

12 Flood Effects from Gauge Height

Table 12.1 details the date and gauge height reached for the 1993 and the 1974 flood event, as listed in the 1995 HydroTechnology report.

Table 12.1: Flood Data - HydroTechnology

Date	Gauge Height (m)	Gauge Height (m AHD)	Flow (ML/d)	Location
12/10/93	1.895	104.45	10,100	Walsh's Bridge
14/10/93	2.20	102.08	9,700	Nathalia
17/5/74	1.60	-	-	Walsh's Bridge
17/5/74	2.01	-	9,700	Nathalia

Information on historical flood levels for the 1993 and the 1974 event, as supplied by Goulburn-Murray Water is detailed in Table 12.2.

Table 12.2: Flood Data – G-MW

Date	Gauge Height (m)	Location
12/10/93	3.95	Walsh's Bridge
14/10/93	2.20	Nathalia
22/5/74	3.66	Walsh's Bridge
22/5/74	2.01	Nathalia

Information on historical flood levels for the 1993 and the 1974 event, as supplied by Thiess is detailed in Table 12.3.

Table 12.3: Flood Data – Thiess

Date	Gauge Height (m)	Flow (ML/d)	Location
12/10/93	0.91	10,140	Walsh's Bridge
14/10/93	2.178	9,741	Nathalia
22/5/74	3.66	-	Walsh's Bridge
24/5/74	2.32	10,000*	Nathalia

Information on historical flood levels for the 1993 and the 1974 event, as supplied by the Bureau of Meteorology is detailed in Table 12.4.

Table 12.4: Flood Data – Thiess

Date	Gauge Height (m)	Location
12-13/10/93	2.95	Walsh's Bridge
15/10/93	2.2	Nathalia
22/5/74	2.69	Walsh's Bridge
24/5/74	-	Nathalia
24/7/95	2.58	Walsh's Bridge
27/7/95	1.75	Nathalia

The gauge heights shown above, although inconsistent can be used to reach a number of conclusions. Although approximately the same flow was recorded at Nathalia in 1974 as it was in 1993, changes along the river have increased flood levels for the same flow. This is clearly demonstrated in town where the addition of levees has increased levels by approximately 200mm. The second conclusion is the travel time between Walsh Bridge and Nathalia appears to be between 2 to 3 days. Thirdly, a single flood gauge should be placed at Walsh's Bridge and Nathalia such that a single reading of gauge height is taken.

From survey there are currently four (4) one meter gauge boards upstream of Walsh's Bridge with a zero gauge at 100.98mAHD and three (3) one meter gauge boards upstream of the Murray Valley Highway Bridge at Nathalia with a zero gauge at 100.01mAHD.

Modelling Results

From the hydraulic model the flood height for different ARI events was extracted at Walsh's Bridge and Nathalia (Murray Valley Highway). Table 12.5 summarises the results.

Table 12.5: Flood Levels from Hydraulic Model

ARI (years)	Gauge Level (m AHD)	Location
5	103.94	Walsh's Bridge
	101.87	Nathalia
10	104.16	Walsh's Bridge
	102.13	Nathalia
20	104.32	Walsh's Bridge
	102.22	Nathalia
50	104.49	Walsh's Bridge
	102.32	Nathalia
100	104.61	Walsh's Bridge
	102.39	Nathalia
500	104.77	Walsh's Bridge
	102.49	Nathalia

Community input to the Floodplain Management Plan has been sought throughout the process of its development. The aims of the consultation were to:

- clearly articulate the study's aims and objectives to the community;
- establish and maintain the interest and enthusiasm of the community in the study;
- ensure that the community has ownership of the study by involving them in the decision making process;
- ensure that views of all target audiences are heard and there is a two-way communication process established;
- utilise established community networks and links to disseminate information to the wider community;
- utilise the forums as a commencement of the flood awareness program;
- ensure that all material presented is in a clear and concise plain English manner; and
- establish clear lines of communication between the community and the consultants at the outset of the project.

The key elements of the consultation undertaken were:

- a) collection of data and community input through direct surveys
- b) maintaining public awareness of the Study through a newsletter and newspaper articles
- c) utilising the membership of the Community Reference Group (CRG) as a conduit for community views throughout the Study
- d) obtaining informal community input through public forums in Nathalia following the development of mitigation options
- e) presenting the draft Floodplain Risk Management Study and Plan for comment via a period of public exhibition.

13.1 Stage 1 Consultation

The key objective of the first stage of the consultation process was to collect information from the community. In order to assist in the collection of data a survey form was devised. This is provided in Appendix E. The focus of the information collected was to assist in understanding the nature of flooding within the study area.

A survey together with a newsletter was mailed to all residents within the study area, using Council's database. The objective of the newsletter was to raise the community awareness of the project; provide an opportunity for the community to forward feedback on flood history and form a Community Reference Group from community member interested in being part of the advisory group.

Council sent out during the month of June 2002. A total of 61 surveys were returned, from residents of various locations within the study area.

13.2 Stage 2 Consultation

The first public meeting with the CRG was held on the 31 July, 2003 in Nathalia. The objectives of the meeting were to:

- Inform the community on the process of the Floodplain Management Plan
- Discuss and verify the initial modelling results based on their experiences of flooding in the area

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- Undertake a site inspection with members of the community.

13.3 Stage 3 Consultation

A second public meeting was held with the Community Reference Group in Nathalia on the 30 November 2004. The objective of this meeting was to discuss and inform the group of the risks of flooding and asking them to identify any ways that flood effects could be minimised in Nathalia.

Following this meeting a second survey was sent out during the month of December 2004 to the residents informing them of the risks of flooding and asking them to identify any ways that flood effects could be minimised in Nathalia. Various options were identified and have been discussed further in Section 10 of this report. A summary of the residents' responses is found in Appendix E

13.4 Stage 4 Consultation

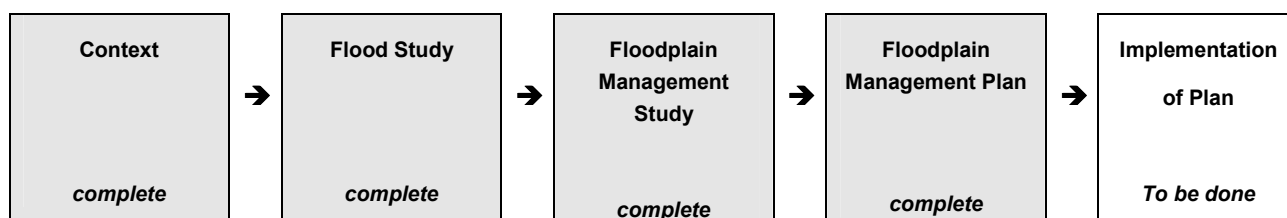
The draft Floodplain Management Plan will be placed on public exhibition during the second week of December 2005 (08, December 2005). Following the exhibition period, comments on this report will be taken into account and the Reports finalised and submitted to the GBCMA, Moira Shire Council, DSE and the CRG.

14 Conclusions

The purpose of the study is to prepare a comprehensive Floodplain Management Plan for the township of Nathalia. The recommended plan comprises of a number of appropriate structural and non-structural flood mitigation measures, which will reduce the social and economic impacts of flooding within the Nathalia district up to the 100-year ARI flood standard.

As part of this study a comprehensive set of flood inundation maps for the study area have been prepared. These can be used by the Victoria State Emergency Service (VICSES), Moira Shire Council, Goulburn Broken Catchment Management Authority, Department of Sustainability and Environment and the community as part of a flood warning system as well as provide a basis for appropriate flood controls in the Moira Shire planning scheme.

The study has been undertaken using a risk management approach in accordance with AS/NZ code. The steps involved in formulating and implementing a Floodplain Management Plan are shown below.



This report identifies and compares various management options, including a multi-criteria assessment of their social, economic and ecological impacts, together with opportunities to maintain and enhance river and floodplain environments.

This report also reports on the flood study which characterises the flooding behaviour of the catchment and the results from the hydraulic model produced. The results of the hydraulic model provided information on flood hazard and a means of assessing the impact of options emerging from the floodplain management studies on flooding behaviour and flood hazard.

Often, no single floodplain management option will suffice by itself. The determination of the optimum mix of measures, as undertaken in this study, involved extensive community consultation and the careful balancing of social, economic and environmental issues, as well as flooding issues. In assessing the impact of proposed developments on flooding behaviour elsewhere, it is incorrect to assess developments on an isolated and ad hoc basis. Their effects must be assessed on a cumulative basis within the context of the Floodplain Management Plan. This includes both the effect of development on flood behaviour and the number of people who may have to evacuate.

14.1 Floodplain Management Measures

14.1.1 General

A wide range of floodplain management measures were developed for the township of Nathalia and presented in Section 10. These measures are summarised in Table 14.1 below.

Table 14.1: Floodplain Management Measures Considered

Structural Measures (Flood Modification)	Land Use Planning Measures (Property Modification)	Flood Emergency Measures (Response Modification)
Retarding Basins	Land Use Zoning	Community Awareness
Levees	Voluntary Purchase	Community Preparedness
Bypass Floodways	Building Lines	Flood Prediction and Warning
Channel Improvements	Floor Level Controls	Emergency Response Plans
Flood Gates		Emergency Recovery Plans
House Raising		Insurance
Flood Proofing Buildings		

These options were presented to the Community in the form of a brochure in December 2004. Feedback was received and the multi-criteria assessment undertaken. The outcomes of this process indicated which options were considered appropriate for detailed investigation.

Section 11 presents the detailed investigations undertaken for each of these options and the final recommendations made for inclusion in the Nathalia Floodplain Management Plan.

14.2 Final Recommendations

The final recommendations for floodplain management measures are summarised in Table 14.2 below.

Table 14.2: Summary of Recommended Floodplain Management Measures

Management Option	Objective	Recommended for inclusion in the FMP
Flood Modification Measures		
Raise Levee for 100-year ARI with 300mm freeboard (Option 1)	Protect town	Yes
Raise Levee for 100-year ARI with 600mm freeboard (Option 2)	Protect town	No
Open up northern floodway by removing the levees on both the left and right banks between the old railway bridge and Drain 13 (Option 3)	Protect town	No (see option 5)
Open up northern floodway by placing a 50m siphon on the farm channel to the north of the show grounds, lower the east-west road by 0.3m over 50m between Allotments 4B and 4K and reconstruction of the irrigation layout in Allotment 4B. Open up the western floodway by including a 50m siphon for Channel 38/12 adjacent to Chinamans weir (Option 4)	Protect town	No (see option 5)
Option 3 and 4 combined (Option 5)	Protect town	No
Construct an overflow channel to the south east of town directing flow from the Broken Creek into the Broken River system (Option 6)	Protect town	No
Open up the southern floodway by placing a 100m siphon on channel 38/12 (Option 7)	Protect town	No
Option 3, 4 and 7 combined (Option 8)	Protect town	No
Remove the railway embankment between north of town located within the northern floodway (Option 9)	Protect town	No

Table 14.2: Summary of Recommended Floodplain Management Measures (cont.)

Management Option	Objective	Recommended for inclusion in the FMP
Property Modification Measures		
New flood maps	Show level of flooding and therefore development controls applying to property	Yes
Land Use Zoning	Ensures consistent, equitable, and compatible land management within flood prone areas.	Yes
Voluntary Purchase	Removes development and people from high hazard areas	No
House Raising	Raises development above flood planning levels in flood affected areas	No
Flood Proofing	Minimises the potential impacts of flooding	No
Response Modification Measures		
Flood Warning	Enable and persuade the community to take the appropriate actions to increase safety and reduce the damages associated with flooding	Yes
Community Awareness & Preparedness	Ensure that the community is fully aware that floods are likely to interfere with normal activities in the floodplain	Yes
Emergency Plans	<p>Provide a sound basis for planning, preparation, response and recovery activities by VICSES and other emergency service providers during flood event</p> <p>The flood inundation maps devised as part of this report should be incorporated</p> <p>The access during flood should be addressed with the Murray Valley Highway inundated during significant events and the town is isolated</p>	Yes

14.2.1 Discussion of Preferred Structural Mitigation Scheme

During a 100-year ARI type flood, the township of Nathalia is vulnerable to flooding for long periods of time, likely to be more than ten days. The level of over the floor flooding is extensive with more 80% of the buildings affected including dwelling, retail, office, commercial and industrial buildings.

Ideally, opening up floodways is desirable as it lowers the flood height. Hydraulic analysis has however shown small reduction in flood height outside the town levees, leaving the town still vulnerable to flooding during a repeat of a 100-year ARI type flood.

All options, except the levee treatment to the 100-year ARI standard, would require floor levels to be set 300mm above flood level within town, which would mean finished floor heights would be some 900 to 1,200mm above ground. Also, subdivision would be prohibited with floodway areas as defined under the Victoria Planning Provisions.

Initially levees with 600mm freeboard above the 100-year ARI flood height were considered. To raise the levees with this amount of freeboard would raise concerns from the community. The previous refusal by sections of the residents to accept the visual intrusion caused by the levees, even at the existing height, resulted in the absence of any levee in sections of Weir Street, indicates that increasing the existing levee height to provide 600mm freeboard over significant lengths is likely to be strongly opposed.

There are sections of the levee system which are not obstructing the creek view from any residences, including the majority of levee 3 and short sections of levees 1 and 2. These sections could be raised as an earthen bank, with the remaining levee provided by a different solution. The Goulburn Broken Catchment Management Authority has advised, given the nature of flood flows, the freeboard could be reduced to 300mm if the existing levee is structurally capped or similar.

The recreational structural treatment of providing a 1.2m wide shared foot/bike path along the majority of the levee would provide sufficient 300mm freeboard above the 100-year ARI flood height. This in turn would offer protection to the planning and building standard, but must be complimented with awareness, flood warning, and alerting programs. The existing levees would require raising by generally 200mm.

This option has support for both the Moira Shire Council and the Goulburn Broken Catchment Management Authority.

At an estimated cost of \$1.5 million (including 40% contingencies) this option could be implement over a two year time frame with funding available on an equal basis from Australian, State and Local Governments. The elements of the preferred structure mitigation scheme include:

- temporary barrier system for 500m for Weir Street and Murray Valley Highway;
- provision of recreational 1.2m wide shared concrete foot/bike path along the existing levees for some 4,900m along levees 1 and 2;
- earthen strengthening along 2060m of levee 3 and portion of levee 2; and
- Lift and extend Levee 1 by 200m.

14.2.2 Discussion of Non-Structural Mitigation Options Recommended

The recommended non-structural options to be implemented into the Nathalia Floodplain Management Plan are as follows.

Planning Scheme Amendment

- It is recommended that the Moira Shire Council amend its planning scheme to include the revisions to the planning zones and overlays as outlined in Section 7.
- It is recommended that the Moira Shire Council and the Goulburn Broken Catchment Management Authority adopt the 100-year ARI flood levels shown on the inundation maps as outlined in Section 7.

Flood Warning Arrangements

It is recommended that the Bureau of Meteorology continue to provide flood warning for Nathalia with the following trigger levels at Walsh's Bridge are included:

- Minor: 1.5m
- Moderate: 2.58m
- Major: 3.34m

The recommendations for the warning process are:

- Undertake a calibration of the Casey Weir gauge during a large flow event.
- Replace existing flood level boards at Walsh's Bridge and Nathalia with a single flood level gauge. Also places the flood boards downstream of Walsh's Bridge.
- Add a telemetry (ERTS) stream gauge and link to the Bureau of Meteorology at the following sites:
 - Broken Creek at Nathalia (optional)
 - Broken Creek at Walsh's Bridge
 - Broken Creek and Katamatite (streamflow and rain gauges already operating)
 - Boosey Creek at Tungamah (streamflow and rain gauges already operating)
- Telephone alerting arrangements to communicate impending floods to the affected community (Expedite System as used for Benalla and Shepparton-Mooroopna).
- Develop and prepare flood education information and community flood response guidelines.

The capital cost for the above would require approximately \$60,000 and approximately \$5,000 per annum for maintenance costs. In the past funding for flood warning capital has been provided equally by the Australia and State governments with the on-going maintenance provided from the local beneficiaries, via local municipalities or CMAs. Note Nathalia gauge would require additional capital of \$17,000 and \$2,500 for annual maintenance.

Dissemination of Flood Warning

In general the flood warning dissemination detailed in the Moira Shire Flood Sub-Plan is adequate. However, it is recommended that dissemination channels are made clearer, perhaps with a diagram detailing the steps undertaken and the ways that the message is to be delivered to the community.

Also there is considerable dependence on telephone landlines or mobile coverage for the successful passage of information and directions. Many components of the telephone system are subject to flooding or, in the case of overhead lines, breakage during floods. In addition, floods cut normal access routes to many sections, so sound communications links are vital to a successful flood

operation. If telephone lines are inoperable and mobile coverage is not available other forms of communication such as radio linkages should be incorporated into the plans.

The Moira Shire may also explore the viability of automatic telephone dialling as an alternative to deliver flood warnings to individual properties. Telephone alerting arrangements to communicate impending floods to the affected community are now in place including the Expedite System as used in Benalla and Shepparton-Mooroopna.

Flood Response

The flood inundation maps for emergency response, as discussed in Section 7 should be incorporated into the Moira Shire Flood Sub-Plan (2002).

Also the Moira Shire Sub-Flood Plan (2002) details three local VICSES units within the Moira Shire, Yarrowonga, Cobram and Numurkah. The plan for Nathalia should state which unit is the first point of contact for Nathalia and where the office which co-ordinates activities for Nathalia is located. If a site is established for use in Nathalia it is important that an alternative location is established outside of town if the levees become overtopped and the town is inundated.

Access to and from Nathalia during a large flood event should also be addressed in the Moira Flood Sub-Plan (2002). The main access road to Nathalia, the Murray Valley Highway, is inundated during a significant event.

Access during flood events is not only by roads. Consideration should be given in the emergency planning activity to where boats can be launched or berthed in quiet floodwaters. This approach should be considered as a last resort due to the risks involved in operating boats during floods. Development planning should also consider where helicopters could safely land in flood time.

Access also covers the continued operation of essential services, e.g. water supply, sewerage and power. The need to be able to shut down critical facilities, such as pump stations, by physical presence at the site, or by remote control is a flood access issue that must be included in flood plans.

Community Awareness and Preparedness

It is recommended that the Moira Shire in conjunction with the VICSES and the GBCMA develop a program to increase community awareness of existing flood risks, flood emergency response and flood warning arrangements. The program should at least outline contact phone numbers, context of local flooding issues, flood warning arrangements and tips for reducing damage and enhancing safety.

Flood Recovery

The location of evacuation centres and how well they are fitted out to cater for relatively large numbers of people of all ages is an essential item to be addressed in the Moira Shire Sub-Flood Plan (2002) for Nathalia. It is essential that these centres are above all risk of flooding which for Nathalia is out of town.

The importance of such centres, and the community's knowledge of their existence, cannot be overstressed. It is essential that the Moira Shire Sub-Flood Plan (2002) clearly establishes the location of evacuation centres, what facilities they have and what and where are alternative sites in the event of either overcrowding or threat of greater depths of flooding.

The sites should be chosen on the basis of:

- the available space for short term sleeping accommodation;
- the available space for storage of belongings;

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- the capacity of the site to supply sufficient hygiene facilities; and
 - the capacity of the site to service the food and beverage requirements of the evacuees.

Department of Natural Resources and Environment (DNRE) (2000). Flood Data Transfer Project.

Department of Natural Resources and Environment (2000), Rapid Appraisal Method (RAM) for Floodplain Management

DI Smith, (1980) The Assessment of Urban Flood Damage in Australia: Methods, Problems and Recommendations, CRES, ANU, Australian Water Resources Council, Proceedings of the Floodplain Management Conference, Canberra, Australia, 7-10 May 1980

DI Smith et al, (1986) An Approach to Assessing the Effectiveness of Urban Floodplain Management in Australia, Hydrology and Water Resources Symposium 1986, Griffith University, Brisbane 25-27 November, 1986

Findlay Consulting (1997). Nathalia Levee Audit Report.

Hill, P.I., Meheepala, U.K., Mein, R.G., and Weinmann, P.E. (1996) Empirical Analysis of Data to Derive Derived Losses for Design Flood Estimation in South-Eastern Australia. Report 96/5. Cooperative Research Centre for Catchment Hydrology, Monash University, Victoria, Australia.

Goulburn-Broken Catchment Management Authority (GBCMA) (2001). 1993 Flood Level Reconnaissance.

HydroTechnology (1995a). Documentation and Review of 1993 Victorian Floods: Volume 1: Flood Summary Report. Department of Conservation and Natural Resources.

HydroTechnology (1995b). Documentation and Review of 1993 Victorian Floods. Volume 4: Broken River Catchment Floods October 1993. Department of Conservation and Natural Resources.

IEAust (1987). Australian Rainfall and Runoff – Volume 2. Institution of Engineers, Australia.

IEAust (1997a). Australian Rainfall and Runoff. Book 2: Design Rainfall Considerations. Institution of Engineers, Australia.

IEAust (1997b). Australian Rainfall and Runoff. Book 5: Estimation of Design Flood Hydrographs. Institution of Engineers, Australia

King, I.P. (2003); RMA2 – A Two Dimensional Finite Element Model for Flow in Estuaries and Streams, Version 7.1; Resource Management Associates, 2003.

Moira Shire (2000), Municipal Emergency Management Plan (Flood Plan).

Resource Management Associates (1998) *RMAPLT Version 2, Users Guide*.

Resource Management Associates (1999) *RMAGEN A Program for Generation of Finite Element Networks, Version 5, User Instructions*.

Siriwardena, L. and Weinmann, P.E. (1996). Development and Testing of Methodology to Derive Areal Reduction Factors for Long Duration Rainfall. Working document 96/4. Cooperative Research Centre for Catchment Hydrology, Monash University, Victoria, Australia.

Sinclair Knight Merz (SKM) (1998). Broken Creek Management Strategy – Volumes 1 and 2. Lower Goulburn Waterways.

Sinclair Knight Merz (2000). Shepparton-Mooroopna Floodplain Management Study – Draft Hydrology Report. City of Greater Shepparton.

SMEC (2004), Cowra and Gooloogong Floodplain Management Studies – Draft

SMEC (2003), Wollondilly River and Mulwaree Ponds Floodplain Risk Management Study and Plan

State Rivers and Water Supply Commission (SRWSC) (1978). Nathalia Flood Mitigation Report. November 1978.

Willing and Partners Pty. Ltd. (1994). RAFTS-XP Runoff Analysis & Flow Training Simulation with XP Graphical Interface. Version 4.0. WP Software 1994.