Waitohu Stream Study Summary Document

FOR FURTHER INFORMATION

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1 Introduction

The Waitohu Stream flows from the Tararua foothills to the Tasman Sea north of Otaki (Figure 1). The catchment (54km^2) incorporates a range of physical environments, including native and exotic forest, pastoral farmed floodplains, lakes, wetlands, sand dunes, urban areas and a coastal estuary. Tributaries include the Mangapouri Stream and the Ngatotara Stream/Drain.

Greater Wellington became involved in the management of the stream after local government reorganisation in 1989. It soon became apparent that there were a number of ongoing and longstanding issues with the stream, including:

- Degraded water quality, in particular in the Mangapouri Stream but also in the lower reaches of the Waitohu
- Lack of aquatic species diversity in the lower reaches of the stream
- Stream bank erosion, leading to loss of land and to siltation of the streambed
- Livestock in the stream channel
- Vegetation management in the stream channel
- Flood risk, with occasional flooding of properties in Convent Road and Bennett Road
- The movement of the stream mouth at Otaki Beach and a longstanding debate about how best to manage the mouth position
- Spread of pest plant species like climbing asparagus, hornwort, banana passionfruit and tradescantia
- Changing land use patterns in the Kapiti and Horowhenua from dairying to semi-rural lifestyle blocks
- Extreme low flows in the stream in dry summers
- Gravel build up in parts of the stream

To better understand these issues and their inter-relationships, Greater Wellington initiated the "Waitohu Stream Study" in 2003.

1.1 Report Structure

This report summarises the findings of the Waitohu Stream Study investigations, links them and makes recommendations for ongoing management and further studies. The information gathered and collated has been presented pictorially, reach by reach along the stream. This aids the process of developing common threads/overlaps and interconnections, and is easier to explain and understand.

The Study covers the entire Waitohu catchment, but concentrates on the stream itself. Investigations have considered the tributary streams, insofar as they impact upon the main Waitohu Stream. Possible responses identified are those that are likely to improve the Waitohu Stream health and management. Nonetheless, issues and matters more specific to the tributaries have been identified during the course of the study. If not directly impacting upon the Waitohu Stream, those issues and matters have been flagged as requiring further, separate, investigations.

The Study has been broken down into several component investigations carried out in tandem with a consultation programme involving all interested landowners and organisations. Each of these investigations, including the consultation summary, has been published separately.

2. Current Management

2.1 Greater Wellington - Flood Protection

In 1948, the Manawatu Catchment Board proposed a River Control and Drainage Scheme for the Otaki area, which covered the Waitohu downstream of the Waitohu Valley Road Bridge. The principal proposals for the stream were as follows:

- mouth cutting;
- willow clearing/planting;
- bank stabilisation; and
- building a stopbank to the south to prevent overflow of the Waitohu flood waters to the Rangiuru Stream.

Figure 2, an extract from the original Scheme Report, shows these proposals.

The management policy remains essentially unchanged today, although mouth cutting is less severe than that originally proposed. The flood capacity and alignment of the stream are maintained using vegetation methods where possible. In the upper reaches willow buffer zones have been established to minimise the need for ongoing channel alignment works. Annual maintenance expenditure is typically around $25,000.

The Flood Protection Department renewed its existing resource consent in 2004 for a further three year period to enable maintenance of the Waitohu Stream to continue. The reach of the Waitohu subject to this consent covers 4km, between Ringawhati Road and the Cow Race Bridge (Figures 4-6). Outside of this reach, maintenance is limited to those activities permitted under the Regional Freshwater Plan and the Regional Coastal Plan.

During the 1990s, the Otaki River Floodplain Management Plan (ORFMP) was prepared. The ORFMP provides a blueprint for the management of the Otaki River and floodplain. The Waitohu Stream physically links with the Otaki River, with overflows between the two systems occurring occasionally via the Mangapouri and Rangiuru Streams. Four future items of work identified in the ORFMP are of relevance to the Waitohu: the south Waitohu stopbank (i.e. similar to that originally envisaged in 1948), house raising, raising of the Convent Road bridge and enlargement of the Mangapouri channel. Otherwise, the ORFMP does not explicitly deal with the flood and erosion hazard in the Waitohu in detail.

2.2 Greater Wellington - Environment

Current environmental management in the Waitohu catchment by Greater Wellington includes monitoring, research projects, biosecurity measures, support of care groups and the *Streams Alive* programme.

The Environmental Investigations Department monitors water quality in the Waitohu and Mangapouri Streams, carrying out testing on a regular basis in the upper Waitohu Stream and near the mouth, and intermittently at a number of other sites on the Waitohu and the Mangapouri when specific investigations require it

The Department also maintains a water level and flow recorder at the Water Supply Intake (Figure 1) and rainfall recorders in the Tararua Range. Information from these recorders is used in real-time for monitoring flood events while collated and audited data are used for flood hazard assessment work.

Pest animal control in the catchment is focussed on the forested upper catchment where possums are controlled as part of the *Bovine TB Eradication* programme. Possum population numbers in the upper catchment are regularly monitored and control was most recently carried out in August 2004. There has also been support given to care groups in the catchment where plantings were being browsed by hares.

There is a wide range of both land and water pest plants in the catchment. These include old man's beard, banana passionfruit, evergreen buckthorn and hornwort. The Biosecurity Department helps private landowners to identify weeds and with management strategies. The Department also helps landowners with applications to the Queen Elizabeth II National Trust for covenanting significant natural and cultural features on their land.

There are two community revegetation projects in the catchment - these are run by the Waitohu Stream Care Group and O Te Pua Care Group. The Waitohu Stream Group is planting the dunes at the mouth of the stream and enhancing the brackish swamp opposite the motor camp. The O Te Pua group is restoring a wetland on their properties near the intersection of SH1 and Forest Lakes Road. Greater Wellington is supporting these groups through the *Take Care* programme.

The Waitohu Stream is also in the *Streams Alive* programme. *Streams Alive* is Greater Wellington's streamside assistance programme for high value stream catchments around the region. The 12 catchments in the programme were selected because streamside planting in just a few areas of each catchment will make a difference to the overall ecological health of the streams. The programme is administered by Wairarapa's Land and River Operations Department. In 2004, work started with six landowners in the catchment who are removing willow, blackberry and tradescantia and establishing native plants along 0.8 km of stream banks.

2.3 Kapiti Coast District Council

The Kapiti Coast District Council (KCDC) has a number of roles and responsibilities of relevance to the management of the Waitohu Stream.

Since 1995 the KCDC District Plan has included flood spread maps showing a 100 year flood event in the Waitohu Stream. The District Plan also includes objectives, policies and rules that control how land and buildings can be developed within the 100 year flood extent. Figure 8 shows the land use zones in the Waitohu catchment.

Flood hazard information is also provided by KCDC through their building consent process and through Land Information Memorandums (LIM's).

As part of its roading network, KCDC owns and maintains several bridge and culvert crossings of the Waitohu Stream and its tributaries.

Along with Greater Wellington, KCDC has a statutory role in emergency management. It maintains a Civil Defence Emergency Management (CDEM) Office. As well as planning and preparing for flood events, KCDC would have a major role during a flood event and during the recovery phase.

A comprehensive Coastal Strategy looking at the coast in its entirety is currently being developed by KCDC. This will focus on developing a long-term plan for the coast dealing with hazard management, access, the natural and built character of local communities, restoration and protection.[1]

KCDC has a water supply intake from the Waitohu Stream and an associated water treatment plant (Figure 1). Until recently this was the main water source for Otaki township. Bores now supply the town, and the intake and plant are no longer used. No decision on whether to decommission them has yet been made however.

KCDC has also initiated the "Greater Otaki Project", with the intention that a range of projects dealing with community visions for the area be linked. Any further initiatives arising from the Waitohu Stream Study could potentially link with the Greater Otaki Project.

2.4 Ngati Raukawa

Ngati Raukawa is the tangata whenua in the area, and has kaitiakitanga over the Waitohu Stream.[2]

The Te Wananga o Raukawa has played an active role in the management of the Mangapouri Stream in particular. Activities it has initiated include monitoring, research and stream restoration.

Ngati Raukawa is also a major riparian landowner in the catchment.

2.5 Community

Most of the Waitohu Stream bed and catchment below the Tararua Forest Park is in private ownership. Landowners thus have a significant role in stream management.

Care groups are another part of the community that is active in the management of the Waitohu Stream. As noted above, two care groups currently operate within the catchment: the Waitohu Stream Care Group and the O Te Pua Care Group.

[1] http://www.kapiticoast.govt.nz/DistrictDevelopment/BeachAndCoastalManagement/

[2] Te Runanga o Raukawa (2000); Ngati Raukawa Tangata Whenua Values Assessment Report on Waitohu Stream – Wellington Regional Council Proposed Resource Consent for Waitohu Stream.

2.6 Other Authorities

The Department of Conservation manages the Tararua Forest Park, within which most of the upper catchment of the Waitohu lies. The Department also has responsibilities within the coastal area and an advocacy role relating to the stream environment.

Transit New Zealand and Ontrack own the State Highway One and railway bridges respectively and have at times undertaken works around the bridges to protect them from stream erosion.

3. Consultation

River and stream management today is no longer the responsibility solely of statutory authorities such as Greater Wellington; to be successful the management requires involvement of the local community. This is particularly so in the case of the Waitohu as almost all of the stream bed and catchment below the Tararua Forest Park is in private ownership.

The Waitohu Stream "community" consists of all individuals and organisations with an interest in the stream, including those mentioned in Section 2 above. In addition to Greater Wellington, relevant organisations include KCDC and the Otaki Community Board. Ngati Raukawa, and its constituent and related organisations, is a key part of the community. Several bodies responsible for infrastructure can also be considered part of the community, as they have assets over or adjacent to the stream: Transit New Zealand, Ontrack (New Zealand Railways Corporation), Natural Gas Corporation, Transpower, Telecom and Electra (an electricity network company). Stream Care Groups (largely consisting of local residents) and the Department of Conservation are other important parts of the community.

Finally, the community also includes residents and landowners – individually and as neighbourhoods.

While there are many interrelationships between all these elements of the community, the elements all have their own interests and objectives. Thus the consultation process attempted to engage all of these elements of the community.

Consultation with iwi, landowners and relevant organisations began in February 2004. The purpose of the consultation was to provide the Council with an indication of the community aspirations for the stream, to identify issues and concerns, to obtain additional information and baseline data, and to present findings arising from the Council's technical investigations.

Key findings from the consultation process are presented below in Section 4.10, while full details of the process and records of the meetings are documented in a separate report.[3]

[3] Greater Wellington (2006); Waitohu Stream Study – Consultation Summary

4. Key Findings

Key findings from each of the investigations are presented below.

4.1 History of Flood Protection

It is unclear exactly when river control and drainage works in the Waitohu Stream and its tributaries began, but it is likely to have been in the early 1900s. By 1948 however the capacity of the stream was compromised by willow growth and shingle deposits, and the stream was included in the River Control and Drainage Scheme for the Otaki area. Nonetheless, it was not until 1951 that appeals over rating were resolved and works along the stream began.

The original Scheme proposals for the Waitohu (see Section 2 above) formed the management philosophy of the Manawatu Catchment Board (confirmed in reviews of the Scheme in 1978 and 1983) until 1989. Since 1989, Greater Wellington has essentially continued the same approach although there is no longer a "Scheme" as such. (In 1998, Greater Wellington adopted the Otaki Floodplain Management Plan[4] that provides a blueprint for the river and floodplain, although only in limited detail for the Waitohu Stream.)

A review of Greater Wellington and Manawatu Catchment Board file records reveals several recurring issues:

- Stream mouth – the mouth naturally migrates up and down the beach, causing concerns for many years about dune erosion and drainage. The position of the MCB and GW has been to occasionally cut a more direct path to the sea to reduce these concerns, but neither has considered it cost-effective to create a fixed mouth.

- Erosion of stream banks, resulting from flood events, has been another long-standing concern. There has in the past been pressure from landowners on the MCB and GW to repair such damage.

- Erosion damage to bridge abutments and approaches has also occurred on many occasions and frequent repairs have been needed.

- Drainage, particularly of the Ngatotara sub-catchment, has at times been an issue.

- Numerous flood events have occurred, although none have been large.

- Although development has been limited, the residential development of Otaki Beach and Greenwood Boulevard generated some debate.

[4] Wellington Regional Council (1998); Otaki Floodplain Management Plan. Publication WRC/FPSA-G-98/28

4.2 Flood Hydrology

Peak flood flows for a given probability flood are higher than was previously believed. Current estimates are that the peak flow in a 100 year flood[5] at the Waitohu Water Supply intake could be as high as 180m^3/s. For comparison, the largest flows recorded (since 1994) have been 87.5m^3/s and 86m^3/s in 1996 and 2000 respectively. These are estimated at being around 10 year floods. However, records are limited, making it difficult to extrapolate flow estimates to extreme events.

Climate change has not been taken into account in the analysis. It is possible that floods will occur more frequently in the future as a result of climate change. Some studies suggest that the frequency of heavy rainfall events and floods could increase by up to fourfold by 2070[6].

Refer to recommendations: 5.11, 5.12 and 5.13 in this report.

4.3 Flood Extent

Using the results from the flood hydrology investigation, a computer model of the river and floodplain hydraulics has been built. Maps of predicted flooding for a range of flood scenarios are given in Figure 9. Figure 10 shows flood extents and depths for a 100 year flood, including a freeboard allowance for uncertainties and waves. Flooding from the Mangapouri upstream of Convent Road and within the Greenwood Boulevard area is beyond the scope of the study and has not been considered.

Since the completion of the flood maps, the flood event on 6 January 2005 caused some damage to floodplain properties, despite flow at the Water Supply Intake site being estimated at only around a 4 or 5 year flood. This flood illustrates that changes in the stream bed (due to gravel movement, debris and vegetation obstructions etc) can change the bank overflow points and hence the areas flooded. This in turn highlights the uncertainty in determining flood risk to particular areas and hence the need for a cautious approach when considering the flood risk to assets or property.

Refer to recommendations: 5.1, 5.2, 5.3, 5.8, 5.12 and 5.13

4.4 Land Ownership

The only extensive areas of public ownership of the catchments are in the Tararua Range in the upper catchment, under the control of the Department of Conservation and an area on the south bank near the mouth, owned by KCDC. Other than small areas of road reserve, a KCDC block at the Water Treatment Plant and small KCDC reserves near Otaki township, the remainder of the catchment is in private ownership (including large blocks owned by various Maori trusts).

[5] A "100 year flood" is also known as a "1 in 100 year flood" or a "1% Annual Exceedance Probability (AEP) flood". There is a 1 in 100 (i.e. 1%) chance of getting a "100 year flood" or a larger flood in any one year. Likewise, for example, there is a 1 in 2 (i.e. 50%) chance of getting a "2 year flood" (50% AEP flood) or larger in any one year.

[6] Ministry for the Environment (2002); Climate Change Impacts on New Zealand

4.5 Potential Flood Losses

The cost of potential flood damage in the Waitohu floodplain is relatively low compared to floodplains of other major streams and rivers in the western Wellington region, due to the current low intensity land use (mostly for dairying, grazing and lifestyle blocks). Nonetheless, the floodplain is unprotected from stream flooding and the flood event of January 2005 showed that relatively small floods can cause some residential damage and anxiety for landowners.

In a more severe flood, several houses as well as high value crops such as kiwifruit and vegetables would be at risk of inundation. A 100 year flood would inundate approximately 300ha of the floodplain, and lead to agricultural and horticultural losses in the order of up to $850,000. Sixteen houses within the floodplain are expected to be surrounded by floodwaters during a 100 year flood. Most of these are in the Convent Road and Bennetts Road area. Floor levels are known for five of these 16 houses. Of those five, three can be expected to flood in a 100 year flood. Other houses may be affected by loss of access during a flood event or damage to garages.

In addition to the land at risk of inundation, flooding also poses a risk to the eight bridges (including State Highway One and the NIMT railway) across the stream, and to assets such as water supply lines and fibre optic cables. Several instances of bridge abutment damage have occurred in the past.

Refer to recommendations: 5.1, 5.2, 5.3, 5.8, 5.12 and 5.13.

4.6 Stream Morphology, Sedimentation and Management Implications

(Refer to Figures 3 to 7 for locations)

Waterworks Bridge to State Highway One Bridge

The stream in this reach is steep and has the overall form of a single low flow channel within a wider gravel bed area. The stream is very active, and the low flow channel moves about during flood events and becomes fixed during flood recessions. Persistent erosion of the bridge abutments is evidence of this. Flood flows are not large enough, however, to mobilise the entire gravel bed. This is demonstrated by the colonisation of the higher areas of the gravel bed by weedy vegetation and willow snags.

The low flow channel is also becoming more incised and stream banks now are relatively high where the stream is eroding into the buffer trees. In such situations the stream can undercut the root zone of willows.

Various landowners commented that the stream bed seemed to be aggrading in this reach. This is not borne out by the technical investigations, but the perception probably derives from the low flow channel becoming more incised and the remainder of the bed being colonised by vegetation.

A design fairway and buffer zone alignment has been drawn up (Figures 4-7). This fairway is wide enough to allow migration of the low flow channel within the existing

streambed, but the buffer zone has been modified slightly in some places to fit around property boundaries. In general, the alignment is similar to the current alignment.

To date, willows have been used as bank protection and in the buffer zone. However, "*Willows are not particularly effective along this stream reach, and have adverse impacts through obstructive blockages and snag colonisation of the active channel area. The aim is to retard the rate of bank erosion as channel migration occurs, through a constant renewal of the edge vegetation, and thereby contain the stream movement within a defined area. … a stream corridor should be defined by a retirement fence, and vegetation used within the corridor area to contain the stream movement. Along this reach of the stream a greater diversity of vegetation would be more effective, and tall grasses such as flax and toetoe could be used along the channel edges. When the channel banks collapse from undermining, these grasses hold together relatively large chunks of bank along the toe of the bank, and are relatively effective in deflecting flood flows in small streams."*[7]

State Highway One Bridge to Taylors Rd Bridge

The stream flattens in this reach and gravel is deposited – 1500m^3 per year, on average, accordingly to current information. (The actual supply will vary markedly from year to year, depending on what floods have occurred). Aerial photos taken in 1948 show the stream in its current alignment through this reach, but "*prior to that it would have followed completely different courses for long distances as the channels built up with gravel and then broke out"*[8]. Left alone, the stream would do this again in the future.

The design fairway and buffer zone alignment have been continued through this reach. Similar recommendations about planting to those above apply in this reach.

Taylors Rd Bridge to Convent Road

The stream grade reduces further and the stream flows in a single channel which migrates quite slowly. The stream still has a gravel bed with some small beaches. As with the upstream reaches, erosion has been a concern of landowners at various times in the past.

"Preventing erosion at one bend, by strengthening the outer bank, will have an effect on the channel form as channel migration continues elsewhere, and this can give rise to alignment distortions that increase erosion pressures at the bend and elsewhere. While willow and other vegetation can be quite effective in preventing erosion along this reach, if it is well placed and managed, the longer term consequences because of meander migration should be considered when undertaking such measures. Denser and stronger rooting vegetation should be restricted to outer banks at bends, and even here there should still be some accommodation of meander migration in the layout and extent of the vegetation.

A stream corridor could be developed by fencing off around the outside of the meandering channel, from outside of bend to outside of bend down the reach. The

[7] Williams, G. (2004); Waitohu Stream Flood Hazard Assessment: River Characteristics and Sedimentation, and Channel Management.
[8] ibid

channel could then slowly migrate within this corridor area, in a relatively unhindered way. In this case, a wider diversity of tall grasses, shrubs and trees could be planted along the stream margins, and in a way that reflected local variations in stream character, of inner and outer bank etc."[9]

Downstream of Convent Road

Downstream of Convent Road, the stream channel becomes even flatter and more meandering as it crosses what was once a large area of swamp land. There is little erosion pressure at bends, but channel flood capacity (and recreational access) is compromised by excessive willow growth.

"The main management issue along this reach is … channel capacity, not bank erosion or change of course threats. … Where there are easily eroded materials, such as sand, in the stream banks, then some vegetation cover is needed to prevent erosion, and in these areas willows should be removed progressively, and replaced by tall grasses and shrub vegetation."[10]

Mouth

"The coastal and estuarine reach of the stream is affected by a complex interplay of sea and stream forces and processes, and it is naturally a place of continual change with a high degree of variation and movement of the stream channel"[11]. Refer Figure 11 for examples of the mouth alignment over time. Such change has led to decades of disagreements regarding the best management option for the mouth.

Despite advice that there are *"natural limits to this variability, and the best approach is to provide sufficient space for the stream to alter and move naturally without constraint"*[12], diversion cuts have been made through the beach formation periodically over many years. In more recent years, the Regional Coastal Plan has allowed cuts when the mouth moves as far as defined limits north or south along the beach or when sand dune erosion scarp reaches a defined height and steepness. However the *"relief gained, in terms of reduced erosion pressures at one place or another, is necessarily temporary"*.

"Structural measures to hold the outlet in one place are not, though, recommended, because of their design problems, implementation difficulties and expense, both of construction and/or repairs and maintenance".[13] Expected effects of climate change, such as more frequent intense storms and rising sea levels, will make it even more difficult to design and maintain a permanent mouth.

Refer to recommendations: 5.4, 5.5, 5.6, 5.7, 5.9 and 5.10.

[9] ibid
[10] ibid
[11] ibid
[12] ibid
[13] ibid

4.7 Catchment ecology

There are six significant types of ecological community in the catchment: forested hill country, remnant lowland native forest, remnant wetlands and dune swamps, streamside, instream and estuarine communities (Figures 1 and 3-7). Within these types there are complex relationships between the land and water plant and animal communities.

Eighteen land and water sites with natural vegetation cover have been identified as significant "ecosites" in a survey by Kapiti Coast District Council (Figures 3 to 7). However, the extent of fragmentation in the catchment means that the only significant connection between these ecosites and other communities is the Waitohu Stream and its tributaries.

Significant inputs of fine sediment and nutrients, and the lack of appropriate streamside vegetation, contribute to a degradation of ecological communities along these vital corridors. Sedimentation of the streambed reduces instream habitat for vital aquatic insect communities. The sediment's effect on water clarity affects the ability of fish and birds to prey on these insects, reducing the range of species and their total numbers. The lack of appropriate streamside vegetation reduces the number and variety of land insects for both fish and birds and contributes to elevated light levels and water temperatures (Figure 13), and decreased amounts of oxygen in the water.

Refer to recommendations: 5.9, 5.11 and 5.15.

4.8 Water quality

Water quality in the catchment has been monitored since the early 1990s with additional investigations in June 2000.[14] Water quality is tested monthly at two sites, one in the upper catchment and the other near the stream mouth (the Norfolk Crescent site). Water quality is tested intermittently at a number of other sites on the Waitohu and the Mangapouri. Physico-chemical (pH, temperature etc) results for the reference site in the upper catchment indicate very good water quality and this is confirmed by Macroinvertebrate Community Index (MCI) scores. Water quality deteriorates in downstream reaches and although there has been some improvement in recent years (Figures 14 -16), it is graded poor at the Norfolk Crescent site.[15]

Community water quality testing between 2000 and 2003 confirms the downstream deterioration in stream health.

Research into groundwater quality at nearby Te Horo shows that nitrogen contamination of groundwater is from human and/or animal sources rather than chemical fertilisers.[16] Cattle in the streambed are likely to be one source of such contamination in the Waitohu Stream.

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[14] Robertson, G. (2000); Targeted investigation of ecosystem health within the Waitohu Stream. Report prepared by Resource Investigations, Wellington Regional Council.

[15] Greater Wellington (2005); Freshwater quality monitoring technical report

[16] MacLarin W., Bekesi G., Brown L.J. & McConchie J. (1999); Nitrate contamination of the unconfined aquifer, Manakau, Horowhenua, New Zealand. *Journal of hydrology, New Zealand* 38:2

Ecological stress caused by pollution is exacerbated by the stream's low flows in dry summers. Between the Rail Bridge and Taylors Road Bridge, the amount of water lost to groundwater can cause the stream to run dry, removing habitat between the bridge and the golf course where groundwater returns water to the stream. Low flows combined with a lack of shading along middle and lower reaches of the stream can lead to water temperatures that are above the tolerance levels for some invertebrates (Figure 13). These high temperatures may also have sub-lethal effects on native fish. Staff from the Resource Investigations Department are studying the stream's low flows, but with the higher than average rainfall in the summer of 2003-2004 and early in 2004-2005, and the cessation of abstraction for the Otaki town water supply, the report has yet to be completed.

Water quality improvements to the middle reaches coincide with a change in dairyshed effluent disposal from the stream to land between 1999 and 2001 and the shift of Otaki's water supply abstraction from the stream to groundwater in 2003.

Water quality is at its worst in the lower reaches of the Mangapouri. Recent data for Mangapouri Stream[17] (2003/2004) show high water temperatures (range 10.1º to 18.4ºC), frequent low oxygen saturation (7 out of 14 sampling days) and high dissolved reactive phosphorus (double the trigger level set in ANZECC guidelines[18]). A previous study shows high levels of faecal contamination.[19] An investigation into the source of this pollution was undertaken in 2000 but failed to find the cause. Pollution in the Mangapouri has a major effect on the lower reaches of Waitohu Stream.

Refer to recommendations: 5.9 and 5.11

4.9 Freshwater fish

There are over 40 years' of records in the New Zealand freshwater fish database for this catchment. Surveys have been carried out in all decades since the 1960s and a reasonably consistent picture of the fish that are present has emerged. Eighteen fish species have been recorded over this time as well as koura (freshwater crayfish).

Fourteen native fish species have been recorded. Four of these (shortjaw kokopu, giant kokopu, lamprey and longfin eel) have such low numbers nationally that they require conservation action. Four introduced fish species are present in the catchment, perch, tench, rudd and brown trout. These compete with native fish for small insect larvae and crustacea. Larger perch also feed on small native fish.

It is encouraging to find 14 of the 22 species of freshwater fish of the region in this catchment; however, the population size of many species is discouragingly small. Some species that one would expect in the upper reaches are not present. This could be because of the poor water quality downstream or because of physical barriers to fish passage, for example stream grading weirs.[20] Fish that were not found during surveys

[17] Greater Wellington water quality database.
[18] Australia and New Zealand Environment and Conservation Council (2000); Australian water quality guidelines for fresh and marine waters. ANZECC. Canberra.
[19] Robertson, G. (2000); Targeted investigation of ecosystem health within the Waitohu Stream. Wellington Regional Council, Resource Investigations Department technical report.
[20] Greater Wellington (2003); Structures in rivers of the greater Wellington region.

of the upper catchment but which might have been expected in such habitat are: torrentfish, bluegill bully, banded kökopu, Cran's bully and dwarf galaxias. If Cran's bully and dwarf galaxias are actually absent from the catchment, they will remain absent unless actively reintroduced because they do not go to sea to complete their lifestyle.

Refer to recommendation: 5.11 and 5.16

4.10 Instream ecology of Mangapouri Stream[21]

The Mangapouri Stream is an urban and rural, semi-modified sub-catchment of the Waitohu. Roughly 60% of the sub-catchment is pastoral, and sections of the stream are prone to erosion.

Ian Boothroyd of Kingett Mitchell classified 26 streams in the Wellington region into seven groups according to significant ecological characteristics. Mangapouri Stream falls into the group with the poorest habitat, with low diversity communities containing mainly pollution tolerant macroinvertebrates. The stream has poor riparian vegetation comprising more than 90% grass or pasture, and only three types of pollution sensitive macro-invertebrates. These made up less than 1% of the total invertebrate community. Statistical analysis of stream invertebrates indicates severe pollution. As a result of inputs from the Mangapouri, Waitohu Stream is classified as one of the six worst polluted in the region.

Data collected by students and staff of Te Wananga o Raukawa in 2003 show that the Mangapouri Stream is affected by high nutrient loading, low dissolved oxygen and high water temperatures[22]. The impact these pressures have on the stream is reflected in the low species diversity. When compared with anecdotal records, native fish and koura numbers have declined considerably over the last fifty years. The health of fauna in the stream is also poor with many eels showing symptoms of disease such as skin lesions and fin rot. Koura (freshwater crayfish) appear to have low fertility when compared with populations in Waitohu Stream.

The study also highlights poor water quality caused by dissolved sediment and peat staining, lack of microinvertebrate habitat because of siltation of the cobbled streambed, and extensive areas of aquatic and terrestrial weeds. Aquatic weeds proliferate where water nutrient levels are high, stream currents are slow and sunlight levels are good.

Refer to recommendations: 5.11, 5.14 and 5.15.

4.11 Iwi

Te Runanga o Ngati Raukawa was invited to contribute to the Waitohu Stream Study, but for a variety of reasons no direct input eventuated. Nonetheless, a report prepared

[21] Kingett Mitchell Ltd (2004); Aquatic ecology and stream management groups for urban streams in the Wellington region. Unpublished report prepared for Greater Wellington.
[22] Caleb Royal (2003); Stream monitoring and the development of Mäori cultural water quality indicators: a project of Te Wänanga o Raukawa. Unpublished report for Greater Wellington Regional Council.

by the Runanga for Greater Wellington in 2000 provides a good summary of the relationship of Ngati Raukawa with the Waitohu Stream.[23] The iwi arrived in the Otaki area in the 1820s and established mana whenua. Various pa and kainga existed alongside the Waitohu Stream. Eels and flax were important resources collected in the area. Inseparable from the role of such rivers in providing resources is the mauri of water: "*Maori was and still is one of those cultures that use water for both taha wairua* [spiritual] *and taha tinana* [bodily or physical] *needs"*[24].

Further information has come from Greater Wellington's dealings with the Te Wananga o Raukawa, particularly regarding the Mangapouri Stream (as noted above in Section 4.10 for example). An oral history project has also confirmed the importance of the Mangapouri Stream as an eel resource during the lifetime of still-living Ngati Raukawa kaumatua.[25]

Refer to recommendation: 5.15.

4.12 Community consultation

The community was divided into eight groups based on location and meetings were held with each of these groups. A number of public and private groups and organisations who had an interest in the study were also contacted.

More detailed information about the groups and people consulted and their comments are detailed in the "Consultation Summary Report"[26]. Key findings are summarised below:

How the Stream affects them

Most people understand that the Waitohu Stream floods. However, the extent of recent small events, including the January 2005 flood event, came as a surprise to some Convent Road residents. On the whole, more people were concerned about the smaller more frequent events than the larger less frequent events. The reasons given were that smaller events were happening more often and were causing significant disruption in terms of damage to bank edges, fences, pasture, hay, and out-buildings and were resulting in the loss of income. Disruption was worsened if flood water could not get away quickly.

A number of comments were made about the lack of maintenance in the stream, particularly in lower reaches where willows were starting to clog the stream or cause erosion in flood events. There was a perception that Greater Wellington lacked a visible presence in the Waitohu Stream. People did not think Greater Wellington was actively managing the stream.

Gravel build up was mentioned by most groups as a problem. Residents in the upper reaches were concerned that gravel build-up was causing the stream to braid and erode.

[23] Te Runanga o Raukawa (2000); op. cit.
[24] ibid
[25] Rachael Selby, Pataka Moore and Caleb Royal 2004: Hokio and Mangapouri Streams oral history project. Presentation at National Library 23 April 2004.
[26] Greater Wellington 2006; Waitohu Stream Study – Consultation Summary.

Residents in the lower reaches were concerned that gravel build up appeared to be increasing the risk of flooding.

Other more site specific issues were the inadequate length of bridges in the upper reaches causing erosion and flooding, loss of dunes at the mouth, the adverse effects of the present mouth cutting policy and poor water quality in the lower reaches which affected white baiting and breeding habitat.

What they thought was important

Most people thought good water quality in the Waitohu was important. A number of people expressed surprise at how poor water quality was, particularly in the lower reaches of the stream.

In the lower reaches, white baiting, swimming, access and a healthy dune system were important to people. In the upper reaches, planting of stream banks had seemed to work well to reduce erosion.

What they would like to see happen

What people want to see happen varies depending where they live along the stream. However, one issue that was raised by all groups was a need for increased maintenance of the stream, particularly dealing with overgrown willows and gravel build-up. A number of people also suggested an overall maintenance strategy that they could contribute to through removing willows on their properties or streamside planting. People want obstructions in the stream to be cleared regularly. Advice and help with clearing drains, and flood-proofing on individual properties was also suggested.

Most people want to see land uses remain the same or similar and were not keen on stop-banks and other expensive flood control options.

A number of more site specific issues were raised. In the lower reaches, people would like improved access to, and up and down, the stream. They would like Greater Wellington to plant natives as alternatives to willows and would like to see more areas of the stream fenced off for streamside planting. They requested that the Greater Wellington review its mouth cutting policy and practices. Effective drainage was also mentioned.

A number of people want better flood warning and support during flood events. This comment was made in light of the perceived lack of response from both Greater Wellington and Kapiti Coast District Council after the January 2005 event.

In the Convent Road area people want Greater Wellington to scrap a proposal to raise the Convent Road Bridge. As an alternative they want Greater Wellington to look at the undersized culvert and blocked drains in Convent Road, the state of the Mangapouri Stream and the existing stop-bank which runs behind properties in Bennetts Road. They think this a matter of urgency.

In the upper reaches of the stream people want to see increased gravel extraction, keeping the stream to one channel and preventing it meandering all over the place and increased water quality monitoring to see what is happening above State Highway 1.

Refer to recommendations: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.10, 5.12, 5.13 and 5.14.

5. Recommendations

The Waitohu Stream Study has initially been a process of information gathering and analysis, with the aim of identifying and understanding various issues regarding the management of the Waitohu Stream.

However it is clear from the consultation that there are several issues upon which some action is desired and expected. From the Study to date, several obvious actions have been identified which can be initiated now to address these issues. There are some issues however that require further analysis before appropriate solutions can be identified.

The following recommendations are grouped into those that can be implemented now (recommendations 5.1 – 5.11), those that require further investigation (recommendations 5.12 – 5.16) and finally one outlining future reporting (5.17).

Measures that can be implemented now

5.1 Continue using planning controls on future development of the floodplain as the primary means of mitigating the flood risk

Comment

- The floodplain is relatively undeveloped, despite increasing demand within surrounding districts for lifestyle blocks. Other than alongside the Mangapouri Stream within Otaki township, there are only isolated pockets of housing. The flood extent maps, as well as the experiences of landowners, do not support greater development. These show that much of the floodplain is flooded even in relatively small flood events.

- The relative lack of assets on the floodplain leads to relatively low potential flood damages. Nor do landowners expect or demand any such works. This suggests that, other than in isolated areas such as Convent Rd, it would be very difficult to justify major flood protection works.

5.2 Publish flood extent maps for smaller floods and make the maps available to KCDC

Comment

- The vulnerability of much of the floodplain to flooding in smaller events needs to be recognised. Flood maps will be provided to KCDC, so that they can be used in LIM reports, for more general public enquiries and for emergency management planning.

5.3 Facilitate the quick drainage of flooded areas

Comment

- A significant concern of many landowners is the length of time that floodwaters stay after an event. Although flooding will remain a problem, some measures can be taken to reduce the ponding time.

- Landowners in the Ngatotara catchment have agreed to keep drains clear. Willow clearance on adjoining blocks of land by landowners will also help. Greater Wellington is responsible for clearing and maintaining the Waitohu and Mangapouri Streams and for clearing Ngatotara culvert under the Waitohu stream. KCDC is responsible for clearing and maintaining road culverts. Transit New Zealand and Ontrack are responsible for their culverts. These agencies also need to hear from the public if there are blockages in these culverts.

- Reports of blockages to the Ngatotara/Waitohu culvert and other culverts over the years during flood events illustrate the importance of keeping riparian berm areas clear of unsecured objects that could be swept into the culverts. This is primarily the responsibility of landowners but Greater Wellington and KCDC field staff have an advocacy and advisory role.

5.4 Clear the lower reaches of the Waitohu Stream of overgrown willows and other obstructions

Comment

- Willows have become overgrown to the point where they restrict access up the stream by canoeists and are likely to restrict flood passage. Some clearance has been made in recent years, but more is needed.

- Care will be needed when removing trees, so as to avoid erosion while new vegetation becomes established. Gradually clearing and removing willows will enable replacement with tall grasses and shrub vegetation.

5.5 Manage the stream channel between Ringawhati Road and Taylors Road Bridge to the design channel and buffer zones proposed in Figures 4 and 6.

Comment

- Currently maintenance is relatively low key, within consent conditions. The consent is due to expire in mid 2007.

Suggested management approach:

- Minor in-channel works (including vegetation clearing) will be undertaken where severe distortions develop and where these significantly eat into the buffer zone.

- Undertake occasional bank repairs and/or replanting as needed to re-establish buffer zone.

- Emphasise to landowners that the design channel and buffer zones drawn up are not absolute requirements, but are a general guide to alignment.

- Review possible channel diversion identified downstream of Ringawhati Bridges (Figures 6 and 7). If considered desirable, practical and affordable, then it will need a separate consent. Currently, however, the diversion is not considered necessary.

- Monitor the need for the "transition strengthening" identified a little further downstream (Figures 6 and 7). If considered a priority, then undertake the works under the current resource consent.

5.6 Manage the stream channel downstream of Taylors Road Bridge

Comment

- Work with landowners by offering advice, and assistance under the *Streams Alive* programme.

- Encourage the planting of buffer zones along alignments between the apexes of meanders (Figures 3 and 4).

- Undertake willow clearing

5.7 Undertake gravel extraction, within the identified zone

Comment

- The current estimate of gravel supply to the reach from State Highway One to the Taylors Rd access is 1500m^3 per annum, on average. Although this figure will vary greatly, depending on the number and size of floods each year, it is a good initial target annual extraction rate. Regular monitoring of the stream bed in this reach will be necessary to refine the target rate.

- Gravel extraction will need to be performed in such a manner to minimise ecological impact. This will be difficult given the narrow stream bed and awkward access. Ideally, extraction would take place during times when the stream dries up; however such times do not always coincide with times of demand for gravel. The preferred extraction zone is between State Highway One and the railway, where the stream bed is slightly wider (Figure 4). In that reach it will be possible to avoid working in the flow. Where it is not possible to avoid this, filter cloths or similar methods will be used to minimise the amount of sediment flowing downstream during extraction.

- Little extraction has occurred in recent years, although during 2004 and 2005 there has been some resumption of extraction. Extraction will need to be actively

encouraged, within the constraints of the existing Flood Protection resource consent. Local residents have expressed some interest in obtaining gravel for driveways and access tracks. Although such demand may be only small and infrequent, it nonetheless should be followed up.

5.8 When bridges are replaced or upgraded, require that they are constructed to allow at least a 100 year flood to pass unobstructed (unless there is an adequate secondary flow path and no adverse upstream effects)

Comment

- The eight bridges are a significant obstruction to flood flows, and access over them has often been hampered by erosion damage. At least three of the bridges are smaller than ideal (Waterworks, Ringawhati Rd, SH1).

- It is not expected that the bridges will be replaced or upgraded in the near future. At some point, however, they will need replacing. At that time the replacement bridges will need to have an adequate waterway to pass at least a 100 year flood.

- Gravel build-up further restricts capacity of the SH1 and rail bridges.

5.9 Encourage the management of streamside vegetation through Greater Wellington's existing policies and programmes

Comment

- Waitohu Stream has been included in Greater Wellington's *Streams Alive* programme because:

  - Current high levels of aquatic habitat can be improved;

  - Assistance will successfully address degraded habitat in the catchment;

  - The stream will work as a functioning ecosystem for aquatic life that would naturally live there;

  - Once rehabilitated it will provide effective links or corridors from sea or lake; and

  - The stream is representative of the range of stream types within the region.

- All streams in the Waitohu catchment are eligible for streamside planting assistance from Greater Wellington's *Streams Alive* programme. This programme provides financial and practical assistance for landowners wishing to plant native vegetation beside streams.

- Streamside planting will restore a more natural stream environment by diminishing the effect of runoff on water quality, lowering water temperature and increasing the diversity of habitats and species.

- As well as working with landowners, Flood Protection staff and *Streams Alive* programme staff must work together in any planting work.

- Planting needs to be consistent with the proposed buffer zones and with recommendations on appropriate species for the zones. (See Figures 3 to 7).

Access requirements for maintenance needs to be considered in any planting work.

5.10 Adopt the following guidelines for future mouth cutting

- Increase the frequency of cutting. It is anticipated that typically, an average of twice a year will be adequate.

- Reduce the distance the mouth meanders to the north before cutting it to about 750 metres rather than the 1000 metres at present. This will allow the mouth to move, but not too drastically, avoiding erosion of the dune system; and

- Cut the mouth along the alignment shown in Figure 12.

Comment

- The guidelines are fully described in a separate document.[27]

- These guidelines aim to protect dunes on both sides of the mouth and thus satisfy a range of parties. The guidelines have been discussed and agreed with those parties.

- In storm conditions the stream mouth can move rapidly and there will inevitably be times when the stream mouth does move beyond its desired limits or when the dunes do suffer erosion.

- The guidelines are to be trialled for an initial two year period, until June 2007. The outcomes should be fed into the next review of the Regional Coastal Plan.

5.11 Continue and improve monitoring of water quality parameters, species diversity and flood flows

Comment

- Updated records, consistent sites and measurement techniques are required for successful monitoring over time.

- Gauging in flood flows needs to be undertaken. This may be difficult due to floods being normally short duration events. Some gauging of tributary

[27] Greater Wellington 2006; Mouth Cutting Guidelines - Waitohu Stream Mouth.

catchments to calibrate the hydrological model would also be useful. This will also have flood warning benefits, enabling better warnings to be given.

Further Investigations

5.12 Improve existing flood warning systems

Comment

- The Waitohu's short catchment means that little warning will be able to be given, but even a short warning time will enable residents and landowners to take some measures to lift or move assets, or take other precautions.

- Some thought needs to be given as to how and when to best disseminate warnings. The flood of January 2005 showed that even relatively small floods at the Water Supply Intake can lead to significant inundation of property downstream.

- Consideration should also be given to support that could or should be given to local residents during flood events.

5.13 Undertake further detailed studies on Convent Road/Bennetts Road flooding and potential options.

Comment

- Flooding occurs relatively frequently, the most recent event was in January 2005.

- The Otaki Floodplain Management Plan included proposals to raise Convent Road bridge, to raise a limited number of houses in the area and to enlarge the Mangapouri Stream channel to address the flooding problems. However all of these proposals were given low priorities.

- Indications are that at number of residents do not believe the bridge raising proposed in the Otaki River FMP is required. Further investigations should reconsider this option.

- The potential for house raising should also be reconsidered as an option.

- More detailed flood and topographical data, as well as more sophisticated modelling techniques, have become available since the Otaki FMP was prepared (and even since the technical investigations of the Waitohu Study were completed).

- The culvert under Convent Road restricts the drainage of the floodwaters, and a programme for improvements to the culvert is needed (KCDC).

- Consideration of the downstream effects of any option is required – restricting overflows from the Waitohu into the Mangapouri via Convent Road may cause additional problems downstream of the bridge for example.

5.14 Review the proposed Mangapouri channel enlargement (as currently included in the Otaki River FMP) and either confirm or remove as an intended future work

Comment

- Channel enlargement was proposed in the Otaki FMP, although it has been given a low priority and is therefore unlikely to proceed for a number of years.

- The uncertainty over when (if at all) it will be done means that it is difficult to commit to streamside planting. Some landowners want to start such planting.

- Channel enlargement is expected to be costly, as the channel passes through numerous private properties

5.15 Continue investigating the causes of Mangapouri Stream pollution

Comment

- Continuing problems with high levels of faecal contamination in the Mangapouri need to be resolved.

5.16 Assess all grade control structures in the Waitohu Stream to see whether they are still required

Comment

- If they are no are no longer needed and their removal does not have adverse effects, grade control structures can be removed or part removed. Alternatively, the effects on fish passage should be assessed and suitable works done to enhance fish passage, e.g. the placement of rock ramps below the structure.

Reporting

5.17 Report back to the Landcare and Environment Committees of Greater Wellington annually on progress in implementing recommendations

Comment

- This Study has been a new approach to stream management, and ongoing monitoring would be useful to determine how effective it has been.

- The Waitohu Stream is dynamic and will change over time. Data collection will be ongoing and new information will become available.

- Information to be presented would include: maps of riparian areas planted (with species names), areas cleared, areas damaged/lost, changes in mouth alignment.

6. Diagrams

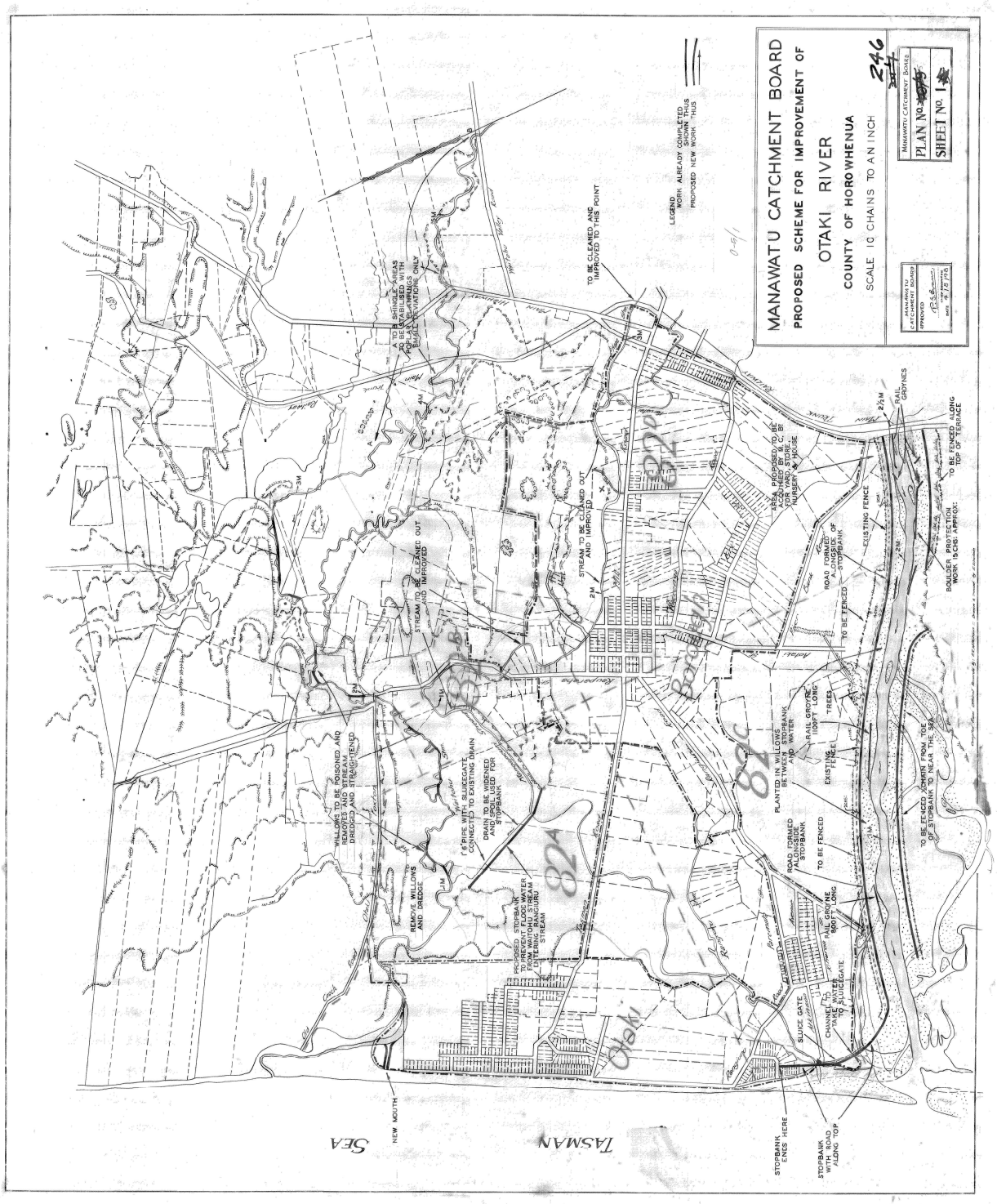

Figure 2 1948 Otaki Scheme

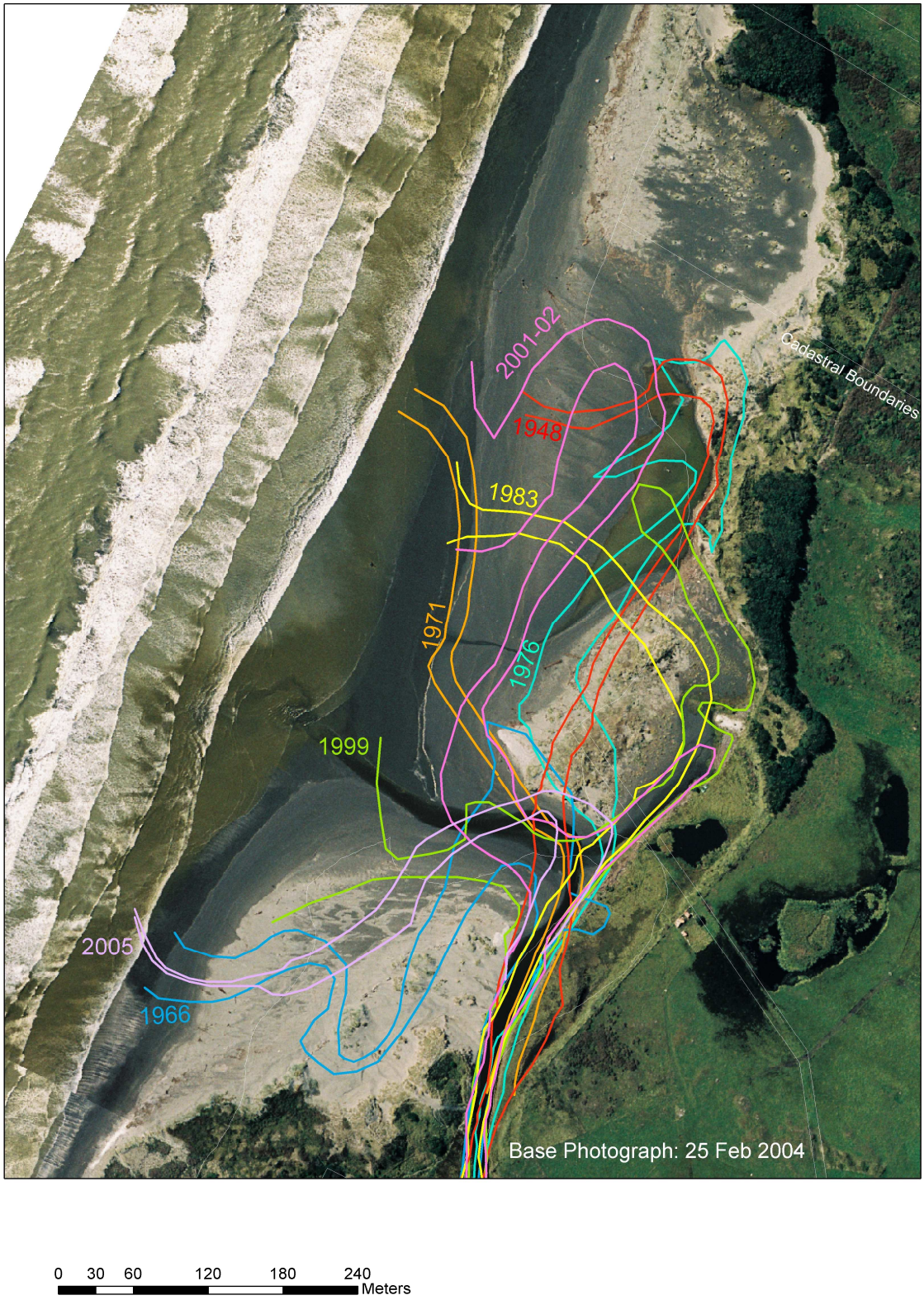

Figure 11 Waitohu Stream Mouth Alignment

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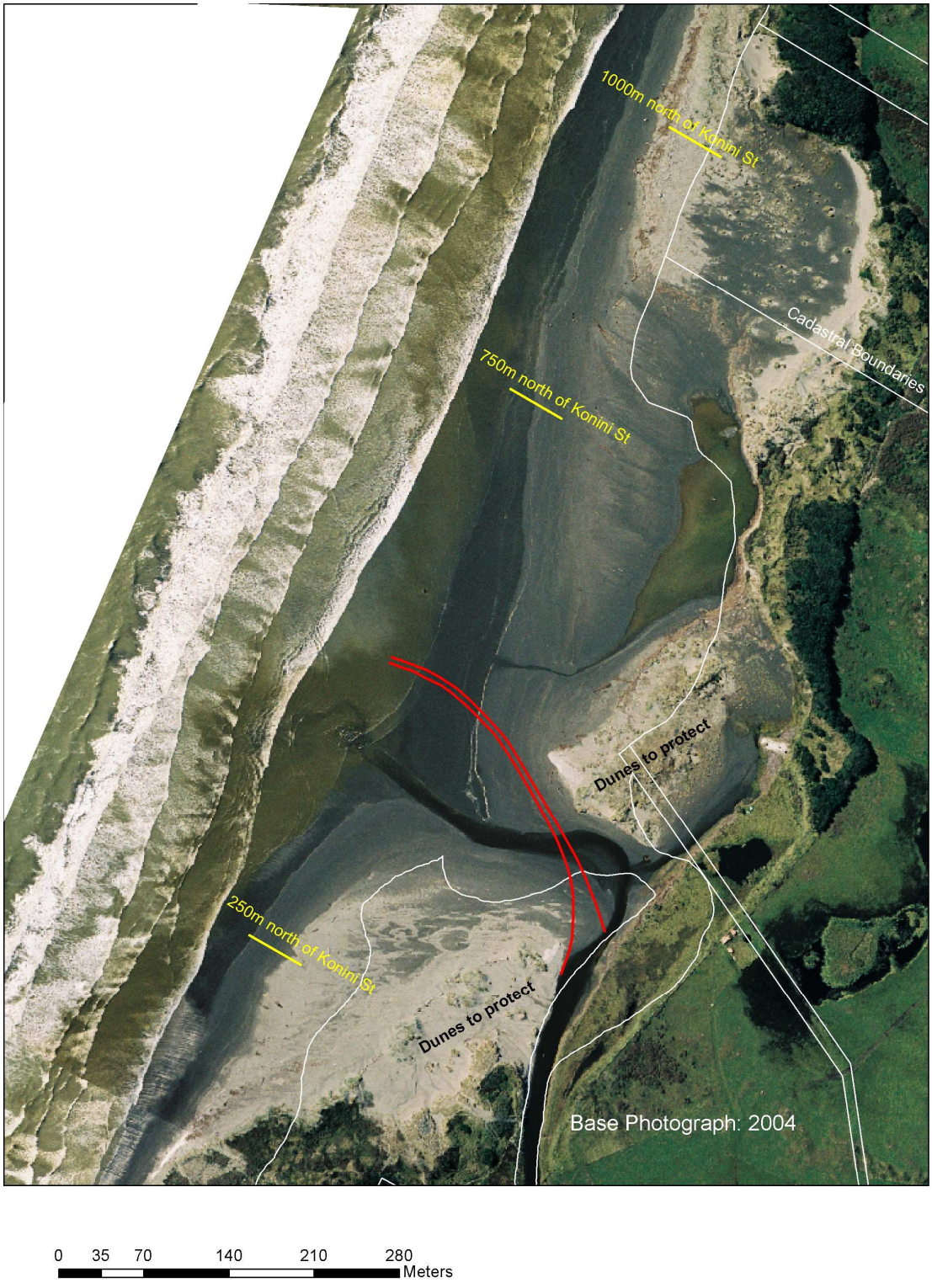

Figure 12 Preferred Alignment of Mouth Cut - Waitohu Stream

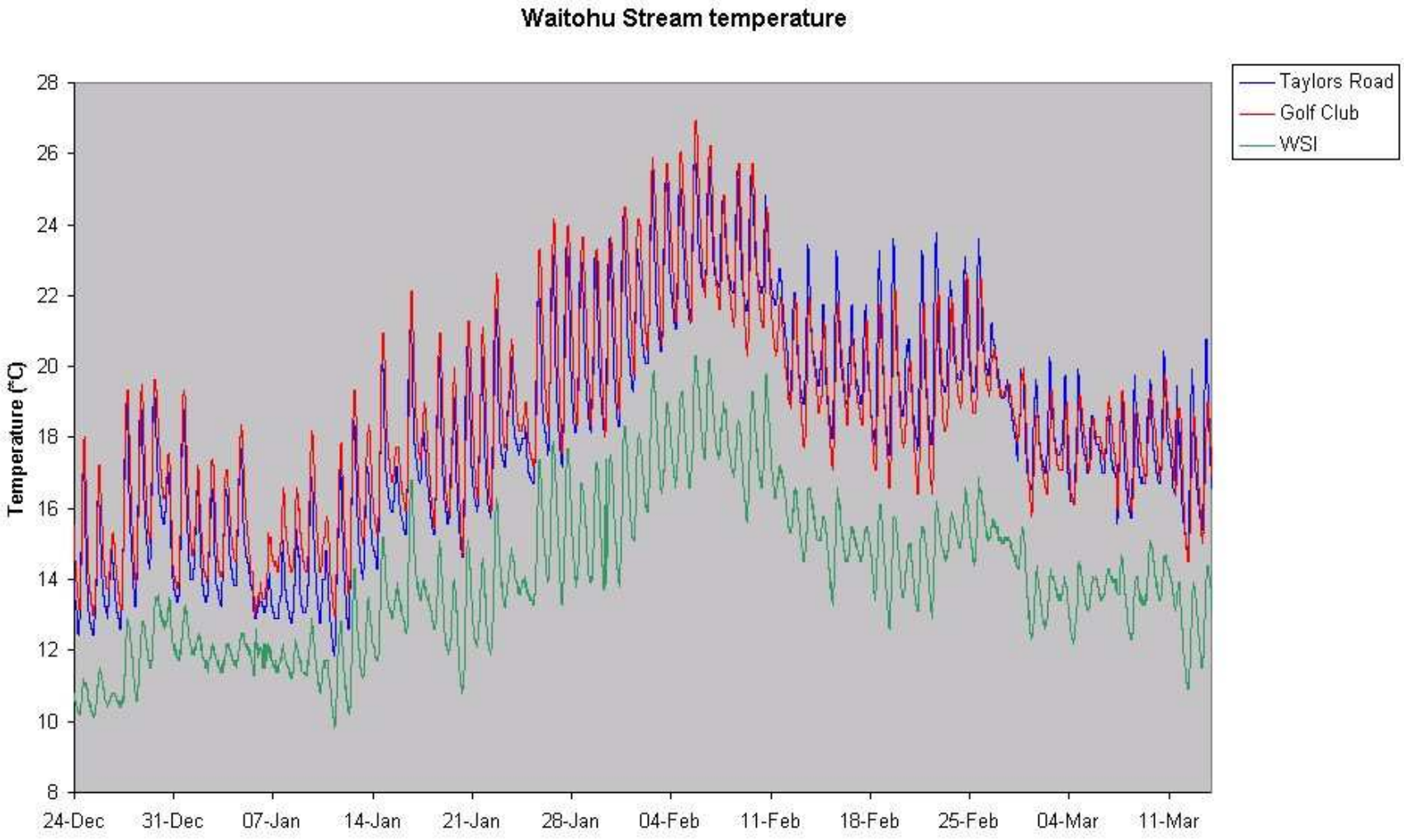

Figure 13 Waitohu Stream Temperature, Summer 2004/05

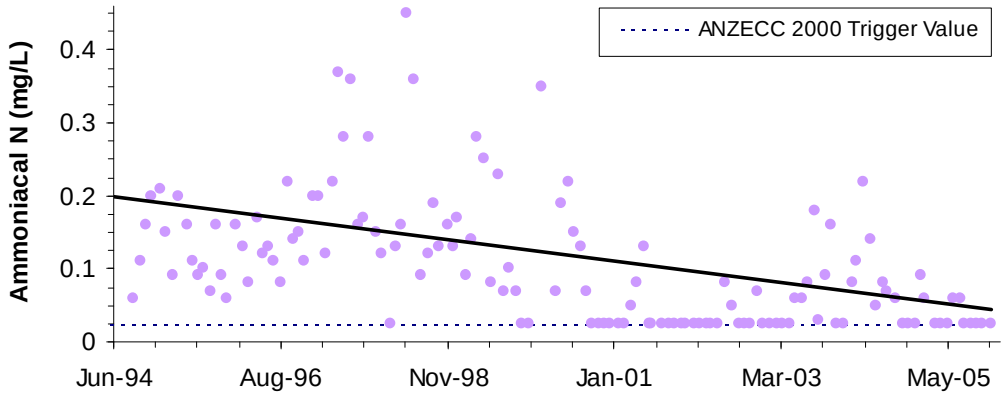

Figure 14 Ammoniacal nitrogen concentrations recorded in the Waitohu Stream at Norfolk Crescent. (The solid black line shows the overall trend in the data record.)

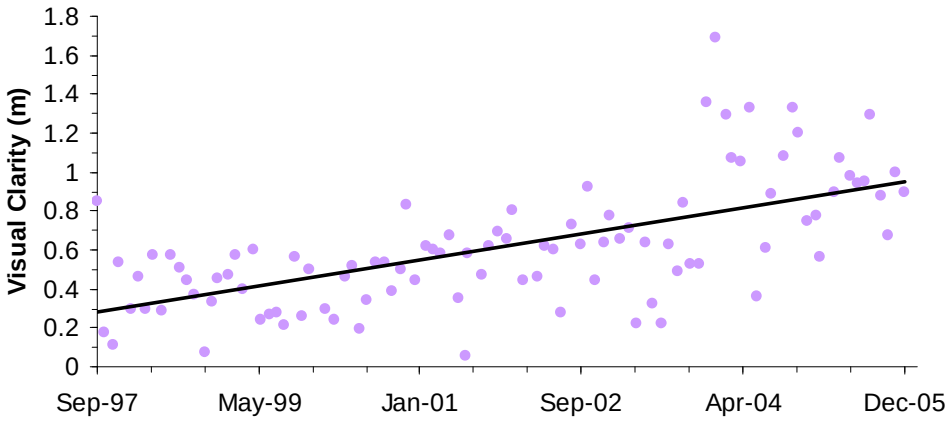

Figure 15 Clarity measurements recorded in the Waitohu Stream at Norfolk Crescent

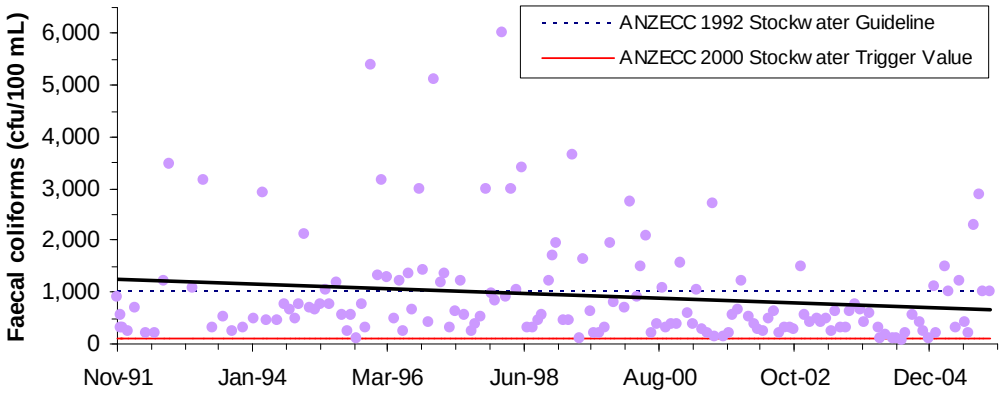

Figure 16 Faecal coliform measurements recorded in the Waitohu Stream at Norfolk Crescent

Bibliography

Adkin,G.L (1948); Horowhenua. Dept of Internal Affairs, Wellington

Australia and New Zealand Environment and Conservation Council, (2000); Australian water quality guidelines for fresh and marine waters. ANZECC. Canberra.

Blaschke, Paul and Forsyth, Frances (2004); Ecological Assessment of the Waitohu Catchment and Stream. Report for Greater Wellington Regional Council.

Greater Wellington (2003); Structures in Rivers of the Greater Wellington Region.

Greater Wellington (2003); Waitohu Stream Flood Report.

Greater Wellington (2005); Freshwater Quality Monitoring Technical Report

Greater Wellington (2006); Waitohu Stream Study – Consultation Summary

Greater Wellington (2006); Waitohu Flood Hazard Assessment – A History of the Management of the Waitohu Stream.

Greater Wellington (2006); Waitohu Stream Study - Flood Hazard Assessment – Potential Flood Damages.

Greater Wellington (2006); Waitohu Stream Study – Consultation Summary

Greater Wellington (2006); Mouth Cutting Guidelines - Waitohu Stream Mouth

Kingett Mitchell Ltd (2004); Aquatic Ecology and Stream Management Groups for Urban Streams in the Wellington region. Unpublished report prepared for Greater Wellington.

MacLarin W., Bekesi G., Brown L.J. & McConchie J. (1999); Nitrate contamination of the unconfined aquifer, Manakau, Horowhenua, New Zealand. Journal of hydrology, New Zealand 38:2

Manawatu Catchment Board (1948); Report of Proposed River Control and Drainage Scheme - Otaki Area.

Manawatu Catchment Board and Regional Water Board (1978); Otaki Scheme Review 1948-1978

Manawatu Catchment Board and Regional Water Board (1981); Objectives, Policies and Management for the Water and Soil Resources of the Otaki River, Waitohu Stream and Mangaone Stream Catchments. Report No. 38.

Manawatu Catchment Board and Regional Water Board (1988); Otaki Scheme Review, 1979-1982 and Proposed Works 1983-1988.

Ministry for the Environment (2002); Climate Change Impacts on New Zealand

Montgomery Watson (2000); Waitohu Stream Environmental Survey. Report prepared for Wellington Regional Council, June 2000.

Robertson, G. (2000); Targeted investigation of ecosystem health within the Waitohu Stream. Report prepared by Resource Investigations, Wellington Regional Council.

Royal, Caleb (2003); Stream Monitoring and the Development Of Mäori Cultural Water Quality Indicators: A Project Of Te Wänanga o Raukawa. Unpublished report for Greater Wellington Regional Council.

Selby, Rachael, Pataka Moore and Caleb Royal (2004); Hokio and Mangapouri Streams Oral History Project. Presentation at National Library 23 April 2004.

Te Runanga o Ngati Raukawa (2000); Ngati Raukawa Tangata Whenua [Values Assessment] Report on Waitohu Stream: Wellington Regional Council Proposed Resource Consent for Waitohu Stream**.**

Wellington Regional Council (1994); Otaki River Floodplain Management Plan – Phase One Investigations: A History of the Management of the Otaki River and Flood Control Scheme. Report No WRC/RI-T-92/58

Wellington Regional Council (1998); *Otaki River Floodplain Management Plan – Mangapouri Stream Upgrade Hydraulic Modelling Report.* Report No WRC/RI-T-97/48

Wellington Regional Council (1998); Otaki River Floodplain Management Plan. Publication No. WRC/FPSA-G-98/28

Wellington Regional Council (2000); Targeted Investigation of Ecosystem Health within the Waitohu Stream. Publication No. WRC\RINV-T-00/17

Williams, G.J. (2000); Waitohu Stream – Resource Consent: Review of Stream Management and of Potential Changes Over Time.

Williams, G. (2004); Waitohu Stream Flood Hazard Assessment: River Characteristics and Sedimentation, and Channel Management.