MARLBOROUGH DISTRICT COUNCIL

Only Marlborough

RIVERS & LAND DRAINAGE

ASSET MANAGEMENT PLAN 2015-25

Record No 1678041

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1. Executive Summary

1.1 Purpose of Plan

The Marlborough District Council (Council) is a unitary authority that carries out both regional and district council functions in the management of rivers, watercourses and drains throughout Marlborough.

The purpose of this plan is to describe the flood control and drainage services provided by Council, the assets that have been constructed or inherited from predecessor authorities that are integral to the provision of these services and Council's plan to manage, maintain and where appropriate upgrade these assets to provide the agreed level of service.

The plan is to cover the period from 2015 – 2025 and is a key input into Council's proposed LTP. However most of the assets are long life assets that are effectively maintained in perpetuity and so any plan must consider a horizon longer than the core 10 year period covered by this plan.

The plan also describes the key challenges that will need to be addressed during the 10 year period including climate change and sea level rise, rezoning for growth to the north and west of Blenheim including the proposed expansion of Renwick Township onto the lower terrace (Wairau floodplain) and the proposed transition to a new asset management information system.

1.2 A bit of history

A constant battle to control the Wairau has been the history and is the legacy for the people of Blenheim and the Wairau floodplain. The Wairau River system has provided the valuable resource of its floodplain, but is also its potential destroyer. The flood control works for the Wairau have to cope with floods larger than any other New Zealand river similarly controlled.

The need to maintain, monitor and upgrade river control works is ongoing.

Works have been carried out to control the Wairau River since soon after European settlement nearly 150 years ago by various, and at times opposing, River Boards. Since 1921 there has been one river authority responsible for the flood control works for the whole of the Wairau, and since 1992 for the whole of Marlborough.

There were also Wairau tributaries from the southern hills – the Omaka, Fairhall, and Taylor which converged at Blenheim which presented a major flood threat to the township, and have required considerable flood control works.

There has also been a long history of drainage management on the 8000 ha low lying lower Wairau floodplain by various organisations. Associated with drain construction for agricultural purposes is the management of stormwater drains and small streams from urban and industrial development on the Wairau plains – Blenheim, Renwick, Riverlands Industrial.

River control and land drainage by their very nature have to be community works. Over the years differently constituted local bodies acting under a variety of legislation have carried out actions to reduce flooding and improve drainage.

Over recent years the issues involved in river control and drainage have become more complex, more stringent legislation for defined outcomes and ecological values, and larger local bodies in less day to day communication with ratepayers and stakeholders. A clear asset management plan is a way of ensuring Council's activities are appropriate, ecologically sensitive, adequately funded and transparent.

Local Government amalgamation in the 1989-1992 period resulted in the formation of the Marlborough District Council as a unitary authority. This led to smaller stream control and stormwater works (eg; in Blenheim and Picton) being included in the same asset management plan as the larger rivers.

This river control and drainage asset management plan embraces management of these streams also and other river management responsibilities that have evolved over the last 15 years.

Flood control and land drainage management is different from other Council infrastructure asset management. Flood control and drainage is provided naturally by rivers and streams. Council's flood control and drainage 'assets' are infrastructure that seeks to improve on what nature provides. Increased population also makes little difference to the required flood control assets – so demand for assets is not linked to population growth.

In some areas there is the unusual situation that without the construction of any recognised assets Council is expending funds on maintaining 'natural' rivers to the status quo by vegetation control and sediment excavation.

Nevertheless this asset management plan sets out to demonstrate that council is responsibly carrying out and funding its responsibilities in the river control and drainage management area.

1.3 Assets covered

Council's rivers and Drainage assets are broken down under various systems. These different systems have either separate funding mechanisms or different performance standards (levels of service).

- **Wairau floodplain major rivers and stopbanked floodways** covering 20,000 hectares of fertile land around Blenheim. (This is Council's major river control and drainage activity). This involves 180 kilometres of stopbanks; a major dam; 4.8 million cubic metres of compacted earth in stopbanks and dams; 1 million tonnes of quarried rock as bank protection; 62 ha of willow and poplar trees as bank protection; and other miscellaneous structures.

- **Wairau tributaries (not stopbanked)** outside of the main floodplain covering the rest of the 4,000 km² Wairau catchment. Approx 120 kilometres of river and stream channels are regularly kept clear including the main Wairau River channel from the Waihopai River confluence to the Wye River confluence.

- **Wither Hills soil conservation works** to lessen sediment erosion from the 1030 hectares of erodible hills immediately south of Blenheim.

- **Wairau land drainage** covering 8,000 hectares of low lying floodplain being drained by 150 km of minor watercourses and 18 pumping stations.

- **Blenheim, Riverlands, Picton and Renwick urban stormwater disposal channels** and pumping stations that are the outfalls from the urban piped stormwater system. It involves 25 km of minor watercourses and 10 pumping stations.

- **Gibsons Creek rewatering** to supply irrigation, groundwater recharge and ecological values; as a mitigating action arising from river control diversions. This involves two river intakes and maintaining 25 kilometres of small channels.

- **Council river control (floodway) reserve land** much of which is used for secondary purposes of ecological planting, public amenity, commercial forestry, other commercial leasing etc with an area of 3500 hectares.

- **Sounds watercourses** that are managed for limiting flooding in Picton and Waikawa. This involves 3 kilometres of managed channels.

1.4 Key Issues for 2015 – 2025

The key issues addressed by this plan are as follows;

Maintenance, renewals and minor upgrades

Ongoing inspection and asset assessments have identified a number a number of assets or sections of floodway systems where additional maintenance and or minor upgrades/renewals are required to maintain the assets in good order and a ready to go state.

Examples of the items identified:

- Need for more regular removal and overhaul of pumps to ensure a higher reliability of operation. The inspection and check schedules are being refined to make this happen.

- Work required at Taylor Dam to meet Dam Safety regulations including upgrade of seepage monitoring, installation of new crest survey monitoring points and minor upgrades to the auxiliary spillway.

- Identified erosion areas on the Lower Wairau and Diversion requiring new rock work to maintain a stable channel alignment and ensure security of adjacent stopbanks. In the Diversion the maintenance budget has been increased so that the two main areas of sediment deposition have regular vegetation removal to encourage sediment to shift through to the coast.

- Berm erosion in the lower Tuamarina River exacerbated by the June 2014 flood event now requiring permanent repair to ensure the security of this key Wairau River stopbank during major flood events.

- The remaining 20% of the lower Opawa River stopbanks that need to be brought up to standard in a timely fashion including resolving land ownership/access issues. Once the Opawa is complete we will look at the upgrade that is appropriate along the lower Spring Creek.

- Seepage under the Waihopai/Gibsons Creek intake structure requiring a permanent repair. The current proposal is to shift the control gate into an upstream structure and cut-off the seepage with an extended inlet pipe and sealing bund.

- Berm/bank edge strengthening required in the Omaka River to ensure the integrity of the existing east bank stopbank both upstream and downstream of SH 6. The highest priority being a 300 m section upstream of Godfrey Road.

- Up the maintenance budget in Gibsons Creek for removal of sediment from SVIS intake ponds, maintenance of channel capacity (silt and vegetation removal) and routine checks of both Waihopai and Wairau River inlet control structures.

The above programme of work is proposed to be funded by an 8.5% increase in direct operating spend and an additional $500,000 (approx) capital spend over the first 4 years of the plan. The overall condition of assets including floodway channels is intended to be formally reviewed at 3 yearly intervals using a 1 – 4 ranking scale so that progress can be measured on asset condition. (See comments on AMIS)

Blenheim stormwater

The plan includes provision for stormwater upgrades to be completed in Town Branch drain as part of the Redwood Street stormwater network upgrade, and in the lower 450 m of Caseys Creek as part of the upgrades required for the Blenheim North residential growth area.

Likely outcome from the Redwood Street/Town Branch option assessment currently underway is some upgrading of the Town Branch east-west channel system to take additional Redwood Street stormwater discharge and additional gravity and pumped outfall capacity to the Opawa River. Note it is possible that additional internal system storage could delay the need for additional pump capacity to the Opawa River.

Preliminary design plans for the Caseys Creek outfall upgrade are also being prepared. This plan makes some provision for the cost of the outfall channel upgrade (downstream of the stopbank), upgrade of the over lying Opawa River stopbank and interim upgrades to the Caseys Creek pump station. The majority of the cost of the outfall upgrade will be funded from a development levy.

Rivers Section will also continue to contribute technical expertise into the options assessment for proposed additional stormwater discharge into Murphy's Creek at Middle Renwick Road. No specific capital upgrade provision is included in this plan for either channel improvements or flood proofing the 3 existing properties with some risk of flooding.

However some provision has been included in the Murphys Creek maintenance budget to enable increased hand maintenance work to be undertaken to maintain channel capacity and the general stream environment.

Wairau Rating classification review

This plan assumes that Council will adopt and implement the new rating classification that aims to match up rates share paid with the level of service provided. The rating classification was last reviewed in 1994 and growth (housing, industrial and land use change) has been significant over the last 20 years.

The current proposal is to consult over the proposed changes to the classification over 2015/early 2016 and implement from July 2016.

Implementation should ensure that the costs of providing the flood protection, stormwater outfall and drainage services is fairly spread and the classification can be easily and readily updated in futures to reflect any changes in services that may occur.

Climate change impacts focussing on the Wairau Scheme

Climate change will impact the flood and drainage services provided by Council in two ways:

- Altering the frequency and severity of flood events – rule of thumb advice is that by 2050 a given 100 year or 1% AEP flood will increase in size by 10 – 15% ie; the current 5500 cumec Wairau flood could increase to over 6000 cumecs

- Sea level rise will impact on coastal erosion and drainage of low lying farm land. Average sea levels are predicted to rise by 0.3 m by 2050. This will impact on drainage gravity outfalls and require more pumping, alter general water table levels and may increase saline intrusion in very low lying areas. Sea level rise is also likely to lead to an increase in wave lap type erosion in the lower reaches of the Wairau and Opawa Rivers.

The current plan is to review the Wairau Scheme hydrology in about 2019, or about 25 years after it was last formally reviewed for the Wairau Floodways Management Plan. Such review will take into account the latest recommendations on climate change allowances, as well as the additional 25 years of flow data record.

Once the likely impacts of climate change are understood it is then proposed to look at the options for upgrading current flood protection and drainage works to adapt to the expected changes. The current thinking is that relatively minor upgrades will be required to preserve existing levels of service to about 2050 but after 2050 other options including accepting increased flood risk or retreat from some very low lying areas may need to be considered.

Note a climate change allowance is already built into current Blenheim stormwater planning. Also Picton rivers were more recently reviewed following the very large Waitohi and Waikawa River floods in 2004.

Other matters

There are a number of other matters that will need to be attended to during the term of this plan. These include:

Implementing the drainage network upgrade

The main part of this project is due to be implemented over the first three years of the plan. However this assumes good landowner support, particularly from landowners where work is proposed. Delays are possible although early indications are generally supportive of the overall proposal.

Renewal of resource consent to use herbicides for control of aquatic weeds

The current approval expires in February 2019. In preparation significant monitoring work is proposed for 2015/16, 2016/17, 2017/18 to both meet existing consent monitoring requirements and assist with the renewal application.

The use of the herbicides is a key tool for maintaining the drainage network and a number of key streams infested with aquatic weed. Therefore renewal of the consent with reasonable terms and conditions will be an important task. Council can expect some contest from some sections of the community who would prefer that non chemical means are used.

Pukaka Quarry extension

The Pukaka Quarry has about 3 or 4 years of productive capacity before a decision needs to be made on possible extension up the hill. The key to the extension will be whether the 3.5 ha of land required can be obtained by agreement and at reasonable cost.

The quarry provides about 65% of the rock rip-rap requirements for ongoing river works and is becoming an important source of construction and roading aggregates. It is a self-funding business unit.

This plan assumes that any capital funding required for the proposed extension will be funded by the business without the need for rate funding.

Waitohi triple culverts

Further upgrade of the Waitohi triple culverts will be required to meet the desired 50 year flood standard. This work can only be cost effectively completed if it can be fitted in with upgrade plans within the KiwiRail shunting yard and Interislander parking area.

An opportunity to upgrade the section of culvert to the east edge of the KiwiRail yard may arise within the term of this plan. KiwiRail will likely be making changes to meet changed business needs as the remaining two rail freight capable ships are retired from the fleet.

This plan does not include any provision for the capital cost of upgrading another section of the culvert because of the uncertainty. However the matter can be considered as an Annual Plan/LTP adjustment should the opportunity arise. The alternative option is simply to continue to recognise the current flood risk to the lower Dublin Street area of Picton.

Renwick Lower Terrace flood study

The proposed rezoning of the lower terrace (south of Gibsons Creek) of Renwick from rural to large lot residential was delayed until the flood risks are better understood. The potential flood risks include from the Wairau River due to failure or overwhelming of existing protection works, from Gibsons Creek due to inadequate channel capacity or from the two tributary streams that carry stormwater from Renwick – Terrace and School Creeks.

The purpose of the study will be to better quantify the risks, what further mitigation by either capacity or channel improvement works may be appropriate and then make a recommendation back to Council on the rezoning proposal. The aim is to have the study completed and a recommendation made by June 2016.

The final outcome could be a plan to allow the more intense development but with some upgrade works and a combination of building restrictions in high hazard areas.

Implementing an Asset Management Information System (AMIS)

Rivers and drainage assets are currently managed the old school way – key spreadsheets and very good staff knowledge of the assets. However this systems has it limits on tracking asset condition, work done and better understanding the core areas of cost so that efficiency strategies can be considered.

It is proposed that from 2016 the Rivers Section will begin using the new asset management software purchased by Council to help manage the $140 million of rivers and drainage assets.

Shifting to the new software and gaining the benefits will however take considerable staff resource but over time should help better quantify asset condition. Key areas of expenditure and better forecasting of future maintenance and renewal requirements from 2016 will require considerable staff resource.

1.3 Levels of Service

1.3.1 General comment

This plan proposed no significant changes to currently agreed and adopted levels of service within the first half of this plan. Instead the focus will be on ensuring existing assets are maintained or upgraded to ensure as far as possible in the event of a design event occurring our flood and drainage systems perform to expectations. The principle being one of “ready to go”. The measurement of this readiness state is now a compulsory performance measure in the LTP.

However from 2019 it will be 25 years since the core Wairau flood protection and drainage works were last reviewed. A further review of service levels taking into account the key external factor – climate change will be appropriate at this stage.

Once a flood risks are updated and the desires and readiness to pay of the community are understood it is proposed to update the plan for the key Wairau works with a new plan taking the community through to 2050.

1.3.2 Wairau Floodplain Floodways

The Wairau floodplain is generally that land downstream of the Waihopai confluence, north of New Renwick Road, or otherwise bounded by the hills and the sea.

Desired Level of Service:

To maintain and upgrade the floodways passing across the main Wairau floodplain to provide a capacity for flood sizes of up to a 1 in 100 year return period for the Wairau river and other major floodplain rivers of the Lower Wairau, Wairau Diversion, Opawa, Taylor, Omaka, Riverlands Co-op and others.

Performance Measure:

To monitor the various floodway performance of floods that occur, and carry out hydraulic computer of the design flood analysis using river bed resurveys and calibrated with monitored flood levels. Sediment build-up in rivers and other factors change the floodway performance.

Assessed Current Level of Service:

Most of the floodways are up to the desired level of service. Two of the dozen floodways are not to the required hydraulic capacity and works are underway to upgrade the lower Wairau and Riverlands Co-op floodways to complete the capacity upgrades

Works are also proposed in the Wairau Diversion, Lower Wairau, Lower Opawa River and Lower Tuamarina to upgrade bank edge protection works and some older sections of stopbanks to ensure the integrity and security of the floodways during major flood events.

1.3.3 Wairau Floodplain Tributaries

As well as the tributaries feeding directly into the floodplain this also includes the Wairau above the Waihopai confluence.

Level of Service:

To keep the river channels clear of trees and debris as economically practical.

Performance Measure:

Regular visual inspection on an annual basis and after floods.

Assessed Current Level of Service:

Desired level of service is being met except for the Upper Wairau channel, and to a lesser extent the Waihopai upstream of SH 63, where keeping the channel cleared to a good standard is not able to be achieved using conventional heavy machinery techniques and within an acceptable cost. Options being considered are targeted work only or using aerial applied herbicide. A modest budget increase has been included in this plan for the Upper Wairau channel work

1.3.4 Soil Conservation

Council owns an erodible area of hill country – the Wither Hills Farm Park - that it manages for soil conservation and recreation purposes.

Level of Service:

To manage vegetation on the Wither Hills Farm Park so that little or no sediment is deposited in watercourses at the base of the hills.

Performance Measure:

Regular annual inspection and monitoring after storm events.

Assessed Current Level of Service: Recent storm damage during 2011-2013 period suggested that in places previous soil conservation achievements were being gradually eroded and risk of significant sediment movement beyond the Farm Park boundary was increasing. Council agreed to invest in both some capital works and operating budget increase so that the deterioration of the hill faces and gully systems could be reversed and bought back up to a high standard. The budget increases are included in the draft Council LTP.

Desired level of service will continue to be met.

1.3.5 Wairau Lower Floodplain Land Drainage

This concerns the approx 8000 hectares of low lying Wairau floodplain to the east of Blenheim and O'Dwyers Road.

Desired Levels of Service:

To provide drainage by maintaining as hydraulically efficient a network of 175 km of deliberately excavated drains or natural watercourses with floodgated culverts into the major rivers in an ecologically sensitive manner, and providing pumping stations with a capacity of removing 15 mm of rainfall in 24 hours. The riparian margins of selected channels are managed for ecological purposes.

Performance Measure:

Twice yearly inspection and monitoring during prolonged rainfall.

Assessed Current Level of Service:

- Drainage network.
  It is proposed to increase the managed drain network by about 5.5% to ensure an equitable level of service to following significant land use intensification including subdivision, to formalise roadside drain arrangements and to formally adopt a number of drains that are currently managed but not part of the formal network. This will result in an increase level of service to some properties and no change to the majority.

- Drain clearing of weed and silt:
  Desired level of service being achieved. The current consent to use agrichemicals as the key tool to control aquatic weeds expires in February 2019. This plan assumes that this resource consent will be renewed with similar conditions to present.

- Floodgated outlets:
  Desired level of service being achieved. It is proposed to further assess the existing outlets for renewal requirements during the first three years of this plan to get a better understanding of which of the older outlets may require renewal.

- Pumping stations:
  Desired level of service is being achieved, however a number of pump stations having aging mechanical and electrical equipment and a more aggressive overhaul and renewal programme is to be adopted to ensure that the pump stations continue to provide good service with a high level of reliability.

- Aquatic weed removal:
  Desired level of service being achieved. Detailed weed management practices have been defined for half a dozen ecologically sensitive watercourses. Another 60 of the 162 watercourses have specific times of year for weed control activities due to possible conflict with fish ecology.

- Riparian plantings:
  Desired level of service being achieved. An interdepartmental Council landscape group has been set up to prioritise landscape planting on appropriate watercourses.

1.3.6 Blenheim, Riverlands and Renwick Stormwater Outfall channels

The urban and industrial areas of Blenheim, Riverlands and Renwick have piped networks that discharge into river and drainage channels, assisted in some locations by pumping stations.

Desired Level of Service:

To ensure that the system of drains, natural watercourses, pumping stations, and floodgates adequately cope with a 1 in 50 year return period flood to cater for the water from the pipe networks operated by Councils services section.

Performance Measure:

To assess the probable design stormwater runoff, to carry out hydraulic computer modelling of these design floods, and to monitor flood levels during storm events so as to calibrate computer modelling with actual events.

Assessed Current Level of Service*:*

Desired level of service is being met for many, but not all of the dozen watercourses.

The desired level of service is not being met for one of the ten Blenheim urban pumping stations. Provision has been included for the upgrade or renewal of three of these pump stations in this plan.

A major interdepartmental investigation is underway as part of a Council stormwater strategy to assess adequacy of stormwater system and the need for upgrading of the various components to meet the required level of service. At present the work is focussing on Murphys Creek (to meet growth to the west), Redwood Street/Town Branch system (renewal and additional capacity to meet previous infill growth) and Caseys Creek (to meet growth following rezoning of land north of Old Renwick Road).

This plan includes some capital expenditure to meet the likely outfall channel requirements that is not funded by zone levies.

1.3.7 Gibsons Creek Rewatering

Gibsons Creek is a network of outwash channels on the Wairau floodplain formerly sourced from time to the Wairau and Waihopai rivers, but now cut off from these rivers by river control works. Deliberate off takes have been constructed from Wairau and Waihopai to rewater Gibson's creek and the Opawa river downstream.

Level of Service:

- To supply the requirements of the Southern Valleys Irrigation Scheme.
- To provide continuous flow to the sea in the Gibsons Creek/Opawa system without flooding riparian land (within resource consents constraints).

Performance Measure:

Monitoring and management the intake into Gibsons Creek from the Wairau so that the required flow amounts are met.

Assessed Current Level of Service: Desired level of service is being met.

1.3.8 Council River Control Floodway Reserve Land

Council or the crown own some 3000 of the 3500 hectares of floodway land of the Wairau floodplain. Much of this land can be used for secondary purposes without compromising flood control objectives.

Desired Level of Service:

While ensuring that the space required for flood control works or drainage access is not compromised; to allow large areas to be accessible for public recreation, to plant some areas in ecological/amenity plantings, other floodway land to use for economic gain by forestry and/or leasing.

Assessed Current Level of Service:

Desired level of service is being met, but incremental improvements for recreation and environmental amenity are proposed to continue.

1.3.9 Sounds Watercourses Flood Management

Significant rivers flow through the urban areas of Picton and Waikawa. causing a flood hazard.

Level of service:

To obtain a river capacity and standard of protection for flood sizes of up to 1 in 50 year return period for the, Waikawa and Waitohi its Kent Street tributary for the urban and residential areas of Picton and Waikawa

Performance Measure:

To monitor the various floodway performance of floods that occur, and carry out hydraulic computer of the design flood analysis using river bed resurveys and calibrated with the monitored flood levels.

Assessed Current Level of Service:

For the Waikawa River the desired level of service is now being met and in due course review of residual flood risks to adjacent properties may be appropriate.

The Waitohi River and its Kent Street tributary do not reach the desired level of service. Improvements to both watercourses were completed in 2011 and 2012. Further upgrading has been deferred due to cost including significant interruption and logistical costs of further Waitohi triple culvert improvements under the KiwiRail shunting yard.

In the interim a lower level of service is being accepted and surrounding riparian land is noted as having a flood hazard requiring minimum floor levels for new buildings.

1.4 Upgrading Work and Maintenance Issues

The bulk of these river control assets are maintained in perpetuity. Natural processes of riverbed erosion and deposition are regularly altering the performance of many of the riverbeds. For the small stormwater carrying rivers the flood flows are also altering.

Regular expensive maintenance is required, though the cost of maintenance is not directly related to the value of the particular asset component.

Significant upgrading works are also required. A summary of the upgrading works required, or probably required during the term of this plan is summarised as follows:

Wairau Diversion

- Stabilising of one major section of bank edge where natural enlargement is at or beyond original design channel alignment.
- Continued work to remove or loosen aggradation islands.

Lower Wairau

- Raising/strengthening of 3 remaining sections of stopbank on the north sides of the river.
- Upgrading and increasing the length of some floodgated culverts under the stopbanks.
- Removal of remaining impeding crack willow trees at river bend opposite Grovetown lagoon outfall.

- New bank protection rock linings downstream of McDonald's lease land and opposite the Grovetown lagoon.

Wairau (Tuamarina to Waihopai)

- New willow tree bank protection work.
- Some further upgrading of existing gravel extraction haul roads.
- Rock training bank or spur bank upgrades.
- Protection/production tree planting.
- Regular expensive repair of rock bank protection work.

Lower Opawa River

- Continue upgrade of the remaining 20% of stopbanks to bring up to current structural and top width standards.
- Continue to monitor river bed levels from the Opawa Loop junction down to Butter Factory corner and as necessary undertake remedial dredging to maintain flood capacity and drainage outfall.
- Purchase remaining floodway land from four commercial properties in Park Terrace.

Taylor River

- Replace the failing crib wall at Boathouse Theatre.
- Realign and upgrade stopbank at 220 High Street subject to satisfactory land purchase agreement.
- Investigate options for the permanent upgrade of the section of stopbank from High Street to end of George Street.
- New edge protection works (willows and/or rock) upstream of the Burleigh Bridge to maintain a stable channel alignment.

Taylor Dam

- Implement the recommendations from the Comprehensive Safety Review (CSR) completed in 2013 including minor spillway improvements and raising of dam crest by 300 mm, dam monitoring upgrades including dam crest level pins and upgrades to seepage flow monitoring manholes,
- The CSR also requires preparation of three documents including a Dam Safety Action Plan, a maintenance and surveillance manual, and an emergency action plan. This documentation is proposed to be materially completed in 2015.
- The dam also requires some relatively minor catch-up asset maintenance including re-grouting of construction joint cracks in the outlet culvert, refurbishment of the outlets gates gantry platform and some new signage.

Upper Opawa/Roses Overflow /Fairhall

- Continue the removal of trees in the floodway initially focusing on the crack willow downstream from State Highway 1 to the Roses Overflow confluence.
- Upgrade the section of stopbank between Lansdowne Park and end of Waipuna Street.

- Gravel removal from the channel downstream of the Omaka River confluence and from the Fairhall floodway downstream from SH 6.

- Continue removal of the aging Lombardy poplars from the Fairhall floodway stopbanks

Omaka below Hawkesbury

- Rebuild berm and renew rock edge protection works (300 m) true right bank upstream of SH 6.

- New debris fence groynes and willow planting with some rock downstream of SH 6.

- Possible short section of stopbank retreat at Hawkesbury Road Bridge.

Opawa Loop

- Renew refurbish control gates as required.

- Continue monitor bed levels at Roses Overflow end of the loop and assess need for dredging.

Riverlands Floodway

- Complete land agreements at Boon and Hook and undertake excavation of berm and construction of new stopbank on true right side.

- Acquire the pan handle from LIL and bring isolated low points up to height.

- Assess need for channel dredging clearing downstream of SH 1 to Department of Conservation boundary and undertake as appropriate.

Doctors Creek

- Complete channel and berm improvements just upstream from Taylor River confluence to reserve boundary.

Wairau tributaries outside floodplain

For the larger braided tributary rivers the following active channel fairway are intended to be kept clear to the following widths.

- Wairau above Waihopai to Wye Confluence:
  A generally 600 metre wide fairway to a defined location. Option to use aerially applied herbicide to significantly improve annual clearing coverage to be investigated.

- Waihopai:
  A 150 metre wide fairway.

- Fairhall:
  A 30 metre wide fairway channel.

- Omaka:
  A 50 metre wide fairway channel as far as is acceptable to adjacent riparian landowners.

Wither Hills soil conservation

- A Wither Hills Farm Management Plan has been approved by Council which clearly sets out sets out the dual objectives of soil conservation and public recreation for the land.

- The Farm Park grazing lease was recently been reviewed with clear conditions regarding the manner in which the land can be farmed. The arrangement is working well.

- An expanded work programme is propose for 2015-2025 to ensure soil conservation objectives are met including new contour ripping and resowing, additional gully planting and check dams, and water supply, fence and Redwood Street wool shed infrastructure upgrades.

Lower Wairau Land Drainage

Network

The current drainage network is proposed to be extended by 15.3 km or 5.4% increase in length on the current approved network. The reasons for the review underway include:

- New areas requiring drainage primarily because of crop type change.

- Subdivision into smaller lots requiring a greater length of public drain.

- Inadequate sized culverts in some drains.

- Current road drains to be adopted into the network and upgraded to the required standard to ensure the appropriate maintenance and capacity is maintained.

- Stabilisation of banks because of a lack of room for drain.

Adoption of the extended network will require approximately $300,000 worth of capital works improvement works to construct the new drains, place new culverts, improve existing drains, undertake drain bank stabilisation work where required, and possibly some riparian ecological plantings in places. The implementation is proposed to be spread over three financial years commencing in 2015/16.

Pump stations

The rural pumping stations were upgraded under the 1996 Wairau Drainage plan to achieve a revised level of service. No further significant capacity increase is suggested at present.

However there is a need to install telemetry equipment at most of these rural pumping station sites, and install telemetry control equipment at selected control gate sites.

A more regular lift out and mechanical overhaul schedule is proposed to maintain the reliability and efficiency of the pumps.

Floodgated outlets

No upgrades are proposed just routine maintenance and replacement. The large majority of the 280 outlet gates are in good working order and only require regular checking for debris blockage and free movement.

However it is known that a small number of the older large outlet culverts and headwalls, and at least one control gate are in need of major refurbishment and/or partial replacement. The exact programme of significant work required is still being determined. Budget provision has been included in the capital programme to do a large gate refurbishment/upgrade every second year over the life of this plan. This rate may need to be increased at a later date.

Blenheim, Riverlands and Renwick stormwater outfall channels

- **New channel works:**
  Upgrading of Town Branch Drain network is proposed to enable more Redwood Street stormwater to be diverted into this outlet. Upgrade works are likely to include some channel improvements, a second outfall from the Abattoir pump station (via

Snowdens is the current preferred option) and possibly a new pump station. Modelling of the upgrade options is underway.

- The only other significant Blenheim stormwater outfall upgrades proposed during the term of this plan is to lower Caseys Creek to provide for increased stormwater outflows from the Blenheim north growth area. Technical investigations for this upgrade are also underway. The work is proposed to be largely funded from a zone levy and so only minor provision is included in the Flood Protection budget for this work.

- Minor upgrades to Wither Hill channels (eg; Sutherlands) including bank stabilisation works may be required as a result of flood damage during the term of this plan. This work is can be funded from the flood damage reserve fund if beyond available maintenance funds.

- **New Blenheim pumping stations:**
  A number of the Blenheim urban pumping stations still need major capacity upgrades to achieve the required level of service, and three other more minor refurbishment upgrades. Those requiring major capacity upgrades are Redwood Street, Abattoir (as part of the Redwood Street upgrade project) and towards the end of this plan period Caseys Creek (to meet urban growth requirements). High Street needs further investigation to determine likely capacity upgrades but at the very least the existing machinery and electrical equipment will need a major refurbishment (as was done as an interim upgrade to Redwood Street in 2014).

- Note a new pumping station on Snowdens Drain is likely to be preferred to a major upgrading of the existing Abattoir pumping station on the Town Branch Drain network.

- There is also a need to install telemetry equipment at most of these pumping station sites. The various technical and equipment options for this are still being investigated.

- **Probable new floodgated culvert upgrades:**
  Waterways for which penstock gates are desirable are Redwood Street pumping station, High Street pumping station, Leeds Quay, Waterlea Creek, Andrew Street Pumping Station, and Fultons Creek.

Sounds Watercourses Flood Management

- In 2011 Council completed inlet improvements to the Waitohi triple culvert at a cost of $450,000. These works while apparently offering at least the 5 m^3/sec predicted capacity improvements are only Stage 1 of a 3 stage improvement to the culverts to meet the desired 1 in 50 year standard (2% AEP). The next stages under the KiwiRail shunting yard and the final stage under the Interislander car parking yard have been deferred indefinitely due to the cost of shifting the existing above ground infrastructure.

- Council staff are however maintaining contact with KiwiRail to see if an opportunity will arise to undertake the works as part of a proposed KiwiRail shunting yard reconfiguration now that the decision has been made that the Interisland ferries will remain in Picton for the foreseeable future.

- Recent flood events in early 2014 indicate that further channel capacity and stopbank improvements may be appropriate on the true left bank of the Waitohi River between Dublin Street and Broadway. These are proposed to be investigated within the first three years of this plan. Provision has been included for modest upgrade works.

- No further upgrade work is currently planned to the Buller Street branch of the Kent Street drain following the Broadway culvert replacement and upgrade of the downstream channel. However if any of the undersize road and other culverts needs replacing it is proposed to upgrade to the 50 year design flow standard.

- The remaining flood risk in the Dublin Street area and adjacent to the Kent Street drain (Buller Street branch) will be identified as flood hazard in Council's hazard register and requiring some building restrictions being mainly minimum floor levels.

- The hydraulic upgrade of the lower Waikawa River is complete and working well. Bed level monitoring does indicate a sediment build-up at the mouth which may require dredging at some point to maintain flood capacity of the channel.

Council River Control Floodway Reserve Land

- **Floodway land:**
  There is a continuing need for Council to acquire land either for new infrastructure such as pump stations, stopbank upgrades or waterway enlargements in the urban area or to obtain a higher degree of floodway management than the private landowner is comfortable with. The Upper Opawa and Riverlands Co-op floodways are examples of such rivers. This plan includes an annual provision of $200,000 for land purchases in these situations.

- **Maintenance access beside drains and small watercourses:**
  The majority of small watercourses and channels managed for public drainage purposes or urban stormwater are on private land and only a third is on Council reserve or road reserve. It is desirable in some situations to acquire more robust riparian access arrangements by purchase of access easements or reserve strips.

1.5 Financial Summary

Direct costs not including staff costs and other overheads.

Wairau Floodplain Floodways and Rivers	Annual Mtnce	Proposed capital 2015/16	Proposed capital 2016/17	Proposed capital 2017/18	Proposed capital 2018/19	Proposed capital 2019/20	Proposed capital 2020/21	Proposed capital 2021/22	Proposed capital 2022/23	Proposed capital 2023/24	Proposed capital 2024/25
Lower Wairau	84	250	200	250	100	250		250		50	50
Wairau Diversion	55		200		200		200		100		100
Wairau (Tua to Waihopai)	685	50	50	90	50	90	50	90	50	90	50
Waihopai below SH 63	40			30		30		30		30	
Lower Tuamarina edge	10	300	300	150							
Omaka below Hawkesbury	25	200		200		200		100		100	50
Roses and Upper Opawa	65		25	25	25						
Lower Opawa	80	40	60	40	60	40	60	40	60	40	60
Opawa Loop	25										
Riverlands & Tributaries	60			40			20		20		20
Taylor Dam	25	10	10	50							
Taylor River	120	20	70	20	70	20	70	20	70	20	70
Gibsons Creek	80	60									
Spring Creek	24										
Are Are/Lamberts	13										
Floodgates/control gates					30		30		30		30
Wairau gravel extraction	95										
Floodway land/purchase	110	200	200	200	200	200	200	200	200	200	200
Total Wairau floodplain river works	**1596**	**1130**	**1115**	**1095**	**735**	**830**	**630**	**730**	**530**	**530**	**630**
Wairau Floodplain Tributaries	162	20									
Wither Soil Conservation	207	95	50	40	22	54	37	28	20	20	20
Wairau Floodplain											

Wairau Floodplain Floodways and Rivers	Annual Mtnce	Proposed capital 2015/16	Proposed capital 2016/17	Proposed capital 2017/18	Proposed capital 2018/19	Proposed capital 2019/20	Proposed capital 2020/21	Proposed capital 2021/22	Proposed capital 2022/23	Proposed capital 2023/24	Proposed capital 2024/25
Drainage (Rural)											
Drain network	210	0	150	100		40		40		40	
Pumps	160	30	30	30	30	30	30	30	30	30	30
Urban Stormwater Watercourses											
Pumping Stations Blenheim	47	100	15	50	565	150		50	550	150	
Blenheim minor streams	60	100	100	100	60	60	120	120		60	
School/Terrace Creeks	12										
Sounds Rivers/Out of District											
Waitohi, Waikawa, Kent	55										
Picton/Waikawa minor streams	21	20	20	20	20	20	20	20	20	20	20
Pelorus/Sounds general	40										
Awatere/southern minor	11										
Totals	**2581**	**1495**	**1480**	**1435**	**1432**	**1184**	**837**	**1018**	**1150**	**850**	**700**

2. Introduction

2.1 Background

The Marlborough District Council is a unitary authority that carries out both regional and district council functions in the management of rivers, watercourses and drains throughout Marlborough. Flood control of the Wairau River and tributaries is a particular major regional responsibility.

A constant battle to control the Wairau has been the history and is the legacy for the people of Blenheim and the Wairau floodplain. The Wairau River system has provided the valuable resource of its floodplain, but is also its potential destroyer. The flood control works for the Wairau have to cope with floods larger than any other New Zealand river similarly controlled.

The need to maintain, monitor and upgrade river control works is ongoing. This plan details the manner in which this is done and the resulting financial commitments for Council.

Works have been carried out to control the Wairau River since soon after European settlement nearly 150 years ago by various, and at times opposing, River Boards. The blocking of the Opawa distributary of the Wairau by Conders Groyne in 1914 was the most significant and most contentious work. Here, 3 km upstream of the Renwick SH 6 bridge, up to half the Wairau floodwaters rushed down the Opawa River to, and into, Blenheim (or as it was known at one time “Beavertown”). The construction of Conders Groyne blocked this Opawa flow towards Blenheim, but resulted in frequent and larger floods down the main Wairau and Lower Wairau. This caused strong argument between Spring Creek and Blenheim residents.

Since 1921 there has been one river authority responsible for the flood control works for the whole of the Wairau, and since 1992 for the whole of Marlborough.

There were also Wairau tributaries from the southern hills – the Omaka, Fairhall, and Taylor which converged at Blenheim which presented a major flood threat to the township, and have required considerable flood control works.

These Wairau River and main Wairau tributaries works have been carried out as a regional council operation in the past.

There has also been a long history of drainage management on the 8000 ha low lying lower Wairau floodplain by various organisations. Associated with drain construction for agricultural purposes is the management of stormwater drains and small streams from urban and industrial development on the Wairau Plains – Blenheim, Renwick, Riverlands Industrial and more recently Cloudy Bay.

River control and land drainage by their very nature have to be community works. Over the years differently constituted local bodies (Lower Wairau River board, Wairau River Board, Marlborough Catchment Board, Nelson-Marlborough Regional Council, Marlborough District Council) acting under a variety of legislation (Hawkes Bay and Marlborough Rivers Act 1868, River Boards Act 1908, Wairau River Empowering Act 1934, Soil Conservation and River Control Act 1941 etc); have carried out actions to reduce flooding and improve drainage.

Over recent years the issues involved in river control and drainage have become more complex, more stringent legislation for defined outcomes and ecological values, and larger local bodies in less day to day communication with ratepayers and stakeholders. A clear asset management plan is a way of ensuring Council’s activities are appropriate, ecologically sensitive, adequately funded and transparent.

Local Government amalgamation in the 1989-1992 period resulted in the formation of the Marlborough District Council as a unitary authority. This has led to smaller stream control

stormwater works (eg; in Blenheim and Picton) being included in the same asset management plan as the larger rivers. In other areas on NZ these are carried out by Regional and District councils separately.

This river control and drainage asset management plan embraces management of these streams also and other river management responsibilities that have evolved over the last 20 odd years.

Flood control and land drainage management is different from other Council infrastructure asset management. Flood control and drainage is provided naturally by rivers and streams. Council's flood control and drainage 'assets' are infrastructure that seeks to improve on what nature provides.

Options can exist for flood capacity to be enlarged by constructing a stopbank 'asset'; or alternatively for the same objective to be achieved by deepening the river channel through gravel extraction – not considered to be creating an asset under NAMs asset guidelines.

Another complication is that nature and natural rivers are constantly changing on an irregular basis. Erosion, sedimentation, climate change, growth of trees and aquatic vegetation are examples of natural processes that affect the performance of rivers, as well as irregular flood damage.

This leads to the situation that without the construction of any recognised assets Council can be expending funds on maintaining 'natural' rivers to the status quo by vegetation control and sediment excavation, and this expenditure is often irregular over time depending on weather conditions.

Nevertheless this asset management plan sets out to demonstrate that council is responsibly carrying out and funding its responsibilities in the river control and drainage management area.

2.1.1 Previous Asset Management Plans

The "Wairau River Floodways Management Plan (1994)" was produced as a Resource Management Plan under the Resource Management Act. In reality it was a combination of an asset management plan for all major rivers in the Wairau catchment, and securing planning permission to carry out the required river control works. This document was a major review of sensible flood hazard standards, maintenance and new works required for the major river systems of the Wairau floodplain. Its format was designed to allow for full consultation with the public as a *one stop shop* document.

The "Wairau Drainage Management Plan (1996)" was effectively an asset management plan for the pumping stations, floodgated culverts, gates and other structures within the network of drains and small rivers of the Lower Wairau plains. This document was a major review of drainage pumping standards, maintenance and new works required for the structures of Council's drainage network.

These two documents were incorporated into "Wairau Floodplain River Control and Drainage Asset Management Plan (1999)". This document basically summarized the two above documents and also included valuations of the assets. In 2008 Picton river assets were added to the Rivers and Drainage asset plan.

This current document herein updates the 2008 plan. It sets out the key issues to be managed in next 10 year period including some asset renewal and flood damage catch-up, proposed new asset management information system, proposed Wairau scheme review taking into account climate change and stormwater upgrades required in Blenheim and Renwick as a result of urban growth.

2.1.2 Purpose of the Plan

The purpose of this plan is to document a long term strategy for the management of river control and drainage infrastructure. The key objective of the strategy is to provide the desired levels of service in the most cost effective manner for present and future ratepayers.

2.1.3 Relationship with Legislation and other Council Documents

Legal empowerment/requirement

The Marlborough District Council is empowered to carry out public river control and drainage mitigation measures under the following main statutes:

Land Drainage Act 1908
Soil Conservation and Rivers Control Act 1941
Local Government Act 200
Local Government (Rating) Act 2002

Legal constraints

Other legislation covers the manner in which any river works and measures are carried out primarily being:

Resource Management Act 1991
Reserves Act 1977
Building Act 2004

The Resource Management Act 1991 requires Council to develop resource management plans for the Marlborough region/district. Marlborough has prepared two main combined regional/district plans which directly permit Council to carry out many river control and drainage activities, these being:

Proposed Wairau/Awatere Resource Management Plan 1998
Marlborough Sounds Resource Management Plan 2004

Some rivers and drainage works have required specific resource consents with particular consent conditions

eg; Wairau diversion of water into Gibsons Creek 2003.
Use of aquatic herbicides 2009

Wairau River flow split bank 2010

There are also Council documents that set out standards for common river control and drainage activities.

Code of Practice for Subdivision and Land Development (MDC 1994)
Marlborough Rivers Management and Ecology and Code of Practice (1995).

Other constraints on Council's river control and drainage operations are imposed by the riparian landowners through where the watercourses run, especially if they have built major structures. A particular example is the culverts constructed in 1970 to carry the Waitohi River under the Picton railyard and Interislander Terminal Parking area by the Marlborough Harbour Board (now Port Marlborough) and NZ Rail (now KiwiRail). This major culvert structure is undesirably small for Waitohi floodwaters and has resulted in flooding of upstream property. The asset is considered owned by KiwiRail and Port Marlborough and so any upgrading by Council on behalf of Picton residents can only be done by agreement.

Council public consultation and asset management policy development

Obviously Council should only be carrying out activities that are desired and have the support of the community. The process of a three yearly production of a Long Term Plan is

a well-established requirement of councils, with the production of an annual plan in the other two years. This document is to foster broad scale consultation with the public at large.

More intensive consultation/council policy development has been carried out on rivers and drainage proposals from time to time, often following major floods, or resource consent applications or changes in government policy.

A major review of the Wairau River control works was carried out through:

> Proposed Wairau River Floodways Management Plan 1993, leading to
> Wairau River Floodways Management Plan 1994

This 1994 document was produced as a resource management plan under the Resource Management Act 1991. It contains regulatory (RMA) measures and also detailed asset management information/policies.

The regulatory (RMA) measures have since been subsumed into the Wairau/Awatere Resource Management Plan. The detailed river information/policies in the WRFMP however remain very valid as Council asset management policy.

The Wairau Drainage Plan 1996 was a similarly produced document, again with a selected public consultation panel, though it is not a resource management plan under the RMA.

Specific proposals come up from time to time. The resource consent application process is a high profile consultation process, for example Council's resource consent for applicant of agrichemical herbicide to control aquatic weeds in watercourses. This was last granted in 2009 with prescribed conditions.

Sometimes specific desired actions arise without the need for resource consent. These situations are handled as Council agenda items with targeted public consultation as required; eg; the need to upgrade soil conservation measures on the Wither Hills following the December 2000 fire; Wairau River Gravel Extraction policies 2013.

The proposed extension of the rural drainage network will be subject to direct consultation with affected and benefitting landowners and any new works on private land will require landowner agreement.

River control actions – especially river diversions – are usually for perpetuity. Historical decisions regarding such actions impose a maintenance responsibility into the future and continue to be of relevance. Particular decisions for Marlborough are:

> Wairau Valley Scheme 1960
> Wairau River Commission 1917

Summary

These various empowerment, constraining and consultation documents all affect the final form of Council's River and Drainage Asset Management Plan. This includes historical decisions which are fundamental to today's management.

It should be noted that the resulting asset management plan actions are not simply limited to a capital works and maintenance programme.

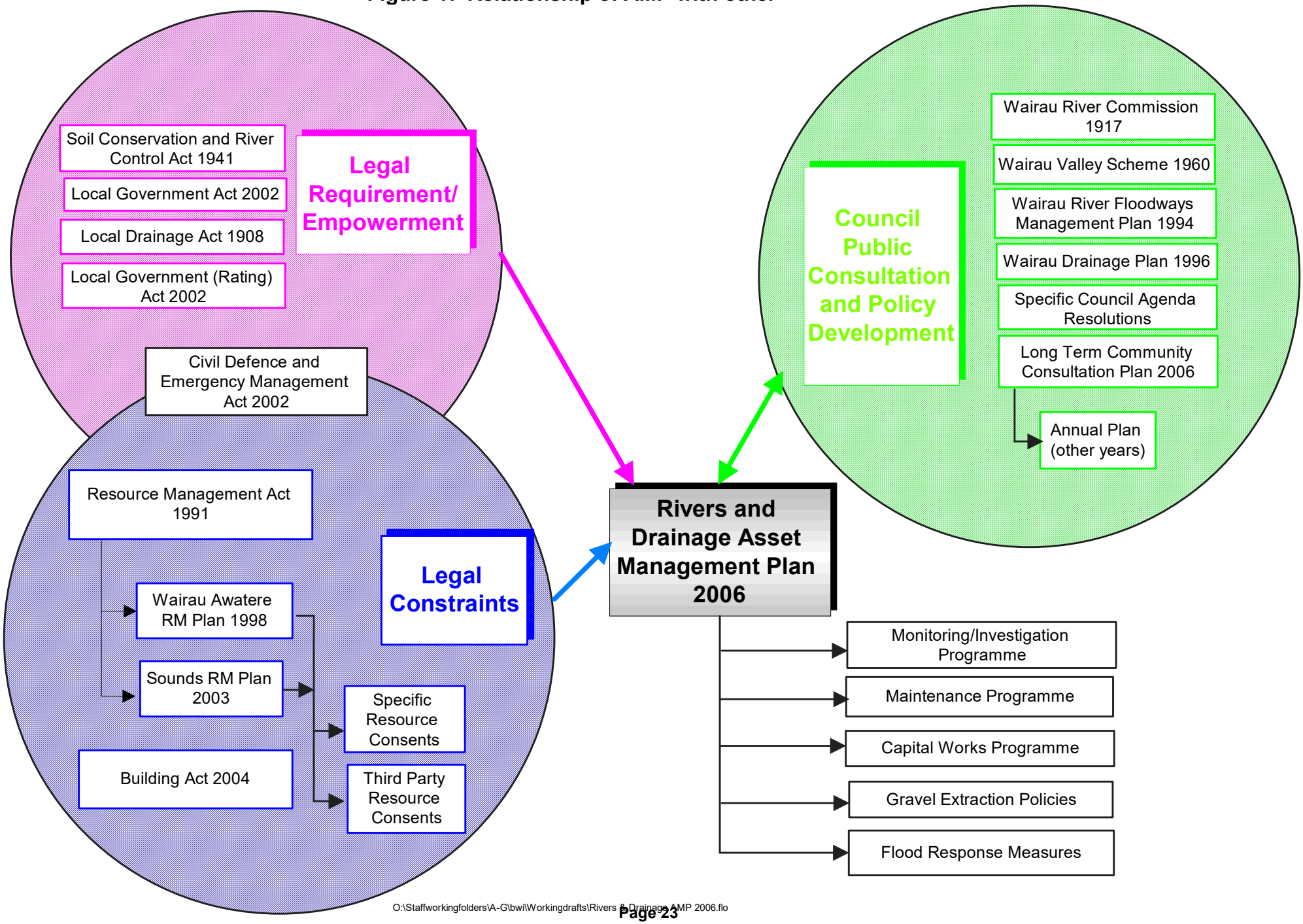
Management of the river channels' size is influenced by the manner in which gravel extraction is permitted/encouraged by gravel extraction contractors. The development of gravel extraction policies is therefore an important part of river control asset management.

Monitoring and investigation of natural changes to the river system is a significant requirement in its management.

Emergency flood and drainage response measures are required for events approaching or exceeding the design standards.

The interface of the various documents is depicted diagrammatically on Figure 1.

Figure 1: Relationship of AMP with other



2.1.4 Assets Covered

Council's rivers and drainage assets are broken down under various systems. These different systems have either separate funding mechanisms or different performance standards (levels of service).

- **Wairau floodplain major rivers and stopbanked floodways** covering 20,000 hectares of fertile land around Blenheim (depicted as Fig 2). (This is Council's major river control and drainage activity). This involves 180 kilometres of stopbanks; a major dam; 4.8 million cubic metres of compacted earth in stopbanks and dams; 1 million tonnes of quarried rock as bank protection; 62 ha of willow and poplar trees as bank protection; and other miscellaneous structures.

- **Wairau tributaries (not stopbanked) outside of the main floodplain** covering the rest of the 4,000 km² Wairau catchment. Approx 120 kilometres of river and stream channels are regularly kept clear.

- **Wither Hills soil conservation** works to lessen sediment erosion from the 1030 hectares of erodible hills immediately south of Blenheim.

- **Wairau land drainage** covering 8,000 hectares of low lying floodplain being drained by 150 km of minor watercourses and 18 pumping stations. (See Figure 3).

- **Blenheim, Riverlands, Picton and Renwick urban stormwater disposal channels and pumping stations** that are the outfalls from the urban piped stormwater system. It involves 25 km of minor watercourses and 10 pumping stations. (See figure 3).

- **Gibsons Creek rewatering** to supply irrigation, groundwater recharge and ecological values; as a mitigating action arising from river control diversions. This involves two river intakes and maintaining 25 kilometres of small channels.

- **Council river control (floodway) reserve land** much of which is used for secondary purposes of ecological planting, public amenity, commercial forestry, other commercial leasing etc with an approx area of 3000 hectares.

- **Sounds watercourses** that are managed for limiting flooding in Picton and Waikawa. This involves 3 kilometres of managed channels and emergency assistance to a large number of other catchments including the Rai Valley, Wakamarina River, Pelorus River, minor streams in Havelock, Momorangi and Ngakuta Bays, Okiwi Bay and a number of other sites in the outer sounds.

Fig 2: Wairau Floodplain Stopbanked Floodways

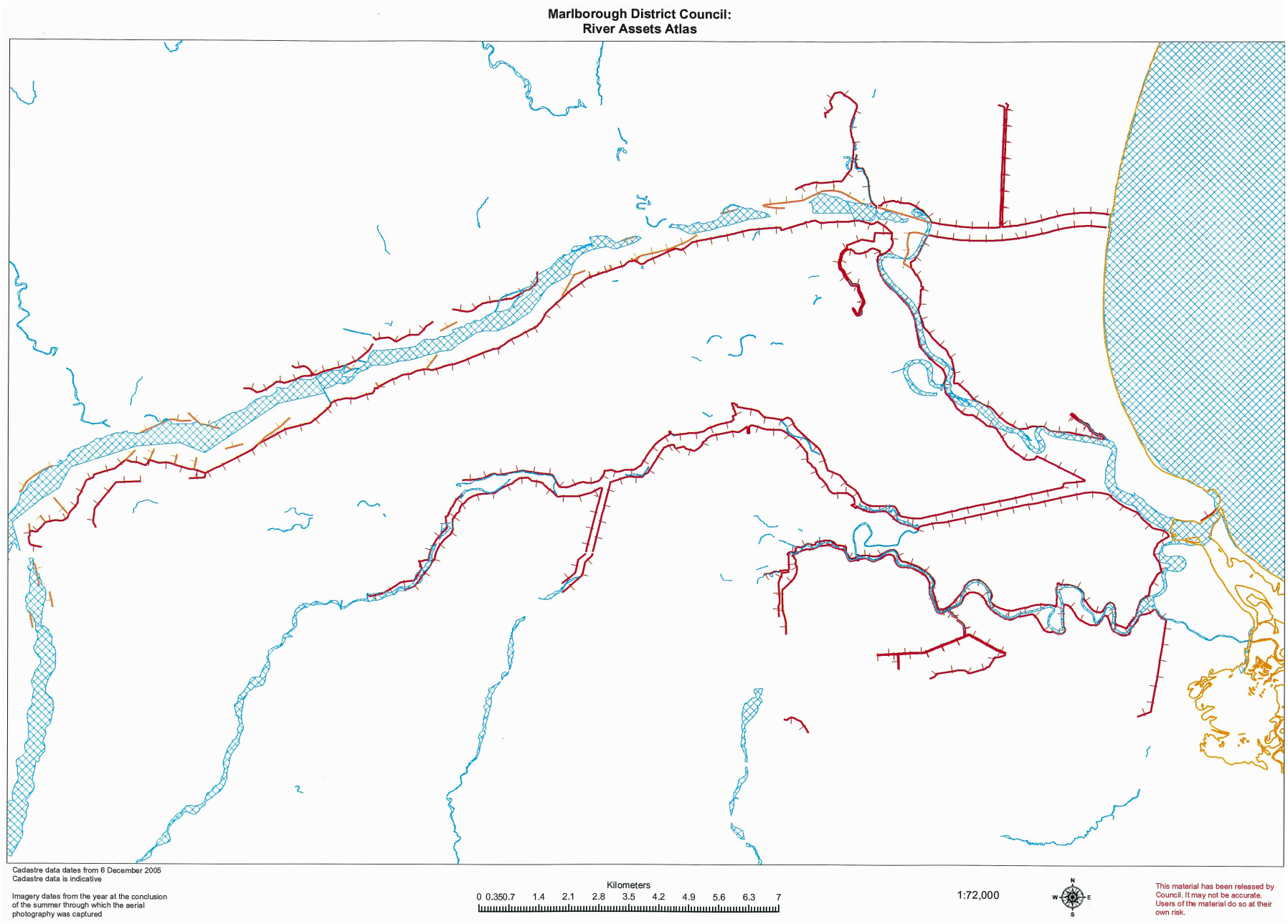
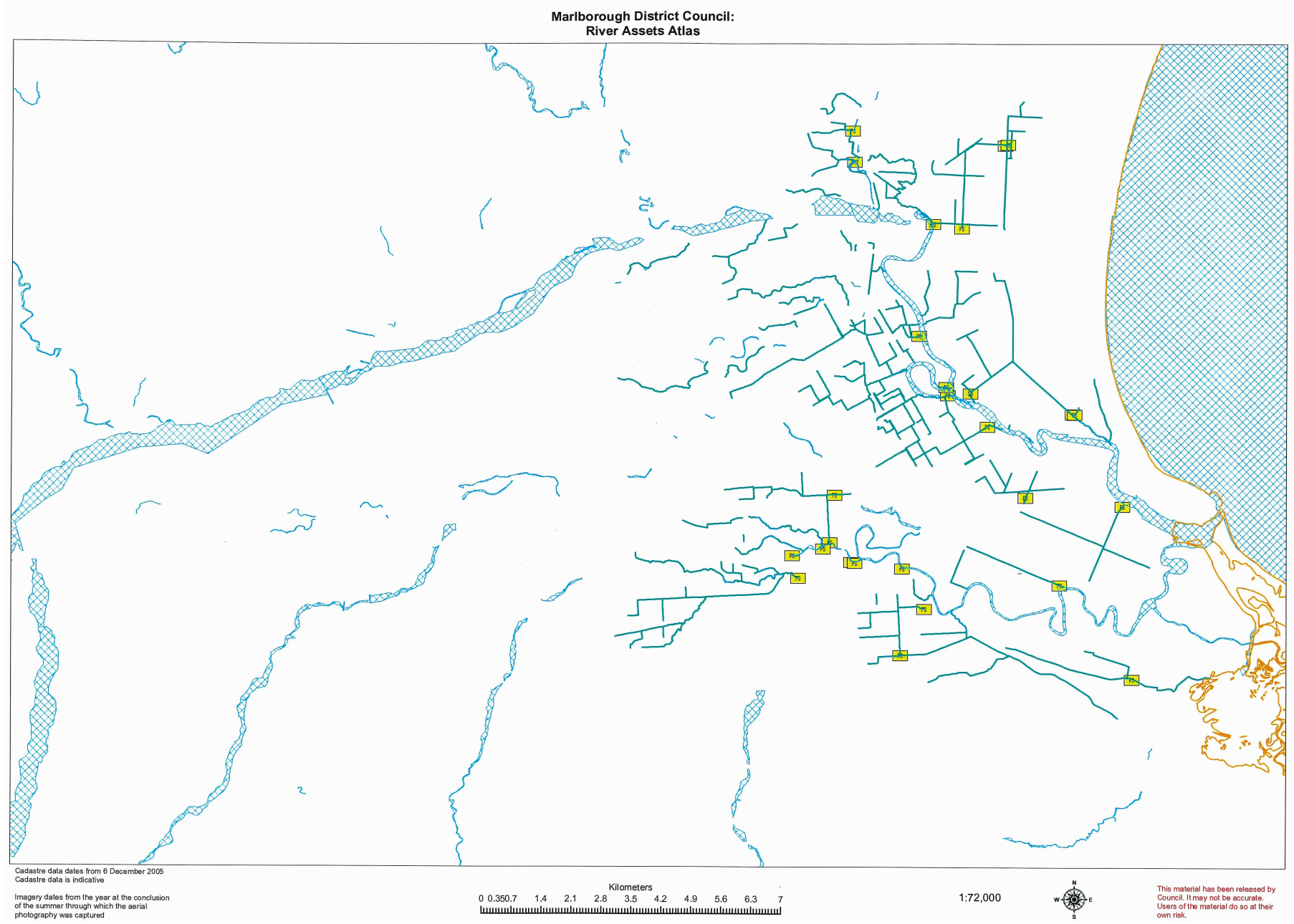


Fig 3: Wairau land drainage and urban watercourses and pumping



3. Levels of Service

3.1 Introduction

The drivers behind determining the appropriate levels of service for river control and land drainage are legislative requirements, customer expectations, historical decisions, risk management, affordability and preserving environmental values.

The relative balance of these parameters is changing. The long history of flood control and drainage on the lower Wairau floodplain initially had an emphasis on risk management and affordability. Historical decisions made by the Wairau floodplain community 100 years ago are still fundamental to the level of service council has to provide.

More recently the ratepayers (customers) are expecting that Council will provide a high standard of flood control and drainage throughout Marlborough and this is being enshrined to some degree in legislation. The Building Act 2004 and Resource Management Act 1991 have tighter requirements regarding managing flood hazard to buildings and subdivision than earlier regulatory legislation. There are also tighter conditions on ecological and other environmental values of watercourse management.

These factors are of particular relevance in the Sounds area, an area with less history of flooding problems.

3.2 Customer Expectations and Consultation

The levels of service (or performance standards) are discussed separately for each subset.

3.2.1 Wairau Floodplain Floodways

The 20,000 ha main Wairau floodplain has a long history of flooding and drainage problems and various local government bodies have set about fixing the problems since early Pakeha settlement 150 years ago. This floodplain is generally that land downstream of the Waihopai confluence, north of new Renwick road, or otherwise bounded by the hills and the sea.

Flood control management has the unusual feature that flood hazard improvement for one ‘community’ may be at the expense of worsening flood hazard for a neighbouring ‘community’. This occurred in Marlborough in the late 19th century. The Lower Wairau River Board was responsible for the southern half of the Wairau floodplain, and the Spring Creek Board the northern half. (There were also three other minor river boards).

Each board then built stopbanks on its side of the Opawa River to a higher level – so that any flood breakout would be away from their own district but into the neighbouring district. River diversions that were carried out had a similar effect.

After 40 years of flooding and wrangling the Government stepped in with the public hearings of the Wairau River commission in 1917. This commission endorsed the action of blocking the Opawa distributary channel from the Wairau and other major diversions, but on the requirement that a single river board would in future be responsible for all river control works in the Wairau floodplain for the benefit of all.

The enactment of the 1917 Wairau River Commission recommendations in endorsing the blockage of the Opawa breach and the other blockages and diversions of Wairau floodplain channels established the direction of river control works on the Wairau floodplain. Blenheim and residents on the south side of the valley got their way in blocking the Opawa breach, but on the understanding of continuing responsibilities for ensuring the adequacy of the Wairau River and other watercourses down the full length of the floodplain.

The level of service defined in the 1917 decision was for “the largest flood hitherto observed with a reasonable margin of safety”. This 1917 decision underpins flood standards for the floodways of the Wairau floodplain.

This was again publicly discussed in the Wairau Valley (river control) Scheme 1960, which proposed a 200 year return period flood for the Wairau – but with limited flood information to determine this figure. Other major floodplain rivers were based estimations of the largest flood measured in the previous 50 years.

A thorough review was again carried out in the Wairau Rivers Floodway Management Plan 1994 (WRFMP). A 1 in 100 year return period flood was adopted for the standard all the main rivers of the Wairau floodplain – and with the benefit of 30 years of good flood flow record. (The 1994 reassessment of a 1 in 100 year flood is in fact greater than the 1960 assessment of a 1 in 200 year flood). In this document it was noted that all river patterns have been highly modified by previous river and catchment boards’ diversions. None of the waterways are carrying their original ‘natural’ flood flows.

The WRFMP was put out as a resource management plan so as to ensure the maximum public consultation. A community consultation group was set up for discussion of issues; and the plan was appealable to the Environment Court. No appeals were made.

A view expressed by some Blenheim residents was that the river control works that protect the town have been completed long ago, and they find difficulty in relating the continuing expense on the Wairau and other rivers to their situation.

Blenheim – or Beavertown as it was known in earlier days, was at the confluence of a number of river systems – Taylor, Fairhall, Omaka and significantly the upper Opawa that was a distributary channel of the Wairau.

To bypass the town, the original channels were diverted or blocked. Fairhall and Omaka water was diverted north into the Upper Opawa/Rose’s Overflow and the distributary channel of the Wairau – the Opawa breach – was blocked in the Conders area. The areas that these flows were diverted to now had to deal with much larger flood flows.

The authorities of the day were faced with legal battles to justify the protection of Blenheim, apparently at the expense of such locations as Tuamarina, Renwick, Grovetown and the Lower Wairau.

It was accepted – this acceptance forms the basis of the rating principle – that Blenheim could not expect to carry out works to protect itself at the expense of other areas. It was also accepted that the protection of the other areas should be carried out concurrently with or even ahead of, the work to protect Blenheim.

This principle holds as firmly today as when it was first promulgated by the 1917 Wairau River Commission.

Fundamentally, the standard for all river works on the Wairau floodplain derive from blocking the ‘Opawa breach’ in the Conders area, and other historic diversions to protect Blenheim. This sets the standard for all the floodplain and a commitment on all floodplain ratepayers.

The fact that the rivers were diverted many years ago is not an issue, as the river systems take many years to adjust and the Council must continue upgrading and maintaining the whole interlinked system to a consistent standard.

Improving and maintaining this jigsaw of interlinked modified waterways on the floodplain to an appropriate standard carries with it the responsibility that all flood control work on these Wairau floodplain floodways should be planned, promoted and funded as one scheme to a uniform high standard.

The standard (levels of service) was set to be for the floodways and major rivers to be upgraded to be able to carry a 1 in 100 year return period flood.

The 1998 Proposed Wairau/Awatere Resource Management Plan incorporated the 1994 WRFMP into a broader district and regional resource management plan. The flood control aspects of this resource management were not appealed against.

An objective of this plan is the following level of service:

- "*to obtain a floodway capacity and standard of protection for flood sizes up to a 1 in 100 year return period for the major rivers of the Wairau (Rural 3 zone) floodplain*."

This level of service cannot be altered without a resource management plan change.

These floodways include the Wairau, the Lower Wairau, Wairau Diversion, Opawa, Taylor, Omaka, Riverlands Co-op and others.

The standard is achieved by building and maintaining stopbanks, river diversions, detention dams, stopbank erosion protection (rock and trees), river channel clearing, channel excavation, channel training, flow control gates and other miscellaneous structures.

Main references

"Wairau Valley Scheme" Report of the Marlborough Catchment Board - C C Davidson 1960.

"Wairau River Floodway Management Plan" Council Resource Management Plan
E B Williman 1994.

3.2.2 Wairau Floodplain Tributaries

Wairau tributaries to the main floodplain have a lesser history of flooding, erosion and drainage because there is less of a hazard, and/or less economic to do full flood protection or channel alignment works, and/or a lessor need for local government to carry out activity as a community effort (this includes the main stem Wairau above Waihopai).

Under the Government subsidised 1960 Wairau Valley Scheme significant river works were carried out on these tributaries as a source to the sea scheme with considerable Government subsidy. For example attempts were made to train the braided Wairau (above Waihopai) with rock work and trees to a narrower 600 metre width curving channel; significant river training/bank erosion etc works were also carried out on the Onamalutu, Omaka, Tuamarina, Waihopai and other rivers. Some stopbanks were also built.

The 1994 Wairau River Floodways Management Plan reviewed those works with public consultation as discussed as above. As a result the level of service was reduced to only that of maintaining the river channels as cleared stable channels as far as practical and economic. This was because the works in the main consist of individual elements and each element protects a single or only a few landowners and therefore a community scheme was not required to construct river control works, which were also generally uneconomic. Council's decision was not appealed against.

Under this policy Council has stopped maintaining the previously constructed rock work, trees, gabions, stopbanks and other physically constructed assets. The Wairau/Awatere Resource Management Plan confirmed this policy.

- Council's level of service is to keep the river channels clear of trees and debris.

Under NAM's guidelines these river channels are not assets that can be valued so Council no longer owns any river control assets for the Wairau tributaries.

Council is prepared to pay landowners up to 50% of the costs of private bank protection, stopbanks and other river control assets that they wish to construct.

3.2.3 Soil Conservation

The Wairau Valley Scheme 1960 contained many soil conservation measures as part of its source to the sea flood control and erosion containment policies. These were reviewed in the 1994 WRFMP, and a decision taken to discontinue carrying out further soil conservation works. The exception is for the Wither Hills where active soil conservation operations of tree and grass planting and management, check dams, and stock control is carried out.

A major fire on the Wither Hills in December 2000 confirmed the need for continuing such soil conservation works so as to minimise the likelihood of sediment erosion depositing in rivers downstream and creating a flood hazard. Two relevant reports are the basis for Council's policies.

> "Wither Hills Erosion Management – Re-establishing Cover for Erosion Management following the December 2000 Fire (2001)".
>
> "Wither Hills Farm Park Management Plan – (2003)".

The level of service can be summarised as:

- Minimal sediment is deposited in watercourses at the base of the Wither Hills.

3.2.4 Wairau Floodplain Land Drainage

'Flood Control' works are those that prevent damage from large sudden inundation from the major rivers. 'Drainage' is the steady longer term removal of water from sodden ground or ponded areas to reduce groundwater levels so as to enable productive use of the land to occur.

There is a degree of overlap between 'flood control' and 'drainage' assets on low lying land requiring drainage. Drains and natural watercourses that are specifically excavated to drain otherwise swampy land will also reduce the flood level in storm events, especially where there is good channel capacity and outfall capacity to the main river systems.

The low lying land of the lower Wairau Floodplain has several thousand hectares less than 2 metres above sea level. Drainage of this land greatly increased agricultural productivity and facilitates road construction and operations. There has been a long history of drainage works by a variety of organisations since Pakeha settlement. The 'drainage' activity here includes flood control from small local streams.

Drainage works consist of channel excavation, keeping channels clear of aquatic weed and siltation, floodgates, culverts, pumps and miscellaneous structures. Channel excavation is a mixture of deepening existing natural watercourses and/or straightening and diverting watercourses, and/or excavating entirely new drainage channels in locations where surface flow did not previously occur.

While the Marlborough District Council took over this function in 1992 there had been a succession of previous Drainage authorities with the earliest noted being the Pukaka River and Drainage Board (formed in 1878), and the large Grovetown drainage district was formed in 1944.

Under the Wairau Valley Scheme (1960) the then Catchment Board took over the 1200 ha Grovetown Drainage District which had fallen into disrepair. The WVS reconstructed the various channels, installed floodgated culverts and constructed a pumping station.

Over the years further areas on the plain were added under specific request and (Catchment) Board resolution.

By the earlier 1990s some 8,000 hectares were benefiting from the newly amalgamated Marlborough District Council drainage works and much of this area was also served by pumping stations.

Following drainage problems during a wet winter in 1995 a major review was carried out with consultation through a community panel and resulting in the "Wairau Drainage Plan 1996". This resulted in Council approving an upgrading of the pumping stations of the drainage network and other works.

The management of aquatic weed has required several specific resource consents. The resource consent application process has resulted in comprehensive public discussion on the manner in which aquatic weed is removed including how much is left, when and by what methods removal is carried out. There have also been environmental studies on specific rivers that have also focussed on the manner and frequency of weed removal so as to ensure or enhance ecological habitat. Other branches of Council have been leading these studies which impact upon the "level of drainage service" provided by Council. Weed left in land drainage channels for ecological reasons can impair the drainage level of service provided in the event of heavy rain.

There is no simple performance measure to assess the quantity or quality of maintenance works required for maintenance of scheme standards. In a long period without significant rainstorm or river flood event the asset value and performance standard can be maintained at a moderate cost and conversely following serious events high levels of expenditure may be necessary and may follow through to a subsequent financial year.

Council's current policies re Wairau land drainage levels of service can be summarised as:

- To maintain a public land drainage channel where three or more landowners require one.
- To clear those watercourses/drainage channels of impeding weeds up to twice a year.
- To clear silt build up in drains, usually requiring excavation at approximate eight year intervals.
- To maintain floodgated outlets to the major rivers so that backflow is minimised in times of river flood or high tide.
- To supplement gravity drainage with pumping stations so that maximum ponding period on the paddocks is three days in a 1 in 10 year rainfall event; this generally requiring pumping station capacity of removing 15 mm rainfall in 24 hours.
- To carry out aquatic weed removal in an ecologically sensitive manner with methodology targeted to be specific to particular watercourses.
- The riparian margins of selected channels to be managed in an aesthetic and ecologically sensitive manner.

During 2013 and 2014 considerable work has gone into reviewing the formally adopted network managed and maintained by Council. This was last formally done in 1960 when the current network was adopted as part of the then new Wairau Valley Scheme.

Since 1960 there has been significant intensification of land use and subdivision, a trend towards viticulture and an expectation of a generally high level of service. The proposed new network will add 15.3k m (about 5.4% increase) to the currently managed network of drains and increase the level of service to a direct connection to all properties over 1 ha in size. Note most of the drains proposed to be brought into the Council managed network already exist so only require bringing up to standard.

The network review proposal is out for consultation with benefitting and affected landowners and the final change to the network is proposed to be adopted by Council at its meeting in May 2015.

Reference – "Wairau Lower Floodplain Land Drainage – Network Review" report to A & S Committee, November 2014.

3.2.5 Blenheim, Riverlands, Picton and Renwick Stormwater Outfalls

The management and operation of the stormwater carrying urban stream channels and pumping stations is very similar to that of rural land drainage.

Differences are that a higher level of service is required for flood management. The channel network should be able to cope with a 1 in 50 year return period flood event so as to meet the standards that the Building Act 2004 imposes on building floor levels. Pumping stations are required when local stormwater runoff coincides with high water levels in the receiving rivers.

The hydraulic requirements of these channels are determined by the stormwater pipe network feeding into them. This stormwater pipe network is dealt with by another section of Council under a different asset management plan. The design of these two components is being integrated as part of the stormwater strategy.

The manner in which Council deals with its urban stormwater is under review as part of an interdepartmental Council stormwater strategy. This includes design guidance for determining the likely runoff quantities, pipe network capacity, secondary the pumping stations capacity, the receiving watercourse capacity, water quality aspects and required resource consents.

Removal of aquatic weed from urban watercourses is also for aesthetic and health reasons as well as hydraulic efficiency. The LTCCP process can be used to assess if residents require a higher standard than currently being provided or better aesthetic/environmental values. It should be noted that several of the watercourses and pumping stations drain a mixture of urban and rural land.

The key areas of work underway;

- Detailed hydrologic and hydraulic review of the combined Redwood Street and Town Branch drainage network to determine the best solution for meeting the 1 in 50 year design storm level of service standard, the upgrades required and a proposed work programme.

- Hydrologic and hydraulic review of the Caseys Creek catchment and Opawa River outfall to determine upgrades required to service the Blenheim north urban growth area.

- How best to deal with expected additional stormwater discharge in the upper Murphys Creek catchment due to urban growth. Residents are concerned that additional stormwater will degrade the water and general environmental quality of this spring fed creek and have asked Council to by-pass pipe the additional upper catchment stormwater to the Taylor River.

3.2.6 Gibsons Creek Rewatering

One of the branches of Gibsons Creek was a distributary channel of the Waihopai River. It flowed over the floodplain to join the Upper Opawa River (also a distributary of the Wairau). The flow in the Gibsons Creek/Opawa River augmented groundwater levels by leaking and also benefited ecological values of several rivers and streams in the lower Wairau plains.

River control works early in the 20th century blocked off these distributary channels from the Waihopai and Wairau rivers. There was considerable public concern following this.

As a result of this public concern one of the first tasks constructed under the Wairau Valley Scheme 1960 was a diversion of up to 2.8 m³/sec from the Waihopai to re-water Gibsons Creek.

The Waihopai River however cannot supply this amount of water during low flows. Furthermore under the Wairau/Awatere Resource Management Plan 1998 this abstraction was reduced at times of low river flow to 0.35 m³/sec (to benefit competing Waihopai River users). At times of higher flow up to 1.2 m³/sec may be taken.

Following public requests for irrigation for viticulture a resource consent (with associated considerable public consultation) was obtained in 2003 to also abstract water from the Wairau River into Gibsons Creek so as to supply the Southern Valleys Irrigation Scheme (SVIS), augment groundwater recharge to the Wairau aquifer and ecological benefits for lower plains watercourses.

The level of service was determined by a publicly representative water management group set up as a resource consent condition to establish a water management plan.

The level of service (within resource consents constraints) is:

- To supply the requirements of the SVIS.
- To provide continuous flow to the sea in the Gibsons Creek/Opawa system without flooding riparian land, and thereby also maximising groundwater recharge of the Wairau aquifer.

3.2.7 Council River Control Floodway Reserve Land

Council owns or manages a considerable amount of floodway reserve land for the purpose of conveying floodwaters. The need for Council to acquire floodway land is to ensure that the land is managed in such a way as not to compromise the performance of the floodway. For example in some areas the hydraulic performance of the floodway is critical and the planting of trees needs to be limited to ensure this hydraulic performance. Conversely in other floodways trees are desirable to slow flood waters and thus reduce the likelihood of erosive scour of the stopbanks. More floodway land is being purchased all the time.

While the main purposes of the floodway land is for river control much of this land also has secondary land uses – public access, commercial leasing and ecological plantings.

Historically one of the secondary level uses – where appropriate – has been the planting of commercial forestry.

Under the Wairau River Floodways Management Plan 1994 (and its consultation process), policies were made to facilitate public recreational access on Council floodway land and to plant native and other amenity/ecological plantings.

Council has more recently in 2004 formed a public working party on landscaping matters that has as one of its objectives ecological and amenity planting on river floodway (and other) Council reserve land.

The level of service can be summarised as:

- The space required for flood control works is not compromised.
- Much of Council floodway land is accessible for public recreation.
- To plant and maintain at least 20 hectares of land in ecological/amenity plantings.

- To utilise other floodway land for economic gain by forestry and/or leasing.

3.2.8 Sounds Watercourses Flood Management

There has been limited flooding of residential areas in the Marlborough Sounds.

The need for Council to have river control works to a defined standard has arisen from the legislation in the early 1990s of the Building Act, Resource Management Act 1991 and local government amalgamation.

Public concern from flooding has arisen following flood events especially in Picton/Waikawa in 1998 and 2004. This has led to Council investigation, analysis and public consultation with concerned resident user groups.

Council's desired level of service is:

- For the urban and residential areas of Picton and Waikawa to obtain a river capacity and standard of protection for flood sizes of up to 1 in 50 year return period for the Waitohi, Waikawa and their major tributaries; and higher if practical.

It should be noted that Council (Marlborough Catchment Board) formerly maintained a Pelorus Valley river control scheme, but maintenance of those river control assets lapsed in 1990 following withdrawal of Government subsidy and public consultation on the matter.

3.3 Overview of Current Compared to Desired Levels of Service

3.3.1 Introduction

This section presents an overview of the degree to which levels of service are being reached for each subset. More details for individual items and the need for capital works to upgrade the various systems will be discussed in s5.

There is a wide scope of definition of level of service depending on the particular asset system. It is also noted that some of the asset systems have "levels of service" that are subjective in definition. Most of the asset systems are providing the desired level of service, but some of the systems are not, and some of the systems may in the future not reach the desired level of service.

Natural sedimentation and vegetation growth is constantly occurring, and expected flood runoff also changes with better information. Regular monitoring of flood events is therefore required to assess the level of service being provided by each watercourse.

3.3.2 Wairau Floodplain Floodways

Desired Level of Service:

A floodway capacity for flood sizes up to a 1 in 100 year return period for the Wairau and the dozen other major floodplain rivers.

Performance Measure:

To monitor the various floodway performance of floods that occur, and carry out hydraulic computer analysis of the design flood using river bed resurveys and calibrated with monitored flood levels. Sediment build-up in rivers and other factors change the floodway performance.

Assessed Current Level of Service:

Most of the floodways are up to the desired level of service. Two of the dozen floodways are not, and works are underway to upgrade the lower Wairau and Riverlands Co-op floodways.

3.3.3 Wairau Floodplain Tributaries

Level of Service:

To keep the river channels clear of trees and debris.

Performance Measure:

Regular visual inspection on an annual basis and after floods.

Assessed Current Level of Service:

Desired level of service is being met.

3.3.3 Soil Conservation

Level of Service:

Little or no sediment is deposited in watercourses at the base of the Wither Hills. Grass, trees and other vegetation are the major methods of preventing soil erosion.

Performance Measure:

Regular annual inspection and monitoring after storm events.

Assessed Current Level of Service:

Desired level of service is being met.

3.3.4 Wairau Lower Floodplain Land Drainage

Desired Levels of Service:

- To maintain a public land drainage channel that provides a connection point for most individual holdings greater than 1 hectare.
- To clear those watercourses/drainage channels of impeding weeds up to twice a year.
- To clear silt build up in drains, usually requiring excavation at approx seven year intervals.
- To maintain floodgated outlets to the major rivers so that backflow is minimised in times of river flood or high tide.
- To supplement gravity drainage with pumping stations so that maximum ponding period on the paddocks is three days in a 1 in 10 year rainfall event; this generally requiring pumping station capacity of removing 15 mm rainfall in 24 hours.
- To carry out aquatic weed removal in an ecologically sensitive manner with methodology targeted to be specific to particular watercourses.
- The riparian margins of selected channels to be managed in an aesthetic and ecologically sensitive manner.

Performance Measure*:*

Twice yearly inspection and monitoring during prolonged rainfall.

Assessed Current Level of Service:

- Drainage network – will be achieved once the new extended network is in place and the capital upgrade programme complete

- Drain clearing of weed and silt:
  Desired level of service being achieved.

- Floodgated outlets:
  Desired level of service being achieved.

- Pumping stations:
  Desired level of service being achieved. Aquatic weed removal: Desired level of service being achieved. Detailed weed management practices have been defined for half a dozen ecologically sensitive watercourses.

- Riparian plantings:
  Desired level of service being achieved. An interdepartmental Council landscape group has been set up to prioritise landscape planting on appropriate watercourses.

3.3.5 Blenheim, Riverlands and Renwick Stormwater Outfall channels

Desired Level of Service:

The channel network and pumping stations to cope with a 1 in 50 year return period flood event.

Performance Measure:

To assess the probable design stormwater runoff, to carry out hydraulic computer modelling of these design floods, and to monitor flood levels during storm events so as to calibrate computer modelling with actual events.

Assessed Current Level of Service:

Desired level of service is being met for many, but not all of the dozen watercourses. The desired level of service is not being met for three or four of the ten Blenheim urban pumping stations.

A major interdepartmental investigation is underway as part of a Council stormwater strategy to assess adequacy of three high priority stormwater catchments to determine the upgrade required and the expected cost.

3.3.6 Gibsons Creek Re-watering

Level of Service:

- To supply the requirements of the SVIS.

- To provide continuous flow to the sea in the Gibsons Creek/Opawa system without flooding riparian land (within resource consents constraints).

Performance Measure:

Monitoring and management the intake into Gibsons Creek from the Wairau so that the required flow amounts are met.

Assessed Current Level of Service:

Desired level of service is being met.

3.3.7 Council River Control Floodway Reserve Land

Desired Level of Service:

- The space required for flood control works is not compromised.

- Much of Council floodway land is accessible for public recreation.

- To plant and maintain at least 20 hectares of land in ecological/amenity plantings.
- To utilise other floodway land for economic gain by forestry and/or leasing.
- Riparian access for maintenance of drains and small watercourses is not compromised.

Assessed Current Level of Service:

Desired level of service is being met.

3.3.8 Sounds Watercourses Flood Management

Level of service:

For the urban and residential areas of Picton and Waikawa to obtain a river capacity and standard of protection for flood sizes of up to 1 in 50 year return period for the, Waikawa and Waitohi its Kent Street tributary.

Performance Measure:

To monitor the various floodway performance of floods that occur, and carry out hydraulic computer of the design flood analysis using river bed resurveys and calibrated with the monitored flood levels.

Assessed Current Level of Service:

For the Waikawa River the desired level of service is virtually being met and arrangements are in hand to reach the required level.

The Waitohi River and its Kent Street tributary do not reach the desired level of service. An option to be seriously considered is a lower level of service because of the very high costs of upgrading of these river channels to a 1 in 50 year return period standard. Surrounding riparian land will then need to be depicted as having a flood hazard and require minimum floor levels for new buildings. Further investigation of upgrading costs, and also of possible revenue sources is required; followed by discussion with the affected community.

4. General Life Cycle Management Plan Issues

4.1 River Control Asset Management

4.1.1 River Control Works - Elements of Typical River

A typical river has the river control components of stopbanks, river fairway, vegetated river berms, bank edge protection (trees), bank edge protection (rock, structural).

These common river control elements are demonstrated by use of an example of a small gravel bed river (attached). This is an example to demonstrate where such elements are typically located to make up a whole package of a riverbed system. Other rivers often have a greater or lesser degree of the various elements. Bigger rivers usually have a lot more rock work. Deeper, slower and narrower silt bed rivers usually have wider berms for the purpose of more waterway capacity to carry flood flows, and consequently much of which is kept clear of trees.

All elements need to be maintained, especially after flood damage.

Stopbank (1)

Usually constructed from compacted silt or silty gravel and surfaced with a robust grass to inhibit erosion. Typically 2 metres high, 4 metres top width, and a 12 metre base width. Stopbanks are rarely greater than 4 metres high.

River Fairway (2)

A width of river fairway in a gravel bed river is kept clear of trees and other vegetation by bulldozing, herbicide spraying, etc. The flood capacity of the river is provided by the product of the width of the fairway and the height difference between the river bed level and the stopbank level. If and where river bed aggradation occurs, gravel extraction is often carried out to maintain or enlarge waterway capacity.

Stopbank erosion protection (trees)

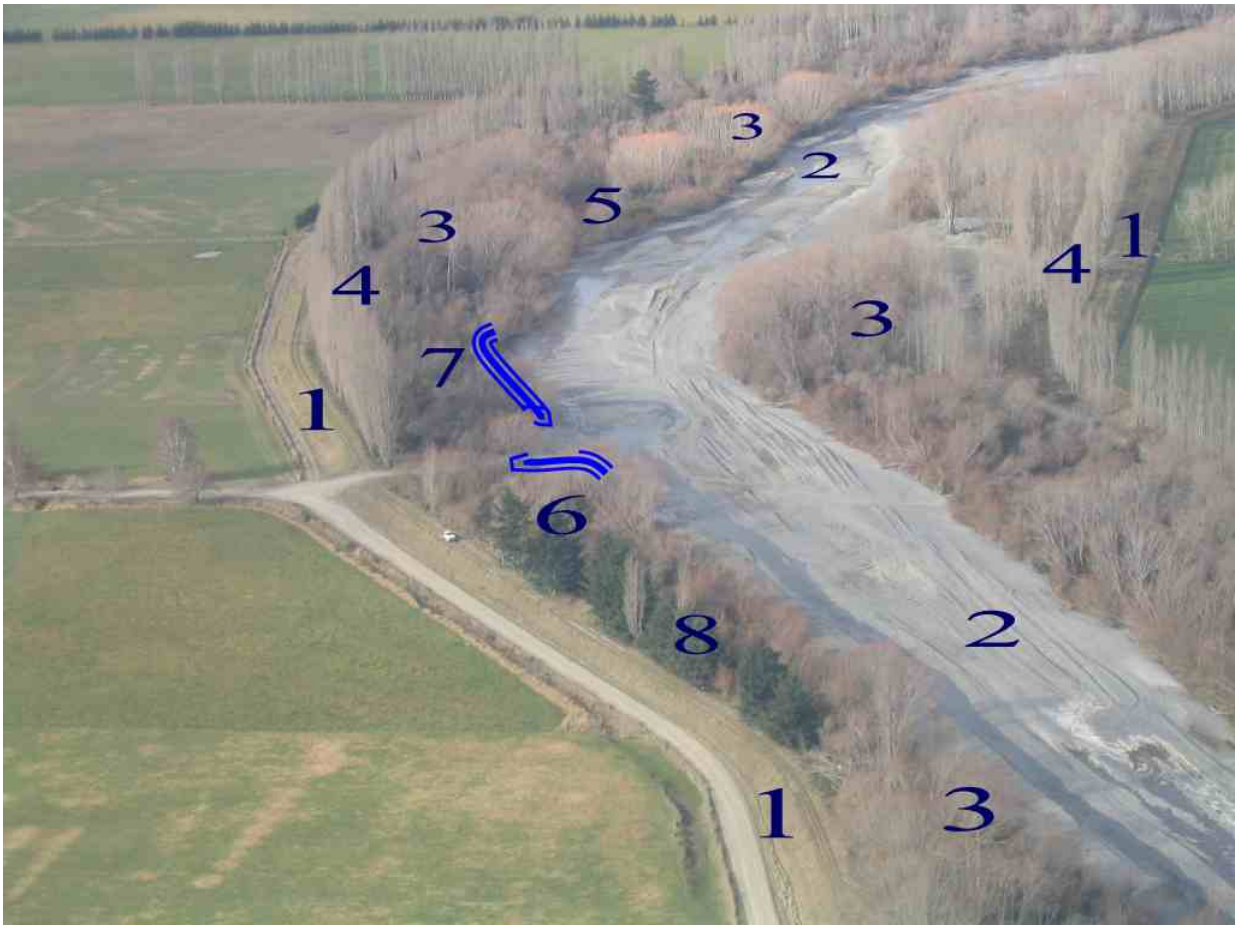
A buffer of such trees is planted on the berm separating the stopbank from the river fairway. This buffer of trees keeps high velocity floodwaters away from the stopbank and thus inhibits the stopbank itself from being eroded. Willow trees (3) now mature - which have been planted for their erosion resistant properties, and poplar trees (4) now mature - which have been planted because their “cable” root type is complementary to the “fibrous” willow tree root in resisting soil erosion.

In areas of more severe bank attack tied willow trees (5) on the outside of the bends lopped willow limbs have been tied by heavy wire to driven iron stakes (often railway irons) to provide even stronger erosion resistance, especially while the trees are still young and developing root systems. Although the root systems of Production/Protection trees are less good, pine trees (8) offer some erosion protection while also being of commercial value.

Where increased waterway capacity needs to be provided a large amount of the river berms is not planted in trees but is kept in grass, which enables the water to move faster.

Bank edge protection (rock, structural)

In an area of particularly severe river bank attack on the outside of a bend an earthen groyne or spur bank with a head of heavy erosion resistant rock rip rap (6) offers even greater protection against stop bank attack. Several of these may be placed at regular intervals. In some locations large concrete blocks (sputniks), or gabions of stones in wire mesh baskets is used instead of rock. An alternative to a rock spur bank/groyne is placing a fairly continuous length of rock rip rap (7) along the face of the river bank under heavy river attack. This can extend for tens or hundreds of metres depending on need due to severity of attack, and will reach from the top of the bank to the full depth of the river.



4.1.2 Design Issues - Rivers

Sedimentation:

Sedimentation is a natural process that fills up river channels and reduces flood capacity. The degree of sedimentation is not linear with time. It is related to catchment condition, tectonic activity and patterns of major storms. Sedimentation particularly occurs where flood flows have been reduced by damming and or diversions. Monitoring of sediment build up in river channels and assessing the impact on the level of service provided is a fundamental task of asset management.

Where the sediment is gravel there can be opportunity for commercial gravel extraction to remove surplus sediment at little cost to Council. If sediment cannot be readily removed by gravel extractors Council has to make provision in the form of new works. Minor sedimentation is covered as a maintenance activity.

New soil conservation works may be desirable where hillside erosion is causing sedimentation of channels that cannot be readily maintained.

Design Flood size (including climate change)

Design flood sizes are determined by examining historical flood records and presuming mathematical probability formulae for the occurrence of these events. Long records for the river in question are the best form of information. Where this is not available records from nearby rivers are used – though of course with less accuracy. If flow records are not available then rainfall information is used – also with lesser accuracy.

The climate may be changing resulting which could result in increased flood flows. Flood flow monitoring for the major river systems over the last 10 years appears to show a change

in flood frequency in the major river systems of the Wairau and Taylor – that the flood flows are going down! But very little should be read into this as the length of record is very short.

Or, alternatively, in some areas new analysis of flood flows is showing an increase in flood size because a longer record of analysis is now available. This particularly applies to the Sounds rivers flowing through Picton and Waikawa.

There is a need to upgrade some river systems because of increased design flood flows whether it be climate change or better records, especially for rivers that are sensitive to design flood flow size and/or for which the consequences of flooding are particular damaging.

Flood capacity (hydraulics)

The flood capacity of a river is determined by the width of the river, the height of the (stop)banks and the flow velocity. The velocity itself will be reduced by vegetation growing in the channel or floodway, or any changes in slope of the river system.

The hydraulics of many rivers is particularly complex. Wide river berms are one cause of complexity and it has been noted that flood levels on the extensive berms of the Wairau and Lower Opawa rivers are often different from that in the main channel.

Other sources of complexity are where a degree of storage is provided by the channel (eg; Riverlands Co-op floodway).

Sophisticated computer modelling is required to analyse the hydraulics of such river systems with calibration against monitored floods.

Stopbank Erosion protection

High velocity river water will erode stopbanks. Riverbanks and stopbanks are susceptible to erosion from river flow attack. Rock rip rap, retards and trees are work components used to control this.

It is prohibitively expensive on rivers such as the Wairau to construct bank protection works everywhere that erosion could occur. Instead bank protection work has been constructed in locations where the river is, or has historically, attacked the riverbank. As the river meander pattern may change from flood to flood – especially in the steep braided rivers – the areas of severe bank attack can change thus requiring new bank protection work.

Stopbank structural integrity

Stopbanks are “dams’ that hold back water, and the issues involved in the structural performance for dams also apply to stopbanks. Design issues relate to the type of material used in the stopbank, its compaction during construction and foundation conditions – especially whether the foundation material is susceptible to piping under hydraulic head.

Flow control mechanisms

Design flood levels can be affected by backing up of a river outlet to the sea, or to another larger river, or at constrictions such as bridges. Constricting bridges are owned by another party – a factor that leads to further complication.

4.2 Drain and Stormwater Channel Asset Management

4.2.1 Drain and stormwater channel elements

A typical drain has the components of excavated channel, bank strengthening, pipe culverts, and often a pumping station at the drain outfall to pump through a stopbank to a bigger river. The attached photograph demonstrates these elements.

All elements need to be maintained.

Excavated channel

Shown in centre foreground - needs to be kept clear of aquatic and terrestrial weed and deposited sediment.

Bank revetment

The banks of the drain are strengthened in this case by gabions. Alternative strengthening is concrete or timber walls, or simply rock rip rap.

Pumping station

Water flows through screens across the channel into a pumping station that pumps under the stopbank into the main river when the river is in flood. The pumps are axial flow pumps with automatic start and stop electrodes and powered by electric motors.

Pipe culverts and floodgates

Pipe culverts under roads and stopbanks are common. In this example the entry to pipe culverts is beside the screens at the end of the channel. When the main river is not in flood the drain outfalls by gravity. A simple floodgate (flapgate) is mounted on the other end of the culvert to prevent back flow from the river when it is in flood.

4.2.2 Design issues drainage and stormwater channels

General

The design issues for drainage and stormwater channels are similar but different from those of large rivers. Generally the channels are of artificial construction often on a very flat slope and quite low flow velocity.

Sedimentation

Sedimentation by silt and fine sediments is a typical problem in drainage channels and requires regular excavation and removal.

Capacity and depth

Agricultural drains need to be typically at least a metre deep so as to keep water levels below the ground surface of the land being drained. Unlined drains of sufficient depth with battered earth banks usually also have sufficient capacity to carry the required flows. Flooding of land from drainage channels is acceptable – provided that it is for less than three days. However flooding of houses from urban stormwater channels is not acceptable, and a different level of service is required.

Blockage by weed

The blocking of drainage and stormwater channels by thick aquatic and terrestrial weeds is a major issue. The hydraulic performance of such channels can be reduced by a factor of 10 by such weeds. Regular annual removal by agrichemical or excavation is essential. The spread and extent of weed is increasing and new weeds regularly arrive in Marlborough. Conversely there is an increasing expectation from the public of more weed removal and there is generally increasing environmental (resource consent) constraints on the manner in which aquatic weed removal is carried out.

Bank strengthening

Erosion of banks is seldom a problem for drainage channels. However bank strengthening is often required to enable vertical or near vertical banks to be constructed. This is because drainage and stormwater channels have often been constructed where there is a lack of room – especially in urban areas or in roadways.

Flow control restrictions

Outletting into the sea or larger rivers is a major issue for drains. At high tide – or flood conditions – these outlet levels are higher than desired drain water levels. Simple floodgates (flapgates) are used to prevent back flow.

Pumping stations

Pumping stations are required on drainage channels where high downstream levels are encountered for long periods of time. Without the provision of pumping facilities such areas would be virtually unproductive and subject to extensive flooding for periods of the year. Pumping stations can be even more critical for urban stormwater channels feeding into larger rivers that are coincidently in flood.

4.3 General Monitoring and Maintenance Activities

	Item/Activity	Description	Frequency
A	**River Floodways** General overview	Oversight and general inspection of floodway.	1 year
	Bank erosion	Assess where undesirable bank erosion may be occurring, and the need for strengthening.	1 year or after significant flood events
	Rock rip rap condition.	Rock rip rap being undermined, scrub and trees growing in rock and needing removal.	1 year
	Bank protection tree condition.	Health of willow and poplar trees, need for lopping and layering trees, fences kept stock-proof.	1 year
	Channel fairway clearance	Active channel is kept clear of growing or stranded trees.	1 year
	Stopbank condition	Stopbank surface is maintained in good sward of grass and scrub, trees removed. Rabbit holes or stock damage or vehicle damage repaired.	1 year
	Berm condition	Berms are kept clear of scrub and trees where water way capacity is needed; berms are kept vegetated by trees where there is a need to prevent surface erosion.	1 year
B	**Gravel /sediment extraction** Undesirable gravel bar build up.	Oversight and general inspection of reach.	1 year.
	Gravel extraction by permit	Ensuring gravel is extracted in right place and in right amounts.	Before and during extraction.
	Riverbed survey	Assessing degree of build up or lowering of riverbeds.	3 to 15 years depending on

	Item/Activity	Description	Frequency
			river.
C	**Flood Inspections** Integrity during floods Aerial photography during flood Post flood damage inspection	Assess if stopbank is likely to fail and the need to advise police of public evacuation procedures. Obtaining record of flow patterns and flood spread. Assess damage to river control assets.	During floods. During large floods As flood waters recede after large floods.
D	**Hydraulic review** Reassess hydraulic performance of floodway	Reassess the capability of river channels to carry the design flow, especially where riverbed is changing or the design flood changes.	10 to 15 years, or after major flood depending on river.
E	**Hydrologic review** Reassessment of design flood size	As more hydrologic information comes to hand, especially after very large flood.	15 to 20 years or after very large flood depending on river.
F	**Specialist structures**	Inspection and report.	1 to 10 years
G	**Drainage Channels** Channel weed removal Channel siltation Bank stabilisation and other channel maintenance	Spring and autumn weed spray Machine excavation. Oversight and general inspection of drain. Provision for new and maintenance of existing rip rap as required for drain edge or road stabilisation.	6 months 8 years 1 year
H	**Drainage Channel Riparian management** Ensuring adequate maintenance access is preserved	Requiring land owners to remove problem trees; removing self-seed scrub etc.	1 year

	Item/Activity	Description	Frequency
I	**Gravity Outfalls (150 mm-300 mm)** Minor floodgates Annual inspection Miscellaneous maintenance	 Regular operational check (high risk gates) Oversight and inspection. Miscellaneous minor repairs to stopbanks/culverts/fences/gabion baskets.	 Prior to floods 1 year 2 years
J	**Major Floodgates (450 mm - 1200 mm)** Normal inspection Annual inspection Desilting Miscellaneous maintenance Ancillary replacement	 Regular operational check (high risk gates) Condition/settlement check and repair. Sediment removal around floodgates. Floodgate chains/bolts etc. Flapgates/winches/retaining walls/timber.	 Prior to floods 1 year 3 years 3 years 20 years
K	**Pump Stations** Normal inspection Operational during floods Electrical inspection Mechanical maintenance Pump recondition Major maintenance	 Regular operational check, motors, floodgates, check screens. Operational and screen clearing Full pump station electrical check. Repair/replace seals, bearings, minor electrical, repaint buildings, steelwork. Replace bell mouth, shaft, deflector casing, build up and balance impellors. Refurbish weed screens. Replace weed screens, switchboards, control equipment.	 Weekly During floods 3 months 5 years 10 years 20 years
L	**Control Gates and Equipment** Structural Mechanical service	 Inspection and report. Bolt replacement, sand blasting, repainting, deck replacement/refurbish, thrust bearing overhaul	 1 year 5 years

4.4 Need for New Assets

4.4.1 River Flood Control (Main Rivers)

New river assets may be required for several reasons:

- New areas desire flood control protection; often because there is a gap between the public's desired level of service and current standards.
- Land development increases the flood runoff from the land.
- Awareness of increases sizes of floods due to climate change better or simply better hydrological flood record.
- Monitoring of flood events shows that the hydraulic performance of floodways is less than presumed in design.

- The height, size or strength of stopbanks and other river control structures are clearly inadequate or do not have an adequate margin of safety.

- Channel waterway capacity needs to be increased because sedimentation is reducing capacity.

- Changes to river meander pattern so that high velocity erosive flows are impacting on unprotected river bank and new bank protection works are required.

- Historic river control works have a detrimental impact on the river ecosystem; and new works to improve the ecology are desirable to mitigate the effects of those previous river control works.

4.4.2 New Areas

The main Wairau floodplain (below Waihopai confluence) interfaces with smaller tributary floodplains (Omaka, Fairhall, Taylor, Are Are, etc). Currently the upper stems of most of these tributary floodplains are provided with the lesser standard of "Wairau tributary" flood protection. Increased viticulture development up these tributary floodplains could result in an increased level of service request to the 1 in 100 year standard of the Wairau floodplain by channel enlargement etc.

New protection works may also be required in areas of the sounds undergoing residential development. Here it is likely that capital works would be a requirement of the developer and Council's role would be to fund and manage ongoing maintenance. Okiwi and Ngakuta Bays are examples of this.

Urban, industrial and commercial development is creating more impermeable surfaces and thus causing increased runoff into the small rivers, streams and drains serving built up areas.. This is occurring in all urban areas especially Blenheim, Picton, and Renwick. The Riverlands Industrial area is also expanding rapidly, including the rezoning of rural land to industrial zoning.

Increased flood run-off is anticipated to have occurred in much of urban Blenheim affecting urban pumping stations and both urban and rural stream channels. Current work in the Redwood Street catchment confirms that significant outfall upgrades are required to meet the desired flood standard.

Grape development also appears to be causing increased runoff on the gently sloping, moderately impermeable land of the southern valleys to the south of New Renwick road and state highway 63 to the west of Renwick.

4.4.3 Drainage

- Increased subdivision has resulted in some new properties not having access to a Council public drain within a rated Council drainage area, and new drains are required.

- Historic drainage works have a detrimental impact on the ecosystem; and new works to improve the ecology are desirable to mitigate the effects of those works.

- Drainage channels could be modified to provide a much better ecological or aesthetic habitat.

- There may be new areas desiring drainage that Council is currently unaware of.

4.4.4 Stormwater channels

- Expansion of Blenheim – to the north and west will require waterway and outfall culverts to be enlarged. Eventually at least one existing pump station, Caseys

Creek, will require a capacity upgrade or replacement to meet outfall requirements during the infrequent large flood events in the Upper Opawa River.

- Infill housing and increased runoff from existing urban areas will require enlarged channels and pumping stations. The key area being addressed at present is the Redwood Street/Town Branch catchment.

4.4.5 Gap Analysis

The gap between ratepayers desired level of service and what is provided interfaces with the above discussed natural process changes.

The ratepayers desire for an increased level of service is usually only expressed following a major flood event.

Since 2010 significant flood events have occurred in most of the region's rivers and streams including the Rai/Pelorus/Wakamarina catchments, outer Sounds Catchments, in the wider Picton/Waikawa/Koromiko area, Wither Hills and Southern valleys and the main Wairau River and lower Wairau floodplain. Generally existing flood systems coped well but all the flood events required post flood examination and reporting to Council.

No major changes to existing service levels have followed from these flood debriefs. They have however pointed out where some additional work was required including pump overhauls, new river edge protection works, minor capacity upgrades to several smaller watercourses (15 Valley Stream, Sutherlands floodway, Mapps waterway) and some catch-up channel clearing in the Tuamarina River and its Koromiko tributary.

The December 2010 Canvastown flood affected about 6 residential/lifestyle properties, one commercial property and a number of community buildings . The flood was estimated to be greater than 1 in 100 year return period. A thorough review of the flood, its impacts and examination of affordable flood improvement upgrades was undertaken and presented to the Canvastown community. The end result was some financial and practical assistance to assist three properties with flood proofing works, some new river edge protection works in collaboration with Marlborough Roads and some culvert capacity upgrades and SH 6 bridge capacity improvements on Racecourse Creek. None of this required setting up a new rating district to achieve.

Land use change (mainly to viticulture) and subdivision have led to proposals to modestly increase the drainage service on the Lower Wairau Plains by a 5.4% extension of the network. No significant change in pumping or outfall capacity standards is proposed but a more rigorous asset maintenance/renewal programme is proposed to make sure existing pumping equipment works reliably and to design capacity.

There is a continuing demand for Council to maintain high ecological standards for its river and drainage particularly with regard to the Spring Creek and tributaries trout fishery and eel habitat in general. There is also a demand to maintain and enhance remaining riparian ecological habitats including whitebait spawning areas and bird nesting habitat.

These environmental expectations of the community need to be built into all the work undertaken by the Rivers section whether it be maintenance, capital improvement works or a policy setting. Provision is made in the capital budget for ongoing purchase of floodway land where the existing private is not consistent with floodway management requirements or to facilitate capital upgrades especially drainage, stormwater and stopbank improvement works in the vicinity of Blenheim.

As viticulture land becomes more scarce there is likely to be further proposals to plant private land within key Wairau Floodplain floodways (Opawa, Wairau, Taylor River floodways especially). In some circumstances the best way to resolve this conflict is for Council to purchase this land and then have full control on how it is used

5. Issues for Specific Waterway Life Cycle Management Likely to Require New Works to Meet New Desired Levels of Service or maintain the existing LoS

5.1 Wairau Floodplain Floodways and Main Rivers

This includes

1. Wairau Diversion
2. Lower Wairau
3. Wairau from Tuamarina to Waihopai Confluence
4. Waihopai
5. Lower Opawa
6. Taylor
7. Taylor Dam
8. Upper Opawa/Roses Overflow
9. Opawa Loop
10. Omaka
11. Riverlands Co-op Floodway
12. Gibsons Creek
13. Doctors Creek.

5.1.1 Wairau Diversion

Channel characteristics (typical)

Type	:	Gently curving artificial channel through beach gravels
Length	:	4.2 km
Slope	:	0.07% (1 in 1500)
Channel Width	:	150 m
Floodway Width	:	300 m
Design Flood	:	3000 m³/sec Design Freeboard 0.6 m.

5.1.1.1 Issue: Channel Development – Wairau Diversion

The Wairau Diversion was constructed so as to take a large portion of the flood flow from the frequently flooding Lower Wairau. It was initially constructed as a 10 metre wide pilot channel within a 300 metre wide floodway from Bothams Bend to the sea, with only enough material excavated from the pilot channel so as to construct the stopbanks. Natural erosion of this pilot cut to a deeper and wider channel was intended to occur during floods with time. In fact deliberate excavation of hard points has been found to be necessary.

The Diversion has been regularly monitored at about three yearly intervals since its original construction in 1963. Monitoring of the Wairau Diversion has found that:

- The Wairau Diversion channel has enlarged by erosion by some 1.6 million cubic metres since its initial pilot cut excavation in 1963.
- This erosion has been by a mixture of natural erosion during floods, assisted by deliberate Council excavation of hard points during the 1990s.

- There has been little erosion enlargement since 1998, and a number of gravel silt islands have formed in the channel below the normal area of commercial gravel extraction.

- In a 700 m section on the true right bank the diversion has now eroded to or beyond the original design line and it is proposed to top up and strengthen the scour limiting rock placed at the time of the diversion construction.

The quantity of material that the Wairau Diversion has eroded is similar to the quantity that the Lower Wairau channel has aggraded. However the Diversion is less than half the length of the Lower Wairau. Therefore the rate that the waterway capacity of the Diversion increased from 1964 to 1998 was approx twice the rate that the Lower Wairau channel reduced in capacity**.**

The Diversion will not enlarge significantly more – and nor is it desirable for it to enlarge much more due to adverse environmental consequences on the Lower Wairau River

The current capacity at the top end of the Diversion is estimated by detailed hydraulic modelling at 3000 m³/sec. This needs increasing to 3200 m³/sec to achieve scheme objectives. Further downstream, especially below Rarangi Bridge, the waterway capacity is already in excess of 3200 m³/sec.

Summary

The Diversion channel needs to be continually monitored with the aim of achieving the desired 3200 m^3 capacity likely requiring controlled gravel extraction and regular stripping of built up islands.

Rock armouring work is required where the channel has naturally scoured to the design channel width to stop development of undesirable meanders in the channel.

Main References

"Lower Wairau and Diversion Capacity" Report to Council" E B Williman October 1999.

"Lower Wairau and Wairau Diversion Hydraulic Analysis" K J Christensen Council Internal Report Sept 2006.

"Hydraulic Review of the Lower Wairau Floodway" L Kuta, Council internal report, June 2011.

5.1.1.2 Issue: Closure of Diversion Bar

The Wairau Diversion bar has only on a minor scale the problems that the Lower Wairau mouth bar has. The mouth does block completely at times and flows of up to approximately 10 m³/sec can seep throughout the 2.3 metre high barrier. Flows greater than this will overtop this barrier and scour out a new mouth. This backing up effect of a mouth bar blockage is limited to 2 km due to the steepness of the channel upstream, and is of fairly short duration. There is no significant impact on flooding, or drainage. Extension of the existing guidebanks is not expected to be required.

5.1.1.3 Issue: Maintaining the erodible bank control structure at Diversion/Lower Wairau flow split

In July 2009 the erodible flow split bank was constructed so that 70% of the flow went down the lower Wairau channel in floods of up to 1400 m^3/sec. These regular and more frequent flood events are a major transporter of the finer sand/silt sized sediments that were accumulating in the lower Wairau.

The construction of the erodible bank has given a good level of control of smaller flood events. In large flood events greater than 1400 m^3/sec the gravel bank over tops, breaches and the full capacity of both channels is available to convey the flood flow. The bank has

breached 8 times since construction and takes typically 1 – 3 days with a bulldozer to rebuild once river levels drop back to normal.

The erodible bank is working is providing the flow control as designed and the most recent lower Wairau bed survey (Feb 2013) indicates a minor scouring of fine sediments, the first period of degradation since the Diversion was constructed in the mid-1960s.

The construction of the erodible bank has had a number of minor side effects including erosion of the natural ground spit at Bothams Bend where the bulldozer bank joins up to, and some minor erosion of the true left bank below the rail bridge immediately adjacent to the erodible banks rock head.

In late 2013 a new rock head was constructed against the natural Bothams Bend peninsular by placement of fill to shape and 3000 tonnes of large rock. The erodible bank is now pushed up against this rock wall. Plans are underway to repair the currently minor erosion of the true left bank immediately downstream of the rail bridge.

There is no man made control structure to proportion the flow down the Diversion and the Lower Wairau channels. The natural bed levels are the control mechanism. The deposition and erosion pattern in this flow division area is the predominant factor in determining the flow split.

The size, shape and waterway capacity of the Lower Wairau River channel is a delicate balance between its sediment transport capacity, the flood flow regime, the river mouth opening and any changes in supply of sediment to the river system. The construction of the Wairau Diversion changed this balance and has led to aggradation of the Lower Wairau channel.

This aggradation is deleteriously affecting flood capacity, drainage, water quality ecological values, recreation, and aesthetics of the Lower Wairau.

Monitoring on patterns of Lower Wairau aggradation indicate that the larger floods scour the Lower Wairau while a quieter flood period results in aggradation. This indicates that suitable flow control at the mouth of the Wairau Diversion could reverse the aggradation presently occurring in the Lower Wairau channel – with associated flood protection, ecological, recreational and drainage benefits.

The construction of “full flow” control gates at the head of the Diversion is one possible option. Control gates have been used at other locations in the country, notably in the Manawatu. The Lower Manawatu/Moutua Floodway provides an example of flow control being successfully used to minimise sedimentation in a system very similar to the Lower Wairau/Wairau Diversion.

This indicates that a gated flow control structure at the mouth of the Diversion would work, it will be very expensive. No estimate has been made, but is likely exceed $20 million dollars.

An erodible gravel bank as a flow control structure will be much cheaper. Such erodible banking will act partial flow control and will be positioned to divert a higher percentage of Wairau river flow down the Lower Wairau channel during lower to medium flood events than occurs at present. The design provides for the bank to fail during larger floods. These larger floods will then flow through the main Lower Wairau channel and the Wairau Diversion through to the sea as they do at present. The erodible bank will be around 500 metres long and 1.9 metres high and it will have “a lower section” 100 metres long at a specific location which will ensure a reliable failure and make it easier to repair. It is proposed to rebuild the erodible bank after each flood. The design is based on the successful operation of a similarly designed bank on the Wilberforce River near Lake Coleridge in Canterbury.

The main reason for the need for the proposed erodible banking (and other river control works on the Lower Wairau) is because that channel is aggrading through the deposition of sand and silt.

The overall aims of this partial flow control are to:

(a) To halt the current aggradation of the Lower Wairau River that has occurred through the deposition of sand and silt; and to reverse the trend by encouraging scour of this deposited sediment.

(b) This will increase the flood capacity of the lower Wairau system.

(c) The water quality of the lower Wairau River will improve, including reducing salinity. This in turn will improve the ecological and recreational values of the lower Wairau River.

(d) The river is becoming shallower through siltation which directly impairs recreational values of rowing, swimming and kayaking. This will be corrected.

(e) To increase average flows in the Lower Wairau River that is better for ecological habitat.

(f) Improve the self-scouring process of the Wairau Bar so as to improve the tidal flux through the bar. This in turn will improve the ecological values of the Vernon Lagoons and also improve gravity drainage of the lower plains watercourses.

Main Reference:

"The use of a flow control structure to erode deposited sediment from the Lower Wairau River" K J Christensen 2006.

"A first look at effects from the Erodible Bank on the Lower Wairau River's Mean Bed level" L Kuta internal memo, May 2013

Summary of new works required

Some additional rock edge control works as required

5.1.2 Lower Wairau Floodway

Channel characteristics (typical)

Type	:	Deep narrow silt bed river
Length	:	9 km
Channel Width	:	120 m
Floodway Width	:	350 m
Slope	:	Tidal, flood slope 0.05% (1 in 2000)
Design Flood	:	2300 m³/sec Design Freeboard 0.5 m.

Issue: Sedimentation

Adequate flood capacity of the Lower Wairau has been a long-standing issue for Marlborough. Stopbanks were first built around the 1890 period, generally close to the river bank. In those days there were three river boards flanking the Lower Wairau River, two on the northern bank and one on the southern bank. The different boards were differently funded and built the stopbanks in their respective areas to different standards.

However not enough flood capacity was provided, especially as stopbanking further up the Wairau was preventing spill out upstream and thus concentrating all flow into the Lower Wairau River. The blocking off of the Opawa distributary channel in 1914 was a particular action that increased flood flows in the Lower Wairau. Government review led to a single river board being formed in 1921 – called the Wairau River Board – with the responsibility of dealing with flood control works in a holistic manner.

In the late 1920s the Wairau River Board moved back the stopbanks in several locations on the Lower Wairau so as to enlarge the floodway to deal with the flood problems, as well as raising the stopbanks. This was carried out at six locations; the Peninsular Road (south bank), Morrins Hollow (north bank), Parker (north bank near Dicks Road), Wairau Pa, Beatsons overflow (south bank) and Maori bend (north bank). Most of this floodway land was purchased by the Wairau River Board, or alternatively compensation was often paid for land now being part of the floodway.

Flood breakout continued to occur during the 1930s, 1940s, 1950s and 1960s, with stopbank repair and minor upgrading at regular intervals in an ad hoc manner; though still not achieving adequate flood protection for the Lower Wairau plains. Flood breakout was occurring about every six years.

Consequently in 1964 the Wairau Diversion was constructed by the Marlborough Catchment Board so as to share the flood burden with the Lower Wairau. It was expected that the Diversion would remove the future need of any further upgrading to the Lower Wairau floodway, and indeed that minimal maintenance would be required from then on.

The Diversion was required to enlarge by scouring – it was not up to size by the time of the 1983 floods- and unfortunately the Lower Wairau, at the same time has silted up – albeit at a lesser rate.

By 1999 the combined capacity of the Diversion and Lower Wairau had enlarged sufficiently to reach the required floodway capacity of a 1 in 100 year return period flood – about the size of the July 1983 flood; and that siltation had slowed, but from 1999 siltation increased again. since then.

River channel cross sectional survey has been carried out regularly at about 6 yearly intervals since 1989 and less regularly before then. This monitoring of the Lower Wairau river channel has found that:

- Since the mid-1960s there has been aggradation of some 1.9 million cubic metres of sediment.
- This represents an average build-up of 1.5 metres depth, and narrowing of the channel by some 15 metres.
- The 1994 to 1999 period had very little aggradation. This was a period of significant flood activity in the river. On 11 occasions in this period the flow exceeded 1500 m^3/sec – twice the normal average, and one of 3800 m^3/sec.
- Conversely the 1999 to 2005 period was a period of the greatest rate of aggradation on record. This was a period of very little flood activity, with only three floods exceeding 1500 m^3/sec – half the long term average, and the largest of only 2000 m^3/sec.

This silt deposition is due to the reduction in flows with the construction of the Diversion in 1963 and its increasing development particularly since 1972. The reduction in the sediment transporting capability of the freshes and floods is proportionally greater than the reduction in flow.

The effects of the Lower Wairau siltation are:

- Reducing floodway capacity.
- Detrimental ecological effects on fauna and flora, including in the Vernon Lagoons.
- Poorer water quality, increased salinity.
- Impaired drainage.

- Impacts on rowing and general boating activities, and other recreational activities.

A package of new works was approved to address these issues. The works completed included:

- Extension of the rock guide wall at the sea outlet of the Lower Wairau so as to improve the outlet efficiency.
- Strategic sediment removal especially in the Spring Creek outlet area.
- Removal of spurbanks blocking Beatsons overflow.
- Raising/strengthening of low sections of stopbank on both sides of the river. The south bank works are completed with the north bank works still to be completed,
- Removal of thick impeding crack willow trees within the floodway which slow floodwaters, and targeting those trees that have no bank erosion protection benefit and/or no ecological or aesthetic value. Some back planting of less impeding native trees was to be carried out – such as cabbage trees (Ti Touka).
- Construction of the flow split bank at the Bothams Bend Diversion/Lower Wairau flow split confluence.

All the above improvement works have been completed except for the main sections of stopbank raising on the north bank due to property ownership/access issues and there is one further section of willow clearing that would be ideal to complete.

Initial monitoring suggests that the package of works has stopped the ongoing sedimentation and in fact that there was a small decline in overall bed levels. The floodway capacity improvements won't really get tested until we have a flood event exceeding about 3000 m3/sec.

Main references:

"Lower Wairau Sedimentation Proposed Remedial Works" Report to Council E B Williman Nov 2006.

"Hydraulic Review of the Lower Wairau Floodway"; L Kuta, internal report, June 2011.

"A first look at effects of the Erodible Bank on the Lower Wairau River's Mean Bed Level, L Kuta, Internal memorandum, May 2013.

Issue Inadequate floodgated culverts

Several of the drainage and pump culvert pipes under the stopbanks are short, and these are potential failure paths. There are several such culverts not of adequate length. Lengthening these culverts is desirable.

Simple floodgates (or flap valves) are constructed on the outlet of these culverts to prevent water flowing back from the river. These floodgates, while essential for preventing the backflow of floodwater, are claimed to adversely affect movement of whitebait and other fish into the drainage network. Replacement of floodgates for culverts in strategic locations with side hung floodgates easier for fish passage will be part of a staged programme.

Main reference

"Wairau Drainage Plan 1996" Council Management Plan, R M Fitzgerald.

Issue: Wairau River Mouth Bar

(i) The Wairau river mouth bar is a natural feature that has a dominating effect in normal river flows on Wairau estuary levels, the Wairau lagoons, the lower Wairau to upstream

of Ferry bridge, and the lower Opawa. Even in flood flows a poor configuration of the bar has resulted in raising flood levels many kilometres upstream both in the Wairau and its tributaries the Lower Opawa and the Riverlands Co-op floodway.

The bar is formed by a combination of marine forces, tidal flows into the Vernon Lagoons and river flows from the lower Wairau and to a lesser extent the lower Opawa.

The marine storm wave forces are very important. In times past they formed a bar typically extending a kilometre to the north. When such a bar formed there would be significant water friction loss down this extra distance of coarse gravel bed channel. In these situations the water level in the whole lower Wairau upstream is kept at virtual high tide levels with little or no tidal variation.

This has a significant environmental effect on the Lower Wairau, lower Opawa and Vernon Lagoons. With this partially closed bar the water there may stay almost completely devoid of saline water, or conversely stay with an extensive saline wedge.

Gravity drainage of the extensive areas of flat lower plains into the lower Wairau is prevented and expensive drainage pumping required.

With a direct open mouth there is twice daily flushing of saline water, tidal water level variation in the lower Opawa and lower Wairau and good gravity drainage.

Boat access across the bar is also much better with a direct mouth outlet and was a concern of Harbour authorities when the Wairau and lower Opawa were important for shipping.

The Wairau bar is typically built by waves to a height of 2.3 m above sea level. It can be overtopped by floods that occur from time to time and when this occurs a direct mouth is then scoured out. This scouring takes some time to achieve, and in a fast rising flood the flood water levels upstream may be much higher for some period. This can lead to overtopping of stopbanks.

Once a direct new mouth is formed the cycle begins to repeat itself with sea forces gradually extending the bar further north.

These combined tidal flushing flows and river flows can be concentrated by a guide bank to inhibit the development of the bar. At least three such guide banks or jetties have been built by river or harbour authorities over the last 85 years starting with the Harbour Authority of the day in 1897. A rock bank some 500 metres long, was built as part of the Wairau Valley Scheme in 1961. In 2009 this banking was extended by another 120 m to form the guide bank we have today.

This 1961 rock guide bank, at a cost of $1 million in today's terms was very effective at keeping a direct open river mouth. Since its construction only twice, in 1974 and 1992, had the mouth partially blocked. In both occasions reopening of a direct mouth was helped by mechanical excavation which enabled a new mouth to open and scour out in a relative small fresh in the river. However by the early 2000s the partial mouth blocking was getting progressively worse and a decision was made to extend the control groyne

Summary of new works required

- Regular inspection and maintenance of the rock guide wall particularly after storms leading to heavy seas at the river mouth.

- No further capital works proposed at present.

"Lower Wairau Sedimentation Proposed Remedial Works" Report to Council E B Williman Nov 2006.

5.1.3 Wairau (Tuamarina to Waihopai Confluence)

Channel characteristics (typical)		
Type	:	Semi braided gravel bed river
Length	:	22 km
Floodway Width	:	800 m (reduced from 1000m in 1958)
Fairway Width	:	400 m (reduced from 600m in 1958)
Slope	:	0.3% (1 in 300), but steepens from 1 in 700 at Tuamarina to 1 in 200 at Waihopai Confluence.
Design Flood	:	5500 m³/sec Design Freeboard 0.9 m.

Issue: Sedimentation

(i) The prospect of gravel build up in this reach of the Wairau River was a major concern for a long time. The Marlborough Catchment Board established a set of 30 river cross sections over the reach for survey which has been carried out regularly at approx six yearly intervals since 1958; and regular analysis of this survey.

Up till 1991 gravel deposition exceeded gravel extraction with an average deposition of 90,000 m³/year of gravel deposited in this reach.

Such deposition was reducing the flood capacity of the river.

Commercial Gravel extraction from this section of the river was encouraged.

Over the last ten or so years the rate of gravel extraction has greatly exceeded the rate of gravel deposition. The floodway capacity of the river is up to design capacity.

However should extraction continue at too high a rate flood protection works (stopbanks and groynes) in some areas will be undermined increasing the risk of failure in large floods and making reinstatement much more expensive.

This necessitated a comprehensive review of Wairau gravel extraction activities. In order to shift gravel extractors away from sites becoming over-extracted on to more appropriate sites and maintain an economic gravel supply in the mid 2000s Council approved a range of gravel extraction policy actions for the Wairau downstream of the Waihopai confluence.

- *That defined annual limits for specific sites are set. Permits will not be issued for more than one year.*
- *That differential increased gravel extraction charges be imposed on extraction from the Wairau riverbed reserve land mainly under Council control. Class A rates would be imposed on sites most convenient to extract from and with least river control benefit. For sites hardest to extract from and of greatest river control benefit Class E rates would apply. Classes B, C and D classes progressively intermediate between A and E.*
- *That all gravel extraction from the river is required to be accurately measured by surveyed stockpile or similarly verifiable method.*
- *That the charges and the setting of cost categories for the various sites be reviewed on an annual basis.*
- *That specified acceptable access routes will be included as part of the contractor's permit. The 6 km of Tuamarina Track from south of Tuamarina pocket township westward around the hills will also be excluded from use by contractors. Where feasible to construct, river berm tracks will be preferred to narrow under-strength local roads.*

- *That speed limits be gazetted for gravel extraction using Council river berm land.*

- *That new environmental constraints such as seasonal timing of extraction due to bird nesting concerns also be incorporated into permit conditions as and when relevant information comes to hand.*

- *That Council will also offer to extract and stockpile gravel for extractors where wanted. The charge for such stockpiled gravel will be further increased so as to incorporate Council's stockpiling costs.*

- *That Council will provide for minor extractors by provision of such stockpiles of gravel. This will usually be at two sites, one in SH 6 area and one in the SH 1 area.*

- *That the increased income from the gravel charges be put towards roading construction/maintenance costs to access the gravel extraction sites; to be set aside for quarried rock rip rap for expected increased river bank maintenance stabilisation work; and for increased monitoring/supervision costs.*

- *That the Rivers and Drainage Engineer consult with the various gravel extractors with regard to allocating specific sites on an equitable basis.*

- *That the contractors be advised that abuse of the permit conditions will result in Council withdrawing the gravel permit.*

These policies have now been in place for close to 10 years and considered to be working well. The most recent gravel extraction quantity review was completed in mid-2012 and an allocation of 130,000 m^3 set for the 2013/14 monitoring year with a 10% reduction in the year following.

Gravel demand is now exceeding supply and contractors are being either directed to hard rock quarries or to the Loddon Lane area of the Upper Wairau River for supplementary supply to their current allocations.

Main Reference

"Statement of Proposal Wairau River Gravel Extraction Policies" Council resolution Dec 2005.

"Changes in the Wairau River Bed", L Kuta, internal report, July 2012.

"Wairau Gravel Review", report to Assets & Services Committee, October 2012.

Issue: Stopbank Erosion Protection

Stopbank erosion protection is a very important issue because of its very high expense.

The Wairau Valley Scheme sought to impose a single thread channel training pattern on the river. The major advantage of this single thread channel was the expected stable meander pattern that was achieved. Rock bank protection work would then only be required on the outside of the defined bends. The initial design of heavy bank protection was only about one-third the total length of stopbanks

However a stable meander pattern on the intended alignment has not developed; and further review indicates that this initial 1960 design was an optimistic wish.

Some form of continuous bank protection works are required on both sides of the river for its full length.

Willow trees provide some bank protection but are not strong enough to hold direct attack of the Wairau River. They are very valuable as back up to training bank rock lines and can prevent washing out of the rock line by overtopping flows

Trees, when developed, are also capable of resisting river attack of lesser river braids. Piled retards with willow or other tree limbs lashed on are used to strengthen the tree plantings. These have been in the form of driven rail iron piles, or willow limbs constructed as a cruciform shape. These retards are particularly useful in strengthening tree planting during early years of tree growth.

If greater river attack is later experienced, stronger bank protection works are needed.

There are two main alternatives for providing stronger protection.

- A continuous rock lined guide or training bank, parallel with the river, and backed up with a band of willow trees.

- Rock headed groynes at right angles to the river, use considerably less rock and are therefore cheaper. Again, tree planting in between the groynes is useful back up and will inhibit turbulent eddying flows between the groynes.

Over the last 20 years new bank protection works in the form of willow tree planting and rock work has been carried out. Further new work of this nature will still be required.

Issue: Berm erosion

Extensive areas of grassed berms, especially where there are old channels, need some plantings of trees to reduce berm velocities and scour potential. Berms need a careful blend of tree planting and open pasture. Planting options include:

- Bands of shrubby willows;

- Protection/production commercial tree planting;

Any new or replacement plantings need to be examined for the situation on its merits. This is a continuous process as pine plantations are harvested and willow buffer zones are either strengthened where less than ideal or being replaced after flood damage.

Main Reference

“Wairau River Floodways Management Plan 1994”. Council Resource Management Plan.

Probable new works required

New willow tree bank protection work.

New rail iron retards.

New river tracks for gravel extraction truck use.

Upgrading Council roads for gravel extraction truck use.

Rock training bank or spur bank upgrades, particularly upstream of SH 6 where bed degradation has led to undermining of some existing works.

Ongoing management of existing protection/production tree planting. Some harvesting of existing blocks can be expected over the life of this plan.

Regular repair of rock bank protection work.

5.1.4 Waihopai (Wairau Confluence to 500 metres upstream of SH 63 Bridge)

Channel characteristics

Type	:	Wide Braided gravel river
Length	:	2 km
Fairway Width	:	150 metres
Slope	:	0.6% (1 in 160)
Design Flood	:	1200 m³/sec

No new capacity improvement works are required or likely to be required in the foreseeable future. However it is proposed to strengthen existing edge protection works at two key locations beginning in 2017/18.

Main reference

"Lower Waihopai Flood Levels" Internal memo K J Christensen May 2003.

5.1.5 Lower Opawa/Taylor

Channel characteristics (typical)

Channel blocks were put across the Opawa Loop in 1967 to separate the Upper Opawa from the Lower Opawa. The lower Opawa/Taylor is now a single river up through Blenheim, until the Doctors Creek tributary on the west side of Blenheim.

(Up to Doctors Creek confluence)

Type	:	Deep narrow silt bed river
Channel Width	:	30 m
Floodway Width	:	150 m
Slope	:	Tidal, flood slope 0.025% (1 in 4000)
Design Flood	:	170 m³/sec Design Freeboard 0.4 m.

Issue: Sedimentation

(a) Situation

Generally cross section survey of the river channel has been carried out at 10 yearly intervals since 1957.

Downstream of Riverlands (Butter Factory) corner the lower Opawa channel has been extremely stable, with no change in width, position or channel bed levels.

From Riverlands corner up to Taylor river confluence some deposition of the channel has occurred. This deposition is of silt, sand and fine gravels and over 30 years is at a maximum of 1 metre at the downstream end of town at the confluence of the lower Opawa and Taylor. Downstream the deposition steadily reduces for the 2.5 km to Riverlands corner.

The Taylor Dam, Opawa channel blocks, and Munro street gravel trap now reduce the amount of sediment that would have potentially deposited in the Lower Opawa. In the upper Taylor gravel extraction has been halted, allowing the build-up of a paving layer of large gravels that inhibit further bed erosion.

To date this aggradation has not significantly reduced flood capacity or drainage efficiency. However at low flow it is proving a nuisance for large commercial tourist boats on the river.

Possible new works required

Dredging the Lower Opawa/Taylor is a possibility, albeit difficult because of access constraints. No specific provision has been made within this plan but ongoing monitoring may determine at some point that the work is required.

Issue: Waterway Capacity

Prior to the construction of the Taylor dam the 1 in 100 year flood for the Taylor (at the dam site) would have been approximately 270 m^3/sec. The Taylor Dam, constructed in 1965 and the outlet of which was adjusted in 1980 has (together with the 1967 Opawa Loop channel blocks) reduced this design flood to 108 m^3/sec. To these figures needs to be added some 62 m^3/sec of inflow from Doctors Creek, Rifle Range Creek and other tributaries.

More recently considerable berm improvements have also been carried out on the Lower Opawa by berm shaping works that have removed berm material and shaped the berms to more readily carry flood water. As part of the process the overhanging willow trees that have steadily been growing and impeding the flood have also removed. These works have been carried out from Blenheim to the Vernon lagoons enabling the water to get away more easily from town. The July 2008 flood demonstrated how effective these works have been.

There is no apparent need at the present to further increase the waterway capacity; though if there was a need the best option would appear to be dredging of the river from Blenheim to Riverlands corner – which is also desirable from a boat navigation reason.

Issue: Stopbank structural integrity

The Lower Opawa stopbanks are typically 1.2 metres with 1 metre top width and steep sides. Inconsistent original construction, animal damage and vehicle crossing damage is reducing the strength and height of the stopbanks in places. This is particularly so where fencing is along the top of the stopbank. Stopbank improvement works have been underway for some time with about 84% of the of the total length of stopbank now considered up to standard and about 20 % still requiring upgrade.

These remaining stopbank improvement works are scheduled to be completed over the term of this plan. There is about 4100 m of stopbank to bring to standard or 16.5% of the length maintained.

Main References

“Wairau River Floodways Management Plan 1994” Council Resource Management Plan.

“Lower Opawa, Taylor, Doctors Hydraulic Analysis and Required River Control Works” Report to Council E B Williman May 1997.

“Internal email memo from Roger Fitzgerald dated 25 August 2014” with schedule and cost estimate of remaining upgrade works

Probable new works required

For the Taylor through Blenheim, walls and buildings comprise the "stopbanks" in some locations. Over the last 20 years these have been steadily upgraded and or replaced until this work is now nearing completion. The remaining works are considered to be;

- 100 m of crib wall immediately upstream of the Boathouse Theatre that is proposed to be replaced.

- A section of private building foundation wall immediately upstream of the Alfred Street bridge that we understand the owner intends to strengthen and thereby making it flood proof.

There are still a number of sections of Taylor River stopbank downstream of the Burleigh bridge and upstream of the Hutcheson Street bridge that are located in private land where

land purchase/upgrade/relocation works are desirable but have been given are a low priority as flood failure risk is considered low to very low. Some provision has been included in the plan to tackle these sections of stopbank as the opportunities arise to work with the landowner.

5.16 Taylor (Above Doctors Creek Confluence to Farm Park)

Type	:	Deep narrow silt bed river
Channel Width	:	30 m
Floodway Width	:	150 m
Slope	:	Tidal, flood slope 0.025% (1 in 4000)
Design Flood	:	170 m³/sec Design Freeboard 0.4 m.

Issue: Bank erosion protection of riparian land

Land development upstream of Doctor's Creek confluence is now making any erosion of riparian land less acceptable.

Probable new work required

Increased bank protection work by rock or trees - a modest increase in the capital expenditure budget has been provided to continue construction of new bank protection works or strengthening existing. In addition this will be backed up with an active willow planting programme as part of routine maintenance.

Work will also continue on developing (tidying, levelling, planting, track upgrades) the secured berm area as part of the general development of the Taylor River reserve.

5.1.7 Taylor Dam

Issue: Dam emergency spillway for Probable Maximum flood

During 2014 a comprehensive safety review of the Taylor Dam was completed. This concluded the review of the flood hydrology and hydraulics of the Taylor dam as well as a comprehensive inspection and review of the construction records.

The key outcomes of the safety review were;

- The emergency spillway is marginally inadequate to pass the minimum 1 in 10,000 year flood event. There are a variety of options to address the problem including minor raising of the dam crest and spillway adjustments.
- The dam requires some upgraded monitoring infrastructure including improved toe seepage manholes, crest survey points and location of the outlet pipe underdrain.
- The main outlet culvert needs some further resealing work to the construction joints.
- Some additional safety fencing at the outlet structure.

Provision has been included in the Rivers budget to complete this work.

Main References

"Design Floods for Taylor Dam Marlborough" NIWA Client Report CHC00/788 July 2001.

"Taylor Dam PMF" Opus International Consultants 2004.

"Taylor Dam Spillway Review" Damwatch Services March 2007.

"Taylor Dam Comprehensive Safety Review 2013", Tonkin & Taylor report.

5.1.8 Upper Opawa and Rose's Overflow

Channel characteristics (typical)

(Channel blocks were put across the Opawa Loop in 1967 to separate the upper from the lower Opawa. The upper Opawa and Rose's Overflow is really a single, albeit artificial river channel).

Type	:	Artificial watercourse on Wairau floodplain
Length	:	16 km
Channel Width	:	10 m
Floodway Width	:	200 m
Slope	:	0.06% (1:600), varying from 0.1% (1:1000) at Rose's Overflow to 0.25% (1:400) at Omaka Confluence
Design Flood	:	600 m³/sec up to Fairhall Confluence, 400 m³/sec above Confluence
Design Freeboard	:	0.4 m on right bank up to Fairhall Diversion 0.3 m for left bank above Fairhall Diversion.

Issue: Waterway capacity

Historically the upper Opawa carried flood flows of over 1000 m³/sec from the Wairau and was typically several hundred metres wide. Over the last 30 years the stopbanks have been reconstructed so as to narrow the floodway to only carry the design flood of the Omaka and Fairhall tributaries. The waterway is unusual in that a narrow main channel carries typically only 20% of the design flood and the majority is carried on the wide floodway berms. This is a legacy of the artificial nature of the watercourse in that the flood flows are much less now than the flood flows that laid down the original channel. Current flood flows are unable to erode out a bigger cleared channel.

It is therefore particularly important that the floodway berms are kept in as a hydraulically efficient waterway. For optimum conditions the floodway would be in grass with a minimum of trees, bushes or scrub.

The hydraulic calculations of waterway capacity to carry the design flows assume reasonably good hydraulic conditions on the berms. Berm conditions are good for much of the floodway. Council recently purchased a further 6 ha of floodway opposite Waipuna Street to continue improvements to the floodway flow capacity.

Main Reference

“Roses Overflow/Upper Opawa Hydraulic Review. Council Internal Report K J Christensen June 2004.

New works required

Further tree removal downstream of the Grove Road (State Highway 1) Bridge.

Possible new works

Further land purchase as opportunities arise. Not all the land is in Council ownership yet, and it is desirable that it should.

5.1.9 Fairhall River (to New Renwick Road) and Omaka River (Upper Opawa Confluence to Hawkesbury Road Bridge

Type	:	Braided gravel river
Length	:	4.8 km braided gravel river
Slope	:	.8% (1 in 130)
Fairway Width	:	50 m
Floodway Width	:	150 m
Design Flood	:	400 m³/sec Design Freeboard 0.4 m.

Issue: Fairhall floodway maintenance

The Fairhall has a nearly 2 kilometre diversion from its former, pre 1930 channel. The 150 flood of 210 m³/sec, even though the floodway is very flat graded. Down each side of the floodway is a single row of ageing Lombardy poplars that need to be removed and the stump holes repaired to maintain the integrity of the stopbank. This work is underway.

Periodic excavation of gravel from the central channel is also required to maintain a low flow channel and clear the stormwater outfall from the airport.

Between the top of its diversion and New Renwick Road the Fairhall divides into its tributary Mill Stream and the mainstream Fairhall. Neither of these are stopbanked, but both are quite entrenched rivers. Both channels just coped with the July 2008 flood event, which was an approx 1 in 20 year return period event hence. In the current partly vegetated state the channels are probably not up to full design standard, and need enlargement.

Main Reference

"Southern Valleys, Blenheim and Picton Flood 31 July 2008" Report to Council E B Williman August 2008.

Probable new works required

Tree clearing of Fairhall and Mill Stream is the practical solution to improve the capacity of those streams.

Issue: Omaka River stopbank protection works

The Omaka River is stopbanked along the majority of the reach from the Hawkesbury Road Bridge down to the Upper Opawa River confluence. The river slope is relatively steep meaning high velocity flood flows during major events. This river requires either strong (heavy rock) edge works where there is only room for a narrow berm to the adjacent stopbank or a strengthened willow buffer zone where there is more room.

The Omaka River floods of 2011 and 2014 damaged the aging existing works and significant renewal/upgrade of the protection works is proposed during the term of this plan.

5.1.10 Opawa Loop

The Opawa Loop is a 2.5 km reach of river that formerly joined the Upper Opawa and Lower Opawa rivers, and carried large flood flows. The flat graded reach was not significantly stopbanked and considerable flooding occurred of adjacent urban land in the May 1966 flood event. The loop was subsequently blocked at both the upstream and downstream end in 1967. Gated 1.8 m culverts at both ends allow for low flows to be diverted through it.

The Opawa Loop now has a much lesser flood role in dealing with stormwater from urban Blenheim.

However, being an urban river, the aesthetics and other environmental aspects of this channel are very important. There is also significant potential recreational use.

There is some build-up of sediment immediately downstream of the upstream control gates. Both the upstream and downstream control gates are also due for a mid-life overhaul.

Probable new works required

Refurbishment of control gates.

Ongoing bed level monitoring.

5.1.11 Riverlands Floodway

Type	:	Straight artificial channel for drainage and floodwater from Wither Hills Streams
Slope	:	Tidal 0.025% (1 in 4000)
Length	:	7 km plus 1.7 km of channel within Vernon Lagoons
Design Flood	:	up to 26 m³/sec Design Freeboard 0.2 m.

The Wither Hills streams include Mapps, Dry Hills, Fifteen Valley, Sixteen Valley, Sutherlands and Wither. These latter two flow through and also receive stormwater from 'Blenheim' urban areas.

Issue: Sedimentation

The location of this flat graded channel at the base of the erosion prone Wither Hills is likely to result in sedimentation of the channel with reduction in waterway capacity. For this reason a low level floodway berm is required to enable future machine access to excavate out such deposits. This low level berm also increases the flood capacity of the floodway. Currently the low level berm is not continuous along the floodway.

Issue: Inadequate waterway capacity

Stopbanking exists on both sides of the Riverlands floodway for a distance of 3.5 km below Blenheim to where higher ground levels are intercepted, and for the left bank for the full length to the Vernon lagoons.

Main Reference

“Riverlands Floodway Hydraulic Review” Council Internal Report K J Christensen May 2002.

New works required

On the right bank from Cob Cottage to upstream end of the new Wine Business Park subdivision the required new stopbank is required to be built in association with excavating a low level berm.

On the left bank a new stopbank is required from Cob Cottage Road downstream to the Railway embankment then downstream of the main Riverlands industrial area to raise some isolated low points down to Cloudy Bay Drive. It is proposed to acquire a strip of land known as the “pan handle” adjacent to the Pernod Ricard winery to help facilitate this section of left bank upgrade..

5.1.12 Wither Hills Streams

These are tributary streams of the Riverlands floodway that flow off the Wither Hills.

- Sutherland stream was controlled and diverted to flow into the Riverlands Co-op floodway with a major upgrade in 1986.

- Wither Stream flows through the most urban developed area. Flood design standards are now needed to be higher than when the Stream channel was initially enlarged by channel excavation in the 1960s when the land was mainly

undeveloped. Ironically the intrusion of the urban development reduced the waterway capacity of the channel and inhibited its economic maintenance.

Following a report from Davidson Ayson (1991) the Council decided to improve the waterway capacity by construction of a detention dam at Harling Park, and reconstructing the Wither Hills as an open concrete channel.

- Rifle Range Creek was upgraded following the 1980 flood on the area, and again in 2002 following a review.
- Mapps Stream and Dungeys Gully Stream were upgraded as part of an overall rural residential development in 2000.

New works

No new works are envisaged in the immediate future.

5.1.13 Doctors Creek

A previously proposed Doctors Creek diversion was previously proposed to assist in reducing the flood risk from the Taylor River through Blenheim

McNabb (1993) showed that farming practices have adapted to the extensive ponding in the Battys Road/Bells Road area on the occasions of Doctors Creek flooding, and that relatively little expenditure is justified for agricultural benefit.

Currently the land on which ponding takes place is not zoned as floodway. The expected area of land over which ponding would occur in a one in 100 year flood event is approximately 300 hectares.

Channel enlargement, road bridge enlargement and banking are options are to reduce the ponding area and so benefit rural residential lifestyle land use near Blenheim. More detailed investigation would be required to do this. However no major upgrade is proposed for the foreseeable future.

Proposed further improvement works

Minor floodway enlargement and berm lowering just upstream of the Taylor River confluence to improve hydraulic efficiency at this point.

5.1.14 Lower Tuamarina River

The lower Tuamarina River from downstream of the Railway Line is part of a stopbanked floodway designed to cope with either a 1% AEP event in the Wairau River (typically during a large Wairau flood event Wairau water will flow back upstream into the Para Swamp) or a 1% AEP event in the Tuamarina River or a lessor combination of both.

The Tuamarina River is continuously stopbanked on at least one side from the confluence with ???? Creek down to the Wairau River confluence

Issue: Bank erosion damage on the true left bank over the lower 750 m of the channel

Over a number of years willow and other tree growth had partially blocked the lower section of channel and just as concerning hid some gradual erosion damage that was reducing the berm width at the base of the adjacent stopbank. This section of stopbank is really a Wairau River stopbank and must be maintained in very good condition to ensure its security in a large flood event.

The Tuamarina flood event of June 2014 was unusual in that it had a large flow from the Tuamarina Valley but Wairau River levels were close to normal winter flows. As a results a

strong downstream flood occurred which ripped out many of the overhanging willows, severely damaged the existing mouth control groyne and exacerbated the pre-existing left bank erosion over three left bank locations.

Works are planned to repair the flood damage including;

- Removal of remaining willows and fallen trees – completed.
- Reconstruction of the left bank berm over the three identified erosion reaches and rocking to permanently protect.
- Reconstruction of the right bank mouth control groyne at the Wairau.
- Replanting of the true right bank with appropriate species.

Funding has been included in the capital programme for this work.

Issue: Check of stopbank height and condition upstream of the Kaituna-Tuamarina Track Bridge.

There is some concern that some sections of this bank may be under height during a 1% AEP flood event in the Wairau River.

It is proposed to detail survey the bank (crest level and condition) and undertake any minor improvements to ensure the bank meets Level of Service requirements.

5.2 Wairau Tributaries outside the Floodplain

5.2.1 Description of Issue

Activities on the Wairau tributaries have little effect on the main Wairau Floodplain and are of different communities of interest. A considerable amount of work was done on these tributaries in the 1960 to 1992 period when government subsidies were available. The Wairau River above the Waihopai Confluence is considered to be a tributary in this context.

The works consisted of rock lined training banks, channel cleaning, tree planting, minor stopbanking, and minor diversions. The work on these tributaries was complicated by being poorly defined as what work is to be done to achieve what standard of river control.

With the government subsidy, the expenditure was also considerably in excess of rating money from the areas, and often of doubtful economic value.

Much of the specific works were done to benefit individuals only – and not a community scheme.

Under the Wairau River Floodways Management Plan (1994) Council decided to discontinue maintenance of the stopbanks, rock lined training banks, tree planting, groynes, other rock work and other constructed river control assets.

However channel clearing of tree and weed growth or stranded tree debris is relatively cheap and having benefit to ratepayers over extensive lengths of each tributary. Even on a low budget therefore, it is feasible to devise a programme of works that is to the benefit to the community of interest, and predominantly paid for by this community. Under the Wairau River Floodways Management Plan (1994) Council therefore decided to continue to maintain keeping the channels of these tributaries clear.

Council therefore does not have any constructed assets within these channels.

Council policies are therefore:

(i) To carry out channel clearing work (including flood damage repair works) with the intention of maintaining clear stable channels as far as practical and economic.

(ii) To use the annual rate intake from the relevant tributary benefitting areas as a guide to the scale of activity to be carried out.

(iv) Where the affected landowners, desire more extensive river works then jointly funded works may be carried out with Council contribution of up to 50%.

Where the tributaries are large braided rivers there is some difficulty in defining what the sensible width of the river channel. The following have been adopted

Wairau above Waihopai to Wye Confluence

A generally 600 metre wide fairway to a defined location.

Waihopai (for 6 km above SH 63)

A 150 metre wide fairway.

Fairhall (above New Renwick Road)

A 30 metre wide fairway channel.

Omaka (above Hawkesbury Road Bridge)

In places the current fairway remains too narrow despite widening by erosion during a number of flood events since 2008. In addition in places no edge buffer zone exists due to either flood damage or over encroachment by grape development.

A 50 metre wide fairway is desirable. It is to be noted that historic river control works together with natural tree growth have narrowed the accepted river channel to less than 25 metres in many places – a width that is inadequate to carry large flood flows.

Most adjacent vineyard owners have now recognised that it is in their interest to leave an adequate fairway to provide for flood capacity and to undertake edge protection works typically some combination of rock and willow planting to provide a good buffer between the active channel and productive vineyard. Accordingly since floods of 2011 and 2012 Council has assisted about 6 to 8 properties with the design and construction of new works, with the works to be “owned” by the landowner paying.

Council will continue to undertake the channel clearing, flood debris removal role and has made some contribution to the new protection works

It would be technically possible to stopbank the low lying sections of land adjacent to the upper Omaka. A minimum design would be a 50 m width cleared fairway, flanked by a buffer of 15 m of willow plantings on each side to provide bank protection. The total floodway width would be 100 metres, and would require some existing grape plantings to be ripped out. There is no current interest in this next level of protection works upgrade.

Further new works

The probable course of action is development of a 50 metre wide channel over time by the removal of trees in the channel and managed gravel extraction. This should really be considered as overdue maintenance work on the channel. Further landowner initiated works as required.

Tuamarina River (Railway to Lindens Road and including Koromiko tributary)

Large flood events occurred in the Tuamarina River in April and June of 2014. The flood events confirmed the need for an active channel clearing programme in the Tuamarina River backed up by assistance to landowners with bank protection works as required. Overland flows during these flood events were extensive and scoured out a flood underpass bridge in

Speeds road. A new development adjacent to Sounds Airs Koromiko airstrip will require an active inspection and clearing programme to keep the properties closest to the river safe.

Good progress has however been made over the last two or three years to reduce the overgrowth of crack willow and remove obvious blockages. A large one had been located the top end of the Para Swamp and required heavy machinery to clear. Similarly an emergency channel clearing done in the about 4 km of the lower Koromiko tributary paid benefits in the subsequent June event.

Similarly the Rivers Section now has a management understanding for the maintenance of the central channel through the Para Swamp that will maintain some flood capacity without compromising swamp restoration objectives.

Need for new works

Nothing proposed but continuance of the active channel clearing programme and regular contact with adjacent landowners.

References

"Tuamarina and the Para Swamp" report to Assets & Services Committee by Brin Williman, July 2005

"Para Wetland Restoration and Development Plan" prepared by Nelson/Marlborough Fish and Game and the New Zealand Game Bird Habitat Trust, April 2012.

5.3 Wither Hills Soil Conservation

The valuable and important soil conservation works on the Wither Hills need to be to be maintained by ensuring that there is good grass and tree vegetation and other soil conservation works. Much of the trees and grass were destroyed by fire of December 2000. The grass vegetation was re-established in 2001/2 together with check dams in the main streams. Further tree planting and earthworks are required.

A Wither Hills Farm Management Plan has been approved by Council which clearly sets out sets out the dual objectives of soil conservation and public recreation for the land.

The lease for grazing of the farm park was recently renewed with a lessee very much on board with the manner in which the land can be farmed.

In 2013 the required work programme and budgets were reviewed to ensure that an appropriate work programme with adequate resourcing was in place to achieve soil conservation objectives. The review was driven by a combination of the Taylor Road housing development altering where the key farm facilities (wool shed, stock yards) were located, a recognition that some of the faces vulnerable to tunnel gully erosion needed reworking and a desire to speed up some retirement gully planting.

The enhanced work programme was adopted as part of the 2014/15 annual plan, and has been incorporated into the 2015-25 budget numbers.

Work is well underway including the design of the Redwood Street woolshed upgrade and tunnel gully contour ripping completed above Rifle Range Creek.

Main references:

"Wither Hills Catchment Control Scheme – scheme review 1980" Marlborough Catchment Board report R MacArthur.

'Wither Hills Erosion Management – Re-establishing Cover for Erosion Management following the December 2000 Fire. Report to Council PALMS Ltd, July 2001.

"Wither Hills Farm Park Management Plan". A Council adopted report September 2003.

"Wither Hills - Blenheim's playground", Power point presentation June 2013.

5.4 Land Drainage

5.4.1 Lower Wairau Channel Network

Provision of adequate drainage channels and the maintenance of natural watercourses and drains for flood drainage mitigation purposes has been a priority for the lower Wairau floodplain for many years. The present drainage area is best described as an area of some 8,000 hectares generally to the east bisected by the main river systems and drained by 150 kilometres of Council maintained scheduled watercourses and drains. Council also maintains 25 rural flood protection and drainage pumping stations and 249 floodgated gravity outlets to the main river systems.

Main Reference

"Wairau Drainage Management Plan" A report of Council. R M Fitzgerald Nov 1996.

5.4.1.1 Pumped Drainage

These are areas which are dependent on the pumping stations especially during times of river floods.

Without the provision of pumping facilities these areas would be virtually unproductive and subject to extensive flooding for periods of the year. The flooding potential of these areas has been increased by the continued development of the drainage channel network and the introduction of 'foreign' stormwater to the pumping catchments from adjacent areas. Areas: 1, 2, 3, 4, 5, 6, 8, 9a. See figure 5.

5.4.1.2 Pump Assisted

These areas are assisted by pumping operations when high river levels close gravity outfalls. Gravity drainage is usually available for significant periods of the year. Areas: 7, 9b, 10, 11, 12, 13, 14, 15a and b.

5.4.1.3 Gravity Drainage

These are areas that rely totally on gravity drainage. This backing up of storm run-off is usually of short duration and significant flooding only occurs in localised areas. Some of the drainage areas do not discharge to river outfalls but instead discharge unimpeded to lower-lying drainage areas or via control structures which regulate overflows. Areas: 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26.

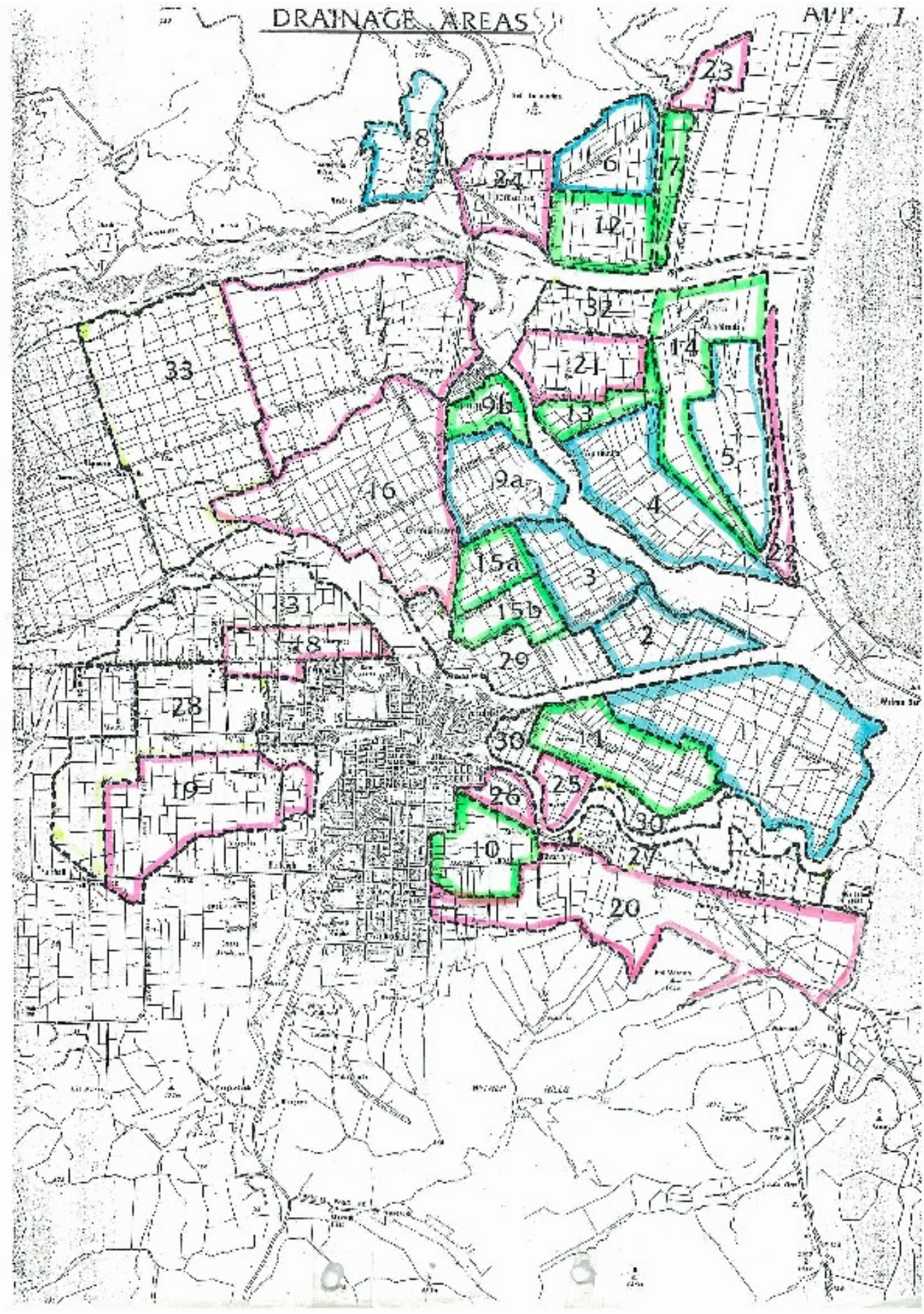
5.4.1.4 Contributing Drainage Catchments

These areas adjoin the above three types of area in various locations and contribute "foreign" water into the systems. These catchment areas in effect receive betterment from the downstream drainage infrastructure. Areas: 27, 28, 29, 30, 31, 32, 33

5.4.1.5 Vernon Lagoon Area

A total of 4.5 kilometres of drainage channel are outside the formal stopbanking systems and require periodic maintenance which primarily comprises machine excavation of sediments. This is necessary to provide for tidal inflow/outflow to optimise drainage levels and also provides for adequate flood channel capacity to convey sediments in times of high Wither Hills run-off.

It has been observed that channel maintenance works enhance tidal flows and help provide a dynamic and healthy environment within the area to the west of Chandlers Lagoon and the Upper Lagoon.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5.4.1.6 Schedule of Lower Wairau Watercourses maintained for Land Drainage purposes

The below table is a summary of watercourse and drain classification and ecological management categories, with abbreviations as follows.

Outlet type: G – Gravity; PA – Pump assisted; P – Pumped.

Flow regime: PF – Permanently flowing, UD – Usually dry.

Grade: Moderate – slope usually steeper than 0.2%; Flat – slope usually between 0.2% and 0.05%; Very Flat – slope usually less than 0.05%

Management Category

Category A High ecological values or revegetation/habitat and fish spawning values. High public expectation as to environmental outcomes integrated with specific drainage and flood control requirements.

Management plans required with enhancement programmes, operational constraints and hydraulic outcomes specified.

Category B Specific ecological values identified. Maintenance operations to be carried out in accordance with Resource Consent conditions and site specific standards maintained as defined by a general "Code of Practice". Performance standards may be able to be specified but subject to seasonal variations.

Category C. No ecological/habitat values that warrant special maintenance techniques. Operations in accordance with consent conditions to meet drainage/flood protection/ structural requirements. Programmed maintenance regime. Some advance scheduling of maintenance activities possible with delegation to contractors for meeting performance standards.

Category D High public expectation for attainment of drainage/flood protection values and avoidance of economic losses. Impractical and uneconomic to provide for other values. Drainage maintenance undertaken on an as determined/needed basis to maintain a high order of flood control and drainage efficiency subject only to resource consent conditions.. May be performance based with avoidance of flood loss critical factor.

Watercourse and Drain Classification for Weed Management

Waterway	Length (m)	Drain Size	Catchment Draining to	Outlet Type	Flow Regime	Grade	Management Category
Bells Road No 1	483	medium	Doctors	G	PF	moderate	C
Bells Road No 2	240	medium	Doctors	G	PF	moderate	C
Camerons Creek	1045	medium	Doctors	G	PF	flat	B
David Street	60	medium	Doctors	G	PF	flat	B
Doctors Creek	3825	large	Doctors	G	PF	flat	B
Douglas No 2	240	medium	Doctors	G	PF	moderate	B
Fairhall Co-op	2255	large	Doctors	G	PF	flat	B
Fairhall School Creek	845	medium	Doctors	G	PF&UD	moderate	B
Golf Course Creek	1610	medium	Doctors	G	PF	moderate	B
Morrisons	485	small	Doctors	G	PF	moderate	C
Old Fairhall Creek	4325	large	Doctors	G	PF	moderate	B

Watercourse and Drain Classification for Weed Management							
Waterway	**Length (m)**	**Drain Size**	**Catchment Draining to**	**Outlet Type**	**Flow Regime**	**Grade**	**Management Category**
Osgoods	200	medium	Doctors	G	E	flat	B
Yelverton	845	medium	Doctors	G	E	flat	B
Dr C	1005	medium	Grovetown	PA	PF	flat	C
Dr H	720	medium	Grovetown	P	PF	flat	C
Awarua Park	195	medium	Grovetown	G	E	moderate	C
Awarua Park West	160	medium	Grovetown	G	PF	moderate	C
Dr A	1086	large	Grovetown	P	PF	very flat	A
Dr B	241	large	Grovetown	P	PF	very flat	A
Dr C1	160	small	Grovetown	PA	UD	flat	C
Dr D	1410	medium	Grovetown	PA	PF	flat	C
Dr D 2	442	small	Grovetown	PA	E	flat	C
Dr D1	160	small	Grovetown	PA	UD	flat	C
Dr F	1370	medium	Grovetown	PA	E	moderate	C
Dr G	820	medium	Grovetown	PA	E	moderate	C
Dr H 2	400	small	Grovetown	PA	E	flat	C
Dr H1	725	medium	Grovetown	PA	E	flat	C
Dr I	845	medium	Grovetown	PA	E	flat	C
Dr J	600	medium	Grovetown	PA	PF	flat	C
Dr K	725	medium	Grovetown	PA	PF	flat	C
Dr M	1045	medium	Grovetown	PA	PF	flat	C
Dr N	3440	large	Grovetown	G, P	PF	moderate	C
Dr N 1	400	small	Grovetown	G	PF	moderate	C
Dr N2	700	medium	Grovetown	PA	UD	moderate	C
Dr O	5150	medium	Grovetown	P, G	PF	moderate	B
Dr O1	200	medium	Grovetown	G	E	mm	C
Dr P	240	small	Grovetown	G	PF	flat	C
Dr Q	744	medium	Grovetown	G	PF	moderate	C
Dr R	1210	medium	Grovetown	G,P	PF	flat	C
Dr S	605	small	Grovetown	PA	E	flat	C
Dr V	565	small	Grovetown	PA	UD	flat	C
Dr W	360	small	Grovetown	G	E	flat	C
Dr X	645	medium	Grovetown	P	PF	flat	C
Dr Y	725	medium	Grovetown	P	PF	flat	C
Dr Z	505	small	Grovetown	P	PF	flat	C
Dr W extn		small	Grovetown	G	UD	flat	C
Grovetown Lagoon	2,230	large	Grovetown	PA	PF	very flat	A
Kennedys	1770	medium	Grovetown	PA	PF	flat	C
Kennedys Overflow	284	medium	Grovetown	PA	PF	flat	D
Murrays Road between Dr R & Q		small	Grovetown	G	UD	flat	C
Murrays Road E	800	small	Grovetown	G	UD	moderate	C
Murrays Road W	820	medium	Grovetown	G	PF	moderate	C

Watercourse and Drain Classification for Weed Management							
Waterway	**Length (m)**	**Drain Size**	**Catchment Draining to**	**Outlet Type**	**Flow Regime**	**Grade**	**Management Category**
Sadds	1408	large	Grovetown	P	PF	very flat	C
Staces	360	medium	Grovetown	G	PF	flat	C
Wallaces	1165	medium	Grovetown	PA	PF	flat	C
Blind Creek 0-1450	1450	large	Pembers			flat	A
Blind Creek 450-4325	3875	large	Pembers	P	PF	flat	B
Blind Road	705	small	Pembers	G	UD	flat	C
Bruces	400	medium	Pembers	PA	PF	very flat	C
Dooles	520	small	Pembers	G	E	flat	C
DR Evans	805	small	Pembers	PA	UD	flat	C
Gundys	563	medium	Pembers	PA	UD	flat	C
Hill	400	small	Pembers	P	PF	very flat	C
Hunters Road	1370	medium	Pembers	PA	PF	flat	A
Pembers Road	1530	large	Pembers	P	PF	very flat	D
Peters	121	small	Pembers	PA	UD	very flat	C
Pickerings	1045	small	Pembers	P	PF	very flat	C
Pukaka Pondage	724	large	Pembers	P	PF	very flat	C
Pukaka Stream	2655	large	Pembers	G	PF	very flat	A
Quarry Drain	665	medium	Pembers	G	PF	very flat	C
Rarangi Road (Nth)	500	medium	Pembers	G	E	flat	C
SH No 1	700	small	Pembers	G	UD	flat	C
Thomas Road	1850	large	Pembers	P	PF	very flat	D
Township Drain	845	medium	Pembers	G	E	flat	D
Bowns Creek - 0-400	400		Spring Creek Tribs			moderate	A
Bowns Creek 400 - 905	505	large	Spring Creek Tribs	G	PF	moderate	B
Cravens Creek 0-800	800		Spring Creek Tribs			moderate	A
Cravens Creek 800-1372	570	large	Spring Creek Tribs	G	PF	moderate	B
Dentons Creek	1170	large	Spring Creek Tribs	G	PF	moderate	B
Dowlings Creek	2820	large	Spring Creek Tribs	G	PF	moderate	
Footes	905	medium	Spring Creek Tribs	G	PF	flat	B
Ganes Creek	1085	medium	Spring Creek Tribs	G	PF	moderate	B
Giffords Creek	2715	medium	Spring Creek Tribs	G	PF &E	moderate	B
Halls Creek	520	large	Spring Creek Tribs	G	PF	moderate	B
Hollis Creek	1448	medium	Spring Creek Tribs	G	PF	moderate	B
Marris Creek	1900		Spring Creek Tribs	G	PF	slope	B
Rapuara Rd	565	small	Spring Creek Tribs	G	E	moderate	C
Roses Creek	3660	medium	Spring Creek Tribs	G	PF	moderate	B
Spring Creek Res east	240	small	Spring Creek	G	PF	flat	B

Watercourse and Drain Classification for Weed Management							
Waterway	**Length (m)**	**Drain Size**	**Catchment Draining to**	**Outlet Type**	**Flow Regime**	**Grade**	**Management Category**
			Tribs				
Spring Creek Res West	250	medium	Spring Creek Tribs	G	PF	flat	B
Spring Creek	10,665	large	Spring Creek Tribs	G	PF	flat	A
Whites	1220	medium	Spring Creek Tribs	G	UD	flat	C
Bays	600		Swamp Road				
Eyles	820	medium	Swamp Road	P	E	very flat	C
Frosts	2112	medium	Swamp Road	P	PF	very flat	C
Jeffries	1930	large	Swamp Road	P	PF	very flat	C
Swamp Rd	2515	large	Swamp Road	P	PF	very flat	C
Upper Dillons 1	400	small	Swamp Road	PA	UD	flat	C
Upper Dillons 2	820	medium	Swamp Road	PA	UD	flat	C
Barnetts Ck	845	small	Tuamarina	P	E	moderate	C
Cow CK	966	large	Tuamarina	G	PF	moderate	C
Hastilows Ck	2115	large	Tuamarina	P	PF	flat	B
Parkes Bros	1207	large	Tuamarina	P	PF	flat	C
Tuamarina Lagoon	262	large	Tuamarina	P	PF	flat	A
Wakefield St	850	small	Tuamarina	PA	UD	flat	C
Waterfall Ck	1400	large	Tuamarina	G	PF	flat	C
Chaytors Pump	200	large	Wairau Pa	P	PF	very flat	D
Connollys Rd	420	small	Wairau Pa	PA	E	very flat	C
Corrys Outlet	100	large	Wairau Pa	G	PF	very flat	A
Cresswells	400	small	Wairau Pa	G	UD	very flat	C
Dicks Drain	1170	medium	Wairau Pa	P	PF	very flat	C
Dunkinsons Ck	2010	large	Wairau Pa	G	PF	flat	B
Marukoko 0-1250	1250	large	Wairau Pa			very flat	B
Marukoko 250-3015	2765	large	Wairau Pa	PA	PF	very flat	C
Outlet Drain	220	large	Wairau Pa	P	PF	very flat	A
Pa Drain	605	small	Wairau Pa	P	PF	very flat	C
Pipitea Ck	1610	medium	Wairau Pa	G	PF	very flat	A
Pukaka	1951	large	Wairau Pa	PA	PF	very flat	A
Rarangi Road	483	medium	Wairau Pa	C	UD	flat	C
Roberts Drain	1460	large	Wairau Pa	P	PF	very flat	A
Smith & Dicks	705	medium	Wairau Pa	G	PF	very flat	C
Wells Drain	1045	medium	Wairau Pa	G	PF	flat	B
Aireys	485	medium	Woolley & Jones	PA	E	very flat	C
Aubrey's	483	medium	Woolley & Jones	G	UD	very flat	C
Glovers	724	medium	Woolley & Jones	G	UD	very flat	C
Jones Rd	724	small	Woolley & Jones	G	UD	very flat	C
Lower Wairau 0-362	362		Woolley & Jones				A

Watercourse and Drain Classification for Weed Management							
Waterway	**Length (m)**	**Drain Size**	**Catchment Draining to**	**Outlet Type**	**Flow Regime**	**Grade**	**Management Category**
Lower Wairau 362-2815	2453	large	Woolley & Jones	P	PF	very flat	C
Lower Wairau Pump	320	large	Woolley & Jones	G	PF	very flat	D
Sutherlands	485	small	Woolley & Jones	G	UD	very flat	C
Woolley & Jones 0-200	200	large	Woolley & Jones				B
Woolley & Jones 200-2412	2212	large	Woolley & Jones	P	PF	very flat	D
Harvey Rices	2736	large	Riverlands	G	PF	very flat	A
Hocquards	705	medium	Riverlands	G	UD	very flat	C

5.4.1.7 Proposed extension of drainage network

The current drainage network is currently under review to reflect land use changes, subdivision and general land use intensification and need to rationalise maintenance responsibility for some existing drains (including roadside and some private drains) that are not part of the formal network but are integral to an equitable level of service being provided. The current network was last formally reviewed as part of preparation of the 1960 Wairau Scheme proposal.

A network extension proposal has been prepared and is out with benefitting and affected landowners for comment. Briefly the proposed network changes can be summarised as follows;

- An additional 15.3 km of drain to be added to the network which is a 5.4% increase on the currently managed network.
- Of the 15.3 km of drain to be added 4.5 km is existing roadside drain, 9.5 km is existing privately maintained drains and 1.3 km of new drain is proposed.
- The intention is to provide drainage outfall to all (or nearly all) properties greater than 1 Ha within the defined drainage areas. Therefore nearly all landowners will have direct access to a Council maintained drain and will not have to rely on a downstream neighbour maintaining their drain.
- The estimated capital cost to bring the new drains up to standard and improve some existing drains is $300,000. Maintenance costs are forecast to increase approximately in proportion to the additional length of drain to be maintained.

Provision for both the capital implementation and additional maintenance costs have been included in the draft Rivers budget from 2015/16. The capital works are proposed to be spread over three years. The new network is proposed to be adopted in May 2015 following receipt of landowner comments and consideration of any appropriate changes to the new network.

Proposed new works

New drains, new culverts, drain bank stabilisation work, riparian ecological plantings.

Reference

"Wairau Lower Floodplain Land Drainage – Network Review", report to the Assets & Services Committee, November 2014.

5.4.1.8 Council access for maintenance

The majority of watercourses and channels managed for public drainage purposes are on private land and only a third is on Council reserve or road reserve. With the increased value of land, a change of land use type, and a changing public attitude it has become more contentious for council to expect free access maintenance, particularly within the immediate vicinity of Blenheim.

In more built up areas itis therefore desirable to acquire more robust riparian access arrangements by:

- Local Purpose Reserves (Drainage) to be created where access is necessary, or
- Entry easements or right of ways be created as appropriate, or
- Land acquisition be undertaken where required by property owners.

This access formalisation process is undertaken only when necessary and usually trigged by either capital works upgrades by Council, or land subdivision or development by the landowner. An annual land purchase budget of $200,000 per year is provided to undertake these acquisitions as required.

5.4.2 Flood control pumping stations: Rural Area

5.4.2.1 Probable new works - general

The rural pumping stations were upgraded under the 1996 Wairau Drainage plan to achieve a revised level of service. No further significant capacity increase is suggested at present. However there is a need to install telemetry equipment at most of these rural pumping station sites, and install telemetry control equipment at selected control gate sites.

Details for individual stations are as follows.

5.4.2.2 Lower Wairau

Constructed in 1957 to serve an area of 212 hectares and is equipped with a single PPF 12/14 pump. Later a dual speed motor was fitted to provide a maximum pumped rate of 18,000 litres per minute and more recently a PPF 9/10 pump with a multi-speed motor for low speed operations with subsequent low drainage channel velocities and low water levels being obtainable if necessary.

Data

Main PPF 12/14 discharge	18,000 l/min
Multi-speed PPF 9/10 discharge	12,250 l/min
Combined total discharge	30,250 l/min
Drainage capability	15.4 mm/24 hrs
Pumping control range	300 mm - 600 mm above MSL

5.4.2.3 Pembers Road

Constructed in 1957 to serve a drainage area of 203 hectares with an additional catchment of 165 hectares of hill country. Equipped with two PPF 12/14 pumps.

Pump capacity was increased 40% in 1971 in conjunction with the Thomas Road pumping station construction. Pump capacity was further modified in 1984 by the fitting of a dual speed motor to one pump.

Data

1971 upgraded discharge	31,800 l/min
1971 upgraded drainage capability	12.70 mm/24 hrs
Pumping control range	400 mm to 1200 mm above MSL

5.4.2.4 Dillons Point

Constructed in 1959 to serve an area of 695 hectares this station is equipped with three PPF 12/14 pumps giving a maximum discharge of 38,500 litres per minute, and a drainage capability of 8.20 millimetres per 24 hours. More recently a PPF 9/10 pump replaced one of the 12/14 pumps and dual speed motors installed.

Data

Total discharge 2 x PPF 12/14 pumps	36,000 l/min
1 x PPF 9/10 pump	12,000 l/min
Proposed total discharge	48,000 l/min
Proposed discharge capability	10.25 mm/24 hrs
Pumping control range	00.0 mm to 600 mm above MSL.

5.4.2.5 Chaytors Drain

Constructed in 1961 to serve an area of some 500 hectares is equipped with twin PPF 12/14 pumps discharging 23,000 litres per minute. Dual-speed motors have more recently been installed.

Data

Discharge	36,000 l/min
Drainage capability	10.5 mm/24 hrs

Problems continue to be experienced with weed and debris blockages and secondary debris screens located 75 metres upstream of the pumphouse are recommended.

5.4.2.6 Swamp Road

Constructed in 1978, this station differs from normal design in that dual-speed motors are fitted to the two PPF 9/10 pumps to give four rates of discharge as required by operating conditions. More recently re-equipped with twin dual-speed PPF 12/14 pumps is a practical option. The effective catchment is 320 hectares.

Data

Two multi-speed PPF 12/14 pumps discharge	36,000 l/min
Drainage capability	16.2 mm/24 hrs
Pumping control range	350 mm to 600 mm above MSL

No gravity drainage is available at the pumping station site. The total drainage area served comprises three distinct portions. An area to the south of Dillons Point Road is afforded flood protection in that excess flood water can transfer northwards to the pumping catchment. The western portion of the catchment is deliberately limited as to drainage flow rates to avoid inundation of lower land areas adjacent to the pumping installation.

5.4.2.7 Rouses Drain

Constructed in 1965 to serve an area of 390 hectares and equipped with twin PPF 12/14 pumps. Drainage flows are contributed to by both the surrounding area and Roberts Drain via a control structure. No serious problems are known to exist but pumps are deteriorating due to age with one pump dating from 1936.

Data

Existing pumped discharge	24,000 l/min
Existing drainage capability	8.9 mm/24 hrs
Pumping control range	minus 300 mm to 300 mm above MSL

Addendum

This pumping station serves a very low lying area of land and drainage inflows from the Roberts Drain area to the north are controlled by a weir structure. Drainage water levels are approximately 400 mm higher within the Roberts Drain system due to major spring inflows with the Marukoko system at the lower level with little flow gradient. This level control must be maintained for optimum drainage and to assist in reducing spring inflow rates.

This structure is of a ‘stop-log’ type and should be modified to an adjustable gate activated by rack and pinion drive. The continuation of the flow control structure operation is recommended to provide for optimum drainage.

5.4.2.8 Roberts Drain

Constructed in 1968 to serve an area of 275 hectares and equipped with twin PPF 12/14 and more recently upgraded by fitting of a new PPF 15/18 pump and repowering the remaining PPF 12/14 with a dual-speed motor.

Data

Total discharge (25,000 + 18,000)	43,000 l/min
Drainage capability	22.52 mm/24 hr
Pumping control range	minus 200 mm to 400 mm above MSL

Addendum

Further lowering of pumping levels is not recommended due to significant spring inflow to the system, and level control provided by the Wairau Bar Road culvert invert levels.

This drainage system is acknowledged as having habitat values (whitebait) and the gravity floodgates have been modified to hinge from the side. Machine maintenance of the outfall drain to the Wairau River is critical to the operation of the drainage system

5.4.2.9 Tuamarina Lagoon

Constructed in 1970 and equipped with one high capacity PPF 12/14 pump.

The pump station has been modified with larger pump forebay and extended decking slabs (1990) and further structural works are not necessary. Significant lagoon storage is available but pumping rate is low considering the location and hill run-off. More recently fitted with a PPF 15/18 pump.

Data

Pumping capability	25,000 l/min
Drainage capability	22.6 mm/24 hrs
Pumping control range	2.5 metre to 3.5 metre above MSL

5.4.2.10 Parkes Bros

Constructed in 1970 this station is equipped with a MacEwan 300 millimetre diameter pump installed at 25 degrees to the horizontal as motive power was originally intended to be by diesel motor. More recently modified to incorporate a standard PPF 12/14 axial flow pump.

Data

Pumping capability	17,400 l/min
Drainage capability	22.6 mm/24 hr
Pumping control range	3.0 m to 3.0 m above MSL

5.4.2.11 Thomas Road

Constructed in 1970 and equipped with twin PPF 15/18 pumps this station serves a drainage area of 192 hectares. The drainage capability obtained from the combined pumping of Pembers and Thomas Road pumps is the highest in the rural area at 25.60 millimetres in 24 hours for the 460 hectare catchment.

Data

Pumped discharge	59,100 l/min
Drainage capability	25.60 mm/24 hrs
Pumping control range	700 mm to 1200 mm above MSL

5.4.2.12 Blind Creek

This structure was built as part of the above Thomas Road scheme and was intended to transfer a pre-determined amount of drainage water to Thomas Road during Wairau River floods.

A new pumping facility has recently been commissioned at this site and the transfer of drainage water to Thomas Road discontinued. A single PPF 15/18 axial flow pump is fitted.

Data

Pumped discharge	25,000 l/min
Pumping capacity	19.3 mm/24 hrs
Pumping control range	800 mm to 1400 mm above MSL

5.4.2.13 Woolley and Jones

Constructed in 1972 to serve an area of 300 hectares of farmland and is equipped with twin PPF 12/14 pumps fitted with dual speed motors. Staged pumping capability between 9,000 and 36,000 litres per minute and the pumphouse.

Data

Existing pumped discharge (maximum)	36,000 l/min
Existing drainage capability	17.3 mm/24 hrs
Pumping control range	MSL to 400 mm above MSL

5.4.2.14 Pukaka Pondage

Constructed in 1972 to serve an area of 120 hectares and equipped with a single high capacity PPF 12/14 pump with a maximum discharge of 17,500 litres per minute. More recently upgraded with a PPF 15/18 pump.

Data

Pumping capacity	25,000 l/min
Drainage capability	29.80 mm/24 hrs

No upgrade needed at present.

5.4.2.15 Grovetown Southern and Northern

The southern pumping station was constructed in 1961 to serve an area of 1,200 hectares. It also includes the small township of Grovetown, but stormwater from this source is a minor component of runoff. This station is the largest operated by the Council and is equipped with twin PPF 18/22 pumps with maximum discharge of 74,000 litres per minute.

The improved drainage efficiencies from regular maintenance and culvert upgradings the run-off is being rapidly transferred to the low lying Grovetown area which has undergone intensive residential development. The Grovetown lagoon provides considerable storage to buffer flood flows. If Grovetown lagoon levels exceed pumping output capability then these floodwaters irreversibly overtop Steam Wharf road and into the Woolley and Jones catchment downstream.

A similar sized northern pumping station has been recently constructed in 2000.

Data

Combined discharge	148,000 1/min
Drainage capability	17.6 mm/24 hrs
Pumping control range	300 mm to 900 mm above MSL

5.4.2.16 Watsons Road

This pump station was constructed in 1984 to drain a rural catchment of 140 hectares and to provide for the discharge of excess stormwater from the township of Spring Creek. The station is equipped with one PPF 12/14 pump fitted with dual speed motor with a maximum capacity of 18,000 litres per minute.

A PPF 15/18 pump is also installed and has a pumped capacity of 25,000 litres per minute and is only operational if significant storm flows eventuate from Spring Creek.

Data

Existing maximum pumping capacity	43,000 l/min
Existing drainage pumping capacity	18,000 l/min
Existing drainage capability PPF 12/14	18.5 min/24 hrs
Existing overall pumping capability	44.2 mm/24 hrs
Pump control range	N/A

Addendum

An important feature of the system is the provision of storage for run-off water within a "control environment" in the event of a major spillage of contaminants from the industrial area of Spring Creek. Supplementary slide gates and weir controls are recommended for installation to provide for this controlled situation.

5.4.2.17 Tuamarina (Pioneer Place)

A small submersible Flygt pump was installed in an existing stormwater manhole in 1995 to pump excess storm runoff directly to the river when gravity outfalls were closed by high river levels. These works were undertaken primarily to remove runoff from the State Highway and to reduce surface flooding of residential properties and the Tuamarina Hall.

Electrical starting equipment is mounted at ground level and discharge piping is of steel fabrication and installed over the Tuamarina River stopbank. A debris screen is located within the drainage channel prior to the entry to the manhole and piped floodgated outfall and roadside litter is prevented from entering this outfall system.

Existing pumping capacity	50 litre/sec.
Drainage capability	N/A
Pump Control Range	N/A

5.4.3 Floodgated Gravity Outlets

A total of 249 floodgated gravity outlets have been installed under river stopbanks and now form an historic and integrated part of the drainage and flood protection network.

A significant number of floodgated culverts exist within the river stopbanking systems on the lower plains. A total of 249 floodgated outlets have been installed to provide flood protection from high river levels for the drainage district.

In summary the floodgated outlets by type are as follows:

Pumping station outlets	25
Fibreglass floodgates	24
Side hung wooden gates	16
Steel "Top Hung" MacEwan type	172
Concrete "Top Hung"	12
Outlet total	249
(Individual floodgate total)	305

An investigation of the methodologies and effectiveness of floodgate mechanisms is warranted with a view to assisting fish passage where possible without compromising flood protection standards.

Detailed analysis is required of methodology and effectiveness of gravity floodgate operation to rivers and comparison between side hung gates, top hung steel, top hung fibreglass for the purposes of whitebait spawning at specific locations.

Proposed new works:

The inventory of floodgates is currently being assessed for condition and appropriates including such factors as condition, appropriateness and security.

Once the gates have all been assessed, and any emergency repairs completed, the gates will be scheduled for renewal and upgrade as required including some of the older concrete headwall structures.

Capital funding has been provided from year 4 of this plan to do this work.

Note: The previous 2008 version of this plan estimated that for safety and effectiveness and ecological reasons some 20 new fibre glass gates, 20 new gabions outlet headwalls, three new side hung floodgates, and five new steel floodgates are desirable and a further five "Penstock" type gates are installed to provide supplementary flood protection at sites where failure of a floodgate is likely to cause substantial flooding.

5.5 Urban Stormwater Disposal

5.5.1 Channel Network

5.5.1.2 Blenheim

The small urban watercourses of Murphys, Fultons, Town Branch, Waterlea, Wither, etc receive stormwater from a piping reticulation network to subsequently discharge through pumping stations or gravity into the main rivers of the Taylor, Opawa, and Riverlands Co-op. A total of eight flood mitigation pumping stations directly serve the town with a further two joint rural and urban pumping.

Even where the channels are of adequate capacity there are situations where a lack of room requires that the banks be stabilised by gabions or concrete walls or rock rip rap.

Detailed analysis of the expected stormwater runoff into these watercourses has recently commenced as part of a Blenheim interdepartmental stormwater strategy investigation.

Murphys Creek was reviewed in 2006, and more recently in 2012/13 with regard to waterway capacity and has been shown to be adequate for all likely stormwater discharges into it from present development. However a diligent ongoing aquatic weed management programme is required!

In 2012 a large new stormwater main was constructed down Middle Renwick Road to provide initially for the Westwood commercial development and ultimately urban growth on the west of Blenheim. This pipe is currently only consented for the Westwood flows.

Significant analysis including flow modelling, including an analysis of Taylor River back water levels to assess likely impacts of additional flow from the growth area of the catchment at full development. Similar work is underway to look at the likely impacts of water quality and ecological habitat of proposed additional stormwater. This work includes significant consultation with residents adjacent to Murphys Creek. At the completion of this study a decision will made on what, if any, additional stormwater discharge resource consent will be applied for. The alternative is to extend the Middle Renwick Road stormwater pipe all the way to the Taylor River.

For either option the Rivers Section management of Murphys Creek will be essentially unchanged. Even with additional stormwater discharge at Middle Renwick Road no channel or culvert upgrades are required. The key management issue will be to continue an appropriate and regular aquatic weed and riparian vegetation control and deal with any minor bank erosion issues promptly.

Fultons Creek has been reviewed in 2006 with regard to waterway capacity and has been shown to be adequate for probable stormwater discharges into it, though a detailed analysis of the likely stormwater discharges into Fultons Creek taking into account the new western rezone areas has not yet been carried out. Preliminary analysis indicates that with appropriate development this provides for onsite detention storage of stormwater any necessary upgrades of Fultons Creek will be minor.

Town Branch Drain network (including Alabama and de Castro drains) has been shown by preliminary examination to be well under capacity for the existing stormwater discharges into it, let alone desirable new discharges into it.

A detailed investigation is currently underway. The hydrological analysis is complete including a preliminary look at upgrade options. A detailed computer hydraulic model is currently being built that links the pipe network in town with the open channel outfall network. The model will be used to assess the design requirements for the various upgrade options and enable more accurate costings. The option analysis is due to be completed by June 2015 with a recommendation on a preferred option for implementation.

The likely outcome is channel upgrades over some sections of Town Branch Drain, alterations to the Tremorne Avenue Drain outfall, an additional outfall pipe to the Opawa River possibly via the Snowdens Drain outfall and additional storage/pumping capacity to deal with outflow during periods of High Opawa River levels.

The upstream Redwood Street pipe network will be upgrade (size and renewal of key trunk main down Redwood Street and feeder mains) and outfall flow split amended to the adopted preferred upgrade option.

Preliminary estimates suggest that the upgrade of the key trunk main pipes, Town Branch drain channels and outfalls to the Taylor and Opawa Rivers will cost somewhere between 5 and $10 million.

Waterlea Creek - A preliminary investigation indicates that the stream is of adequate capacity unless there is more urban development of the catchment. In addition the Waterlea Creek pump station has been upgraded to provide adequate capacity and ability to operate before Nelson Street is closed due to surface flooding from the Taylor River.

Wither Stream - A 1991 review resulted in a major channel upgrade and the construction of a flood detention pond on the Harling Park tributary. The upgrading works were carried out in 1992/93. Flood levels from more recent floods indicate that a 1 in 50 year return period is likely to be greater than assessed in 1991. More investigation is required of this, but this is currently a low priority work item

Camerons Creek was shown by a preliminary study in 2002 to require upgrading works in the likely event of urban development of the catchment.

The hydraulic capacity of Camerons Creek was further reviewed in early 2014 as part of a study to better determine Old Fairhall/Camerons Creek upgrade requirements should the catchments of both these waterways be rezoned from Rural to residential. The key outcomes of the study for Camerons Creek included;

- The existing culvert under Battys Road would need upgrading including to allow for the sewer main crossing that substantially reduces existing culvert capacity.

- Consideration should be given to lowering the old Fairhall outlet culvert to improve efficiency and provide for fish passage.

- A new pump station will be required to provide outfall during infrequent periods of Taylor River/Doctors Creek flooding in the event of significant further development in the catchment.

The proposed rezone of the upper catchment from rural to residential (PC 70) was turned down by the hearing Commissioner, so none of the above improvements is proposed for the near future. Staff however took the opportunity to work with the developer doing a 6 section development at the end of Purkiss Street to obtain appropriate river reserve including room for a future pump station, upgraded the Old Fairhall stopbank and tidied the Camerons Creek outfall.

Caseys Creek requires a major outfall channel upgrade to enable development of the Blenheim North rezone areas – Plan Change areas 64, 65 and 67. Investigation and preliminary design of the required works is underway. Preliminary information of the likely scope of works is as follows:

- Upgrade of most private driveways to from the Deluxe Motors property downstream to equivalent of 1.8 m culvert. About 12 required.

- New 90 m outfall pipe require under upper Opawa stopbank including inlet and outlet headwalls and floodgating.

- Adjustments to the existing pump station including two new 450 mm pump outfall pipes including lengthening by about 25 m.

- Regrading of outfall channel from just upstream of the existing Waipuna Street culvert to Opawa River confluence.

- Channel cross section upgrading of the section of channel within the Upper Opawa floodway. This has been allowed for in the development of the adjacent sports fields.

- Channel stabilisation (both sides) over most of the 1150 m length of channel that is parallel to old Renwick Road.

The aim is to have the preliminary design and scoping work including consultation with Marlborough Roads, Marlborough Lines and key adjacent landowners complete by June 2015. All going well it is intended to apply for the necessary resource consents for both the stormwater discharge and outfall upgrade works in the latter part of 2015.

The total estimated cost of the upgrade works is about $1.8 million to be largely funded by a zone levy.

Main References

"Murphys Creek Hydraulic Analysis" Council internal report. K J Christensen January 2007.

"Fultons Creek stormwater" Application for resource consent based on a report of T H Jenkins June 1997.

"Fultons Creek Flood Flows upstream of Murphys Road" File memo. E B Williman December 2006.

"Town Branch Drain Stormwater Investigation Brief" Memo to Connell Wagner. E B Williman January 2008

"Wither Stream Report" Report to Council. Davidson Ayson Consulting Engineers February 1991.

"Camerons Creek Study" Report to Council. Davidson Partners April 2002.

"Urban Expansion in Western Blenheim & Required Channel Works, L Kuta internal report, May 2014

New works

Upgrading of Town Branch Drain network and Caseys Creek to meet existing and future growth requirements.

5.5.1.3 Other urban stormwater streams

Riverlands Industrial (Industrial Estate):
The Riverlands industrial drain ability to drain the Industrial Estate was examined in 2002 and as a result a new pumping station was constructed at the discharge exit to the Vernon lagoons and other channel upgrading activities. With rezoning of more land in the area to Industrial a further review was carried out in 2006. The resulting channel upgrading work is essentially complete.

School Creek (Renwick):
A review was carried out in 1993 resulting in diverting the upper rural part of the catchment direct to the Omaka River and an upgrade of the channel to carry the urban stormwater flow. No new works are envisaged.

Terrace Creek (Renwick):
An analysis of Terrace creek hydraulics has been carried out in 2008 and the capacity of the channel shown to be sensitive to assessments of likely stormwater runoff, especially soakage to groundwater. Further investigation is required to determine if any channel works are required. This investigation will need to take into account the proposed rezoning of the Renwick lower terrace area to large lot residential and consequent need for greater control and regular maintenance of the outfall channel. It is proposed to commence the lower terrace flood hazard investigation in 2015/16.

Endeavour Stream (Waikawa):
Urban expansion of Waikawa required analysis of this stream system with the required upgrade costs being met by the developer. No new works are expected unless there is further urban development, and if so the costs are likely to be met by the developer.

Picton/Waikawa Minor Creeks:
The various minor creeks carrying urban stormwater in Picton and Waikawa are likely to need upgrading work. Such work will need interface with the pipe stormwater network controlled by another section of Council.

Main References.

"Riverlands Industrial Estate Design flood Level update" Internal report. K J Christensen August 2006.

"Waikawa Hydrological Assessment and Hydraulics of Endeavour stream" Internal report. K J Christensen April 2004.

"Upper Terrace creek Capacity report" & "Lower Terrace Creek Capacity report. Opus International Consultants. March and June 2008.

"Growing Marlborough – Renwick" report to the Regional Planning & Development Committee, August 2014.

5.5.1.4 Schedule of watercourses maintained for urban stormwater purposes.

The below table is a summary of watercourse and drain classification and ecological management categories, with abbreviations as described previously.

Watercourse and Drain Classification for Weed Management							
Waterway	**Length (m)**	**Drain Size**	**Catchment draining to**	**Outlet Type**	**Flow Regime**	**Grade**	**Management Category**
Industrial Drain	750	large	Riverlands	G	PF	very flat	D
Riverlands Industrial 0-1529	1529		Riverlands				A
Riverlands Industrial 1529-5120	3589	large	Riverlands	G	PF	very flat	D
Snowdens	905	medium	Riverlands	G	E	very flat	C
Adams Lane	160	small	Stormwater Blen	G	UD	flat	C
Caseys Dr A	2535	large	Stormwater Blen	PA	PF	flat	B
Caseys Dr B	1207	medium	Stormwater Blen	PA	E	flat	C
Chinamans Dr	160	medium	Stormwater Blen	G	PF	flat	B
Cooper & Morrison		medium	Stormwater Blen	G	UD	flat	C
Fultons Creek 0-200	200	large	Stormwater Blen	G		flat	A
Fultons Creek 1018-1368	350	large	Stormwater Blen	G		flat	A
Fultons Creek 200-718	518	large	Stormwater Blen	G		flat	A
Fultons Creek 2515-4005	1488	large	Stormwater Blen	G	UD	flat	C
Fultons Creek 368-1911	543	large	Stormwater Blen	G	E	flat	A
Fultons Creek 718-1018	300	large	Stormwater Blen	G		flat	A
Fultons Creek 911-2515	604	large	Stormwater Blen	G	UD	flat	A
Murphys Creek	2090	large	Stormwater Blen	G	PF	flat	A
Old Renwick Road	645	small	Stormwater Blen	G	UD	flat	C
Taylor berm - Bank Street	50	medium	Stormwater Blen	G	PF		B
Taylor berm - Dashwood Street	50	large	Stormwater Blen	P	PF		B
Taylor berm - High Street	50	large	Stormwater Blen	P,G	PF		B
Taylor berm - Murphys Creek	150	large	Stormwater Blen	G	PF		B
Taylor berm -Fultons Creek	50	large	Stormwater Blen	G	PF		B
Taylor berm- Waterlea Creek	30	medium	Stormwater Blen	P,G	PF		B
Waterlea racecourse Ck	545	medium	Stormwater Blen	P,G	PF	flat	B
Alabama Rd	1045	large	Stormwater Blen	P	PF	very flat	D
De Castros	220	medium	Stormwater Blen	P	UD	very flat	C
Railway	300	medium	Stormwater Blen	P	UD	very flat	D
Rileys	725	medium	Stormwater Blen	P	PF	very flat	D
Town Branch	2055	large	Stormwater Blen	P	PF	very flat	D
Town Abattoir Br	720	large	Stormwater Blen	P	PF	very flat	D

5.5.2 Urban Pumping Stations

5.5.2.1 Alabama Road (Blenheim Urban and Rural)

Constructed in 1963 to serve a combined rural (140 ha) and urban Blenheim (80 ha) catchment and equipped with twin PPF 12/14 pumps.

The station is powered with dual speed motors for each pump giving total flow rates of 28,000 litres per minute (low speed) and 38,000 litres per minute (high speed).

This drainage area is an integrated component of the Town Branch System drain network which is also served by the Abattoir Pumping Station discharging to the Opawa.

Observations on recent floods and computer hydraulic modelling show that the pumping capacity of the station is well under size, and an upgrade to deal with increasing urban stormwater runoff is required.

Data

Existing low speed discharge	28,000 l/min
Existing high speed discharge	31,800 l/min
Pump control range	N/A
Drainage capability (rural and urban)	
Existing overall rate	36.5 mm/24 hrs

5.5.2.2 Caseys Creek

Constructed in 1970 to serve a rural area of approx 120 hectares and a more recent urban area of 10 hectares and potentially increasing urban area. Equipped with two PPF 12/14 pumps. The drainage rate in excess of 20 millimetres per 24 hours appears reasonable but any overspill escapes into urban areas to the south. The increasing urban component also needs to be catered for.

An upgrade is desirable. Pumping capacity can be increased by installing a third PPF 12/14 pump with a higher speed motor.

Pump forebay and debris screen area also require modification to the adjusted standard of 6.0 metre screen width. The gravity culvert intake requires incorporation within the screened area to provide for the screening out of roadside rubbish and debris and for the prevention of deposition of rubbish within the Opawa River system.

Data

Existing pumped discharge	24,000 l/min
Existing drainage capability	18.4 mm/24 hrs
Pumping control range	N/A

Addendum

Gravity drainage to the Opawa River is available except during major flood events. Normal maintenance routines are required and no ecological factors of any significance have been noted.

5.5.2.3 Town Branch Drain (Abattoir)

This pump station was constructed in 1983 to serve a 50 hectare rural area and also serves an urban eastern Blenheim of some 150 ha. The station is equipped with twin PPF 15/18 pumps with a capacity of 54,000 litres per minute and also provides for emergency pumping of borough sewage to the river.

Observations on recent floods and computer hydraulic modelling show that the pumping capacity of the station is barely to size, and an upgrade to deal with increasing urban stormwater runoff is needed especially if there is further urban development. Further investigation of this is required, including the option of partial diversion to the Snowdens drain and the construction of a completely new pumping station on that drain. Any major new urban development would be required to fund such a new pumping station.

Data

Existing pumped discharge	54,000 l/min
Pump control range	N/A

Addendum

Stringent drainage maintenance regimes are necessary within the drainage system to provide for optimum flows and water level control adjacent to the urban area of Blenheim.

5.5.2.4 High Street Aviary - (Blenheim Urban)

This station was originally constructed in 1953 with a pump of 450 millimetre diameter axial flow type with a capacity of approximately 25,000 litres per minute serving an 80 hectare urban catchment encompassing the commercial area of Blenheim. The basic design of the pump forebay and screen area is inadequate.

Data

Existing discharge	25,000 l/min
Existing discharge capability	35.9 mm/24 hrs
Pumping control range	N/A

The station is not up to capacity to deal with the required stormwater runoff coincident with high Taylor River levels. A review is underway as part of the interdepartmental stormwater strategy.

5.5.2.5 Main Street (Blenheim Urban)

This pump station was constructed in 1953 and serves an urban catchment of 40 hectares and has low pumping capability. The pump forebay and debris screens are inadequate. The pipelines serving the pump station have been enlarged in size and major upgrading of the pumping is required. A review is underway as part of the interdepartmental stormwater strategy.

Data

Existing pumped discharge	7,000 l/min
Existing pumping capability	25.0 mm/24 hrs

5.5.2.6 Redwood Street (Blenheim Urban)

This station was constructed in 1953 and is equipped with a mild steel fabrication 450 millimetre diameter pump with a capacity of 25,000 litres per minute serving an urban catchment of some 130 hectares. The drainage capability is 30 millimetres in 24 hours which is low.

A full upgrading of this station is considered necessary. A review is underway as part of the interdepartmental stormwater strategy.

Data

Existing pumped discharge	25,000 l/min
Existing drainage capability	27.7 mm/24 hrs
Pumping control range	N/A

5.5.2.7 Monro Street (Blenheim Urban)

Constructed in 1963 to serve a primarily urban catchment of 40 hectares and equipped with two PPF 12/14 pumps.

Data

Existing pumping discharge	24,000 l/min
Existing drainage capability	86 mm/24 hrs
Pump control range	N/A

Addendum

Pumping capability at 86 millimetres in 24 hours appears adequate but pumphouse forebay area and debris screen width are inadequate and should be modified. As with Waterlea Creek, the adjacent gravity culvert (floodgated) should be incorporated within the new pumping forebay to provide for screening out of debris and rubbish to prevent deposition of unwanted material within the river system.

5.5.2.8 Waterlea Creek (Blenheim Urban)

Constructed in 1961 and equipped with twin 300 millimetres diameter pumps this station potentially serves an urban area of 120 hectares including Waterlea Racecourse and Park. Partially upgraded in 2007/8, and this upgrading needs to be finalised.

Total Discharge

PPF 12/14	12,000 l/min
2 new PPF 15/18 pumps	50,000 l/min
Proposed total discharge	62,000 l/min
Proposed discharge capability	74.4 mm/24 hrs

An important feature of this outfall point is the amount of debris, rubbish and weed that are discharged into the Taylor River system. The debris screens serving the flood pumping station will also screen the gravity outfall and preclude the deposition of urban rubbish within the river system.

5.5.2.9 Andrew Street (Blenheim Urban)

Constructed in 1964 to serve an urban catchment of 44 hectares and equipped with twin PPF 9/10 pumps.

The pumping rate of 57 millimetres in 24 hours is marginal and problems of street flooding are known to exist. The pumphouse forebay and screened area presently provided is inadequate and difficult to clean and modified and extended debris screens are also necessary. It is cost-effective to incorporate a new pumping sump within the modified forebay and this will enable the fitting of a third pump (PPF 12/14).

Data

Existing pumping capacity	17,500 l/min
Existing drainage capability	57 mm/24 hrs
Pumping control range	N/A

Recommendation

To fit an extra PPF 12/14 pump in a new pumping sump.

Proposed total discharge	27,500 l/min
Proposed drainage capability	89 mm/24 hrs

5.5.2.9 Boyce Street (Springlands) (Blenheim Urban)

This pump station was built in 1992 to serve the Springlands area. The pumping equipment comprises two PPF 15/18 pumps with a total pumping capability of 36,000 litres per minute.

The duty requirement of this station is such that the drainage capability of 75 millimetres in 24 hours is indicative only as the contributing area is unclear, and the performance may be much better than this.

Data

Existing pumping capacity	36,000 l/min
Existing drainage capability	75 mm/24 hours

Pumping control range	N/A

5.4.2.10 Probable new works – Blenheim pumping stations

Several of the Blenheim urban pumping stations need major upgrades to achieve the required level of service, and others more minor upgrades. Those requiring major upgrades are Main Street, Redwood Street, Alabama Road, and High street. A new pumping station on Snowdens Drain is likely to be preferred to a major upgrading of Abattoir pumping station on the Town Branch Drain network. Minor upgrading is required for Caseys Creek, Andrew Street, Monro Street and Waterlea Creek.

There is also a need to install telemetry equipment at most of these pumping station sites.

Further detailed investigation of the details of the required upgrading is underway as part of the interdepartmental stormwater strategy.

5.5.2.11 Riverlands Industrial Pumping Station

A new pumping station was built in 2004 for a combined Riverlands Industrial 52 ha and. Rural 280 ha catchment.

The station is equipped with two PPF 18/18 and one PPF 12/14 axial flow pumps.

Data

Existing pumping capacity	
Low level pump 1 PPF 12/14	13,000 l/min
pump 2 PPF 18/18	32,000 l/min
pump 3 PPF 18/18	32,000 l/min
Drainage capability	N/A
Pumping control range	Start MSL Stop – 200 m

5.5.2.12 Riverlands Industrial Estate

The Industrial Estate road network has been designed as a ponding area with some secondary overflow paths when levels are particularly high. Including the storage and flow routing provided by the road storage is very important in controlling levels in the Industrial Estate.

5.5.2.13 Picton (Dublin Street Pumping Station)

This station was upgraded in 2006 and is now equipped with two PPF 18/18 pumps.

Data

Existing pumping capacity 70,000 litre/min	
Drainage Capability	N/A

5.5.3 Urban Floodgated Outlets

Due to the probability of major flood flows into the Taylor River there is potential for extensive damage to occur within this area should flood protection structures malfunction or fail. Outlets are itemised in more detail as follows: For these important locations penstock gates are recommended as in effect a double floodgate to provide flood protection.

Waterways for which these penstock gates are desirable are Redwood Street Pumping Station, High Street Pumping Station, Leeds Quay, Auckland Street, Waterlea Creek, Andrew Street Pumping Station, Fultons Creek, and Murphys Creek.

5.6 Gibsons Creek System

River intakes from the Wairau River supply old ephemeral floodplain channels of the Waihopai and Wairau River which have been upgraded and need maintenance.

Both intakes consist of a river entry point that leads via a supply channel to control gates located where the channels pass through the river stopbanks. The Wairau intake is for up to 2.5 m³/sec, and the Waihopai one for up to 1.2 m³/sec.

The two abstraction channels join to one channel some 3.5 km from the Waihopai intake, and 1.5 km below the Wairau intake.

The combined Gibsons Creek channel then takes up to 2.7 m³/sec for a kilometre before it divides into a north branch and a south branch. A dividing structure proportions the flow 60% south channel (1.6 m³/sec) and 40 % north channel (1.1 m³/sec). The channels each flow some 6 km before joining again. The northern channel also supplies 0.1 m³/sec a far north channel that flows some 3.5 km before re-joining the north channel again. The south channel supplies the Southern Valleys Irrigation Scheme with up to 0.9 m³/sec.

The single combined Gibsons Creek channel then flows a further 6 km before joining the Upper Opawa River.

These river abstractions need to be kept operable on a 24 hours a day seven days a week basis within the constraints of the resource consents. All the components need to be maintained to adequate capacity and standard including removal of silt build up in the channels.

The system has more than enough capacity to supply the needs of the SVIS and the groundwater recharge that occurs. No expansion is expected.

5.7 Waitohi and Waikawa Rivers

This includes:

1. Waikawa River
2. Waitohi River
3. Kent Street Creek

5.7.1 Waikawa River

Channel characteristics (typical)

Type	:	Narrow incised channel through urban area.
Length	:	1 km
Channel Width	:	18 m
Slope	:	0.14% (1 in 70) Confluence
Design Flood	:	70 m³/sec Design Freeboard 0.6 m.

5.7.1.1 Issue: Sedimentation

In heavy floods gravel is brought down from upstream, compromising flood capacity. Such sediment is difficult to remove due to limited riparian access. A gravel trap has therefore been constructed upstream of the urban section of channel.

5.7.1.2 Issue: Waterway capacity and channel width

Waterway capacity has been achieved by excavation of this reach and design flood levels are below ground level.

The required waterway capacity is achieved by ensuring an adequate width of channel. The required width of 18 metres has been achieved over much of the channel, these lengths of channel being in Council ownership. There are two short reaches that the channel width is only 14 metres. Negotiations are well in hand to purchase this land – some under multiple Maori land title- so as to enable the channel to be excavated to its required width.

5.7.1 Waitohi River

Channel characteristics (typical)

Type	:	Narrow incised river through urban area and reserve land.
Length	:	1.5 km
Channel Width	:	25 m
Slope	:	0.07% (1 in 150) Confluence.
Design Flood	:	90 m³/sec Design Freeboard 0.4 m.

5.7.1.1 Issue: Inadequate capacity of triple culvert under wharves

The Waitohi River outlet to Picton Harbour passes through a 320 metre long culvert under the railway sidings at the port. It was constructed in 1970 by the then Marlborough Harbour Board to enable the port to be developed for the interislander ferry. This culvert is of limited capacity and has resulted in flooding of the upstream industrial area occurred in July 1998 and February 2004.

The culvert is now owned by Port Marlborough Ltd.

The culvert and has three barrels, each 3.86 m wide by 2.05 m high. The ceiling is constructed using double-T units, which severely restrict the flow as soon as the water surface touches the ceiling. Based on examining a range of hydraulic conditions, the capacity of the existing culvert is estimated at 65 m³/s. before flooding of Picton urban industrial area would occur.

Flood flow assessments show that credible 50-year return period flood estimates range from 70 to 110 m³/s, with a middle value of 90 m³/sec. The 50 year standard is that prescribed in the Building Act. MDC's preferred design flood standard is the 100-year flood which is 10% higher than the 50-year flood estimate. The February 2004 flood of 130 m³/s was assessed as a 200-year return period event.

Flood detention storage at the rugby grounds has been estimated to absorb some 5 m³/s off a flood peak. Therefore, the existing culvert plus an allowance for flood detention could accommodate a peak flood flow of 70 m³/s. Based on the hydrology of the upstream catchment MDC wish to have the culvert upgraded to a minimum of 85 m3/s to accommodate a peak flood flow of 90 m³/s, otherwise planning restrictions may have to be imposed on new buildings in the Picton urban industrial zone. An upgrade size of 120 m³/sec (1 in 100 year flood) would be even better.

Various options of greater or lesser flood improvements have been looked at because of the high costs involved and the wide range of cost/benefits of the different options.

5.7.2.2 Issue: Flow constriction - Canterbury Street Bridge and sewer/weir

A flow constriction exists at the Canterbury Street Bridge due to the small capacity of the bridge and a weir immediately upstream. The weir is to protect a gravity sewer line just below the surface. To get rid of this constriction requires lowering or raising the sewer line and installing a sewer pumping station. It also requires a new bridge. A partial alternative to this is to define the surrounding riparian land as being a flood hazard with limitations as to its use.

5.7.2.3 Issue: Flow constriction - building foundation

A flow constriction also exists where a subdivision occurred 30 years ago and the river has been substantially constricted to 10 metres width instead of the typical 20 metres. The

constriction is by earthworks for garden development and out buildings. No detailed investigation has been carried out, but the only practical solution appears to be the removal of the constriction, which will also involve land purchase negotiations.

5.7.3 Kent Street Creek, Buller Street Branch

Channel characteristics (typical)

Type	: Narrow channel through urban area.
Length	: 1.2 km
Channel Width	: 5 m
Slope	: 0.17% (1 in 60) Confluence.
Design Flood	: 15 m³/sec

5.7.3.1 Issue: waterway capacity

The channel is only about half the size required to carry the design flood. Most road culverts are undersize as is the channel itself as it passes through urban properties. Upgrading works will require major enlargement of culverts and structural banking of the channel. A more detailed investigation is currently underway with consultants to define engineering options and costs.

5.7.4 New Works Required

Expensive engineering works are desirable to upgrade the Waitohi River and its tributary the Kent Street Creek. Preliminary estimates of costs are in the millions. Further investigations are underway to refine the costs. A budget for the work has yet to be approved by Council.

An alternative option for Council is to define the affected area as having a flood hazard, with restrictions on minimum floor levels for new buildings. This much less expensive option represents a substantial drop in level of service provided and may not be acceptable to the community.

5.8 Floodway Reserve Land

5.8.1 Introduction.

Council floodways are located on the 20,000 hectare Wairau floodplain downstream of the Wairau confluence. The purpose of these floodways is to carry flood waters without scouring its stopbanks. The floodway consists of the active non vegetated river channel and vegetated berms. The vegetated berms only flow during flood time.

The need to manage the active river channel to readily carry flood flows is obvious.

Careful management of the floodway berm land is also required. This care is required as to the degree and type of vegetation required at the location; and the degree of earth works and banking; including not allowing solid fencing.

The floodway land is a combination of public and private land. Council river management restrictions on private land may constrain the aspirations of the land owner for the land. Council ownership of the floodway land is the appropriate solution where there is potential conflict between the Council and the land owner.

Public land includes Crown riverbed, crown marginal reserves and other reserves. Some is controlled by DOC, other land by LINZ. LINZ and DOC have indicated that they are generally comfortable with Council river management policies for the floodways.

Council controls a considerable amount of land by direct ownership as a reserve or in freehold title; or as a Crown reserve vested in Council, or as legal unformed road reserve, or as esplanade reserve, or an interest through an esplanade strip or other form of easement.

5.8.2 Floodway areas

The areas of the Wairau floodplain floodway land are shown in the below table.

		Area - hectares	
Floodway	**Council or Crown Owned**	**Privately owned**	**Total Area**
Waihopai	95	3	98
Wairau	1782	83	1855
Wairau Diversion	179	5	184
Lower Wairau	441	125	566
Omaka	37	24	61
Fairhall	27	15	42
Upper Opawa	124	175	299
Roses Overflow	73	21	94
Taylor	76	27	103
Lower Opawa	85	102	187
Riverlands & tribs	19	17	36
Spring Creek	30	10	40
Pukaka	8	7	15
Totals	**2976**	**614**	**3590**

These areas do not incorporate the potential for accretion or erosion where the legal boundary is a riverbed boundary.

5.8.3 Secondary Land Use of Floodways

Much of the floodway land comprises active river channel, or tree plantings for bank erosion protection, or is land occupied by the stopbanks.

However there is some 950 hectares of Council owned floodway land for which there are secondary uses available.

Currently this land is used as

- Public amenity and recreation areas 115 hectares
- Council owned production/protection forestry 167 hectares
- Commercial lease 641 hectares
- Ecological plantings 26 hectares

5.8.5 Issues

5.8.5.1 Further floodway land purchases

In various areas Council needs a higher degree of floodway management than the private landowner is comfortable with. The Upper Opawa and Riverlands Co-op floodways are examples of such rivers. There is a need for Council to carry out further floodway land purchases in these situations.

5.8.5.2 Council access for maintenance beside drains and small watercourses

The majority of small watercourses and channels managed for public drainage purposes or urban stormwater are on private land and only a third is on Council reserve or road reserve. With the increased value of land, a change of land of land use type, and a changing public attitude it has become more contentious for Council to expect free access maintenance. It is therefore desirable to acquire more robust riparian access arrangements by

- Local Purpose Reserves (Drainage) be created where access is necessary, or
- Entry easements or right of ways be created as appropriate, or
- Land acquisition be undertaken where required by property owners.

5.8.5.3 Land Management maintenance costs

There are various costs associated with management of floodway land.

Commercial leases are self-funding, as is commercial forestry.

Other costs are:

- Fencing, roading, land preparation for non-profit making leases – sports clubs etc.
- Land preparation, sign posts, grass mowing, scrub control for public amenity and access.
- Planting, fencing and maintenance of ecological plantings.
- Noxious weed control.
- Good neighbour tree maintenance and removal of fallen trees across boundaries.

Regular inspections are also required to ensure that the floodway land is being utilised by lessees and the public in the manner that is intended.

5.8.5.4 Land management options

There are various options for secondary land use of much of the floodway land. This ranges from commercially profitable leasing, or forestry, to non-profit activities such as public recreational use or ecological planting. The attractiveness of the options change from time to time.

Council needs to be cognisant of the opportunities and constraints of the many and various pieces of floodway land. A database of all floodway land is maintained and staff are employed specifically to keep abreast of this issue.

5.8.5.5 Pastoral grazing of floodway land dirtying water etc

Pastoral grazing of floodway land is a common secondary land use. There is an issue of the animals potentially contaminating the watercourse and or damaging stopbanks and river control plantings.

The preferred grazing animals are sheep.

Cattle, deer, and goats will only be allowed to graze Council floodway lease land provided that they are adequately controlled by fencing, stocking rates or other means to prevent contaminating the water or damaging stopbanks or plantings.

6. Financial Summary

6.1 Financial Projections

6.1.1 Maintenance, Renewal, Flood Damage and Capital Items

River control assets are different from many other engineering assets. Rock work and earthworks – the majority of river control assets – do not deteriorate steadily with time. Damage to those items only occurs during floods. Otherwise the assets remain in good condition. Floods occur on an irregular basis.

There is no programmed renewal for rock work, stopbanks and most other river control assets. Instead 'maintenance' covers minor flood damage and 'provisional flood damage' covers major flood damage.

Apart from mechanical pumping station equipment, all other river control and drainage assets are presumed to be maintained in good working condition.

Depreciation is only used to fund mechanical pumping equipment. Maintenance costs, including flood damage, are presumed to maintain all other assets in perpetuity.

There is also capital works that deal with new assets.

6.1.2 Forecast Projections

The projected proposed financial projections for the next 10 years are shown in Table 1 and Table 2 for the various items. The projections are for the recurring annual maintenance and for new capital items. All costs are in $000s (2008). Maintenance costs are assumed to remain the same into the future, though there will the need for adjustments to cover inflation.

The costs are only the direct costs and do not include staff costs or other overheads.

Wairau Floodplain Floodways and Rivers	Annual mtnce	Revised capital 2008/9	Proposed capital 2009/10	Proposed capital 2010/11	Proposed capital 2011/12	Proposed capital 2012/13	Proposed capital 2013/14	Proposed capital 2014/15	Proposed capital 2015/16	Proposed capital 2016/17	Proposed capital 2017/18	Proposed capital 2018/19
Lower Wairau	77	400	200	70	70	70	70	70	70	70	70	70
Wairau Diversion	25	70	70	10	10	10	10	10	10	10	10	10
Wairau (Tua to Waihopai)	320	100	150	150	150	150	150	150	150	150	150	150
Waihopai below SH 63	17											
Omaka below Hawkesbury	17											
Roses and Upper Opawa	69											
Lower Opawa	95	20	30	30	30	30	30	30	30	30	30	30
Opawa Loop	22			0	0	0	20	20	20	20	20	20
Riverlands & Tributaries	53	130	10	20	20	20	20	20	20	20	20	20
Taylor Dam	16	70										
Taylor	132	20	20	40	40	40	20	20	20	20	20	20
Miscellaneous rivers	37											
Wairau gravel extraction	270	80	80	80	80	80	80	80	80	80	80	80
Provisional flood damage	250											
Total Wairau floodplain floodways	1449	890	560	400	400	400	400	400	400	400	400	400
Wairau Floodplain Tributaries	138											
Wither Soil Conservation	126		20	20	20	20	20	20	20	20	20	20
Wairau Floodplain Drainage	320	90	90	220	220	220	220	220	220	220	220	220
Urban Stormwater Watercourses												
Pumping Stations Blenheim	17	130	0	130	260	260	260	260	260	260	260	260
Blenheim & Townships streams	53	70	70	100	100	100	100	100	100	100	100	100
Picton/Waikawa minor streams	21		20	20	20	20	20	20	20	20	20	20
Total Urban Stormwater	90	200	350	380	380	380	380	380	380	380	380	380

Wairau Floodplain Floodways and Rivers Watercourses	Annual mtnce	Revised capital 2008/9	Proposed capital 2009/10	Proposed capital 2010/11	Proposed capital 2011/12	Proposed capital 2012/13	Proposed capital 2013/14	Proposed capital 2014/15	Proposed capital 2015/16	Proposed capital 2016/17	Proposed capital 2017/18	Proposed capital 2018/19
Gibsons Creek	53											
Floodway land management and purchase	80	250	250	250	250	250	250	250	250	250	250	250
Sounds Rivers (Waitohi, Waikawa, Kent)	42	400	600	600	600	600	600	600	600	600	600	600

6.2 Funding sources

6.2.1 Wairau Valley Scheme Differential Rating

A major source of funding is a differential rating scheme based on benefit to the each ratepayer. This funding source is used for all river and drainage works within the Wairau catchment. This includes the Wairau Floodplain Floodways, The Tributaries outside of the floodplain, the Wither Hills soil conservation, the lower Wairau floodplain Drainage, Blenheim and Wairau townships stormwater watercourses, Gibsons Creek, and floodway reserve land.

There are nine classes of protection.

In the rural area there are four categories

- Class A: Protected by stopbanks to a 100 year flood standard from Wairau and other flood plain tributaries and provided with drainage. (We have 150 km of drainage channels). Full rate of 100%.
- Class B: Stopbank protection as for 100 year flood but no drainage works required or provided. 63% of full rate.
- Class C: No stopbank protection provided, but significant bank edge stabilisation provided - includes land within floodways. 49% of full rate.
- Class D: Whole rest of catchment. Some channel clearing work otherwise just indirect benefit. 11% of full rate.

In the Blenheim urban areas there are also four zones.

- Class U1: Full stopbank protection etc to a 100 year standard from Wairau and Taylor and Wither Hills streams and pumping of stormwater in flood times. 87% of full rate.
- Class U2: Protected by stopbanks and flood detention dam from the Taylor and Wither Hills streams at 61%.
- Class U3: Protected from the Wither Hills streams 41 %.
- Class U4: Indirect benefit at 30%.
- Class R: For the rural townships of Renwick and Spring Creek 61%.

The boundaries of these rating classes are shown on the attached Figure 4. To be noted is that Class D -the area of indirect benefit – is not specifically depicted. It covers the whole of the 4000 km² Wairau catchment apart from the areas specifically shown as a higher class.

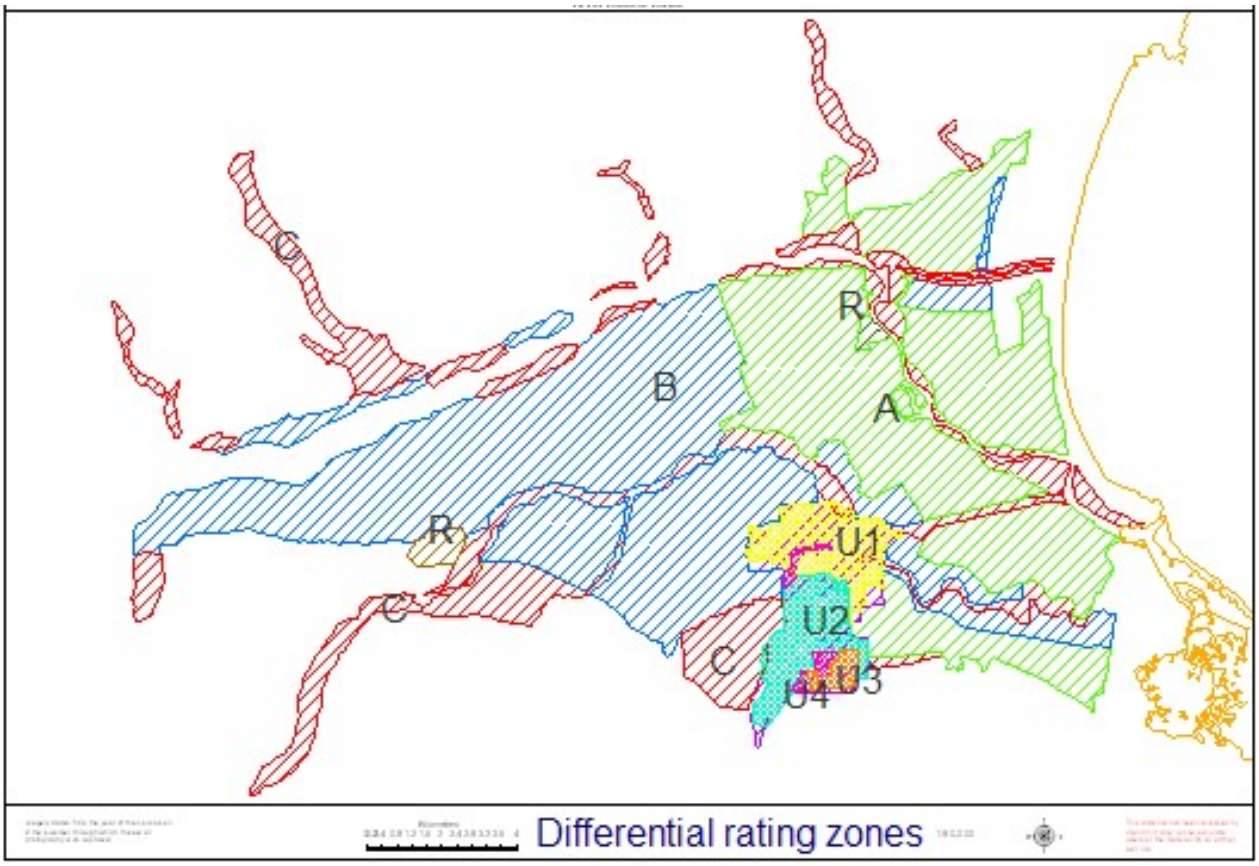

Figure 4: Rating zones for Wairau Valley (River Control) Scheme

6.2.2 Sounds Area Geographic Rate

The funding source for Picton and the Sounds river control schemes and stormwater water is as follows:

District-wide Rates Res/Rural	0.87%
District-wide Rates Com/Ind	0.13%
Geo Rate Ptn Res/Rural	36.42%
Geo Rate Ptn Com/Ind	9.81%
Geo Rate P/Vic Res/Rural	3.65%
Geo Rate P/Vic Com/Ind	0.12%
Geo Rate Gen Rur Res/Rural	47.21%
Geo Rate Gen Rur Com/Ind	1.79%

6.2.3 Lease Income from River Control Reserve Land

Income from the commercial leasing of river control land is used as a funding source, especially for building up a reserve to fund flood damage and also capital projects.

6.2.4 Gravel Extraction

A supervision fee of 0.75 cents per cubic metre is charged for contractors extracting gravel from Marlborough rivers. This fee goes towards funding physical survey and aerial photography of the riverbeds and staff time in supervision.

Where Council owns or controls access to riverbed land on the Wairau River a further fee of up to $2.45 per cubic metre is charged.

This extra fee goes towards funding the roading and river track network to the gravel extraction sites, and extra costs of river control bank protection works necessitated from increased riverbank erosion due to gravel removal.

6.2.5 Quarry and Tree Nursery Income

Council operates its own quarries and tree nursery for its river control work. Large rock rip rap (from quarries) and river protection trees (from the nursery) are 'sold' from the 'quarry/nursery' accounts to the river control account. There are also private sales from both the quarries and the nursery. These sales are used to offset the costs of large rock rip rap or willow trees.

The income and charges from the quarry and nursery accounts are set to be self-balancing.

6.2.4 LAPP Insurance

Council is a member of the New Zealand Local Authority Protection Programme. This insurance provides cover to river control assets for 40% of damage occurring following a disastrously large flood.

6.3 Valuations

6.3.1 Introduction

As part of its statutory obligations, Marlborough District Council is required to determine the replacement cost of their assets, the current depreciated value and the annual decline in service potential (DISP).

It should be noted that only 3% of Council's river control assets are funded by depreciation, the other 97% being maintained in perpetuity. Thus this valuation of the river control assets is of less importance for funding management than for other Council infrastructure assets.

(a) Rivers Protection Works

- Stopbanks, Dams
- Bank protection
- Retards and trees

(b) Drainage Works

- Structures, Culverts, Gates
- Excavations, Drainage, Diversions
- Pumping Stations

The Table below summarises the values of the valuation (in $000s)

River	Earthworks (GRC/DRC)	Rock work (GRC/DRC)	Trees & Retards (GRC/DRC)	Misc Structure (GRC/DRC)	Misc Structures (DRC)	Excavation (GRC/DRC)	Pumping Stns (GRC)	Pumping Stns (DRC)	Total Replacement Value	Depreciated Replacement Cost	Depreciation To Date
Lower Wairau	$4,807	$5,449	$372	$1,705	$1,705				$12,333	$12,333	$0
Wairau Diversion	$1,873	$3,784	$18	$619	$619	$13,500			$19,794	$19,794	$0
Wairau - Tuamarina to Waihopai	$16,187	$23,605	$3,478	$336	$336				$43,605	$43,605	$0
Lower Opawa/Taylor	$3,386	$853	$60	$1,935	$1,935				$6,234	$6,234	$0
Taylor Dam* (1965)	$6,500	$500		$2,650	$1,510				$9,650	$8,510	$1,140
Upper Opawa /Roses/Omaka	$7,163	$1,872	$519	$347	$347	$1,320			$11,220	$11,220	$0
Riverlands / Wither Hills streams	$1,673	$87		$1,453	$1,453				$3,213	$3,213	$0
Pumping Stations							$7,025	$3,988	$7,025	$3,988	$3,037
Misc Watercourses & Drainage	$2,846	$30		$3,213	$3,213	$8,767			$14,856	$14,856	$0
TOTAL	**$44,435**	**$36,179**	**$4,446**	**$12,257**	**$11,118**	**$23,587**	**$7,025**	**$3,988**	**$127,929**	**$123,752**	**$4,177**

This valuation has been undertaken in accordance with Financial Reporting Standard NZ IAS 16 Property, Plant & Equipment and the New Zealand Infrastructural Asset Valuation and Depreciation Guidelines.

The valuation has calculated the funding to allow for the decline in service potential using the straight line depreciation method.

This valuation has been prepared exclusive of GST.

6.3.2 Valuation Report

6.3.2.1 Background

This valuation covers the Wairau Flood Plain Rivers and Drainage Asset networks Marlborough District Council own and operate. The completed valuation assigns a replacement cost, a depreciated value and calculates annual loss of service potential to each component of each asset network. The valuation was last carried out in 2005.

Prior to commencing this 2008 valuation a methodology was agreed between Council Staff and Alexander Hayward Ltd (Registered Valuers).

The assets have been valued at component levels based on the practical ability to identify and manage the asset at that component level.

For this valuation Age has been used on all depreciable asset components as a factor to calculate the value of the asset.

The upper Wairau above the Waihopai River and some of the tributaries off the Wairau Plains have river protection works. None of the works on these rivers are valued and neither are natural river channels nor land beneath rivers.

6.3.2.2 Scope

The valuation was carried out on the following asset components:

- Rivers - earthworks, rockworks, trees and retard, excavations, miscellaneous structures.

- Drainage - excavations, miscellaneous structures, pump station, mechanical and electrical and structures.

2007-2008 asset additions did not form part of the revaluation.

6.3.3 Valuation Process

6.3.3.1 Data Sources and Verification

Rivers and Drainage asset information for the valuation has been obtained from Asset Registers held as Excel spreadsheets for asset management planning purposes.

6.3.3.2 Data Procedures

- Most of the rivers and drainage assets are considered to be maintained into perpetuity, with maintenance work expensed, so apart from pump station assets and Taylor Dam structural components where depreciated replacement cost values have been calculated, the replacement cost is maintained.

- Where asset attribute information is missing in the database and the detail is not available on hardcopy plans, assumptions have been made on the attribute based on staff personal knowledge.

- If any assets are past their useful life and they are not planned to be written off or replaced in 2008 a residual life has been allowed in line with their replacement year as indicated in the asset management plans. In assessing older assets the economic life has been modified by an age factor. For assets whose economic life has expired the factor has the effect of extending the useful life of the asset. Age factors used are those set out in the New Zealand Infrastructure Asset Management Manual 1996, but modified for local conditions.

6.3.3.3 Unit Rates

The unit rate for assets used in the calculation of the replacement cost are minimum costs of replacing an asset by another asset offering the same level of service most efficiently. Materials and plant costed are those that council would utilise today.

The unit rates used in the valuation have been obtained from contracts completed in the last five years and are an average of all situations. All items have been subject to a multiplier to cover design, administration and sundry expenses of constructing the item.

Other rivers and drainage asset costs have been obtained from completed contracts and quotes for plant from suppliers.

6.3.3.4 Asset base lives

The valuation has adopted unlimited life for stopbanks, rockwork, rock groynes, channel works and drainage channels, together with their associated structures.

Base lives used in the pump station valuation are as set out in the International Infrastructure Asset Management Manual 2000, but modified by local experience of actual useful lives.

6.3.4 Depreciation Methodology

6.3.4.1 General

Three components; the *Replacement Value*, the *Depreciated Replacement Value* and the *Annual Decline in Service Potential* (DISP) have been calculated.

The Replacement Value is the value of the asset today should it be replaced. In calculating the value it is assumed that modern construction techniques are used but that the physical result replaces the asset as it exists.

The *Depreciated Replacement Value* is an accounting procedure that distributes the cost or value of an asset over its estimated useful life. Thus depreciation only applies to those assets with finite lives. Earthworks such as ponds, embankments and drains have an infinite life and have not been depreciated.

The formula used to calculate the *Depreciated Value* for pump station assets was:

Remaining life/economic life x replacement cost

where the remaining life is calculated from the base life and the date of construction of the asset.

The *Annual Decline in Service potential (DISP)* has been calculated using the straight line depreciation method. The formula used was:

Depreciated Replacement Value/Remaining Life

6.3.4 2008 Valuation

The table below summarises the total values for the 2008 and 2005 valuations (in $000s).

River	Earthworks		Rock work		Trees & Retards		Misc Structures		Excavation		Pumping Stns		Total Replacement Value	
	2008	2005	2008	2005	2008	2005	2008	2005	2008	2005	2008	2005	2008	2005
Lower Wairau	$4,807	$4,244	$5,449	$5,449	$372	$326	$1,705	$1,308					$12,333	$11,327
Wairau Diversion	$1,873	$1,605	$3,784	$3,721	$18	$16	$619	$516	$13,500	$11,700			$19,794	$17,558
Wairau - Tuamarina to Waihopai	$16,187	$13,821	$23,605	$22,994	$3,478	$2,763	$336	$280					$43,605	$39,858
Lower Opawa/Taylor	$3,386	$2,824	$853	$810	$60	$53	$1,935	$1,504					$6,234	$5,192
Taylor Dam	$6,500	$5,500	$500	$500			$2,650	$2,200					$9,650	$8,200
Upper Opawa/Roses/Omaka	$7,163	$6,309	$1,872	$1,872	$519	$461	$347	$289	$1,320	$1,200			$11,220	$10,131
Riverlands/Wither Hills streams	$1,673	$1,432	$87	$59			$1,453	$1,334					$3,213	$2,825
Pumping Stations											$7,025	$5,783	$7,025	$5,783
Misc Watercourses & Drainage	$2,846	$2,422	$30	$30			$3,213	$2,192	$8,767	$7,668			$14,856	$12,312
TOTAL	$44,435	$38,158	$36,179	$35,454	$4,446	$3,618	$12,257	$9,623	$23,587	$20,568	$7,025	$5,783	$127,929	$113,186

- Valuation figures vary between 2008 and 2005 due mainly to the change in river works contract rates which rose 17.5%, earthwork replacement increases of 15% and other asset increases of 20%. Any increases in rock work relate to additions during the period as unit values did not change from 2005. The costs for rock replacement remain the same due to efficiencies in operating MDC quarries since 2005.

7. Appendix 1 – Asset Valuation

7.1 2008 Valuations

Detailed valuations.

TABLE 1							
WAIRAU FLOODPLAIN RIVER & DRAINAGE ASSET VALUATION							
SUMMARY OF ASSET VALUES							
VALUED AT 30 June 2008	in $1000's						
River	Earthworks	Rock work	Trees & Retards	Misc Structures	Excavation	Pumping Stns	Total
	stopbnks, dams	bank protection	bank protection	culverts, gates	drains, diversions		
Lower Wairau	$4,807	$5,449	$372	$1,705			$12,333
Wairau Diversion	$2,308	$3,784	$18	$619	$13,500		$20,229
Wairau - Tuamarina to Waihopai	$16,187	$23,605	$3,478	$336			$43,605
Lower Opawa / Taylor	$3,386	$853	$60	$1,935			$6,234
Taylor Dam	$6,500	$500		$2,650			$9,650
Upper Opawa / Roses / Omaka	$7,163	$1,872	$519	$347	$1,320		$11,220
Riverlands / Wither Hills streams	$1,673	$87		$1,453			$3,213
Misc Watercourses & Drainage	$2,846	$30		$3,213	$8,767	$7,025	$21,880
Picton	$117	$853		$114			$1,084
TOTAL	$44,870	$36,179	$4,446	$12,257	$23,587	$7,025	$128,364
River	Earthworks	Earthworks	Rock work	Trees & Retards	Misc structures	Excavation	Pumping Stns
	stopbank length km	stopbank & dam vol m3*1000	rock volume m3*1000	area of tree planting hectares	culverts, gates	drains, diversions	
Lower Wairau	21	490	87	3.0			
Wairau Diversion	10	330	71	0.3			
Wairau - Tuamarina to Waihopai	44	1862	373	53.2			
Lower Opawa / Taylor	31	377	11	1.0			
Taylor Dam		380					
Upper Opawa / Roses / Omaka	46	854	30	3.6			
Riverlands / Wither Hills streams	13	164	2				
Misc Watercourses & Drainage	17	286	1				
Picton							
TOTAL	180	4743	575	61			

TABLE 1

WAIRAU FLOODPLAIN RIVER & DRAINAGE ASSET VALUATION

SUMMARY OF ASSET VALUES

VALUED AT 30 June 2008 | **in $1000's**

River	Earthworks (GRC/DRC)	Rock work (GRC/DRC)	Trees & Retards (GRC/DRC)	Misc Structures (GRC)	Misc Structures (DRC)	Excavation (GRC/DRC)	Pumping Stns (GRC)	Pumping Stns (DRC)	Total Gross Replacement Value	Total Depreciated Replacement Cost	Depreciation To Date
											($1,000's)
Lower Wairau	$4,807	$5,449	$372	$1,705	$1,705				$12,333	$12,333	$0
Wairau Diversion	$2,308	$3,784	$18	$619	$619	$13,500			$20,229	$20,229	$0
Wairau - Tuamarina to Waihopai	$16,187	$23,605	$3,478	$336	$336				$43,605	$43,605	$0
Lower Opawa / Taylor	$3,386	$853	$60	$1,935	$1,935				$6,234	$6,234	$0
Taylor Dam	$6,500	$500		$2,650	$1,510				$9,650	$8,510	$1,140
Upper Opawa / Roses / Omaka	$7,163	$1,872	$519	$347	$347	$1,320			$11,220	$11,220	$0
Riverlands / Wither Hills streams	$1,673	$87		$1,453	$1,453				$3,213	$3,213	$0
Pump Stations	$0						$7,025	$3,988	$7,025	$3,988	$3,037
Misc Watercourses & Drainage	$2,846	$30		$3,213	$3,213	$8,767			$14,856	$14,856	$0
TOTAL	**$44,870**	**$36,179**	**$4,446**	**$12,257**	**$11,118**	**$23,587**	**$7,025**	**$3,988**	**$128,364**	**$124,187**	**$4,177**

8. Appendix 2 – River Control Assets Details

WAIRAU FLOODPLAIN RIVER CONTROL WORKS					
SUMMARY OF ESTIMATED VALUE OF RIVER SYSTEM AT 30 June 2008					
River section	**Earthworks (Stopbanks, spur banks, dams, etc)**	**Rock protection work**	**Misc. structures**	**Tree & Retard Work**	**Excavated Diversions**
Lower Wairau (inc Flow division area)	$4,807,064	$5,449,000		$372,100	
Wairau Diversion	$2,307,852	$3,784,200		$18,000	$13,500,000
Wairau - Tuamarina to Waihopai	$16,187,094	$23,604,600		$3,477,500	
Lower Opawa & Taylor	$3,385,508	$853,000	$492,000	$60,000	
Upp Opawa, Roses, Omaka, Fairhall	$7,163,085	$1,872,000		$518,500	$1,320,000
Riverlands & Wither Hills streams	$1,673,175	$86,500	$1,042,500		
Misc. floodplain streams.	$2,846,100	$30,000	$2,888,000		
Taylor dam	$6,500,000	$500,000	$2,650,000		
Totals	**$44,869,878**	**$36,179,300**	**$7,072,500**	**$4,446,100**	**$14,820,000**
Total value of river system	**$107,387,778**				
NB The Upper Wairau above the Waihopai, and some of the tributaries off the plains have river protection works on them					
However, they are not included in the Asset Management plan, are not maintained to a defined standard, and have works carried out					
that is related to the rate intake from the benefitting area, not to the need to maintain the asset. This was a Council decision.					
None of the works on these rivers are valued in the Asset Valuation schedules. The value is approximately $15 million.					
Natural river channels are not valued, except to some degree by incorporation in the value of the stopbanks constructed from the excavated material.					
Council ownned land is not valued in this asset management plan.					

LOWER WAIRAU										
NB. ENTRIES ONLY TO BE MADE IN SHADED COLUMNS - ALL OTHERS SELF COMPUTE.							NB In table below, figures in bold are measured,			
							those in plain are estimated.			
Location or reach	**Length**	**Av X - Sect. Area m2**	**Volume**	**Est. cost/m3**	**Estimated value**	**I.D**	**Average section data**			
Stopbanks (inc wing banks, groynes and	m		m3				Bank height	Top width	Slope	X-Sect. area
rock supporting banks) from; - to;							m	m	X:1	m2
RB stopbank Opawa confl to Roses Ovflw						LW 1				
RB stopbank Roses Oflo to Blen Rowing C	1700	24.375	41438	$8.5	$352,219	LW 2	2.5	3.5	2.5	**24.375**
Rbstopbank Blen Rowing Cl to Grovetown	2650	15.54	41181	$8.5	$350,039	LW 3	2.1	3.2	2	**15.54**
RB stopbank Grovetown toFerry Br	2600	36.75	95550	$11.5	$1,098,825	LW 4	3.5	3.5	2	**36.75**
RB stopbank Ferry Br to Peninsula rd end	800	33	26400	$9.0	$237,600	LW 5	3	5	2	**33**
RB stopbank Peninsula Rd to SH 1	1400	24.375	34125	$9.0	$307,125	LW 6	2.5	3.5	2.5	**24.375**
LB stopbank Marakoko Dn to Roberts Dn	3500	20.75	72625	$9.0	$653,625	LW 7	2.5	3.3	2	**20.75**
LB stopbank Roberts Dn to Flow Diversion	4115	23.14	95221	$9.0	$856,990	LW 8	2.6	3.7	2	**23.14**
Wairau Mouth training bank	500	50	25000	$18.0	$450,000	LW 9	5	5	1	**50**
						LW 10				
						LW 11				
Total Cost of Stopbanks in reach	**17,265**		**431,540**		**$4,306,422**					
	Length	**m3/m**	**Rock volume**	**Est cost/m3**	**Esimated value**					
Rock in rock lined banks : - from: - to :	m	**Est average**	**in place - m3**							
LB berm level rock/rubble	2500	12	30000	$60.0	$1,800,000					
RB berm level rock/rubble	2000	12	24000	$65.0	$1,560,000					
Wairau mouth training bank	500	40	20000	$70.0	$1,400,000					
Total cost of rock in banks in reach			**74,000**		**$4,760,000**					
Tree work and retard bank protection.	**length (m)**	**depth (m)**	**area (m2)**	**value/m2**	**Estimated value**					
L B Willows	6250	5	31250	$1.2	$37,500					
RB Willows	1900	5	9500	$1.2	$11,400					
LB above Ferry	700	20	14000	$1.2	$16,800					
RB above ferry	1100	20	22000	$1.2	$26,400					
Retards	**length**			**cost/m**						
morrins hollow	200			$300.0	$60,000					
Total cost of trees/retards			**76,750**		**$152,100**					

WAIRAU - FLOW DIVISION AREA

NB. ENTRIES ONLY TO BE MADE IN SHADED COLUMNS - ALL OTHERS SELF COMPUTE.

NB In table below, figures in bold are measured, in plain are estimated.

Location or reach	Length (m)	rage X - Sect. a m2	Volume - m3	Est. cost/m3	Estimated value	Average section data			
Stopbanks (inc wing banks, groynes and						Bank height	Top width	Slope	X-Sect. area
rock supporting banks) from; - to;						m	m	x:1	m2
left bank stopbank div to sh1	1300	18.48	24024	$8.5	$204,204	2.2	4	2	**18.48**
left bank stopbank [old[div to sh I	1500	16.875	25313	$8.5	$215,156	2.5	3	1.5	**16.875**
right bank stopbank [adj stockpile]	450	21.25	9563	$8.5	$81,281	2.5	3.5	2	**21.25**
Total Cost of Stopbanks in reach	**3,250**		**58,899**		**$500,642**				

	Length (m)	m3/m	Rock volume	Est cost/m3	Esimated value
Rock in rock lined banks : - from: - to :		Estimated avera	in place - m3		
top diversion to SH 1	500	8	4000	$53.0	$212,000
left bank lower wairau	500	8	4000	$53.0	$212,000
right bank peninsular rd	500	10	5000	$53.0	$265,000
Total cost of rock in banks in reach			**13,000**		**$689,000**

Tree work and retard bank protection.	length (m)	depth (m)	area (m2)	value/m2	Estimated value
left bank willows	1200	20	24000	$6.0	$144,000
right bank willows	600	10	6000	$6.0	$36,000
Retards	**length**			**cost/m**	
bothams behd	100			$400.0	$40,000
Total cost of trees/retards			**30,000**		**$220,000**

Combined Total Cost of Stopbanks in reach	**20,515**		**490,439**		**$4,807,064**
Combined Total cost of rock in banks			**87,000**		**$5,449,000**
Combined Total cost of trees/retards			**106,750**		**$372,100**

WAIRAU DIVERSION

NB. ENTRIES ONLY TO BE MADE IN SHADED COLUMNS - ALL OTHERS SELF COMPUTE.

NB In table below, figures in bold are measured in plain are estimated.

Location or reach	Length	verage X - Sect. ar	Volume - m3	Est. cost/m3	Estimated value	Average section data			
Stopbanks (inc wing banks, groynes and	**m**	**m^2**	**m^3**			Bank height	Top width	Slope (X t	X-Sect. area
rock supporting banks) from; - to;						m	m	X	m2
left bank sea to Rarangi rd	2100	25	52500	$7.0	$367,500	2.5	5	2	**25**
right bank sea to Rarangi rd	2100	22.5	47250	$7.0	$330,750	2.5	4	2	**22.5**
left bank Rarangi rd to SH1	3500	41.4312	145009	$7.0	$1,015,064	3.66	4	2	**41.4312**
right bank Rarangi rd to SH 1	2050	41.4312	84934	$7.0	$594,538	3.66	4	2	**41.4312**
Total cost of stopbanks in reach	**9,750**		**329,693**		**$2,307,852**				

	Length (m)	m3/m	Rock volume	Est cost/m3	Estimated value
Rock in rock lined banks : - from: - to :		**Estimated average**	**in place - m3**		
rock /rubble protection left bank	2100	8	16800	$53.0	$890,400
rock rubble protection right bank	2100	10	21000	$53.0	$1,113,000
rock/rubble pro rb Rarangi rd to top diversion	2000	8	16000	$53.0	$848,000
rock/rubble pro lb Rarangi rd to top diversion	2050	8	16400	$53.0	$869,200
spur banks rb at Bothams	150	8	1200	$53.0	$63,600
Total cost of rock in banks in reach			**71,400**		**$3,784,200**

Tree work and retard bank protection.	**length (m)**	**depth (m)**	**area (m2)**	**value/m2**	**Estimated value**
left bank willows	600	5	3000	$6.0	$18,000
Retards	**length**			**cost/m**	
Total cost of trees/retards			**3,000**		**$18,000**

Excavated diversion channel	**current volume m3**	**cost / m3**	**Estimated value**
Wairau Diversion 4.2 km	1800000.00	$7.5	$13,500,000
Total value of excavated channels			**$13,500,000**

WAIRAU - SH1 TO SH6

NB. ENTRIES ONLY TO BE MADE IN SHADED COLUMNS - ALL OTHERS SELF COMPUTE.

NB In table below, figures in bold are measured, those in plain are estimated.

Location or reach	Length (m)	Av X - Sect. area	Volume - m3	Est. cost/m3	Estimated value	Average section data			
Stopbanks (inc wing banks, groynes and		**m2**				Bank height	Top width	Slope	X-Sect. area
rock supporting banks) from; - to;						m	m	X:1	m2
Tua Marina to Kaituna track	1200	33.33	39996	$8.5	$ 339,966.00	3.3	3.5	2	**33.33**
LB stopbank Lower Barnetts [old]	1650	38	62700	$8.5	$ 532,950.00	4	3.5	1.5	**38**
LB stopbank Lower Barnetts[new]	2530	46.4	117392	$8.5	$ 997,832.00	4	3.6	2	**46.4**
L B Middle Barnetts	420	30.625	12863	$8.5	$ 109,331.25	3.5	3.5	1.5	**30.625**
L B stopbank Tyson	370	23.7	8769	$8.5	$ 74,536.50	3	3.4	1.5	**23.7**
L B stopbank Huddlestone	3100	46	142600	$8.5	$ 1,212,100.00	4	3.5	2	**46**
LB stopbank Norths	1600	19.24	30784	$8.5	$ 261,664.00	2.6	3.5	1.5	**19.24**
LB upstrea,m of SH1	250	60	15000	$8.5	$ 127,500.00	4	5	2.5	**60**
RB stopbank SH1 to Cravens	2450	46.4	113680	$8.5	$ 966,280.00	4	3.6	2	**46.4**
RB stopbank Cravens to Selmes	1450	69.54	100833	$8.5	$ 857,080.50	3.8	5	3.5	**69.54**
RB stopbank Selmes toToons	1140	50.4	57456	$8.5	$ 488,376.00	3.6	5	2.5	**50.4**
RB stopbank Toons to Giffords Rd	4940	60	296400	$8.5	$ 2,519,400.00	4	5	2.5	**60**
RB stopbank Giffords to SH6	5700	60	342000	$8.5	$ 2,907,000.00	4	5	2.5	**60**
Total Cost of Stopbanks in reach	**26800**		**1340473**		**$ 11,394,016.25**				

	Length (m)	m3/m	Rock volume	Est cost/m3	Esimated value
Rock in rock lined banks : - from: - to :		**Estimated averag**	**in place - m3**		
LB berm rock SH1 to Lower Barnetts	1400	12	16800	$55.0	$ 924,000.00
LB rock Middle /Upper Barnetts/C&C	2000	12	24000	$55.0	$ 1,320,000.00
L B Stedmans	1400	12	16800	$55.0	$ 924,000.00
LB Huddlestones	2500	12	30000	$55.0	$ 1,650,000.00
LB Norths	900	12	10800	$57.0	$ 615,600.00
RB SH1 to Selmes Road	3000	10	30000	$57.0	$ 1,710,000.00
RB Selmes to Wratts Rds.	2300	10	23000	$58.0	$ 1,334,000.00
RB McLauchlans to Giffords road	2600	14	36400	$60.0	$ 2,184,000.00
Orchards	1900	10	19000	$60.0	$ 1,140,000.00
Boyces & upstream spur banks	120	60	7200	$60.0	$ 432,000.00
Giffords road spurs	500	10	5000	$65.0	$ 325,000.00
Total cost of rock in banks in reach			**219000**		**$ 12,558,600.00**

Tree work and retard bank protection.	length (m)	depth (m)	area (m2)	value/m2	Estimated value
LB Willows SH1 - Cow creek	1000	5	5000	$6.0	30000
LB Willows - upper Barnetts training curve	2700	20	54000	$6.0	324000
L.B C&C/Tysons	1000	20	20000	$6.0	
LB Willows Waikakaho mouth area	1500	20	30000	$6.0	180000
LB Stedmans	1000	5	5000	$6.0	30000
LB Huddlestones - SH6	4000	15	60000	$6.0	360000
RB Willows - Hillocks rock	1200	20	24000	$6.0	144000
RB Willows Hillocks to Cravens creek	1700	15	25500	$6.0	153000
RB Willows Cravens to Selmes rd +	1600	20	32000	$6.0	192000
RB McLauchans	2400	20	48000	$6.0	288000
RB Giffords - SH6	3500	15	52500	$6.0	315000
Retards	**length**			**cost/m**	
LB Barnetts rail iron groynes	130			$450.0	$ 58,500.00
L.B C&C/Tysons rail iron retards	600			$450.0	$ 270,000.00
LB Stedmans rail iron retards	300			$450.0	$ 135,000.00
L B Huddlestones rail iron retards	430			$450.0	$ 193,500.00
R B Cravens rail iron retards	60			$450.0	$ 27,000.00
McLauchlan rail iron retards	600			$450.0	$ 270,000.00
RB Pigou rail iron retards	60			$450.0	$ 27,000.00
Total cost of trees/retards			**356000**		**$ 2,997,000.00**

WAIRAU - SH6 TO WAIHOPAI

NB. ENTRIES ONLY TO BE MADE IN SHADED COLUMNS - ALL OTHERS SELF COMPUTE.

NB In table below, figures in bold are measured, in plain are estimated.

Location or reach	Length (m)	Av X - Sect. area m2	Volume - m3	Est. cost/m3	Estimated value	Average section data			
Stopbanks (inc wing banks, groynes and						Bank height	Top width	Slope X:1	X-Sect. area
L B stopbank SH 6 to Kaituna	2400	25.48	61152	$9.0	$550,368	2.8	3.5	2	**25.48**
L B Mahers	800	25.76	20608	$9.0	$185,472	2.8	3.6	2	**25.76**
L B Rock Ferry	1200	30	36000	$9.0	$324,000	3	4	2	**30**
L B Wilsons	900	28.5	25650	$9.0	$230,850	3	3.5	2	**28.5**
R B stopbank SH6 to O"Flow	3810	48.125	183356	$9.0	$1,650,206	3.5	5	2.5	**48.125**
Conders backup bank	550	48.125	26469	$9.0	$238,219	3.5	5	2.5	**48.125**
RB stopbank O"Flow to Upper Conders	3160	24.625	77815	$10.0	$778,150	2.5	3.6	2.5	**24.625**
Upper Conders	700	24.375	17063	$9.0	$153,563	2.5	3.5	2.5	**24.375**
Upper Conders to Waihopai	1000	17.6	17600	$10.0	$176,000	2.2	3.6	2	**17.6**
Waihopai confluence to SH63	800	30	24000	$9.0	$216,000	3	4	2	**30**
Waihopai LB D/S SH63	1500	21.5	32250	$9.0	$290,250	2.5	3.6	2	**21.5**
Total Cost of Stopbanks in reach	**16,820**		**521,963**		**$4,793,078**				

	Length (m)	pic metres per m Estimated averag	Rock volume in place - m3	Est cost/m3	Esimated value
Rock in rock lined banks : - from: - to :					
RB Lower Conders	2000	20	40000	$70.0	$2,800,000
RB Groyne heads	400	50	20000	$70.0	$1,400,000
R B Upper Conders	1600	10	16000	$72.0	$1,152,000
R B Waihopai	950	15	14250	$72.0	$1,026,000
L B Pylons	1000	15	15000	$70.0	$1,050,000
L B Mahers	350	20	7000	$72.0	$504,000
L B Mahers spur groynes	300	15	4500	$72.0	$324,000
L B Rock Ferry	1200	15	18000	$75.0	$1,350,000
L B Wilsons	1000	12	12000	$75.0	$900,000
L B Waihopai SH Bridge D/S	600	12	7200	$75.0	$540,000
Total cost of rock in banks in reach			**153,950**		**$11,046,000**

Tree work and retard bank protection.	length (m)	depth (m)	area (m2)	value/m2	Estimated value
L B Willows Pylons			20000	$6.0	$20,000
LB Mahers			25000	$6.0	$25,000
LB Rock Ferry			3000	$6.0	$3,000
LB Wilsons			2500	$6.0	$2,500
RB SH 6 Bridge			20000	$6.0	$10,000
RB Lower Conders			60000	$6.0	$60,000
RB all Crossbanks			20000	$6.0	$20,000
Waihopai d/s SH 63			25000	$6.0	$25,000
Retards	**length**			**cost/m**	
L B Pylons rail iron retards	200			$450.0	$90,000
R B Groynes rail iron retards	500			$450.0	$225,000
Total cost of trees/retards			**175500**		**$ 480,500.00**
Total Cost of Stopbanks in reach	**43,620**		**1,862,435**	**-**	**16,187,093.75**
Total cost of rock in banks in reach			**372,950**	**-**	**23,604,600.00**
Total cost of trees/retards			**531,500**	**-**	**3,477,500.00**

LOWER OPAWA & TAYLOR

NB. ENTRIES ONLY TO BE MADE IN SHADED COLUMNS - ALL OTHERS SELF COMPUTE.

NB In table below, figures in bold are measured, those in plain are estimated.

Location or reach	**Length**	**Av X - Sect. Area**	**Volume - m3**	**Est. cost/m3**	**Estimated value**	**Average section data**			
Stopbanks (inc wing banks, groynes and	m	**m2**	m3			Bank height	Top width	Slope (X to	X-Sect. area
rock supporting banks) from; - to;						m	m	X	m2
Lower Opawa) 0m to Taylor. LB	12200	9.75	118950	$11.5	$ 1,367,925.00	1.5	3.5	2	**9.75**
Berm Development LB Dillons Pt		0	55000	$3.0	$ 165,000.00				**0**
Lower Opawa 0m to Taylor. RB	10800	8.25	89100	$11.5	$ 1,024,650.00	1.5	2.5	2	**8.25**
Berm Development Opawa St area		0	30000	$3.0	$ 90,000.00				**0**
Berm development Long Bend			5000	$3.0	$ 15,000.00				
Taylor River LB to Burleigh/Pony Club	2750	8.25	22688	$9.5	$ 215,531.25	1.5	2.5	2	**8.25**
Doctors Creek/Old Fairhall LB	1200	8.25	9900	$7.0	$ 69,300.00	1.5	2.5	2	**8.25**
Taylor River RB To Burleigh Bridge	4200	10.98	46116	$9.5	$ 438,102.00	1.8	2.5	2	**10.98**
Opawa Loop S/B L/B Lane St area	250	1.92	480	$7.0	$ 3,360.00	0.6	2	2	**1.92**
Opawa Loop Upper Channel Block	50	150.5	7525	$9.5	$ 52,650.00	7	4	2.5	**150.5**
Opawa Loop Lower Channel Block	30	175	5250	$9.5	$ 49,875.00	7	4	3	**175**
Total Cost of Stopbanks in reach	**31150**		**376754**		**$ 3,385,508.25**				

	Length (m)	ıbic metres per me	Rock volume	Est cost/m3	Esimated value
Rock in rock lined banks : - from: - to :		**Estimated average**	**in place - m3**		
Lower Opawa LB Wave Lap Fenn	350	8	2800	$70.0	$ 196,000.00
Lower Opawa LB Dillons Pt McKay	100	10	1000	$70.0	$ 70,000.00
Training Curves Burleigh To Dam	800	8	6400	$70.0	$ 448,000.00
Town section rock work	200	3	600	$40.0	$ 24,000.00
Stone Groynes /Gabions	160	3	480	$200.0	$ 115,000.00
Total cost of rock in banks in reach			**11280**		**$ 853,000.00**
Miscellaneous Structures					**Estimated value**
Cuddons Floodwall LB	80				$ 90,000.00
Royal Hotel Floodwall LB	45				$ 66,000.00
Opawa Loop Upper Channel Block culvert					$ 120,000.00
Opawa Loop Upper H/w Gate /Walkway					$ 48,000.00
Opawa Loop Lower H/W Gate/Walkway					$ 48,000.00
Opawa Loop Lower Channel Block Culvert					$ 120,000.00
Total cost of miscellaneous structures.					**$ 492,000.00**
Tree work and retard bank protection.	**length (m)**	**depth (m)**	**area (m2)**	**value/m2**	**Estimated value**
Willow Protection Above Burleigh	2000	5	10000	$6.0	$ 60,000.00
Retards	**length**			**cost/m**	
Total cost of trees/retards			**10000**		**$ 60,000.00**

UPPER OPAWA / ROSES OVERFLOW / OMAKA / FAIRHALL

NB. ENTRIES ONLY TO BE MADE IN SHADED COLUMNS - ALL OTHERS SELF COMPUTE.

NB In table, figures in bold are measured, in plain are estimated.

Location or reach	**Length**	**Av X - Sect. area**	**Volume**	**Est. cost/m3**	**Estimated value**	**Average section data**			
Stopbanks (inc wing banks, groynes and	m	**m2**	m3			Bank height	Top width	Slope	X-Sect. area
rock supporting banks) from; - to;						m	m	x:1	m2
LB Grove Rd Bridge ro Thomsons Ford	3300	17.38	57354	$8.5	$ 487,509.00	2.2	3.5	2	**17.38**
L.B Thomsons Ford to Hammerichs Rd	2250	15	33750	$8.5	$ 286,875.00	2	3.5	2	**15**
LB Hammerichs to Jacksons Rd	3500	15	52500	$8.5	$ 446,250.00	2	3.5	2	**15**
LB Jacksons Rd to end	2400	15	36000	$8.5	$ 306,000.00	2	3.5	2	**15**
RB Grove Rd to Thomsons Ford	3450	16.17	55787	$8.5	$ 474,185.25	2.1	3.5	2	**16.17**
RB Thomsons Ford to Hammerichs Rd	2000	17.38	34760	$8.5	$ 295,460.00	2.2	3.5	2	**17.38**
RB Hammerichs to Jacksons Rd	3200	15	48000	$8.5	$ 408,000.00	2	3.5	2	**15**
RB Jacksons to Old Renwick Rd	2800	13.87	38836	$8.5	$ 330,106.00	1.9	3.5	2	**13.87**
LB Roses Overflow from Grove Rd bridge	5900	30	177000	$8.5	$ 1,504,500.00	3	2.5	2.5	**30**
RB Roses overflow	4400	30	132000	$8.5	$ 1,122,000.00	3	2.5	2.5	**30**
Omaka									
LB Stopbank Junction to SH 6	1600	15	24000	$8.0	$ 192,000.00	2	3.5	2	**15**
LB Stopbank SH6 to Hawkesbury Rd	1900	15	28500	$8.0	$ 228,000.00	2	3.5	2	**15**
RB Stopbank	1750	15	26250	$8.0	$ 210,000.00	2	3.5	2	**15**
Fairhall									
LB Stopbanks to SH6	1500	18	27000	$8.0	$ 216,000.00	3	1.5	1.5	**18**
LB Stopbank SH6 to end	2500	9	22500	$8.0	$ 180,000.00	2	1.5	1.5	**9**
RB Stopbank to SH6	1650	22.5	37125	$8.0	$ 297,000.00	3	1.5	2	**22.5**
LB Stopbank SH6 to Grahams Rd	1600	14	22400	$8.0	$ 179,200.00	2	3	2	**14**
Total Cost of Stopbanks in reach	**45700**		**853762**		**$ 7,163,085.25**				

	Length (m)	bic metres per me	Rock volume	Est cost/m3	Esimated value
Rock in rock lined banks : - from: - to :		**Estimated average**	**in place - m3**		
Opawa					
Grove Rd to Thomsons Ford berm rock	100	8	800	$55.0	$ 44,000.00
Thomsons Fd to Hammerichs berm rock	150	8	1200	$55.0	$ 66,000.00
Hammerichs to Jacksons Rd berm rock	150	8	1200	$55.0	$ 66,000.00
Jacksons to Omaka berm rock	250	8	2000	$55.0	$ 110,000.00
Omaka					
LB Junction to SH6	1100	8	8800	$65.0	$ 572,000.00
LB SH6 to Hawkesbury Bridge	700	8	5600	$65.0	$ 364,000.00
RB Junction to SH6	250	8	2000	$65.0	$ 130,000.00
RB SH 6 to Hawkesbury	1000	8	8000	$65.0	$ 520,000.00
Fairhall	400	8	3200	$65.0	$ 208,000.00
Total cost of rock in banks in reach			**29600**		**$ 1,872,000.00**
Tree work and retard bank protection.	**length (m)**	**depth (m)**	**area (m2)**	**value/m2**	**Estimated value**
Upper Opawa willows					$ 10,000.00
Omaka Left bank willowa			16000	$6.0	$ 96,000.00
Omaka right bank willows			20000	$6.0	$ 120,000.00
Retards	**length**			**cost/m**	
Railiron retards 650 lineal metres @ $250 l/m	650			$450.0	$ 292,500.00
Total cost of trees/retards			**36000**		**$ 518,500.00**
Excavated diversion channel	**current volume m3**			**cost / m3**	**Estimated value**
Roses Overflow		220000.00		5.5	$1,210,000
Fairhall Diversion		20000.00		5.5	$110,000
Total excavated diversion channel value					**$1,320,000**

WITHER HILLS STREAMS

NB. ENTRIES ONLY TO BE MADE IN SHADED COLUMNS - ALL OTHERS SELF COMPUTE.

Location or reach **Stopbanks (inc wing banks, groynes and rock supporting banks) from; - to;**	**Length** m	**Av X - Sect. area** **m2**	**Volume** m3	**Est. cost/m3**	**Estimated value**
Riverlands F/way.Mapps to Hospital Rd	6400	14	89600	$11.5	$ 1,030,400.00
Wither Stream	500	6	3000	$9.5	$ 28,500.00
Sutherlands Stream	600	4	2400	$9.5	$ 22,800.00
Rifle Range Creek	600	12	7200	$11.5	$ 82,800.00
Mapps Floodway/Snake Gully	1500	5.5	8250	$7.0	$ 57,750.00
Mapps Stream	800	4	3200	$8.5	$ 27,200.00
Vernon Crossbank to Opawa R.	2300	21.25	48875	$8.5	$ 415,437.50
Harling Park Detention Dam/Stopbanks	100	9.75	975	$8.5	$ 8,287.50
Total Cost of Stopbanks in reach	**12800**		**163500**		**$ 1,673,175.00**

NB In table below, figures in bold are measured, in plain are estimated.

Average section data

Bank height	Top width	Slope	X-Sect. area
m	m	X:1	m2
2	3	2	**14**
1	2	4	**6**
1	2	2	**4**
1.5	3.5	3	**12**
1	3.5	2	**5.5**
1	2	2	**4**
2.5	3.5	2	**21.25**
1.5	3.5	2	**9.75**

Rock in rock lined banks : - from: - to :	**Length (m)**	**bic metres per me** **Estimated average**	**Rock volume** **in place - m3**	**Est cost/m3**	**Esimated value**
Riverlands Floodway/Brooklyn Park	250	3	750	$50.0	$ 37,500.00
Sutherlands Stream Rubble	100	2	200	$50.0	$ 10,000.00
Vernon cross bank Rock Protection	75	8	600	$50.0	$ 30,000.00
Rifle range creek 3 Drops/rubble			300	$30.0	$ 9,000.00
Total cost of rock in banks in reach			**1850**		**$ 86,500.00**

Miscellaneous Structures					**Estimated value**
Wither Stream Concrete channel					$ 870,000.00
Harling Park Culvert Works					$ 14,500.00
Rifle Range Creek 3 Drops/ Rubble			300	$30.0	$ 9,000.00
Mapps Stream S/B Gabions Drops					$ 27,000.00
Sandhills Outlet Penstock Gates					$ 110,000.00
Rifle Range Creek R/Iron debris screens					$ 12,000.00

Total cost of miscellaneous structures.	**$ 1,042,500.00**

PICTON RIVERS

NB. ENTRIES ONLY TO BE MADE IN SHADED COLUMNS - ALL OTHERS SELF COMPUTE.

Location or reach Stopbanks (inc wing banks, groynes and rock supporting banks) from; - to;	Length m	X - Sect. Ar m2	Volume - m3 m3	Est. cost/m3	Estimated value
Waitohi	600	6.75	4050	$20.0	$ 81,000.00
Waitohi tribs (Kent, Hampden etc)	0	0	0	$20.0	$ -
Waikawa	100	2.48	248	$15.0	$ 3,720.00
Waikawa tribs (Endeavour etc)	60	36	2160	$15.0	$ 32,400.00
Total Cost of Stopbanks in reach	**760**		**6458**		**$117,120**

Rock in rock lined banks : - from: - to :	Length (m) : metres per Estimated aver	Rock volume in place - m3		Est cost/m3	Esimated value
Waitohi	150	7	1050	$70.0	$ 73,500.00
Waitohi tribs (Kent, Hampden etc)	100	5	500	$70.0	$ 35,000.00
Waikawa	1300	7	9100	$70.0	$ 637,000.00
Waikawa tribs (Endeavour etc)	10	3	30	$40.0	$ 1,200.00
Total cost of rock in banks in reach			**11280**		**$ 853,000.00**

Gabions	Length (m)			
Waitohi	100	300	$	30,000.00
Waitohi tribs (Kent, Hampden etc)	20	300	$	6,000.00
Waikawa		300	$	-
Waikawa tribs (Endeavour etc)	25	500	$	12,500.00
Total cost of rock in banks in reach			**$**	**48,500.00**

Miscellaneous Structures					Estimated value
Kent st block wall					$ 10,000.00
Kent & Hampden wooden retaining walls	110			$300.0	$ 33,000.00
Waimarima wooden retaining wall	35			$300.0	$ 10,500.00
Endeavour throttling culverts					$ 12,000.00
Total cost of miscellaneous structures.					**$ 65,500.00**

Total				**$1,084,120**

NB In table below, figures in bold are measured, those in plain are estimated.

Average section data

Bank heigh	Top width	Slope (X to	X-Sect. area
m	m	X	m2
1.5	1.5	2	**6.75**
0	0	0	**0**
0.8	1.5	2	**2.48**
3	6	2	**36**

MISC. FLOODPLAIN STREAMS

NB. ENTRIES ONLY TO BE MADE IN SHADED COLUMNS - ALL OTHERS SELF COMPUTE.

Location or reach Stopbanks (inc wing banks, groynes and rock supporting banks) from; - to;	Length m	Av X - Sect. area m2	Volume	Est. cost/m3	Estimated value
Pukaka Stream S/B Nth & Sth	5500	14	77000	$11.5	$ 885,500.00
Spring Creek Stopbanks	5000	10.08	50400	$9.5	$ 478,800.00
Waterfall creek	1200	24	28800	$9.5	$ 273,600.00
Tuamarina Wairau to Swamp LB Stopbank	1200	35	42000	$9.5	$ 399,000.00
Tuamarina RB Stopbank	2200	35	77000	$9.5	$ 731,500.00
Lamberts d/s Northbank Rd stopbank	600	9.75	5850	$7.0	$ 40,950.00
Are Are Creek Kaituna Tk to McVicars stopbank	1000	5.25	5250	$7.0	$ 36,750.00
Total Cost of Stopbanks in reach	**16700**	**133**	**286300**	**64**	**$ 2,846,100.00**

NB In table below, figures in bold are measured, those in plain are estimated.

Average section data

Bank height	Top width	Slope	X-Sect. area
m	m	X:1	m2
2	3	2	**14**
1.8	2	2	**10.08**
3	2	2	**24**
3.5	3	2	**35**
3.5	3	2	**35**
1.5	3.5	2	**9.75**
1.5	2	1	**5.25**

Rock in rock lined banks : - from: - to :	Length (m)	bic metres per me Estimated averag	Rock volume in place - m3	Est cost/m3	Esimated value
Miscellaneous rock					
Total cost of rock in banks in reach			1000	$30.0	$30,000.0

Miscellaneous Structures					Estimated value
Pukaka Sream Spillway					$ 28,000.00
Pukaka Control Gates/Culvert					$ 570,000.00
School Creek Diversion Piping/Channel					$ 680,000.00
Spring Creek Control Gates					$ 500,000.00
Gibsons Creek Waihopai Intake Structures					$ 280,000.00
Gibsons Creek Wairau Intake					$ 600,000.00
Terrace creek Intake/Piping/Drop Structure					$ 230,000.00
Total cost of miscellaneous structures.					**$ 2,888,000.00**

9. Appendix 3 – Drainage Assets

9.1 2008 Assets Summary Sheet

DRAINAGE ASSETS SUMMARY SHEET AS AT 1 JULY 2008

	Drainage Channels in area		Pumping Stations	Floodgated culverts		Misc. Structs
Drainage Area	Tot Length (m)	Excavation value		River	Value	Value
Tuamarina - Pembers	26,171	$1,433,708	$1,322,400			
Spring Creek & Township	18,617	$812,078	$282,000			
Wairau Pa - Marshlands	15,394	$931,086	$762,000			
Grovetown District	31,181	$1,492,008	$678,000			
Lower Wairau	8,478	$523,710	$490,000			
Doctors Creek	16,458	$722,447				
Blenheim urban area	6,252	$603,539	$2,563,000			
Dillons Point	8,597	$389,480	$577,200			
Riverlands	29,961	$1,858,670	$350,000			
				Marukoko	in Lwr Wairau	
				Lr Opawa/Taylor	$1,443,160	
				Pukaka	in Diversion	
				Riverlands	$410,400	
				Spring Creek	in Lwr Wairau	
				Upr Opawa/Roses	$346,800	
				Tuamarina	$336,000	
				Vernon Lgns	in Lwr Wairau	
				Lwr Wairau	$1,704,600	
				Wairau Diversion	$619,200	
				General		$324,500
Total	**161,109**	**$8,766,726**	**$7,024,600**		**$4,860,160**	**$324,500**
Total Value of Assets	**20,975,986**					

FLOODGATED CULVERTS THROUGH STOPBANKS

LOWER OPAWA

Number	Size mm	hung	Type	Comments	Value	
OR001	600	top	Steel MacEwan		$18,600	
OR002	600	top	Steel MacEwan		$16,800	
OR003	750	top	Steel MacEwan		$15,600	
OR003a	450	top	Fibreglass		$14,400	
OR004	600	top	Fibreglass		$19,800	
OR005	300	top	Steel MacEwan		$11,400	
OR005a	300	top	Steel MacEwan		$11,400	
OR006	750	top	Steel MacEwan		$19,800	
OR007	300	top	Steel		$8,400	
OR007a	600	top	Fibreglass		$15,600	
OR007b	450	top	Fibreglass		$18,600	
OR008	150	top	Steel MacEwan		$10,800	
OR009	150	top	Steel MacEwan		$10,800	
OR009a	300	top	Steel MacEwan		$10,800	
OR009b	600	top	Steel MacEwan		$16,800	
OR010	900	top	Fibreglass		$33,000	
OR011	2 x 375	top	Steel		$10,000	
OR012	300	top	Steel MacEwan		$11,400	
OR013	300	top	Steel MacEwan		$14,400	
OR013a	150	top	Steel MacEwan		$10,800	
OR013b	150	top	Steel MacEwan		$10,800	
OR014	300	top	Steel		$10,800	
ORO14b	150	top	Concrete		$10,800	
OR015	300	top	Steel MacEwan		$10,800	
OR016	300	top	Steel MacEwan		$12,600	
OR017	300	top	Steel MacEwan		$15,600	
OR018	600	top	Steel MacEwan		$108,000	
OR019	2 x 1350	side	Wooden		$19,800	
OR020	600	top	Fibreglass		$4,560	
OR021	900	top	Steel		$8,400	
OR021a	300	top			$26,400	
OR021b	300	side	Steel		$42,000	
OR022	600	top	Steel MacEwan		$19,800	
OR023	2 x 300	top	Steel MacEwan		$0	
OR023a	300	top	Steel MacEwan		$13,200	
OR024	300	top	Steel MacEwan		$12,000	
OR025	225	top	Steel MacEwan		$12,000	
OR026	225	top	Steel MacEwan		$0	
RSO 017				Sandhills outlet	**$18,600**	
RSO 018				Sandhills outlet	**$10,800**	
				subtotal		**$666,160**

OPAWA LOOP

ORL 027	2 x 1800	side	Wooden		$48,000	
ORL 028	300	top	Steel MacEwan		$11,400	
ORL 029	600	top	Steel MacEwan		$18,600	
ORL 030	750	top	Steel MacEwan		$25,200	
ORL 031					$0	
ORL 032	600	top	Steel MacEwan		$19,800	
ORL 033	375	top	Steel MacEwan		$10,800	
ORL 034	300	top	Steel MacEwan		$10,800	

ORL 035	300	top	Steel MacEwan	$10,800	
ORL 036	300	top	Steel MacEwan	$11,400	
ORL 037	300	top	Steel MacEwan	$11,400	
ORL 038	300	top	Steel MacEwan	$9,600	
ORL 039	225	top	Steel MacEwan	$10,800	
ORL 040	2 x 2286	top	Steel MacEwan	$72,000	
				subtotal	**$270,600**

TAYLOR

TR 002	750	top	Steel MacEwan	$24,000	
TR 003	750	top	Steel MacEwan	$24,000	
TR 004	900	top	Steel MacEwan	$24,000	
TR 005	150	top	Steel MacEwan	$10,800	
TR 006	150	top	Steel MacEwan	$10,800	
TR 007	600	top	Steel MacEwan	$20,400	
TR 008	450	top	Steel MacEwan	$16,800	
TR 009	375	top	Steel MacEwan	$12,000	
TR 010	2 x 100	top	Steel	$10,800	
TR 011		top		$0	
TR 012	900	top	Steel MacEwan	$48,000	
TR 013	2 x 450	top	Steel MacEwan	$0	
TR 014	2 x 300	top	Steel	$0	
TR 015	1800	side	Wooden	$48,000	
TR 016	300	top	Steel MacEwan	$10,800	
TR 017	600	top	Steel MacEwan	$18,000	
TR 018	1500	side	Wooden	$60,000	
TR 019	150	top	Steel MacEwan	$8,400	
TR 020	150	top	Steel MacEwan	$8,400	
TR 021	750	top	Steel MacEwan	$30,000	
TR 022	450	top	Steel MacEwan	$10,800	
TR 023	300	top	Steel MacEwan	$10,800	
TR 024	600	top	Steel MacEwan	$13,200	
TR 025	600	top	Steel MacEwan	$16,800	
TR 026	750	top	Steel MacEwan	$24,000	
TR 027	750	top	Steel MacEwan	$24,000	
TR 028	2 x 375	top	Steel	$0	
TR 029	300	top	Steel MacEwan	$10,800	
TR 030	300	top	Steel MacEwan	**$10,800**	
				subtotal	**$506,400**

UPPER OPAWA & ROSES OVERFLOW

Number	Size mm	Hung	Type	Comments	Value	
OR041	300	T	Steel		$8,400	
OR042	300	T	Steel		$13,200	
OR043	300	T	Steel		$12,000	
OR044	300	T	Steel		$13,200	
OR045	2 x 1050	S	Wooden		$48,000	
OR046	2 x 375	T	Steel MacEwan			
OR047	600	T	Steel MacEwan		$24,000	
OR048	600	T	Steel MacEwan		$24,000	
OR049	300	T	Steel		$10,800	
OR050	150	T	Steel MacEwan		$8,400	
OR051	150	T	Steel MacEwan		$8,400	
RO 001	375	T	Steel MacEwan		$12,000	

RO 002	600	T	Fibreglass	$32,400	
RO 003	450	T	Steel MacEwan	$30,000	
RO 004	750	T	Steel MacEwan	$24,000	
RO 005	600	T	Steel MacEwan	$12,000	
RO 006	900	T	Fibreglass	$31,200	
RO 007	2 x 375	T	Steel		
RO 008	450	T	Steel MacEwan	$15,600	
RO 009	600	T	Steel MacEwan	$19,200	
			Subtotal		**$346,800**

MARUKOKO

Number	Size mm	Hung	Type	Comments	Value	
M001	1200	top	Fibreglass		$24,000	
M002	300	top	Steel MacEwan		$12,000	
M003	150	top	Steel MacEwan		$8,400	
M004	300	top	Steel MacEwan		$8,400	
M005	300	top	Steel MacEwan		$9,600	
M006	2 x 450	top	Steel			
M007	600	top	Steel MacEwan		$15,600	
M008	2 x 375	top	Steel			
M009	2 x 900	top	Steel MacEwan		$42,000	
				Subtotal		**$120,000**

PUKAKA STREAM

Number	Size mm	Hung	Type	Comments	Value	
PS 001	600	top	Steel MacEwan		$19,200	
PS 002	450	top	Steel MacEwan		$13,200	
PS 003	300	top	Steel MacEwan		$12,000	
PS 004	900	top	Steel MacEwan		$28,800	
PS 005	300	top	Steel MacEwan		$13,200	
PS 006	900	top	Steel MacEwan		$30,000	
PS 007	600	top	Steel MacEwan		$18,000	
PS 008	900	top	Steel MacEwan		$32,400	
PS 009	300	top	Steel MacEwan		$13,200	
PS 010	900	top	Steel MacEwan		$30,000	
PS 011	900	top	Steel MacEwan		$18,000	
PS 012	750	top	Steel MacEwan		$18,000	
PS 013	2 x 450	top	Steel MacEwan			
PS 014	375	top	Steel MacEwan		$10,800	
PS 015	600	top	Steel MacEwan		$20,400	
PS 016	375	top	Steel MacEwan			
PS 017	900	top	Steel MacEwan		$30,000	
PS 018	300	top	Steel MacEwan		$12,000	
PS 019	900	top	Steel MacEwan		$27,600	
PS 020	900	top	Steel MacEwan		$27,600	
PS 021	600	top	Steel MacEwan		$19,200	
PS 022	300	top	Steel MacEwan		$12,000	
				Subtotal		**$405,600**

RIVERLANDS CO-OP FLOODWAY

Number	Size mm	hung	Type	Comments	Value	
RC 001	375	top	Steel MacEwan		$13,200	
RC 002	300	top	Steel MacEwan		$14,400	
RC 003	375	top	Steel MacEwan		$15,600	
RC 004	375	top	Steel		$14,400	
RC 005	375	top	Steel		$15,600	
RC 006	300	top	Steel MacEwan		$13,200	
RC 007	2 x 450	top	Steel MacEwan		$28,800	
RC 008	150	top	Steel MacEwan		$8,400	
RC 009	150	top	Steel MacEwan		$8,400	
RC 010	600	top	Steel MacEwan		$18,000	
RC 011	600	top	Steel MacEwan		$18,000	
RC 012	450	top	Steel MacEwan		$9,600	
RC 013	600	top	Steel MacEwan		$18,000	
RC 014	300	top	Steel MacEwan		$8,400	
RC 015	450	top	Fibreglass		$15,600	
RC 016	300	top	Steel		$9,600	
RC 019	375	top	Steel MacEwan		$9,600	
RC 020	300	top	Steel MacEwan		$9,600	
RC 021	2 x 600	top	Steel MacEwan		$39,600	
RC 022	600	top	Steel MacEwan		$18,000	
RC 024	300	top	Steel MacEwan		$9,600	
RC 025	2 x 300	top	Steel MacEwan			
RC 026	2 x 900	top	Steel		$42,000	
RC 027	600	top	Fibreglass		$14,400	
RC 028	300	top	Steel		$8,400	
RC 029	300	top	Steel MacEwan		$9,600	
RC 030	600	top	Fibreglass		$10,800	
RC 031	450	top	Fibreglass		$9,600	
				Subtotal		**$410,400**

VERNON LAGOONS

Number	Size mm	hung	Type	Comments	Value	
VL 001	900	top	Fibreglass		$18,000	
VL 002	600	top	Steel MacEwan		$12,000	
VL 004	600	top	Steel MacEwan		$14,400	
VL 005	2 x 900	top	Fibreglass		$44,400	
VL 006	375	top	Steel MacEwan		$15,600	
VL 007	2 x 450	top	Fibreglass		**$24,000**	
				Subtotal		**$128,400**

SPRING CREEK

SC 001	450	top	Steel		$10,800
SC 002	375	top	Concrete		$10,800
SC 003	2 x 600	top	Steel		$31,200
SC 004	375	top	Concrete		$10,800
SC 005	2 x 1800	top	Wooden		$27,600
SC 006					$6,000
SC 007	375	top	Concrete		$10,800
SC 008	300	top	Steel		$10,800
SC 009	375	top	Concrete		$10,800
SC 010	150	top	Steel MacEwan		$10,800
SC 011	375	top	Concrete		$9,600
SC 012	225	top	Concrete		$14,400

SC 013	450	top	Concrete		$10,800	
SC 014	225	top	Concrete		$10,800	
SC 015	150	top	Steel MacEwan		$10,800	
SC 016	300	top	Steel		$10,800	
SC 017	150	top	Steel MacEwan		$10,800	
SC 018	450	top	Steel		$15,600	
SC 019	150	top	Steel MacEwan		$10,800	
SC 020	300	top	Steel MacEwan		$10,800	
SC 021	375	top	Steel		$10,800	
SC 022	150	top	Concrete		$10,800	
SC 023	2 x 225	top	Wooden		$8,400	
SC 024a	300	top	Steel		$10,800	
SC 024	150	top	Steel MacEwan		$10,800	
SC 025	300	top	Steel		$10,800	
SC 026	900	top	Concrete		$18,000	
SC 027	300	top	Steel		$10,800	
SC 028	450	top	Steel		$12,000	
				Subtotal		**$358,800**

TUAMARINA RIVER

Number	Size mm	hung	Type	Comments	Value	
TU 001	450	top	Steel		$18,000	
TU 002	150	top	Steel MacEwan		$14,400	
TU 003	150	top	Steel MacEwan		$12,000	
TU 004	150	top	Steel MacEwan		$12,000	
TU 005	2 x 900	top	Fibreglass		$33,600	
TU 006	300	top	Steel MacEwan		$18,000	
TU 007	600	top	Steel MacEwan		$26,400	
TU 008	375	top	Steel			
TU 009	600	top	Steel MacEwan		$18,000	
TU 010	300	top	Steel MacEwan		$12,000	
TU 011	600	top	Steel MacEwan		$24,000	
TU 012	375	top	Steel			
TU 013	600	top	Steel MacEwan		$28,800	
TU 014	600	top	Steel MacEwan		$28,800	
TU 015	900	top	Steel MacEwan		$27,600	
TU 016	2 x 1500	top	Wooden		$33,600	
TU 017	600	top	Steel MacEwan		$18,000	
TU 018	300	top	Steel		$10,800	
				Subtotal		**$336,000**

LOWER WAIRAU RIVER

$0

Number	Size mm	hung	Type	Comments	Value	
WR 001	600	top	Steel MacEwan		$18,000	
WR 002	900	top	Steel MacEwan		$28,800	
WR 003	3 x 450	top	Steel MacEwan			
WR 004	450	top	Steel		$8,400	
WR 005	300	top	Steel MacEwan		$8,400	
WR 005a	1200	top	Fibreglass		$39,600	
WR 006	375	top	Steel MacEwan		$9,600	
WR 007	450	top	Steel MacEwan		$9,600	
WR 008	600	top	Steel MacEwan		$9,600	
WR 009	150	top	Steel MacEwan		$8,400	
WR 010	150	top	Steel MacEwan		$9,600	
WR 010a	150	top	Steel MacEwan		$9,600	

WR 011	600	top	Fibreglass		$24,000	
WR 012	2 x 900	top	Steel MacEwan		$39,600	
WR 013	2 x 450	top	Fibreglass			
WR 014	450	top	Steel		$18,000	
WR 015	900	top	Steel		$24,000	
WR 016	150	top	Steel MacEwan		$6,000	
WR 017	2 x 1200	side	Wooden		$72,000	
WR 018	2 x 375	top	Steel			
WR 019	2 x 600	top	Steel MacEwan			
WR 020	1900+1500	side	Wooden		$54,000	
WR020a	1650	top	steel	extra parallel culvert	$135,000	
WR 021	2 x 1370	side	Wooden		$54,000	
WR 022	600	top	Fibreglass		$18,000	
WR 023	2 x 450	top	Fibreglass			
WR 024	600	top	Steel MacEwan		$19,200	
WR 025	1200	top	Steel MacEwan		$24,000	
WR 026	600	top	Steel MacEwan		$21,600	
WR 027	900	top	Steel		$26,400	
WR 028	150	top	Steel MacEwan		$10,800	
WR 029	450	top	Steel MacEwan		$12,000	
WR 029a	300	top	Steel		$10,800	
WR 030	600	top	Fibreglass		$18,000	
WR 031	600	top	Steel MacEwan		$18,000	
WR031a	300	top	Steel MacEwan		$8,400	
WR 032	900	top	Fibreglass		$28,800	
WR 033	450	top	Fibreglass			
WR 034	900	top	Steel		$45,600	
WR 035	375	top	Steel		$10,800	
WR 036	150	top	Steel MacEwan		$9,600	
WR 037	2 x 1800	top	Wooden		$39,600	
WR 038	300	top	Steel MacEwan		$8,400	
WR 039	300	top	Steel		$8,400	
WR 040	900	top	Steel MacEwan		$24,000	
WR 041	300	top	Steel		$8,400	
WR 042	750	top	Steel MacEwan		$36,000	
WR 043	2 x 1200	top	Steel		$48,000	
WR 044	300	top	Steel		$12,000	
WR 045	900	top	Steel MacEwan		$32,400	
WR 046	150	top	Steel MacEwan		$12,000	
				Subtotal		**$1,097,400**

WAIRAU RIVER DIVERSION

Number	Size mm	hung		Comments	Value	
WRD 001	1200	top	Steel MacEwan		$42,000	
WRD 002	900	top	Steel MacEwan		$30,000	
WRD 003	300	top	Steel MacEwan		$24,000	
WRD 004	2 x 300	top	Steel MacEwan		$32,400	
WRD 005	3600+1800	side	Steel			
WRD 006	900	top	Steel MacEwan		$32,400	
WRD 007	300	top	Steel		$13,200	
WRD 008	900	top	Steel		$39,600	
WRD 009	2 x 450	top	Steel		-	
				Subtotal		**$213,600**

TOTAL VALUE OF FLOODGATED CULVERTS		**$4,860,160**
DRAINAGE CHANNEL STRUCTURES		
Alabama Rd Control Gate	$30,000	
Town Branch Control Gate	$30,000	
Hunters Road Weir	$21,500	
Thomas Road Piping & M.H.	$50,000	
Swamp Rd Piping UD1-Swamp Rd	$72,000	
Drain I Piping	$32,000	
Town Branch Drain gabions	$50,000	
Town Branch drain culverts	$20,000	
Tuamarina township conc channel	$9,000	
Fultons creek culvert Peters	$10,000	
TOTAL		**$324,500**

LOWER WAIRAU PLAINS - PUMPING STATIONS

SUMMARY SCHEDULE				
Pumping Station Location	**Mechanical.**	**Electrical**	**Structural Works**	**Estimated Value**
Tuamarina - Pembers area				
Parkes Bros	$ 32,400	$ 19,200	$ 150,000	$ 201,600
Tuamarina Lagoon	$ 32,400	$ 15,600	$ 162,000	$ 210,000
Pembers Road	$ 49,200	$ 10,800	$ 180,000	$ 240,000
Thomas Rd	$ 60,000	$ 13,200	$ 180,000	$ 253,200
Pukaka Pondage	$ 36,000	$ 6,000	$ 156,000	$ 198,000
Blind Creek	$ 30,000	$ 10,800	$ 150,000	$ 190,800
Tuamarina Village	$ 8,400	$ 6,000	$ 14,400	$ 28,800
				$ 1,322,400
Spring Creek & Township				
Watsons Road	$ 66,000	$ 24,000	$ 192,000	$ 282,000
				$ 282,000
Wairau Pa - Marshlands				
Rouses Drain	$ 51,600	$ 18,000	$ 192,000	$ 261,600
Roberts Drain	$ 52,800	$ 12,000	$ 192,000	$ 256,800
Chaytors Drain	$ 51,600	$ 12,000	$ 180,000	$ 243,600
				$ 762,000
Grovetown district				
Grovetown Lagoon No 1	$ 78,000	$ 36,000	$ 216,000	$ 330,000
Grovetown Lagoon No 2	$ 84,000	$ 48,000	$ 216,000	$ 348,000
				$ 678,000
Lower Wairau area				
Woolley & Jones	$ 54,000	$ 18,000	$ 180,000	$ 252,000
Lower Wairau	$ 46,000	$ 12,000	$ 180,000	$ 238,000
				$ 490,000
Blenheim urban				
Alabama Rd	$ 50,400	$ 14,400	$ 180,000	$ 244,800
Town Branch	$ 57,600	$ 19,200	$ 258,000	$ 334,800
Main Street	$ 20,400	$ 10,800	$ 156,000	$ 187,200
Caseys	$ 48,000	$ 12,000	$ 186,000	$ 246,000
Waterlea Creek	$ 115,000	$ 12,000	$ 216,000	$ 343,000
Redwood Street	$ 30,000	$ 3,600	$ 186,000	$ 219,600
High Street	$ 30,000	$ 3,600	$ 186,000	$ 219,600
Andrew Street	$ 36,000	$ 12,000	$ 186,000	$ 234,000
Monroe Street	$ 48,000	$ 12,000	$ 186,000	$ 246,000
Boyce Street	$ 60,000	$ 18,000	$ 210,000	$ 288,000
				$ 2,563,000
Riverlands				
Riverlands industrial	$ 36,000	$ 30,000	$ 284,000	$ 350,000
Dillons Point				
Swamp Road	$ 36,000	$ 12,000	$ 222,000	$ 270,000
Dillons Pt	$ 67,200	$ 18,000	$ 222,000	$ 307,200
				$ 577,200
Total pumping station value	**$ 1,367,000**	**$ 439,200**	**$ 5,218,400**	**$ 7,024,600**

Lower Wairau Plains Excavated Drains and Watercourses

Wairau Pa Area									
N.B Only shaded sections to be filled in. All others compute									
Location	Length	X-sect. area	Volume	Cost/m3	Est. Value		Av width	Av Depth	Av X-Sect area
Drains									
Wells	1045	8	8360	$ 7.50	$ 62,700				8
Rarangi Rd	483	5	2415	$ 7.50	$ 18,113				5
Dunkinsons Ck	2010	8	16080	$ 7.50	$ 120,600				8
Smith &Dicks	705	8	5640	$ 7.50	$ 42,300				8
Cresswells	400	2.25	900	$ 16.50	$ 14,850				2.25
Dicks	1170	8	9360	$ 7.50	$ 70,200				8
Pa	605	5	3025	$ 7.50	$ 22,688				5
Outlet Drain	220	11	2420	$ 7.50	$ 18,150				11
Roberts	1460	11	16060	$ 7.50	$ 120,450				11
Connollys Rd	420	5	2100	$ 7.50	$ 15,750				5
Corrys Outlet	100	5	500	$ 7.50	$ 3,750				5
Chaytors Pump	200	11	2200	$ 7.50	$ 16,500				11
					$ 526,050				
Modified waterways									
Marukoko	3015	11	33165	$ 6.00	$ 198,990				11
Pipitea Creek	1610	8	12880	$ 6.00	$ 77,280				8
Pukaka Stream	1951	11	21461	$ 6.00	$ 128,766				11
	15394				**$ 405,036**				
TOTAL						**$931,086**			

Tuamarina Area									
N.B Only shaded sections to be filled in. All others compute									
Location	**Length**	**X-sect. area**	**Volume**	**Cost/m3**	**Est .Value**		**Av width**	**Av Depth**	**AvX-Sect area**
Drains									
Township Dr	845	5	4225	$ 7.50	$ 31,688		2	4	5
Blind Road	705	5	3525	$ 7.50	$ 26,438				5
Hunters Rd	1370	5	6850	$ 7.50	$ 51,375				5
Pembers Rd	1530	8	12240	$ 7.50	$ 91,800				8
Pickerings	1045	5	5224	$ 7.50	$ 39,180				5
Hill	400	2.25	900	$ 13.50	$ 12,150				2.25
Quarry	665	8	5320	$ 7.50	$ 26,600				8
Thomas Rd	1850	11	20350	$ 7.50	$ 152,625				11
Peters	121	2.25	272.25	$ 16.50	$ 4,492				2.25
Bruces	400	2.25	900	$ 16.50	$ 14,850				2.25
Gundys	563	2.25	1266.8	$ 16.50	$ 20,901				2.25
Pukaka Pondage	724	5	3620	$ 7.50	$ 27,150				5
Dr Evans	805	5	4025	$ 7.50	$ 30,188				5
Dooles	520	2.25	1170	$ 16.50	$ 19,305				2.25
Modified waterways									
Blind Creek	4325	11	47575	$ 6.00	$ 285,450				11
Pukaka Stream	2655	11	29205	$ 6.00	$ 175,230				11
Total	**18523**				**$ 1,009,421**				

Lower Wairau Area									
N.B Only shaded sections to be filled in. All others compute									
Location	Length	X-sect. area	Volume	Cost/m3	Est Value		Average width	Average Depth	Average X-Sect area
Woolley &Jones	2412	11	26532	$ 7.50	$ 198,990				11
Jones Rd	724	2.25	1629	$ 18.00	$ 29,322				2.25
Lower Wairau	2815	8	22520	$ 7.50	$ 168,900				8
Lower Wairau Pump	350	12	4200	$ 7.50	$ 31,500				12
Sutherlands	484	2.25	1089	$ 18.00	$ 19,602				2.25
Auberys	484	2.25	1089	$ 16.50	$ 17,969				2.25
Glovers	724	5	3620	$ 9.50	$ 34,390				5
Aireys	485	5	2425	$ 9.50	$ 23,038				5
Total	**8478**				**$ 523,710**				

Tuamarina Pocket Area									
N.B Only shaded sections to be filled in. All others compute									
Location	Length	X-sect. area	Volume	Cost/m3	Est Value		Average width	Average Depth	Average X-Sect area
Drains									
Hastilows	2115	8	16920	$ 7.50	$ 126,900				8
Barnetts Creek	848	2.5	2120	$ 12.00	$ 25,440				2.5
Cow Creek	966	8	7728	$ 7.50	$ 57,960				8
Parkes Bros	1207	8	9656	$ 7.50	$ 72,420				8
Wakefield St	850	5	4250	$ 7.50	$ 31,875				5
Modified waterways									
Waterfall Creek	1400	11	15400	$ 6.00	$ 92,400				11
Tuamarina Lagoon	262	11	2882	$ 6.00	$ 17,292				11
Total	**7648**				**$ 424,287**				

Spring Creek Area									
N.B Only shaded sections to be filled in. All others compute									
Location	Length	X-sect. area	Volume	Cost/m3	Est Value		Average width	Average Depth	Av X-Sect area
Cravens Creek	1370	11	15070	$ 7.50	$ 113,025				11
Bowns Creek	905	8	7240	$ 7.50	$ 54,300				8
Footes	905	5	4525	$ 7.50	$ 33,938				5
Roses Creek	3660	8	29280	$ 7.50	$ 219,600				8
Ganes Creek	1085	5	5425	$ 7.50	$ 40,688				5
Dentons Creek	1170	8	9360	$ 7.50	$ 70,200				8
Rapuara Rd	565	5	2825	$ 7.50	$ 21,188				5
Giffords Creek	2715	5	13575	$ 7.50	$ 101,813				5
Hollis Creek	1448	5	7240	$ 7.50	$ 54,300				5
Wallaces	1164	5	5820	$ 7.50	$ 43,650				5
Kennedys	1770	8	14160	$ 7.50	$ 106,200				8
Whites	1220	5	6100	$ 7.50	$ 45,750				5
Spring Creek Reserve east	240	2.25	540	$ 13.50	$ 7,290				2.25
Spring Creek Reserve west	250	2.25	562.5	$ 13.50	$ 7,594				2.25
Wallaces Overflow	150	2.25	337.5	$ 16.50	$ 5,569				2.25
		0	0						0
Total	**18617**				**$ 812,078**				

Riverlands Area

N.B Only shaded sections to be filled in. All others compute

Location	Length	X-sect. area	Volume	Cost/m3	Total cost		Av width	Av Depth	Av X-Sect area
Drains									
Town Branch	2055	11	22605	$ 11.00	$ 248,655				11
Hocquards	705	5	3525	$ 20.00	$ 70,500				5
Railway	300	5	1500	$ 7.50	$ 11,250				5
DeCastros	220	2.25	495	$ 7.50	$ 3,713				2.25
Alabama Rd	1045	8	8360	$ 7.50	$ 62,700				8
Rileys	725	8	5800	$ 7.50	$ 43,500				8
Industrial Drain	750	8	6000	$ 7.50	$ 45,000				8
Snowdens	905	2.25	2036.25	$ 18.00	$ 36,653				2.25

Grovetown									
N.B Only shaded sections to be filled in. All others compute									
Location	Length	X-sect. area	Volume	Cost/m3	Est Value		Average width	Average Depth	Average X-Sect area
Drain O	5150	8	41200	$ 7.50	$ 309,000				8
Drain B	241	11	2651	$ 7.50	$ 19,883				11
Drain P	240	2.5	600	$ 15.00	$ 9,000				2.5
Awarua Park	200	5	1000	$ 7.50	$ 7,500				5
Murrays Rd No1 W	820	8	6560	$ 7.50	$ 49,200				8
Murrays Rd No 2 E	800	5	4000	$ 8.00	$ 32,000				5
Drain W	360	5	1800	$ 8.00	$ 14,400				5
Drain X	645	5	3225	$ 8.00	$ 25,800				5
Drain Y	725	5	3625	$ 8.00	$ 29,000				5
Drain N	3440	8	27520	$ 8.00	$ 220,160				8
Drain N1	400	5	2000	$ 8.00	$ 16,000				5
Drain Q	744	5	3720	$ 8.00	$ 29,760				5
Drain R	1210	5	6050	$ 8.00	$ 48,400				5
Drain Z	505	2.25	1136.25	$ 16.50	$ 18,748				2.25
Drain A	1086	8	8688	$ 7.50	$ 65,160				8
Sadds	1408	8	11264	$ 7.50	$ 84,480				8
Drain C	1005	2.25	2261.25	$ 16.50	$ 37,311				2.25
Drain C1	160	2.25	360	$ 16.50	$ 5,940				2.25
Drain D	1410	2.25	3172.5	$ 16.50	$ 52,346				2.25
Drain D1	160	2.25	994.5	$ 7.50	$ 7,459				2.25
Drain D2	442	2.25	1575	$ 11.00	$ 17,325				2.25
Drain N2	700	2.25	3082.5	$ 9.00	$ 27,743				2.25
Drain F	1370	5	4100	$ 13.00	$ 53,300				5
Drain G	820	5	3600	$ 9.00	$ 32,400				5
Drain H	720	2.25	1631.25	$ 16.50	$ 26,916				2.25
Drain H1	725	2.25	1901.25	$ 14.50	$ 27,568				2.25
Drain I	845	2.25	1350	$ 23.00	$ 31,050				2.25
Drain J	600	2.25	1631.25	$ 14.00	$ 22,838				2.25
Drain K	725	2.25	2351.25	$ 12.00	$ 28,215				2.25
Drain M	1045	2.25	1361.25	$ 28.00	$ 38,115				2.25
Drain S	605	2.25	1271.25	$ 7.50	$ 9,534				2.25
Drain V	565	5	1000	$ 21.50	$ 21,500				5
DrainO.1	200	8	2880	$ 7.50	$ 21,600				8
Staces	360	8	3200	$ 7.50	$ 24,000				8
Drain H2	400	2.25	787.5	$ 19.50	$ 15,356				2.25
Drain W(extn)	350	2.25	788	$ 16.50	$ 13,002				2.25
		0	0		$ -				0
Total	**31181**				**$ 1,492,008**				

Town Area									
N.B Only shaded sections to be filled in. All others compute									
Location	Length	X-sect. area	Volume	Cost/m3	Total cost		Average width	Average Depth	Average X-Sect area
Drains									
Chinamans Drain	160	5	800	$ 9.50	$ 7,600				5
Caseys Drain A & Outlet	2535	8	20280	$ 9.50	$ 192,660				8
Csaeys Drain B	1207	5	6035	$ 9.50	$ 57,333				5
Old Renwick Rd	645	2.25	1451.25	$ 16.50	$ 23,946				2.25
Cooper & Morrison	500	5	2500	$ 9.50	$ 23,750				5
Adams Lane	160	2.25	360	$ 17.00	$ 6,120				2.25
TAYLOR OUTLETS Golf Course Creek	50	5	250	$ 9.50	$ 2,375				5
Fulton Creek(Daf Glade)	100	5	500	$ 9.50	$ 4,750				5
Murphys Creek	100	5	500	$ 9.50	$ 4,750				5
High St	50	5	250	$ 9.50	$ 2,375				5
Bank St	50	5	250	$ 9.50	$ 2,375				5
Chinamans Drain	100	5	500	$ 9.50	$ 4,750				5
Dashwood St	50	2.25	112.5	$ 9.50	$ 1,069				2.25
Waterlea Racecourse Creek	545	5	2725	$ 9.50	$ 25,888				5
Modified waterways									
Murphys Creek	2090	8	16720	$ 5.00	$ 83,600				8
Fultons Creek	4005	8	32040	$ 5.00	$ 160,200				8
Total	**6252**				**$ 603,539**				

Doctors Creek									
N.B Only shaded sections to be filled in. All others compute									
Location	Length	X-sect.	Volume	Cost/m3	Total cost		Average width	Average Depth	Average X-Sect area
Drains									
Douglas No 2	240	8	1920	$ 8.00	$ 15,360				8
Bells Rd No 1	483	8	3864	$ 8.00	$ 30,912				8
Bells Rd No 2 W	240	5	1200	$ 8.00	$ 9,600				5
Golf Course Creek	1610	5	8050	$ 8.00	$ 64,400				5
Morrisons	485	5	2425	$ 8.00	$ 19,400				5
Yelverton	845	5	4225	$ 8.00	$ 33,800				5
Osgoods	200	5	1000	$ 8.00	$ 8,000				5
Camerons Creek	1045	5	5225	$ 8.00	$ 41,800				5
David St	60	2.25	135	$ 17.50	$ 2,363				2.25
Modified waterways									
Doctors Creek	3825	11	42075	$ 5.00	$ 210,375				11
Fairhall Co-op	2255	8	18040	$ 5.00	$ 90,200				8
Fairhall School Creek	845	5	4225	$ 5.50	$ 23,238				5
Old Fairhall Creek	4325	8	34600	$ 5.00	$ 173,000				8
Total	**16458**				**$ 722,447**				

Riverlands										
N.B Only shaded sections to be filled in. All others compute										
Location	**Length**	**X-sect. area**	**Volume**	**Cost/m3**	**Total cost**			**Av width**	**Av Depth**	**Av X-Sect area**
Drains										
Town Branch	2055	11	22605	$ 11.00	$ 248,655					11
Hocquards	705	5	3525	$ 20.00	$ 70,500					5
Railway	300	5	1500	$ 7.50	$ 11,250					5
DeCastros	220	2.25	495	$ 7.50	$ 3,713					2.25
Alabama Rd	1045	8	8360	$ 7.50	$ 62,700					8
Rileys	725	8	5800	$ 7.50	$ 43,500					8
Industrial Drain	750	8	6000	$ 7.50	$ 45,000					8
Snowdens	905	2.25	2036.25	$ 18.00	$ 36,653					2.25
Harvey Rices	2736	5	13680	$ 7.50	$ 102,600					5
Riverlands Industrial	5120	12	61440	$ 7.50	$ 460,800					12
Town Abattoir Branch	720	11	7920	$ 7.50	$ 59,400					11
Dungys	300	3	900	$ 15.00	$ 13,500					3
Upper Wither stream	1400	3	4200	$ 15.00	$ 63,000					3
					$ 1,144,770					
Modified waterways										
Mapps Waterway	2135	11	23485	$ 5.00	$ 117,425					11
Sandhills Outlet	845	11	9295	$ 5.00	$ 46,475					11
Riverlands Co-op	10000	11	110000	$ 5.00	$ 550,000					11
	29961				**$ 713,900**					
TOTAL						**$1,858,670**				