Pohangina – Oroua Catchment Control Scheme Scheme Review

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regional council

AMENDED REPORT

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Author
John Philpott
of
John Philpott & Associates Ltd

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For more information contact—

Service Centres	*Regional Houses*	*Depots*
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FOREWORD

It is Council's policy to review the river and drainage schemes under its management, to set the design standards to be maintained, identify improvements, and develop future management strategies.

This review is wide-ranging, examining the erosion control and channel management requirements of the whole Scheme, exploring funding options to enable a greater expenditure on Scheme works without significant impacts on the level of rating required. The review recommends a management strategy for the Scheme for the next 15 to 20 years. It has also clarified the need for a re-classification for rating purposes.

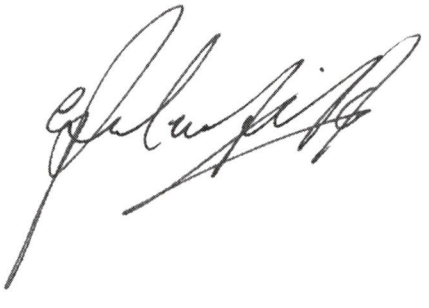
Following the adoption of the Scheme Review by Council in September 2001, the recommendations of the draft review have been amended along with a number of minor technical corrections and amendments to the body of the report.

Many people have contributed to this technical review, which was prepared by John Philpott, Consulting Engineer with particular input from Allan Cook, Area Engineer.

We acknowledge the assistance from ratepayers with the investigation work, the Liaison Committee for helping to target issues and review draft options, and other Horizons Regional Council staff for providing technical support and peer review.

NOTE:

This review has been updated in light of the changes to the Scheme that occurred as a result of the very large February 2004 flood event. Changes to the review have focused on the areas of channel alignment, the works programme and scheme finances. Minor adjustments have been made to other sections of the 2001 review to maintain consistency with the more significant changes.



M McCartney
GENERAL MANAGER

G Murfitt
CHAIRMAN

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EXECUTIVE SUMMARY (Updated 2006)

1.1 The 2006 Amendments

Following the flood of February 2004, the subsequent repair works, and the alterations that occurred to the channel alignment, especially on the Pohangina River, a mini review of the Scheme has been undertaken. Part way through this process at the end of April 2006, a significant flood over an extended period caused further river bank erosion with an estimated repair cost of $150,000.

A new programme of works has been developed that focuses on both the remedial work required following the April flood, and on the need for a programme of maintenance that will ensure the flood-carrying capacity of the channel is maintained and the buffer strips established and expanded.

One positive outcome of the 2004 flood was that a large percentage of the capital works identified in the 2001 review were completed without the need to draw on the funds from the Goulters Gully forestry. This has resulted in a fund of over $600,000 being available for increasing the integrity of the existing and new erosion control works, and for increasing finances available to achieve the design flood fairway without unduly increasing the level of Scheme rating.

1.2 Objective of the Review

The objective of the Pohangina-Oroua Scheme Review was to assess the present performance of the Scheme and identify how it can be managed in the future to best meet the needs of the ratepayers in a sustainable manner.

1.3 The Present Scheme

The Scheme provides landowners within the Scheme area a degree of protection against the adverse effects of changes in the alignment of the Pohangina and Oroua Rivers, and of erosion that can occur when the unstable coarse sand deposits present in the catchment become exposed. The Scheme also provides small areas with drainage and, to a limited extent, controls flooding of some of the low-lying river flats.

The Pohangina-Oroua Scheme covers the main stem of the Pohangina River from its confluence with the Manawatu River to its confluence with the Makawakawa Stream at Komako and the Oroua River from its confluence with the Kiwitea Stream to the Apiti bridge. Minor works on some of the smaller tributaries of the rivers have also been carried out.

Early river control works focused on stabilising the Pohangina River into a 120m wide channel using tree bank protection works and continuous bands of willows along each bank. Work in the Oroua River focused on maintaining a channel width of 100m. Planting work was required in some areas and in other areas work was required to widen the channel to achieve this design width.

Soil conservation works carried out as part of the Scheme concentrated on stabilising the Belmont and Goulters gullies and some other minor tributaries of both the Pohangina and Oroua Rivers.

1.4 Issues Considered in the Review

The review sets out the early history of the area and the development of the Scheme that commenced in 1967. Landowners had made significant attempts to control erosion on the two rivers prior to the establishment of the Scheme. Extensive early work was also carried out in the sand country following a very severe storm in 1935 that caused significant erosion in the unconsolidated sand formations that bisect the Scheme area.

The review briefly examines the geology, hydrology and sediment transport and gravel extraction issues that relate to the Scheme. The review examines factors influencing channel shape and the rivers' responses to the actions of the Scheme.

The review examines the effectiveness of the Scheme to date, establishes a set of design principles, and applies those principles to the Scheme to determine a plan for the future management of the Pohangina and Oroua Rivers. A long-term estimate has been prepared considering both future income and all works and non works expenditures. The appropriateness of the existing classification has been considered.

Findings of the Review

The Scheme has managed to a large degree to stabilise the two rivers. However the flood-carrying capacity of both rivers has not been maintained. Gravel build-up and encroaching vegetation has confined the flood flows placing undue pressure on the protection works on the outside of bends. This has caused significant and reasonably regular damage to the protection works and the consequential loss of productive land.

To a large extent this problem has been caused through the expectations by ratepayers that all erosion damage will be repaired whilst at the same time limiting available financial resources. These two factors have resulted in there being insufficient funds to carry out both robust protection works and the necessary channel maintenance.

The soil conservation works have been very successful with both the sand gullies and the minor tributaries being significantly stabilised. Very little work has been required in these areas over the last ten years.

The analyses of past and proposed expenditure in the Scheme have shown that the existing classification was reasonably equitable for the first ten years or so but in the last ten years the level of expenditure on the Oroua River has not been aligned with the proportion of rates sourced from the Oroua ratepayers.

1.5 The Future Scheme

A set of design parameters has been established for both rivers and applied where appropriate. A complete plan for the future alignment of the Pohangina River below the Totara Reserve has been prepared. However, because the meander pattern in the Oroua River is constantly being restarted from bend distortions and areas of harder materials, Oroua River management cannot be significantly improved by following an overall design channel. An overall plan for the Oroua River has therefore not been prepared. Design channels have however been drawn up for representative reaches and these can be used as a

guide to management where applying these design channels would assist river management measures, site by site.

Estimates have been placed on the cost of implementing the Pohangina River design and on a level of expenditure considered appropriate to manage the Oroua River. Under the programme of works set out in the review, expenditure on the Pohangina River would be almost double the existing level for the next five years and then drop back to a level very similar to the existing level. This will be possible because of the improved alignment that will be created by the proposed works, the more robust works being carried out, and because of the maintenance of the flood-carrying capacity of the river that will reduce the damage potential during flood events.

The estimate for the Oroua River proposes a level of expenditure forty percent higher than at present. This will enable more robust works to be carried out along with a programme of channel maintenance. It is expected that works will be required on an ongoing basis on the Oroua River because of the inability to apply an overall design.

It is recommended that drain maintenance works continue in the scheme only where the drains service more than one property, and that close attention is paid to the ongoing management of the Goulters Gully complex.

The review recommends that the income from the sale of the Goulters Gully Forestry be used to replant and manage the ongoing forestry to provide protection to the unstable sand formations and the remaining funds be used to fund scheme works over the next 25 years.

1.6 Conclusions

The Scheme has to a large extent achieved its original objectives of controlling and preventing erosion in the Castlecliffian sand formations and in stabilising the Pohangina and Oroua rivers as nearly as possible in the positions that existed in the late 1960s.

The original scheme envisaged that the ongoing river management work would maintain a clear fairway along both rivers to maintain their flood-carrying capacity. This has not been achieved. The Oroua River over much of its length is still too narrow and consequently large flood events cause considerable damage to established edge protection works.

The Pohangina River generally has a channel width close to the original design, but build-ups of gravel and vegetation on the beaches have impacted on its flood-carrying capacity, resulting in continual high levels of flood damage.

The Pinus Radiata Forest planted to control runoff on the edges of Goulters Gully and to make good use of land purchased by the Scheme, is now ready to be harvested. Once replanting and forestry management expenses have been deducted, the income from the sale of these trees will provide the Scheme with an annual income. The level of this income will depend on the proportion of the capital spent in the first five years. The proposed expenditure plan for the Scheme will provide an ongoing level of income of approximately $25,000.

The replanting of these trees will be vital to maintain the stability of the sand gullies, and careful management of the area will be required during and following the harvesting work.

The proposed significant increases in scheme expenditure will be funded from the forestry income as well as a small increase in Scheme rates.

The Scheme is being managed in a professional manner with a good balance of input from a Liaison Committee made up of ratepayers within the catchment. The current management system should continue being heavily guided by the river management regime set out in this review. Failure to implement this management regime will not only ensure a continuation of the existing level of flood damage but will probably see an even greater amount of damage occur as the flood-carrying capacity of the channels reduces further.

RECOMMENDATIONS

Pohangina River

a. adopt the Pohangina River design alignment as detailed in Section 12 of the Review and as shown on Figure 9;

b. undertake the protection works in priority order unless flood damage requires work on a reach of the river to be done out of sequence with its priority;

c. undertake the planting programme on each reach of the river along with the protection works on that reach, and layer and maintain existing trees as part of this work;

d. assign any surplus funds in any year to planting and channel maintenance;

e. maintain beaches and clear vegetation to ensure the design fairway is kept clear;

f. carry out changes to work priorities in the future if required using the principles set out in the Review;

g. obtain, as far as possible, agreements with landowners in regard to protection plantings.

Oroua River

h. undertake the protection works in priority order unless flood damage requires work on a reach of the river to be done out of sequence with its priority;

i. undertake works wherever possible in accordance with the Oroua River Design Parameters as set out in Section 12 table 10 of the Review;

j. prioritise protection works in accordance with section 13 table 12 of the Review;

k. carry out planting works to create the 20 metre bands of willows as detailed on Figure 11;

l. carry out changes to work priorities in the future if required using the principles set out in the Review;

m. obtain, as far as possible, agreements with landowners in regard to protection plantings.

Gravel Management

n. direct gravel extractors to beaches where gravel extraction would facilitate general river management;

Soil Conservation works

o. utilise the income from the sale of the Goulters Gully forest to:

- re-establish the protection forest as soon as possible in such a way as to maximise erosion protection as well as future tree production; and
- assist with the funding of Scheme works spread over a 25-year period;

Drainage

p. fund all future Scheme drainage works through rates over those who directly benefit from those works;

Maintenance

q. maintain existing Scheme assets ahead of constructing new Scheme assets;

r. always include the cost of ongoing maintenance works when preparing estimates for new capital works;

Non-Scheme Assets

s. obtain funding from the asset owner for works required to protect assets where the owner of those assets does not contribute to the Scheme unless otherwise agreed to by Horizons Regional Council and the Scheme ratepayers;

t. share funding of protection works required to prevent riverbank erosion that is threatening both non-ratepayer assets and ratepayer assets except where natural river processes would be accepted if the non-scheme asset was not present. In these cases the total cost of the protection works shall be fully funded by the asset owner;

Scheme Finances

u. fund the Scheme by way of rates and a loan repaid over a 10-year period;

v. manage scheme income and expenditure in line with the details set out on table 18 of the review; and

w. allocate Goulters Forestry Reserves to cover the matters set out in Section 21.1; and

x. monitor expenditure of Scheme funds over the long term to maintain rating equity within the Scheme.

1. The Scheme (as per the 2001 report)

The Pohangina-Oroua Catchment Control Scheme is essentially a ratepayer collective managed by Horizons Regional Council. It provides landowners within the Scheme area with a degree of protection against changes in river alignment causing a loss of productive land through erosion, and against the adverse effects of the erosion that can occur when the unstable coarse sand deposits present in the catchment become exposed. The Scheme also provides small areas with drainage (by maintaining a network of drains), and, to a limited extent, controls flooding of some of the low-lying river flats.

The Pohangina-Oroua Scheme area, shown on Figure 2, covers the main stem of the Pohangina River from its confluence with the Manawatu River to its confluence with the Makawakawa Stream at Komako and the Oroua River from its confluence with the Kiwitea Stream to the Apiti Bridge. Both rivers have their headwaters in the Ruahine Ranges. Minor works on some of the smaller tributaries of the Pohangina River have also been carried out.

For the 1998-99[1] financial year the Scheme expenditure was $208,756, which ranks as the 5th largest river control scheme operated by Horizons Regional Council. Of this total $67,039 was funded by a General Rate contribution. The remaining $141,717 was funded by ratepayers and from interest on reserves. The relative distribution of the $141,717 is shown in the Figure 1. The General Rate contribution funded survey work carried out for the scheme review process and the engineering management costs over above the 20% of works costs[2]. Details of Scheme expenditure are set out in the chart in Appendix A.

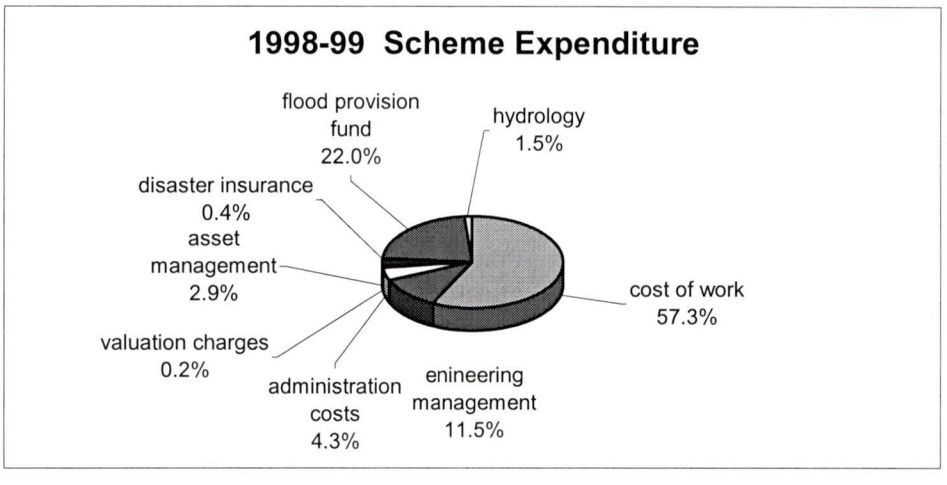

Figure 1. Relative distribution of 1998-1999 Scheme Expenditure

[1] This year was chosen as it represents a more typical year in the recent history of the Scheme. The repair of severe flood damage that occurred in November 1999 and April 2000 has resulted in a very atypical year.

[2] Under Horizons Regional Council 's new funding policy Review and Classification costs are fully funded from the general rate, along with 20% of all other scheme costs.

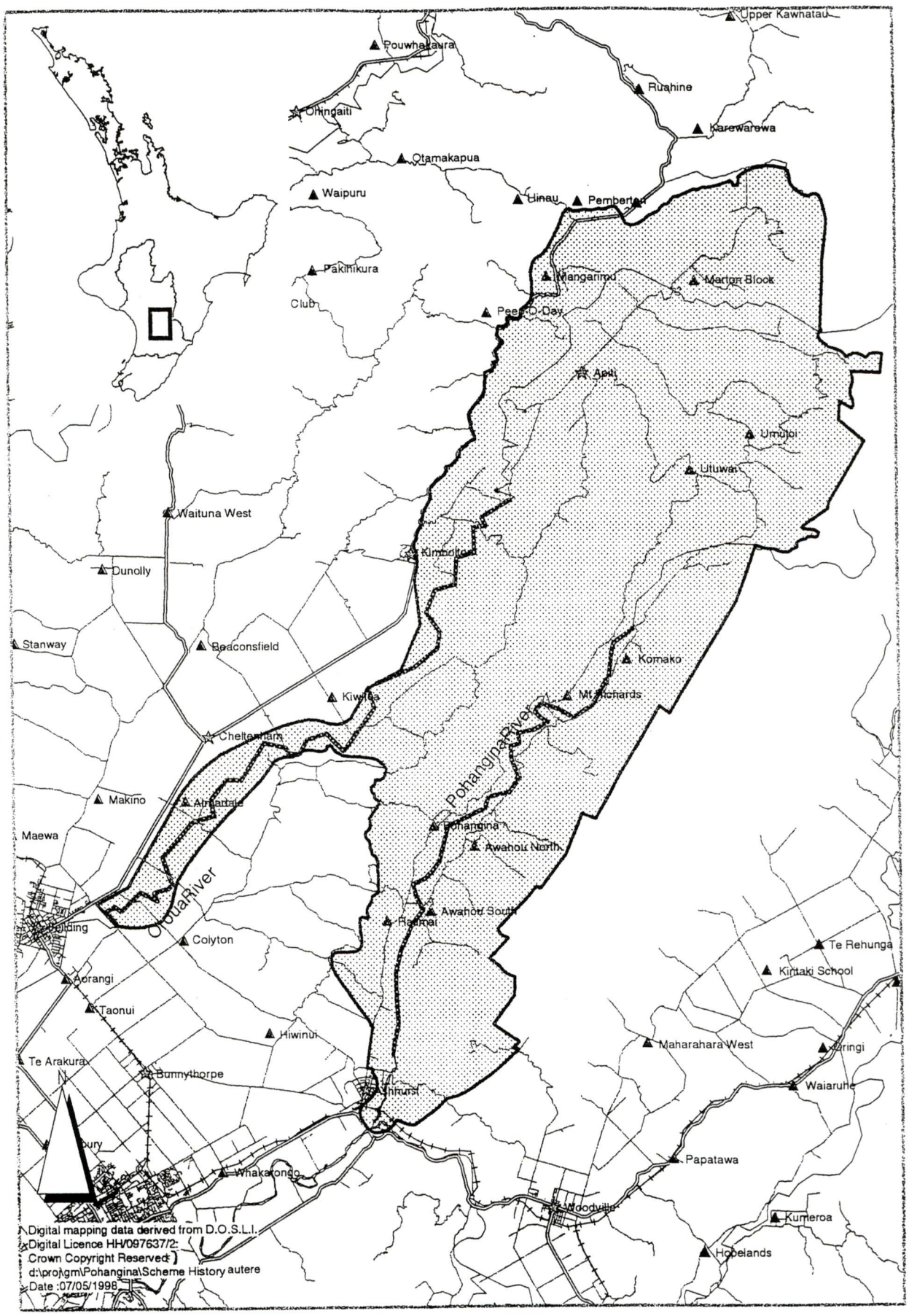

Figure 2. Scheme Map

2. History (as per the 2001 report)

2.1 Pre-Scheme History of the Area

Early European settlement commenced in the Pohangina Valley in the 1840s although settlement in any number didn't commence until the 1880s. By 1898 many of the present roads had been formed but were rough and difficult to negotiate in the winter months.

Over this early period, the initial development of farms located on the unconsolidated sand area took place as the New Zealand dairy and meat export industry was being established.

By 1906 a considerable proportion of the indigenous forest had been felled and burnt and English grasses sown. After a few years the initial fertility created from the ash declined and the pasture was invaded with fern and scrub. The use of cattle and subdivision on smaller blocks helped to prevent reversion and a rotation of cutting and burning scrub every few years generally kept the pasture clear.

By the 1930s increased runoff from the poor pasture and the decay of the tree roots increased the land's susceptibility to erosion. In 1935 an exceptionally severe storm resulted in accelerated gully erosion in the unconsolidated sand country. In each successive high-intensity storm, further gullies began actively eroding whilst more modest storms kept the erosion active once it had begun.

The 1859 survey maps of J T Stewart showed the Pohangina River as a narrow (140m) channel meandering between heavily vegetated banks. Photographs of the area in 1906 to 1910 showed that the Pohangina River had become a wide (350m to 370m) braided channel with eroded banks and little evidence of indigenous or exotic riparian vegetation. Present channel widths range between 50m and 250m but are more commonly about 70m. Over most of the channel length there are narrow bands of willow protection work along both banks.

In 1944 the Manawatu Catchment Board was constituted under the Soil Conservation and Rivers Control Act 1941 and almost immediately the Board initiated research on soil conservation techniques within its district. The control of erosion using engineering structures, vegetation and vegetative structures, and improved livestock and pasture management techniques were investigated.

Prior to the formation of the Catchment Board, river protection works had been intermittent and dependent on finance available from property owners. Considerable lengths of bank protection had been established along the Oroua River while some had been established along the Pohangina River.

The initial Pohangina-Oroua Scheme report was produced in March 1964 and no further river control work was carried out until scheme funds became available in 1967. Soil conservation works continued over this intervening period funded from the Board Works programme.

2.2 History of the Scheme

The Soil Conservation and Rivers Control Council gave financial and technical approval for the Scheme in 1966.

The Scheme was established with two main objectives. These were:

- to control and prevent erosion in the catchment area and to achieve maximum economic production taking a long term view; and

- to stabilize the Pohangina and Oroua river channels as nearly as possible in their position at that time and to carry out work to stabilise the larger tributaries. These included Beehive Creek, Coal Creek, the Mangoira and Mangahuia Streams and the tributaries of the Pohangina running up into the Ruahine Ranges.

Lesser objectives were:

- the control of flooding through the maintenance of the stopbank that existed at the time the Scheme was established;

- the reclamation of large areas of bare shingle or areas covered in lupin; and

- the improvement of existing drains and the construction of drains into swampy areas.

The financial approval was for $228,000 at a $3 for $1 subsidy and a further $60,000 was given from the Soil Conservation and Rivers Control Council as a special grant. The total amount was spent in a series of annual works programmes between February 1967 and March 1978.

2.3 The Original Soil Conservation Programme

Two broad categories of conservation work were recognised as the programme of scheme works was developed. These were farm benefits and community benefits.

Farm benefits covered all work that was of direct benefit to individual farms. This work was to be carried out with normal soil conservation subsidy under a guidance provided by a Soil Conservation Farm Plan.

Community benefit covered work with considerable offsite impact, ie the reduction of sediment input to the rivers. The work was to be carried out to overcome serious erosion and the costs were to be borne entirely by the Scheme. The objectives for this type of work were:

- the control of active erosion and major sources of sediment principally in the Castlecliffian sand formations;

- the storage of erosion products; and

- the prevention of gully development.

Groenendijk[3] reviewed the soil conservation work completed in the first five years and then again after the next five years in 1971 and 1977 respectively. As a result of his reviews a number of changes were made to the gully planting programmes, moving away from fencing to using larger planting protected from stock with netlon sleeves. Gully structures had been successful but flood detention dams proposed for steep narrow valleys had not proceeded on the grounds that they were not cost-effective. In the first five years of the Scheme, 160 ha of land had been voluntarily retired.

Concrete block drop structures were found to be successful in controlling gully erosion as these gave almost instant results. A number of these were then used in Culling's Gully and the Goulter-Belmont Gully complex.

Details on the soil conservation work carried out up to 1979 is set out in the 1979 review by E C O'Connor and G G Brougham[4] and in the two reports by Groenendijk 1971[5] and 1977[6]

The 1979 Review recommended that the works that were identified in the initial Scheme, which had not been completed prior to the 1979 review, be completed.

2.4 The Original River Control Programme

River control work on the Pohangina River was proposed to stabilise the channel at a width of 120m, as nearly as possible in the alignment at that time by means of tree bank protection where necessary and elsewhere by planting willow and poplar to form a continuous growth 10 metres wide along both banks. Plantations of trees were proposed to be planted behind the willows and in other suitable sites for groyne work in future years. These works were planned to be carried out from the confluence with the Manawatu River to the Totara Reserve. Lighter work was proposed above that point to the Piripiri Bridge.

Fencing work was proposed along both banks to exclude stock from growing areas. Abandoned river channels were to be blocked off using groynes and banks. Four areas covering 450ha were to be drained.

Works on the Oroua River were proposed to stabilise the channel as far as possible in its position at that time. This would be achieved by thickening up and improving the willow and poplar planting to form a continuous growth 10 m along both banks, particularly on the outsides of bends. The channel was proposed to be 100m wide, and some trees would need to be removed to achieve this. Planting of trees for bank protection was to be carried out as part of the Scheme. These works were proposed to be carried out from the

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3 Gerald Groenendijk was employed by the Catchment Board as a soil conservator during the period of Scheme implementation and was heavily involved in the soil conservation works within the Scheme.

4 Pohangina-Oroua Catchment Control Scheme Review , Scheme Design and Works 1980-1985, prepared in 1979.

5 Pohangina-Oroua Catchment Control Scheme, Soil Conservation 1967-1971, MCB report unpublished. 1971.

6 Pohangina-Oroua Catchment Control Scheme, Soil Conservation. A review of the first 10 years of operation. MCB report unpublished. 1977.

confluence with the Kiwitea Stream to the London's Ford at 25 Mile. Lighter work was proposed above that point to the Apiti Bridge.

Four areas covering 250ha were to be drained.

Note only one large area is currently drained.

3. Geology (as per the 2001 report)

The headwaters of the Pohangina and Oroua Rivers lie in the Ruahine Range. This Range is made up of highly fractured and deeply weathered greywacke (alternating siltstone and sandstone) that has been eroded into very steep land of ridges and valleys. Away from the range the rivers flow within entrenched valleys, cut deeply into synclinal folds in old uplifted peneplains (of marine deposits). The faults of the uplifted Ruahine Range and the syncline/anticline folding have a north-east trend. The uplifted peneplains are tilted, and the deep entrenchments expose, in places, thick deposits of coarse poorly-consolidated sands, along with layers of pumice and greywacke derived gravels. Severe gully erosion occurs where these coarse sand deposits are exposed.

The primary supplies of river channel bed material are gravel from the rangeland greywacke and sand from the exposed sand deposits of the peneplains. There is a relatively low input of gravel from the Oroua River headwaters, with the Pohangina River having a more eroded headwater, and many tributaries coming from the range land along its course. On the other hand, there is a much more substantial input of sand to the Oroua River than to the Pohangina River.

4. Hydrology (as per the 2001 report)

There is a steep rainfall gradient from the peneplains up into the Ruahine Range, and the orographic influence of the range is stronger the more intense the storm. Most floods occur in autumn and winter, from about May to September, when monthly average discharges are high. However, intense short-duration storms can occur from January to March.

The flood flows of the Pohangina are relatively higher (per unit of catchment area) than the Oroua, and while rainfall patterns generally affect the river catchments in a similar way, the relative magnitude of flood flows down the two rivers can be significantly different.

Flood flows follow complex patterns, with an interspersing of quiescent and stormy periods. The available records, since the 1940s, show periods of greater flood intensity around 1948-50, 1965-67, 1970-72, around 1975, 1979-81, 1988 and recently from 1999. There was also a single large flood event in 1992, and another significant one in 1985.

Appendix B sets out the historical flood pattern for the two rivers.

5. Sediment Transport and Gravel Extraction (as per the 2001 report)

5.1 Sediment Transport

The channel material of the Pohangina River is mainly gravel derived from the Ranges, and re-worked down the channel. The material moves down in a complex pulsing way, with continual channel change of both bed and banks. The cross-section surveys carried out over recent decades show little in the way of overall trends, with perhaps some slight degradation along the lower reaches. Localised variations occur, especially at natural controls on the channel migration, and at artificial constrictions, such as bridges.

There is a relatively lower input of gravel to the Oroua River, and the available cross-section data shows some overall degradation trend up to Te Awa. This degradation has increased the undercutting of banks, with an associated trend towards more asymmetric sections at bends. At the same time, there has been a compensating silting along the channel banks, especially within the willow edge vegetation.

The degradation trend is probably a response to channel confinement, and except in very localised areas is not due to the extraction of gravel bed material, which has not been excessive.

The large inputs of sand to the Oroua River, which have occurred along the areas of exposed sand deposits, have affected the channel form downstream. The erosion of bank material along this river gives rise to relatively high suspended silt loads.

5.2 Gravel Extraction

The Pohangina River is a primary source of gravel for the Lower Manawatu River. The lower part of the Pohangina River, downstream of the Saddle Road Bridge and at the confluence are, or have been, sites of significant gravel extraction. Gravel accumulates at these sites which are accessible and in reasonable proximity to their end use.

There are a variety of potential adverse effects associated with over-extraction from these sites, including:

- destabilisation of bridge sites;
- damage to scheme works; and
- starvation of the Lower Manawatu River of gravel.

Several attempts have been made to assess gravel transport rates and volumes for the Pohangina River including:

- channel efficiency surveys of the entire river carried out in the 1970s and in the early 1990s;

- gravel monitoring between Totara Reserve and Komako during the late 1970s and early 1880s;

- gravel monitoring in the vicinity of the Saddle Road Bridge during the mid to late 1980s;

- basic monitoring surveys of the confluence area at various times.

From these surveys and monitoring, annual bed load transport rates have been estimated to be:

- from the channel efficiency surveys, c 20,000 m^3

- from the Totara Reserve monitoring reach, c 18,000 m^3

Because of the potential for over-extraction from the Pohangina River and its impact on the Lower Manawatu gravel resource, a maximum annual extraction volume of 25,000 m^3 was set for the Pohangina River in the Regional Beds of Rivers, Lakes and Associated Activities Plan.

The setting of a volume for the river does not provide any guidance on how the available resource should be allocated, nor where extraction should cease / be encouraged along the River. There is concern that most of the extraction would be concentrated in the reach between the Saddle Road Bridge and the confluence.

To ensure that this does not occur the future granting of gravel extraction consents will be managed to ensure that:

- extraction volumes from this reach will be restricted and extractors encouraged to find alternative sites on the Pohangina River; and

- extraction from berm and island areas be encouraged (as opposed to active river extraction).

6. Channel Shape (as per the 2001 report)

The rivers are relatively steep gravel-carrying rivers, with varying channel form depending on variations in sediment loading and riverside vegetation. The channel form can vary over both space and time, from a single thread meandering form, to semi-braided or a split channel form with quite long relatively straight reaches. Thus, as the intensity of floods vary and the gravel bed material moves down the river channel in pulses, the channel form changes. During quiescent periods and where there is a relative deficit of gravel bed material, the river channel will develop a well-defined meander with a single thread form. During periods of more intense floods and where there is a relative accumulation of gravel bed material, the river channel will develop a semi-braided form, or if there is confining edge vegetation, the river will respond by breaking out and forming long parallel channels around the vegetation. This breaking out and development of long split channels is called ana-branching, to give what is called a anatomising channel form. This form is common along rivers where the spread of tall tree vegetation confines or restricts flood flows, and disrupts the normal channel form adjustments.

The channel reaches that are semi-braiding, single thread meandering or straight, vary along the rivers, although a particular form can predominate along a given reach due to the presence of natural control features, such as bluffs, or artificial constrictions such as bridges. In general, river management should allow for the development of the full range of likely channel forms all the way along the rivers.

There are different meander forms that are used by the rivers to make up the different overall channel patterns, and the size and shape of these meanders can be determined from empirically derived relationships as well as from a study of aerial photography. The flood pattern of the rivers is reasonably well known from the hydrological records, and the size of the bed material has been assessed from samples taken along the rivers. Some general information on river grades is given in the 1979 Scheme Review, based on cross-section survey data. Using this information on channel slopes, bed material sizes and dominant flood flows, the widths of the various meander channels (in metres) have been assessed. These are set out in Table 1.

Table 1: Pohangina River and Oroua River Meander Widths

Meander Type	Oroua	Pohangina
Minor threshold of motion meander (Smallest well formed meander)	20m	30m
Major threshold of motion meander (Longer slope adjusting meander)	35m	60m
Live bed flow dominant meander (Overall active width meander)	65m	110m

These widths are quite consistent along the managed reaches of the rivers, despite changes in bed material size and channel grade.

The threshold of motion meanders tend to oscillate from one form to the other down the river, with a continuous meandering starting from control points, such as bluffs, break-outs, bed accumulations etc, or artificial controls of managed vegetation or structures. The overall flow dominant meander is less well-defined in these gravel bed rivers, but is the general form within which single threads or semi-braiding patterns form.

7. Scheme & River Responses (as per the 2001 report)

The channels of the Pohangina and Oroua rivers have been confined by farm development and river works over a long period of time, prior to the Scheme, as well as by Scheme management. There have been on-going attempts to suppress the semi-braiding response of the river, and following break-outs, to re-instate the single thread channel. Thus, following the larger flood events when the river responds to its confinement by widening and/or breaking out, river management has re-imposed a narrow single thread channel form. This form will persist naturally, with a relatively low level of management, during quiescent periods and along reaches of relative bed material deficit. Difficulties arise as an aggradation phase moves into a reach, while the reinstated protection works are again destroyed when the next period of intense floods occurs.

Overlays of the river channels, taken from the 1985, 1992 and 2000 aerial photography, indicate little overall change in the position and form of the rivers. This similarity over time is however mainly due to the continual management of the rivers. The original legal surveys of the channel of the two rivers show how far the existing general river alignment has been displaced from the position it was in when these early surveys were undertaken.

The Pohangina River, for obvious reasons, is more braided than the Oroua River, and along this river there are reaches that have remained more braided. This would be partly due to the level of management exercised, given prevailing river conditions along a reach, and partly due to natural differences, because of valley slope adjustments, bluff controls etc.

The Oroua River has been more confined and managed by vegetation, and where there is semi-braiding it is less intense than on the Pohangina River. The Oroua is more easily constrained by vegetation, but responds by entrenching, and can develop deep asymmetric sections at over-tight bends.

There is a general tendency for bank erosion to occur where the river channel is narrow and of restricted amplitude, and where over-tight bends have developed due to either natural controls or because of the partial restraint of edge vegetation. However, whether bank erosion is of concern depends on the prevailing condition of the river (semi-braided or single thread) and the level of management being exercised.

8. Hazard Areas (as per the 2001 report)

The areas of hazard from bank erosion, channel break-outs and flooding are, in general terms, well defined by the terrace system within which the rivers flow. There is a major entrenchment due to the down cutting into the old marine surfaces, with high terraces being formed along both sides of the rivers. Within this major entrenchment there is some more complex terracing, and on the valley floor there is some minor terracing from recent channel migration and re-working of the valley deposits.

The overall risk area can be readily identified from aerial photography, using stereo pairs to observe relief. The finer detailing of the hazards is more difficult to achieve, although some recognition can be given to the minor terracing on the valley floor.

The higher risk areas have then been defined from the aerial photography, without field checking, to give a general risk identification, without any specific division into risks from flooding, channel break-outs and bank erosion. Any activities within these identified areas should then be assessed in terms of the likely risks from these hazards.

The risk to the assets on the valley floor including productive farmland, roads, bridges and farm access has been taken into consideration when prioritising the proposed future works described in Section 12 and 13.

9. Scheme Effectiveness to Date (as per the 2001 report)

Comparing the outcomes of implementing the Scheme over the past 34 years with what was planned to be achieved when the original Scheme Plan was prepared in 1964, will provide not only an appreciation of the success of works carried out to date but also a guide as to what should be continued and what could be changed to ensure the Scheme meets the needs of present and future ratepayers.

The principle objectives of the Scheme were:

- to control and prevent erosion in the catchment area and to achieve maximum economic production taking a long term view; and

- to stabilize the Pohangina River and Oroua River channels as nearly as possible in their position at that time and to carry out work to stabilise the larger tributaries.

The works in the Scheme have been divided into two distinct activities managed quite separately for a number of years. These are the soil conservation activities that had a high profile in the early years and the river control activities where nearly all the recent focus has been. This shift in focus has been seen by some as the Scheme neglecting its soil conservation responsibilities, but the proven success of the soil conservation works and the ongoing need for river control works justifies this shift.

9.1 Soil Conservation Activities

The original Scheme divided the soil conservation works into two categories: farm benefits and community benefits.

The farm benefit work has been carried out through the development of soil conservation farm plans and has been funded by direct landowner contribution and subsidised initially as "Board Work" and more recently as part of the **Horizons Regional Council's** Soil Conservation Environmental Grant Scheme. A large number of Soil Conservation Farm Plans have been prepared for the Scheme area.

Soil conservation works providing a community benefit have involved the control of active erosion in the Castlecliffian sand formations, the storage of erosion products; and the prevention of gully development. The majority of this work has been funded by the Scheme.

The principal focus of the Community Benefit work has been on the stabilisation of the Goulters/Belmont Sand Gullies and other gullies draining to the Pohangina River where gully erosion was occurring in the unconsolidated sand formations. Other work that has provided community benefit involved the stabilisation of the streams that feed to the Pohangina River from both the steep unstable hill country to the west of the Pohangina and from the foothills below the Ruahines to the east.

Goulters Gully Area

Land clearance for farming, the breakdown of the root material after 30 to 40 years and two intensive storms in quick succession in 1936 caused severe gully erosion that cut through three properties and rendered nearly 200 hectares useless in the area now known as the Goulters Gullies.

One hundred hectares of the gullies were placed in the control of the Manawatu Catchment Board in 1958 and remedial work was carried out on both Board and Private land. Willow and poplar planting was carried out along with the construction of detention dams and drop structures.

Fencing was carried out to keep stock out of the gullies where the nature of the gullies enabled stock to enter. Further fencing was carried out as the gully floor stabilised and the gully sides battered off giving access to stock.

Many of the early gully control structures failed as their foundations were undermined and these were not replaced. One of these structures has survived as it is surrounded by heavy planting. Any further grade control structures will only work when combined with heavy planting.

Major work carried out as part of the Scheme, to productively utilise the Scheme owned land and to control run-off, involved the planting of more than 40 hectares of Pinus Radiata forestry, the most recent completed in 1994 to overcome problems in Face Gully. The planting of pine trees has significantly reduced the run-off into the gullies at their heads and the gully control structures referred to above have not been replaced, as there is no longer a need for them.

Care will need to be taken when the trees are harvested to ensure that run-off does not start a new phase of gully erosion.

The majority of these forestry assets are now mature and plans to harvest them are currently being prepared. Refer to Section 14 on the Goulters Gully Forestry.

Following the stabilisation of the base of the gullies and the resulting stabilisation of the gully sides, natural revegetation has occurred on the more shaded sides of the gullies. The exposed sunny gully sides are still fairly bare and wind and rain are now the main erosion elements. This erosion is however very slow and not of great concern to the Horizons Regional Council staff who manage the gullies. The success of the erosion control work can be measured by the fact that no works have been required in these gullies since 1994 other than the control of animals.

Details of the soil conservation work carried out up to 1979 are set out in the 1979 Review by E C O'Connor and G G Brougham[7] and in the two reports by Groenendijk 1971[8] and 1977[9]. Copies of the two unpublished reports are included in Appendix C.

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7 Pohangina-Oroua Catchment Control Scheme Review , Scheme Design and Works 1980-1985, prepared in 1979.

8 Pohangina –Oroua Catchment Control Scheme, Soil Conservation 1967-1971, MCB report unpublished. 1971.

9.2 River Control Activities

The 1964 Scheme proposed to stabilise the Pohangina and Oroua Rivers as nearly as possible in the alignments that existed at that time, by carrying out tree bank protection and tree planting works to form a continuous band of willows along both banks of both rivers. Prior to the Scheme, protection works had been carried out by landowners over fairly long lengths of river and some farmers had attempted to get ahead of the river by planting up banks which could be attacked in the future.

Pohangina River Channel Geometry

The Scheme proposed that the Pohangina River channel be 120m wide between 10m wide bands of willow growth and that the channel be kept clear of weeds, logs and other trees. It was proposed that the entire length of both banks be fenced to exclude all stock. Existing stopbanks were to be maintained, and some abandoned river channels, which still carried floodwater, were to be closed off.

Without carrying out extensive time-consuming research into past reports, it is not possible to readily determine what works were actually carried out in the early stages of the Scheme. However it can be seen from the series of aerial photographs taken in 1950, 1971 and 2000 set out in Figure 3 that the principle objective of the Scheme has been achieved as a result of the works.

These photographs show that the river no longer has a wide braided bed and below the Totara Reserve it has been transformed into a relatively narrow single thread channel, similar, in some extent, to the river around the time of the early European settlement in the mid 1800s. In 1859, the Surveyor J T Stewart described the Pohangina River as having a narrow (140m wide) channel meandering between heavily vegetated banks. Above the Totara Reserve the river is now much narrower than it was prior to the Scheme but is still generally much wider than the river below the Reserve.

Even where the river has been narrowed up, a number of significant factors exist today that did not exist in the mid 1800s which contribute to the need for the ongoing high levels of expenditure to maintain the channel in its existing alignment. These differences include the change from a river flowing between heavily vegetated river banks to a river edged with a relatively narrow band of willows, and large vegetated gravel beaches that form and confine the river into a deep channel on the outside of the bends.

It can be seen from Figure 4 that as the channel has been narrowed up over the past 30 years, the flood damage sustained has increased significantly for the same sized flood events.

It should be noted that the 1999 flood damage is very high because of the change in the type and extent of repair work that has been carried out to repair the flood damage that occurred in two significant flood events in 1999 and 2000.

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[9] Pohangina –Oroua Catchment Control Scheme, Soil Conservation. A review of the first 10 years of operation. MCB report unpublished. 1977.

The 1979 review indicated that the need for the high levels of ongoing maintenance and flood damage repair were possibly due to shortcomings in the original scheme design with respect to channel width, amplitude and radius. This argument is supported by flood damage reports which state that bank erosion persists in reaches with a narrow channel width and restricted amplitude.

Close examinations of the 1964 and 1979 Scheme reports however show that the channel width and radius of curvature recommended in each report were very similar. The only major difference in the two reports was the meander length. The 1979 report recommended a meander length approximately 20% longer than the 1964 figure. The meander length in the Pohangina River however is constrained by the many bluffs and other fixed points on the river. The design analysis carried out as part of this review has identified a very similar channel geometry to that set out in the 1964 and 1979 reports, and it would therefore be reasonable to assume that the persistent erosion was not caused by a shortcoming in the design but instead from a shortcoming in its implementation.

Investigation and design work carried out as part of this review, and design work carried out following the April 2000 flood event[10], identified that the critical factor in ensuring that the Scheme is effective is the need to maintain an effective river channel. That is one with the ability to pass flood flows without concentrating a high proportion of the river's energy into a very narrow band, especially on the outside of a bend.

In simple terms the Scheme has not created a river channel with a width of 120m with 10m bands of willows along each bank. In many areas the channel is much narrower than 120m.

Section 12 sets out the proposed management plan which would ensure that such a channel would be created and maintained.

[10] Extensive flood damage occurred during this flood and it was recognised that more comprehensive design was required. This design work has formed the basis for the recommendations in this review.

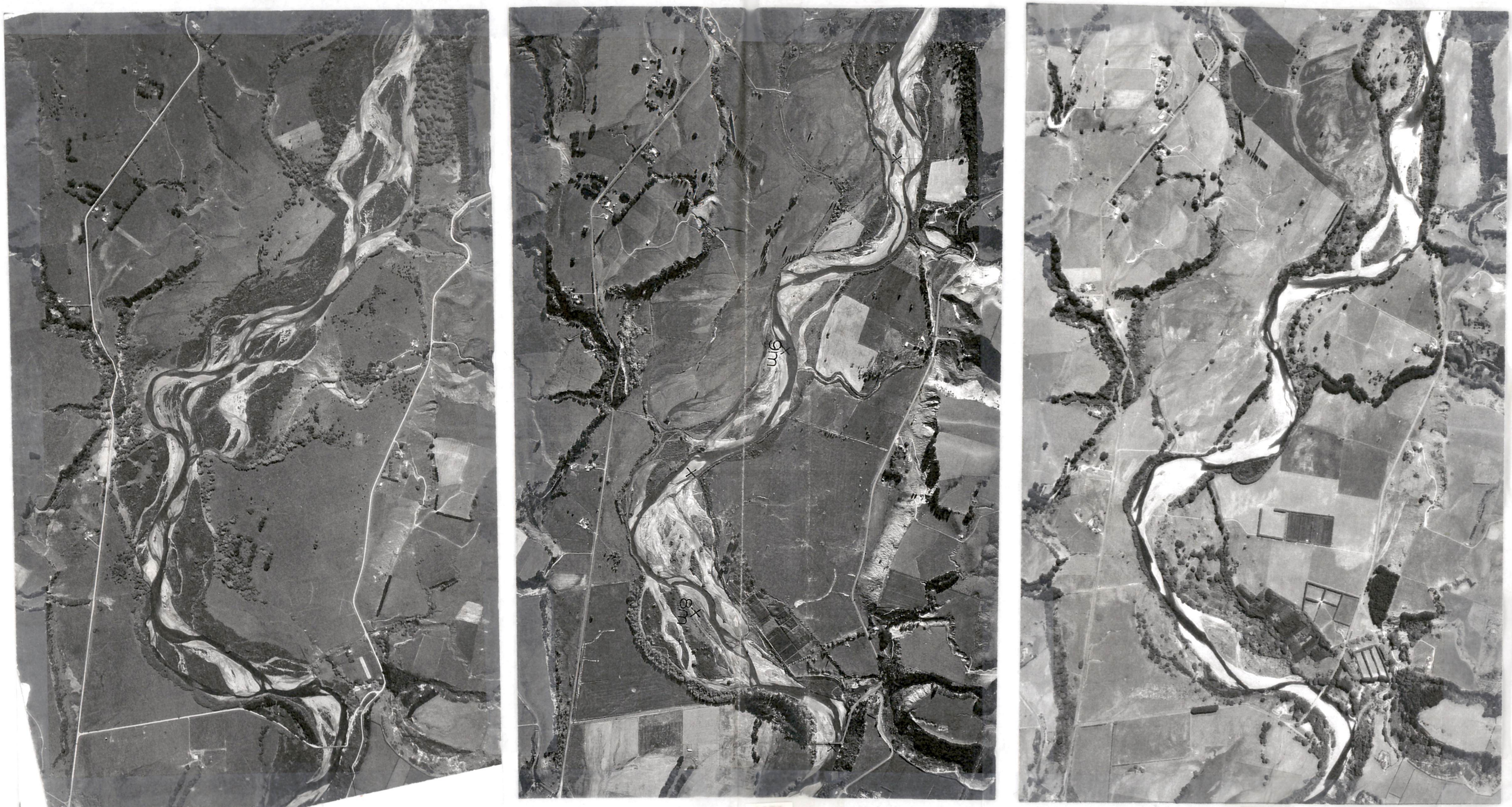
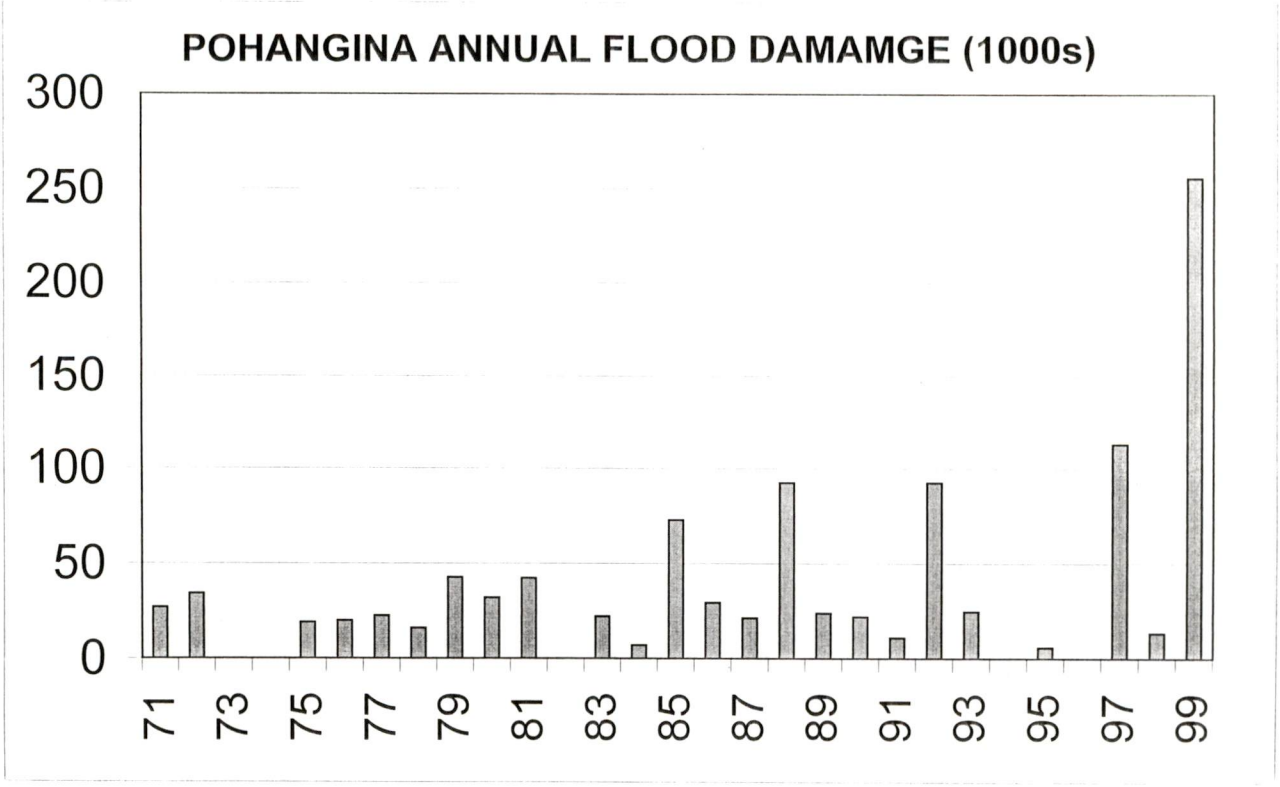


Figure 3. Changes in the Pohangina River Channel Geometry



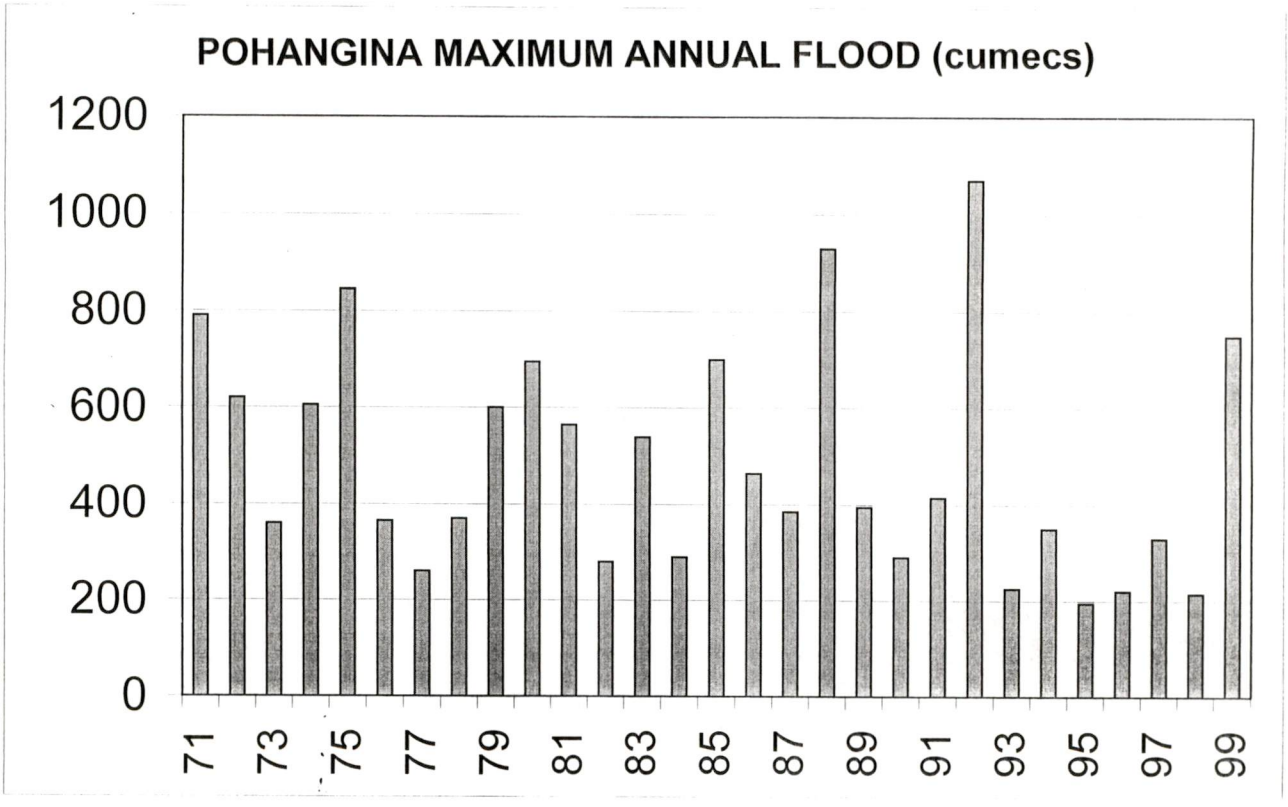


Figure 4. Pohangina River Comparison of Annual Flood Damage and Maximum Annual Flood

Pohangina River Tree Planting

Extensive tree planting has been carried out over the years along the edges of the channel and even though the plan to create 10m bands of willows along both banks has not been fully achieved, there is clearly far more edge protection and willow planting on the Pohangina River than was there prior to the Scheme.

For various reasons however, in many cases the width and robustness of the planting, on the outside of the bends where erosion has frequently occurred, is inadequate.

Until relatively recent times many sections of the river had wide rough willow infested areas adjacent to the channel in addition to the edge protection planting. In many cases these areas were old river bed that had silted up and vegetated. Farming practices however over the last 30 years, and especially in the last 10, have resulted in most of these areas being cleared to enable the land to be utilised for production.

The net results of this land clearance have been: to remove a tree resource for protection works; to remove a line of defence that existed should the river breach the line of the protection work; and to remove an area that filtered flood debris from the flood flows thus reducing the debris deposits on the productive pasture.

The need for increased production to maintain farming profitability has also made landowners less willing to give up land to accommodate the 10m band of riparian planting.

The Closing Off of Old Pohangina River Channels

By comparing the aerial photographs of 1968, 1971, 1980, 1985, 1992 and 2000 it was easy to see that the 1964 goal to close off old river channels was not really achieved until the early 1980s. The 1985 photographs show a significant reduction in the number of overflow channels and a much more confined single thread channel was definitely evident by 1992.

Oroua River Channel Geometry

The Scheme proposed that the Oroua River channel be 100m wide between 10m metre wide bands of willow growth particularly on the outer side of bends. It was also proposed that the entire river from the confluence with the Kiwitea Stream to the Apiti Bridge be fenced to exclude all stock.

Extensive willow planting was carried out by landowners prior to the Scheme and large areas of rough, undeveloped and heavily willow-infested berm land outside this planting has been progressively cleared over the years with a noticeable increase in this clearance work quite recently.

Because of this extensive planting, the Oroua River channel at the time the Scheme was established was narrower than the design channel width over much of its length. The Catchment Board's Chief Engineer, Paul Evans, set the

design width at 100m (5 chain) and recognised that some willow growth would need to be removed to achieve this width.

As with the Pohangina River, without carrying out extensive time-consuming research into past reports, it is not possible to readily determine what works were actually carried out in the early stages of the Scheme. However it can be seen from the series of aerial photographs taken in 1950, 1971, and 2000 set out in Figure 6 that the river was narrowed up and confined between 1950 and 1971 especially in the lower reaches. It can also be seen from these photographs that the early control works carried out prior to the Scheme, and then by the Scheme, have prevented major channel changes since 1971 in this particular reach. This is reasonably typical throughout the river.

In 1971 approximately 40% of the river had a fairway width of 60m (the new design width, refer to Table 3 in section 11.5). Since that date the channel has been further confined into a single thread channel and by 1992 only approximately 30% of the river was at the design width. The only significant alignment changes have occurred from meander migration.

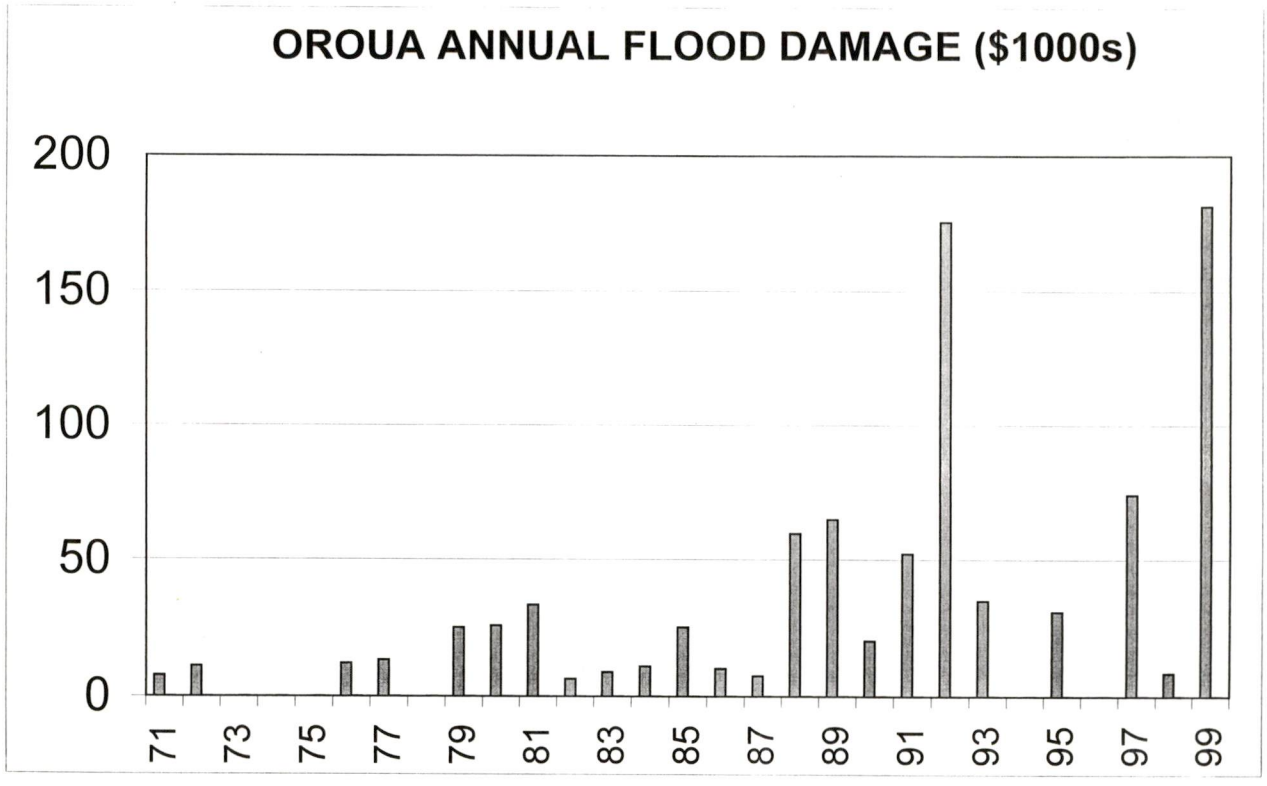
With the exception of some small sections of willow clearance very little proactive channel widening has been carried out in an attempt to create a river that meets the original design.

The Oroua River in its present form is not able to easily move the alluvial deposits it flows through and the channel meanders are constantly being distorted and deflected. The meanders are thus less well formed than in the Pohangina River with the meander pattern constantly being restarted from bend distortions and areas of harder materials. This prevents major changes to the meander pattern occurring, which to some extent limits the ability of the channel to widen itself naturally over time.

An examination of the annual flood damage sustained by the Scheme between 1971 and 1999 shows that during the period from 1971 to about 1988 there was a very low level of flood damage repair work carried out compared to the period 1989 to 1999. Refer Table 2 below.

Table 2: Flood Damage Repair Costs, Oroua River 1971 to 1999

Period	Oroua River Flood Damage Repair Costs	% of Total
Whole period from 1971 to 1999	$630,000	100%
1971 to 1988 (18 years)	$133,000	21%
1989 to 1999 (11 years)	$479,000	79%



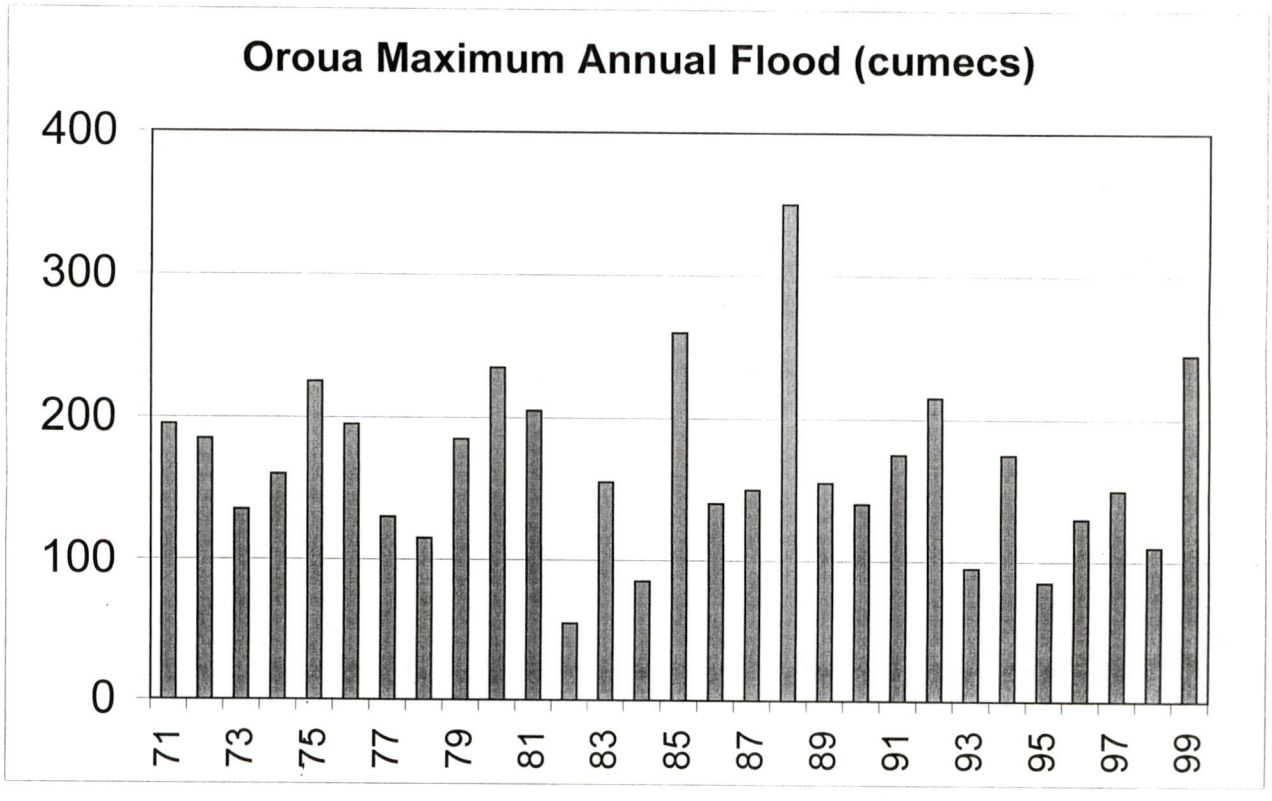


Figure 5. Oroua River Comparison of Annual Flood Damage and Maximum Annual Flood

1950

1971

2000

Figure 6. Changes in the Oroua River Channel Geometry

Figure 6 enables the comparison of flood damage and maximum annual flood flows over this period. It is reasonable to conclude that the narrow channel width was reasonably sustainable during the period when there were no significant flood events. This narrow channel however has not been adequate to carry the large floods that occurred between 1988 and 1992 and the channel widened out considerably in places during those and subsequent events.

Extensive protection works have been carried out in the last 10 years to maintain this channel and provide a degree of stability to the channel now that it has widened out. It is important to note however that during the period 1971 to 1999, the flood damage which occurred did so where the channel was narrow, and the sections of the river where flood damage has been very light are areas where the channel is close to the design width.

It is interesting to note that the annual average flood damage for the 12 years since 19988-89 has been almost six times greater than for the period of 18 years prior to that. It may be reasonable to assume that if the Scheme plan had been implemented and the channel proactively widened, the channel would have been able to handle the floods during the 1988 to 1992 period and the expenditure over the past few years could have been significantly smaller than what actually occurred.

This may however be over-simplifying the situation. The intensity of farming has resulted in landowners being more aware of the impacts of erosion on their properties and has as a result demanded a greater level of expenditure on erosion repairs. Whilst this has probably contributed to the increase in expenditure, a wider channel more capable of passing the floods without placing undue pressure on the bank protection works would have reduced the level of flood damage.

9.3 Scheme Stopbanks

The 1964 Scheme plan proposed that the stopbanks that existed at the time the Scheme was established would be maintained. These are primarily in place to control overflows during moderate flood events and were not put in place to prevent flooding during large events. The Scheme has carried out maintenance of a number of these stopbanks over the years and some have even been replaced when severe erosion of the river bank has scoured them away. The cost of maintaining these banks is very low and this work should continue. Any new classification however should consider the beneficiaries and establish a system to ensure that those who benefit should fund the cost of their maintenance.

Some stopbanks have been built by landowners since 1964 but these are not considered to be scheme assets and have not been maintained by the Scheme.

The Scheme stopbanks are shown on figures 9 and 11.

9.4 Scheme Drains

Four areas in the Pohangina Valley and four areas in the Oroua Valley covering 450ha and 250ha respectively were planned to be drained in the original scheme proposal.

Drainage works have been carried out in four areas in the Pohangina Valley but only one area in the Oroua Valley. Only one area in the Oroua has been rated for drainage.

The Scheme maintains 15.4km of drains to service these areas on an as-required basis. Maintenance is generally carried out once per year. Refer to Section 15 – Drainage.

10. River Design Principles (as per the 2001 report)

Management of the rivers will be more effective, and less costly overall (taking account of both farming costs and river management costs) when account is taken of the natural processes of the rivers, and the way in which they respond over time to natural variations and to imposed management changes. Vegetation management should consider the natural spread of vegetation and the way in which the channel form will alter depending on the nature and extent of edge vegetation.

There are specific meander shapes that the rivers naturally follow, and these shapes can be used to guide bank protection and river training works. Thus when repairing protection works at bends, the re-established works can be laid out to fit in with the width, radius and amplitude of the natural meanders.

Continuous protection works around the full length of a bend, to the curvature of a natural meander, will be more effective than works that only repair the gap, do not fit in with upstream and downstream conditions, and are not well aligned.

The threshold of motion meander shapes can be used to lay out and align bank protection works and vegetation buffer zones. However, the longer and wider meander of the flow dominant form should be considered as well, as this provides some guidance on the nature and spread of the semi-braiding response during periods of more intense river activity.

The width of the natural meanders can also be used as a guide to the thickness of vegetation buffer zones, as the size of erosion embayments is related to these meander shapes.

A more comprehensive management of the rivers does not necessarily mean heavier protection works, or the use of rock structures instead of vegetation works. Vegetation management, with some strengthening in places, using anchor weights or driven piles and cabling (in different arrangements) is likely to be the only practical approach, except at major structures, such as bridges and road formations. The effectiveness of vegetation works can, though, be greatly increased by:

- carrying out more extensive works at one time;
- aligning the works to the natural meander shapes;
- allowing for channel migration and widening within the managed channel;
- having a continuous on-going programme of buffer zone establishment and extension (by planting and layering trees, fencing off from stock etc);
- responding quickly to damage to protection measures, to maintain edge consistency as much as practical; and
- carrying out channel clearing, channel shaping, beach raking, gravel extraction, the management of invasive shrubs and trees etc – to allow channel migration and form adjustments to occur with least distortion from spreading vegetation and gravel accumulations.

11. River Design Application (Reformatted 2006)

The design principles have been applied to the Pohangina and Oroua rivers to draw up design channels and buffer zone areas to guide management of the rivers. The meander form used has depended on the natural conditions of a given reach, the effects of past management and the assets at risk. The rivers can express different forms depending on the prevailing conditions, and as conditions change the channel form will change.

Thus the design channels have been adapted to fit the prevailing conditions, with a minimum of alteration, by using different forms and applying the meander pattern (of width, amplitude and wave-length) to the existing river channel. The natural meander forms are clearly evident in the river meanders, and in general a design meander pattern can be fitted to the existing channel. However, as river conditions change over time, the form of the river changes. There can also be sudden changes in form.

The Pohangina River is a powerful enough river to actively move its bed material and erode its banks, and relatively consistent and well-formed meander patterns form along the river. The Oroua River is less able to move the alluvial materials it flows through, and the channel meanders are constantly being distorted and deflected. The channel meanders are then less well-formed, and the meander pattern is constantly being re-started, from bend distortions and areas of harder materials.

In preparing the future design alignment and works programme for the Pohangina River, three meander forms have been used.

11.1 The Threshold of Motion Meander

Where the river has formed a single channel, and is being relatively tightly managed, then the smallest design channel, based on the threshold of motion meander form, has been applied. This gives a well-defined channel that meanders consistently (of similar meander amplitude and wavelength). This design channel is lined by a constant width buffer zone around the outer (erosion) side. The well-defined channel will still migrate downstream, and some allowance has been made for this natural movement in the definition of the channel and buffer zone areas.

This design channel requires the highest level of management, as a particular channel position (of many possible channel positions) is being maintained. Downstream migration will continue to occur, and an important part of river management under this regime will be to minimise the generation of distortions, by considering what is happening along a series of bends, and the downstream response from management interventions at a given bend.

11.2 The Flow Dominant Meander – type 1

Where there is a less defined and more mobile main channel within a wider channel area, then a wider design channel has been applied, based on the flow dominant meander width. This channel width provides sufficient space for the active main flow channels to migrate, with a constant width buffer zone along the overall line of channel movement. The buffer zones on each side contain

the channel meanders, but come under less pressure because channel migration can occur, albeit within a confined space.

Under this management regime the buffer zones do not have to be repaired so promptly, following erosion damage, so that reinstatement can take place over a period of time. Thus wider buffer zones are used, but repairs are less expensive as more gradual reclamation of eroded areas can be achieved using mainly vegetative means. The wider channel is, though, more prone to re-vegetation, especially by vigorous exotic species, and some regular channel clearing would be necessary as part of this approach.

11.3 The Flow Dominant Meander – type 2

Where there is sufficient space available, and the river tends towards a wider semi-braided form, then an even wider design channel, or fairway, can be applied. In this case the fairway is wide enough to allow main flow channel migration with a minimum of restraint, but sufficiently narrow to inhibit channel splitting. The management approach is one of quite frequent but low-level interventions, mainly of channel clearing and re-vegetation of eroded areas within the buffer zones.

Fully implemented, there is still a considerable management cost, although not of heavy protection works. However, a lower level of management is possible, by accepting some channel re-vegetation and less than consistent buffer areas, and in this case without giving rise to much increase in the risk of major break-outs. The channel form is likely to adapt to an ana-branching[11] form, with a relatively low risk of complete break-out beyond the defined river area of channel and buffer zones. For the other design channels explained above, the intensity of management suggested for this option would directly and proportionally increase the risk of channel breakouts.

11.4 Application of these in the Pohangina River

Figure 8 shows samples of the three different meander forms. Tables 5, 6 and 7 describe the works that will be carried out to maintain the river in each form. These are also fully applicable to the Oroua River.

[11] Ana branching is when the main flow forms a new channel away from the existing main channel and shortcuts quite a long section of the main channel.

11.5 Summary of Design Parameters

Tables 3 and 4 summarise the design parameters determined for the Pohangina and Oroua Rivers respectively.

Table 3: Pohangina River Design Parameters

Meander Form	Channel width	Fairway width	Radius of Curvature	Buffer Zone Width
The threshold of motion meander form	60m	110m	240m to 360m	30m [12]
The Flow Dominant Meander – type 1	na	110m	na	30m
The Flow Dominant Meander – type 2	na	180m	na	50m

Table 4: Oroua River Design Parameters

Meander Form	Channel width	Fairway width	Radius of Curvature	Buffer Zone Width
The threshold of motion meander form	35m	65m	140m to 210m	20m
The Flow Dominant Meander – type 1	na	65m	na	20m
The Flow Dominant Meander – type 2	na	105m	na	35m

na – not applicable

Table 5: The Threshold of Motion Meander Form

General Description	A tightly controlled meander of radius either 240 (140)m or 360 (210)m and a channel width of 60 (35)m with the outside of the bend protected with live tree bank protection. A clear fairway 110 (65)m wide around the bend will be maintained. A 30 (20)m wide buffer will be planted on the outside of the bend.
1. Bank protection	The bank protection on the outside of the bend must be strong, continuous and extend far enough upstream to above the thalweg crossover point. The downstream extent of the work must be such that the river is guided into the next meander but not so far as to totally restrict meander migration.

[12] The 30 meter buffer width could be reduced to 20 metres for the threshold of motion meander form when the standard of protection work is very high.

2. Outside of curve - bank realignment	Maintaining the protection works on too tight an alignment will increase the chances of failure. If additional effort is to be put into maintaining the integrity of the protection work it will need to be on the design alignment. This will require some existing protection works to be removed but their removal must be seen as an integral part of providing and maintaining the integrity of the works.
3. Buffer strip planting	A continuous 30 (20)m strip of planting is required behind the protection work extending upstream and downstream to above and below the bank protection but tapering out to maintain the channel width. Existing planting will be incorporated into the new planting and layering carried out as required. The planting must be fenced off from stock by the landowner. The 30 (20)m strips of planting may be reduced to 20 (15)m where the riverbank has a long history of being stable and there is a limited potential for it to be attacked by the river in the future.
4. Inside of bend beach clearing	The full 110 (65)m of channel width must be maintained to ensure that floods do not put undue pressure on the protection works. This will involve both the removal of vegetation on a regular but as-required basis and by maintaining the gravel beaches to control their height. The latter will either require the beach to be pushed into the channel or for the beaches to be moved back from the edge of the water. The latter may be carried out by commercial extraction.
5. General fairway maintenance	This will involve maintaining the channel width between bends. Failure to do this will cause an early or late cross over between meanders and will cause an unsatisfactory alignment to form.
6. Allowance for meander migration	Meander migration will occur and it is important when constructing or maintaining protection works that the river's desire for the meanders to migrate downstream is recognised. Failure to do this will increase the risk of over tight bends occurring with the inevitable increase in maintenance costs. It will be important that landowners are made aware of the likelihood of meander migration and its impacts on their assets.

NOTE: The figures in brackets are those for the Oroua River.

Table 6: The Flow Dominant Meander Form – Type 1

General Description	A loosely controlled meander where the channel width provides sufficient space for the active main flow channels to migrate, with a constant width buffer zone along both sides of the overall line of channel movement. A clear fairway width of 110 (65)m will be maintained.
7. Buffer strip planting	A continuous 30 (20)m strip of planting is required along both banks from one end of the reach to the other unless a cliff or other hard natural feature makes the buffer strip unnecessary. Existing planting will be incorporated into the new planting and layering carried out as required When this buffer is damaged during flood events it must be replanted to ensure its effectiveness is maintained. The planting must be fenced off from stock.
8. Fairway maintenance	This work will involve maintaining a clear waterway between the buffer zones. This will involve keeping the fairway clear of vegetation and by preventing the build-up of large gravel deposits that confine the river and place heavy pressure on the protection work on the outside of the bends. The latter is unlikely to occur as long as the fairway width is maintained at 110 (65)m.

Table 7: The Flow Dominant Meander Form – Type 2

General Description	A loosely controlled meander where the channel width is sufficient to enable the river to have a semi-braided form. In this case the fairway is wide enough to allow main flow channel migration with a minimum of restraint, but sufficiently narrow to inhibit channel splitting. A wide buffer along the overall line of channel movement. A reasonably clear fairway width of 180m will be maintained.
9. Buffer strip planting	A continuous 50 (35)m strip of planting is required along both banks from one end of the reach to the other unless a cliff or other hard natural feature makes the buffer strip unnecessary. Existing planting will be incorporated into the new planting and layering carried out as required When this buffer is damaged during flood events it must be replanted to ensure its effectiveness is maintained but not in as high a priority as for type 1 meander forms. The planting must be fenced off from stock by the landowner.
10. Fairway maintenance	This work will involve maintaining a reasonably clear fairway between the buffer zones.

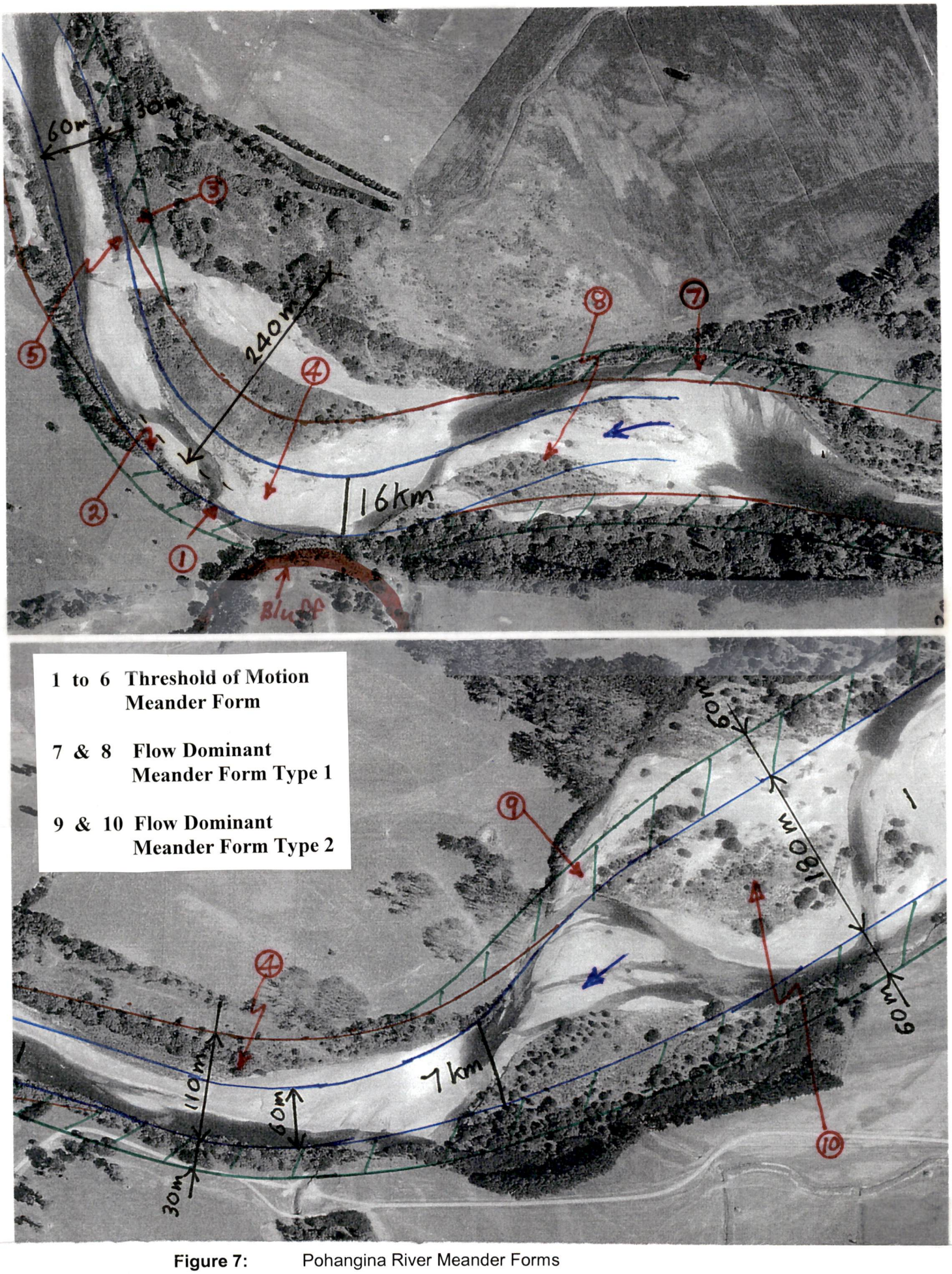


Figure 7: Pohangina River Meander Forms

12. The Pohangina River (Updated 2006)

A detailed design amended since the floods of 2004 has been prepared for the Pohangina River up to the Totara Reserve. All three types of design channels have been applied, in the proportions detailed in Table 8, with transition reaches as required.

For the section of river above the Totara Reserve up to river distance 36km (old river distance 21 Miles) the Flow Dominant Meander predominates. Very little flood damage repair works have been carried out above the Totara Reserve Bridge over the past 30 years, and carrying out a comprehensive programme of works in this reach of the river is probably not cost effective.

The design channels and buffer zones for the river below the Totara Reserve are shown on aerial photographic plans. Refer to Figure 9, sheets 1 to 13. These design alignments should be taken as a strong guide to management, with the approach and intensity of management fitting the requirements of the different channel forms.

Table 8: Meander Forms used for the Pohangina River Design below the Totara Reserve

Meander Form	Length of River
The Threshold of Motion Meander	11.2km
The Flow Dominant Meander – type 1	9.4km
The Flow Dominant Meander – type 2	1.2km

Over time these design channel boundaries will need to be altered, and should be reviewed in response to changing conditions. There is an important time variation in channel conditions. The pattern of floods goes through periods of high intensity and more quiescent times, and resulting changes in river conditions over time, as well as in space along the river, must be taken account of in managing the river.

Prior to the Scheme the river had a wide braided channel and if the "Flow Dominant Meander regime" had been adopted at that time, the cost of managing the river would most likely be far less than it costs today. There would however be approximately 250 ha less land in production.

There is potential for the river above the Totara Reserve to further narrow up as edge vegetation encroaches and gravel beaches vegetate, significantly increasing the amount of bank erosion. It would therefore be prudent to carry out channel management work to maintain the 110m wide channel.

The large flood in the Scheme in 2004 caused considerable damage to the protection works on the Pohangina River and to sites identified as requiring protection or significant upgrading. These assets were insured and as a result repairs and major new works have been carried out which have resulted in extensive works being carried out at almost all of the sites identified in the June 2001 Review.

A complete re-examination of the works required to implement the Scheme design was underway prior to the significant flood event in the Pohangina and Oroua Rivers at the end of April 2006. This very long flood event caused significant new flood damage and as a result a further new programme of works has been prepared for the Pohangina River and the Oroua River.

One of the most significant changes to the river resulting from the flood events is the extent of the large gravel beaches that have built up on the river from its confluence with the Manawatu up to the Totara Reserve. These beaches are confining the river flow with the result that the erosion protection works are coming under significant pressure even during small floods in the river. If the erosion control works are to be effective it is important the flood-carrying capacity of the river is maintained by removing and or relocating these gravel beaches. The cost of managing each of the gravel beaches has been identified and is included in the schedule of works set out in Table 5. Almost 50% of the costs of works on the Pohangina River identified in this re-examination of the Scheme involved gravel beach management.

In the 2001 Review it was identified that there were extensive works required to clear vegetation which has encroached over time on the active river channel and has reduced the ability of the river to effectively carry its flood flows without placing undue pressure on the erosion control works. The need for this work still remains and although some clearing has been carried out, vegetation has continued to encroach on the river channel and reduce the width of the flood fairway. The works required and the cost of clearing the vegetation have been identified and are included in the summary of works set out in Table 9 and the full schedule in table 10.

A further critical component of the Scheme is the planting, strengthening, and maintenance of the vegetation buffers located along 25km (50%) of the Pohangina River bank. The 2001 Review identified in detail the planting and layering work required. Over the life of the Scheme the works on these activities will change and need continual reappraisal to optimise their effectiveness. For this reason, the site-specific detail has been removed from the review but a significant allowance has been made in the budget for planting and layering. This will be required every year on the river to at first establish and strengthen the 30m to 60m wide buffer strips and to undertake layering as required to maintain their effectiveness. The location of the buffer strips are shown on the aerial photographs in Figure 9. The cost of the planting and buffer strip development is included in Table 4.

Table 9: Estimate for Works Required to Implement the Pohangina River Design below the Totara Reserve (2006)

Type of work	Estimated Cost
Works Years 2006-2007 to 2009-2010	
Erosion control works (*Total cost*)	$106,000
Beach removal and management	$295,000
Vegetation removal	$150,200
Planting and layering- Buffer strip development	$72,000
TOTAL	**$623,200**

Fundamental to the success of the Scheme will be that all the proposed works are carried out including the planting, the layering and the channel management work. Failure to carry out protection works on one bend may put the works on the next bend downstream at risk of being out-flanked or damaged due to poor alignment of the flow.

Failure to plant and manage the buffer strips, and maintain the clear fairway will result in ongoing high levels of flood damage with the resultant uncertainty that this brings.

Protection works often fail when high velocity floodwater either breaks out through the protection planting/buffer planting or returns to the river through this planting. Wider buffer strips reduce the velocity of these flood flows with a consequential reduction in damage.

Landowners on whose property the protection works are being constructed will be required to make available a strip of land between 30m and 50m wide on which to plant the buffer strips. In many cases along the river the buffer strips already exists but are narrower than that recommended in the Review. The buffer strip needs to be only 30m or 50m wide in total and not an additional 30m to 50m on top of the existing buffer strip width. Landowners will be required to fence off the buffer strips to exclude all stock.

Where sections of the river bank are non-erodible, planting will not necessarily be required. The final decision on planting requirements lies with the Scheme Manager.

The area directly upstream of the Raumai Bridge should be the responsibility of the Manawatu District Council and the area adjacent to the Saddle Road Bridge and the Natural Gas Pipeline are the responsibility of the owners of those assets.

Prior to the buffer strip planting on the left bank at river distance 20.8km, the stopbank shall be relocated to a new line on the inland side of the planting. The cost of this work will be shared 50:50 between the Scheme and the landowner and all future maintenance will be funded by the landowner.

12.1 Pohangina River Flood Damage

The level of flood damage sustained by the Pohangina River will reduce as a result of the proposed works. It is proposed however, that $10,000 will be set aside annually into a emergency reserve to fund the damage that will inevitably occur during significant flood events. (An additional $15,000 will be set aside for the Oroua River bringing the total to $25,000.)

In the past, during years when only small floods occurred, about $19,000 of flood damage has occurred in the Pohangina River. The amount of the annual damage expenditure will reduce quite quickly as the higher priority protection works are completed and the flood fairway is cleared of vegetation and the build-up of gravel beaches. A sum of $10,000 has been allowed for in the scheme estimate to fund this more regular damage in the future. The $10,000 is budgeted in the annual works budget.

12.2 Pohangina River Works Priority

It is clearly not possible to fund the entire programme in the first year, nor are there sufficient physical resources to carry out the works. The works have therefore been prioritised to ensure that the funds are spent where they will give the greatest scheme benefit. Three factors were considered when determining the priorities. These were:

- the amount of work that has historically been carried out at each site. The information can be obtained from Figure 7;
- the land at risk if the works were not carried out; and
- the potential for the loss of alignment control.

Table 10 sets out the results of the analysis and shows the four-year programme of works required to carry out all the currently identified works.

When future flood damage works are required that exceed the annual funds available within any one year, the works will need to be prioritised using the criteria set out above.

12.3 Design and Priority Flexibility

The programme of works set out in Table 10 appears to be very prescriptive. That is, it sets out what is to be done when and where. It is possible however that flood damage will occur during the first four years of the proposed programme that may require the priorities to be adjusted. If damage occurred for example in year two at a site programmed for works in year three, it would be sensible to carry out the year three programmed work and then rearrange the works programme from then on.

The real difficulty comes when there is a need to carry out works at a number of sites on the programme but where the available funding is insufficient either because the total cost is too high, the year's budget has already been spent, or the emergency reserves are low.

At this point, a number of options are available. These are:

- leave the repair of the damage until the following year and reprioritise the programmed works;
- take out a loan to fund the works and pay it back over say 10 years;
- take out a loan and pay it back as soon as possible by not carrying out any capital works other than the flood damage repair until the loan is repaid;
- take out a loan and pay it back through rating in the following year.

The first option could result in the damage being made worse during subsequent floods. This risk is always there but would be made worse if the repair work was left for an extended period.

The second option would result in less funds being available for the programmed works because capital and interest payments would be required.

The third option may be acceptable but would depend on the sites at which works were carried out and how far through the Scheme was on the programme

of capital works. This option however may delay works at sites that give the highest benefit to the Scheme and make it vulnerable to significant flood damage.

The fourth option would enable the programme to be kept on track but would result in a very uneven and unpredictable rating cash flow for Scheme ratepayers.

When the situation arises where the cost of the damage repair exceeds the funds available, the options, advantages and disadvantages need to be weighed up and put to the liaison committee for consideration.

12.4 Pohangina River through Totara Reserve

When the Scheme was first established in 1966, a local authority contribution was paid to the Scheme in lieu of rates to enable works to be carried out as part of the Scheme on the section of river through the Totara Reserve. The land through the Totara Reserve is non-rateable.

When the Scheme was reviewed and the new rating system prepared in 2002, the Manawatu District Council decided not to continue with this contribution and no works have been carried out as part of the Scheme on that section of the river over the past four years.

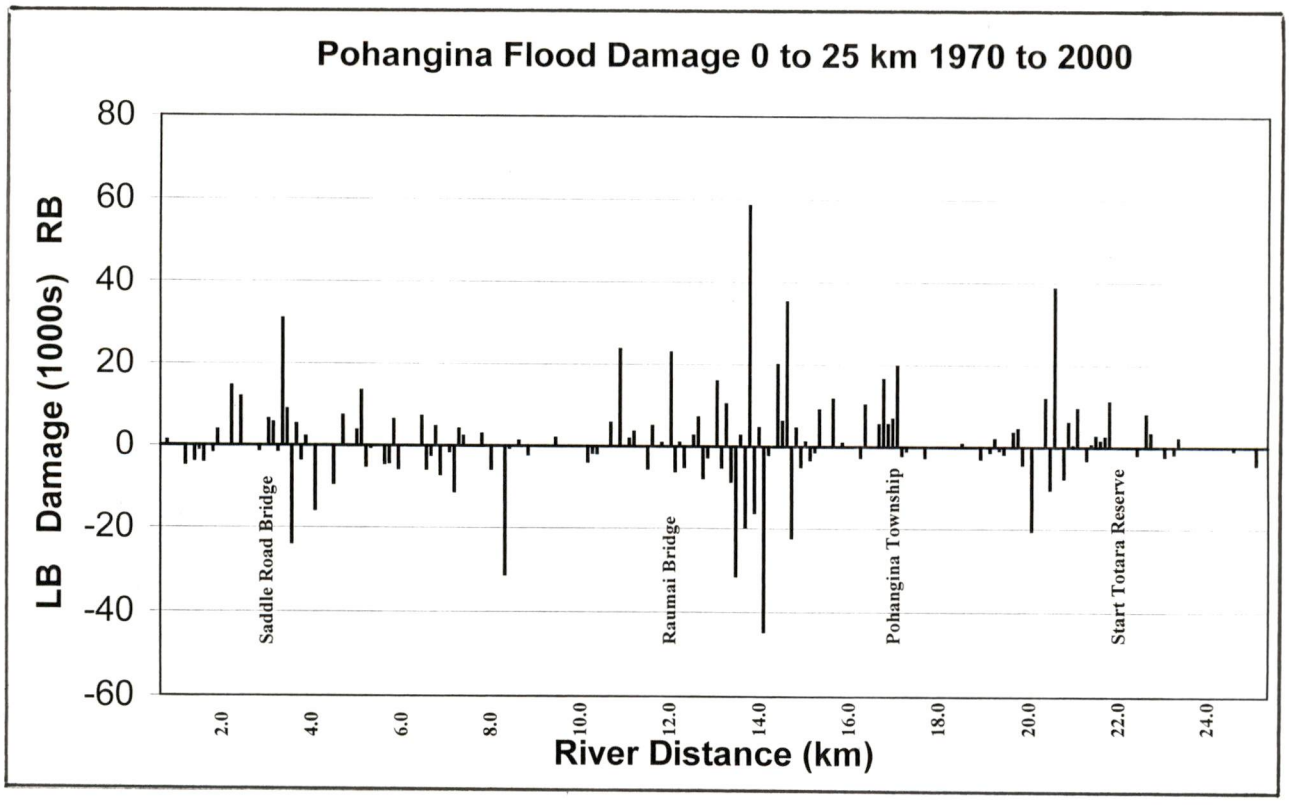
The 2004 flood caused significant damage to the river through the reserve and severe erosion has and is continuing to occur during flood events. This has resulted in the loss of a considerable number of mature native trees that are now lying in the bed of the river causing significant log jambs and erosion as the river flow is deflected towards adjacent riverbanks.

The real potential for these trees to move downstream causing damage to Scheme works is a significant concern to landowners and the Scheme Manager.

A new Regional Park has been proposed in the Council's 2006-16 LTCCP and provision has been made for substantial expenditure on capital works to address the erosion problems and clear the log jambs and flood debris from that section of the river.

It is proposed that works will be funded from the Regional Park funds but will be managed by the Pohangina-Oroua Scheme Manager.

Detail design works will be undertaken on the erosion control works required early in 2006-2007 and a design channel alignment will be prepared and added to sheets 12 and 13 of Figure 9.



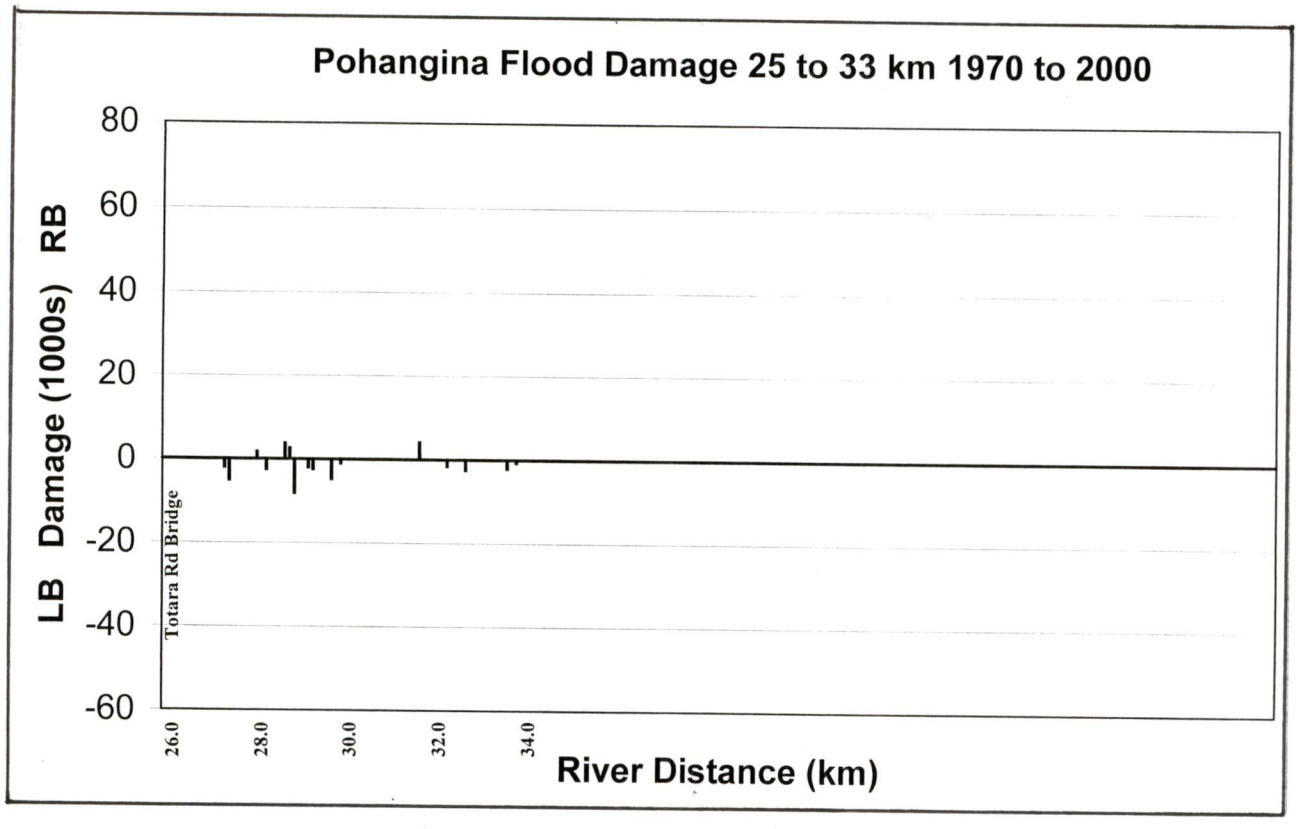


Figure 8: Location of Pohangina River Flood damage 1970 to 2000

Table 10 - Pohangina River - Programme of works 2006/2007 to 2009/2010

River Distance km	Bank	Length or area	Description	vegetation	erosion control	Gravel	land at risk factor	alignment factor	historical damage factor	Erosion Sum of risk	vegetation clear factor	beach factor
6.7	L		Groynes need repair		2000		5	3.5	5	11		
11.4	R	40	Hole in protection works needs protection		6000		5	4	6	12		
14.2	R		Protection needs strengthening		7500		5	5	10	15		
14.6	L		PMU fence needs maintenance		2000		5	5	10	15		
15.2	R		Maintain pmu		3000		5	5	10	15		
18	R		Erosion starting 20 m TBPW		3000		5	4	7	12.5		
20.9	R	40	Tree bank protection - repair		3000		4	3	8	11		
21.3	L		Very large rock groyne required – remove failed PMU first		9000		5	5	7	13.5		
21.9	??		30m TPPW		4500		5	4	7	12.5		
10.1	R	100	Tree bank protection		23000		5	2	2	8		
11.5	L	2 ha	Clear vegetation of inside bend to create flood fairway	6000							4	
13.9	L	2 ha	Clear vegetation of inside bend to create flood fairway	5000							4	
14.6	R	0.5 ha	Clear vegetation of inside bend to create flood fairway	1500							4	
15.2	L	0.5 ha	Clear vegetation of inside bend to create flood fairway	1500							4	
15.3	L	70	Tree bank protection		10,000		4	3	5	9.5		
15.6	R	1.5 ha	Clear vegetation of inside bend to create flood fairway	6000							4	
16.2 to 17.2	C	2.5 ha	Clear vegetation from channel fairway	7000							4	
18	L	1 ha	Very large gravel beach to be extracted			20000						5
21.6	L	0.5 ha	Clear vegetation from channel fairway	2000							4	
21.6	L	1 ha	Very large gravel beach to be extracted			20000						5
22.5	R	1.5 ha	Clear vegetation from channel fairway	5000							4	
23	L	1 ha	Clear vegetation from channel fairway	3000							4	
23.8	CL	0.2 ha	Clear central channel trees	1000							4	
23.4	R		Strengthen top end of protection works		2000		5	3	5	10.5		
4.1	R	0.4 ha	Clear vegetation of inside bend to create flood fairway	1000							3	
5	L	2 ha	Clear vegetation of inside bend to create flood fairway	7000							3	
5.6	R	1.2 ha	Clear vegetation of inside bend to create flood fairway	4000							3	
8.9	R	1 ha	Clear vegetation of inside bend to create flood fairway	2500							3	
10-11	R		Strengthen tree protection		15000		5	2	2	8		
14.5	LR	0.75ha	Clear vegetation of inside bend to create flood fairway	3000							3	
17.3 - 17.8	L	2.5 ha	Large gravel beach needs removing			40000						4
18	L	3 ha	Clear vegetation of inside bend to create flood fairway	10000							3	
19.5	R		TBPW and planting		6000		4	3	3	8.5		
20	R	1.5 ha	Clear vegetation of inside bend to create flood fairway	5000							3	
22	L	2 ha	Large gravel beach needs removing			40000						4
23	L	1.5 ha	Large gravel beach needs removing			30000						4
23.5	R	1 ha	Clear vegetation from channel fairway	3000							3	
1.2	R	250	TBPW and planting		30,000		3	1	1	4.5		
3.3	R	1.2 ha	keep inside bend Clear to maintain flood fairway	4000							2	
3.5	R		Maintenance required of existing protection works		15000		5	2	1	7.5		
5.4	L	1.5 ha	Very large gravel beach to be extracted			30000						3.5
6.2	R		Groynes required to improve alignment		5000		2	2	1	4.5		
6.2	L	1.75 Ha	Clear vegetation of inside bend to create flood fairway	7000							2	
6.7	R	1.5 ha	Clear vegetation of inside bend to create flood fairway	6000							2	
7 to 8	C	6 ha	Clear vegetation from channel fairway and Gravel	25000							2	
9.1	R	1.25 ha	Very large gravel beach to be extracted			25000						3.5
11.5	L	1 ha	Large gravel beach needs removing fine material 30 m TBPW			20000						3.5
12.2	R	1.5 ha	Clear vegetation to create flood fairway	4500							2	
12.8 to 13.5	L	2 ha	Clear vegetation to create flood fairway 2/3 MDC 1/3 P-O 5000	1700							2	
17.3	R	0.75	Clear vegetation of inside bend to create flood fairway	3000							2	
18.7 to 19.7	L	3 ha	Clear vegetation of inside bend to create flood fairway	10000							2	
20.6	R	0.4 ha	Clear vegetation from channel fairway	1500							2	
1.3	L	0.3 ha	Clear vegetation to create 110 m flood fairway	1000							1	
1.8 to 2.8	L	2 ha	Clear left bank tree encroachment on flood fairway	5000							1	
5.6	R	0.25	Large gravel beach to be extracted			5000						3
6.7	R	0.75 ha	Very large gravel beach to be extracted			15000						3
8.3	L	0.8 ha	Clear vegetation of inside bend to create flood fairway	2000							1	
10.1	L		Very large gravel beach needs removal - hydro site			10000						2.5
10 to 11	L R	2 ha	4-5 beaches need removing			40000						3
12.4	L		Debris in channel pushing river flow to rb - should be removed	1000							1	
12.5	R	0.35 ha	Clear vegetation of inside bend to create flood fairway	1000							1	
18.7	R	1.5 ha	Clear vegetation of inside bend to create flood fairway	4000							2.5	

				TOTAL
	150,200	146,000	295,000	
05/06	$0	$40,000	$0	$40,000
06/07	$38,000	$35,000	$40,000	$113,000
07/08	$35,500	$21,000	$110,000	$166,500
08/09	$62,700	$50,000	$75,000	$187,700
09/10	$14,000	$0	$70,000	$84,000

Pohangina River: Figure 9:

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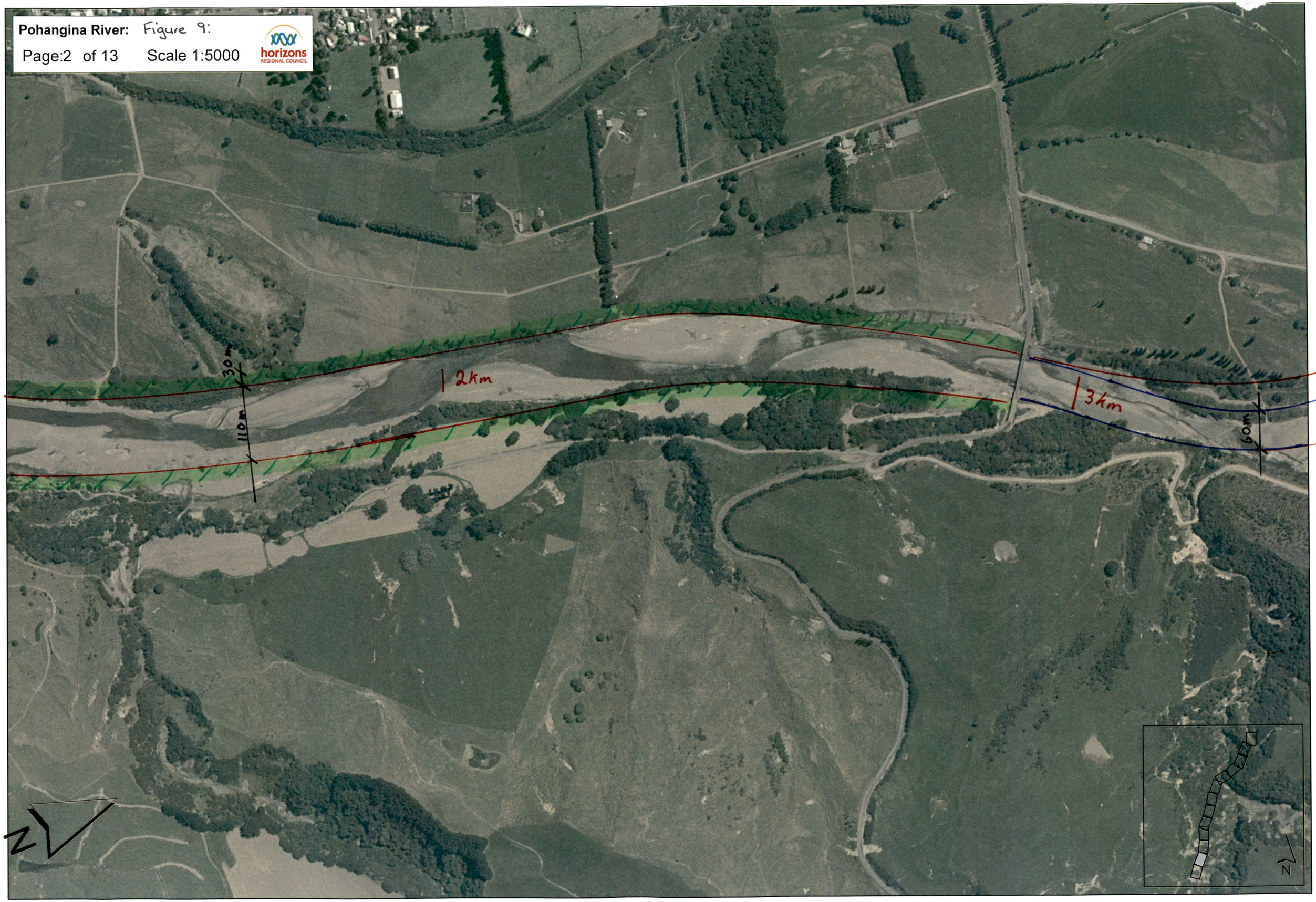

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5km

4km

110m

60m

N

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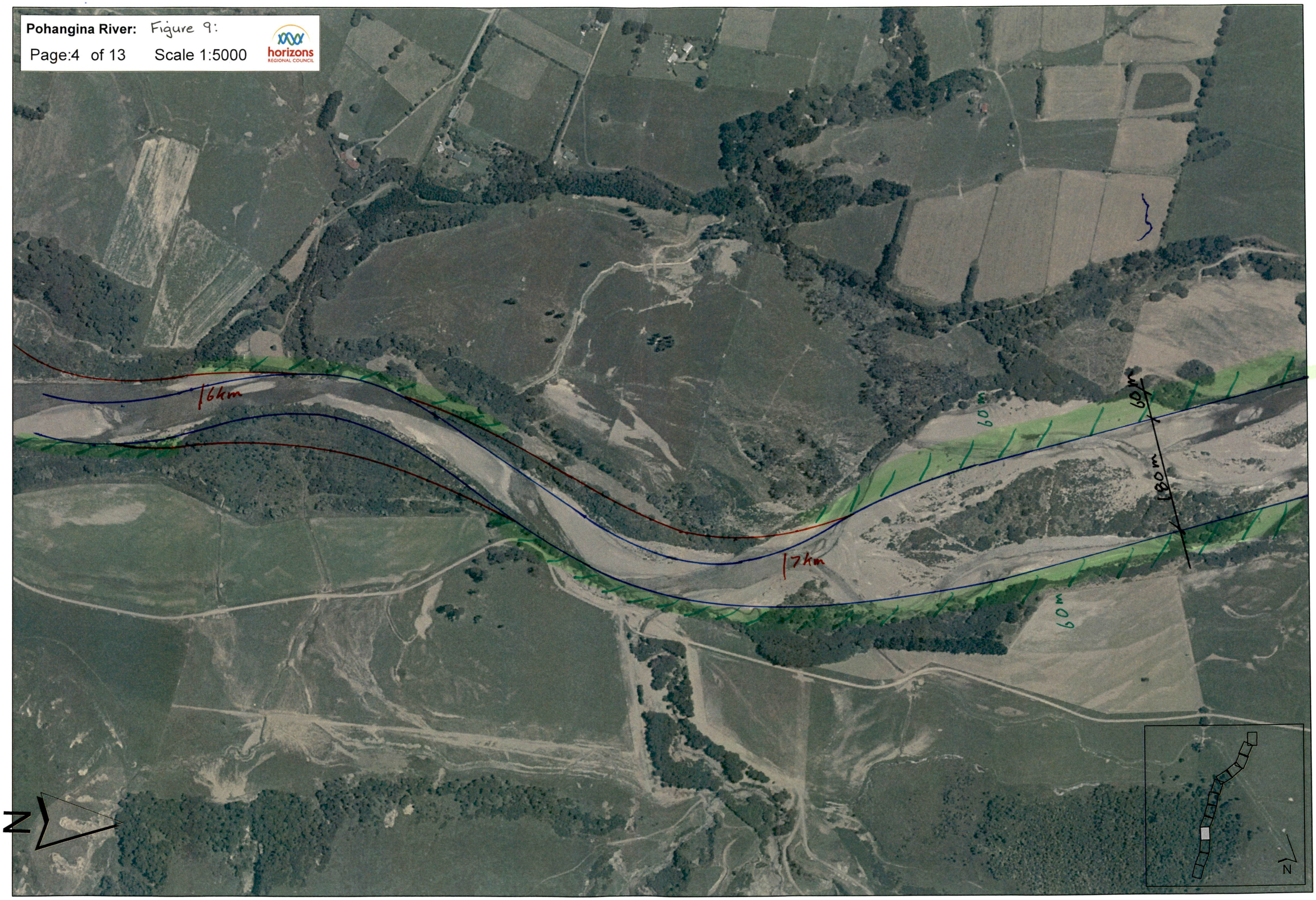

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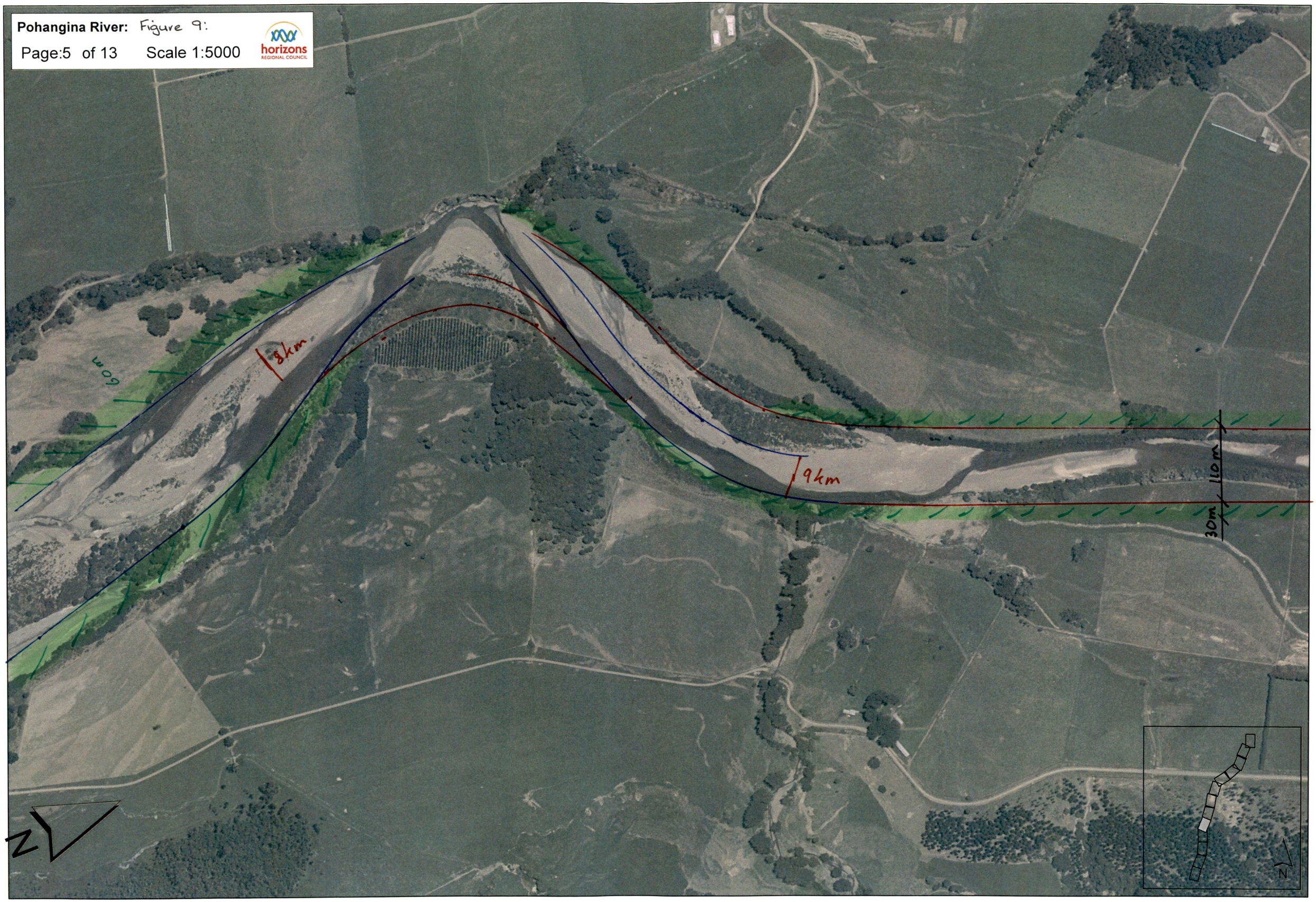

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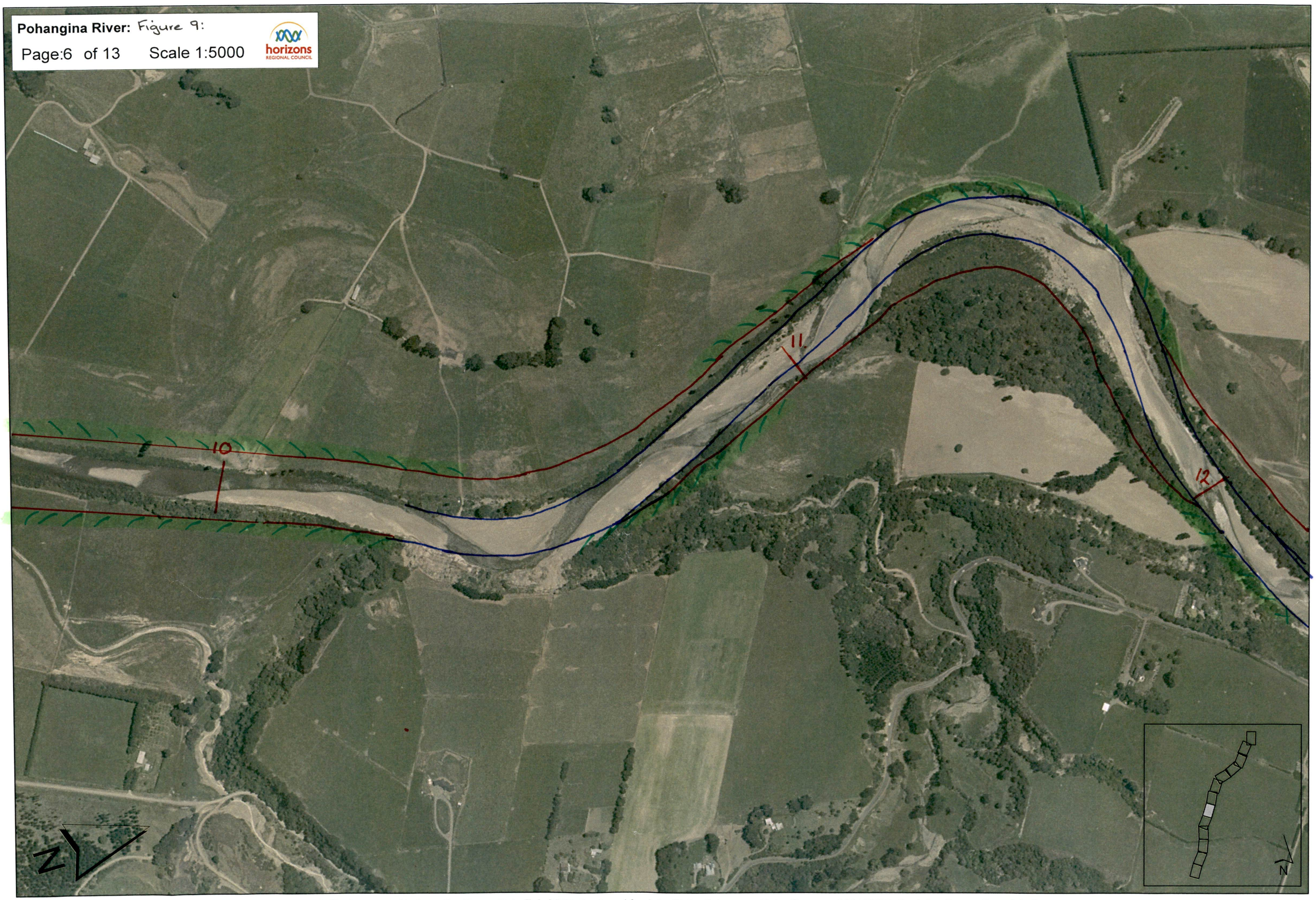

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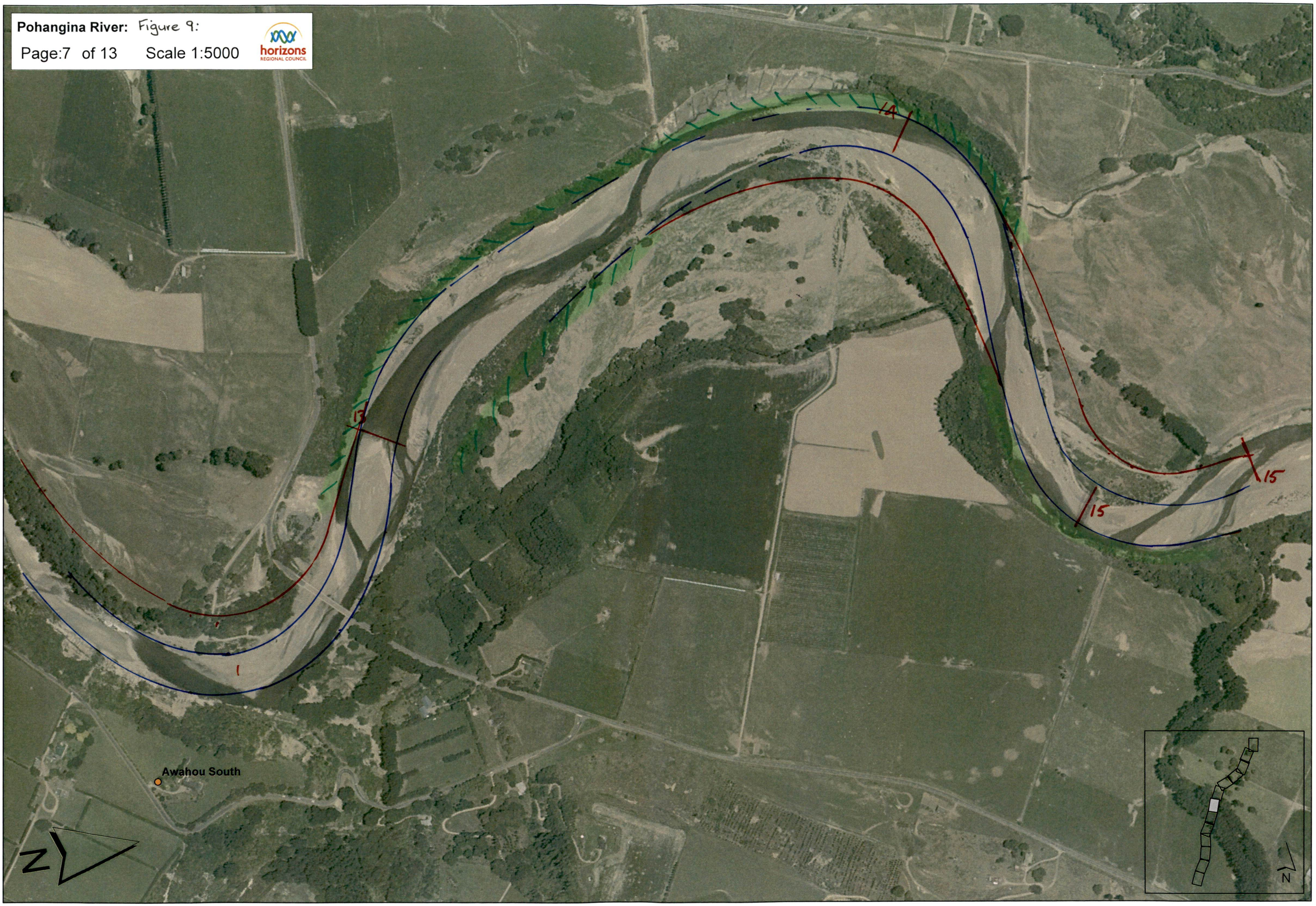

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18km

19km

11.7km

N

N

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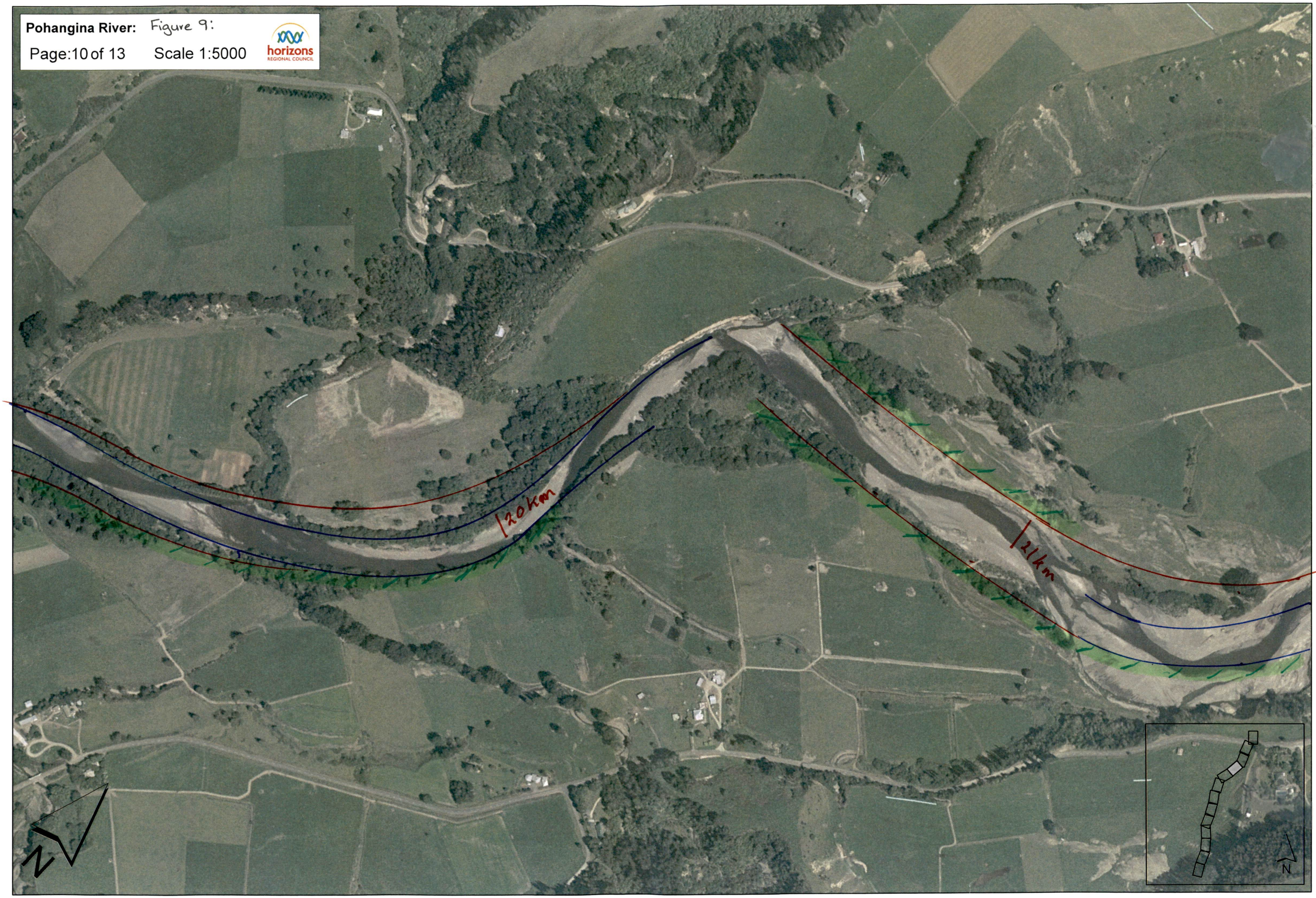

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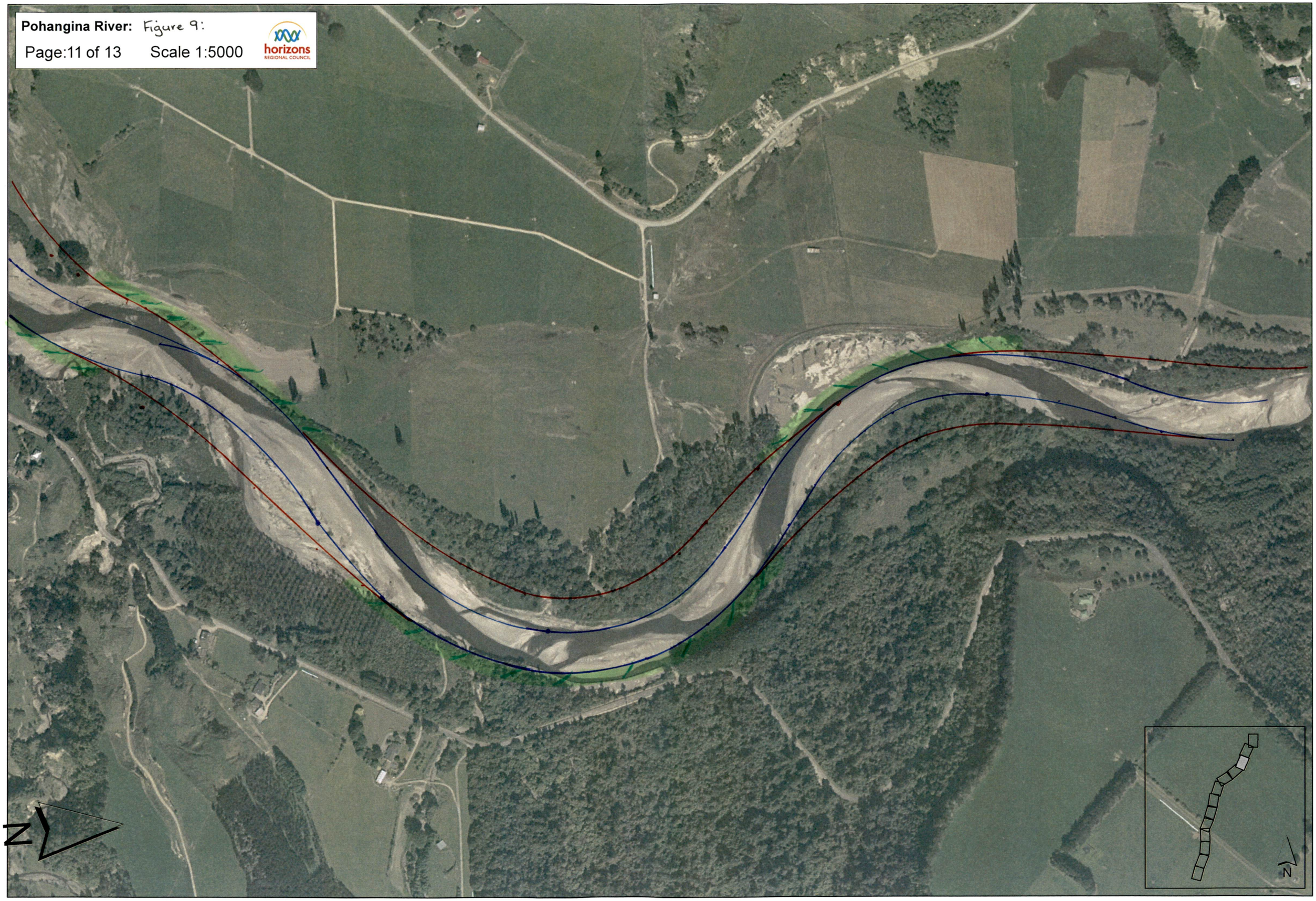

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13. The Oroua River (Updated 2006)

As noted in Section 9 the overall alignment of the Oroua River cannot be significantly improved because the river is constantly being restarted from bend distortions and areas of harder materials. Design channels have however been drawn up for representative reaches and these can be used as a guide to management, site by site. Refer to sheets 13 & 14 of Figure 11.

Where there are substantial areas of river flats, and where a greater intensity of river management would be worthwhile, applying a "type 1" design channel, (refer to Section 11 for general descriptions of design channel types) based on the flow dominant meander, will provide a useful management guide. Because of these limitations, management must then be more piece-meal, and will therefore inevitably be less effective.

Analysing Scheme expenditure for the Oroua River over the period from 1988 to 2000 showed a reasonably consistent level of expenditure on works except following the 1992 and the 1999-2000 floods.

Table 11 sets out the average annual expenditure on the Oroua River over that period and an estimate of the proposed annual expenditure required to largely continue with the existing management regime. The proposed expenditure also recognises the need to carry out a greater level of maintenance and the widening of the buffer zones. Refer to Section 9 – Oroua River Channel Geometry regarding the need for this work.

Past flood damage and expenditure records for the Oroua River show that the level of flood damage sustained does not vary significantly above the average of $36,000 until 10 year plus floods occur. At that point the annual flood damage jumps by $80,000 - 90,000 to approximately $120,000.

The proposed future funding plan would provide $40,000 per annum and the additional allowance of $15,000 for the emergency reserves will cover the damage that will occur during the larger less frequent events. This will only be adequate however if the proactive channel works are carried out, and all future river control works are carried out, in line with the design parameters.

Table 11: Oroua River Actual and Proposed Expenditure

Type of works	Average Annual Expenditure (past 12 years)		Proposed Annual Expenditure	
Channel clearing	$2,600		$5,000	
Tree planting	$4,900		$5,000	
Tree layering	$900		$5,000	
Flood damage repair	$36,000		$40,000	++
Contribution to emergency reserve	$10,000		$15,000	* *
TOTAL	**$54,400**		**$70,000**	

+ + excluding the large flood expenditure (to be funded from the flood damage reserves).

* * Total reserve contribution includes $10,000 from the Pohangina River.

The design of future works on the river must, where possible, take into account the width and shape requirements of the meander forms set out in Tables 5,6 and 7 in Section 11. Much of the river however does not fit within these parameters and so in these situations creating a smooth alignment for the reach of river affected should be the main consideration. This may result in carrying out more work than just repairing the immediate problem, but should ensure a more sustainable alignment long-term.

From an analysis of the 2000 aerial photographs it was determined that approximately 25% of the river has planting up to the design standard of 20m on both banks, and 40% of the planting on either bank is up to the design standard. The remaining sections of the river are planted quite well, however, with the total planting of approximately 80% of the design. To bring all the riparian planting up to design width would involve the planting of between 14ha and 17ha of trees at a cost of about $7,000. This planting will fit easily into the existing programme of tree planting. When the tree planting has been completed the allocation for planting should be used to maintain the existing trees and maintain the channel fairway width.

Any new protection works must be planted behind the work to a width of 20 to 35m depending on the meander form being managed. Landowners on whose property the protection works are being constructed will be required to make available a strip of land for the planting. Landowners will be required to fence off the buffer strips to exclude all stock.

The large flood in the Scheme in 2004 caused considerable damage to the protection works on the Oroua River. Many of the damaged assets were insured and as a result, repairs and major new works were carried out where the protection was lost entirely. These new works now provide a high standard of protection in many locations, but because of their nature they will remain vulnerable until the associated willow growth becomes well established. Some of these works were damaged by the April 2006 flood event.

A complete re-examination of the works required to implement the Scheme design was underway prior to the significant flood event at the end of April 2006 and further repair works have been added to the future works programme.

13.1 Oroua River Works Priority

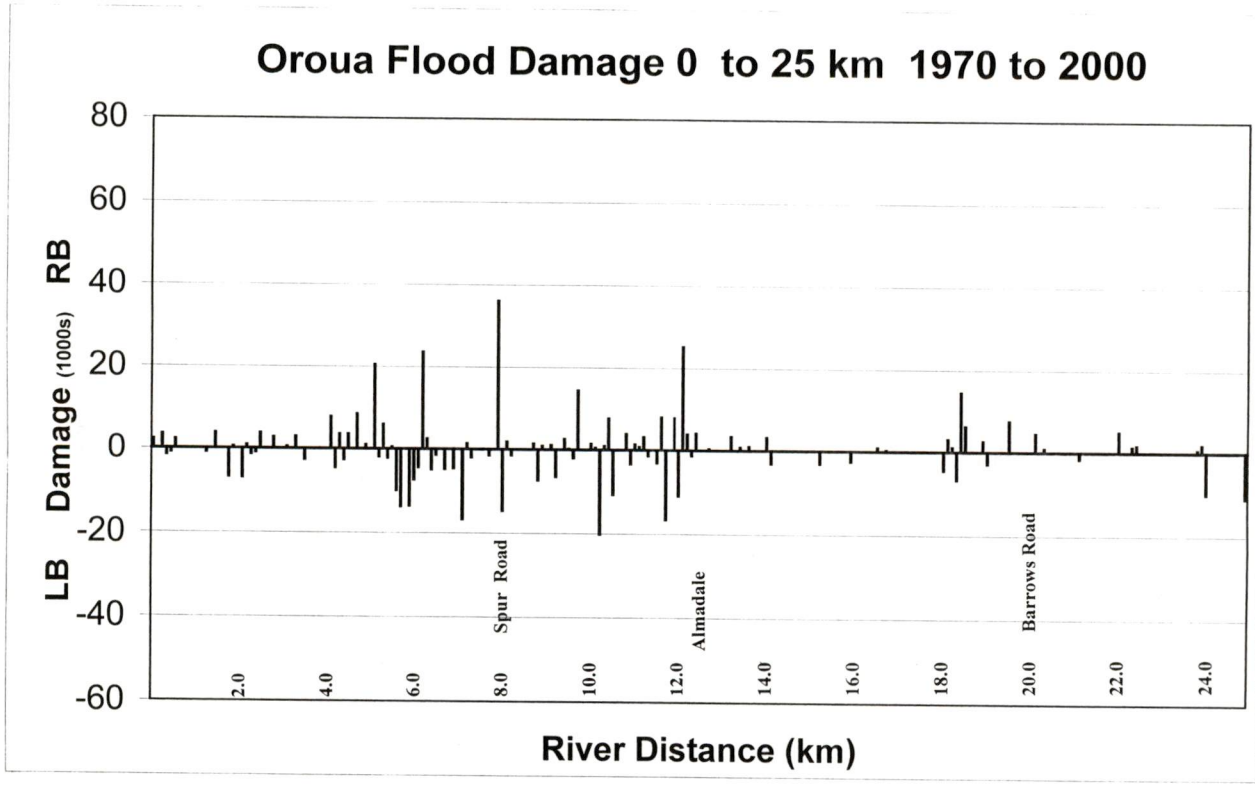
Like the works required in the Pohangina River, it is clearly not possible to fund all the works identified in the recent (2006) examination of the river, nor are there sufficient physical resources to carry out the works even if the funds were available. The new works still remaining following the 2004 flood and new works arising from the April 2006 flood have therefore been prioritised. The list of works and their priority are set out in Table 13. The following matters have been taken into account when determining the works priorities:

- the land at risk if the works were not carried out;
- the impact on the loss of alignment if the works were not carried out;
- to a limited extent the historical pattern of works.

When the Scheme was reviewed in 2001, an analysis of the river in relation to the prioritising criteria divided the river into four prioritised reaches. This analysis is still valid and can be used to assist with establishing works priorities. The highest priority reaches are set out in Table 12 and marked in red on Figure 11.

Table 12: Priority Reaches for Oroua River Works

Priority	Reach of River
1	5.0 km to 12.0 km
2	31.5 km to 38.0 km
3	18.0 km to 20.0 km
4	25.5 km to 27.7 km



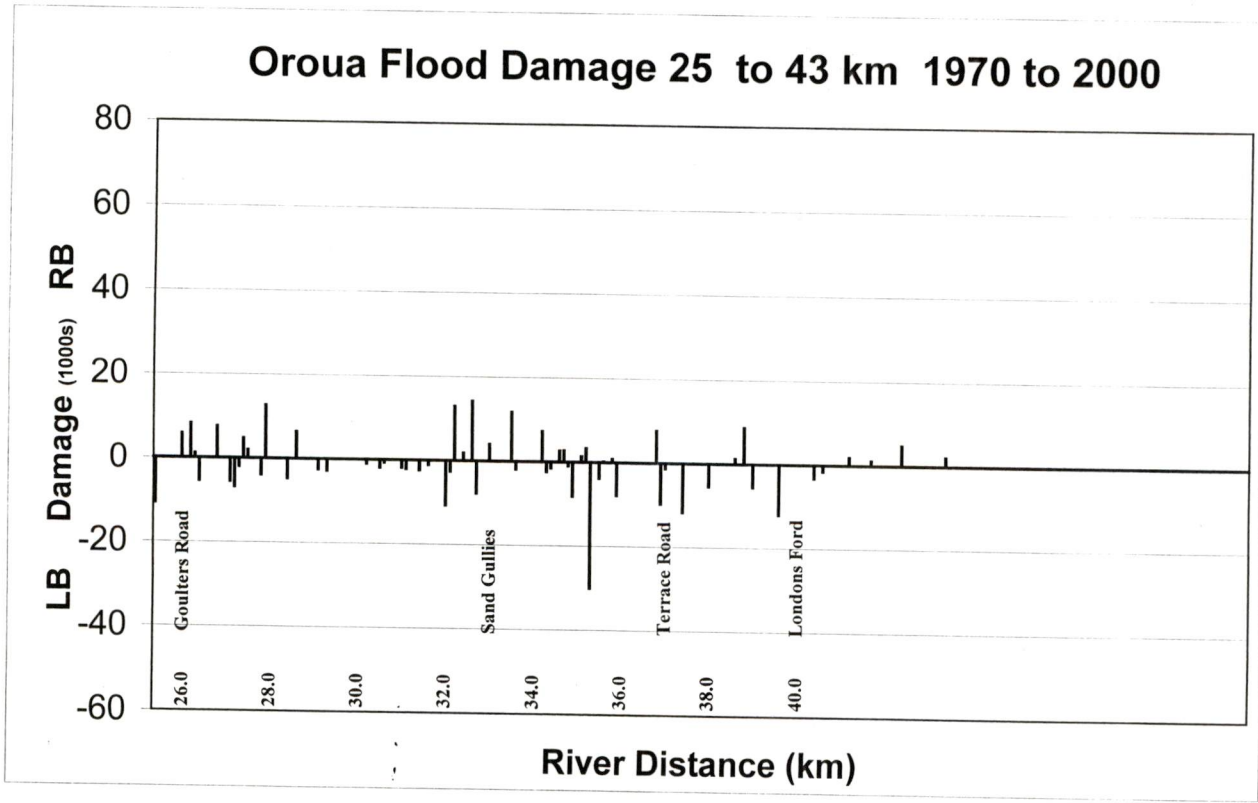


Figure 10. Location of Oroua River Flood Damage 1970 to 2000

Table 13 - Oroua River - Programme of works 2006/2007 to 2008/2009

River Distance	Bank	area of vegetation or	Description	vegetation removal	Erosion Control	beaches extraction	land at risk factor	alignment or existing asset	Sum of risk factor	vege clear factor	beach factor
3.3	R		New erosion blowout		2000		5	5	10		
11.5	R		Redrive & tidy up		3000		5	5	10		
27	R		TTPW		$5,500		3	5	8		
27.3	R		TTPW		$30,000		5	4	9		
35.4	R		wire rope fence		15000		5	5	10		
36.2	R		wire rope fence		7000		5	5	10		
2.2	L	0.3 ha	Clear vegetation to maintain flood fairway	1000						4	
2.2 – 2.5	R		TTPW		3000		5	4	9		
2.7-3	R		TTPW		4000		5	4	9		
3.1	L		Redrive piles		3000		5	4	9		
3.1	R		Beach mtce required – medium size			6000					5
5.5	L&R		Redrive piles etc		8000		4	5	9		
5.5	R	0.6 ha	Beach build up			6000					5
6	L	0.2 ha	Clear vegetation to maintain flood fairway	250						4	
6.5	L	0.3 ha	Clear vegetation to maintain flood fairway	250						4	
7.25	R	0.6 ha	Clear vegetation to maintain flood fairway	2000						4	
7.6	L	0.2 ha	Clear vegetation to maintain flood fairway	500						4	
9.15	L	0.2 ha	Clear vegetation to maintain flood fairway	500						5	
9.7	L		Concrete		3000		4	5	9		
10.3	L	0.1 ha	Clear vegetation to maintain flood fairway	250						4	
11	R	0.4 ha	Clear vegetation to maintain flood fairway	1000						5	
13.4	L	0.75 ha	Beach needs removal possibly tree removal			5000					4
14–14.2	R		Needs maintenance add TTPW		5000		5	5	10		
14.2	L	1 ha	Big beach			10000					5
15.8	R	0.1 ha	Clear vegetation to maintain flood fairway	250						4	
17	R	0.2 ha	Clear vegetation to maintain flood fairway	300						4	
18.4	L	0.2 ha	Clear vegetation to maintain flood fairway	400						4	
18.6	L		Erosion – fence close – drive trees along edge and TTPW		15000		4	4	8		
18.95	L	0.1 ha	Clear vegetation to maintain flood fairway	300						5	
24.7	L		Repair PMU		$13,000		3	4	7		
26.5	L		Maitnenace required		$2,000		3.5	5	8.5		
28.8	R	0.5 ha	Clear vegetation to create flood fairway	1500						5	
34.1	L		Groyne repair		8000		3	4	7		
34.7	R		additional trees		1000		4	5	9		
4.75	R		Erosion but appers stable		14000		5	2	7		
5.7	R		Keep inside of bend clear	500						3	
11–11.5	R		clean pmu redrive and xtra trees		3000		5	3	8		
12.3	R		Erosion – hydro site u/s of TTPW		5000		3	3	6		
14.5	L		Add TTPW		4000		4	4	8		
14.5-14.7	R	1.5 ha	Clear vegetation of inside bend to create flood fairway	4500						3	
15.2	L	0.1 ha	Clear vegetation to maintain flood fairway	250						3	
18.3	R		TTPW		10000		4	3	7		
19.45	R		Erosion protection required Allow for some protection works		12000		4	3	7		
27.75	L		Trim trees to open up channel	10000						3	
32.8	R		Extend protection downstream		8000		4	4	8		
34.8-34.9	L		Add ttpw		2000		3	4	7		
4.4	R	0.3 ha	Beach needs watching			3000					2
6.4-6.6	R		Add TTPW		4000		3	3	6		
6.9	R		Small erosion		1000		4	2	6		
19.75	R	0.5 ha	Clear vegetation to maintain flood fairway	1000						2	
23.4	R	1 ha	Clear vegetation to maintain flood fairway	2000						2	
24	R		Potential erosion spot		$5,000		1	1	2		
31.75	L	1 ha	Beach			10000					2
31.5 – 32.5	L&R	2 ha	Keep vegetation Clear to maintain flood fairway	4000						2	
32.25	L		groynes		6500		3	2	5		
33.5-34.5	L&R	2 ha	Clear vegetation to maintain flood fairway	4000						2	
39	R	0.2 ha	Clear vegetation to maintain flood fairway	300						1	
39.3 – 39.4	R		Add TTPW		15000		2	3	5		
41.2	L		Large beaches			5000					1
41.7	C	0.75 ha	Clear vegetation to maintain flood fairway	2500						2	

				TOTAL
	37550	217000	45000	
05/06	$0	$62,500	$0	$62,500
06/07	$8,500	$65,000	$27,000	$100,500
07/08	$15,250	$58,000	$0	$73,250
08/09	$13,800	$31,500	$18,000	$63,300

0km

1km

Key

Indicates Priority of various reaches of river

Indicates Priority reaches

Plantings

Km River Distance

Figure 11. Oroua River Design Channel

Sheet 1 of 16

Figure 11. Oroua River Design Channel

Sheet 2 of 16

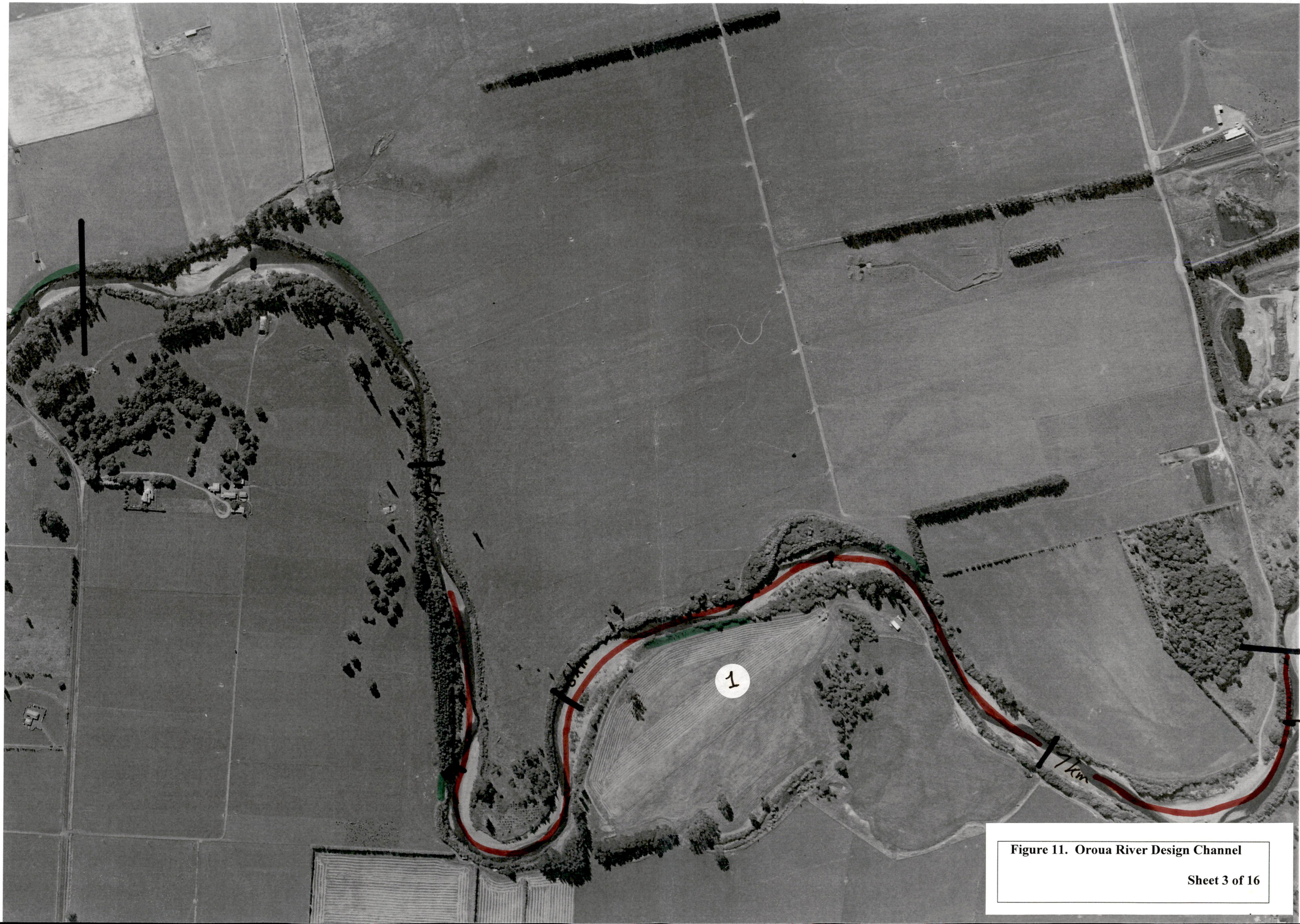


Figure 11. Oroua River Design Channel

Sheet 3 of 16

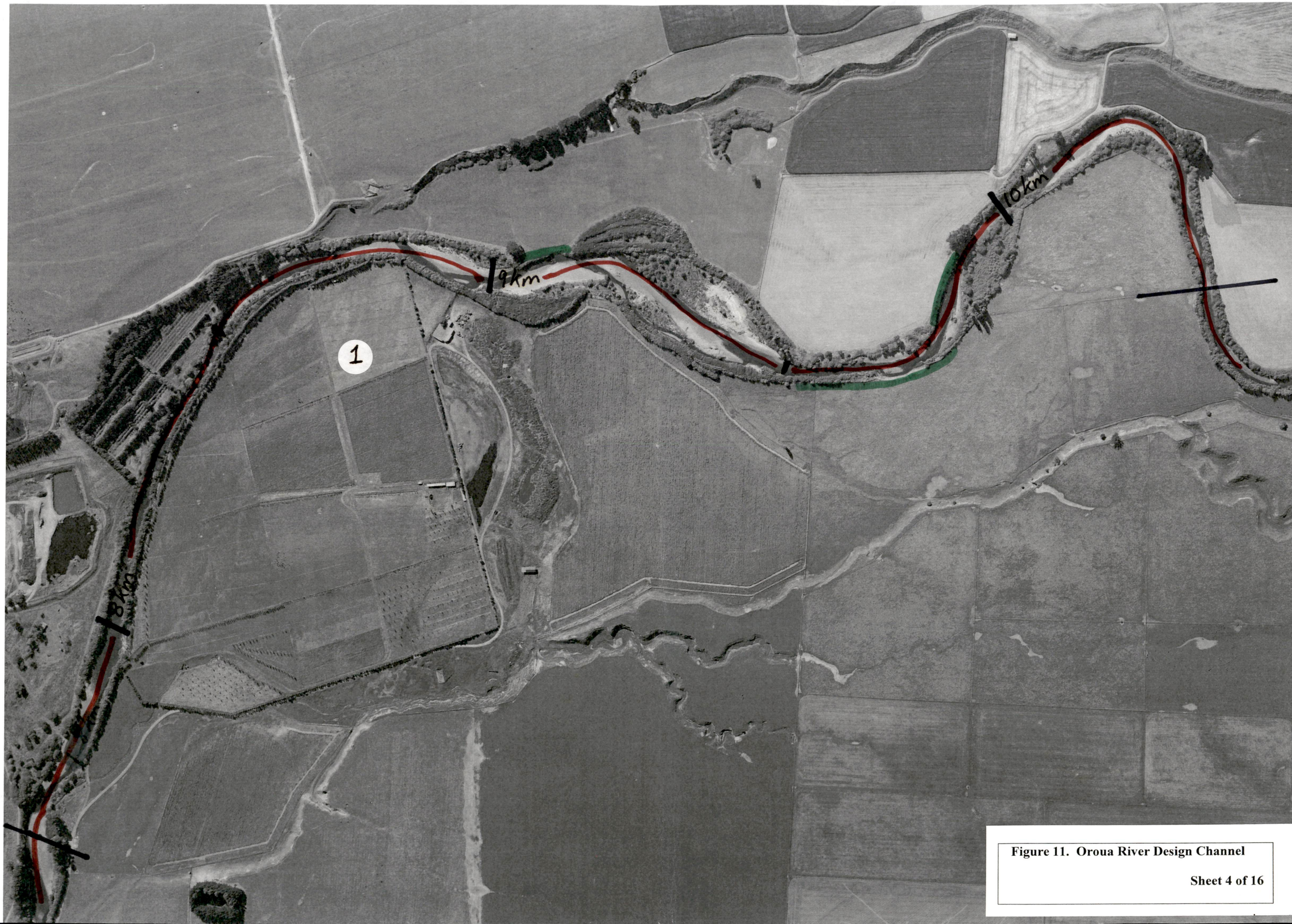


Figure 11. Oroua River Design Channel

Figure 11. Oroua River Design Channel

Sheet 5 of 16

Figure 11. Oroua River Design Channel

Sheet 6 of 16

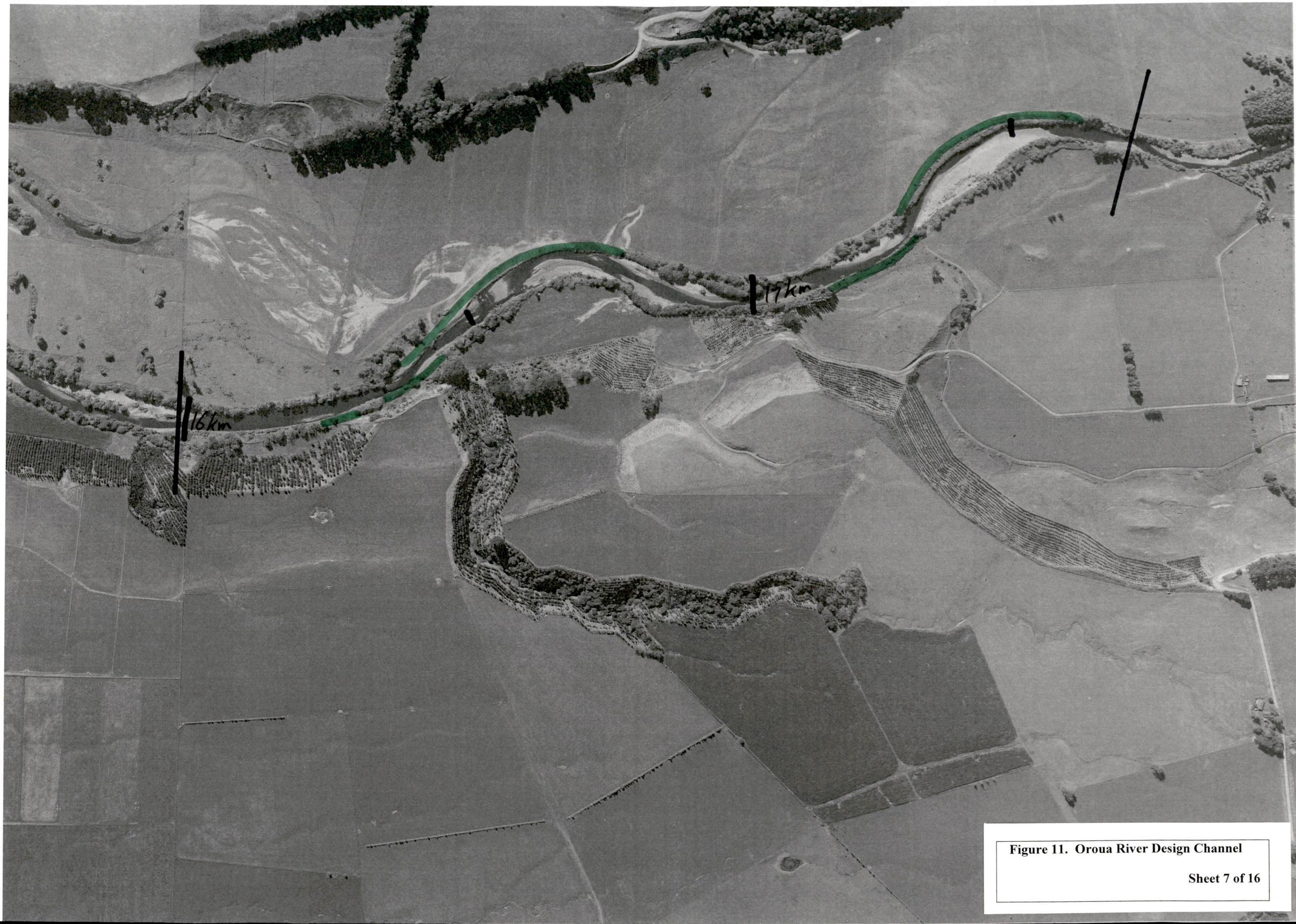


Figure 11. Oroua River Design Channel

Sheet 7 of 16

Figure 11. Oroua River Design Channel

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Figure 11. Oroua River Design Channel

Sheet 9 of 16

Figure 11. Oroua River Design Channel

Sheet 10 of 16

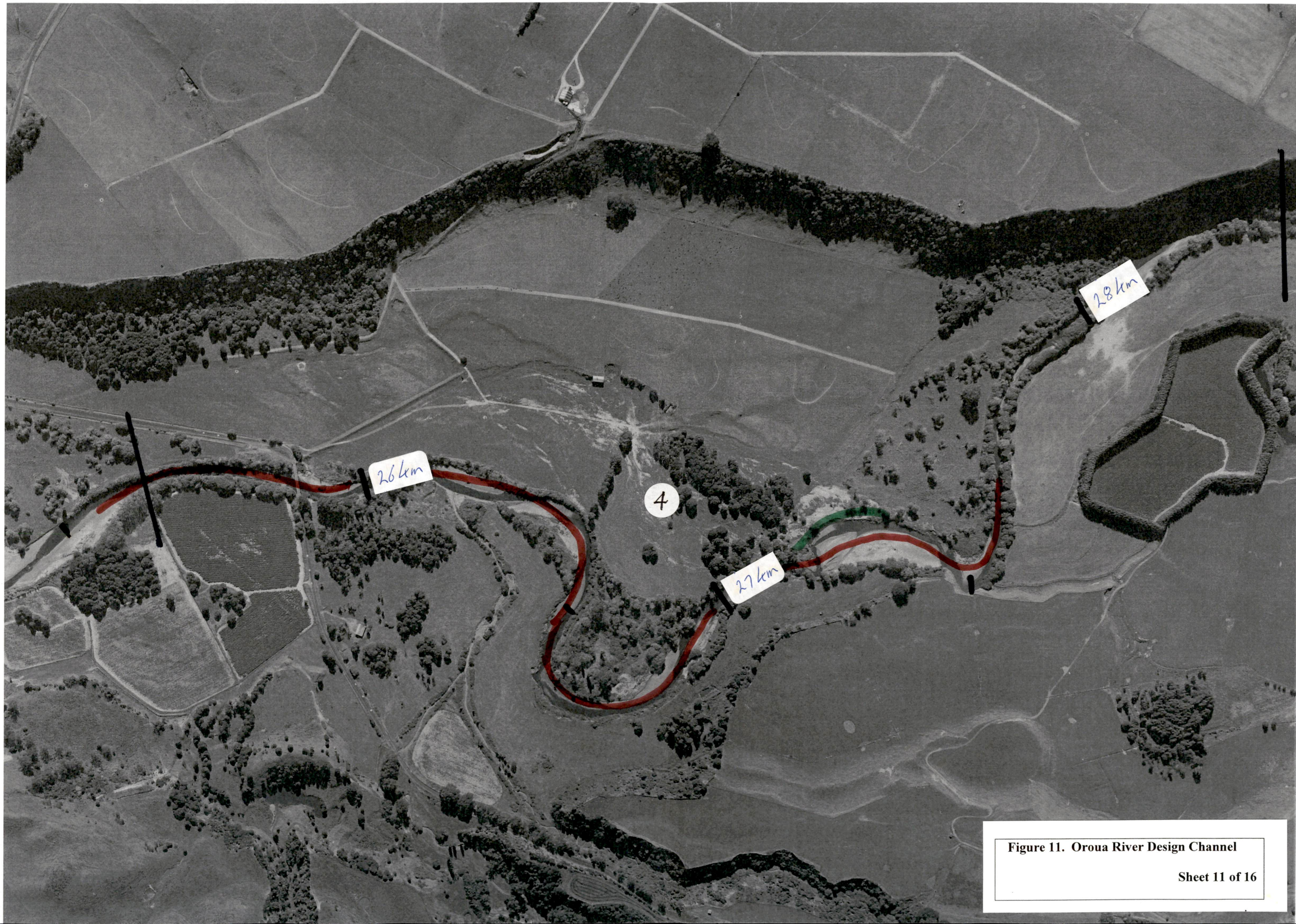


Figure 11. Oroua River Design Channel

Sheet 11 of 16

Figure 11. Oroua River Design Channel

Sheet 12 of 16

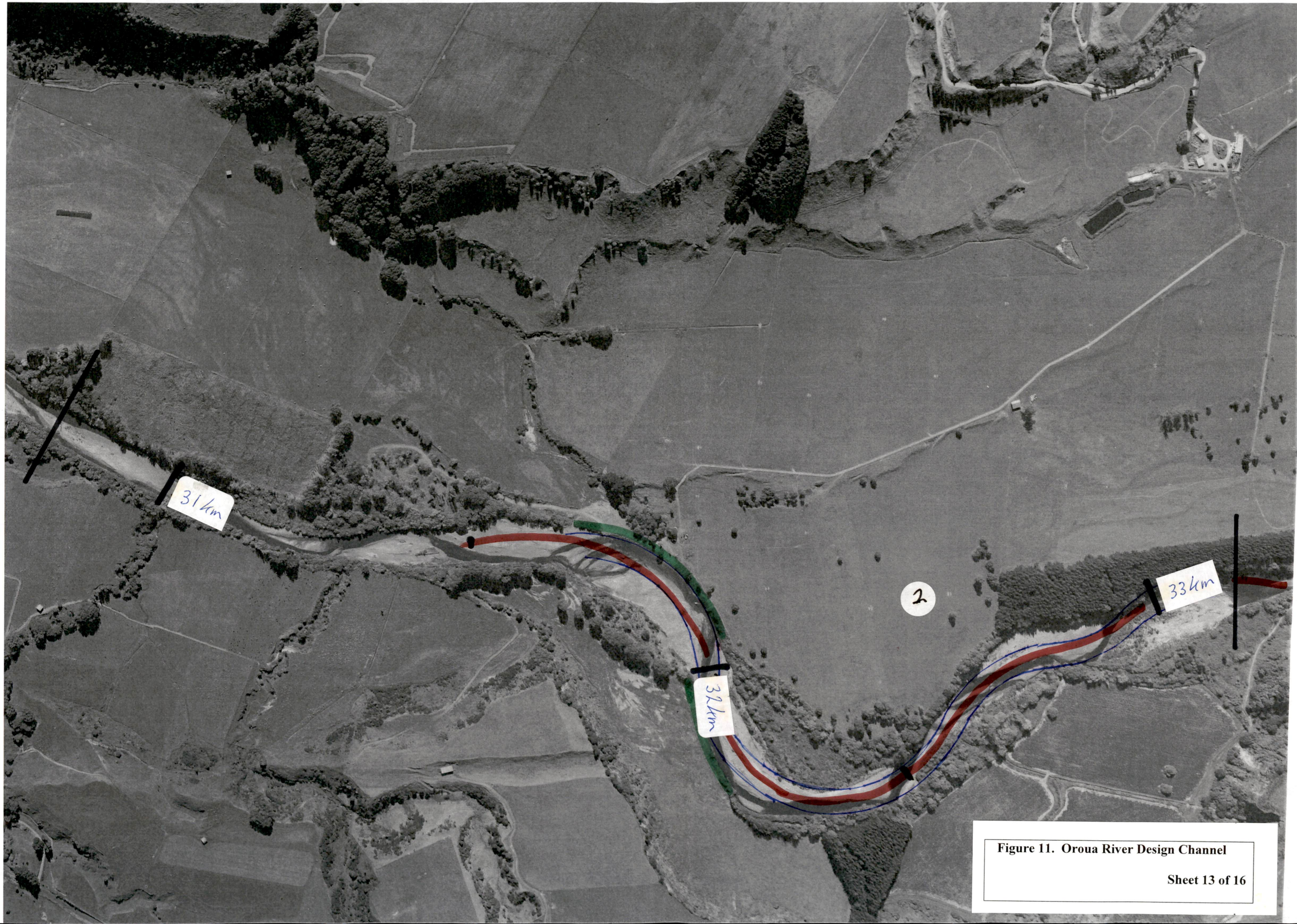


Figure 11. Oroua River Design Channel

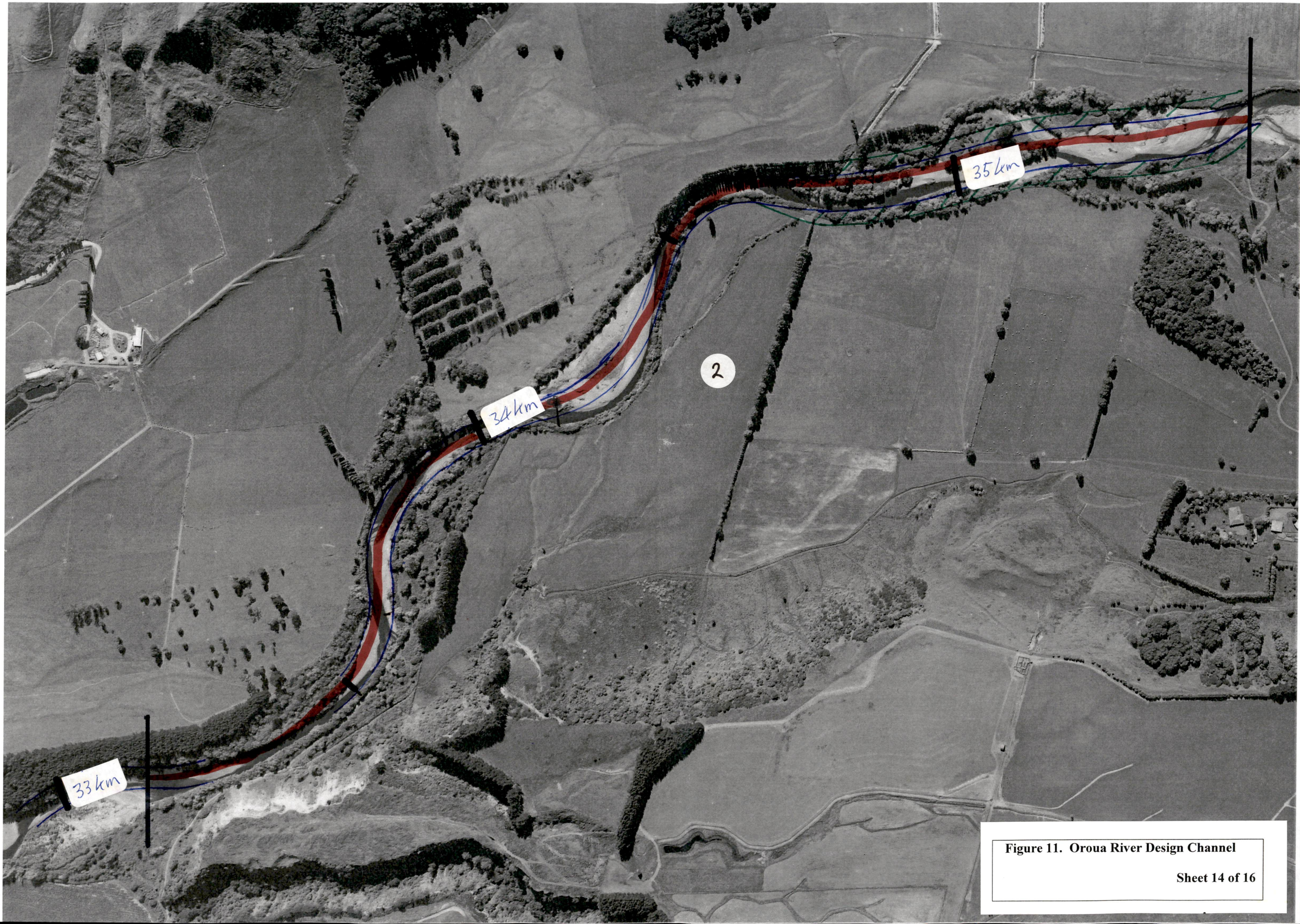


Figure 11. Oroua River Design Channel

Figure 11. Oroua River Design Channel

Figure 11. Oroua River Design Channel

Sheet 16 of 16

14. Goulters Gully Forestry (as per the 2001 report)

Sections 2 and 9 above set out the historical development of the forestry in the Goulters Gully complex.

Approximately 38.4ha of Pinus Radiata was planted between 1969 and 1978 with a further 30ha planted by Belmont Station in 1994.

The 38.4ha have now been are now ready for harvesting and plans are well underway to harvest the trees over the next two to three years.

The timing of their release to the market is critical to ensure that the income from the trees is optimised.

Horizons Regional Council's soil conservation staff have prepared a budget for the harvesting, and a cash flow for the first 15.3 hectares and estimates for the remaining 23.1hahave been prepared based on these figures. As the costs and returns will vary from block to block and the demand from the market at the time of harvest will also vary it was considered that a more detailed estimate was not warranted at this stage.

The management of the various blocks has been variable when compared to the management practices undertaken today. Pruning varies from 0m to over 8m and stocking rates vary considerably from the low 200s to over 300 stems per hectare. Details of the tree crop and conditions for the different blocks are set out in an unpublished report titled "Goulters Gully Logging Report"[13].

Table 14 sets out the information for the blocks that have been evaluated to date.

Table 14: Value of the Harvested Trees from the first 15.3 ha

Stand	Area hectares	Tree Value per hectare	Logging and Management Costs per hectare	Net Return per hectare	Net Total Return
1	10.3	$34,200	$17,040	$17,160	$176,750
3	5.0	$29,250	$12,920	$16,330	$81,650
TOTAL	**15.3 ha**				**$258,400**

The average value of the trees harvested from stands 1 and 3 is $16,900/ha. Using this average to determine the value of the full 38.4ha of trees gives an approximate value of $650,000.

The ongoing management of the Goulters Gullies is critical to the stability of the area. Harvesting without recognising the fragile nature of the underlying soils could easily result in further severe erosion occurring. This consideration has increased the cost of the harvesting work resulting in the lower than normal net return from these trees, and taking these matters into consideration, the cost of

[13] Goulters Gully Logging report – Horizons Regional Council library, Regional House, Palmerston North. Undated but produced in 2000.

future planting and management of the trees has been estimated to be $5,600/ha. This brings the total replanting and management cost to $215,000.

The total return from the forestry is therefore estimated to be

$650,000 - $215,000 = $435,000.

The actual return will depend on the state of the market at the time the trees are sold, the cost of harvesting, replanting and ongoing management. It is not possible to predict these with accuracy but for planning the future Scheme expenditure, the net return figure from the forestry will be taken to be $435,000.

The forestry asset has a significant value and is now insured for $511,000 for the timber and $50,000 to replant. The cost of the insurance is approximately $245 per annum.

Future Management

As stated above, the future management of the area on which the forestry is situated is critical to ensure the ongoing stability of the very fragile sand formations. Prior to any harvesting a detailed programme of re-establishment will need to be produced and approved by the Scheme Manager.

15. Drainage (as per the 2001 report)

Currently the Pohangina Oroua Scheme maintains 15.4km of drains. An amount of $4,000 to $5,000 per annum or 5% of the normal level of Scheme expenditure is allocated annually to the drain maintenance programme.

When the Scheme was established in 1967 the land which received drainage benefit was rated Class A. In the 2000-2001 year $4,064 were collected from A class ratepayers over and above the level of the Class B rate. This is considerably less than the overall cost of carrying out the drain maintenance works when adding on an allowance for management and administration. A new classification will need to address this problem.

The drains provide drainage to four areas in the Pohangina Valley and one area in the Oroua Valley. Some of the drains service only one landowner whereas some extend over a number of kilometres providing drainage outlets to a large number of properties.

The Scheme was established initially to ensure that in the long term maximum economic production is obtained from the land. This was achieved largely by carrying out soil conservation and river control activities in the Scheme area. Effective drainage is also a factor contributing to the productive potential of the land, and for this reason was included in the Scheme.

The impact on the economic productivity of the Scheme area from the maintenance of the drains is minor, and their continued inclusion in the Scheme should be questioned.

In the other schemes managed by Horizons Regional Council which have been reviewed in recent years, the drains providing little if any community benefit, ie they lie entirely on one farm, have been removed from the drain maintenance programme by agreement with the landowners.

An examination of the drains in the Scheme show that many of the drains lie entirely on one farm and the future management of these drains as part of the Scheme should be considered further and decisions made when the Scheme is reclassified. Table 14 sets out the drains that currently form part of the Scheme. Only Drain N lies in the Oroua Catchment. The drains are shown on Figure 12.

Table 14: Scheme Drains

Drain no.	Landowner	length km	Drain no.	Landowner	length km
A	O'Neil	0.4	H	Leamy-Pratt	0.5
B	O'Neil	0.8	J	Leamy	0.7
C	Hepburn-O'Neil	1.4	K	McCartney-Edwards	1.4
D	O'Neil	0.3	L	Carroll	1.3
E	Akers	1.1	M	Caldwell	1.0
F	Jones-Lucas	3.0	N	Paorangi-Moss	2.4
G	McDonald	1.1			
TOTAL LENGTH					**15.4 km**

Figure12. Location of Scheme Drains – Sheet 3

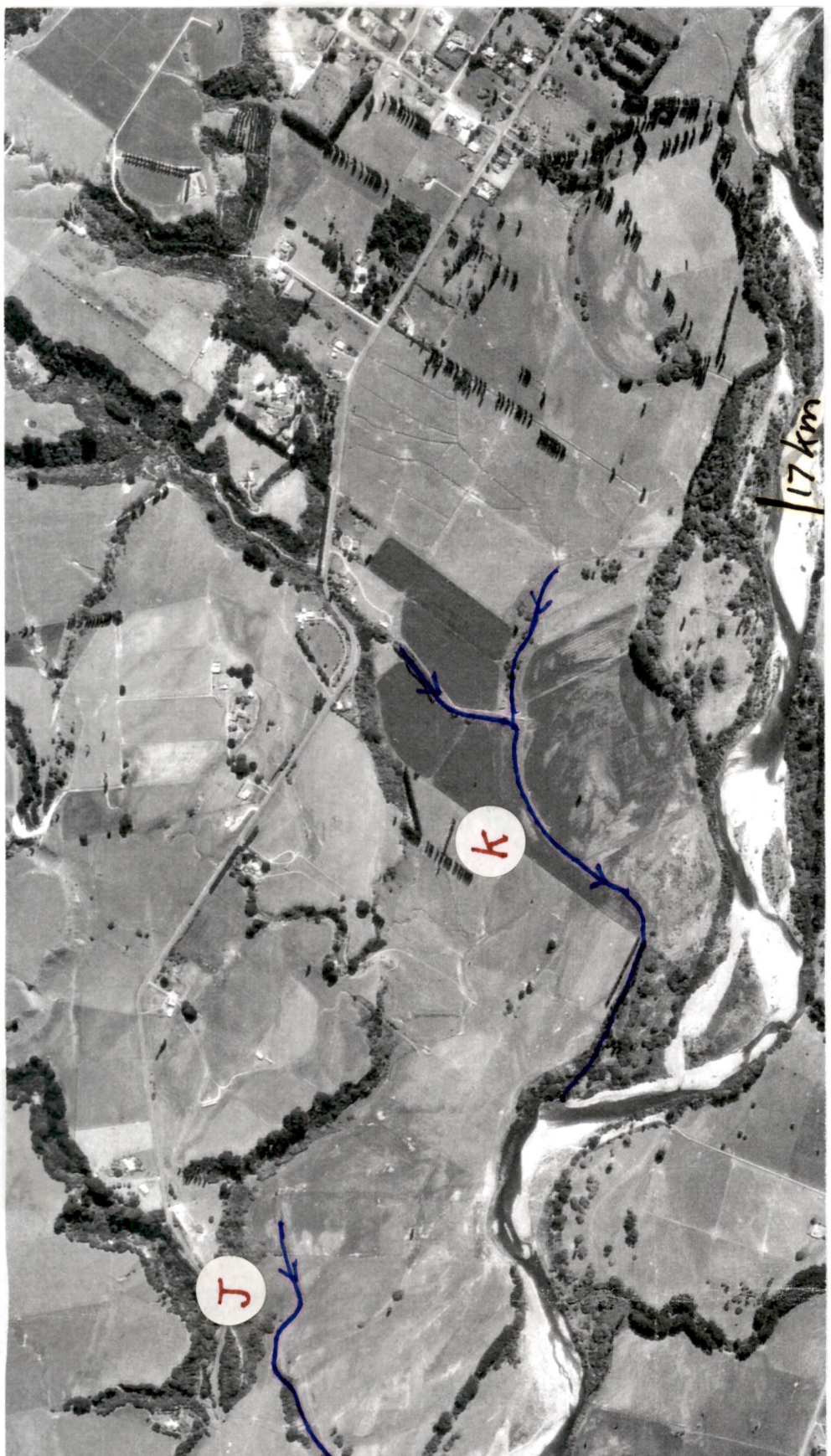


Figure 12. Location of Scheme Drains – Sheet 2

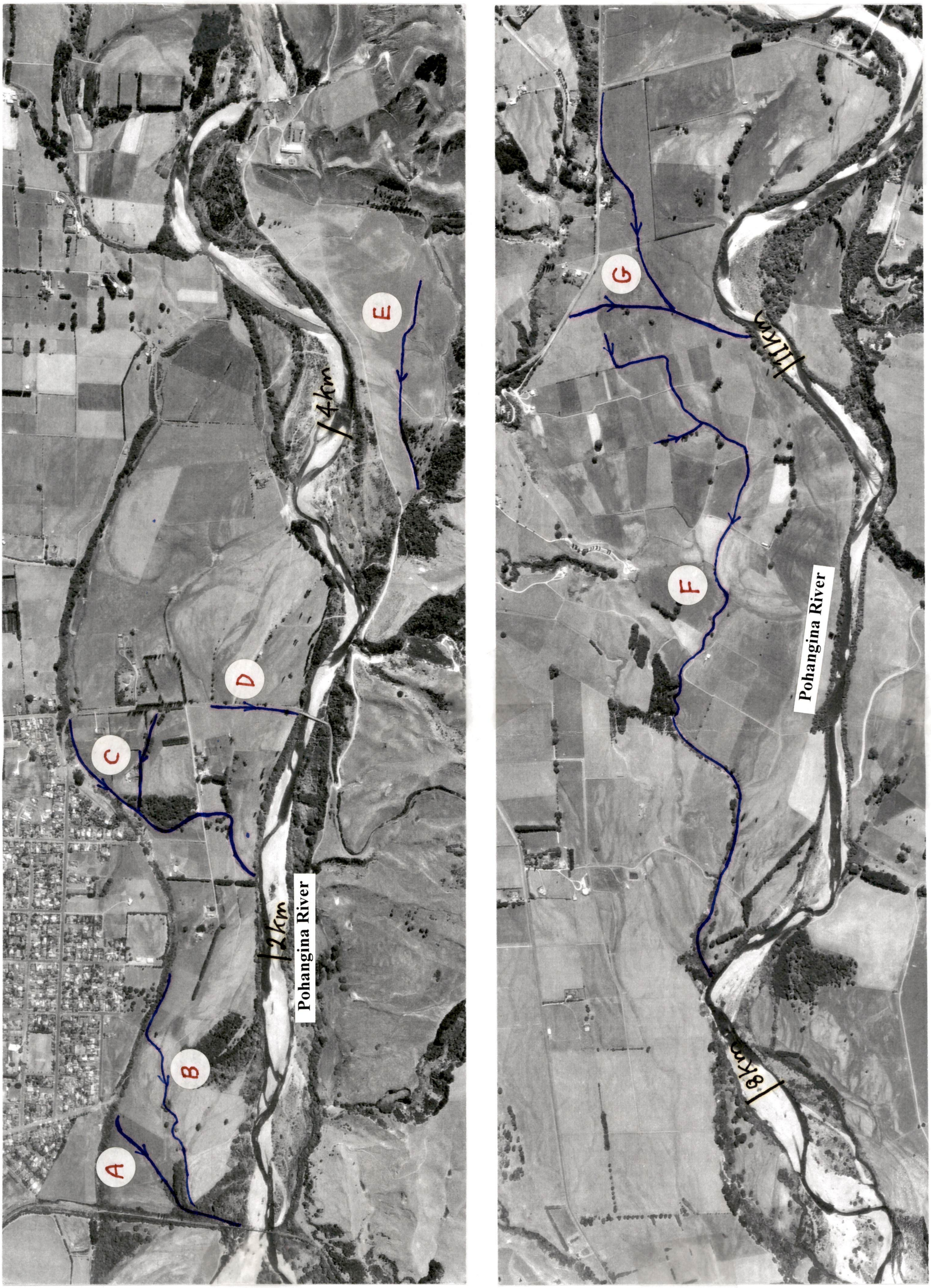


Figure 12. Location of Scheme Drains – Sheet 1

16. Maintaining Scheme Assets (as per the 2001 report)

Fundamental to the success of the Scheme will be the maintenance of all scheme assets to ensure they continue to provide their design level of service.

Existing Scheme assets which include erosion protection works, stopbanks, plantings and drains must be maintained ahead of constructing new Scheme assets, and Scheme assets should not be constructed unless there is a plan to fund the necessary maintenance works.

The channels of the Pohangina and Oroua Rivers are not considered assets in the Scheme Asset Management Plan, but to ensure the effectiveness of the Scheme is maintained the flood-carrying capacity of these channels must be maintained as if they were Scheme assets.

Without maintaining these channels, history has shown that a significant loss in capacity will occur through gravel beach build-ups, edge vegetation encroachment, and beach vegetation.

17. Protection of Accretion (as per the 2001 report)

17.1 Rating Accreted Land

There are a number of issues with respect to the accretion land within the Scheme. Accretion land that has not been claimed by the adjacent landowner has no title and therefore no rate reference. Therefore despite the fact that this land benefits from the scheme works either directly or indirectly, it cannot be rated to recognize the benefit received. For this land to be rated, the adjacent landowner would need to claim it as accretion.

The area of unclaimed accretion in the Pohangina River is approximately 150ha. This is approximately 15% of the land in classes A, B and C. There is a similar amount of titled land in Classes A, B, and C that now forms part of the riverbed. Overall at this point in time one compensates the other, but when the Scheme is reclassified the titled land in the riverbed will not be rated for the high level of benefit that it is currently rated for.

The problem of not being able to rate the unclaimed accretion for the landowner who farms the unclaimed accretion will be examined during the reclassification of the Scheme.

17.2 Protection of Accreted Land

The other significant concern raised by ratepayers is the expenditure of scheme funds to protect land that is not rated. Nearly all the works proposed in this review of the Scheme are required to maintain channel alignment. Therefore even if a particular protection work was providing protection to an area of accreted land, failure to carry out the work would place other sections of rated land at risk.

Of the 28 sites where capital works will be carried out over the next seven years according to the programme of works identified in the review, or have recently been carried out, only four of them provide significant protection to unclaimed accretion. Of those four, only one could be left and not have a significant impact on channel alignment.

If the location of accreted land was taken into consideration when determining the order of priority for the proposed works, the works protecting accreted land would not move very far at all on the priority list from where they are now.

18. Local Authority Contribution and The Protection Of Non-Scheme Assets (as per the 2001 report)

18.1 The Totara Reserve

When the Scheme was first established and the classification prepared in 1966, no Local Authority contribution was established through the classification process. A Local Authority contribution has however been paid to the Scheme since very soon after the classification was finalised. The contribution has been collected from the Manawatu District Council and the 2000-2001 level of contribution was set at $6,567 (GST excl).

There has been considerable debate over the years about what the contribution covered. A study of the old files[14] has determined that the contribution is a contribution in lieu of a rate for the Totara Reserve.

When the classification was prepared in 1967 the Pohangina Valley Domain, now known as the Totara Reserve, was classified within the Scheme with 300 acres in Class B, 88 acres in Class C and 361.25 acres in Class E.

The Totara Reserve land is however non-rateable, but at that time, if it had been rateable, the rates would have been $251.52.

Following discussions between the Palmerston North City Council and the Manawatu Catchment Board, the two authorities agreed in November 1969 that the City Council would make an annual grant in lieu of rates of $250 commencing in 1970-71 and subject to annual review.

In a letter[15] dated 10 November 1969, the Board undertook to maintain all river protection work in the reserve area as part of the Pohangina-Oroua Scheme.

When the reclassification of the Scheme was completed in 2002, the Manawatu District Council decided not to continue with its contribution to the Scheme and no works have been carried out by the Scheme in the Reserve since the Reviewed Scheme was adopted in 2001.

18.2 Ashhurst Township

The Pohangina-Oroua Scheme Classification included part of Ashhurst Township, then under the administration of the Oroua County Council. At that time, the Catchment Board collected its scheme rate from the urban area of Ashhurst and because of a legislative requirement a minimum rate of 50 cents per property was collected. Because this almost doubles the rate that was struck for each property, there was considerable pressure from Ashhurst ratepayers to collect the rate in a way that resulted in them only paying the rate that was struck and not the minimum rate. It was finally agreed after a petition and much debate that the Oroua County Council would collect the Scheme rate on behalf of the Catchment Board through its normal rating system. This rate is now collected through the Palmerston North City Council.

[14] File 30/X in **Horizons Regional Council**'s file system (Old MCB file) and File 27/6 in **Horizons Regional Council**'s file system (Old MCB file)

[15] File 30/X in **Horizons Regional Council**'s file system (Old MCB file)

The benefit provided to Ashhurst was identified at the time as both indirect benefit, and direct benefit by way of maintenance of a drainage outlet that catered for water spilling over the edge of the terrace to the west of the town.

The level of benefit received by Ashhurst and the level of rating will need to be considered during the reclassification of the Scheme.

18.3 Protection of Non-Scheme Assets

The protection works carried out as part of the Scheme are designed to protect property and assets of those who contribute to the Scheme through the payment of Scheme Rates.

All protection works required to protect assets where the owner of those assets does not contribute to the Scheme should be funded by the asset owner unless otherwise agreed to by **Horizons Regional Council** and the Scheme ratepayers.

In the Pohangina-Oroua Scheme these assets include all the bridges in the Scheme area owned by the Manawatu District Council, Tranzit NZ, and Tranzrail and sections of roads and railway that are at risk of being flooded or undermined by river erosion.

In some situations it is difficult to determine what the appropriate cost share should be when protection works provide protection to both scheme assets and non-scheme assets.

If works are required to prevent riverbank erosion that is only threatening a non-ratepayer asset, then the works must be fully funded by the asset owner.

If works are required to prevent riverbank erosion that is threatening both a non-ratepayer asset and a ratepayer asset, then the cost of the works must be shared between the Scheme and the asset owner. However in many situations within the Scheme damage to ratepayers' assets may be accepted as part of natural river processes and in these situations the total cost of the protection works shall be funded by the asset owner.

19. River Distances (as per the 2001 report)

Recording the location of works in the river in the past has been by way of a river distance. The original Scheme Plan that detailed the works to be carried out marked the river distances in miles. A 1971 set of 10 chains to the inch aerial photographs that were used for many years for this purpose had slightly different locations for these river distances.

Works carried out since these river distances were established have shortened the channel and these distances are no longer accurate and errors occur when trying to locate past works.

All references to past works in this report relate to the distances used by those keeping the records at the time.

It is now timely to establish a new basis for the measurement of river distance that relates to the river as it stands today.

Zero kilometers on the Pohangina river is a hard point to fix because of the mobile nature of its confluence with the Manawatu River and so the railway bridge at Ashhurst has been set as river distance 1.0 km.

The new river distances are marked on the photographs in Figures 9 and 11.

The same story goes for the Oroua River but the distances are not as far out of alignment with the river today. However to create a river distance recording system that can be used to accurately locate works in the future, the river distances have been repositioned.

In order to duplicate the old distances as much as possible it was decided to match the old 2.5 mile mark with the new 4km mark and renumber up stream and downstream from there. The 4km mark is the bridge on the Colyton-Feilding Road.

20. Classification (as per the 2001 report)

20.1 The Existing Classification (pre-2002)

A classification divides the Scheme area into relative benefit areas or classes that provide an equitable basis for the setting of rates to distribute the costs of carrying out capital and maintenance works.

The existing classification was carried out under the provisions of the Soil Conservation and Rivers Control Act 1941 on an area basis. It was prepared for the Manawatu Catchment Board in 1966 by I G Macdonald and signed by the Chairman on 17 January 1967. A copy is at Appendix F.

Table 15 sets out the existing classification for the Scheme and the proportions of the rates collected for the 2000-2001 financial year.

Table 15: Scheme classification and Rating Levels for 2000-2001 (GST INCL)

Class	Area	Relative % benefit	Rate per hectare	Rate collected
A	166.00	100	$71.99	$11,950
B	1419.68	66	$47.51	$67,454
C	1015.74	33	$23.76	$24,131
D	11885.09	4	$2.88	$34,229
E	10280.14	2	$1.44	$14,803
F	30640.20	1	$0.72	$22,060
TOTAL	**55406.85**			**$174,627**

A number of interesting points that influenced the assignment of classes to the various areas of the Scheme were made by the classifier. These can be summarised as follows:

The Pohangina River

- in contrast to the Oroua River the Pohangina River is unstable and has for the greater part a wide area of river bed wherein it may change its course considerably even over brief periods;
- protection work is negligible considering the total length involved and there is a shortage of willows; and
- there is a major deficiency in fencing.

The Oroua River

- the Oroua River is generally stable in comparison to the Pohangina River;
- there are several stretches much too narrow to cope with normal floods;
- there is a wide variation in the standard of the bank protection works in the Oroua River;

- there are cases of well-planted, well-fenced river banks; however there could be some removal of willows required to widen the bed even in these cases; and

- in comparison with conditions on the Pohangina, existing protection work is generally of a good standard.

20.2 The Need for a New Classification

Reclassification is generally required when there are significant changes to the expenditure from that planned at the time of the last classification.

By analysing the rates collected from riparian ratepayers it can be determined that the ratio of rates collected from the Oroua ratepayers to the rates from the Pohangina ratepayers was approximately 40 to 60.

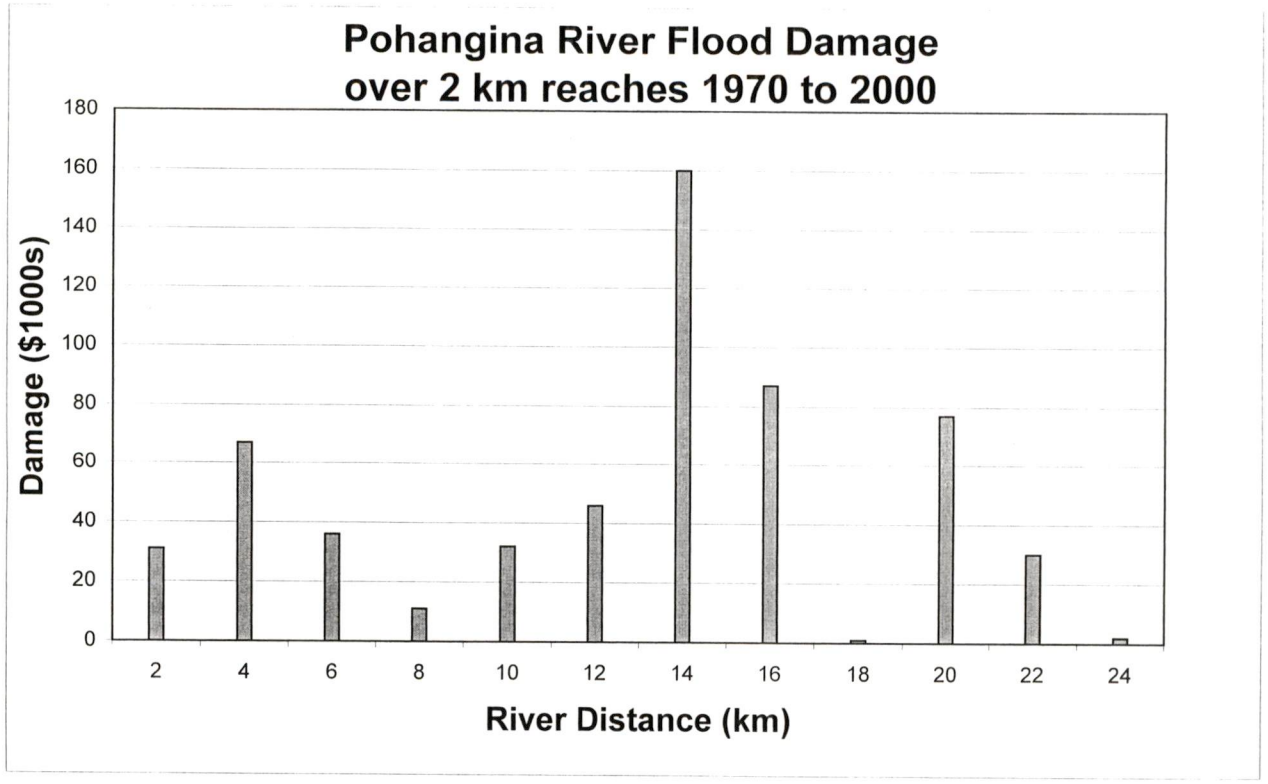
The past expenditure on the Scheme is reasonably well documented but the expenditure on maintenance between the Pohangina and the Oroua Rivers up until 1989 was not split between the two rivers. The expenditure on flood damage has therefore been used as an indicator of overall expenditure and this has been analysed for the period from 1971 to 2000. The results of this analysis are shown in Table 16.

Table 16: Rating Levels compared to Flood Damage Expenditure

River	Relative Riparian Rating	Expenditure on Flood Damage		
		1971 to 1981	1971 to 1989	1988 to 1998
Pohangina	60 %	62 %	49 %	43 %
Oroua	40 %	38 %	51 %	57 %

It is clear from these records that up until 1981 the proportion of the rates collected from the two rivers matched the expenditure in the two rivers. However since that time the expenditure distribution has almost switched. This therefore shows that the existing rating system is no longer collecting rates in an equitable way.

Comparing the expenditure on flood damage over 2km reaches of the Pohangina and Oroua Rivers with the rate income obtained from riparian ratepayers in those reaches, it can be seen that over the period 1970 to 2000 the income and expenditure are not aligned. Figures 13, 14 and 15 clearly show these discrepancies.



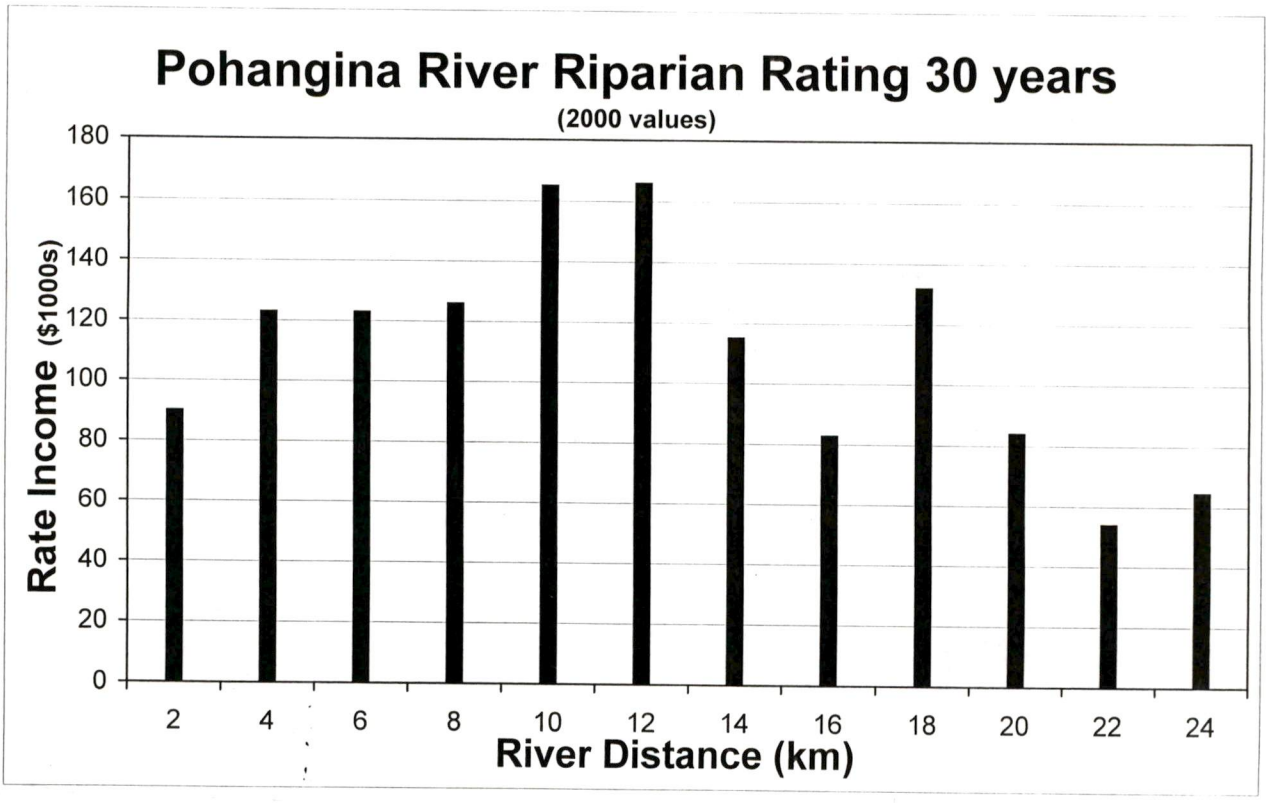
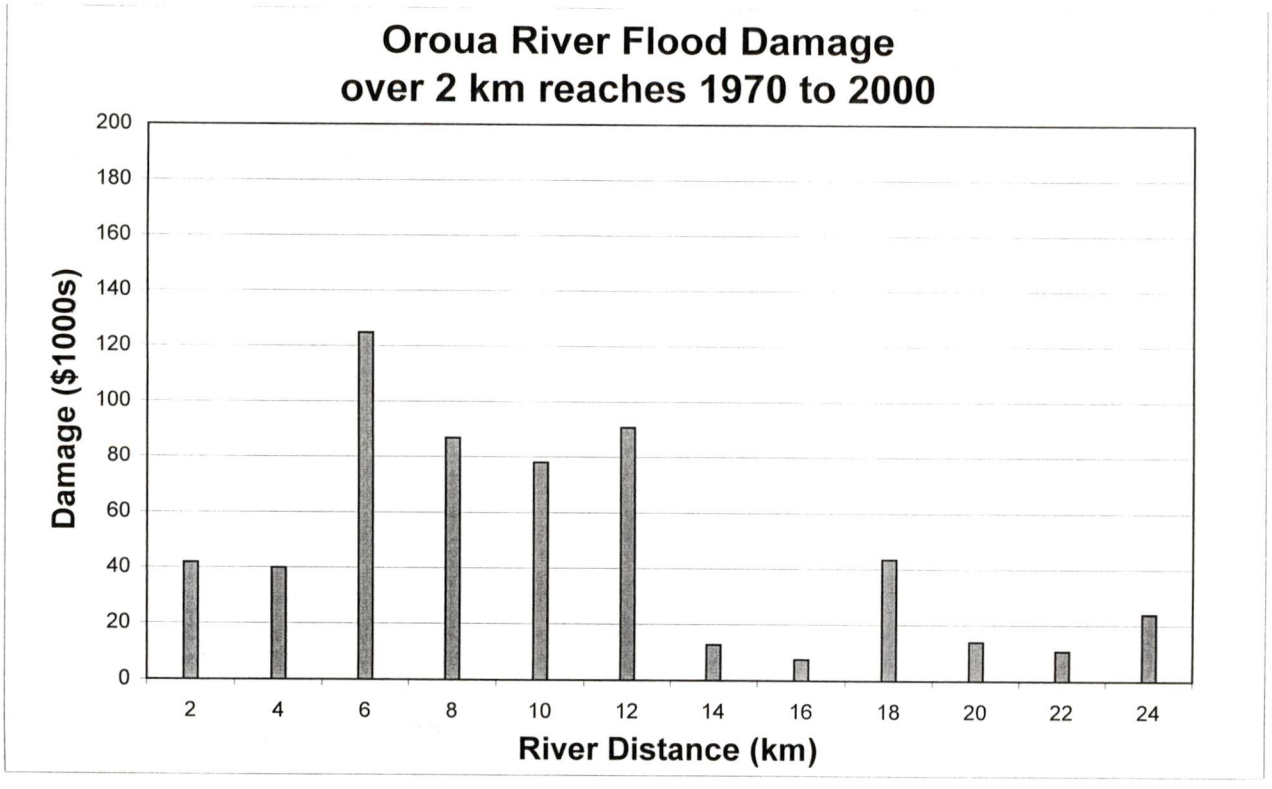


Figure 13. Comparison of Pohangina River Flood Damage Expenditure with Rating Income 1970 to 2000



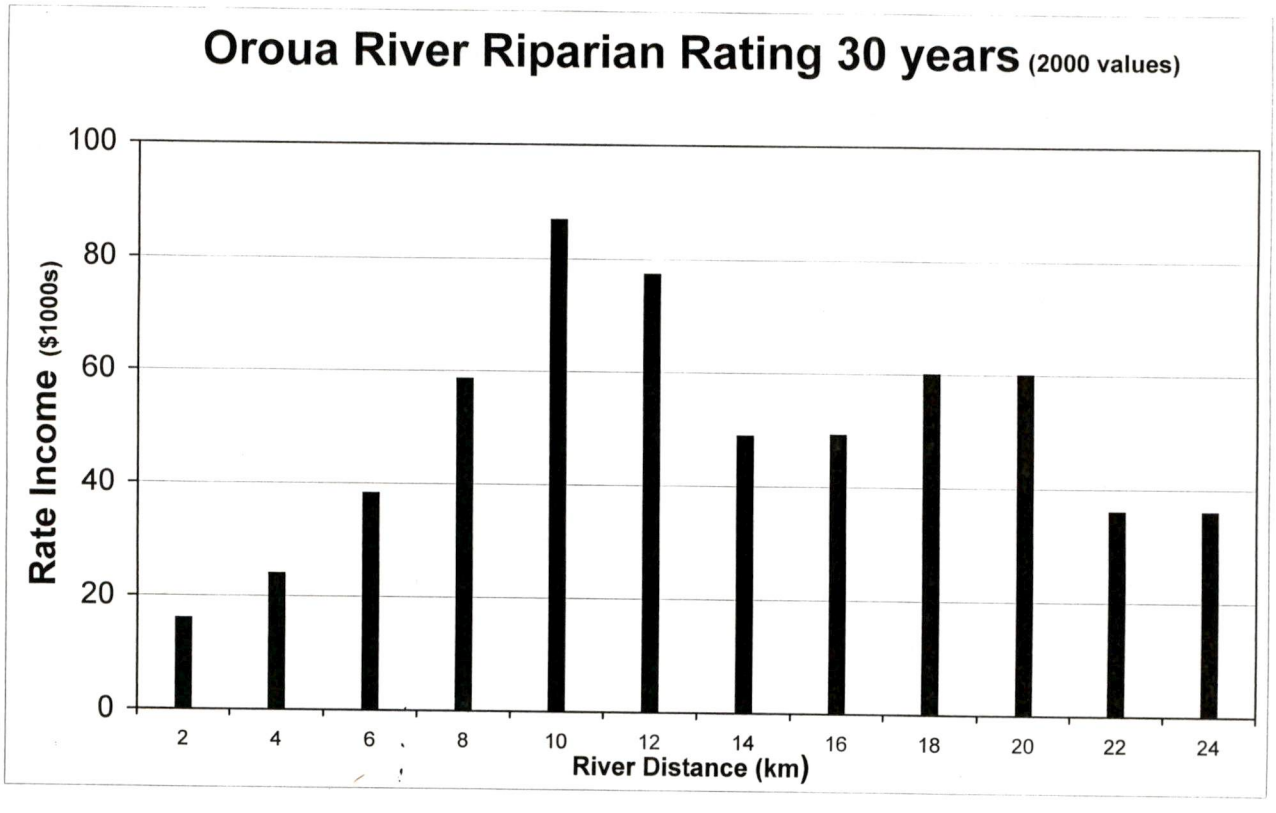
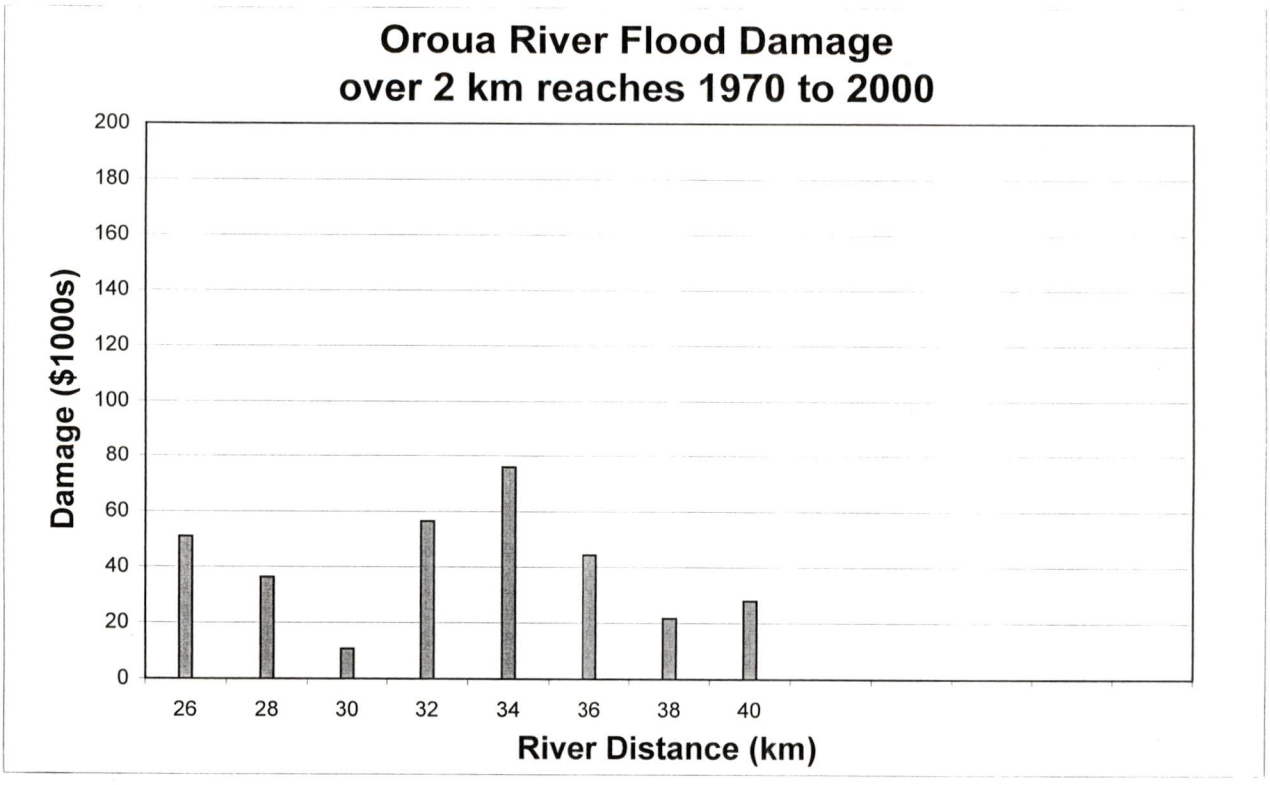


Figure 14. Comparison of Oroua River Flood Damage Expenditure with Rating Income 1970 to 2000 – Sheet 1



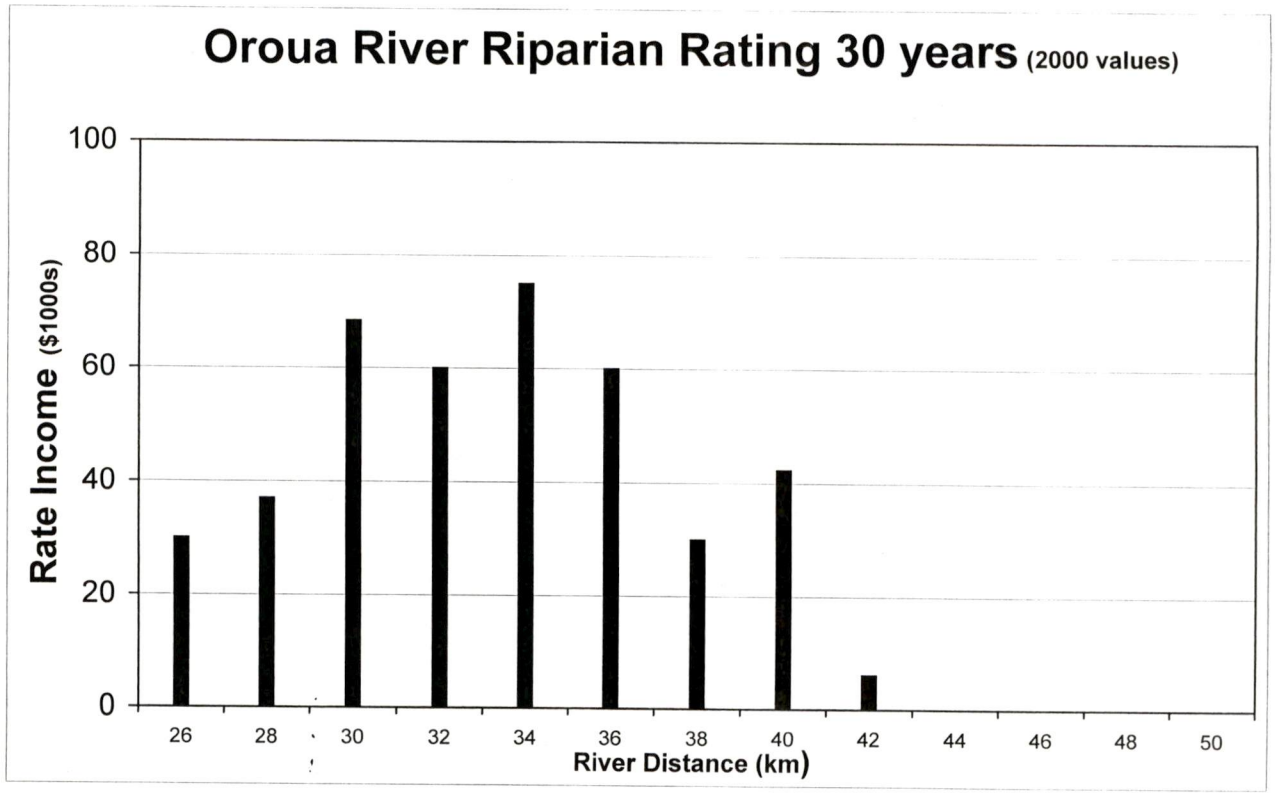


Figure 15. Comparison of Oroua River Flood Damage Expenditure with Rating Income 1970 to 2000 – Sheet 2

Figure 16 sets out the proposed expenditure on the Pohangina River by 2km reaches and the rating income for 30 years. It can clearly be seen that the existing classification will not be equitable for the funding of future works.

Soil Conservation

Under the original classification approximately 25% of the rates were to be collected from the Class D area, which was the area requiring community-funded soil conservation work. This area was mainly the area of the sandy silty very erodable soils. When the initial works were undertaken more than 25% of the Scheme's funds were budgeted to be spent in this area but there has been almost no expenditure since 1992 and even that was an isolated year.

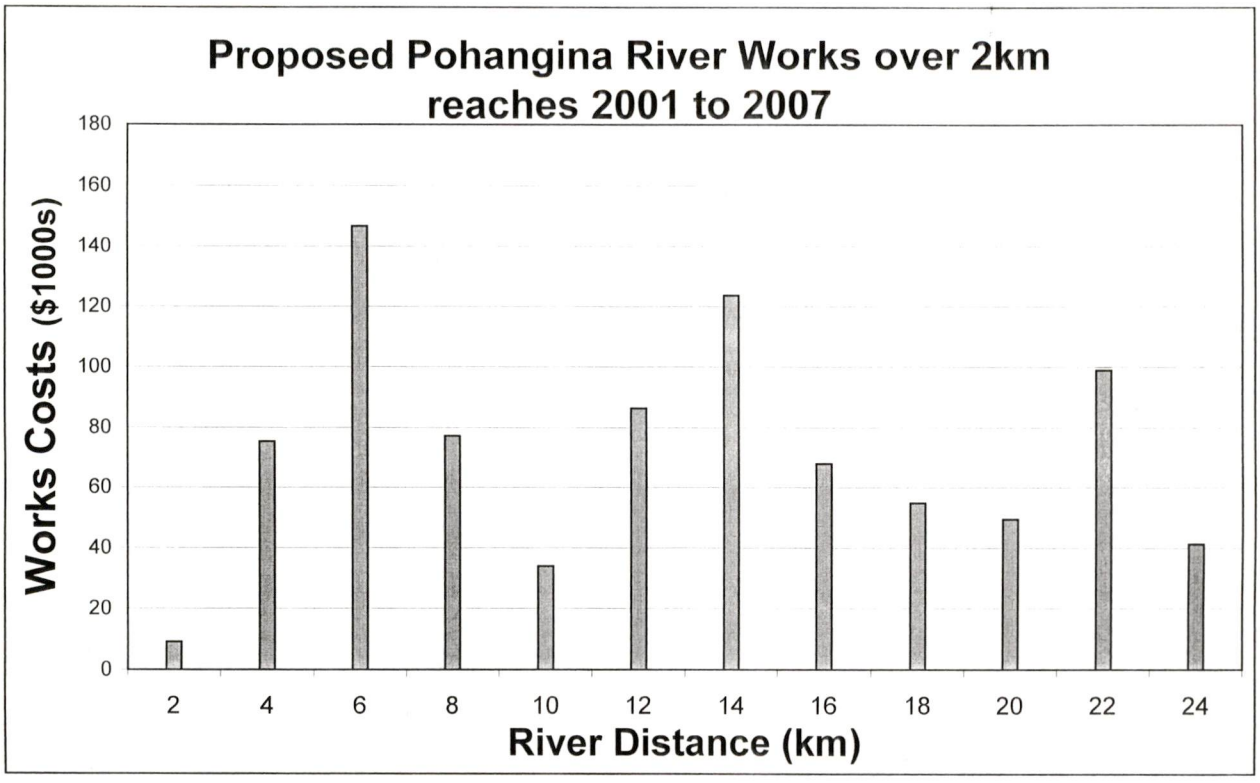
With the future maintenance of scheme works in this area funded from returns from the forestry, very little if any rating will be required in the future. It is therefore considered inequitable to continue collecting soil conservation rating under the existing classification.

20.3 A New Differential Rating System

The rating provisions of the Soil Conservation and Rivers Control Act 1941 were repealed with the introduction of the Rating Powers Act in 1988.

The new Act does not limit the number of classes or categories as they are called today and instead allows as many categories to be used as is necessary to ensure an equitable rating system is developed. This would allow separate rating categories (classes) for each of the Oroua and Pohangina river systems, for indirect benefit, for the urban areas, for drainage, and to reflect how the use of all land within the catchment either contributes to or alleviates the need for works.

A new differential rating system was developed in 2002 and adopted by the Council on 25 June 2002. A separate Regional Council report number 2002/EXT/535 dated July 2002 sets out the matters considered when preparing this classification and the final form and details of the new Differential Rating System.



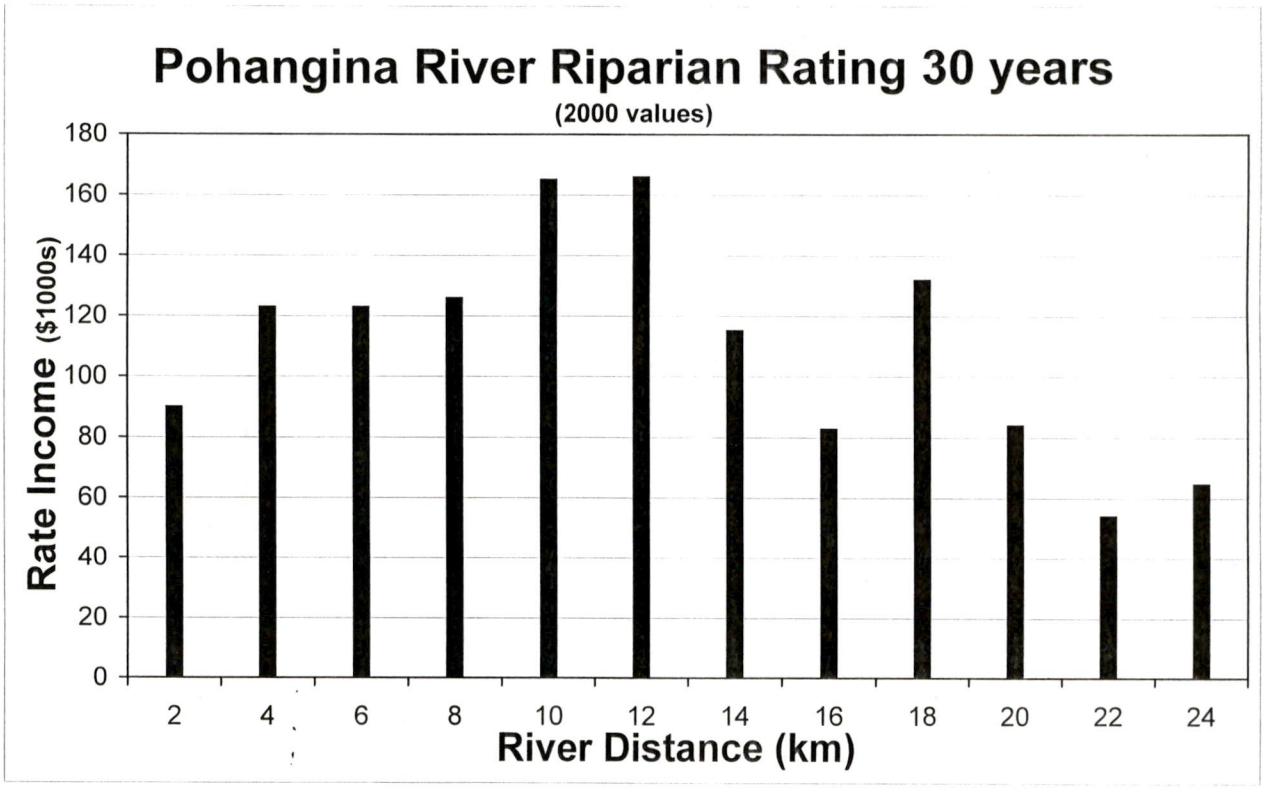


Figure 16. Comparison of Proposed Pohangina River Expenditure with Rating Income 1970 to 2000

21. Scheme Finances (Amended in 2006)

A long term programme for funding the works on the Pohangina River, the Oroua River, the Goulters Gully Forestry, and the Drainage activity, set out in Sections 12 to 15, has been prepared and is set out in Tables 17 and 18. This has been modified since the original 2001 report to take account of the new scheme management programme and the recommendations in Section 21.1.

The tables set out the Scheme income from Scheme rates, general rates, and the Goulters Forestry reserves, and the Scheme expenditure on works, management, and other costs including loan repayments. Table 17 is for the additional works to be funded by rate increases and by drawing down the Goulters Forestry Reserves, whereas Table 18 smooths the rate changes with additional loans repaid over 10 years.

Table 17 (no loan) shows that to enable the works proposed in the Scheme Review to be carried out, the level of Scheme rates will be very irregular. They would need to rise in 2007-2008 by 25%, reduce by 25% in 2008-2009 and further rise and fall through to 2016-2017 to the rating level of 2001. Should large flood events occur in the future where the repairs cannot be funded from reserves, the rates may need to rise again to cover the repair costs. The proposal however places an increased component of the rates into the emergency reserves to reduce the chances of this occurring.

Table 18 (loan option) shows that to enable the works proposed in the Scheme Review to be carried out, a loan of $115,000 would be required, drawn down over two years, repaid over 10 years, with no further increase in rates. A series of rate decreases would actually be possible from 2008 onwards to again reach a level of rating close to the 2001 level by 2016-2017.

An integral component of these two options would be a structured and targeted draw down of the Goulters Forestry reserves as set out in Section 21.1.

It is important to stress here that the proposed reduction in rates is subject to the following:

- that the proposed rate increases occur as programmed;
- that the works programme including all maintenance be fully implemented as proposed in the review;
- that the level of expenditure on Scheme works is as proposed; and
- that the draw down of the Goulters Forestry reserves is as discussed in Section 21.1.

The two charts in Figures 17 and 18 on the following pages show the Scheme expenditure for 2006-07 and for 1998-99. It can be clearly seen that the proposed works programme will spend a significantly larger proportion of the Scheme income on works than was the case in 1998-99.

The proposed works programme for 2006-07 is 250% larger in dollar terms than the 1998-99 works programme (excluding the expenditure on Soil Conservation Forestry).

21.1 Use of the Goulters Emergency Reserve Funds

Prior to the February 2004 flood event, it was proposed that a large proportion of the funds that became available following the harvesting of the Goulters Forestry area would be spent to carry out works on both the Pohangina and Oroua Rivers which would strengthen the existing protection works and achieve the recommended design channel alignment where possible.

As noted in the updated review, these works were undertaken with funding from insurance and Government assistance following the 2004 flood, and thus the reserve fund has remained intact.

There is now therefore the need to determine how to allocate the funds from this reserve to benefit the Scheme without adversely affecting the long-term scheme funding mechanism.

If the fund were used to offset rates required to fund normal maintenance and flood damage repair works, a time would come when the reserve had all been taken up and the level of rating at that time would be insufficient to effectively manage the Scheme. History would show that, at that point, there would be a reluctance of ratepayers to increase the level of rating to the necessary level, and this would then impact on the level of available funds for the necessary scheme maintenance works.

To avoid this possible problem, it is now necessary to establish a protocol for the use of the Reserve Fund.

The Goulters Forestry area has been replanted and in 25 years time a second injection of funds into the Goulters Forestry Reserve will occur. It is therefore not necessary to maintain the current level in the reserve fund for ever.

In the first instance it would appear to be reasonable that at least the interest from the fund could be used to assist with normal Scheme management. The current level of interest is about $46,000 per annum.

The review has identified a substantial amount of works required to improve the overall scheme effectiveness, namely the establishment of the clear flood fairways, the strengthening of existing works at key sites, and the construction of works to improve river alignment.

The works required to achieve the design flood fairway can be divided into two categories. These are the clearing of well-established long-term trees that narrow up the channel, and recently established vegetation. Clearing the recently established vegetation will be an ongoing process and thus funding it from a finite reserve fund is not logical. However clearing the older vegetation/trees will to a large extent be a one-off cost and could logically be funded from a "one-off" reserve.

River bank erosion can often result in the creation of a poor channel alignment. The prevention of further erosion usually involves works located along the line of the eroded river bank which can leave a channel alignment that is inconsistent with the design alignment. Works required to establish a line of protection that keeps the river on a better alignment will usually need to be more robust in the first instance and would often be over a greater river channel length. The additional works involved in achieving the design alignment would, in my opinion, be works that could be funded from the Goulters reserve fund.

As there is usually more erosion control work to fund than the funding available, there is a tendency to undertake just sufficient works to achieve the desired outcome. If an additional 20% of erosion control works costs was available, it would be possible to carry out works that are more robust and effective than at present. The projected cost of erosion control works over the next 10 years on the Pohangina and Oroua Rivers is $750,000. If an additional 20% was made available from the reserve fund, the drawdown of the reserve would be $150,000. ($15,000 per annum)

The reserves can only be reinstated in 25 years time if the forestry is well managed. All forestry management cost should therefore be funded from the reserves.

In summary the drawdown from the Goulters Forestry Reserves could occur as follows:

- all Goulters forestry management cost would be funded from the reserve;
- the interest from the reserve fund could be used to fund regular Scheme operational activities;
- 20% of the cost of all erosion control works could be funded from the reserve to enable them to be undertaken to a higher standard; and
- the cost of works to remove all well-established trees and vegetation from the flood fairway (not ongoing maintenance of recent re-vegetation) could be funded from the reserve.

The impact of this drawdown will be very dependent on the extent of future flood damage. However, to minimise the impact of this uncertainty, the contribution to the flood damage reserve fund has been increased from year seven onwards. This has also been done to keep the rates at a reasonable level.

The following table shows the approximate level of the Goulters reserve fund over the next 25 years under the current works and Scheme management programme.

Year	Reserve fund	Year	Reserve fund
06-07	$666,000	20-21	$385,000
10-11	$485,000	25-26	$335,000
15-16	$435,000	30-31	$285,000

Table 17: Pohangina-Oroua Scheme Long-Term Estimates - No Loan

	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Scheme Balance (at start of period)	**2,829**	**40,384**	**12,260**	**71**	**-1,967**	**4,430**	**828**	**-700**	**2,696**	**3,409**	**3,422**	**2,735**
INCOME												
% Rate rise (+) / Decrease (-ve)	2.50%	0.00%	25.00%	0.00%	-25.00%	-13.00%	7.00%	0.00%	-4.00%	0.00%	0.00%	0.00%
Scheme Rates (2000/2001 $154,773)	201,554	201,653	252,066	252,066	189,050	164,473	175,986	175,986	168,947	168,947	168,947	168,947
Territorial Bulk Rates	8,551	8,555	10,694	10,694	8,021	6,978	7,466	7,466	7,168	7,168	7,168	7,168
General Rate Contribution	55,617	76,525	78,648	80,893	50,122	44,602	45,475	44,340	44,251	44,251	44,251	45,251
Emergency Reserve Interest	9,945	1,625	3,250	4,875	6,500	8,125	1,625	4,550	7,150	9,750	12,350	2,600
transfer from reserves		0										
loan			0	0								
draw from Forest reserve to cover forestry expenses												
Extra draw from forestry reserve	75000	94,881	89,429	99,572	52,853	44,663	43,963	43,263	42,563	41,863	41,163	40,463
TOTAL INCOME	**350,668**	**383,240**	**434,087**	**448,100**	**306,545**	**268,842**	**274,516**	**275,606**	**270,079**	**271,979**	**273,879**	**264,429**
EXPENDITURE												
Pohangina below Totara Reserve	137000	141000	194500	215700	112000	80000	80000	80000	80000	80000	80000	80000
		9000	6200	12000	2000	2000	2000	2000	2000	2000	2000	2000
Pohangina above Totara Reserve	3000	3000	0	0	0	0	5000	0	0	0	0	5000
Oroua	65000	125500	98250	88300	50000	55000	55000	55000	55000	55000	55000	55000
		16,000	14,600	9,300	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Drain Maintenance	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
Soil Conservation Forestry	1,727	2,112	24,787	15,798	18,040	16,307	22,041	960	960	960	960	960
TOTAL WORKS EXPENDITURE	**210,727**	**300,612**	**342,337**	**345,098**	**194,040**	**165,307**	**176,041**	**149,960**	**149,960**	**149,960**	**149,960**	**154,960**
Management Costs												
Engineering Management	58,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
Asset Mgmt Planning	1,600	4,738	4,738	4,738	4,738	4,738	4,738	4,738	4,738	4,738	4,738	4,738
Rates Administration	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
Other Costs												
Valuation services	520	520	520	520	520	520	520	520	520	520	520	520
Asset insurance and LAPP	867	86	86	86	86	86	86	86	86	86	86	86
Hydrological	4,100	2,912	2,912	2,912	2,912	2,912	2,912	2,912	2,912	2,912	2,912	2,912
Scheme Reclassification	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Reserve Interest Trans	9945	1625	3250	4875	6500	8125	1625	4550	7150	9750	12350	2600
Emergency Reserve Contribution	25000	25000	25000	25000	25000	25000	25000	45000	40000	40000	40000	40000
Loan Repayment - Int	0	11,871	3,433	2,910	2,352	1,756	1,121	444	0	0	0	0
Loan Repayment - Prin			7,857	8,380	8,938	9,533	10,168	10,845	0	0	0	0
TOTAL EXPENDITURE	**314,759**	**411,364**	**446,276**	**450,138**	**300,148**	**272,444**	**276,044**	**272,210**	**269,366**	**271,966**	**274,566**	**269,816**
Scheme Balance (at end of period)	**38,738**	**12,260**	**71**	**-1,967**	**4,430**	**828**	**-700**	**2,696**	**3,409**	**3,422**	**2,735**	**-2,652**

Table 18: Pohangina-Oroua Scheme Long-Term Estimates - Loan option

	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Scheme Balance (at start of period)	**2,829**	**40,384**	**12,260**	**884**	**1,430**	**4,312**	**7,460**	**1,351**	**887**	**1,262**	**1,775**	**2,489**
INCOME												
% Rate rise (+) / Decrease (-ve)	2.50%	0.00%	0.00%	0.00%	-5.00%	-8.00%	0.00%	0.00%	-2.50%	0.00%	0.00%	0.00%
Scheme Rates (2000/2001 $154,773)	201,554	201,653	201,653	201,653	191,570	176,245	176,245	176,245	171,839	171,839	171,839	171,839
Territorial Bulk Rates	8,551	8,555	8,555	8,555	8,128	7,477	7,477	7,477	7,290	7,290	7,290	7,290
General Rate Contribution	51,617	76,525	79,057	82,109	51,657	45,983	46,688	45,372	45,089	44,880	44,654	45,412
Emergency Reserve Interest	9,945	1,625	3,250	4,875	6,500	8,125	1,625	4,550	7,150	9,750	12,350	2,600
transfer from reserves		0										
loan			55,000	60,000								
draw from Forest reserve to cover forestry expenses												
Extra draw from forestry reserve	75000	94,881	89,429	99,572	52,853	44,663	43,963	43,263	42,563	41,863	41,163	40,463
TOTAL INCOME	**346,668**	**383,240**	**436,944**	**456,764**	**310,708**	**282,493**	**275,998**	**276,908**	**273,931**	**275,622**	**277,297**	**267,604**
EXPENDITURE												
Pohangina below Totara Reserve	127000	141000	194500	215700	112000	80000	80000	80000	80000	80000	80000	80000
Additional erosion control works		9000	6200	12000	2000	2000	2000	2000	2000	2000	2000	2000
Pohangina above Totara Reserve	3000	3000	0	0	0	0	5000	0	0	0	0	5000
Oroua	55000	125500	98250	88300	50000	55000	55000	55000	55000	55000	55000	55000
Additional erosion control works		16,000	14,600	9,300	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Drain Maintenance	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
Soil Conservation Forestry	1,727	2,112	24,787	15,798	18,040	16,307	22,041	960	960	960	960	960
TOTAL WORKS EXPENDITURE	**190,727**	**300,612**	**342,337**	**345,098**	**194,040**	**165,307**	**176,041**	**149,960**	**149,960**	**149,960**	**149,960**	**154,960**
Management Costs												
Engineering Management	58,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
Asset Mgmt Planning	1,600	4,738	4,738	4,738	4,738	4,738	4,738	4,738	4,738	4,738	4,738	4,738
Rates Administration	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
Other Costs												
Valuation services	520	520	520	520	520	520	520	520	520	520	520	520
Asset insurance and LAPP	867	86	86	86	86	86	86	86	86	86	86	86
Hydrological	4,100	2,912	2,912	2,912	2,912	2,912	2,912	2,912	2,912	2,912	2,912	2,912
Scheme Reclassification	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Reserve Interest Trans	9945	1625	3250	4875	6500	8125	1625	4550	7150	9750	12350	2600
Emergency Reserve Contribution	25000	25000	25000	25000	25000	25000	25000	45000	40000	40000	40000	40000
Loan Repayment - Int	0	11,871	5,477	8,990	10,030	8,657	7,185	5,606	4,190	3,144	2,016	802
Loan Repayment - Prin			9,886	15,252	19,016	20,389	21,861	23,441	13,567	14,613	15,741	16,955
TOTAL EXPENDITURE	**294,759**	**411,364**	**448,320**	**456,218**	**307,826**	**279,345**	**282,107**	**277,372**	**273,556**	**275,110**	**276,582**	**270,618**
Scheme Balance (at end of period)	**54,738**	**12,260**	**884**	**1,430**	**4,312**	**7,460**	**1,351**	**887**	**1,262**	**1,775**	**2,489**	**-525**

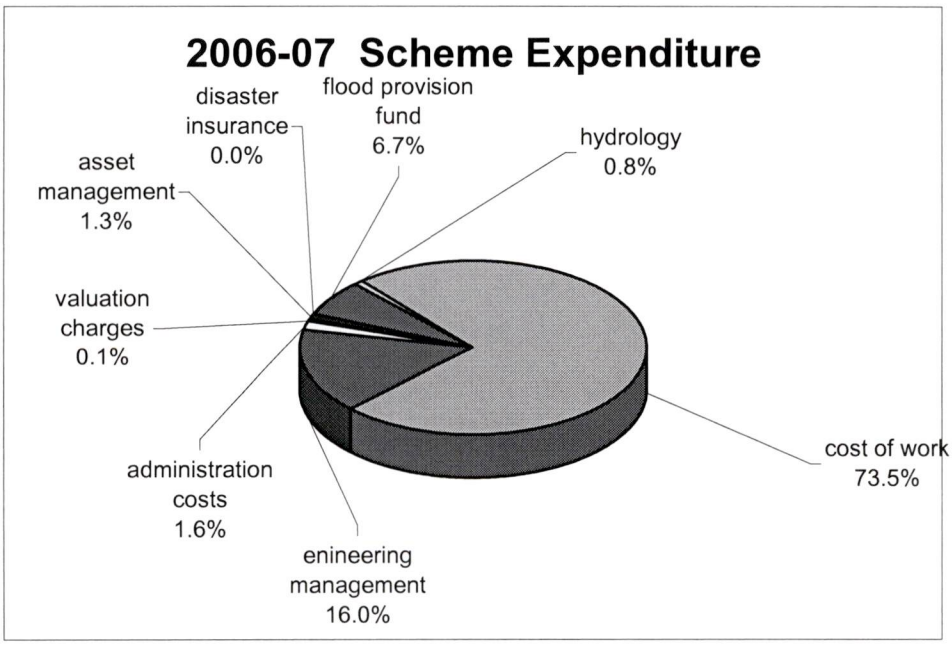


Figure 17: 2006-07 Scheme Expenditure

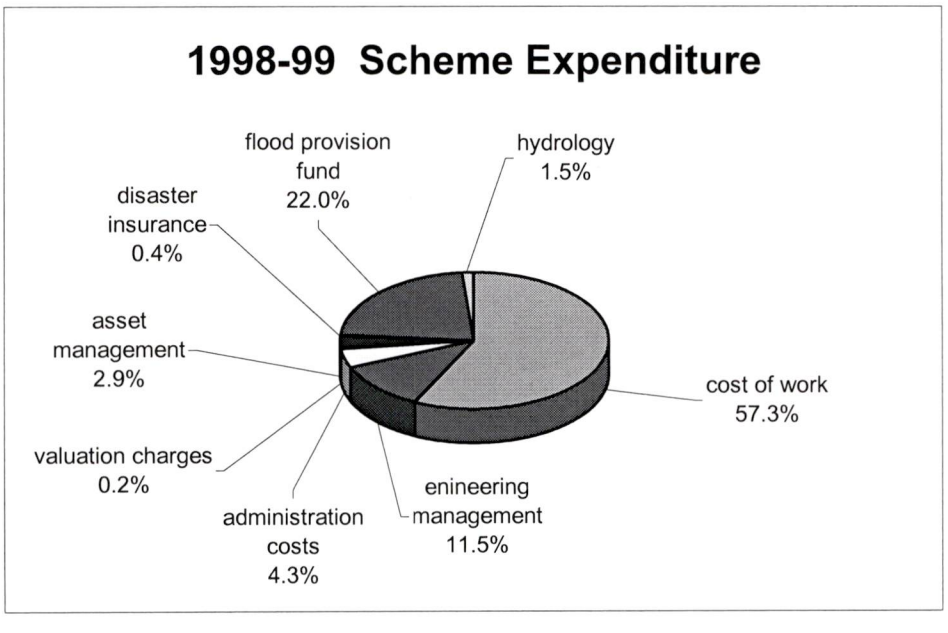


Figure 18: 1998-99 Scheme Expenditure

22. Scheme Management (as per the 2001 report)

22.1 General

The Scheme was managed until 1989 by the Manawatu Catchment Board under the legislative power of the Soil Conservation and Rivers Control Act 1941.

In 1989 the reform of local government resulted in the functions of the Catchment Board being transferred to the Manawatu-Wanganui Regional Council (now re-branded as **Horizons Regional Council**). This change made no significant difference to the management of the Pohangina-Oroua Scheme.

Management of the scheme assets has been put on a more sound footing by the Scheme Asset Management Plan which was completed in 1999. This was prepared to satisfy the statutory requirements of the Local Government Amendment Act 1996 to improve accountability and decision making for ratepayers. The Plan provides a strategic approach to managing the Scheme assets. The Plan will need to be reviewed if this Scheme Review is adopted.

Management policy, procedures, performance and practices are similar for all the River and Drainage Schemes managed by Council and are assumed to be appropriate and therefore outside the scope of this Review.

22.2 Liaison with Ratepayers

To ensure that the Scheme provides the required standard of service at an acceptable cost, the Council seeks input from Scheme ratepayers at annual meetings and more regularly through the Scheme Liaison Committee. Annual meetings provide a forum for ratepayers to discuss budgets and works programmes, and Council holds meetings with the Liaison Committee chairmen to discuss policy, budgets and significant issues arising during the year.

A lack of communication with new ratepayers can lead to problems associated with the operation and maintenance of the Scheme works. Information leaflets are being prepared to help improve awareness of the functions of the respective schemes.

22.3 Scheme Liaison Committee

The Liaison Committee is an informal committee established to facilitate effective communication between Scheme Ratepayers and **Horizons Regional Council**. Its role is essentially to represent ratepayers by making known to **Horizons Regional Council** staff the views of ratepayers on Scheme issues and to disseminate information to ratepayers on Scheme activities. The Pohangina-Oroua Scheme Committee has met on at least two occasions per year over recent years.

The terms of reference prepared in 1996 for the Scheme Committee is as follows:

a. each Liaison Committee shall consist of five members with a broad representation of the Scheme taking into account both the main ratepayer interests and the geographical extent of the Scheme. Additional or fewer

Committee members may be appointed at the discretion of the Regional Council;

b. members of the Liaison Committee will usually be nominated by ratepayers at the annual Scheme Ratepayer Meeting and will be confirmed in writing by the Regional Council shortly thereafter;

c. a Chairman for the Liaison Committee shall be appointed by the Liaison Committee members;

d. the Regional Council will request meetings with the Liaison Committee as necessary to discuss works programmes and other Scheme management issues;

e. the Chairman of the Liaison Committee or in his absence another member, may be required from time to time to attend meetings with the Operations Committee of the Regional Council; and

f. liaison between the Regional Council and the Liaison Committee will generally be through the Council's Area Engineer for the Scheme, or his assistants.

22.4 The Role of the Ratepayers

The first paragraph of this report states that the Scheme is essentially a ratepayer collective managed by the Council. In order that the Scheme provides the best service to its ratepayers, it is important that the ratepayers, especially the riparian ratepayers and those who have scheme drains on their properties, are vigilant in carrying out their responsibilities especially following flood events. The Scheme Ratepayers have a responsibility to:

a. prevent unnecessary damage to protection works and Scheme drains caused by stock and other farming practices; and

b. notify the Area Engineer or Scheme Liaison Committee of any problems with the integrity of the protection works or blockages in the Scheme drains.

22.5 The Scheme Manager

The Scheme is managed by an Area Engineer appointed by **Horizons Regional Council**. The Scheme Manager is responsible for preparing and implementing an annual works programme to ensure the Asset Management Plan and the recommendations of the Scheme Review are implemented.

Engineering Management Costs are charged directly to the Scheme and along with other Scheme costs are subsidised by 20% through the General rate contribution.

22.6 Global Warming

A section on the effects of global warming has been added at this point as the response required at this stage will be a management one.

The effects of global warming will increase the temperature of the sea which will result in an increased level of evaporation. This will in turn cause more high intensity rainstorms. On the other hand the warming will reduce the frequency of the more normal rainfall events.

For the Pohangina-Oroua Scheme this may result in years with very small flood damage and an increase in the frequency of the larger events. The net result in damage cost may be much the same as at present but this is pure speculation.

There is still insufficient information with which to chart the trend over the next 20 or 30 years and so the Scheme manager will need to keep an eye on the changes that are occurring in the Scheme and recommend to ratepayers appropriate courses of action when these are identified.

The type of scheme works that are now being undertaken, and the recommendations in this review to maintain the flood-carrying capacity of the channel, should cater for at least some of the changes that are likely to occur.

22.7 Consents

The works necessary to manage the Pohangina and Oroua Rivers involve activities that are controlled by the Regional Plan for the Beds of Rivers and Lakes and Associated Activities. A number of these activities are permitted under the Plan but some, especially those that require significant disturbance of the active channel, will require a consent.

Maintenance of the works that existed prior to the notification of the Regional Plan for Beds of Rivers and Lakes and Associated Activities are permitted.

A consent was applied for and granted, subject to a range of conditions, to carry out the river control works that were required at eight sites on the Pohangina and Oroua Rivers following the November 1999 and the April 2000 floods.

A consent will be required to carry out many of the protection works set out in this report, and for practical and efficiency reasons it would be worthwhile applying for a global consent for all works on the two rivers.

A copy of the consent granted for the work at the eight sites is attached in Appendix G. (Now removed and replaced by new global consent – refer to next paragraph)

A global consent was applied for in 2003 and granted subject to a number of standard conditions. This consent has been attached to this report in Appendix G.

22.8 Other Management Costs

Time spent and other costs associated with asset management and rates administration are charged directly to the Scheme and are subsidised in the same way as engineering management costs.

22.9 Scheme Review Costs

Scheme review, survey, detailed design and classification costs are charged to the scheme. However under current Council Policy, those costs are fully offset by a contribution from General Rate.

23. Conclusion (Updated 2006)

The Scheme, established in 1967, has, to a large extent achieved its original objectives of controlling and preventing erosion in the Castlecliffian sand formations and in stabilising the Pohangina and Oroua rivers as nearly as possible in the positions that existed in the late 1960s.

The original scheme envisaged that the majority of the work would be completed in the first seven years and that the ongoing river management work would maintain a clear fairway along both rivers to maintain their flood-carrying capacity. The latter however was not achieved. The Oroua River over much of its length is still too narrow and consequently large flood events cause considerable damage to established edge protection works.

The Pohangina River works have on one hand been more successful as the river is now confined to largely a single thread channel (in 1970 much of the river was wide and braided), but on the other hand the flood-carrying capacity of the fairway has not been maintained, resulting in continual high levels of flood damage.

Insufficient funding to carry out erosion control works sufficiently robust to stand up to these flood events has been the root cause of this regular flood damage. The need for the repair of this damage has further exacerbated the shortage of funds available for the maintenance of the channel and flood fairway.

To provide the level of protection expected by landowners today, sufficient scheme funds will be necessary to carry out both the robust protection works as well as works necessary to maintain the flood-carrying capacity of both rivers. Significant increases in expenditure on Scheme works will be required over the next six to seven years to carry out the necessary works. Following their completion it will be necessary to maintain the level of expenditure at a level 40 to 50% higher than at present but less than in the preceding six to seven years.

The key to the success of the works will be the planting and ongoing management of the planted buffer strips. Ratepayer commitment will be required to make land available for the buffer strips and to fence the strips to prevent stock damage.

The stabilisation of the eroding Goulter and Belmont gully systems has been successfully achieved, and extensive Pinus Radiata forest plantings planted to control run-off and make good use of land purchased by the Scheme, are now ready to be harvested. Plans are in place to harvest these trees over the next two years and the return from them, once replanting and forestry management expenses are deducted, will provide the Scheme with an average annual income and a capital injection to enable the programmed works to be completed as soon as possible.

The replanting of these trees will be vital to maintain the stability of the sand gullies and careful management of the area will be required during and following the harvesting work.

The proposed significant increase in scheme expenditure to undertake the improvement and strengthening work was to be funded from a small increase in

Scheme rates as well as income from the forestry investments. However the works that followed the February 2004 flood were funded to a large extent by insurance and Central Government input. This has resulted in the forestry investment funds still being available to assist with future scheme works.

Analysis in 2001 of the rating system showed that it was no longer collecting rates on an equitable basis and concluded that the scheme should be reclassified following the adoption of the recommendations of the 2001 review.

The Review concluded that the Scheme was being managed in a professional manner with a good balance of input from a Liaison Committee made up of ratepayers within the catchment. The review concluded that the management system should continue whilst being heavily guided by the river management regime set out in the 2001 review. Failure then and now to implement the recommended management regime would ensure that significant levels of flood damage would continue to occur.

24. Recommendations (Updated 2006)

Pohangina River

y. adopt the Pohangina River design alignment as detailed in Section 12 of the Review and as shown on Figure 9;

z. undertake the protection works in priority order unless flood damage requires work on a reach of the river to be done out of sequence with its priority;

aa. undertake the planting programme on each reach of the river along with the protection works on that reach and layer and maintain existing trees as part of this work;

bb. assign any surplus funds in any year to planting and channel maintenance;

cc. maintain beaches and clear vegetation to ensure the design fairway is kept clear;

dd. carry out changes to work priorities in the future if required using the principles set out in the Review;

ee. obtain as far as possible, agreements with landowners in regard to protection plantings.

Oroua River

ff. undertake the protection works in priority order unless flood damage requires work on a reach of the river to be done out of sequence with its priority;

gg. undertake works wherever possible in accordance with the Oroua River Design Parameters as set out in Section 12 table 10 of the Review;

hh. prioritise protection works in accordance with section 13 table 12 of the Review;

ii. carry out planting works to create the 20 metre bands of willows as detailed on Figure 11;

jj. carry out changes to work priorities in the future if required using the principles set out in the Review;

kk. obtain, as far as possible, agreements with landowners in regard to protection plantings.

Gravel Management

ll. direct gravel extractors to beaches where gravel extraction would facilitate general river management;

Soil Conservation works

mm. utilise the income from the sale of the Goulters Gully forest to:

- re-establish the protection forest as soon as possible in such a way as to maximise erosion protection as well as future tree production; and

- assist with the funding of Scheme works spread over a 25-year period;

Drainage

nn. fund all future Scheme drainage works through rates over those who directly benefit from those works;

Maintenance

oo. maintain existing Scheme assets ahead of constructing new Scheme assets;

pp. always include the cost of ongoing maintenance works when preparing estimates for new capital works;

Non-Scheme Assets

qq. obtain funding for works required to protect assets where the owner of those assets does not contribute to the Scheme from the asset owner unless otherwise agreed to by Horizons Regional Council and the Scheme ratepayers;

rr. share funding of protection works required to prevent riverbank erosion which is threatening both non-ratepayer asset and ratepayer assets except where natural river processes would be accepted if the non-scheme asset was not present. In these cases the total cost of the protection works shall be fully funded by the asset owner;

Scheme Finances

ss. fund the Scheme by way of rates and a loan repaid over a 10-year period;

tt. manage scheme income and expenditure in line with the details set out on table 18 of the review; and

uu. allocate Goulters Forestry Reserves to cover the matters set out in Section 21.1; and

vv. monitor expenditure of Scheme funds over the long term to maintain rating equity within the Scheme.

APPENDICES

APPENDIX A

HISTORICAL EXPENDITURE

HISTORICAL EXPENDITURE ON THE POHANGINA OROUA SCHEME

	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
			12 months				
River control works POHANGINA							information
Channel clearing	130	0	349		1,725	10,769	not
Tree planting	3,081	4,928	4,977	2,313	677	5,601	available
tree layering	2,878	1,105	2,035	1,599	283		
Tree protection							
rock protection							
stopbanks					1,628		
flood damage repair POHANGINA	75,596	18,365	15,610	7,658	67,886	17,653	
Pohangina Totals	**81,685**	**24,398**	**22,971**	**11,570**	**72,199**	**34,023**	
River control works OROUA							
Channel clearing	3,124		4,088	4,818	330	200	
Tree planting	214	5,234	6,483	3,234	991	6,187	
tree layering							
Tree protection							
rock protection							
miscellaneous							
stopbanks					1,351		
flood damage repair OROUA	48,402	45,999	18,355	38,968	127,240	25,089	
Oroua Totals	**51,740**	**51,233**	**28,926**	**47,020**	**129,912**	**31,476**	
Soil conservation				7,710			
Drain Maintenance	4,645	5,956	2,751	3,498	415	4,056	
TOTAL WORKS EXPENDITURE	**138,070**	**81,587**	**54,648**	**69,798**	**202,526**	**69,555**	**78,986**
Management Costs							
Engineering management	34,517	20,376	10,935	13,930	13,922	16,096	17,500
Administration charge		7,165	2,683	1,404	4,400	2,796	3,500
Asset mgmt	0	0		0	0	0	0
LAPP Levy	0	0		0	0	146	146
Valuation charges	250	265		2,907	0	638	638
Review/Design/survey		0		0	0	0	0
Hydrology charge	2,000	2,000	2,000	2,000	2,000	2,004	2,000
other costs (incl Loans)		0		0	0	0	
TOTAL MANAGEMENT	36,767	29,806	15,618	20,241	20,322	21,680	23,784
Transfer to emergency reserves	0	0	25,000	24,400	24,000	23,000	23,000
transfer interest to emergency reserves			0		3,616	0	1,725
loan repayement interest							
Loan repayement capital							
TOTAL EXPENDITURE	**174,837**	**111,393**	**95,266**	**114,439**	**250,464**	**114,235**	**127,495**
Income							
rates	110,363	110,363	146,751	107,354	107,354	112,722	112,722
local authority rates and contributions	4,680	4,680	5,892	4,553	4,553	4,781	4,781
interest off reserves			0		3,616	0	1,725
General Rate contribution							
transfer from emergency reserves					79,003		
other income	25,857	25,857	11,200	6,200	52,046	9,474	1,396
Loan							
Grant from General Rate							
TOTAL INCOME	**140,900**	**140,900**	**163,843**	**118,107**	**246,572**	**126,977**	**120,624**

HISTORICAL EXPENDITURE ON THE POHANGINA OROUA SCHEME

	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
			12 months				
River control works POHANGINA							information
Channel clearing	130	0	349		1,725	10,769	not
Tree planting	3,081	4,928	4,977	2,313	677	5,601	available
tree layering	2,878	1,105	2,035	1,599	283		
Tree protection							
rock protection							
stopbanks					1,628		
flood damage repair POHANGINA	75,596	18,365	15,610	7,658	67,886	17,653	
Pohangina Totals	**81,685**	**24,398**	**22,971**	**11,570**	**72,199**	**34,023**	
River control works OROUA							
Channel clearing	3,124		4,088	4,818	330	200	
Tree planting	214	5,234	6,483	3,234	991	6,187	
tree layering							
Tree protection							
rock protection							
miscellaneous							
stopbanks					1,351		
flood damage repair OROUA	48,402	45,999	18,355	38,968	127,240	25,089	
Oroua Totals	**51,740**	**51,233**	**28,926**	**47,020**	**129,912**	**31,476**	
Soil conservation				7,710			
Drain Maintenance	4,645	5,956	2,751	3,498	415	4,056	
TOTAL WORKS EXPENDITURE	**138,070**	**81,587**	**54,648**	**69,798**	**202,526**	**69,555**	**78,986**
Management Costs							
Engineering management	34,517	20,376	10,935	13,930	13,922	16,096	17,500
Administration charge		7,165	2,683	1,404	4,400	2,796	3,500
Asset mgmt	0	0		0	0	0	0
LAPP Levy	0	0		0	0	146	146
Valuation charges	250	265		2,907	0	638	638
Review/Design/survey		0		0	0	0	0
Hydrology charge	2,000	2,000	2,000	2,000	2,000	2,004	2,000
other costs (incl Loans)		0		0	0	0	
TOTAL MANAGEMENT	36,767	29,806	15,618	20,241	20,322	21,680	23,784
Transfer to emergency reserves	0	0	25,000	24,400	24,000	23,000	23,000
transfer interest to emergency reserves			0		3,616	0	1,725
loan repayement interest							
Loan repayement capital							
TOTAL EXPENDITURE	**174,837**	**111,393**	**95,266**	**114,439**	**250,464**	**114,235**	**127,495**
Income							
rates	110,363	110,363	146,751	107,354	107,354	112,722	112,722
local authority rates and contributions	4,680	4,680	5,892	4,553	4,553	4,781	4,781
interest off reserves			0		3,616	0	1,725
General Rate contribution							
transfer from emergency reserves					79,003		
other income	25,857	25,857	11,200	6,200	52,046	9,474	1,396
Loan							
Grant from General Rate							
TOTAL INCOME	**140,900**	**140,900**	**163,843**	**118,107**	**246,572**	**126,977**	**120,624**

	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01
POHANGINA						
Channel clearing			1,326	0	250	41,481
Tree planting	5,670	5,658	1,888	521	2,772	6,150
tree layering		1,878	500	2,995	3,570	1,888
Tree protection						
rock protection		512				
stopbanks						
flood damage repair POHANGINA	18,000	19,248	66,438	21,064	104,738	191,613
Pohangina Totals	**23,670**	**27,296**	**70,152**	**24,580**	**111,330**	**241,132**
OROUA						
Channel clearing	3,926	6,000	700	1,373	450	7,573
Tree planting	4,190	7,690	11,655	2,758	7,144	13,686
tree layering	656		0	4,566	4,774	360
Tree protection						
rock protection		2,218				
miscellaneous						
stopbanks						
flood damage repair OROUA	30,948	28,482	44,201	40,771	110,852	154,006
Oroua Totals	**39,720**	**44,390**	**56,556**	**49,468**	**123,220**	**175,625**
Soil conservation						12,933
Drain Maintenance	11,722	3,341	634	3,995	0	3,780
TOTAL WORKS EXPENDITURE	**75,112**	**75,027**	**127,342**	**78,043**	**234,550**	**433,470**
Management Costs						
Engineering management	18,750	19,200	19,600	44,653	72,485	59,793
Administration charge	3,750	3,840	3,920	4,070	4,165	3,750
Asset mgmt	0	0	0	4,004	78	1,548
LAPP Levy	219	257	231	484	202	1,535
Valuation charges	517	488	486	231	468	533
Review/Design/survey	0	0	0	38,075	32,511	64,930
Hydrology charge	2,004	2,000	2,000	2,000	10,780	4,196
other costs (incl Loans)	545	700	721	1,830	293	
TOTAL MANAGEMENT	25,785	26,485	26,958	95,347	120,982	136,285
Transfer to emergency reserves	23,000	23,000	23,000	30,000	24,000	16,000
transfer interest to emergency reserves	3,958	6,270	8,126	5,366	6,779	345
loan repayement interest						12,256
Loan repayement capital						22,073
TOTAL EXPENDITURE	**127,855**	**130,782**	**185,426**	**208,756**	**386,311**	**620,429**
Income						
rates	117,867	120,725	120,726	132,795	138,373	154,773
local authority rates and contributions	5,020	5,120	5,119	5,634	5,916	6,567
interest off reserves	3,958	6,270	8,126	5,366	6,779	345
General Rate contribution				67,039	80,654	100,736
transfer from emergency reserves			50,000		146,000	
other income						
Loan						260,122
Grant from General Rate						100,000
TOTAL INCOME	**126,845**	**132,115**	**183,971**	**210,834**	**377,722**	**622,543**

APPENDIX B

HISTORICAL FLOOD PATTERNS

HISTORICAL FLOOD PATTERN - POHANGINA RIVER AT MAIS REACH				
YEAR	**PEAK FLOW (m3/s)**	**NUMBER 2 year & greater**	**DURATION above 2 year**	**FLOOD DAMAGE $1000 s**
1970	540	2 year	2	
1971	790	5-10 year	16½	40.8
1972	620	2-5 year	8	54
1973	360			0
1974	605	2-5 year	3¼	0
1975	845	10 year	6¾	28.5
1976	365			29.4
1977	260			32.9
1978	370			23.4
1979	600	2-5 year	10½	65.4
1980	695	multi 5 year, 2 year	11½	49.8
1981	565	2 year	3¾	64.8
1982	280			0
1983	540	2 year	2	33.8
1984	290			10.3
1985	700	double 5 year	11¼	107.4
1986	465			43.7
1987	385			31.2
1988	930	multi 15-20 year, 2 ye	21¾	136.6
1989	395			35.2
1990	290			32.7
1991	415			16.3
1992	1070	20-50 year	16	140.8
1993	225			37.1
1994	350			0
1995	195			8.8
1996	220			0
1997	330			168.2
1998	215			13.2
1999	750	5 year	7½	273.7
2000	845	10 year	7¼	0

HISTORICAL FLOOD PATTERN OROUA RIVER AT ALMADALE				
YEAR	**PEAK FLOW (m3/s)**	**NUMBER 2 year & greater**	**DURATION above 2 year**	**FLOOD DAMAGE $1000 s**
1948	220	5 year	8¼	
1949	230	5 year	19½	
1950	245	5-10 year	20¾	
1951	105			
1952	110			
1953	145			
1954	175	2 year	6½	
1955	145			
1956	270	10 year, +	27¼	
1957	155			
1958	360	50 year	7½	
1959	120			
1960	70			
1961	115			
1962	165			
1963	175	2 year	2¼	
1964	95			
1965	285	multi 15-20 year, +	55¾	
1966	170	2 year	1¼	
1967	240	5-10 year, +	9½	
1968	155			
1969	85			
1970	185	2-5 year	1¾	
1971	195	2-5 year	9	24.8
1972	185	2-5 year	2	4.1
1973	135			0
1974	160			0
1975	225	5 year	5	0
1976	195	2-5 year	10	17.8
1977	130			19.4
1978	115			0
1979	185	multi 2-5 year	¾	38.3
1980	235	5-10 year, 2 year	12½	35.2
1981	205	two 2-5 year	6½	51.4
1982	55			9.7
1983	155			13.5
1984	85			15.9
1985	260	10 year	17½	36.9
1986	140			15
1987	150			11
1988	350	multi 50 year, 5 year	25	87.9
1989	155			95.8
1990	140			30.2
1991	175	2 year	¼	78.4
1992	215	5 year		266.9
1993	95			52.7
1994	175	2 year	2½	0
1995	85			46.1
1996	130			0
1997	150			109.2
1998	110			8.4
1999	245	5-10 year	15½	194.3
2000	190	2-5 year	2¼	0

APPENDIX C

SOIL CONSERVATION REPORTS – FIRST 10 YEARS

MANAWATU CATCHMENT BOARD

POHANGINA/OROUA CATCHMENT CONTROL SCHEME

SOIL CONSERVATION WORKS COMPLETED

The first year of operation - winter 1967 - saw the establishment of 16 fenced planting blocks. This block planting was done in strategic localities e.g. around vulnerable waterfalls in active or potentially active gullies. The first year's work was concentrated in the Raumai - Pohangina Township area. This work took 1,600 sheep poles and 2,280 stakes.

Gully planting in the first year was confined to the Goulter - Krull - Belmont system where 5,500 stakes were used.

Also in the same year one wooden flume, 4 cable-pole netting dams and 7 pole-netting dams were constructed. The wooden cantilever flume with a heavy concrete anchor is serving its purpose very well. The use of netting dams has been discontinued in the main gullies because, although succesful in small catchments, they do not stand up to the force of floodwaters and debris in the bigger gullies.

In 1968 - the second year - 15 blocks were established involving 9, 142 sheep poles and 2, 910 stakes. The locality of these was further north in the Ridge Road, Te Awa Road, area.

The gully planting was again concentrated in the Goulter/Belmont gullies, taking 490 cattle poles 14,000 sheep poles, 4,000 stakes and 1,000 Tasmanian Blackwood plants.

A big slip blocked the main Goulter/Belmont gully. An attempt was made to convert the sandy slip into a permanent silt trap but the attempt failed.

Third year - 1969 - Eight gully blocks were established in various localities in the district.

The first helicopter drop was made in this season, placing 6,600 stakes and sheep poles (27 flights) in 1¼ hours in the difficult Goulter Belmont system. This was so successful that later in the same season a second drop was arranged of 600 cattle poles, 5000 sheep poles and 4,00 stakes. This time the locality was Culling's gully and Beehive Creek. Another 1000 sheep-poles were taken into Krull's gully by truck and tractor. A timber weir to act as stable base for flood measurements was constructed in Beehive Creek. Retirement fencing of Beehive Creek was subsidised by the scheme involving 93 chains.

Fourth year 1970 - Five blocks were established this season, consisting of 750 cattle poles half of which were protected with netlon sleeves.

The gully work was in Goulter - Belmont, Beehive Creek, Nichol and Young's gullies. This involved 970 cattle poles, 18,000 sheep poles and 6,000 pines.

A half steel pipe flume was constructed at the head of the 'sand gully" and another one in a tributary gully head of Belmont's No. 7 gully ~~last~~.

Another flume on Jackson's in the Kimbolton area is serving its purpose very well and protects a potentially dangerous gully degrade. A small diversion - detention bank was constructed on Stewart's - Te Awa.

207 chains of gully retirement fencing was subsidised by the Scheme.

Fifth Year 1971 - Ten gully blocks, mainly on eastern tributaries of the Pohangina River, were established this year.

Gully work was done in the following localities:- Moar, Culling, Carrick, Beehive, Nichol, Young, Goulter - Belmont. A concrete block drop structure in Cullings gully looks very successful. 172 chains of fencing were completed.

RESULTS

As can be seen from the above yearly description the fenced gully blocks from the early years were not continued. Because of the short length of the fencing, they were difficult to keep and maintain stock proof and the creek - crossings, especially in the larger catchments needed constant attention. Most of the blocks are in inaccessible localities and maintenance proved to be too high. Therefore, in the later blocks, the fencing was dispensed with and instead larger material was used: Cattle poles individually protected with netlon sleeves. This has proved more effective, and cheaper, with an overall lower death rate. It was found that small material often gave a poor strike and growth rate. Especially in the gully planting, where large numbers of plant material were used, the obvious economy of smaller material gave disappointing results. The use of stakes was therefore discontinued and the minimum size is now the so - called sheep pole.

Most of the block planting has been successful, except in some of the eastern tributaries of the Pohangina River where successive flooding caused heavy losses. Replacement work has since been carried out.

Farmer cooperation has been excellent throughout and in several instances scheme works in strategic localities has spurred the farmers on to continue this work on a farm scale under the normal subsidy schemes.

Gully structures have been successful except the netting dams and one instance where a steel flume was undermined.. No large debris dams, have been constructed to date as no economic technique has been designed so far. Similarly, no flood detention dams have been constructed as the steep and narrow shape of the valleys provided too little ponding in relation to the earthworks required.

Planting has been successful in the gullies where some initial stabilisation has occurred. In the more active sections we are experiencing the same problems as originally happened with the Te Awa gullies. Patience is the first requirement and only by repeated attempts can success be expected in the long run.

STOCK AND OPOSSUMS

Exclusion of stock is undoubtedly a first requirement to obtain success with gully work. So much so that in some cases, if a choice had to be made between (1) stock and planting and (2) no stock and no planting, the latter would be more advisable. This is because of the natural regrowth first by pioneer plants of grasses, clovers, lupins, tree lucerne through to eventually a scrubby cover of tutu, manuka, coprosma, five finger, matipo etc. Later, taller native tree species like rewa-rewa, kowhai, black beech, totara etc. can be expected to take over.

That is the reason why the retirement fencing of a large tributary of the Pohangina River in the middle of the unconsolidated sand country has been encouraged under the scheme. So far 5 miles of fencing has been done on Beehive Creek, with very encouraging results. Over the whole area approx-400 acres have been retired for Soil Conservation purposes. This has been done on a voluntary basis, with no compensation or purchase of land, and only a token offer of scheme funds.

Opossums are a constant worry and the choice of plant species depend to a large degree on the expected level of opossum activity.

To cope with the Scheme demand on plant material approximately 20 acres of unproductive river bank areas in the Pohangina Valley were planted in stool nurseries. Stocking was mainly in the new Italian hybrid varieties. Unfortunately these are suffering from heavy losses compared to some of the older varieties. In several cases plantings have to be restricted to less palatable types e.g. silver poplars (poor strike rates so far), generosa and yunnanensis poplars and Booth willows.

POHANGINA/OROUA CATCHMENT CONTROL SCHEME

1967 - 1971

SOIL CONSERVATION EXPENDITURE

	BLOCK PLANTING	GULLY PLANTING	STRUCTURES	
	Item 1	Item II	Item III	Total Items I to III
1967	$1,735	$633	$741	$3,109
1968	5,591	2,182	1,970	9,743
1969	1,374	7,584	760	9,718
1970	827	6,629	2,830	10,286
1971 (To 23.12.71)	882	4,740	1,765	7,387
TOTALS	$10,409	$21,768	$8,066	$40,243

POHANGINA/OROUA CATCHMENT CONTROL SCHEME
SOIL CONSERVATION PROPOSALS
FIVE YEARS 1972-1976

No major changes in techniques or policy are envisaged over the next five years.

It is hoped that some way can be found to afforest the catchment of Goulters "sand gully." Reduction of run-off will render the chances of stabilizing this gully much more feasible.

At the same time a vigorous policy of stock and opossum control in the Goulter Krull/Belmont gully system will be continued to give the plantings every possible chance of success. More retirement fencing is therefore necessary.

The Moar/Kennedy "cactus country" has substantially benefited from Moar's Farm Forestry Encouragement Loan Scheme. Complete stock exclusion by fencing is the aim with further planting required. Over the whole area it is expected that another 900 acres will have to be retired for water and soil conservation purposes. Another concrete block structure in Culling's gully is planned and further work will be dove tailed with the Farm Plan proposals.

Control of Beehive Creek and Nichol's gully is well under way. Supplementary planting will only be necessary up till Seddon's tributary. Upstream of this it is expected that natural revegetation coupled with protection of tributary outlets by paired planting will restore the balance of stability.

The blow - out of the headwaters of the Paramai Stream, a tributary of the Oroua River near Apiti has already partially been treated under a farm scheme but further works are necessary for complete safety. This will be done under the P.O.S. scheme.

Other isolated silt - contributing erosion areas such as Jackson's Kimbolton and the slump opposite Totara Reserve will also be attended to.

Goulters East area of Culling's Duchess by Bond 2/3/1977

MANAWATU CATCHMENT BOARD

POHANGINA/OROUA CATCHMENT CONTROL SCHEME

FIVE YEAR SOIL CONSERVATION PROPOSALS 1972 - 1976

	1972	1973	1974	1975	1976	TOTAL
Item I Tributary planting	$800	$1,500	$3,000	$4,000	$5,000	$14,300
Item II Gully planting and fencing.	4,000	3,000	3,500	3,000	2,500	16,000
Item III Structures or Upper Catchment Plantings	2,000	3,000	3,500	4,000	5,000	17,500
Item IV Isolated slump and Bank erosion control.	500	500	1,000	1,500	2,000	5,500
Item V Contingencies 20%	1,430	1,500	2,200	2,500	2,900	10,530
TOTALS	$8,730	$9,500	$13,200	$15,000	17,400	63,830

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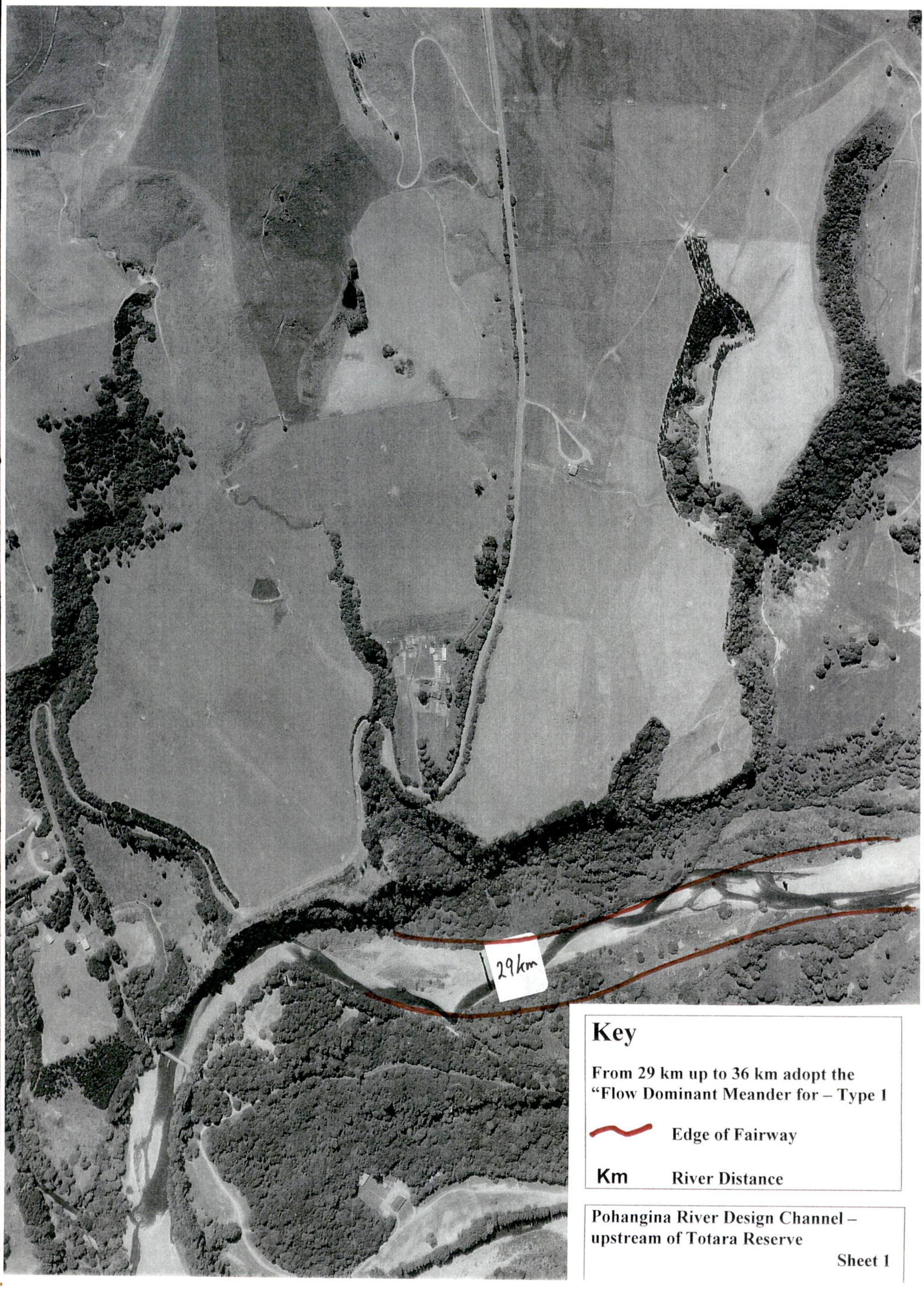
APPENDIX D

POHANGINA RIVER UPSTREAM OF TOTARA RESERVE



Key

From 29 km up to 36 km adopt the "Flow Dominant Meander for – Type 1

Edge of Fairway

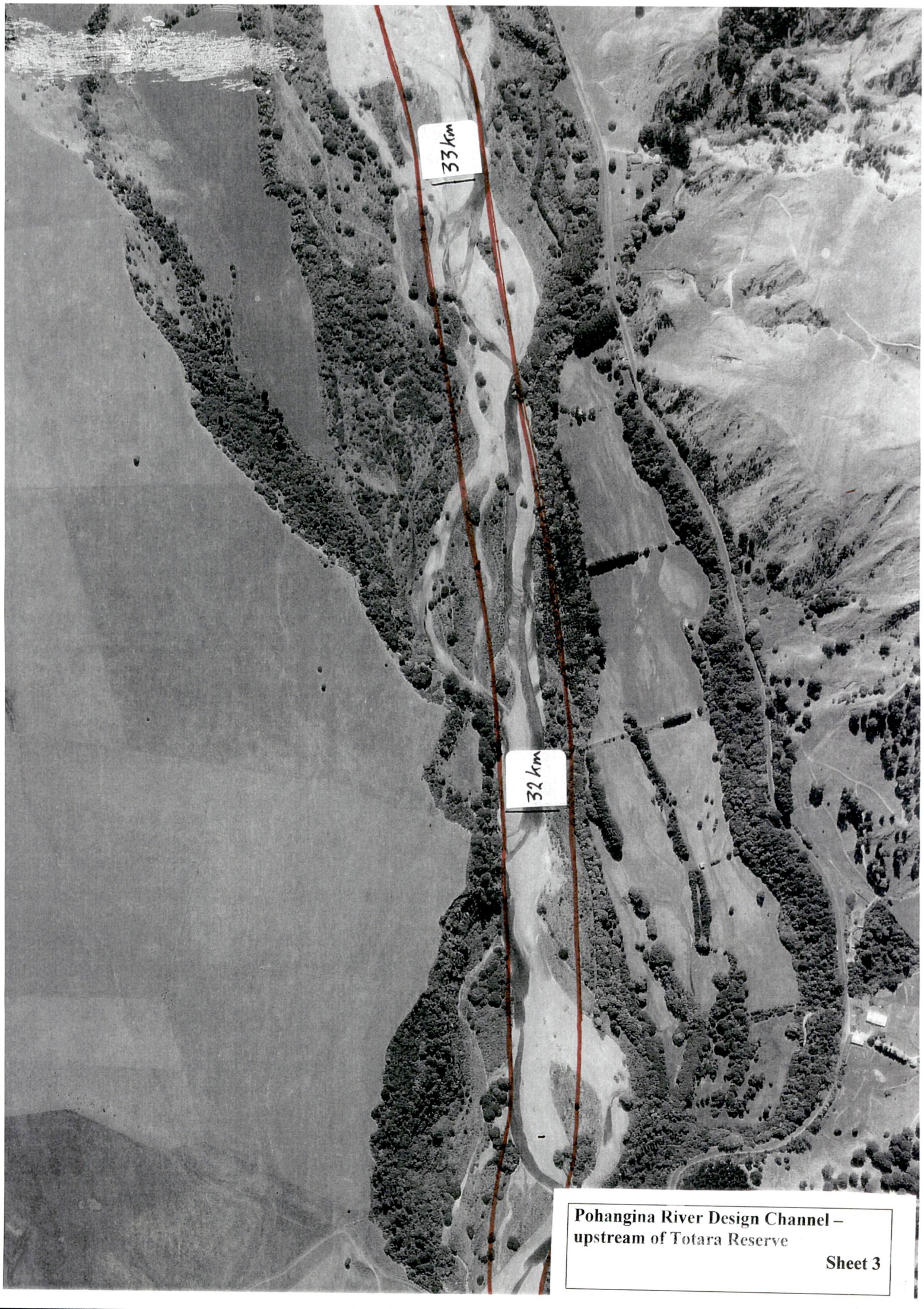
Km River Distance

Pohangina River Design Channel – upstream of Totara Reserve

Sheet 1

Pohangina River Design Channel – upstream of Totara Reserve

Sheet 2

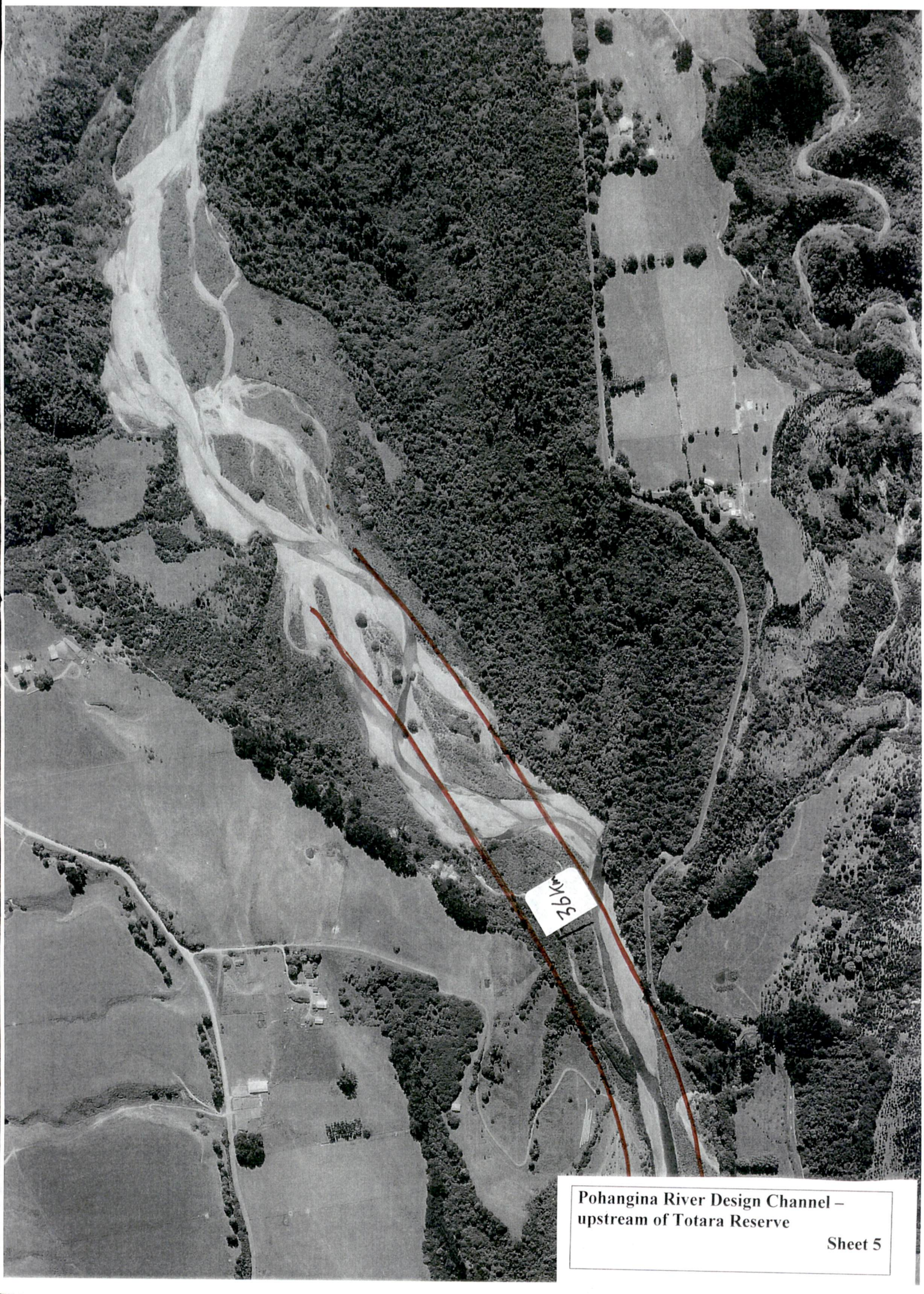


Pohangina River Design Channel – upstream of Totara Reserve

Sheet 3

Pohangina River Design Channel – upstream of Totara Reserve

Sheet 4



Pohangina River Design Channel –
upstream of Totara Reserve

Sheet 5