MEAN BED LEVEL TRENDS IN THE MANUTAHI AND MANGAHAREI STREAMS; RUATORIA

1979 to 2015

PEACOCK D H LTD & MARDEN ENVIRONMENTAL SERVICES

December 2017

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1.0 Introduction:

This is one of a series of reports on river bed level trends in the Waiapu catchment, Ruatoria, commissioned by the Environmental section and the (former) Roading section of the Gisborne District Council.

The Manutahi Stream (aka Ngata Gully or College creek) and the Mangaharei Stream have their headwaters in the Manutahi Forest, which was established over the period 1972 to 1986 in response to serious flooding problems along the southern flank of Ruatoria township and particularly at Ngata College.

The following trends in mean bed levels have been derived from cross section surveys by the former East Cape Catchment Board and the Gisborne District Council, commencing in 1979. "*Mean bed levels*" has a specific meaning in relation to braided rivers on the east coast, and a full definition is provided in the Addendum. The bed level surveys were commenced in 1979, presumably to measure the streams response to reforestation.

2.0 Catchment and stream characteristics:

Figure 1 shows Ruatoria, the Manutahi Forest and the streams surrounding Ruatoria. The Manutahi and Mangaharei streams have their headwaters in the Manutahi Forest. The Mangakinonui to the west of Ruatoria and the Makaraka stream to the east, are shown as they demonstrate what the Manutahi and Mangaharei streams would have been like prior to reforestation of their watersheds.

Figure 2 shows the Manutahi and Mangaharei streams situated in the Manutahi Forest. Both streams are about two kilometres in length, from Ruatoria to the headwaters. The Manutahi Stream has a catchment area of approximately 100 ha while the Mangaharei has an area of about 200 ha, upstream of Tuparoa Road and Waiomatatini Road respectively.

Both streams are quite steeply graded even in the lower reaches just upstream of Ruatoria. The Manutahi Stream has an average grade of 40 to 43m/km over a distance of 429 metres upstream from Tuparoa Road; while the Mangaharei has a grade of 35 to 38m/km over a distance of 587 metres upstream of the Waiomatatini road bridge.

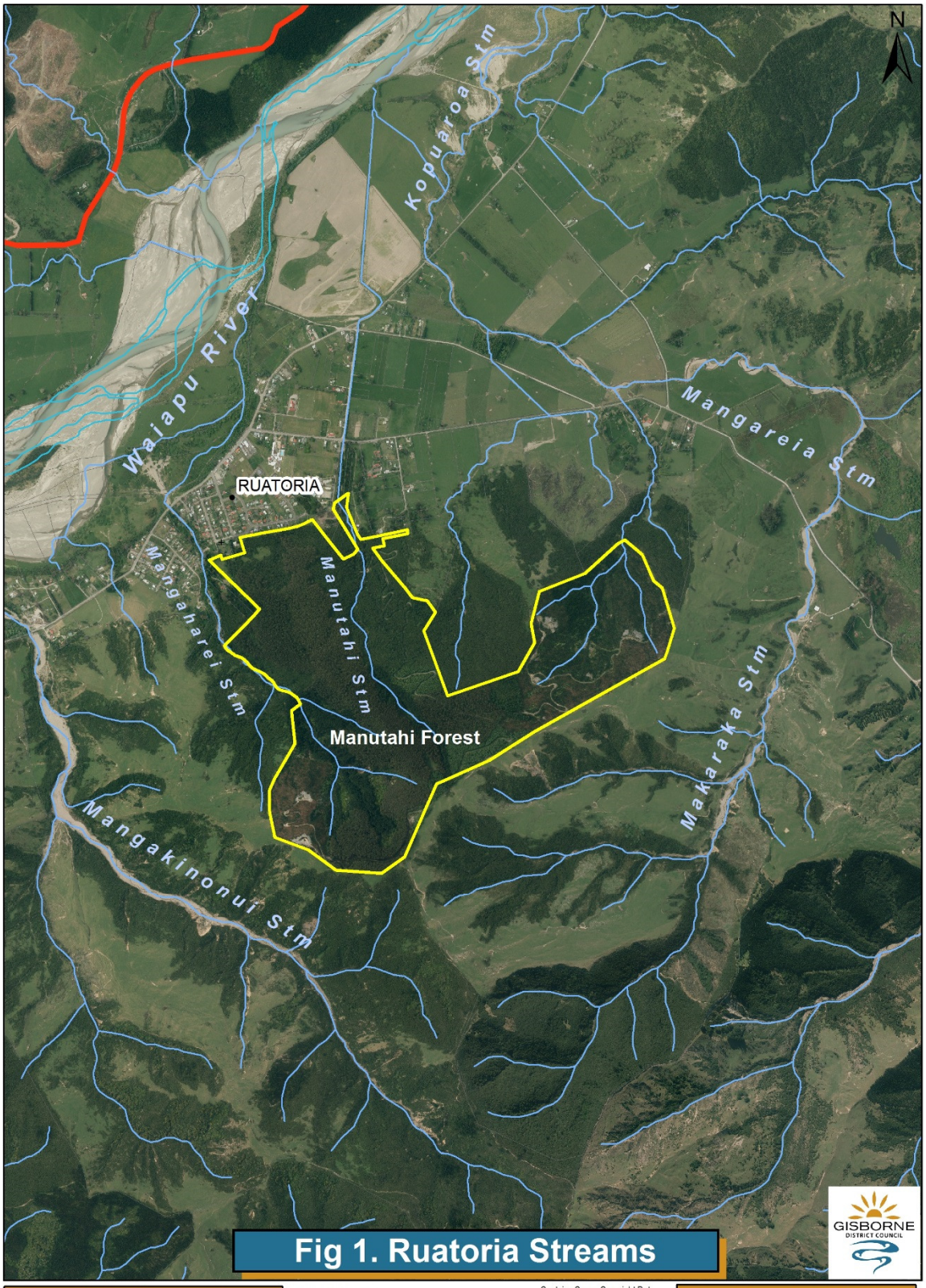

Fig 1. Ruatoria Streams

Land Information

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Date: 2/05/2017
User: mdc

Contains Crown Copyright Data - Sourced from Land Information NZ. Orthophotography - NZAM,Terralink & Aerial Surveys

Scale 1:25,000

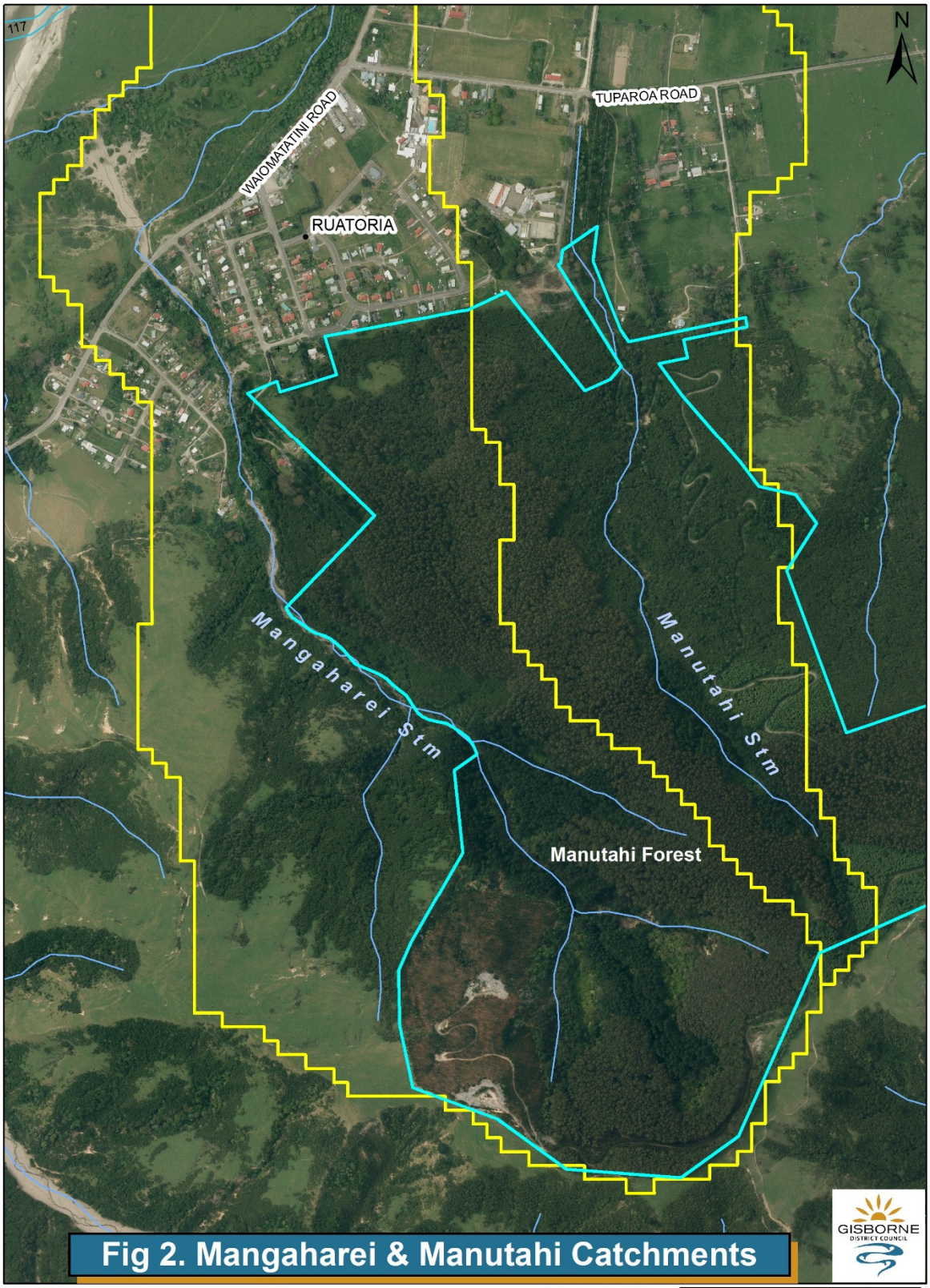

Fig 2. Mangaharei & Manutahi Catchments

Land Information

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Date: 21/04/2017
User: mdc

Scale 1:10,000

3.0 Executive Summary:

The township of Ruatoria is located on a shingle fan of the Manutahi and Mangaharei streams. This was probably not obvious when the town was originally established, but after the indigenous bush in the watershed was cut down for pasture in the 1930's/40's the two streams, the Manutahi and the Mangaharei, began to discharge their sediment loads into properties flanking the south side of the township.
As early as the late 1960's, the Technical Committee of Inquiry Report on the Poverty Bay-East Cape District recognised that the area now comprising Manutahi Forest was in a state of advanced erosion, and recommended it as an area requiring urgent protection.

By 1975, floodwaters and debris had threatened to inundate Ngata College prompting moves to purchase the headwaters of the "Ngata Gully" (in this report referred to as the Manutahi Stream), Kopuaroa and Mangaharei watersheds for reforestation, and by 1988 about 99% of the entire 225 ha that comprises Manutahi Forest was forested in a combination of planted exotic and native species and significant areas of scrub reversion.

Results of the mean bed level surveys commencing in 1979 show that while the Mangaharei had begun degrading over the lower reaches since that time, the Manutahi Stream bed was aggrading in the lower reaches until circa 2006. It was apparent however that this aggradation of the lower Manutahi Stream was due to reworking of material previously deposited upstream going back to the 1930's - 1950's.

Since 2006 both stream beds appear to have been degrading substantially, however the mean bed level plots are of limited value because of difficulties in assessing the active bed limits prior to 2006, the excavation of stream bed material (near the downstream cross sections in particular), and the construction of debris dams in the lower Manutahi Stream channel.

For the Manutahi a different method of monitoring of the stream channel has therefore been recommended, while for the Mangaharei it is recommended to relocate at least two of the cross sections further upstream.

4.0 The historical context:

Because of the changes in vegetation cover and various engineering works within the alluvial surface of both streams over the past 35 (or more) years, interpretation of data from cross section surveys cannot realistically be carried out without reference to the historical context. The following is a very brief summary of the changes that have taken place.

4.1 The pre-reforestation period:

The land in what is now known as the Manutahi Forest was cleared of native bush in the late 1930's, early 1940's (pers com; A Reedy, 13/04/17). In a report by Marden and Rowan, 1999; it was stated that, *"By the mid-1950's, hill country farm land in the Manutahi area showed signs of severe gully and mass movement erosion; a direct consequence of the removal of indigenous forest cover……The earliest aerial photography (1956-1957) of the area currently known as Manutahi Forest, …….at this time 73% of the land area was in pasture and 21% had subsequently reverted to scrub (mānuka-kānuka)……*

As early as the late 1960's, the Technical Committee of Inquiry Report on the Poverty Bay-East Cape District recognised that the area now comprising Manutahi Forest was in a state of advanced erosion, and recommended it as an area requiring urgent protection"

During the 1960's and 1970's the Poverty Bay Catchment Board (PBCB) and later the East Cape Catchment Board (ECCB), were actively trying to stabilise the two stream courses, and preventing overflows on either sides of the Manutahi Stream adjacent to College Road. In 1964 reforestation of the Manutahi and Mangaharei catchment control was first proposed by the PBCB, followed in 1965 by a proposal for the "Manutahi Gully Control Scheme", (PBCB, 1965).

4.2 The reforestation period (1972-1988):

By 1973 plans were drawn up for floodway and channel works in the Manutahi and Mangaharei streams, (PBCB, 1973).
Marden and Rowan, 1999, reported that; *"By 1975, floodwaters and debris had threatened to inundate Ngata College prompting moves to purchase the headwaters of the "Ngata Gully"* (in this report referred to as the Manutahi Stream*), Kopuaroa and Mangaharei watersheds for reforestation……By 1975, the area of reverting scrub had increased to 32%, 22% had been planted in pines and 43% remained in pasture……gully erosion was now the principal source of sediment generation particularly in the Mangaharei watershed……."The source of the material of concern to the Catchment Board in the mid 1970's was not the result of renewed landsliding events in the upper watersheds but of the reworking of material stored in the upper channel reaches as a consequence of historical erosion events dating back to the period 1930's -1950's".*

In 1979 bench marks were established along the lower reaches of both streams, (PBCB, 1979), and the first cross section surveys were carried out.

According to Marden and Rowan; *"By 1988, about 99% of the entire 225 ha that comprises Manutahi Forest was forested in a combination of planted exotic and native species and significant areas of scrub reversion. Erosion scars had further declined to less than 1% of the forest area, despite the wrath of Cyclone Bola".*

4.3 Post 1988:

Prior to the commencement of reforestation, there was general consensus that the plantings would be foremost for *'watershed protection and development for recreation and amenity purposes, though commercial species including radiata pine would probably be the main species planted'* (NZ Forest Service, 1975).
However the objective for the Manutahi Forest was changed from that of "conservation forestry' to "production-conservation" forestry. Despite objections from some quarters this change proceeded and in 1999 Landcare Research was tasked with assessing the likely impacts of harvesting on soil erosion and the potential downstream impacts.

In 2004 and 2005 48.2 ha (Compartments 701 and 703) of radiata pine in the Kopuaroa and Mangaharei watersheds was harvested, and in 2005 and 2006 a further 16.7 ha of radiata pine in the Mangaharei headwaters was harvested.
More recently, (January 2017), seven small timber debris dams have been erected in the Manutahi Stream bed; two of them opposite Ngata College, and the other five upstream of the

cross sections, (Appendix 4). Figures 3 and 4 show two of these erosion control dams. Willow poles (with plastic sleeves) have been planted adjacent to the dams, but rubber aprons have yet to be added to the downstream sides.

Fig. 3: Alex Reedy, supervisor, at left; and Selwyn Temaro; at dam No. 1; *November 2017.*

Fig. 4: Dam No. 5; *Photo: D Peacock, 17th October 2017.*

5.0 Mean Bed Level Plots:

5.1 Manutahi Stream:

The figure below shows the mean bed levels in the lower Manutahi Stream from cross section at 1300m to the most upstream cross section at 1729m, over the 37 year period 1979 to 2015. Note that cross section 1300m is approximately 80m upstream of the Tuparoa Road culvert. The locations of the cross section bench marks may be seen on the aerial photograph in Appendix 2.

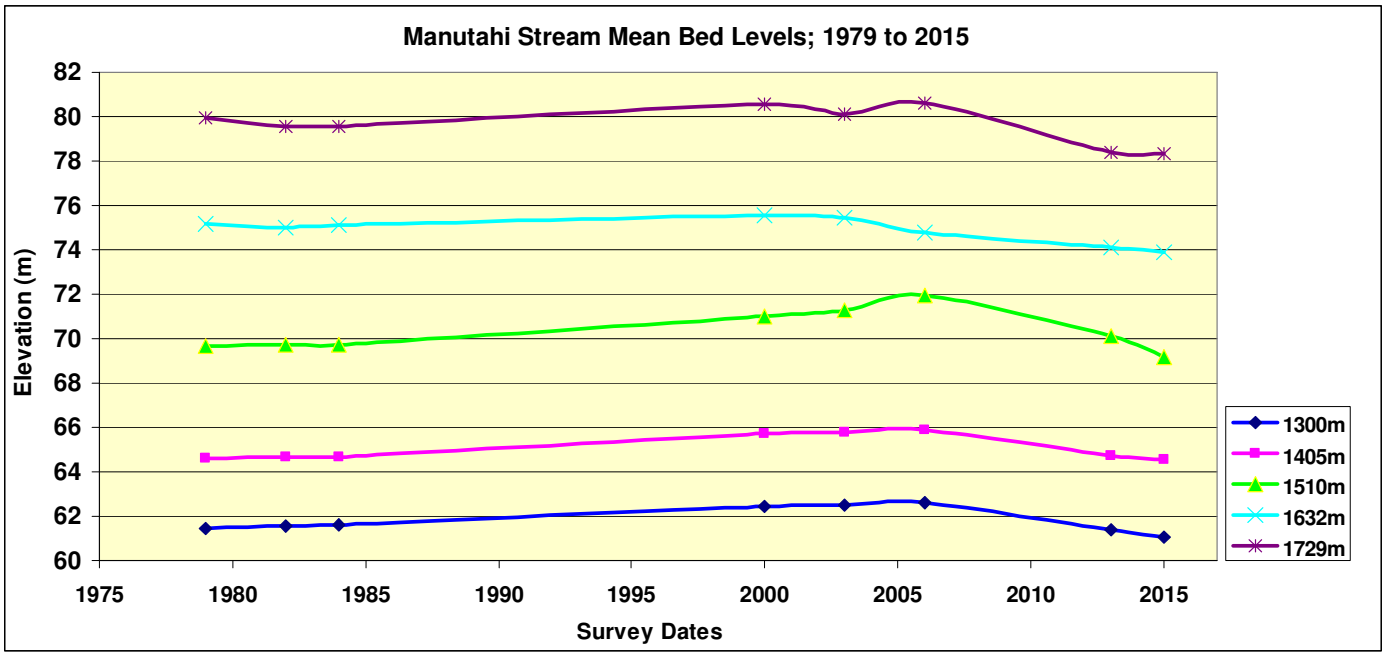


Fig. 5

Figure 5 shows a gradual increase in mean bed levels at all cross sections (except at 1632m) up to 2006, followed by a very rapid degradation to 2015, with a maximum rate of 308 mm/year at 1510m. Although the Manutahi Forest was well established by 1988 and had reportedly reduced erosion scars to less than 1% of the forest area (Marden and Rowan, 1999), aggradation of the Manutahi Stream bed at most cross sections continued up until circa 2006. This was no doubt due to the reworking of material already in the channel, referred to in clause 4.2.

A short distance upstream of dam No. 7 there are alluvial deposits on the true left bank four metres higher than the current stream level. This is evidence of past episodes of large-scale erosion in the upper catchment resulting in aggradation in the mid-reaches. Subsequent to the successful establishment of the forest plantings, and the recolonization of these alluvial deposits by secondary indigenous species, the stream has periodically incised into these alluvial deposits leaving a set of preserved terraces. There are two terraces suggesting two separate episodes of channel incision during which these deposits were excavated from this site and transported to lower reaches.

While the Manutahi channel has been degrading some of this degrade could be attributed to excavation works particularly in the vicinity of the downstream cross sections. For instance it is known that channel excavation works had been carried out prior to the 2015 survey at the

1300m and 1405m cross sections. Such channel excavation works have been repeated over many years following significant freshes, to prevent overflowing upstream of the Tuparoa Road culvert. There is also an "overflow" channel between cross sections 4 and 5 which is likely to have affected the mean bed levels at these two sections.
The apparent irregular changes circa 2000 to 2006 in mean bed level at some of the above cross sections could be at least partially explained by the difficulties in assessing the active stream bed widths from the data prior to the 2006 survey. From 2006 onwards, the left and right active bank distances have been included in the survey files.

5.2 Mangaharei Stream:

Figure 6 shows that the stream bed at the two upstream cross sections at 1887m and 1703m has been degrading since the first survey in 1979 at an average rate of 67 and 77 mm/year respectively. The terraces left by the degrading stream in 2006 are clearly visible in Figure 7.

Unfortunately, the last cross section survey at 1477m was in 2006, and the last two surveys show that the stream bed had risen somewhat. There is no certainty that the degrade apparent up until the year 2000 is still proceeding. The cross section at 1300m is at the upstream side of the Waiomatatini Road bridge, and it is well known that bed load material is deposited in this area during and after freshes. When the stream bed level beneath the bridge builds up too high the material is excavated and deposited on the shingle fan downstream of the bridge, or elsewhere.

A log/rail wall was constructed downstream of the bridge by the East Cape Catchment Board in 1985 to deflect the stream to the north-east, however this was not successful as the area is a natural shingle fan and inherently will always deposit bed load material because of the flattening of the grade. While the Mangaharei Stream appears to be flowing in a north-easterly direction in Figure 1, this is not always the case as shown in Figure 8; where fan material is mainly depositing in a south-westerly direction towards the Waiapu River.

There appears to be a sudden increase in mean bed levels between 2003 and 2006 at all cross sections (and also apparent for the Manutahi Stream), but the author believes that this could be at least partially explained by the difficulties in assessing the active stream bed widths from the data prior to the 2006 survey.

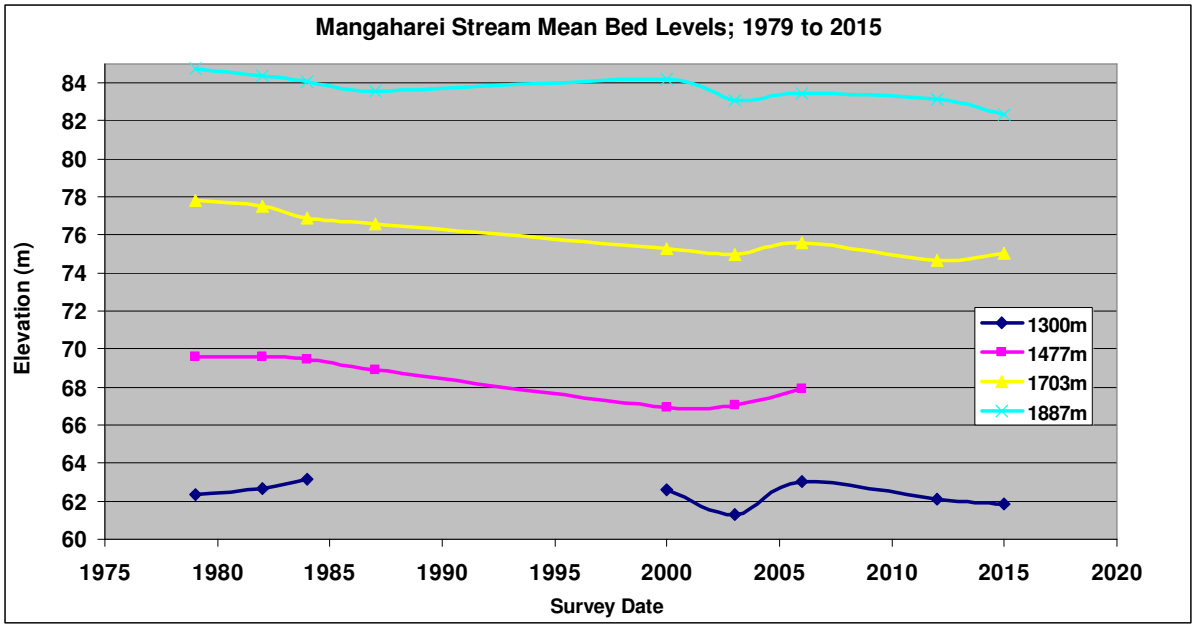


Fig. 6

Fig 7: *Terracing in the upper Mangaharei Stream.*
Photo: D Peacock, 31st August 2006.

Fig. 8: *Mangaharei Stream fan downstream of Waiomatatini Road. Photo: P F Olsen; 1st February 2007.*

6.0 Comparison of the mean bed level trends in the two streams:

Since the Manutahi Stream catchment is only half the area of the Mangaharei catchment it would normally be expected (all other factors remaining equal), that the Manutahi bed levels would respond to the effects of reforestation more rapidly than bed levels in the Mangaharei Stream. However the opposite appears to be the case, as the Manutahi Stream began to degrade at all cross sections circa 2000 to 2006, whereas the Mangaharei bed levels began to degrade at two cross sections in 1978, and in the year 2000 at another section.

However, *all other factors are not equal*. Hydraulically, the streams are quite dissimilar in a number of ways which would affect the way in which the two streams would respond to changes in sediment input and deposition of sediment on the alluvial surface, or erosion of sediment from the alluvial surface.

The Manutahi Stream is highly modified in its lower reaches where the cross sections are located. It has been channelised and stopbanked alongside College Road, and is forced through an undersized culvert beneath Tuparoa Road. The Manutahi is also quite incised upstream of Ngata College, and has an overflow channel between sections 4 and 5. There has been a history of building debris dams and other grade control structures in the Manutahi stream, including seven new dams built in January 2017; see Appendix 4.

On the other hand the Mangaharei Stream is largely unmodified, except for the confined channel under the Waiomatatini road bridge. Upstream of the cross sections, it has a relatively wide alluvial surface over a reach of some 500 metres, averaging 10 to 15 metres width with a maximum width of 25 metres.

Additional factors which are likely to have influenced mean bed level measurements in the streams are as follows:

- In-channel excavation works in both streams, particularly in the vicinity of the downstream sections;
- Uncertainties about the active bed limits prior to the 2006 survey;
- Post-2002 deforestation in parts of the upper catchment

7.0 Conclusions:

- The mean bed level plots are not considered to be reliable due to measurement difficulties and channel excavation works, however the plots do confirm that both streams have been degrading since 2006, but the rates of degrade are debateable;
- The cross sections on both streams are generally located too far downstream to effectively monitor mean bed level trends; and have become redundant now on the Manutahi Stream with the construction of seven new debris dams;
- The Manutahi Stream may best be monitored in the future by means other than by cross section surveys;
- Although both streams are degrading they still deposit significant quantities of bed load material at Waiomatatini Road and Tuparoa Road;

8.0 Recommendations:

It is recommended that:

1. A longitudinal profile survey of the Manutahi Stream be carried out this summer, and repeated as and when necessary, to monitor the effectiveness of the debris dams and to determine whether any further dams may be required in the future;
2. Surveys at the two downstream cross sections on the Mangaharei be discontinued, and replaced by two cross sections further upstream, at sites to be selected in conjunction with the GDC surveyor.

References:

Poverty Bay Catchment Board. *Manutahi Gully Control Scheme Dwg. No. 2345*, August 1965.
Poverty Bay Catchment Board. *Manutahi Gully Control Scheme Dwg. No.3101,* August 1973.
NZ Forest Service file 6/2/118, 3/2/1975.
Poverty Bay Catchment Board. *Channel Measurements-Manutahi Gully, Dwg. No. 3184/7*, June 1979.

Unpublished report for Ruru Willis & Co. Ltd; *Pre- and Post-Harvest Site Stability: Manutahi Forest*,
Marden, M., and Rowan, D; August 1999.

Acknowledgements:

- Ian Hughes and Brian Currie; for providing a continuous high quality survey record for the past 37 years;
- Mark Cockburn for the preparation of Figures 1 and 2;
- Alex Reedy for comments on historic issues and descriptions and photographs of the debris dam construction works;
- Dr. J Tunnicliffe, Environmental Science Dept; University of Auckland; for preparation of terms in the addendum.

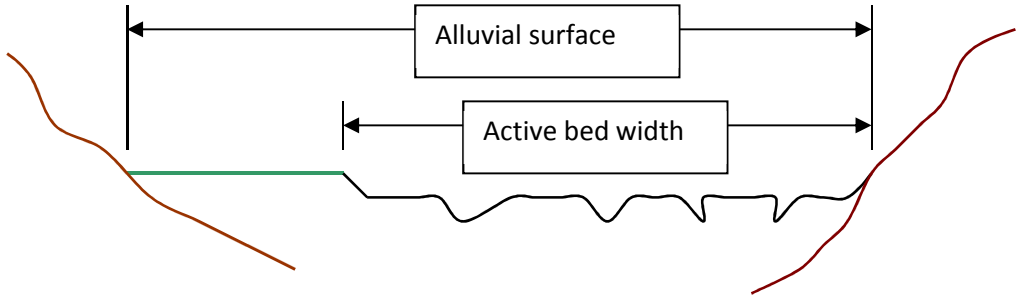
ADDENDUM

The following definitions and explanations have been provided to clarify the terms used in this report. Items 1 & 2 have been kindly provided by Dr Jon Tunicliffe; while item 5 has been prepared by Dr Mike Marden.

1. Mean river bed level:
"In the context of actively braiding or anabranching rivers found in the East Cape, ***mean river bed level*** refers to the average topographic elevation across multiple channels (including bed and banks) and the actively reworked (non-vegetated) alluvial surfaces, such as bars and braidplains. Changes to the mean bed elevation across this active transport corridor reflects adjustments to reach-wide sediment storage over time.

2. Reach:
A ***reach*** is length of river, typically constituting several meander wavelengths, with relatively homogenous governing conditions, e.g. discharge, channel geometry and floodplain extent."

3. Alluvial surface and active bed width:



The above diagram (not to scale), shows the ***alluvial surface*** for a braided river bed and the ***active bed width*** as measured by the cross section surveys. The green coloured terrace on the left of the diagram represents a terrace covered with vegetation which is no longer considered to be part of the active river bed. To be considered to be outside the active bed, a terrace (or island) has to be covered with established vegetation at least two years old, and which may be covered in water during floods but not be subject to scour or deposition of bed load material.

Mean bed levels are computed for each cross section from the mean of all the levels taken within the active bed width.

4. Aggradation rates chart:

The following chart applies only to rivers/streams in the Waiapu catchment or the upper Waipaoa catchment.

Aggradation Rate mm/yr	**Descriptive term**
0 to 9	Negligible
10 to 29	Gradual
30 to 99	Moderate
100 to 199	Rapid
200 to 499	Very rapid
>500	Extreme

5. Manutahi and Mangaharei catchment lithologies:

The lithologies consist of a mix of calcareous and non-calcareous mudstones comprising the Whangai Formation intercalated in places with smectitic mudstone and thin glauconitic sandstones of the Wanstead Formation. Typically these formations show signs of tectonic crushing and when eroded the clast sizes tend to be predominantly cobble, pebble, sand, and silt-sized with only minimal boulder sized material (see Figure 5). These lithologies are the same as those found within parts of the Mangaoporo, Poroporo and the upper reaches of the Maraehara Rivers (see Mazengarb and Speden, 2000) where the bedload similarly consists of a high proportion of fine-grained sediment that is highly mobile, has a high attrition rate, and therefore rapidly fines as it is transported downstream with much of it able to be transported as suspended load.

Reference.

Mazengarb, C & Speden I. (2000). Geology of the Raukumara Area. Institute of Geological and Nuclear Sciences 1:250 000 geological map 6. Institute of Geological and Nuclear Sciences Limited, Lower Hutt, New Zealand.

APPENDIX 1

This appendix, which is available on request from the environmental section of the GDC, comprises all mean bed level and profile plots prepared for this report in electronic form.

APPENDIX 2: MANUTAHI STREAM BENCH MARKS

APPENDIX 3: MANGAHAREI STREAM BENCH MARKS

APPENDIX 4: LOCATION OF DEBRIS DAMS IN MANUTAHI STREAM