Mangaroa River Flood Hazard Assessment

EROSION HAZARD REPORT

GW/FP-G-06/64

- Revision A
- 29 May 2006

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Contents

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
Revision A	24/02/06	CMM	CMM	29/05/06	Final

Distribution of copies

Revision	Copy no	Quantity	Issued to
Revision A	1	1	Philip Purves (Greater Wellington)

Printed:	19 September 2006
Last saved:	1 June 2006 01:24 PM
File name:	I:\Aenv\Projects\AE02482\Deliverables\Erosion Report.doc
Author:	Benjamin Fountain
Project manager:	Benjamin Fountain
Name of organisation:	Greater Wellington Regional Council
Name of project:	Managaroa River Flood Hazard Assessment
Name of document:	Erosion Hazard Report
Document version:	Revision A
Project number:	AE02482

Executive Summary

The geological features of the Mangaroa River Valley were investigated and mapped using a variety of resources and tools including stereopair aerial photographs, hyposometric relief mapping, geological maps and site walkovers. Composite geological maps were developed that were used to identify the constraints on river morphology and locate areas of erosion risk.

The locations of erosion risk were assessed using a matrix of likelihood of failure versus consequence of failure. A relative risk rating was assigned to each of the identified erosion risk locations.

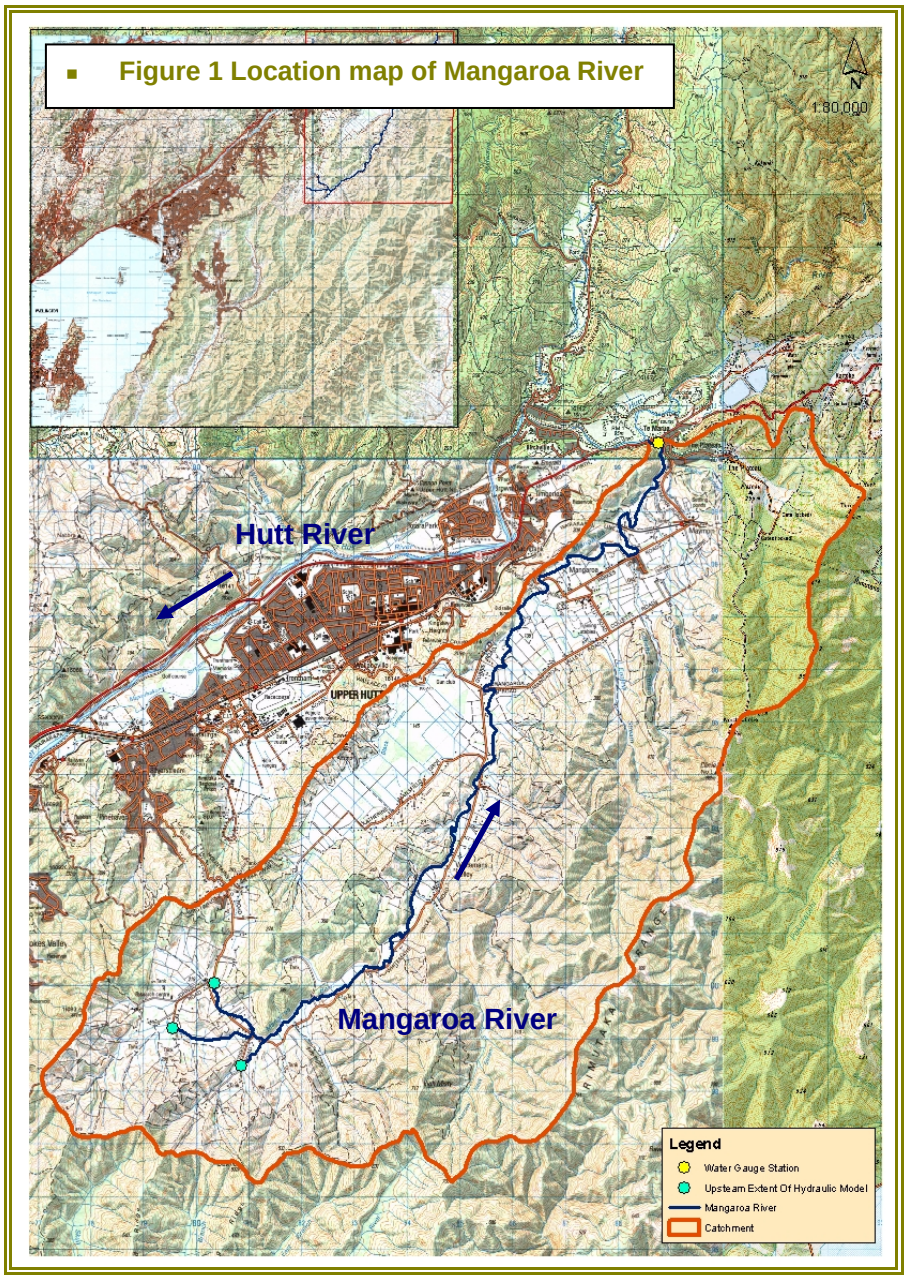
Building on the risk assessment analysis building exclusion offsets have been recommended for each of the erosion risk sites.

The findings of this study have been collated in a set of plans (Plans 1-5) that will assist in the development of policy controls to help manage development in the Mangaroa River Valley.

1. Introduction

Erosion caused by the Mangaroa River has the potential to damage infrastructure and buildings built around the river channel. An investigation has been carried out into the morphology of the Mangaroa River and an assessment was made to identify and quantify the erosion risks.

This investigation forms part of the hazard investigation study undertaken by SKM on behalf of Greater Wellington to identify the erosion and flooding hazards on the Mangaroa River. A location map of the study area is detailed in Figure 1.



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2. Erosion Hazard Identification

2.1 Geological Mapping

The geological features of the Mangaroa River Valley have been mapped. These maps provide much of the base information to identify the constraints on river morphology and locate areas of erosion risk. The maps were prepared using the following resources:

- examination of the January 2005 1:50,000 stereopair aerial photographs,
- interpreted hyposometric relief mapping derived from the LiDAR contours,
- the 1:50,000 geological map- 'Geology of the Wellington Area' (GNS, 1996)
- walkover site inspection was made of the critical areas of interest to confirm the interpreted geology.

The geological mapping has been undertaken solely with a view to providing background specific to this project. The mapping is not necessarily suitable for other applications, and all development within this area will require site-specific geological investigation. SKM accept no responsibility for the use of this map for purposes other than this study.

The geological maps are attached to this document as Plans 1-5.

2.2 Mangaroa River Valley Geology

The underlying Geology of much of the Mangaroa Valley floor is made up of alluvium. Holocene aged alluvium deposits, that have been recently reworked, usually do not have significant cohesion except in situations where overbank silt deposits have occurred. These cohesionless deposits are highly susceptible to erosion. Some of the older Holocene alluviums tend to have some cohesion where there is a silty matrix, and it is possible that some cementation occurs. In places lower level Holocene terraces are located in close proximity to the existing Mangaroa River alignment.

The Pleistocene alluvium is significantly more resistant to erosion that the Holocene alluvium, likely due to cohesion of silt or clay matrix and cementation. The Pleistocene alluvium forms high level terraces across the wider valley, in places dissected with steeply incised gullies and scarps where watercourses occur.

The steeper hills surrounding the valley are generally comprised of greywacke and argillite. These geological formations are considered to have a low susceptibility to erosion. For the purposes of this study, within a 50-100 year life, it may be considered that greywacke is not susceptible to erosion.

The peat deposits in the vicinity of Black Creek have not been considered in this study.

2.3 Erosion and Landslide Identification

The hazards associated with erosion have been identified and assessed using both historic and present day information.

2.3.1 Geomorphologic Based Assessment of Historic Erosion

The geological maps developed for this study, Plans 1-5, were used to obtain an understanding of the historic erosion and geomorphology of the river system. A "corridor of erosion" was developed that encompassed all the identified historic erosion features and significant landforms surrounding the existing river channel. It is considered that the majority of these features within this zone are probably less than 3000 years old.

The corridor is shown on the plans and labelled as the Erosion Hazard Avoidance Zone.

2.3.2 Existing Evidence of Erosion and Landslides

The potential for significant bank erosion and landslides was assessed by site visits to areas of the river accessible by road, and by stereopair aerial photograph examination.

It should be noted that, in the Wellington Region, 2004 was the worst year for storm induced landslide damage since the storms of 1976. Evidence of significant landslides in 2004, say greater than 500m^3, would be expected to be readily evident. The catchment was found to have been largely unaffected by landslide failure suggesting that the area has relatively stable ground conditions. However future development, eg roads, change in land use or building platforms cut into hills, may trigger landsliding in areas currently considered stable.

A schedule of the areas of river bank considered to be at a significant risk of erosion is attached in Table 1. The features reference the areas identified on geological maps prepared for this study, Plans 1-5.

Table 1 Identified Locations at Risk of Erosion or Landslide

Erosion/Landslip Feature	Type	Estimated Height (m)	Verified (V) or unverified (UV)	Geological Material
A	Scour	3	V	Silty gravel
B	Scour	6	V	Silty gravel
C	Scour	8	UV	Silty gravel
E1	Scour	24	UV	Silty gravel
E	Scour	18	V	Silty gravel
F	Scour	10	UV	Greywacke / silty gravel
G	Scour	10	UV	Silty gravel
H	Scour	6	UV	Silty gravel
I	Scour	5	V	Silt + silty gravel
J	Scour	5	UV	Silty gravel

K	Scour	1	UV	Silty gravel
L	Scour	1	UV	Silty gravel
M	Scour	0	UV	Silty gravel
N	Scour	3	UV	Silty gravel
O	Scour	4	UV	Silty gravel
P	Scour	3	V	Silty gravel
Q	Scour	3	UV	Silty gravel
R	Scour	3	UV	Silty gravel
S	Erosion induced Landslide	9	UV	Silty gravel
T	Scour	2	UV	Silty gravel
U	Scour	1	UV	Silty gravel
V	Scour	2	UV	Silty gravel
W	Scour	8	UV	Silty gravel
X	Earthworks induced landslip	18	UV	Weathered greywacke

2.4 Erosion and Landslide Risk Assessment

An assessment has been made of the risk associated with each of the erosion and landslide features. This assessment is qualitative in nature and relies on subjective judgments, it is provided as a tool for identifying and comparing the areas of high risk.

Each feature was allocated a rating based on the 'likelihood of failure within the next 50 years', and a 'consequence of failure' rating based on Table 2.

Table 2 Rankings used in the Risk Assessment

Likelihood of Failure (50yrs)		**Consequence of Failure**	
Rare	1	Insignificant	1
Unlikely	2	Minor	2
Moderate	3	Moderate	3
Likely	4	Major	4
Almost Certain	5	Catastrophe	5

By multiplying the two ratings each feature was allocated a measurement of risk out of 25 and a description of the risk based on the risk matrix is shown in Table 3.

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- **Table 3 Risk Matrix**

		Consequence				
		Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophe (5)
Likelihood	Rare (1)	LOW	LOW	MEDIUM	HIGH	HIGH
	Unlikely (2)	LOW	LOW	MEDIUM	HIGH	EXTREME
	Moderate (3)	LOW	MEDIUM	HIGH	EXTREME	EXTREME
	Likely (4)	MEDIUM	HIGH	HIGH	EXTREME	EXTREME
	Almost Certain (5)	HIGH	HIGH	EXTREME	EXTREME	EXTREME

The risk assessment for the areas considered to contain significant erosion or landslide hazards is shown in Table 4.

- **Table 4 Risk Assessment for the Identified Erosion and Landslip Features**

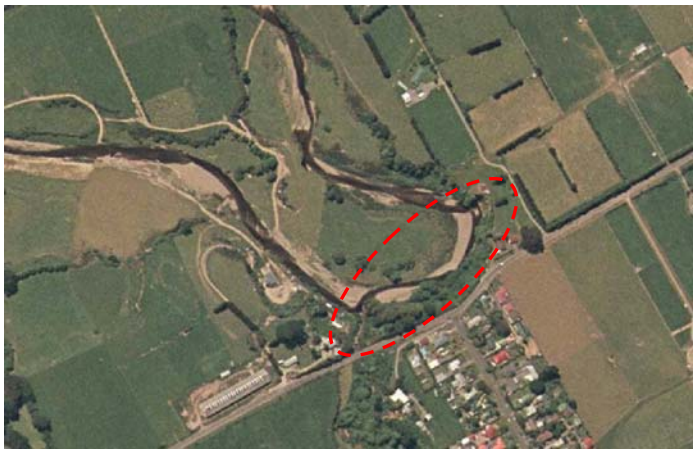
Erosion or Landslip Feature	Likelihood	Consequence	Consequence description	Risk Rating	Risk Ranking
A	5	2	Retreat < 10m	10	HIGH
B	5	5	Retreat > 10m and damage to structures	25	EXTREME
C	3	4	Retreat > 10m and possible damage to structures	12	EXTREME
E1	4	2	Retreat > 10m	8	HIGH
E	5	4	Retreat > 10m and possible damage to structures	20	EXTREME
F	3	2	Retreat < 10m	6	MEDIUM
G	3	3	Retreat > 10m	9	HIGH
H	3	3	Retreat > 10m	9	HIGH
I	5	3	Retreat > 10m	15	EXTREME
J	3	2	Retreat < 10m	6	MEDIUM
K	3	3	Retreat > 10m	9	HIGH
L	3	3	Retreat > 10m	9	HIGH
M	3	3	Retreat > 10m	9	HIGH
N	3	2	Retreat < 10m	6	MEDIUM
O	4	3	Retreat > 10m	12	HIGH
P	5	5	Retreat > 10m and damage to structures	25	EXTREME
Q	5	3	Retreat > 10m, no damage to structures	15	EXTREME
R	3	3	Retreat > 10m	9	HIGH
S	3	3	Retreat > 10m	9	HIGH
T	3	3	Retreat > 10m	9	HIGH
U	3	3	Retreat > 10m	9	HIGH
V	3	3	Retreat > 10m	9	HIGH
W	3	3	Retreat > 10m	9	HIGH
X	3	3	Retreat > 10m	9	HIGH

2.4.1 Areas of Extreme Risk

Areas B and C have been classified under the extreme risk category. This section of river, running adjacent to Maymorn Road, is confined by steep banks and has a steeper gradient than much of the upper catchment. The river through this area has relatively higher velocities than those found in the rest of the Mangaroa. These factors contribute to the scour along the banks, see Figure 2.

- **Figure 2 Erosion Hazard Identified Adjacent to Maymorn Road, Areas B and C**

Area E, adjacent to Parkes Road represents another erosion hazard classified in the extreme category, see Figure 3 and Figure 4. The Maymorn housing area is located on a river terrace 15-20m above the river. The steep banks on the river bend have the potential to slip endangering the infrastructure and properties above.



- **Figure 3 Erosion Hazard Identified Near Parkes Line Road (Area E)**

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- **Figure 4 River Banks adjacent the Parkes Road.**

Area I covers 300m of the true right bank upstream of the Mangaroa Hill Road Bridge. This area is also considered to be in the extreme category of erosion risk. Figure 5 depicts the loose alluvial material that the banks consist of.

- **Figure 5 Mangaroa Hill Bridge Erosion Area**

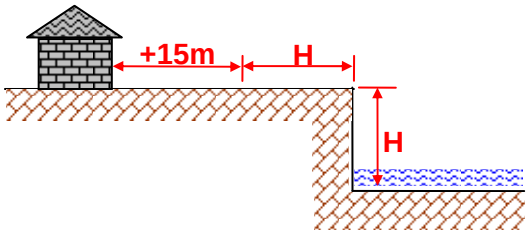
Areas P and Q surround the Mangaroa Valley Road Bridge. The banks in this area demonstrate evidence of recent erosion. Figure 6 shows the close proximity of buildings to the river. Unchecked erosion in this location has the potential to endanger half a dozen buildings at this location.

Figure 6 Erosion of the Banks Near Mangaroa Valley Road.

2.5 Recommended Building Exclusion Offsets

Using the outcomes of the risk assessment building exclusion offsets have been recommended for the previously identified erosion and landslip risk areas. As a minimum it is recommended that structures should be setback from the bank crest at least the distance equal to the height of the river bank (H) plus a margin of safety. As the risk ranking (table 4) increases the setbacks should also be increased to reflect this. The following formulae are considered appropriate for the purposes of this study. This methodology is illustrated in Figure 7.

Risk	Proposed Setback from Bank Crest (m)
Extreme	3H + 15m
High	2H + 15m
Other	H + 15m



- **Figure 7 Minimum Recommended Setback**

Table 5 below records the recommended building exclusion offsets for each of the erosion zones detailed in the geology maps, Plans 1-5. Where the height of the bank has not been verified on site the height was estimated using the LiDAR data.

- **Table 5 Proposed Building Setbacks**

Erosion or Landslip Feature	Risk Ranking	Estimated Bank Height (m)	Verified (V) or unverified (UV)	Proposed Setback (m)
A	HIGH	3	V	21
B	EXTREME	6	V	33
C	EXTREME	8	UV	39
D	HIGH	10	UV	35
E1	HIGH	24	UV	39
E	EXTREME	18	V	69
F	MEDIUM	10	UV	25
G	HIGH	10	UV	35
H	HIGH	6	UV	27
I	EXTREME	5	V	30
J	MEDIUM	5	UV	20
K	HIGH	1	UV	17
L	HIGH	1	UV	17
M	HIGH	0	UV	15
N	MEDIUM	3	UV	18
O	HIGH	4	UV	23
P	EXTREME	3	V	24
Q	EXTREME	3	UV	24
R	HIGH	3	UV	21
S	HIGH	9	UV	33
T	HIGH	2	UV	19
U	HIGH	1	UV	17
V	HIGH	2	UV	19
W	HIGH	8	UV	31
X	HIGH	18	UV	51

These building exclusion offsets have been detailed on the geological maps (Plans 1-5). While these setbacks are considered to be adequate for a 50 year design life some areas of erosion and slip hazard will require further investigation and may require mitigation, eg bank protection or river training works. Furthermore, in places, buildings already exist within the building exclusion offsets. It is recommended that these locations be investigated to further identify the risk and potential mitigation options.

2.6 Flood Erosion Hazard Zone

The Building Exclusion Zone with the Erosion Hazard Zone shown on plans 1-5 have been combined to identify the zone of erosion risk. The Mangaroa River Flood Hazard Assessment Summary Report collates this zone of erosion risks and the 100 year ARI flooding risks into a single set of plans. These plans are can be used to assist in the management of the hazards within the Mangaroa Valley.

Legend

- Erosion Hazard Avoidance Area
- Significant Areas at Risk from Erosion
- Building Exclusion Offset
- road_cl

fa
tr
lg
A
B
C
E1
MAIN ROAD NORTH
MAYMORN ROAD

LEGEND

Geological Unit

- fa Holocene Alluvium
- fs Holocene Swamp/Peat
- lg Pleistocene Alluvium
- tr Triassic Rimutaka Belt Greywacke
- tw Triassic Wellington Belt Greywacke

Document Status:

	Name	Date

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Disclaimer:

This map shows interpreted geology from examination of aerial photographs and surface exposures.
It should not be used for site specific works, which require a specific investigation.
Reference has been made to GNS 1996 'Geology of the Wellington Area' for cross checking purposes.

1:10,000

0 100 200 300 400 500 m

N

SKM

MANGAROA VALLEY
PARTIAL GEOLOGICAL MAP
SHEET 1

Legend

- Erosion Hazard Avoidance Area
- Significant Area at Risk from Erosion
- Building Exclusion Offset
- road_cl

PARKES LINE ROAD

MANGAROA HILL ROAD

MANGAROA VALLEY ROAD

LEGEND

Geological Unit

- fa Holocene Alluvium
- fs Holocene Swamp/Peat
- lg Pleistocene Alluvium
- tr Triassic Rimutaka Belt Greywacke
- tw Triassic Wellington Belt Greywacke

Document Status:

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1:10,000

0 100 200 300 400 500 m

N

SKM

MANGAROA VALLEY
PARTIAL GEOLOGICAL MAP
SHEET 2

Legend

- Erosion Hazard Avoidance Area
- Significant Areas at Risk from Erosion
- Building Exclusion Offset
- road_cl

H
I
J
K
L
M
N
O
P
Q

PARKES LINE ROAD
MANGAROA HILL ROAD
MANGAROA VALLEY ROAD
WALLACEVILLE ROAD

tr
fa
lg
tw
fs

LEGEND

Geological Unit

fa	Holocene Alluvium
fs	Holocene Swamp/Peat
lg	Pleistocene Alluvium
tr	Triassic Rimutaka Belt Greywacke
tw	Triassic Wellington Belt Greywacke

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0 100 200 300 400 500m

N

SKM

MANGAROA VALLEY PARTIAL GEOLOGICAL MAP SHEET 3

Legend

- Erosion Hazard Avoidance Area
- Significant Areas at Risk from Erosion
- Building Exclusion Offset
- road_cl

tw
tr
lg
fs
fa
lg
tr
WALLACEVILLE ROAD
MANGAROA VALLEY ROAD
WHITEMANS VALLEY ROAD
P
Q
R
S
tr
lg
tr

LEGEND

Geological Unit

fa	Holocene Alluvium
fs	Holocene Swamp/Peat
lg	Pleistocene Alluvium
tr	Triassic Rimutaka Belt Greywacke
tw	Triassic Wellington Belt Greywacke

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1:10,000

0 100 200 300 400 500 m

N

SKM

MANGAROA VALLEY
PARTIAL GEOLOGICAL MAP
SHEET 4

Legend

- Erosion Hazard Avoidance Area
- Significant Areas at Risk from Erosion
- Building Exclusion Offset
- road_cl

tr
lg
tr
T
U
lg
V
W
X
WHITEMANS VALLEY ROAD
fa
tr
lg
tr
tr

LEGEND

Geological Unit

- fa Holocene Alluvium
- fs Holocene Swamp/Peat
- lg Pleistocene Alluvium
- tr Triassic Rimutaka Belt Greywacke
- tw Triassic Wellington Belt Greywacke

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0 100 200 300 400 500 m

N

SKM

MANGAROA VALLEY
PARTIAL GEOLOGICAL MAP
SHEET 5