7. Salt Water Flooding

7.1 Background

Several residents along Waiotoi Road reported problems relating to tidal flooding. Included with one questionnaire response was a petition by nine Waiotoi Road residents who experienced section and non-habitable floor salt water flooding on this occasion.

According to Mr. L.B.B. Blackhall of 23/25 Waiotoi Road, the worst incident of tidal flooding occurred on 11-12 March 1997 during Cyclone Gavin. At this time, an unusually high tide occurred in the Ngunguru Estuary. This situation was aggravated by an oscillating flood wave in the main creek west of Waiotoi Road with an estimated amplitude of 200-300 mm. Peak water levels in the creek resulted in overtopping of the existing stopbank at 17 Waiotoi Road and flooding of several other properties from associated open drains and pipes. Mr. Blackhall confirmed that similar salt-water floods have occurred on at least two other occasions since 1974 when he first took up residence at his current property. GHD considers the information provided by Mr. Blackhall to be reliable based on Mr. Blackhall's experience as a civil engineer in stormwater drainage and related fields.

Mr. Blackhall's petition outlined two possible solutions to this problem:

1) Option 1 would involve raising existing stopbanks (where required), the construction of new stopbanks (mainly along the golf course side of the creek) and the installation of one-way valves at the outlets of at least four existing local drains.
2) Option 2 would involve replacement of the existing one lane bridge on Ngunguru Road with a multiple barrel flood-gated box culvert.

Based on a preliminary assessment of the above options by WDC, GHD were commissioned to review Option 1 and identify the extent of works required to provide protection for properties for a tidal event equivalent to that which occurred during Cyclone Gavin.

To reasonably establish the cost of the proposed scheme, it is considered that some preliminary design and investigation work would be required to determine the appropriate stopbank design requirements and issues such as local drainage, etc. This is considered to be outside the scope of this study.

Based on a preliminary assessment of the system, staging of the work would be possible. It is recommended that work along the catchment boundary of Catchment T proceed first, with other sections of the stopbank being completed later.

7.2 Design Flood Level

Surveyors who visited the Ngunguru area during May 2000 took spot levels at a number of locations affected by salt water flooding in 1997. Of particular importance was a stopbank near No. 17 Waiotoi Rd, which was breached on 11 March 1997 and resulted in flooding and subsequent damage to a newly established orchard. A level of RL1.9 was measured at this location. Further upstream of this point at Nos. 23-25 Waiotoi Rd, a tidal flood level of 1.8 was measured.

Based on tidal predictions for Tutukaka the following levels apply:

MHWS	2.3 m
MHWN	2.0 m
MSL	1.3 m
MLWN	0.6 m
MLWS	0.3 m
Chart Datum	0.0 m

MSL corresponds to the Lands and Survey datum (0.0). Therefore, MHWS = 1.0 m with respect to the Lands and Survey datum. Considering that a low barometric pressure can result in an increase in tidal levels of 0.4 m, and further that an increase in on-shore winds can raise tidal levels by 0.6 m. a total increase of 1.0 m above MHWS is possible. This corresponds to RL 2.0 m.

Information obtained from Whangarei Ports indicates that on 11 March 1997, wind speeds of up to 37 knots were recorded with the wind direction varying between 100° and 200°. An elevated tide at Whangarei Port of 3.420 m or RL1.512 m was recorded at the time of the tidal surge at Ngunguru. This is approximately 0.22 m above the predicted tide for Whangarei Port at 2305 hours on 11 March 1997 of 3.2m (relative to the Whangarei Port chart datum). Therefore, allowing for barometric pressure effects and wind effects a tidal elevation of 1.62 m would be possible at Ngunguru.

This suggests that the surveyed flood levels of RL 1.9m at 17 Waiotoi Rd and RL 1.8m at 23-25 Waiotoi Rd would be possible, particularly given that an oscillating flood wave of 200-300 mm was observed to be operating in the Waiotoi Rd tidal drain by Mr Brye Blackhall, as discussed earlier.

Based on a flood level of 1.9 and a freeboard of 0.3 m, a design flood level of 2.2 m was determined.

7.3 Recommendations

It is therefore recommended that:

- A minimum level of RL 2.20 m be adopted for all existing and new stopbanks;

- All stormwater lines that drain into the estuary that have manhole lid levels or cesspit levels below RL 2.2 m be fitted with tide gates to protect low-lying property areas from flooding.

Drawing 16194/00/10 shows the approximate extent of stopbanks required to protect Waiotoi Rd properties and adjacent areas from tidal flooding similar to that which occurred on 11 March 1997.

8. Northern Ngunguru Flood Plain Modelling

8.1 Background

Following submission of the draft CMP to Council, GHD were asked to undertake additional investigation and analysis work as a result of events that had occurred after commissioning of the study. The main issues this additional work addressed are outlined below.

8.1.1 Filling of the land north of the Cemetery Access Road

During the course of the study, members of GHD's team noticed that earth filling of an area of land immediately north of the access road for the Ngunguru Cemetery was taking place in what appeared to be an uncontrolled manner. On discussing this issue with Council it was found that no formal approval had been obtained for this work. GHD raised concerns that related to the impact that this filling could potentially have on downstream flooding due to a reduction in the natural floodplain. This was particularly relevant for properties along Shoebridge Crescent and Ngunguru Rd. Some of these properties were flooded during the course of this study as a result of overflows across the Cemetery access road following a severe storm event.

8.1.2 General Approach

To resolve the above issues GHD extended the work undertaken for the catchment management plan by developing a detailed stormwater model of the existing drainage system and floodplains upstream (north) of Ngunguru Rd. This work has now been completed and the results are included in this final version of the Ngunguru Catchment Management Plan.

8.2 Scope of Modelling Study

The main objectives of the Northern Ngunguru Modelling Study were:

- To determine the extent of the existing floodplain for the main drainage system, which includes culverts PC16 and PC17.
- To determine what system upgrades would be required to protect existing properties adjacent to the drainage system on Ngunguru Rd and Shoebridge Crescent.

8.3 Stormwater Model

The XP-SWMM stormwater modelling software, developed by XP Software in Australia was used to model this drainage problem. More details of this package can be found in Section 5.3 of this report. Prior to development of the model, Kennedy & Associates, consultants to WDC, undertook a detailed survey of the drainage system and floodplain area.

This included a topographical survey of the main floodplain area, cross sections of open drains and other specific details including invert levels, crest levels, sizes and lengths for all culverts. Plans and details generated as a result of the survey can by found in Appendix 7.

The model included nodes along the main drainage channels at relevant locations such as culverts, changes of cross-section and intersections of drains. Dummy nodes were also created to allow overflow between channels across the flood plain as would happen in the real world situation.

Storage nodes were created wherever this was considered to be significant.

Local catchment flows from Catchment AA were not considered in the model.

A MHWS tide level of RL 1.0 was used as the downstream control for the XP-SWMM model.

Full details of the model can be seen in Appendix 7.

8.4 Results

8.4.1 Existing Situation

The XP-SWMM model demonstrated that extensive flooding of the area north of the access road to the Cemetery would occur in a 50 yr ARI event. A flood level of RL 3.25 would occur at the access road to the Cemetery. This is above the minimum crest level on the access road of RL 3.03. A flood level of RL 3.13 would occur upstream of culvert PC17. Upstream of the access road, flooding of land on both sides of the main drain would occur. The results of the XP-SWMM model indicate that this flooding would primarily be caused by both the restricted capacity of the existing drainage system and the flat nature of the terrain in this area.

Downstream of the Cemetery access road, the majority of the floodwaters would drain to culvert PC17, while a portion would flow across 2049 Ngunguru Rd and into the low-lying area adjacent to Shoebridge Crescent. The lowest point of this area is a cesspit next to the right of way that services Nos. 8 & 10 Shoebridge Crescent. The spill level for water to flow across 2049 Ngunguru Rd and into 8 Shoebridge Crescent is RL 2.71. The garage of this property has been flooded in the past.

The XP-SWMM model indicates that a flood level of RL 3.08 would occur in a 50 yr ARI event at the rear of 2049 Ngunguru Rd. Overflow into the low-lying area off Shoebridge Crescent would therefore occur. As a detailed survey of this area was not conducted as part of this study it was not possible to determine the exact flood level in this area. However, estimated ground levels and potential flood storage indicate that flooding of habitable floors would be unlikely to occur. Drawing 16194/00/14 shows the modelled floodplain for the area upstream of the cemetery access road with the existing drainage system and current development.

8.4.2 *Remedial Works*

Using the model a number of remedial solutions were evaluated. These are outlined briefly below:

- Upgrade PC17 to a concrete box culvert (2.0m wide x 1.5m high) and leave PC16 unchanged.
- Upgrade PC17 to a concrete box culvert (2.0m wide x 1.5m high) and install an additional 1.2 m diameter pipe at PC16.
- Upgrade PC17 to a concrete box culvert (2.0m wide x 1.5m high) and replace PC16 with a new 1.5 m diameter pipe.
- Upgrade both PC16 and PC17 to concrete box culverts (2.0m wide x 1.5m high).

The most effective solution was found to be upgrading both of the existing culverts (PC 16 and PC 17) as in the last option above. Although this is also the most expensive option, it would reduce flood levels upstream of culvert PC17 to approximately RL 2.4 from RL 3.13 and would significantly reduce overflow across the access road to the Cemetery. No overflow across 2049 Ngunguru Rd would occur and therefore flooding of habitable and non-habitable floors would not be expected. However, as the water level at the rear of the above property would be RL 2.52, less than 200 mm of freeboard would be present in a 50 yr ARI event.

Flood levels in the area upstream of the cemetery access rd would also be reduced. However, this reduction would only be on the order of approximately 150-200 mm and this effect would only extend upstream as far as CS 8.

For this option, the following upgrading works would be required:

- Upgrade PC 16 to a 2.0 m wide by 1.5 m high box culvert;
- Upgrade PC 17 to a 2.0 m wide by 1.5 m high box culvert and lower both the upstream and downstream invert by approximately 0.5 m;
- Upgrade the existing 375 mm dia culvert that discharges to the upstream end of PC16 to a twin 375 mm diameter culvert and construct inlet and outlet structures.

Flood levels for both the existing drainage system and the proposed upgraded system are shown on drawings 16194/00/15-17.

8.5 Estimated Cost of Proposed Works

The total estimated cost for the proposed remedial works is $325,360.00 (excl. GST). This includes an allowance for traffic control and contingencies of 20%. A detailed summary of the specific cost components of this work is included in Appendix 7. The above cost has been determined based on completion of the entire works in a single contract.

8.6 General Recommendations

The following recommendations have been identified as a result of the above work:

1. As additional loss of floodplain would exacerbate flooding of properties on Shoebridge Crescent and Ngunguru Rd in Catchment AA, it is recommended that no further filling of land be permitted within the defined 50 yr ARI floodplain.
2. That the recommended upgrading works (Section 8.4.2) are undertaken at the earliest opportunity. Staging of the works would be possible, with culvert PC17 proceeding first, followed by PC16 and the remaining works.

9. Flood Hazard Areas

9.1 Overview

Flood hazard areas for Ngunguru were determined from contour information provided by WDC dated 15 October 1975 and a digital terrain model (DTM) from more recent aerial photography from which GHD generated 1.0 metre contours.

Of these two sources, the 1975 contours were considered to be more accurate and these were therefore used for flood hazard mapping, except in areas where significant changes in ground contours have occurred since 1975 – for example, at the sports complex and golf course. In these areas the newer data was used.

As part of this exercise, recent work on flood hazard areas in the Ngunguru Township area by Fraser Campbell Consultants Limited (as shown on the WDC Proposed Planning Map 30R) was reviewed.

As detailed stormwater modelling was not undertaken as part of this study, the flood hazard areas shown on plans 16194/00/12 & 13 are indicative only and should be used as such. They were determined using the following information:

- Flood levels obtained from the XP-SWMM model of major open channel and culverts systems;
- Flooding incidents reported by residents in the drainage questionnaire survey undertaken in January 2000;
- On-site investigations by GHD engineers;
- Previous flood hazard mapping of the Ngunguru Township.

Plans 16194/00/13-14 identify the flood hazard mapping undertaken as part of this report. These plans show stormwater flooding areas only, with the exception of the known saltwater flooding problem along the Waiotoi Rd drain.

10. Erosion & Sediment Control

10.1 Overview

Inspections of the Ngunguru Township stormwater drainage system by GHD staff in April 2000, and questionnaire responses by residents indicate that erosion resulting from stormwater runoff is not a major problem at present. Some concern over the loss of sand from the main beach areas was raised during the public submission process. It is recommended that this issue be addressed as part of a separate study to identify what effects coastal processes and stormwater discharges are having on beach sand movement.

10.2 Existing Situation

Some of the erosion sites reported by residents in the drainage questionnaire survey include:

- 1807, 1811 Ngunguru Road – local open drains;
- 28A Kakariki Rd – Kakariki Road drain;
- 1985, 1991 Ngunguru Road – drain between sports complex and Ngunguru Road properties;
- 3B, 5 Waiotoi Rd & 2001 Ngunguru Road – Waiotoi Road Drain / Estuary;
- 40 Te Maika Rd – watercourse southeast of Te Maika Rd.

The extent of erosion at the above sites appears to be minor at present. GHD therefore considers that erosion protection works are not justified at this time. However, should the existing situation change significantly in the future, some form of protection may be required.

10.3 Sediment Control

Of some concern in the Ngunguru area is the potential damage to the estuarine environment due to sediment deposition. Several catchments discharge directly to shallow estuarine areas, which can gradually become silted up, increasing the potential mangrove environment and changing the natural ecology of the area. In this regard, it is recommended that strict controls be placed on all earthworks in the Ngunguru area to minimise sediment load and subsequent sediment deposition.

10.4 Loss of Beach Sand

In their public submissions two residents raised the issue of the whole scale loss of sand from the beach, which they conclude is the result of discharges from existing stormwater outfalls. While we consider this issue to be an important one, we believe that other factors, such as tides, river flows, etc., are likely to have contributed to this problem. An investigation of this nature is considered to be outside the scope of this study and it is therefore recommended that the services of a coastal engineer be engaged to investigate this issue further.

For the outfall shown in Photo 10 (Line L), an improvement could be made to the existing outfall structure by undertaking the following:

- Removing the existing outlet structure and apron.
- Installing a drop manhole above the existing sea wall with a final invert level slightly below the existing beach level. Install a new outlet structure at a lower level corresponding to the invert level of the drop manhole.
- Replace the concrete apron with a reno mattress or similar mattress to protect the beach area immediately downstream of the outlet.

It is estimated that the above works would cost approximately $10,000. As this work would be undertaken in the Coastal Marine Area, a separate Coastal Permit would be required to undertake the works.

10.5 Other Issues

Until recently, most catchments in the Ngunguru area were made up of large undeveloped bush areas in the upper catchment and developed residential areas in the lower catchment. Under this scenario, peak flows, peak velocities and flow volumes would only be greater than pre-development values in the lower catchment. However, this situation has changed in recent years with the development of some of the upper ridge areas such as the Ngunguru Heights.

The development of these areas has increased the potential for erosion of hillsides and watercourses in downstream catchment areas. While no sites of erosion were identified at the time of GHD's inspection of this area, it is possible that loss of topsoil and development of gullies in new areas could be a problem in the future. For this reason the installation of good drainage systems in these areas is essential if erosion from surface runoff is to be avoided. Measures such as on-site detention tanks may be required in the long term to minimise erosion in open drains and streams.

10.6 Recommendations

- Monitoring of streams, watercourses and open drains at least annually to check major open drains and watercourses for new erosion and to identify areas with rapidly progressing erosion (if any).
- Should erosion protection works be considered necessary in the future, it is recommended that options for stream bank planting be investigated prior to the construction of retaining walls or similar structures. Planting is both cost effective and can offer significant benefits to the natural environment.
- The placement of strict controls and compliance monitoring on earthworks projects to ensure that the amount of sediment from this source is kept to a minimum.

11. Stormwater Quality

11.1 Overview

Based on reports by local residents, water quality is not perceived to be an issue in the Ngunguru Estuary and its associated waterways. However, according to monitoring data collected by the Northland Regional Council (NRC) levels of some contaminants are significantly above NRC requirements.

11.2 Monitoring

11.2.1 Introduction

From 1990-1996, the NRC undertook selected monitoring for faecal coliforms (FC) in stormwater runoff at six outfalls along the Ngunguru Estuary and at a further three sites in the Waiotoi Road drain. The NRC also undertook tests for salinity (SAL) and suspended solids (SS) at seven sites in the Waiotoi Road drain on 16 July 1999.

At the time of completing the final report for this study in December 2001, the NRC was in the process of undertaking water quality monitoring at Ngunguru for enterococci and faecal coliforms. The initial test data from this latest study, as was available at this time, was also reviewed.

11.3 Reports by Residents

Approximately 50% of the questionnaire responses received indicated that stormwater quality in Ngunguru Township is 'not an issue', while 20% indicated that stormwater quality is of 'high significance'.

One resident in the Pine Rd / Chloe Place area reported fish and eel kills due to 'high toxicity' in the adjacent watercourse. However, this problem appears to be isolated and may be the result of salt water flows during exceptionally high tides.

11.4 Marine Bathing Water Quality

Based on requirements specified by the Ministry for the Environment (MFE), the Northland Regional Council has developed the following test indicators for bathing water quality at Northland beaches (reproduced from the Northland Regional Council Guidelines for Marine Bathing Water Quality).

Enterococci[1]		Faecal Coliforms (colonies)[2]	
n $100ml^{-1}$	Classification	n $100ml^{-1}$	Classification
<136	Considered safe for bathing	<150	Considered safe for bathing
136-277	Considered potentially unsafe for bathing	150-600	Considered potentially unsafe for bathing
>277	Highly likely to be unsafe for bathing	>600	Highly likely to be unsafe for bathing

1 Enterococci levels are taken from MfE and Ministry of Health 1999 suggested marine bathing guidelines. Levels are for any single sample.

2 Faecal Coliform levels are taken from the Northland Regional Council Revised Proposed Regional Coastal Plan, Contact Recreation Standard CB. Levels are based on not fewer than 5 samples within any 30 day period, where the median is <150 $100ml^{-1}$ and an 80%ile of <600 $100ml^{-1}$.

Based on discussions with NRC in December 2001, the NRC considers these guidelines to be applicable to Ngunguru.

11.4.1 Monitoring Results

According to "Marine Bathing Water and Contact Recreation: A Monitoring Programme for Northland", a report published by NRC in October 2000, the NRC will only notify the Medical Officer of Health (MOH), when a single test sample exceeds the guidelines for both FC and Enterococci. This indicates that a beach is likely to be unsafe for recreational bathing.

For the 1990-1996 data, monitoring was undertaken for FC only, while the 2001-2002 monitoring study included both FC and Enterococci.

1990-1996 Monitoring Study:

FC levels along the Ngunguru Estuary were found to be significantly above the recommended value of 150/100ml. High readings were recorded in the Waiotoi Rd drain (more than three readings greater than 2000/100ml), at the boat ramp opposite 2019 Ngunguru Rd (two readings greater than 3000/100ml) and at the beach ramp opposite 29 Te Maika Rd (three readings greater than 2000ml/100ml).

2001-2002 Monitoring Study:

For the 2001-2002 study, monitoring was undertaken at 7 sites from Tongatu Rd in the southwest to Te Maika Rd in the northeast (see Appendix 5 for details). Based on the monitoring data available on 17 January 2002[1], levels for FC and Enterococci greater than NRC's guideline values were identified at 5 of the 7 sampling sites located in Ngunguru. Two sites exceeded the guideline values for both parameters on three occasions: the foreshore areas adjacent to Tongatu Rd (site 61) and Ngunguru Beach adjacent to the outfall of Line K (site 76).

[1] Monitoring was undertaken on the following dates: 3/12/2001, 4/12/2001, 6/12/2001, 19/12/2001, 14/01/2002 and 15/1/2002.

11.4.2 Commentary

Monitoring results for both the most recent study (2001-2002) and earlier studies both indicate that levels of microbiological contaminants are greater than would be expected for an area of this nature. Ngunguru is served by a wastewater reticulation system and treatment plant. Treated effluent is pumped to a neighbouring catchment that does not discharge to the Ngunguru Estuary. In addition, use of land in the catchment for agricultural use does not appear to be significant.

Based on GHD's study of this area, there are no clear reasons why this contamination should be occurring. Possible sources of contamination include the following:

- Runoff from agricultural land with livestock;
- Overflows from wastewater pump stations;
- Old or improperly operating septic tanks on properties not served by the wastewater reticulation system.

11.4.3 Recommendations

It is recommended that the NRC and WDC work together to identify sources of contamination that can potentially be eliminated or minimised. It is possible that some or all of the above sources of contamination are contributing to the problems currently being experienced in the estuary.

11.5 Other Contaminants

While the NRC has not undertaken monitoring of stormwater runoff for other contaminants, the possibility of this occurring appears to be remote. The main reason for this is the absence of industry in the Township, which tends to be a primary cause of stormwater contamination, particularly from heavy metals. While some contamination from roads in the Township is possible, the relatively low volume of traffic on these roads means that the concentration of contaminants entering stormwater runoff is likely to be small.

12. Maintenance & Monitoring

12.1 Overview

With a large part of Ngunguru being serviced by an open stormwater drainage system, regular maintenance and monitoring of the system is essential if flood protection of residential and commercial property is to be maintained. Site inspections by GHD staff in April 2000 indicated that the drainage system was generally in acceptable condition, although a few drains were in need of attention.

12.2 Mangroves

The main issue at present is the growth of mangroves in tidal stormwater drains. While the growth of mangroves improves the natural environment, uncontrolled growth can significantly reduce hydraulic capacity, which can result in the flooding of properties and buildings. A programme for the control of the growth of mangroves is therefore needed if the drainage system is to provide flood protection to properties.

12.3 Proposed Maintenance Programme

General maintenance of drains for the control of other vegetation is also required. It is therefore recommended that a regular maintenance and monitoring programme be established. The following general guidelines are recommended:

- Vegetation control in the open drainage system at least five times annually from October to May.
- Inspections of culverts and other major drainage structures on at least a monthly basis with additional visits after heavy rainfall when considered necessary by WDC.

The above recommendations are based on GHD Ltd. experience with other catchments, predominantly in the Auckland region.

GHD's experience has shown that spraying is generally not an effective means of vegetation control in open drains and watercourses. This causes total loss of vegetation, which leads to erosion of stream banks, particularly near structures such as culverts and bridges.

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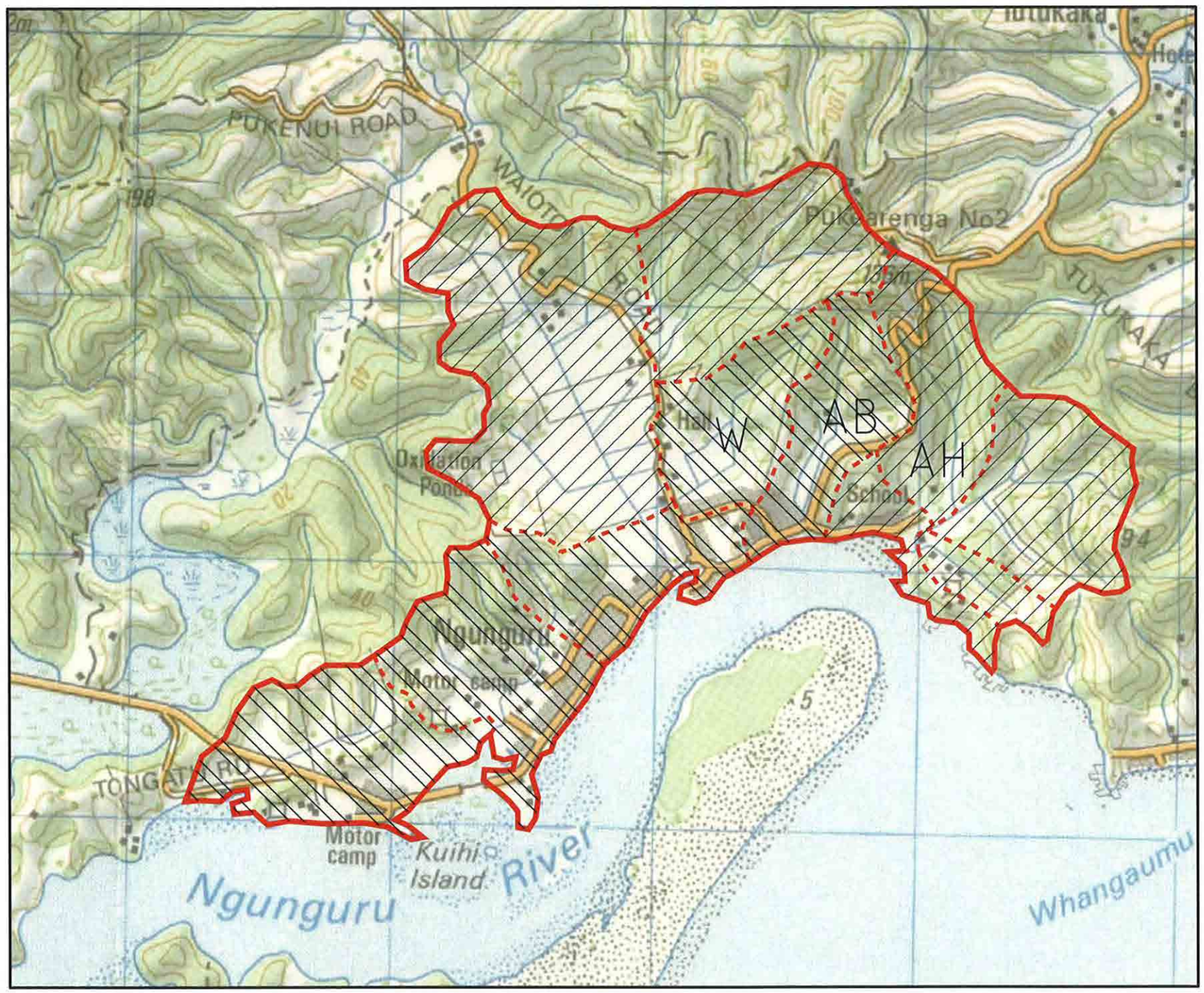

LEGEND

- MAIN CATCHMENT BOUNDARY
- EXISTING URBAN & PARTIALLY URBANISED CATCHMENTS
- EXISTING RURAL CATCHMENTS
- W — CATCHMENT LABEL (for catchments not fully shown on Drawing 16194/00/03).

NOTE

CATCHMENT BOUNDARIES SHOWN ON THIS PLAN ARE APPROXIMATE & ARE BASED ON CONTOURS AT 20m INTERVALS.

No.	Revision — Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\16194\ACAD\CATCH_(V1)

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Scale: 1:10000 APPROX. AT A1

Drawn/Traced: S.G./D.R. 12/01 | Engineer Design: D.R 09/00

Draft Check | Engineer Check

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Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: MAJOR CATCHMENT BOUNDARIES

Size: A1 | Drg. No. 16194/00/01 | Rev

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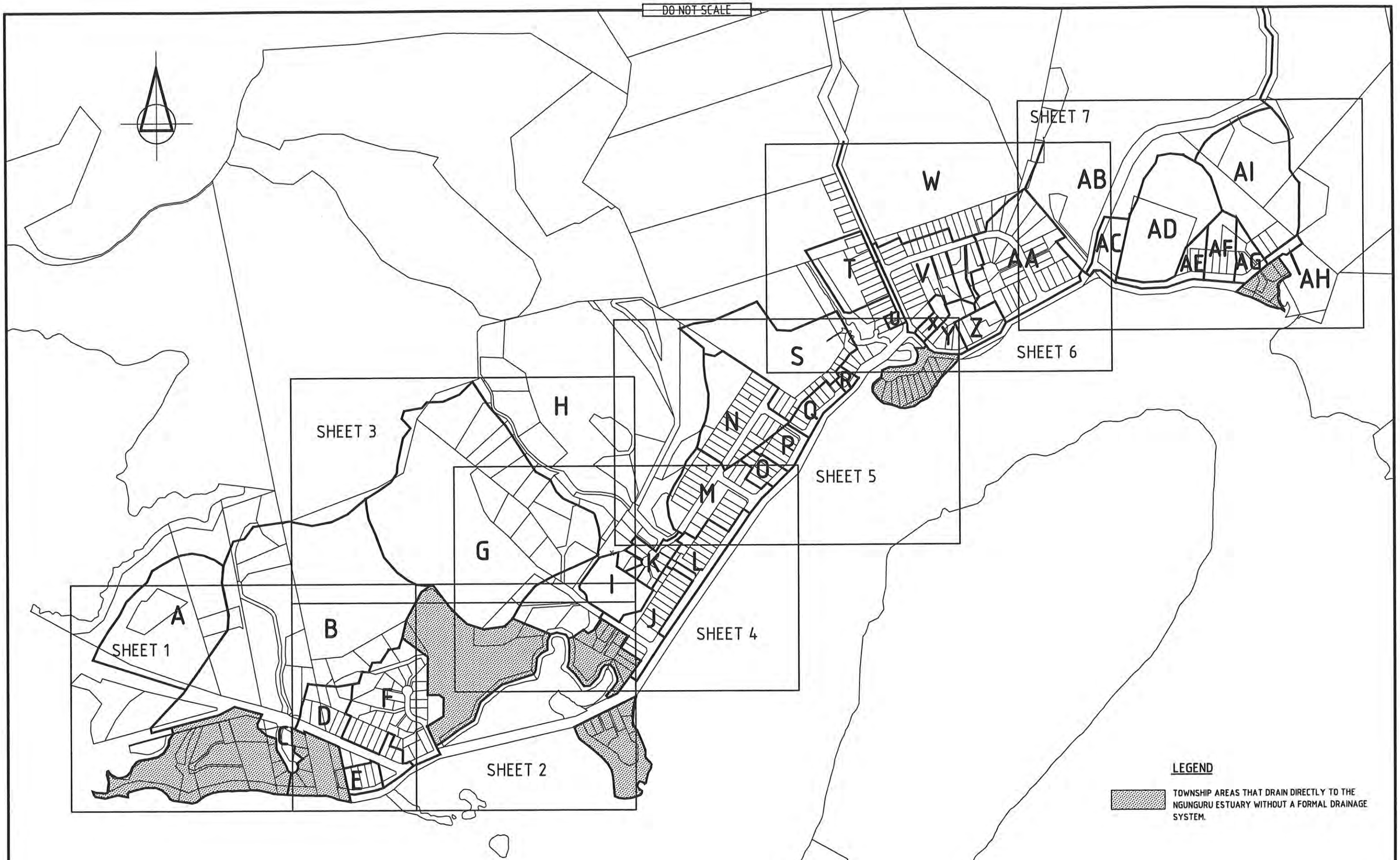

LEGEND

TOWNSHIP AREAS THAT DRAIN DIRECTLY TO THE NGUNGURU ESTUARY WITHOUT A FORMAL DRAINAGE SYSTEM.

PRELIMINARY

No.	Revision – Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\16194\ACAD\Catchment Boundaries.dwg

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Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: KEY PLAN AND
MINOR CATCHMENT BOUNDARIES

Size: A1 | Drg. No. 16194/00/02 | Rev

DO NOT SCALE

A

B

C

D

E

F

PC1

PC2

PC3

PC4

PC5

LINE A

LINE B

LINE C

LINE D

TONGATU ROAD

NGUNGURU ROAD

PAPAKA ROAD

HAVEN PL

MUNRO PL

1807 1815 1817 1819 1821 1823 1825 1827 1829 1830 1831 1833 1834 1835 1837 1839 1841 1842 1843 1845 1847 1849 1851

2 4 6 8 1 3 5 7 9 10 14 18 20 22 25 23 23 27 27 29 31 33 26 12 10 8 6 4 2 11 7 5 9 9

6000 6001 6004 6079 6002 6003

PRELIMINARY

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Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: EXISTING DRAINAGE SYSTEM
SHEET 1

Size: A1 | Drg. No. 16194/00/03 | Rev

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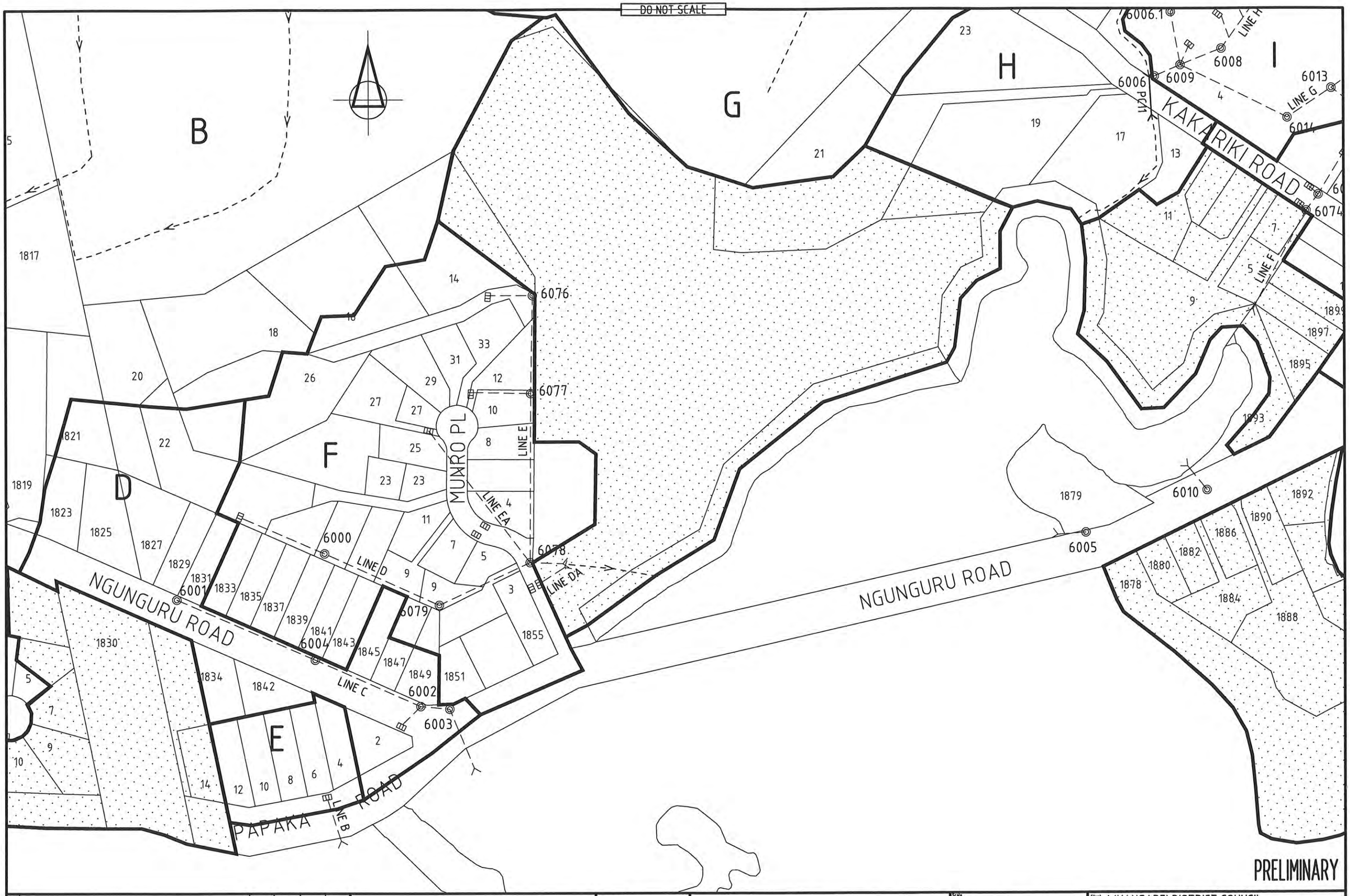

PRELIMINARY

No.	Revision — Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

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Draft Check		Engineer Check	
Approved			

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Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: EXISTING DRAINAGE SYSTEM
SHEET 2

Size: A1 | Drg. No. 16194/00/04 | Rev

DO NOT SCALE

H

G

B

38

35

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29

24

23

NGUNGURU

HEIGHTS

2

14

24

26

1

34

28

28

26

PC7

PC6A

30

PC6B

22

23

6007

LINE I

6011

6006.1

LINE H

6008

6009

6006

6013

PRELIMINARY

No.	Revision – Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

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Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: EXISTING DRAINAGE SYSTEM
SHEET 3

Size: A1 | Drg. No. 16194/00/05 | Rev

DO NOT SCALE

HEIGHTS

KOPIPI CRES

PINE ROAD

CHLOE PL

KAKARIKI ROAD

NGUNGURU ROAD

LINE I

LINE H

LINE G

LINE F

LINE J

LINE K

LINE L

LINE M

PC6A

PC6B

PC7

PC8

PC9

PC10

PC11

6006

6006.1

6007

6008

6009

6011

6012

6013

6059

6060

6061

6062

6066

6069

6070

6071

6072

6073

6074

6075

G

H

I

J

K

L

M

O

PRELIMINARY

No.	Revision – Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\16194\ACAD\SW.dwg (V4)

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Engineer Design	D.R. 12/01
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Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: EXISTING DRAINAGE SYSTEM
SHEET 4

Size: A1 | Drg. No. 16194/00/06 | Rev

DO NOT SCALE

PRELIMINARY

No.	Revision — Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\16194\ACAD\SW.dwg (V5)

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Engineer Design	D.R. 12/01
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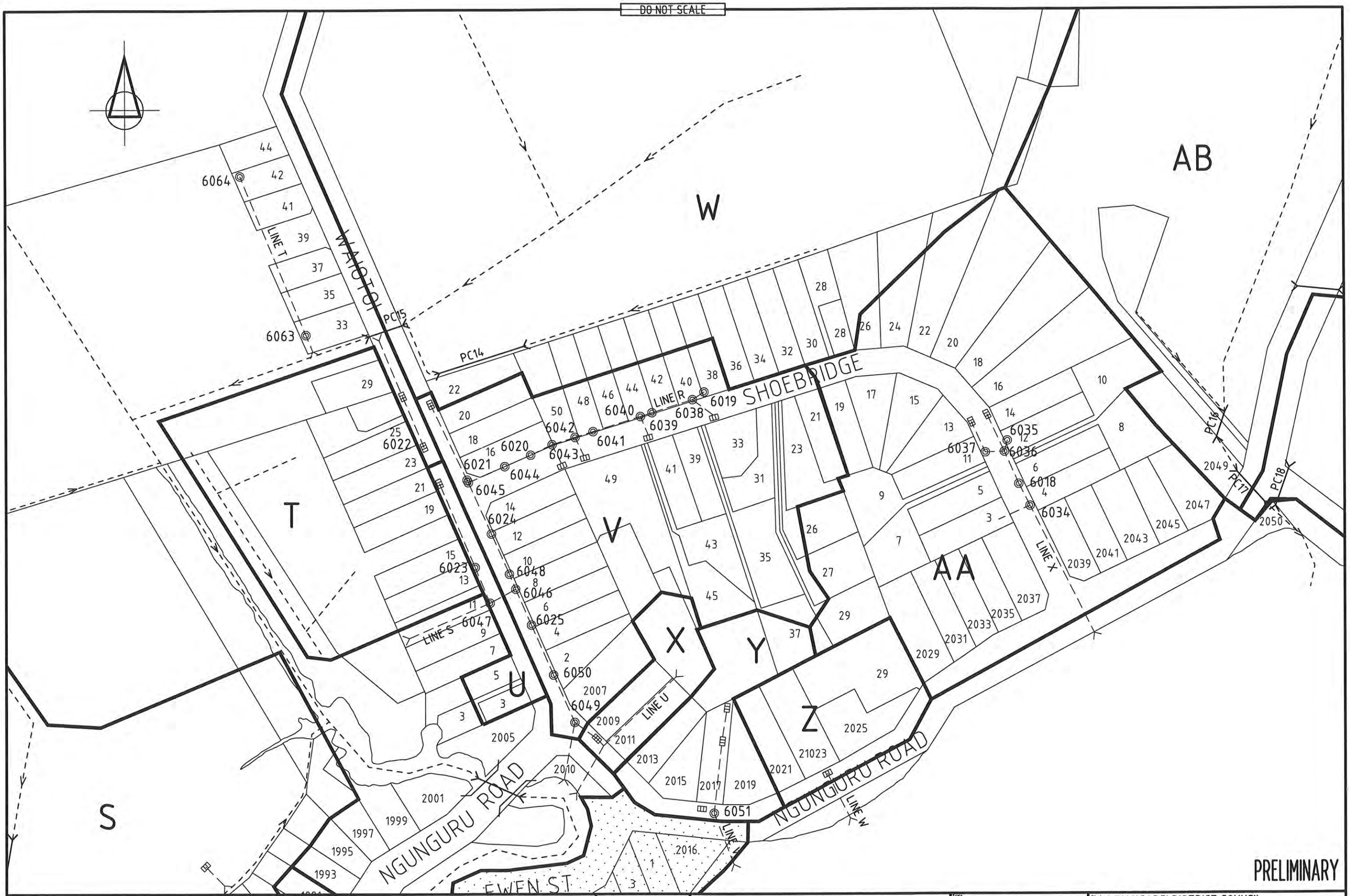
Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: EXISTING DRAINAGE SYSTEM
SHEET 5

Size: A1 | Drg. No. 16194/00/07 | Rev

DO NOT SCALE



PRELIMINARY

No.	Revision — Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\16194\ACAD\SW.dwg (V6)

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Draft Check		Engineer Check	
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Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MJANAGEMENT PLAN

Title: EXISTING DRAINAGE SYSTEM
SHEET 6

Size A1 | Drg. No. 16194/00/08 | Rev

DO NOT SCALE

AB

AI

AA

AC

AD

AE

AF

AG

AH

TE MAIKA

LINE X

LINE Y

LINE Z

LINE ZA

LINE ZB

LINE ZC

PC16

PC17

PC18

PC19

2049

2050

6035

6036

6018

6034

6016

6017

6033

6015

6032

PRELIMINARY

No.	Revision — Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\16194\ACAD\SW.dwg (V7)

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Scale: 1:1000

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Draft Check		Engineer Check	
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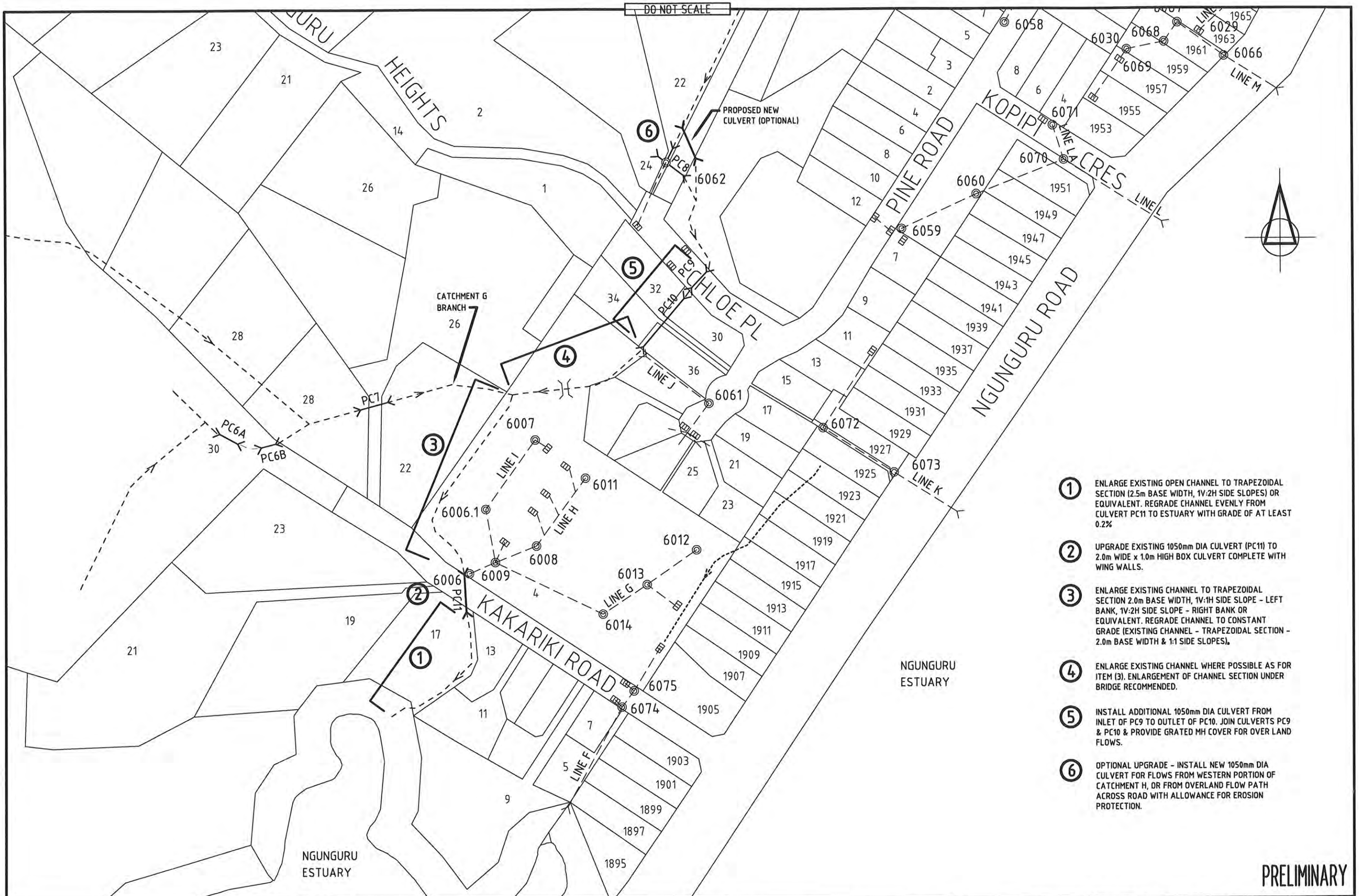
Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: EXISTING DRAINAGE SYSTEM
SHEET 7

Size: A1 | Drg. No.: 16194/00/09 | Rev

DO NOT SCALE



1. ENLARGE EXISTING OPEN CHANNEL TO TRAPEZOIDAL SECTION (2.5m BASE WIDTH, 1V:2H SIDE SLOPES) OR EQUIVALENT. REGRADE CHANNEL EVENLY FROM CULVERT PC11 TO ESTUARY WITH GRADE OF AT LEAST 0.2%

2. UPGRADE EXISTING 1050mm DIA CULVERT (PC11) TO 2.0m WIDE x 1.0m HIGH BOX CULVERT COMPLETE WITH WING WALLS.

3. ENLARGE EXISTING CHANNEL TO TRAPEZOIDAL SECTION 2.0m BASE WIDTH, 1V:1H SIDE SLOPE - LEFT BANK, 1V:2H SIDE SLOPE - RIGHT BANK OR EQUIVALENT. REGRADE CHANNEL TO CONSTANT GRADE (EXISTING CHANNEL - TRAPEZOIDAL SECTION - 2.0m BASE WIDTH & 1:1 SIDE SLOPES).

4. ENLARGE EXISTING CHANNEL WHERE POSSIBLE AS FOR ITEM (3). ENLARGEMENT OF CHANNEL SECTION UNDER BRIDGE RECOMMENDED.

5. INSTALL ADDITIONAL 1050mm DIA CULVERT FROM INLET OF PC9 TO OUTLET OF PC10. JOIN CULVERTS PC9 & PC10 & PROVIDE GRATED MH COVER FOR OVER LAND FLOWS.

6. OPTIONAL UPGRADE - INSTALL NEW 1050mm DIA CULVERT FOR FLOWS FROM WESTERN PORTION OF CATCHMENT H, OR FROM OVERLAND FLOW PATH ACROSS ROAD WITH ALLOWANCE FOR EROSION PROTECTION.

PRELIMINARY

No.	Revision – Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\16194\ACAD\SW.dwg (V9)

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Scale: 1:1000

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Draft Check		Engineer Check	
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Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: CHLOE PLACE TO NGUNGURU ESTUARY UPGRADING REQUIREMENTS (BASED ON FUTURE DESIGN FLOWS)

Size: A1 | Drg. No. 16194/00/10 | Rev

DO NOT SCALE

EXTENT OF STOPBANK TO BE DETERMINED DURING DETAILED DESIGN

POSSIBLE LOCATION OF NEW CULVERT & TIDE GATE

EXTENT OF STOPBANK TO BE DETERMINED DURING DETAILED DESIGN

WAIOTOI ROAD

REACH OF DRAIN BECOMING CHOKED BY UNCONTROLLED GROWTH OF MANGROVE

PIPE EXISTING OPEN DRAIN & INSTALL TIDE GATE

SHOEBRIDGE

CONSTRUCT STOPBANK & INSTALL TIDAL GATE ON EXISTING WAIOTOI ROAD OUTLET

EXTEND OUTFALL TO DOWNSTREAM OF JUNCTION WITH DRAINS TD1 & TD2

EXISTING CULVERT & TIDE GATE

NGUNGURU ROAD

EWEN ST

NGUNGURU ROAD

TD1 TD2 TD3 TD4 TD5 TD6 TD7 TD8 D1 D2 D3

NOTES

1. STOPBANK TO BE CONSTRUCTED TO RL 2.2
2. EXISTING BANK ELEVATIONS VARY FROM RL 1.28 TO 2.31 (SEE APPENDIX 5)
3. ADDITIONAL TIDE GATES MAY BE REQUIRED FOR UNIDENTIFIED OUTLETS.
4. EXTENT OF STOPBANKS MAY BE REVISED ON SITE DURING CONSTRUCTION & ADDITIONAL SURVEY.
5. PIPE ARRANGEMENT ALONG WESTERN SIDE OF WAIOTOI ROAD DETERMINED FROM SITE INSPECTION.

PRELIMINARY

No.	Revision – Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\16194\ACAD\TIDAL-DRAIN.dwg (V1)

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Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: PROPOSED FLOOD PROTECTION WORKS FOR WAIOTOI ROAD TIDAL DRAIN

Size A1 | Drg. No. 16194/00/11 | Rev

DO NOT SCALE

NOTE

1. FLOOD PLAIN EXTENTS ARE INDICATIVE ONLY AND HAVE TO BE CONFIRMED BY DETAILED SURVEY
2. FLOOD LEVELS ARE IN TERMS OF MEAN SEA LEVEL

LEGEND

EXTENT OF FLOOD PLAIN

OVERFLOW PATH FOR FLOOD PLAIN

PRELIMINARY

No.	Revision — Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\16194\ACAD\FLOODHAZARD VER2 (V1)

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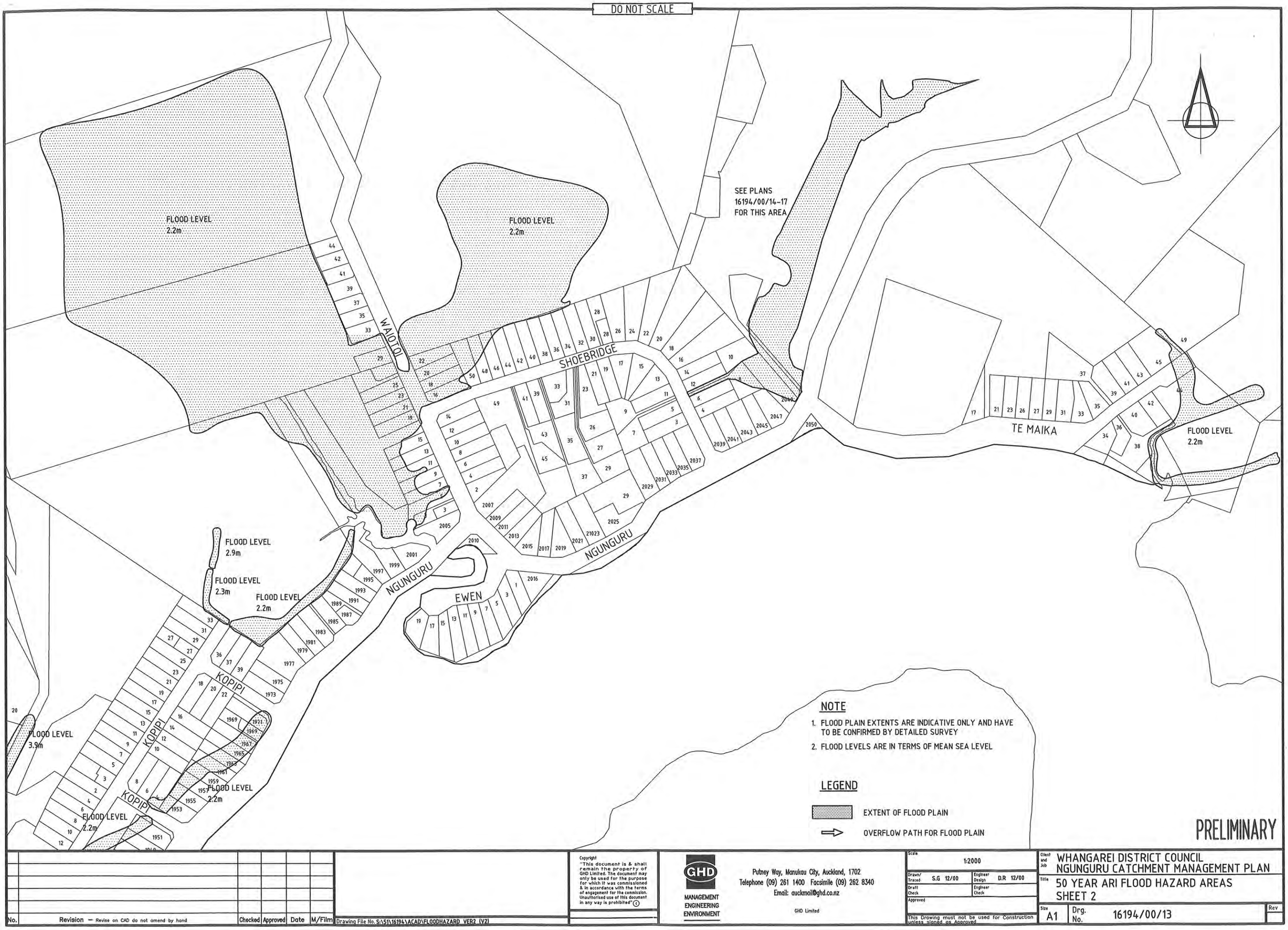
Client and Job	WHANGAREI DISTRICT COUNCIL NGUNGURU CATCHMENT MANAGEMENT PLAN	
Title	50 YEAR ARI FLOOD HAZARD AREAS SHEET 1	
Size A1	Drg. No. 16194/00/12	Rev

DO NOT SCALE



NOTE

1. FLOOD PLAIN EXTENTS ARE INDICATIVE ONLY AND HAVE TO BE CONFIRMED BY DETAILED SURVEY
2. FLOOD LEVELS ARE IN TERMS OF MEAN SEA LEVEL

LEGEND

EXTENT OF FLOOD PLAIN

OVERFLOW PATH FOR FLOOD PLAIN

PRELIMINARY

No.	Revision — Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\16194\ACAD\FLOODHAZARD_VER2 (V2)

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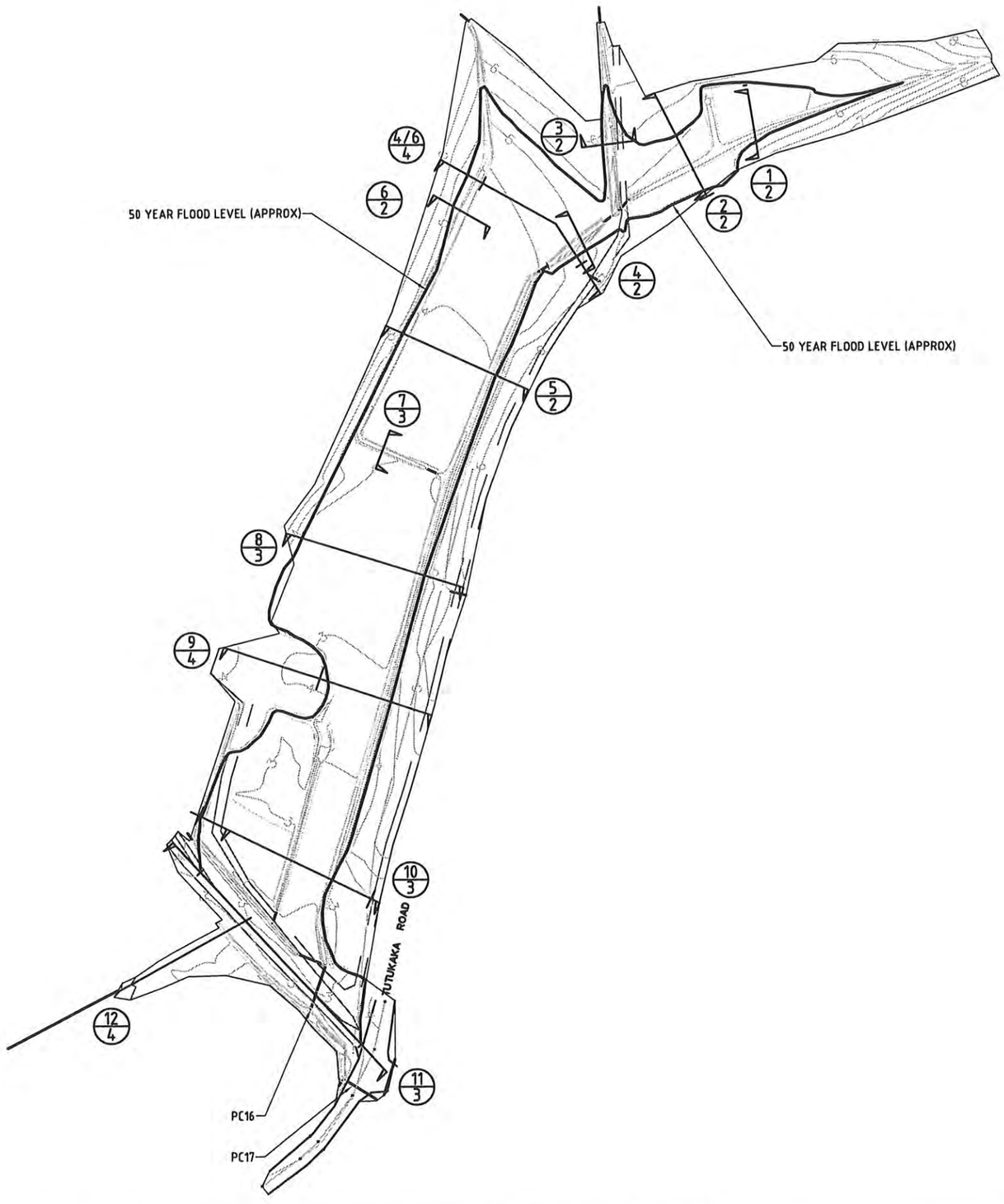
Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: 50 YEAR ARI FLOOD HAZARD AREAS
SHEET 2

Size: A1 | Drg. No. 16194/00/13 | Rev

DO NOT SCALE



PRELIMINARY

No.	Revision — Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\16194\LDD\NGUNGURU SW\DWG\X-SECTIONS REV1.DWG (1)

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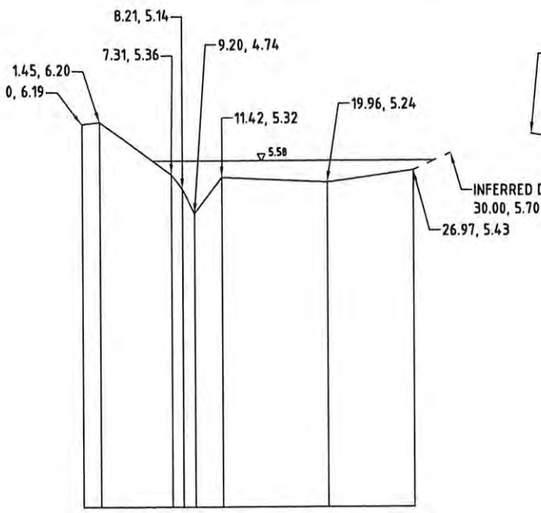
Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

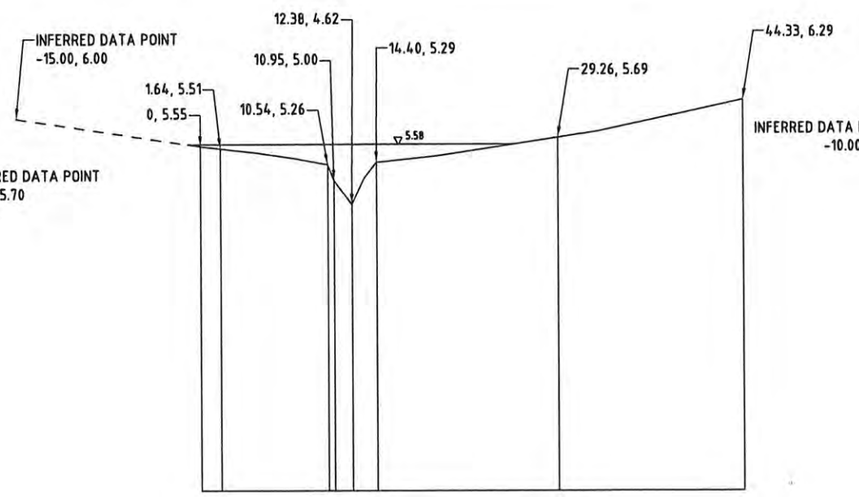
Title: NORTHERN NGUNGURU
50 YEAR ARI FLOOD HAZARD AREAS

Size: A1 | Drg. No. 16194/00/14 | Rev

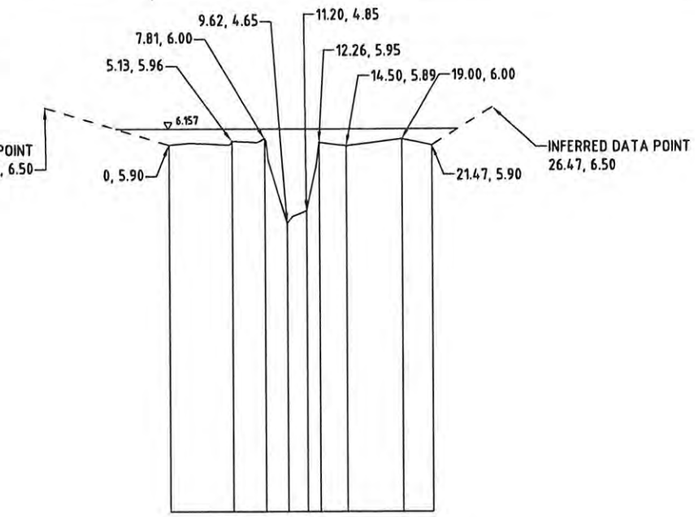
DO NOT SCALE



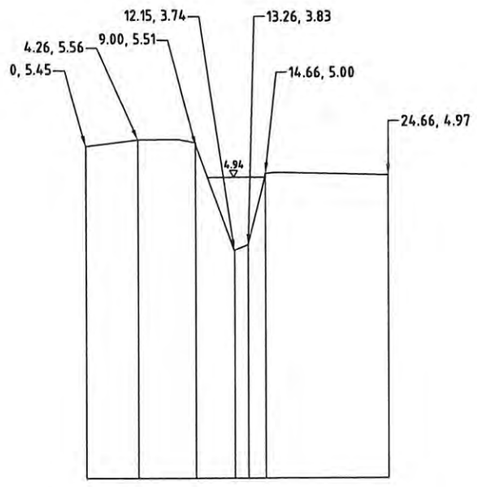
1/1 X-SECTION 1



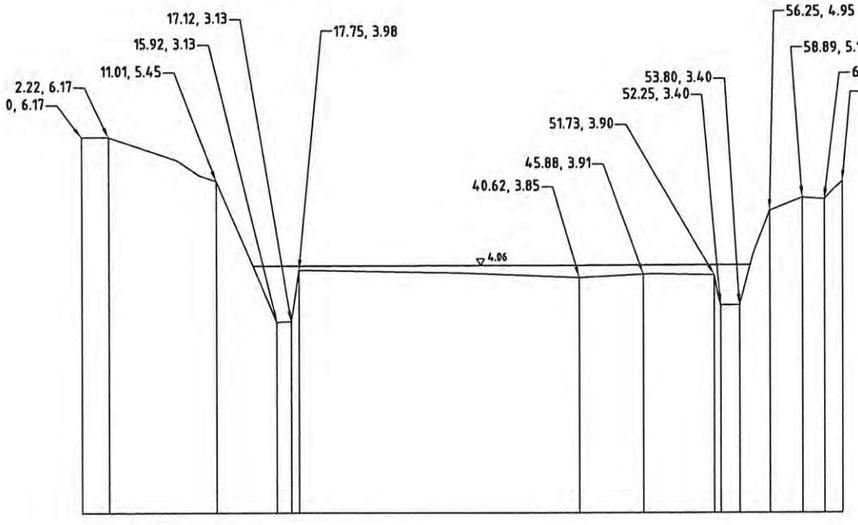
2/1 X-SECTION 2



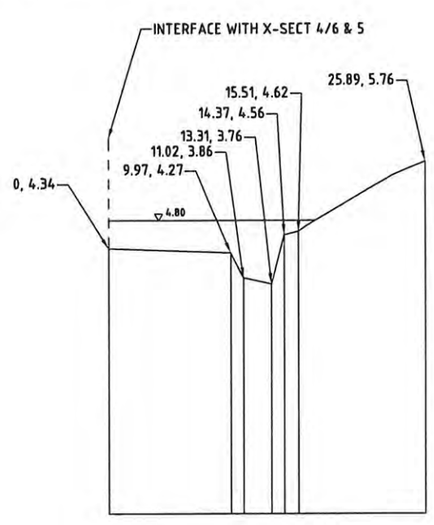
3/1 X-SECTION 3



4/1 X-SECTION 4



5/1 X-SECTION 5



6/1 X-SECTION 6

——— FLOOD LEVEL FOR CURRENT DRAINAGE SYSTEM

····· FLOOD LEVEL AFTER REMEDIAL WORKS

– – – INFERRED GROUND LEVEL

LONGSECTION
SCALE 1:250H, 1:50V @A1
ALL DATUMS = 0.0m (RL)

NB: FLOOD LEVELS AT X-SECTIONS 1, 2, 3, 4, 5 & 4/6
WOULD NOT BE AFFECTED BY THE PROPOSED REMEDIAL WORKS

PRELIMINARY

No.	Revision – Revise on CAD do not amend by hand	Checked	Approved	Date	M/Flm

Drawing File No. S:\51\19028\ACAD\50 YEAR LEVELS.DWG (2)

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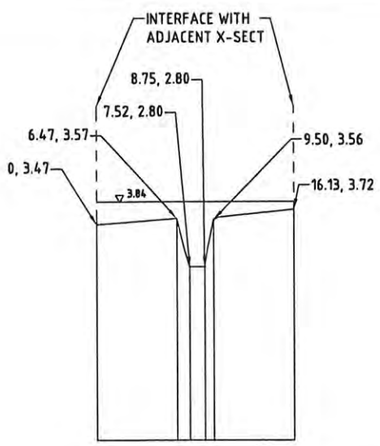
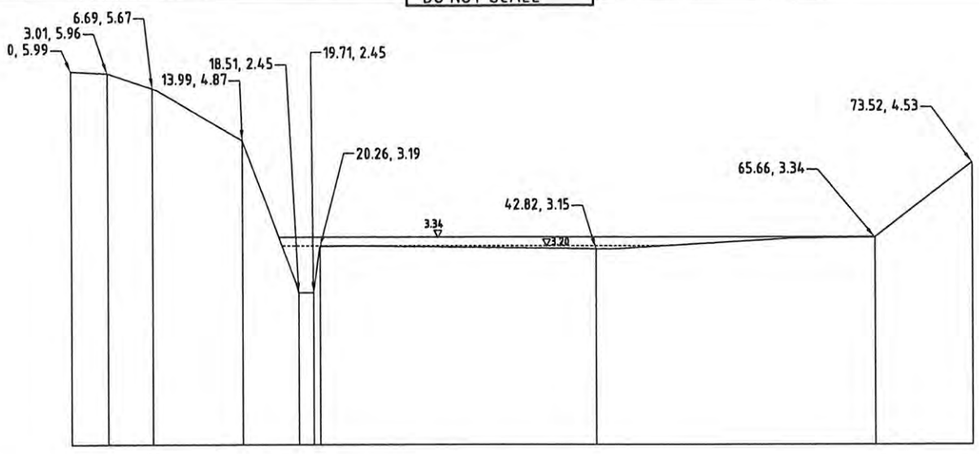
Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: NORTHERN NGUNGURU
50 YEAR ARI FLOOD LEVELS - SHEET 1

Size: A1 | Drg. No. 16194/00/15 | Rev

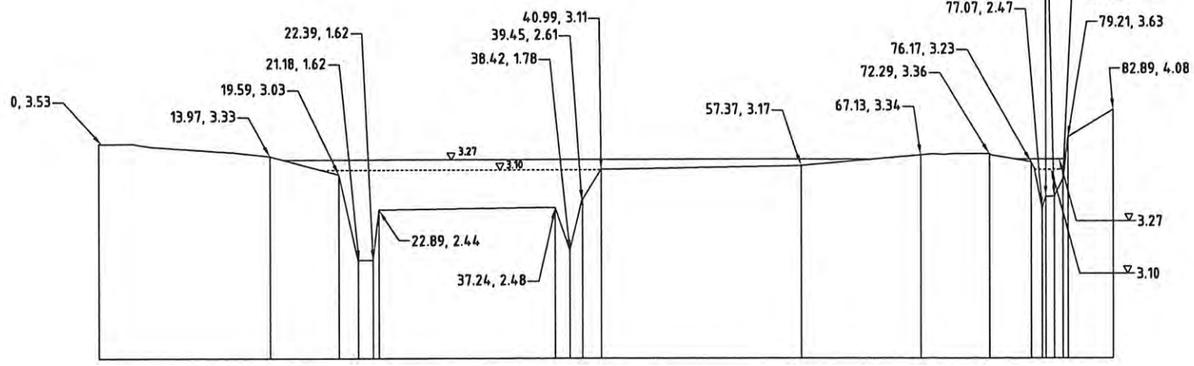
DO NOT SCALE



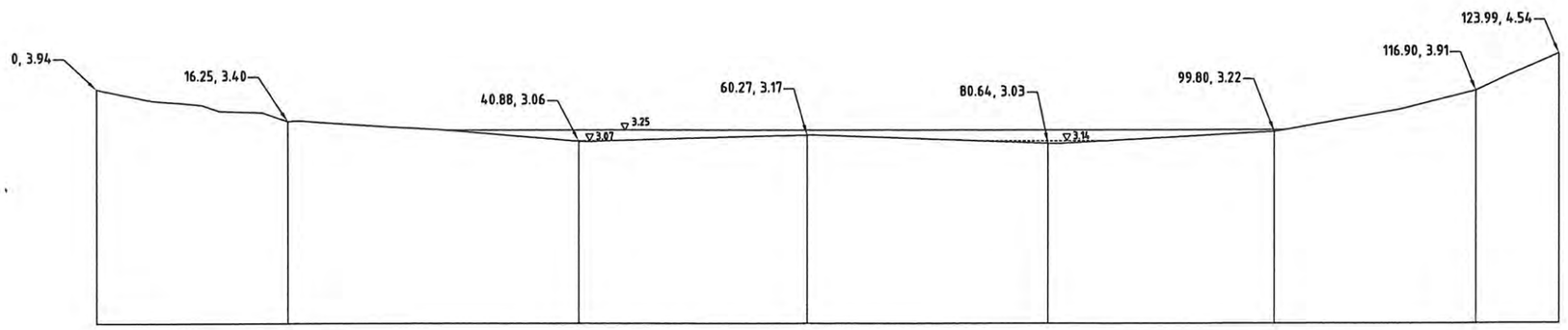


7/1 X-SECTION 7

8/1 X-SECTION 8



10/1 X-SECTION 10



11/1 X-SECTION 11 CEMETERY ACCESS ROAD

LONGSECTION
SCALE 1:250H, 1:50V @A1
ALL DATUMS = 0.0m (RL)

——— FLOOD LEVEL FOR CURRENT DRAINAGE SYSTEM

---------- FLOOD LEVEL AFTER REMEDIAL WORKS

— — — INFERRED GROUND LEVEL

PRELIMINARY

No.	Revision – Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\51\19028\50 YEAR LEVELS.DWG (3)

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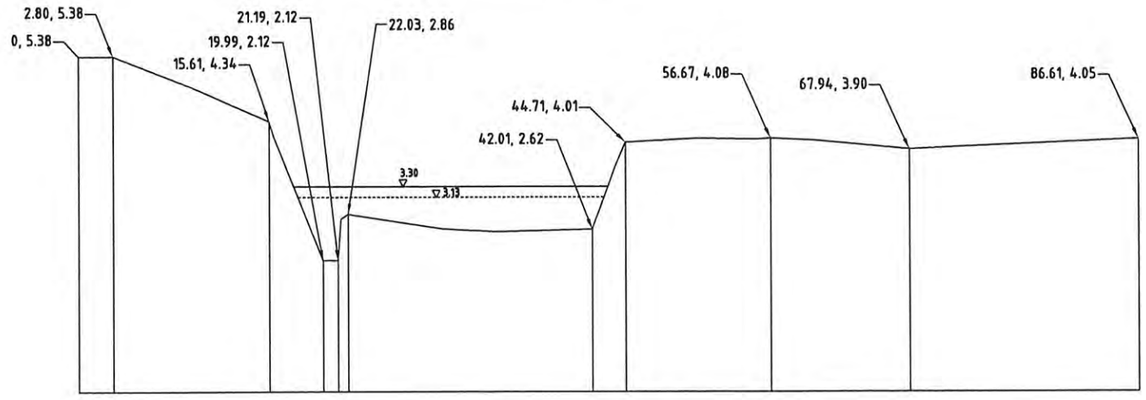
Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

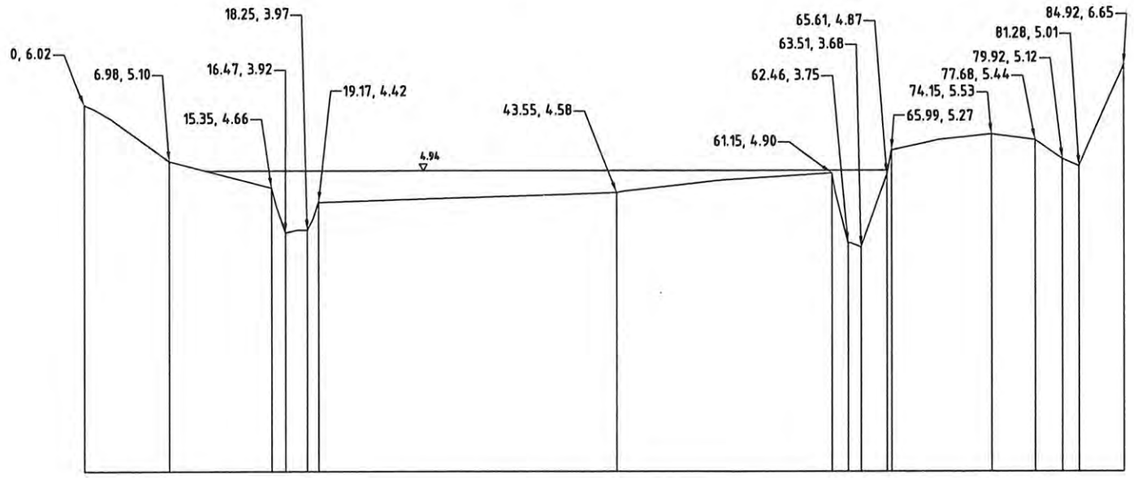
Title: NORTHERN NGUNGURU
50 YEAR ARI FLOOD LEVELS - SHEET 2

Size: A1 | Drg. No.: 16194/00/16 | Rev:

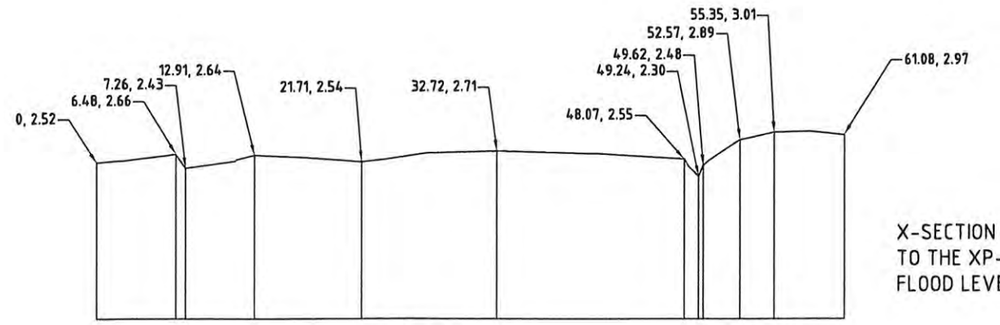
DO NOT SCALE



9/1 X-SECTION 9



4/6/1 X-SECTION 4/6



12/1 X-SECTION 12

LONGSECTION
SCALE 1:250H, 1:50V @A1
ALL DATUMS = 0.0m (RL)

——— FLOOD LEVEL FOR CURRENT DRAINAGE SYSTEM

····· FLOOD LEVEL AFTER REMEDIAL WORKS

– – – INFERRED GROUND LEVEL

X-SECTION 12 IS A LONG-SECTION WITH RESPECT TO THE XP-SWMM MODEL AND THEREFORE FLOOD LEVELS HAVE NOT BEEN SHOWN

PRELIMINARY

No.	Revision – Revise on CAD do not amend by hand	Checked	Approved	Date	M/Film

Drawing File No. S:\511\19028\ACAD\50 YEAR LEVELS.DWG (4)

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Engineer Check	AM 09/02
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Client and Job: WHANGAREI DISTRICT COUNCIL
NGUNGURU CATCHMENT MANAGEMENT PLAN

Title: NORTHERN NGUNGURU
50 YEAR ARI FLOOD LEVELS - SHEET 3

Size: A1 | Drg. No. 16194/00/17 | Rev -