REPORT

CHRISTCHURCH CITY COUNCIL

Preliminary Assessment of Historical Flooding

AKAROA HARBOUR SETTLEMENTS

Report prepared for:
CHRISTCHURCH CITY COUNCIL

Report prepared by:
TONKIN & TAYLOR LTD

Distribution:

CHRISTCHURCH CITY COUNCIL	9 copies
TONKIN & TAYLOR LTD (FILE)	1 copy

May 2008

T&T Ref: 51253/ver2.0

Table of contents

1 Introduction **1**
- 1.1 General 1
- 1.2 Methodology 1
- 1.3 Mapping 2
- 1.4 Limitations 3

2 Flooding Assessment **4**
- 2.1 Akaroa Harbour Basin Characteristics 4
- 2.2 Key Historical Observations 5
- 2.3 Mapped Flood Events 6
- 2.4 Storm Frequency 6
- 2.5 Summary 8

3 Recommended Further Study **9**

4 References **11**

Appendix A: Figures

1 Introduction

1.1 General

Tonkin and Taylor Ltd (T&T) was engaged by Christchurch City Council (CCC) to undertake an assessment of historical flooding information within defined settlement areas of Akaroa Harbour. This work was undertaken based on CCC's project brief and T&T's proposal of 2 November 2007.

CCC's project aim provided in the brief is "to delineate areas most suitable for development in the defined study areas in terms of their history of flooding events". The project scope involves the assessment of information collected and mapping of areas that have flooded in the past, within and immediately beyond settlement areas, at a scale appropriate for district planning purposes of 1:10,000. The mapped areas have been assessed and digitised into GIS format.

CCC has provided T&T with settlement boundaries in electronic format. The locations of the settlement boundaries are shown on Figure 1. The following settlement areas are identified:

- Akaroa
- Takamatua
- Robinsons Bay
- Duvauchelle
- Barrys Bay
- French Farm
- Tikao Bay
- Wainui

1.2 Methodology

The scope of work requires the collation of information in a GIS system, mapping of identified historic flooding events, review of the information/flooding, comment on possible frequency and return periods, and provide a preliminary prioritised scope for future flooding studies.

The research into historical flooding has been conducted by Suky Thompson of Peninsula Projects (Thompson 2008, Reference 1).

Components of the methodology include:

- Meeting with Peninsula Projects and handover of information. Additional liaison and clarification as required.
- Compilation of GIS database of historic information registered relative to available topography and cadastral layers.
- Estimation of flooding areas for identified events and create map layers of inundation by specific events to the detail possible from the available information.

- Engineering review of the historic information and maps to provide comment and discussion of possible event frequency and return periods. Comparisons will be made with rainfall data, but no analysis will be undertaken.
- Preliminary scope for future flooding studies, including a prioritisation by settlement area. This will primarily be focussed on flood prediction studies incorporating the historic information with rainfall, catchment and flood level analysis.
- A brief report outlining the methodology and describing the GIS database and maps.

1.3 Mapping

Digital historical flood extents were derived from the hand drawn flood maps produced in the Historical Flooding Research and Mapping Project (Thompson 2008, Reference 1). The report maps selected known flood events (between 1934 and 2002) where there is sufficient information to attempt to define areas of inundation within the boundaries of the 8 settlements, with at least one flood event per settlement (see Figures 1 to 9).

The hand mapped flood extents were checked against 2m contour interval topography where it is available to establish if there is scope for extending or modifying the apparent historic flood extents. Based on the 2m contours, the probable extent of historic flooding could be adjusted by about 5 to 10m on some sections of Balguerie Stream (Akaroa) and Pawsons Stream (Duvauchelle). This has not been attempted as the potential changes are insignificant compared to the scale of flooding and accuracy of the historical flood extents. The contours do not assist in any further interpolation of flood extents in low lying areas.

T&T received the following files from CCC and Environment Canterbury (ECan) to include in the database for the study:

- settlement boundary maps
- contour lines at various scales for each region (i.e. 2 m – 20 m contours);
- digital aerial imagery for all regions
- digital copies of historical flood maps.

ArcGIS 9.1 software was utilised to digitise the spatial extent of each flood event into polygon shp (shape) file format (NZMG[1]). The shp files also contain the following attribute information:

- EVENT = the date of the flood event.
- LOCATION = the location (settlement) of the flood event.
- REPORT = a hyperlink to a PDF of the full report (Thompson, 2008).
- O_RAIN_1 = The first row of Onawe rainfall data (mm) for the specific flood event, as presented in Table 1 (pg 9-12) of the report.
- O_RAIN_2 = The second row of Onawe rainfall data (mm) for the specific flood event, as presented in Table 1 (pg 9-12) of the report.

[1] New Zealand Map Grid projection.

- O_RAIN_3 = The third row of Onawe rainfall data (mm) for the specific flood event, as presented in Table 1 (pg 9-12) of the report.
- A_RAIN_1 = The first row of Akaroa rainfall data (mm) for the specific flood event, as presented in Table 1 (pg 9-12) of the report.
- A_RAIN_2 = The second row of Akaroa rainfall data (mm) for the specific flood event, as presented in Table 1 (pg 9-12) of the report.
- A_RAIN_3 = The third row of Akaroa rainfall data (mm) for the specific flood event, as presented in Table 1 (pg 9-12) of the report.

1.4 Limitations

The information contained in this report and on the accompanying maps has been prepared specifically for CCC as inputs to be considered by CCC in strategic planning for potential future growth of the existing Akaroa Harbour settlements. This report has been prepared for the benefit of CCC with respect to the particular brief given to us and it may not be relied upon in other contexts.

The accuracy of the maps is limited to the accuracy of the hand drawn flood maps produced in the Historical Flooding Research and Mapping Project (Thompson 2008, Reference 1), the historical information the maps are based on and topographic contours available.

No liability is accepted for the accuracy of any of the information presented from this study of historic flood areas of Akaroa Harbour. The information provided in this report and accompanying maps should not be used as a replacement for site, or area specific detailed flood assessments. The site specific hazard and risk of flooding should be assessed by a suitably experienced water resource engineer or hydrologist to provide information for planning approval and/or design.

2 Flooding Assessment

2.1 Akaroa Harbour Basin Characteristics

The Akaroa Harbour Basin Settlement historic flooding study covers eight settlement areas within Akaroa Harbour totalling approximately 1900 ha, as shown in Figure 1. Generally the settlements are located in inlets and bays at the mouths of valleys along the coastline of Akaroa Harbour. The settlement areas are centred on significant streams that drain into the harbour as follows.

Settlement area	**Number of significant streams through the area**	**Named streams**
Wainui	2	
Tikao	1	
French Farm	1	
Barrys Bay	1	Barrys Bay Stream
Duvauchelle	2	Pawsons Stream Pipers Stream
Robinsons Bay	1	
Takamatua	1	Takamatua Stream
Akaroa	3	Grehan Stream Balguerie Stream Aylmers Stream

Land use within the settlement study catchments is predominantly rural, with small settlement areas along the main highway and valley roads. Existing development results in a 'patchwork' landscape of pasture, horticulture, dwellings, forest and scrub.

The harbour basin drainage is approximately radial around the centre of the harbour reflecting the original development of drainage patterns within the extinct volcano, before breaching to the open sea to the south (Figure 1).

Typical stream catchment characteristics are as follows:

Catchment characteristic	Approximate range
Area	4 to 10 km^2
Length	3 to 4 km
Elevation	Sea level to RL 400-600 m
Average stream slope	9 to 13%

Based on the above summary the time of concentration[2], or catchment response time for major harbour catchments will be in the range of 20 to 60 minutes. Therefore peak flood discharge volumes would be expected as 'flash floods' from short duration high intensity rain storm events, typically concentrated in individual catchments. Such short duration events are often 'embedded' in longer duration storms that result from major low pressure weather systems.

2.2 Key Historical Observations

Key observations, based on our review of the Historical Flooding Research and Mapping Project report (Thompson 2008, Reference 1) include:

- The rainfall records in Akaroa harbour are for daily rainfall. There are no sites to record stream flows or flood levels.
- Significant flooding appears to have been noted historically when daily rainfall exceeded 120mm at Akaroa and 50mm at Onawe.
- In the complete list of rainstorm events identified there are 18 events with 24 hr rainfall above 100mm where no flooding has been documented. This includes 184mm in 2000 and 135mm in 2003.
- Peak flood flows seem to occur for relatively short periods and are often not witnessed, but identified by debris levels and flood marks.
- Flood flows are often bank full in the streams, with breakout occurring onto flood plains at bends and restrictions in the channel. It is noteworthy that breakout has not always occured at the same locations between different flood events (e.g. see Figure 8 for break out from Takamatua Stream to the valley road for 1994 and 2002), due to differences in local restriction between flood events.
- Vegetation and small landslides falling from the stream banks are cited as causing breakout of flood water from stream channels. In some cases the inference is that

[2] Time of concentration is the time required for storm water runoff from the outermost points of the catchment to flow to a specified downstream location. The peak flow at the specified location will therefore be produced by a rainfall event with a similar duration to the time of concentration.

flooding was noted in smaller rainfall events due to these local channel restricting events.

- Bridges and culverts are restrictions that have contributed to historic out of channel flooding. The secondary flood flow path is often down roads.
- Ponding in low lying areas has been observed near sea level in Akaroa, Takamatua, Robinsons Bay and French Farm.
- Flood waters have been noted to spread from relatively confined upstream channels to alluvial fans at Duvauchelle golf course (Pawsons Stream) and Barrys Bay between the Cheese Factory and Half Moon Cottage.
- The flood plain in Wainui valley between the YMCA camp and the foreshore holiday homes is relatively flat and low lying. Although there are no historic records of flooding in this area it is considered potentially vunerable to flooding during significant flows.
- Historical observations of storm surges are available at Wainui, Tikao Bay and Duvauchelle, affecting the foreshore main road and potentially the first row of properties upslope of the road. Storm surge effects are mentioned for Akaroa, but no specific information is provided.

2.3 Mapped Flood Events

The Historical Flooding Research and Mapping Project report (Thompson 2008, Reference 1) has mapped 9 flood events where there is sufficient historical information to allow an estimate of the areas of inundation. The mapped events, as shown on Figures 1 to 9 illustrate that different events resulted in flooding of specific settlement areas. Generally if there is flooding in the east there is none recorded in the west and vice versa.

Correlation between historic flood events and rainfall has been made by using daily (24 hr) rainfall data collected at Stanley Park (Akaroa township) and Onawe Peninsula. There are usually significant differences between recorded rainfall at the two stations, indicating that different storm events are concentrated on different parts of the harbour basin.

2.4 Storm Frequency

To provide a preliminary assessment of flooding frequency we have compared the 9 mapped flooding events with results from NIWA's HIRDS (High Intensity Rainfall Design System) version 2.0.

Also available is a preliminary assessment of Akaroa rainfall frequency compared to the Christchurch City area statistics (Reference 2). This was produced by CCC in order to derive some short duration rainfall intensities for potential use in Akaroa Harbour stormwater design.

Akaroa Harbour selected event	24 hour rainfall (mm)	Estimated Return Period	
		HIRDS v 2.0 Average Return Interval (ARI) (y)	CCC assessment (ref 2) ARI (y)
1895 (not mapped)	180 (Ak)	40 to 50	50
1936	298 (Ak)	>150	approx 200
1963	217 (On)	80 to 100	approx 75
1968	206 (On)	70 to 80	approx 75
1981	78 (Ak)	<2	<2
1986	112 (Ak)	5	5
1992	110 (Ak)	5	5
1994	198 (Ak)	60 to 70	approx 60
2000	100 (On)	5	approx 3
2002	144 (Ak)	approx 20	approx 20

The HIRDS 2.0 and CCC return periods for 24hr duration events are in general agreement.

From the raw rainfall data it is noted that for the 73 years from 1934 to 2007 there were 45 days where rainfall exceeded 100mm and four days where it exceeded 200mm.

The results from HIRDS 1.50 (an earlier version of HIRDS still favoured by hydrologists for calculations in some areas of New Zealand) was checked and found to be significantly over estimating rainfall for a given ARI compared to the HIRDS 2.0 and CCC information. Further investigation of the potential significance of these differences is beyond the scope of this study.

The nine mapped flood events were selected because they were noteworthy/newsworthy events, i.e. there was significant flooding in one or more parts of the harbour basin. These noteworthy flood events have a range from 2 to 100 years ARI for the measured 24 hr rainfall. There appears to be no strong correlation between noteworthy flood events and rainfall as recorded on a 24 hr basis.

The typical times of concentrations of 20 to 60 minutes, and the observed 'flash flood' nature of the streams means that critical storm durations will be in the 20 to 60 minute range to generate highest peak flows. This observation may go at least part way to explaining the poor correlation between 24hr rainfall and reported flood activity, where about 40% of days with >100mm of rainfall showed no significant flooding, potentially due to no significant 20 to 60 minute duration rainfall within that 24 hr period. The significance of short duration rainfall is also highlighted by the variation in reported

flooding in different catchments around the harbour, due to short duration 'cloud bursts' affecting one or two neighbouring catchments, but not passing over catchments around the rest of the harbour.

Although it seems that there is a poor correlation between historic flooding events and daily rainfall of about 20 to 100 year frequency, the flooding is actually being generated by shorter duration rainfall events (20 to 60 minute storms). It is important that shorter duration design rainfall estimates are utilised for flood studies undertaken on specific sites.

2.5 Summary

The stream catchments flowing into Akaroa Harbour are relatively short and steep, resulting in short times of concentrations and 'flash flood' type conditions.

There have been several historically noted flood events in the past 110 years, with at least nine providing sufficient records to allow estimation of the areas of inundation. Although no short duration rainfall data is available, the most significant events seem to have been noted when daily rainfall has occurred with a return period of about 20 to 100 years.

Generally stream flows have been confined in channels, with man made restrictions such as roads, bridges and culverts contributing to out of channel flows down streets, and to a lesser extent across properties. Local collapse of vegetation and debris from bank erosion and small landslides along the stream banks exacerbates flooding by reducing channel capacity at locations specific to each event.

Ponding of flood water in low lying areas has been observed in Akaroa, Takamatua, Robinsons Bay and French Farm (see Figures 4, 7, 8, 9). Significant overland flow has historically occurred on alluvial fans at Barrys Bay and the Pawsons Stream catchment in Duvauchelle (Figures 5 and 6).

The broad valley floor at Wainui has potential for flooding, but no historical flooding has been recognised. This lack of history may be due to a lack of witnesses rather than an absence of flood waters.

3 Recommended Further Study

The Akaroa Harbour catchments are typically short, steep stream catchments with limited low lying areas or wide flood plains. This means that flood extents are likely to be generally confined close to the main stream channel, except where localised constrictions cause overflow. Nonetheless, hydrologic modelling to determine design events, and computational; hydraulic modelling could provide useful information on flood extents and flood heights to assist planning and development decisions.

A possible scope of work which can be conducted on any one, or group of catchments around the harbour basin is outlined as follows:

1. Determination of design rainfall data for the Akaroa Harbour catchments, to enable rainfall runoff modelling for design flows. A comparison of HIRDS and CCC derived rainfall duration and intensity information should be conducted to assess the 'reasonableness' of the adopted design rainfall. Design data should also include provision for the possible effects of future climate change.
2. Assess peak catchment flood flows for design using the Rational Method and/or SCS (US Soil Conservation Service) unit hydrograph, or similar.
3. Identify and 'catalogue' stream channel restrictions and common breakout points for each stream from the Historical Flooding Research and Mapping Project report (Thompson 2008, Reference 1), aerial photograph interpretation and field reconnaissance.
4. Surveying stream channel cross sections, along with secondary out-of-channel flow paths and low lying areas around historical flood ponds as appropriate.
5. Develop HECRAS[3] stream flow models for the lower catchments to assess design flood levels, and confirm likely extent of future flooding especially at likely restrictions and known breakout points in the channels.
6. Develop concept designs for improvement of channel capacity and containment of flood flows as feasible. For example, it is considered that mitigation work on bridges and culverts in Akaroa town has the potential to improve conveyance capacity and reduce flood damage.
7. Prepare flood hazard maps which identify areas likely to be affected by flooding during the selected design events. Therefore, for development to proceed in these areas Council might require specific analysis to confirm suitability of possible development projects.

Tasks 1 to 3 could be undertaken as part of first stage investigations by CCC, in order provide a consistent framework for future flood and stormwater studies on specific sites, which might be undertaken by individual developers, or CCC. The output from tasks 1 to 3 will also enable the extent and scope of the later tasks.

[3] HECRAS (Hydraulic Engineering Centre River Analysis System) is a readily available computer program developed by US Army Corps of Engineers that models the hydraulics of water flow through natural rivers and other channels.

Priority for future work depends to a large extent on where development is likely to be targeted. The current first priority appears to be Akaroa, because of the existing level of development and repeated historic flood damage. Takamatua and Robinsons Bay may have second and third priority for further study, because they include areas of low lying land close to Akaroa Town. Pawsons Stream in Duvauchelle and Barrys Bay both contain sloping coastal land with a potential for future development and a history of flooding.

4 References

1. Thompson, S. 2008: Historical Flooding Research and Mapping Project, 8 February 2008. Report prepared for Christchurch City Council. Pp 106.

2. Harrington, G. February 2008: Akaroa Rainfall Short Duration Intensities Derived from 24 Hour Rainfall Data. Christchurch City Council internal information.

TONKIN & TAYLOR LTD

Environmental and Engineering Consultants

Report prepared by:

.....

Barry McDowell

Senior Engineering Geologist

Authorised for Tonkin & Taylor by:

.....

pp Tom Bassett

Principal Hydrologist

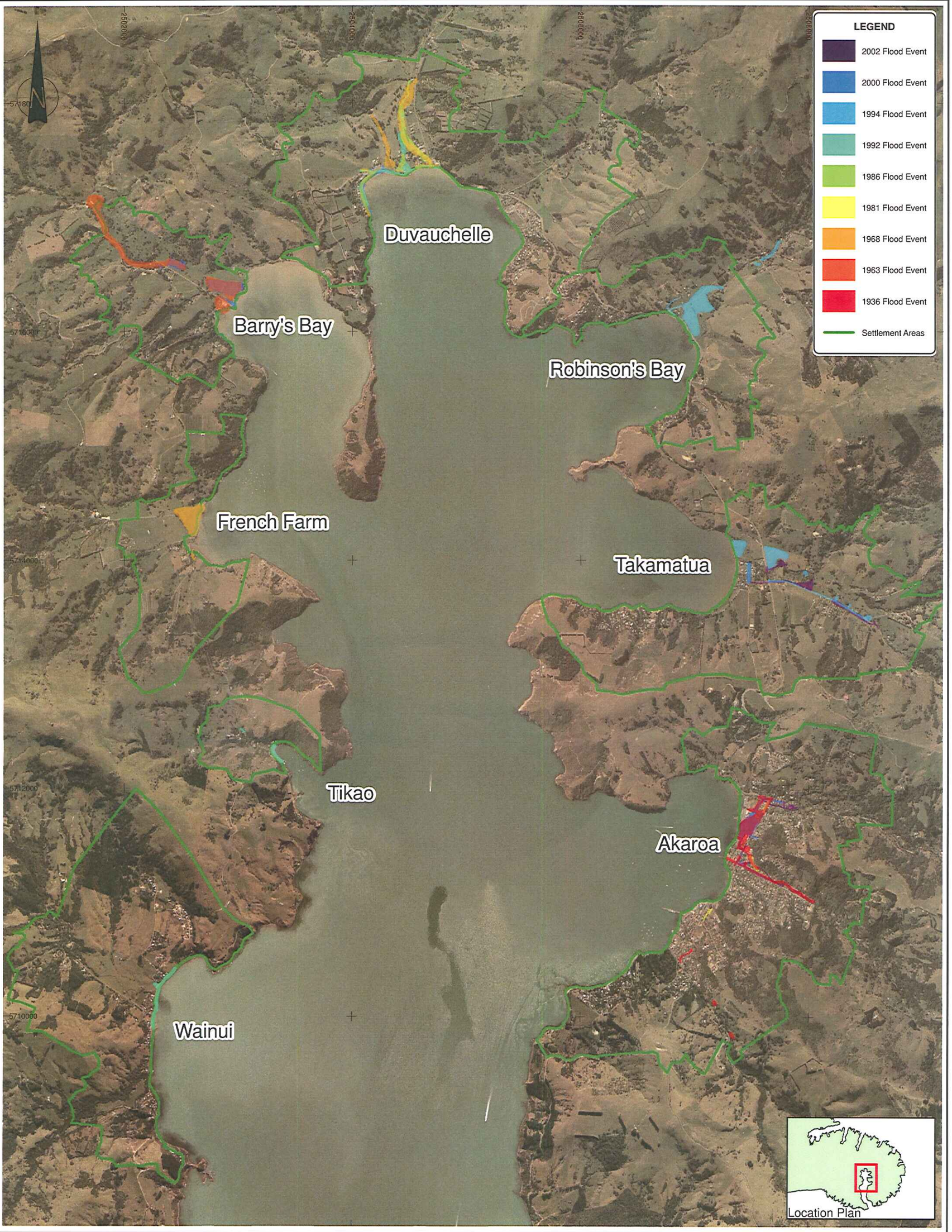
bmcd

P:\51253\IssuedDocuments\Flood Assessment report ver 2.0.doc

Appendix A: Figures

- **Figure 1 Settlement Boundaries and Mapped flood Events**
- **Figure 2 Mapped Flood Events Wainui**
- **Figure 3 Mapped Flood Events Tikao**
- **Figure 4 Mapped Flood Events French Farm**
- **Figure 5 Mapped Flood Events Barrys Bay**
- **Figure 6 Mapped Flood Events Duvauchelle**
- **Figure 7 Mapped Flood Events Robinsons Bay**
- **Figure 8 Mapped Flood Events Takamatua**
- **Figure 9 Mapped Flood Events Akaroa**

C:\Program Files\ArcGIS\Bin\Templates\TONTAY\A3FP-MBV-MG.mxt: Wednesday, April 18, 2006 5:17:07 p.m.



Notes: Background aerial sourced from Terralink Ltd.
Mapped flood extents are digitised from maps in Peninsula Projects report "Historical Flooding Research and Mapping Project", 8 February 2008.

0 500 1,000 1,500 Meters

Tonkin & Taylor
Environmental & Engineering Consultants
Hamilton
www.tonkin.co.nz

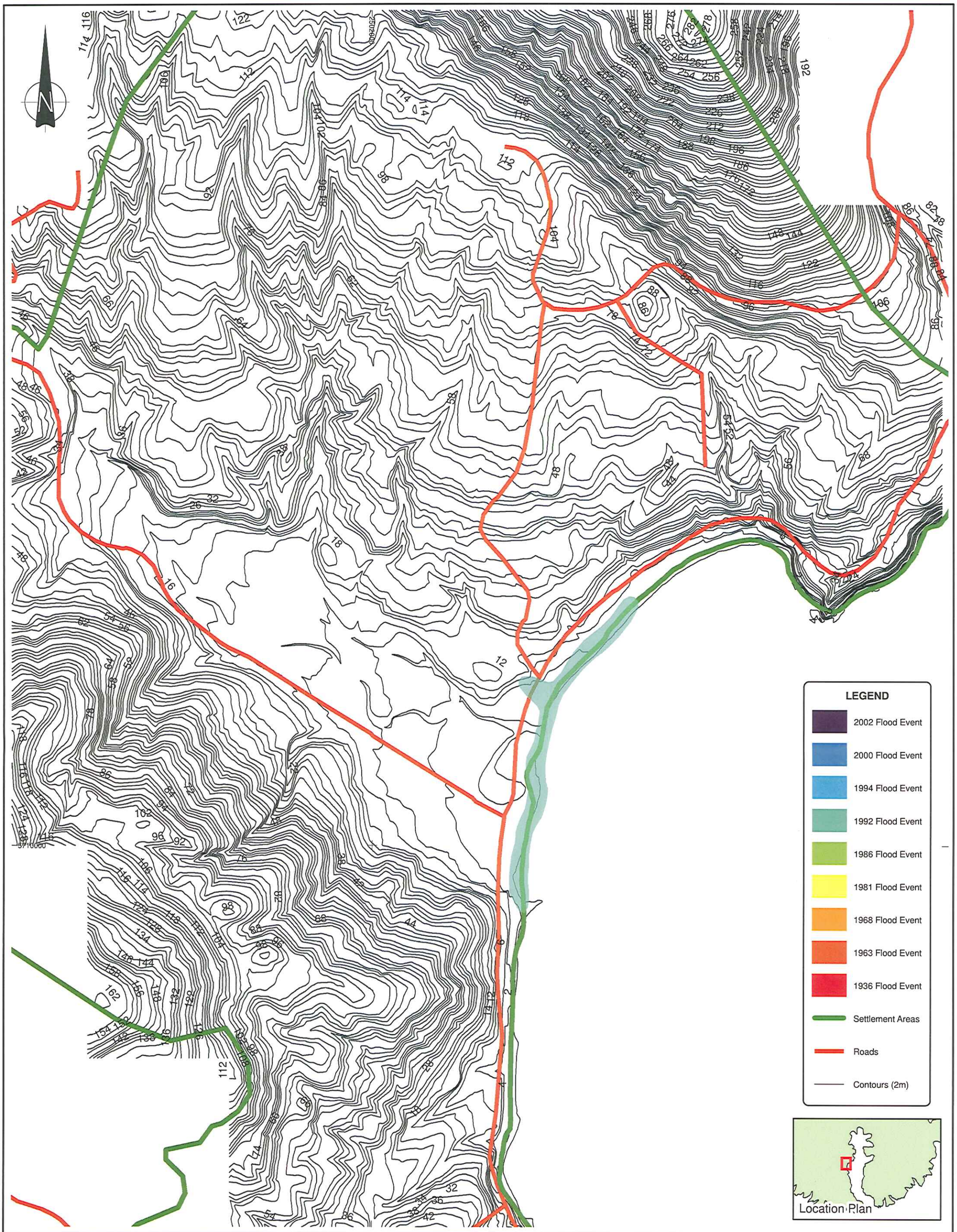
DRAWN	MCI	Apr.08
DRAFTING CHECKED		
APPROVED		
ARCFILE	Figure1.mxd	
SCALE (AT A3 SIZE)	1:30,000	
PROJECT No.	51253	

CHRISTCHURCH CITY COUNCIL
Akaroa Settlements Study
Preliminary Assessment of Historical Flooding
Settlement Boundaries and Mapped Flood Events

FIG. No. Figure 1.

REV. 0

C:\Program Files\ArcGIS\Bin\Templates\TONTAY\A3FP-MBV-MG.mxt: Wednesday, April 18, 2006 5:17:07 p.m.



Notes: Vector Road data sourced from LINZ.
Vector Contour data sourced from CCC.
Mapped flood extents are digitised from maps in Peninsula Projects report "Historical Flooding Research and Mapping Project", 8 February 2008.

0 100 200 Meters

Tonkin & Taylor
Environmental & Engineering Consultants
Hamilton
www.tonkin.co.nz

DRAWN	MCI	Apr.08
DRAFTING CHECKED		
APPROVED		
ARCFILE	Figure2.mxd	
SCALE (AT A3 SIZE)	1:6,000	
PROJECT No.	51253	

CHRISTCHURCH CITY COUNCIL

Akaroa Settlements Study

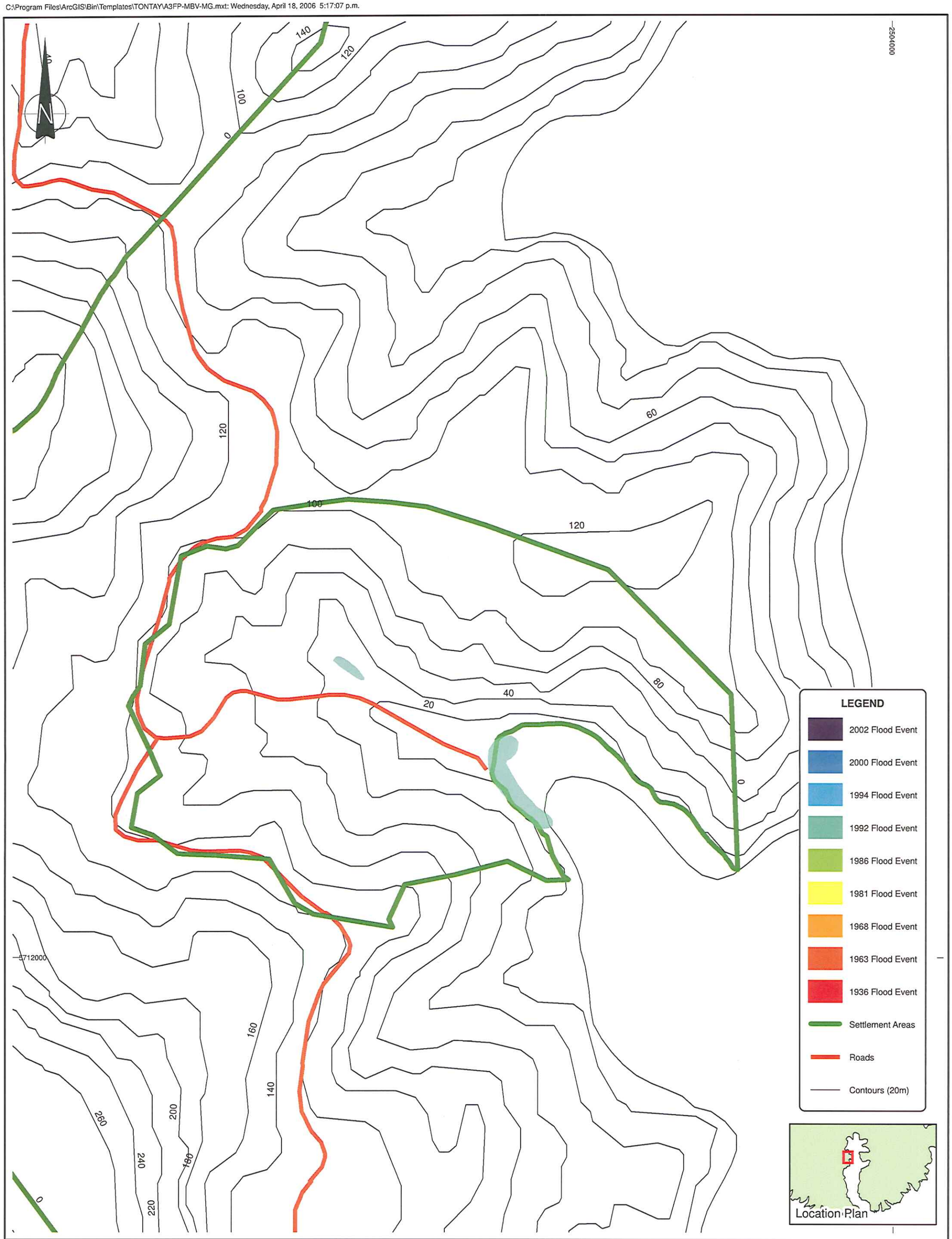
Preliminary Assessment of Historical Flooding

Mapped Flood Events Wainui

FIG. No. Figure 2.

REV. 0

C:\Program Files\ArcGIS\Bin\Templates\TONTAY\A3FP-MBV-MG.mxt: Wednesday, April 18, 2006 5:17:07 p.m.



Notes: Vector Road data sourced from LINZ.
Vector Contour data sourced from CCC.
Mapped flood extents are digitised from maps in Peninsula Projects report "Historical Flooding Research and Mapping Project", 8 February 2008.

0 100 200 Meters

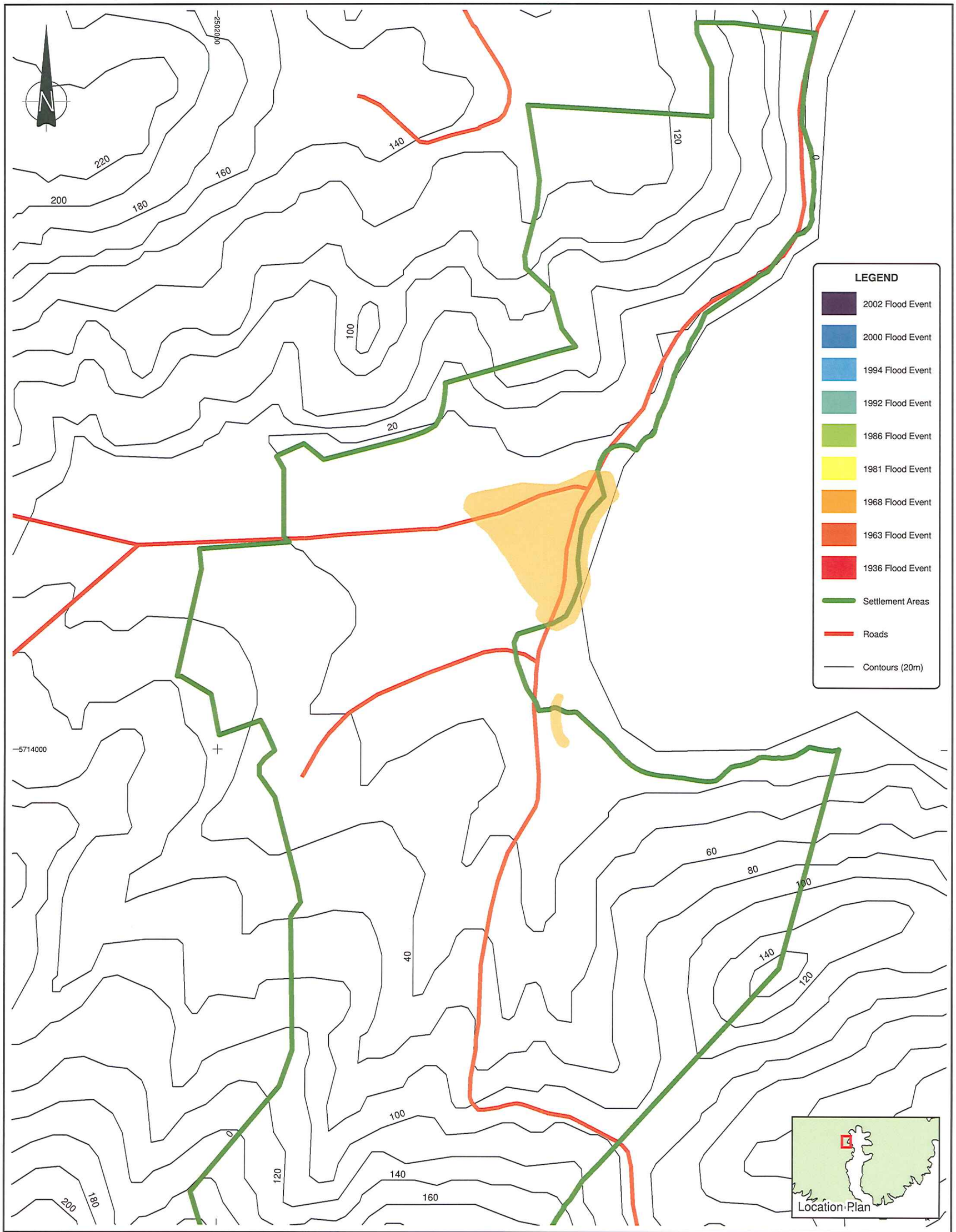
Tonkin & Taylor
Environmental & Engineering Consultants
Hamilton
www.tonkin.co.nz

DRAWN	MCI	Apr.08
DRAFTING CHECKED		
APPROVED		
ARCFILE	Figure3.mxd	
SCALE (AT A3 SIZE)	1:6,000	
PROJECT No.	51253	

CHRISTCHURCH CITY COUNCIL
Akaroa Settlements Study
Preliminary Assessment of Historical Flooding
Mapped Flood Events Tikao

FIG. No. Figure 3. REV. 0

C:\Program Files\ArcGIS\Bin\Templates\TONTAY\A3FP-MBV-MG.mxt: Wednesday, April 18, 2006 5:17:07 p.m.



Notes: Vector Road data sourced from LINZ.
Vector Contour data sourced from CCC.
Mapped flood extents are digitised from maps in Peninsula Projects report "Historical Flooding Research and Mapping Project", 8 February 2008.

0 100 200 Meters

Tonkin & Taylor
Environmental & Engineering Consultants
Hamilton
www.tonkin.co.nz

DRAWN	MCI	Apr.08
DRAFTING CHECKED		
APPROVED		
ARCFILE	Figure4.mxd	
SCALE (AT A3 SIZE)	1:6,000	
PROJECT No.	51253	

CHRISTCHURCH CITY COUNCIL

Akaroa Settlements Study

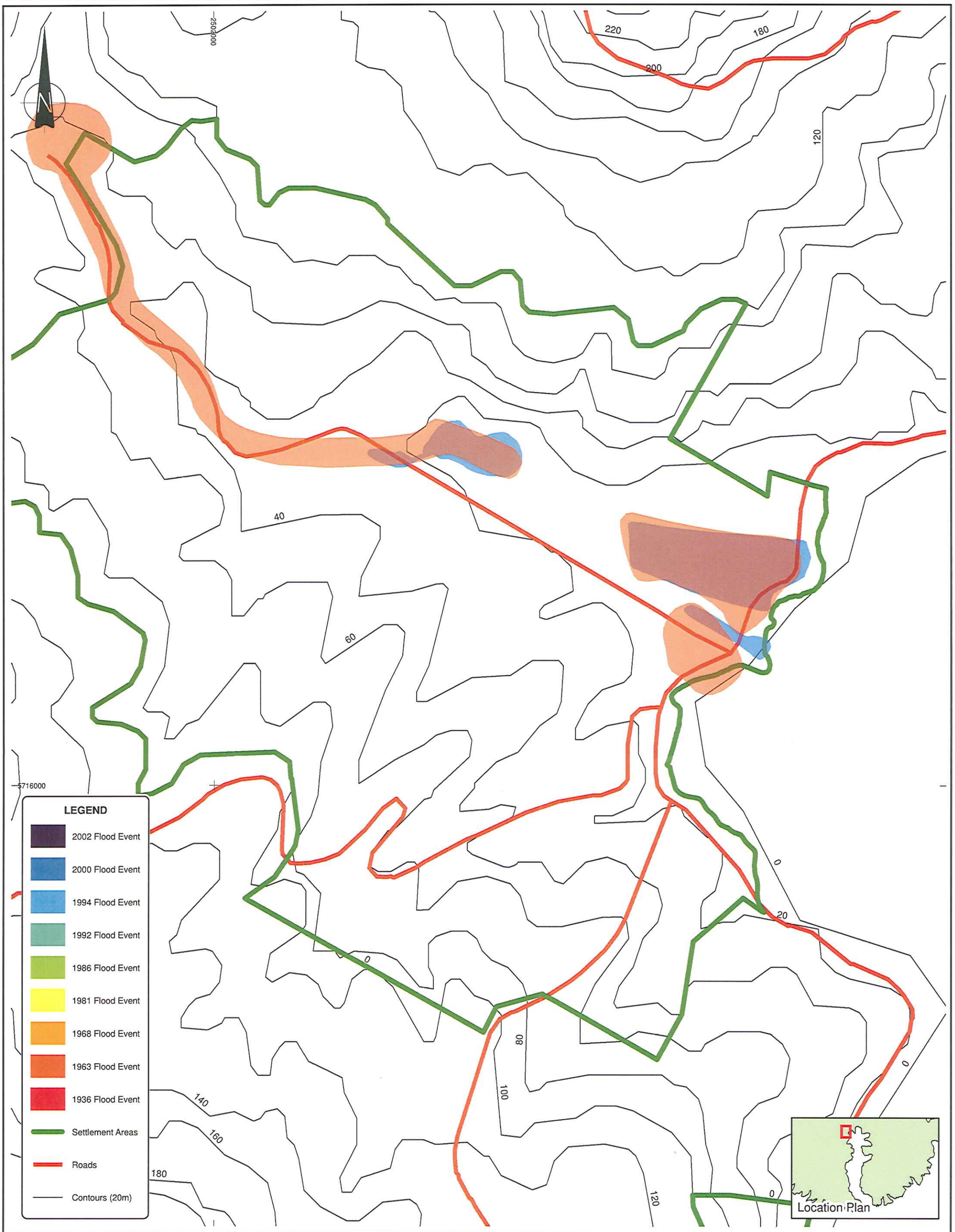
Preliminary Assessment of Historical Flooding

Mapped Flood Events French Farm

FIG. No. Figure 4.

REV. 0

C:\Program Files\ArcGIS\Bin\Templates\TONTAY\A3FP-MBV-MG.mxt: Wednesday, April 18, 2006 5:17:07 p.m.



Notes: Vector Road data sourced from LINZ.
Vector Contour data sourced from CCC.
Mapped flood extents are digitised from maps in Peninsula Projects report "Historical Flooding Research and Mapping Project", 8 February 2008.

0 100 200 Meters

Tonkin & Taylor
Environmental & Engineering Consultants
Hamilton
www.tonkin.co.nz

DRAWN	MCI	Apr.08
DRAFTING CHECKED		
APPROVED		
ARCFILE	Figure5.mxd	
SCALE (AT A3 SIZE)	1:6,000	
PROJECT No.	51253	

CHRISTCHURCH CITY COUNCIL

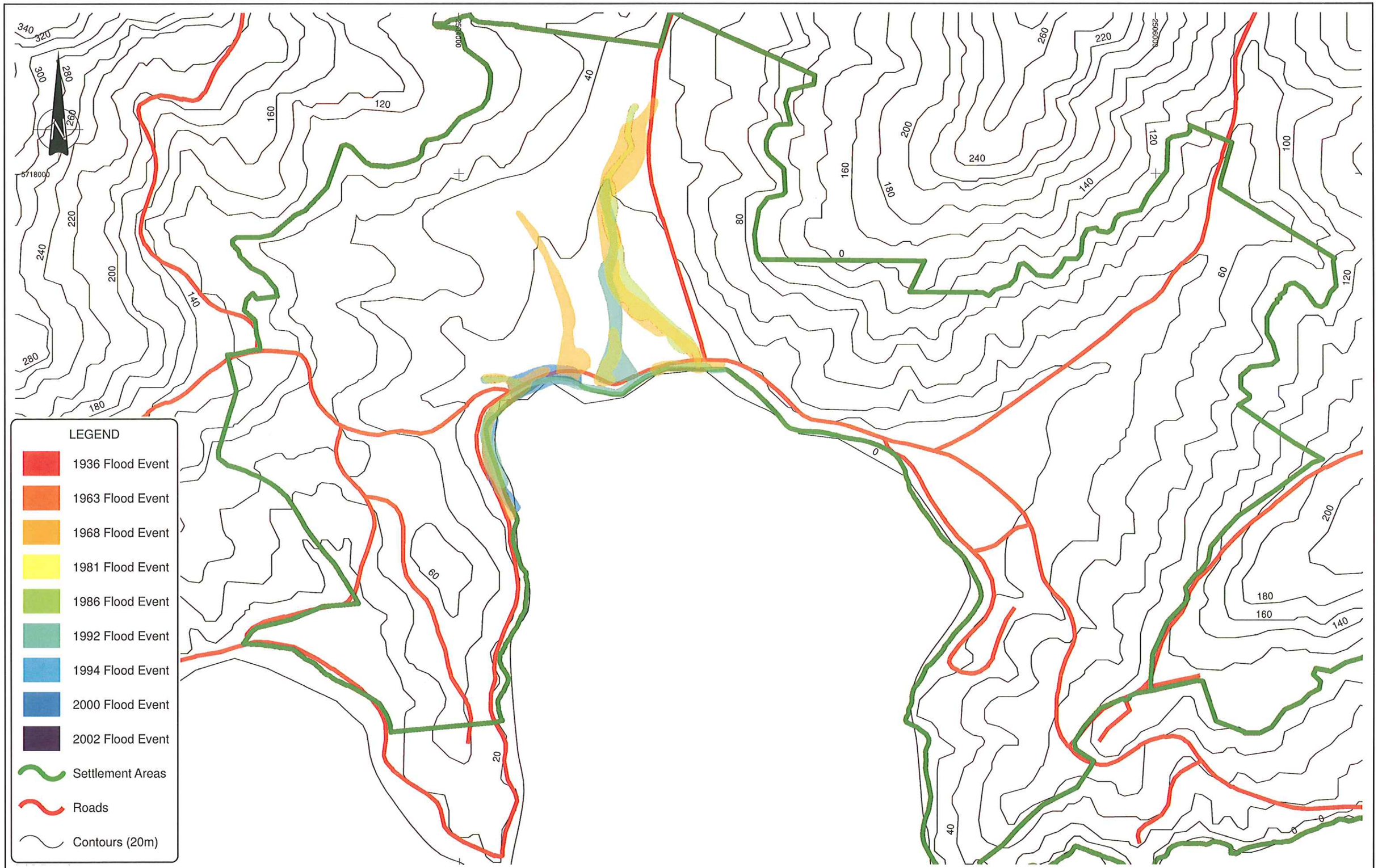
Akaroa Settlements Study

Preliminary Assessment of Historical Flooding

Mapped Flood Events Barry's Bay

FIG. No. Figure 5.

REV. 0



A3 SCALE 1:10,000

0 100 200 Meters

Notes: Vector Road data sourced from LINZ.
Vector Contour data sourced from CCC.
Mapped flood extents are digitised from maps in Peninsula Projects report "Historical Flooding Research and Mapping Project", 8 February 2008.

Location Plan

Tonkin & Taylor
Environmental & Engineering Consultants
Hamilton
www.tonkin.co.nz

DRAWN	MCI	Apr.08
DRAFTING CHECKED		
APPROVED		
ARCFILE	Figure6.mxd	
SCALE (AT A3 SIZE))	1:10,000	
PROJECT No.	51253	

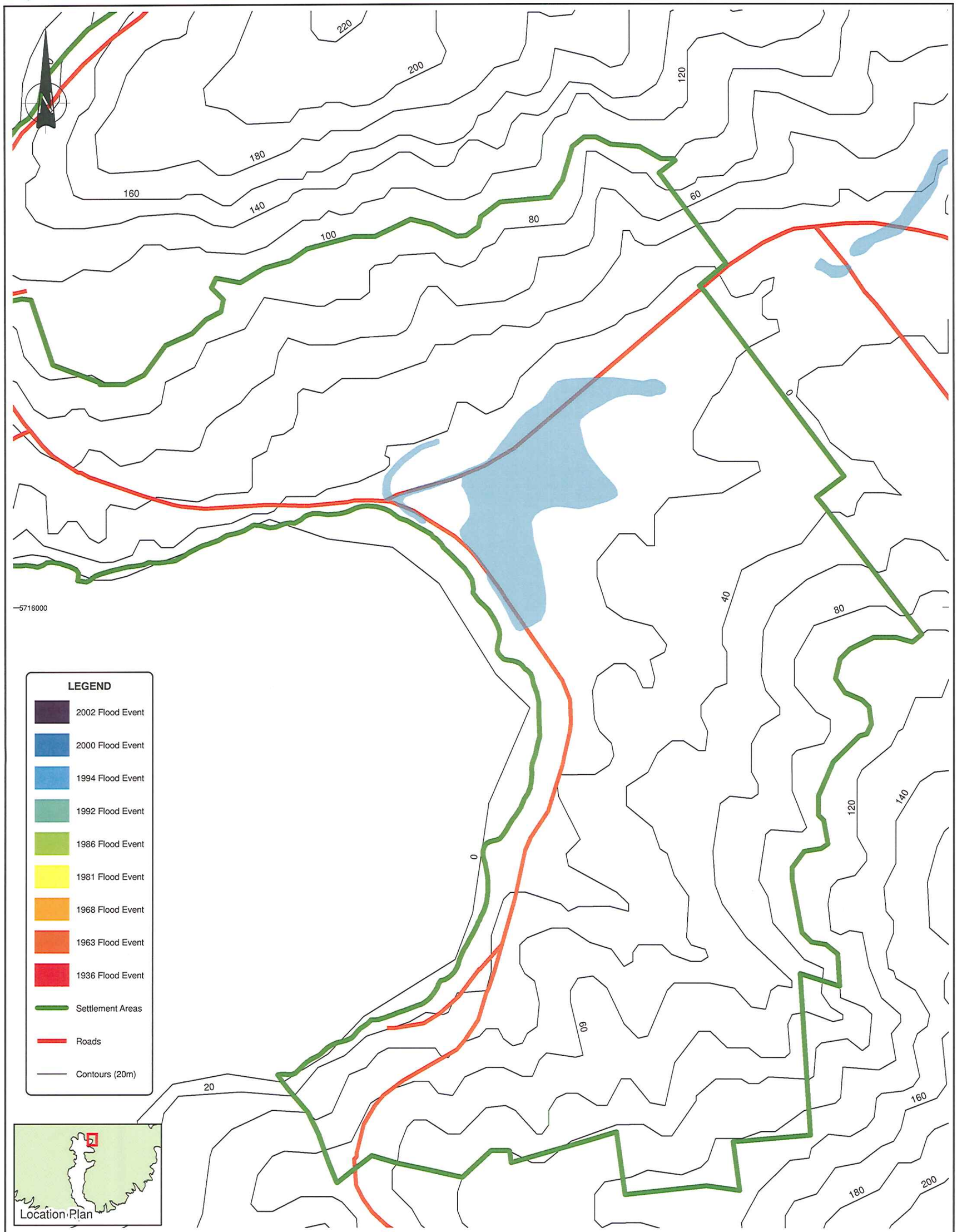
CHRISTCHURCH CITY COUNCIL

Akaroa Settlement Study
Preliminary Assessment for Historical Flooding
Mapped Flood Events Duvauchelle

FIG. No. Figure 6. REV. 0

L:\T_T-SUPPORT\ARCVIEW9\TONKIN & TAYLOR\A3FL-HAM-MG.mxt: Sunday, April 8, 2006 3:02:06 p.m.

C:\Program Files\ArcGIS\Bin\Templates\TONTAY\A3FP-MBV-MG.mxt: Wednesday, April 18, 2006 5:17:07 p.m.



Notes: Vector Road data sourced from LINZ.
Vector Contour data sourced from CCC.
Mapped flood extents are digitised from maps in Peninsula Projects report "Historical Flooding Research and Mapping Project", 8 February 2008.

0 100 200 Meters

Tonkin & Taylor
Environmental & Engineering Consultants
Hamilton
www.tonkin.co.nz

DRAWN	MCI	Apr.08
DRAFTING CHECKED		
APPROVED		
ARCFILE	Figure7.mxd	
SCALE (AT A3 SIZE)	1:6,000	
PROJECT No.	51253	

CHRISTCHURCH CITY COUNCIL

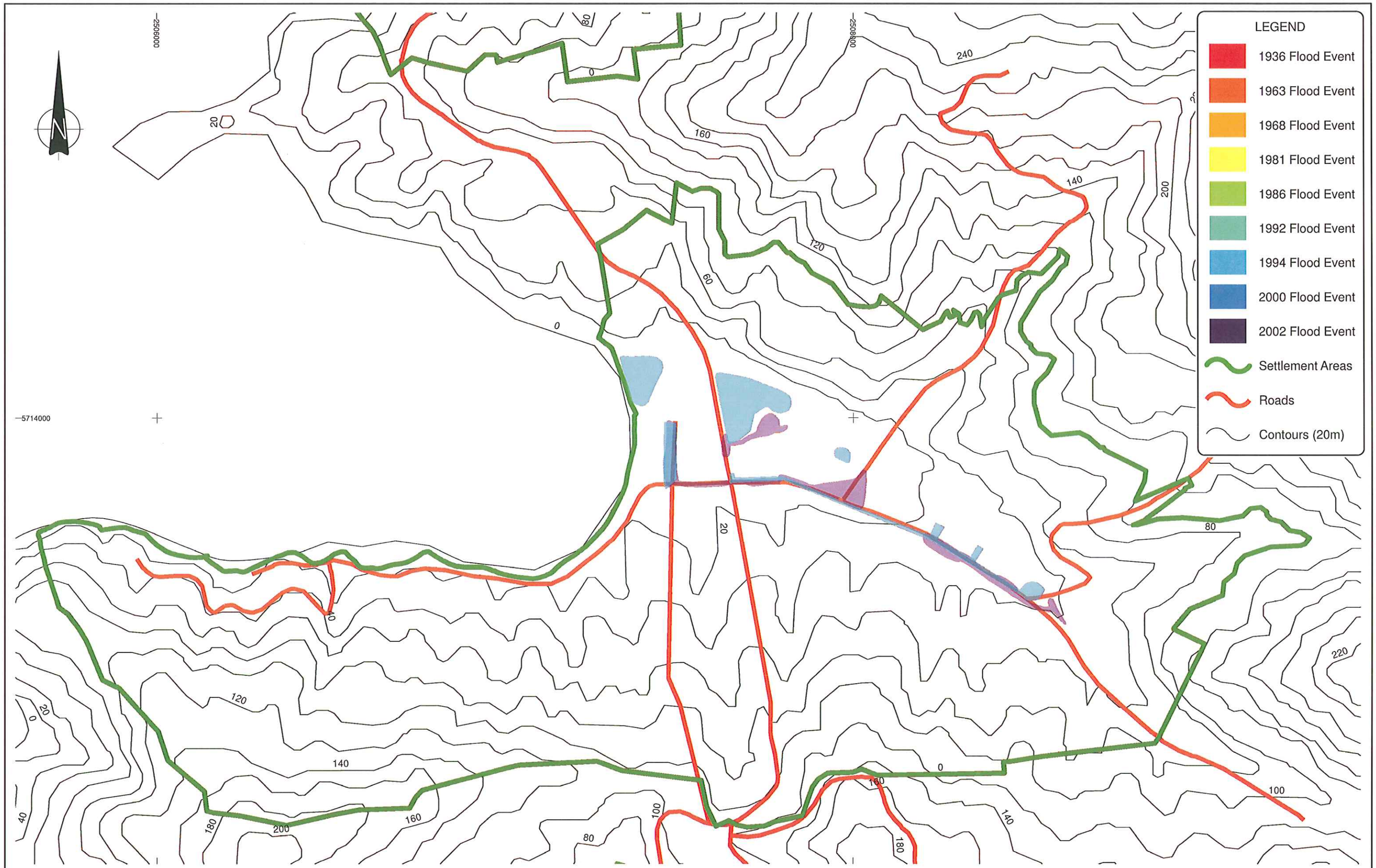
Akaroa Settlements Study

Preliminary Assessment of Historical Flooding

Mapped Flood Events Robinson's Bay

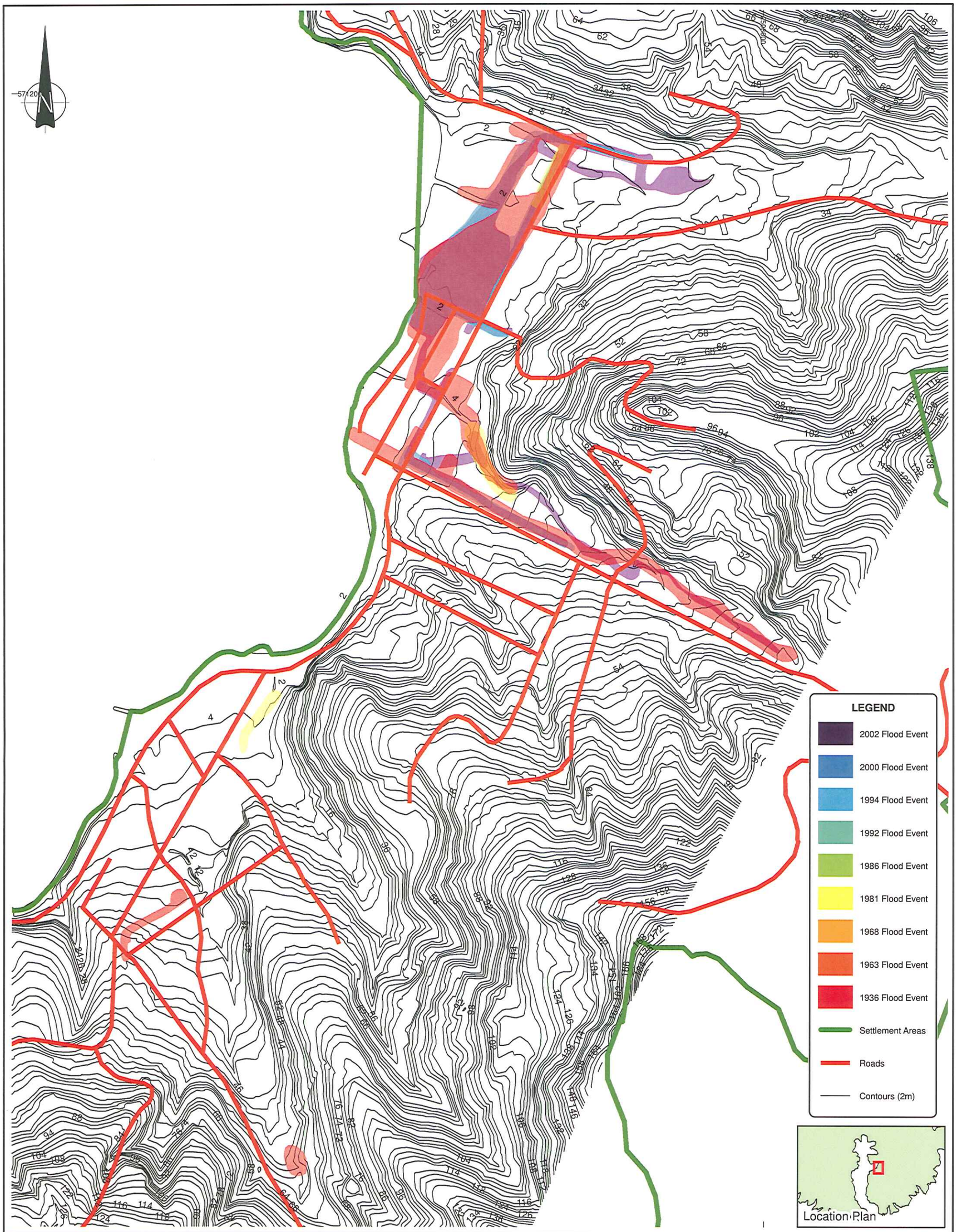
FIG. No. Figure 7.

REV. 0



L:\T_T-SUPPORT\ARCVIEW9\TONKIN & TAYLOR\A3FL-HAM-MG.mxt: Sunday, April 6, 2006 3:02:06 p.m.

C:\Program Files\ArcGIS\Bin\Templates\TONTAY\A3FP-MBV-MG.mxt: Wednesday, April 18, 2006 5:17:07 p.m.



Notes: Vector Road data sourced from LINZ.
Vector Contour data sourced from CCC.
Mapped flood extents are digitised from maps in Peninsula Projects report "Historical Flooding Research and Mapping Project", 8 February 2008.

0 100 200 Meters

Tonkin & Taylor
Environmental & Engineering Consultants
Hamilton
www.tonkin.co.nz

DRAWN	MCI	Apr.08
DRAFTING CHECKED		
APPROVED		
ARCFILE	Figure9.mxd	
SCALE (AT A3 SIZE)	1:6,000	
PROJECT No.	51253	

CHRISTCHURCH CITY COUNCIL

Akaroa Settlements Study

Preliminary Assessment of Historical Flooding

Mapped Flood Events Akaroa

FIG. No. Figure 9. REV. 0