



King River Rural Floodplain Study Study report and floodplain management plan



Report No. J066/R02 Final 1 September 2004

WATER TECHNOLOGY

Specialist Water and Coastal Engineers







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Front cover photo: King River at the Snow Road Bridge during the October 1993 flood event

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EXECUTIVE SUMMARY

Overview

This report summarises the investigations undertaken as part of the King River Rural Floodplain Study. The study was commissioned by the North East Catchment Management Authority (North East CMA) in association with the Rural City of Wangaratta (RCoW).

The study area encompasses the floodplains of the King River from Lake William Hovell to 200 metres upstream of the One Mile Creek Diversion Channel adjacent to the Hume Freeway, and the downstream 2 kilometres of all tributaries of the King River tributaries. These tributaries include but limited to: Hurdle Creek, Meadow Creek, Black Range Creek and Boggy Creek.

Flooding along the King River occurs regularly on a seasonal basis. Minor flooding results in minor disruption and inconvenience. Significant flooding events as in 1917, 1974, 1993, and 1998 have resulted in extensive property, agricultural and infrastructure damages.

The investigations lead to the development of a floodplain management plan for the King River.

Study objectives and scope

The study objectives are summarised as follows:

- To quantify the nature of flooding (frequency, depth, extent) and to assess the existing flood risk to the study area within a risk management framework in accordance with AS/NZ code.
- To establish and maintain effective two-way communications between stakeholders, including the general public, of the existing flood risk and possible risk treatment options.
- To develop a comprehensive floodplain management plan based on knowledge of existing flooding and extensive consultation with the community.

The study included the preparation of flood planning maps that will be utilised by the relevant agencies for appropriate land use planning. The planning maps will provide a basis for appropriate flood controls in the RCoW planning scheme.

The study has been carried out "in accordance with existing floodplain management policies and guidelines" as required by the study brief.

The key study tasks were as follows:

- Collation and review of available flood information
- Review of existing floodplain works
- Review of flood planning maps and planning scheme amendments
- Development of a dwelling inventory
- Assessment of flood damages
- Identification and description of flood mitigation measures
- Identification of stock evacuation options and stock loss reduction strategies
- Development of a floodplain management plan

• Reporting of study methodology and findings.

Community consultation

To provide regular input to the study from the community, a three stage community process has been undertaken. The aims of the three stages were as follows:

- First stage community consultation:- to raise awareness of the study and identify community concerns
- Second stage community consultation:- to seek community feedback/input regarding the impacts of existing works, existing flood planning maps and possible mitigation measures
- Third stage community consultation:- to seek community feedback/input on the draft floodplain management plan.

Flood mapping

Revisions to current flood related planning overlays have been undertaken during this study. The proposed revisions have been based on further examination of the available flood information and community consultation. In particular, several large islands were identified through community consultation and included in the floodway overlay (FO) and land subject to inundation overlay (LSIO) delineation. These proposed revisions to the overlays are recommended for adoption by RCoW and insertion into the planning scheme.

Flood damages assessment

A preliminary flood damages assessment for the study area has been undertaken. This preliminary assessment was carried out using the Rapid Assessment Method (RAM) developed by DNRE. Key results were as follows:

- Estimated flood damages for a 100 year ARI flood event: \$4.9 million
- Average annual damages: ~ \$600,000

The RAM analysis employed by this study was developed to provide comparative flood damages estimates at a regional scale. RAM is by nature a broad scale approach to the estimation for flood damages. RAM is based a number of assumptions and approximations. Flood damages estimated by RAM should be treated with considerable caution and more robust techniques should be applied to refine flood damage estimates.

Floodplain Management Plan

The King River Rural Floodplain Management Plan consists of the following elements:

- Recommended structural works
- Recommended non-structural works (e.g. flood warning arrangements flood response plan)
- Land use delineations (planning zones and overlays)
- Specific land use planning requirements (Local floodplain development plan)

The Floodplain Management Plan has been developed in consultation with the study's reference committee and the broader community. The plan focuses on the reduction of future flood damages. The plan provides for the construction and operation of structural mitigation measures where deemed appropriate. Also the plan acknowledges the roles and responsibilities of various agencies (RCoW, Police and VicSES) in flood emergency response

and seeks to minimise danger to the various agencies personnel through appropriate land use and development.

The Floodplain Management Plan draws on the floodplain management plan developed for the Ovens floodplain between Whorouly and Wangaratta (Lower Ovens River Floodplain) (GHD 2003). The Floodplain Management Plan is similar in format and content to the Lower Ovens Floodplain Management Plan, with appropriate changes to reflect local conditions. This consistency between the plans enables a transparent approach to be applied by the North East CMA and RCoW in managing and assessing development for the King and Lower Ovens Rivers.

The Local Floodplain Development Plan is recommended for insertion into the Rural City of Wangaratta Planning scheme. The Local Floodplain Development Plan provides the North East CMA and RCoW with development requirements to manage existing and future development on the King River rural floodplain. The development requirements are framed to embody the key principles underlying the Best Practice Principles for Floodplain Management in Australia (CSIRO 2000) and Victoria Flood Management Strategy (DNRE 1998). The following requirements are considered by the study team to be fair and reasonable, and strike a balance between flood risk and development.

Study recommendations

Levees and earthworks (Section 5.2.2)

The study team makes the following recommendations with regard to future analysis and/or development controls for the existing levees and significant earthworks:

- In conjunction with landholders, the North East CMA to determine the ownership of existing levees as detailed in the North East CMA Levee Inventory (LICS 2001)
- In conjunction with landholders, the North East CMA to identify existing levees not documented in the North East CMA Levee Inventory (LICS 2001) and where considered appropriate update the levee inventory
- Maintenance of the levees, identified in the North East CMA Levee Inventory (LICS 2001) and in any subsequent revisions to the levee inventory, be permitted to maintain the current status quo.

Roads and road crossings (Section 5.3.2)

The study team makes the following recommendations with regard to future analysis and/or development controls for roads and road crossings:

- Relevant road constructing authority (VicRoads and RCoW) seek to minimise the impact of future road crossings on flooding behaviour including flood levels and flow velocities. This should be undertaken in accordance with the design principles outlined in VicRoads Design Guidelines and Waterway Design Guide (AustRoads 2000)
- Relevant road constructing authority (VicRoads and RCoW) seek to refine existing road crossings, where practicable, to minimise impact on flooding behaviour particularly when undertaking significant repairs and upgrades
- RCoW continues to seek the opinion of the North East CMA regarding the flooding impact performance criteria for road crossings being considered by the road constructing authority.

Revised flood mapping for land use planning (Section 6.4)

Revision of the current flood related planning overlays has been undertaken during this study. The proposed revisions were based on further examination of the available flood information and community consultation. In particular, several large islands were identified through community consultation and included in the FO and LSIO delineation. These proposed revisions to the overlays are recommended for adoption by RCoW and insertion into the planning scheme.

Waterway management activities (Section 8.2.5)

This study recommends the Willow Management Strategy (North East CMA 2003) be implemented, with community consultation, for the King River.

Flood awareness, preparedness, warning and response (Section 8.3.2)

This study recommends the continuation of the maintenance of the Ovens and King River flood warning system. This includes maintaining the physical infrastructure and the continuing flood awareness campaigns within the study area. The study team recommends the RCoW in conjunction with the North East CMA revise and condense the previous issued flood response guidelines into a single handout. The revised handout should outline the key flood information and appropriate landholder flood response. The revised handout should be distributed to landholders within the study area at regular intervals to refresh the community flood awareness and preparedness.

Stock loss management (Section 8.2.7)

This study recommends the use of raised stock pads as a measure to manage stock loss. This recommendation is in line with the Lower Ovens floodplain management plan (GHD 2003). The construction and operation of stock pads must be in accordance with the floodplain management plan outlined in Section 10.

Land use planning (Section 8.3.3)

This study recommends the King River Rural Floodplain Management Plan, as outlined in Section 10, be implemented for the study area.

Implementation of the plan (Section 10.7)

This study recommends that the following actions be undertaken to enable the implementation of the plan:

- Revise the format of the local floodplain development plan for insertion into the RCoW planning scheme
- Adopt and insert the local floodplain development plan into the RCoW planning scheme
- Revise the format of the flood related planning overlays for insertion into the RCoW planning scheme
- Adopt and insert the flood related planning overlays into the RCoW planning scheme
- Revise and condense the previous issued flood response guidelines into a single handout. The revised handout should be distributed to landholders at regular intervals
- Develop and document a process for the review of the floodplain management plan and flood related planning overlays
- Develop a series of guidelines outlining the required format and scope of a planning permit application e.g. content of planning permit application for levee maintenance

ACKNOWLEDGEMENTS

Numerous organisations and individuals have contributed both time and valuable information to the King River Rural floodplain Study. The study team acknowledges the contributions made by these groups and individuals, in particular:

- The study's reference committee consisting of:
 - Lindsay Jarvis, North East CMA Board (Chair)
 - Roel von't Steen, North East CMA Floodplain Manager (secretary and project manager)
 - Malcolm Styles, Rural City of Wangaratta General Manager Infrastructure/ Deputy CEO
 - Ian Gauntlett, Floodplain Management Department of Sustainability and Environment
 - Anthony Griffiths, Rural City of Wangaratta Councillor (former)
 - Neville Wright, Rural City of Wangaratta Councillor
 - Frank Griffiths, North East CMA Implementation committee
 - Robert Cook, King Valley resident & Victorian Federated Farmers
 - Gavin Kelly, VicSES
 - David Heathcote, King Valley resident
 - Chris Arnold, King Valley resident
- The staff of the Rural City of Wangaratta not mentioned above, in particular Neil Ottaway.

The study team also wishes to thank all members of the community who attended the information sessions, contributed flooding information, returned questionnaires and discussed their experiences with the study team.

This study is jointly funded by the Federal, State and Local governments under the Natural Disaster Risk Management Studies Program.

GLOSSARY

Annual Exceedance Probability (AEP)	Refers to the probability or risk of a flood of a given size occurring or being exceeded in any given year. A 90% AEP flood has a high probability of occurring or being exceeded; it would occur quite often and would be relatively small. A 1%AEP flood has a low probability of occurrence or being exceeded; it would be fairly rare but it would be relatively large.
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level. Introduced in 1971 to eventually supersede all earlier datums.
Average Recurrence Interval (ARI) Cadastre, cadastral base	Refers to the average time interval between a given flood magnitude occurring or being exceeded. A 10 year ARI flood is expected to be exceeded on average once every 10 years. A 100 year ARI flood is expected to be exceeded on average once every 100 years. Information in map or digital form showing the extent and usage of land, including structs lat boundaries water every attact.
Catchment	The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main
Design flood	stream. A significant event to be considered in the design process; various works within the floodplain may have different design events. e.g. some roads may be designed to be overtopped in the 1 in 1 year or 100%AEP flood event.
Discharge	The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is moving.
Flash flooding	Flooding which is sudden and often unexpected because it is caused by sudden local heavy rainfall or rainfall in another area. Often defined as flooding which occurs within 6 hours of the rain which causes it.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
Flood frequency analysis	A statistical analysis of observed flood magnitudes to determine the probability of a given flood magnitude.
Floodplain	the flood depth and velocity. Area of land which is subject to inundation by floods up to the probable maximum flood event, i.e. flood prone land.
Flood storages	Those parts of the floodplain that are important for the temporary storage, of floodwaters during the passage of a flood.
Geographical information systems (GIS)	A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data.
Hydraulics	The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.
Hydrograph	A graph that shows how the discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.

Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of the principal watercourses in a catchment. Mainstream flooding generally excludes watercourses constructed with
Management plan	pipes or artificial channels considered as stormwater channels. A document including, as appropriate, both written and diagrammatic information describing how a particular area of land is to be used and managed to achieve defined objectives. It may also include description and discussion of various issues, special features and values of the area, the specific management measures which are to apply and the means and timing by which the plan will be implemented.
Ortho-photography	Aerial photography which has been adjusted to account for topography. Distance measures on the ortho-photography are true distances on the ground.
Peak flow	The maximum discharge occurring during a flood event.
Probability	A statistical measure of the expected frequency or occurrence of flooding. For a fuller explanation see Average Recurrence Interval.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. For this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.
Stage	Equivalent to 'water level'. Both are measured with reference to a specified datum.
Stage hydrograph	A graph that shows how the water level changes with time. It must be referenced to a particular location and datum.
Topography	A surface which defines the ground level of a chosen area.

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1 INTRODUCTION

This report summarises the investigations undertaken as part of the King River Rural Floodplain Study. These investigations led to the development of the Floodplain Management Plan for the King River.

In 1997 the North East Catchment Authority (North East CMA) became the responsible floodplain management authority for Victoria's North East rivers and streams including the Mitta Mitta, Kiewa and Ovens Catchments. A Regional Floodplain Management Strategy was developed for the region and approved by the Board and the Minister for Environment and Conservation in March 2000. Among other issues the strategy identified and prioritised a number of areas where flood studies were required and floodplain management plans were to be developed. The King River Flood Study and Floodplain Management Plan was identified as having a high priority because of potential flood damages and the damages experienced from the October 1993 and September 1998 floods.

The North East CMA in association with the Rural City of Wangaratta (RCoW) has commissioned the King River Rural Floodplain Study. The study area encompasses the floodplains of the King River from Lake William Hovell to the Hume Freeway, and the downstream 2 kilometres of all King River tributaries. The study attempts to evaluate the existing flooding risk to the community and develop a floodplain management plan for the study area. The floodplain management plan will provide the North East CMA and RCoW with a basis for the appropriate management of the floodplain within a risk management context. The plan addresses land use planning, flood mitigation measures, flood emergency response, flood warning and, community awareness and preparation.

The study was funded through a grant from the Natural Disaster Risk Management Studies Program with matching contributions from the State Government and the Rural City of Wangaratta.

A reference committee consisting of the North East CMA, RCoW, VicSES personnel, and representatives from the community are advising the study team.

A study team consisting of Water Technology and LICS, was commissioned by the North East CMA to undertake this study. The investigations were carried out in accordance with Federal and State government floodplain management principles.

Throughout this study report, this study makes a number of recommendations regarding future floodplain management measures. These recommendations are highlighted in this report by a surrounding box outline.

The structure of this report is as follows:

- Study background, objective, and scope briefly describes the King River floodplain and its flooding behaviour and presents the study objective and scope (Section 2)
- Previous studies and available related information reviews the previous studies and available flood related information (Section 3).
- Community consultation outlines the community consultation undertaken during this study (Section 4).
- Floodplain and waterway works identifies and reviews the impact of various floodplain and waterway works and recommends future actions regarding the construction and operation of such works (Section 5).

- Floodplain mapping details the delineation of revised flood related planning overlays (Section 6).
- Flood risk and damage assessment outlines the preliminary estimation of flood damages (Section 7).
- Flood mitigation measure identification identifies and reviews the impact of various flood mitigation measures and recommends future actions regarding the implementation of flood mitigation measures (Section 8).
- Floodplain management framework outlines the underlying legislative and policy framework (Section 9).
- Floodplain management plan summarises the key elements of the floodplain management plan developed for the study area (Section 10).
- Recommendations summarises the key recommendations from this study (Section 11).

2 STUDY BACKGROUND, OBJECTIVES AND SCOPE

2.1 Overview

This section summarises the study area features and flooding behaviour. The section then outlines the study scope and objectives. The structure of this section is as follows:

- Study area feature and flooding behaviours provides a brief description of King River floodplain and its flooding behaviour (Section 2.2)
- Study objectives details the study objective as provided in the study brief. (Section 2.3).
- Study scope outlines the study scope and key tasks (Section 2.4).

2.2 Study area features and flooding behaviour

The study area encompasses the floodplains of the King River from Lake William Hovell to 200 metres upstream of the One Mile Creek Diversion Channel adjacent to the Hume Freeway, and the downstream 2 kilometres of all tributaries of the King River tributaries. These tributaries include but limited to: Hurdle Creek, Meadow Creek, Black Range Creek and Boggy Creek.

Figure 2-1 displays the study area for the King River Rural Floodplain Study.

Flooding along the King River occurs regularly on a seasonal basis. Minor flooding results in minor disruption and inconvenience. Significant flooding events as in 1917, 1974, 1993, and 1998 have resulted in extensive property, agricultural and infrastructure damages.

The King River drains some 1200 km^2 with its headwaters in the Great Dividing Range around Mount Stirling. Within the King River catchment are located the small townships of Cheshunt, Whitfield, Moyhu and Oxley. Wangaratta is located at the confluence of the King and Ovens Rivers and as shown in Figure 2-1. Wangaratta is outside the study area and was not considered by this study. Adjacent to the King River floodplain, the rural land use consists of grazing, horticulture and viticulture.

Mean annual rainfall varies greatly across the catchment due to the topography. Around Mount Stirling, the mean annual rainfall is approximately 1700 mm and decreases to approximately 640 mm in Wangaratta.

Lake William Hovell is located in the upper King River catchment. Lake William Hovell is operated by Goulburn Murray Water (GMW) and provides irrigation and domestic water supplies for the King Valley. From Lake William Hovell for about 5 km downstream, the King River is confined to a narrow steeped sided valley with no floodplain. The longitudinal floodplain slope is relatively steep and accordingly the flow velocities during flood events are high. In the main waterways, velocities in excess of 1.5 m/s may occur with lower velocities in the floodplain. (The above velocities are indicative and determined from a simple analysis of available flood data).

The King River emerges from the narrow valley to develop a narrow floodplain, some 900 m in width. This floodplain extends downstream to Cheshunt. The King River West Branch joins the King River upstream of Cheshunt. The longitudinal floodplain is still relatively steep. However, flow velocities decrease due to the additional floodplain width. The flow velocities in this reach are still relatively high, approximately 1.2 m/s. The bed of the King River in this reach consists of coarse gravel. Due to the high velocities, high sediment loads occur during flood events, with gravel deposits forming on the floodplain. (The above velocities are indicative and determined from a simple analysis of available flood data).

The reach from just upstream of Cheshunt to Edi consists of the King River main channel with several anabranches running parallel to the main channel. The floodplain widens to an average width of around 1500 m. Willow colonisation has reduced the flow capacity of the main King River channel. This reduction in capacity has resulted in more frequent over bank flooding. (North East CMA 2003). Willow colonies have provided mixed results with regard to stream course stabilisation. The Edi cutting, located just south of Edi, restricts the King River floodplain to 500 m in width.

From Edi to just upstream of Moyhu, the King River is similar in character to the reach from to Cheshunt to upstream of the Edi Cutting. The floodplain consists of the main King River channel with several anabranches carrying flood flows.

Adjacent to Moyhu, the significant tributaries of Boggy Creek and Black Range Creek join the King River. Between Moyhu and Oxley other significant tributaries including Hurdle Creek and Meadow Creek, join the King River. The floodplain widens in this reach to some 1700 m. The longitudinal floodplain slope is flatter than the upper reaches and accordingly flow velocities reduce to less than 1 m/s. (The above velocities are indicative and determined from a simple analysis of available flood data).

Downstream of Oxley, the King River floodplain merges with the lower Ovens River floodplain. This combined floodplain consists of numerous anabranches that convey flows during flood events. These anabranches enable transfer of flood flows between the Ovens and King Rivers.

2.3 Study objectives

The study objectives are summarised as follows:

- To quantify the nature of flooding (frequency, depth, extent) and to assess the existing flood risk to the study area within a risk management framework in accordance with AS/NZ code.
- To establish and maintain effective two-way communications between stakeholders, including the general public, of the existing flood risk and possible risk treatment options.
- To develop a comprehensive floodplain management plan based on knowledge of existing flooding and extensive consultation with the community.

The study will include the preparation of flood planning maps that will be utilised by the relevant agencies for appropriate land use planning. The planning maps will provide a basis for the appropriate flood controls in the RCoW planning scheme.

2.4 Study scope

The study is being carried out in accordance with existing floodplain management policies and guidelines. Attention is paid to the following guidelines and policies:

- Best Practice Principles for Floodplain Management in Australia (ARMCANZ 2000),
- Victoria Flood Management Strategy State Flood Policy Committee (DNRE 1998),
- Regional Floodplain and Drainage Strategy (North East CMA 2000)
- Victorian Planning Provisions (DOI 2000)

The key study tasks are as follows:

• Collation and review of available information

- Review of existing floodplain works
- Review of flood planning maps and planning scheme amendments
- Development of a dwelling inventory
- Assessment of flood damages
- Identification and description of flood mitigation measures
- Identification of stock evacuation options and stock loss reduction strategies
- Development of a floodplain management plan
- Reporting of study methodology and findings



Figure 2-1 Study area

3 PREVIOUS STUDIES AND AVAILALE RELATED INFORMATION

3.1 Overview

This section summarises the previous flood related studies and available flood related information for the study area. The structure of this section is as follows:

- Previous studies provides a brief summary of previous flood related studies undertaken for the study area (Section 3.2)
- Available flood related information provides a brief summary of the available flood related information including streamflow data, historical flood data and topographic survey (Section 3.3).

3.2 Previous studies

The previous flood related studies undertaken for the study area include the following:

- 1936 King River Survey series plans (State Rivers and Water Supply Commission): Delineates "edge of high ground" based on field survey and observations. Also documented are spot flood heights for historical events prior to 1936 and flood flow direction arrows and notes relating to flood flow behaviour.
- Documentation and Review of 1993 Victorian Floods Volume 3 (Hydro Technology 1995): A comprehensive review of October 1993 floods for the Ovens and King River catchments. This report summarises the nature and severity of the October 1993 flood within the study area. Estimates of flood damages for the 1993 flood events are provided.
- Floods in North East Victoria of 23 and 25 September 1998 (North East Catchment Management Authority 1999): A brief report documenting the nature and the damages that occurred during the September 1998 flood.
- North East CMA Regional Floodplain Management Strategy and Regional Rural Drainage Management Strategy (February 2000): This strategy outlines the North East CMA board policy directions regarding floodplain and rural drainage management. This current study was identified as a high priority.
- Ovens and King River flood warning project: This project, completed in June 2001, was undertaken to improve flood warning throughout the Ovens River catchment including the study area. Extensive community consultation was undertaken to develop effective mechanisms for the dissemination of flood warnings to the community. As part of the study, a number of telemetered rainfall and river height gauges were installed throughout the Ovens and King River catchments. These gauges enable reliable and timely predictions of river heights and issue of associated flood warnings. The flood warnings will be disseminated via personal contact by authority personnel, radio broadcasts, and fax broadcast. A set of flood response guidelines was distributed throughout the Ovens and King Rivers catchment to flood affected properties.

3.3 Flood related information

3.3.1 Streamflow data and flood frequency analysis

Streamflow data has been recorded throughout the study area, including the following locations:

- King River at Docker Road (Station no. 403223)
- King River at Edi (Station no. 4032240)

- King River at Cheshunt (Station no. 4032240)
- King River downstream Lake William Hovell (Station no. 403228)

DNRE (2000) undertook flood frequency analyses for the streamflow gauges at Docker Road and Cheshunt. Results of the these frequency analyses with various historical flood events are provided in Table 3-1 and Table 3-2.

Table 3-1 Historical flood events and flood frequency analysis for King River at Docker Road

Historical event	Peak flow (ML/d)	Approximate ARI
1993	111 800	111
1998	76 200	40
1974	51 300	15
1975	31 600	7
1970	29 900	6
1996	23 550	4
Flood frequency		
	105 000	100
	82 000	50
	56 000	20
	40 000	10
	26 000	5

Table 3-2 Historical flood events and flood frequency analysis for King River at Cheshunt

Historical event	Peak flow (ML/d)	Approximate ARI	
1998	63 000	83	
1981	34 100	20	
1974	32 600	18	
1993	18 600	7	
1996	17 600	6	
1986	16 400	5	
Flood frequency			
	68 000	100	
	50 000	50	
	34 000	20	
	23 000	10	
	15 000	5	

Comparison of the historical peak flows from Table 3-1 and Table 3-2 shows the 1993 event was larger in the lower King River (downstream of Moyhu) than the 1998 event. The 1993

event has an approximate ARI at Docker Road of 111 years compared with an approximate ARI of 40 years for the 1998 event at Docker Road. However for the upper King River at Cheshunt, the 1998 event was greater then the 1993 peak flow. The 1998 peak flow at Cheshunt has an approximate ARI of 83 year with the 1993 peak flow having an approximate ARI of 7 years at Cheshunt.

The comparison of the 1993 and 1998 events highlights that each flood event is different. The 1993 event consisted of significant inflows from the major tributaries to the lower King River, such as Boggy, Hurdle and Meadow Creeks. This contribution was reflected in the relative flood magnitude at Docker Road and Cheshunt.

3.3.2 Historical flood data

A summary of available flood information for the study area was provided in DNRE (2000). The available flood information includes:

- Aerial flood photography:
 - October 1993 flood Ovens River to upstream of Moyhu
 - May 1974 flood Ovens River to approximately 3 km upstream of Oxley
 - September 1998 flood Lake William Hovell to Moyhu & King and Ovens River from Oxley to Wangaratta North
- Spot height flood level data for the 1917, 1934, 1935, 1974, 1993 and 1998

3.3.3 Topographic data, levee details and aerial ortho photography

The available topographic data, levee details and aerial ortho photography for the study area includes the following:

- North East CMA Levee Inventory (LICS 2001)
- Aerial ortho photography (DNRE 2001)
- Photogrammetric survey of a 16 km section of the King River floodplain extending from Gentle Annie Lane to Cheshunt South.

4 COMMUNITY CONSULTATION

4.1 Overview

This section summarises the community consultation components of the King River Rural Floodplain Study. Both the consultation process employed and the community responses are described.

The structure of this section is as follows:

- Communications strategy details the communications strategy employed for this study (Section 4.2)
- Community consultation approach outlines the broad community consultation process developed for this study (Section 4.3).
- Stage 1 community consultation summarises the activities undertaken and outcomes from Stage 1 consultations (Section 4.4).
- Stage 2 community consultation summarises the activities undertaken and outcomes from Stage 2 consultations (Section 4.5)
- Stage 3 community consultation summarises the activities undertaken and outcomes from Stage 3 consultations (Section 4.6)

4.2 Communications strategy

A key ingredient in the development of a widely accepted and functional floodplain management plan for the King River is the active engagement of the community in the study. The communications strategy adopted by this study was aimed at the community developing a "sense of ownership" of the final floodplain management plan.

In an effort to engender this "sense of ownership" the consultation process was based on relationships with landholders within the study area. These relationships have been developed over the course of the study through several meetings with individuals and/or small groups and on-going communication of study progress. The meetings have been taking place at local venues and/or on the landholders' properties. An approach of meetings with individuals and/or small groups was preferred to larger public meetings, as the landholder was more likely to feel personally involved in the study given the face to face contact with the study team.

4.3 Community consultation approach

To provide regular input to the study from the community, a three stage community process was undertaken. The aims of three stages were as follows:

- First stage community consultation:- to raise awareness of the study and identify community concerns
- Second stage community consultation:- to seek community feedback/input regarding the impacts of existing works, existing flood planning maps and possible mitigation measures
- Third stage community consultation:- to seek community feedback/input to the draft floodplain management plan.

Table 4-1 outlines the three stages of community consultation.

Task and action	Target group	Desired outcome
<i>First phase community consultation</i> Place media release in relevant newspapers. Mailout brochure /questionnaire to community Collate and process questionnaire responses Organise and conduct community information sessions	Community	- Collect flood related information/ concern from
CIS #1 Information sessions Second phase community consultation Place media release in relevant newspapers. Organise and conduct community information sessions CIS #2 second community information sessions	Community	- Collect input on flood maps and possible mitigation measures
Third phase community consultationPlace media release in relevant newspapers.Organise and conduct community information sessionsCIS #3third community information sessions	Community	- Collect input on draft plan and reports

Table 4-1 Outline of proposed community consultation

4.4 Stage 1 community consultation

4.4.1 Overview

As outlined in Section 4.3, the first stage community consultation consisted of the following three elements:

- Media releases and public notices
- Information brochure and questionnaire
- Community information sessions

Sections 4.4.2 to 4.4.4 detail the above three elements with a summary of the key flooding related concerns raised by the community outlined in Section 4.4.5. Appendix A contains a copy of the information brochure and questionnaire.

4.4.2 Media releases and public notices

The study team in conjunction with the North East CMA drafted a media release. The media release was aimed at raising public awareness of the study, and informing the community about the information brochure, questionnaire and community information sessions. The media release was supplied to the Wangaratta Chronicle and was incorporated into an article. A copy of the article is provided in Appendix A.

A public notice outlining the study objective and scope, and the location and timing of the community information sessions was placed in the Wangaratta Chronicle on Monday 17 March and Friday 21 March 2003. Copies of the public notice were provided to the Oxley and Moyhu Post Offices, and the Whitfield General Store for display. A copy of the public notice is provided in Appendix A

4.4.3 Information brochure and questionnaire

In consultation with the North East CMA, the study team developed an information brochure and questionnaire. The purpose of the information brochure and questionnaire was two fold:

- Raise awareness of the study's objectives and scope within the community
- Provide an opportunity for the community to express their knowledge of past flooding and present flood related concerns.

The information brochure was a double-sided colour A4 page folded into thirds. The brochure outlined the objectives and scope of the study, and identified opportunities for the community to be involved in the study. Photographs included in the brochure showing the flooding during October 1993 were obtained from RCoW. A copy of the brochure is provided in Appendix A.

The questionnaire consisted of a doubled sided A4 page containing seven questions. The questions were aimed at seeking local community flood knowledge and their present flood related concerns. A plan showing the study area was attached to the questionnaire. The intent of the plan was for the respondent to mark the approximate location of their property.

The information brochure and questionnaire were bundled in A4 envelopes and delivered to approximately 120 residences located within the study area. Australia Post undertook the delivery.

A total of 27 questionnaire responses were received. This represents approximately a 20 % response rate. This is considered a good response rate given the lack of flooding in recent years and the threat of bushfires at the time of the questionnaire. Responses were received from throughout the study area.

A summary of the community responses to the questionnaire is provided in Section 4.4.5.

4.4.4 Community information sessions

Three community information sessions were held as follows:

- Oxley Hall Snow Road Tuesday 25 March 2003,10 am 1pm
- Whitfield RSL Hall Wangaratta –Whitfield Road Wednesday 26 March 2003, 10 am 1 pm
- Moyhu Hall Supper Room Moyhu-Glenrowan Road Wednesday 26 March 2003, 6 pm – 9pm

The sessions were conducted in an informal manner with no structured presentations. Various historical aerial photo flood mosaics (October 1993 & September 1998) and the current flood planning maps (Department of Natural Resources and Environment 2000) were displayed.

A number of discussions were conducted with small groups of residents by the study team and the North East CMA during the course of three information sessions.

A total of 13 residents attended the three community information sessions. The attendance was evenly spread between the three sessions.

4.4.5 Summary of questionnaire responses and concerns

Table 4-2 outlines the various aspects of flooding and the community concerns as raised by responses to the questionnaire and/or at the community information sessions.

Flooding aspect	Concerns
Frequency of flooding and	Land flooded regularly
damages (Questionnaire questions No. 1 and 2)	• Residences flood occasionally (5 responses)
	• Main damages – fences, stock loss, erosion and deposition
Nature of flooding	Rapid rise of flood waters
(Questionnaire questions No. 3 and 4)	• Differences between behaviour of 1993 and 1998 floods
	• Changes over time in the flood behaviour
	• More rapid rise today than in the past
Flood warning (Questionnaire question No. 5)	• Main sources – family and friends, radio, TV & experience
	• One response specifically referred to flood warning fridge magnet
	• Several residents indicated that they had not received the flood warning booklets
Main concerns (Questionnaire	Stock evacuation – evacuation routes
No. 6)	• Waterway management – Erosion, deposition and willows and debris
	• Fences – flood damage
	• Flood warnings – inadequate warning for upper catchment
General concerns raised at community sessions	• Snow Road bridges – capacity of bridge waterways and associated increase in upstream flood levels
	• Flood warnings – problems with communication of warnings e.g. electric fence interference with fax
	• Confusion with CMA and other agencies roles

Table 4-2	Summary	of	community	responses

4.5 Stage 2 community consultation

4.5.1 Overview

As outlined in Section 4.3, the second stage community consultation consisted of the following three elements:

- Public notices
- Community information sessions
- Wangaratta Chronicle article

Sections 4.5.2 to 4.5.4 detail the above three elements.

4.5.2 Public notices

A public notice outlining the study objective and scope, and the location and timing of the community information sessions was placed in the Wangaratta Chronicle in mid July 2003. Copies of the public notice were provided to the Oxley and Moyhu Post Offices, and the Whitfield General Store for display. A copy of the public notice is provided in Appendix A.

4.5.3 Community information sessions

Three community information sessions were held as follows:

- Oxley Hall Snow Road Tuesday 22 July 2003, 10 am 1pm
- Whitfield RSL Hall Wangaratta –Whitfield Road Tuesday 22 July 2003, 2 pm 4pm
- Moyhu Hall Supper Room Moyhu-Glenrowan Road Tuesday 22 July 2003, 6 pm 8pm

The sessions were conducted in an informal manner with no structured presentations. The main focus of the community information sessions was to obtain community feedback and input into the revised flood planning maps. To aid in feedback concerning the revised flood planning maps various historical aerial photo flood mosaics (October 1993 & September 1998) were displayed.

A number of discussions were conducted with small groups of residents by the study team and the North East CMA during the course of three information sessions. Numerous comments were obtained regarding the revised flood planning maps. These comments were incorporated into further refinements of the flood planning maps. Section 6 provides details of the revised flood planning maps.

A total of 13 residents attended the three community information sessions. The attendance was evenly spread between the three sessions and similar to the first stage community information sessions. Of the 13 attendants at the second stage sessions about 6 to 7 had attended the first stage sessions.

4.5.4 Wangaratta Chronicle article

During the course of the Oxley information session, the study team and the North East CMA floodplain manager, Roel von't Steen undertook a short interview with the Wangaratta Chronicle. The study aims, scope and process was discussed during this interview. The subsequent article was published on 25 July 2003. A copy of the article is provided in Appendix A.

4.6 Stage 3 community consultation

4.6.1 Overview

The aim of the third stage was to obtain community feedback on the draft study report and floodplain management plan. The third stage community consultation consisted of the following items:

- Public notices: advertising the availability of the draft study report and floodplain management plan, and the community information sessions.
- Community information sessions: Informal sessions to gain community feedback.

Sections 4.6.2 and 4.6.3 detail the above two elements.

4.6.2 Public notices

A public notice outlining the study objective and scope, and the location and timing of the community information sessions was placed in the Wangaratta Chronicle in mid July 2004.

Copies of the public notice were provided to the Oxley and Moyhu Post Offices, and the Whitfield General Store for display. A copy of the public notice is provided in Appendix A.

4.6.3 Community information sessions

Two community information sessions were held as follows:

- Oxley Hall Snow Road Tuesday 3 August 2004, 10 am 12 pm
- Moyhu Hall Supper Room Moyhu-Glenrowan Road Tuesday 3 August 2004, 5 pm 7pm

The sessions were conducted in an informal manner with no structured presentations. The main focus of the community information sessions was to obtain community feedback and input into the revised flood planning maps and the draft floodplain management plan. A number of discussions were conducted with small groups of residents by the study team and the North East CMA during the course of two information sessions. Numerous comments were obtained regarding the revised flood planning maps. These comments were incorporated into further refinements of the flood planning maps and floodplain management plan. Section 6 provides details of the revised flood planning maps with Section 10 providing detail of the floodplain management plan.

A total of about 20 residents attended the two community information sessions.

5 EXISTING FLOODPLAIN AND WATERWAY WORKS REVIEW

5.1 Overview

This section summarises the review of the impact of flooding behaviour arising from existing floodplain works including levees, significant earthworks, roads and road crossings (bridges and culverts). Also this section provides recommendations for the future analysis and/or development controls for existing and planned floodplain works. The structure of this report is as follows:

- Levees and earthworks provides an assessment of existing levee and earthworks impacts on flooding behaviour and outlines recommendations for future analysis and/or development controls (Section 5.2)
- Roads and waterway crossings provides an assessment of existing roads and road crossings' impacts on flooding behaviour and outlines recommendations for future analysis and/or development controls (Section 5.3)

5.2 Levees

5.2.1 Overview

Existing levees within the study area were identified using the North East CMA levee inventory (LICS, 2001) and available aerial ortho-photography (DNRE, 2001). The levee inventory detailed the location and extent of existing levees. However, the levee inventory is not definitive and other levees may exist that have not been identified. No topographic survey of the levee crest and no assessment of the levee integrity was undertaken as part of this inventory.

The existing levees and significant earthworks identified include:

- Cheshunt levee adjacent to the King Valley Road
- Oxley levee adjacent to Snow Road crossing
- King River levees downstream of Oxley
- Laceby Park levee upstream of Hume Freeway crossing.

A series of plans in Appendix B display the locations and extent of the above levees.

A formal review of the impacts of the above levees would require hydraulic analyses. Such hydraulic analyses were considered outside the scope of this study. As a result some general comments regarding the impacts have been formed based on available flood information and community consultation.

The first three of the above levees were considered to have limited impact on the local flooding behaviour. This limited impact arises from the height and extent of the levees allowing overtopping for relatively frequent flood events. These levees were also found to be discontinuous and allowed flood waters to inundate areas behind the levees. As such, these levees provide limited protection against frequent flooding. However, this limited protection may have a benefit to the local landholders during frequent flood events.

Further, GHD (2003) provides extensive comments on the nature and influence of the Laceby Park levee on flooding behaviour. The Laceby Park levee consists of a ring levee providing protection to about 50 ha. The levee was constructed after the May 1974 flood event. The levee provides limited protection, and is likely to be overtopped in 5 year ARI flood event (Binnie 1984). In smaller floods (lesser than 5 year ARI), the levee is considered likely to

increase local flood levels in Tea Garden Creek. For larger flood events (greater than 5 year ARI), it is considered the levee has no substantial influence on local flood levels.

All the above levees provide limited protection for frequent flood events with overtopping of the levees occurring during major flood events. These existing levees have been constructed some time ago and have endured a number of minor and major flood events. Their impacts on local flood behaviour have been observed by adjacent landholders. The limited protection afforded by these levees provides the landholders with a benefit during frequent flood events. As the impacts and benefits of the above existing levees are known by the local landholders the study team considers appropriate the maintenance of these levees to the current status quo. Nevertheless, the North East CMA should undertake to establish the benefits or otherwise of the above levees. Further the North East CMA should engage local landholders to resolve the ownership of the above levees.

As the levee inventory is not definitive, the North East CMA should undertake a community consultation process to identify other existing levees and determine their ownership. Following the community consultation, any additional levees identified may be included in an updated levee inventory. Once included in a revised levee inventory, maintenance of these additional existing levees shall be permitted to maintain the status quo.

5.2.2 Recommendations for the future analysis and/or development control regarding existing levees

The study team makes the following recommendations with regard to future analysis and/or development controls for the existing levees and significant earthworks:

- In conjunction with landholders, the North East CMA to determine the ownership of existing levees as detailed in the North East CMA Levee Inventory (LICS 2001)
- In conjunction with landholders, the North East CMA to identify existing levees not documented in the North East CMA Levee Inventory (LICS 2001) and where considered appropriate update the levee inventory
- Maintenance of the levees, identified in the North East CMA Levee Inventory (LICS 2001) and in any subsequent revisions to the levee inventory, be permitted to maintain the current status quo.

The above recommendations are summarised in Section 11.

5.3 Roads and waterway crossings

5.3.1 Overview

The existing significant road crossings of waterways within the study area were identified using the available aerial ortho-photography (DNRE 2001). No topographic survey of the crossing arrangements and no formal assessment of the crossing impacts on the local flood behaviour were undertaken as part of this study.

The significant road crossings identified include:

- King Valley Road at Cheshunt South
- King Valley Road at Cheshunt
- Gentle Annie Lane
- Manlooks Lane
- Fosangs Lane

- Edi Cheshunt Road
- Moyhu Road
- Docker Road
- Snow Road at Oxley
- Hume Freeway just upstream of Wangaratta

Also in a number of locations the roads located on the edge of the King River floodplain, influence the flooding behaviour.

A series of plans in Appendix B display the locations of the above roads and waterway crossings.

A formal review of the impacts of the above road crossings would require hydraulic analyses. Such hydraulic analyses were considered outside the scope of this study. As a result some general comments regarding the impacts have been formed based on available flood information and community consultation.

The above road crossings may influence local flooding behaviour and increase upstream flood levels. This increase in flood levels is due to the constriction of the channel flow capacity and entrapment of debris during flood events. Apart from the Snow Road and Hume Freeway crossings, the above road crossings are overtopped during frequent flood events. The crossing at Snow Road is inundated for large flood events with the Hume Freeway crossing only overtopped during extreme flood events. Additionally the crossings act to concentrate flood flows which may lead to increased local downstream scour.

For the Hume Freeway crossing, anecdotal evidence suggests a localised significant increase in upstream flood levels occurring for the 1993 event (GHD (2003)). The design of the Hume Freeway crossing was undertaken prior to the 1993 event for a 100 year ARI peak flow based on the May 1974 event. The 1993 event at Wangaratta resulted in flood levels significantly higher than the estimated 100 year ARI peak flow based on the frequency analysis including the May 1974 event. As the crossing was designed for a smaller flood event than the 1993 event, the increases in flood levels would be expected to be greater than designed. As the design of the Hume Freeway crossing satisfied industry practice at the time and any improvements are likely to be at significant costs, the study team makes no recommendations specifically related to the Hume Freeway crossing.

5.3.2 Recommendations for future analysis and/or development controls regarding roads and crossings

The study team makes the following recommendations with regard to future analysis and/or development controls for roads and road crossings:

- Relevant road constructing authority (VicRoads and RCoW) seek to minimise the impact of future road crossings on flooding behaviour including flood levels and flow velocities. This should be undertaken in accordance with the design principles outlined in VicRoads Design Guidelines and Waterway Design Guide (AustRoads 2000)
- Relevant road constructing authority (VicRoads and RCoW) seek to refine existing road crossings, where practicable, to minimise impact on flooding behaviour particularly when undertaking significant repairs and upgrades
- RCoW continues to seek the opinion of the North East CMA regarding the flooding impact performance criteria for road crossings being considered by the road constructing authority.

6 FLOODPLAIN MAPPING

6.1 Overview

This section summarises flood related provisions available under the planning scheme and the associated flood mapping for land use planning purposes. The structure of this section is as follows:

- Victorian planning provisions flood related planning zones and overlays provides a brief summary of flood related provisions under the Victorian planning provisions (Section 6.2).
- Flood data transfer project flood related planning overlays outlines the delineation of flood related planning zone and overlays as part of the Flood Data Transfer Project (Section 6.3).
- Revised flood related planning zones and overlays– outlines the delineation of flood related planning zone and overlays as part of this study (Section 6.4).

Victorian Planning Provisions, as they relate to flood management, are discussed further in Section 9.3.3.

6.2 Victorian Planning Provisions - flood related planning zones and overlays

Planning controls and building regulations provide mechanisms for ensuring appropriate use of land and building construction given the physical constraints of flooding from rivers and streams.

As part of ongoing municipal reform, the State Government recently introduced a consistent planning scheme format for application across the State. The Victoria Planning Provisions (VPPs) are being adopted, to incorporate local requirements, by all Victorian municipalities and will help prevent the escalation of future flood problems.

In respect of floodplain management, the VPPs aim to achieve consistency in the application of planning controls for areas subject to flooding throughout the State. The stated objectives are to protect life, property and community infrastructure from flood hazard, and to preserve flood conveyance capacity, floodplain storage and natural areas of environmental significance.

Under the Victoria Planning Provisions (DoI 2000) there is provision for two overlays and one zone associated with mainstream flooding. These are:

- Land Subject to Inundation Overlay (LSIO),
- Floodway Overlay (FO),
- Urban Floodway Zone (UFZ).

Generally the LSIO identifies land in flood storage or areas with low flood hazard which are subject to inundation during a 100 year ARI flood, or some other nominated flood if the 100 year ARI flood has not been determined.

The urban floodway zone and floodway overlay (UFZ and FO) identify main flood paths and flood storage areas and/or flood prone areas having a high hazard. Such areas are usually associated with significant flood depths and/or velocities, frequent flooding, or are important for conveying significant flood flows or storing significant flood volumes. As the name suggests, UFZ is applied in urban areas affected by mainstream flooding with a high flood

hazard. As there is no flood affected urban areas within the study area, UFZ is not considered relevant to this study.

Within the LSIO and FO, development requirements can be applied under the municipal planning scheme. The aim of these development requirements is to reduce future flood related damages to residents and property. The development controls may be applied to:

- Construction of dwellings and extensions
- Construction of non-habitable buildings
- Access to and from dwellings
- Construction and maintenance of levees

Victorian Planning Provisions, as they relate to flood management, are discussed further in Section 9.3.3.

The study team has recommended a number of development requirements for application in the King River rural floodplain. Details of the recommended requirements are provided in Section 10, as part of the King River rural Floodplain Management Plan.

6.3 Flood Data Transfer Project flood related planning overlays

The Flood Data Transfer Project (FDTP) was undertaken for the whole of regional Victoria by DNRE (now DSE). The FDTP aimed to capture, collate, analyse and interpret available flood information. As the FDTP applied a broad scale approach to the identification of flood affected areas, the reliability of the identified areas was dependent on the available flood information. Where available, flood affected areas were determined through rigorous hydrologic and hydraulic analyses. However, in many areas such as the King River, no rigorous analysis had been undertaken and the flood affected areas were identified using flood aerial photography and flood level marks.

As part of the FDTP, flood planning maps were developed for the study area based on the identified flood affected areas. Both LSIO and FO were determined from the flood planning maps and were incorporated into the RCoW planning scheme.

Further the FDTP collated historical flood level information in a series of flood data maps. The flood data maps for the King River provide peak flood levels and flood extents based on available information for major historical flood events.

6.4 Revised flood related planning zones and overlays

This study undertook further examination of the available flood information and community consultation and has recommended revisions of the current flood overlays. In particular, several large islands were identified through community consultation and included in the FO and LSIO delineation. These proposed revisions to the overlays are recommended for adoption by RCoW and insertion into the planning scheme.

Appendix C contains the draft revised flood planning maps as A3 size maps. The draft flood planning maps provided in this report are yet to be adopted by the North East CMA or RCoW. Further revisions may be undertaken prior to their adoption.

6.4.1 Hume Freeway to Moyhu

Between the Hume Freeway and Moyhu, the LSIO has been defined as land inundated by the 1993 flood event. As shown in Table 3-1, the 1993 event at the Docker Road gauge has an approximate ARI in excess of 100 years. The 1993 flood extent was captured by aerial

photography and spot flood heights. Consultation with the local community has provided information enabling refinements to the LSIO extent.

The FO delineation for Moyhu to the Hume Freeway was based on the aerial flood photography for the 1974 and 1993 flood events, and 'edge of high ground' line from the 1936 Survey plans. As shown in Table 3-1, the 1993 event at the Docker Road gauge has approximately ARI in excess of 100 years with the 1974 event having an approximate ARI of 15 years.

Where it could be established that flooding occurs relatively infrequently, (i.e. where there was a significant gap between 1993 flood extent and the 1974 flood extent and/or the 'edge of high ground') these areas were excluded from the floodway zone.

Consultation with the local community has provided information enabling refinements to the LSIO and FO extent.

6.4.2 Moyhu to Lake William Hovell

The FO and LSIO extent was defined using the following information:

- 1936 King River Survey series plans
- September 1998 flood aerial photography.

The aerial photography for the September 1998 flood was flown some 18 hours after the peak. As such the flood extent shown in the photography required further interpretation to delineate the FO/LSIO. The 1936 river survey provided guidance on the "edge of high ground".

Through this reach, the King River is confined to a relatively narrow floodplain. This confinement combined with the relatively steep longitudinal floodplain slope results in higher flow velocities. To reflect these higher velocities and the higher associated flood hazard, the inundated areas adjacent to the main King River channel was delineated as FO with the balance of the inundated area in the 1998 flood event delineated as LSIO.

Consultation with the local community has provided information enabling refinements to the FO and LSIO extent.

7 FLOOD RISK AND DAMAGES ASSESSMENT

7.1 Overview

The flood risk can be expressed as:

Flood risk = flood likelihood multiplied by flood consequences

The flood likelihood can be assessed as the frequency of flooding for a given flood depth and extent. The revised FO and LSIO extents provide an indication of the flood likelihood at any given location. Section 6 provides details of the FO and LSIO extents.

The flood consequences can be assessed as the damages arising from a given flood depth. The flood risk for location can then be determined, with the overall flood risk to the community given as the sum of the flood risks for all locations.

A flood damages assessment has been undertaken for the study area under existing conditions. The flood assessment determined the monetary value of flood damages for design flood events up to the 100 year ARI were considered. The average annual damage (AAD) was also determined.

Damages from flooding can be sub-divided into a number of categories. Figure 7-1 shows the various categories commonly used in flood damage assessments.



Figure 7-1 Categories of flood damage

Tangible flood damages are those to which a monetary value can be assigned and include property damage, business losses and recovery costs. Intangible flood damages are those to which a monetary value cannot be assigned and include anxiety, inconvenience and disruption of social activities. Both are a function of flood magnitude. The flood damages assessment focuses on the tangible flood damages. Intangible damages are important and are considered, but under the broader assessment of existing conditions and flood mitigation options.

Tangible damages can be sub-divided into direct and indirect damages. Direct damages are those financial costs caused by the physical contact of flood waters and include damage to property, roads and infrastructure.

Property damage can be sub-divided into internal and external damage. Internal damage includes damage to carpets, furniture and electrical goods. External damage includes damage to building structures, vehicles, and in rural areas, crops, fencing and machinery.

Indirect damages are those additional financial costs generally incurred after the flood during clean-ups and include the cost of temporary accommodation, loss of wages, loss of production for commercial and industrial establishments and the opportunity loss caused by the closure or limited operation of business and public facilities.

Tangible damages can also be treated as potential or actual damages. Potential damages are the maximum damages that could occur for a given flood event. In determining potential
damages, it is assumed that no actions are taken (whether months or hours) prior to or during the flood to reduce damage by, for example, lifting or shifting items to flood free locations, shifting motor vehicles or sandbagging. Actual damages, in this context, are the expected damages for a given flood event. Their value - a proportion of potential damages - is based on the community's flood preparedness, a function of community awareness and the leadtime of flood warnings.

This section details the input data, methodology and outputs for the flood damage assessment. The structure of the section is as follows:

- Damage assessment methodology outlines the flood damage assessment employed by this study (Section 7.2)
- Damage assessment input data outlines the properties, infrastructure and flood data used in the flood assessment (Section 7.3)
- Flood damage costs details the flood damage cost relationships adopted by this study (Section 7.4)
- Flood damage assessment under existing conditions provides a summary of the flood damages for the existing conditions in the study area (Section 7.5).

7.2 Damage assessment methodology

The Rapid Appraisal Method (RAM) (DNRE, 2000) was applied to determine the flood damages within the study area. RAM provided estimates of the flood damages to property, infrastructure and agriculture. The direct potential damage for each building was determined via a unit damage rate per property inundated. Similarly, the damage for inundated infrastructure (roads, etc) was determined via unit direct damage costs for various road classes (major sealed, unsealed etc). Estimates of flood damage to agriculture were determined using a unit damage cost for various agricultural activities inundated. This unit damage cost was varied throughout the year to reflect the change in the value, and hence potential flood damages, of various agricultural activities through the calendar year. A damage reduction factor (DRF) is applied to reflect the reduction in damages due to flood awareness and warning.

7.3 Flood damage assessment input data

7.3.1 Flood data

The FO and LSIO overlays, as discussed in Section 6.4, were utilised to determine the extent of flood inundation. For the purpose of the present study, the extent of the FO and LSIO were taken as representing the 10 year and 100 year ARI flood extents respectively. This assignment of ARI to the FO and LSIO is in line with the recommendations of the RAM. The FO (10 year ARI) and LSIO (100 year ARI) flood extents were overlain the aerial photography to enable the identification of buildings, infrastructure and agricultural activities inundated by the 10 and 100 year ARI flood events.

7.3.2 Building data

Flooded buildings and sheds were identified using aerial photography of the study area. Buildings and sheds were counted together for two reasons:

- With the resolution of the photographs, it was not possible to determine if a roof belonged to a residential building or a farm shed.
- No allowance is included in the RAM approach for loss of equipment. As the floodplain area is largely rural, it was assumed that the value of residential damage to each shed is

equivalent to the possible loss of farm machinery and tools likely to be contained within a shed.

Appendix D contains a listing of the buildings affected by the 100 year flood event (i.e. buildings lying within the 100 year ARI flood extent).

7.3.3 Infrastructure data

For this study, as detailed in the RAM, damage to infrastructure (including major bridges and culverts) was based on the length of infrastructure inundated. The RAM considers this assumption reasonable as much of the service infrastructure follows the paths of road reserves and the quantity of other infrastructure might be expected to be broadly a function of the length of road.

Roads were subdivided into three categories as used in the RAM – highway, sealed road and unsealed road. Each was determined using the cadastral information supplied by the North East CMA and by inspection of aerial photos.

7.3.4 Agricultural data

The location and nature of various agricultural activities were determined via examination of aerial ortho photography and through community consultation

7.4 Flood damage costs

7.4.1 Direct building damages

The RAM adopted a unit damage cost for building inundated of \$20,500. As the analysis contained in the RAM was undertaken in 2000, this study has revised the unit damage cost in line with CPI. No CPI data is readily available for North East Victoria. In lieu, the CPI for Melbourne was employed. Given the board nature of the RAM and the number of assumptions made in its application, any error introduced by the use of the CPI for Melbourne was considered insignificant.

The CPI for Melbourne for the 2000 period was 124.7 (Base index 1989-1990 = 100.00). The current CPI for Melbourne (March, 2003) is 140.9. The damage unit cost was obtained by multiplying by a factor of 1.13 (140.9/124.7) to account for the change in CPI since the publication of the RAM. Information regarding the CPI was obtained from Australian Bureau of Statistics website (www.abs.gov.au/Ausstats). This study adopted a revised direct building potential unit damage of \$ 23,370 per building inundated.

7.4.2 Indirect property damages

The RAM suggests that "in most cases" indirect property damage be calculated as 30% of the total direct property damage. This study adopted the RAM approach for indirect property damages.

7.4.3 Infrastructure damages

Damage to infrastructure includes roads repairs (including restoration of weakened subgrades), bridge and culvert repairs, telephone and telecommunications facilities, electrical connections, water supply and sewerage infrastructure and resulting higher maintenance costs.

The RAM provides infrastructure cost data for "roads and bridges". It does not provide any damage estimate for other infrastructure but notes that "damages for other regional infrastructure (telecommunications, electricity, water, sewerage and other underground services) are small relative to roads and bridges". In the absence of "other" infrastructure damage data, the "road and bridges" has been used as representative of all infrastructure.

As for the direct building damages, this study revised infrastructure damage provided by the RAM in line with CPI. Table 7-1 summarises the adopted damages for the infrastructure represented by inundated road length with the respective RAM value provided in brackets.

Road Type	Damage (\$/km)
Highway	67,200 (59,000)
Sealed Road	21,090 (18,500)
Unsealed Road	9,436 (8,350)

 Table 7-1 Inundated infrastructure damages (via road lengths)

Note that the analysis did not consider the influence of flood depth, flow velocity or inundation time on infrastructure damages.

7.4.4 Agricultural damages

Dryland Pasture

The area of dryland pasture was estimated from aerial photography. Based on the RAM, there was assumed to be a negligible cost associated with damage to dryland pasture. As such, this item was not included in the damage assessment. Other costs associated with this land use include fencing, soil renovation and stock losses.

Fencing and Soil Renovation

Repairs to fences and soil renovation for dryland pasture areas have been considered. The RAM recommended a cost of \$25 per hectare. This increases to \$28 per hectare when the adjustment for CPI was made.

Stock

Stock numbers were estimated based on recommendations of the RAM which states that the estimated mean loss is likely to be 0.5 head of cattle per hectare inundated. The area used for this computation was the area of dryland pasture derived from aerial photography.

In determining the damage costs, two factors were considered, the cost of disposing of the stock and the cost of replacing the stock. Both disposal and replacement costs were based on those reported in the RAM.

This study adopted the following damage costs for cattle:

- Disposal cost \$80 per head
- Replacement cost: \$650 per head

Whilst there are seasonal variations in the likely average age and density of stock it was not possible to determine the different breeds or ages, of cattle and sheep within the study area for a particular flood event and as such an average has been applied.

Broadacre Crops

There was some difficulty in determining the extent of inundated broadacre crops. This item was distinguished from dryland pasture by two main factors, the colour and consistency of vegetation in a paddock and the location of any regular wheel marks within the paddock. Based the RAM, an estimation of \$100 per hectare was made for damage to any dryland broadacre crops, no matter what time of the year the flood occurred.

7.4.5 Damage reduction factors

As the above damage data is based on potential damages, damage reduction factors (DRFs) must be applied to reflect expected actual damages. The DRF is simply a ratio of actual

damage to potential damage. The RAM suggests DRFs can range from 0.9 for inexperienced communities with less than 2 hours flood warning to 0.4 for experienced communities with more than 12 hours flood warning. For the study area, a DRF of 0.7 was adopted (experienced community, warning time 2 to 12 hours).

7.5 Flood damages (consequences) under existing conditions

The flood damage assessment was undertaken for the design 10 and 100 year ARI flood events. The 100 year ARI flood damage, as estimated by the RAM, is approximately **\$4.9** million under existing conditions.

Average annual damage was calculated as the area under a curve of total monetary damages (from Section 7). The average annual damage (AAD) for the existing conditions was estimated at approximately **\$600,000**.

The RAM analysis employed by this study was developed to provide comparative flood damages estimates at a regional scale. RAM is, by its nature, a broad scale approach to the estimation of flood damages. RAM is based a number of assumptions and approximations. Flood damages estimated by RAM should be treated with considerable caution and more robust techniques should be applied to refine flood damage estimates.

Appendix D contains details of the flood damages assessment.

8 FLOOD MITIGATION MEASURES IDENTIFICATION AND PRELIMNARY ASSESSMENT

8.1 Overview

This section identifies and provides a preliminary assessment of the suitability of potential mitigation options. As discussed in Section 7 the existing flood risk within the study area, expressed as the average annual damage (AAD), was determined at \$600,000. Mitigation measures provide a means to reduce the existing flood risk (AAD). Mitigation measures can reduce existing flood risk by lowering the likelihood of flooding and/or lowering the flood damages (consequences) for a given flood depth. Mitigation measures can be broken into:

- Structural structural works such as levees, floodways, waterway works, improvements to hydraulic structures
- Non-structural- land use planning, flood warning

The structure of the section is as follows:

- Structural measures summarises potential structural measures and provides a preliminary assessment of their feasibility (Section 8.2)
- Non-structural measures summarises potential non-structural measures and provides a preliminary assessment of their feasibility (Section 8.3)

8.2 Structural measures

8.2.1 Overview

Structural measures are physical barriers or works designed to prevent flooding up to a specific design flood standard. Structural measures aim to reduce existing flood risk by lowering flood likelihood at a given location. Structural measures include:

- Upstream storages
- Levees
- Floodways
- Waterway management works
- Improvements to bridge/culvert structures
- Stock loss management (stock pads)

8.2.2 Upstream storage

Lake William Hovell can provide a degree of attenuation through the temporary storage of flood waters. The storage capacity of Lake William Hovell is relatively small compared to catchment area upstream and the runoff volumes generated during large flood events. The current spillway arrangements consist of a free overflow without spillway gates. These two factors combine to limit the flood attenuation benefits provided by Lake William Hovell. Also the location of Lake William Hovell in the upper King River catchment limits any flood attenuation benefit in the lower reaches of the King River, due to the potential of significant tributary inflows.

Provision was made as part of the existing dam structure for a second stage to increase storage capacity and flood attenuation. The study team's attention was drawn to this provision through comments made during the community consultation.

In assessing the feasibility of a flood mitigation measure, both the costs and benefits of the measure need be to be determined. No formal assessment of the cost involved in the construction of the second stage has been undertaken by this study. However, the study team considers that it is likely the cost would be significant. To the knowledge of the study team Goulburn Murray Water is not currently considering any such augmentation. As discussed above, the benefits through the reduction in flood levels and in turn flood damages due to the augmentation of Lake William Hovell would be concentrated in the upper King River. The reductions in flood damages, while significant at a local scale, are considered by the study team to be limited at a study area scale.

From the above discussion the study team considers the likely costs would outweigh the benefits gained from the augmentation of Lake William Hovell in an economic sense. At a regional scale, there may be substantial water supply and social benefits gained.

The study team considers the augmentation of Lake Hovell William, based solely on flood mitigation benefits, is not feasible.

8.2.3 Levees

Levees provide a physical barrier to flood waters thus restricting the extent of flooding up to a given design flood. Levees are usually earth embankments, and can be landscaped to present an attractive appearance through grassing, planting with native shrubs, and/or variations to the alignment, width and height of the embankment.

Potential benefits and disadvantages of levees include:

- Reducing flood damage to property behind the levee
- Allowing some development to occur with a higher level of protection from flooding behind the levee
- Failure of levees due to poor construction and/or lack of ongoing maintenance
- Loss of floodplain storage and obstruction to flood flows
- Loss of visual amenity
- Potential to increase flood levels elsewhere within the floodplain.

As part of the King River Rural Floodplain Management Plan (refer to Section 10), the study team recommends a number of development requirements for the construction of new levees. The study team considers in cases where these requirements are met, levees can be a feasible flood mitigation measure. The cost sharing arrangements entered into for new levee construction will need to be resolved between the proponent, RCoW or the North East CMA. The study team considers unlikely any significant contributions to the maintenance of existing levees or the construction of new levees, deemed to be in private ownership, would be made by RCoW and the North East CMA. Further details of the recommended development requirements for the construction of new levees are provided in Section 10.6.11.

8.2.4 Floodways

Floodways provide additional flood flow paths, and reduce flood levels by providing additional flow carrying capacity and by diverting flow away from areas susceptible to flooding and damage. Ideally, floodways should make use of existing natural depressions in the floodplain. One of the main limitations of floodways is their often limited effectiveness in significant flood conditions where the bulk of the flow is carried in the floodplain. In these events, floodways provide little additional flow capacity. Their benefit is usually in small to

medium floods. This was reflected somewhat in the likely lower design standards of the floodway based mitigation options.

The nature of the floodplain does not lend itself to the siting of major floodways. The King River waterway channels are of a limited flow capacity and flows across the floodplain occur for events with an ARI approximately greater than 5 years. It is likely little additional flow capacity could be achieved with a constructed floodway. The study team considers the construction of floodways is not a feasible mitigation measure in general for larger flood events. However, local small scale floodways may provide a feasible mitigation measure for smaller flood events at a given location. Any proposal for local floodways should be assessed in terms of its economic, social and environment impacts. As for levees, the cost sharing arrangements will need to be resolved between the proponent, RCoW and the North East CMA. Further, the study team considers unlikely any significant contributions to the construction of new floodways, deemed to be in private ownership, would be made by RCoW or the North East CMA.

8.2.5 Waterway management works

Waterway management works can include local widening, deepening, re-shaping and clearing of channels and verges. It also includes clearing of in-channel debris and mostly non-native riparian vegetation. Such works increase the flow capacity of the channels and floodplain, although the benefits are dependent on the existence and severity of channel and floodplain constrictions. Local works are likely to have only local benefits. However, waterway management works have the potential to cover significant lengths of the waterway.

Generally the benefits of waterway management works will be most evident in small to medium floods. In larger floods, where the waterway carries only a small proportion of the flow, improvements will provide only minor benefit.

Waterway management works do have disadvantages. There are environmental and geomorphologic issues associated with both the clearing of vegetation and the reshaping or enlarging of channels. Removal of large trees should be avoided, for example. For the same reasons, reshaping of land surfaces, sediment removal and alteration to creek cross-sections should be done sparingly, and with consideration for the likely hydraulic and geomorphologic consequences. Tampering with the beds and banks of streams can trigger hydraulic responses that are undesirable. In any given area, works should be selective – excessive clearing or channel reshaping will inevitably have adverse impacts. Waterway management also has a high maintenance cost.

The North East CMA Willow Management Strategy (North East CMA, 2003) identified that willow colonisation has lead to a reduction in channel flow capacity. Further this strategy recommends measures to manage willows while preserving the stream stability benefits of the willow colonies. Further discussion of the North East CMA Willow Management Strategy is provided in Section 9.3.4.

The management of willows may lead to localised increases in the flow capacity of the waterway channel. In turn, limited reductions in the frequency of overbank flooding may occur with reductions in flood damages for smaller flood events. The reductions in flood levels and associated damages from the strategy, during large events, is considered by the study team to be minimal.

This study recommends the Willow Management Strategy (North East CMA 2003) be implemented, with community consultation, for the King River.

8.2.6 Improvements to road floodplain embankments and waterway structures

As discussed in Section 5.3, road embankments and waterway crossings (bridges and/or culverts) within the floodplain potentially act as a barrier or constriction to flood flows and impact on flood levels. The hydraulic performance of road embankments and waterway crossing can be expressed as afflux. The afflux is the change in the flood levels from downstream to upstream across the structure. The magnitude of the afflux reflects the degree to which the structure obstructs the flood. Improvements to road embankments and waterway crossing structures include:

- Provision of additional culverts under road embankments
- Minor earthworks to removal abrupt changes in the waterway and floodplain dimension adjacent to the crossing

These improvements will reduce the afflux occurring for a given flood event and provide localised reductions in flood levels. No formal analysis of the afflux for the crossings discussed in Section 5.3 has been undertaken by this study. The study team considers the likely affluxes would be locally significant, however, would reduce to a minimal afflux a short distance upstream of the crossing. Further, the study team considers the reductions in flood damages due to improvements to existing structures are unlikely to outweigh the costs associated with the construction of such improvements, at a local scale.

With to regard the construction of new crossings and/or major upgrades to existing crossing, the study team has made a number of recommendations as outlined in Section 5.3.2. These recommendations are aimed to minimise affluxes for the new crossing and reduce affluxes for existing crossings where considered practicable.

8.2.7 Stock loss management strategy

GHD (2003) provided comments on stock loss management strategies as follows:

- It is generally accepted that unconfined stock can locate high ground during a flood
- Flood flows in anabranches which inundate stock egress routes, can limit stock's ability to locate high ground on wide floodplains
- Raised stock pads within the floodplain can provide a safe refuge up to the design flood event
- Raised stock pads can be overtopped in larger floods than the design flood.

This study recommends the use of raised stock pads as a measure to manage stock loss. This recommendation is in line with the Lower Ovens Floodplain Management Plan (GHD 2003). The construction and operation of stock pads must be in accordance with the King River Rural Floodplain Management Plan, as outlined in Section 10.

8.3 Non-structural measures

8.3.1 Overview

Non-structural measures are management activities aimed at reducing the growth in future damages. Non-structural measures aim to reduce existing flood risk by lowering flood damages (consequences) at a given location. Non-structural measures include:

- Flood awareness, preparedness, warning and response
- Land use planning

8.3.2 Flood awareness, preparedness, warning and response

Flood awareness, preparedness, warning and response aims to reduce the growth in future flood damages by improving community awareness of flooding and emergency services response. Flood awareness within a community reflects the frequency of significant flooding (i.e. infrequent insignificant flooding leads to a lower community flood awareness).

The Ovens and King River flood warning system developed in 2001, is designed to provide reliable and timely prediction of river heights and associated flood warnings. As part of the system, a number of telemetered rainfall and river height gauges were installed throughout the Ovens River catchment. The flood warnings will be disseminated via personal contact by authority personnel, radio broadcasts, and fax broadcast. Accompanying the warning are recommended actions for landholders aimed at reducing flood damages.

This study recommends the continuation and where possible enhancement of the Ovens and King River flood warning system. This includes maintaining the physical infrastructure and the continuing flood awareness campaigns within the study area.

The study team recommends the RCoW in conjunction with the North East CMA revise and condense the previously issued flood response guidelines into a single handout. The revised handout should outline the key flood information and appropriate landholder flood response. The revised handout should be distributed to landholders within the study area at regular intervals to refresh the community awareness and preparedness.

8.3.3 Land use planning (development requirements)

As discussed in Section 6.2, land use planning through the application of development requirements aims to reduce the growth in future flood damages. The flood related development requirements can be applied within LSIO and FO. LSIO and FO have been identified as outlined in Section 6.4. The study team recommends a number of development requirements be applied as outlined in Section 10.

9 FLOODPLAIN MANAGEMENT FRAMEWORK

9.1 Overview

This section summarises the key elements in the current floodplain management framework employed in Victoria. The structure of this section is as follows:

- Floodplain management process- outlines the floodplain management process employed in Victoria (Section 9.2).
- Legislative and policy framework provides a brief summary of legislative and policy framework underlying floodplain management. (Section 9.3)

9.2 Floodplain management process

As noted in Section 2.4, this study has been carried in accordance with:

- Best Practice Principles for Floodplain Management in Australia (CSIRO 2000),
- Victoria Flood Management Strategy State Flood Policy Committee (DNRE 1998),
- Arrangements for Flood Warning Services in Victoria (VFWCC 2000)
- Regional Floodplain and Drainage Strategy (North East CMA 2000)
- Victorian Planning Provisions (DOI 2000)

The Victoria Flood Management Strategy (VFMS) provides the principal framework for the floodplain management in Victoria. The strategy outlines the roles of key agencies at a regional and local scale in floodplain management. In particular, the strategy defines the .regional and local planning roles within the floodplain management framework. Further discussion of the VFMS is provided in Section 9.3.

At a regional scale, the strategy identifies the regional catchment strategy and regional floodplain management strategy prepared by the catchment management authorities as the principal regional planning instruments. These regional strategies provide strategic direction and governing philosophies for catchment and floodplain management.

At a local scale, the VFMS identifies the municipal strategic statement and the municipal planning scheme prepared by the municipal authority as the local planning instrument. Further the VFMS indicates a local floodplain management plan can be inserted into the municipal planning scheme to provide a set of development controls for a given local area.

Figure 9-1and Figure 9-2 outline the regional and local flood management planning framework. These figures also highlight the linkage between the planning scheme, floodplain management plan and local floodplain development plan. The King River Rural Floodplain Plan, as outlined in Section 10, consists of a local floodplain development plan that can be inserted into the RCoW planning scheme as shown in Figure 9-2.



Figure 9-1 Regional flood management planning framework (from Victoria Flood Management Strategy (DNRE 1998))



Leg	gend
	Links between elements
(1)	Victoria Planning Provisions
(2)	A floodplain management plan can contain some or all of these elements

Figure 9-2 Local flood management planning framework (from Victoria Flood Management Strategy (DNRE 1998))

Further discussion of the regional catchment and floodplain strategies, and the municipal strategic statement and planning scheme, which apply to the study area, is provided in Section 9.3.

9.3 Legislative and policy framework

9.3.1 State legislation

Catchment and Land Protection Act 1994 (CALP)

The Catchment and Land Protection Act (1994) has the following objectives:

- To set up a framework for the integrated management and protection of catchments
- To encourage community participation in the management of land and water resources
- To set up a system of controls on noxious weeds and pest animals

The Act established ten Catchment and Land Protection Boards, which have since expanded their roles to become Catchment Management Authorities. The Catchment and Land Protection Act (1994) provides for the development of Regional Catchment Strategies (RCS's) that must assess the nature, causes, extent and severity of land degradation of the catchments in each region and identify areas for priority investigations and works. Local Planning schemes must have regard for the Regional Catchment Strategies in their respective area.

The Catchment and Land Protection Act is an important instrument as it establishes the local Catchment Management Authority (North East CMA), which is the responsible authority for floodplain and land management issues within the study area.

Planning and Environment Act 1987

The purpose of this Act is to establish a framework for planning the use, development and protection of land in Victoria, in the present and long-term interests of all Victorians. The Act defines the planning procedures that are required for development approval and establishes local planning schemes as the tools that govern local land-use planning.

Water Act 1989

The purpose of the Water Act is to provide for the integrated management of all elements of surface-water and promote the orderly, equitable and efficient use of water resources. Importantly, in relation to flooding and floodplain management, it establishes the CMAs (in the study area this is the North East CMA) as the responsible authority.

The primary role of the North East CMA in floodplain management is to manage regional flooding issues in an integrated and coordinated manner, having regard for the overall impacts of works and activities within its catchment management area, including waterway health and environmental values (North East CMA Floodplain Management Strategy, 1999). The North East CMA undertakes its catchment management functions under the Water Act (1989) and the CALP Act (1994).

The key roles are as follows:

- Determine the extent and height of floodwaters and provide flood advice
- Declare flood levels, land liable to flooding, floodway areas, flood fringe areas and building lines
- Control developments that have occurred or that may be proposed
- Develop and implement plans and to take any action necessary to minimise flooding and flood damage

The Water Act along with the Catchment and Land Protection Act and the Planning and Environment Act provide the legislative authority and structure for waterway and floodplain management through both the CMA's and local government.

Planning and Environment (Planning Schemes) Act 1996

The purpose of this act is to reform the structure of planning schemes by establishing two clear levels of planning policy within the overall state planning framework. This comprises the Victoria Planning Provisions, which include the State Planning Policy Framework (SPPF) and the Local Planning Schemes that include Municipal Strategic Statements (MSS), which are part of the Local Planning Policy Framework (LPPF) within each local government area.

9.3.2 State policy/strategy

Victoria Flood Management Strategy, 1998

The Victoria Flood Management Strategy was launched in July 1998. The purpose of this strategy is to enable effective flood management by providing a consistent, statewide framework for the management of flood related issues. Central to this framework is the adoption of a risk management approach to floodplain management where the likelihood and consequence of flooding are integral to defining appropriate actions and responses.

At the local level, the strategy is implemented through a range of service providers, such as Catchment Management Authorities (North East CMA), Local Government (RCoW) and DSE regions. The strategy provides the framework for regional plans such as the North East CMA Floodplain Management Strategy (1999).

Victorian River Health Strategy 2002

The Victorian River Health Strategy provides an overall framework for the management of rivers within Victoria. It comprises the strategic background, vision for management and river restoration, integrated management framework, specific management issues and management arrangements. The strategy specifies how the various natural resource management agencies in Victoria should work in an integrated way to provide for the maintenance and improvement of river environments. The Regional Catchment Strategy, produced by the North East CMA is pivotal in the river management framework, along with the sub-plans such as the North East CMA Floodplain Management Strategy, the North East CMA Willow Management Strategy and the North East CMA Ovens River Basin Water Quality Strategy.

State Environment Protection Policy (Waters of Victoria) 2003

This State Environment Protection Policy (SEPP) sets a statutory framework for the protection of the uses and values of Victoria's fresh and marine water environments. As designated by the Environment Protection Act 1970, the SEPP includes:

- The beneficial uses and values of the water environment that the community and government want to protect
- The objectives and indicators which describe the environmental quality required to protect beneficial uses
- An attainment program that provides guidance to catchment management authorities, coastal boards, water authorities, communities, businesses and local government and state government agencies to protect and rehabilitate water environments to a level where environmental objectives are met and beneficial uses are protected

The SEPP was developed in conjunction with, and aims to supports the Victorian River Health Strategy (VRHS), which was developed by the former Department of Natural Resources and Environment (DNRE) (now the Department of Sustainability and Environment (DSE). The VRHS aims to set future directions for the management of Victoria's rivers and streams.

9.3.3 Victorian Planning Provisions

The Planning and Environment (Planning Schemes) Act 1996 amended the Planning and Environment Act 1987 to introduce the Victoria Planning Provisions (VPP) and Municipal Strategic Statements (MSS). This facilitated a new planning scheme format consisting of standard statewide provisions and local provisions.

The VPP is a statewide reference document or template that governs the development of planning schemes to ensure that consistent provisions for various matters are maintained across Victoria and that the layout of planning schemes for all municipalities is the same. The VPP contains a complete set of standard planning provisions for Victoria and provides a standard format for planning schemes. The structure includes:

- The State Planning Policy Framework (SPPF) which provides statewide policy direction.
- The Local Policy Planning Framework (LPPF) this incorporates the Municipal Strategic Statement (MSS) that lays out local vision and planning policy.
- The template for defining planning zones and overlays.

The relevance of the VPP to this study is that it sets the State Planning Policy Framework and the structure for the RCoW planning scheme, including the LPPF and MSS.

In addition, a series of practice notes have been prepared by the Department of Infrastructure to assist authorities and development applicants with the application of the flood related provisions. A brief discussion of the relevant practice notes is provided below.

State Planning Policy Framework (SPPF)

The SPPF states "Society has various needs and expectations such as land for settlement, protection of the environment, economic well-being, various social needs, proper management of resources and infrastructure. Planning aims to meet these by addressing aspects of economic, environmental and social well-being affected by land use and development."

The SPPF consists of seven general principle statements that elaborate upon the objectives of planning in Victoria and describe the factors that influence good decision-making in land use and development planning. The policy areas that are considered of relevance to this study are within Clause 15 Environment and are listed in Table 9-1 below.

Clause	Objective	General implementation related to floodplains
15.01 Protection of catchments, waterways and groundwater	To assist the protection and, where possible, restoration of catchments, waterways, water bodies, groundwater, and the marine environment.	 Decision-making by planning and responsible authorities must be consistent with any relevant requirements of State environment protection policies as varied from time to time (Waters of Victoria and specific catchment policies). Responsible authorities should ensure that works at or near waterways provide for the protection and enhancement of the environmental qualities of waterways
		and their instream uses and are consistent with Guidelines for Stabilising Waterways (Rural Water Commission 1991) and Environmental Guidelines for River Management Works (Department of Conservation and Environment 1990), and should have regard to any relevant river restoration plans or waterway management works programs approved by a catchment management authority
		 Planning and responsible authorities should consider the impacts of catchment management on downstream water quality and freshwater, coastal and marine environments and, where possible should encourage: The retention of natural drainage corridors with vegetated buffer zones at least 30m wide along waterways to maintain the natural drainage function, stream habitat and wildlife corridors and landscape values, to minimise erosion of stream banks and verges and to reduce polluted surface runoff from adjacent land uses.
		• Measures to minimise the quantity and retard the flow of stormwater runoff from developed areas. Measures, including the preservation of floodplain or other land for wetlands and retention basins, to filter sediment and wastes from stormwater prior to its discharge into waterways.
15.02 Floodplain	To assist the protection of:	Planning controls for areas subject to flooding should be consistent throughout the State
management	infrastructure from flood hazard.	• Flood risk must be considered in the preparation of
	• The natural flood carrying capacity of rivers, streams and	planning schemes and land use planning decisions to avoid intensifying the impacts of flooding through
	floodways.	inappropriately located uses and developments.
	• The flood storage function of floodplains and waterways.	• Land affected by hooding, including hoodway areas, as verified by the relevant floodplain management
	• Floodplain areas of environmental significance	authority, should be shown on planning scheme maps. Land affected by flooding is land inundated by the 1 in
		100 year flood event or as determined by the floodplain
		 Developments and uses which involve the storage or
		agricultural chemicals or wastes and other dangerous goods (including piggeries, poultry farms, feedlots and
		sewage treatment plants) must not be located on floodplains unless site design and management is such that potential contact between such substances and floodwaters is prevented, without affecting the flood carrying and flood storage functions of the floodplain

Table 9-1: Relevant sections of the SPPF

Victoria Planning Provisions Practice Notes: flood related provisions

The Department of Infrastructure has prepared the following practice notes:

- Applying for a planning permit under the flood provisions: A guide for councils, referral authorities and applicants (DoI 2000a)
- Applying the flood provisions in planning schemes: A guide for councils (DoI 2000b)

The above practice notes provide guidance to councils, referral authorities and applicants regarding the application of the flood related provisions. General set of development requirements for appropriate development is provided. However, it noted that the further consideration of local flooding behaviour is required to establish appropriate local development controls.

9.3.4 Regional and Local Policy/Strategy

Rural City of Wangaratta - Municipal Strategic Statement and Local Planning Policy

The Municipal Strategic Statement (MSS) and Local Planning Policy (LPP) are two important sections of the RCoW Planning Scheme. The MSS is a concise statement of the key strategic planning, land use and development objectives for the municipality and the strategies and actions for achieving these objectives. The MSS covers a number of different aspects of planning relevant to the present study and references various other local policy documents that need to be considered. RCoW advised the study team the MSS is currently review with a draft MSS due for release in August 2004. The local authority are required to review their MSS each three years.

The current RCoW MSS highlights the importance of flooding in Section 21.01 as follows:

The Rural City is formed around the Ovens and King Rivers. The water from these rivers, and the fertile soils distributed by their regular flooding, forms the basis of the agricultural and viticultural industries that are important contributors to the economy of the area. This reliance on the river systems by a variety of land users has resulted in property being damaged by flooding. Flooding is a major regional issue for the Rural City and adjoining local governments.

Sections of the MSS that have been identified as being relevant to the present study are identified below in Table 9-2.

Clause	Objective	Strategies
21.03 – 2: Planning vision	 To ensure that development does not detrimentally impact on salinity, erosion and degradation of the natural environment; To reduce flooding impacts throughout the municipality 	- Implement the actions within the 2020 Community Plan.
21.05-1 Environment	 To discourage inappropriate land use and development in flood prone areas. To discourage inappropriate land use which may result in land degradation due to salinity or erosion. To protect life and minimise loss of property within the planning area. To maintain or improve the quality of the surface and groundwaters of the Ovens Basin. To ensure supplies of high quality water to foster development. To maintain and improve riverine environments throughout the municipality. 	 Implementation of early flood warning systems in the Ovens and King valleys. Recognise the importance of protecting wetlands, particularly those of high conservation, landscape, recreation or other value that need protection from detrimental development or land use. Promote landcare and catchment management strategies. Ensure that flood levees are part of approved flood mitigation schemes.

Table 9-2: Relevant Sections of RCoW MSS

Sections of the LPP that have been identified as being relevant to the present study are identified below in Table 9-3.

Clause	Objective	Strategies
22.14 Flood and rural drainage management	 To minimise flood risk and the impact of flooding within the Municipality. To prevent inappropriate development on floodplains. To recognise the natural flood carrying capacity of rivers, streams and floodways and the flood storage function of the floodplains. To protect surface and ground water quality and preserve important wetlands and areas of environmental significance. 	- Implement the objectives of the North East Catchment Management Authority's <i>Regional Floodplain Management Strategy</i>
44-03 & 44-04: Floodway and land subject to inundation overlays	 To identify land in a flood storage or flood fringe area affected by the 1 in 100 year flood or any other area determined by the floodplain management authority. To ensure that development maintains the free passage and temporary storage of floodwaters, minimises flood damage, is compatible with the flood hazard and local drainage conditions and will not cause any significant rise in flood level or flow velocity. To reflect any declaration under Division 4 of Part 10 of the Water Act, 1989 where a declaration has been made. To protect water quality in accordance with the provisions of relevant State Environment Protection Policies, particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria). To identify waterways, major floodpaths, drainage depressions and high hazard areas which have the greatest risk and frequency of being affected by flooding. To ensure that any development maintains the free passage and temporary storage of floodwater, minimises flood hazard area is compatible with flood hazard and is compatible with flood hazard and is compatible with flood hazard and soliting and silting flood and soliting and silting flood and soliting and silting flood hazard. 	- Implement the objectives of the North East Catchment Management Authority's <i>Regional Floodplain Management Strategy</i> - Develop local floodplain development plan for insertion into the RCoW planning scheme.

Table 9-3: Relevant Sections of RCoW LPP

North East CMA Regional Catchment Strategy 2003-2008

The Regional Catchment Strategy (RCS) for 2003-2008 provides long-term direction for managing the future of land, water resources, and biodiversity of the North East Region, and the foundation for investment decisions to ensure improved natural resource outcomes.

The RCS provides the broad, overarching direction for natural resource management within the North East Region for the next 5 years and is established in accordance with the Catchment and Land Protection Act 1994.

North East CMA Regional Floodplain Management Strategy, 2000

The North East Regional Floodplain Management Strategy (2000) provides the strategic direction for future floodplain management in the North East region. The strategy promotes the following visions for North East region with respect to floodplains:

"With the involvement of the community, maintaining and enhancing the floodplains by implementing flood management measures which reduce flood risk to lives, health and property, and flood damage costs, whilst allowing for natural floodplain storage and enhancing the environmental values of floodplains".

The strategy identified the following land use planning and development controls:

- Agree on the delineation of the 1% flood extent and floodway;
- Ensure that there is a consistent approach to delineating the flood zones and overlays across the region;
- Review the Municipal Strategic Statements to ensure a consistent approach (agree on changes as required);
- Develop a local policy, which is consistent across the region, to be incorporated into the planning schemes;
- Encourage the development of "local floodplain development plans" to assist assessment of development proposals;
- Investigate the use of schedules to overlays, referral agreements and incorporated documents where deemed appropriate; and
- Initiate a program, to implement at the next opportunity, for reviewing of the planning schemes.

North East CMA Willow Management Strategy, 2003

This strategy identified that willow colonisation of waterways, amongst other impacts, leads to a reduction in stream flow capacity. This reduction in stream capacity results in greater frequency of overbank flooding, increased risk of floodplain erosion and accelerated morphologic change. The strategy indicated the King River between Cheshunt South and Edi Cutting had lost stream capacity due to willow colonisation.

Willow plantings have been employed as a stream stabilisation measure. The strategy recommends a number of alternative measures targeted at rehabilitating waterways.

10 KING RIVER RURAL FLOODPLAIN MANAGEMENT PLAN

10.1 Overview

This section outlines the development and scope of the King River Rural Floodplain Management Plan. As discussed in Section 9.2, a floodplain management plan may consist of the following elements:

- Recommended structural works
- Recommended non-structural works (e.g. flood warning arrangements flood response plan)
- Land use delineations (planning zones and overlays)
- Specific land use planning requirements (Local floodplain development plan)

The structure of the section is as follows:

- Underlying principles summarises the underlying principles guiding the development of the King River Rural Floodplain Management plan (Section 10.2)
- Recommended structural measures outlines the recommended structural mitigation measures for inclusion in the floodplain management plan (Section 10.3)
- Recommended non-structural measures discusses recommended non-structural measures for inclusion in the floodplain management plan (Section 10.4)
- Land use delineations discusses the recommended revised flood related planning overlays recommended (10.5)
- King River Local Floodplain Development Plan outlines the development requirements recommended for inclusion in the RCoW planning scheme (Section 10.6).

The King River Local Floodplain Development Plan provides the North East CMA and RCoW with development requirements to manage the existing and future development on the King River rural floodplain. Additionally the plan aims to encourage new development on the floodplain by providing landholders with guidance on appropriate development proposals.

10.2 Underlying principles of the King river Rural floodplain management plan

The King River Rural Floodplain Management Plan draws its' underlying principles from the Best Practice Principles for Floodplain Management in Australia (CSIRO 2000) and Victoria Flood Management Strategy (DNRE 1998). In particular the Victoria Flood Management Strategy (DNRE 1998) provides the following vision for the sustainable use of floodplain and the responsible management:

- Local communities participate in flood risk decisions
- Land use planning measures minimise future flood risk and damages
- Structural flood mitigation measures reduce flood risk and damages, and acceptable to the local community
- Flood warning and emergency planning measures minimise risk to health, life and safety of the community.

The plan has been developed in consultation with the study's reference committee and the broader community. The plan focuses on the reduction of future flood damages through

appropriate land use and development controls. The plan provides for the construction and operation of structural mitigation measures where deemed appropriate. Also the plan acknowledges the roles and responsibilities of various agencies (RCoW, Police and VicSES) in flood emergency response and seeks to minimise danger to the various agencies personnel through appropriate land use and development.

The King River Rural Floodplain Management Plan draws on the floodplain management plan developed for the Ovens floodplain between Whorouly and Wangaratta (Lower Ovens River floodplain) (GHD 2003). The plan is similar in format and content to the Ovens floodplain management plan with appropriate changes to reflect local conditions. This consistency between the plans enables a transparent approach to be applied by the North East CMA and RCoW in managing and assessing development for the King and Lower Ovens Rivers.

10.3 Recommended Structural Measures

As discussed in Section 8.2, potential structural mitigation measures were identified and a preliminary assessment of the suitability of potential mitigation options undertaken. Recommendations regarding the various structural measures identified and assessed are provided in this section.

10.3.1 Levees

As discussed in Section 8.2.3, this study considers, in specific cases, levees can be a feasible flood mitigation measure. A number of development requirements for the construction of new levees are provided as part of the local floodplain development plan (refer to Section 10.6). The cost sharing arrangements entered into for new levee construction will need to be resolved between the proponent, RCoW and the North East CMA.

10.3.2 Waterway management activities

As discussed in Section 8.2.5, this study recommends the Willow Management Strategy (North East CMA 2003) be implemented, with community consultation, for the King River.

10.3.3 Stock loss management

As discussed in Section 8.2.7, this study recommends the use of raised stock pads as a measure to manage stock loss. This recommendation is in line with the Lower Ovens floodplain management plan (GHD 2003). The construction and operation of stock pads must be in accordance with the floodplain management plan outlined in Section 10.

10.4 Recommended Non-structural Measures

10.4.1 Flood awareness, preparedness, warning and response

As discussed in Section 8.3.2, this study recommends the continuation of the maintenance of the Ovens and King River flood warning system. This includes maintaining the physical infrastructure and the continuing flood awareness campaigns within the study area.

The study team recommends that RCoW in conjunction with the North East CMA revise and condense the previous issued flood response guidelines into a single handout. The revised handout should outline the key flood information and appropriate landholder flood response. The revised handout should be distributed to landholder within the study area at regular intervals to refresh the community awareness and preparedness.

10.5 Land Use Planning Delineations

As discussed in Section 6.4, a revision of the current flood related planning overlays has been undertaken during this study. The proposed revisions were based on further examination of

the available flood information and community consultation. In particular, several large islands were identified through community consultation and included in the FO and LSIO delineation. These proposed revisions to the flood related planning overlays are recommended for adoption by RCoW and insertion into the planning scheme

10.6 King River Local Floodplain Development Plan

10.6.1 Overview

This section details the development and scope of the King River Local Floodplain Development Plan. This local floodplain development plan contains requirements for development assessment and schedules for insertion into the RCoW planning scheme. Requirements are provided for sub-division, dwellings, dwelling extensions, non-habitable buildings, minor earthworks, stock pads and levees. The following requirements are recommended for application within the King River Rural Floodplain Precinct.

The requirements are framed to embody the key principles underlying the Best Practice Principles for Floodplain Management in Australia (CSIRO 2000) and Victoria Flood Management Strategy (DNRE 1998). The following requirements are considered by the study team to be fair and reasonable, and strike a balance between flood risk and development.

The structure of the local floodplain development plan is as follows:

- King River Rural Floodplain Precinct defines the precinct covered by this plan.
- Flood history and behaviour briefly summarises key flooding behaviour characteristics
- Requirements for development within flood related overlays describes the requirements for development and the schedules for insertion into the RCoW planning scheme. Requirements are provided for sub-divisions, dwellings, dwelling extensions, non-habitable buildings, minor earthworks, stock pads, and proposed levees.

10.6.2 King River Rural Floodplain Precinct

The study area encompasses the floodplains of the King River from Lake William Hovell to 200 metres upstream of the One Mile Creek Diversion Channel adjacent to the Hume Freeway, and the downstream 2 kilometres of all tributaries of the King River tributaries. These tributaries include but limited to: Hurdle Creek, Meadow Creek, Black Range Creek and Boggy Creek. Figure 2-1 displays the study area for the King River Rural Floodplain Study.

For the purposes of the King River Rural Floodplain Management Plan, lots located in the study area that lie partially or wholly within the Floodway Overlay and/or Land Subject to Inundation Overlay are referred to as the King River Rural Floodplain Precinct.

10.6.3 Flood history and behaviour

Flooding along the King River occurs regularly on a seasonal basis. Minor flooding results in minor disruption and inconvenience. Significant flooding events as in 1917, 1974, 1993, and 1998 have resulted in extensive property, agricultural and infrastructure damages.

The floods in the King River travel quickly down the valley due to the relatively steep slope. This quick flood travel time is reflected in a relatively rapid rise and fall of flood event in the King River.

10.6.4 Development application requirements

An application to construct a building, construct or carry out works or subdivide land, must be accompanied by four sets of plans and supporting documents that demonstrate the following relevant development requirements have been meet.

Where relevant, the supporting documents and plans (drawn to scale) must show the following:

- The boundaries and dimensions of the property.
- A regional locality plan showing the property whereabouts within the region, including roads, streams and other prominent land marks.
- The layout plan of the existing and proposed building, works or subdivision boundaries.
- Floor level of any existing and proposed buildings to Australian Height Datum.
- Natural ground levels of the proposed dwelling site to Australian Height Datum, taken by a licensed surveyor.
- Natural ground levels along access routes to flood free land (as indicated by the planning scheme flood overlays and zone) to Australian Height Datum, taken by a licensed surveyor. The access route includes access along any relevant government road to the property and then to the proposed dwelling location.

10.6.5 Subdivision

General requirements

In addition to Clauses 44.03 and 44.04 of the RCoW planning scheme, the following conditions shall be considered as part of the assessment for **subdivision** proposals within the King River floodplain precinct:

- Excision of new lot(s), solely for the purposes of dwelling construction, located partly within FO, or located partly or wholly within LSIO, must have a building envelope above the 100 year ARI flood level.
- Access to the building envelope by a defined access route along which the 100 year ARI flood depth is not greater than 0.5 m above natural surface.

10.6.6 Dwellings

Schedule to RCoW planning scheme

The RCoW planning scheme should be amended for the following exemptions in Schedules to Clauses 44.03 and 44.04 for the assessment of **dwelling** proposals within the King River floodplain precinct:

• A replacement dwelling where the floor level is at least 300 mm above the 100-year ARI flood level, or a higher level set by the responsible authority;

General requirements for dwellings within flood related overlays

In addition to Clauses 44.03 and 44.04 of the RCoW planning scheme, the following conditions shall be considered as part of the assessment for any **dwelling** proposals within the King River floodplain precinct:

• Construction of new dwellings (including replacement dwellings) shall be located on the highest land and/or where the 100 year ARI flood depth is less than 0.5 m above the natural surface. Unless the applicant can demonstrate to the satisfaction of the responsible authority and floodplain management authority that an alternative site is more suitable.

- Along the defined access route (road) to any new dwelling(s) the 100 year ARI flood depth above the natural surface shall be less than 0.5 m.
- Building pads for new dwellings shall be limited to be no more than 2 metres from the building footprint.
- Minimum floor level of all new dwellings shall be 300 mm above the 100 year ARI flood level or a higher level set by the responsible authority.
- Only one new dwelling will be permitted per lot. A replacement dwelling will require the removal of the existing dwelling within 3 months of completion of the replacement dwelling.

10.6.7 Dwelling extensions

Schedule to RCoW planning scheme

The RCoW planning scheme should be amended for the following exemptions in Schedules to Clauses 44.03 and 44.04 for the assessment of **dwelling extensions** proposals within the King River floodplain precinct:

- No planning permit is required for the construction of a single or multiple dwelling extension where the combined floor area is not greater than 20 m² since 25 February 1998 (the date of gazettal of the RCoW planning scheme).
- No planning permit is required for the construction of a pergola, veranda, car port or in ground swimming pool associated with an existing dwelling.

Requirements for extensions within flood related overlays

In addition to Clauses 44.03 and 44.04 of the RCoW planning scheme, the following conditions shall be considered as part of the assessment for any **dwelling extension** proposals within the King River floodplain precinct:

- Where a dwelling extension (or multiple extensions) is greater than 20 m² and below the nominal flood protection level the owner must:
 - use water resistant materials up to the nominal flood protection level.
 - within the **FO** areas obtain approval from the responsible authority and the floodplain management authority.
- The construction of the ground floor area of any dwelling extension (single or multiple), which is more than 300 millimetres below the 100-year ARI flood level and greater than 20 m² to the existing dwelling at 25 February 1998, must be set at least to the nominal flood protection level or a higher level as determined by the responsible authority.
- The construction of the ground floor area of any dwelling extension (single or multiple) between the 100-year ARI flood level and 300 millimetres below the 100-year ARI flood level, must not be more than 40 m² greater than the existing dwelling at 25 February 1998. Where a dwelling extension (or multiple extensions) is greater than 20 m² and below the nominal flood protection level the owner must:
 - enter into an agreement with Council under Section 173 of the *Planning and Environment Act 1987*, stating that combined ground floor area of the constructed extension together with any future extensions, must not be lower than the highest existing ground floor level, and must not exceed 40 m². Extensions beyond 40 m² must be set at least to the nominal flood protection level.

- The construction of the ground floor area of any dwelling extension (single or multiple) between the 100-year ARI flood level and the nominal flood protection level, must not be more than 80 m² to the existing dwelling at 25 February 1998. Where a dwelling extension (or multiple extensions) is greater than 20 m² and below the nominal flood protection level the owner must:
 - enter into an agreement with Council under Section 173 of the *Planning and Environment Act 1987*, stating that combined ground floor area of the constructed extension together with any future extensions, must not be lower than the highest existing ground floor level, and must not exceed 80 m². Extensions beyond 80 m² must be set at least to the nominal flood protection level.
- Building pads for new extension shall be limited to be no more than 2 metres from the extension footprint

10.6.8 Non-habitable buildings

Schedule to RCoW planning scheme

The RCoW planning scheme should be amended for the following exemptions in Schedules to Clauses 44.03 and 44.04 for the assessment of **non-habitable buildings** proposals within the King River floodplain precinct:

- No planning permit is required the construction of a non-habitable building (other than for retail and/or industrial purposes) with a floor area not greater than 100 m².
- No planning permit is required for an extension to an existing non-habitable building provided the total area is not greater than 100 m².

General requirements within flood related overlays

In addition to Clauses 44.03 and 44.04 of the RCoW planning scheme, the following conditions shall be considered as part of the assessment for **non-habitable buildings** proposals within the King River floodplain precinct:

- All non-habitable buildings shall be designed to minimise flood flow path blockage.
- No fill or build up shall be undertaken to achieve an elevated (above natural surface) building platform without equivalent free draining compensatory flood storage provided.

10.6.9 Minor earthworks

Schedule to RCoW planning scheme

The RCoW planning scheme should be amended for the following exemptions in Schedules to Clauses 44.03 and 44.04 for the assessment of **minor earthworks** proposals within the King River floodplain precinct:

• No planning permit is required for minor earthworks that do not obstruct or impact natural drainage lines and do not raise the natural surface by more than 100 mm provided that the earthworks are greater than 100 m from neighbouring dwellings. Minor earthworks may include maintenance of access route to an existing dwelling.

10.6.10 Stock pads

General requirements

In addition to Clauses 44.03 and 44.04 of the RCoW planning scheme, the following conditions shall be considered in the assessment for **stock pad** proposals within the King River floodplain precinct:

- Stock pad raised area above the 100 year ARI provided based on an maximum allowance of 10 m^2 per head of property cattle carrying capacity. The property cattle carrying capacity is determined by the current general formulae employed by DSE and/or DPI.
- No restriction to the finished height of the stock pad. However, the height of fill required for the finished height to reach the 100 year ARI flood level shall not be greater than 0.5 m.
- Stock pads shall only be permitted where the entire property lies within LSIO and/or FO.
- Equivalent free draining compensatory flood storage is required in association with stock pad construction.
- Stock pads shall be shaped to minimise any obstruction to the flood flow.
- Stock pads shall be permitted as part of building pads for other non-habitable buildings.
- Stock pads may adjoin an existing levee. The finished height of the remainder of the levee shall not increase.
- For an approved stock pad, RCoW at its' discretion may enter into, with the owner, a Section 173 agreement under the provisions of Planning and Environment Act (1987). This agreement should state the finished height of the stock pad and that the owner is responsible for maintenance and use of the stock pad. Also the agreement must state that the RCoW or the North East CMA do not accept liability for any loss incurred.

10.6.11 New levee construction and additions to existing levees

General requirements

In addition to Clauses 44.03 and 44.04 of the RCoW planning scheme, the following conditions shall be considered in the assessment for **new levee construction and additions to existing levees** within the King River floodplain precinct:

- Any new levee construction shall be designed to protect the immediate surrounding of an existing habitable dwelling, where the floor level is below the 100-year ARI flood level, with the total area enclosed (protected) by the new levee limited to less than 1000 m² (including foot print of new levee).
- Any addition to an existing levee shall be designed to protect the immediate surrounding of an existing habitable dwelling where the floor level is below the 100-year ARI flood level, with the total area enclosed (protected) by the new levee limited to less than 1000 m² (including foot print of new levee).

10.7 Implementation of the Plan

The implementation of the plan requires a number of actions to be undertaken by various agencies. Table 10-1 outlines the required actions, the responsible agencies and considered priority.

Description of required action	Responsible action	Priority
Revise the format of the local floodplain development plan for insertion into the RCoW planning scheme	RCoW in liaison with North East CMA and DSE	High
Adopt and insert the local floodplain development into the RCoW planning scheme	RCoW and DSE	High
Revise the format of the flood related planning overlays for insertion into the RCoW planning scheme	RCoW in liaison with North East CMA and DSE	High
Adopt and insert the flood related planning overlays into the RCoW planning scheme	RCoW and DSE	High
Develop and document a process for the review of the floodplain management plan and flood related planning overlays	RCoW in liaison with North East CMA and DSE	Medium
Develop flood data maps showing 100 year ARI flood depths and flow velocities. (note: These flood data maps could readily be developed from the data collated as part of the Flood Data Transfer Project (DNRE 2000))	North East CMA in liaison with DSE	Medium
Revise and condense the previously issued flood response guidelines into a single handout. The revised handout should be distributed to landholders within the study area at regular intervals	RCoW in liaison with North East CMA	Medium
Develop a series of guidelines outlining the required format and scope of a planning permit application e.g. content of planning permit application for levee maintenance	RCoW in liaison with North East CMA	Medium

 Table 10-1
 Key actions required in the implementation of the Plan

11 SUMMARY OF STUDY RECOMMENDATIONS

This section provides a summary of the study's key recommendations. For further background to each recommendation refer to the relevant sections in this report. The key study recommendations are as follows:

Levees and earthworks (Section 5.2.2)

The study team makes the following recommendations with regard to future analysis and/or development controls for the existing levees and significant earthworks:

- In conjunction with landholders, the North East CMA to determine the ownership of existing levees as detailed in the North East CMA Levee Inventory (LICS 2001)
- In conjunction with landholders, the North East CMA to identify existing levees not documented in the North East CMA Levee Inventory (LICS 2001) and where considered appropriate update the levee inventory
- Maintenance of the levees, identified in the North East CMA Levee Inventory (LICS 2001) and in any subsequent revisions to the levee inventory, be permitted to maintain the current status quo.

Roads and road crossings (Section 5.3.2)

The study team makes the following recommendations with regard to future analysis and/or development controls for roads and road crossings:

- Relevant road constructing authority (VicRoads and RCoW) seek to minimise the impact of future road crossings on flooding behaviour including flood levels and flow velocities. This should be undertaken in accordance with the design principles outlined in VicRoads Design Guidelines and Waterway Design Guide (AustRoads 2000)
- Relevant road constructing authority (VicRoads and RCoW) seek to refine existing road crossings, where practicable, to minimise impact on flooding behaviour particularly when undertaking significant repairs and upgrades
- RCoW continues to seek the opinion of the North East CMA regarding the flooding impact performance criteria for road crossings being considered by the road constructing authority.

Revised flood mapping for land use planning (Section 6.4)

Revision of the current flood related planning overlays has been undertaken during this study. The proposed revisions were based on further examination of the available flood information and community consultation. In particular, several large islands were identified through community consultation and included in the FO and LSIO delineation. These proposed revisions to the overlays are recommended for adoption by RCoW and insertion into the planning scheme.

Waterway management activities (Section 8.2.5)

This study recommends the Willow Management Strategy (North East CMA 2003) be implemented, with community consultation, for the King River.

Flood awareness, preparedness, warning and response (Section 8.3.2)

This study recommends the continuation of the maintenance of the Ovens and King River flood warning system. This includes maintaining the physical infrastructure and the continuing flood awareness campaigns within the study area.

The study team recommends that RCoW in conjunction with the North East CMA revise and condense the previous issued flood response guidelines into a single handout. The revised handout should outline the key flood information and appropriate landholder flood response. The revised handout should be distributed to landholder within the study area at regular intervals to refresh the community awareness and preparedness.

Stock loss management (Section 8.2.7)

This study recommends the use of raised stock pads as a measure to manage stock loss. This recommendation is in line with the Lower Ovens floodplain management plan (GHD 2003). The construction and operation of stock pads must be in accordance with the floodplain management plan outlined in Section 10.

Land use planning (Section 8.3.3)

This study recommends the King River Rural Floodplain Management Plan, as outlined in Section 10, be implemented for the study area.

Implementation of the plan (Section 10.7)

This study recommends the following actions are undertaken to enable the implementation of the plan:

- Revise the format of the floodplain management plan for insertion into the RCoW planning scheme
- Adopt and insert the local floodplain development plan into the RCoW planning scheme
- Revise the format of the flood related planning overlays for insertion into the RCoW planning scheme
- Adopt and insert the flood related planning overlays into the RCoW planning scheme
- Develop and document a process for the review of the floodplain management plan and flood related planning overlays
- Liaise with VicRoads regarding a desired revision to the hydrologic and hydraulic analysis for the Hume Freeway crossing and, potential mitigation measures
- Develop a series of guidelines outlining the required format and scope of a planning permit application e.g. content of planning permit application for levee maintenance

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APPENDIX A COMMUNITY CONSULTATION

Floodplain study plan

landowners will be sought later this month as part of a King River floodplain study.

While the prospect of flooding is probably far from many locals' minds as they battle the effects of drought and bushfires, a series of forums (dates and venues for which will be announced opportunity for landholders to voice their opinions on the issue.

The study has been set in motion by the North East Catchment Management Authority and Ruo ral City of Wangaratta, with assistance from consultant Water Technology.

The aim of the study, which focuses on the King River downstream of Lake William Hovell to the Ovens junction, is to develop a management

It is expected to improve understanding of flood behavior, and help NECMA and the rural city to ensure appropriate management of flood prone land.

An information brochure and questionnaire will be distributed in mid-March to landholders adjacent to questionnaire seeks resiflooding. stanty -

INPUT from local plan for the floodplain. A reference committee of landholders, catchment management authority members, and representatives from the Rural City of Wangaratta and Department of Natural Resources and Environment has been established to work with Water Technology.

The study is due for completion in July, with shortly) will provide an the King River. This recommendations from the report to be included dents' concerns about in the rural city's planning scheme.

Re-produced from Wangaratta Chronicle 5 March 2003.

Flood study discussions

COMMUNITY information sessions will be held next week as part of a King River floodplain study. The sessions aim to provide an opportunity for landholders to meet individually with the study team and discuss their flooding knowledge and concerns.

Information collected during the study will be used to produce flood inundation maps for use by the Rural City of Wangaratta and State Emergency Service when responding to major flood events. Sessions will be held next week at:

• Oxley Hall, Snow Road, Tuesday, March 25, 10am to 1pm;

 Moyhu Hall, Moyhu-Glenrowan Road, Wednesday, March 26, 6pm to 9pm; and

• Whitfield RSL Hall, Wangaratta-Whitfield Road, Wednesday, March 26, 10am to 1pm.

For further information, contact Roel von't Steen at the North East Catchment Management Authority of (02) 60437600.

Re-produced from Wangaratta Chronicle 19 March 2003.



Re-produced from Wangaratta Chronicle 21 March 2003.



As part of the community consultation for the King River Rural Floodplain study, this questionnaire has been prepared to seek information from the local residents regarding knowledge of past floods and present flood related concerns.

Your contribution will provide important information to assist the study. Please complete the following questionnaire and return your response to the North East Catchment Management Authority using supplied pre-paid return envelope. If insufficient space is provided to write your response, please attach additional sheets.

Thank you for your time and co-operation. Personal details are optional.

	Name (<i>optional</i>) Address (<i>optional</i>) Contact telephone/fax/e-mail (<i>option</i>) Please indicate your approximate loc	al) ation on the attached map
1.	Have you been affected by floods in the	past, and if so, when (month and year)?
2.	If flooded in the past, what damage appropriate box(s) and provide date of flo	or disruption was experienced? (place tick(s) in ooding if known)
	□ Land flooded - date of flooding	
	Residence and land - date of floodi	ng
	Crop/Pasture damage	
	□ Other damage or disruption (eg acc	cess cut) - date of flooding
3.	If flooded, please describe the flooding flooding)	(place tick(s) in appropriate box(s) and provide date of
	How deep ?	How fast ?
	□ shallow (<0.3m deep)	[]"ponded" or slow flowing
	■ moderate (0.3m to 0.5m deep)	gently flowing
	deep (>0 5m deep)	anickly flowing

King River rural floodplain study

Page 1 of 1

4. Do you have any other comments or information ? (photos or videos of flooding in your area that would be valuable—please indicate if these are to be returned).

5. How are you currently made aware of imminent flooding? e.g. media (radio/TV) warnings, community groups, friends/family.
6. What do you see as the main flooding issues in your area? e.g. flood warning, flood damage, levees, inappropriate development, stock evacuation etc.

7. Three community sessions will be held at various locations within the King River Valley. The aim of the community sessions is to provide an opportunity for landholders to meet individually with the study team and discuss their flooding knowledge and concerns. The sessions are not conduct as a public meeting. Rather individual or small group meetings with the study team will be undertaken. Do you wish to attend and participate in a community information session ?

□ YES □ NO

If you answered YES to question 7, can you provide us with your personal details (at the start of the questionnaire). The first round of community information sessions will be conducted at the locations and times indicated below. Please tick the box for location that suits you best:

- □ Oxley Hall Snow Road Tuesday 25 March 10 am 1pm
- □ Moyhu Hall Supper Room Moyhu-Glenrowan Road Wednesday 26 March 6 pm 9pm
- □ Whitfield RSL Hall Wangaratta Whitfield Road Wednesday 26 March 10 am 1 pm

Thank you for taking the time to complete this questionnaire. Please return using the supplied pre-paid envelope by Friday 21 March 2003.

The King River Rural Floodplain Study is being undertaken for the North East Catchment Management Authority and the Rural City of Wangaratta by a study team led by Water Technology Pty Ltd.

Please note: The information collected by this questionnaire will be used for the sole purposes of the King River Rural Floodplain Study. The information will be gathered and used in accordance with the Victorian Information Privacy Act (2000).

King River rural floodplain study

Page 2 of 2
The study area For more information RURAL CITY OF **Study Contacts** AUTHORITY Roel vont Steen Floodplain Manager Wangaratta North East Catchment Management Authority 1B Footmark Court, WODONGA VIC 3690 Ph: (02) 6043 7600 King River Malcolm Styles General Manager, CivicNET Rural City of Wangaratta Municipal Offices Ovens Street, 3 WANGARATTA VIC 3677 Ph (03) 5722 0888 Study The King River rural floodplain study is being undertaken for the Rural City of Wangaratta and the North East Catchment Management Authority by a study team led by Water Technology Pty Ltd. Information brochure Flooding on Merriang South Road, west of King River Bridge during October 1993 Source:RCOW King River Bridge during October 1993 Source: RCOW What's going to happen in the King River flood study? We need your help! Despite ensuring a long dry spell in recent times, history has shown us that floods can have a Your involvement in the study will be greatly devastating effect on communities along the King Catchment Management Authority (CMA) gain further insights into past floods and the present River. This brochure is to inform you about the King River rural floodplain management study and concerns of the community regarding flooding.

The Rural City of Wangaratta in conjunction with the North East Catchment Management Authority is undertaking a floodplain management study for the King River. This study is aimed at providing improved understanding of flooding, and to assist in future floodplain management and emergency response. This study is jointly funded by the Federal, State and Local governments under the Natural Disaster Risk Management Studies Program

to seek your involvement.

The study area includes the floodplains of the King River between Lake William Hovell and the Hume Freeway (see locality map on other side of brochure).

Wangaratta during Octobe



Flooding on Snow Road Oxley, west of King River Bridg during October 1993 Source:RCOW

This study will involve the following tasks:

- · Consultation with the community to seek local flooding knowledge and concerns. Also to provide feedback of study results.
- Review of previous flood studies
- · Review of the impacts of existing floodplain works such as levees and road embankments.
- · Mapping of flooding within the study area for land use planing purposes
- · Estimation of flood damages
- · Identification of stock evacuation options and stock loss reduction strategies.
- Development of a floodplain management plan aimed at providing a framework for managing existing flooding risk and future development on the floodplain

The study is due for completion by July 2003. At any stage during the study, if you are interested in study progress or have any concerns/information, please feel free to contact the CMA or the City. appreciated as it will help the City and the

This current first stage of the community consultation provides the following ways that you can be involved.

<u>Questionnaire</u>: By filling out the questionnaire included with this brochure and returning it to the CMA (details provided in questionnaire).

Community information sessions : As part of the community consultation, it is proposed to conduct several rounds of local community information sessions during the course of the study.

The aim of community information sessions is to provide an opportunity for interested landholders to meet individually with the staff from the City and CMA and share their knowledge and concerns about flooding.

The sessions will be held at several locations throughout the study area during late March. Details of the locations and times of the first round of community information sessions are provided in the attached questionnaire. If you wish to attend the community information sessions, please complete Question 7 in the questionnaire. The subsequent rounds of the community information sessions will be held in mid year.





Rural Floodplain

FYI 307301-SHM.

Chrowicle 25/7/03

Catchment body learns from local knowledge

INFORMATION ses sions regarding the King River Rural King River Rural Floodplain Study were held in Oxley, Whitfield and Moyhu communities on Tuesday.

North East Catchment Management Authority floodplain manager, Roel Von't Steen, and executive engineer, Steve Muncaster, from Water Technology, specialist water and coastal engineering consultants, were on hand to discuss with King River area residents recently prepared flood inundation maps.

The maps show the flood extent expected during the one in 100 year flood and NECMA and the Rural City of Wangaratta will use the maps to assess suitabil-

the King River floodplain. The community in-

formation sessions al-lowed people to provide their feedback on the maps. Land use planning

and flood mapping are two components of an overall floodplain management plan. Mr Muncaster said

King River residents

ity of development on could expect further meetings in the September/October period to discuss the draft floodplain management plan which will also identify opportunities for people to evacuate stock and identify possible mitigation measures which might be looked at such as works at bridges and road, crossings. Community consultation has been a

strong aspect of the King River Rural Floodplain Study.

Back in March, local landholders completed questionnaires and attended information sessions, providing the study team with valuable information.

"The feedback we've got certainly demonstrated people's knowledge of the river," Mr Muncaster said.



At the Oxley community information session for the King River Rural Floodplain Study, (centre) farmer Brian Read is shown one of the flood inundation maps by (left) North East Catchment Management Authority floodplain manager, Roel Von't Steen, and executive engineer, Steve Muncaster, from Water Technology, specialist water and coastal engineering consultants.

Re-produced from Wangaratta Chronicle 25 July 2003.



King River Rural Floodplain Study Community information sessions

Thank you to the local landholders who responded to the questionnaire distributed in March 2003 as part of the King River Rural Floodplain Study.

A good overall response to the questionnaire was achieved with about 30 responses received from throughout the study area. Also a number of local landholders attended the community information sessions held in late March. This local interest occurred despite the ongoing dry spell and the bushfire threat at the time. Responses to the questionnaire and information sessions provided the study team with valuable information and knowledge about floods in the King River.

Currently a series of flood inundation maps are being prepared. These flood inundation maps will show the flood extent expected during the 1 in 100 year flood. The North East Catchment Management Authority and the Rural City of Wangaratta will use these flood inundation maps to assess the suitability of development on the King River floodplain.

To provide an opportunity for feedback on the flood inundation maps, community information sessions will be held at various locations within the King River Valley. The sessions are not conducted as a public meeting. Rather individual or small group meetings with the study team will be undertaken. The information sessions will be conducted at the following location and times:

Oxley Hall Snow Road Tuesday 22 July 10 am – 12pm

Whitfield RSL Hall Wangaratta –Whitfield Road Tuesday 22 July 2 pm – 4 pm

Moyhu Hall Supper Room Moyhu-Glenrowan Road Tuesday 22 July 6 pm – 8 pm

If you are interested in being involved, please come along to any of the three sessions. Also feel free to bring your neighbours and other interested local landholders.

For further information, please contact Roel Von't Steen at the North East Catchment Management Authority (ph. 02 6043 7600) or Steve Muncaster (ph 03 95589366) at Water Technology (consultant)



King River Rural Floodplain Study Community information sessions

A draft plan for the management of the King River floodplain has been developed on behalf of the North East Catchment Management Authority and the Rural City of Wangaratta.

The draft floodplain management plan aims to promote appropriate development on the King River's floodplain. The draft plan outlines a number of recommendations regarding land use planning, development proposals and flood warning arrangements.

The draft floodplain management plan is available from the North East Catchment Management Authority (<u>www.necma.vic.gov.au</u>) and the Rural City of Wangaratta (<u>www.wangaratta.vic.gov.au</u>) websites. Also limited hard copies will be available from the Oxley Post Office, Moyhu Post Office and Whitfield General Store.

To provide an opportunity for feedback on the draft floodplain management plan, community information sessions will be held at various locations within the King River Valley. The sessions are not conducted as a public meeting. Rather individual or small group meetings with the study team will be undertaken. The information sessions will be conducted at the following location and times:

Oxley Hall Snow Road Tuesday 3 August 10 am – 12pm

Moyhu Hall Supper Room Moyhu-Glenrowan Road Tuesday 3 August 5 pm – 7 pm

If you are interested in being involved, please come along to either sessions. Also feel free to bring your neighbours and other interested local landholders.

For further information, please contact Roel Von't Steen at the North East Catchment Management authority (ph. 02 6043 7600) or Steve Muncaster (ph 03 95589366) at Water Technology (consultant)

APPENDIX B EXISTING FLOODPLAIN FEAUTRES













APPENDIX C REVISED DRAFT FLOOD PLANNING MAPS

























APPENDIX D FLOOD DAMAGES ASSESSMENT

King River rural floodplain study		
DISCOUNT RATE	0.08	
DAMAGES TO ROADS AND BRIDGES		
Mean damage per km Major Sealed roads	\$67,200	
Mean damage per km Minor Sealed roads	\$21,090	
Mean damage per km Unealed roads	\$9,436	
DAMAGES TO BUILDINGS		
Mean potential cost per property	\$23,370	
Mean potential cost per large non-residential property		
WARNING TIME		
Less than 2	0.8	0.9
2 to 12 hours (linear reduction from 0.8 to 0.4)		0.8
Greater than 12	0.4	0.7
MEAN RESIDENTS PER HOUSE (for AAPA)	2.6	
Rural cleaning up costs	Major	Minor
Broadacre mean cost per hectare	\$28	\$50
Intensive mean cost per hectare	\$350	\$350

AGRICULTURAL DAMAGES No. days before pasture death occurs (threshold) 5

	Damages per hectare									
				11-1	ess than th	iresnola da	ays	-		
	Devland	Irrigated	Dryland	Irrigated			Flood			Typical
	pastures	pastures	crops	crops	Vegetables	Grapes	orchard	Tobacco	Hops	horticulture
Jan	\$0	\$90	\$0	\$0	\$5.600	\$2,500	\$6.000	\$2.070	\$1.656	\$5,600
Feb	\$0	\$90	\$0	\$0	\$5,600	\$2,500	\$6,000	\$2,403	\$1,923	\$5,600
Mar	\$0	\$90	\$0	\$0	\$5,600	\$2,500	\$6,000	\$2,737	\$2,189	\$5,600
Apr	\$0	\$90	\$0	\$0	\$5,600	\$2,500	\$6,000	\$3,070	\$2,456	\$5,600
May	\$0	\$90	\$84	\$147	\$5,600	\$2,500	\$6,000	\$320	\$256	\$5,600
Jun	\$0	\$90	\$84	\$147	\$5,600	\$2,500	\$6,000	\$320	\$256	\$5,600
Jul	\$0	\$90	\$84	\$147	\$5,600	\$2,500	\$6,000	\$320	\$256	\$5,600
Aug	\$0	\$90	\$84	\$147	\$5,600	\$2,500	\$6,000	\$320	\$256	\$5,600
Sep	\$0	\$90	\$84	\$147	\$5,600	\$2,500	\$6,000	\$320	\$256	\$5,600
Oct	\$0	\$90	\$84	\$147	\$5,600	\$2,500	\$6,000	\$1,070	\$856	\$5,600
Nov	\$0	\$90	\$84	\$147	\$5,600	\$2,500	\$6,000	\$1,403	\$1,123	\$5,600
Dec	\$0	\$90	\$84	\$147	\$5,600	\$2,500	\$6,000	\$1,737	\$1,389	\$5,600
				IE au	Damages p	er hectare	devie			
			Dadaad	IF gr	Damages p eater than	er hectare threshold	days	1	1	
	Drvland	Irrigated	Dryland	IF gr	Damages p eater than	er hectare threshold	days Flood			Typical'
	Dryland pastures	Irrigated pastures	Dryland broadacre crops	IF gr Irrigated broadacre crops	Damages p eater than Vegetables	er hectare threshold Grapes	days Flood sensitive orchard	Торассо	Hops	Typical' horticulture
Jan	Dryland pastures \$30	Irrigated pastures \$368	Dryland broadacre crops \$100	IF gr Irrigated broadacre crops \$0	Damages peater than Vegetables \$5,600	er hectare threshold Grapes \$9,050	days Flood sensitive orchard \$27,000	Tobacco \$2,070	Hops \$1,656	Typical' horticulture \$5,600
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Jan Feb Mar Apr May Jun Jun Jul Aug Sep Oct Nov	Dryland pastures \$30 \$30 \$30 \$30 \$30 \$30 \$30 \$30 \$30 \$30	Irrigated pastures \$368 \$368 \$368 \$368 \$368 \$368 \$368 \$368	Dryland broadacre crops \$100 \$100 \$100 \$100 \$100 \$100 \$100 \$10	IF gr Irrigated broadacre crops \$0 \$0 \$0 \$170 \$201 \$2233 \$264 \$295 \$3266 \$3268	Damages p eater than vegetables \$5,600 \$5,600 \$5,600 \$5,600 \$5,600 \$5,600 \$5,600 \$5,600 \$5,600 \$5,600 \$5,600	er hectare threshold of \$9,050 \$9,567 \$10,083 \$10,600 \$2,5	days Flood sensitive orchard \$27,000 \$27,000 \$27,000 \$6,000 \$6,000 \$6,000 \$6,000 \$6,000 \$6,000 \$6,000 \$27,000	Tobacco \$2,070 \$2,403 \$2,737 \$3,070 \$320 \$320 \$320 \$320 \$320 \$1,070 \$1,403	Hops \$1,656 \$1,923 \$2,189 \$2,456 \$256 \$256 \$256 \$256 \$256 \$256 \$256 \$2	Typical' horticulture \$5,600 \$5,600 \$5,600 \$5,600 \$5,600 \$5,600 \$5,600 \$5,600 \$5,600 \$5,600

Livestock losses per hectare flooded

300

Study Area	SICAL DAMA	GES IN LSI EV	/ENT						
			NO. large						
			non						Average
		Total area	residential	No. urban	No. urban	No. rural	No. rural		Annual
	Urban	flooded	buildings	buildings	properties	buildings	properties		Damages
	Rural	ha	flooded	flooded	flooded	flooded	flooded.	AAPA	(AAD)
King river rural floodplain	Rural	7,738	0	0	0	78	78	28	\$630,862
Total		7,738	0	0	0	78	78	28	\$630,862

DAMAGES FOR LSI EVENT						
Buildings	Roads	Agriculture	Indirect	Total		
\$947,887	\$735,620	\$2,108,833	\$1,137,702	\$4,930,042		
\$947,887	\$735,620	\$2,108,833	\$1,137,702	\$4,930,042		
19%	15%	43%	23%	100%		

	LSI	AAD
Urban (Buildings)	\$0	\$0
Rural (Buildings & Agriculture)	\$3,100,000	\$400,000
Infrastructure	\$700,000	\$100,000
Indirect	\$1,100,000	\$100,000
Total	\$4,900,000	\$600,000

Dwelling inventory

B	uilding	/prope	erty af	ffected	during	100	year	ARI	flood	event
	····· 0						J			

Street/Lot number	Road	Туре
2	Upper King River Road	Building
6 LP56931	Upper King River Road	Dwelling
5 LP56931	Upper King River Road	Dwelling
2A	Burrowes Road	Building
3A	Burrowes Road and Upper King River Road	Building
CP165789	Upper King River Road	Dwelling
2A	Upper King River Road	Building
9	Cnr Upper King River Road and Unnamed Road	Dwelling
1A	Upper King River Road	Building
PT15	Upper King River Road	Dwelling
1/7	Upper King River Road	Building
PT15	King Valley Road	Building
PC351531	King Valley Road	Building
1 LP72120	King Valley Road	Dwelling
10A	King Valley Road	Dwelling
10	King Vallley Road	Dwelling
1	King Valley Road	Dwelling
9	Edi-Cheshunt Road and King Valley Road	Building
3	Edi-Cheshunt Road	Building
2 LP94402	Edi-Cheshunt Road	Building
4	King Valley Road and Mill Lane	Building
4	Mill Lane	Dwelling
2 PS414323	King Valley Road	Building
4A CL PT4	Edi-Cheshunt Road	Building
1 LP117336	King Valley Road	Building
13B	Gentle Annie Lane	Dwelling
PS409894	Wangaratta-Whitfield Road	Building
16	Wangaratta-Whitfield Road	Building
2 LP85914	Wangaratta-Whitfield Road	Dwelling
1 LP85914	Wangaratta-Whitfield Road	Dwelling
14	Wangaratta-Whitfield Road	Building
13	Wangaratta-Whitfield Road	Building
22B	Unnamed Road near Mahlooks Lane	Building
12	Edi-Cheshunt Road	Dwelling
10	Wangaratta-Whitfield Road	Building
2 PT6 LP126765	Edi-Cheshunt Road and Unnamed Road	Dwelling
8	Edi-Cheshunt Road	Dwelling
PT1	Unnamed Road	Dwelling
1	Unnamed Road	Building
1	Unnamed Road	Dwelling
4	Unnamed Road	Dwelling
2 PS337570	Whitfield Road and Unnamed Road	Building
1A CL J	Wangaratta Road	Dwelling
1A J	Wangaratta Road	Dwelling
8A CL 4	Unnamed Road	Building
11	Unnamed Road	Dwelling
7	Wangaratta Road	Building
4A	Unnamed Road	Building
PT4	Unnamed Road	Dwelling
4BCL	Unnamed Road	Dwelling
1 IP7654	Unnamed Road	Dwelling
1A	Unnamed Road	Dwelling
1A	Unnamed Road	Building
PIA 1		Dwelling
2	Cnr Edi-Meadow Road and Unnamed Road	Dwelling
P12	Unnamed Road	Dwelling
1A	Unnamed Road	Building
6C	Unnamed Road	Building
P16	Unnamed Road	Dwelling
LP133601	Edi-Meadow Road	Building
	GIDDS Lane	Dwelling
35/PTA	Wangaratta-winitileid Road	Dwelling
20	Moynu-Meadow Creek Road	Dwelling
15	Novhu Moodow Crook Road	Dwelling
2 LP204291	Moynu-Meadow Creek Road	Dwelling
	Nuulingal Malk Lalle	Dwelling
	n unans Lalle Oxlov Meadow Creek Read	Dwelling
10	Chicy-Ivieduuw Cieek Rudu	Dwelling
10	On Oxley-Weadow Creek Road	Dwelling
10	Oxley-Ivieduow Creek Road	Dwelling
2 05333546	Oxley-Inication Creek Road & Linnamed Road	Dwelling
2 NI IA	Ovley-Meadow Creek Road & Unnamed Road	Dwelling
PT2 I P63451	Reillys Lane	Dwelling
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