

# 2017

## Wimmera Floodplain Management Strategy



### VISION

"Build a flood resilient community", where Wimmera communities, businesses, government agencies and Traditional Owners are aware of flooding and are actively taking measures to manage their flood risks to minimise the consequences to life, property, community wellbeing and the economy.



LIFE



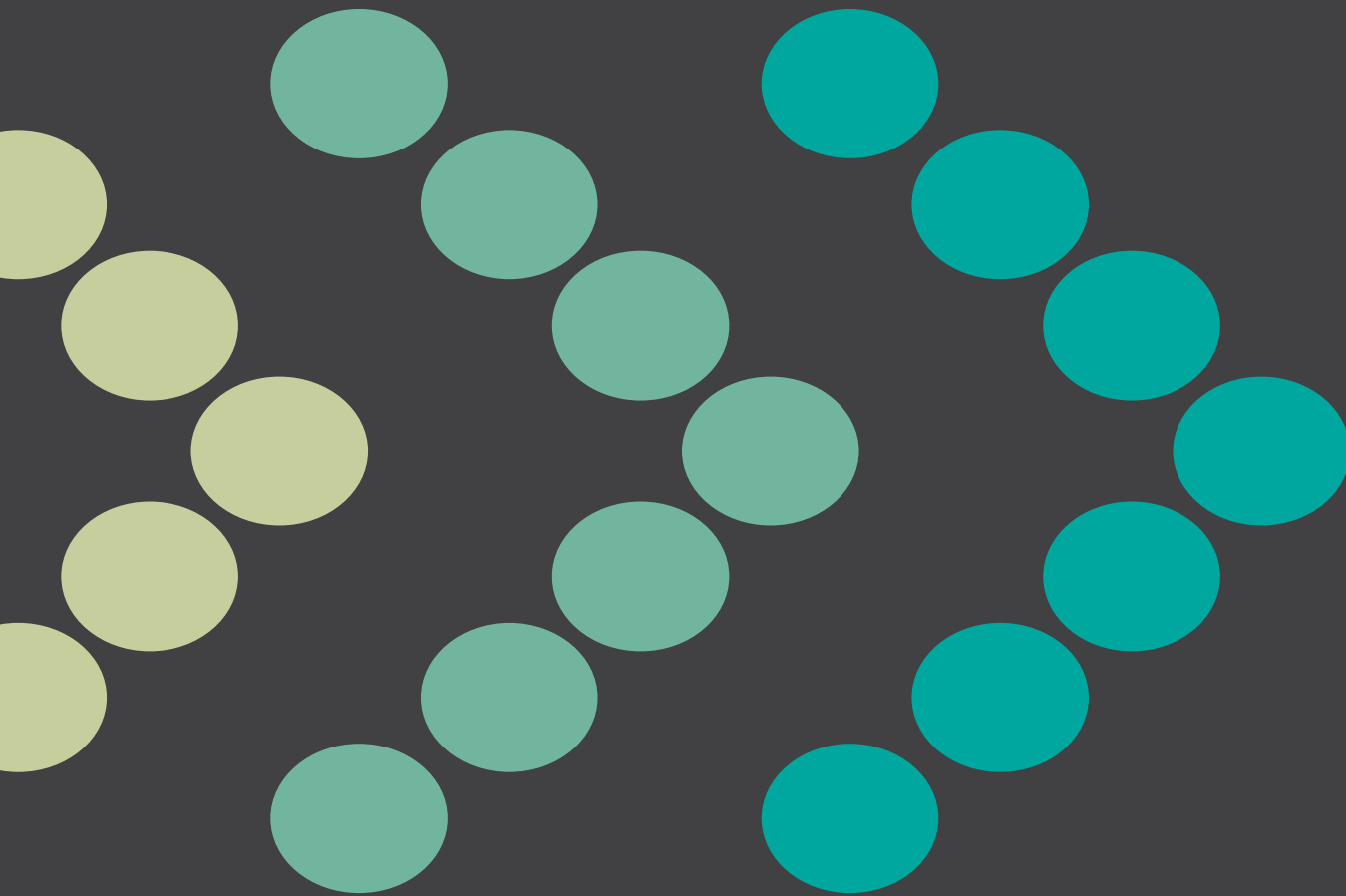
PROPERTY



COMMUNITY



ECONOMY



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Australian Government



# Wimmera Floodplain Management Strategy - Forward

The purpose of the Wimmera Floodplain Management Strategy (Wimmera FMS) is to provide:

- a regional planning document for floodplain management
- a regional work program to assist with future investment priorities.

The strategy delivers the relevant policies and actions of the Victorian Floodplain Management Strategy (Victorian FMS) that was informed by the Victorian Floods Review and the Victorian Parliament Environment and Natural Resources Committee Inquiry into Flood Management Infrastructure of the 2010-11 floods.

## **The Victorian Floodplain Management Strategy Vision is:**

*Victorian communities, businesses and government agencies are aware of flooding and are actively taking measures to manage their flood risks to minimise the consequences to life, property, community and wellbeing and the economy.*

The Victorian FMS sets out policies, accountabilities and actions that will help implement the Victorian Government's response to those inquiries. It also clarifies organisational roles and accountabilities to ensure continual improvement in all aspects of floodplain management to ensure Victoria is better protected.

This Wimmera FMS is the starting point for operationalising the policies, actions and accountabilities of the Victorian FMS at a local scale. The key aim of this strategy is for all agencies with flood emergency management functions to align their priorities in an agreed 3-year rolling regional work plan - see appendix A.

At a regional level, the Wimmera FMS is directly linked to the Wimmera Regional Catchment Strategy (RCS), explained further in section 1. At a local level the Wimmera FMS will influence local government planning schemes and Flood Emergency Management Plans (FEMP). The relationship with other strategic documents is shown in figure 1.

The Wimmera FMS is a joint document between, LGAs, VICSES, GWMWater, Wimmera CMA, traditional owners and other partner agencies for example VicRoads and the Bureau of Meteorology. It recognises and builds on previous floodplain management works and planning undertaken by the community in partnership with government authorities.

## **Wimmera Floodplain management Strategy Vision**

*"Build a flood resilient community", where Wimmera communities, businesses, government agencies and Traditional Owners are aware of flooding and are actively taking measures to manage their flood risks to minimise the consequences to life, property, community wellbeing and the economy.*



1999 steering committee



LIFE



PROPERTY



COMMUNITY



ECONOMY



2016/17 steering committee

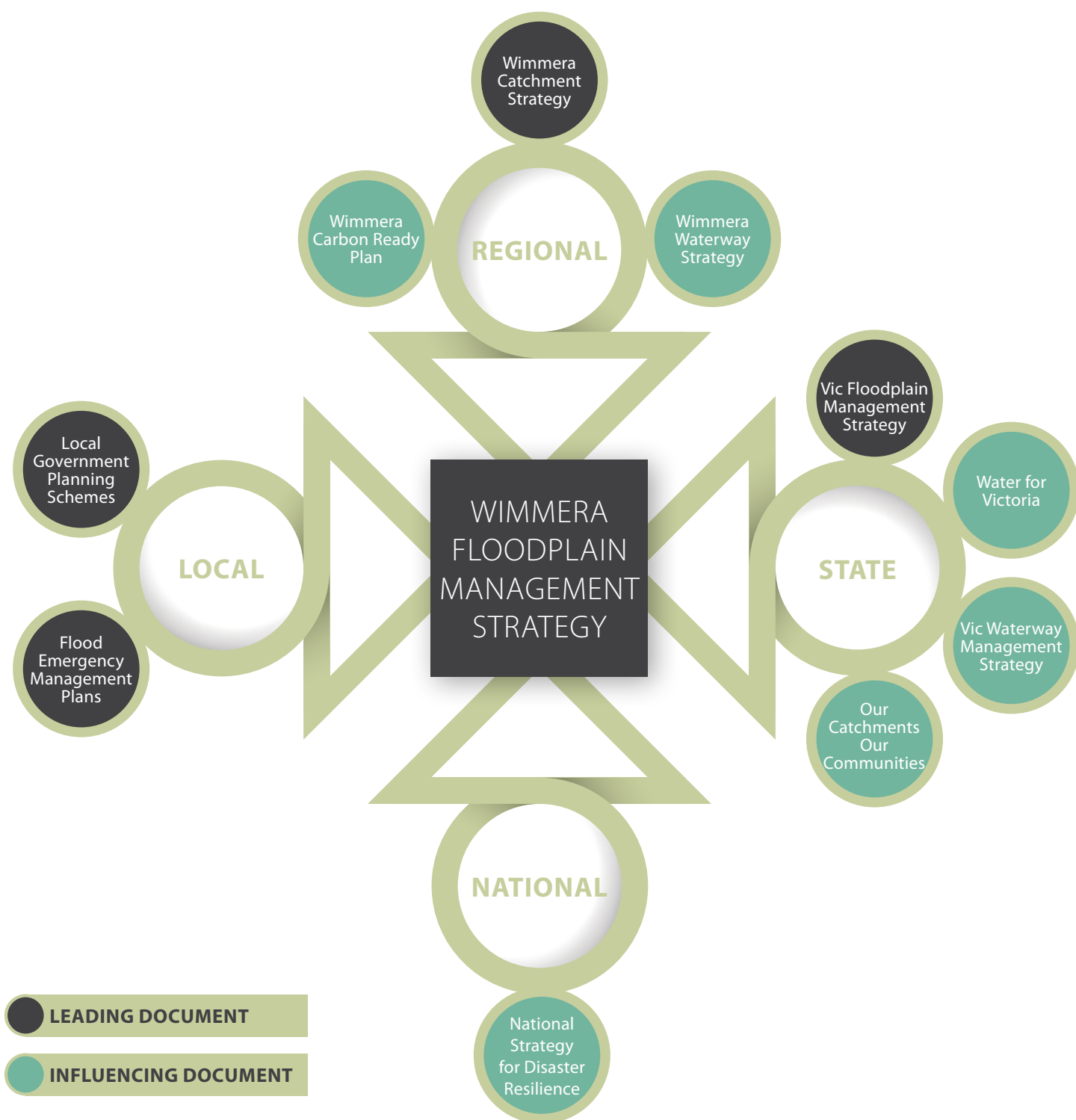


Figure 1: Strategic links to Wimmera FMS

The presentation of the strategy has been divided into the following sections:

- Wimmera FMS development process including governance and community engagement processes
- Background/regional overview included strategic links
- Risk Methodology
- Other considerations that influence priority setting – this also includes discussion about each LGA, its characteristics and floodplain management risks identified.
- An analysis of current risk level management
- Workplan - a three year rolling workplan with agreed priority actions – supported by an extensive list of actions.
- A description of the proposed monitoring framework to support the strategies development.



# 1. Wimmera FMS Development Process

## Development

The Wimmera FMS development process (figure 2) involved:

- Review of the Wimmera Floodplain Management Strategy 1999;
- An assessment of flood risks across the region;
- Risks were then assessed against what stakeholders believed to be the regional community's tolerance for those risks; and
- A range of mitigation measures were then explored, before a prioritised list of actions was developed.

The development of the Wimmera FMS involved discussions with a range of agencies with floodplain management responsibilities or with responsibilities that can influence the management of water or assets at risk of flood waters. It involved relating their understanding of flood risk to overall catchment flood risks.

The Wimmera FMS has prioritised future mitigation actions for the region (see appendix A). Priority has been given to measures that reduce unacceptable risks to stakeholders and the community and willingness of agencies to undertake the action. Mitigation measures include;

- Strategic plans for land use;
- Improvements to flood warning;
- Structural mitigation options such as levees;
- Emergency response and recovery arrangements; and
- Appropriate community education and engagement.

At the local level, flood mitigation measures have been investigated and assessed through detailed flood studies that have captured 95% of the Wimmera floodplain. Local mitigation measures may include improvements to Total Flood Warning Systems, changes to land use planning controls, changes to Municipal Flood Emergency Plans, and improvements to flood mitigation infrastructure.

## Governance and stakeholder engagement

The Wimmera CMA Board's Business and Planning Committee (B & PC) agreed on the following governance structure for the development of the Wimmera FMS. This structure allowed for a number of levels of engagement with stakeholders and the community.

- The Wimmera CMA B & PC oversee the project on behalf of the Wimmera CMA Board;
- Establish a steering committee with representatives from Local Government, VICSES, GWMWater and Barengi Gadjin Land Council;
- Given the multi-agency ownership of the document, that the Steering Committee will have decision making powers about the content and approval;
- Steering Committee be chaired by the Wimmera CMA Chief Executive Officer;
- Utilise Municipal Emergency Management Planning Committees (MEMPC's) in each of the local councils (7 different councils within and around the Wimmera CMA boundary) to liaise across emergency management agencies at local government level to ensure local and relevant information is discussed, analysed, prioritised and supported by those with responsibility and accountability as determined by the state strategy; and
- In relation to project management it is proposed that:
  - The Program Manager will be the Manager Statutory and Strategy; and
  - The Project Manager will be the Floodplain Management Team Leader.

In addition DELWP stipulated that Regional Floodplain management Strategies must be released for a minimum of one month public consultation period to seek comment on the draft strategy.



Figure 2: Process for work plan development





Wimmera River near Jeparit 2011 | Image credit: Wimmera CMA



## 2. Background

### *Flooding in the Wimmera*

Flooding is a regular event across the Wimmera's 30,000km<sup>2</sup> landscape (see table 1). Floods severely disrupt communities by causing, property damage, personal hardship, regional economic losses injury and loss of life.

It is well documented that Aboriginal people in the Wimmera have had a long term connection with both the land and water. Waterways in the Wimmera are recognised as both important spiritual places but also as locations where significant Aboriginal cultural heritage exists. The link between these places and Aboriginal people was recognised in 2005 when the Federal Court recognised Traditional Owners non-exclusive native title rights over a part of their original claim area. Much of this area includes Wimmera floodplains.

Early development and settlement of the Wimmera's towns were along waterways. In some cases levees were constructed to prevent floodwater impacting on buildings.

Original farming homesteads were located, just above the floodplain high water marks often clearly identified by vegetation change.

Much of the region's agricultural prosperity is based upon fertile floodplains. Farmers manage land in recognition that damaging floods in one year can benefit crops in following years.

Over the decades many rivers and streams have had stream gauges (figure 3) built within their bed and banks to provide stream flow or stream height information (see table 1). In more recent times some of these locations have incorporated real-time telemetry to further improve the timeliness and accuracy of information for flood forecasting and response agency planning.

Many Wimmera towns also have detailed flood studies which provide vital information for land development as well as flood emergency management planning.

Floodplains play an important function in the management of floods, waterways and the health of the wider environment. The Victorian Floodplain Management Strategy (Victorian FMS) acknowledges that wetlands on floodplains reduce the impacts of flooding by holding and slowing floodwater. The vegetation on and adjacent to waterways and wetlands also act as sediment traps that filter nutrients from catchments and help to protect water quality. Opportunistic connectivity between rivers, wetlands and floodplains is important for many fish species to complete their life cycle and for nutrient exchange between habitats.



Wimmera River upstream of Horsham 2011 | Image credit: Wimmera Mail Times



Table 1: Flood History in the Wimmera

Month/Year	River/Stream	Towns Affected	Peak Flow Estimate at Horsham Gauge (ML/D)	Comment
October 1894	Wimmera River	Horsham, Glenorchy, Dimboola and Jeparit	24,792	5% AEP Flood event (1 in 20 Year ARI flood event)
August 1909	Wimmera River Yarriambiack Creek	Horsham, Glenorchy, Warracknabeal, Dimboola and Jeparit	38,880	Larger than 1% AEP event (Larger than 1 in 100 year ARI flood event)
September 1915	Wimmera River Yarriambiack Creek	Horsham, Glenorchy, Warracknabeal, Dimboola and Jeparit	27,648	Between 5% AEP & 2% AEP event (Between 20 year & 50 year ARI event)
September 1916	Wimmera River	Horsham and Glenorchy	23,242	Between 10% AEP & 5% AEP event (Between 10 year & 20 year ARI event)
August 1923	Wimmera River	Horsham	25,056	5% AEP Flood event (1 in 20 Year ARI flood event)
October 1973	Wimmera River	Glenorchy	15,266	Between 20% AEP & 10% AEP event (Between 5 year & 10 year ARI event)
October 1974	Nhill Swamp	Nhill		10% AEP Flood event (1 in 10 Year ARI flood event)
August 1981	Wimmera River Yarriambiack Creek	Horsham, Warracknabeal, Dimboola and Jeparit	23,879	Between 10% AEP & 5% AEP event (Between 10 year & 20 year ARI event)
October 1983	Wimmera River	Horsham	25,312	5% AEP Flood event (1 in 20 Year ARI flood event)
September 1988	Wimmera River	Glenorchy	21,005	larger than 10% AEP Flood event (larger than 1 in 10 Year ARI flood event)
October 1996	Wimmera River	Dimboola	19,198	10% AEP Flood event (1 in 10 Year ARI flood event)
September 2010	Wimmera River	Glenorchy	11,723	Less than 20% AEP Flood event (smaller than 1 in 20 Year ARI flood event)
January 2011	Wimmera River MacKenzie River Mt William Creek Yarriambiack Creek Dunmunkle Creek	Navarre, Glenorchy, Halls Gap, Rupanyup, Horsham, Natimuk, Dimboola, Warracknabeal	33,000	Close to 1% AEP Flood event (close to 1 in 100 year flood event)
September 2016	Wimmera River MacKenzie River Dunmunkle Creek	Rupanyup		5% AEP Flood event

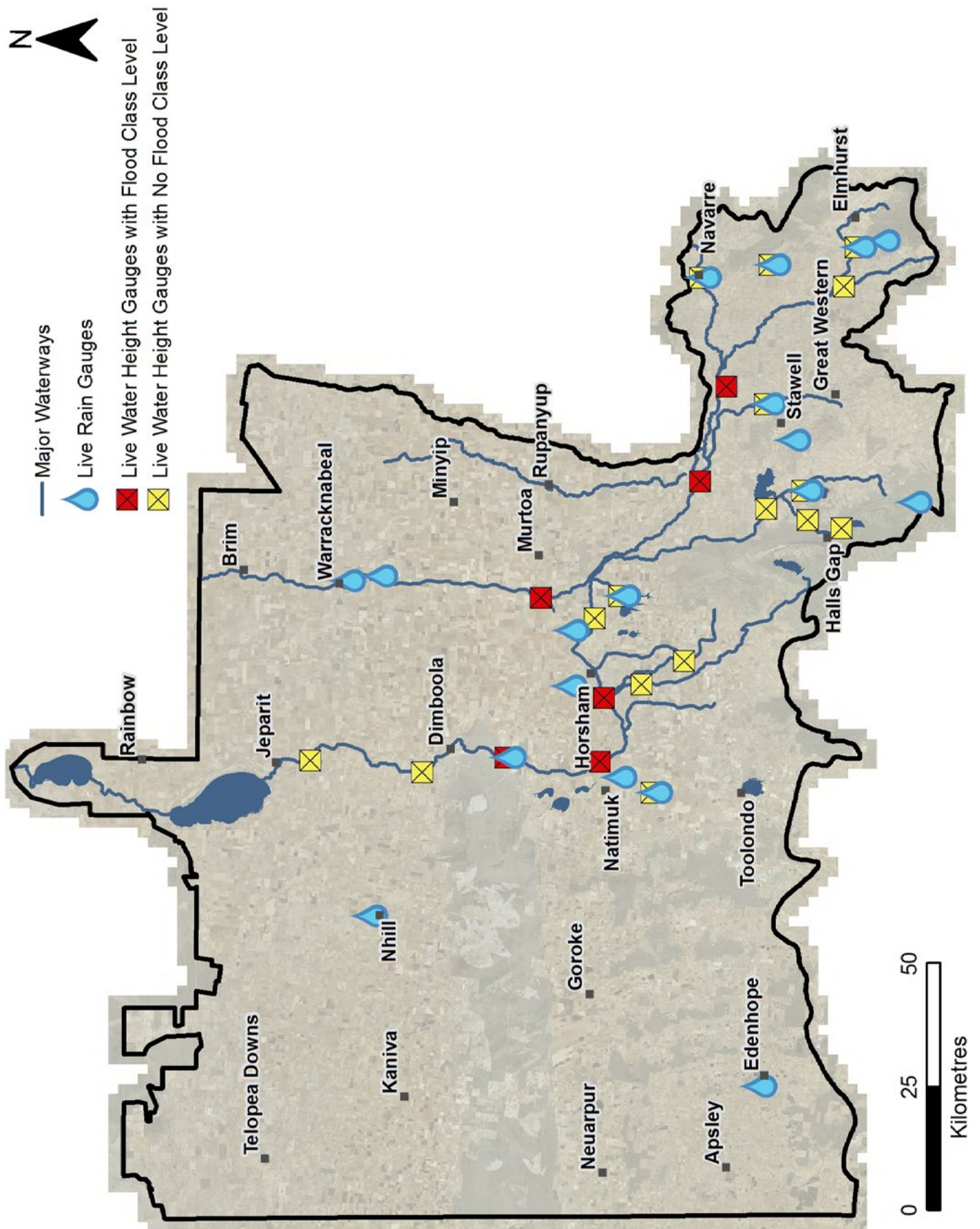


Figure 3: Existing distribution of stream gauges and pluviographs for the Wimmera flood warning network



## Strategic context

Victoria has a long and proud history of Floodplain Management. The 1998 Victorian Flood Management Strategy was the first document of its kind to share floodplain management understanding and knowledge, and many principles presented remain relevant today.

As floodplain management is a shared responsibility between Australian Government, Victorian Government and Local Governments, the Victorian FMS aligns with both Victorian and National approaches to emergency management and disaster resilience.

The 2009 National Strategy for Disaster Resilience describes a disaster-resilient community as one that works together to understand and manage the risks it confronts. It further states that disaster resilience is the collective responsibility of all sectors of society, including all levels of government, business, the non-government sector and individuals.

The Victorian FMS supports the National Strategy by:

- Developing systems and processes to improve the quality of flood maps;
- Developing maps that show a range of flood probabilities, to better regulate land use in areas subject to flooding;
- Considering appropriate changes to land use planning and building codes; and
- Ensuring that local inputs are considered when developing solutions to local issues.

The Victorian FMS also has four objectives that are relevant to the Wimmera FMS including:

- Encouraging communities to act responsibly to manage their own risks;
- Reducing legacy issues to minimise exposure to future flood risk and consequence;
- Not making things worse; and
- Providing support to emergency services by focusing on prevention activities.

### **Wimmera Floodplain Management Strategy Vision**

*"Build a flood resilient community", where Wimmera communities, businesses, government agencies and Traditional Owners are aware of flooding and are actively taking measures to manage their flood risks to minimise the consequences to life, property, community wellbeing and the economy.*

The 2012 Victorian Emergency Management Reform White Paper reinforced the 'all-hazards all-agencies' approach to emergency management through strategic priorities including building community disaster resilience and streamlining governance arrangements.

The Victorian Emergency Management Act 2013 implemented many of the reforms from the White Paper, repealing most of the 1986 Act. The reforms in the 2013 Act include:

- Formally establishing the State Crisis and Resilience Council as Victoria's peak emergency management advisory body;
- Establishing Emergency Management Victoria as the responsible agency for the coordination and development of whole-of government policy for emergency management in Victoria;

- Establishing the State and Regional Emergency Management Committees;
- Establishing the Emergency Management Commissioner as the successor to the Fire Services Commissioner with an overarching management role for major emergencies; and
- Establishing the Inspector General for Emergency Management to provide assurance to the Government and the community regarding Victoria's emergency management arrangements.

Water for Victoria has also strongly influenced the development of the Wimmera FMS, in particular the acknowledgement of Aboriginal peoples connection with land and water and their involvement in the development of the strategy.

There is also a strong focus in the Wimmera FMS on achieving shared benefits and triple bottom line outcomes. This is consistent with both the Water for Victoria and Our Catchments Our Communities- *framework for integrated catchment management*.

The following approach has been applied when considering integrated catchment management through the Wimmera FMS:

- Strengthen community engagement in regional planning and priority setting;
- Clarify roles and responsibilities of key agencies in floodplain and catchment management;
- Strengthen coordination of partners implementing the regional strategies; and
- Improve state and regional floodplain management reporting using a consistent set of indicators.

Figure 1 shows how the Wimmera FMS links with national, state, regional and local strategies and plans.

The Wimmera Regional Catchment Strategy (RCS) has two relevant, twenty-year objectives and four, six year management measures related to this strategy. The management measures have been used to develop the Wimmera FMS objectives.

### **20 year objectives**

Eighty percent of riverine floodplain areas have accurate modelled flood mapping incorporated into council planning schemes. Such information is included in council and community supported response plans.

Net gain in extent and quality of floodplain Ecological Vegetation Class.

### **6 year management measures:**

Improve knowledge of floodplains and their flood characteristics, including the improvement of flood overlays.

Manage floodplains to minimise the risk or damage to people and property.

Enhance the ecological values of floodplains.

Achieve a balance between social, economic and environmental values of floodplains.

Figure 4 presents the program logic summary for the Wimmera FMS. This is based on more detailed risk program logics developed for the Victorian Floodplain program, which is explained in more detail in appendix C. Regional risk assessment

# 3. Regional Risk Assessment

## Background

The assessment of flood risk is an important input towards the determination and prioritisation of future floodplain management activities within the Wimmera FMS. Once the risk is understood, management activities to educate, reduce, contain or mitigate can be considered.

The Wimmera FMS considers the following activities as critical to achieving the vision of *“building a flood resilient community”*:

- Improving our understanding of floodplain risk;
- Delivery and operation of total flood warning systems;
- Implementation and ongoing use of statutory land use planning provisions;
- Education and engagement of the community; and
- Construction and management of flood mitigation structures.

Using the DELWP developed methodology, developing an evidence-base for effective risk management decisions and fostering consistent baseline information allows for risks to be managed transparently across regions and priorities for investment to be determined. This is consistent with state and national emergency management reform agendas and is aligned with the requirements of the Victorian Floodplain Management Strategy. Details of the methodology are provided Appendix B.

## Program Logics

State developed program logics were applied to the Wimmera FMS objectives and actions. These are shown in Appendix C.

Outcomes for the region have been identified including and differ slightly from those developed for State identified risks;

- Improving knowledge of floodplains and their flooding characteristics;

- Manage floodplains to minimise risk or damage to people and property;
- Enhance the ecological value of floodplains; and
- Achieve a balance between social, economic and environmental values of floodplains.

A representation of the alignment between the two strategies is presented below in figure 5. This allows the Wimmera FMS to align with both the VFMS and the Wimmera RCS.

## Risk Method

DELWP has developed a consistent approach to desktop risk assessment that has been applied in the development of the Wimmera FMS. This involves:

- A rapid appraisal of flood risk methodology, and
- An appraisal tool for the assessment of the service provided by Total Flood Warning Systems relative to the level of flood risk.

The two methodologies aim to provide a simplified appraisal tool that can be used to rapidly gain an understanding of firstly flood risk and then warning service provision relative to this risk. These are used to guide decision making rather than determine it. Stakeholder consultation and local knowledge were used to confirm or refine the risk assessment when making decisions about which actions to make and in what priority from the collective list.

The rapid risk appraisal of flood risk, assesses flood risk via financial indicators including density, annual average damages and population (see following examples). The process does not consider either the existing level of flood risk understanding or mitigation that has previously been undertaken.

The Total Flood Warning System assessment tool considers both the current level of flood understanding as well as any mitigation that may have occurred. It provides an assessment of the existing level of service that is provided within the unit compared with what could be expected in that region based upon the level of flood risk that is understood to exist.

Each of the assessments was carried out across the Wimmera region for a number of floodplain management units (figure 8).

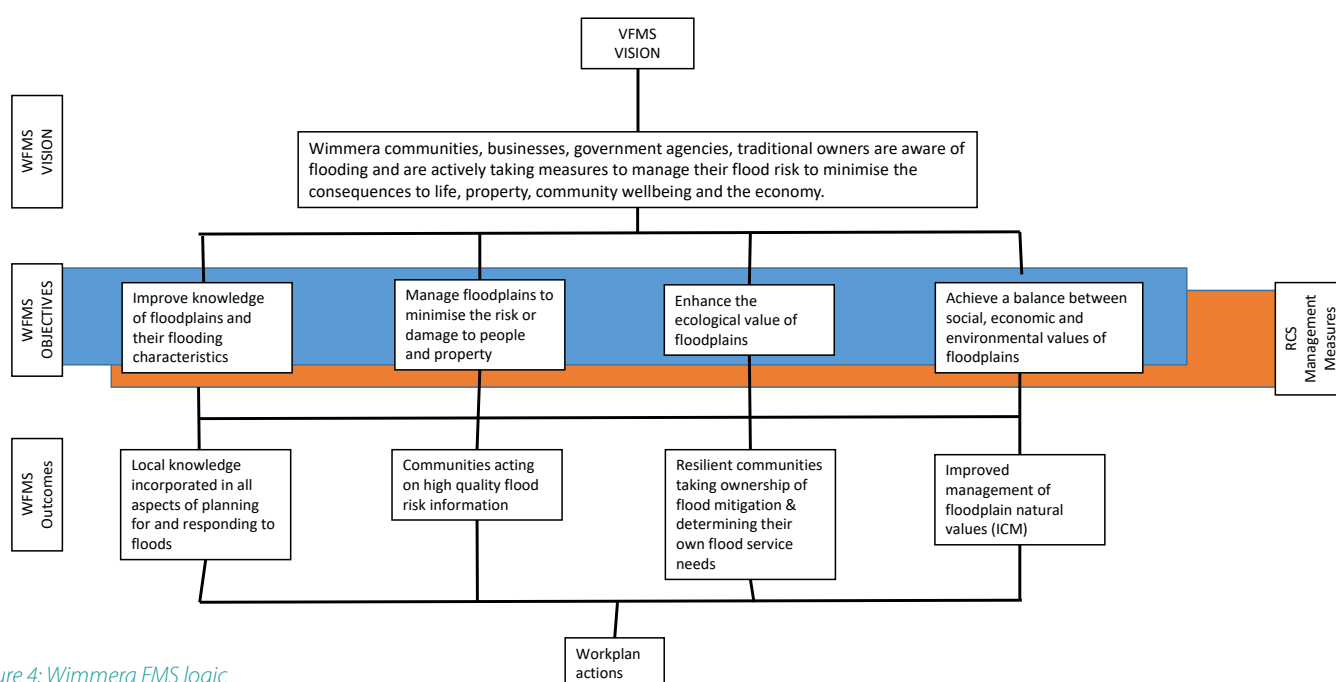


Figure 4: Wimmera FMS logic





## WFMS Outcomes

## State Writers Group Outcomes

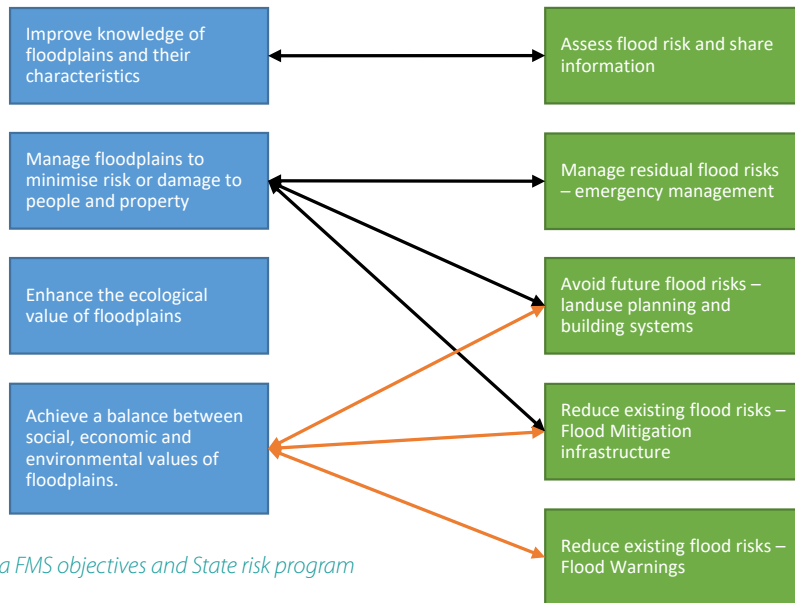


Figure 5: Alignment of Wimmera FMS objectives and State risk program logic outcomes

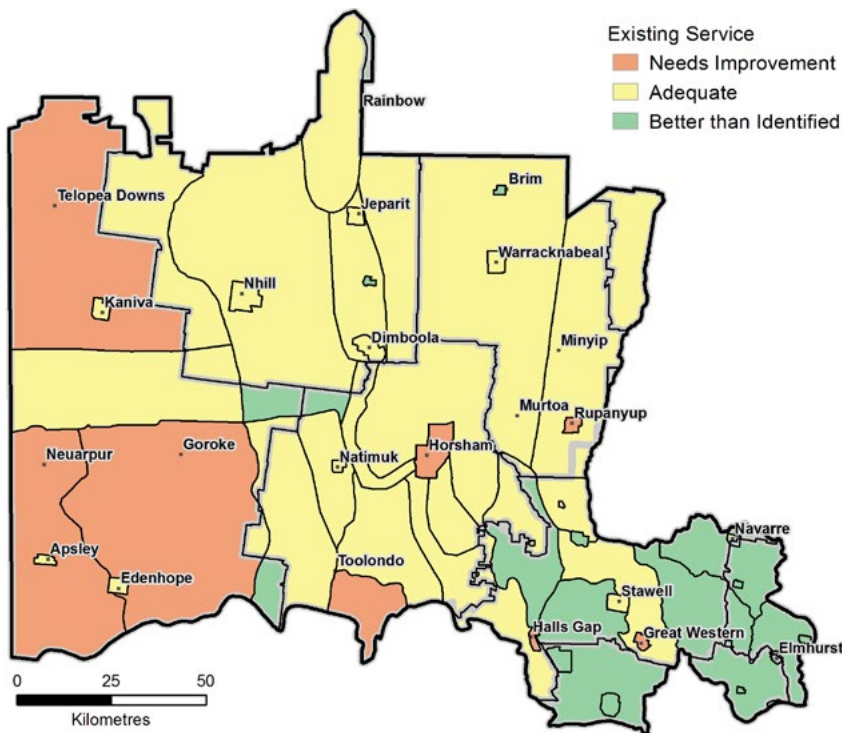
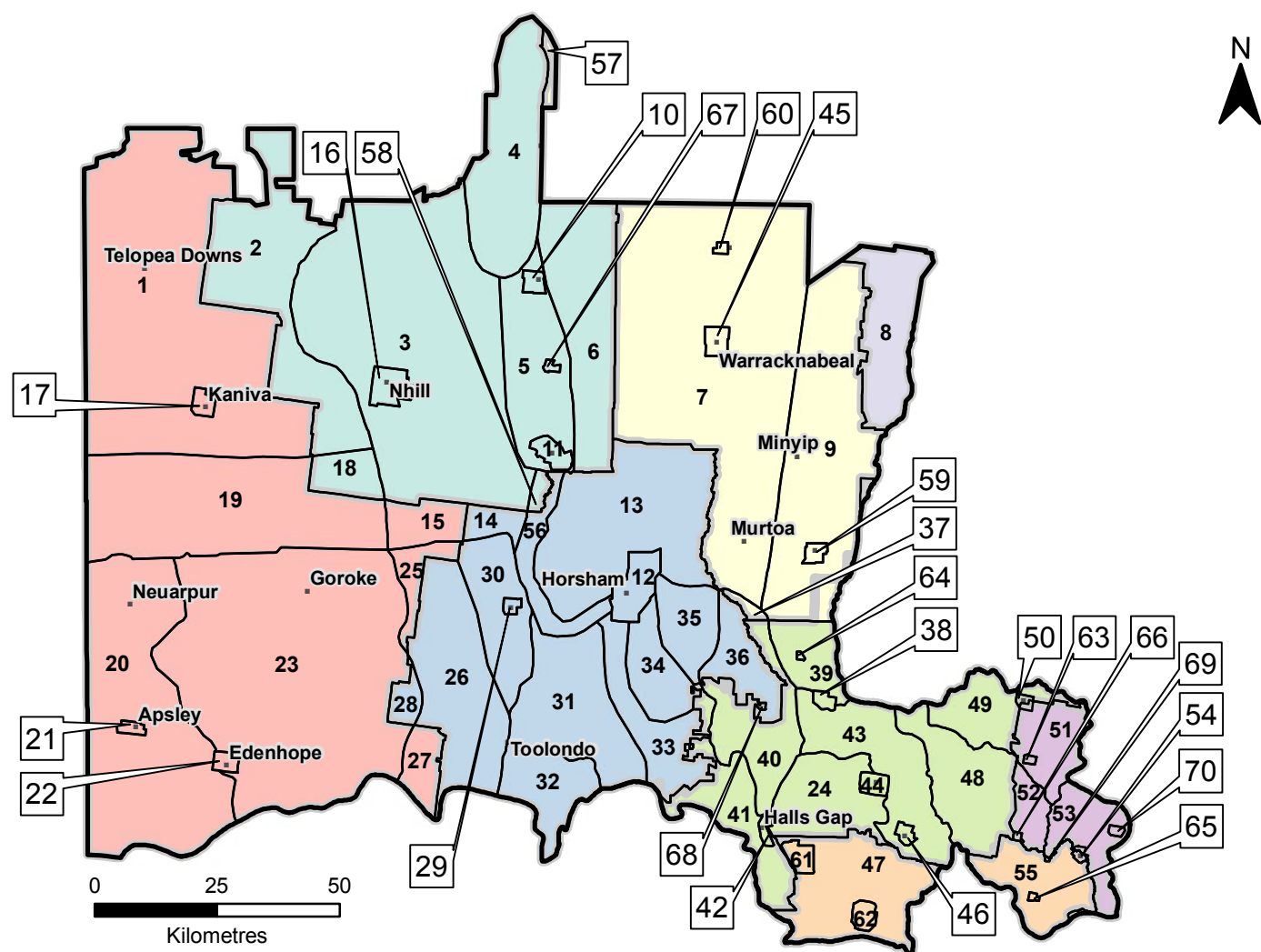


Figure 6: Example flood TFWS assessment presenting the existing service minus the identified risk for Wimmera councils.

LGA	Number of management units			AAD	AAPA	Area inundated 1% AEP	Number of management units overall risk rating		
	Overall	Urban	Rural				High	Moderate	Low
West Wimmera	10	3	7	317,000	1	37	0	1	9
Hindmarsh	11	4	7	1,318,000	28	159	0	4	7
Pyrenees	6	3	3	135,000	6	50	0	1	5
Northern Grampians	13	6	7	3,064,000	99	481	1	8	4
Ararat	7	5	2	256,000	12	121	0	2	5
Buloke	1	0	1	2,000	0	0	0	0	1
Horsham	15	3	12	4,297,000	171	332	2	3	10
Yarriambiack	7	3	4	1,343,000	54	138	2	1	4

The largest damages (AAD) and the greatest population affected (AAPA) are in Horsham Rural City. The greatest number of management units with a high or moderate risk rating are in Northern Grampians Shire.

Figure 7: Example flood risk assessment information for Wimmera CMA area Shire Councils



- |  |  |  |
|--|--|--|
| ◆ 1: WWSC North from Little Desert NP          | ◆ 24: NGSC Upper Mt William Creek System     | ◆ 47: ARCC Upper Mt William Creek System |
| ◆ 2: HSC North from Little Desert NP           | ◆ 25: WWSC Douglas Depression                | ◆ 48: NGSC Wimmera River                 |
| ◆ 3: HSC Heritage River System                 | ◆ 26: HRCC Douglas Depression                | ◆ 49: NGSC Wattle Creek System           |
| ◆ 4: HSC Terminal Lakes System                 | ◆ 27: WWSC Douglas Depression 2              | ◆ 50: Navarre                            |
| ◆ 5: Heritage River System Lower               | ◆ 28: HRCC West Millicent Coast Lakes System | ◆ 51: PSC Wattle Creek System            |
| ◆ 6: HSC East Yarriambiack Creek System        | ◆ 29: Natimuk                                | ◆ 52: PSC Mt Cole Creek System           |
| ◆ 7: YSC Yarriambiack Creek                    | ◆ 30: HRCC Natimuk Creek System              | ◆ 53: PSC Upper Wimmera River System     |
| ◆ 8: BSC Dunmunkle Creek System                | ◆ 31: HRCC Norton Creek System               | ◆ 54: Elmhurst                           |
| ◆ 9: YSC East Dunmunkle Creek System           | ◆ 32: HRCC Toolondo Creek System             | ◆ 55: ARCC Mt Cole Creek System          |
| ◆ 10: Jeparit                                  | ◆ 33: HRCC Mackenzie River System            | ◆ 56: Heritage River System Upper        |
| ◆ 11: Dimboola                                 | ◆ 34: HRCC Burnt Creek System                | ◆ 57: YSC Terminal Lakes System          |
| ◆ 12: Horsham                                  | ◆ 35: HRCC Wimmera River System              | ◆ 58: HSC East Heritage River System     |
| ◆ 13: HRCC North                               | ◆ 36: HRCC Mt William Creek System           | ◆ 59: Rupanyup                           |
| ◆ 14: HRCC Little Desert                       | ◆ 37: YSC Mt William Creek System            | ◆ 60: Brim                               |
| ◆ 15: WWSC Wimmera North                       | ◆ 38: Glenorchy                              | ◆ 61: Pomonal                            |
| ◆ 16: Nhill                                    | ◆ 39: NGSC Dunmunkle Creek System            | ◆ 62: Moyston                            |
| ◆ 17: Kaniva                                   | ◆ 40: NGSC Lower Mt Williams Creek System    | ◆ 63: Landsborough                       |
| ◆ 18: HSC Little Desert NP System              | ◆ 41: Grampians National Park                | ◆ 64: Wal Wal                            |
| ◆ 19: WWSC Little Desert NP System             | ◆ 42: Halls Gap                              | ◆ 65: Warrak                             |
| ◆ 20: WWSC Millicent Coast West Flowing System | ◆ 43: Concongella Creek System               | ◆ 66: Crowlands                          |
| ◆ 21: Apsley                                   | ◆ 44: Stawell                                | ◆ 67: Antwerp                            |
| ◆ 22: Edenhope                                 | ◆ 45: Warracknabeal                          | ◆ 68: Dadswell Bridge                    |
| ◆ 23: WWSC Millicent Coast Lakes System        | ◆ 46: Great Western                          | ◆ 69: Eversley                           |
|  |  | ◆ 70: Glenpatrick                        |

Figure 8: Wimmera floodplain management risk assessment units.



Through analysis and the review of the Wimmera Flood Strategy (1999), it was apparent that the Wimmera CMA's undertaking of multiple flood studies during the intervening period placed the region in a strong position to manage existing and future flood risk.

The analysis information was presented to each of the stakeholder groups with the aim to develop proposed actions under the following categories;

- I. Flood Investigation.
- II. Planning & Building Systems.
- III. Urban & Stormwater flood Management.
- IV. Warnings & Emergency Management.
- V. Flood Mitigation Infrastructure.
- VI. Flood Insurance.
- VII. Flood Risk Information Assessment & Sharing.
- VIII. Other.

A full list of actions has been included in the draft work plan in Appendix A.

Stakeholders are yet to prioritise these actions into a three year rolling work plan, although have determined an initial categorisation of three separate timespans that actions will be completed. It is expected that the implementation committee will focus on this task as its immediate task.

## Other considerations

### Important regional and community infrastructure

Important regional and community infrastructure can be defined as infrastructure that is relied upon by residents, businesses and industry on a day to day basis. Such infrastructure may include premises, assets, goods or social systems. It can exist at the town scale, local scale or whole of region. Such infrastructure may also be important to the critical functionality of other towns and regions (e.g. highways, airports, power sub-stations and generation systems).

Neither the rapid risk assessment or TFWS assessment directly consider potential impacts to important regional and community infrastructure stemming from flooding. They also did not consider previous actions such as floodplain studies or mitigation solutions stemming from them.

Identifying important regional and community infrastructure at risk assessment will ensure that an appropriate risk category will be allocated for an area with significant infrastructure where two areas may otherwise be considered equivalent. Through the development of the Wimmera FMS, stakeholders have identified important regional and community infrastructure.

Table 2 lists types of infrastructure that is considered regionally important and some examples.

Type	Examples	Wimmera specific experiences in historic floods
Emergency management facilities	Police stations, fire stations, hospitals and ambulance services, VICSES facilities, incident control centres.	<ul style="list-style-type: none"> <li>VICSES Horsham Unit – isolated</li> <li>Horsham Ambulance Station - isolated</li> </ul>
Utilities	Water, sewage, electricity (generation and distribution), gas, communication	<ul style="list-style-type: none"> <li>Water supply infrastructure – concern for supply in small towns (Pomonal, Moyston)</li> <li>Horsham substation at risk of flooding</li> </ul>
Transport	Roads, railways, bridges, and airports.	<ul style="list-style-type: none"> <li>Western Highway – major transport route between Melbourne &amp; Adelaide cut for periods of time</li> </ul>
Food supply	Irrigation infrastructure, livestock exchange, intensive animal industries (e.g. Broiler Farms), abattoirs, food production and distribution facilities	
Finance	Banks, ATMs,	
Education	Schools, TAFEs, universities, kinder gardens	<ul style="list-style-type: none"> <li>Holy Trinity Lutheran School - isolated</li> <li>St Brigids College - isolated</li> <li>School bus routes – cut for long periods</li> </ul>
Security	Military facilities	
Recreation	Sports facilities, tourist attractions, walking/cycling trails	<ul style="list-style-type: none"> <li>Dimboola Recreation Reserve facilities - flooded above floor level</li> <li>Big Koala - isolated</li> <li>Grampians National Park – road cut, potential landslide and damage to park assets</li> <li>Dadswells Bridge Hall – isolated</li> <li>Horsham Aquatic Centre - isolated</li> </ul>
Social	Organised sports, community events, annual festivals	

Table 2: At risk critical infrastructure



# 4. Analysing Risk Treatment Service Levels

The review of existing risk treatment service levels based on the new risks identified in Part 3 include:

- Planning Scheme controls;
- Structural flood mitigation works and their management arrangements; and
- Total Flood Warning System services.

A description of the process used to make decisions is outlined in appendix C.

## Planning scheme controls

Victoria's statutory land use planning system operates through Planning Schemes, which are subordinate legislation under the *Planning and Environment Act 1987*. Planning Schemes set out policies and provisions for the use, development and protection of land.

Planning Schemes are prepared using the Victoria Planning Provisions (VPPs). The VPPs contain a comprehensive set of planning provisions for Victoria, including compulsory state and local policies, strategic priorities, zones and overlays.

The VPPs require LGAs to consider flood risks when preparing Planning Schemes (strategic planning), and in making land use planning decisions (statutory planning). Statutory land use planning is an integral part of the optimum suite of flood mitigation measures for every flood-prone area.

Planning Schemes contain a Local Planning Policy Framework that includes a Municipal Strategic Statement that explains an LGA's strategic direction for the management of floodplains. The Local Planning Policy Framework also contains Local Planning Policies that provide guidance on how the LGA will exercise its discretion under a zone or overlay.

For instance the schedules to the floodplain overlays, Land Subject to Inundation Overlay (LSIO) or Floodway Overlay (FO) each provide an ability to schedule out minor works where a permit would not be required.

Municipal Strategic Statements provide LGAs with an opportunity to achieve an integrated approach to planning across all areas of council. This is reinforced by clearly expressed links to the LGA's plan. The Statements are deliberately dynamic; they enable community involvement in their ongoing review.

LGAs develop and refine their strategic directions in response to the changing needs of their communities.

Statutory planning controls include zones and overlays that regulate the use and development of land. The VPPs include one zone (urban floodway zone) and three overlays (floodway, special building and land subject to inundation overlays) directly relevant to flood-prone areas.

Nearly all flood studies undertaken as a result of the previous flood management strategy (1999) have developed proposed planning scheme controls upon their completion. Around 95% of the Wimmera floodplains have had detailed studies completed or have studies that are currently underway at the time of writing.

Despite this work, not all flood studies have been incorporated into planning scheme controls. These are detailed in the council descriptions in section 5. In practice Councils normally refer applications for development in floodplains to Wimmera CMA for comment and Wimmera CMA will use the most up to date information for their response. However if councils do not incorporate the most recent flood information into their planning schemes as overlays there is a risk that some development may not be referred to the CMA or appropriately conditioned. There is also a risk that development applications are referred to the CMA unnecessarily creating inefficiencies for both authorities and proponents. It is agreed that no further flood studies will be updated or reviewed in an individual local government until all planning schemes have been updated to existing flood information. It is worth noting there are a number of towns that require stormwater studies to be included into planning schemes. These are highlighted in section 5.

## Structural flood mitigation works and their management arrangements

A number of structural measures are used to mitigate the effects of flooding, including levees, channel modifications, bypass floodways, retention basins, dams and floodgates. Collectively, these measures are referred to as flood mitigation infrastructure.

The 2010-11 Wimmera floods revealed serious deficiencies in the management arrangements for flood levees as well as physical infrastructure that performed levee functions during times of flooding (for instance River weirs and no longer operational channel banks). Responsibilities were unclear and accountabilities were not assigned.

As outlined in the Victorian FMS, a 'beneficiary pays' principle will determine the management and funding arrangements for flood mitigation infrastructure into the future. Some of the Wimmera's flood mitigation infrastructure is in rural areas, where it provides private benefits by protecting agricultural production. The Victorian FMS identifies two main types of public benefits: community and environmental benefits.

The Wimmera FMS, documents information on structural flood mitigation works, as well as identify whether the current service levels are appropriate or should improve (see appendix A).

If no formal management arrangements can be established it will be assumed that the infrastructure will be privately managed or not managed at all. A likely consequence of this is that the flood mitigation infrastructure will continue to deteriorate. This may in some circumstances impact on emergency management and land use planning.

Where existing flood mitigation infrastructure exists the Wimmera FMS documents information including: where possible the service level, the main beneficiaries and the management arrangements. Any gaps in knowledge or gaps in the management arrangements should also be documented.

The Wimmera FMS also identified where new flood mitigation infrastructure is desirable or whether there is a plausible case for modifying or expanding the existing flood mitigation infrastructure.

For example:

- Levees exist at Jeparit, Dimboola and Horsham. None of these have formal management arrangements and they are not being managed. They offer limited protection from major floods in that they do not provide protection in events up to the 1% AEP level. They all require formal arrangement to be established and appropriate maintenance if they are to be of any use. This is a priority action outlined in the workplan in appendix A;
- A recommendation of the Natimuk flood study included the creation of a levee along Lake Avenue that was ultimately not supported by the community and council have determined to reassess community interest in future years;
- A recent flood study for Warracknabeal identified the need for a combination of temporary and permanent levees for the township. This has been designed and costed and awaits funding; and
- A flood study for the Dunmunkle Creek identified the removal of redundant water storages and is the single highest priority for the protection of Rupanyup. GWMWater are currently working with local government on how to best deliver this outcome.

There are numerous private levees that have been established over the years, many of which are not maintained. These will not be maintained by authorities unless a clear case for public benefit can be established.

More detail is provided in section 5 and appendix A.

## Total flood warning systems (TFWS) services

The Australian Institute for Disaster Resilience in their Australian Emergency Manual Series (Manual 21) describes the TFWS as “the full range of elements that must be developed if flood warning services are to be provided effectively. It recognises that flood warning systems are multi-faceted in nature and that their development and functioning involves input from a number of agencies with specialised roles to play.” They are more than just flood gauges. The concept is presented in Figure 9. The Wimmera region has been recognised (see case study - Victorian Floods Review below) for its achievements in this area. Many of the TFWS actions identified in this strategy involve future developments that have been identified in past flood studies which provide the basis to develop more specialised warning systems relative to the flood risk identified.

Considerable work was undertaken in the Wimmera between 2005 and 2009 to enhance the service of telemetered gauges in the catchment aimed at enabling the provision of flood forecasting services from the Bureau of Meteorology (BoM). The level of gauge infrastructure established along with ongoing improvements, such as the Natimuk catchment in 2014 for the provision of information such as stream level and rainfall intensity, is considered to be some of the best in the State.

Whilst the gauges themselves function very well, there is confusion about the ongoing costs of operation and maintenance. Many gauges are utilised for multiple purposes including water delivery, environmental water flows and flood warning and as a result there are many parties that have an interest in them, for example GWMWater, Wimmera CMA and Local Governments.

A priority for the strategy is to determine management and cost sharing arrangements for the network of gauges. This is further explained in section 5 and actions are outlined in appendix A.

Flood information and warnings are most useful when the community is engaged with them. Recent flooding (September 2016) highlighted the Wimmera’s community awareness of how to access and interpret flood emergency information remains very low. Currently when the community receive a forecast stream gauge level from the Bureau of Meteorology (BOM) many are unable to relate this to flood magnitude, and have little idea what flood risk the level or warning presents to for their property. The challenge for the Wimmera is to develop products that relate forecast flood levels to flood risk for towns communities and individuals. Wimmera CMA, VICSES and local councils have identified as a priority the need to raise the community flood awareness surrounding both flooding and flood warning. The aim of this work is to enable the community to be more aware of flooding so that they can actively take measures to manage their flood risk to minimise damages – to “build a flood resilient community”. These aims are further explained in section 5 and actions are outlined in appendix A.

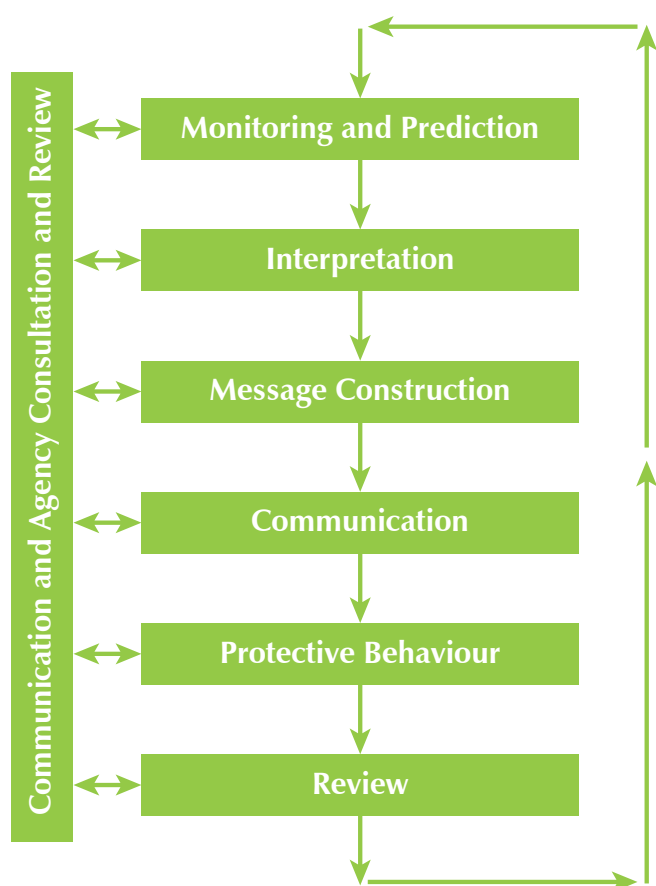


Figure 9: TFWS service level assessment process.





# CASE STUDY

## Horsham

There has been considerable preparation for flooding at Horsham. This preparation, including detailed flood mapping and assembly of relevant flood intelligence, provides a good understanding of flood risk and a sound base from which to initiate flood response.

The Wimmera CMA Regional Floodplain Management Strategy of 2001, identified the assessment and treatment of the flood risk at Horsham as a key priority. Subsequent to 2001, a number of investigations were undertaken including the Horsham Flood Study, which identified and analysed flood risks and the Horsham Floodplain Management Study and Plan, which assessed, prioritised and proposed measures aimed at mitigating the risks.

The investigations were conducted with the close cooperation of Wimmera CMA, VICSES, Horsham Rural City Council, BoM and GWMWater. Each of the investigations included extensive community consultation.

The investigations led to the following deliverables:

- flood inundation maps for a range of flood events that show flood extent, flood depths and affected properties, both above ground and over floor
- a flood emergency plan that contains relevant flood intelligence extracted from the study reports and the flood inundation maps and which has since been incorporated into the Horsham MEMP
- improvements to elements of the flood warning system and comprising additional event reporting rain and river gauges within the catchment, individual property specific flood level cards and a Horsham specific flood information brochure
- a draft flood warning service level agreement.

The additional real time rain and river data assisted in determining and confirming the scale of the events in September 2010 and January 2011. This was particularly important during the January event which was similar to the 1909 flood with a return period of around 200 years. The additional data increased confidence in BoM predictions for the gauge at Walmer, downstream from Horsham, which was provided with good lead time.

In January, the intelligence contained in the flood emergency plan coupled with the inundation maps guided VICSES and Horsham Rural City Council flood response activities. As the flood emergency plan and maps identified properties, assets and infrastructure at risk, community messaging was accurate and appropriate flood protection works were completed within the town in an orderly manner well ahead of the flood. The flood inundation maps also enabled an informed assessment of the risk of the Horsham power terminal station being flooded.

Initial assessment has indicated consistently between the flood inundation mapping and on ground observations of flood extent, depths and overall flood behaviour.

While the lead time available at Horsham is more than for many other Victorian communities, the benefits of comprehensive flood inundation maps for a range of design floods that include events in excess of the 100 year event and the extraction of the intelligence from those maps were clearly demonstrated in January 2011. A downside to the benefits is that the mapping and intelligence was primarily restricted to the urban area of Horsham.

The VFR is of the view that flood preparedness at Horsham provides an example of good practice which informed an ordered and timely response and assisted in minimising avoidable flood related damage. Extension of these preparedness activities to other communities in Victoria would facilitate a step change in flood warning services: from examples of good practice to a statewide model of best practice.

The VFR supports the Wimmera CMA's stated intention to survey the floor level of other houses within the Wimmera floodplain as a first step in extending the mapping, flood intelligence and property flood level information to the rural area. The VFR also supports the CMA's proposal to load flood inundation maps to local websites in order to increase flood awareness and assist individual flood response. The availability of this information will enable people who know their floor level to calculate to what extent a flood may affect their property.

Western Highway in Horsham 2011 flood | Image credit: Wimmera Mail Times





# 5. Factors Influencing Priority Setting

## Aboriginal involvement

### Values

The Wimmera's floodplains continue to display the connection Aboriginal people have with these special areas.

The values of Wimmera waterways to the indigenous and broader community cannot be oversold. They are the centre of vivid creation stories like how the Wimmera River and Grampians were formed along with the creation of iconic native fauna such as the emu.

Knowledge passed down through the generations as well as innumerable examples of archaeological cultural heritage such as scar trees and shell middens provide additional testimony to the cultural values associated with Wimmera waterways and their floodplains.

Many of these areas are still important sources of food, medicine and meeting places for families and communities to come together for cultural, social and recreational activities, and to teach culture to young people.

In the Wimmera, Traditional Owners use floodplains for:

- Hunting;
- Gathering food and medicine;
- Meeting places;
- Making canoes; and
- Gathering resources and making tools.

As a Registered Aboriginal Party, Barengi Gadjin Land Council (BGLC), is the primary source of advice and knowledge for the Victorian Government on matters relating to Aboriginal places located in or Aboriginal objects originating from the area for which the party is registered. BGLC participates in the preparation of Cultural Heritage Management plans and evaluates plans written by other cultural heritage advisors. They also consider and advise State and Local Governments on applications for Cultural Heritage Permits, negotiate and enter into Cultural Heritage Agreements and advise and negotiate the repatriation of Aboriginal cultural heritage.

Traditional Owner aspirations are articulated in the *"Growing What is Good Country Plan, voices of the Wotjobaluk Nations. Wotjobaluk, Jaadwa, Jadawadjali, Wergaia and Jupagalk peoples."* 2017.

### Native Title

The link between these places and Aboriginal people was recognised in 2005 when the Federal Court recognised the Wotjobaluk, Jaadwa, Jadawadjali, Wergaia and Jupagalk peoples' non-exclusive native title rights over a part of their original claim area. Much of these areas cover Wimmera floodplains. The native title rights are the right to hunt, fish, gather and camp for personal, domestic and noncommercial purposes, under their traditional laws and customs. These rights are also subject to the laws of the State of Victoria and the Commonwealth of Australia.

### Priorities

Priorities for Traditional Owners and Aboriginal communities in relation to flooding and floodplain management may include:

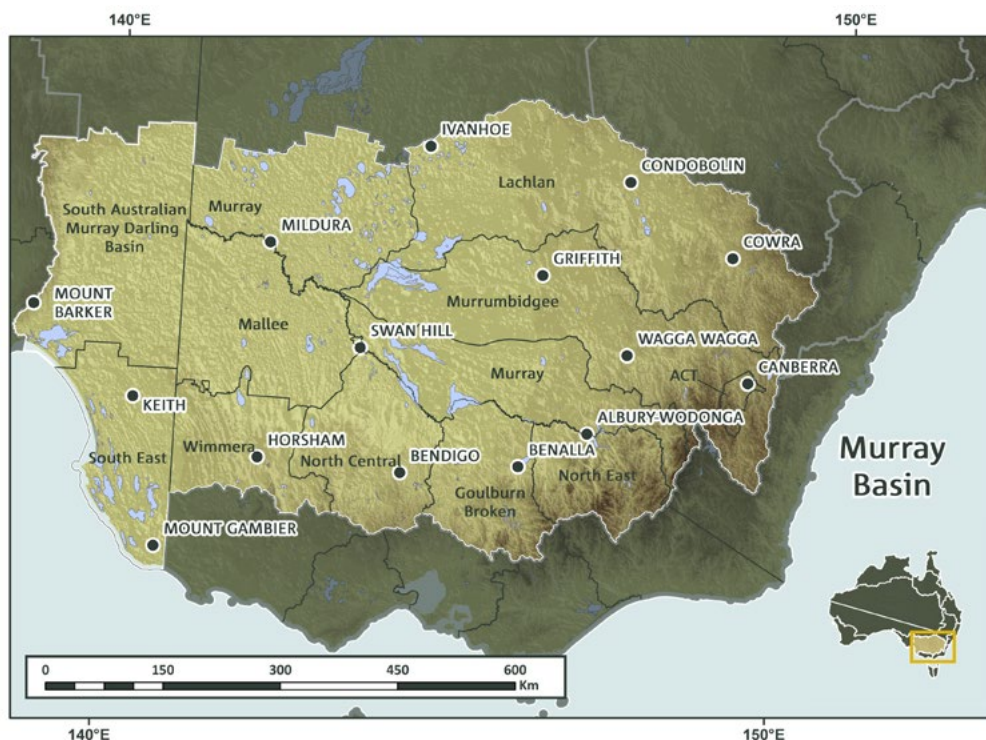
- Government authorities responsible for floodplain management activities will partner with BGLC or the relevant Registered Aboriginal Party in relation to floodplain management.
- Ensuring Traditional Owners are consulted when floodplain management activities are carried out where Native Title has been determined or where they could potentially impact on cultural heritage. The Wotjobaluk peoples will be consulted through Barengi Gadjin Land Council.

- Investigate opportunities for Traditional Owners and Aboriginal communities to be involved in floodplain management and flood response and recovery activities.
- Improve access to significant floodplains in the Wimmera region where there are recognised impediments.

## Climate change

Lower winter rainfall, higher summer rainfall, temperature increases and extremes in all seasons, more hot days and fewer very cold days are all future predictions for the Wimmera region from the Victorian Climate Change Adaptation Program 2008. This has been confirmed in the CSIRO's Climate change modelling for the Murray Cluster (figure 10) (CSIRO, 2013).

Figure 10: Murray Darling Basin Cluster area taken from Timbal, B. et al. 2015, Murray Basin Cluster Report.



Relevant messages from the climate change projections under current emission rates to 2090 for the Murray cluster area include:

- By late in the century, less rainfall is projected during the cool season, with high confidence. There is medium confidence that rainfall will remain unchanged in the warm season;
- Even though mean annual rainfall is projected to decline, heavy rainfall intensity is projected to increase, with high confidence; and
- On annual and decadal basis, natural variability in the climate system can act to either mask or enhance any long-term human induced trend, particularly in the next 20 years and for rainfall.

In a warming climate, rainfall extremes are expected to increase in magnitude mostly due to a warmer atmosphere being able to hold more moisture (Sherwood et al, 2010).

So while there may be reduced rainfall in traditional wetter months there is a likelihood that extreme storm events will become more prevalent leading to flooding. The BoM and others are constantly updating forecasting models and methodologies to take account of climate change which are expected to lead to improved flood extents and forecasts.

Wimmera CMA has modelled a 22% increase in rainfall intensity assessments in each flood study since 2011 to consider the risk posed by climate change. The increase is based upon the climate change report from the CSIRO. (CSIRO, 2007)

There are other secondary factors of climate change that can influence flooding including:

- Extended dry conditions have brought about changes in gardening and landscaping practices across the Wimmera. The millennium drought changed the practice of many urban residences to focus their gardens to be more water tolerant. In many instances lawns have been removed from yards and replaced by hard faced surfaces such as gravel or crushed rock. This has changed the water regime of individual allotments and ultimately the towns themselves as rather than water infiltrating into the lawn and down through the soil profile it now passes directly into the drainage system of the town. The new landscaping is similar to having concrete or bitumen within the yards as almost every drop of rainfall is transferred to the drainage network; and
- Climate change can also lead to landuse change as landholders modify their land and practices to adapt. For example in the South West of the Wimmera a proportion of grazing land has been converted to cropping land as rainfall has declined. This may be a factor a reduction in runoff experienced in these catchments.

An ongoing action will be to continually update flood modelling with revised and accurate considerations of impervious surfaces and drainage systems along with climate change information.

## Identification of integrated catchment management threats and opportunities

Integrated catchment management recognises the intrinsic linkages between land use in catchments and subsequent impacts on land, water and biodiversity and seeks a holistic approach to their management.

Identification of activities and/or processes that create threats to floodplains or opportunities for improved outcomes is a critical step in determining appropriate management responses.

The following are recognised as the key catchment based threats to floodplain management where they are not managed appropriately:

- Residential and commercial development;
- Industrial development (e.g sand and gravel extraction);
- Agriculture, revegetation and forestry;
- River regulation; and
- Climate change and severe weather.

In protecting and enhancing lives, floodplain management can lead to changes in natural processes.

The two main types of flood controls are:

- Channel modification; and
- Levee construction including roads or other infrastructure that operate as levees.

As mentioned previously, floodplains play a critical role in the functioning of healthy waterways and there are ongoing opportunities to improve this functionality, particularly where it has been degraded by past activities. For example some floodplain wetlands have been degraded due to poor management practices and in other cases barriers have been established between the two. The rehabilitation and reconnection of floodplains to waterways can help reduce the impacts of flooding (economic and social) but also provide important environmental benefits. When opportunities arise authorities can work with land managers to implement change that provides an integrated catchment management (ICM) benefit.

In the Wimmera the following integrated catchment management threats and opportunities have been identified and a range of management measures suggested:

Threat /Opportunity	Management measure
Improved management of floodplains	Where funding is available, assist landholders improve the management of floodplains to improve their functionality and connectivity with waterways.  Where opportunities arise purchase floodplain land of high environmental value for community benefit.
Remove unmanaged levees	Where ownership of levees cannot be determined and no one will take responsibility for them, opportunities for decommissioning will be investigated to restore floodplain functions.
Enhance ecological value of floodplains.	Offer incentives to landholders to improve the management of vegetation on floodplains.
Achieve a balance between social, economic and environmental values on floodplains.	Assess flood referrals consistent with state Guidelines for Development in Flood-prone Areas.

Table 3: Integrated catchment management priorities





Constructed levee, Warracknabeal 2011 flood | Image credit: Jenny Taylor

## *Differentiating between flood mitigation and rural drainage*

Rural drainage is not within the scope of the Wimmera FMS and it is important to make a differentiation between the two.

The primary purpose of rural drainage is to increase the productive capacity and economic value of land that would otherwise be waterlogged and unsuitable for traditional forms of agricultural production for significant periods of the year. Rural drainage systems have therefore been developed for the protection of agricultural land from seasonal inundation and waterlogging.

The primary purpose of flood mitigation is to reduce the incidence or severity of flooding. Flood mitigation infrastructure is designed to protect public and private assets from inundation by surface waters. In more recent times, flood mitigation infrastructure is constructed following the completion of a detailed assessment of the appropriate treatment option to manage the flood risk.

In some areas there is overlap between the management of rural drainage assets/systems and flood mitigation assets/systems, which has caused confusion and misunderstanding. The Victorian government is developing a Victorian Rural Drainage Strategy to clarify the mechanisms for managing rural drainage across Victoria.

## *Stormwater*

Stormwater is the inundation of land by local runoff by heavier than usual rainfall. It can be caused by local runoff exceeding the capacity of urban stormwater drainage systems, overland flow on its way to waterways.

There are many towns within the Wimmera catchment that experience stormwater flooding. In many cases these issues have been identified through flood studies or through consultation with LGAs.

However there are some towns that do not have detailed stormwater information. The steering committee has identified as a priority a number of towns that either require further stormwater investigation or works to improve drainage.

Those most at risk are outlined in the LGA descriptions and relevant actions are outlined in detail in the workplan (appendix A).

## *Overland Flooding*

Overland flooding occurs as localised rainfall forms as runoff on its way to a waterway. Such flooding can by its very nature add to the impacts of riverine flooding in downstream catchments. The management of this runoff in the form of drainage often occurs on agricultural land.

Drainage is not within the scope of this strategy.

## *Education and community engagement*

It is recognised that the community have a desire for flood information to be readily available. Ensuring the community are educated is vital to ensuring they can understand their flood risk and take responsibility and action for their own protection.

There is a need for regional authorities to work together with VICSES to ensure education and engagement is coordinated and targeted to the greatest need.

Authorities will also ensure that local flood information is made available on websites and other solutions so the community can access this information when needed. The preference is for the community to access such information prior to floods so as to make appropriate plans relative to their risk.



# 6. Local Government Risks and Priorities

Local councils play an important role in flood management in the areas of land-use and development decisions with input from the relevant floodplain management authority. Under emergency management arrangements, they provide extensive support for emergency response and recovery, and many are involved in the provision of local flood warning services. They play a lead role for the management of urban stormwater flooding.

Major roles of local councils in flood management include;

- Develop and implement local floodplain management plans to reduce the adverse effects of flooding to acceptable levels, agreed to in consultation with local communities and relevant agencies;
- Incorporate flood mapping and controls into their local planning schemes to manage land use and development (buildings, works and subdivisions) within known floodplain areas;
- Communicate the existence and requirements of abovementioned controls to the community;
- Provide, own and manage local community infrastructure within their boundaries in accordance with agreed levels of service;
- Implement and maintain local flood warning systems, including systems for flash flood events;
- Support, develop and resource the implementation of flood response plans, as part of their municipal emergency management plans; and
- Provide for the conservation of natural resources and environmental values of significance.

(From [www.floodvictoria.vic.gov.au](http://www.floodvictoria.vic.gov.au))

School bus routes have the potential to be impacted by flood water. They have previously not been addressed through Flood Emergency Plans (MFEPs). Such work is seen as a priority action and has been added prior to the completion of this strategy as visible layer within the Victorian governments flood management portal, Floodzoom.

*Floodzoom provides incident management personnel, intelligence relating to flood and other mapping products as well as real-time gauge levels, emergency management plans and weather in a common operating space.*

Similarly Councils have an interest in which roads are likely to be inundated during floods so they can either inform the public or put appropriate blocks or warnings in place. This is an important action that can be incorporated into MFEPs where relevant flood study information is available.

## Northern Grampian Shire Council

The Northern Grampians Shire (NGSC) covers 5,918 square kilometres with parts of it split between the North Central and Wimmera CMA regions. The shire contains a large part of what is referred to as the Upper Wimmera Catchment and includes significant parts of the Grampians National Park, Black Range (Stawell) and the foothills of the Pyrenees Range. These ranges coupled with numerous waterways and floodplains capture large volumes of water when rain falls. When rainfall is heavy or prolonged this can create flooding and in some cases severe flash flooding with minimal warning time meaning community warnings need to be prompt.

Past land management has resulted in a large proportion of the catchment being cleared of large areas of vegetation, with many hill slopes having grass for limited portions of the year. These slopes generate large volumes of water during rain that has resulted in erosion upon the slopes and within the waterways of the region. The community has taken considerable action to manage this risk over the years although there are still many areas that require remediation work.

The NGSC contains many of the regions valuable water storages including Lake Bellfield, Lake Fyans, Lake Lonsdale and Lake Wartook. During heavy or prolonged rain these may spill large volumes of water. None of the storages are designed to provide flood management protection and will pass flows when they exceed capacity. There is no effective means in any of the storages for flood relief releases as the outflow infrastructure is of a far smaller volume than that received from catchments during heavy rain. While they are structurally sound and managed in accordance with Victorian regulations for dam safety, there is always a need to maintain effective oversight.

Victoria faces many risks including bushfires, floods, severe storms, climate change and drought. Compared to these, the risk to the public from dam failure is relatively low. In recent times agencies have conducted mock emergency events including failure of reservoir walls.

At its northern boundary the shire includes the beginning of the Dunmunkle Creek which is a distributary of the Wimmera River. The Dunmunkle Creek flows north from Northern Grampians Shire Council and through the Yarriambiack Shire Council before terminating within the Buloke Shire. The Dunmunkle Creek is wholly dependent upon flood flows within the Wimmera River. Prior to European settlement, the creek would only flow as a result of floodwater leaving the Wimmera River and flowing overland before connecting with the Dunmunkle Creek channel. Excavation between the Wimmera River and the beginnings of the creek was undertaken for water distribution purposes in the late 1800s. A channel was also constructed prior to 1870, immediately upstream of the Dunmunkle Creek offtake to provide water to Swedes Creek and into the Richardson River catchment. Although not operating for many years, flooding overflows are able to connect the two river system catchments.

In the south of the Shire there are a growing number of landholders that are absentee or new to the area which create challenges communicating with the community about floods, flood history as well as future flood preparedness.

All of the towns in the NGSC that are at risk of flooding experienced flooding in the 2010/11 floods and many have experience numerous floods throughout their history with some experiencing more recent flooding in September 2016.

Halls Gap is considered the town with the highest flood risk in the Wimmera as a result of its position within a steep valley of the Grampians National Park. It is prone to flash flooding and many







Stony Creek residents protecting the Halls Gap shopping precinct during the 2011 floods | *Image credit: Wimmera Mail Times*

houses are at risk of damage from overland floods from the side of the mountain range. It is also a very popular destination for tourists, many from overseas, adding to the complexity of flood and emergency managers. When floods occur many tourists are not aware of the risk.

Glenorchy is the second most at risk town in the NGSC. Although not densely populated there are a large proportion of the towns housing and infrastructure that is impacted by flooding at relatively low flood levels often resulting in significant damage.

Flood forecast warnings provided by the Bureau of Meteorology are available for Glenorchy but many other townships in the NGCS do not have forecast warnings arrangements established. Stream and rain gauges are scattered throughout the shire to provide some information to community and authorities about the risk of flooding. The Glenorchy Flood Study 2006 identified that the housing first becomes at risk from inundation in events exceeding the 14% Annual Exceedence Probability (AEP) flood. The Annual Recurrence Interval (ARI) for this would be 7 years.

Other townships that are at risk of flooding include Great Western, Navarre and Stawell. The latter is one of the region's largest towns and can be significantly impacted by stormwater and floodwaters from Mt Pleasant Creek on the towns edge.

Many rural areas are impacted by flooding. In the past fences, roads, livestock and farm buildings have been damaged or destroyed by floods with the restoration bill following the 2011 flood running to \$19 million.

Flood studies have been completed for Halls Gap and the catchments of Mt William Creek and the Upper Wimmera River, meaning these areas are well placed to understand their flood risk and apply management commensurate with the risk. Despite this improved intelligence, planning schemes and FEMPs have not been updated. This remains a priority action.

Proposed flood mitigation actions put forward through flood studies or agreed by stakeholders through the development of the RFMS include:

- Investigate the impact of changes in landuse such as channel decommissioning and agricultural methods on floodwater behaviour;
- Identify priority flood mitigation work for Halls Gap;
- Update FEMP to incorporate information from relevant flood studies;
- Update Planning Schemes to incorporate information from relevant flood studies;
- Incorporate dam failure scenarios into FEMP for Lake Lonsdale, lake Bellfield and Lake Fyans;
- Incorporate school bus runs into FEMPs;
- Formalise management arrangements for existing levees; and
- Undertake discussions with neighbouring councils regarding cost sharing arrangements for flood warning infrastructure.

More detailed actions are outlined in the workplan in Appendix A.







Warracknabeal residents monitoring floodwaters during the 2011 floods | Image credit: Wimmera Mail Times





## Yarriambiack Shire Council

The Yarriambiack Shire Council (YSC) boundary within the Wimmera CMA area, covers 7,158 square kilometres. The YSC is impacted by flooding from the Yarriambiack Creek at both Warracknabeal and Brim and from the Dunmunkle Creek at Rupanyup. Along their lengths agricultural land and infrastructure is also impacted, as are a number roads.

Both creeks are distributaries of the Wimmera River and experience significant flows when the Wimmera River is in flood. Floods in the abovementioned towns from riverine flooding will only occur when the Wimmera River is experiencing significant flooding.

Given the flat topography, flood waters move relatively slowly meaning there is usually several days warning lead time to prepare for riverine flooding. Townships such as Warracknabeal, Rupanyup and Murtoa have also previously experienced flash flooding as a result of heavy rainfall exceeding the capacity of the town's stormwater drainage systems.

Warracknabeal is the highest risk town in the YSC and the third highest risk township in the region as a result of the cost of damages. A flood study has recently been completed for the Yarriambiack Creek at Warracknabeal/Brim and it will be a priority to update planning schemes and the FEMP following this work. In particular the FEMP will be updated to include a high local rainfall on a flooded creek scenario. The design and construction of a levee was included as part of the study's findings. This includes both temporary and permanent components. The construction of a levee (designed as a part of the study) is a priority for Warracknabeal. There is also a desire to for the BoM to develop a flood forecast for a Warracknabeal township gauge to improve the level of flood planning and response.

Brim has a relatively low risk. There are no actions identified as part of the recent flood study although the improved flood information will be incorporated into the planning scheme and FEMP by the Yarriambiack Shire.

Beulah and Hopetoun are other towns on the Yarriambiack Creek. Given they are in the Mallee CMA region they are not discussed in this strategy. – see *Mallee CMA Flood Strategy* for more detail.

Rupanyup is the fourth highest risk town to flooding in the Wimmera. This risk is largely driven by the number of houses that are impacted within the town. Rupanyup can be impacted by riverine and stormwater flooding and experienced both in 2011, with firstly storm inundation and then riverine flooding from the Dunmunkle Creek three days later.

A flood study has recently been completed for the Dunmunkle Creek including Rupanyup. A priority will be to incorporate this new information into local planning schemes and FEMPs. The study identified the removal of redundant GWMWater storages as an action that can significantly reduce riverine flooding risk in town. These structures were partially removed during the 2016 floods however the removal of the remainder is still a priority and some work is still required to determine a final functional design along with future ownership of the land. Further modelling work is required to fully understand Rupanyup's stormwater characteristic and to assess mitigation options.

The Dunmunkle Creek was previously used to transfer water to landholders as a part of the Wimmera Mallee Channel system. The Dunmunkle Creek flood study investigated the impacts and options for the decommissioning the channel system following the pipeline making much of the infrastructure redundant. The study has concluded that where possible, the channel banks should be decommissioned and further work is being conducted towards the operational practicalities at the time of writing. Where the channel banks cannot be removed restrictions will be established. Where neither of these options is possible the channel will be left and not maintained.

Following considerable community and agency discussion, agreed intent of these actions is to share flood water equitably along the length of the creek.

Proposed flood mitigation actions put forward through flood studies or agreed by stakeholder through the development of the RFMS include:

- Updating planning schemes and FEMP with information from recent flood studies;
- Decommission channel and other water management infrastructure, consistent with the recommendations of the Dunmunkle Creek Flood Study;
- Incorporate school bus runs into the FEMP's;
- Undertake discussions with neighbouring councils, Wimmera CMA and GWMWater regarding cost sharing arrangements for flood warning infrastructure; and
- Build Warracknabeal levee.

More detailed actions are outlined in the workplan.



Rupanyup residents protecting commercial buildings during the 2011 floods

## Horsham Rural City Council

The Horsham Rural City Council (HRCC) covers an area of 4,267 square kilometres at its intersection within the Wimmera CMA boundary. HRCC also has some land within the Glenelg-Hopkins CMA boundary. It has a population of 19,774, three quarters of which live in Horsham.

The Wimmera River traverses the municipality and flows through Horsham and Quantong.

The municipality also includes a number of other tributaries of the Wimmera River which flow out of the foothills of the Grampians National Park and Black Range State Park. Mt William Creek flows through Dadswells Bridge and the MacKenzie River flows out of Lake Wartook, on the western side of the Grampians, through the localities of Wartook and Laharum.

Dadswells Bridge although lying low on the floodplain has a relatively low flood risk due to the small population, although this strategy has identified opportunities for future flood warning improvements. Whilst a flood study was completed in (Mount William Creek Flood Investigation 2014) none of the recommendations, for example updating the local planning scheme, have yet been completed. Flooding in September of 2016 highlighted considerable concern from locals in the town and local area with respect to future flooding. Education products to describe the nature and extent of various floods identified in the study is required.

There have been numerous flood studies covering Horsham over a period dating back more than 30 years. At the time of writing an updated flood study commencing in 2016 was almost complete for Horsham, and included both McKenzie River and Burnt Creek.

Wartook is prone to flash flooding as a result of its close proximity to the steep ranges of the Grampians Ranges. The information generated from the current flood study will be vital for future flood preparedness in this area. Once complete it will be important to incorporate information into the local planning scheme and FEMP. Appropriate flood warning systems and community education are also a priority for the project.

Horsham is considered the second most at-risk town within the region due to the level of damage floods generate. Horsham has good flood information, planning and warnings to manage this risk having experienced multiple major floods through its history. Ongoing development means that updated flood information is continually required. Priority actions for Horsham will largely stem from the new flood study including updating FEMP and the planning schemes. There is also a need to do further stormwater modelling to better understand interactions with the Wimmera River when it is in flood. Natimuk Creek has its own closed catchment in the west of the municipality.

Natimuk Creek flows from farm land to the north, through the township of Natimuk and into Natimuk Lake and Lake Wyn Wyn. The creek is prone to flash flooding from its small undulating catchment. A relatively large proportion of the population are

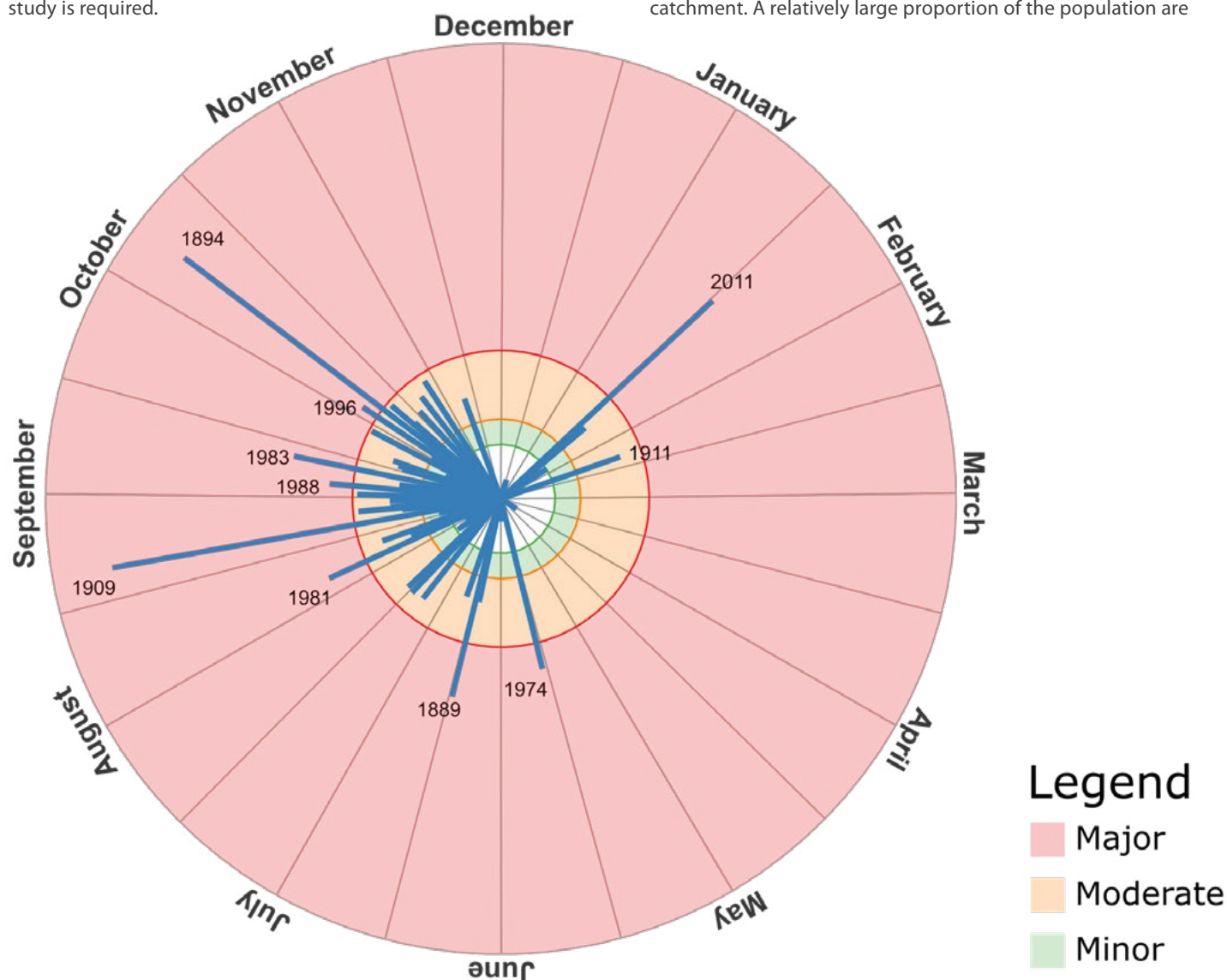


Figure 11: Flood volume history for the Walmer (415200) streamflow gauge in Horsham with current Flood Class Levels applied – 1894-2017. Flow volumes increase as lines approach the edges of the circle.



impacted by flooding and as a result the town is considered the fifth most at risk town in the Wimmera region. A flood study was completed for the catchment in 2012 leading to a number of flood management improvements including, installation of stream and rainfall gauges along with a revised FEMP.

The updating of the planning scheme and the automation of triggers and messaging of the flood warning system are priority actions identified in the study that are yet to be complete. Given the flashy nature of flooding in Natimuk it is also important for VICSES to develop and maintain community education information so the community are aware of risk and warning mechanisms and can prepare accordingly.

Proposed flood mitigation actions put forward through flood studies or agreed by stakeholder through the development of the RFMS include:

- Updating planning schemes and FEMP with information from recent flood studies;
- Establishing automated warning system for Natimuk; and
- Developing and maintaining community education programs.

More detailed actions are outlined in the workplan.

## *Hindmarsh Shire Council*

The Hindmarsh Shire Council covers an area of 7,527 square kilometres. It includes the end of the Wimmera River including terminal Lakes Hindmarsh and Albacutya. It has very flat terrain and water meanders along the Wimmera River from the south to the north.

Major townships at risk from flooding from the Wimmera River include Dimboola and Jeparit. Given these towns are at the end of the river they have many days of warning time although they can experience flash stormwater flooding from high intensity rainfall. A flood study of the lower Wimmera River Flood study has recently completed for this part of the Wimmera River. The new and revised information from this study will need to be incorporated into local planning schemes and FEMP.

Dimboola is considered to be the ninth most at risk community in the Wimmera although its overall risk is considered moderate. There are some houses in Dimboola that flood above floor level. Dimboola also has interactions between the river (weirpool) and stormwater. Better information about this interaction has been made available through the recent lower Wimmera River Flood study and these scenarios will need to be included into the FEMP.

Jeparit and Antwerp are considered to be relatively low risk towns. Very few houses or infrastructure is impacted by flooding to an extent that would incur significant costs.

Dimboola and Jeparit both have levees and there is uncertainty regarding their management arrangements. The levees haven't been well maintained and their functionality is questionable. During the floods of 2010/11 sandbags were used to increase the height of the Jeparit levee temporarily. A priority action is to determine ownership of the levee and establish appropriate management arrangements.

All of these towns have significant warning time for floods. Flow gauges at numerous locations assist with these warnings although do not have forecast warnings established by the BoM. All of these towns and much of the landscape in between has had detailed flood investigations carried out recently, providing authorities and the community with good information to prepare for floods. Some of these studies have yet to be incorporated into planning schemes and FEMPs.

It has also been recognised that the community have a desire for information about river flow information, particularly during times of flood. While there are standing flood gauges boards in place, sometimes access to them is challenging, particularly at one site on the lower Wimmera River. There is a desire to improve this access.

This part of the Wimmera River is of high value as a result of its environmental, social and economic value and this value has been recognised through Heritage Listing. The floodplain plays a significant part in those values. This part of the river has also a successful Native Title determination over it. Any new floodplain management actions need to be in line with this status and appropriate consultation will need to occur with relevant authorities and BGLC.

Nhill, is not linked to the Wimmera River although it is close to a series of wetlands including Nhill Swamp. Parts of Nhill can experience storm water flooding although there has been very little damage caused in the past. A study into stormwater characteristics is a priority for the shire.

Parts of the Western Highway near Nhill are sometimes subject to flooding resulting in the closure of the highway and significant disruption to travellers. Options for rectifying this will need to be investigated.

Proposed flood mitigation actions put forward through flood studies or agreed by stakeholders through the development of the RFMS include:

- Updating planning schemes and FEMP with information from recent flood studies;
- Establishing flood warning systems;
- Clarify arrangements for levee ownership, and management in Dimboola and Jeparit;
- Improve stormwater information for Nhill; and
- Establish BoM flood warning for Dimboola and Jeparit.

More detailed actions are outlined in the workplan.





Flooding at Arkona on the Lower Wimmera River 2011 | Image credit: Bronwyn Hastings



## West Wimmera Shire Council

West Wimmera Shire Council, covers 9,200 square kilometers within the Wimmera CMA boundary. The shire also encompasses parts of Glenelg-Hopkins CMA. Major townships in the Wimmera region include Apsley, Edenhope, Goroke, Kaniva and Serviceton. It includes thousands of wetlands, many of which are associated with these towns. In some cases there are interactions between stormwater and these wetlands.

Edenhope lies within the catchment of Lake Wallace. Edenhope's stormwater flows into Lake Wallace to the north or Back Swamp to the south. There is limited information about stormwater and flooding in Edenhope although anecdotally there are problem areas within the town. As such a flood / stormwater study is seen as a priority for the town

Apsley has a creek running south of the town that runs into a wetland to the west. There is no formal flood information available for Apsley and as a result its flood risk has been deemed as low. Anecdotal evidence suggests that floods occur regularly and the community has self managed. With time the self management is becoming problematic and support is required. There is a desire to conduct a flood study for Apsley to determine the risk. There is also a need to develop a FEMP for Apsley.

Proposed flood mitigation actions put forward through flood studies or agreed by stakeholder through the development of the RFMS include:

- Undertaking flood studies for Apsley and Edenhope.

## Ararat Rural City Council

Ararat Rural City covers an area of 4,230 square kilometres. A small part of the Ararat Rural City Council lies within the Wimmera Catchment including parts of the Grampians and Pyrenees ranges. A number of towns, including Elmhurst, Pomonal, Moyston and Warrak are impacted by flooding in the Wimmera catchment. Flood studies have been conducted for the Upper Wimmera Catchment and the Mt William Creek Catchment both of which cover parts of the municipality.

Pomonal and Moyston both lie in the upper portion of the Mount William Creek catchment, much of which flows out of the eastern side of the Grampian National Park. Flooding in the catchment is generally caused by significant rainfall over the catchment upstream of Lake Lonsdale. Locally intense rainfall can lead to flash flooding in the upper reaches around Pomonal and Moyston. Both towns lie on the banks of waterways that are prone to flooding however both have very low flood risks. No houses experience over floor flooding in the 1% AEP for either town. Because of its flash flooding nature, agriculture and roads are at risk and there is a need for communities to have access to real-time rainfall intensity and stream flow information.

The main waterway in the catchment is the Wimmera River, which originates south of Elmhurst in

the Mount Cole State Forest. The River flows in a generally westerly direction past the township of

Elmhurst. It has been subject to flooding in the past, most recently in 2011. Floodwaters generally pose little hazard to the town with houses and infrastructure located away from known flood areas. Moderate and high hazard floodwaters are generally confined to the creek systems near the town. However, road crossings into and out of the town at the creeks show high levels of hazard and therefore the town may experience isolation due to the hazards along the roads until floodwaters recede.

Warrak is located east of Ararat near Mt Cole Creek and Spring Creek. A house is impacted above floor in Warrak at the 5%ARI flood level. There are also other buildings impacted by flooding during the 1% AEP event although not above floor. Despite this, other flood impacts are generally restricted to agricultural assets (fences, stock, pasture) and damage and to roads and temporary restrictions to access due to flooded roads. The focus for Warrak will be to incorporate flood study information into the local planning scheme and the FEMP. Proposed flood mitigation actions put forward through flood studies or agreed by stakeholder through the development of the RFMS include:

- Updating planning schemes and FEMP with information from recent flood studies.

More detailed actions are outlined in the work plan.

## Pyrenees Shire Council

The Pyrenees Shire is located in the South east of the catchment and covers 3,433 square kilometres. A small but significant part of the Pyrenees Shire Council is located within the Wimmera catchment. The Pyrenees Ranges include areas of very steep slope, a lot of which is sparsely covered with grasses. Other areas are well vegetated either through native vegetation or pasture. In the lower parts, the topography flattens to form a wide and relatively undefined floodplain.

There are a number of small towns in the Pyrenees Shire Council that are within the Wimmera Catchment including Crowlands, Landsborough and Glenpatrick that can be impacted by floods.

Landsborough is located near the junction of Nowhere Creek and Malakoff Creek which are both subject to flooding. Landsborough has a long history of flooding impacting the town however it has a moderate flood risk level due to the density of impact and the population impacted. The AAD is relatively low. Floodwaters are generally confined to the creek system, however road crossings into and out of town at the creeks show a high level of hazard and therefore Landsborough may experience isolation until flood waters recede. The Upper Wimmera River catchment flood study suggested that raising access roads could be explored to reduce potential isolations.

Crowlands lies near the confluence of the Wimmera River and Spring Creek. Mt Cole Creek also meets the Wimmera River just downstream of Crowlands. The township of Crowlands has minimal flood risk. There is no evidence of buildings being inundated during a 1% AEP event however road access is cut to the town and it risks isolation during floods. The 2011 floods destroyed the Wimmera River bridge south of the township. Glenpatrick has minimal flood risk but is subject to isolation. The flood study recommended that minimal actions were required that included non-structural mitigations such as warnings and FEMPs.

Proposed flood mitigation actions put forward through flood studies or agreed by stakeholder through the development of the RFMS include:

- Install dropdown road closed signs in-situ for those that regularly experience flooding;
- Updating planning schemes and FEMP with information from recent flood studies;
- Investigate opportunities for additional rain gauges in the shire to assist with flash flood warnings; and
- Investigate options for improved access and egress from Landsborough during floods.

More detailed actions are outlined in the work plan.





## Buloke Shire Council

The Buloke Shire covers more than 8,000 square kilometres of the Mallee region in the state's northwest, stretching between Lake Tyrrell, Victoria's largest salt lake, and the northern reaches of the picturesque Avoca River. Buloke encompasses parts of the Mallee, North Central and Wimmera CMA regions. Less than 400 square kilometres is within the Wimmera catchment along the Dunmunkle Creek. The Dunmunkle Creek flood investigation (draft 2017) has determined the 1% AEP extent to comprise just 1.5km<sup>2</sup> of flooded area.

The 2011 major flood event impacted large areas of the municipality along the Dunmunkle creek and associated catchments including localities:

### Wimmera Region

- Carron;
- Watchem West; and
- Warmur.

### Mallee Region

- Wilkur;
- Birchip West;
- Ballapur;
- Kinnabulla;
- Karyrie; and
- Marlbed.

Proposed flood mitigation actions put forward through flood studies or agreed by stakeholder through the development of the RFMS include:

- Remove historic water transfer banks along creek system as per recommendation – Dunmunkle Crk Flood Investigation 2017;
- Review/undertake flood studies to include investigation of impacts from channel decommissioning, formal and informal levee's;
- Update planning schemes to incorporate information from the relevant flood study/studies;
- Update the municipal flood emergency plans to incorporate information from the relevant flood study/studies;
- Update the municipal flood and drainage management plans to incorporate information from the relevant flood study/studies; and
- Participate in water monitoring partnerships for total flood warning/prediction services.



Jeparit weir, 2011 floods | Image credit: Wimmera Mail Times



## Other Relevant Organisations

### VICSES

VICSES has a wide range of legislated roles including planning for and responding to floods and many other emergencies. VICSES also has a major planning role providing support and advice to Local Government in relation to the performance and exercise of their duties and responsibilities under the Emergency Management Act 1986, auditing of Municipal Emergency Management Plans and providing advice and training in emergency management to both Government and non-government organisations.

Priority actions for the VICSES include:

- Ensuring that LGA's Municipal Flood Emergency Management Plans include the relevant information from flood studies and other information as it becomes available; and
- Development of catchment warnings for the community and educating the community on risk and preparedness.

Detailed priority actions for VICSES to lead or partner are outlined in appendix A

### GWMWater

During times of flood the focus for GWMWater is generally on the provision of essential services, in particular water supply and wastewater management. These impacts range from water supply harvesting and distribution systems being damaged resulting from floodwaters particularly in the upper catchment, for example Stawell, Wannon and Willaura diversions to prevent flood water entering sewerage systems.

GWMWater are also a critical stakeholder in relation to discussions about cost sharing for the use of gauge information. GWMWater does not have a lead role in floodplain management and yet currently pays 100 percent of the maintenance costs for some gauges which are used for more than water distribution measurement, for example flood warning. Establishing fair and sustainable cost sharing arrangements for stream and rainfall gauges is seen as a priority action. There are also opportunities to upgrade many gauges across the Wimmera, to provide improvements to the TFWS. As an owner or user of many of these assets, GWMWater will be a key partner in any discussion related to the regions gauge network.

### VicRoads

Amongst other things VicRoads plans, develops and manages the arterial road network for Victoria. Many of these roads intersect floodplains. It is important to build new roads to a standard that allows floodplains to maintain their functionality. In many cases there are legacy issues where existing roads were not built to a standard to allow floodwaters to pass and some also act as barriers to flow.

VicRoads have been working with relevant authorities to ensure where new roads or upgrades are developed they do so with minimal impact on floodplains.

### VicTrack

VicTrack owns Victoria's transport land, assets and infrastructure and works to protect and grow the value of the portfolio, to support a thriving transport system.

VicTracks focus is strategic asset management and supporting the delivery of better transport solutions. In the Wimmera some of the rail network crosses floodplains and similar to roads in some cases can act as barriers to floodplain water.

Priorities for the rail network will be to rectify any issues when rail upgrades are made.

### Wimmera CMA

In relation to floodplain management Wimmera CMAs role is to provide flood information and advice and to provide flood management coordination and leadership across our region.

Wimmera CMA will assist other organisations with a lead role in floodplain management, including responding to flood emergencies, to identify, implement and review priority floodplain mitigation actions. Wimmera CMA will also assist in delivering integrated catchment management outcomes by minimising the impacts of floodplain management mitigation actions and realising opportunities for improvements to social, economic and environmental outcomes.

Prior to this strategy CMA's were responsible for seeking funding for and delivering flood mitigation activities such as flood studies. This is now the responsibility LGAs although Wimmera CMA will continue to assist when requested.

CMA's also have statutory roles under the Water Act. Where activities are associated with designated waterways, CMAs can issue permits for works, and condition them to ensure they do not negatively impact waterways. CMAs are also a recommending authority under the Planning and Environment Act. Where activities require a planning permit under a local government planning scheme and occur in areas identified as floodplains they will be referred to the CMA by LGA's for advice.





# 7. Development and Improvement Plan

## *Documenting Regional Priorities*

Priority actions identified to manage risk are outlined in appendix A.

Many more actions have been identified through the development process than can be resourced over a three year period. A two tiered prioritisation process has been applied. First, the areas where risk is high and manageable are identified (determine priority management units). Secondly, the priority management actions within these management units are identified using multiple criteria analysis (determine priority actions).

These will be further refined into a three year rolling plan by the Steering Committee in collaboration with the relevant stakeholders.

## *Presenting a Regional Works Program*

In addition to the requirements listed above, to assist in program planning and implementation it is proposed that each priority action in the Work Plan include:

level of priority (low, medium or high).

It is proposed that the Wimmera FMS Steering committee (refer section 1) will be retained, with the view to periodically review the workplan and administer the monitoring, evaluation and review and implementation plan (section 7).

# 8. Updated Information

## *Rating Tables*

A rating table or curve is a relationship between stream height and stream discharge (usually expressed as ML/day) at a known cross-section of the waterway. Many measurements of stream flow are taken over long periods of time to establish the relationship at multiple gauge heights.

In order to model the impacts of a variety of flows in waterways (flood modelling – both hydrologic and hydraulic), the data needs to be expressed as stream flow using rating tables. Conversely, the output from either an hydrologic or hydraulic model is a flow, which can then be expressed as stage height for dissemination to the public. The conversion from height to discharge (and vice versa) is a relationship that can change throughout time due to modifications within the landscape and waterway through and over which water may flow.

It is important that regular checks (undertaken through additional measurements) are undertaken to ensure the relationships remain current to today's conditions. The use of old relationships has the potential to misrepresent the impacts brought by rainfalls and flows. In extreme cases flood models may either under or over predict the impact of rare flood events upon communities.

## *Rainfall Data - Intensity Frequency Durations*

Work undertaken by the BoM to update historic design rainfalls has shifted the likely distribution of rainfall totals used for flood design studies across the region compared with previous practice. These new IFD's will be used for future flood studies.

The 2016 IFDs are based on a more extensive database, with more than 30 years of additional rainfall records and inclusion of data from an extra 2300 rainfall stations across Australia. By combining contemporary statistical analysis and techniques with this expanded rainfall database, the 2016 IFDs provide more accurate design rainfall estimates for Australia.

The change resulting from this work for the Wimmera is presented on the following page;

The results indicate that rainfall volumes for rare events (1% AEP) will increase by up to 30% in the northern areas (in the vicinity of the Lower Wimmera River and Lake Hindmarsh) whilst rainfall along the Western fringe of the Grampians for the same events are likely to be slightly drier than previously expected with figures being down by up to 30% for the same rare events. This general trend appears consistent for rainfall durations ranging from 2 hours through to 3 days although the extent of reduced rainfall is larger in the shorter duration events. For rainfall events that are more common, the change is less pronounced with smaller changes in extent compared to previous figures expected.

Shorter duration, more common rainfall events are likely to be up to 20% drier than that previously anticipated in the Upper Wimmera catchment.



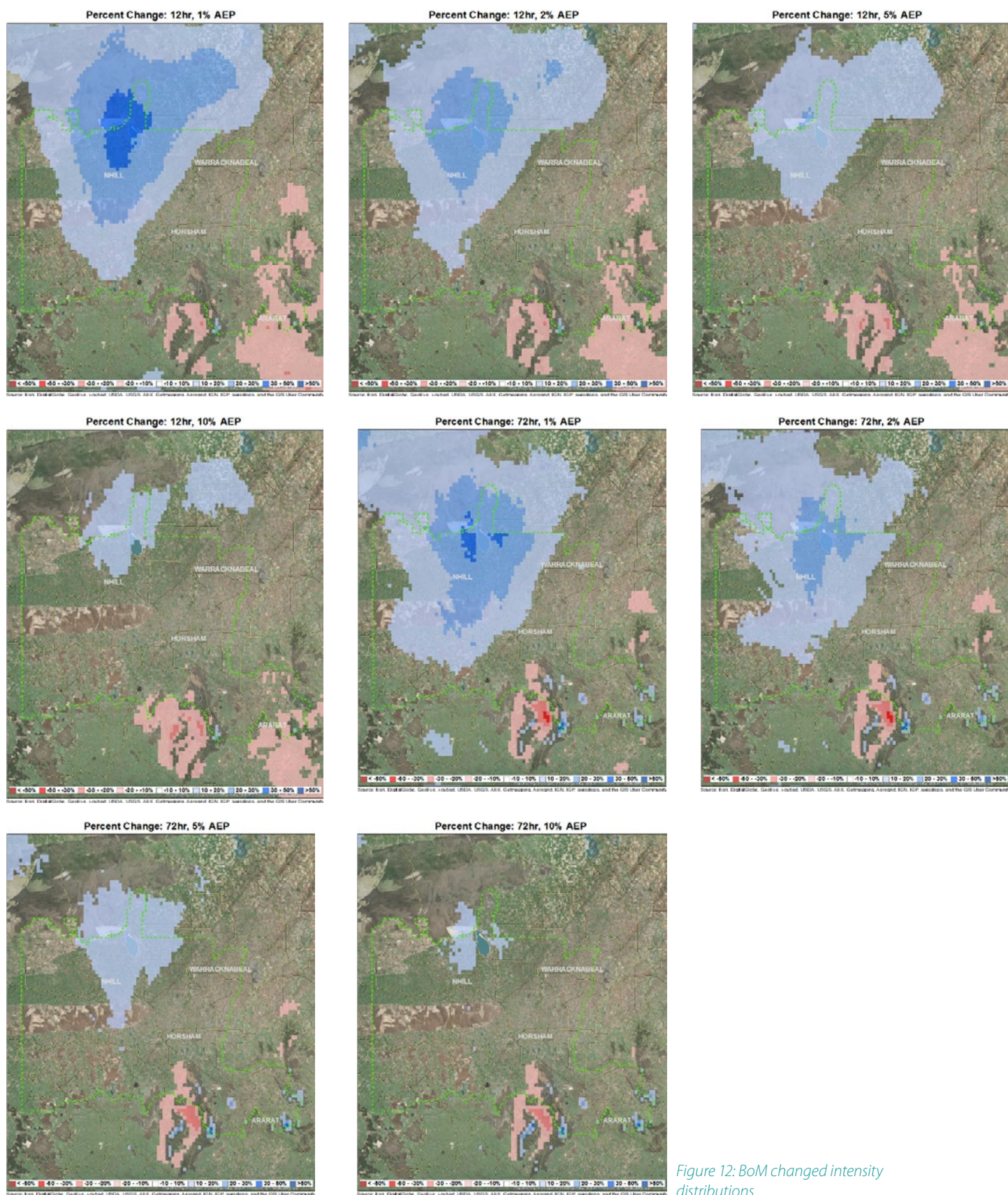


Figure 12: BoM changed intensity distributions.

### What does this mean?

In the north of the catchment, relatively common rainfall events (5-10% AEP) are likely to have up to 10% more rain, with rarer rainfall events (1-2% AEP) likely to experience up to 30% more rain. This will have an impact upon the type and sizing of infrastructure considered for future stormwater management projects. This is consistent for both short intense rain as well as prolonged events (3 days).

Rainfall intensity or extent does not appear to have changed within the Upper Wimmera River and Mt William Catchments as the headwaters for flooding for townships located alongside the Wimmera River, Mt William Creek, Dunmunkle Creek, Yarriambiack Creek and MacKenzie River. Already developed flood models and flood mapping for these Wimmera floodplains remain accurate as the results are driven by rainfall in these areas.



# 9. Monitoring, Evaluation, Review and Implementation Plan

DELWP have provided the following text as a guide to the contents of this plan.

The management of floodplains in the region is conducted within an adaptive management framework. At its core, adaptive management involves flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood (National Research Council, 2004).

To support this approach, a detailed monitoring, evaluation and reporting plan has been developed from planning to regional strategy completion. The monitoring, evaluation and reporting (MER) plan:

- Presents the program logic underpinning the regional strategy;
- Clarifies the assumptions associated with the program logic and identifies strategies to manage potential risks;
- Identifies the key questions for evaluation and establishes processes to monitor progress within the framework of the statewide monitoring program;
- Clarifies the communication and reporting needs and identifies the processes required to support these needs; and
- Enables lessons learned from monitoring and evaluation to be gathered and inform improvement.

## MER stages and timeframe

MER requires a three-phase cycle of planning, implementation and review:

- Planning - development of the program logic and using it to develop the MER Plan;
- Implementation of the MER Plan - includes ongoing monitoring, periodic evaluation and reporting of achievements and impacts including progress towards the targets; and
- Review of the MER Plan - ongoing and occurring annually as a minimum. This will enable assumptions to be reviewed and updated where necessary, activities to be documented and areas for improvement or modification identified.

## Monitoring

Monitoring activities will be targeted to inform evaluation and reporting on regional strategy implementation.

Monitoring activities also include the collection of information relating to foundational influences and externalities that impact on regional strategy implementation. Foundational influences include factors such as climatic variability, drought, flood, bushfire and potential impacts of climate change; and externalities include factors such as land use change, population growth, government support, economic conditions, community expectations and landholder attitudes.

Monitoring activities will be consistent with the Victorian Floodplain Management Strategy's MER framework (to be developed). This framework will include:

- Processes for monitoring and reporting delivery of actions at the local, regional and state levels;
- A process to update the Strategy if required; and
- A five-yearly progress review of the Strategy's implementation.

## Evaluation

Evaluation questions will be developed to assess the effectiveness of the regional strategy and gain new knowledge and information.

Evaluation of the regional strategy will include an assessment of the extent to which the outcomes have been achieved. This will be undertaken through the tracking KPI targets for outcomes, management actions and foundational activities.

It will also address any assumptions in the program logic and provide direction and improved knowledge for subsequent planning cycles.

The evaluation questions developed for the Strategy will address the following five categories (DSE, 2012):

- Impact - changes to resource condition, management activities or institutions;
- Appropriateness - addressing the needs of beneficiaries and against best practice;
- Effectiveness - achievement of desired management outputs and resource condition objectives;
- Efficiency - value or return from investment; and
- Legacy - after the activity/program ends.

The scale and frequency of evaluation will vary throughout the life of the regional strategy, and will include an annual review cycle and more detailed reviews after three years and in the final year of the regional strategy.

The annual reviews will assess progress towards the planned management activities and KPIs, and associated financials. These reviews will consider any new knowledge and information that may require changes to the management activities (via the risk assessment or prioritisation processes). Each annual review will be undertaken by the CMA in collaboration with partners responsible for implementing actions, and will align with regional investment processes.

The three year review will also assess progress towards management activities and KPIs, and where possible, review progress towards management outcomes. This review may also provide new knowledge and information that may lead to an update of the regional strategy to support an adaptive approach.



The final review of the regional strategy will focus on capturing all of the knowledge gained during implementation, and an assessment of achievements and progress towards the objectives. This will ensure that there is a clear record of achievements and lessons learned, and an evidence base for updating or changing programs and management approaches in the future.

## Reporting

Reporting is an important tool to ensure accountability for the investment of funds. Over the long-term, consistent and effective reporting provides evidence to evaluate and communicate the effectiveness of the regional strategy.

Annual management reporting is a component of the annual review cycle, and includes reporting on the activities and KPIs achieved for the year and associated financials. For CMAs, this reporting is delivered through the CMA Annual Report, and annual investment reports for existing funding arrangements with the State Government.

Partner organisations, participating in the delivery of this strategy, will have their own budgeting and reporting processes.

Key stakeholders at organisational, community, regional, state and Commonwealth levels who should be kept informed on the progress of the regional strategy will be identified and appropriate communication tools developed.

Public reporting against outcome KPI targets will occur, at a minimum, at the three year review phase. The CMA will also support reporting of management outcome targets for the Victorian Floodplain Management Strategy at its five year review phase.

## Implementation

The strategy writing group steering committee agreed at its first meeting, upon completion of the strategy an implementation committee be formed to determine and monitor the performance of the region in delivery of strategy actions. The committee is to meet at least twice annually.





# 10. Steering Committee Terms of Reference

## *Terms of reference for WIMMERA FMS Steering Committee:*

### Scope

The committee will have decision making powers about the content and approval of the document and may seek advice from sub-committees as required.

### Frequency of meetings

Meetings will be held as required; however, key points will be identified in the project plan.

### Culture of the Steering Committee

Collaborative

Professional

Open

Solutions focused

Supportive

### Role of the Steering Committee

Provide a conduit for agency input and feedback

Provide catchment wide perspective

Work together to achieve the best possible outcomes for the Wimmera community

Approve satisfactory achievement of project hold points and milestones

Be a champion of the project within their organisation and externally

### Chairperson

The Chairperson for the Steering Committee will be the CMA Chief Executive, Dave Brennan.

### Role

The Chairperson will:

Establish professional conduct

Ensure equity and balance amongst committee members

Promote and foster a collaborative culture for the life of the project

Authorise meeting agendas

Overview meeting outcomes

### Term

The term shall be for the life of the project (expected to be no later than December 2017).

### Delegations

The Chairperson will be delegated to act on behalf of the Steering Committee but limited to those outcomes as agreed by the Steering Committee members. The Chairperson will have the capacity to co-opt other members of the Steering Committee to assist with undertaking these delegated functions.

### Membership

The Steering Committee membership is as follows:

- Project Sponsor and Project Manager;
- Wimmera Catchment Management Authority;
- VICSES;
- Horsham Rural City Council;
- Northern Grampians Shire Council;
- Yarriambiack Shire Council;
- Hindmarsh Shire Council;
- West Wimmera Shire Council;
- GWMWater; and
- Barengi Gadjin Land Council.

Additional members may be seconded by the committee if required.

### Decision making

Decisions will generally be made by consensus. If consensus agreement is not possible, then the matter will be put to a vote, where the decision will be based on majority view. Each organisation / agency will have one voting right and voting can only be made by attendance.

Co-opted members do not have voting rights.

### Proxies

Consistent representation will be required as far as practicable; however, Steering Committee members may nominate a delegate to attend in their place on occasion if absolutely necessary.

### Support

Minutes will be taken by the Project Manager. WCMA administrative support staff may be required on occasion to assist in administrative support activities.

### Frequency of Meetings

Meetings will held be as per the Project Plan, with additional meetings scheduled if required with the agreement of Steering Committee members.



## Agenda

The Project Manager will circulate an agenda (approved by the Chairperson) at least one week prior to the meeting.

- Minutes of Meetings; and
- Minutes will be prepared and circulated within two weeks of the meeting concluding.

## Guests

Invitations to attend the Steering Committee meetings must be endorsed by the Chairperson.

## Code of Conduct

It is expected that members and guests of the Steering Committee will commit to the following Code of Conduct:

Conduct themselves in a professional and respectful manner at all times

Attend scheduled meetings or send an appropriate delegate if not available

Actively participate in all discussions and complete any actions assigned to them within given timeframes

## Sunset Clause

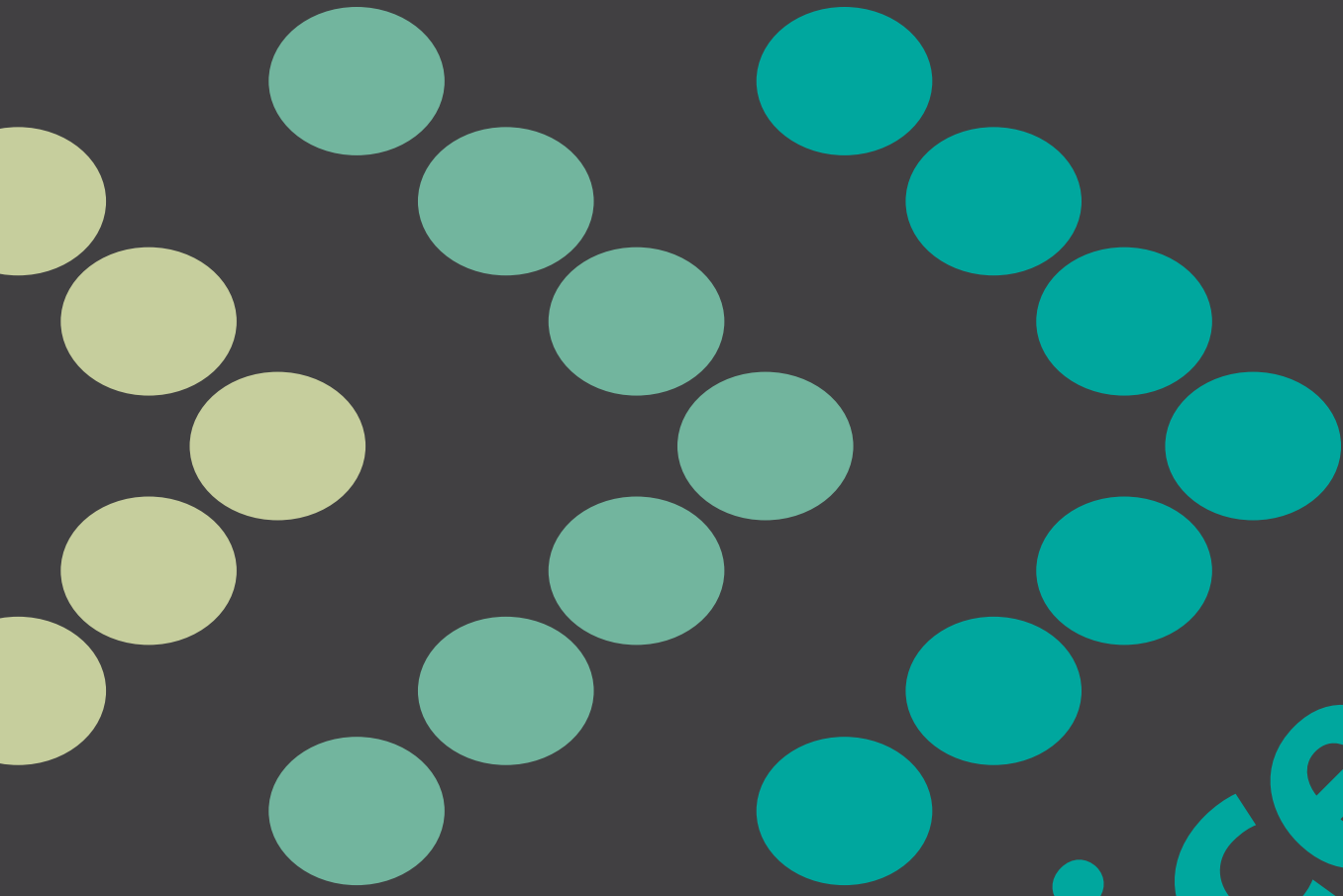
The role and purpose of the Steering Committee will conclude upon sign-off of the final project documents.



Keen residents exploring public transport opportunities in Horsham during 2011 flooding | Image credit: Wimmera Mail Times



# 11. Appendices



## Appendix A – Work Plan

The work plan below is continually in development. The items below are the High prioritised list (to be implemented in the first 3 years of the plan). The document itself will be kept online, referred to and amended by the implementation committee at its twice annual meetings so as to reflect the most up to date intention for floodplain effort in the Wimmera.

Actions are subject to the availability of funding and resources for organisations.

Action #	Location	Description	Lead	Partners
1	Halls Gap	Update MFEP to incorporate flood study review (2014)	VICSES	NGSC, WCMA
2	Halls Gap	Incorporate existing warning gauge infrastructure to regular maintenance	NGSC	
3	Halls Gap	Update planning scheme to incorporate flood risk – (Review of Halls Gap Flood Investigation 2017)	NGSC	WCMA
4	Great Western	Undertake Flood Investigation – focus on community consultation, mitigation, MFEP, planning scheme amendment and warning systems	NGSC	WCMA
5	Great Western	Update planning scheme to incorporate flood risk (Concongella Creek Regional Flood Mapping 2014)	NGSC	WCMA
6	Grampians National Park	Investigate and implement flash flood warning gauge infrastructure in the Grampians National Park	NGSC	Parks Vic
7	Mt William Creek	Update MFEP to incorporate Mt William study (2014)	VICSES	HRCC, WCMA, GWMWater, ARCC
8	Upper Wimmera River	Update MFEP to incorporate Upper Wimmera flood investigation 2014	VICSES	WCMA, NGSC, PSC
9	Dunmunkle Creek	Update MFEP to incorporate Dunmunkle Creek flood investigation 2017	VICSES	WCMA, NGSC, YSC
10	Dunmunkle Creek	Update planning scheme to incorporate flood risk (Dunmunkle Creek Flood Investigation 2017)	YSC, NGSC	WCMA
11	Upper Wimmera River	Update planning scheme to incorporate flood risk (Upper Wimmera Flood Investigation 2014)	NGSC	WCMA
12	Mt William Creek	Update planning scheme to incorporate flood risk (Mt William Creek Flood Investigation 2014)	NGSC, ARCC, HRCC	WCMA
13	WCMA area	Determine approach to manage changes to school bus runs brought about by flooding within updates to MFEP's. Incorporate roads inundated within MFEP.	VICSES	WCMA, all councils, DET
14	WCMA area	Undertake discussions with neighbouring councils for cost sharing arrangements for flood warning infrastructure	GWMWater	All councils, WCMA
15	WCMA area	Lobby for improved weather prediction services including radar coverage	WDA	WCMA, VICSES and regional councils
16	Horsham	Investigate opportunity for flood mitigation within township and surrounds	WCMA	HRCC, VICSES
17	Horsham	Update MFEP to incorporate Horsham Wartook Flood Investigation results	VICSES	HRCC, WCMA
18	Horsham	Investigate impacts of high rainfall on flooding river – stormwater impacts for town	WCMA	VICSES, HRCC
19	Horsham	Investigate coincident flood flows in Burnt and Wimmera at Horsham	WCMA	
20	WCMA area	Incorporate levee and dam overtopping and failure scenarios in MFEP planning	VICSES	WCMA
21	Dadswells Bridge	Develop & deliver community flood awareness and information programs relating to flood risk and warnings.	VICSES	WCMA, HRCC
22	Natimuk	Complete works for flash flood warning disseminations from gauges	HRCC	WCMA
23	Burnt Creek, Norton Creek and MacKenzie River	Improve flood intelligence relating to a range of flood flows	WCMA	HRCC





Action #	Location	Description	Lead	Partners
24	Horsham	Formalise management arrangements / maintenance for levees and channel infrastructure with known flood benefits	HRCC	
25	WCMA area	Lobby for changes to flood recovery funding criterion relating to updating and improving assets to latest design requirements	Councils	WCMA
26	Warracknabeal	Construct designed levee	YSC	WCMA
27	Warracknabeal	Request for forecast gauge in town.	YSC	WCMA
28	Warracknabeal / Brim	Update planning scheme to incorporate flood risk (Warracknabeal / Brim Flood Investigation 2016)	YSC	WCMA
29	Warracknabeal / Brim	Update MFEP to incorporate Warracknabeal / Brim study	VICSES	YSC, WCMA
30	Warracknabeal	Pilot project to measure the benefits of individual property awareness charts	VICSES	YSC, WCMA
31	Dunmunkle Crk	Develop and implement a works plan, including decommissioning of banks and regulating structures as per Dunmunkle Creek Flood Investigation (2017).	GWMWater	WCMA, YSC
32	Rupanyup	Decommission redundant storages in accordance with recommendation from Dunmunkle Creek flood investigation (2017)	GWMWater	WCMA, YSC
33	Pyrenees Shire	Install dropdown road closed signs in-situ for those that regularly experience flooding	PSC	
34	Pyrenees Shire	Investigate opportunities for additional rain gauges in the shire to assist with flash flood warning	PSC	
35	Apsley	Develop Local Flood products for township & consider installation of awareness signs and gauge boards at key locations.	VICSES	WCMA, WWSC
36	Edenhope	Develop Local Flood products for township & consider installation of awareness signs and gauge boards at key locations.	VICSES	WCMA, WWSC
37	WCMA area	Undertake operational readiness training that incorporates MFEP in operational response in ICC's	VICSES	
38	WCMA area	Develop accreditation process for flood specialist and analysts	DELWP	
39	MacKenzie River	Upgrade telemetry from existing gauges for remote communication from Lake Wartook and MacKenzie River gauges	GWMWater	HRCC
40	WCMA area	Consideration for the inclusion of cultural significance sites within MFEP's	VICSES	Barengi Gadjin
41	Statewide	Develop floodplain development guidelines	DELWP	
42	WCMA area	Update Victorian Flood Database within 6 months of Flood Investigation project completion	WCMA	DELWP
43	Statewide	Improve process for the provision of flood information in non-emergency periods	DELWP	

Actions that are prioritised as a medium priority (to be undertaken between 3-5 years from strategy commencement) are presented below;

Action #	Location	Description	Lead	Partners
44	Halls Gap	Develop & deliver community flood education programs using flood intelligence information	VICSES	NGSC, WCMA, Parks Victoria
45	Great Western	Develop map of council drainage infrastructure for MFEP along with management arrangements during high intensity events	NGSC	VICSES
46	Great Western	Understand impact of proposed bypass to flooding	VicRoads	WCMA
47	HRCC area	Undertake actions towards illegal floodplain development – enforcement	HRCC	WCMA
48	Dadswells Bridge	Install gauge boards in town as per – Mt William Crk Flood Investigation 2014	HRCC	
49	Natimuk	Update planning scheme to incorporate flood risk identified in Natimuk Flood investigation 2012	HRCC	WCMA
50	Natimuk	Develop and deliver community flood risk education programs, consider installation of awareness signs.	VICSES	HRCC, WCMA
51	Heritage River System – Wimmera River	Update planning scheme to incorporate flood risk identified in Lower Wimmera Flood Investigation 2016	HRCC, HSC	WCMA
52	MacKenzie River	Determine Visitor management responsibility within the Grampians National Park for high flows.	Parks Victoria	
53	Jeparit	Formalise management arrangements of Levee	HSC	VICSES, WCMA
54	Lower Wimmera River	Update MFEP to incorporate Lower Wimmera Flood Investigation results	VICSES	HRCC, HSC
55	Tarrenyurk	Develop rating table for gauge to aid with flood forecast	WCMA	BoM
56	Nhill	Investigate flood risks for Nhill	HSC	WCMA
57	Rupanyup	Undertake stormwater modelling for township to ascertain risk and propose mitigation solutions for the town	YSC	WCMA
58	Yarriambiack Shire	Develop process to combat / followup illegal works in/on floodplains	YSC	
59	Ararat Rural City	Update planning scheme to incorporate flood risk – Mt William Flood Investigation 2014	ARCC	WCMA
60	Ararat Rural City	Update planning scheme to incorporate flood risk – Upper Wimmera Flood Investigation 2014	ARCC	WCMA
61	Pyrenees Shire	Update planning scheme to incorporate flood risk – Upper Wimmera Flood Investigation 2014	PSC	WCMA
62	Apsley	Undertake flood investigation to determine flood risk	WWSC	WCMA
63	Apsley	Develop formalised arrangement for management of drainage bores	WWSC	
64	Lillimur & Serviceton	Investigate sections of highway regularly impacted by stormwater for possible improvements	VicRoads	
65	Edenhope	Undertake flood investigation to determine flood risk	WWSC	WCMA
66	Wimmera water headworks	Update control infrastructure for remote management and data during flood conditions	GWMWater	
67	Wimmera region	Develop education and awareness program regarding storage role and storage manager responsibilities during flooding	GWMWater	
68	Buloke Shire	Update findings of Dunmunkle flood investigation within MFEP	BSC	VICSES
69	Wimmera Region	Investigate opportunities for Aboriginal people to be involved in floodplain management and flood response and recovery activities	BGLC	
70	Wimmera Region	Improve access to significant floodplains in the Wimmera region where there are recognised impediments.	BGLC	
71	Wimmera Region	Obtain floor levels for all buildings within flooded areas in region – put into Floodzoom and MFEP's for emergency management	WCMA	VICSES
72	Wimmera Region	Develop education program for gauge understanding	WCMA	
73	Wimmera Region	Develop standard approach for overtopping scenario modelling of storages and levees	DELWP	
74	Wimmera Region	Develop and review standards for flood study maps.	DELWP	
75	Wimmera Region	Develop a Community Flood Observers Network Website to enhance the ability for the provision of local knowledge to and between agencies and the community during floods.	VICSES	



Actions that are prioritised as a low priority (to be undertaken between 5-10 years from strategy commencement) are presented below;

Action #	Location	Description	Lead	Partners
76	Great Western	Investigate flood warning system for community and deliver community flood education programs, installing signs and stream gauge boards.	NGSC	WCMA
77	Great Western	Update planning scheme to incorporate flood risk	NGSC	WCMA
78	Stawell	Undertake Flood Investigation – focus on community consultation, mitigation, MFEP, planning scheme amendment and warning systems. Include stormwater modelling scenarios	NGSC	WCMA
79	Stawell	Update MFEP to incorporate changes to retardation basins and include reference to tailings dam emergency plan.	VICSES	NGSC
80	Stawell	Develop and deliver community flood education programs	VICSES	NGSC
81	Stawell	Clarify management arrangements for tailings dam of Stawell Gold Mine.	VICSES	NGSC
82	Glenorchy	Incorporate triggers for safe access for return to township into MFEP.	VICSES	NGSC, WCMA
83	Glenorchy	Prepare map of drainage infrastructure within MFEP along with details of operation intention.		
84	Glenorchy	Undertake community flood education program	VICSES	NGSC
85	WCMA region	Update historic flood mapping to incorporate bridge overtopping in outputs.	WCMA	Local Governments, VICSES
86	Navarre	Install additional rain gauge – Upper Wimmera Flood Study 2014	NGSC	Other councils
87	Lower Mt William Crk	Investigate opportunities for stream gauge installations upstream of Lake Lonsdale – Mt William Creek Flood Investigation – 2014	NGSC	VICSES, WCMA
88	Concongella Crk	Update planning scheme to incorporate flood risk	NGSC	WCMA
89	NGSC	Formalise management arrangements of existing levees	NGSC	
90	Dadswells Bridge	Install permanent telemetered stream gauge	HRCC	
91	Dadswells Bridge	Request flood warning forecast for township	HRCC	WCMA, VICSES
92	HRCC	Further develop community led gauging infrastructure for provision of data during flood events	HRCC	WCMA
93	WCMA	Investigate ministerial appointed planning scheme amendments following flood investigations	WCMA	
94	Dimboola	Formalise management arrangements of existing levees	HSC	
95	HSC	Investigate standing water scenario modelling for future planning, incorporate existing understanding into MFEP	HSC	WCMA
96	Moyston	Install telemetered rain gauge in vicinity of Moyston – Mt William Flood Investigation 2014	ARRC	
97	Wimmera Region	Provide all storage rating tables, failure mapping and historical spill information to emergency management database (floodzoom)	GWMWater	

## Appendix B – Review of 1999 Wimmera Flood Strategy

A detailed review of the previous floodplain management strategy was conducted. The review included:

- A stock take of the actions achieved;
- An assessment of actions not complete to determine if they were still a priority or redundant; and
- Discussions with stakeholders.

### To what extent have the planned works plans, targets and objectives been achieved?

Wimmera CMA conducted a review of its previous RFMS (circa 1999) and conducted a stock take of the actions achieved and an assessment of the relevance of any incomplete actions in preparation and anticipation of the new strategy.

The previous strategy contained 46 actions, some with sub-actions. Of these 24 are considered complete, 15 are partially complete or in progress, 7 are considered redundant.

### Aim

The aim of the strategy was: To minimise flood risk and promote sustainable use of the floodplains in the Wimmera through community involvement and best management practice.

Whilst not all of the actions in the strategy have been delivered the key activities have been delivered which have led to improved flood risk mitigation and improved development decisions relating to the floodplain.

Most significantly 21 flood studies were completed in collaboration with stakeholders and the community between 1999 and 2016. There are also others that are almost complete. By the end of 2017 every major town on the Wimmera River, its tributaries and distributaries will have had some form of flood study over this period, which means most of the key flood intelligence gathering has been completed. This has led to many changes in municipal planning schemes, emergency management plans, warnings systems, public information and in some cases the development of flood mitigation infrastructure.

Stakeholders on the current steering committee agree that during this period the aim of the strategy has been met.

### Objectives

The following table outlines the objectives of the previous strategy and an explanation of performance against them during its life.

Objective	Performance
Improve community awareness of floodplain issues	<p>The community has participated in numerous flood studies across the region either as members of steering committees or at public meetings. The process of the development of every study has included a very active community consultation process in both the initial model creation (the community is requested to verify against historic events for depth timing and extent) and subsequent mitigation solutions. Many have contributed information and knowledge and many have gained a greater understanding of the floodplain issues relevant to their area.</p> <p>VICSES have developed a number of local flood guides which have helped the community better understand their flood risk and some of the measures they can take to manage this risk.</p> <p>Significant floods in 2010 and 2011 have reminded the community about the flood risks in the region. Community meetings held by councils following the floods were a vital opportunity for the community to seek further information from authorities and for authorities to collect information from the community.</p> <p>Wimmera CMA has provided improved flood information on its website and during floods have worked with authorities to make this information available to the community.</p>
Identification of roles of all stakeholders and in particular the effective partnership between Wimmera CMA and local government.	<p>This has evolved over time as Victorian government policy has changed. The Victorian Floodplain Management Strategy has clearly outlined the roles and responsibilities of relevant authorities. CMAs are now a recommending authorities.</p> <p>Further clarification in relation to regional and local actions will be articulated through the revised Wimmera FMS.</p>
Clarification of cost sharing arrangements	<p>Cost sharing arrangements for flood studies and floodplain management infrastructure has been clarified through the Victorian Floodplain Management Strategy.</p> <p>Cost sharing arrangements for warning systems and stream gauges need to be further refined.</p>
Identification of information needs to provide the basis for sound decision making	<p>Considerable effort in the development of flood studies throughout the region over the life of the strategy provides a very strong basis for floodplain related decision making.</p> <p>Some information is still required to be incorporated into planning schemes and FEMPs.</p>



Objective	Performance
Adaption of best management practice, which will assist in planning and provide a consistent basis to assess development applications.	DELWP are developing guidelines to assist CMA decisions.
Completion of flood studies to identify the issues and best long term solutions for providing coordinated management that lead to productive floodplains and healthy waterways and wetlands	<p>Flood studies have been completed for every major township located near the Wimmera River, its tributaries and distributaries. Studies have also been completed for other catchment such as Natimuk Creek.</p> <p>Authorities have been working together to have the information from these studies incorporated into planning schemes and emergency management plans and information as quickly as possible.</p>
Implementation of floodplain management measures that will reduce flood risk.	<p>Numerous flood mitigation measures have been implemented across the region designed to reduce risk including:</p> <ul style="list-style-type: none"> <li>• The installation of real-time telemetry within the Wimmera Basin that enhances the provision of accurate flood forecasting.</li> <li>• Planning provisions. Updates to Hindmarsh Shire Council planning scheme.</li> <li>• Warning systems – new gauges at Natimuk for flash flood response. New Flood Class Levels's (FCL's) and forecast locations for Horsham, Quantong and upstream of Dimboola</li> <li>• Local Flood guides – Glenorchy, Natimuk, Dimboola,, Halls Gap.</li> <li>• Design of levees – Warracknabeal</li> <li>• Updates to Municipal Flood Emergency Plans (MFEP's) following more than 15 flood investigations</li> </ul>

Some of the actions have not been complete. In many of these situations the reason for them not being complete is unknown. This is due to a lack of a coordinated MER plan that assisted lead and partner agencies to review and articulate their priorities regularly.

The overall budget estimate for the 45 actions was \$1.59 million. This is much less than the actual investment in the region during the strategies lifetime. More than \$2.5M has been invested in the region through the Wimmera CMA alone since 2011.

The costs of works and services have increased significantly since 1999, however it is also worth noting that the Wimmera has been very successful in obtaining funding for flood investigations and other initiatives, particularly early in the life of the strategy. The strategy has been used successfully in investment planning, both to demonstrate the logic for the investment but also to prioritise the investment that was sought. Focus has been placed in foundational activities such as flood studies which inform other work such as warning systems and flood mitigation infrastructure.

#### **To what extent do the actions need to be maintained/managed into the future?**

As the floodplain landscape is developed and modified there has been a need to review flood information. These changes come about through exempt or unauthorised activities or where planning provisions allow for some loss of floodplain storage. In some cases this has meant that a review of a previous study has been seen as a higher priority than other actions within the strategy. In some locations like Horsham, numerous studies have taken place during the strategies life, due to either changes in the landscape, improvements in modelling techniques or technologies and development pressures necessitating further or extended understanding. This could be considered maintenance of flood information and is vital to ensure planning decisions and flood emergency preparedness is appropriate.

A number of stream gauges have been modified to provide real-time information to the Bureau of Meteorology for the purpose of flood forecasting services. In most cases the operation and maintenance costs for flood monitoring are not being covered by all organisations who have an interest in the gauge. There is a strong need to clarify cost sharing arrangements for many of these as they provide and serve multiple purposes.

## **To what extent were the approaches to communication and engagement successful in supporting strategy development, implementation and review?**

### **Development**

The approach was not dissimilar to that which is in place for the development of the new strategy.

The focus of the strategy or at least the layout included background information relating to the various waterways and their floodplains – describing the nature and understanding of risk presented by each. There is a stark variation in how the catchments would be described as a result of the intelligence gathering that has taken place during the implementation of the strategy. Notably some of this understanding resulted from the largest floods in the region in living and recorded history with the 2011 flood.

For example the Dunmunkle Creek was described within the original strategy as having a narrow and well defined floodplain. A recently completed flood study has highlighted just how low the level of knowledge in this space was, with the 1% flood extent spreading across some 5km at its widest point near the Brynterion Forest, south of Rupanyup.

Similarly the 2016 investigation for the Lower Wimmera River highlighted a floodplain in excess of 3.5km wide, west of Pimpinio. This is in contrast to the 1999 description of a narrow well defined floodplain that was described in 1999.

### **Implementation**

During implementation of the strategy, strong working relationships between Councils and Wimmera CMA has been vital to success and ongoing reprioritisation of actions. In particular, discussions regarding funding proposals as investment opportunities became available has allowed for reprioritisation and many successful proposals have been developed. This open communication has also meant that roles and responsibilities have been clear.

### **Review**

All local government authorities, VICSES, GWMWater and other stakeholders have been keen to be involved in the review of the strategy.

Wimmera CMA, LGA, VICSES and GWMWater have been active participants of the review steering committee. In addition to this, one on one meetings have been held with each stakeholder to discuss their risks and aspirations for future flood plain management.

## **To what extent were risks management practices undertaken throughout the implementation of the strategy?**

Risk management was largely instigated during project/action delivery. Most authorities apply their standard risk management approaches to project management and these were successfully applied. All projects have been delivered to the satisfaction of the investors.

A formal MER plan would have been useful in helping manage the higher level risk associated with the delivery of the entire strategy. It would also have assisted with updating of the strategy in a more formal and transparent manner.

## **What was achieved through implementation of the strategy?**

Refer to sections above on aim and objectives.

## **To what extent did the strategy provide a clear program logic from the regional actions to the overall vision.**

Although not shown diagrammatically there are descriptions of how actions lead to objectives and the vision.

### **Recommendations from the review**

That a MER plan be established to ensure the strategy is implemented, reviewed and improved on a regular basis. This plan will also ensure that risk are identified and where possible mitigated.

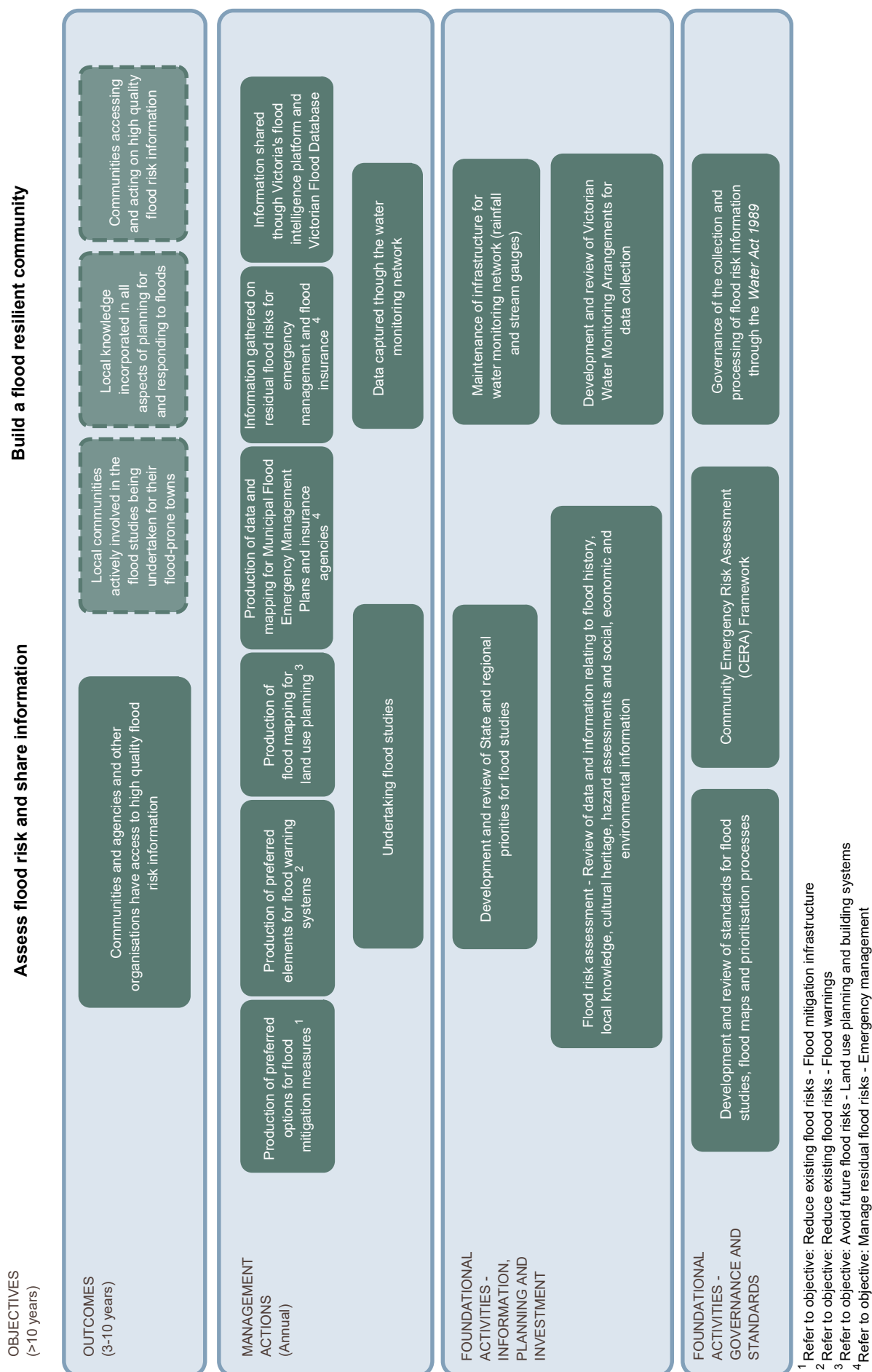
To support this the relevant lead agencies could form an ongoing steering committee with a clear terms of reference. It is recommended that the committee meet at least annually.

The MER plan should include details on communication and engagement with the community.

The clarification of cost sharing arrangements for flood mitigation infrastructure should be resolved as through the strategy or be an action from the strategy.



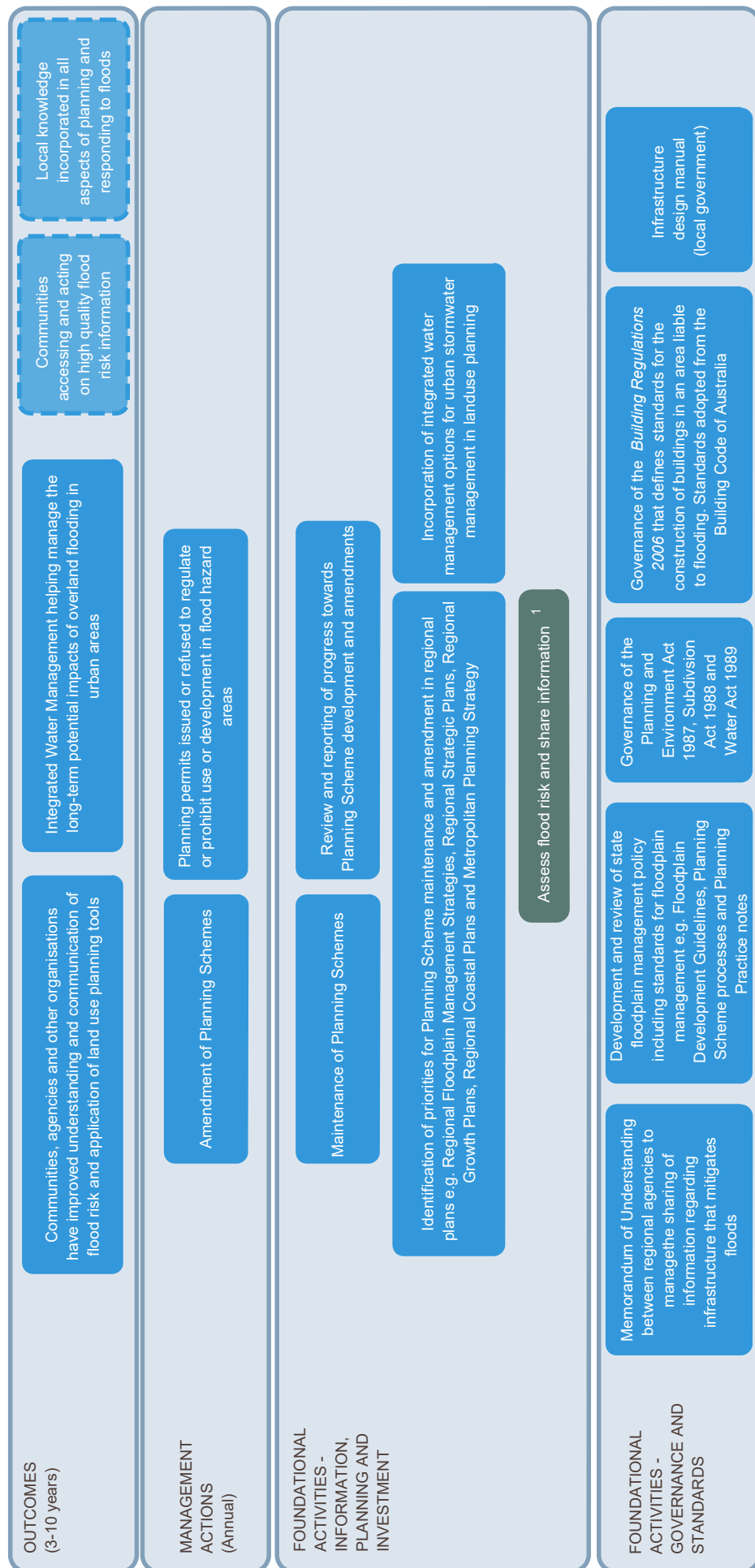
## Appendix C – Risk assessment logic and methodology



OBJECTIVES  
(>10 years)

## Avoid future flood risks - Land use planning and building systems

Build a flood resilient  
community



<sup>1</sup> Refer to objective: Assess flood risk and share information

## Reduce existing flood risks - Flood mitigation infrastructure<sup>1</sup>

## Build a flood resilient community

OBJECTIVES  
(>10 years)

OUTCOMES  
(3-10 years)

Flood mitigation infrastructure is built and maintained where it is cost effective and socially and environmentally feasible.

Ongoing management and maintenance arrangements for flood mitigation infrastructure

Benefiting communities contributing to the capital costs, and the ongoing maintenance and management costs, of flood mitigation infrastructure

Accountability and auditing regime to provide better understanding of risks of failure

Individuals maintaining levees on Crown land under streamlined arrangements

Appropriate flood mitigation activities on waterways

Appropriate risk management planning for critical infrastructure

Insurance affordability driven by informed market

Resilient communities taking ownership of flood mitigation

Local communities determining their own flood service needs, such as the need for mitigation infrastructure

Communities enabled to maintain levees on Crown land

MANAGEMENT ACTIONS  
(Annual)

Construction and maintenance of mitigation infrastructure for public benefit

Inspection and auditing of mitigation infrastructure (third-party auditing arrangements)

Levee maintenance permits issued to private beneficiaries for maintenance of levees on crown land

Levees on private land managed and funded by beneficiaries

Planning permits issued or refused for construction and modification of levees

Information regarding flood mitigation infrastructure made available to community, insurers and agencies e.g. ownership, maintenance and management arrangements, risk of failure

FOUNDATIONAL ACTIVITIES - INFORMATION, PLANNING AND INVESTMENT

Development of Water Management Schemes for new and existing flood mitigation infrastructure or existing formal management arrangements continued

Investigation of new flood mitigation infrastructure through flood studies and Water Management Schemes

Incorporate information regarding construction and management of flood mitigation infrastructure into Planning Schemes

Flood risk assessment and development of management plans for critical infrastructure

Identification of areas where there is a case to investigate the need for new flood mitigation infrastructure or for existing infrastructure to be brought into a Water Management Scheme

Assess flood risk and share information <sup>2</sup>

FOUNDATIONAL ACTIVITIES - GOVERNANCE AND STANDARDS

Victorian guidelines and standards for the management of flood mitigation infrastructure e.g. management framework and inspection and auditing requirements

Governance of the Water Act 1989 which provides for the implementation of Water Management Schemes

Governance of the Emergency Management Act 2013 (Part7A) which requires operators of critical infrastructure to assess and manage flood risks

Governance of the Planning and Environment Act 1987 which provides for Planning Schemes

Development and review of the Victorian Critical Infrastructure Resilience Strategy

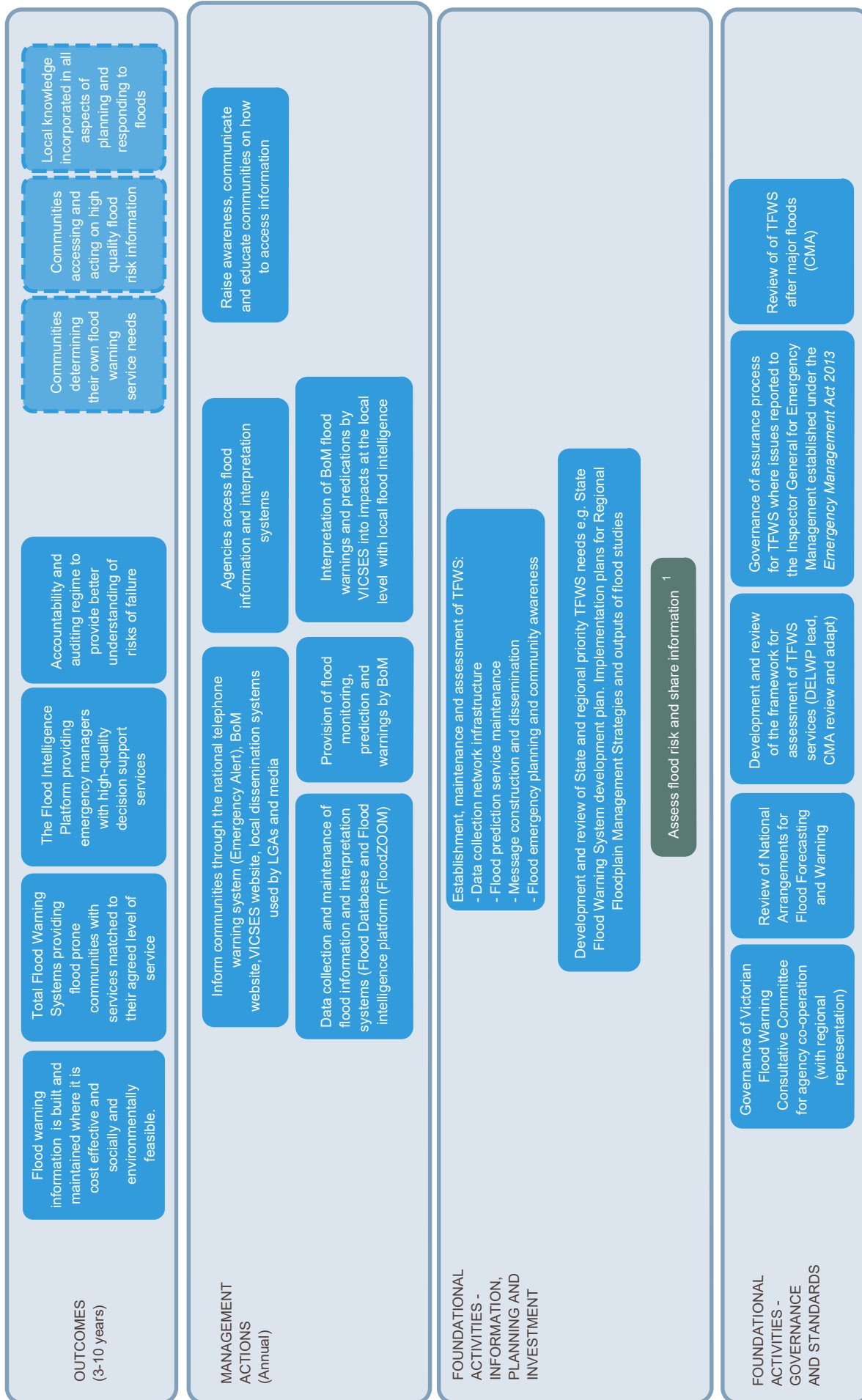
<sup>1</sup> Includes infrastructure that may not have been specifically designed to mitigate flood but inadvertently provides for flood mitigation  
<sup>2</sup> Refer to objective: Assess flood risk and share information





OBJECTIVES  
(>10 years)

## Reduce existing flood risks - Flood warnings

Build a flood resilient  
community<sup>1</sup> Refer to objective: Assess flood risk and share information

OBJECTIVES  
(>10 years)

## Manage residual flood risks - Emergency management

## Build a flood resilient community

OUTCOMES  
(3-10 years)

Community networks providing dependable flood information to emergency managers during floods

Flood response and recovery actions manage residual flood risks

Emergency management planning underpinned by high quality information

Accountability and auditing regime to provide better understanding of risks of failure

Local knowledge incorporated in all aspects of planning for and responding to floods

Communities accessing and acting on high quality flood risk information

MANAGEMENT ACTIONS  
(Annual)

**Flood preparedness**  
VICSES identify local networks

**Flood preparedness**  
VICSES coordinate MFEPs

**Flood preparedness** VICSES prepare, coordinate and deliver awareness, educational materials and programs regarding flooding e.g. FloodSafe, local flood guides

VICSES defines roles and responsibilities of incident control team

### Flood response

Undertake emergency response actions e.g. flood warnings, evacuations, construction of temporary levees, diversion of waterways or alteration of existing flood mitigation infrastructure

Evaluation and authorisation of emergency works

Development of a Multi-agency Incident Action Plan

Establishment of Multi-agency forums (e.g. Emergency Management Teams)

Establishment of control structure by Incident Controller

**Flood recovery** e.g. assisting flood affected communities and individuals, management of flood debris, erosion and siltation, residual floodwater and damage to infrastructure

FOUNDATIONAL ACTIVITIES - INFORMATION, PLANNING AND INVESTMENT

**Flood Prevention**  
Undertaking prevention activities to avoid future flood risks or reduce existing flood risk e.g. flood mitigation infrastructure<sup>1</sup>, land use planning and building systems<sup>2</sup>

**Flood preparedness** - Flood emergency planning including development, review and auditing of the State, Regional and Municipal Flood Emergency Plans

Provision of information from Total Flood Warning Systems<sup>3</sup>

Assess flood risk and share information<sup>4</sup>

FOUNDATIONAL ACTIVITIES - GOVERNANCE AND STANDARDS

Governance of the *Emergency Management Act 1986* and *Victoria State Emergency Service Act 2005* to support emergency management

Management of the Emergency Management Manual Victoria

Development and review of guidelines and processes for evaluation and authorisation of emergency works and for the management of residual floodwater

VICSES local knowledge

<sup>1</sup> Refer to objective: Reduce existing flood risks - Flood mitigation infrastructure

<sup>2</sup> Refer to objective: Avoid future flood risks - Land use planning and building systems

<sup>3</sup> Refer to objective: Reduce existing flood risks - Flood warnings

<sup>4</sup> Refer to objective: Assess flood risk and share information

## Regional risk assessment - rapid appraisal

The rapid appraisal of flood risk methodology assesses risk associated with agriculture, property, buildings, and emergency services.

The Wimmera region was broken into discrete areas, or management units that were determined based upon the following conditions;

Urban flooding was separated from rural flooding. An individual town may be further divided, depending upon whether flood mitigation was considered best managed in separate areas or not.

Rural flooding was divided into areas of land management practice where appropriate.

Rural units were separated at major confluences or distribution points.

Units were separated where the level of expected warning time were substantially different. The separation being, flash flooding (less than 6 hours warning), between 6-12 hours warning and finally areas with greater than 12 hours warning.

A management unit can only reside within one Local Government boundary

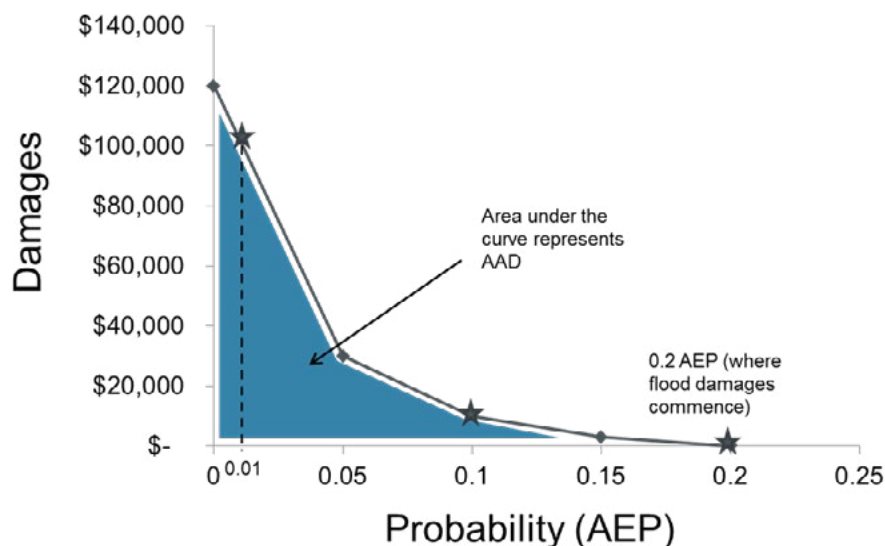
A total of 27 urban and 43 rural management units were determined within the Wimmera CMA boundary.

### Developing a loss probability curve

Flood risk is calculated using a loss probability curve that can be developed from any number of flood events. The curve plots damages against their probability of occurrence. The loss probability curve can be developed with estimates of “potential” damage, or estimates of “actual” damage. Potential damage is that which would occur if no remedial action of any kind were undertaken, consistent with no ability or opportunity to reduce exposure to damages (e.g. Based on early warning of flood events).

The area under the curve represents the average annual damage (AAD) resulting from all flood events over a long period.

For the Wimmera, the curve was developed using three points and linear interpolation between these points. Conservatively, the damages at they intersect are assumed to be equal to those for the 1% AEP event.



It presents risk using three metrics using a 1 to 5 scale of relativity. The three metrics are:

- Density of damages (measured as the AAD divided by the area of inundation for the 1% AEP or 100 year ARI flood event);
- Proportion of Population affected (measured as the AAPA (annual average population affected) divided by the population of the management area); and
- Absolute risk (the absolute size of the AAD from the cost-probability curve).

The key output of the methodology is a ranking of relative risk on a 1 to 5 scale (with 1 representing lowest risk, and 5 the highest risk). This comparative basis will be used to inform flood risk management decisions. The methodology is not designed to be an absolute assessment of flood risk for the justification of flood risk mitigation expenditure at a local level but more to rank relative risk across a management unit or series of units and can be used as a starting point for more robust discussions.

### Results

A collective assessment of each local government area is presented below as an indication of flood risk across the Wimmera CMA boundary area.

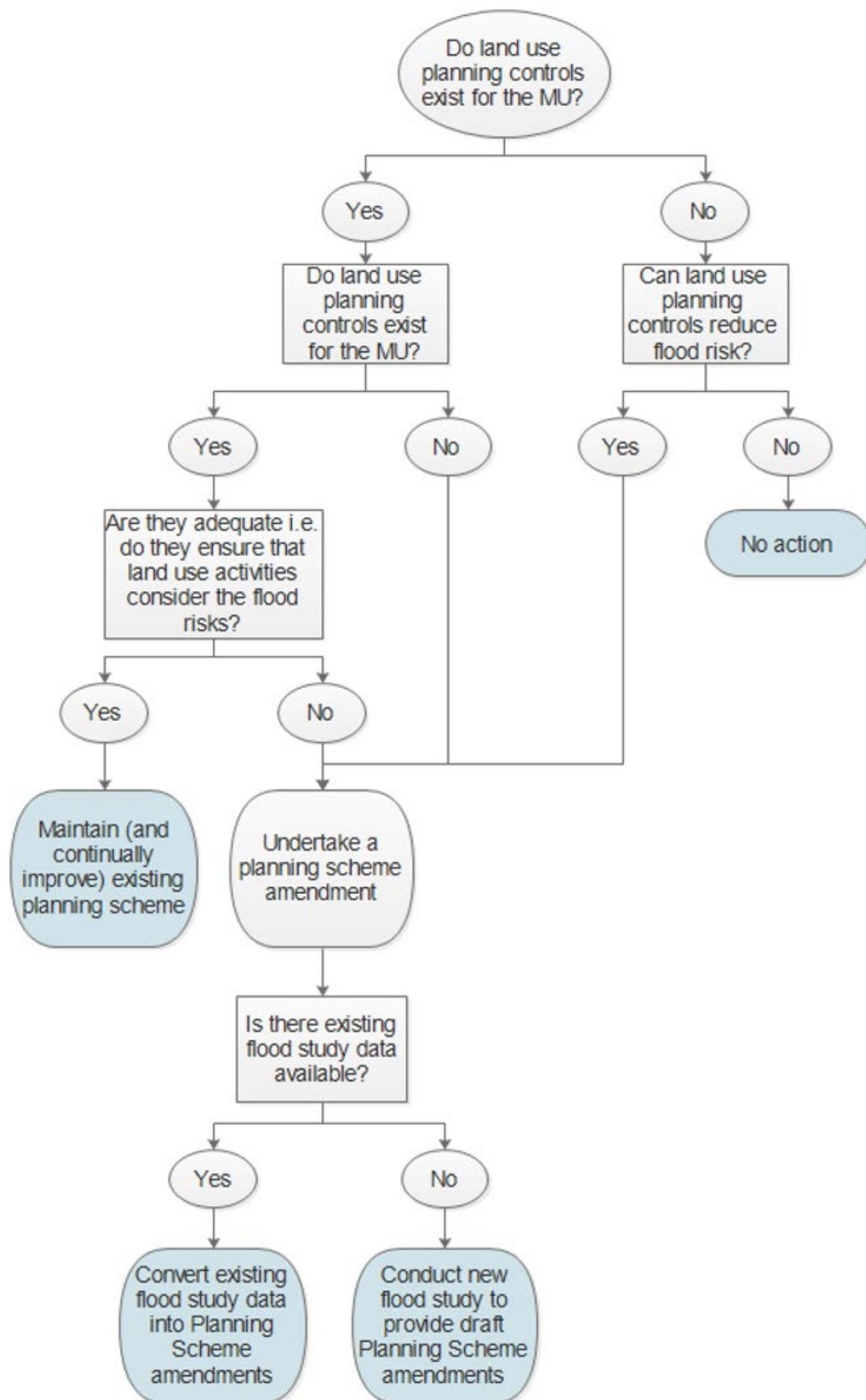
LGA	Number of management units			AAD	AAPA	Area inundated 1% AEP	Number of management units overall risk rating		
	Overall	Urban	Rural				High	Moderate	Low
West Wimmera	10	3	7	317,000	1	37	0	1	9
Hindmarsh	11	4	7	1,318,000	28	159	0	4	7
Pyrenees	6	3	3	135,000	6	50	0	1	5
Northern Grampians	13	6	7	3,064,000	99	481	1	8	4
Ararat	7	5	2	256,000	12	121	0	2	5
Buloke	1	0	1	2,000	0	0	0	0	1
Horsham	15	3	12	4,297,000	171	332	2	3	10
Yarriambiack	7	3	4	1,343,000	54	138	2	1	4

### Total Flood Warning Assessments

An assessment of the total flood warning system in each of the 70 management units identified through the rapid appraisal methodology was undertaken. It provided a comparative as well as service level based assessment of the status of elements of the Total Flood Warning System (TFWS) for each unit. It did not consider the rate of performance for each of the elements but assumed that they were functioning as designed.

The assessment provides a starting point for conversations about the elements of the TFWS and whether they are commensurate to the flood risk and a community's expectation for the service to be provided.





## Appendix D – Flood studies completed in the Wimmera since previous Flood Strategy

Glenorchy 2006

Dimboola 2006

Beulah 2006

Halls Gap 2008 / 2017

Jeparit 2007/08

Lower Wimmera Catchment 2014

Warracknabeal 2006 / 2015

Natimuk

Brim 2015

Upper Wimmera River Catchment 2014

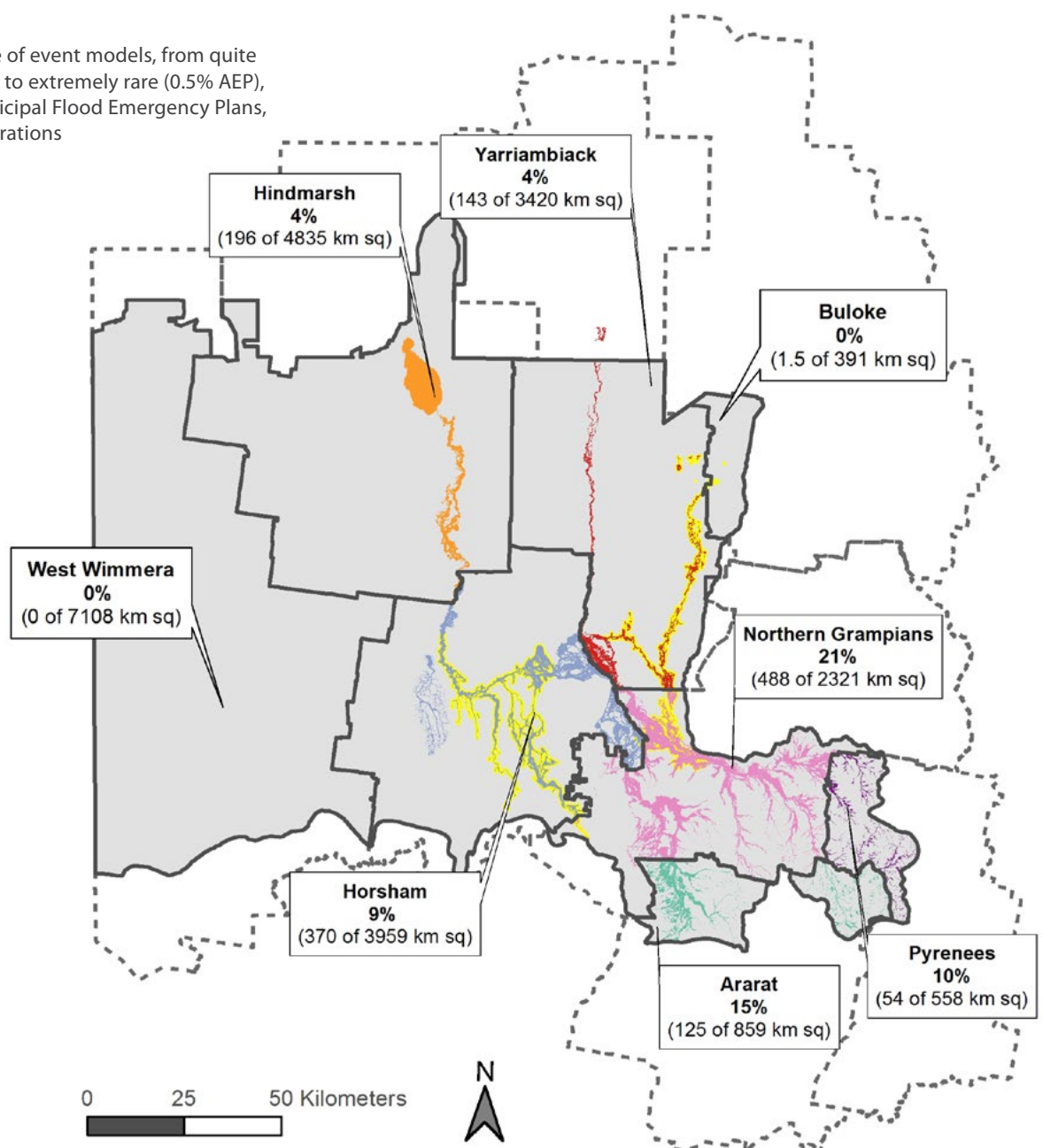
Dunmunkle

Concongella Creek Catchment

Mt William Creek Catchment 2014

MacKenzie River Catchment

Most studies include a range of event models, from quite common (20% AEP), through to extremely rare (0.5% AEP), as well as items such as Municipal Flood Emergency Plans, Mitigation solutions considerations and recommendations.



## Appendix E – Glossary

### Adaptation

Adjustment in response to actual or expected climate change or its effects, which moderates harm or exploits beneficial opportunities.

### Annual Exceedance Probability (AEP)

The likelihood of the occurrence of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood flow of 500 m<sup>3</sup>/s has an AEP of 5%, it means that there is a 5% (one-in-20) chance of a flow of 500 m<sup>3</sup>/s or larger occurring in any one year (see also average recurrence interval, flood risk, likelihood of occurrence, probability).

### Average annual damage (AAD)

Depending on its size (or severity), each flood will cause a different amount of flood damage to a flood-prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time. If the damage associated with various annual events is plotted against their probability of occurrence, the AAD is equal to the area under the consequence–probability curve. AAD provides a basis for comparing the economic effectiveness of different management measures (i.e. their ability to reduce the AAD).

### Average Recurrence Interval (ARI)

A statistical estimate of the average number of years between floods of a given size or larger than a selected event. For example, floods with a flow as great as or greater than the 20-year ARI (5% AEP) flood event will occur, on average, once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event (see also Annual Exceedance Probability).

### Australian Rainfall and Runoff (ARR)

ARR is a national guideline for the estimation of design flood characteristics in Australia published by Engineers Australia. ARR aims to provide reliable (robust) estimates of flood risk to ensure that development does not occur in high risk areas and that infrastructure is appropriately designed. The edition is currently being revised. The revision process includes 21 research projects, which have been designed to fill knowledge gaps that have arisen since the 1987 edition was published.

### Avulsion

The rapid abandonment of a river channel and the formation of a new river channel. Avulsions occur as a result of channel slopes that are much lower than the slope that the river could travel if it took a new course. Avulsions typically occur during large floods that carry the power necessary to rapidly change the landscape.

### Catchment

The area of land draining to a particular site. It is related to a specific location and includes the catchment of the main waterway as well as any tributary streams.

### Coastal erosion

Short-term retreat of sandy shorelines as a result of storm effects and climatic variations.

### Coastal flooding (inundation)

Flooding of low-lying areas by ocean waters, caused by higher than normal sea level, due to tidal or storm-driven coastal events, including storm surges in lower coastal waterways.

### Coastal hazard assessments

Coastal hazard assessments commonly define the extent of land expected to be threatened by coastal hazards (inundation, coastal erosion, coastal recession) over specific planning periods. They are typically used for development assessment purposes and to inform land-use planning considerations. In particular such assessments include consideration of future sea level rise scenarios, typically to the year 2100.

### Consequence

The outcome of an event or situation affecting objectives, expressed qualitatively or quantitatively. Consequences can be adverse (e.g. death or injury to people, damage to property and disruption of the community) or beneficial.

### Curtilage

The land occupied by a dwelling and its yard, outbuildings, etc, actually enclosed or considered as enclosed.

### Design flood event (DFE)

In order to identify the areas that the planning and building systems should protect new development from the risk of flood, it is necessary to decide which level of flood risk should be used. This risk is known as the design flood event.

### Development

Development may be defined in jurisdictional legislation or regulation. It may include erecting a building or carrying out work, including the placement of fill; the use of land, or a building or work; or the subdivision of land.

New development is intensification of use with development of a completely different nature to that associated with the former land use or zoning (e.g. the urban subdivision of an area previously used for rural purposes). New developments generally involve rezoning, and associated consents and approvals. Major extensions of existing urban services, such as roads, water supply, sewerage and electric power may also be required.

Infill development refers to the development of vacant blocks of land within an existing subdivision that are generally surrounded by developed properties and is permissible under the current zoning of the land.

Redevelopment refers to rebuilding in an existing developed area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.

Greenfield development refers to building in a currently undeveloped area or development that is unrestrained by prior work.



## Flash flooding

Flooding that is sudden and unexpected, often caused by sudden local or nearby heavy rainfall. It is generally not possible to issue detailed flood warnings for flash flooding. However, generalised warnings may be possible. It is often defined as flooding that peaks within six hours of the causative rain.

## Flood

A natural phenomenon that occurs when water covers land that is normally dry. It may result from coastal or catchment flooding, or a combination of both (see also catchment flooding and coastal flooding).

## Flood awareness

An appreciation of the likely effects of flooding, and a knowledge of the relevant flood warning, response and evacuation procedures. In communities with a high degree of flood awareness, the response to flood warnings is prompt and effective. In communities with a low degree of flood awareness, flood warnings are liable to be ignored or misunderstood, and residents are often confused about what they should do, when to evacuate, what to take with them and where it should be taken.

## Flood Class Level (FCL)

The Bureau of Meteorology (BoM) uses a three tiered classification scheme that defines flooding as minor, moderate or major at key river height stations. Each classification is defined by the water level that causes certain impacts upstream and downstream of the station.

The terms minor, moderate and major flooding are used in flood warnings to give a general indication of the types of problems expected with a flood

**Minor flooding:** Causes inconvenience. Low-lying areas next to watercourses are inundated. Minor roads may be closed and low-level bridges submerged. In urban areas inundation may affect some backyards and buildings below the floor level as well as bicycle and pedestrian paths. In rural areas removal of stock and equipment may be required.

**Moderate flooding:** In addition to the above, the area of inundation is more substantial. Main traffic routes may be affected. Some buildings may be affected above the floor level. Evacuation of flood-affected areas may be required. In rural areas removal of stock is required.

**Major flooding:** In addition to the above, extensive rural areas and/or urban areas are inundated. Many buildings may be affected above the floor level. Properties and towns are likely to be isolated and major rail and traffic routes closed. Evacuation of flood-affected areas may be required. Utility services may be impacted.

## Flood damage

The tangible (direct and indirect) and intangible costs (financial, opportunity costs, clean-up) of flooding. Tangible costs are quantified in monetary terms (e.g. damage to goods and possessions, loss of income or services in the flood aftermath). Intangible damages are difficult to quantify in monetary terms and include the increased levels of physical, emotional and psychological health problems suffered by flood-affected people that are attributed to a flooding episode.

## Flood education

Education that raises awareness of the flood problem to help individuals understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.

## Flood emergency management

Emergency management is a range of measures to manage risks to communities and the environment. In the flood context, it may include measures to prevent, prepare for, respond to and recover from flooding.

## Flood hazard

Potential loss of life, injury and economic loss caused by future flood events. The degree of hazard varies with the severity of flooding and is affected by flood behaviour (extent, depth, velocity, isolation, rate of rise of floodwaters, duration), topography and emergency management.

## Flood peaks

The maximum flow occurring during a flood event past a given point in the river system (see also flow and hydrograph). The term may also refer to storm-induced flood peaks and peak ocean or peak estuarine conditions.

## Flood-prone land

Land susceptible to flooding by the largest probable flood event. Flood-prone land is synonymous with the floodplain. Floodplain management plans should encompass all flood-prone land rather than being restricted to areas affected by defined flood events.

## Flood proofing of buildings

A combination of measures incorporated in the design, construction and alteration of individual buildings or structures that are subject to flooding, to reduce structural damage and potentially, in some cases, reduce contents damage.

## Flood readiness

An ability to react within the effective warning time (see also flood awareness and flood education).

## Flood risk

The potential risk of flooding to people, their social setting, and their built and natural environment. The degree of risk varies with circumstances across the full range of floods. Flood risk is divided into three types – existing, future and residual. Existing flood risk refers to the risk a community is exposed to as a result of its location on the floodplain. Future flood risk refers to the risk that new development within a community is exposed to as a result of developing on the floodplain. Residual flood risk refers to the risk a community is exposed to after treatment measures have been implemented. For example: a town protected by a levee, the residual flood risk is the consequences of the levee being overtopped by floods larger than the design flood; for an area where flood risk is managed by land-use planning controls, the residual flood risk is the risk associated with the consequences of floods larger than the DFE on the community.

### Flood severity

A qualitative indication of the 'size' of a flood and its hazard potential. Severity varies inversely with likelihood of occurrence (i.e. the greater the likelihood of occurrence, the more frequently an event will occur, but the less severe it will be). Reference is often made to major, moderate and minor flooding (see also flood class levels).

### Flood study

A comprehensive technical assessment of flood behaviour. It defines the nature of flood hazard across the floodplain by providing information on the extent, depth and velocity of floodwaters, and on the distribution of flood flows. The flood study forms the basis for subsequent management studies and needs to take into account a full range of flood events up to and including the largest probable flood. Flood studies should provide new flood mapping for Planning Scheme inclusion, data and mapping for MEMPs, and a preliminary assessment into possible structural and non-structural flood mitigation measures.

### Flood warning

A Total Flood Warning System (TFWS) encompasses all the elements necessary to maximise the effectiveness of the response to floods. These are data collection and prediction, interpretation, message construction, communication and response. Effective warning time refers to the time available to a flood-prone community between the communication of an official warning to prepare for imminent flooding and the loss of evacuation routes due to flooding. The effective warning time is typically used for people to move farm equipment, move stock, raise furniture, transport their possessions and self-evacuate.

### Floodplain

An area of land that is subject to inundation by floods up to, and including, the largest probable flood event.

### Floodplain management

The prevention activities of flood management together with related environmental activities (see also floodplain).

### Flow

The rate of flow of water measured in volume per unit time, for example, megalitres per day (ML/day) or cubic metres per second (m<sup>3</sup>/sec). Flow is different from the speed or velocity of flow, which is a measure of how fast the water is moving, for example, metres per second (m/s).

### Freeboard

The height above the DFE or design flood used, in consideration of local and design factors, to provide reasonable certainty that the risk exposure selected in deciding on a particular DFE or design flood is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest heights and so on. Freeboard compensates for a range of factors, including wave action, localised hydraulic behaviour and levee settlement, all of which increase water levels or reduce the level of protection provided by levees. Freeboard should not be relied upon to provide protection for flood events larger than the relevant design flood event. Freeboard is included in the flood planning controls applied to developments by LGAs.

### Frequency

The measure of likelihood expressed as the number of occurrences of a specified event in a given time. For example, the frequency of occurrence of a 20% Annual Exceedance Probability or five-year average recurrence interval flood event is once every five years on average (see also Annual Exceedance Probability, Average Recurrence Interval, likelihood and probability).

### Hazard

A source of potential harm or a situation with a potential to cause loss.

### Hydraulics

The study of water flow in waterways; in particular, the evaluation of flow parameters such as water level, extent and velocity.

### Hydrology

The study of the rainfall and runoff process, including the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.

### Intolerable risk

A risk that, following understanding of the likelihood and consequences of flooding, is so high that it requires consideration of implementation of treatments or actions to improve understanding of, avoid, transfer or reduce the risk.

### Likelihood

A qualitative description of probability and frequency (see also frequency and probability).

### Likelihood of occurrence

The likelihood that a specified event will occur (see also Annual Exceedance Probability and average recurrence interval).

### Local overland flooding

Inundation by local runoff on its way to a waterway, rather than overbank flow from a stream, river, estuary, lake or dam. Can be considered synonymous with stormwater flooding.

### Mitigation

Permanent or temporary measures (structural and non-structural) taken in advance of a flood aimed at reducing its impacts.

### Municipal Flood Emergency Plan

A sub-plan of a flood-prone municipality's Municipal Emergency Management Plan. It is a step-by-step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations. The objective is to ensure a coordinated response by all agencies having responsibilities and functions in emergencies.

### Planning Scheme zones and overlays

Planning Schemes set out the planning rules – the state and local policies, zones, overlays and provisions about specific land uses that inform planning decisions. Land use zones specify what type



of development is allowed in an area (e.g. urban (residential, commercial, industrial), rural, environmental protection). Overlays specify extra conditions for developments that are allowed in a zone. For example, flooding overlays specify that developments must not affect flood flow and storage capacity of a site, must adhere to freeboard requirements, and not compromise site safety and access.

### Probability

A statistical measure of the expected chance of flooding. It is the likelihood of a specific outcome, as measured by the ratio of specific outcomes to the total number of possible outcomes. Probability is expressed as a number between zero and unity, zero indicating an impossible outcome and unity an outcome that is certain. Probabilities are commonly expressed in terms of percentage. For example, the probability of 'throwing a six on a single roll of a dice is one in six, or 0.167 or 16.7% (see also Annual Exceedance Probability).

### Rainfall intensity

The rate at which rain falls, typically measured in millimetres per hour (mm/h). Rainfall intensity varies throughout a storm in accordance with the temporal pattern of the storm (see also temporal pattern).

### Regional Coastal Boards

Members of Victoria's three coastal boards have been appointed by the Minister for Environment and Climate Change because of their experience and expertise in areas such as local government, coastal planning and management, tourism and recreational use of the coast. The functions of the Western, Central and Gippsland Coastal Boards, set out under the Coastal Management Act 1995, include developing regional coastal plans and providing advice to the Minister on regional coastal development issues.

### Risk analysis

Risk is usually expressed in terms of a combination of the consequences of an event and the associated likelihood of its occurrence. Flood risk is based upon the consideration of the consequences of the full range of flood events on communities and their social settings, and the natural and built environment. Risk analysis in term of flooding is a combination of defining what threat exists (see flood risk) and what steps are taken (see risk management) (see also likelihood and consequence).

### Risk management

The systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, treating and monitoring flood risk.

### Riverine flooding

Inundation of normally dry land when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam. Riverine flooding generally excludes watercourses constructed with pipes or artificial channels considered as stormwater channels.

### Runoff

The amount of rainfall that drains into the surface drainage network to become stream flow; also known as rainfall excess.

### Stormwater flooding

The inundation by local runoff caused by heavier than usual rainfall. It can be caused by local runoff exceeding the capacity of an urban stormwater drainage systems, flow overland on the way to waterways or by the backwater effects of mainstream flooding causing urban stormwater drainage systems to overflow (see also local overland flooding).

### Vulnerability

The degree of susceptibility and resilience of a community, its social setting, and the natural and built environments to flood hazards. Vulnerability is assessed in terms of ability of the community and environment to anticipate, cope and recover from flood events. Flood awareness is an important indicator of vulnerability (see also flood awareness).

### Water Management Scheme

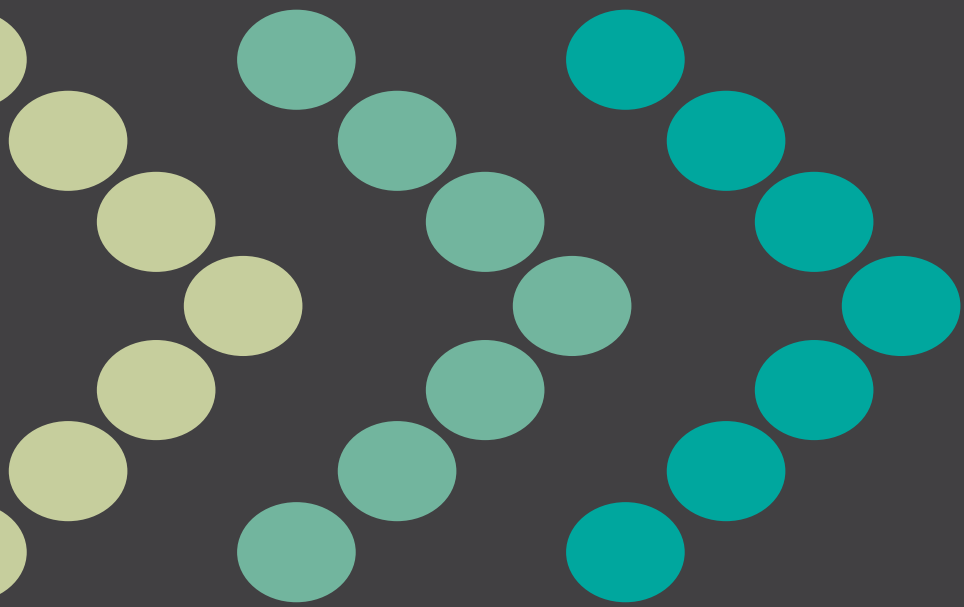
The formal process set out in the Water Act 1989 that can be applied to a flood mitigation infrastructure development and its ongoing management. It can be based on and carried out in parallel with a floodplain management study.



## 12. Acronyms

AAD	Average Annual Damage
AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
BCA	Building Code of Australia
BGLC	Barengi Gadjin Land Council
BoM	Bureau of Meteorology
CMA	Catchment Management Authority
DELWP	Department of Environment, Land, Water and Planning
DET	Department of Education and Training
DFE	design flood event
GWMWater	Grampians Wimmera Mallee Water
LGA	Local Government Authority
LPPF	Local Planning Policy Framework
MFEP	Municipal Flood Emergency Plan
SPPF	State Planning Policy Framework
TFWS	Total Flood Warning System
VCS	Victorian Coastal Strategy
VFD	Victorian Flood Database
VFMS	Victorian Floodplain Management Strategy
VICSES	Victoria State Emergency Service
VPP	Victoria Planning Provisions
YSC	Yarriambiack Shire Council
WMS	Water Management Scheme





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