Lower Waiwhakaiho Flood Control Scheme

Asset Management Plan

Taranaki Regional Council
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Summary

Objectives

The Lower Waiwhakaiho Flood Control Scheme consists of a number of component infrastructural assets to provide the following:

- security from floods in the Waiwhakaiho River up to a flood flow of 1,180 cumecs (1% AEP) to the land in the Waiwhakaiho Basin (The Valley);
- security from floods in the Mangaone Stream up to a flood flow of 73 cumecs (1% AEP) to the land in the Waiwhakaiho Basin;
- minimal riverbank erosion; and
- an unobstructed and stable flood fairway within the maintenance reaches of the Waiwhakaiho River and Mangaone Stream.

Term

In perpetuity

Maintenance

Maintenance is funded to ensure the Scheme objectives will be met.

Reporting

Annually
- Prepare annual maintenance plan and budget.
- Discuss and agree with Council (report in LTP)
- Report on works undertaken and costs to Council.

Three Yearly - Revalue infrastructural assets

Six Yearly - Review asset management plan. Agreed and adopted by Council.

Flood Performance

Report to Liaison Committee and Council on performance of scheme in all floods exceeding 750 cumecs at Rimu St.

Funding

Maintenance funded by:	Targeted rate over the New Plymouth District
Damage repairs funded by:	Rates (as above) Financial reserves Reprioritising works Loan

Financial reserves	Aim to:	- Build up reserves to meet above average planned expenditure. - Draw down reserves to meet unexpected expenditure.
Review of plan	Review when there is a change in maintenance standards, a change in funding policy, or at 6 yearly intervals.	

1. Introduction

1.1 The Plan

This management plan has been prepared to assist those delegated the responsibility for managing the Lower Waiwhakaiho Flood Control Scheme on behalf of the Taranaki Regional Council (the Council).

The Lower Waiwhakaiho Flood Control Scheme fundamentally provides flood protection to the land in the Waiwhakaiho Basin. Figure 2 shows the location of the Scheme works area.

The Lower Waiwhakaiho Flood Control Scheme assets include earthen stopbanks, gabion basket stopbanks, concrete flood walls, rock riprap protection, and other erosion protection measures, floodgates, and plantings. The current valuation of these assets (in terms of Local Government requirements) to 30 June 2020 is $3,541,750.

1.2 Purpose and ownership of the Plan

The purpose of this Plan is to provide the means and mechanisms to enable the Scheme Manager to plan for the most efficient economic and sustainable management of the Lower Waiwhakaiho Flood Control Scheme.

The Lower Waiwhakaiho Flood Control Scheme assets need to be managed, to ensure they continue to effectively deliver scheme benefits on a long term, sustainable basis. Management requires provision for monitoring, maintenance and, in some instances, eventual replacement of these assets.

This Plan defines the objectives and performance standards for the Lower Waiwhakaiho Flood Control Scheme and the level of maintenance needed to ensure these are met at all times.

The Plan also provides a base against which Council's performance in maintaining these infrastructural assets can be measured. This management plan will provide a framework for technical and financial inputs relating to the assets and their impact on long term financial planning.

Responsibility for implementing the Plan lies with the Council, which is the body responsible for managing the asset.

1.3 Duration and review of the Plan

The duration of the Plan is ten years from the date of formal preparation and acceptance by Council. However, this Plan has also been prepared with a 50-year planning horizon. Maintenance costs and rates are current to June 2020.

The Plan will be reviewed and updated, after six years or earlier if required, to ensure that the requirements of the community are met, and that the assets are maintained at their most effective levels of service.

1.4 Legislative requirements

The principal statute affecting the management of infrastructure assets is the Local Government Act 2002 (the Act).

The Act empowers local authorities to provide a range of services. Specifically, the Act, together with the Soil Conservation and Rivers Control Act 1941, obligates regional councils to minimise and prevent damage by floods and erosion. The Council executing its responsibilities and powers as a catchment authority in terms of the Soil Conservation and Rivers Control Act 1941 constructed the schemes.

Part VI of the Act requires councils to effectively and efficiently manage their finances and assets. This involves planning for the maintenance, loss of service potential and capital upgrade of all assets. The associated funding for these commitments also needs to be provided for.

This asset management plan will assist the Council with defining the basis for determining long-term financial strategies. Information from the Plan will be used in preparing financial plans and statements required by the Act.

The Office of the Controller and Auditor-General (OAG) has a responsibility to ensure that councils comply with the requirements of the Local Government Act 2002. Part of this involves ensuring that councils are adequately providing for the ongoing maintenance, renewal and capital expenditure on infrastructure assets. The OAG has issued a number of guidelines to assist councils in the preparation of asset management plans.

1.5 Assumptions

There are a number of assumptions made in preparation of this asset management plan. These are made using current knowledge and experience, but may vary with time and in the light of further experience. Further, they will be updated when the Plan is reviewed. The assumptions are:

- that the Council will continue to perform its existing functions in respect to the current legislation;
- there will be no major changes that impact upon the role of the Council in terms of soil conservation and river control; and
- financial projections are in 2019/2020 dollars.

1.6 Assets to be managed

The Lower Waiwhakaiho Flood Control Scheme covers the Waiwhakaiho River downstream of Devon Road and particular assets in the Mangaone Stream catchment.

On the lower Waiwhakaiho River, the Scheme consists of:

- Flood protection stopbanks (compacted earth fill and gabion basket walls)
- A mass block retaining wall
- Erosion protection works (rock riprap)
- River channel berm areas
- Culvert headwalls
- Access track
- Fences and barriers

On the Mangaone Stream, the Scheme consists of

- Flood protection stopbanks (compacted earth fill and gabion basket walls)
- Erosion protection works (rock riprap)
- Stream channel berm areas
- Floodgated outlets
- Gabion spillway
- Culvert headwalls
- Concrete block flood walls

The location of the Waiwhakaiho Scheme assets are shown in Figure 3.

1.7 Scheme history

River and flood control works have occurred on the Waiwhakaiho River in isolated locations for many years. However, with the more recent development of the 40 hectares of flood prone land in the Waiwhakaiho Basin located on the right bank of the river downstream of Devon Road and the left bank of the Mangaone Stream downstream of Katere Road, a more concerted effort has been made to control flooding from the river.

Prior to the mid-nineties, the area of land now protected by the Lower Waiwhakaiho Flood Control Scheme was used for activities such as contractors yards, heavy industrial manufacturing, the New Plymouth show grounds, the stockcar track and gravel extraction and processing activities. These activities were less prone to damage by large flood events in the river than the current land use.

The Lower Waiwhakaiho Flood Control Scheme was constructed to give flood protection to the 40 hectares of land that was fast becoming developed for more commercial and light industrial uses. It was originally constructed in 1996 and 1997 in response to a large flood in the Mangaone Stream in April 1995. Work commenced with replacing the undersized culvert on the Mangaone Stream under Katere Road and was followed by the construction of the gabion basket floodwall along the left bank of the Mangaone Stream down to the culvert under State Highway 3. At the same time a gabion basket and reno mattress lined spillway was constructed over a length of undersized twin culverts in the then NZ Farmers Fertilizer Company property adjacent to Katere Road. Whilst the New Plymouth District Council

replaced the Katere Road culvert, the rest of the Scheme works were undertaken under the control and direction of the Council.

Works followed soon after to construct a new stopbank and the gabion basket walls along the right (east) bank of the Waiwhakaiho River commencing 160m downstream of the Devon Road Bridge and extending downstream along Rifle Range Road to the Mangaone Stream confluence. Construction of the Lower Waiwhakaiho River Flood Control Scheme was completed in August 1997.

The new stopbanks constructed in 1996/97 along the Waiwhakaiho River and the Mangaone Stream were designed to give flood protection against a 2% Annual Exceedance Probability (AEP) flood (50-year).

River bank protection works involving the placement of a heavy rock lining along the right bank of the channel were also undertaken at that time to prevent erosion of the narrow berm on the outside of the long bend in the river opposite the Firths concrete yard. The ford across the river downstream of the Firths concrete yard was removed from the river.

The provision of flood protection to this area allowed the large format retail development to proceed to the level that it has reached today. However in light of this development and the significant increase in the potential losses that would occur in the event of an over design flood occurring in either of the Waiwhakaiho River or Mangaone Stream, the Council decided in 2008 to commence an investigation into the raising of the protection standard on the Lower Waiwhakaiho Flood Control Scheme.

The investigation was separated into three stages.

Stage one, which focused on the Waiwhakaiho River, was completed in mid 2010. The results of this investigation determined a new design level for the Waiwhakaiho River stopbank from Constance Street to the Mangaone Stream confluence to contain a 100 year (1%AEP) flood event with 500 mm of freeboard and an allowance for climate change to the year 2060. Stage one of this upgrade was substantially completed in June 2011.

Stage two involved the construction of stopbanks along both sides of Mangaone Stream channel downstream of Devon Road (SH3) and changes to the Rifle Range Road culvert headwalls. These works were completed in 2012.

It was proposed that stage three would involve the construction of detention dams in the upper Mangaone Stream catchment but because of site difficulties and cost, this proposal was abandoned. Stage three finally involved increasing the capacity of the Devon Road and Katere Road culverts by raising their headwalls and raising the height of the stopbank along the left bank of the Mangaone Stream between Katere Road and Devon Road. The works were substantially completed in July 2013.

A more detailed table of dates and activities is set out at Appendix 1.

1.8 Catchment description

The Waiwhakaiho River has a catchment of some 136 square kilometers rising up onto the northern slopes of Mount Taranaki. Approximately 25 % of the catchment lies within the Egmont National Park above the 450 m contour. The river drains to the sea at Fitzroy with its last 4.5 kilometers separating the urban areas of New Plymouth and Bell Block. Refer to Figure 1.

The Mangaone Stream, its only significant lowland tributary, joins the main channel 1.5 kilometers upstream of its river mouth, at the downstream end of Waiwhakaiho Basin.

The Waiwhakaiho River is relatively incised in its lower reaches downstream of Egmont Village/SH3. Less than 100 meters downstream of Devon Road however, the floodplain widens out into the Waiwhakaiho Basin (The Valley), an area formerly used for industrial and recreational uses. Whilst a larger part of the area is used for industrial purposes, a significant proportion of the area is occupied by commercial and large format retail developments.

The grade of the river follows the normal pattern for rivers flowing off Mount Taranaki with very steep headwaters reducing to a much flatter grade downstream of Devon Road of approximately 0.4%. Ten Kilometers upstream of Devon Road the grade is about 1% and at the bush line about 4%.

Within the National Park, the catchment is still heavily bush covered but downstream of the Park the bush has nearly all been replaced with pasture. Isolated patches of bush do however remain in some areas and other areas have been planted in exotic trees.

Water is drawn from the river a short distance downstream of SH3, stored in Lake Mangamahoe and released again to the river through the Mangamahoe Power Station. This results in fluctuations in river level on a daily basis that do not appear to have any adverse effects on the stability of the lower river especially that reach of the Waiwhakaiho River managed by the Scheme.

The bed of the Waiwhakaiho River is made up of gravel with occasional outcrops of bedrock and laharic deposits. The gravel size is very large especially in its upper reaches. By the time the river has reached Devon Road where the grade has dropped significantly, the rock size has reduced considerably down to a maximum size of about 300mm. An increasing amount of finer material now appears to be moving down through the river system and building up in its lower reaches. A large amount of gravel drops out on the sharp bend in the river 350 meters downstream of Devon Road with slightly finer material moving through to the beach beside the Firths concrete plant.

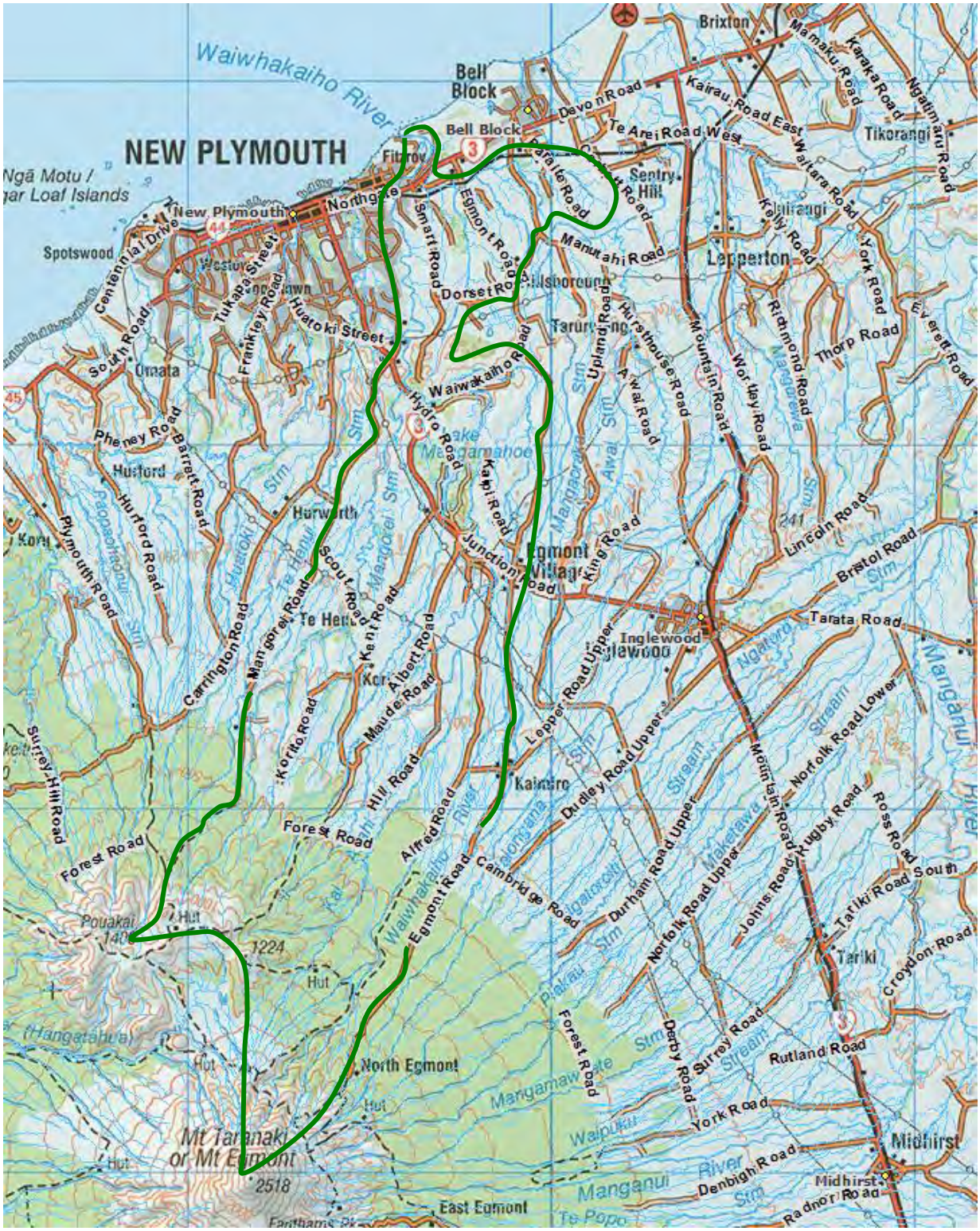

Figure 1: Waiwhakaiho Catchment

The left bank of the river downstream of Devon Road is characterized by a high terrace that drops drop down about 1500 meters downstream of Devon Road and in very large flood events water can spill over the left bank into Lake Rotomanu.

Flood waters historically flooded the Waiwhakaiho Basin every few years until the construction of the first significant stopbanking in 2005.

The Mangaone Stream forms part of the Lower Waiwhakaiho Flood Control Scheme as it can also contribute to flooding in the Waiwhakaiho Basin. The stream has a catchment of approximately 15 square kilometers and whilst most of it is in farmland, part of it along its northern edge is continuing to be developed into for industrial and commercial uses. The main stem of Mangaone Stream has its headwaters at about Hillsborough with a major tributary, the Manganaha Stream having its headwaters further to the south close to Egmont Village.

1.9 Climate

Because of its exposure to disturbed weather systems from the Tasman Sea, the Taranaki region is often quite windy, but has few climate extremes. The most settled weather occurs during summer and early autumn. Summers are warm. Typical summer daytime maximum air temperatures range from 19°C to 24°C and seldom exceed 30°C. Winters are relatively mild with daytime maximum air temperatures ranging from 10°C to 14°C but are normally the most unsettled time of the year. Frost occurs inland during clear calm conditions in winter. Annual sunshine hours average about 2000 hours. Northwesterly airflows prevail and sea breezes occasionally occur along the coast during summer.

The mountain and ranges have a strong influence on rainfall in the area by attracting orographic type events which are often associated with frontal systems and depressions moving through the Tasman Sea. Annual rainfall on the upper slopes of the northern Egmont National Park ranges from 1500 to 5000mm.

Although the annual totals are quite high, the way in which rainfall is delivered is more significant. Also of significance is that only 25% of the catchment is located within the National Park and above the 450m contour.

1.9.1 Climate change

Some of the predicted impacts of a moderate rate of climate change for Taranaki include changes in average temperature, sea level rise and rainfall patterns. In general, Taranaki, like much of the west coast of New Zealand, is likely to become warmer and wetter.

Climate scientists estimate that Taranaki's temperature could be up to 3°C warmer over the next 70-100 years. This compares to a temperature increase in New Zealand during last century of about 0.7°C. Taranaki could be up to 20% wetter with more varied rainfall patterns and flooding could become up to four times as frequent by 2070.

As extreme weather events become more frequent or severe, the costs and damages associated with them are also likely to increase.

Allowances have been made in the design of the Lower Waiwhakaiho Flood Control Scheme for the effects of climate change.

1.10 Land ownership

The Lower Waiwhakaiho Flood Control Scheme assets are located on land under a range of ownership situations and arrangements.

The stopbank is located on land that was owned by New Plymouth District Council, partly on reserve land that is vested in the District Council and partly on Crown Reserve. The District Council land was part Esplanade Reserve, part River Reserve, part stopped road and part road. The Council and New Plymouth District Council agreed that the most appropriate mechanism for the vesting of the District Council land to the Council was pursuant to section 237D of the Resource Management Act 1991 on the basis that all the land could be classified as Esplanade Reserve.

In consideration of New Plymouth District Council agreeing to vest the District Council land to the Council a consideration of $1.00 inclusive of GST was provided. The Council further agreed to grant any easement in gross in favour of the New Plymouth District Council to protect any existing services which are located on the NPDC land.

The only land originally under the control of TRC is adjacent to Constance Street along to the end of Smart Road and on the river side of the privately owned land at 19 and 21 Constance Street.

The gabion basket wall located within 19 and 21 Constance Street is protected by way of a Memorandum of Encumbrance signed 20 November 1998.

The gabion basket wall along the Mangaone Stream between Devon Road and Rifle Range Road is protected by way of a Memorandum of Encumbrance signed 2012.

The gabion basket wall located on the left bank of the Mangaone Steam between Katere Road and Devon Road was located on private land and protected by way of a number of Memorandums of Encumbrance's signed in 1998.

As part of the 2013 upgrade to this bank, the land was purchased (peppercorn purchase) from three of the four landowners and the Memorandum of Encumbrance was released. The fourth landowner (Foodstuffs) as at 30 June 2014, have not yet agreed to sell the land but negotiations are still underway.

1.11 Protection standard

The Lower Waiwhakaiho Flood Control Scheme was designed to provide protection:

- from a 1,180 cumec flood in the Waiwhakaiho River with 500 mm of freeboard and an allowance for climate change through to the year 2060.
- From a 73 cumec flood event in the Mangaone Stream with 300mm of freeboard.

In 2010 these design flow rates were determined to be the 1% AEP (annual exceedance probability) flood events.

The scheme was upgraded to the 1% AEP standard between 2010 and 2013.

2. General scheme information

2.1 Principal scheme features

2.1.1 Objectives of the Scheme

The Lower Waiwhakaiho Flood Control Scheme consists of a number of component infrastructural assets to provide the following:

- security from floods in the Waiwhakaiho River up to a flood flow of 1,180 cumecs (1% AEP)to the land in the Waiwhakaiho Basin (The Valley);
- security from floods in the Mangaone Stream up to a flood flow of 73 cumecs (1%AEP) to the land in the Waiwhakaiho Basin;
- minimal riverbank erosion; and
- an unobstructed and stable flood fairway within the maintenance reaches of the Waiwhakaiho River and Mangaone Stream.

2.1.2 Scheme works' boundaries

Refer to Figure 2.

Waiwhakaiho River
The flood control works on the Waiwhakaiho River extend from the Devon Road (SH3) Bridge of the downstream end of Rifle Range Road.

Maintenance works on the river channel will extend downstream of the Mangaone Stream confluence to maintain the capacity of the flood fairway.

Mangaone Stream
The main flood control works on the Mangaone Stream extend from the upstream side of the gabion floodway structure at Katere Road to the confluence with the Waiwhakaiho River.

Maintenance works on the stream channel will extend up to Egmont Road.

2.1.3 Hydrology

Waiwhakaiho River
The design flood event for the Waiwhakaiho River is the 1,180 cumec flood with an allowance for climate change of 1.5 degrees C through to the year 2060. This is estimated to be the 1% AEP.

Mangaone Stream
The design flood event for the Mangaone Stream is the 73 cumec flood. This is estimated to be the 1% AEP.

The stopbanking on the channel between Katere Road and Devon Road carries 73 cumecs and the capacity of the culverts at Katere Road and Devon Road have been increased to pass the design flood flow by raising the culvert headwalls.

The channel downstream of Devon Road has been designed for a 73 cumec flow coinciding with a 700 to 800 cumec flood in the Waiwhakaiho River. Floods larger than this reduce the 300 mm of freeboard allowance until there is no freeboard when the 73 cumec flood flow in the Mangaone Stream coincides with the design flood flow of 1,180 cumecs in the Waiwhakaiho River.

2.1.4 Overview of Scheme assets

The majority of the flood protection and erosion control measures were built since 1995 when the original stopbanking was constructed on the Mangaone Stream and stopbanking, channel management and erosion control works were undertaken on the Waiwhakaiho River.

Significant upgrading on the Waiwhakaiho River stopbanks was undertaken in 2011.

The principal Scheme assets include the following:

- Gabion basket and reno mattress floodway (Mangaone Stream)
- Gabion basket stopbank wall (Mangaone Stream, Katere Road to Devon Road (raised in 2013))
- Gabion basket stopbank wall (Mangaone Stream, Devon Road to Rifle Range Road)
- Concrete block flood walls (Mangaone Stream)
- Earth stopbank (Mangaone Stream)
- Gabion basket stopbank wall (Waiwhakaiho River)
- Earth stopbank (Waiwhakaiho River)
- Massbloc wall (Waiwhakaiho River)
- Rock riprap lining (Waiwhakaiho River)
- Floodgated outlets (Mangaone Stream)
- Access track (Waiwhakaiho River)
- Headwall at the Katere Road, Devon Road and Rifle Range culverts (Mangaone Stream)

Note: The Katere Road Culvert and the Devon Road Culvert on the Mangaone Stream are not Scheme assets and were constructed by the New Plymouth District Council and NZTA respectively.

Figure 2: Scheme works area

3. Assets

3.1 Description of assets

Refer to Figure 3.

3.1.1 Earthfill stopbanks

Earthfill stopbanks are compacted earth structures which provide protection to properties in the Waiwhakaiho Basin from flooding.

Stopbanks are built to a level and grade where they will not be overtopped by the design flood. They are constructed to meet appropriate compaction standards, batter slopes and top width to ensure their structural integrity.

3.1.2 Gabion basket floodwalls

Gabion basket floodwalls are wire mesh gabion baskets filled with river stones, with spray-concrete on their river side face, which provide protection to properties in the Waiwhakaiho Basin from flooding.

The floodwalls are built to a level and grade where they will not be overtopped by the design flood.

3.1.3 Concrete block floodwalls

Concrete block floodwalls are reinforced concrete block walls which provide protection to properties in the Waiwhakaiho Basin from flooding. They are used when there is insufficient area to construct an earth stopbank or gabion basket floodwall.

The floodwalls are built to a level and grade where they will not be overtopped by the design flood.

The floodwalls across the Rifle Range Road culvert have been constructed 500 m higher than the adjacent stopbank to allow for future stopbank grading if required without having to raise the flood wall which would be structurally difficult.

3.1.4 Massbloc retaining walls

Massbloc retaining walls are one cubic metre blocks of lightweight open pore concrete stacked to retain the earthfill of a stopbank where a batter-slope cannot be accommodated.

3.1.5 Gabion basket floodway

A gabion basket floodway is a flood overflow channel constructed using gabion baskets and Reno Mattresses to provide an erosion resistant steep sided flood channel where there is insufficient room to form a natural earthen channel.

3.1.6 Rock riprap erosion protection

Rock riprap is large rock placed mechanically on an eroded or potentially erodible riverbank to prevent riverbank erosion that may threaten the integrity of the adjacent stopbank.

The rock is sized and placed to meet particular standards to ensure it withstands the river forces that occur during large flood events.

3.1.7 Access track

The access tracks in this context is a formed access track on the river side of the Waiwhakaiho River stopbank used to provide access to the river side of the stopbank and river bank for inspection and maintenance purposes.

3.1.8 Fences and gates

Fences and gates including bollards are installed to control access onto or along stopbanks.

3.1.9 Floodgates

Floodgates are steel or wooden flaps that are attached to the river end of a culvert through the stopbank and prevent floodwaters flowing up the pipe and flooding land on the inland side of the stopbank when the river level rises.

In the Lower Waiwhakaiho Flood Control Scheme on the Waiwhakaiho River, the pipes through/beneath the stopbank are the property of the New Plymouth District Council, as are the flood gates. However, given any failure of the gates can negate the benefits provided by the stopbanks, inspection and monitoring of the floodgates will be undertaken as part of the Scheme asset management activity. Pipes and floodgates on the Mangaone Stream are either privately owned or owned by the Council. The Council maintains Mangaone Stream pipes and floodgates.

3.1.10 Flood fairway (Berm)

Whilst a flood fairway is not strictly an asset, it is included here in recognition of the need for ongoing maintenance to ensure that the flood carrying capacity of the river or stream channel is not lost as this will reduce the effectiveness of the Scheme's stopbank system.

The flood fairway includes that area of land adjacent to the river edge and below the design flood level.

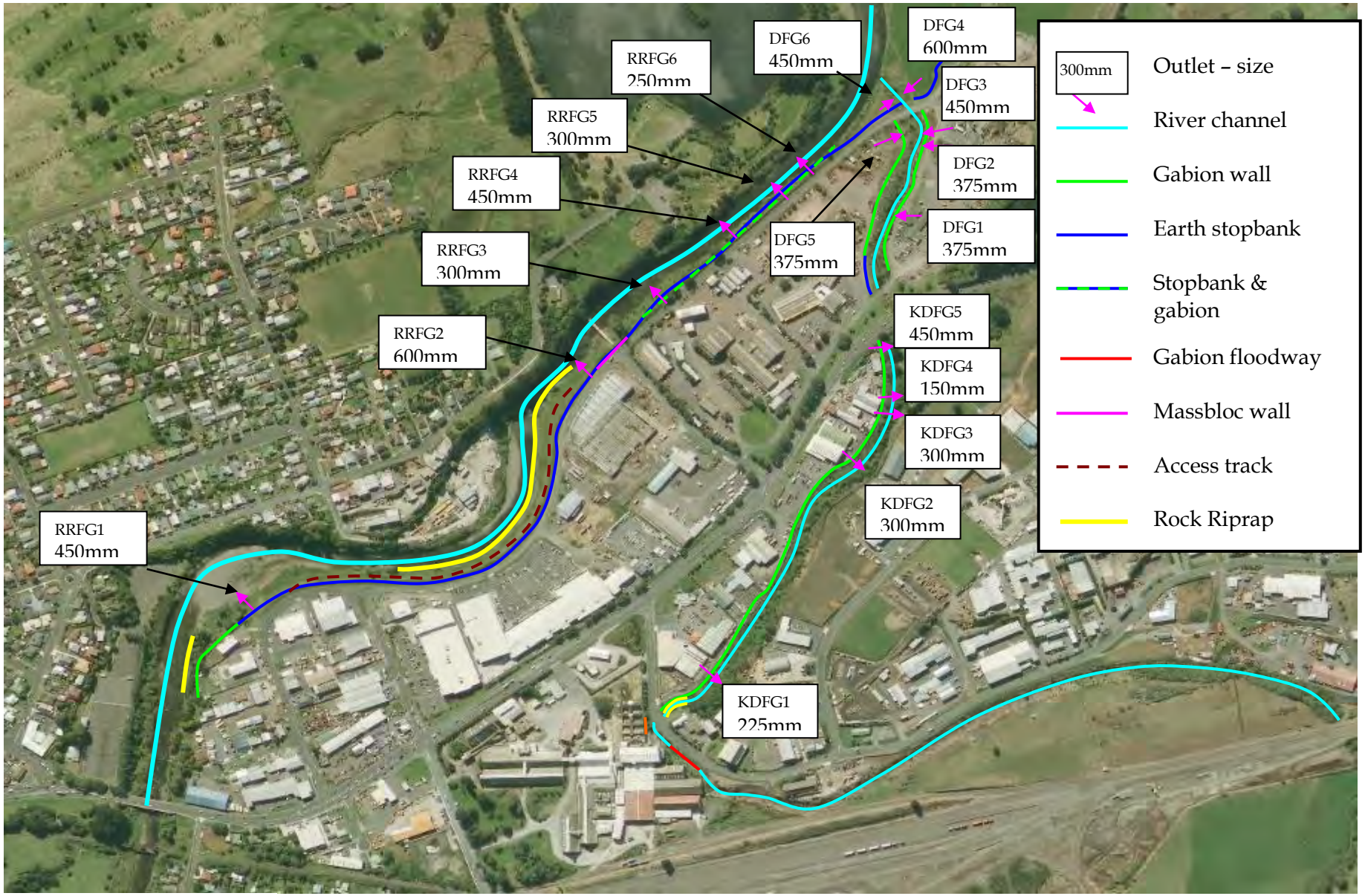

Figure 3: Asset Location

3.2 Asset capacity – design standards

3.2.1 Stopbanks, floodwalls and channels

When the Lower Waiwhakaiho Flood Control Scheme works were first constructed in 1995, the design standard was the 2% AEP flood event known at that time.

The new design standard on the Waiwhakaiho River stopbank is the 1,180 cumecs (1% AEP flood event in 2010). Freeboard of 500 mm has been allowed for and the design flood level has included an allowance for climate change to the year 2060.

Hydraulic modeling on the Waiwhakaiho River is very difficult due to the steep channel, the sharp bend at Constance Street and the sudden changes in bed form. The hydraulic model used to determine the 1,180 cumec stopbank design level was calibrated with levels recorded in relatively small flood events and the flood profile was set by smoothing out a very irregular modeled flood profile.

The allowance of 500mm of freeboard and the allowance for increased flows due to climate change, make the design flood profile conservative for quite some time.

Flood levels should be pegged and surveyed for each flood following a 3.9m warning being issues for the Waiwhakaiho River at Egmont Village.

This will coincide with a flood flow of approximately 500 cumecs and these levels should be plotted and compared with a long section of the stopbank. If the flood level long section plot varies significantly from the stopbank long section, the information should be referred to a suitably qualified engineer for an assessment of the need for amendment to the design stopbank profile. Refer to Section 7.

The left bank stopbank on the Mangaone Stream between Katere Road and Devon Road was constructed following the 1995 flood. Hydraulic modeling undertaken in 2010 identified that the capacity of the channel was 54 cumecs with an allowance for 300 mm of freeboard. Stopbank raising works undertaken in 2013 have increased the channel capacity to 73 cumecs with 300mm of freeboard.

Downstream of Devon Road the stopbanking will contain the 73 cumec flow with 300mm of freeboard coincident with only a moderate flood flow in the Waiwhakaiho River. It is considered that the probability of 100 year flood events in the Waiwhakaiho River coinciding with 73 cumec flows in the Mangaone is lower than 1%.

3.2.2 Structures

(a) Floodgates

Floodgates are designed to stop flow backing up tributary drains or pipe systems when the river channel is in flood and are designed to allow the drainage water to discharge to the river when the flood recedes.

All of the floodgated outlets on the Waiwhakaiho River are the responsibility of the New Plymouth District Council but should they fail to close during floods, the effectiveness of the

stopbank system is compromised. Therefore whilst the capacity of these floodgates is not an issue to be addressed by the Lower Waiwhakaiho Flood Control Scheme, ensuring they close effectively is.

There are a number of floodgated outlets along the Mangaone Stream between Katere Road and Devon Road that prevent backflow into the stormwater system servicing the adjacent properties. These floodgates are the responsibility of the Scheme.

(b) Culverts

There is only one significant culvert structure that is an asset managed by the Scheme and forms part of the spillway structure upstream of the Katere Road Culvert. The capacity of the structure has been checked and will pass the design flood flow.

The large culverts beneath Rifle Range Road and Katere Road, are the responsibility of the New Plymouth District Council; with the Devon Road culvert being the responsibility of NZTA.

The raised headwalls on these three structures are Scheme assets and have been constructed to increase the culvert capacity.

3.2.3 Edge protection

Rock riprap is designed to remain effective in a design flood event and will depend on the velocity and the batter slope at the site. Rock in the Waiwhakaiho River and Mangaone stream has remained very stable and any future rock used in these channels must be of similar size and grading.

3.3 Physical parameters

Table 1: Physical parameters

Asset Type	Location	Life (years)	Quantity			
Waiwhakaiho River						
Stopbanks	Constance Street & Rifle Range Road	Indefinite	29,580	m^3	1,360	m
Gabion basket Walls	Rifle Range Road	50/35	884	m^3	320	m
Gabion basket Walls	Constance Street	50/35	390	m^3	140	m
MassBloc walls	Rifle Range Road	50	320	each	125	m
Access Track	Rifle Range Road	20	2,100	m^2	625	m
Rock Riprap	Rifle Range Road	Indefinite	4,934	tonnes		
Rock Riprap	Constance Street	Indefinite	80	tonnes		
Fences & Gates	Rifle Range Road	20	3	no.		
Mangaone Stream						
Gabion basket Walls	U/s Devon Road	35	1,430	m^3	630	m
Gabion basket Walls	D/s Devon Road Right bank	50	260	m^3	260	m
Gabion basket Walls	D/s Devon Road Left bank	50	210	m^3	210	m
Rock Riprap	D/s Katere Road	Indefinite	500	tonne		
Gabion basket Spillway	U/s Katere Road	35	900	m^3		
Culvert outlets/floodgates		20	7	no.		
Concrete Block walls	Rifle Range Rd	50	90	m^2	56	m
Stopbank	Left bank d/s Devon Rd	Indefinite	150	m^3	60	m
Culvert headwall	Devon Road	50	1	each		
Culvert headwall upgrade	Katere Road Timber/ concrete	25/50	1	each		

3.4 Asset condition

3.4.1 Stopbanks

Stopbanks on the Lower Waiwhakaiho Flood Control Scheme are built from either compacted Taranaki ash or with gabion baskets or a combination of both.

Whilst settlement of these banks and thus a reduction in the protection provided will be very small owing to the compaction that is readily achieved with the construction material, the level of the banks will be checked every 10 years.

Compacted earth stopbanks will be topped up if the survey shows that the crest has settled more than 150mm and gabion basket banks by more than 200mm.

On the Mangaone Stream, where the freeboard is only 300mm, topping up will be considered if the crest level is shown to reduce by more than 100mm. Settlement of the gabion basket banks is unlikely however.

Bank integrity can also be compromised by toe erosion, by wear and tear caused by vehicle access and pedestrian and bike access, and from large trees growing on the bank. These problems are exacerbated by the lack of adequate berm in some locations. Ongoing maintenance will prevent these issues becoming a problem.

However, it is possible that flood damage repair works may be needed in the future should river bank erosion put the bank at risk.

Stopbank asset condition will continue to be monitored by visual inspection, physical surveys and scheme reviews including detailed computer modeling.

3.4.2 Structures

A regular programme of maintenance will be carried out on all structures. Asset condition is monitored by regular inspection. Structural concrete is inspected periodically.

3.4.3 Edge protection

The condition of live edge protection in the Lower Waiwhakaiho Flood Control Scheme varies depending on its age and its previous maintenance. There are no new plantings and most of the old are largely native plantings along the downstream end of Rifle Range Road. Inspection of these plantings is undertaken regularly and any maintenance will involve replacement and trimming.

Rock riprap is generally in good condition and will be monitored periodically. Replenishment is generally not required but will be undertaken if the riprap reduces to 75% of the placed quantity.

3.5 Asset management system

The Taranaki region has a relatively small number of river control schemes within which infrastructural assets have been constructed and these schemes have a relatively small number of assets.

Because of this, it is possible to manage and keep track of these assets with very simple tools. Other councils that have a large network of infrastructural assets generally have an array of asset management tools used for the management of their assets.

The infrastructural assets are recorded in a simple Excel spreadsheet located on TRC file system, Number 1356510

The Council does not have a Schedule of River Scheme Assets located within its financial record system.

3.6 Asset value

River scheme infrastructural assets in the Taranaki Region are valued at current replacement value.

The valuation of the Lower Waiwhakaiho Flood Control Scheme assets are reviewed and updated annually following a detailed inspection of the total Scheme. This is a practical option on the Waiwhakaiho Scheme as the area involved and the number of scheme assets is relatively small.

With the exception of the culverts and concrete walls, the values have been determined using unit rates obtained from the Scheme upgrade works undertaken in 2010/11 adjusted using CGPI indices.

The 2020 asset values are set out in Table 2 and in internal document 'Asset Valuation Spreadsheet: 2570974'.

Table 2: Asset values

Asset Type	Location	Quantity					Value 30/6/2020
Waiwhakaiho River							
Stopbanks	Rifle Range Road	29,580	m^3	1360	m		$1,150,650
Gabion Basket walls	Rifle Range Road	1274	m^3	460	m		$485,790
Mass Block Wall	Rifle Range Road	320	Each	125	m		$206,320
Access track	Rifle Range Road	2100	m^2				$ 28,310
Rock Riprap	Rifle Range Road	5014	tonnes				$256,120
Rock Groynes	Constance Street						$ 18,430
Fences and gates	Rifle Range Road	3	Each				$ 5,790
Mangaone Stream							
Gabion Basket walls	u/s & d/s Devon Rd	1900	m^3	1100	m		$751,960
Rock Riprap	Katere & Rifle Range Rds	500	tonnes				$ 54,450
Gabion Spillway	Katere Road	900	m^3				$414,610
Culvert outlets	u/s & d/s Devon Rd	7	Each				$ 19,920
Culvert Headwall	Katere, Devon, RR						$ 94,680
Stopbank	d/s Devon Rd	150	m^3	60	m		$ 6,820
Retaining wall anchor	u/s Devon Rd						$ 18,530
Works culvert ramp	Downer/Technix						$ 29,370
TOTAL							**3,541,750**

4. Maintenance and renewals plan

4.1 Asset management system

Maintenance refers to the work necessary to retain the operating standard or service capacity of the Scheme and to keep the asset operational. Because a natural river system is involved, the work needed cannot always be accurately forecast in time. However, experience gives a very good guide as to the type and general level of work necessary to meet scheme requirements in periods of 'normal' river flow i.e. the base level of maintenance.

Maintenance can include:

- Works to maintain a structural element e.g. a stopbank or a length of edge protection;
- Regular operational activities, e.g. fairway/channel weed spraying and mowing; and
- Replacement of elements of the system such as walls, culverts or floodgates.

The maintenance plan will set out the programmes and costs required to maintain the desired level of service.

4.2 Service levels

4.2.1 General

The standard of protection provided by the Lower Waiwhakaiho Flood Control Scheme is 2010 - 1% AEP (100-yr flood) for flooding in the Waiwhakaiho River and the Mangaone Stream.

The hydraulic capacity provided by river control works can be determined with reasonable consistency and accuracy. The greater problem is in determining the security of the primary defenses - stopbanks, floodgates, natural terraces – against erosion. The level of risk of failure can only be estimated roughly.

The greater part of expenditure on maintenance of most river control systems is on erosion protection works. However as the Waiwhakaiho River has a stable strong bed, erosion control works that have been undertaken on the river in the main potential erosion areas are generally very stable and the risk of failure is very low. Consequently there is very little erosion that can threaten the stopbanks integrity. However despite this, no stopbanking system can guarantee absolute protection to the scheme design. Furthermore, it is difficult to precisely determine the risks of a stopbank breach occurring. An initial estimate is that there is a 90-95% likelihood that the stopbanks with adequate freeboard will withstand the design flood.

Minor damage to the erosion protection works at a critical location could result in a failure of the primary stopbanks, leading to inundation of a large part of the floodplain, i.e. the Scheme's value could be retained almost 100%, but its operating standard severely compromised.

Further, in many instances major damage to the erosion protection works could occur even though all floodwater is contained within the system.

4.2.2 Stopbanks

The Council will maintain the stopbanks to a level to ensure the design flood can be conveyed. For design standards see Section 3.2.

An ideal stopbank would have 3 metre top width and 2:1 batters as a minimum. However, the upgraded stopbanks on the Waiwhakaiho River have much steeper banks than this caused by a need to raise the bank to achieve the design standard but with no room to widen their base.

Access is to be available as far as possible along the top of the stopbank.

Settlement of up to 150mm of the freeboard will be allowed before stopbank reconstruction will be undertaken.

4.2.3 Gabion basket walls

The Council will maintain the gabion basket walls to a level to ensure the design flood can be conveyed. For design standards see Section 3.2.

A reduction from the design crest level of up to 200mm of the freeboard will be allowed before reconstruction will be undertaken. On the Mangaone Stream the reduction of only 100mm will be allowed.

4.2.4 Structures and walls

The Council will maintain all structures in a workable condition at all times to function to their design standards.

4.2.5 Edge protection – rock riprap

Rock riprap is generally in good condition and will be monitored periodically. Replenishment is generally not required but will be undertaken if the riprap reduces to 75% of the placed quantity of rock.

4.2.6 Edge protection – plantings

The condition of live edge protection in the Lower Waiwhakaiho Flood Control Scheme varies depending on its age and its previous maintenance. There are no new plantings and most of the old plantings, which are largely native plantings, are along the downstream end of Rifle Range Road. Inspection of these plantings is undertaken regularly and any maintenance will involve replacement and trimming.

4.2.7 Drainage outlets and floodgates

The flood gated drainage outlets on the Waiwhakaiho River are assets owned by the New Plymouth District Council.

TRC will inspect and clear the floodgated outlets on a regular basis as their failure will reduce to some extent the effectiveness of the stopbank system.

On the Mangaone Stream the outlets were installed to pass existing drainage flows through the stream bank beneath the gabion basket wall stopbanks.

TRC will inspect and clear the Mangaone Stream floodgated outlets on a regular basis and replace the gates and outlet pipes as required.

4.3 Maintenance history

Up until 2010, maintenance work on the Lower Waiwhakaiho Flood Control Scheme has largely been limited to stopbank mowing, weed spraying and other vegetation control. The removal of gravel build up has also been undertaken from time to time.

Commencing in late 2010, a concerted programme of vegetation control work on both the Waiwhakaiho River and the Mangaone Stream was undertaken. This work has cleared all large vegetation off the left bank of the Waiwhakaiho River between Devon Road and the downstream edge of the Firths Concrete site. On the right bank, the congestion of trees and other vegetation from the back of 19 Constance Street to the Vickers Road pipe bridge have been cleared. In 2016 the remaining large vegetation on the right bank downstream of Devon Road was cleared.

Again since 2010, the buildup of weeds and vegetation has been cleared from the Mangaone Stream between Katere Road and Devon Road. This included trimming back native trees and removing weed trees from the Department of Conservation reserve on the right bank of the stream. This work was authorized by the Department. Upstream of Devon Road, weeds have been cleared from the gabion basket spillway area and from amongst the riparian planting along the left and right banks, upstream of the fertilizer works.

Gravel build up in the Waiwhakaiho riverbed has been cleared from time to time at the Constance Street Beach, the Firth Beach, and from the channel downstream of the Mangaone Stream confluence.

The Constance Street and Firth sites were heavily extracted in 2011. No resource consents were required for any of these maintenance works.

4.4 Maintenance programme

The Council has developed a maintenance programme, which will minimize the risks of failures to the system, and thereby provide for the most efficient and economic operation, to the service standards determined previously. A detailed assessment has been undertaken of the work required to provide for the long term sustainable management of the Lower Waiwhakaiho Flood Control Scheme assets.

The key work components of this are summarised in Table 3, along with a general description of the activity and its estimated required frequency. Frequencies given are for the range of conditions anticipated throughout the scheme.

The Lower Waiwhakaiho Flood Control Scheme has been separated into three distinct components and subdivided further into reaches or items within those subcomponents.

This separation has been undertaken to ensure the components of the Scheme are inspected at a level that identifies all maintenance issues. Inspection and reporting at a large scale can result in important items being missed.

Table 3: Maintenance frequency

Item/Activity	Description	Estimated Frequency
Channel / Flood fairway		
• General overview	• Overview and general inspection of channel	• 1 yearly
• Cross section survey	• Resurvey at previous cross section locations	• 5-7 yearly
• Gravel beach survey	• Survey gravel beach & compare with cleared levels	• 2-4 yearly
• Gravel beach mtce	• Clear gravel buildup when required	• As required
• Berm mtce	• Tree and weed clearing & rough mowing	• 1 yearly
Riverbanks		
• Normal inspection	• Overview and general inspection of river banks	• 1 yearly
• 6 Monthly inspection	• Detailed inspection looking for erosion damage to riverbanks & rock works and vegetation congestion	• 6 monthly
• Tree vegetation control	• Clear/maintain trees	• 2-3 yearly
• Vegetation control	• spray/clear weeds	• 6 monthly
• Rock riprap	• Realign, and top-up as inspection identified	• As required
Stopbanks		
• Detailed inspections	• Complete walkover inspection	• 6 monthly
• Survey	• Long section & representative cross sections	• 5/10 yearly
• Mowing	• Mow all grass stopbank areas	• Monthly
• Miscellaneous mtce	• Miscellaneous minor repairs to grass cover, weed control, barriers	• 1 yearly
Gabion walls		
• Detailed inspections	• Complete walkover inspection	• 1 yearly
• Grass, weed control	• Remove or spray	• 6 monthly
• Gabion wire repair	• Patch or replace gabion	• As required
• Shotcrete repair	• Patch damaged areas	• As required
Floodgates		
• Operational check	• Regular operation check	• 2 monthly
• Annual inspection	• Integrity check	• 1 yearly
• Replacement	• Full replacement	• 25 years
Structures		
• Walls	• Check Structure	• yearly
• Culverts	• Check Structure	• 5 yearly
	• Debris check and clearance	• 6 monthly and after floods

In general the priority order for maintenance work in the river scheme will be:

- retaining the integrity of the stopbanks;
- retaining the strength and integrity of erosion control works;
- keeping channels clear of obstruction; and
- maintenance of ancillary works.

4.4.1 Programmed inspections

All programmed inspections must be recorded on the inspection sheets setout in Appendix B and filed in the inspections folder kept in the river engineering office.

All matters identified as needing action must be completed as soon as practicable and marked off on the inspection sheets once completed.

4.5 Maintenance costs

4.5.1 Existing

The maintenance expenditure for the Lower Waiwhakaiho Flood Protection Scheme over recent years has been as follows:

2010/11	$ 81,207
2011/12	$ 55,862
2012/13	$ 48,352
2013/14	$ 23,333
2014/15	$ 27,619
2015/16	$ 36,694
2016/17	$ 27,656
2017/18	$ 59,468
2018/19	$123,947
2019/20	$ 47,410

4.5.2 Asset maintenance expenditure requirements

All expenditure on infrastructure assets will fall into one of two categories: capital expenditure or operating expenditure.

(a) Capital Expenditure

Capital expenditure projects are those displaying one or more of the following characteristics:

- Construction works which create a new asset that did not previously exist in any shape or form.
- Expenditure which purchases or creates a new asset (not a replacement) or in any way improves an asset beyond its original design capacity.
- Upgrade works which increase the capacity of the asset.

This work would be charged against a particular job cost code.

(b) Operating expenditure

All maintenance, upgrading, reconstruction, renewal and renovation work that does not increase the capacity of assets is treated as operating expenditure.

Operating expenditure can be divided further into two; normal ongoing day to day routine maintenance works and those other more infrequent larger projects that upgrade or renew the asset to its full (or original) service potential.

(i) Routine maintenance expenditure: Routine maintenance projects can be expected to display some of the following characteristics:

- Regular and ongoing annual expenditure necessary to keep the assets operating at the required level of service, e.g. inspections; management; liaison with ratepayers etc.
- Day to day and/or general upkeep works designed to keep the assets operating, e.g. insurances, power costs.
- Works which provide for the normal care and attention of the asset including repairs and minor replacements.
- Minor response type remedial works i.e. isolated instances where portions or sections of a unit of an asset fail and need immediate repair to make the asset operational again.

This *work would be charged to: "North Taranaki River Maintenance" – 30 03 02 2455*

(ii) Renewal expenditure: Work displaying one or more of the following attributes can be classified as renewal expenditure:

- Works which do not increase the capacity of the asset, i.e. works which improve and enhance the assets restoring them to (or below) their original size, condition, capacity, etc.
- The replacement component of augmentation works which does not increase the capacity of the asset, i.e. that portion of the work which restores the assets to their original size, condition, capacity, etc.
- The replacement component of a capital work which replaces the redundant element of an existing asset.
- Reconstruction or rehabilitation works involving improvements, realignment and regrading.
- Renewal and/or renovation of existing assets, i.e. restoring the assets to a new or fresh condition.

This work would be charged to: "Maintenance Works Rivers" – 30 03 02 2466

4.6 Expenditure

Expenditure in the foreseeable future will focus almost entirely on maintenance and renewals. The capital works component of the Lower Waiwhakaiho Flood Control Scheme was substantially completed by June 2013.

A long term programme of monitoring and maintenance works with detailed cost estimates and the average annual expenditure required to ensure the Scheme is maintained to its full service potential is set out in Section 6.

5. Funding and financial planning

5.1 Accounting policies

It is the accounting policy of the Council that the Lower Waiwhakaiho Flood Control Scheme's assets are not depreciated. The funds required to maintain the asset in an as new condition are considered to be the maintenance budgets in the forthcoming period.

The Council uses the following procedures when applying the above policy:

- all expenditure (routine maintenance, flood damage maintenance and maintenance works) to maintain the existing as new condition (as required by the scheme objectives) is considered to be normal maintenance work and is financed as part of the maintenance budgets established for the period; and
- any additional new minor capital works that increases the assets performance ability are included in the capital works budget for the period, but, are still financed from the accumulated reserve funds.

The Council also indecently values the assets annually.

5.2 Revenue and financing policy

It is the Council's policy that river control schemes are funded by targeted rates over the community benefiting from the protection.

The Lower Waitara and Waiwhakaiho schemes have catchments that, when combined, comprise a substantial portion of the New Plymouth district. Significant flood control assets are managed and maintained within these catchments but because of the types of assets involved, normal maintenance costs are relatively minor. Accordingly, the Lower Waitara and Waiwhakaiho Schemes are funded from a rate that is a 100% capital value based works and services rate, applied over the whole of the New Plymouth district. This system is considered to be the most administratively efficient and appropriate funding mechanism.

5.3 Funding for disaster relief

The Taranaki Regional Council has made the decision to be self-funding in the event of a major disaster in the flood management scheme areas. This philosophy exists due to:

- the potentially high cost of insurance (relative to the benefits)
- the low probability of accessing Government or other disaster funding through participation in projects such as LAPP (Local Authority Protection Programme)
- the ability of the Council to reinstate the assets without significant financial implications

5.4 Routine maintenance costs

Routine maintenance costs for the scheme assets are relatively constant and easy to estimate. The cost of routine maintenance has been based in the past on historical trends. However, with the increase in the Lower Waiwhakaiho Flood Control Scheme's assets (including more stopbanking, and more emphasis on maintenance than has been the case in the past), detailed maintenance plan and estimates have been prepared. The estimated costs include monitoring and maintenance of riverbanks and berms, stopbanks, gabion basket floodwalls and floodway, floodgates and structural flood walls. The new maintenance programme is set out in Section 4.4 and estimated maintenance costs are set out in Section 6.

5.5 Flood damage funding

Due to the variability of flood events and their unpredictability, determining an appropriate programming of flood damage maintenance expenditure is more difficult than estimating routine maintenance allowances. Annual flood damage maintenance expenditure will vary greatly, from virtually nothing to large costs when a substantial rock work sustains major damage in a large flood event. Costs over a number of years could be very low, then, during a period of more intense flooding, maintenance costs could increase greatly to well beyond the annual average.

Therefore, no sensible programming of the flood damage costs can be prepared. Rather the estimated annual average flood damage maintenance cost should be used to guide annual scheme funding, with the unexpended portion of the budgeted costs accumulated year by year. This level is estimated at $15,000 per annum. If unspent it is transferred to the North Taranaki/ River Control Schemes reserve.

In the cases where there are significant flood damage repairs, the process established in Section 5.8 would be utilised to reinstate the schemes to as new condition.

5.6 Non-routine maintenance costs

From time to time the Council needs to expend additional funds to maintain the level of protection offered by the flood control schemes because either the river channel dynamics have significantly changed or the Council's knowledge and understanding of the schemes has improved. This expenditure is not of a capital nature as the overall level of protection offered by the schemes has not changed. Accordingly, it is included in the annual maintenance expenditure budget. This expenditure has to be funded using the same funding policy as the other maintenance expenditure.

The planned maintenance works are included in the reserve fund movements for the next ten years. This expenditure is funded from the accumulated reserve fund balances. However, where the reserve balance is not sufficient to finance the maintenance works expenditure, then the level of the targeted rate would have to be increased.

5.7 Capital works funding

Capital expenditure that increases the level of protection provided by a scheme will generally be funded by either external or internal borrowing. This reflects the long life of the assets and the need to spread the costs of those assets over the life of the assets. Interest and principal repayments for the borrowing will be funded by the targeted rate.

Following the first stage of the review of the Lower Waiwhakaiho Flood Control Scheme, the Council made provision for some $1.5 million spread over a three to four years period to fund the proposed scheme upgrade. The technical review of the Waiwhakaiho Flood Control Scheme as it related to the Waiwhakaiho River was completed in 2010 and detailed design work to upgrade the flood protection standard on the Waiwhakaiho River to the 100 year standard with an allowance for climate change to 2060 was completed in June 2011.

Stage 1 of the upgrade was completed in 2010/11. Stage 2 involving works on the lower Mangaone Stream was completed in 2012 and stage 3 involving the works on the mid Mangaone Stream was completed in 2013.

5.8 Financial planning

The funding of expenditure on the Lower Waiwhakaiho Flood Control Scheme is by way of a targeted rate. This is currently set to cover all expenditure in accordance with the Revenue and Financing Policy.

Any under-expenditure on the scheme is transferred to the North Taranaki/Waitara River Control Scheme reserve. Similarly, any over-expenditure is funded from a transfer out of the reserve. As at 30 June 2020 the balance of this reserve was approximately $1.2 million.

Each year, the targeted rate is expected to fund the routine maintenance plus any flood damage maintenance work identified in the annual review of the schemes. As noted above, if there are an unusually high level of repairs arising out of the annual review then this will be funded via the process outlined in Section 5.1.

If there were no significant repairs arising out of the annual inspections then the reserve fund would continue to grow. The appropriate maximum level for the reserve needs to be considered.

This level is dependent upon the Council's ability to reinstate the assets as a result of a rare large damaging flood event. The Council has a philosophy of self-insurance to recover the service potential of the scheme assets after such an event. The estimated worst case scenario is total flood damage of $500,000. The Council needs to be able to fund this level of expenditure as a maximum.

5.9 Funding of disaster relief

In all river flood control schemes the damage caused by the rare large floods is particularly hard to estimate and can vary greatly. This damage occurs at irregular intervals, with

unpredictable timing. In the case of a major flooding event it is proposed that funding for reinstatement be accessed through the following hierarchy:

- First, any unused/uncommitted funds from the maintenance budgets for the river control schemes for that financial year will be used;
- Second, any balance remaining in the reserve fund will be used;
- Third, any surplus Council-wide cash and investment balances will be loaned to the scheme reserve fund; and
- Finally, consideration will be given to the raising of debt finance.

The individual options available will be considered on a case by case basis.

6. Maintenance and monitoring cost estimates

Table 4 sets out the ongoing cost of maintaining and monitoring the Lower Waiwhakaiho Flood Control Scheme.

The frequency of the works have been estimated but may vary as a result of the frequency of flood events and other changes that may necessitate more frequent activities in some areas.

The actual will vary from year to year but will be known when annual budgets are prepared.

Table 4: Long Term monitoring and maintenance requirements

Item	Work Description	Work Frequency	contractor cost	TOTAL annualised average
		Years		Excluding Staff
General	**General overview**		-	-
	Cross section survey Waiwhakaiho	5	20,000	4,000
	Cross section survey Mangaone	5	6,000	1,200
	Consultants	1	2,500	2,500
	Flood warning system (proposed)	1	40,000	40,000
Riverbank	**Channel Management**		-	
and berms			-	
	Vegetation control	1	7,000	7,000
	Rock riprap	1	3,000	3,000
	Gravel beach mtce	5	2,000	400
Stopbanks	Detailed inspections		-	
	Survey	5	1,500	300
	Mowing	1	10,000	10,000
	Miscellaneous channel mgmtmtce	1	10,000	10,000
	gates/ bollards	1	2,500	2,500
	tracks and paths	1	2,000	2,000
	floodgates	1	2,000	2,000
TOTALS				$84,900

Spreadsheet Frodo No. 2572980 – (Sheet 2021-2022 plus)

Table 5 and Figure 4 set out the estimated cost of managing and maintaining the Lower Waiwhakaiho Flood Control Scheme for the period 2021 to 2031.

The estimates separate the staff and internal cost from external costs that would be contracted out. The flood damage allowance is as per Section 5.5.

Table 5: Cost estimates 2021 to 2031

Year	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
Contracting Costs	79,000	85,000	81,000	79,000	100,500	85,000	81,000	79,000	79,000	100,500
Total Annual Maintenance cost	79,000	85,000	81,000	79,000	100,500	85,000	81,000	79,000	79,000	100,500

Note: In addition to these costs, an allowance for flood damage of $15,000 per annum is shared with the Lower Waitara River Flood Control Scheme and the Okato Scheme.

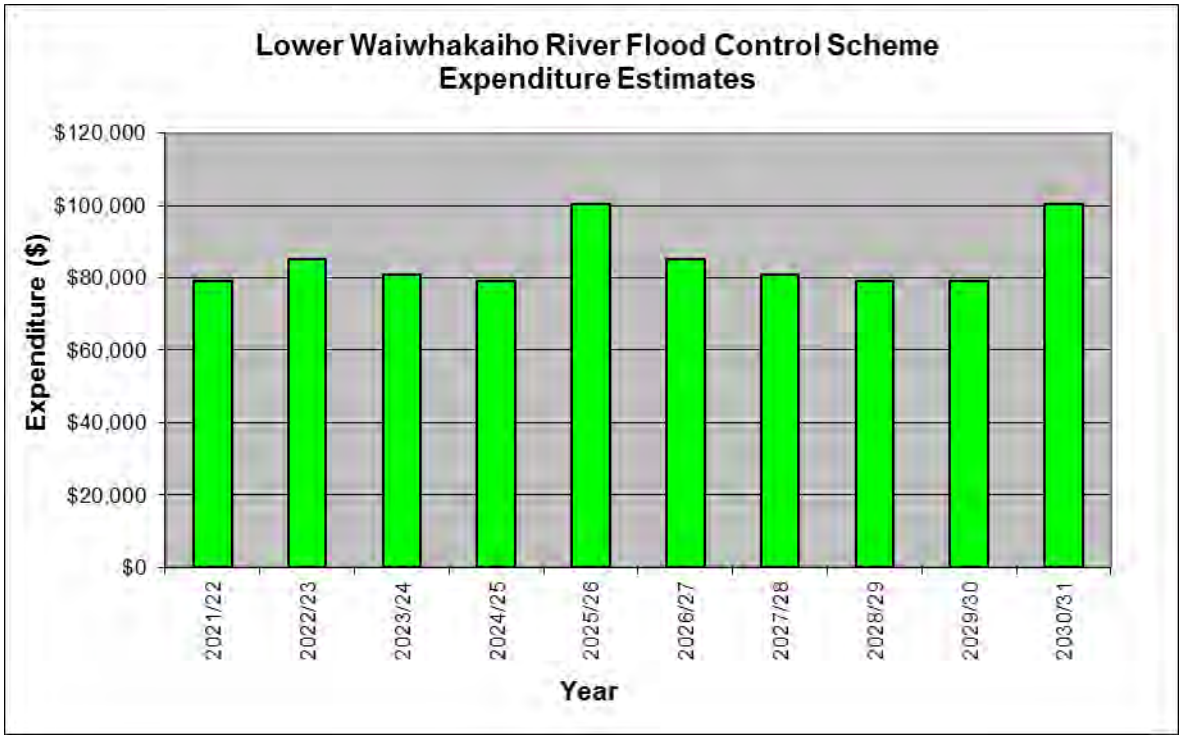

Figure 4: Cost estimates 2021 to 2031

7. Infrastructure strategy

This infrastructure Strategy identifies:

- the infrastructure issues for the Scheme for the period from 2015 to 2045; and
- the principle options for managing those issues and the implications of the options.

The Waiwhakaiho Flood Control Scheme has been upgraded to provide protection from a flood in the Waiwhakaiho River of 1180 cumecs and from the Mangaone Stream of 73 cumecs. These were considered in 2010 to have a 1% Annual Exceedance Probability (AEP) and have made allowance for increased flood levels arising from climate change to the year 2060. The upgrade works were completed in July 2014.

The land use in the area protected by the Scheme is 98% commercial and industrial with approximately 2% residential. The 1% AEP protection standard is considered to be the accepted standard for an area largely used for commercial and industrial uses.

Changes in the industries and commercial entities are likely to occur in the area protected by the Scheme over the life of this strategy but the land use would most likely continue to be commercial and industrial. In the very unlikely event that a change in land use would result in an increase in the percentage of residential land use, the protection standard provided by the Scheme would still be appropriate and therefor a further capital upgrade would not be required.

There is no planned upgrade to the level of service provided by the Scheme before 2060 as the Scheme will provide at least 1%AEP standard until that date.

The risk to the Scheme infrastructure arising from natural disasters is low. The nature and ongoing maintenance of the assets make them resistant to significant damage in large flood events. Any damage that did occur would be funded from Scheme Reserves. $15,000 is budgeted each year for the repair of flood damage from the North Taranaki Schemes and if unspent, accumulates in the Scheme reserves account.

The Scheme has infrastructural assets that fall into seven types. The following table sets out how the Council will manage these asset types.

Asset Type	Renewal or replacement requirements	Expenditure
Earth stopbanks	• No replacement required. Stopbanks will be maintained to the design levels and standards	Operational
Gabion basket structures	• Gabion baskets have a design life in the order of 100 years. The first gabion baskets were constructed in the Scheme in 1997. • Some minor maintenance may be required. • No replacement required before 2047.	Operational
Concrete structures	• Concrete structures have a design life in the 50 to 100 year range. The concrete structures in the Scheme were all constructed since 2011 as part of the Scheme upgrade works. • No replacement required before 2047.	Nil
Concrete culverts	• Concrete culverts have a design life of at least 50 years. • The earliest culverts installed as part of the Scheme were constructed in 1997 as part of the initial Scheme construction works.	Nil

	• No replacement required before 2045.	
Aluminum and galvanised floodgates	• Aluminum floodgates will not need replacing before 2047. • Galvanised floodgates may need replacing prior to 2047. Current asset value of all floodgates is $5,000 and would be replaced as required from annual maintenance funding.	Operational
Rock riprap	• Rock does not need replacement. Minor toping up may be required very irregularly. The Waiwhakaiho River and Mangaone Streams have stable beds resulting in stable riprap works that require minimal attention.	Operational
Ancillary minor structures	• Gates, fences and bollards have a life shorter than 30 years but individually have a low replacement cost and will be replaced as a maintenance activity as required	Operational

Risk Management

The following table sets out the risk faced by the Scheme assets by natural disasters and indicates the financial implications and potential size of that risk.

The potential risk to the Scheme assets arise from over design flood events and from earthquakes.

Asset Type	Disaster Type	Risk	Financial Risk	Expenditure type to fund repair
Earth stopbanks	Flood	Some minor damage possible. If a stopbank was to fail, the damage to the stopbank would be very localised	Minor	Operational
	Earthquake	Could suffer significant damage from cracking and slumping	Significant	Capital
Gabion basket structures	Flood	Minimal	Minor	Operational
	Earthquake	Could suffer significant damage from cracking and toppling	Medium	Capital
Concrete structures	Flood	Minimal	Minor	Operational
	Earthquake	Minimal	Minor	Operational
Concrete culverts	Flood	Minimal	Minor	Operational
	Earthquake	Could have fractures in culverts that would need replacing	Minor	Capital
Aluminum & galvanised floodgates	Flood	Minor damage to floodgates	Minor	Operational
	Earthquake	Minimal		Operational
Ancillary minor structures	Flood	Moderate risk of damage	Minor	Operational
	Earthquake	Minimal		Operational
Rock riprap	Flood	Moderate risk of rock riprap needing to be repositioned or topped up	Minor	Capital
	Earthquake	Minimal	Minor	Operational

The indicative estimated set out below for the management of the Scheme assets is drawn from Section 6 of this plan. There will be no capital expenditure over the next 30 year period.

Year(s)	2021/ 2022	2022/ 2023	2023/ 2024	2024/ 2025	2025/ 2026	2026/ 2027	2027/ 2028	2028/ 2029	2029/ 2030	2030/ 2031	2031/ 2036	2036/ 2041	2041/ 2046	2046/ 2051
Estimated operating costs ($1000's)	79	85	81	79	101	85	81	79	79	101	425	425	425	425

Assumptions Made

The assumptions made in determining the above estimates are:

- That the frequency and size/nature of the future maintenance works required are in line with that which has occurred over recent years.
- That the frequency of damaging flood events and the damage that occurs in these events does not change significantly.

8. Performance monitoring

As well as the regular inspection and monitoring of the Lower Waiwhakaiho Flood Control Scheme assets to ensure that they maintain their integrity and provide the required flood standard, there is a need to monitor the performance of the Scheme in relation to its protection standard.

Traditional performance monitoring techniques are not easily applied to management of river schemes. Outcomes depend on the occurrence of unpredictable flood events, and the nature of fluvial hydraulics is complex and subject to random phenomena. However, it is still possible to apply the general principles of monitoring. Indeed, performance monitoring is required in order to adequately manage the assets. Review of the asset management plan will also depend on findings of performance monitoring.

The goal of the Lower Waiwhakaiho River Flood Control Scheme is to maintain the risk of flood damage at acceptable levels, by maintaining the desired levels of flood protection and erosion control (note that the risk of flood damage rather than actual flood damage is referred to).

River and stream cross section surveys are one of the most important monitoring programmes for management of the scheme. The cross section surveys can be used to help identify volumetric changes to the river and stream channels and banks, and possibly local points of erosion or deposition. Using the cross-section information, the design flood levels can be reassessed every fifteen years or so, and the stopbank surveys used to monitor the available freeboard.

8.1 River and stream channel cross sections

Full cross section surveys are to be undertaken on the Waiwhakaiho River and the Mangaone Stream Channel at 5 to 7 year intervals and compared with the previous cross sections to identify:

- whether or not there has been any significant change in the channel cross sectional area that may impact on the flood carrying capacity of the channel; and
- Whether or not there is any degradation trend that may be affecting the integrity of the erosion control works.

If significant changes are noted, the results of this monitoring must be referred to the Rivers Manager for assessment.

All cross section surveys must be drawn up, printed and hung in the engineering plan cabinet.

8.2 Flood level monitoring

8.2.1 Rivers and streams

Waiwhakaiho River

On the Waiwhakaiho River, flood flows that get to within 2.5 meters of the stopbank crest at any point along the river must be monitored closely. If possible, maximum water levels must be observed and pegged during the flood event and later surveyed. If the actual event can not be monitored, as soon as possible after the flood event has receded, the highest debris marks must be carefully observed, pegged and surveyed.

Care must be taken with observing the debris levels especially on the steep sections of the river banks.

It cannot be stressed strongly enough how important this information is. The stopbank design has been prepared with relatively poor calibration data and good actual flood information will enable the flood models to be checked and stopbank levels fine-tuned if required.

The Waiwhakaiho flood levels must be pegged from 100 m upstream of Devon Road if possible to as far as is practicable downstream of the Mangaone Stream confluence. The most critical section however is between Devon Road and the Mangaone Stream confluence.

If flood levels are pegged during an event, the time at which the levels were observed must be recorded.

Mangaone Stream

On the Mangaone Stream, flood flows that get to within 1.5 meters of the stopbank crest at any point along the Stream must be monitored closely. If possible maximum water levels must be observed and pegged during the flood event and later surveyed. If the actual event can not be monitored, as soon as possible after the flood event has receded, the highest debris marks must be carefully observed, pegged and surveyed.

If flood levels are pegged during an event, the time at which the levels were observed must be recorded.

The flood levels must be pegged from Katere Road to the confluence with the Waiwhakaiho River.

8.2.2 Record keeping

All monitoring records must be filed in the Council's electronic filing system with clear reference to the channel being monitored, and the dates of the event.

Appendix 1

History

The following lists the key historical events that have occurred on the Scheme since 1980.

1980	• Flooding occurred – no plans for stopbanking • The need for culvert upgrade and stopbanking identified
1990	• Breach on Waiwhakaiho left bank in Cylone Hilda into Lake Rotomanu
1990/91	• Waiwhakaiho River Water Management Plan prepared
1994	• Plans being prepared to develop Waiwhakaiho Basin into industrial park
1994/95	• Funding for Waiwhakaiho investigation secured
21/4/1995	• Large flood in Mangaone Stream flooded Fitzroy Engineering and land to the left of Mangaone Katere Rd to Devon Rd
1995	• Flood protection ideas and priorities reassessed following flood
Dec 1995	• TRC adopted a proposal to construct a stopbank along Waiwhakaiho River to protect against a 2% AEP flood • Including flood wall along the left bank of Mangaone from Katere Rd to Devon Rd estimated cost $860k • NPDC to replace undersized Katere Rd culvert • Fertiliser factory to fund upstream floodway construction
Jan 1996	• TRC advised Mangaone landowners that it would fund 60% of left bank stopbank works
Oct 1996	• Farmers Fertiliser Works to fund overflow channel – design completed $170k
1996	• TRC grants consent for stopbank and river works • Gravel removed from Waiwhakaiho River downstream of Devon Rd • Laharic outcrop in Waiwhakaiho River upstream of SH3 lowered • Ford across Waiwhakaiho River removed
Jan 1997	• 3000 m^3 Rock riprap placed along left bank (Vickers Road) $86.5k to protect bank and sewer line – funded by New Plymouth District Council • All in-channel work completed April 1997
Mar 1997	• Contract let to Hurlstone Earthmoving Ltd to construct Waiwhakaiho River stopbank $246,625.50
Dec 1997	• Mangaone Stream Gabion Contract let to Action Blast Clean Ltd - $123,713.70. Work completed April 98
2008-2010	• Tonkin and Taylor undertook detailed investigation and preliminary design/flood modeling of Waiwhakaiho River and Mangaone Streams
Oct 2010	• Major clearance of overgrown vegetation on Waiwhakaiho River and Mangaone Stream commenced • Waiwhakaiho River right bank downstream of Devon Road • Waiwhakaiho River left bank adjacent to Firths • Mangaone Stream Katere Rd to Devon Road • Mangaone Stream upstream of Katere Road
2010/11	• Tonkin & Taylor determined design flood profile Waiwhakaiho River. This was adjusted and finalized by John Philpott – Rivers Manager
Jan 2011	• Contract let to Taranaki Civil Construction to upgrade Waiwhakaiho River flood protection from 2% AEP to 1% AEP with 500 mm freeboard and 50 years climate change allowance (Stage 1)
June 2011	• Practical Completion Certificate for Stage 1 upgrade contract issued
Dec 2012	• Practical Completion Certificate for Stage 2 upgrade contract issued
Mar 2013	• Practical Completion Certificate for Stage 2a upgrade contract issued
July 2013	• Practical Completion Certificate for Stage 3 upgrade contract issued
June 2020	• DHI hydraulic modelling and revised design levels (Frodo # 2530000)

Appendix 2

Inspection Sheets

Lower Waiwhakaiho Flood Control Scheme

Detailed Stopbank Inspection
(6 – monthly)

River Name:	Waiwhakaiho River			Date:	
Inspected by:					
Constance St to Vickers Rd					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Grass cover					
Access track					
Ramps, top of bank crossings, gates, & bollards					
Manholes Surrounding Ground					
Vickers Rd to Mangaone Stm					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Grass cover					
Trees & weeds					
Massbloc wall interface					
Outer toe support					
Mangaone Stm to end of bank					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Grass cover Stock damage ??					
Trees & weeds					
Concrete wall interface					
Access track & ramps					

Lower Waiwhakaiho Flood Control Scheme

Gabion Basket Stopbank Inspection

(6 – monthly)

River Name:	Waiwhakaiho River			Date:	
Inspected by:					
Upstream of Constance St.					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Gabion wire					
Shotcrete					
Toe support & grass cover					
Grass & weeds					
Vickers Rd to Mangaone Stm					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Gabion wire					
Shotcrete					
Grass & weeds					
Damage by trees ??					

Massbloc Wall Inspection

(6 – monthly)

River Name:	Waiwhakaiho River			Date:	
Inspected by:					
End of Vickers Road					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Block integrity					
Block alignment					
Grass & weeds					

Lower Waiwhakaiho Flood Control Scheme

Gabion Basket Stopbank Inspection and stopbank

(6 – monthly)

River Name:	Mangaone Stream			Date:	
Inspected by:					
Katere Rd to Devon Rd					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Gabion wire					
Shotcrete					
Grass & weeds					
Foundation issues					
Devon Rd culvert headwall					
Devon Rd to Rifle Range Rd Left Bank					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Gabion wire					
Shotcrete					
Grass & weeds					
Stopbank					
Devon Rd to Rifle Range Rd Right Bank					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Gabion wire					
Shotcrete					
Grass & weeds					
Concrete wall interface					

Lower Waiwhakaiho Flood Control Scheme

Katere Road Spillway

(6 – monthly)

River Name:	Mangaone Stream			Date:	
Inspected by:					
Katere Road					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Headwall structure					
Gabion Wire					
Grass & weeds					
Culverts					

Lower Waiwhakaiho Flood Control Scheme

Detailed Riverbank and Berm Inspection (6 – monthly)

River Name:	Waiwhakaiho River			Date:	
Inspected by:					
Upstream of Constance St.					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Berm surface					
Trees & weeds					
Riverbank stability					
Rock riprap					
Constance St to Vickers Rd					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Berm surface					
Trees & weeds					
Riverbank stability					
Rock riprap					
Vickers Rd to Mangaone Stm					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Berm surface					
Trees & weeds					
Riverbank stability					
Rock riprap					

Lower Waiwhakaiho Flood Control Scheme

Detailed Riverbank and Berm Inspection
(6 – monthly)

River Name:	Mangaone Stream			Date:	
Inspected by:					
Upstream of Katere Road					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Berm surface					
Trees & weeds					
Riverbank stability					
Rock riprap					
Katere Rd to Devon Rd					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Grass cover					
Trees & weeds left bank					
Trees & weeds right bank					
Rock riprap					
Devon Rd to Waiwhakaiho					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Grass cover Stock damage ??					
Trees & weeds left bank					
Trees & weeds right bank					
Rock riprap					

Lower Waiwhakaiho Flood Control Scheme

Structures

(Annually)

River Name:	Mangaone Stream			Date:	
Inspected by:					
Katere Road Mangaone Stream Culvert					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Upstream headwall integrity					
Ravensdown wall integrity					
Devon Road Mangaone Stream Culvert					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Upstream headwall integrity					
Rifle Range Road floodwalls on Mangaone Stream Culvert					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
Upstream wall integrity					
Downstream wall integrity					

Lower Waiwhakaiho Flood Control Scheme

Floodgates (6 – monthly)

Inspected by:				Date:	
River Name:	Waiwhakaiho River				
Riffle Range Road					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
RRFG1 (upstream) - 450mm					
RRFG2 - 600mm					
RRFG3 - 300mm					
RRFG4 - 450mm					
RRFG5 - 300mm					
RRFG6 (downstream) – 250mm					
River Name:	Mangaone				
Downers side					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
DFG1 (upstream) - 375mm					
DFG2 - 375mm					
DFG3 - 450mm					
DFG4 (downstream) - 600mm					
Technix Side					
	Condition		Comment	Action Required	Date Actioned
	Good	Poor			
DFG5 (upstream) - 375mm					
DFG6 (downstream) - 450mm					
Katere Rd to Devon Rd					
KDFG1 (upstream) - 225mm					
KDFG2 - 300mm					
KDFG3 - 300mm					
KDFG4 - 150mm					
KDFG5(downstream) - 450mm					

NOTE: Any problems with the Waiwhakaiho River floodgates must be referred directly to New Plymouth District Council.

The current (2013) contact person is: Rob Campbell 027 333 5698 06 759 6132