vegetation makes up approximately 27% of the catchment, which is a reduction of 752 hectares. The indigenous vegetation has largely been replaced by pasture and exotic forestry. Other land uses (mostly pasture) now make up 62% of the catchment and exotic forestry today covers approximately 345 hectares of the catchment.

Water Quality

The water quality results in this section are presented as box and whisker plots. An explanation of a box and whisker plot follows.

Box and Whisker Plots An Explanation

Throughout this document mention is frequently made of statistically significant

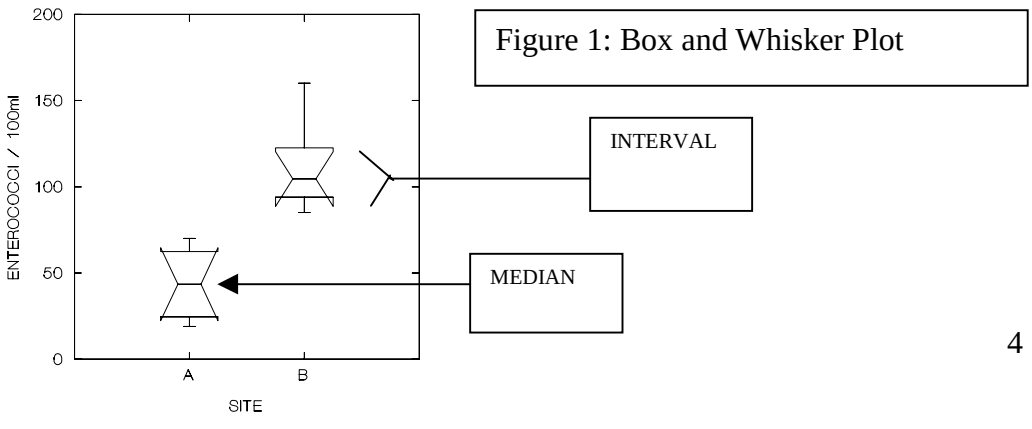
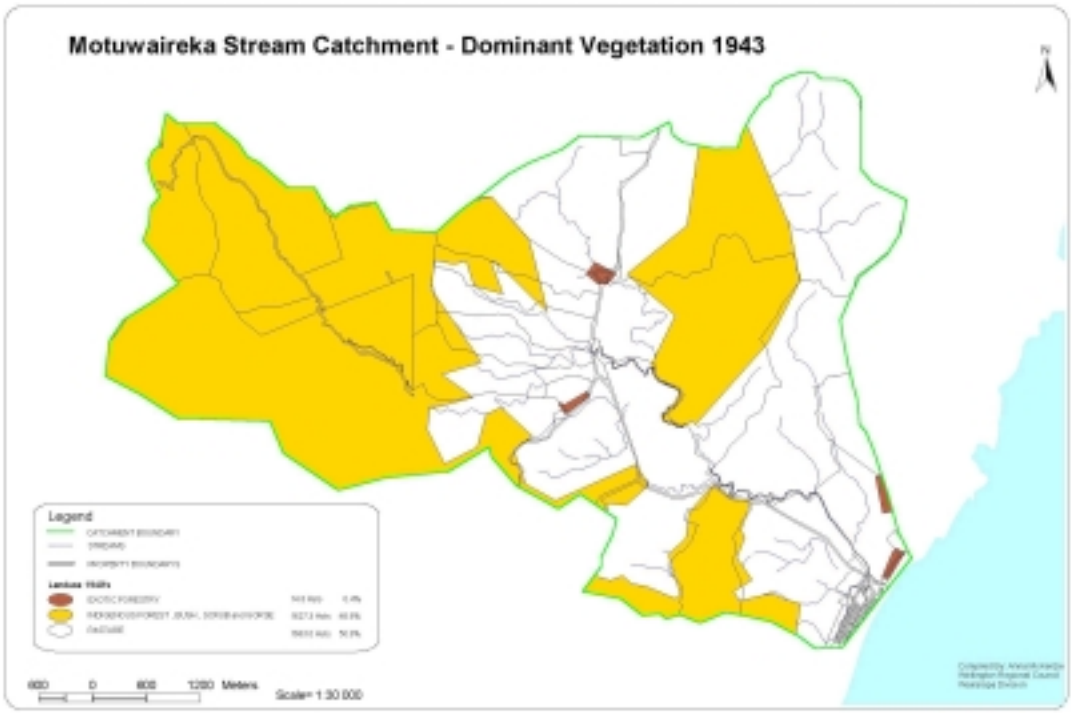
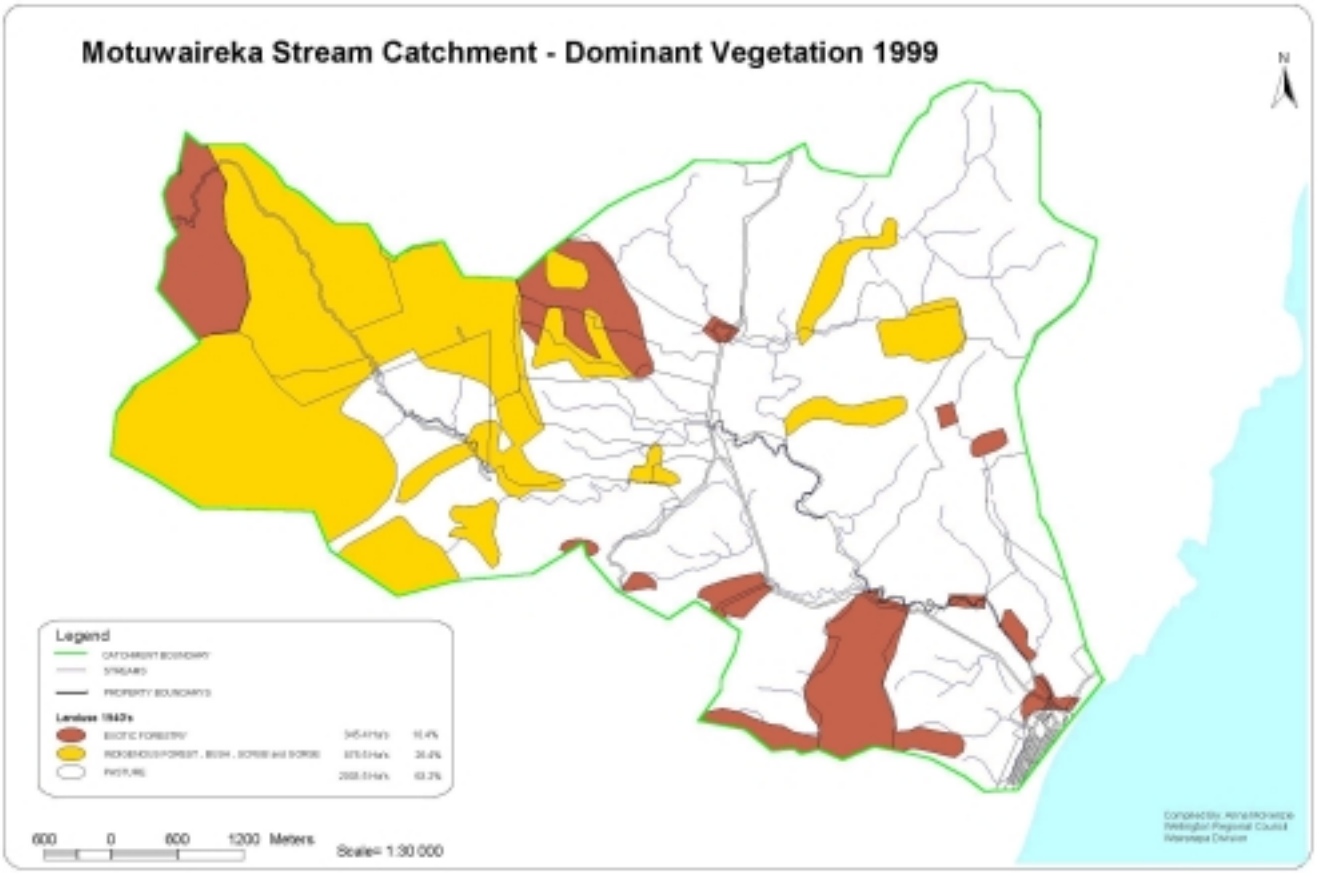


Figure 1: Box and Whisker Plot


Motuwaireka Stream Catchment - Dominant Vegetation 1943
N
Legend
Landuse 1940's
600 0 600 1200 Meters
Scale= 1:30,000


Motuwaireka Stream Catchment - Dominant Vegetation 1999
N
Legend
CATCHMENT BOUNDARY
STREAMS
PROPERTY BOUNDARYS
Landuse 1943's
EXOTIC FORESTRY
PASTURE
600 0 600 1200 Meters
Scale= 1:30 000

differences in respect to the box and whisker plots. A significant difference is detectable (with 95% confidence) if the confidence intervals around two medians do not overlap (McGill, Tukey, & Larsen 1978). This is illustrated diagrammatically on the previous page.

Figure 1 shows that site B has significantly higher *Enterococci* concentrations compared to site A. This is depicted by the intervals around the two medians not overlapping.

If two intervals in a box and whisker plot do overlap, but a trend is observed then the sites are referred to as being generally lower or higher to each other.

If the data has a wide range of values for a site, outliers will be represented by an asterisk while extreme outliers will be represented by a small circle.

Bacteriological Results

Figure 2: Box and whisker plots for E.coli

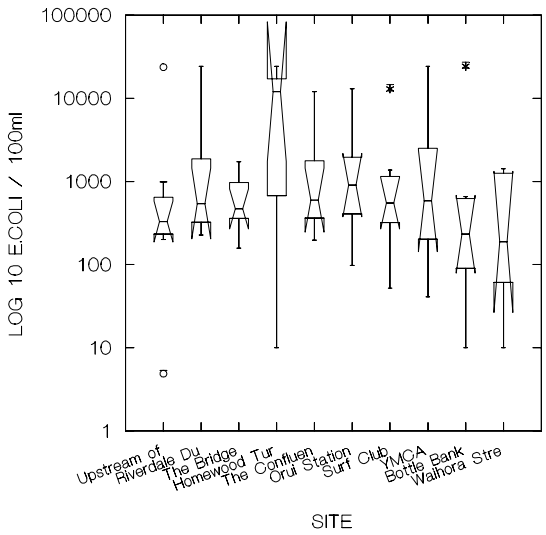


Figure 2 shows that the Homewood turnoff site has significantly higher concentrations of *E.coli* than the other sites. Figure 2 also shows that with the exception of the Bottle Bank site, the *E.coli* concentrations within the Motuwaireka catchment are generally higher than the *E.coli* concentrations in the Waihora Stream.

Figure 3: Box and Whisker plots for Enterococci

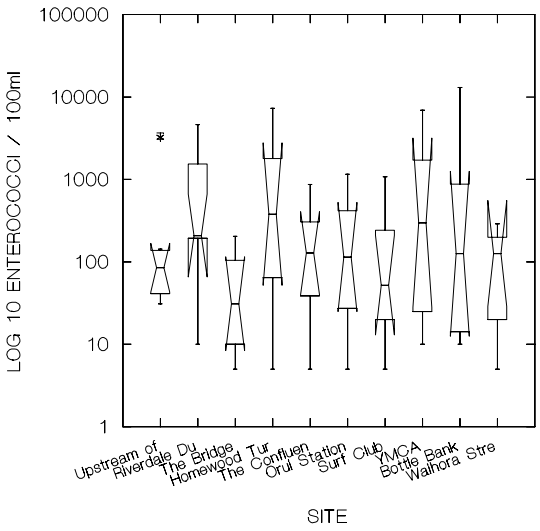


Figure 3 shows that the *Enterococci* concentrations are generally higher at the Riversdale Dump, Homewood Turnoff, and YMCA sampling sites. The Bridge site generally has lower *Enterococci* concentrations than the other sites.

Figure 4: Box and whisker plots of the ratio of Enterococci to E. coli.

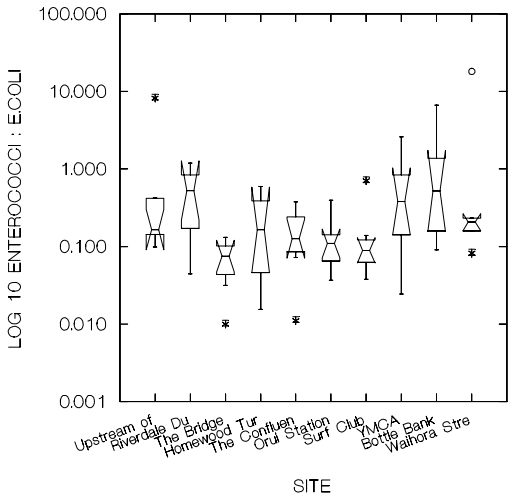
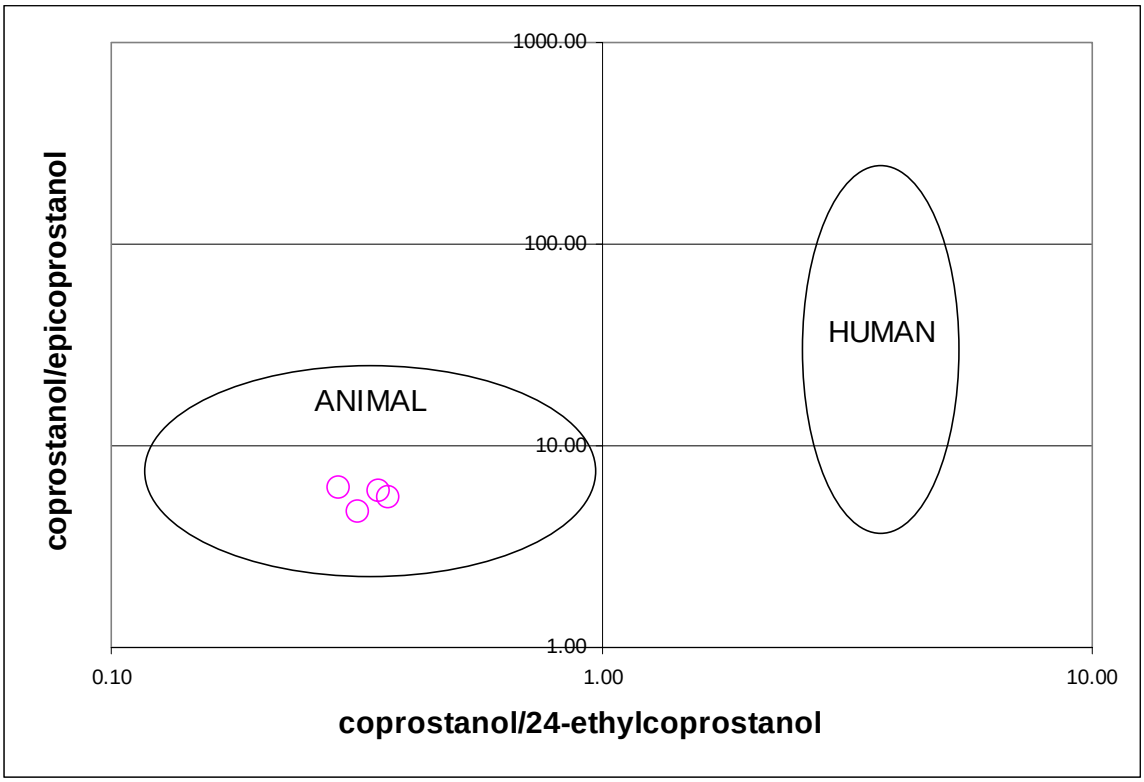


Figure 4 shows that the *Enterococci:Ecoli* ratio is generally higher at the Riversdale Dump, YMCA and Bottle Bank sites.

Faecal Sterol Fingerprinting

Figure 5: Faecal Sterol Analyses



The faecal sterol analyses performed by ESR indicate that the faecal contamination within the Motuwaireka Lagoon is predominantly of animal origin (see reference letter in Appendix 4). Note that the ellipses placed around the data points do not imply statistical confidence limits, they simply represent areas in which the data points commonly fall.

Ground water quality

Riversdale is located on a thin coastal unconfined sand aquifer. The Regional Council has minimal information on the depth and extent of the aquifer and has no aquifer pump-test information. It is likely that the thin sand aquifer is only a few metres thick, overlying impermeable mudstone. There is one filed borelog which reached the mudstone at 6 metres. Most bores in the area are thought to be only 2 to 4 metres deep and the depth to ground water is generally around 1–2 metres. Ground water is generally used only for garden watering as the quality and taste generally makes it unacceptable for potable supply. With the shallow unconfined nature of the aquifer and lack of a significant soil layer, the ground water is extremely vulnerable to contamination.

The aquifer most likely discharges along the lower part of the beach, although there could be some discharge to the lagoon from ground water at the northern end of the township.

Previous sampling of groundwater at Riversdale in 1976-78 and 1998 has shown good bacteriological water quality in most bores. These results are consistent with other groundwater samples from around the Wairarapa. The odd bore has recorded the occasional total or faecal coliform. One site in 1998 showed very high numbers of total and faecal coliforms, indicating a local problem with an up gradient septic tank in close proximity to the bore. Elevated total and faecal coliform levels were also detected in the Orui Station spring, which is not protected from grazing stock. The fine sand aquifer material acts as a filter and bacteria levels are generally orders of magnitude lower than those recorded in surface water. It is therefore unlikely that groundwater is a significant contributor to the elevated bacteria levels recorded in the Motuwaireka lagoon. However poorly operating septic systems close to surface water bodies could have some effect on the lagoon especially if they overflow during peak periods. The tracer dye released at two septic tank systems which operate close to the lagoon did not show up at all. This may be because the dye is inappropriate for this use.

Discussion

The Motuwaireka Stream catchment has seen considerable changes in vegetation and associated land use since 1943. The most notable land use change which will have affected the water quality of the stream is the significant decline in indigenous scrub cover (from 49% to 26% cover). Although no hard data exists as to the effects of this land use change, it is likely that the clearing of indigenous scrub will have resulted in increased agricultural runoff and sediment loading to the stream. Agriculture is also likely to be more intensive today (in terms of stocking units per hectare) compared to 1943 (see Appendix 5 for an example). A close examination of the maps shows that most of the clearing has occurred in the northern and western parts of the catchment. The map also shows that this clearing has occurred to the waters edge. There are many areas within the catchment where stock trampling and crossings are likely to be adversely affecting the Motuwaireka Stream.

The maps also show that there has been a significant increase in the amount of forestry within the catchment. Most of the forestry has replaced what was indigenous scrub so it is unlikely to have affected the overall water yield of the catchment (Cameron pers comm).

Although the Motuwaireka Stream does not have significantly poorer water quality compared to the Waihora Stream. There are sites within the Motuwaireka catchment which have water quality which is generally poorer than the remaining sites of this study. Comparisons of these sites with other eastern catchments cannot be made due to a lack of monitoring in this area.

Poor water quality sites within the Motuwaireka stream catchment include the Riversdale Dump, the Homewood turnoff , and YMCA sites. The Homewood turnoff site has significantly higher *E.coli* concentrations compared to any other site. The ratio of *Enterococci : E.coli* at this site however is not significantly higher than the other sites which indicates that the high bacteria counts are a result of runoff.

The Riversdale Dump, YMCA and Bottle Bank sites generally show high *Enterococci / E.coli* ratios. This indicates that these sites represent a more continuous source of contamination compared to the other sites. Appendix 3 shows photographs of exuding leachates from the Riversdale Tip entering a tributary of the Motuwaireka Stream.

The faecal sterol analysis indicates that the bacterial contamination within the lower reaches of the Motuwaireka Stream is of predominantly animal origin.

Conclusion

Improvement of water quality in the Motuwaireka Stream cannot be achieved through a few one off actions. A gradual improvement is likely to be achieved through the combined application of a number of restorative measures such as:

- Establishment of riparian plantings and fencing off of any tributary of the Motuwaireka Stream catchment. This will reduce the effects of stock wandering and agricultural runoff to this sensitive receiving water. Methods 31 and 32 of the Regional Policy Statement (Fresh water Chapter) indicates that the Wellington Regional Council will:

    - *Identify waterways suffering from the effects of non – point source pollution and investigate the potential of managing riparian margins (eg. by afforestation and other vegetation management systems) to mitigate these effects.*

    - *Encourage landowners and other organisations or agencies acting under other legislation to create and manage riparian margins (including where appropriate, advocating to territorial authorities that esplanade reserves or buffer strips be used for water bodies suffering from non – point source pollution)*

- The backwater of the lagoon in which the YMCA and Bottle Bank sites are located is machine cleaned. The sediments extracted from this operation ideally should be disposed of in a landfill.

♦ The stagnant backwater of the Motuwaireka lagoon needs to be engineered so that it flows in one direction only (out to the lagoon). There are probably a number of options to achieve this, the most suitable would be subject to a WRC engineers approval.

- A community treatment system for all residences must be installed before any further development in the area can occur. Water quality concerns need to be addressed with any future developments in the Wairarapa.

Ideally areas within the catchment which show severe bank erosion and stock trampling should be targeted first. Community involvement is the best way to undertake such projects as they will also promote ‘kaitiakitanga’ of the resource. We are fortunate to have such a pro active community at Riversdale who are prepared to

make the effort to improve water quality for the Motuwaireka Stream. This is evident in their current workings of the lower Riversdale esplanade reserve.

Acknowledgements

Many thanks to Anna McKenzie (Anna Spanna) for doing the land use research for the Motuwaireka Stream catchment. GIS maps have also been produced by Anna.

Matthew Morgan, Steve Blakemore, Brian Bodle, Paul Bodle and Bill Hedley have provided useful comments towards this report. Matthew Morgan wrote the water quality section thanks groundwater guru.

Desmond Till (microbiological consultant) has also reviewed this document and provided useful input.

ESR Public Health Laboratory undertook all bacteriological water quality analysis for this study. I would particularly like to acknowledge Surinah Monson and Jan Gregor for their organised capacity to get the work done.

Brenda Clapp, Matthew Morgan, Anna McKenzie and Matthew Rowland assisted with field sampling on many occasions – thanks team.

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Morgan, M. Section Leader Resource Investigations Section. Wellington Regional Council Wairarapa Division

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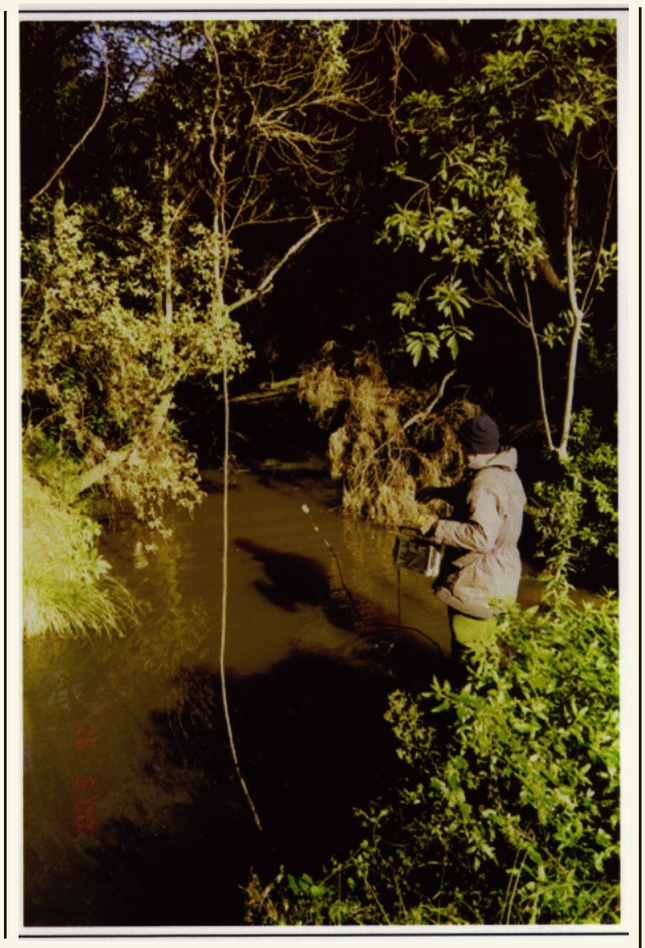
Appendix 1 : Reported Pollution Response Incidents Within The Motuwaireka Stream Catchment

Date	Complaint	Summary	Action
16/04/98	Complaint of putrid odour from stagnant stream.	Foul smell from Live and learn trust camp. Septic waste possible cause.	Letter sent to complainant
21/10/97	Sheep offal regularly dumped in creek.	During landfill monitoring, offal from two sheep was discovered	Farmer required to stop dumping offal in creek
22/10/97	Dead beast floating in lagoon	Dead beast floating in lagoon	Beast removed from lagoon
24/01/00	Discoloration of lagoon caused by break in septic tank pipe resulting in direct discharge to lagoon	A pipe broke behind the ablution block at Camp Anderson which resulted in a direct discharge of grey water into a side tributary of the Riversdale Lagoon	A letter was sent to Camp Anderson informing the owner of the pollution response service. Remedial works have since been undertaken.
12/06/00	Dead sheep in Riversdale Lagoon	Dead sheep floating in lagoon	Sheep removed by regional council
19/06/00	Smell of raw sewage, Riversdale	A resident was machine cleaning the bottom of a backwater of the lagoon in the vicinity of Camp Anderson. No sewage was visible	Reported back to the complainant by 21/06/00

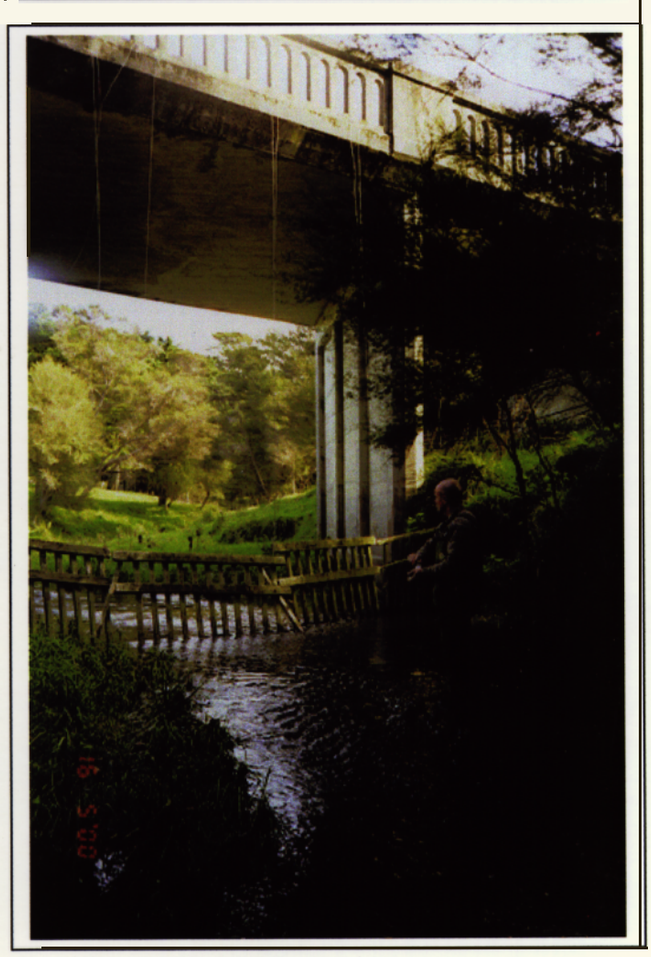
Appendix 2: Sampling Sites

Waihora Stream

Upstream of Riversdale Tip



Riversdale Tip



The Bridge

Homewood Turnoff

The Confluence

Orui Station

YMCA

Bottle Bank

Surf Club

Appendix 3: Leachates entering the Motuwaireka Stream

Appendix 4: Faecal Sterol Analysis from ESR

ESR

	ACT	REP	INIT.
DIV MGR			
OPS MGR			
P/RES MGR	✓		
S/SERV MGR			
BIO MGR			
ENCL			
FILE: 1/12/3/3			

19 July 2000

Brett Stansfield
Wellington Regional Council
Wairarapa Division
PO Box 41
MASTERTON

Dear Brett

Faecal Sterol Analyses and Interpretation

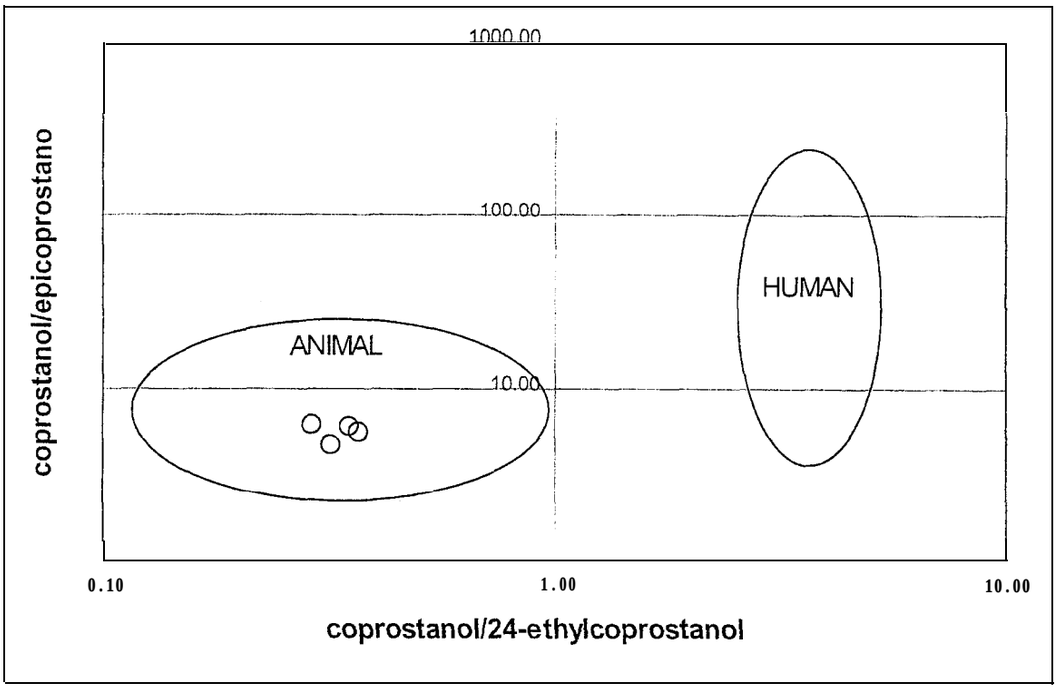
As a follow-up to a sanitary survey that indicated faecal contamination, four water samples were submitted for faecal sterol analysis with the hope that the profiles of these chemical indicators of faecal contamination would provide an indication of the source. There has been a history of septic tank leakage in the vicinity of the receiving waters, and agricultural activities take place upstream. This work was carried out with the knowledge that the faecal sterol "fingerprinting" tool is still under development.

All faecal material contains sterols and their breakdown products, stanols. The literature indicates that coprostanol is the major marker of, but was not exclusive to, human faeces, and 24-ethylcoprostanol is the principal herbivore marker. Because of the multiple inputs of faecal and non-faecal sterols to receiving waters, the absolute concentrations of sterols and stanols and sterol:stanol ratios are unlikely to indicate the faecal source. However, ratios of the various stanols known to form only in the gut of animals (5β-stanols) are likely to be better. The sterol cholesterol is reduced in the gut to the 5β-stanols coprostanol and epicoprostanol. Similarly, plant-derived 24-ethylcholesterol is reduced in the gut of **herbivores** to 24-ethylcoprostanol and 24-ethylepicoprostanol. Humanherbivore (sheep and cattle) discrimination is predicted for the *coprostanol:24-ethylcoprostanol* ratio, with herbivore effluent containing more 24-ethylcoprostanol, The *coprostanol:epicoprostanol* ratio may also be important since humans form predominantly coprostanol. Plotting these two ratios form the basis of the "fingerprinting" tool.

The attached figure shows the position of the four water samples (circles), and the two distinct regions for human and animal effluents, derived from compiled data for a range of effluents. Clearly, the four receiving water samples do not show characteristics of human effluent input, and fit within the region typical of animal effluent input.

Although these results point towards the septic tank not appearing to influence the chemical quality of the water at the time of sampling, sampling at just one point in time is not enough to rule out possible septic tank leachate entering the receiving water at other times.

Institute of Environmental Science & Research Limited
Christchurch Science Centre
27 Creyke Road, Ilam, PO Box 29-181, Christchurch, New Zealand
Telephone: (03) 351-6019, Facsimile: (03) 351-0010



I trust that this report provides a useful interpretation. Please don't hesitate to call me if you wish to discuss this further. We are very encouraged that you are prepared to lead in the use of this developing tool.

The charge for this work is $1900 plus GST, and an account will follow shortly.

Yours sincerely

Jan Gregor
Scientist, Water Group

Appendix 5: A comparison of stocking densities over time.

WAIRARAPA CATCHMENT BOARD

The Chairman
WAIRARAPA CATCHMENT BOARD

17 September 1987
MASTERTON

Dear Sir

SOIL AND WATER CONSERVATION PLAN NO 81/4

FIVE YEAR REVIEW

Name: Denniston Trust

Property: Strathmiglo

Area: 565.3 ha

District: Riversdale

LEGAL DESCRIPTION

1.6646 ha	Lot 2 DP 42871 Blk XVI Kaiwhata SD
563.6787 ha	Lots 2, 4 DP 34943 Sec 1062 Pt Secs 963, 1050 Whareama District Blk XV Rewa SD
565.3433 ha	Total Area

1.0 PHYSICAL DESCRIPTION

1.1 Location and Neighbouring Properties

The property is situated 55 km from Masterton on the Masterton - Riversdale Road, 1.5 km from Riversdale Beach.

Neighbouring properties are Riversdale (SWCP 296), Beaumont (SWCP 337), Roscommon (SWCP 165), Uriti (SWCP 352), Orui (SWCP 280), and Pohatu

1.2 Farm Notes

	1960	1969	1974	1981	1986	Group III Average
Ewes	1200	2190	2694	3345	3670	
Hoggets	500	705	1050	1701	1240	
Lambing %	N/A	90	85	77	120	
cows	120	145	198	102	57	
Heifers				20	15	
Calving %	N/A	N/A	83	78	93	
Total SU	2630	4028	5309	5412	5174	
SU/ha	5.29	7.94	8.20	8.33	9.14	9.51
Wool/ha	N/A	29.7	24.24	28.99	47.10	36.93
Wool/SSU	N/A	5.37	4.42	5.27	5.96	4.76
UPA	N/A	N/A	577	603	1035	767
Area	497.0	506.7	657.6	649.7	565.3	

The property has been managed by Adrian Denniston for the last three years. In that time further subdivision has taken place in Siberia South and North.

Stocking rates have dropped slightly, but wool weights and lambing percentages have risen significantly, producing a UPA well above the Group average.

A large area of P.radiata has been sold recently leaving approximately 15 ha of trees in South Face along with approximately 17 ha of Board retirements.

1.3 Land Use Capability Summary

Class	Area	% of Farm
II	31.3	5.5
III	99.3	17.6
IV	41.3	7.3

Appenidx 6: Peer Review

	INF	ACT	REP	INIT.
DIV MGR				
OPS MGR				
P/RES MGR	✓			
S/SERV MGR				
BIO MGR				
ENCL				
FILE: Y/12/3/3 4999				

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Mr. Brett Stansfield
Water Quality Officer
Wellington Regional Council
Wairarapa Division
PO Box 41
Master-ton

Dear Brett

Report on Motuwaireka Stream catchment and it's impact on the water quality discharging at Riversdale.

May I congratulate you on the above report.

You have achieved in my opinion, a sound scientific yet succinct report, covering your objective to identify factors within the catchment of the Motuwaireka Stream contributing to poor water quality in the Motuwaireka (Riversdale) Lagoon. I concur with your findings and your suggestions for improving the water quality in the future. It is clear that as the analysis of the results from the MfE Freshwater Microbiological Research Programme progresses there will be plenty of evidence in support of your conclusions regarding riparian protection of waterways.

There appears to have been quite a dramatic change in the water quality at Riversdale between 1995 and 1996. Was this due to a change in sampling, laboratory testing methods, or did something dramatic happen in the catchment?

I've heard of other people having trouble with fluorescene dyes for tracing seepage in sandy conditions. A point for the future – coliphages can be useful for detecting septic tank leakage.

Kind Regards

Desmond

Desmond Till