

Hutt River Maoribank Erosion Study – Stage 2 Risk Mitigation

1. Background

All risks in the Maoribank reach, both upstream and downstream of the bend, arise from riverbank erosion potential. The latter is due to existing low strength protection works and degrading river bed levels. In the reach upstream of the bend there is also the potential for accelerated gravel loss and corresponding bed degradation when the rock outcrop at the upper section of the bend “breaks through”. Break through is estimated to occur between five to ten years.

The Stage 1 Maoribank Erosion Study Report described the risks at Maoribank, the Risk Assessment process and the outcomes of the risk assessment. Key aspects of the Stage 1 Risk Assessment are summarised in Section 2 below.

Stage 2 Risk Mitigation reports on options to treat the identified risks at Maoribank consistent with the Hutt River Floodplain Management Plan (HRFMP) proposals for the reach and other works proposed on other reaches of the Hutt River.

2. Stage 1 Risk Assessment Summary

Risks, locations and Descriptions

The risks identified in the Stage 1 Risk Assessment are shown in **Figures 1A and 1B** and described in Table 1:

Table 1: Risks and Descriptions

Risk No.	Risk Title	Risk Description
Risk 1	Totara Park RB Stopbank Failure	The risk of right bank erosion resulting in breach and failure of the Totara Park stopbank and equivalent flooding for each scenario.
Risk 2	Harcourt Area LB Erosion	The risk of left bank erosion extending into private property below Harcourt Park, this erosion would also sever the Hutt Valley trunk sewer.
Risk 3	State Highway 2 LB Erosion	The risk of left bank erosion extending into or preventing traffic entry over SH2 River Road.
Risk 4	Awa Kairangi Park RB Erosion	The risk of bank erosion through the existing buffer zone into the grassed park, and over a reasonable length (in the order of 100 to 200

		metres)
Risk 5	Totara Park Bridge LB Isolation	The risk of Totara Park Bridge being isolated at the left abutment due to bank erosion.
Risk 6	Major LB and RB Reach Damage	The risk of protection works destruction, major bank collapses and substantial erosion over the majority of the study reach. The resulting damage is likely to leave the system severely vulnerable for a considerable period of time.
Risk 7	Norbert Street Footbridge LB Isolation	The risk of Norbert Street Footbridge being isolated at the left abutment due to bank erosion. This erosion would not sever the Hutt Valley trunk sewer.

Risk Analysis

The outcomes of the Stage 1 analysis, after technical and other information was assigned to each risk for 5, 10 and 20 year river bed scenarios, are shown in **Figure 2**. An “operational tolerable risk” line (OTRL) was determined as the boundary between “High” and “Medium” risk. The “operational tolerable risk” line is intended as the trigger for risk treatment options to mitigate current risks.

The tolerable risk should not be confused with the risk category for which a new work may be designed. The latter will depend on the risk relationship with other risk areas e.g. for a high consequence area the work may be designed for a “Low” or “Minor” risk, and for a low consequence area a “Medium” or “High” risk may be acceptable. In the HRFMP this concept was embodied in the 440-year return period Risk Based Design Standard

Intolerable Risks

From Figure 2, the four Maoribank risks that fall above the threshold OTRL in the HIGH and EXTREME category are:

- Risk 1 - Totara Park RB Stopbank Failure
- Risk 6 – Major RB and LB Reach Damage
- Risk 2 – Harcourt Area LB Erosion
- Risk 3 – State Highway 2 LB Erosion (in the 20 year scenario)

Three of the four risks that fall in the HIGH to EXTREME category are those that are all or in part located upstream of the Maoribank Bend bed rock outcrop. If Risks 1 and 2 are controlled

to an acceptable level, Risk 6 would fall from HIGH to a risk category below the tolerable risk line.

Risk Treatment

The Stage 1 report suggested that Risk Treatment Options to be investigated in Stage 2 be considered at three levels:

(a) Treat all Maoribank Reach Risks

Treat all risks so that their risk will be rated at a LOW to MEDIUM level for a high consequence area on the flood protection system. However it is well recognised that even the highest risks in this Maoribank reach are likely to be relatively lower than those prevailing in other reaches on the Hutt system, for example the Boulcott or City Centre reaches.

(b) Treat Maoribank HIGH Risks to a tolerable risk level

This involves treatment options that will bring the three major risks – Totara Park Stopbank Breach, Harcourt Area Erosion, and Major Reach Damage - down to a level so that they would be rated as MEDIUM risk and for the foreseeable period be tolerable. The remaining risk would then need to be dealt with when the Maoribank reach becomes a priority in the Hutt River Floodplain Management Plan improvement process.

(c) Hold HIGH Risks at current risk levels (Holding measures)

This treatment option would hold the three major risks (and the other risks) at current levels. It would involve sufficient works to prevent breakthrough of the outcropping bedrock at Maoribank Bend (and prevent the consequent lowering of upstream gravel bed levels) and maintenance work such that the major and other risks are held at current levels.

This position can be justified on the grounds that (while best practice would require immediate attention to bring the three major risks at least into the tolerable risk zone) there are other higher priority reaches on the Hutt River system that require works more urgently.

3. Stage 2 – Risk Treatment Option Investigations

The Stage 2 investigations covered potential treatment options that could reduce Maoribank risks to any combination of the three treatment levels (a, b, and c above), from full treatment to holding measures.

3.1 Above the Maoribank Bend.

This is the most constrained reach of the Hutt River where there are stopbanks (Totara Park) private property and services must be protected. The right bank berm is very narrow, in the order of 15 metres at narrowest. There is a similar distance on the left bank between bank edge works and the trunk sewer.

The HRFMP design for the Totara Park stopbank is the 440-year flood standard. For the edge protections to provide equivalent 440-year erosion security to the stopbank, over a full range of 440-year flood events, extreme measures are required. For example relocating the Totara Park stopbank ((\$9.3 million including house relocations), sheet piling (\$8.494 million) or rock linings (\$7.5 to 10 million, with rock placed at up to 55 tonne per lineal metre). While these options would eliminate the need to prevent breakthrough of the rock outcrop upstream of the bend (a \$140,000 saving), their cost is disproportionate when compared to other higher risk areas on the Hutt River. They respectively also have associated social, environmental, river management and constructability disadvantages.

For this reason the HRFMP recommended for Totara Park a risk based design standard where the flood standard for the reach would remain at 440-year but with the erosion standard designed to reflect the lower relative risk consequences than other reaches of the Hutt River. This 440-year risk based standard may be viewed as an erosion standard that can handle a lower range of 440-year flood erosion events.

To achieve the floodplain management plan risk based standard, two options were developed:

- The first comprises rock linings, placed at 20 and 15 tonnes per lineal metre respectively on the left and right bank (\$3.696 million).
- The second is based on rock ramps (bed level controls) one at the eroded rock outcrop and two upstream. Light rock linings (about 10 tonnes per lineal metre) underpin sections of the existing "basket" protection works that have not already been underpinned. Total cost \$2.460 million (\$2.310 million for the rock ramps and \$150,000 for underpinning).

Both options would essentially retain existing edge protections works, maximising previous investment. The rock linings have the advantage of a well proven performance record on the river, but they must be constructed in one operation. The rock ramps give advantages in that they suit the river location and can be progressively constructed; but they do potentially have higher maintenance costs than rock linings, they do not give full bank cover and they have not to date been constructed on the Hutt River.

Notwithstanding the uncertainties, rock ramps are recommended because they maximise use of previous investment, and can be staged allowing crucial increments in security to be provided, in balance with other work on the river. They also give environmental advantages by maintaining the rock outcrop, a unique feature on the river.

A further option was considered to reduce risk to the trunk sewer on the left bank at Harcourt Park. The work would involve relocating the trunk sewer further from the river, providing a wider berm and buffer against erosion. The cost for this would be in the order of \$600,000 and should only be reconsidered if the recommended upstream work is not to be completed within 10 years.

3.2 Maoribank Bend.

As noted in Section 3.1 the preferred upstream option includes a rock ramp that infills the eroding northern section (the "gut") of the rock outcrop. The cost for this is included with the upstream measures because the ramp is an essential element in maintaining upstream bed levels, a key feature for erosion risk reduction.

Bedrock erosion is occurring right through the bend and another rock ramp is proposed at the lower end of the base rock control. The purpose is to prevent further entrenchment and back scouring through the rock outcrop. This ramp will also provide bed level control and generate a better spread of floodwaters across the channel at the downstream end of the bend. The downstream benefits include better flow patterns and a reduction in channel asymmetry with associated lower maintenance costs. The cost of the downstream rock ramp is \$210,000.

3.3 Below the Maoribank Bend

The risk analysis indicated that risks below the bend do not warrant mitigation work, over and above current operational maintenance, within the next ten years, assuming degradation continues at current trends.

The options for channel works in the Maoribank reach below the bend were well developed as part of the HRFMP. Key components for the study reach include:

- Enhanced rock protection to the left bank at SH2 (\$280,000). This work is currently carried out as top-ups and implemented under operational budgets, and
- A wider channel from below Maoribank Bend to Totara Park Bridge (The HRFMP provides for widening from below Maoribank Bend to Whakatikei). The estimated cost is \$6.425 million, reducing to \$2.800 million if exposed gravel is excavated for commercial value. Although initially intrusive to Awa Kairangi Park, this option

provides a better long term river management regime. The principal of establishing a wider channel was agreed with Upper Hutt City Council prior to completing the HRFMP. The wide channel option also includes provision for Totara Park Bridge right abutment protection.

This current review did not change the HRFMP options. Sheet piling was considered as an alternative to the SH2 rock lining but was discounted for the same reasons noted for work above the bend. To reduce the risk of embankment loss between the SH2 rockline and SH2, a further option was introduced. This comprises reinforced surface soil and mass vegetative cover (flaxes, toitoi and tall grasses). At a cost of \$60,000 this work could be brought forward under environmental enhancement budgets.

3.4 Ongoing Monitoring Requirements

Ongoing requirements will be aerial photography and gravel bed and rock level surveys, to monitor changes in key areas of the river bed and rock outcrop. The cost for these commitments are covered by operational budgets.

4. Summary of Recommended Maoribank Reach Risk Treatment Options

4.1 Recommended Works, Timing and Budgets

Table 2 collates and summarises the recommended options and costs to mitigate risk in the Maoribank Reach, and suggests timing for funding and construction of the works. The package of works is an integrated strategy to align with the HRFMP, optimise risk reduction and at the same time defer expenditure that can be applied to higher priority reaches of the river. The total cost of the recommended work package is in the same order as the indexed provision made in the HRFMP. This ensures the economics, relativity and priority of projects established by the HRFMP is retained.

Table 2: Summary of Maoribank Reach Treatment Options

Work Component / Funding	Timing	Cost
Rock ramp at XS2300 in the rock outcrop "gut" at the northern end of Maoribank Bend	Recommended 2010/2011, but before 2014	\$140,000
Toe rock protection to existing baskets, right bank above Maoribank Bend. Currently implemented under operational budgets.	2009 to 2014. Dictated by degradation and undermining of existing baskets	\$150,000
Rock ramp XS2330.	2013/2014, determined by bed level monitoring for degradation	\$1,400,000

Rock ramp XS2260	2013/2014, determined by rock outcrop level monitoring for degradation	\$210,000
Rock ramp XS2370	2013/2014 or later, determined by bed level monitoring for degradation	\$770,000
SH2 rock lining top up, as required. Currently implemented under operational budgets.	2009 to 2019 as determined by visual / underwater inspection, and bed level monitoring for degradation	\$280,000
Reinforced earth and vegetative planting. Potentially from operational budgets.	Benefits will accrue incrementally. Commence as soon as possible	\$60,000
Channel Widening (without commercial recovery), or	Beyond 2019, determined by HRFMP priorities	\$6,425,000
Channel Widening (with commercial recovery)	Beyond 2019, determined by HRFMP priorities	\$2,800,000
Total Cost (without gravel resource recovery)		\$9,435,000
Total Cost (with gravel resource recovery)		\$5,810,000

If monitoring indicates lower than projected bed level changes then the rock ramps at XS2330, XS2260 and XS 2370 may be deferred, and the capital expenditure indicated can be programmed further out.

4.2 Risk Rationalisation

Table 3 sets out the expected risk reduction resulting from the recommended risk treatment. Figure 2 illustrates the risk reduction.

Table 3: Table of Cash Flows

Risk No.	Risk Title	Original Risk Rating	Final Risk Rating
Risk 1	Totara Park RB Stopbank Failure	HIGH	MED - LOW
Risk 2	Harcourt Area LB Erosion	HIGH	MED - LOW
Risk 3	State Highway 2 LB Erosion	MED	LOW - MINOR
Risk 4	Awa Kairangi Park RB Erosion	LOW	LOW - MINOR
Risk 5	Totara Park Bridge LB Isolation	MED	LOW - MINOR

Risk 6	Major LB and RB Reach Damage	HIGH	LOW
Risk 7	Norbert Street Footbridge LB Isolation	MED	LOW

The following discussion sets the context for risk reduction, in line with the HRFMP and parameters set in Stage 1 - refer page 3 of this report (a), (b) and (c).

Risk 1

Initial treatment from 2009 to 2014 (Rock ramp construction at XS2300 and toe rock protection to the baskets) will be holding measures. Rock ramps at XS2330 and XS2370 (2013 /2014) will bring the final risk to a level in line with the HRFMP recommended 440-year risk based standard. As noted it is not cost effective to bring final risk to LOW or MINOR.

Risk 2

As for Risk 1

Risk 3

Progressive risk reduction over ten years (2009 to 2019) as the SH2 rock line is topped up, and vegetative cover is established.

Risk 4

Risk reduction will be achieved when the Wide Channel is constructed (beyond 2019). Priority is low as key assets are not unduly exposed.

Risk 5

Current bridge risk exposure is acceptable and will reduce when the Wide Channel is constructed

Risk 6

The majority of the risk will be treated to a tolerable level with completion of recommended works upstream of Maoribank Bend. Remaining risks will be treated with construction of the rock ramp at XS2260 (2013/2014), progressive SH2 rock lining top-up (2009 to 2019), and construction of the wide channel (beyond 2019).

Risk 7

The risk reduction for Risk 7 will derive largely from the treatment for Risk 1, with a stepped benefit from the construction of the rock ramp at XS2370

4.3 OPEX and CAPEX Cash Flows

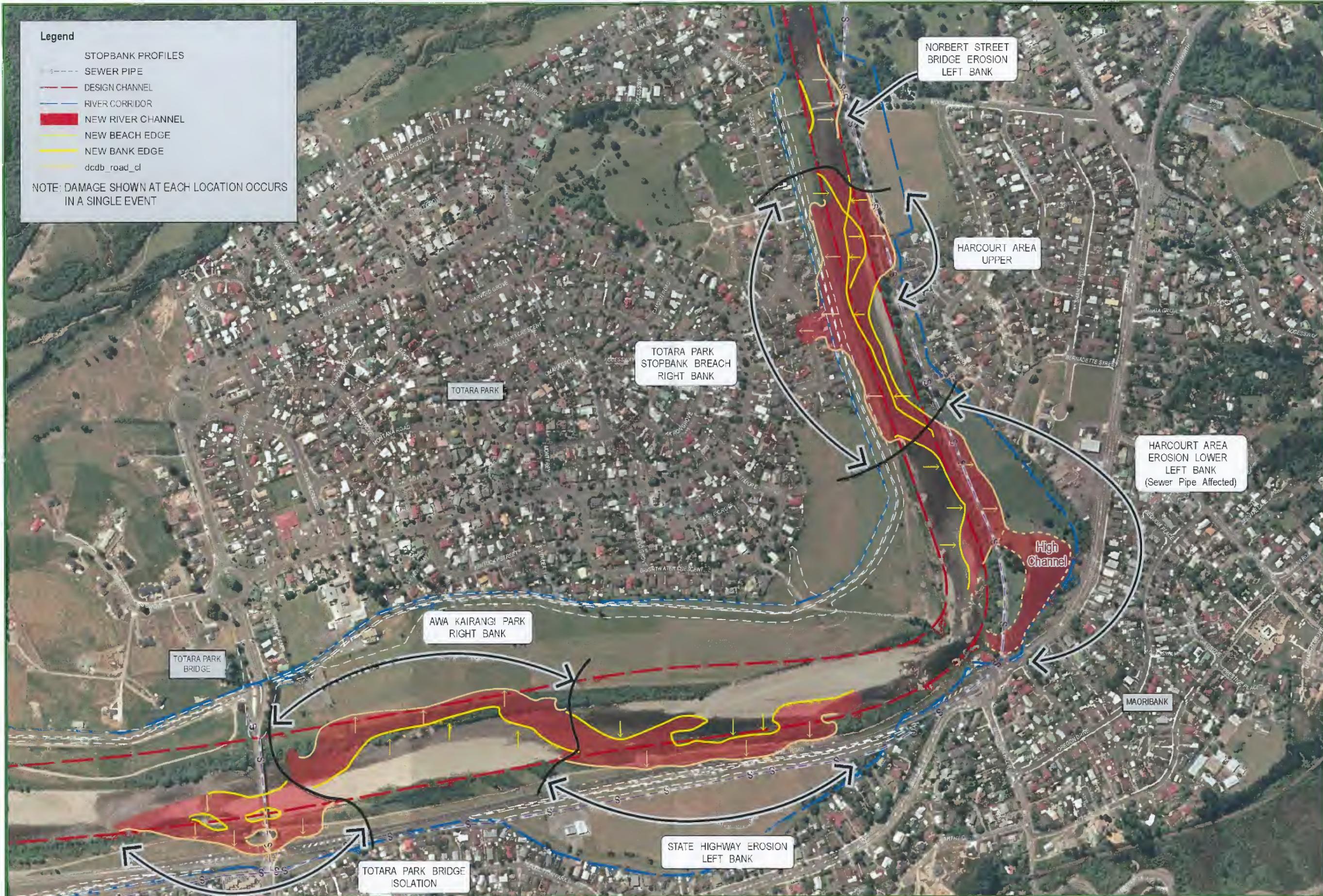
Table 4 sets out Operational and Capital (OPEX and CAPEX) cashflows corresponding to the timing for works set out in Table 2.

Table 4: Table of Cash Flows

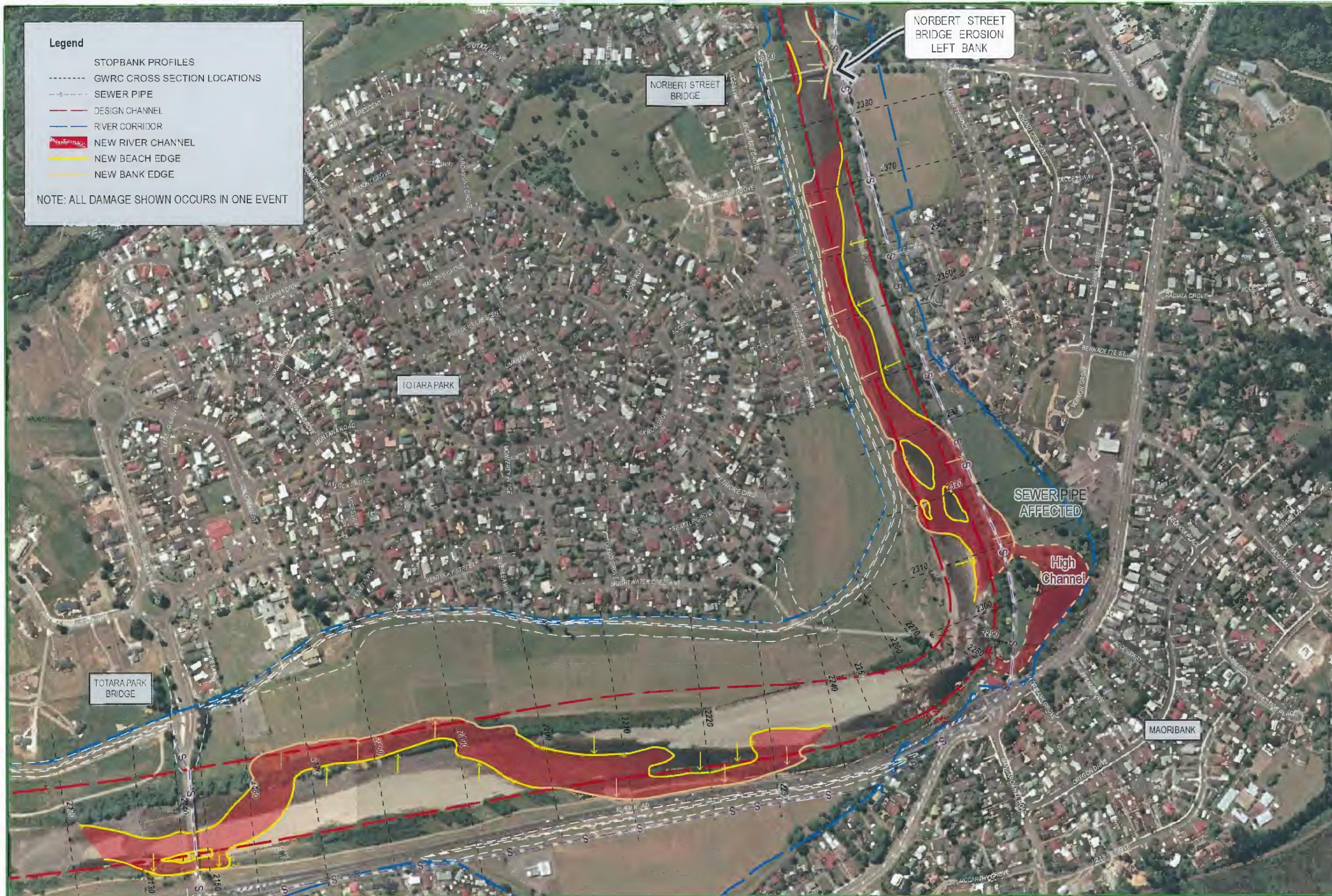
Time period	OPEX	CAPEX	Notes
2009 – 2010	\$58,000	\$140,000	Recommended early construction
2010 – 2011	\$58,000		
2011 – 2012	\$58,000		
2012 – 2013	\$58,000		
2013 – 2014	\$58,000	\$2,380,000	May be spread beyond 2014
2014 – 2015	\$48,000		
2015 - 2016	\$48,000		
2016 - 2017	\$48,000		
2017 - 2018	\$28,000		
2018 - 2019	\$28,000		
2019>>		\$6,425,000 or \$2,800,000	Without commercial gravel recovery With commercial gravel recovery
Total reach cost	\$490,000	\$8,945,000	Without commercial gravel recovery
Or Total	\$490,000	\$5,320,000	With commercial gravel recovery

Attachments:

1. Fig 1A Hutt River/Maoribank – single location damage
2. Fig 1B Hutt River Maoribank – major reach damage
3. Fig 2 Presentation of Current (<5 years) and Projected Risks and Projected Risk Reduction



HUTT RIVER / MAORIBANK - Single Location Damage - FIG 1A



0 20 40 80 120 160 200 Metres
 A3 Scale 1 : 5,000

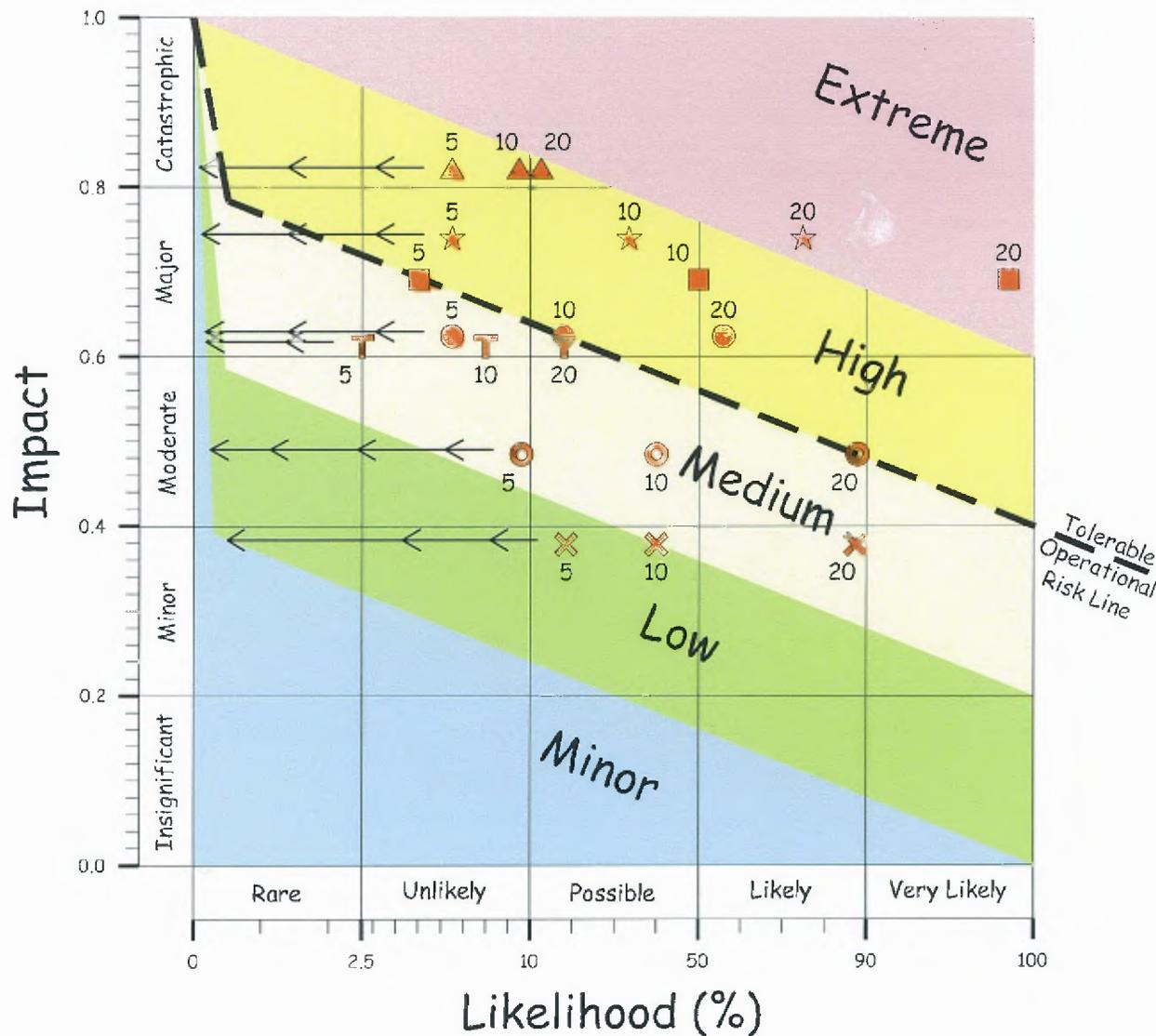
HUTU RIVER / MAORIBANK - MAJOR REACH DAMAGE - FIG 1B

(River damage only, not into protected assets ie. into stopbank but not breached, up to State Highway but not into it)

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FILE REF: MAJOR REACH DAMAGE.mxd



Risk Legend

- ▲ Risk 1 - Totara Park Right Bank
- Risk 2 - Harcourt Park Left Bank
- Risk 3 - SH2 Left Bank
- T Risk 4 - Totara Park Bridge
- × Risk 5 - Awa Kairangi Right Bank
- ★ Risk 6 - Major reach damage
- ⊙ Risk 7 - Norbert Street Footbridge

Refer to Table 2 for risk descriptions

Likelihood (%)

Is the compound probability of the "risk flood" being equaled or exceeded over the scenario duration i.e. 5, 10 or 20 years.

Impact

Is the relative consequence measure assigned to each risk.

Scenarios

The numbers 5, 10 or 20 adjacent to the symbols on the sheet denote for each risk the relevant projected river bed scenario at Maoribank after 5, 10 or 20 years.

Presentation of Current (<5 years) and Projected Risks and Projected Risk Reduction

Figure 2