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1 Introduction

1.1 Background

As part of Project Watershed and Peninsula Project implementation, the Catchment Environmental Monitoring (CEM) Programme was established to demonstrate the long term benefits of soil conservation. To date monitoring has been established in selected priority soil conservation catchments in the Waipa, Lower Waikato, Upper Waikato and Coromandel management zones.

The Catchment Environmental Monitoring (CEM) Programme allows Environment Waikato to:

- demonstrate the long term benefits of soil conservation and river management work programmes
- better utilise resources and leverage opportunities to co-ordinate monitoring internally and externally (e.g. within Environment Waikato, NIWA, Landcare Research)
- integrate new monitoring requirements into existing regional monitoring networks.

Prior to the CEM programme soil conservation implementation relied on regional monitoring information reinterpreted at a catchment scale. However, this approach often provides misleading information because regional scale information is being applied at a finer scale (catchment scale).

This report provides CEM programme results for the 2007/2008 year. The report is the second since the implementation of the CEM Programme in 2002 (see Hill et al. 2006). Copies of reports as described in the list of references can be obtained by contacting Environment Waikato (the Library) on 0800 800 401, or in electronic format from the publications page of the Environment Waikato website www.ew.govt.nz/publications or email: inforeq@ew.govt.nz.

1.2 Report Content

This report provides information on the annual monitoring of the environmental effects of soil conservation and river management works implemented in soil conservation priority catchments across the Waikato Region. Information included in this report is as follows:

- a summary of results up until the end of the 2007/08 monitoring period.
- interpretation of the results and identification of trends (where applicable)
- results from additional monitored sites
- monitoring method changes
- management zone boundary changes
- updated waterway details in the catchment characteristics tables, Appendix 1.

1.3 Monitoring approach

The aim of the CEM programme is to provide a representative (and where possible quantitative) indication of changes in various environmental parameters resulting from soil conservation and river management work. Parameters include changes in the hillslope erosion, stream bank erosion, riparian vegetation and fencing, and sedimentation in surface water, water temperature and in-stream ecological habitat. Details of the methods used are provided in the internal series *Catchment Environmental Monitoring Methods* (Grant, Kotze and Hill, in press).

It is important to note that not all priority soil conservation catchments are monitored. However, the results for the monitored catchments should be more applicable to other priority catchments in a given zone than monitoring results from elsewhere in the region. A standard monitoring approach is recommended for all monitored catchments. However, specific monitoring requirements will differ depending on the type of soil conservation and river management issues within each catchment. Therefore not all catchments have the same monitoring results. There are several key outcomes of the CEM programme.

- An understanding of the long-term benefits of soil conservation, river management and catchment issues in the Waikato Region.

- A regional framework for obtaining, managing and implementing catchment scale monitoring information.

- Efficient integration of existing State of the Environment regional monitoring, Crown Research Institute catchment monitoring, Environment Waikato implemented works consent monitoring, and Environment Waikato initiatives specific catchment monitoring (e.g. Clean Streams, Peninsula Project).

- A long-term picture of the land and water quality benefits of soil conservation and river management initiatives provided by Environment Waikato.

1.4 Management zone boundaries

There have been changes in the boundaries of the management zones since Blair and Hopkins' (2005/06) report, as detailed in Table 1. These changes have resulted in monitored catchments being positioned in four management zones, instead of the five described in the previous report. Zones which do not contain monitored catchments at this stage are Central Waikato (CWK), West Coast (WTC), Waihou-Piako (WPO) and Lake Taupo (TAU) zones. The priority catchments covered in this report are shown in Figure 1, in addition to the updated management zone boundaries.

Table 1: Location of the monitored catchments as at 2007/08.

	Management Zone	
Monitored catchment	**2005/06**	**2007/08**
Matahuru	Lower Waikato	Lower Waikato (LWK)
Mangare	Middle Waikato	Upper Waikato (UWK)
Pokaiwhenua	Middle Waikato	Upper Waikato (UWK)
Tahunaatara	Upper Waikato	Upper Waikato (UWK)
Mangatutu	Waipa	Waipa (WPA)
Wharekawa	Coromandel	Coromandel (COR)

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Figure 1: Monitored priority catchment locations, with updated management zone boundaries (labels explained in Table 1).

1.5 Monitoring information

The reported monitoring information is provided through specific catchment scale monitoring in selected soil conservation priority catchments. In addition, on-going regional monitoring information (Table 2) is utilised to increase our knowledge of soil erosion and sedimentation of water within the various management zones.

Table 2: Environment Waikato regional land and water monitoring programmes

Programme	Main measures	Time frame
Regional soil stability assessment	Soil stability and soil conservation	2002/03; assessment 5-10 yearly
Regional riparian characteristics assessment	Riparian fencing, vegetation and erosion	2001/02; assessment 5-10 yearly
Permanent suspended sediment sites	Water quality including sediment and peak flows	8 sites; reviewed annually
River ecological monitoring sites (REMS)	Stream biological and habitat condition	Ongoing (~10yrs data)
Regional rivers	Water quality including sediment	Ongoing (>10yrs data)

Monitoring has been selected to measure changes on land and in surface water to provide some indication of the resulting on-site and off-site benefits (Table 3).

Table 3: CEM programme methods and benefits assessed.

Assessment method	Issues addressed	Effect measured	On-site benefits	Off-site benefits	Time between sampling
Soil stability	Hillslope erosion and gully erosion.	land stability and bare soil.	Improved land use, soil stability, reduced bare soil.	Improved water quality, less flooding, less infrastructure maintenance.	5 -10 years
Riparian characteristics	Stream bank stability, riparian vegetation and planting and stock access	riparian erosion, vegetation type and condition and fencing.	Improved bank stability, reduced stock access, improved riparian habitat through more stream shading.	Reduced sediment in water, better water quality and riparian habitat, more riparian stability.	2 years
Photo points	Hillslope, gully and riparian erosion, stock access, soil conservation planting.	Aesthetics, short term soil and riparian stability, indication of shading	Aesthetics, increased vegetation, and soil, land and riparian stability,	As above.	2 years
Suspended sediment permanent sites	Catchment sediment yield.	Long term sediment yield and specific sediment yield.	Less sediment in the water, improved water quality and riparian habitat.	Reduced suspended sediment in receiving waters, improved water quality and habitat.	Ongoing for 10+ years
Suspended sediment snapshots	Sub-catchment sources of sediment, nutrients and *E.coli*.	Indication of sub-catchment sediment, nutrient and *E.coli*.sources.	Less contaminants in the water, improved water quality and riparian habitat.	Reduced suspended sediment in receiving waters, improved water quality and habitat.	Event triggered. Done once at high and low flows.
Water Temperature	Stream shading from riparian planting	Long term changes in daily maximum stream temperatures	Lower peak water temperatures provide improved habitat for native fish	Lower peak water temperatures downstream	1 year
Stream ecological health*	Aquatic habitat condition	Long term change in MCI score	Improved water quality (indicating less sediment) and aquatic habitat.	Improved down stream water quality (indicating less sediment) and aquatic habitat.	1 year
* REMS undertaken on stony stream beds only.					

1.6 Monitoring Methods and Indicators

CEM monitoring methods and indicators are continually being developed and improved. The approaches are similar to regional approaches to monitoring and indicators.

Soil Stability

Soil stability assessments involve the interpretation of aerial photographs to estimate soil stability, bare soil and soil conservation treatments. This assessment was last done in 2005/06 for the monitored catchments, with results detailed in Hill, Blair and Hopkins (2006).

- *Land stability* indicates the proportion of the catchment that is stable or has had or does have instability. Unstable areas have varying needs for soil conservation.

- *Bare soil* resulting from natural erosion or land use disturbance indicates the potential for soil loss and a sediment source. Soil loss can cause reduced productivity and sediment can reach waterways, impacting on water quality.

- *Soil conservation* is assessed in terms of effectiveness and the proportion of the catchment using appropriate vegetation cover in the catchment.

Riparian Characteristics

The purpose of the riparian characteristics assessment is to show changes in riparian erosion, extent of fencing and vegetation type and condition. Improvements in riparian condition result in improved water quality. Specifically, soil conservation fencing and planting of riparian areas is likely to reduce surface water contamination by sediments, nutrients and *Escherichia coli* ('*E. coli*') bacteria.

The assessment provides measures of streambank stability, level of stock exclusion and potential biodiversity value.

- *Vegetation and biodiversity value* is assessed in terms the type of vegetation (e.g. native, woody, exotic) and potential to provide shade to surface water and terrestrial riparian margin habitat. The presence of riparian native vegetation, woody vegetation and whether the vegetation is protected by fencing are the primary measures. For example, if woody vegetation is present, the stream is more likely to have shade. If there is riparian fencing the vegetation is more likely to be in better condition due to reduced stock trampling and grazing of the understory.

- *Stock exclusion* is indicated by the presence of fencing on one or more banks. Although some stream bank instability is due to natural stream morphology, instability and soil disturbance is exacerbated by disturbance by stock. Furthermore, access of stock to surface waters results in streambed disturbance and direct inputs of nutrients and faecal bacteria.

- *Stream bank stability* indicates the proportion of the stream bank that has had or does have instability. Of this area there are varying needs for soil conservation. Different combinations of fencing and vegetation provide different degrees of stream bank protection. Generally, the greater the vegetative cover and exclusion of stock, the greater the stability.

The riparian characteristics assessment uses methods developed for the Regional Riparian Characteristics Survey (Hill and Kelly, 2002) and methods developed specifically for catchment environmental monitoring (Haigh, 2004; Grant et. al. in press). Data is collected using a Nomad Personal digital assistant (PDA) set up as a field based Geographic Information System (GIS), designed to capture the attributes of

the assessment. The current PDAs supersede the previously used iPAQ PDA. They function in much the same way but with an inbuilt GPS, faster processing times and larger memories. Further details are included in Catchment Environmental Monitoring Methods (Grant et. al. in press).

Samples of 1km reaches of stream margin are assessed every two years to provide information regarding riparian erosion, vegetation, and fencing. Obstructions, crossings and culverts are also noted. Results from the assessment data are not indicative of the whole catchment but are indicative of the sites at which soil conservation works are planned or are being implemented by River and Catchment Services. The results for the riparian characteristics assessment in this report are presented in percent of total streambank length. The most recent results are compared to a baseline assessment (the first assessment) and changes are presented in absolute terms. For example, the length of stable riparian margin may have increased from 46% to 75% since the baseline year - this correlates to a 29% absolute increase (i.e. 75 – 46 = 29). If the percentage was quoted relative to the individual factors' increase, in this example the length of stable margin would have increased by 63% (i.e. 1.63 x 46 = 75).

Photo Points

Photo points are established in the same locations as the riparian characteristics assessment. For each of the assessed 1km samples of stream, five representative photos of the riparian margin are taken at distances of 0, 250, 500, 750 and 1000m from the start point. Each photo is framed to take in both stream banks with a scale pole placed in the field of view approximately 10m from the camera for reference. Photo details of GPS location, direction, and site information are recorded for each photo and fully documented in the "*Media*" photo database at Environment Waikato for comparison with photos taken in subsequent years.

Water Temperature

Water temperature is measured using two Hobo Water Temp Pro data loggers, which are deployed at the upstream and downstream margins of the monitored section of the stream. The distance between the two loggers is at least one kilometre. The temperature loggers are attached to waratahs which have been secured into the stream bed. The loggers are deployed annually between December and March when water temperatures are at their highest. The GPS location, a reference photo, and the date and time of deployment are recorded. The number used in this report is derived by calculating the average daily maximum temperature at both the upstream and downstream sites, then finding the difference between the two. This figure is then indicative of the change in water temperature between the upstream and downstream logger sites, and dismisses any possible long term changes affecting both sites, such as global warming.

Suspended Sediment Monitoring

There are two approaches that Environment Waikato uses to monitor the suspended sediment in the regions streams; a permanent sampling site at the lower end of the catchment to capture long term sediment yield trends for the catchment, and one off "snapshot" samplings during high and low flow conditions to identify sediment sources within the catchment. Additional water quality analysis provides a useful indication of the state of water quality throughout the catchment. Appendix 2 contains the guidelines and standards used to assess river water quality for ecological health and contact recreation.

It is important to quantify volumes and concentrations of sediment, nutrients or bacterial contaminants in a waterway because these indicate the effects of soil conservation. Sampling at different flow regimes is required because concentrations change depending on the flow conditions. Low flow sampling is useful to indicate background levels of suspended sediment and other water quality parameters such as nutrients and bacteria. Generally, the majority of sediment moves in surface water at

high flows. High flow sampling is useful for indicating the likely sediment sources within a catchment during rainfall events. The average sediment yield is the average of the total amount of suspended sediment passing through the monitoring point in a year, and is described in kilo tonnes per year (kt/yr). The specific yield is a more accurate comparison tool between catchments as it is proportionate to the catchment area.

Stream Ecological Monitoring

The sampling protocols used are those developed by the New Zealand Macroinvertebrate Working Group (Stark *et al.* 2001). Sampling involves evaluating habitat attributes throughout a representative 100 metre reach of stream followed by sampling stream invertebrates from representative stream habitat types using a kick net. Samples are assessed for invertebrate identification and counts to provide a representation of community structure. From the identification of the invertebrates various indices can be calculated to give an indication of the ecological health of a waterway. The sampling is conducted between January and March of each year.

The MCI (Macroinvertebrate Community Index) is a qualitative biotic index based on the assignment of scores to taxa relative to organism sensitivity to habitat disturbance and pollution tolerance. The MCI is calculated by taking the presence or absence of different taxa into account and not the abundance. Score values range between 0 and 200; values less than 75 are indicative of severe degradation and values greater than 125 indicate a clean water environment. This is based on Wright-Stow and Winterbourn's (2003) methodology.

2 Lower Waikato zone

2.1 Introduction

Monitoring is present in one catchment in the Lower Waikato zone; Matahuru catchment. A summary of the catchment characteristics is provided in Appendix 1.

2.2 Matahuru catchment

2.2.1 Monitoring progress

Monitoring is focused on the lower section of the Matahuru catchment (Figure 2). Table 4 presents monitoring completed up until 2007/08.

Table 4: Lower Waikato zone monitoring completed by 2007/08.

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Soil stability and soil conservation assessment	2005	(2005/06)
Riparian characteristics assessment	Complete assessment along the lower section of the Matahuru Stream	2003/04, 2005/06 2007/08	✓
Photo points	Complete assessment along the lower section of the Matahuru Stream	2003/04, 2004/05 2005/06, 2007/08	✓
Permanent suspended sediment sampling site	Event driven sampling	Installed 2003 and ongoing	✓
Suspended sediment snapshots	• Low flow snapshot • Medium flow snapshot • High flow snapshot at next sufficient rainfall event	2003 2008 Not completed	(2005/06)
Water temperature	Install loggers and record stream temperatures along the lower section of the Matahuru Stream	2003/04, 2004/05 2005/06, 2006/07 2007/08	✓

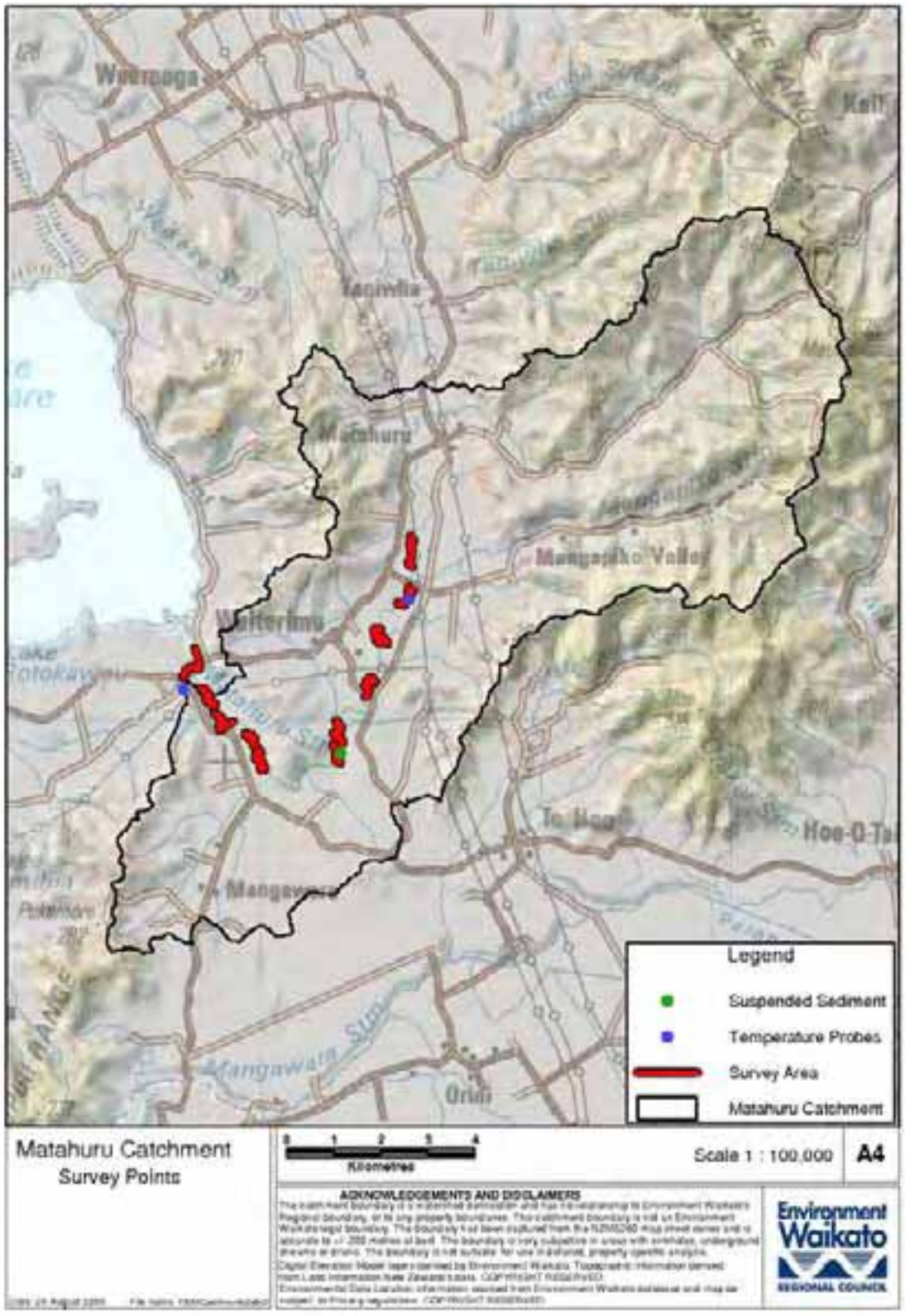

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Figure 2: Matahuru catchment monitoring locations

2.2.2 Soil stability

Refer to Hill et. al. (2006) for the soil stability information in this catchment.

2.2.3 Riparian characteristics

Introduction

Eleven 1km samples of the riparian margin have been assessed in the lower section of the Matahuru Stream. These are locations where Project Watershed funded works have been completed or are scheduled, where stream riparian margin access is possible, and where landowner participation is forthcoming. The baseline assessment was conducted during the 2003/04 summer with the most recent assessment completed in 2007/08.

The reported data for each parameter represents a percentage of the total assessed riparian margin in the catchment. A table of the riparian assessment data is located in Appendix 3. The following summary data was collected where riparian soil conservation has been recently implemented or is planned for the Matahuru catchment. Erosion, vegetation and fencing data summaries are presented in Figures 3, 4, 5 and 6. The number in brackets in each figure is the percentage change from the baseline data collected in the 2003/04 assessment.

Vegetation

Riparian vegetation improves stream bank stability and riparian margin biodiversity, as well as minimising increases in stream temperature due to shading. Riparian vegetation is split into grass and woody vegetation (native + willow + exotic other). Figure 3 shows 30% of the riparian margin is grass. The remaining 70% is woody vegetation, of which 48% is native, 8% is willow and 14% is other exotic species.

The length of the riparian margin in grass has decreased by 23% since the baseline assessment, associated with a corresponding 23% increase in riparian woody vegetation. The increase in woody vegetation is split, with the majority of the increase (13%) being exotic woody vegetation, while the increase in native vegetation accounted for the remaining 10%.

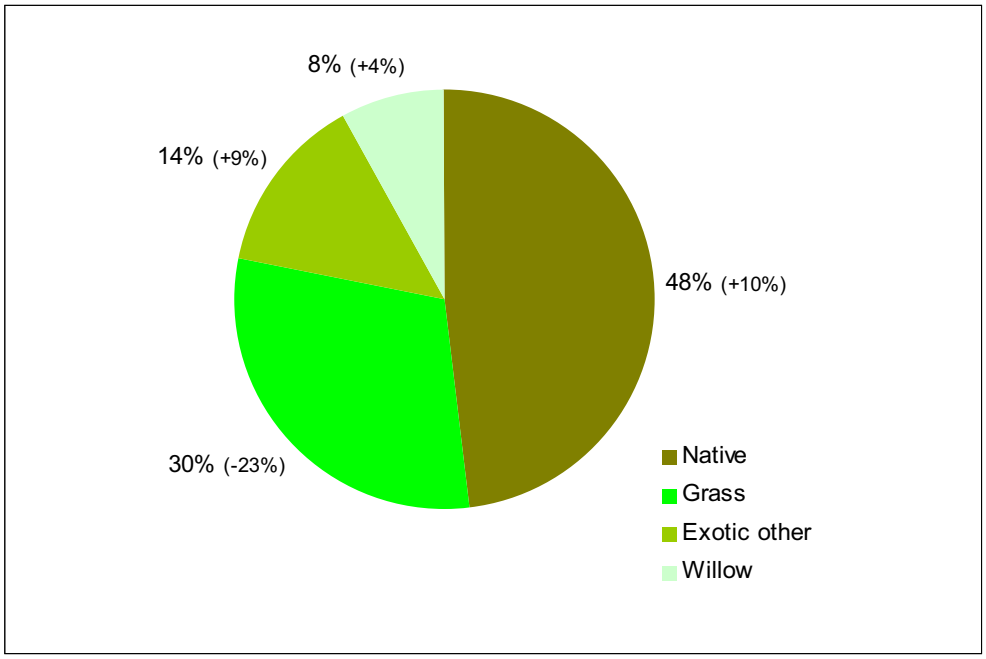

Figure 3: Matahuru riparian vegetation (value in brackets represents the percent change from baseline data)

Fencing

The amount of fencing on one side or both sides of the waterway is an indicator of likely stock exclusion from the waterway. Stock exclusion reduces direct contamination of water by pathogens, direct damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

Stock is excluded from both sides for 63% of the waterway, from one side for 22% of the waterway and are not excluded from either side for 15% of the waterway (Figure 4). There has been an increase in the length of stream fenced on both sides since the 2003/04 assessment.

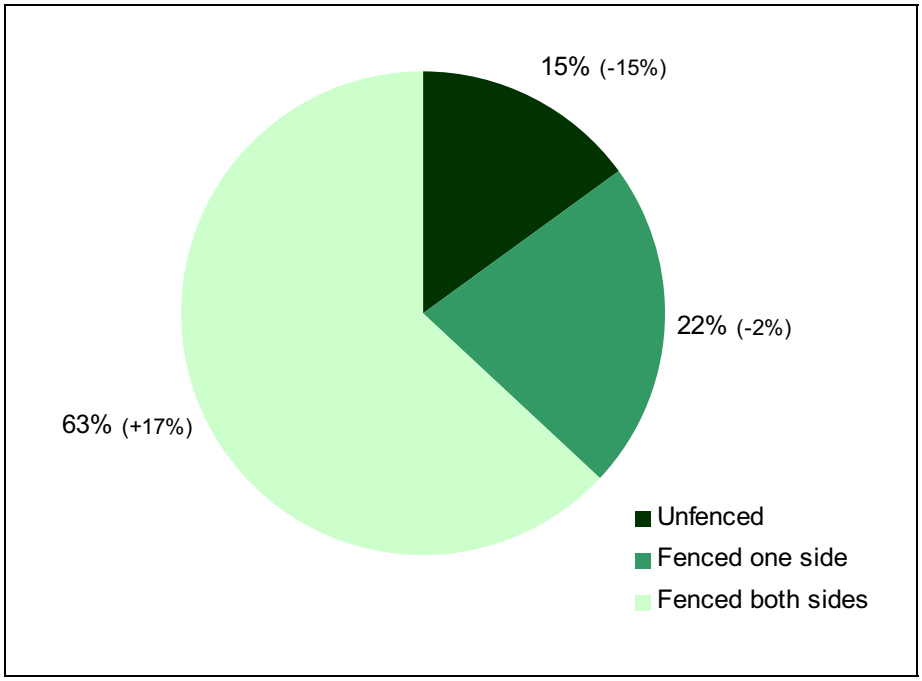

Figure 4: Matahuru stock exclusion by stream length (value in brackets represents the percent change from baseline data)

An estimated 75% of the banks are fenced while 25% are not fenced. The majority (77%) of the total fenced bank length (or 58% of the total bank length) has woody vegetation (Figure 5), an increase of 17%.

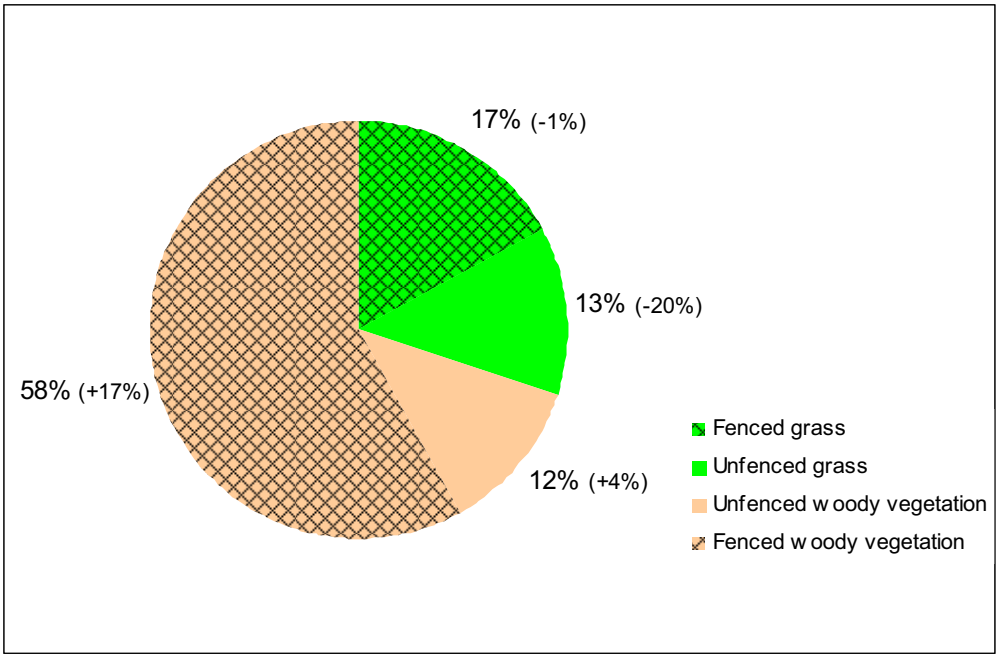

Figure 5: Matahuru riparian margin fencing and vegetation combinations (value in brackets represents the percent change from baseline data)

Stream bank stability

Stream bank stability is measured, as unstable stream banks are one of the main sources of sediment in waterways. Stream bank stability can be improved through the type of riparian vegetation used, and by fencing out stock.

An estimated 75% of the assessed riparian bank length is considered stable, an increase of 28% since the 2003/04 assessment (Figure 6). The remaining 25% is unstable. A greater portion of unstable streambank is unfenced (14%) than fenced (11%). Grass vegetation is present on 10% of unstable banks (40% of the total unstable bank length).

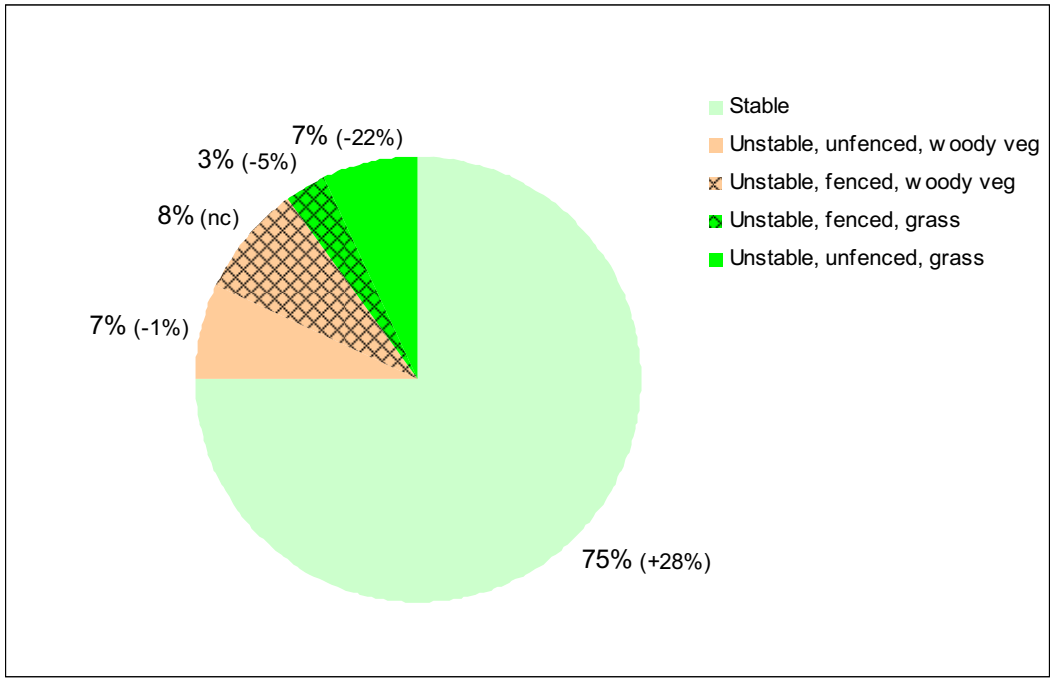

Figure 6: Matahuru streambank instability for fencing and vegetation combinations (value in brackets represents the percent change from baseline data)

2.2.4 Water temperature

The water temperature loggers were deployed in the lower section of the Matahuru Stream; the upstream logger in the vicinity of the Mangapiko Valley Road Bridge and the downstream logger next to the Environment Waikato recorder station by Waiterimu Road. The distance between the two loggers is approximately 20km.

Results

To date five deployments have been made with data collected during each summer between 2003/04 and 2007/08. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the downstream temperature to provide a single number for the monitored section of river (Table 5).

Table 5: Matahuru Stream average daily maximum water temperatures for the 10 week period starting January 1st.

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between u/s and d/s locations (°C)
2003/04	21.86	20.84	-1.02
2004/05	22.78	21.87	-0.91
2005/06	22.20	21.22	-0.98
2006/07	22.61	21.62	-0.99
2007/08	(22.60)	22.41	(-0.18)

The downstream temperature has been cooler than the upstream temperature by approximately 1°C for most years of assessment. The upstream logger was out of the water during the month of January 2008, so the daily maximum average temperature

difference for this summer is not likely to be representative. There is no obvious trend in the data at this stage.

Shading of the Matahuru Stream is sporadic between the two sites with a variety of vegetation types present. As existing vegetation combined with any new plantings establish and grow, shading will increase and result in a larger temperature difference between the upstream and downstream monitoring sites (i.e. a net decrease in water temperature downstream).

2.2.5 Photo points

The initial year of assessment was 2003/04 with subsequent assessments completed in 2004/05, 2005/06 and 2007/08.

Results

Eleven 1km samples of stream were assessed giving a total of 55 photos for the Matahuru catchment (Appendix 4). In general terms the photos indicate little change in riparian characteristics during the period documented by the photo points as minimal fencing and planting has taken place. However, where banks have been fenced off there is a visual change in the form of rank grass (Figures 7a & b), and the small areas of soil conservation plantings have grown noticeably (Figures 7c & d).

	2003/04	2007/08
Assessment 6 at 1000m		
Assessment 2 at 750m		

Figure 7: Matahuru Stream photo point examples of visual change.

2.2.6 Suspended sediment

Permanent sampling site

A permanent suspended sediment sampling site has been in place at Myjers' farm bridge since July 2006. During this time 14 events have been sampled using an automatic sediment sampler. The data set is analysed to estimate sediment variables (Table 6). Data includes all results up until 31/12/2007. For more detailed information, refer to the Suspended Sediment Monitoring Report (Kotze, Grant and Hill, 2008).

Table 6: Matahuru permanent suspended sediment sampling site description and estimated sediment variables

Site name:	**Myjers**	**Map Ref (NZMS260):**		**S13:116-095**
River:	**Matahuru**			
		Start – End Date		**No of samples**
Flow Time Series		17/07/2006 – 31/12/2007		N/A
Sediment Samples		19/07/2006 – 11/07/2007		242
ISCO Period of Record		19/07/2006 – 20/10/2007		14 events
Specific yield ($t/km^2/yr$)	Average sediment yield (kt/yr)	Mean Concentration (mg/l)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
147	12.2	102.1	16.7	5.5

Medium flow snapshot sampling

The medium flow sediment snapshot was sampled at nine sites throughout the Matahuru catchment in April 2008. All samples gave results that indicated unsatisfactory water quality with regards to turbidity, total nitrogen, total phosphorous and *E. coli*. In order to fully understand the conditions in the catchment during high flow events, more sampling and analyses will be undertaken.

2.2.7 Main points

Riparian Characteristics

- The length of riparian margin with woody vegetation has increased from 47% of the total stream bank length in 2003/04, to 70% in the most recent assessment.

- Sixty three per cent of Matahuru Stream is fenced on both sides, up from 46% in the baseline assessment, and 22% is fenced on one side. The length of stream with no fencing on either side has halved from 30% in the baseline assessment to 15%.

- The total length of riparian margin which is fenced and contains woody vegetation has increased from 41% in the baseline assessment to 58% in the most recent assessment. The length of unfenced grass has decreased from 33% to 13% of the total Matahuru riparian length.

- An estimated 75% of the assessed riparian bank length was considered stable (up from 47% in 2003/04) and 25% unstable.

- Out of the length of unstable stream banks, a greater proportion are not fenced than fenced.

- Since riparian soil conservation works began there has been a measurable increase in stream bank stability.

- Photo points have shown some improvements to areas where soil conservation plantings have occurred.

Sedimentation of surface water

- An automatic sediment sampler was installed in the lower reaches of the catchment in July 2006. A longer monitoring period is required in order to produce an indicative specific yield result.

- The medium flow suspended sediment snapshot indicated that all parameters measured (turbidity, nitrogen, phosphorous and *E. coli)* were unsatisfactory.

Aquatic habitat

- The downstream temperature has been cooler on average than the upstream temperature for all years. There is no clear trend in the data at this stage.

- Since 2003/04 river management and soil conservation works have occurred but in general shading of the Matahuru Stream remains sporadic.

- Measurable improvements in aquatic habitat are likely to be evident after about 10 years of monitoring.

3 Upper Waikato zone

3.1 Introduction

Monitoring is present in three catchments in the Upper Waikato zone; Pokaiwhenua, Mangare and Tahunaatara catchments. Catchment characteristics and monitoring progress and results are presented for each catchment individually. A summary of the catchment characteristics for each catchment is provided in Appendix 1.

3.2 Pokaiwhenua catchment

3.2.1 Monitoring progress

The monitoring locations in the Pokaiwhenua catchment are shown in Figure 8. Table 7 presents monitoring completed by 2007/08.

Table 7: Pokaiwhenua catchment monitoring completed by 2008

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Soil stability and soil conservation assessment	2005	(2005/06)
Riparian characteristic assessment	Complete assessment along the middle section of the Pokaiwhenua River	2003/04, 2005/06, 2007/08	✓
Photo points	Complete assessment along the mid section of the Pokaiwhenua River	2003/04, 2004/05, 2005/06, 2007/08	✓
Permanent suspended sediment sampling site	None planned	N/A	N/A
Suspended sediment snapshots	• Low flow snapshot • High flow snapshot at next sufficient rainfall event	2003 Not completed	(2005/06)
Water temperature	Install loggers and record stream temperatures along the middle section of the Pokaiwhenua River	2003/04, 2004/05, 2005/06, 2006/07, 2007/08	✓
Stream ecological health	Assess stream ecological health along the middle section of the Pokaiwhenua River	2003/04, 2004/05, 2005/06, 2006/07 2007/08	✓

N/A = not applicable for 2007/08

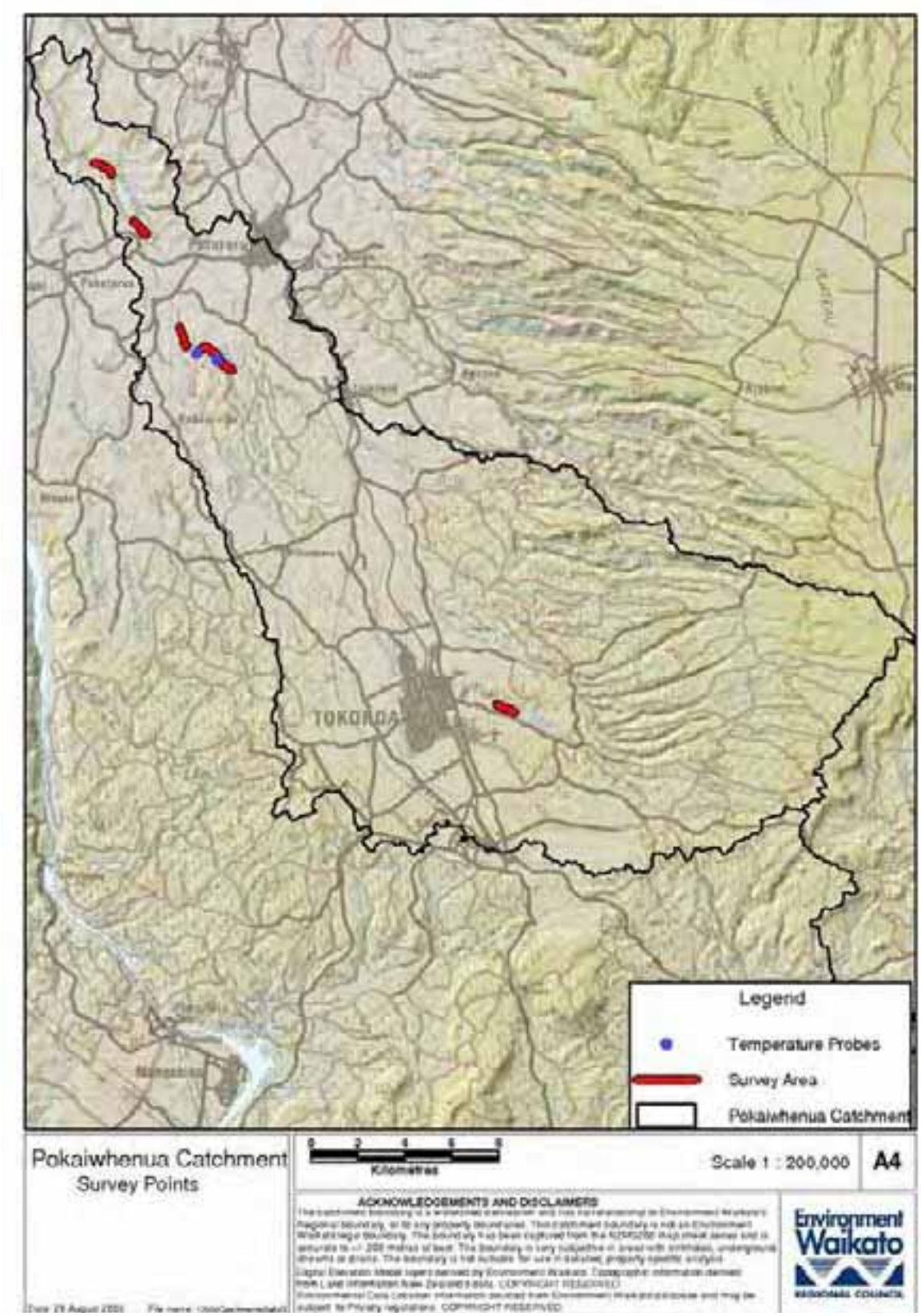

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Figure 8: Pokaiwhenua catchment monitoring locations

3.2.2 Soil stability

Refer to Hill et al. (2006) for the most recent soil stability information in this catchment.

3.2.3 Riparian characteristics

Introduction

For the 2007/08 assessment, six 1km samples were selected for assessment through the mid section of the Pokaiwhenua River. These locations are where funded works have been completed or are scheduled, where stream riparian margin access is possible, and where landowner participation is forthcoming. The samples are the same as used in previous assessments. The baseline assessment was conducted during the summer of 2003/04 with further assessments undertaken in 2005/06 and 2007/08. The reported data for each parameter represents a percentage of the total assessed riparian margin in the catchment. Tabled summary data is presented in Appendix 3. Vegetation, fencing and stream bank stability data summaries are presented in Figures 9, 10, 11, and 12. The number in brackets in each figure is the percentage change from the baseline data collected in the 2003/04 assessment.

Vegetation

Natural biodiversity along the riparian margin can be increased through the planting of native vegetation. Riparian vegetation contributes to stream bank stability and the shading of the stream to help minimise increases in stream temperatures. Riparian vegetation is split in to grass and woody vegetation (native + willow + exotic other). Figure 9 shows 40% of the riparian margin is grass. The remaining 60% is woody vegetation, of which 10% is native, 3% is willow and 47% is exotic other.

The length of the riparian margin in grass has decreased by 16%. There has been a 37% increase in exotic woody vegetation, and an 18% decrease in native woody vegetation since the baseline assessment. This equates to an overall increase in riparian woody vegetation of 16%.

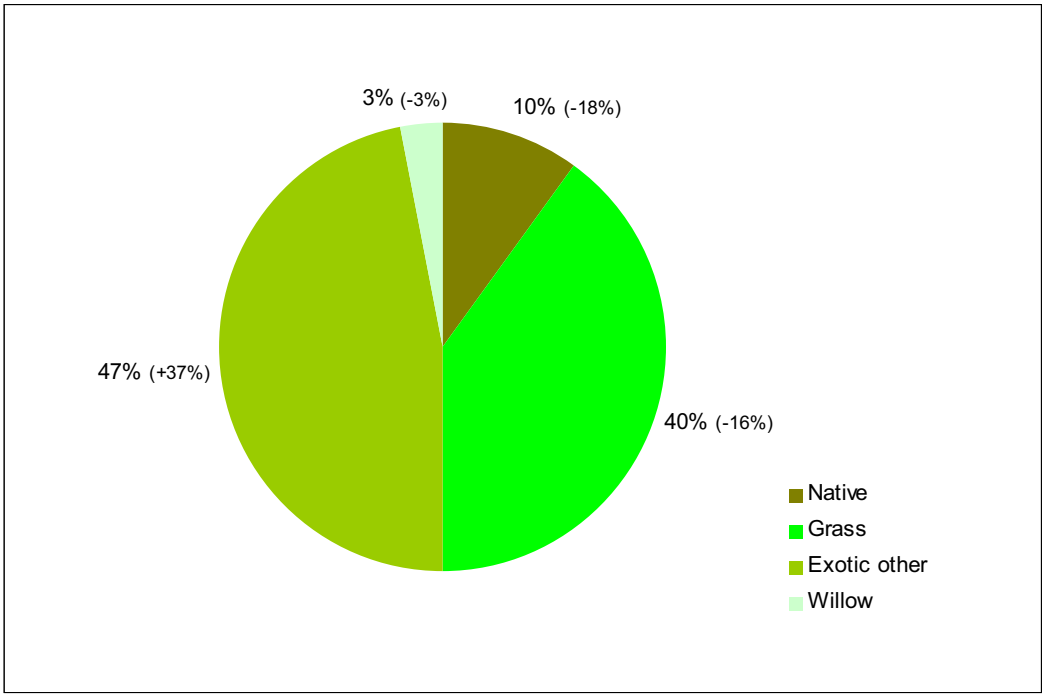

Figure 9: Pokaiwhenua riparian vegetation (value in brackets represents the percent change from baseline data).

Fencing

The amount of fencing on one side or both sides of the waterway is an indicator of likely stock exclusion from the waterway. Stock exclusion reduces direct contamination of water by pathogens, direct damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

Stock is excluded from both sides for 31% of the waterway, from one side for 67% of the waterway and are not excluded either side for 2% of the waterway (Figure 10). There has been an increase in the length of stream fenced on both sides since the 2003/04 assessment.

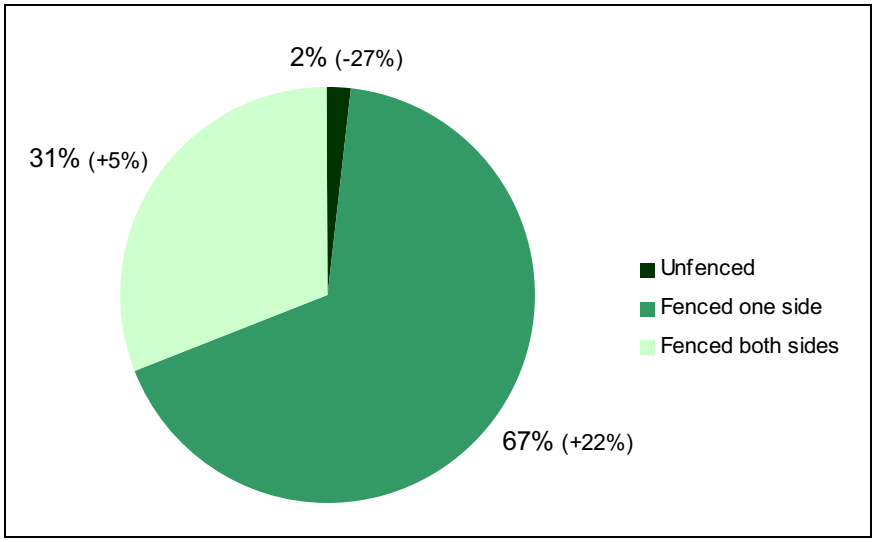

Figure 10: Pokaiwhenua stock exclusion by bank length (value in brackets represents the percent change from baseline data)

An estimated 64% of the banks are fenced while 36% are not fenced. The majority (61%) of the fenced banks (or 39% of the total bank length) have woody vegetation (Figure 11). The length of bank with fenced woody vegetation has increased by 21%.

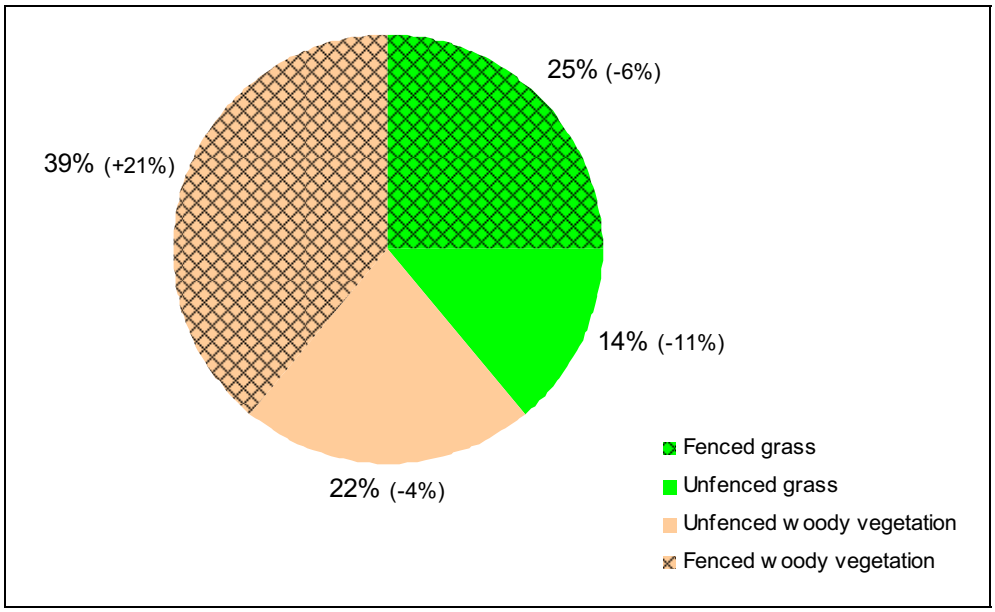

Figure 11: Pokaiwhenua bank length fencing and vegetation combinations (value in brackets represents the percent change from baseline data)

Stream bank stability

Stream bank stability is measured, as unstable stream banks are one of the main sources of sediment in waterways. Stream bank stability can be improved through type of riparian vegetation, and through fencing out stock.

An estimated 85% of the assessed riparian bank length is considered stable, down 3% since the 2003/04 assessment (Figure 12). The remaining 15% is unstable. A greater portion of unstable stream bank is unfenced (9%) than fenced (6%). Grass vegetation is present on 60% of the total unstable bank length.

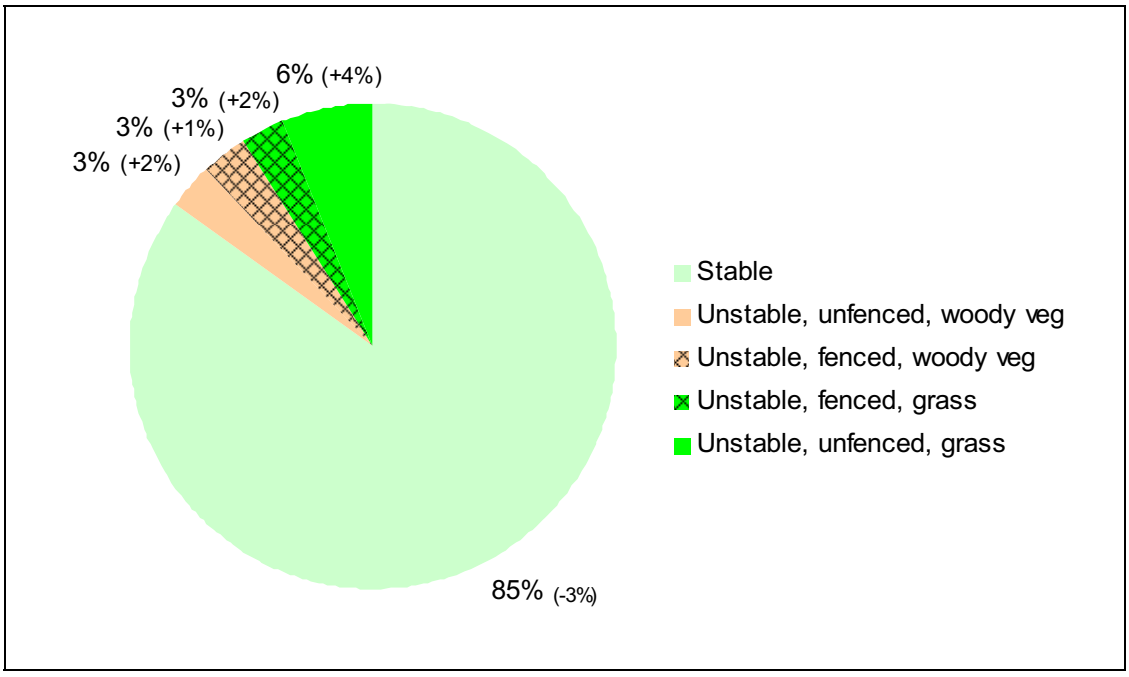

Figure 12: Pokaiwhenua erosion (value in brackets represents the percent change from baseline data)

3.2.4 Water temperature

The water temperature loggers are deployed in the middle section of the Pokaiwhenua River. The distance between the two loggers is approximately 1km. To date five deployments have been made with data collected each summer between 2003/2004 and 2007/2008 inclusive. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the downstream temperature to provide a single number for the monitored section of river (Table 8).

Table 8: Pokaiwhenua Stream average daily maximum water temperatures for the 10 week period starting January 1st.

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between u/s and d/s locations (°C)
2003/04	18.44	18.21	-0.23
2004/05	18.78	18.47	-0.31
2005/06	18.32	17.98	-0.33
2006/07	18.51	18.15	-0.36
2007/08	19.21	18.63	-0.58

Table 8 illustrates the downstream temperature has been slightly cooler on average than the upstream temperature for all monitored summers. At present little shading of the river occurs between the upstream and downstream monitoring sites. The data suggests there is an increase in the downstream cooling through the monitored reach. However, this can not be attributed to the effects of riparian planting. With the width of the river in this vicinity being 5-7m it will be a number of years before any significant vegetative shading influence on the river is observed.

3.2.5 Photo points

The initial year of assessment was 2003/04 with subsequent assessments completed in 2004/05, 2005/06 and 2007/08.

Six 1km samples of stream were assessed giving a total of 30 photos for the Pokaiwhenua catchment (Appendix 4). The initial baseline photos from 2003/04 are in the left column with the most recent photos from 2007/08 in the column on the right. Large sections of the photo assessment have not been fenced, and so little change is evident. However the sections which have been fenced have developed vegetation which is shading the water (Figure 13 a & b). Small areas have had soil conservation planting with mixed success.

Figure 13: Pokaiwhenua Stream photo point examples of visual change, Sample 6 at 750m a) 2003/04; b) 2007/08.

3.2.6 Stream ecological health

The dominant surrounding land use in the vicinity of both of the sampling sites in the Pokaiwhenua River is pastoral/horticultural. The stream ranges between 5-7m in width with the substrate predominantly consisting of a combination of cobble, gravel and sand. The canopy cover is open.

Invertebrate sampling is carried out in the same two locations where the water temperature probes are deployed in the middle section of the Pokaiwhenua River. The initial year of assessment was completed in 2004 with subsequent assessments completed annually.

Table 9 lists the MCI values as calculated for the upstream and downstream sampling sites in the Pokaiwhenua River.

Table 9: MCI values for the Pokaiwhenua River. Samples are taken between January and March of each year.

Site	2004	2005	2006	2007	2008
Pokaiwhenua upstream	99	103	113	113	115
Pokaiwhenua downstream	113	109	116	103	108

In the vicinity of the two sampling sites in the Pokaiwhenua River the presence and abundance of identified invertebrate species and the associated MCI scores indicate that the stream has a mild degradation in ecological health.

3.2.7 Main points

Riparian characteristics

- The amount of native vegetation decreased from 28% to 10% due to low survival of native plantings.
- The length of stream bank fenced increased. Of the increase fencing on both banks increased from 26% to 31% and fencing on one bank increased from 44% to 67%. Only 2% of the sampled stream length has no fencing.
- The length of bank with fenced, woody vegetation has increased from 14% when the first assessment was taken in 2003/04, to 39% in the most recent assessment.
- An estimated 85% of the assessed riparian bank length was considered stable and 15% unstable. This is a slight decrease (3%) in stability since the baseline assessment was taken in 2003/04.
- Of the unstable bank the greatest proportion is unfenced grass (6%).
- Photo points show some changes in areas where soil conservation plantings have occurred.

Aquatic habitat

- The downstream temperature is consistently cooler on average than the upstream temperature for all monitored summers.
- There is an emerging trend in the data showing the downstream site recording increasing cooler temperatures than the upstream site.
- Soil conservation works have occurred along some stretches of bank, but due to the width of the river, the shading effect on the stream temperature may be limited.
- Assessments of the invertebrates in Pokaiwhenua Stream indicate that there is a mild degradation in ecological health.
- Measurable improvements in aquatic habitat are likely to be evident after about 10 years of monitoring.

3.3 Mangare catchment

3.3.1 Monitoring progress

The monitoring locations in the Mangare catchment are shown in Figure 14. Table 10 contains monitoring completed by 2007/08.

Table 10: Mangare catchment monitoring completed by 2007/08.

Monitoring	Planned activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Complete assessment along the middle section of the Mangare Stream	2003/04, 2005/06, 2007/08	✓
Photo points	Complete assessment along the middle section of the Mangare Stream	2003/04, 2004/05, 2005/06, 2007/08	✓
Permanent suspended sediment sampling site	Not planned	N/A	N/A
Suspended Sediment snapshot	Not planned	N/A	N/A
Water temperature	Install loggers and record stream temperatures along the middle section of the Mangare Stream	2006/07, 2007/08	✓
Stream ecological health	Assess stream ecological health along the mid section of the Mangare Stream	2005/06, 2006/07, 2007/08	✓

N/A = not applicable for 2007/08

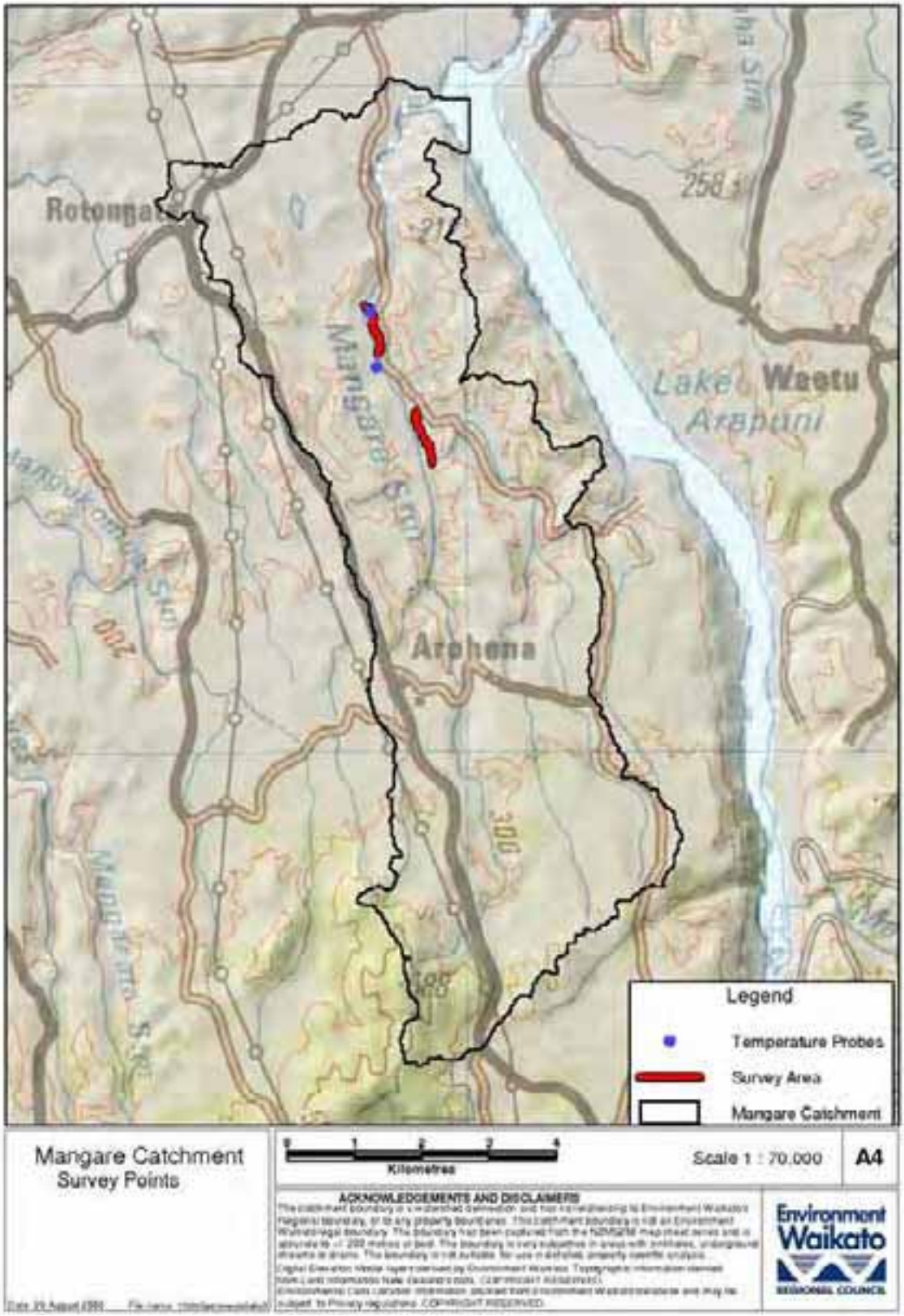

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Figure 14: Mangare catchment monitoring locations

3.3.2 Riparian characteristics

Introduction

Two 1km samples were selected for assessment through the middle section of the Mangare Stream. These locations are where Project Watershed funded works have been completed and are scheduled, where stream riparian margin access is possible,

and where landowner participation is forthcoming. The baseline assessment was conducted in the 2003/04 year with the most recent assessment conducted in 2007/08. The reported data for each parameter represents a percentage of the total assessed riparian margin in the catchment. Tabled summary riparian assessment data is located in Appendix 3.

Vegetation, fencing and stream bank stability data summaries are presented in Figures 15, 16, 17, and 18. The number in brackets in each figure is the percentage change from the baseline data collected in the 2003/04 assessment.

Vegetation

Riparian vegetation contributes to stream bank stability, and improves the shading of the stream to help minimise increases in stream temperatures. Natural biodiversity along the riparian margin can be increased through the planting of native vegetation. Riparian vegetation is split into grass and woody vegetation (native + willow + exotic other). Figure 15 shows 39% of the riparian margin is grass. The remaining 61% is woody vegetation, of which 0% is native, 32% is willow and 29% is exotic other.

The length of the riparian margin in grass has decreased by 55%; associated with a corresponding 55% increase in exotic woody vegetation.

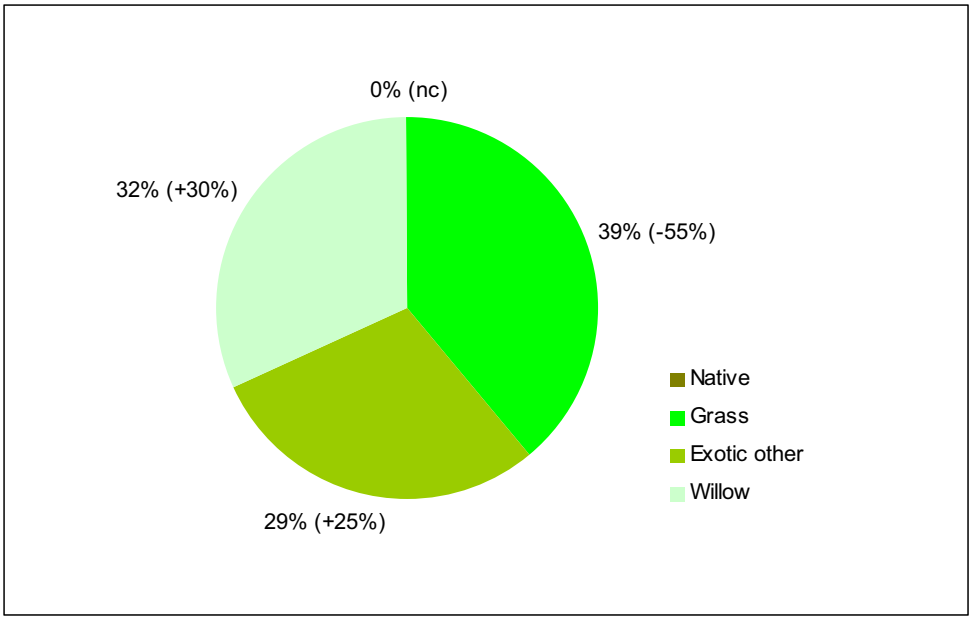

Figure 15: Mangare vegetation (value in brackets represents the percent change from baseline data).

Fencing

The amount of fencing on one side or both sides of the waterway is an indicator of likely stock exclusion from the waterway. Stock exclusion reduces direct contamination of water by pathogens, direct damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

The farm animals are excluded from both sides for 50% of the waterway, from one side for 26% of the waterway and are not excluded either side for 24% of the waterway (Figure 16). There has been an increase in the length of stream fenced on both sides since the 2003/04 assessment.

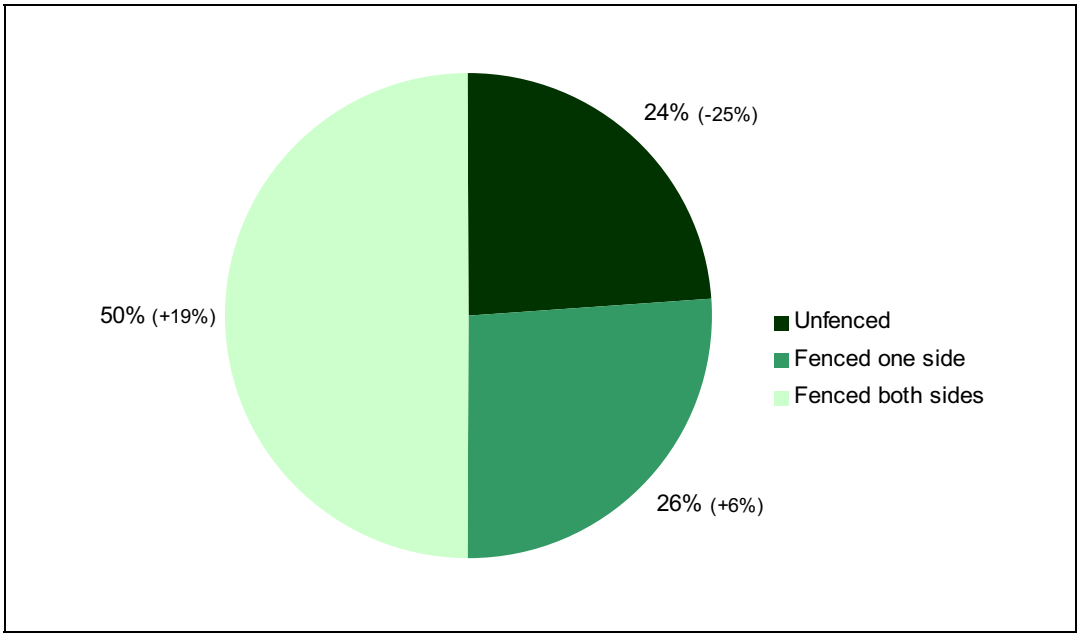

Figure 16: Mangare stock exclusion by bank length (value in brackets represents the percent change from baseline data).

An estimated 63% of the banks are fenced while 37% are not fenced (Figure 17). The majority (89%) of the fenced banks (or 56% of the total bank length) have woody vegetation. The length of bank with fenced woody vegetation has increased dramatically from 2% of the total length, to 56%.

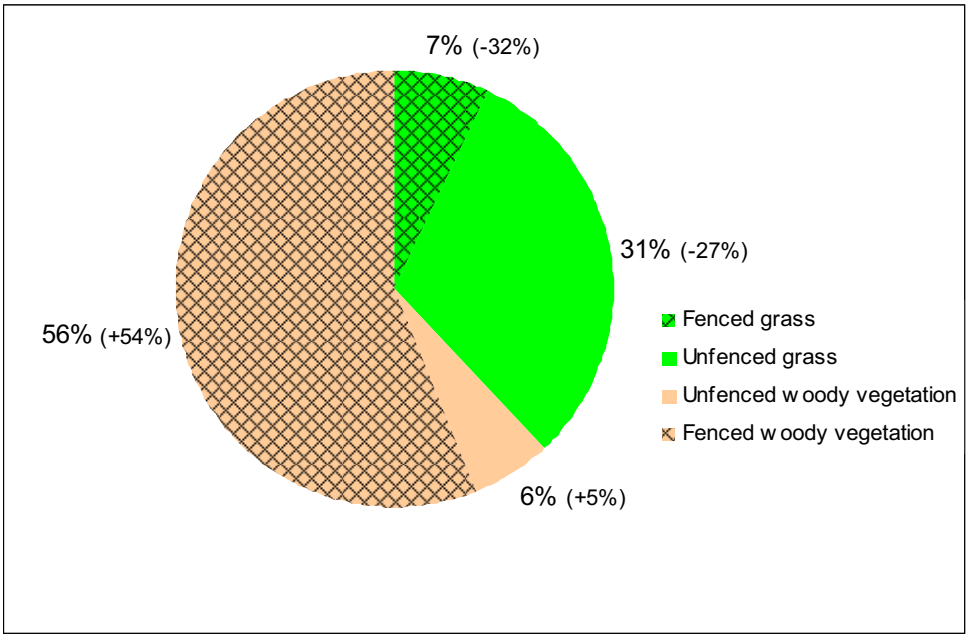

Figure 17: Mangare bank length fencing and vegetation combinations (value in brackets represents the percent change from baseline data).

Stream bank stability

Stream bank stability is measured, as unstable stream banks are one of the main sources of sediment in waterways. Stream bank stability can be improved through type of riparian vegetation, and through fencing out stock.

An estimated 67% of the assessed riparian bank length is considered stable (figure 18). From the remaining 33% unstable bank, a greater portion is not fenced (19%) than fenced (14%) Grass vegetation is present on 61% of the total unstable bank length.

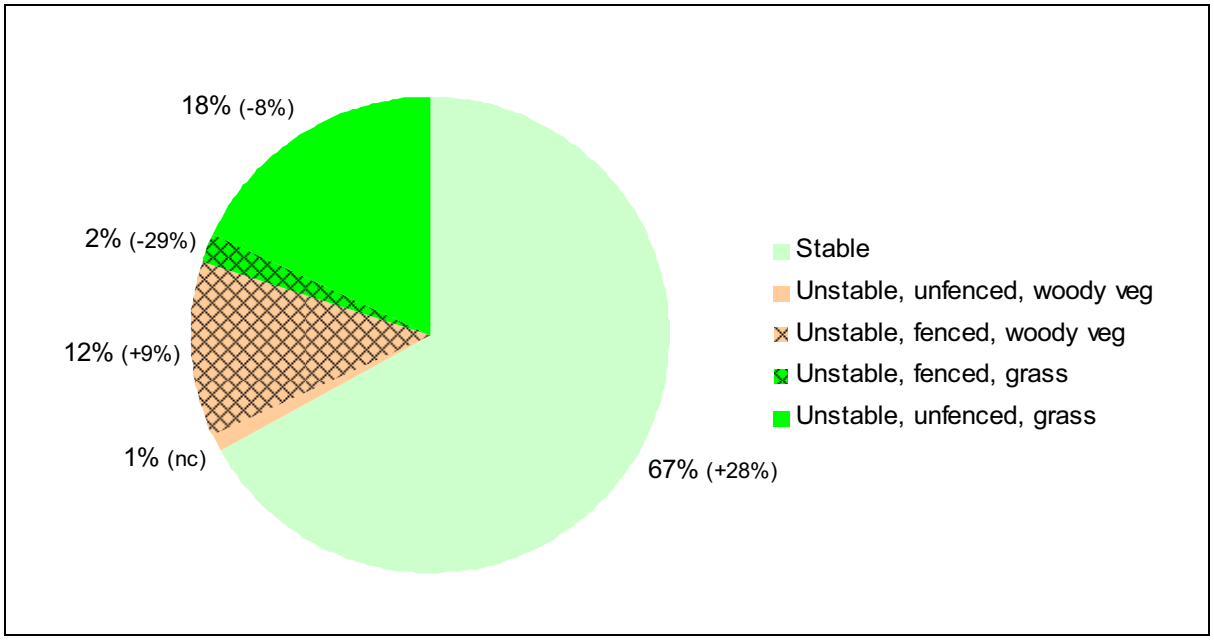

Figure 18: Mangare erosion (value in brackets represents the percent change from baseline data).

3.3.3 Water temperature

The water temperature loggers are deployed in the middle section of the Mangare Stream, with a distance between the two loggers of approximately 1km. The loggers have collected data during the summers of 2006/07 and 2007/08. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the downstream temperature to provide a single number for the monitored section of river (Table 11).

Table 11: Mangare Stream average daily maximum water temperatures for the 10 week period starting January 1st.

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between u/s and d/s locations (°C)
2006/07	21.53	21.27	-0.26
2007/08	22.82	22.28	-0.55

Table 11 illustrates the downstream temperature has been slightly cooler on average than the upstream temperature for both monitored summers. The shading of Mangare Stream has greatly improved for one section of the stream during the years of assessment, however a longer time period is required for the water temperature to reflect these changes.

3.3.4 Photo points

The initial year of assessment was 2003/04 with subsequent assessments completed in 2004/05, 2005/06 and 2007/08. Two 1km samples of stream were assessed giving a total of 10 photos for the Mangare Catchment (Appendix 4). The initial baseline photos from 2003/04 are in the left column with the most recent photos from 2007/08 in the column on the right. The photos in one section of the stream indicate little change in riparian characteristics during the monitored period due to little to no riparian fencing or planting. However, the other section of stream showed significant change where the assessed reach has been fenced and planted with willow poles on both banks (Figure 19 a & b).

Figure 19: Mangare Stream photo point examples of visual change at Sample 1, 750m a) 2003/04; b) 2007/08.

3.3.5 Stream ecological health

The dominant surrounding land use in the vicinity of both of the sampling sites in the Mangare Stream is pastoral. The stream ranges between 1.5-3m in width with the substrate predominantly consisting of a combination of cobble, gravel, and sand with some bedrock in places. The canopy cover is open however partial shading of the stream is beginning to occur from willow poles planted in 2005.

Invertebrate sampling is carried out in the same two locations where the water temperature probes are deployed in the middle section of the Mangare Stream. The initial year of assessment was completed in 2006. The assessments will be conducted annually.

Table 12 lists the MCI values as calculated for the upstream and downstream sampling sites in the Mangare Stream.

Table 12: MCI values for the Mangare Stream. Samples are taken between January and March of each year.

Site	2006	2007	2008
Mangare upstream	99	113	96
Mangare downstream	92	93	82

In the vicinity of the two sampling sites in the Mangare Stream the presence and abundance of identified invertebrate species and the associated MCI scores for the assessment indicate that this stream has a moderate to mild degradation in ecological health.

3.3.6 Main points

Riparian Characteristics

- Sixty one per cent of the Mangare Stream riparian margin is woody vegetation, an increase from 6% in the first assessment in 2003/04, and 39% is grass.

- The amount of unfenced stream has decreased from 49% in the baseline assessment to 24%. Half of the monitored section of Mangare stream has fences along both sides of the stream, an increase since the first assessment was taken. The remaining 26% of the stream bank is fenced on one side.

- The length of bank with fenced woody vegetation has increased from 2% in the baseline assessment, to 56% in the 2007/08 assessment. Unfenced grass has decreased from 58% of the stream bank to 31%.

- An estimated 67% of the assessed riparian bank length was found to be stable, up from 39% in 2003/04.

- A greater fraction of unstable stream banks are unfenced and have grass vegetation.

- Photo points have shown some large improvements to areas where soil conservation plantings have occurred, however little vegetation growth is evident for the sections of monitored stream which haven't been fenced off.

Aquatic habitat

- The downstream temperature has been slightly cooler on average than the upstream temperature, but a longer time period is needed before trends emerge.

- Shading has dramatically increased for half of the assessed stream reach, but the water temperature is unlikely to reflect this improvement for a number of years.

- Assessments of the invertebrates in Mangare Stream indicate that this stream has a moderate to mild degradation in ecological health.

3.4 Tahunaatara catchment

3.4.1 Monitoring progress

Monitoring focuses on the middle section of the Pokaitu Stream, a sub-catchment of the Tahunaatara Stream (Figure 20) which feeds into Lake Atiamuri. Table 13 contains monitoring completed by 2007/08.

Table 13: Upper Waikato zone monitoring completed by 2007/08

Monitoring	Planned activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Not planned	N/A	N/A
Photo points	Not planned	2003/04	(2005/06)
Permanent suspended sediment sampling site	Not planned	N/A	N/A
Suspended Sediment snapshot	Not planned	N/A	N/A
Water temperature	Install loggers and record stream temperatures along the middle section of the Pokaitu Stream	2003/04, 2004/05, 2005/06, 2006/07, 2007/08	✓
Stream ecological health	Assess stream ecological health along the middle section of the Pokaitu Stream	2003/04, 2004/05, 2005/06, 2006/07 2007/08	✓

N/A = not applicable for 2007/08

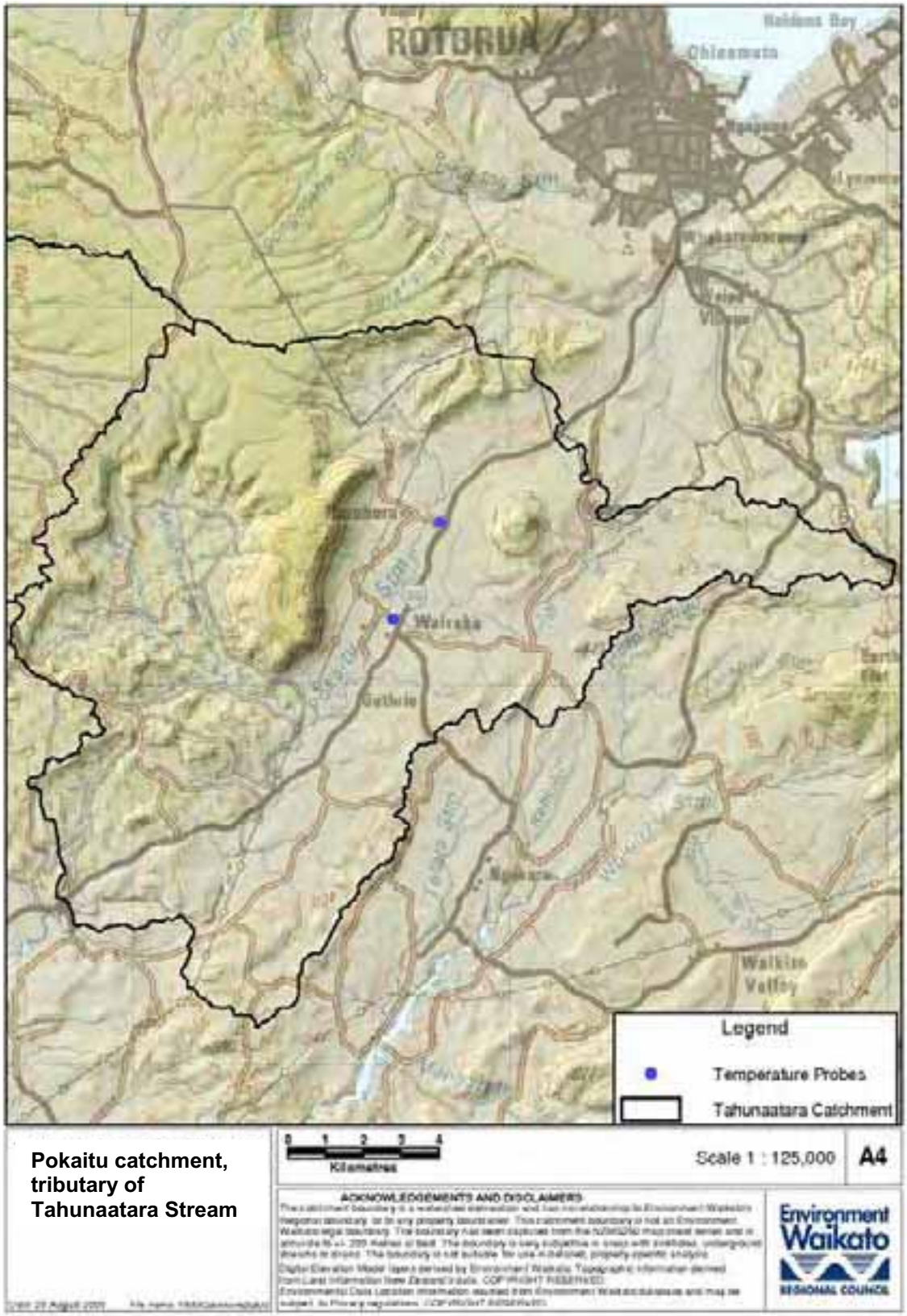

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Figure 20: Tahunaatara sub-catchment monitoring locations

3.4.2 Water temperature

Water temperature loggers are deployed in the middle section of the Pokaitu Stream, with a distance between them of approximately 5km. To date, the temperature data for five summers have been recorded, between 2003/2004 and 2007/2008 inclusive.

The average of the daily maximum water temperatures is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the

downstream temperature to provide a single number for the monitored section of river (see Table 14).

Table 14: Pokaitu Stream average daily maximum water temperatures for the 10 week period starting January 1st.

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between u/s and d/s locations (°C)
2003/04	17.52	16.91	-0.61
2004/05	17.87	17.23	-0.64
2005/06	17.01	16.63	-0.38
2006/07	17.13	16.85	-0.28
2007/08	17.53	17.16	-0.37

As Table 14 illustrates, the downstream temperature has been slightly cooler on average than the upstream temperature for all years of assessment. At present sparse and sporadic shading of the stream occurs between the two temperature probes. A longer time period is required before any trends can be determined.

3.4.3 Photo points

Photo points were not under taken this year. Refer to Hill et. al. (2006) for the most recent photo points taken along the Pokaitu Stream (2003/04).

3.4.4 Stream ecological health

The dominant surrounding land use in the vicinity of the sampling site is pastoral. The stream is 3-4m in width with the substrate predominantly consisting of gravel with some cobble and sand. The canopy cover is open.

Invertebrate sampling is conducted in the Pokaitu Stream under the southern Apirana Road bridge (where the downstream temperature probe is deployed). The initial year of assessment was in 2004 with subsequent assessments completed annually.
Table 15 lists the MCI values as calculated for the Pokaitu Stream sampling site.

Table 15: MCI values for the Pokaitu Stream. Samples are taken between January and March of each year.

Site	2004	2005	2006	2007	2008
Pokaitu downstream	104	116	120	126	122

In the vicinity of the sampling site in the Pokaitu Stream the presence and abundance of identified invertebrate species and the associated MCI scores indicate that the stream has mild to clean water quality in terms of ecological health.

3.4.5 Main points

Aquatic habitat

- The downstream temperature has been slightly cooler on average than the upstream temperature for all assessed summers.
- A longer time period is required before water temperature trends will emerge.
- In general, shading of the Pokaitu Stream remains sparse and sporadic.
- Assessments of the invertebrates in Pokaitu Stream indicate that the stream has mild to clean water quality in terms of ecological health.
- Measurable improvements in aquatic habitat are likely to be evident after about 10 years of monitoring.
- Multiple photo points have not been undertaken. Comparisons in vegetation growth and visual improvement along the riparian margin can not yet be made.

4 Waipa Zone

4.1 Introduction

Monitoring is present in one catchment in the Waipa zone; Mangatutu catchment. A summary of the catchment characteristics is provided in Appendix 1.

4.2 Mangatutu catchment

4.2.1 Monitoring progress

Monitoring focuses on the Mangatutu Stream catchment where river management and soil conservation initiatives are being implemented. Assessment locations are shown in Figure 21. Table 16 contains monitoring completed by 2007/08.

Table 16: Waipa zone monitoring completed by 2007/08

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Complete assessment along the lower section of the Mangatutu sub-catchment	2004/05, 2006/07	✓
Photo points	Complete assessment along the lower section of the Mangatutu sub-catchment	2004/05, 2006/07	✓
Permanent suspended sediment sampling site	Event driven sampling	Ongoing since June 2004	✓
Suspended sediment snapshots	• Low flow snapshot • High flow snapshot at next sufficient rainfall event	2004 Not completed	(2005/06) N/A
Water temperature	Install loggers and record stream temperatures along the lower section of the Mangatutu River.	2003/04,2004/05, 2005/06,2006/07, 2007/08	✓
Stream ecological health	Assess stream ecological health along the middle and lower section of the Mangatutu River.	2004/05,2005/06, 2006/07, 2007/08	✓

N/A = not applicable for 2007/08

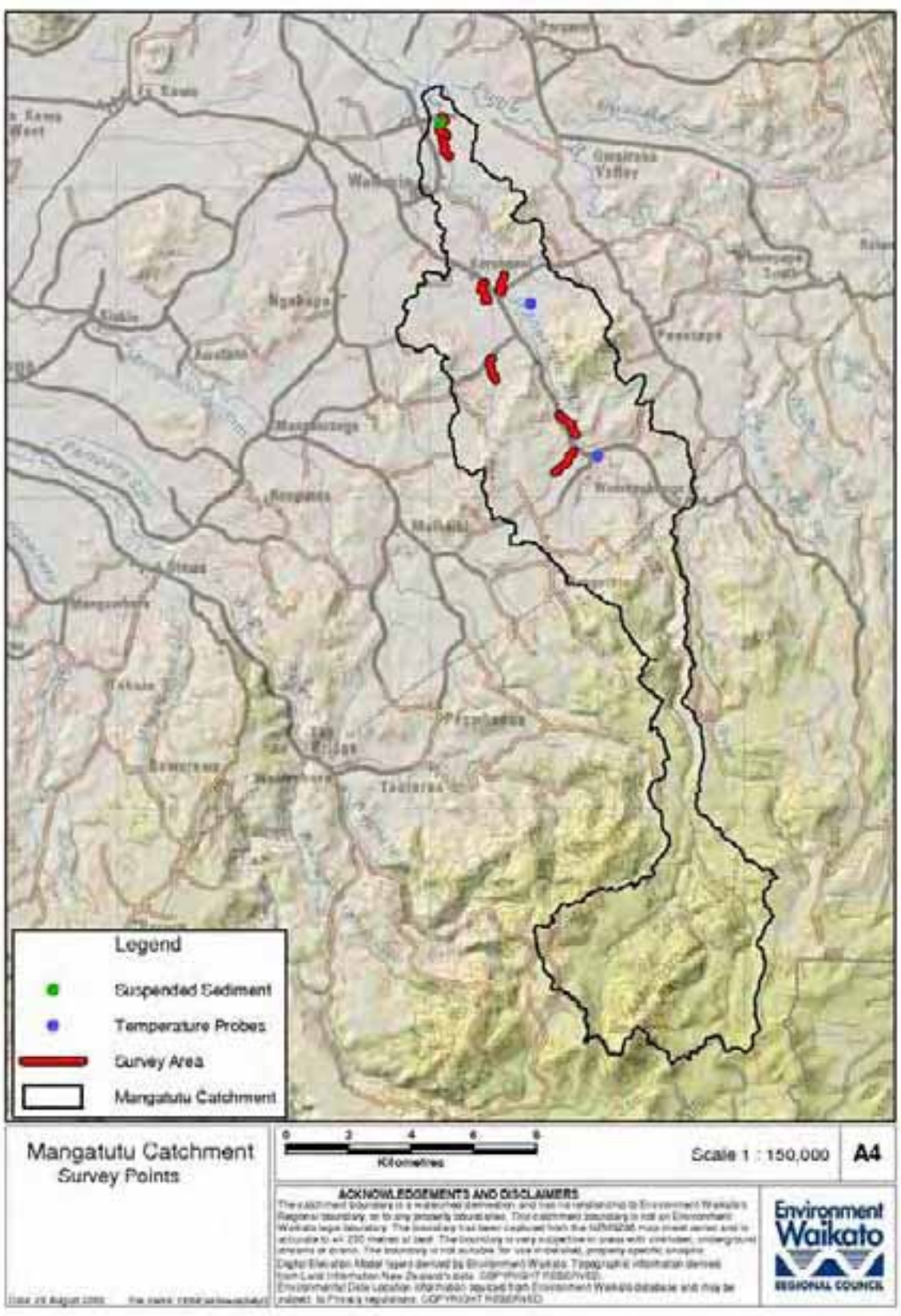

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Figure 21 Mangatutu catchment monitoring locations

4.2.2 Riparian characteristics

Introduction

Seven 1km samples were selected for assessment through the lower section of the Mangatutu sub-catchment with four of the samples on the Mangatutu Stream and three

on its' tributaries. The assessments on the Mangatutu Stream are locations where Project Watershed funded river management and soil conservation works are scheduled. Those on tributaries of the Mangatutu Stream provide for greater geographic spread within the Mangatutu sub-catchment and therefore wider representation of riparian characteristics. The initial assessment was conducted in the 2004/05 year with the latest assessment conducted in 2006/07.

The reported data for each parameter represents a percentage of the total assessed riparian margin in the catchment. Tabled summary riparian assessment data is located in Appendix 3.

The following summary data was collected where riparian soil conservation has been recently implemented or is planned for the Mangatutu catchment. Erosion, vegetation and fencing data summaries are presented in Figures 22, 23, 24 and 25. The number in brackets in each figure is the percentage change from the baseline data collected in the 2004/05 assessment.

Vegetation

Riparian vegetation contributes to stream bank stability and the shading of the stream to help minimise increases in stream temperatures. Natural biodiversity along the riparian margin can be increased through the planting of native vegetation. Riparian vegetation is split into grass and woody vegetation (native + willow + exotic other). Figure 22 shows 54% of the riparian margin is grass. The remaining 46% is woody vegetation, of which 2% of the total length is native, 22% is willow and 22% is exotic other.

The length of the riparian margin in grass has decreased by 2%; associated with a corresponding 2% increase in riparian woody vegetation. The increase in woody vegetation is split between native (1%) and exotic (1%).

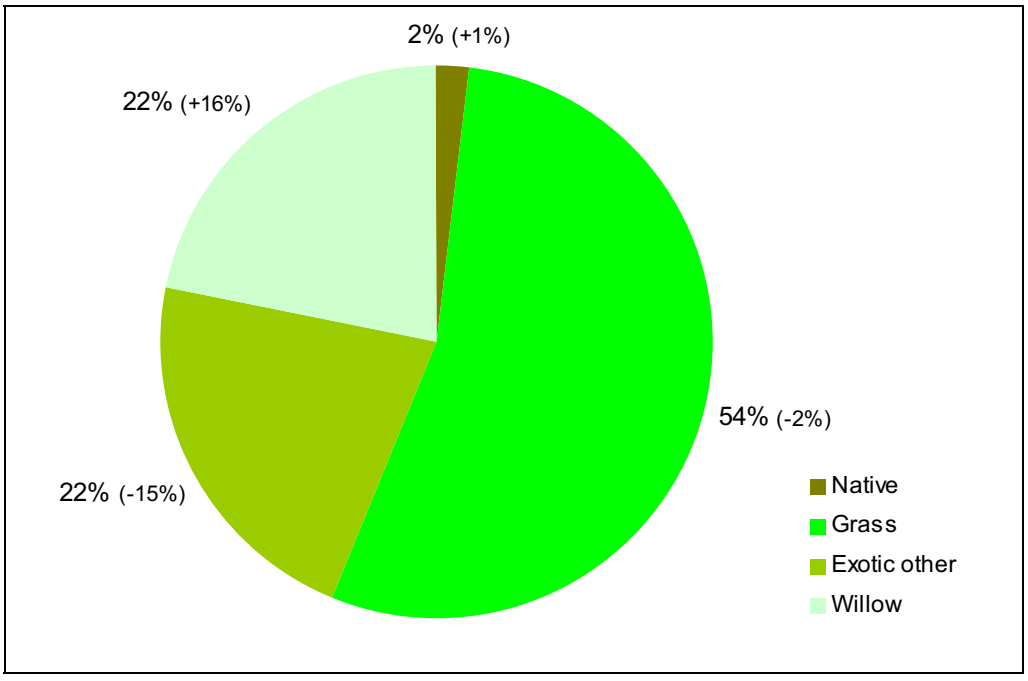

Figure 22: Mangatutu riparian vegetation (value in brackets represents the percent change from baseline data).

Fencing

The amount of fencing on one side or both sides of the waterway is an indicator of likely stock exclusion from the waterway. Stock exclusion reduces direct contamination of water by pathogens, direct damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

Stock is excluded from both sides for 25% of the waterway, from one side for 50% of the waterway and are not excluded either side for 25% of the waterway (Figure 23). There has been an increase in the length of stream fenced on both sides since the 2004/05 assessment.

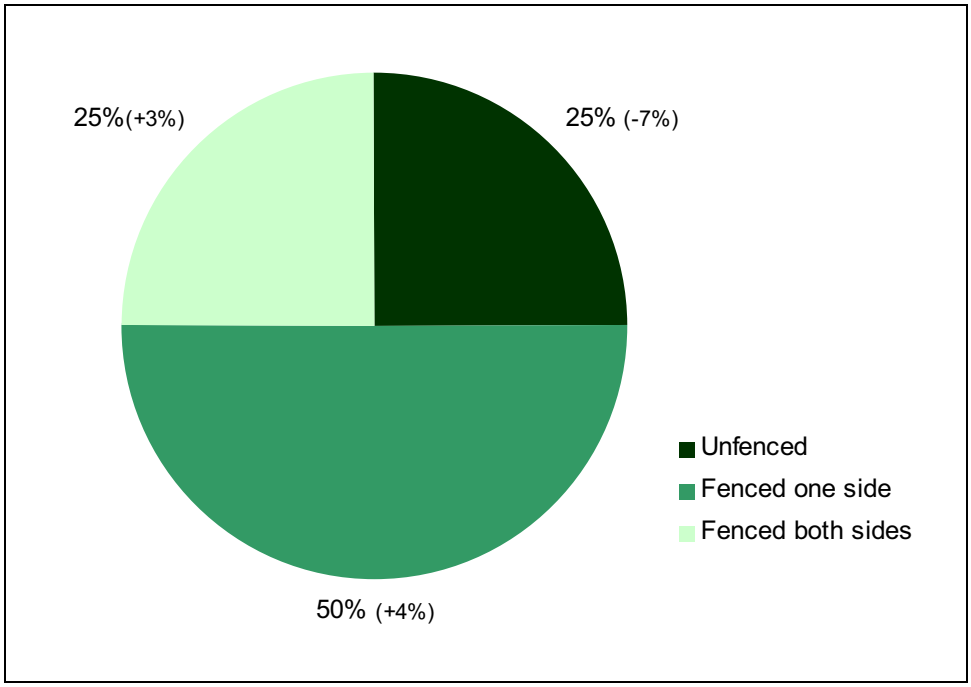

Figure 23: Mangatutu stock exclusion by bank length (value in brackets represents the percent change from baseline data)

There has been an increase in fencing over the total stream bank length since the baseline assessment, from 27% to 50%. The majority of the fenced banks (62% of the total fenced bank length) have woody vegetation (Figure 24). The proportion of stream bank that is fenced off and has woody vegetation has increased from 6% to 31% of the total length over the two years separating the assessments.

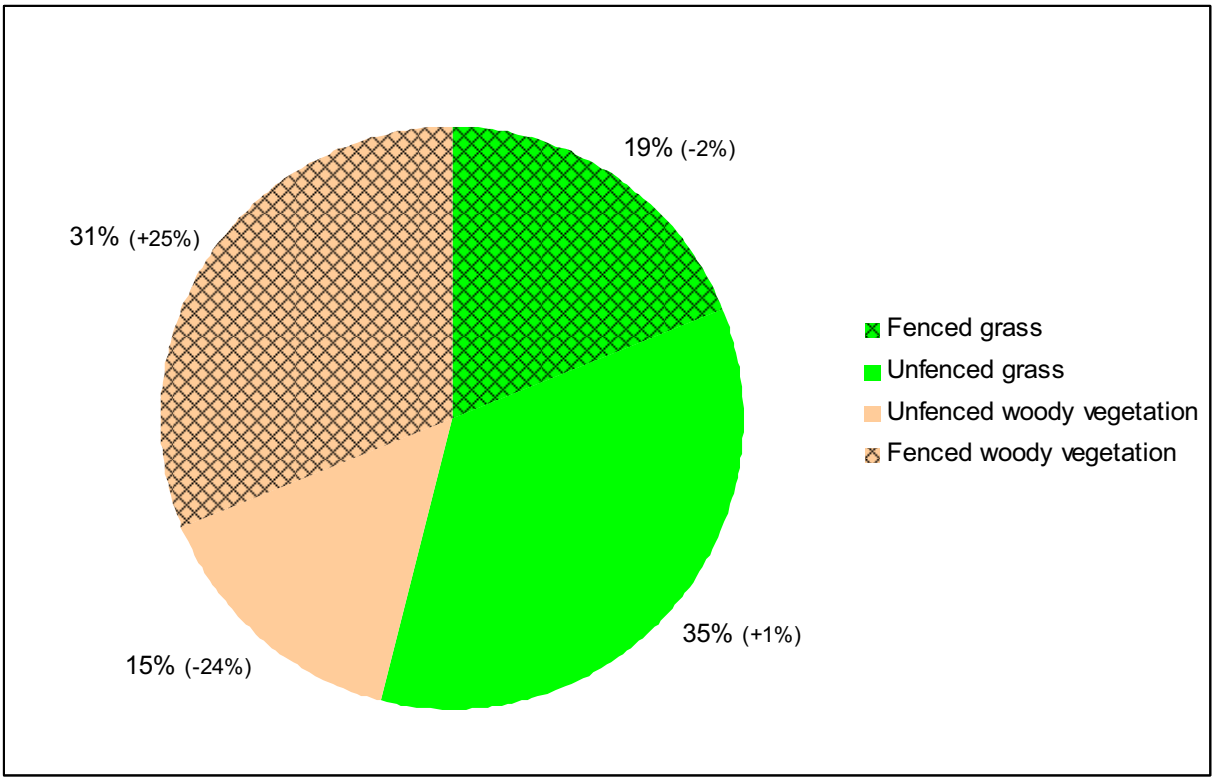

Figure 24: Mangatutu bank length fencing and vegetation combinations (value in brackets represents the percent change from baseline data).

Stream bank stability

Stream bank stability is measured, as unstable stream banks are one of the main sources of sediment in waterways. Stream bank stability can be improved through type of riparian vegetation, and through fencing out stock.

An estimated 86% of the assessed riparian bank length is considered stable, up from the 57% measured in the 2004/05 assessment (Figure 25). The remaining 14% is unstable. A greater portion of unstable stream bank is unfenced (9% of the total stream length) than fenced (5%). Grass vegetation is present on 64% of the total unstable bank length.

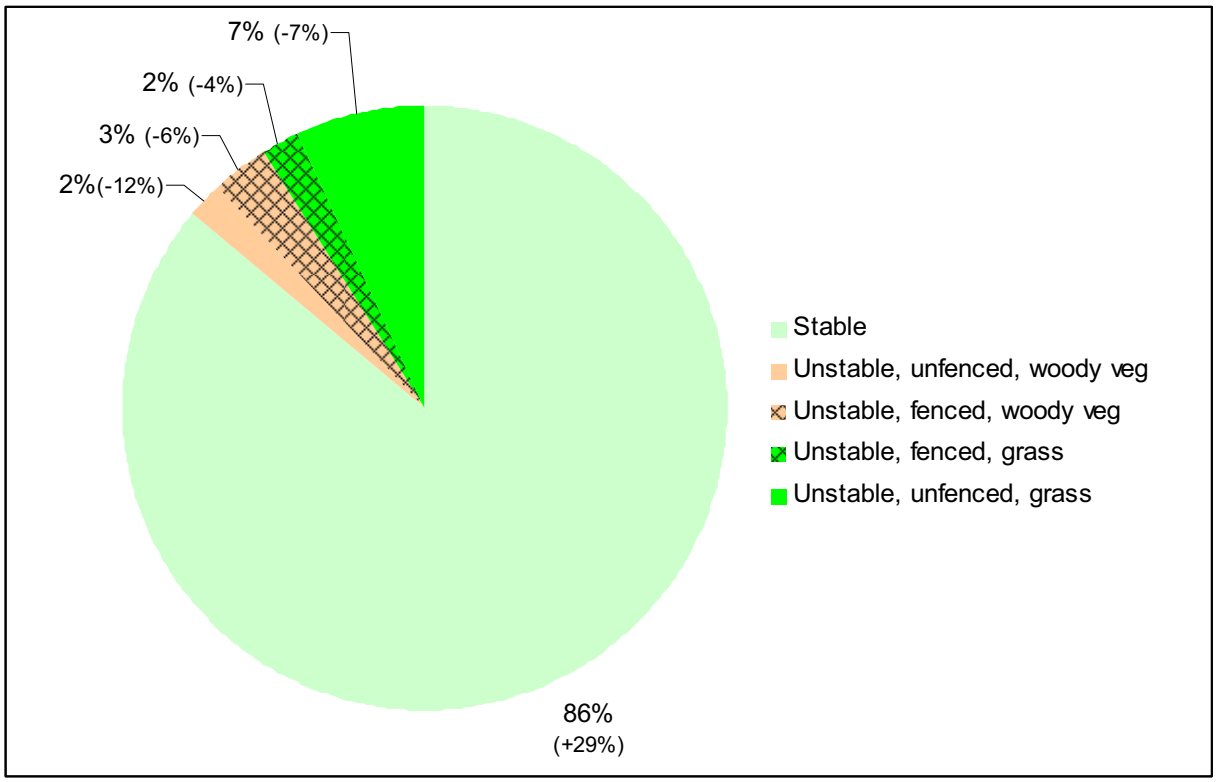

Figure 25: Mangatutu erosion (value in brackets represents the percent change from baseline data).

4.2.3 Water temperature

Water temperature loggers are deployed in the lower section of the Mangatutu Stream. The downstream logger is under the Walker Road bridge, the midstream logger is beneath the Lethbridge Road bridge and the upstream logger is near the Wharepuhunga Road bridge. The distance between the upstream and downstream loggers is approximately 18km. To date five deployments have been made with data collected for the summers between 2003/04 and 2007/2008. The 2003/2004 temperature data collected was only for the period of February to March; therefore the daily maximum average for this summer is not representative and cannot be compared to the other summer's results.

The average of the daily maximum water temperature is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the downstream temperature to provide a single number for the monitored section of river (see Table 17).

Table 17: Mangatutu Stream average daily maximum water temperatures for the 10 week period starting January 1st.

Year	Upstream average daily maximum (°C)	Midstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between u/s and d/s locations (°C)
2004/05	19.85	20.85	20.22	+0.38
2005/06	19.41	20.12	19.89	+0.48
2006/07	20.01	21.15	20.33	+0.32
2007/08	21.74	22.70	21.07	-0.67

As Table 17 illustrates, the downstream temperature has mostly been warmer on average than the upstream temperature. Only the data from the 2007/08 summer has shown the downstream temperature to be cooler than the upstream temperature. Shading of the Mangatutu Stream remains sporadic between the temperature monitoring sites however this level of shading should increase over the long term as new plantings mature.

4.2.4 Photo points

The initial year of assessment was 2004/05 with a subsequent assessment completed in 2006/07.

Seven 1km samples of stream were assessed giving a total of 35 photos for the Mangatutu catchment (Appendix 4). Sample reaches 5, 6 and 7 have shown little change in the two year gap between photo assessments due to no further riparian fencing and planting taking place. However, where banks have been fenced off there is a visual change in the form of rank grass (Figures 26a & b).

Figure 26: Mangatutu River photo point examples of visual change, Assessment 3 at 750m, a) 2004/05; b) 2006/07.

4.2.5 Suspended sediment

Permanent sampling site

A permanent suspended sediment sampling site has been in place at Walker Road bridge on the Mangatutu River since June 2004. During this time 30 events have been sampled using an automatic sediment sampler. The data set is analysed to estimate sediment variables (Table 18). Data includes all results up until 31/12/2007. For more detailed information refer to the Suspended Sediment Monitoring Report (Kotze, Grant and Hill, 2008).

Table 18: Mangatutu permanent suspended sediment sampling site description and estimated sediment variables.

Site name:	**Walker Road**	**Map Ref (NZMS260):**		**S15:203-423**
River:	**Mangatutu**			
		Start – End Date		**No of samples**
Flow Time Series		08/06/2004 – 31/12/2007		N/A
Sediment Samples		22/06/2004 – 09/11/2006		622
ISCO Period of Record		22/06/2004 – 06/11/2007		30 events
Specific yield ($t/km^2/yr$)	Average sediment yield (kt/yr)	Mean Concentration (mg/l)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
43	5.2	17.2	88.3	4.1

A continuing focus is to carry out manual depth-integrated suspended sediment gaugings while the automatic sampler is activated. The collection of these concurrent samples will allow for the automatic series to be calibrated to the whole river cross-section.

Snapshot sampling

Refer to Blair and Hopkins (2005/06) for the low flow snapshot results taken in April 2004. A high flow sediment snapshot will be undertaken at the next opportunity.

4.2.6 Stream ecological health

The dominant surrounding land use in the vicinity of the sampling site is pastoral. The stream is 4-5m in width with the substrate predominantly consisting of gravel and sand with some silt. The canopy cover is partly shaded although the removal of nuisance riparian willow will in the short term reduce canopy cover.

Invertebrate sampling is conducted in the Mangatutu River immediately upstream of the Walker Road Bridge. The initial year of assessment using these methods was in 2005 with subsequent assessments completed annually in summer.

Table 19 lists the MCI values as calculated for the Mangatutu River sampling site.

Table 19: MCI values for the sampling site in the Mangatutu River. Samples are taken between January and March of each year.

Site	**2005**	**2006**	**2007**	**2008**
Mangatutu	114	110	104	108

In the vicinity of the sampling site in the Mangatutu River the presence and abundance of identified invertebrate species and the associated MCI scores indicate that the ecological health of the stream is considered to be mildly degraded.

4.2.7 Main points

Riparian Characteristics

- Grass and woody vegetation have remained relatively the same between the 2004/05 and 2006/07 assessments. Exotic vegetation covers 44% of the riparian margin, and grass covers 54%.

- There has been an increase in fencing over the total stream bank length from 27% to 50%.

- The proportion of stream bank that is fenced off and has woody vegetation has increased from 6% to 31% of the total length over the two years separating the assessments. The length of unfenced grass remains at a similar level on 35% of the stream bank length.

- An estimated 86% of the assessed riparian bank length was considered stable, up from 57% in 2004/05.

- Out of the total unstable length of stream bank, grass is the predominant vegetation covering 64%, and the majority of the same length is not fenced.

- Photo assessments have shown some small changes to areas where soil conservation plantings have occurred.

Sedimentation of surface water

- The specific yield for the Mangatutu catchment above Walker Road bridge is 43 $t/km^2/yr$ after four years of sampling. However a longer monitoring period is required (at least 10 years) in order to produce a more accurate result.

- A low flow snapshot was taken in 2004, with results described in Blair and Hopkins (2005/06). A high flow snapshot will be done at the next opportunity.

Aquatic habitat

- Water temperature has been monitored annually since 2004/05. Only the previous summer of 2007/08 has resulted in cooler temperatures at the downstream site than at the upstream site. A longer monitoring period is required before a trend can emerge.

- Assessments of the invertebrates in Mangatutu Stream indicate that there is a mild degradation in ecological health.

- Large sections of the Mangatutu Stream are unfenced with no woody vegetation which would provide shade on the water, and improve the habitat.

4.2.8 Other monitoring

Automatic sediment samplers are installed on the Otewa and Mangapu rivers to monitor suspended sediment in the Waipa Zone. For more details, refer to the Suspended Sediment monitoring report (Kotze, Grant and Hill, 2008). *Mangatutu Stream Ecological Monitoring Results – 2004 to 2007* has been completed by Gibbs (2008) as an Environment Waikato Internal Series report, and can be accessed internally on DOC #1212429 or by contacting Environment Waikato. This report describes the changes in ecological health in the Mangatutu Stream resulting from the soil conservation work which has occurred since 2004. Due to the willows along Mangatutu Stream banks having been cleared, the water moves more swiftly creating a variety of habitats and less sedimentation, and providing an environment better suited to ecological species.

5 Coromandel zone

5.1 Introduction

Monitoring is present in one catchment in the Coromandel zone; Wharekawa catchment. A summary of the catchment characteristics for Wharekawa is provided in Appendix 1.

5.2 Wharekawa catchment

5.2.1 Monitoring progress

Monitoring will focus on the Wharekawa River catchment where river management and soil conservation initiatives are being implemented (Figure 27). Table 20 contains monitoring completed by 2007/08.

Table 20: Coromandel zone monitoring completed by 2007/08.

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Complete assessment along the monitored section of Wharekawa River.	2006/07	✓
Photo points	Complete assessment along the monitored section of the Wharekawa River	2006/07	✓
Permanent suspended sediment sampling site	Event driven sampling, concluded in 2003.	April 2000 until Feb 2003	✓
Suspended sediment snapshots	Not planned	N/A	N/A
Water temperature	Install loggers and record stream temperatures along the Wharekawa River	2006/07, 2007/08	✓
Stream ecological health	Assess stream ecological health along the Wharekawa River	2004/05, 2006/07, 2007/08	✓

N/A = not applicable for 2007/08

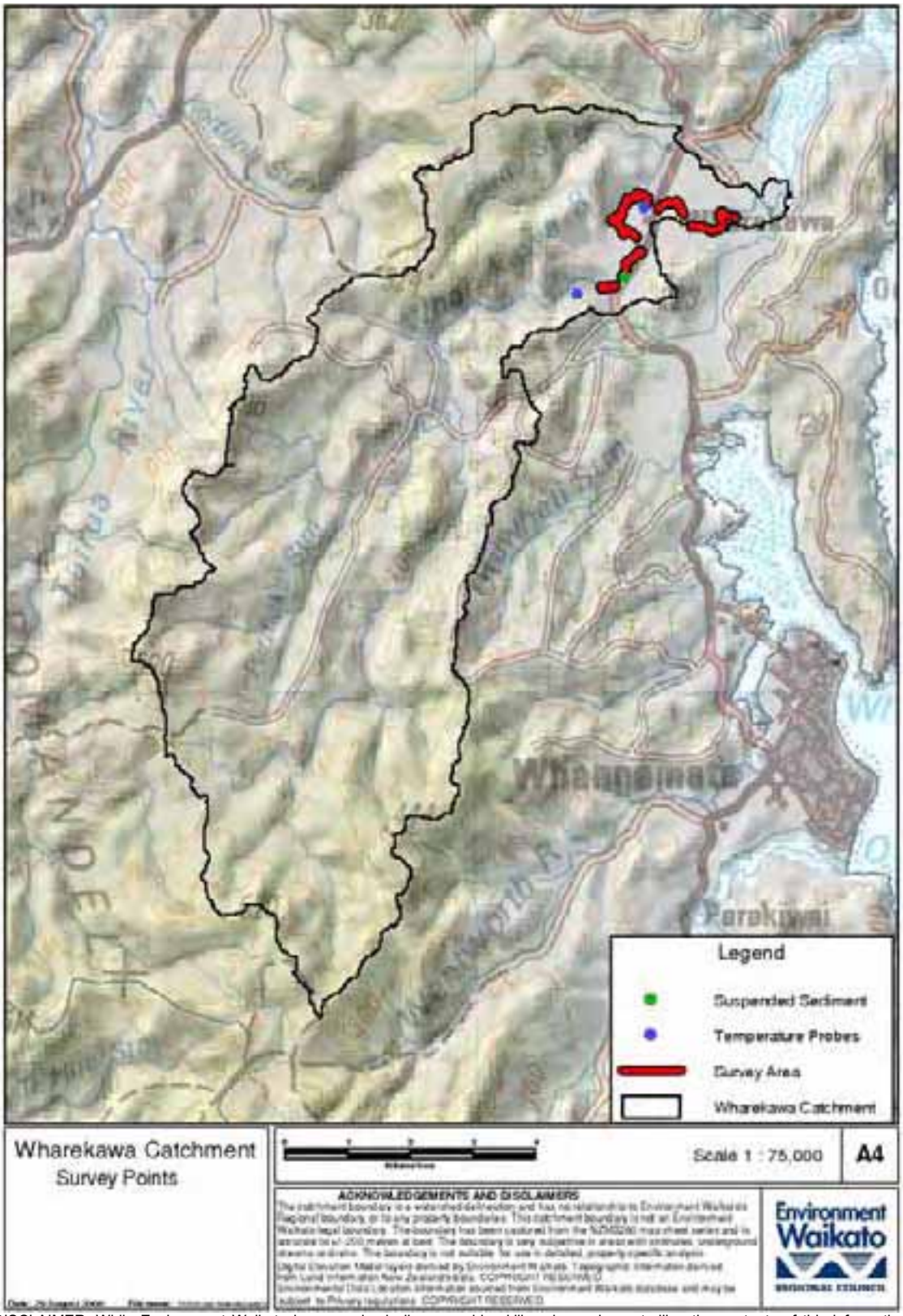

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Figure 27: Wharekawa catchment monitoring locations

5.2.2 Riparian characteristics

Introduction

Four 1km samples and one 500m assessment of the riparian margin have been assessed in the Wharekawa River. These are locations where the Peninsula Project funded works have been completed or are scheduled, where stream riparian margin access is possible, and where landowner participation is forthcoming. There has been

one assessment completed for this catchment in 2006/07, therefore the percentage change in riparian parameters cannot be shown until further assessments are undertaken. The reported data for each parameter represents a percentage of the total assessed riparian margin in the catchment. A summary table of the riparian data is located in Appendix 3.

The following summary assessment data was collected where riparian soil conservation has been recently implemented or is planned for the Wharekawa catchment. Erosion, vegetation and fencing data summaries are presented in Figures 28, 29, 30 and 31.

Vegetation

Riparian vegetation improves stream bank stability and riparian margin biodiversity, as well as minimising increases in stream temperature due to shading.

Riparian vegetation is split into grass and woody vegetation (native + willow + exotic other). Figure 28 shows 2% of the riparian margin is grass. The remaining 98% is woody vegetation, of which 66% is native, 24% is willow and 8% is other exotic species.

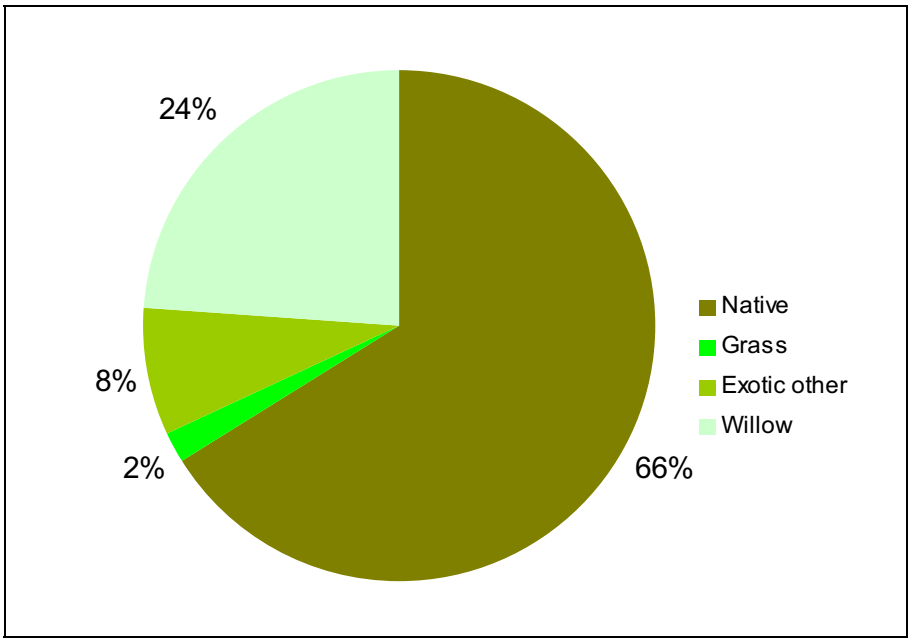

Figure 28: Wharekawa riparian vegetation.

Fencing

The amount of fencing on one side or both sides of the waterway is an indicator of likely stock exclusion from the waterway. Stock exclusion reduces direct contamination of water by pathogens, direct damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

Stock is excluded from the channel on both sides for 40% of the waterway, and from just one side for the remaining 60% of the waterway (figure 29).

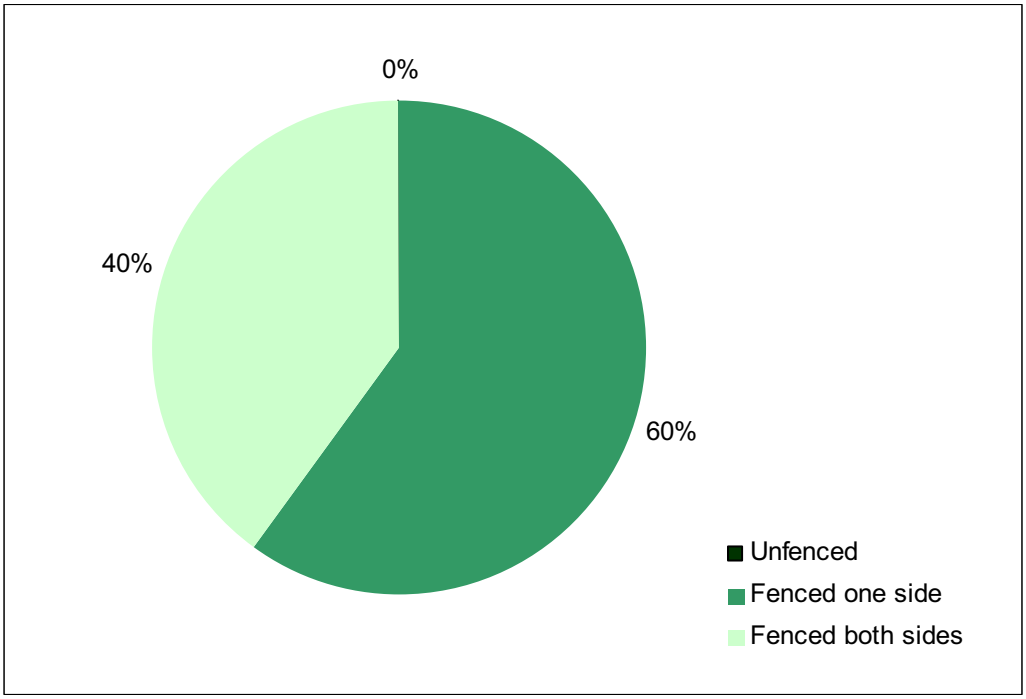

Figure 29: Wharekawa stock exclusion by stream length

An estimated 69% of the banks are fenced while 31% are not fenced. All of the fenced banks have woody vegetation (Figure 30).

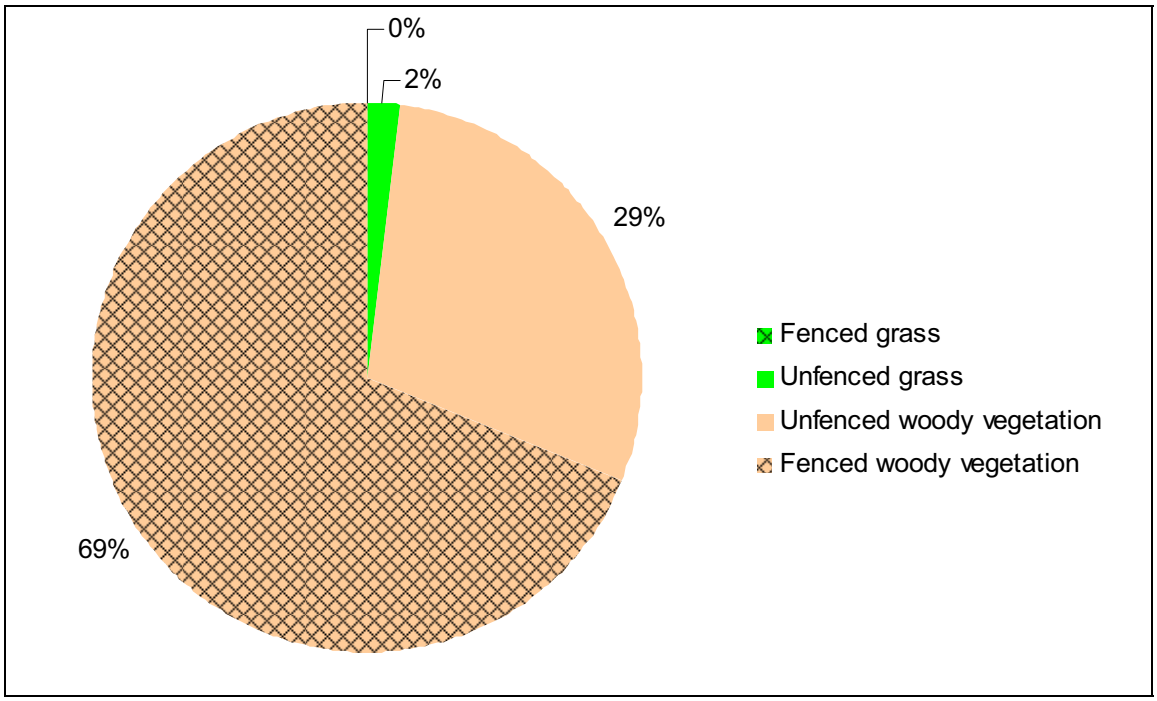

Figure 30: Wharekawa riparian margin fencing and vegetation combinations.

Stream bank stability

Stream bank stability is measured, as unstable stream banks are one of the main sources of sediment in waterways. Stream bank stability can be improved through the type of riparian vegetation used, and by fencing out stock.

An estimated 90% of the assessed riparian bank length is considered stable (Figure 31). The remaining 10% is unstable. A greater portion of unstable stream bank is unfenced (6%) than fenced (4%). Grass vegetation is present on 10% of the total unstable bank length.

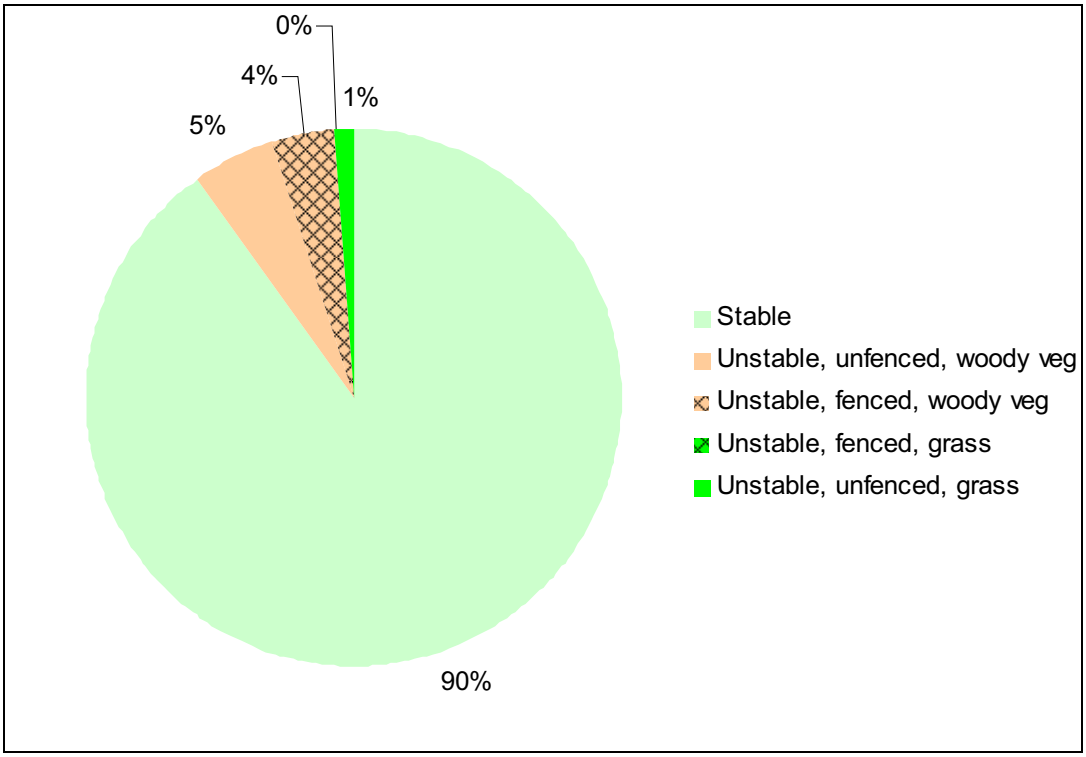

Figure 31: Wharekawa stream bank instability for fencing and vegetation combinations.

5.2.3 Water temperature

Water temperature loggers are deployed in the lower section of the Wharekawa River. The downstream logger is near the SH25 bridge, and the upstream logger is approximately 3km further upstream, near where the river emerges from the forest. Two deployments have been made with data collected for the summers of 2006/07 and 2007/08.

The average of the daily maximum water temperature is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the downstream temperature to provide a single number for the monitored section of river (see Table 21).

Table 21: Wharekawa River average daily maximum water temperatures for the 10 week period starting January 1st.

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between u/s and d/s locations (°C)
2006/07	21.78	21.07	-0.71
2007/08	22.13	21.54	-0.59

As Table 21 illustrates, the downstream temperature has been slightly cooler on average than the upstream temperature. A longer monitoring period is required before trends can be identified. The downstream temperature is expected to decrease in temperature further compared to the upstream temperature as vegetation continues to grow and shade the water.

5.2.4 Photo points

One photo assessment has been done along the Wharekawa River in the summer of 2006/07. Visual changes and comparisons in fencing, vegetation and erosion can not yet be made. 26 photos have been taken along 5 assessments, with a total distance of 4500m (Appendix 4).

5.2.5 Suspended sediment monitoring

A permanent sediment sampling site has been in place at Adams farm bridge on the Wharekawa River since June 1991. During this time 19 events have been sampled using an automatic sediment sampler, which was set up between April 2000 and February 2003. The data set is analysed to estimate sediment variables (Table 22). Data includes all results up until 31/12/2007. For more detailed information refer to the Suspended Sediment Monitoring Report (Kotze, Grant and Hill, 2008).

Table 22: Wharekawa permanent suspended sediment sampling site description and estimated sediment variables.

Site name:	**Adams Farm Bridge**	**Map Ref (NZMS260):**		**T12:623-468**
River:	**Wharekawa**			
		Start – End Date		**No of samples**
Flow Time Series		10/06/1991 – 31/12/2007		N/A
Sediment Samples		25/09/1991 – 31/08/2001		479
ISCO Period of Record		20/04/2000 – 27/02/2003		19 events
Specific yield ($t/km^2/yr$)	Average sediment yield (kt/yr)	Mean Concentration (mg/l)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
34	1.6	5.7	100.0	3.6

The automatic sediment sampler is currently not deployed at this site. However reinstallation is planned as part of the long term monitoring of this catchment. Manual sediment gaugings continue to be taken, which support the information gathered and increase the size of the dataset.

5.2.6 Stream ecological health

The dominant surrounding land use in the vicinity of the sampling site is pastoral but the riparian zone is planted. The stream is up to 14m wide with the substrate predominantly consisting of gravel and sand with some cobbles. The canopy cover is partly shaded.

Invertebrate sampling is conducted in the Wharekawa River immediately downstream of the Adam's Farm bridge. The initial year of assessment using these methods was in 2005 and no sampling was undertaken in 2006. The sampling was undertaken again in 2007 and the assessment will now be conducted annually. Table 23 lists the MCI values as calculated for the Wharekawa River sampling site.

Table 23: MCI values for the sampling site in the Wharekawa River. Samples are taken between January and March of each year.

Site	**2005**	**2007**	**2008**
Wharekawa	95	94	94

In the vicinity of the sampling site in the Wharekawa River the presence and abundance of identified invertebrate species and the associated MCI scores indicate that there is a severe degradation in ecological health.

5.2.7 Main points

Riparian Characteristics

- Ninety eight per cent of the riparian margin is woody vegetation, 66% of which are native species.
- The entire length of stream bank has at least one side fenced off, with both sides fenced for 40% of the total length.
- The riparian margin is stable for 90% of the total length.
- Sixty per cent of the total unstable length is not fenced, and 10% is covered in grass.
- Since this is the first assessment to be done in the catchment, we are unable to make a comparison with previous results or photos.

Suspended sediment monitoring

- The specific yield for the Wharekawa catchment is estimated to be 34 t/km^2/yr, based on samples taken both manually and from an automatic sediment sampler since 1991.
- Continued manual sediment sampling adds to the existing dataset.

Aquatic habitat

- The downstream temperature has been cooler on average than the upstream temperature for both of the monitored years. A longer monitoring period is required to identify a trend.
- Assessments of the invertebrates in Wharekawa River indicate that there is a severe degradation in ecological health.
- With such as large percentage of the stream bank already lined with woody vegetation, improvement in the level of shade is difficult. However more fencing could be put along the riparian margins to encourage thicker undergrowth, and therefore an improved habitat and more stable banks.

5.3 Other monitoring

An automatic sediment sampler is installed on the Opitinui River to monitor suspended sediment. Further details are in the Suspended Sediment Monitoring Report (Kotze, Grant and Hill 2008).

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