Discussion

Standard errors (Table 5a) give a high degree of confidence that sample data represent land uses adjacent to stream banks in the Mahurangi, with two exceptions :

- Intensive uses. Clearly these are under-represented in the sample.
- Non-rural uses. Represented, but not for all sub-types.

For these uses, more reaches could have been sampled only by departing from the random sampling strategy (Section 2). This was not done, firstly to avoid bias through including "selected" reaches; but also because the random sampling in other respects worked well i.e. it was sufficient to represent how sediment sources relate to most stream landforms, bank vegetations and land uses in the catchment.

Table 5b gives frequency distributions for sediment sources along reaches, grouped by adjacent land use. Table 5c summarises the range for each.

Sediment sources range from zero to just over half the length, on reaches adjacent to land in conservation use (scenic reserves, covenants, and informally protected bush or scrub on private property).

They range from zero to just under half, on reaches adjacent to land used for forestry (conifer plantations and hardwood woodlots on farmland).

On reaches adjacent to land used for drystock farms, dairy farms, or lifestyle blocks, sediment sources range from zero to entire reach length.

On reaches adjacent to intensively used and non-rural land, sediment sources range from zero to just over a third of reach length (excepting two reaches heavily trampled by the out-of-bounds pupils of Mahurangi College!).

Some of these ranges parallel what has already been observed for bank vegetation. Forestry holds sediment sources to much the same range as conservation use. Livestock farming, whether drystock or dairy or lifestyle, can have sediment sources on a much greater percentage of reach length - but can also have them on few or zero (Table 5b). Intensive uses - where one might expect less bank vegetation and greater disturbance - have fewer sediment sources than conservation use. Likewise non-rural uses. The reason appears to be that here banks have been deliberately fenced, trees have been planted, and native vegetation allowed to regenerate. Even so, this does not explain why the ranges should be lower than for reaches adjacent to undisturbed bush and scrub.

TABLE 5b: FREQUENCY DISTRIBUTIONS FOR SEDIMENT SOURCES ADJACENT TO LAND USES							
% of reach affected	Conservation	Forestry	Dairy farms	Drystock farms	Lifestyle farms	Intensive uses	Non-rural uses
0-	0.10	0.15	0.05	0.03	0.24		
1-10	0.29	0.20	0.14	0.15	0.31		
11-20	0.23	0.10	0.05	0.19	0.07		
21-30	0.00	0.35	0.18	0.21	0.09		
31-40	0.13	0.10	0.09	0.16	0.11		
41-50	0.06	0.00	0.09	0.06	0.02		
51-60	0.16	0.00	0.09	0.09	0.07		
61-70	0.03	0.00	0.05	0.04	0.02		
71-80	0.00	0.00	0.05	0.03	0.02		
81-90	0.00	0.00	0.05	0.00	0.00		
91-100	0.00	0.00	0.18	0.04	0.05		
Totals:	1.00	0.90	1.00	1.00	1.00	insufficient to calculate	insufficient to calculate

TABLE 5c: RANGE OF SEDIMENT SOURCES BY LAND USE		
Land use	Property type	% of length affected
Conservation	reserve	0-57
	farm	1-63-
	lifestyle	2-56-
Forestry	plantation	0-48
	woodlot	0-43
Farms	dairy	0-100
	drystock	0-100
	lifestyle	0-100
Intensive uses	crop	-
	orchard	0-37
	market garden	-
Non-rural uses	quarry	0-35
	industrial	-
	urban	1-78-

Conclusions specific to this survey are that :

- There is an increase in range of sediment sources, moving from land uses that entail tree or scrub cover (conservation, forestry), to land uses that entail grass cover (drystock pasture, dairy pasture, lifestyle blocks). The range appears to decrease, on reaches that have been sampled adjacent to intensive or non-rural uses.

- Nevertheless, sediment sources are few or absent, on a substantial proportion of reaches adjacent to each land use.

- Sediment sources cannot be attributed to land use alone.

TABLE 6a: SEDIMENT SOURCES ADJACENT TO STREAMS					
Type	Sub-type	Reaches (number)	Sediment sources (paces)	% of sample	sample error (+-2s.e.)
Bed & bank scour	Natural	84	1128	4.1	0.2
	Stock-affected	27	482	1.8	0.2
	Machine-affected	11	490	1.8	0.2
Bed & bank deposition	Natural	46	918	3.4	0.2
	Stock-affected	32	1880	6.9	0.3
	Machine-affected	15	372	1.4	0.1
Bank collapse	Natural	27	467	1.7	0.2
	Stock-affected	15	581	2.1	0.2
	Machine-affected	2	21	0.1	0.0
Above-bank sheetwash	Natural	8	262	1.0	0.1
	Stock-affected	27	1275	4.7	0.3
	Machine-affected	8	180	0.7	0.1
Through-bank tributary	Natural	32	49	0.2	0.1
	Stock-affected	42	75	0.3	0.1
	Machine-affected	13	21	0.1	0.0
Totals:		211	8201	30.1	0.5

6 SEDIMENT SOURCES IN THE MAHURANGI CATCHMENT

Introductory comments

Sediment currently enters streams from a diversity of sources. Many are naturally caused by geomorphological processes. Some are induced by human activities. Recording sediment sources builds up a picture of the "mix" present on reaches that have the same stream landform, or the same bank vegetation, or that are adjacent to the same land use. Table 6a summarises sample data showing what kinds of sediment source are active in the Mahurangi.

Scour of bed or bank

Removal of sediment by running water, exposing a clean surface of sediment or rock, not yet colonised by algal growth, aquatic plants or invertebrates (Photo 23). Present on 4% of sample reach length.

Photo 23: Natural scour of bed and bank

Stock disturbance of bed or bank

Exposure of sediment by livestock trampling (Photo 24), followed by scour of the exposed surface. Present on 2% of sample reach length.

Photo 24: Disturbance of bed by livestock

Photo 25: Disturbance of bed by excavation

Machine disturbance of bed or bank

Excavation of sediment (Photo 25), followed by scour of the excavated surface. Present on 2% of sample reach length.

Deposition on bed or bank

Fresh sediment naturally deposited in the channel, either as bars between pools, or as a layer in pool bottoms, or behind rock bars and other obstructions (Photo 26). Present on 3% of sample reach length.

Photo 26: Natural deposition on channel bed

Photo 27: Sediment trampled by stock

Stock-induced bed or bank deposits

Accumulation of sediment in a channel or on a bank, trampled by stock into a position where it can be re-worked by flowing water (Photo 27). Present on 7% of sample reach length.

Machine-induced bed or bank deposits

Sediment dumped in a channel or on a bank, in a position where it can be re-worked by flowing water (Photo 28). Present on 1% of sample reach length.

Photo 28: Sediment dumped after excavation

Photo 29: Natural bank collapse

Bank collapse

Entry of sediment by natural collapse of a terrace edge, slumping of a footslope, or as debris transported from a slip farther upslope (Photo 29). Present on 2% of sample reach length.

Stock-induced bank collapse

Entry of sediment from a terrace edge collapse, slump or slip that has been induced or exacerbated by stock trampling (Photo 30). Present on 2% of sample reach length.

Photo 30 Bank collapse exacerbated by stock

Photo 31 Bank collapse induced by earthworks

Machine-induced bank collapse

Entry of sediment from a terrace edge collapse, slump or slip that has been induced or exacerbated by machine-constructed earthworks (Photo 31). Examples are deflection of floodwater by a culvert or similar channel obstruction; build-up of soil pore water pressure in the vicinity of a blocked drain or pipe; undercutting of a slope by track excavation Present on <1% of sample reach length.

Sheetwash of soil above bank

Bare soil, naturally exposed on an alluvial flat, terrace edge or footslope, in a position such that sheetwash can transport soil particles over the bank and into the channel (Photo 32). Present on 1% of sample reach length.

Photo 32: Natural exposure of soil to sheetwash

Photo 33: Soil exposed to sheetwash by stock trampling

Stock-induced sheetwash

Bare soil, exposed in similar positions by grazing pressure or stock trampling (Photo 33). Present on 5% of sample reach length.

Machine-induced sheetwash

Bare soil, exposed in similar positions by machine-constructed stock races, farm or forest vehicle tracks, forest landing stages and similar (Photo 34). Present on 1% of sample reach length.

Photo 34: Soil exposed to sheetwash on excavated surface

Photo 35: Natural tributary delivering sediment

Tributary delivery of sediment through bank

Tributary channel entering a reach from a terrace edge, footslope or hillslope, with natural scour upstream of its junction and sediment deposit downstream (Photo35). Present on <1% of sample reach length.

Stock-induced delivery of sediment from tributaries

Tributary channel in one of the above situations, trampled by stock, with subsequent scour upstream of its junction and sediment deposit downstream (Photo 36). Present on <1% of sample reach length.

Machine-induced delivery of sediment from tributaries

Tributary channel in one of the above situations, that has been excavated, deepened or straightened by machinery, with subsequent scour upstream of its junction and sediment deposit downstream (Photo 37). Includes drains. Present on <1% of sample reach length.

Photo 36: Stock-induced delivery of sediment from tributary

Photo 37: Machine-induced delivery of sediment from tributary

Discussion

Standard errors (Table 6a) indicate a high degree of confidence that sample data represent extent of sediment sources along freshwater streams in the Mahurangi catchment. The different types of sediment source provide insight into why total length of sediment sources can vary for any particular stream landform, bank vegetation or land use :

- Sediment sources currently occupy 30% of the stream network's length.
- Sediment enters the channels from a diversity of sources.
- The most extensive sources are stock-disturbed sediment deposits on bed and banks (7%), sheetwash on land adjacent to channels trampled by stock (5%), scour of channel beds and banks trampled by stock (2%), and bank collapses exacerbated by stock trampling (2%).
- Natural scour of channel beds and banks (4%), together with associated deposits of sediment as bars in channels or at the bottoms of pools (3%), and natural bank collapses (2%), are also widespread.
- Disturbances induced by earthworks machinery e.g. tracks on banks, bridges or culverted track crossings, channel straightening/deepening by artificial drainage, are present but individually occupy small percentages of reach length. Collectively they amount to 4%. Most are re-vegetating, but there are a few which are not.
- Sediment supply by lateral tributaries and drains appears minor. These enter 1% of reach length. They are first-order tributaries and drains that enter sideways through banks, transporting sediment from a terrace edge, footslope or hillslope. Sample data includes terrestrial sediment sources; not second or higher-order tributaries (which transport sediment already suspended in flowing water from farther up the network).

Table 6b summarises frequency distributions for different types of sediment source. Clearly any one sediment source is only active on a small proportion of reaches – but where it is active, the percent of reach length affected tends to be large. This suggests that either the natural characteristics of an individual reach, or the activities carried out on it, have a great deal to do with sediment supply.

In many instances, a high incidence of sediment sources can be explained simply by a factor that is reach-specific. Examples are listed here for all reaches where a single source affects more than half the reach length.

120g1/6 : banks disturbed by stock, along 61% of length.

131p6 : colluvial fill, well-drained, trampled by stock along 96% of length, though not severely.

131p7 : colluvial fill, poorly drained, heavily trampled by stock along 100% of length.

131d2/1 : stock-trampled channel sediment, 98% of length.

131d2/2 : similar to 131d2/1, 53% of length.

131d4 : channel recently excavated by machine to improve drainage, 91% of length.

2u3 : sheetwash where bank trampled by pedestrians, 50% of length.

24d2 : banks disturbed by stock, 83% of length.

200d2 : steep convex slopes above banks, beneath a dense canopy of totara, 64% of length with sheetwash where browsed and trampled by stock.

200d1/4 : similar to 200d2, 78% of reach length.

226s2 : unrestricted stock access to scrub, 62% of reach length with sheetwash on banks where groundcover browsed and trampled.

246b3 : sediment deposit along 54% of reach length, behind old dam in bush.

246p1 : sediment in channel, trampled by livestock along 60% of length

282g1/1 : a slumped footslope along 100% of length.

282g2/2 : similar to 200g1/1, 56% of reach length.

283p3 : colluvial fill trampled heavily by stock, 51% of length.

283p5/1 : colluvial fill trampled by stock, 55% of length.

30p1/4 : natural bank collapse on a short reach of lowland channel, 51% of reach length.

61p3 : swampy flat and channel, heavily trampled by stock along 63% of length.

61p6 : similar to 61p3, 80% of reach length.

68p5 : sheetwash where groundcover adjacent to one bank heavily browsed and trampled by stock, 63% of length.

68p6 : similar to 68p6, 63% of reach length.

86p2/2 : short reach, with revegetating earthworks below farm dam, on 56% of length.

TABLE 6b: FREQUENCY DISTRIBUTIONS FOR SEDIMENT SOURCES BY TYPE						
% of reach Affected	Bed and Bank Scour			Bed and Bank Deposits		
	Natural	Stock-Affected	Machine-Affected	Natural	Stock-Affected	Machine-Affected
0-	0.60	0.89	0.95	0.78	0.85	0.93
1-10	0.25	0.05	0.02	0.10	0.04	0.01
11-20	0.08	0.02	0.00	0.08	0.01	0.00
21-30	0.04	0.02	0.00	0.03	0.0 3	0.00
31-40	0.02	0.00	0.01	0.01	0.02	0.02
41-50	0.00	0.01	0.00	0.01	0.01	0.00
51-60	0.00	0.00	0.00	0.00	0.02	0.00
61-70	0.00	0.00	0.00	0.00	0.00	0.00
71-80	0.00	0.00	0.00	0.00	0.00	0.00
81-90	0.00	0.00	0.00	0.00	0.00	0.00
91-100	0.00	0.00	0.00	0.00	0.02	0.02
Totals:	1.00	1.00	1.00	1.00	1.00	1.00
% of reach affected	Bank collapse natural	stock-affected	machine-affected	Sheetwash above bank natural	stock-affected	machine-affected
0-	0.87	0.93	0.99	0.96	0.87	0.96
1-10	0.07	0.02	0.01	0.01	0.04	0.01
11-20	0.03	0.01	0.00	0.01	0.05	0.01
21-30	0.01	0.01	0.00	0.00	0.01	0.01
31-40	0.01	0.01	0.00	0.00	0.00	0.00
41-50	0.00	0.00	0.00	0.01	0.00	0.00
51-60	0.00	0.00	0.00	0.00	0.00	0.00
61-70	0.00	0.00	0.00	0.00	0.02	0.00
71-80	0.00	0.00	0.00	0.00	0.00	0.00
81-90	0.00	0.00	0.00	0.00	0.00	0.00
91-100	0.00	0.00	0.00	0.00	0.00	0.00
Totals:	1.00	1.00	1.00	1.00	1.00	1.00
% of reach affected	Tributary through bank natural	stock-affected	machine-affected			All types
0-	0.85	0.80	0.94			0.13
1-10	0.15	0.20	0.06			0.21
11-20	0.00	0.00	0.00			0.13
21-30	0.00	0.00	0.00			0.16
31-40	0.00	0.00	0.00			0.12
41-50	0.00	0.00	0.00			0.05
51-60	0.00	0.00	0.00			0.08
61-70	0.00	0.00	0.00			0.03
71-80	0.00	0.00	0.00			0.02
81-90	0.00	0.00	0.00			0.00
91-100	0.00	0.00	0.00			0.05
Totals:	1.00	1.00	1.00			1.00

7 SUMMARY OF FINDINGS, CONCLUSIONS, IMPLICATIONS FOR MANAGEMENT

Summary of findings

The survey has identified five processes of sediment entry into streams :

- scour of bed and banks,
- deposition on bed and banks,
- bank collapse,
- sheetwash on exposed soil next to banks,
- delivery by small tributaries which drain adjacent terraces, footslopes or hillsides.

Each process has a natural component, a component induced by animals, and a component induced by human activities.

30% of sample reach length currently delivers sediment to streams. 10% entails natural processes, 16% entails disturbance by stock, and 4% entails disturbance by machinery..

Scour of bed and banks affects 8% of sample reach length. Of this 4% is natural, 2% is stock-induced, and 2% is machine-induced.

Deposition on bed and banks affects 4% of sample reach length. 3% is natural, 7% is trampled in by stock, and 1% is dumped by machines.

Bank collapse affects 4% of sample reach length. 2% is entirely natural, 2% is exacerbated by livestock, and <1% is induced by earthworks, drainage or channel obstruction.

Adjacent soil is exposed to sheetwash on 14% of sample reach length. 1% is natural, 5% is due to stock browsing or trampling, and 1% is due to tracks or other earthworks.

Sediment is delivered from adjacent slopes by small tributaries on 1% of sample reach length. <1% is natural, <1% is exacerbated by livestock, and <1% is exacerbated by machinery.

All stream landforms have active sediment sources on a high percentage of sample reach length, ranging from 26% along infilled lowland channels to 38% along infilled hillslope channels.

Bank vegetations have active sediment sources on variable percentages of sample reach length : from 3% in modified wetland to 39% where wetland is degraded by heavy grazing; from 23% in rank pasture fenced from stock to 54% in open pasture on grazed banks; from 3% in lightly grazed hardwood woodlots to 45% in heavily grazed bank stability plantings; from 20% amongst intact scrub and bush to 54% where under-storey vegetation is grazed by stock.

Sediment sources occupy a moderate to high percentage of sample reach length, relative to all adjacent land uses : up to 30% in reaches that pass through conservation land; up to 21% in commercial forests; up to 56% next to livestock farms; up to 25% next to intensive land uses; and up to 24% next to non-rural uses.

Within any one stream landform, bank vegetation or land use, active sediment sources are highly variable on individual reaches. Zero or low percentages (below 20%) dominate frequency distributions for any particular category; but for each, the typical range is from 0% up to 50% or more; sometimes 100% of reach length.

Conclusions

Conclusions are that :

- Sample data do not show how much sediment enters streams in the course of a year (Doing this was not part of the survey design. Sediment load can only be measured in-stream, and sediment yield by repeat measurements for at least a year and preferably several).

- Sample data measure where and how sediment enters freshwater streams. (This is what the survey was designed to find out).

- Where and how, are partly natural and partly induced - not by the *type* of land use, but certain *activities* that are common to several uses.

- A third of sediment sources are entirely natural, over half are induced or exacerbated by farm livestock, and an eighth are created by human modifications to channel beds or banks.

- Any particular type of sediment source is inactive on most reaches in the network, but is highly active on a small proportion.

- The cumulative result when all combine, is that a large percentage of the Mahurangi's freshwater stream network has sediment sources that are currently active.

Neither stream landform, nor bank vegetation, nor land use can be invoked as a sole control on sediment sources. Nor can variation be explained by their acting in combination. Each combination has several reaches with sediment sources on zero or low percentages of their length, a few with high percentages, and the rest somewhere between. Clearly other factors are involved. What they are, can be seen by looking at the nature of sediment sources; and at what happens on individual reaches.

Examples show that any generic effect from a particular stream landform, bank vegetation or land use can easily be overwhelmed by a specific activity on an individual reach. They ought to give cause for caution, before anybody attributes high sediment loads observed in the Mahurangi, to a catchment-wide phenomenon - stream instability, removal of native bank vegetation, pine harvest or what-ever !

High sediment loads may simply be the product of certain activities, carried out on a few reaches in the Mahurangi, at any particular time. Activities which stand out in the list are :

- Earthworks adjacent to channels,

- Channel excavation (includes drain-cleaning),

- Sedimentation behind dams (though these trap some of the sediment),

- Trampling of swampy alluvium or colluvium by livestock next to infilled channels,

- Browsing and trampling of steep banks by livestock next to incised channels.

Implications for initiatives to control sediment

There are several implications for any initiative to control sediment entering freshwater streams in the Mahurangi :

- It will be necessary to target reaches where there are clear signs of sediment entry, irrespective of stream landform, or bank vegetation, or land use.
- On any particular reach, what is proposed needs to match the type of sediment source that is present and the activity that is causing it.
- Sediment entry can still be expected where banks are fenced and planted with native vegetation, or where native vegetation is allowed to recover. This will particularly be the case on incised lowland channels which are susceptible to large bank collapses.
- If infilled channels are fenced and planted, drying-out of the fill will lead to channel incision.
- Regardless of what vegetation is planted - or isn't - fences to exclude livestock potentially could remove about half of current sediment sources.
- Practically, it is difficult to persuade farmers to fence most hillslope channels. Bank fences are feasible along lowland channels, and also along most valley-bottom channels.
- Avoidance of earthworks in or adjacent to channels - drain-cleaning, drainage, damming, track construction and culverted crossings - potentially could remove another eighth of sediment sources.
- Complete avoidance of earthworks is impractical, given the need to construct these facilities for farming, forestry and other uses of the land. Constructing them in ways that minimise opportunity for sediment to enter channels, would be a more practical proposition.
- Even if all possible measures are taken to control induced sediment sources on streambanks, sediment sources will remain at about one third their current length catchment-wide, due to natural processes.

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APPENDIX A - MAHURANGI STREAM SURVEY METHODOLOGY

Written by E. Hawcridge

Data Collection Hardware

Following stream survey work carried out by Environment Waikato[1], an HP iPAQ Pocket PC h2200 was utilised to collect and store survey information in the field. This was networked with a desktop PC through ActiveSync software and used in conjunction with a bluetooth wireless GPS unit (NAVMAN GPS 4100). A water and shock resistant case was used to protect the iPAQ during field use.

Data Collection Software

ESRI ArcPad 6.3.0 was installed on the iPAQ to capture and store field data. This programme supplied contextual data or background information, which was used to show current location. This consisted of a NZMS 260 grid shapefile, which could then be used to provide information on specific topographic maps for the area of interest.

ArcPad Application Builder was used for the development of drop down menu forms that recorded stream and channel feature data. These were then transformed into excel spreadsheets for analysis.

Survey Details

At each survey site the following information was collected:

Site Details

- Reach number
- Observer name
- Survey date
- Adjacent land use
- Distance in paces from start

Stream Features

- Start or finish point of feature
- Side of change
- Channel type
- Channel features
- Sediment sources

Bank Features

- Start or finish point of feature
- Side of change
- Primary vegetation type and density
- Secondary vegetation type and density
- Bank fence type

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[1] Haigh, A. 2003: Riparian Characteristic Survey data collection using field based GIS technology.

While walking along the banks of the waterway, points were captured using the GPS to mark any changes in continuous data (channel type and features, sediment sources, bank vegetation, fence type, and adjacent land use) or single occurrences (isolated channel feature or sediment source).
Drop-down menus were created for each of these attributes to display pre-set options. These options simplified data collection and saved time in the field. A blank page was included with the forms for any additional information or general comments.

Problems Encountered with Hardware

Utilising the iPAQ and GPS hardware did present a number of logistical constraints during the collection and analysis of field data, however; some of these could be avoided for similar mapping exercises in the future. Explanations for these difficulties were as follows:

- The methodology for this survey had already been developed before the iPAQ and GPS units were set up and functioning, therefore a number of streams had already been surveyed using field sheets. As the iPAQ was not used to record data from the outset, this resulted in two different recording techniques, which were not entirely compatible.

- When data was uploaded onto the computer from the iPAQ unit and saved as an excel spreadsheet, it needed to be manipulated to create the same format as that which had already been entered manually from field sheets. This could be avoided if only one format is used in excel to begin with, namely that which is produced by the attribute table of the shapefile from the ArcMap programme.

- The attributes recorded along the stream were a combination of continuous and discrete points. Many of these were either overlapping or present at the same time, which was not easily recorded on the iPAQ forms. The forms we created could only record one stream feature and one bank feature at a time, therefore where many features were present, a new point would need to be entered for each at the same location. This made the recording process much slower and it was difficult to review the features previously collected without opening each individual point. With further editing of these forms and the separation of continuous and discrete attributes into different categories (fields), this problem could be rectified.

- The GPS unit will only pick up a clear signal in the open. As many reaches were partially or completely covered in bush, often we were unable to use the GPS to locate our position. In these instances we could only estimate on the map where our position was and plot points manually. An external antennae was purchased to be used in conjunction with the GPS unit, however this does not improve the signal unless it is raised up through the tree canopy (i.e. mounting GPS on top of a pole where the canopy is low).

N.B. Power settings should be adjusted on the iPAQ so that minimal battery power is used out in the field. We found the battery would last several hours when fully charged, if the screen backlight was set on medium brightness and if the backlight was set to automatically switch off if not in use. With the screen set on the highest brightness setting, this time is considerably reduced.

Also, if the battery is left to go completely flat, software installed on the iPAQ will be lost. The iPAQ should therefore be left connected to AC power at all times when not in use as the battery will drain even when turned off. If this does occur, a backup file will be saved under programmes – iPAQ backup – restore. Once opened, the programmes will be recovered without needing to reinstall them.

APPENDIX B

SUMMARY OF STREAM REACH DATA

Collected and stored by E. Hawcridge

Collated by D. Hicks

SEDIMENT SOURCES BY TYPE AND NUMBER OF PACES

Sample Reach	Channel Form	Bank Vegetation		Land-use Type	Property	Bed and Bank Scour			Deposits			Bank Collapse			Sheetwash			Tributary			Total	Length
		Primary	Secondary			Natural	Stock-Affected	Machine-Affected	Natural	Stock-Affected	Machine-Affected	Natural	Stock-Affected	Machine Affected	Natural	Stock-Affected	Machine-Affected	Natural	Stock-Affected	Machine-Affected		
118b1	incised valley	bush		Conserva-tion	reserve	40			36									1			77	189
118s1	infilled valley	scrub		Conserva-tion	reserve	29			17												46	81
118s1/2	incised valley	scrub		Conserv-ation	reserve	6			19									1			26	163
120b1/1	incised valley	bush		Conserva-tion	farm	22			25									1			48	236
120b1/2	incised hillslope	bush		Conserva-tion	farm	1															1	160
120g1/1	incised valley	pasture	bush	drystock	farm			30													30	85
120g1/2	incised valley	pasture	Bush (scattered)	drystock	farm		31						2								33	70
120g1/3	incised valley	pasture	bush	drystock	farm	34															34	156
120g1/4	incised valley	pasture	Bush (scattered)	drystock	farm	24							111					1			136	275
120g1/5	incised valley	pasture		drystock	farm		34		1												35	81
120g1/6	incised valley	pasture	scrub	drystock	farm		31														31	51
120g2/1	incised valley	pasture	scrub	drystock	farm											11					11	37
120g2/2	incised valley	pasture		drystock	farm		16						95			27		1			139	235
120g3	infilled valley	Wetland (grazed)	Pasture & scrub	drystock	farm					26						11			1		38	384
120g4	incised hillslope	pasture		drystock	farm	42										1			1		44	109
120g5	infilled valley	Wetland (grazed)	pasture	drystock	farm	27				20			89						2		138	355
12p1	infilled	swampy	pasture	drystock	lifestyle					6											6	110

Sample Reach	Channel Form	Bank Vegetation		Land-use Type	Property	Bed and Bank Scour			Deposits			Bank Collapse			Sheetwash			Tributary			Total	Length
		Primary	Secondary			Natural	Stock-Affected	Machine-Affected	Natural	Stock-Affected	Machine-Affected	Natural	Stock-Affected	Machine Affected	Natural	Stock-Affected	Machine-Affected	Natural	Stock-Affected	Machine-Affected		
	lowland	grass																				
12p2	infilled lowland	swampy grass	Pasture & planted trees	drystock	lifestyle					2											2	170
131d1	incised hillslope	pasture	planted trees	dairy	farm	11			6	33						21					71	105
131d2/1	infilled hillslope	pasture		dairy	farm					121										2	123	123
131d2/2	infilled hillslope	pasture	planted trees	dairy	farm	2	1			125										1	129	235
131d3	infilled hillslope	planted trees	scrub	dairy	farm	34															34	162
131d4	infilled valley	pasture		dairy	farm			332											2	1	335	365
131d5	infilled valley	swampy grass	scrub	dairy	farm	25	4			84									1		114	211
131d6	infilled valley	pasture	planted trees & scrub (scattered)	dairy	farm	1	30	57													88	120
131p1/1	infilled valley	swampy grass	scrub	drystock	farm	28	19			16									1		64	238
131p1/2	infilled valley	swampy grass	Scrub & planted trees	drystock	farm	1	15			24									2		42	72
131p2	incised hillslope	pasture	planted trees & scrub (scattered)	drystock	farm			6											1		7	57
131p3/1	infilled hillslope	pasture	planted trees & scrub (scattered)	drystock	farm	10	11														21	59
131p3/2	infilled hillslope	pasture	planted trees	drystock	farm	10	10														20	58
131p4/1	infilled hillslope	rank grass & wetland	exotic scrub	drystock	lifestyle	13															13	76

Sample Reach	Channel Form	Bank Vegetation		Land-use Type	Property	Bed and Bank Scour			Deposits			Bank Collapse			Sheetwash			Tributary			Total	Length
		Primary	Secondary			Natural	Stock-Affected	Machine-Affected	Natural	Stock-Affected	Machine-Affected	Natural	Stock-Affected	Machine Affected	Natural	Stock-Affected	Machine-Affected	Natural	Stock-Affected	Machine-Affected		
131p4/2	infilled hillslope	rank grass & wetland	exotic scrub	drystock	lifestyle	4						17									21	53
131p5	infilled hillslope	wetland		drystock	lifestyle			20													20	54
131p6	infilled hillslope	swampy grass	Pasture & wetland (scattered)	drystock	lifestyle					221								1			222	231
131p7	infilled hillslope	swampy grass	Pasture & wetland (scattered)	drystock	lifestyle					129											129	129
131p8	infilled hillslope	wetland	Bush & exotic scrub	drystock	lifestyle																0	65
142p	infilled lowland	swampy grass	pasture	drystock	farm					90											90	200
158t	incised hillslope	pines	scrub	plantation	commerc ial	29															29	100
167b	infilled valley	bush		Conserva-tion	lifestyle	2			17									1			20	113
167s	infilled valley	wetland	Scrub & bush	Conserva-tion	lifestyle						17										17	166
168b	infilled hillslope	bush		Conserva-tion	lifestyle	8			21												29	88
168s	infilled hillslope	scrub		Conserva-tion	lifestyle	10			26												36	114
189b1 cl?	infilled valley	bush		Conserva-tion	lifestyle													2			2	89
189p1/1	infilled lowland	wetland	Scrub & bush	drystock	lifestyle			20													20	80
189p1/2& 3	infilled lowland	pasture	Scrub & bush (scattered)	drystock	lifestyle														1		1	80
189p2	incised valley	rank grass?	bush	drystock	lifestyle																0	82
189p3/1& 2	infilled valley	Wetland & rank grass	Scrub & bush	drystock	lifestyle	10															10	68
189p3/3	infilled valley	bush		drystock	lifestyle	27															27	88