

Technical Report

Investigations and
Monitoring Group

Temuka floodplain investigation

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**Environment
Canterbury**
Your regional council

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Executive summary

Temuka township has been exposed to a number of floods since the days of early settlement. Despite stopbanking as part of the Orari, Waihi and Temuka Rivers Control Scheme, overflows still occur. Stopbanks were last breached in the March 1986 flood event. This study used a combined one- and two-dimensional hydraulic computer model to estimate flood extent and depths in lower probability events when overflows into the Temuka township are likely to occur.

Breakout scenarios onto the floodplain have been modelled for the 1%, 0.5% and 0.2% AEP, i.e. 100, 200 and 500 year return period events at the most likely breakout locations.

In the 1% AEP event the lower lying area on the south side of Temuka is most affected. The 0.2% AEP event, which also includes a significant overflow from the Orari River, results in widespread flooding over the majority of the town.

The floodplain maps and associated depths should assist land use planning, public awareness and provide information on appropriate minimum floor levels for new buildings located on the floodplain.



Temuka – March 1986 flood event

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1 Introduction

Temuka township is exposed to flooding as a result of overflows from the Waihi and Temuka rivers in particular, and in larger events, overflows from the Orari River. Stopbanks on the Orari, Waihi and Temuka rivers, as part of the river control scheme, do offer a reasonable level of flood mitigation. However, in larger than design events, the stopbanks are likely to fail from overtopping or lateral erosion. In a 0.2% AEP (Annual Exceedance Probability) i.e. 500 year return period event, the area in and around Temuka likely to be inundated is approximately 10 km².

The last time the Temuka township was flooded was in March 1986 when the Temuka River stopbank was overtopped and breached. This resulted in the southern end of the town being inundated by floodwaters which were ponded between the railway line and the stopbank. Figure 1.1 shows the area inundated in this event.

As a result of this flood and good floodplain management planning, the Timaru District Council adopted the 0.5% AEP (200 year return period) flood for minimum floor level control for any new dwellings on the floodplain.

Previous floodplain investigations (Connell, 1989) using a one-dimensional Mike 11 hydraulic model, predicted depths of flooding for a range of design events. This work has formed the basis of providing flood levels and minimum floor levels for Temuka township since then. Recent advances in floodplain modelling using a two-dimensional model provides greater accuracy and definition of floodplain depths. Hence a two-dimensional model has been used in this current investigation.

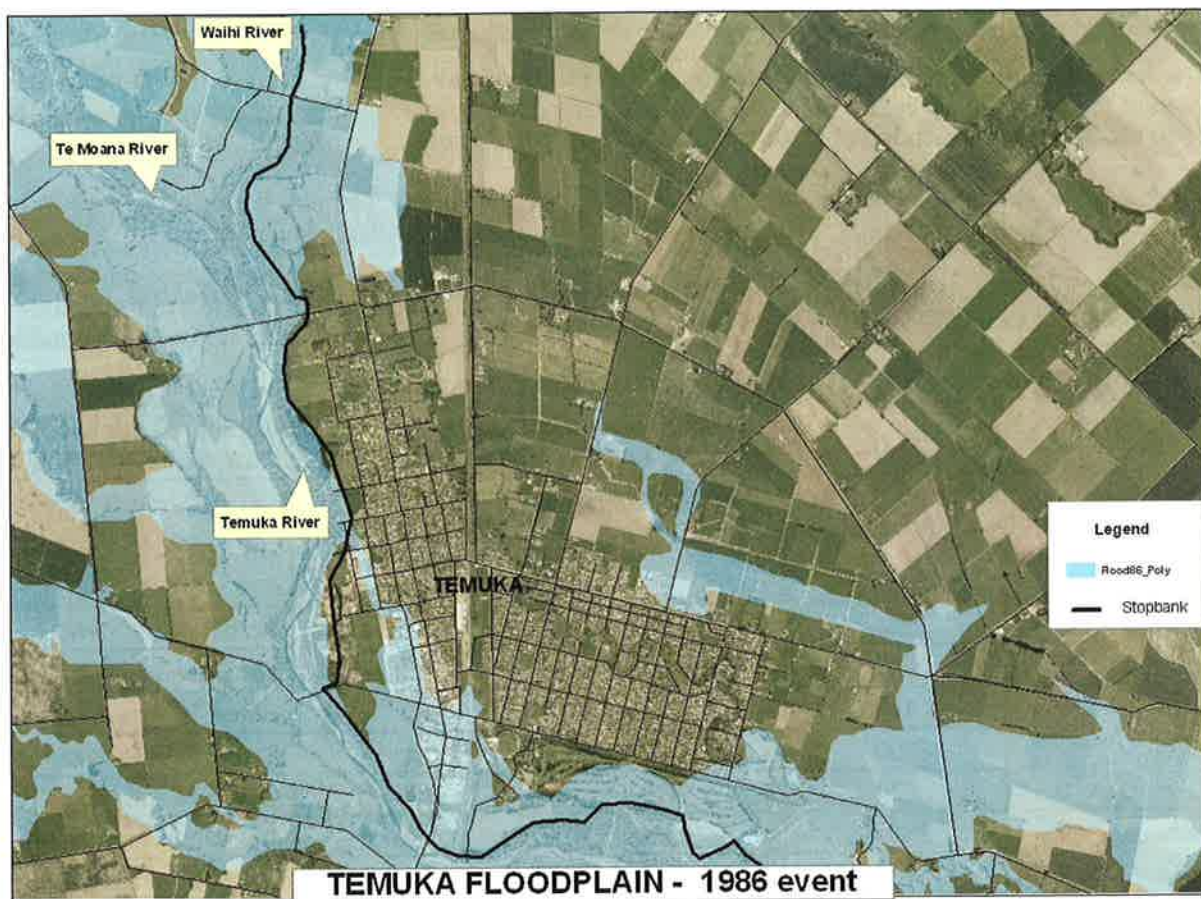


Figure 1.1 Approximate extent of flooding in 1986 event

2 Flood hydrology and breakout estimates

A number of studies have provided estimates of design flood flows on the Orari, Waihi and Temuka rivers. This analysis has mainly been based on historic floods, including the 1986 flood event, estimated to have had a return period in the order of 100 – 150 years on the Temuka River and approximately 60 – 70 years on the Waihi River.

Although continuous monitoring recorders have been installed on the Temuka and Waihi rivers, the record is regarded as statistically too short to estimate lower probability events such as the 100 year return period, i.e. 1% AEP. The design flood flows from the previous analyses is summarised below.

Table 2.1 Estimated river flows (m³/s)

	Orari River			Waihi River (at Te Awa)			Temuka River		
	100yr	200yr	500yr	100yr	200yr	500yr	100yr	200yr	500yr
Temuka Borough Floodplain Management Study June 1989	1250	-	1650	350	415	500	1400	1600	1800
OWT Floodplain Management Plan May 1993	1250	1430	1650	350	415	500	1400	1600	1900
Publication No. R91/31 Rivers previously in SCCB – May 1993	1200	1350	1550	Not available at Te Awa			1450	1700	2000

The location and magnitude of the breakouts onto the floodplain in this study are the same as that used in the previous analyses. This is based on historic breakout locations, including analysis of the 1986 flood, and the likelihood of stopbank breaching through overtopping or lateral erosion.

A geomorphic study (historical topography) of the Orari, Waihi and Temuka floodplains in 1997 by Landcare Research confirmed these likely breakout locations and overland flow paths.

Hydraulic modelling (as part of current investigation) of flood flows on the Temuka River has confirmed these breakout locations on that river as being the “most likely”.

The adopted breakout flows for the previous and current studies are shown in the table below.

Table 2.2 Estimated breakout flows

River	Return period (years)	River discharge m ³ /s	Outflow discharge into floodplain m ³ /s	Comments
Orari	250	1500	0	No breakout
	500	1650	450	Large breakout
Waihi at Te Awa	100	350	50	Below Te Awa Bridge
	200	415	100	Below Te Awa Bridge
	500	500	200	Below Te Awa Bridge
Temuka	100	1400	20	Below Manse Bridge
	200	1600	140	Below Manse Bridge
			20	Below Insulator Works
	500	1900	400	Below Manse Bridge
			200	Below Insulator Works

Note: the breakout flows are estimates only

To take account of local runoff down Taumatakahu Stream an additional 10 m³/s is included in the Waihi River breakouts, since a large portion of that breakout flows into the Taumatakahu Creek.

3 Hydraulic model

Flows over a floodplain are multi-directional and thus are difficult to predict. To determine flood levels, flood depths, flow patterns and velocities, in a realistic manner, a 1D/2D hydrodynamic computer model (Mike Flood) was used. The Mike Flood (DHI software) modelling system combines one-dimensional (Mike 11) for the main rivers, and two-dimensional (Mike 21) modelling for the floodplain, in one modelling system. The linked Mike 11 and Mike 21 models allow flood waters to interchange between the river network and the floodplain.

3.1 One-dimensional channel network model

The 1D, Mike 11, model includes the Temuka River and the lower reach of the Taumatakahu Stream where floodplain overflows are returned to the Temuka River. The Temuka River model extends from cross-section 14 (just downstream of the Te Moana and Waihi Rivers confluence) to approximately one kilometre downstream of cross-section 1 (the Temuka and Opihi Rivers confluence). Refer Figure 3.1. The cross-sections are based on the most recent 2001 survey.

The lower 200 m of Taumatakahu Stream, including the flapgated culvert under the stopbank, is included in the 1D model to provide the physical connection between the floodplain and potential outflows to the Temuka River. A Manning value of 0.04 has been used for the open channel bed resistance and using relative resistance, 0.12 for vegetated berms.

The SH1 and railway bridge details including piers have also been incorporated into the model to take account of head losses associated with such structures.

Although flood levels at the Temuka River cross-sections were surveyed following the 1986 event, these have not been used for calibration owing to the significant uncertainty of what flow was in the channel plus changes in the channel cross-sections since 1986. However, using an estimated in-channel flow of 900 m³/s (Connell, 1989) modelled flood levels compare reasonably well with observed (refer Appendix 1).

Predicted river levels for the 1%, 0.5% and 0.2% AEP flows are show in Appendix 2. The flows used in these model predictions are the estimated remaining in-channel flows after overflows to the right and left bank floodplains, including the Te Moana River, are taken into account.

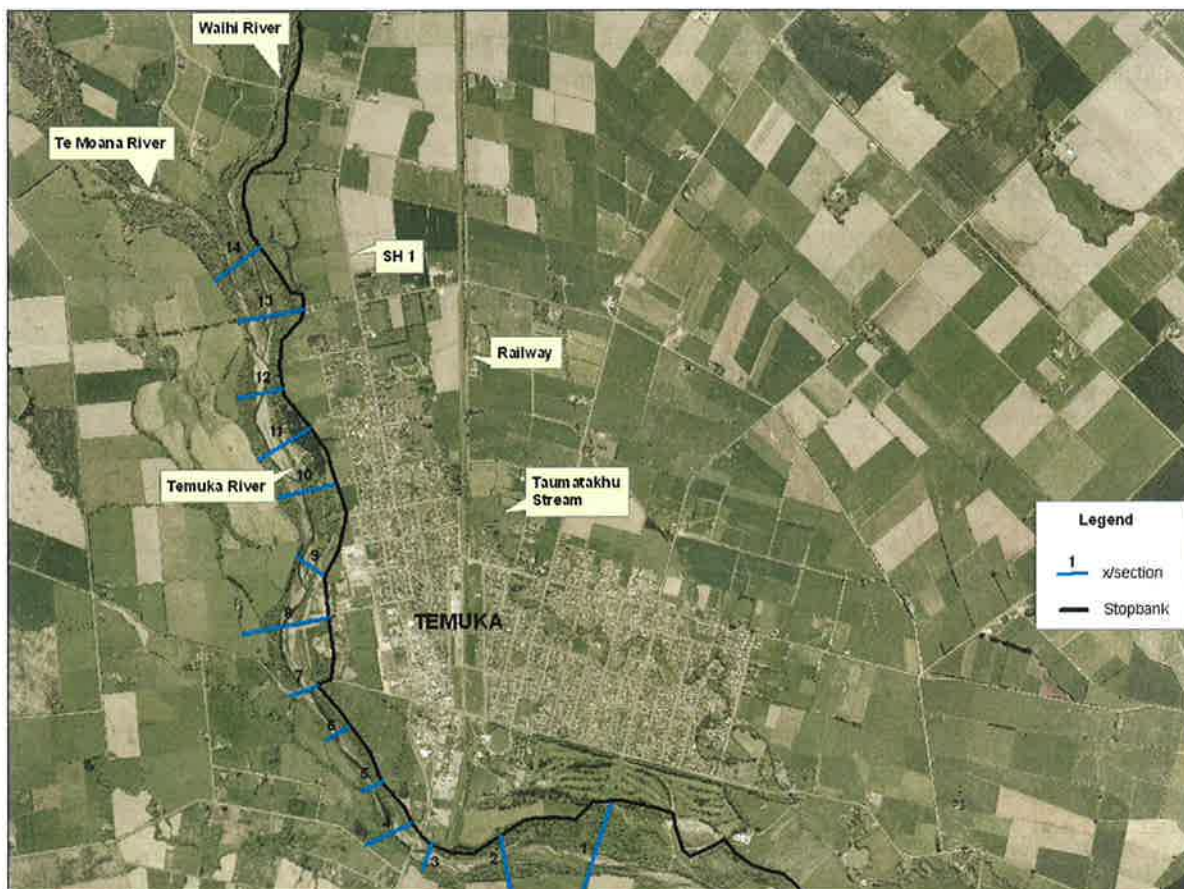


Figure 3.1 Location plan

3.2 Two-dimensional floodplain model

3.2.1 Floodplain topography

The topography (bathymetry) used in the Mike 21 2D model is based on the aerial photogrammetry flown over this area in 1999. The vertical accuracy of this survey is approximately ± 0.25 m. The digital terrain model (DTM) obtained from this survey has been checked and corrections made where necessary.

The DTM has been converted to a 5 m grid, as water levels and flows on the floodplain are resolved on a rectangular grid. The size of the grid is a function of the level of detail to obtain a realistic representation of the floodplain topography, model stability and model simulation time. The 5 m grid has been checked to ensure critical features such as the railway embankment and road levels are correctly represented. Since Taumatakhū Stream is such an important feature across the floodplain, eleven culverts (from the railway embankment at McNair Road downstream to Milford-Clandeboye Road) were included in the Mike 21 grid.

Hydraulic modelling has been undertaken both with and without the buildings on the floodplain. For analysis and design purposes the modelling which includes the buildings on the floodplain should be used. The buildings are represented as high and solid objects and therefore do not provide any potential storage for floodwaters. However this is considered a more appropriate representation and compatible with the calibration. This analysis also includes afflux against buildings which occurs during flooding.

Breakout flows from the rivers, i.e. Orari, Waihi and Temuka were included into the Mike 21 model as "source points" and represented as a flow hydrograph at each location.

Floodplain resistance was represented by a generic Mannings M (reciprocal of n) of 12.5 (n 0.08). This value is based on a 2D model calibration for the 1986 flood in Pleasant Point, where a large number of flood level observations were made.

3.3 Model simulations and results

All model simulations were based on a 0.5 second timestep to ensure stability and results were saved every 15 minutes (real time).

Simulations have been undertaken for the 1%, 0.5% and 0.2% AEP (100, 200 and 500 year return period) events.

Unfortunately very little calibration data is available for the Temuka floodplain. However a flood depth of 0.15 m was recorded at the Salvation Army Home on the Milford-Clandeboyne Road. This compares reasonably well with the current model prediction of 0.1 m in the 1% AEP (100 year return period) event and 0.25 m in the 0.5% AEP (200 year return period) event. The 1986 event was estimated to be in the order of a 100 year return period event.

Some sensitivity analysis of floodplain resistance has also been undertaken.

3.3.1 1% AEP (100 year return period) scenario

In the 1% AEP flood event the predicted breakout scenario is 50m³/s from the Waihi River near Te Awa Road (includes 10 m³/s allowance for Taumatakahu Stream catchment). The other breakout is from the Temuka River in the vicinity of Manse Bridge with a predicted breakout of 20 m³/s from the Temuka River.

As can be seen in Figure 3.2 the Waihi River breakout results in mainly relatively shallow floodwaters (up to 0.5 m) north of Temuka township before being intercepted by Taumatakahu Stream. However, due to the lack of capacity in this stream to contain such flows numerous overflows to the east occur.

Floodwaters would continue to flow over the rural area to the east of Temuka, beyond the project area boundary.

The remaining floodwaters in Taumatakahu Stream will eventually flow through the flapgated culvert into the Temuka River, as the water level in Temuka River drops.

The breakout from the Temuka River near Manse Bridge results in generally moderate flood depths on the southern end of the town with floodwaters ponded up against the stopbanks and the railway embankment. (Note: the 20 m opening under the railway embankment adjacent to the stopbank is included in the model.)

3.3.2 0.5% AEP (200 year return period) scenario

In the 0.5% AEP flood the predicted breakout scenarios include 100 m³/s from the Waihi River, near Te Awa Road, 140 m³/s from the Temuka River near Manse Bridge and an additional 20 m³/s breakout on the Temuka River near the Insulator Works (the site of previous breakouts).

The flooding pattern, as shown in Figure 3.3, is similar to the 1% AEP, but with greater flows onto the floodplain. Flood depths and extent are greater. An alternative breakout at St Leonards Road, approximately 500 m upstream of the Insulator Works was also analysed. However, based on predicted water levels, stopbanks and ground levels it was decided a breakout at this location was unlikely.

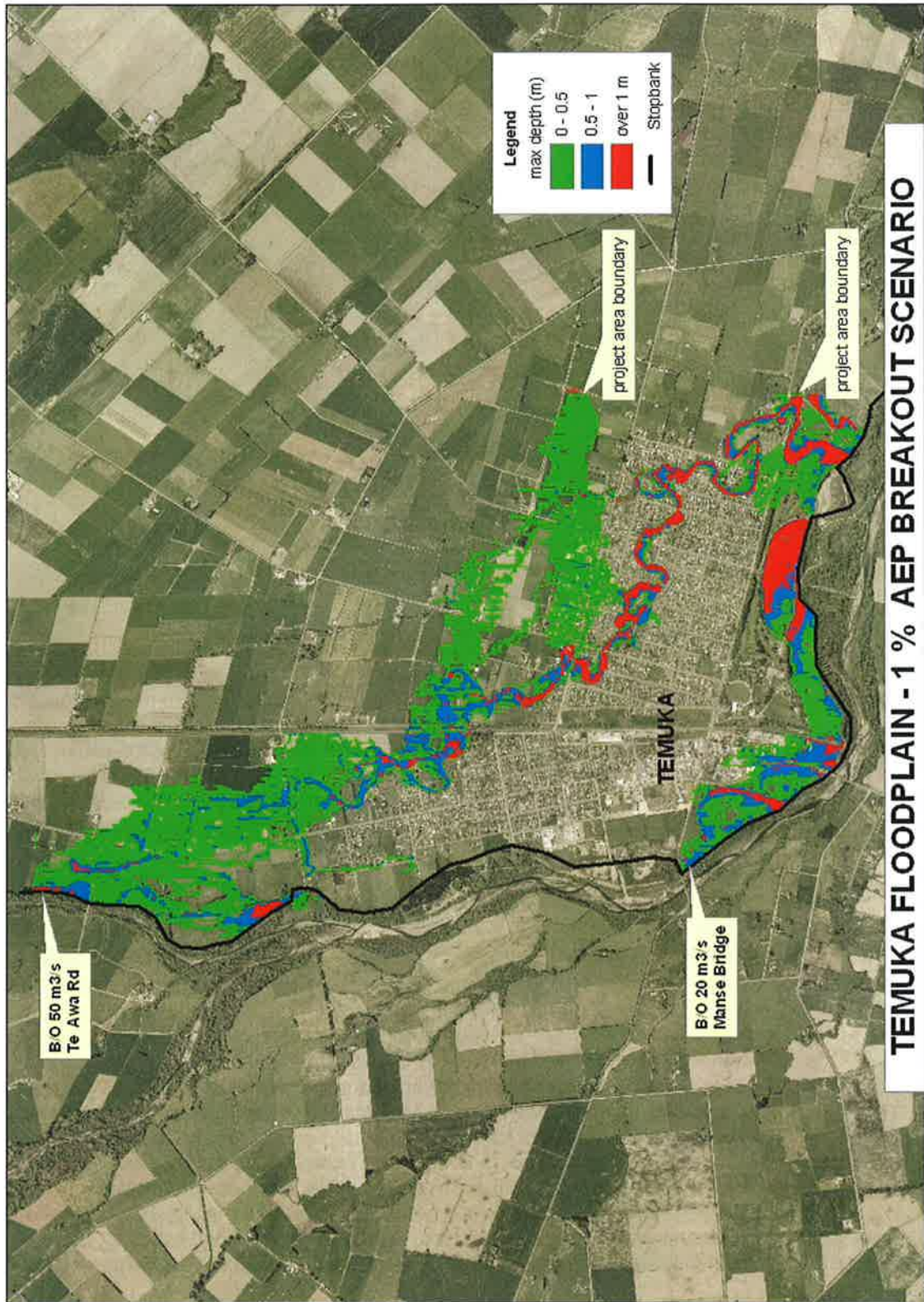


Figure 3.2 Temuka floodplain 1% AEP (100 year return period) breakout scenario

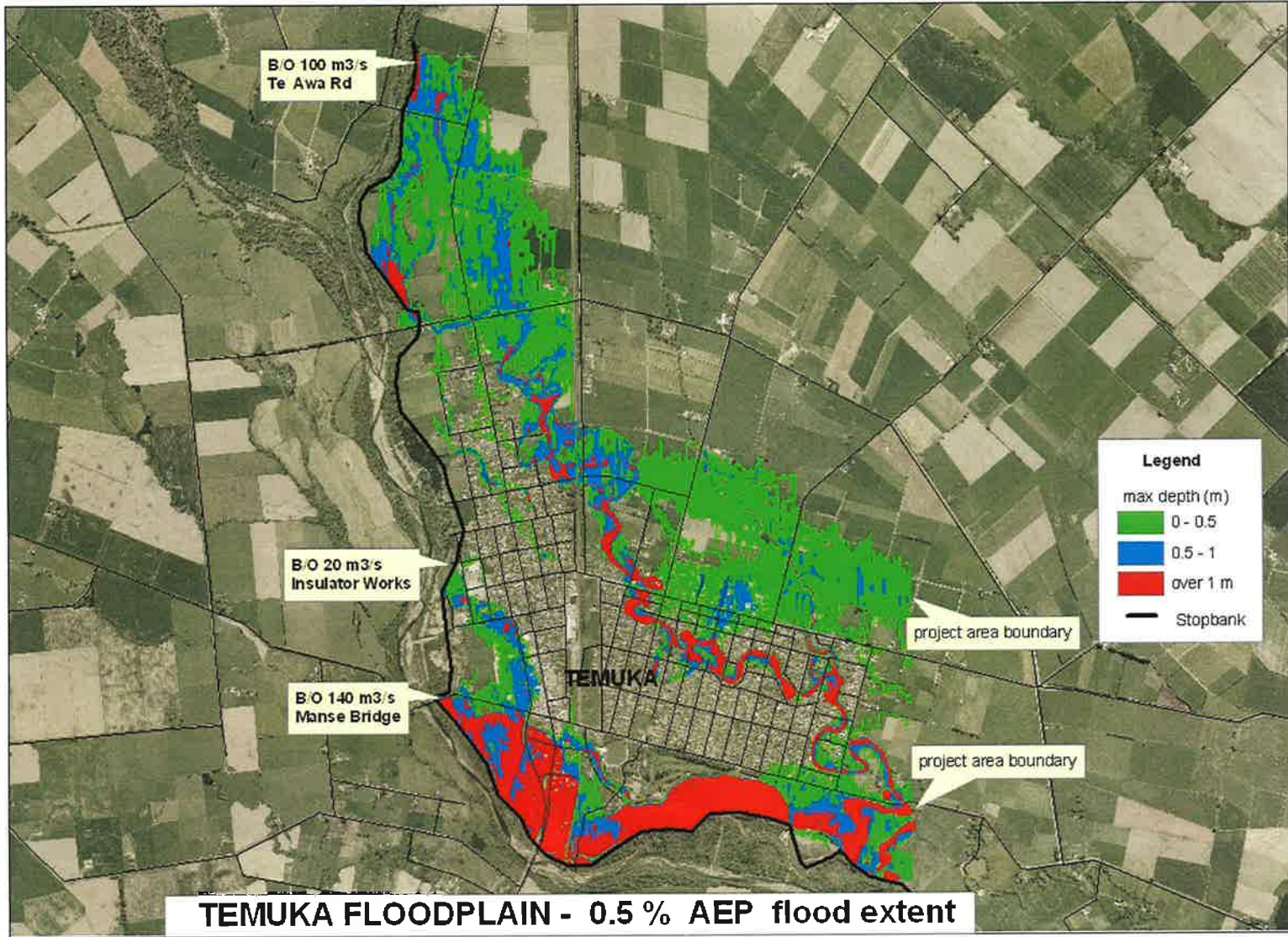


Figure 3.3 Temuka floodplain 0.5% AEP (200 year return period) breakout scenario

3.3.3 0.2% AEP (500 year return period) scenario

The 0.2% AEP flood event results in large overflows onto the floodplain which inundate large parts of Temuka and surrounding rural areas. (Refer Figure 3.4.) Predicted overflows include 350 m³/s from the Orari River, 200 m³/s from the Waihi River, and 200 m³/s and 400 m³/s from the Temuka River at the Insulator Works and Manse Bridge locations respectively. Note: flooding from the Orari River is shown in the Orari – Waihi – Temuka Floodplain Report (CRC 1993).

As can be seen from Figure 3.4 flood depths are particularly high on the south side of Temuka, adjacent to the stopbanks. Flooding in the residential area is typically up to 0.5 m deep, with a few areas over 1 m. While some areas are shown to be free of flooding, there may be still shallow flooding from local surface runoff, which has not been included in the modelling.

3.3.4 Sensitivity analysis

Floodplain depths can be sensitive to floodplain resistance (roughness). The generic Mannings "n" value used of 0.08 was obtained from calibration with Pleasant Point urban area. A simulation was done with a higher generic value of 0.12 in the 0.2% AEP (500 year return period) event. This represents a relatively rough surface (equivalent to being covered in trees) and would be unrealistic for a typical floodplain. Typically floodplain depths increased up to 0.2 m, but in the lower parts of the floodplain depths were typically 0.3 m higher.

The calibrated generic value of 0.08 is considered appropriate, and probably slightly conservative.

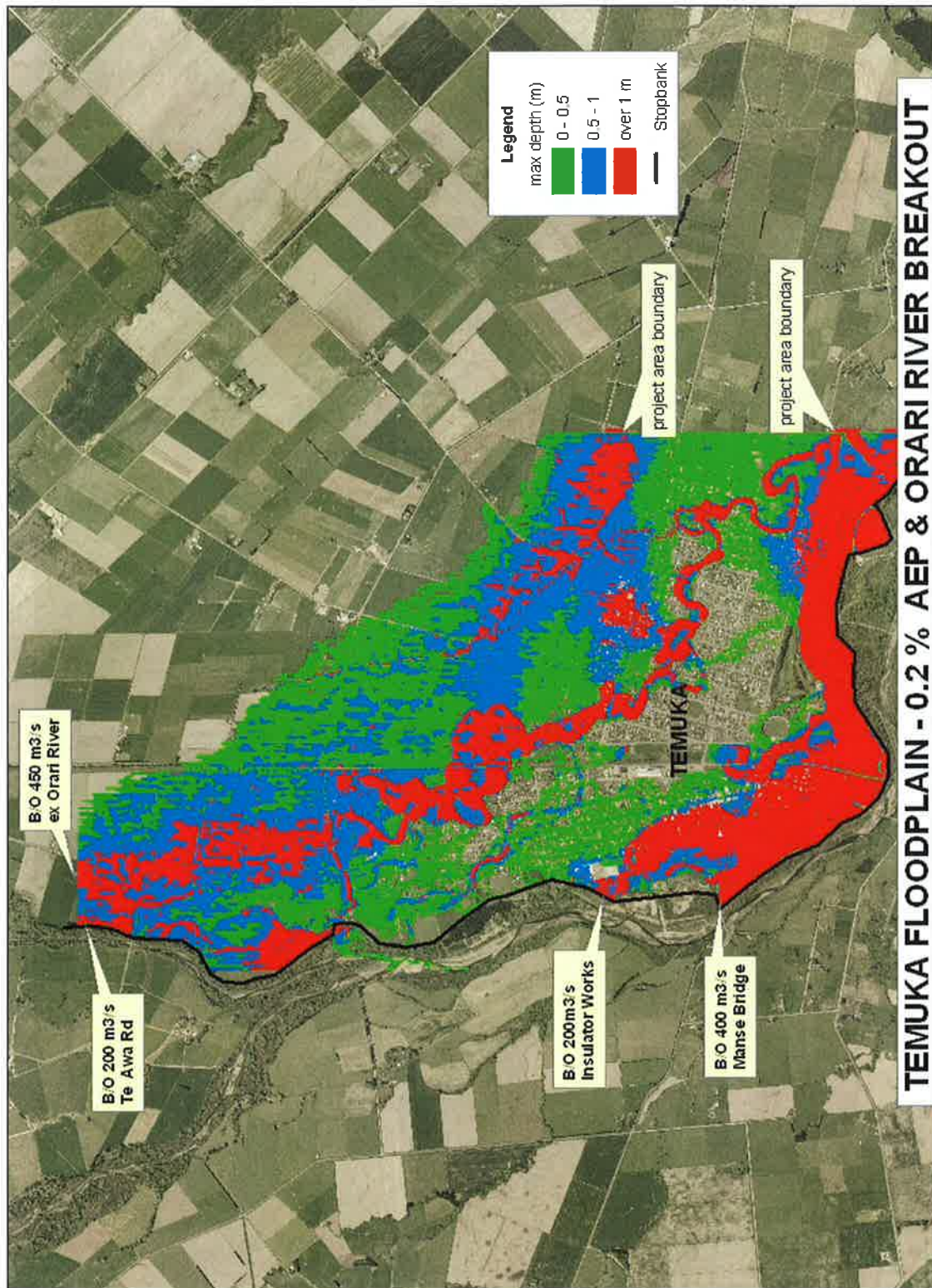


Figure 3.4 Temuka floodplain 0.2% AEP (500 year return period) & Orari River breakout scenario

4 Discussion

The Orari Waihi Temuka River Control Scheme provides a moderate level of flood mitigation to Temuka township. The Orari River stopbank system provides the greatest level of mitigation, in the order of a 1% AEP (100 year return period) event. Potentially breakouts from the Temuka and Waihi Rivers could occur in higher probability events, in the order of a 2% AEP (50 year return period) event, especially as a result of lateral erosion of the stopbank.

The modelling carried out for the 1%, 0.5% and 0.2% AEP, i.e., 100, 200 and 500 year return period events, as expected, show progressive increases in extent and depth of flooding. The 0.2% AEP (500 year return period) event, which also includes a major breakout from the Orari River, results in significant flooding to large areas of Temuka township and the surrounding rural area.

The simulations only include flooding potential from the adjacent rivers, and do not include local stormwater flooding which is also likely to occur in Temuka during such events. Therefore some areas which are not shown as being flooded, are likely to have some shallow local flooding, depending on topography.

Some comparison has been made with the earlier 1989 flood investigation. In many areas predicted flood depths are similar, however in some areas there are some significant differences. This can be attributed to the more physically correct 2D model, which wasn't available in 1989.

Obviously, with a study such as this, when modelling physical systems there are a number of uncertainties, including:

- River hydrology;
- Breakout location and magnitude;
- Topography and accuracy of the topographic survey;
- Channel and floodplain roughness.

The assumptions made in the modelling are based on current best knowledge and practice. Some calibration and sensitivity analysis has also been undertaken to address some of these uncertainties.

As is normal for flood investigations, an allowance needs to be made in predicted design levels, e.g. when setting minimum floor levels, for such uncertainties. In this case it is recommended that 0.2 – 0.3 m be added to the predicted model levels to obtain design flood levels for the various probability events.

Indicative floodplain maps for the 0.5% and 0.2% AEP (200 and 500 year return) events, which can be used for land use planning purposes are shown in Figures 4.1 and 4.2.

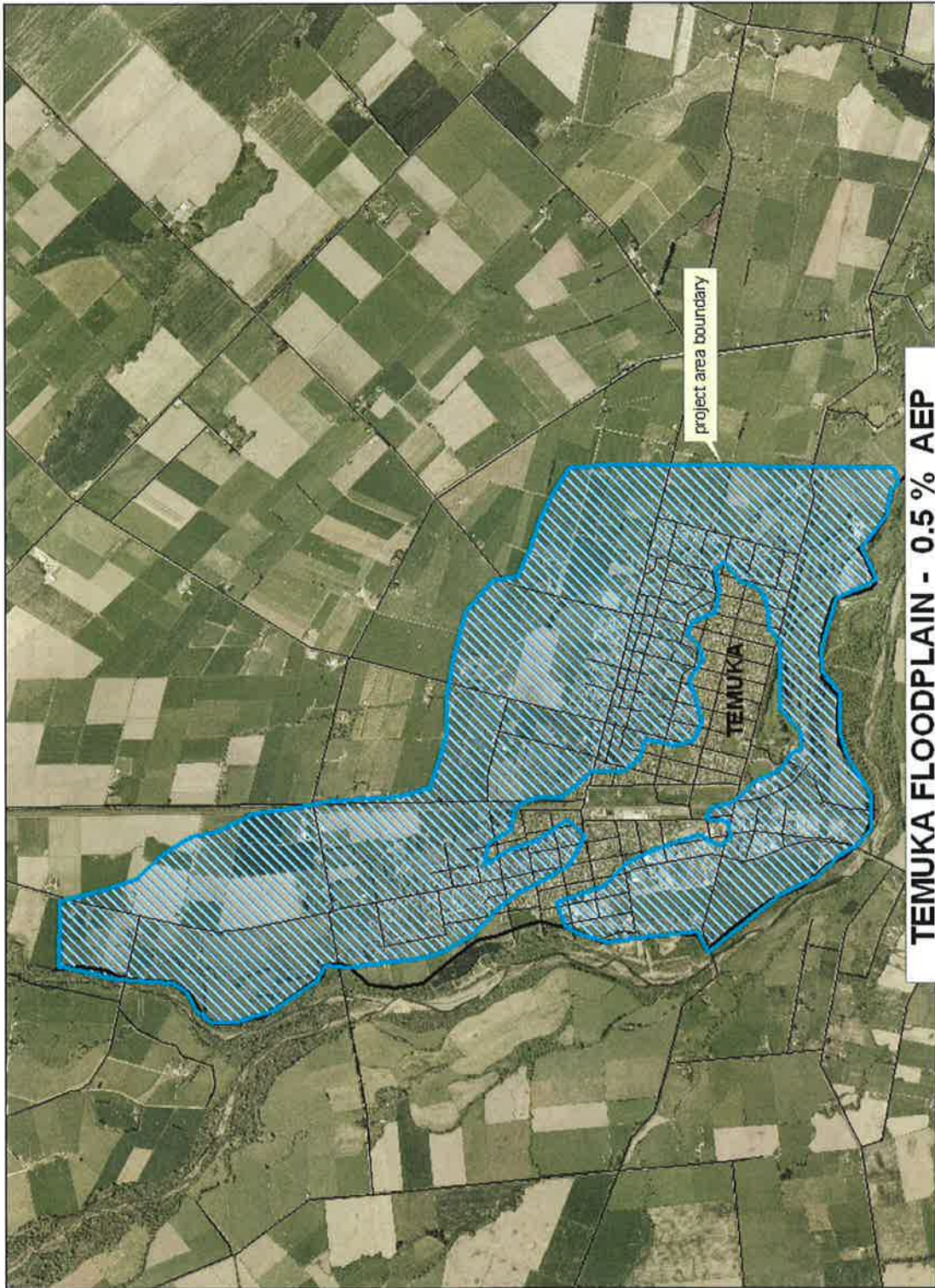


Figure 4.1 Temuka floodplain 0.5% AEP (200 year return period) event

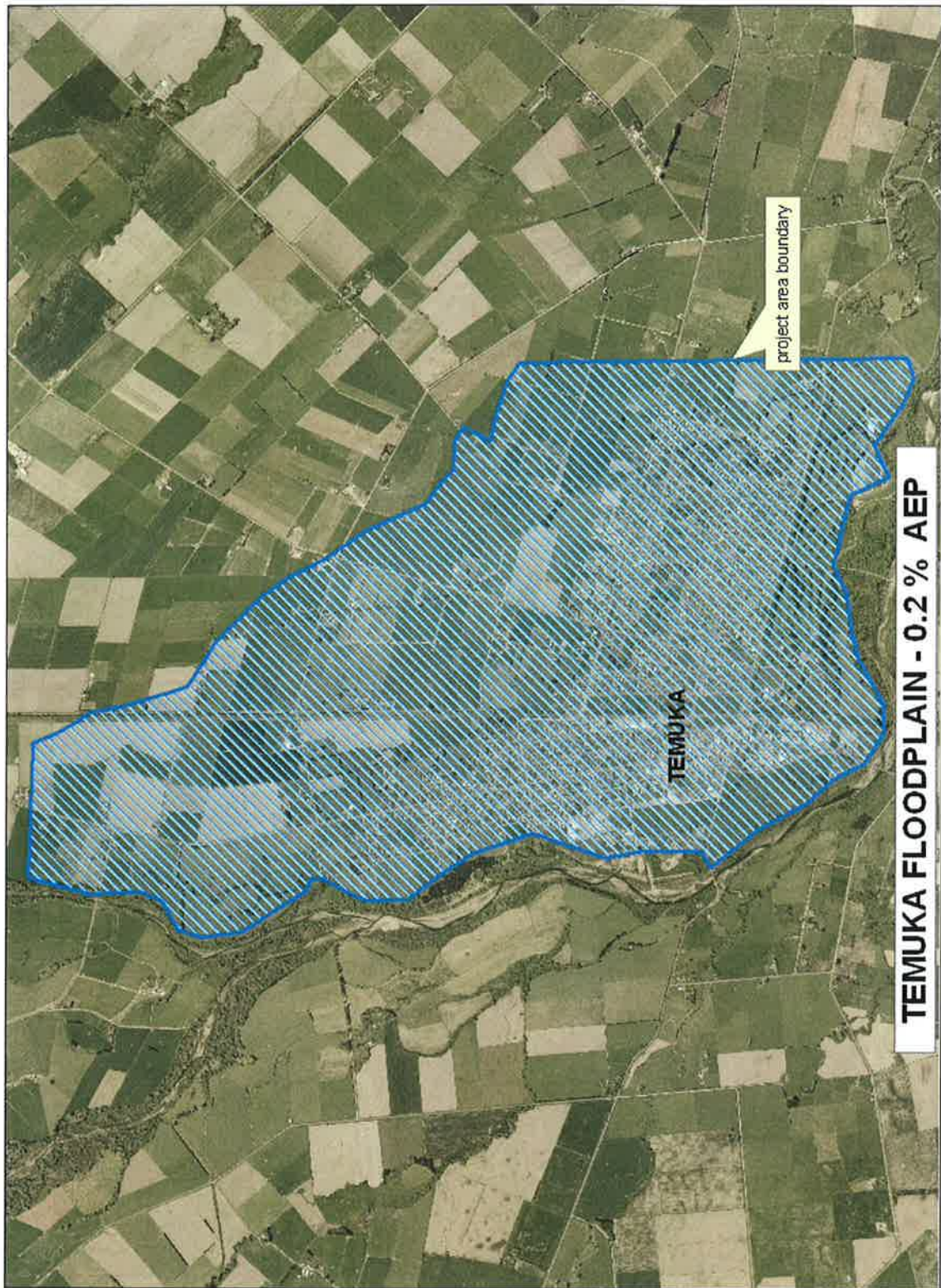


Figure 4.2 Temuka floodplain 0.2% AEP (500 year return period) event

5 References

Connell, R J 1989: *Flood Plain Management Study Temuka Borough*, South Canterbury Catchment & Regional Water Board Publication No. 63, June 1989.

CRC 1993: *Orari-Waihi-Temuka Flood Plain Management Plan: flood hazard discussion document*, Canterbury Regional Council Report 93(12), May 1993.

Appendix 1 Temuka River: computed flood level comparison with observed March 1986 flood levels

		March 1986 estimated flow in channel 900 m ³ /s	March 1986 estimated flow in channel 900 m ³ /s	
Chainage (m)	x/sect no.	Observed WL	Modelled WL	s/b lev LB
5320	14			28.8
5760	13			27.5
6230	12	25.1	25.2	26.8
6600	11	24.0	24.0	25.5
6910	10	23.0	23.0	24.5
7380	9 (Ins Wks)	22.6	21.8	22.5
7760	8	21.7	21.2	21.7
8190	7 Manse Br)	20.6	20.4	20.6
8203				
8256				
8325				
8443				
8520	6	19.7	19.6	19.6
8910	5	19.1	18.6	18.9
9230	4	18.5	18.0	18.25
9325				
9345	SH1			
9356				
9360				
9380				
9470	3	17.6	17.2	17.9
9600				
9605				
9610				
9615				
9620				
9830				
10000	2	15.8	16.1	16.5
10570	1	15.4	15.0	14

Note: Connell (1989) estimated the flow in the river at Manse Br ~ 800 - 900 m³/s. The remaining floodwaters were mainly on the right bank floodplain.

Appendix 2 Temuka River flood & bank levels

		1% AEP (100 yr) In-channel flow 1000 m ³ /s	0.5% AEP (200 yr) In-channel flow 1200 m ³ /s	0.2% AEP (500 yr) In-channel flow 1350 m ³ /s	
Chainage (m)	x/sect no.		Maximum WL	Max WL	s/b lev LB
5320	14	27.8	28.0	28.2	28.8
5760	13	26.6	26.8	27.0	27.5
6230	12	25.3	25.6	25.8	26.8
6600	11	24.2	24.5	24.7	25.5
6910	10	23.2	23.6	23.8	24.5
7380	9 (Ins Wks)	22	22.3	22.5	22.5
7760	8	21.4	21.7	21.9	21.7
8190	7 Manse Br	20.6	21.0	21.2	20.6
8203		20.6	20.9	21.1	
8256		20.4	20.7	21.0	
8325		20.2	20.6	20.8	
8443		20.0	20.3	20.6	
8520	6	19.8	20.2	20.4	19.6
8910	5	18.8	19.1	19.4	18.9
9230	4	18.2	18.6	18.9	18.25
9325		18.0	18.4	18.7	
9345	SH1	17.9	18.3	18.6	
9356		17.7	18.1	18.3	
9360		17.7	18.1	18.3	
9380		17.7	18.1	18.3	
9470	3	17.4	17.8	18.0	17.9
9600		17.3	17.7	17.9	
9605		17.3	17.7	17.9	
9610		17.2	17.5	17.7	
9615		17.2	17.5	17.6	
9620		17.2	17.5	17.7	
9830		16.8	17.1	17.3	
10000	2	16.3	16.6	16.8	16.5
10570	1	15.0	15.3	15.6	14
11090		14.7	15.1	15.4	
11235		14.7	15.1	15.4	
11835		14.7	14.9	15.1	



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