GOULBURN BROKEN
CATCHMENT MANAGEMENT AUTHORITY

Goulburn Broken Regional Floodplain Management Strategy 2018-2028

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The Goulburn Broken CMA would like to thank those who contributed to the development of this strategy, in particular the Steering Committee and Working Groups comprising local government representatives from Benalla Rural City, Campaspe, Greater Shepparton, Mansfield, Mitchell, Moira, Murrindindi and Strathbogie as well as representatives from VICSES, EMV, GVW, G-MW, RDV, DELWP, TCAC, YYNAC, Parks Victoria and NSW Office of Environment and Heritage.

We would also like to thank members of the community who attended forums, made submissions and provided support and advice.

The Strategy

The Goulburn Broken Regional Floodplain Management Strategy (the Strategy), together with related national, state and regional documents and a range of related sub-strategies, underpin the Regional Catchment Strategy (RCS). This Strategy presents an integrated catchment planning framework for floodplain management in the Goulburn Broken region and is the primary guide for improving community flood resilience.

The strategy is intended to be adaptable and able to respond to new information or because new opportunities or priorities change.

International framework

The Australian Government has ratified several international human rights instruments that recognise and maintain Indigenous peoples' special connection to land and waters and provide for the right to practice, revitalise, teach and develop culture, customs and spiritual practices. The Strategy recognises the significant contribution that can be made by indigenous peoples towards implementing the Strategy and the legal requirements to consult.

The Vision

Through partnerships, improve the flood resilience of the catchment's people, infrastructure, land and water resources.

Implementing the Strategy

The implementation of this Strategy will be influenced by available funding and resources. Investment proposals to support actions within the strategy will be developed as investment opportunities arise. This is expected to be influenced by new information, community support and the impacts of extreme climatic events within the region, such as bushfire, drought and floods. The Strategy will be implemented within an "adaptive framework", with continued reviews incorporated into an annual planning cycle.

Guiding Principles

The Goulburn Broken Regional Floodplain Management Strategy 2018-2028, like the Goulburn Broken Regional Catchment Strategy 2013-2019, is underpinned by a resilience approach to catchment management.

Foreword

Floodplains in the Goulburn Broken Catchment are crucially important to our agriculture, food processing, forestry and tourism industries: the industries that underpin our regional economy. However, major floods can destroy crops and livestock, cause significant social and economic hardship for individuals and businesses, disrupt communities, damage property and, in some cases, lead to loss of life.

The Goulburn Broken Catchment Management Authority has partnered with our community and all tiers of government to guide future floodplain management through the Goulburn Broken Regional Floodplain Management Strategy 2018–2028. The Strategy focuses on improving community resilience and managing the environmental values of floodplains. It recognises the importance of Traditional Owners' intrinsic connection with waterways and floodplains.

This Strategy has been largely guided by the 2016 Victorian Floodplain Management Strategy and incorporates requirements of the *Climate Change Act 2017*. As Chair, I commend the Strategy's resilience approach, which aligns with the Goulburn Broken Regional Catchment Strategy 2013-19 and builds the capacity of communities to make well-informed decisions that minimise or avoid the impact of major floods.

Community access to reliable information is the best way to help stakeholders prepare for living in a floodplain area. This is why sharing reliable information is a priority action within all four of the Strategy's program themes: Flood Mitigation, Total Flood Warning Systems, Land-use Planning and Municipal Flood Emergency Plans.

This Strategy will be implemented within an adaptive management framework. This means future management approaches will be flexible enough to embrace opportunities such as new technologies, or to cope with emerging pressures such as urban growth.

By combining clear accountabilities, strong community engagement, partnerships and technical rigour to improve flood resilience, floodplain management actions will continue to be guided by their feasibility, the needs of the community and the availability of resources.

Importantly, the Strategy's Action–Investment Plan forms the business case for investment by all tiers of government to implement floodplain management actions. The success of implementing the Strategy will rely on funding initiatives such as the Natural Disaster Resilience Grants Scheme and through the monitoring, review, reporting and improvement plan process.

I am proud to share the vision for this Strategy with our partners, who have signed below.

Annie Volkering
Chair, Goulburn Broken CMA

We the undersigned…

commend the consultative process that was undertaken by the Goulburn Broken Catchment Management Authority to develop the Goulburn Broken Regional Floodplain Management Strategy and look forward to working in partnership with other stakeholders to deliver the Strategy outcomes.

CEO Benalla Rural City	CEO Campaspe Shire Council	CEO City of Greater Shepparton
CEO Mansfield Shire Council	CEO Mitchell Shire Council	CEO Moira Shire Council
CEO Murrindindi Shire Council	CEO Strathbogie Shire Council	Victoria SES (North East)
CEO Goulburn Valley Water	CEO Goulburn-Murray Water	CEO Taungurung Clans Aboriginal Corporation
CEO Yorta Yorta Nation Aboriginal Corporation	Regional Development Victoria	Regional Manager Parks Victoria

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Part A: The Strategy

Chapter 1: Strategic context

1.1 Background

State-wide, each Catchment Management Authority and Melbourne Water were tasked by Government to coordinate the development of regional floodplain management strategies for their respective regions.

The Goulburn Broken Regional Floodplain Management Strategy (the Strategy) is a shared document for all regional communities and agencies (collectively known as stakeholders) to guide continuous improvement for effective flood resilience.

This Strategy follows the release of the Victorian Floodplain Management Strategy (Department of Environment, Land, Water and Planning, 2016) (VFMS), which included the government's position in response to two investigations:

Investigation	Government response
Review of the Flood Warnings in Victoria (Comrie, 2011)	Victorian Floods Review (Victorian Government, 2012)
Parliamentary Inquiry into Flood Mitigation Infrastructure (Parliament of Victoria, 2012)	Flood Mitigation Infrastructure Review (Victorian Government, 2013)

The Victorian Floodplain Management Strategy (VFMS) included significant stakeholder consultation and sets the direction for floodplain management in Victoria, particularly around policies, actions and accountabilities (institutional arrangements). The VFMS builds on the technical basis of the Victoria Flood Management Strategy 1998 (State Flood Policy Committee, 1998). Regional floodplain management strategies interpret and apply the policies, actions and accountabilities in the VFMS at the regional and local levels.

This regional strategy focuses on floodplain management, which is a subset of flood management. The relationship is described in **Appendix A**: Flood and Floodplain Management.

This Strategy will continue to enhance flood resilience through the implementation of the ten-year Action-Investment plan, taking into account agreed priorities. However, it is important that the Action-Investment plan is adaptable and responsive to new information, technologies and opportunities and changing priorities – this is known as adaptive management.

This Strategy is presented in three parts, the Strategy, the Action-Investment Plan and supporting documents (Appendices). The Appendices largely comprise the investigation and consultation phase of the preparation of the Strategy and should be read in conjunction with the regional Strategy and Action-Investment plan for completeness.

The Strategy is presented in five chapters, namely:

Part A

- Chapter 1 – Strategic Context
- Chapter 2 – Review of previous regional Strategies and current Service Levels
- Chapter 3 – Priority setting
- Chapter 4 – Strategy implementation

Part B

- Chapter 5 – Action-Investment Plan

Part C

- Supporting documents (Appendices)

1.2 Introduction

Floodplains are the commercial, cultural, social and environmental arteries of the Goulburn Broken region. Associated with waterways, they are generally highly fertile areas, and support major agricultural, food processing, forestry and tourism industries of vital significance to the region and to the State of Victoria.

Regular flooding enhances agricultural productivity by increasing soil moisture, recharging groundwater and depositing fertile silt across the floodplain. However, widespread flooding impacts on large-scale rural agricultural areas and many major urban centres within the Goulburn Broken region. Whether floods are caused by high rainfall from upstream catchments, or direct localised severe storms, they can severely disrupt communities and regional economies by causing injury, property and environmental damage, personal suffering, productivity loss and, in some cases, loss of life.

On the other hand, small floods play a vital role on the ecosystems. This has been evident over the past two decades, with increasing recognition given to the interdependence of the health of rivers and their floodplains. Environmental watering programs to improve waterway and floodplain health have received significant commitment from all tiers of government.

The economic, social, environmental and cultural values from living and using floodplains need to be balanced against the inherent disadvantages associated with flood hazard and risks. This requires a good understanding of flood behaviour, something that was not necessarily appreciated by those settling on the floodplains.

Early floodplain management focused on addressing legacy flood problems as many towns were settled on low-lying floodplain areas because of ease of access to water supply and transport links via waterways. Land-use planning to manage the escalation of flood risk (and damage) was developed over the mid-1970s through to the 1990s culminating in the Victoria Planning Provisions, which allowed land use planning to be undertaken consistently across Victoria. More recently, reforms around emergency management and the development of Emergency Management Victoria have greatly assisted flood resilience through consistent and standardised Municipal Flood Emergency Management Plans (MFEPs) across the state.

1.3 The three flood problems

The management of “flood problems” can be broadly categorised as follows:

Management of the existing (legacy) flood problems

- This can involve a range of structural mitigation measures such as floodways, levees, diversion channels, retardation basins, and total flood warning systems.

Management of the future flood problems

- This is achieved by land-use planning policy and guidelines in municipal planning schemes to ensure future decisions around land-use and development do not unduly add to existing legacy flood problems. More recently, taking a strategic policy approach to planning schemes, such as master planning for new areas within the local planning policy framework, is now becoming commonplace in the Goulburn Broken region.

Management of the residual flood problem

- Where the management of above two problems cannot be effectively realised then the residual flood problem must shift to emergency management arrangements at state, regional and local levels, in particular through the Municipal Flood Emergency Plans (MFEPs).

1.4 Developing the Strategy for stakeholders

Sound partnerships and joint ownership of the Strategy are essential for effective implementation of the actions identified in the Action-Investment Plan. It is important that the Strategy belongs to all stakeholders.

The vision and objectives for this Strategy were developed in consultation with community, Steering and Working Group Committees. This recognises that sound partnerships and joint ownership of the Strategy is essential for effective implementation. As such, it is important that the Strategy belongs to all stakeholders who can then advance flood resilience by implementing floodplain management actions over the next decade (outlined in the in the Action-Investment plan – see Part B, Chapter 5:).

Fifteen public forums were held to capture local and regional issues. There were also opportunities to provide written submissions. Development of the Strategy and opportunities to get involved where promoted via local media, social media and the Goulburn Broken CMA and local government websites.

Robust discussions and meetings were conducted with the Steering and Working Group Committees, which were made up of representatives from local government, Traditional Owners, and other government agencies. Input from the committees, public submissions and issues were recorded and guided preparation of the Strategy. The Department of Environment, Land, Water and Planning (DELWP) provided support to ensure a consistent approach was taken by all Catchment Management Authorities and Melbourne Water developing regional Strategies, largely through their coordination of the Victorian Floodplain Managers' Forum and Strategy Writers' Group meetings.

The Strategy, together with a Summary, was released in October 2017 for further stakeholder input.

More information on the early development of the Strategy is presented in **Appendix B**: Consultation Material to Promote Stakeholder Discussions and Input.

1.5 Purpose, vision and objectives of the Strategy

The purpose of the Strategy is to provide pathways to foster and enhance flood resilience (see **Section 1.7**) across the region. This is reflected by the stakeholders' shared vision:

> ***Through partnerships, improve the flood resilience of the catchment's people, infrastructure, land, water and biodiversity.***

This Strategy has four objectives to achieve the long-term outcomes, namely:

- **Build community resilience** – by encouraging communities to act responsibly to manage their own risks (a part of the Total Flood Warning System program) by improving dissemination and communication, education and awareness through the sharing of flood information, etc;
- **Reduce legacy flood risk** to minimise exposure to flood hazard and their consequences (part of all four programs – Flood Mitigation Works, Total Flood Warning Systems, Land-use planning, and Municipal Flood Emergency Plans); and
- **Avoid future flood risk** by not making things worse (part of the Land-use Planning program); and
- **Manage residual flood risk** by with emergency services by integrated sharing of flood intelligence, interpretation at incident control (part of the MFEP and TFWS programs), flood insurance (part of the Total Flood Warning System program).

1.6 Scope

There are four programs that form the basis for the four-year rolling Action-Investment Plan in **Chapter 5:**

- Flood mitigation works
- Total flood warning systems
- Land use planning
- Municipal flood emergency management plans.

The program elements were reviewed against local needs. The process entailed undertaking a stocktake of past floodplain management activities to identify what had been achieved, the determination of service levels in consultation with stakeholders and the identification and prioritisation of actions to address any gaps.

The four-year rolling Action-Investment Plan will be reviewed periodically, as it requires the support of the stakeholders and is subject to the availability of funding.

The scope is illustrated in the program logic shown in Figure 1. The program logic for each of the four programs overlap and are further described in **Appendix C:** Program logic for program delivery.

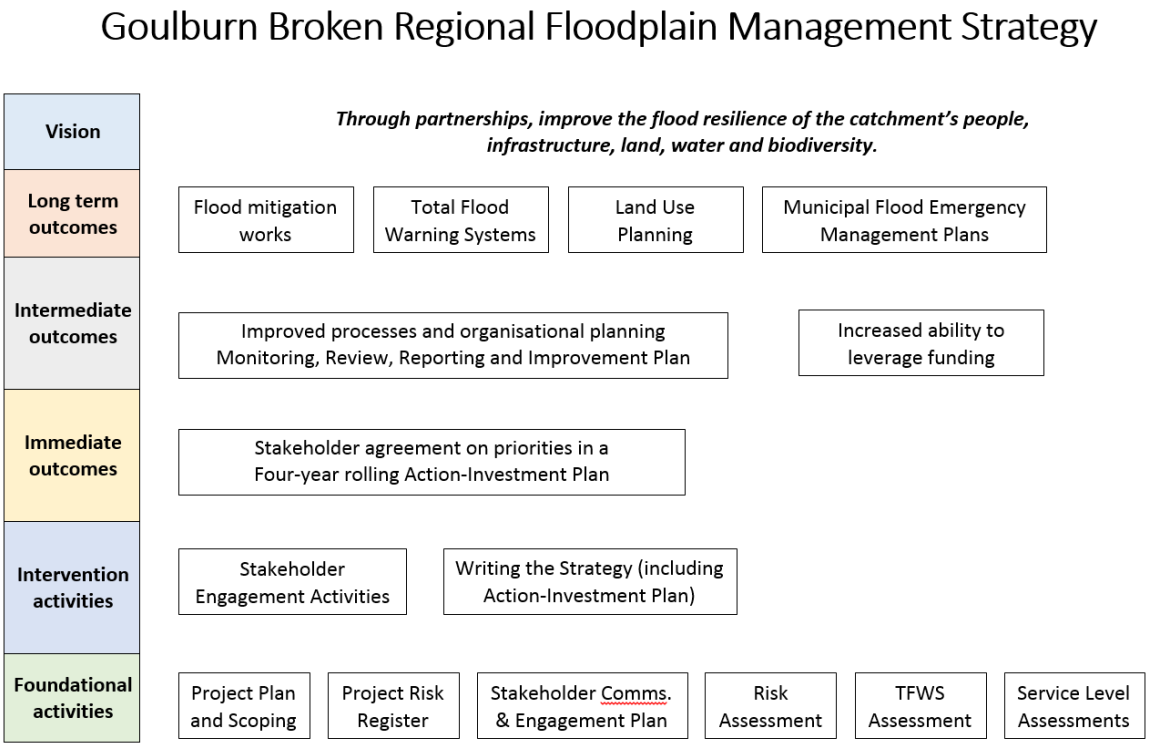


Figure 1: Regional Floodplain Management Strategy Program logic

1.7 Resilience: alignment with the National, Victorian and Regional approaches

Resilience thinking is a multidisciplinary approach for understanding and managing dynamic systems. A resilience-based approach underpins development of this Strategy.

Resilience[1] is defined as a system's capacity to absorb disturbance and continue to function in a desired way. Depending on the scale, a system might be a region, catchment or part of a catchment.

Flood behaviour can be described in terms of the likelihood and consequences of flooding, and the flood hazard, which is often expressed as the extent, depth and velocity of flooding. Understanding

[1] This is discussed in detail in the Goulburn Broken Regional Catchment Strategy (2013-2019)

flood behaviour enables communities to become more flood resilient, provided such information can be made readily accessible. Understanding flood behaviour also enables agencies and communities to assess the benefits of potential flood mitigation measures, flood warning and emergency management arrangements, and land-use planning for managing or minimising flood hazard and risk.

Figure 2 illustrates conceptually how systems can be evaluated. There are three system states: pre-European settlement, desirable and needed (as defined in 2017), and undesirable. However, achieving the pre-European state is not realistically achievable.

Each system (in this case towns are used) can be evaluated in terms of where it is now and where it should be, noting that improving the system state will take resources.

The regional Strategy implementation is building flood resilience to achieve desirable and needed system states. Overall flood impacts have increased significantly since European settlement (and will continue to do so) because of increased (and increasing) infrastructure and assets on the floodplain, but improved management has significantly reduced what the annual average damages would have been.

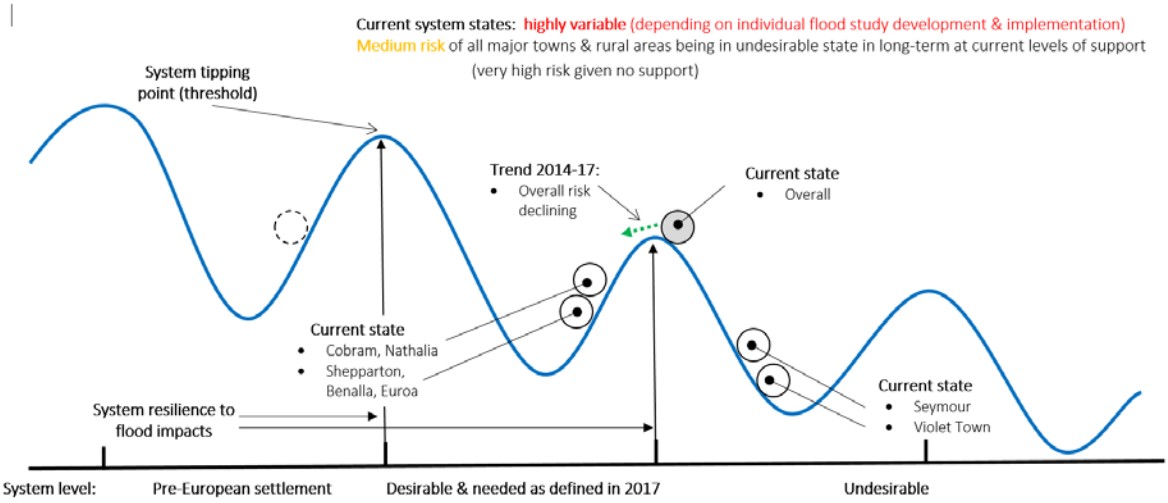


Figure 2: Conceptualisation of building flood impact resilience in example towns

The resilience model helps to narrow the high-level choices in the face of unforeseen and shifting circumstances: restore, prevent, maintain, drive transformation, or accept change and adapt.

National Approach

The National Strategy for Disaster Resilience (CoAG, 2011) makes specific reference to the application of a resilience-based approach not solely for agencies but rather a shared responsibility between government agencies, communities, businesses and individuals. Furthermore, the CoAG document defined a disaster resilient community as one that works together to understand and manage the risks that it confronts.

The National Strategy initiated a national review of land-use planning and building codes to consider ways to enhance disaster resilience in the built environment.

Victorian Approach

The resilience approach is articulated with the Victorian Floodplain Management Strategy (Department of Environment, Land, Water and Planning, 2016), and was purposely aligned with the National approach (Section 5 of the VFMS). In particular, the passage of the *Emergency*

Management Act 2013 paved the way for reforms including the introduction of the State Crisis and Resilience Council, Emergency Management Victoria and the Inspector General for Emergency Management. The alignment of flood warning arrangements and land-use planning is also articulated, which forms part of resilience.

The four objectives of this Strategy are similar to the VFMS's four objectives, namely:

- 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.

Shared responsibility was also highlighted in the Victorian Bushfires Commission Final Report (2010) and again shows consistency with the National approach.

Linkages to regional strategies and plans

The Goulburn Broken Regional Catchment Strategy (Goulburn Broken Catchment Management Authority, 2013) was purposely developed using a resilience approach. The RCS vision reads *Healthy, resilient and increasingly productive landscapes supporting vibrant communities*.

The RCS's strategic objectives relate to floodplain management in the following ways:

- To embed the resilience approach with strategic priorities;
- To update and develop strategies, and with the management measure to review and update sub strategies and create new ones (such as this regional floodplain Strategy) according to need;
- To provide adaptive management and leadership, and with the management measures to build community and agency capacity to respond together to drivers of change.
- To adapt to climate variability with the strategic priority to adapt to climate variability risks, and with the management measure to factor risks of climate variability and identify adaption strategies in the Goulburn Broken CMA and partner plan;
- To adopt land-use change with strategic priority to plan for and manage floods, and with the following management measures:
    - To understand more about the nature of flooding to manage its impacts on the natural and built environments. More specifically, minimise the impact of flooding on the built environments, including infrastructure, and maximise benefits of flooding on natural assets, and
    - To provide floodplain decisions and advice in land-use planning.

Hume Regional Growth Plan (2014) and Municipal Planning Schemes

The Hume Regional Growth Plan (Department of Transport, Planning and Local Infrastructure, 2014) provides a regional approach to land-use planning in the Hume Region, which approximately aligns with the areas within the Goulburn Broken and North East CMAs.

The Growth Plan recognises adaption to climate change and the need to manage exposure to natural hazards. The Growth Plan has selected locations for development based on available infrastructure, access to employment, protection of environmental assets and avoidance of natural hazards. It also recognises that:

- Land-use planning should consider the best available information relating to the potential impacts of, adaptation to and opportunities from climate change.

- Design settlements to maximise resilience to natural hazards and climate change and take advantage of the opportunities from climate change
- The risks of flood must be considered in land-use planning decisions. These decisions should be based on the best quality information on flood hazards to minimise risk to life, property, community infrastructure and environmental assets

All eight municipal planning schemes within the Goulburn Broken region have flood zone and overlay controls, five of which have flood risk assessment guidance as an incorporated document within planning schemes, which are known as *local floodplain development plans*. This fits with the Strategy objective of "not making things worse."

Goulburn Broken Waterway Strategy (2014 – 2022)

In terms of floodplain management, the Goulburn Broken Waterway Strategy (Goulburn Broken Catchment Management Authority, 2014) recognises the resilience approach, land-use planning, and emergency management plans. It also recognises the importance of healthy waterways and their connection to floodplain and wetlands, the link between floodplain management and environmental watering, and opportunities to investigate connecting floodplains to their waterways.

The strategy also describes Traditional Owners' cultural connection to waterways and floodplains (refer to **Section 1.12**).

1.8 Climate change to be part of all future studies

The new Victorian *Climate Change Act, 2017* sets out policy objectives and guiding principles (sections 23 to 28 of the Act) requiring that the impacts due to climate change shall be considered in decision making.

This is consistent with the *Rainfall and Runoff, A Guide to Flood Estimation* (Ball J, 2016), where it advises the wide acceptance that human activities are contributing to climate change, and this change has the potential to alter extreme rainfall and flood behaviour. In all, there are four aspects of flood behaviour that are likely to be impacted by climate change in the region (Ball J, 2016):

- Rainfall Intensity Frequency Duration (IFD) relationships;
- Rainfall temporal patterns;
- Sequences of rain events; and
- Antecedent conditions and base-flow.

Unfortunately, the magnitude of the impact on any of the above aspects has not been studied comprehensively either nationally or internationally (Ball J, 2016).

The VFMS and the *Climate Change Act 2017* recognise that climate change will increase flood risks. It clarifies the roles and responsibilities of Government agencies and authorities for managing floods, and commits to improving flood warnings and the sharing of flood information for communities.

The *Victorian Climate Change Adaption Plan 2017-2020* (Department of Environment, Land, Water and Planning, 2017) states that ongoing flood studies will help flood-prone communities understand their risk, and new flood studies will more explicitly consider the implications of climate change. Floodplain management in the areas of emergency management and land-use planning shall address climate change and increased exposure to vulnerabilities.

Whilst the policy framework is in place to manage flood risk for the impact of climate change, there is substantial uncertainty about such risks posed.

Australia Rainfall & Runoff (ARR) (Ball J, 2016) focuses the potential change in rainfall intensity caused by climate change, but not rainfall temporal patterns, sequences of rain events, antecedent

conditions or base flow. Further research will be required to fill in the gaps. In the interim, a risk based approach is advocated, looking at a planning horizon for the decision and the consequences of failure. This is more aligned for asset considerations. In terms of zone and flood overlay controls for planning schemes, the planning horizon for climate change to 2050 must be considered.

To assess the climate change induced changes in relation to flood risk, ARR has used the projections of Global Climate Models. These models are coarse for application at a regional scale.

More recently, the Victorian government has commissioned CSIRO to develop downscaled climate projections across Victoria that will give a better representation of the influence of local factors such as topography on the change in rainfall intensity. Such data will greatly assist in future flood studies with a more informed focus relating to climate change and its associated impacts.

Bushfire impact

It is expected that the impact from climate change will see an increase in the number of bush fires across the region. Bushfire-impacted areas will lead to increases in rainfall runoff because of the effect of heat on the soil and removal of vegetation. Such impact will be dramatic in terms of increased magnitudes of runoff, which could see a 5% AEP (20-year ARI) rainfall storms result in a 1% (100-year ARI) type flood.

Following bush fires, the increase in flood risk will last around six months for grassland areas and 18 months for forested areas.

1.9 Description of the region

The Goulburn Broken CMA region, covers some 2.4 million hectares, and includes part of the Murray Riverina Basin, the Goulburn and Broken River Basins. Some 1.3 million hectares have dry land agriculture and irrigated agriculture covers 300,000 hectares (Montecillo, 2013). The population in 2011 was 204,000, an increase of almost 9% from 2001.

Seven municipalities are located mostly or entirely within the region (Benalla Rural City, Greater Shepparton City, Mitchell, Mansfield, Murrindindi, Moira and Strathbogie). About half of Campaspe Shire is also located within the CMA boundary, along with small portions of Greater Bendigo City and Rural City of Wangaratta. Municipal and catchment boundaries are in **Figure 3**.

Figure 4 provides an overview of the regional land-use classifications. Generally, the upper parts of the catchment are forested, while the lower parts have been developed for agriculture. Population trends from 2006, 2011 and 2016 census data indicate that most local government areas show relatively low population growth. Greater Shepparton and Mansfield local government areas show higher population growth than the region average. A breakdown of rural and urban population is presented in **Appendix L**: Goulburn Broken regional population statistics.

In recent years, Mitchell Shire has seen significant population growth due its proximity to Melbourne. Since 2001, a 30% growth has occurred.

Plan Melbourne (Chapter 6 – State of Cities) identifies Broadford, Kilmore and Seymour as peri-urban towns with potential to attract housing and population growth out of Melbourne. It is likely that demand for housing in these centres would be accelerated in the future with the imposition of a permanent growth boundary around Melbourne. Consideration around floodplain management priorities has been recognised in preparing the Action-Investment plan.

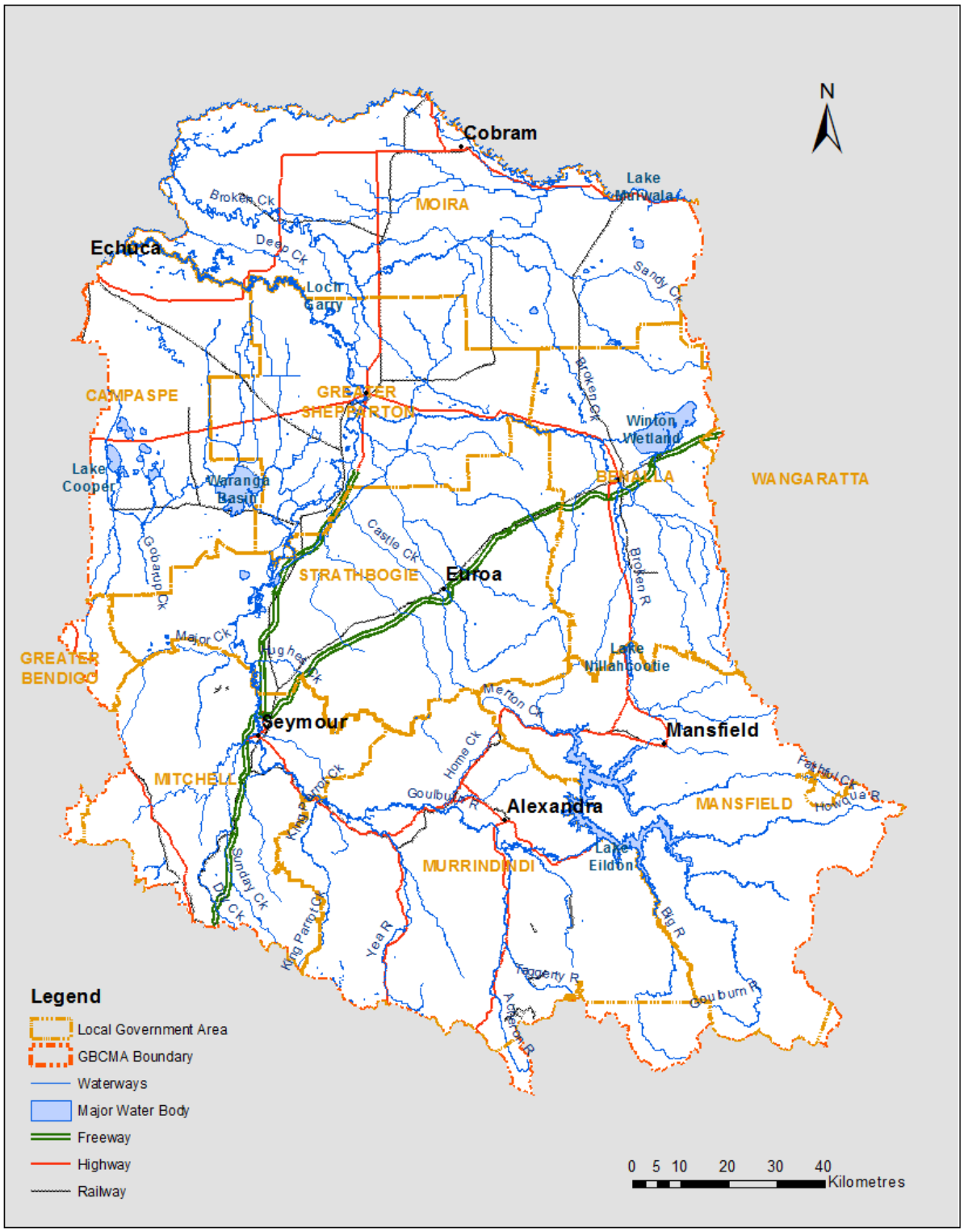


Figure 3: Goulburn Broken Catchment Management Authority Locality Plan

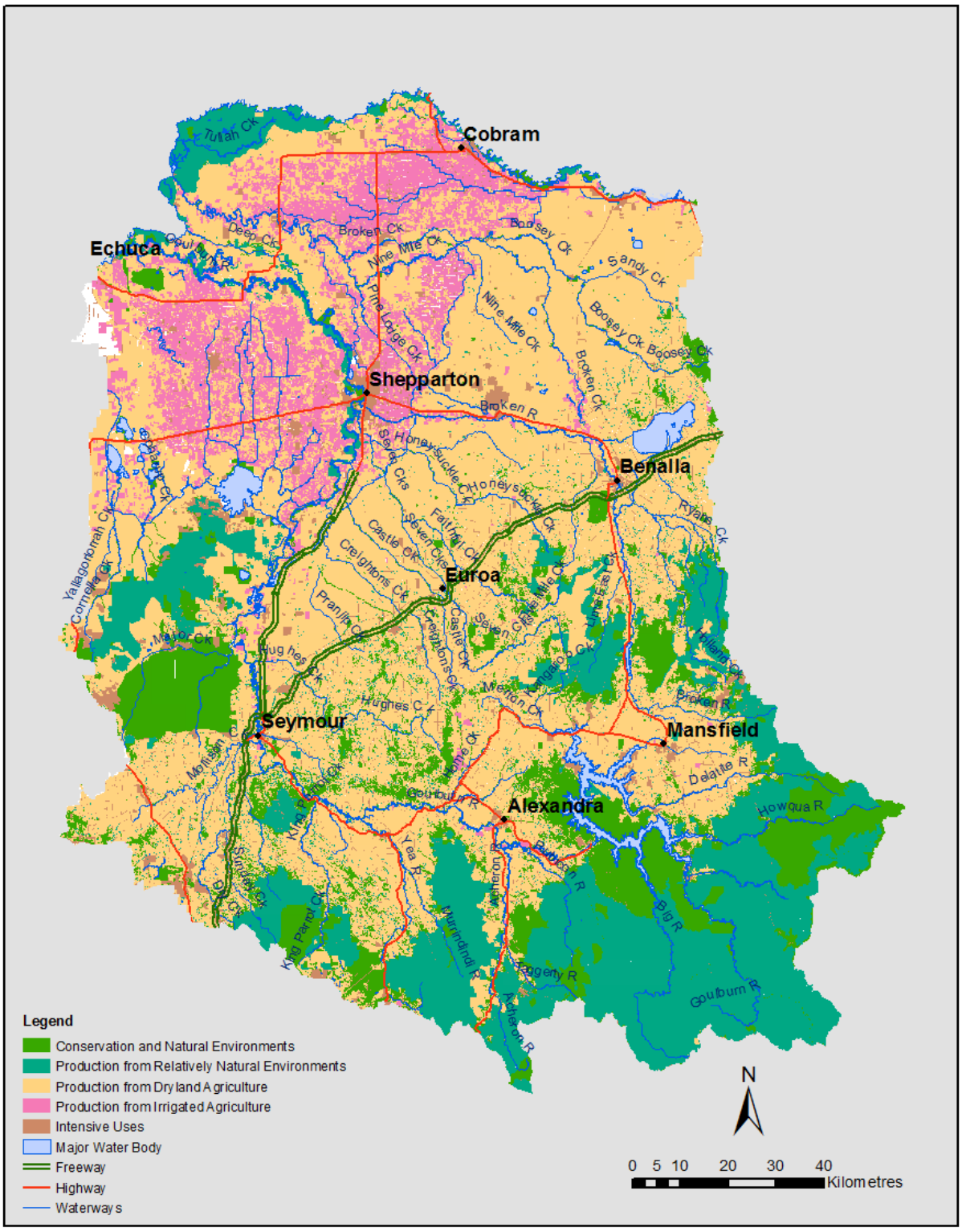


Figure 4: Land Use

Industry and Agriculture

The opening up of the area to agriculture (which commenced in the 1840s) heralded the development of a significant number of agricultural, commercial and public assets (Sinclair Knight Merz, 2002), including:

- Significant irrigation areas in the lower floodplains of the lower Goulburn and Broken Rivers;
- Arterial irrigation and drainage infrastructure such as East Goulburn Main Channel and a number of diversion weirs in Broken River and Broken Creek);
- Water storage reservoirs along many of the major water courses;
- Railways and road systems throughout the region; and
- Private and public softwood and hardwood plantations in the upper Goulburn Broken catchment.

Agriculture is the dominant land-use in the region and a substantial portion of the region's agricultural business is centred on its floodplains. Over 60% of the Goulburn, Broken and Murray River catchments and over 90% of the Broken Creek catchment have been cleared. This has led to increased pressure on waterways. Waterways have been substantially modified in many areas to permit access for stock and people to waterway frontages, to convey water for irrigation purposes during the summer months, to drain excess water and to protect properties from flooding.

The Gross Regional Product in 2008-09 was $7.08 billion and the Output was $15.2 billion of the eight local government areas in the region (Socio-Economic Profile of the Goulburn Broken Catchment, 2013). The services sector is the biggest contributor to the economic activity. Employment in 2011 was 90,000 and manufacturing was the biggest employer (11,000 people), followed by the Health Care and Social Assistance services and Retail sectors.

The gross value of agricultural production was $1.77 billion in 2011 almost the same as the pre-drought level in 2001. Irrigation continues to drive the agricultural sector - contributing two-thirds of this value, although its share declined from 67% in 2005-06 to 62% in 2011.

The results of the natural resources management survey conducted for the financial years 2007-08 and 2009-10 shows farm businesses in the Goulburn Broken region outperformed the State. The Goulburn Broken region provides unique opportunities to value add agricultural produce and provide competitive output. The enhancement of environmental and sustainability values is being achieved with new opportunities to value-add waste products by converting them to an input for another industry, whether it be milk by-products, horticultural processing waste, piggery waste, timber by-products or aquaculture waste.

There is a strong competition between the existing irrigation areas and the dryland for the investment dollars for high value horticulture development, whether it be for fruit, wine-grapes, olives, nuts or any other enterprise. In this regard, the irrigation area already is well served. It has the water, the irrigation infrastructure and many of the supporting services to enable new development to occur.

1.10 Floodplains within the Goulburn Broken region

The current flood zone and overlay information, which has been incorporated into planning schemes across the region, broadly identifies the flood prone areas as illustrated in **Figure 5**. Note there is other information not yet incorporated into planning schemes, which forms part of the Action-Investment plan of this Strategy (see Part B, Chapter 5). In order to gain an understanding of environmental factors and the exposure to flood hazard and risk in the Goulburn Broken region, floodplain areas have been split into their catchments as discussed further below.

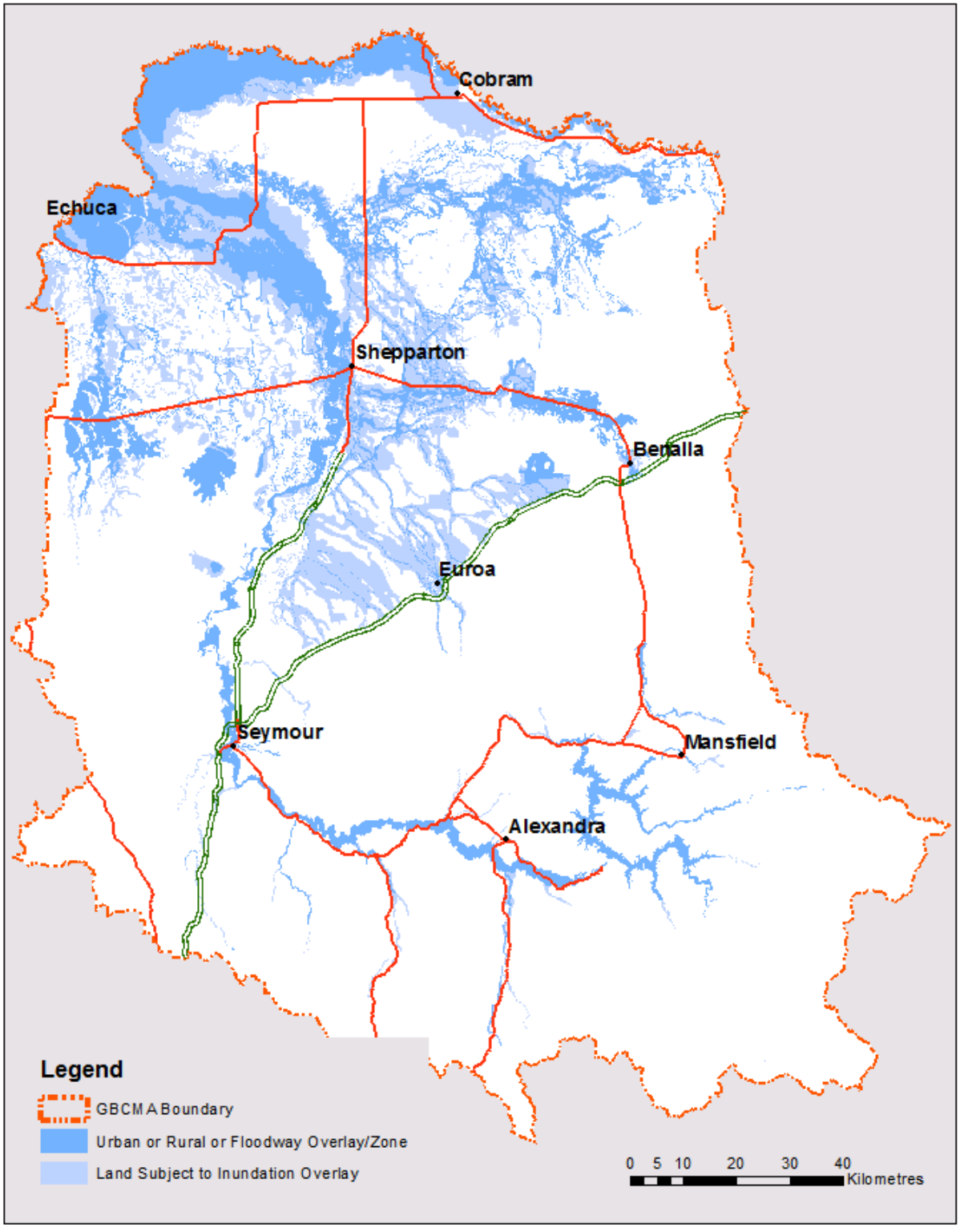


Figure 5: Gazetted planning scheme flood zone and overlay controls

More detailed flood maps are presented in **Appendix B**: Consultation Material to Promote Stakeholder Discussions and Input based on LGA areas together with some of the significant features as described below.

For convenience, floodplains in the Goulburn Broken region have been split into the following areas:

Murray Riverina:

- Lake Mulwala to Tocumwal; and
- Tocumwal to Goulburn River confluence (near Echuca).

Goulburn Basin:

- Upstream of Lake Eildon;
- Lake Eildon to Seymour;
- Seymour to Murchison; and
- Murchison to Murray confluence.

Broken River Catchment

Broken Creek Catchment

1.10.1 Environmental factors linkages

Flooding is a natural phenomenon upon which a number of environmental benefits depend. Floodplains, waterways and their associated wetlands, have a fundamental role in supporting flora and fauna habitats. Floods replenish wetlands, transport food supplies and trigger stages in the life cycles of many plants and animals.

Substantial areas of natural wetlands have been lost since European settlement, particularly in the Goulburn River and Broken Creek catchments.

If the environmental and cultural values of floodplains are to be managed effectively, reliable inventories of their assets and an understanding of potential impact are necessary inputs to the implementation of flood mitigation preparation of future floodplain management plans. Significant environmental features were originally listed in the Goulburn Broken Regional Floodplain Management Strategy (Sinclair Knight Merz, 2002).

Opportunities may arise to purchase freehold land (or use freehold land by agreement) suitable for restoration of natural functioning of floodplain. Government funding opportunities could be pursued if significant community benefits can be identified, such as specific significant environmental values, nutrient reduction and recreational values, for instance.

Other opportunities for enhancing environmental values include nutrient reduction plans, and implementing the standards as outlined in the Infrastructure Design Manual (Local Government Infrastructure Design Association , 2017), in particularly relating to water urban sensitive design that all LGAs are associated across the region.

In addition to these measures, landholders could be encouraged to undertake measures to improve environmental values on their properties. For instance, fencing incentive programs for the protection of riparian areas along waterways, and native re-vegetation programs.

1.10.2 Murray Riverina

The Murray Riverina basin extends from Lake Hume to the confluence of the Wakool River, north of Swan Hill. The portion within the Goulburn Broken region lies between the lower reaches of Lake Mulwala and the confluence of the Goulburn River. Its catchment area is not clearly defined, but is approximately 1,100 square kilometres.

Lake Mulwala to Tocumwal

Flooding for this reach originates from the headwaters of the Murray River, and/or its tributaries (the main ones being the Ovens, Kiewa and Mitta Mitta Rivers). Flooding can arise from rainfall across a number of catchments or from flooding for specific catchments (the Ovens catchment, for instance).

Lake Mulwala is located at the eastern boundary of the CMA. Two other storage reservoirs - Lake Hume and Lake Dartmouth – are located outside the Goulburn Broken region, but have an effect on flood flows and flood frequency along the Murray, particularly for frequent type floods. Further reading can be found in the Murray River Flood Plain Management Study (Gutteridge Haskins & Davey Pty Ltd, 1986).

The floodplain is naturally confined until about five kilometres upstream of Cobram, where sand hills give way to flatter terrain and the floodplain consequently becomes much broader. Two small levees – Dick's Levee (spillway)[2] and Cavagnas Levee – are located between gaps in sand hills immediately upstream of Cobram. Further downstream, a system of levees (with varying integrity) extending from Cobram to Barmah, largely protected rural areas from flooding, as experienced in 2016, which is estimated to be less than a 5% AEP (20-year ARI) type flood.

The construction of these levees has strongly influenced flooding for this reach, as has the development of irrigation, road and railway infrastructure.

Townships at risk from flooding from the Murray River include Cobram, Koonoomoo, Strathmerton, Yarroweyah and parts of Yarrawonga.

Tocumwal to Goulburn River Confluence (near Echuca)

Downstream of Tocumwal, floodwaters leave the Murray through a number of effluent flow paths passing northwards into the NSW's Edward River system. These flow paths are partially obstructed by levees and raised roads on the north side of the river.

On the Victorian side of the Murray, the natural floodplain downstream of Tocumwal is 20 kilometres wide. However, the reach between Cobram and Tocumwal, embankments associated with irrigation and drainage infrastructure[3] confine floodwaters to a width of about 11 kilometres.

Below Tocumwal, a ridge of land between Deniliquin and Echuca, known as the Cadell Fault, has diverted the western-flowing Murray southwards into a former course of the Goulburn River. As a result, flood flows in the Murray River, downstream of the Barmah Forest area, are limited to around 35,000 ML/d. In times of major floods, about 90% of the flood flows leave the Murray into New South Wales, through the Edward/Wakool system. A consequence of this behaviour is that flood levels remain similar for a wide range of floods.

Another interesting effect for this area is the occasional reversal of flows at the western end of the Cadell Fault. This is caused by floodwaters from Goulburn River effluents backing up behind the Bama Sand Hills and flowing northwards into the Edward/Wakool River system.

Barmah is the only significant town at risk of flooding for this reach. However, low-density development areas at Bearii, Lower Picola and Echuca Village are flood prone.

A history of large floods recorded since European settlement, within the Murray Riverina are presented in **Table 1**.

[2] Dick's levee is designed to spill for flood magnitudes around the 2% AEP and is part of an approved Water Management Scheme under the Water Act 1989. Hence the levee is also known as a spillway to alleviate pressures of flooding for Cobram.

[3] Such infrastructure has a primary purpose of supporting agriculture and not flood protection

Table 1: History of large known floods within the Murray Riverina

Date	Waterway Name	Town Affected	Approx. ARI (years) AEP (%)	Comments
1870	Murray River	Yarrawonga & downstream	150 (0.67%)	Largest known flood in the Murray catchment, record flood heights in Echuca & Mildura
1916	Murray River	Echuca	100 (1%)	Largest in the 20th Century
1917	Murray River	Yarrawonga & downstream	100 (1%)	
	Murray River	Cobram	100 (1%)	Levees breach at Cobram.
1956	Murray River	Cobram	<20 (5%)	Long duration flood
1975	Murray River	Yarrawonga to Barmah	35 (0.28%)	Several rural levees breached
1993	Murray River	Yarrawonga & downstream	<20 (5%)	
2012		Yarrawonga	>100 (1%)	Overland flooding largely from direct rainfall
2016	Murray River	Yarrawonga & downstream	<20 (5%)	

Significant identified environmental features within the Murray Riverina

In summary, the following environmental values are recognised:

- Billabongs and forests in the floodplain between Yarrawonga and Cobram;
- Forested areas and wetlands on public land between the levees and the river from Cobram to Barmah Forest;
- Barmah Forest, now a National Park, is one of the top ten Victorian wetland areas classified by the RAMSAR convention as being of international significance for its wildlife and vegetation; and
- A State reserve at Ulupna Island near Tocumwal.

1.10.3 Goulburn River

With a catchment area of around 16,900 km^2, the Goulburn River is the largest river system within Victoria. In the lower reaches of the catchment its floodplains are extensive. Significant floodplains also exist for part of its upstream reaches and for many of its tributaries.

Goulburn River Upstream of Lake Eildon.

Located within Mansfield Shire, the Big, Upper Goulburn, Jamieson, Howqua and Delatite Rivers, and Ford and Merton Creeks all flow into Lake Eildon, which has a catchment area of 3,910 km^2. With the exception of agricultural land along the lower reaches of the Howqua River and the Delatite River, the land is forested. The floodplains of these rivers and creeks are relatively well confined. Towns with known flood problems include Mansfield (flooded from Fords Creek) and Jamieson (flooded from Jamieson and Upper Goulburn Rivers).

Lake Eildon

Because of its size (current capacity 3,390 GL), Lake Eildon has a substantial effect on mitigating flood flows downstream of Eildon dam. This diminishes downstream of the dam, because of the contributions from downstream tributaries. However, the effect can still be substantial. In October 1993, the peak inflow to Eildon was 170,000 ML/d and the maximum rate of release was 48,000 ML/d. This compares with a peak flow of 160,000 ML/d at Shepparton, downstream of Broken River, where despite flows along Broken River reaching record levels, the flood magnitude was substantially less than other historic floods. Lake Eildon was also effective in attenuating floods in 1958 and 1975. Without the attenuation of Lake Eildon, flood flows at Seymour and Shepparton would have been substantially higher.

Goulburn River - Lake Eildon to Seymour

Downstream of Eildon the floodplain is well defined. Within the Shire of Murrindindi, its width generally varies from 1.2 to 3.0 kilometres. Further downstream towards Seymour, its width generally varies from 0.5 to 2.4 kilometres.

A number of significant tributaries flow into this reach of the Goulburn River, including: Snobs Creek; Rubicon River; Acheron River; Home Creek; Yea River (and its tributary, the Murrindindi River); King Parrot Creek (and its tributary, Strath Creek); and Dabyminga Creek.

The floodplains for these tributaries are also well defined.

The floodplains for these rivers and creeks have been mostly cleared. Generally, land-use is consistent with the flood risk, although an urban area in Yea, and low-density developments along Yea River, King Parrot Creek and Strath Creek encroach onto the floodplains. Four townships have areas liable to flooding: Buxton (flooded from Steavenson and Little Steavenson Rivers), Molesworth (flooded from the Goulburn River), Thornton (located at the junction of Goulburn and Rubicon Rivers and almost entirely flood prone) and Tallarook (flooded from Dabyminga Creek).

Over the past two decades, a number of floodplain quarries have been identified, many of which pose intolerable flood risk to infrastructure and the environment.

Seymour to Murchison

The township of Seymour has a history of flooding dating back to 1844, one year after it was founded. Pressure for urban expansion and a desire for flood mitigation for existing development resulted in a number of flood studies being undertaken in the 1980s, and again from 2000 to current day, where Mitchell Shire are coordinating detailed design for a proposed levee protection scheme.

The township is liable to flooding from Goulburn River, Whiteheads and Sunday creeks. The floodplains for the tributaries are well-defined and have steep flood gradients resulting in fast flowing floodwaters.

Sunday and Dry creeks also pass through the township of Broadford and a number of smaller towns including Wandong, Kilmore East, and Waterford Park. Some low-density residential development, to the west of Broadford encroach onto the floodplain areas. Generally, urban developments do not encroach into the floodplain.

Between Seymour and Murchison, the Goulburn River floodplain is well defined but variable, with widths ranging from up to 3.6 kilometres at Lake Nagambie to 200 metres in confined areas and averaging about 1.8 kilometres. Flooding in this reach of the Goulburn River can be the result of flooding from individual or a number of tributaries, combined with flows passing downstream of Seymour.

Nagambie Lake Leisure Park, located on the western side of Lake Nagambie is exposed to significant flood hazard, but the flood risk has been reduced due to a reconfiguration in the mid-2000s, when

the park was transformed from the then Chinaman's Caravan Park to the Nagambie Lake Leisure Park with significant government incentives for infrastructure upgrades. During a 1% AEP (100-year ARI) flood, inundation depths through the Park will range from 0.75 m to in excess of 2 m. The Caravan Park can be exposed to flooding from a combination of flood flows, not just directly from the Goulburn River, but also from its tributaries, Hughes Creek and Major Creek. While flood travel times from the Goulburn River upstream of Seymour are around eight hours or more, and flood warning arrangements along the Goulburn River are satisfactory, flood travel times for tributaries downstream of Seymour are less, and flood warning arrangements are not as reliable.

Between Seymour and Goulburn Weir, Hughes Creek, Major Creek and a number of lesser tributaries flow into the Goulburn River. Generally, floodplains to the west of the Goulburn are not well mapped as there is currently insufficient flood information to define the flood extent. An exception is the Hughes Creek floodplain, which a part of a current investigation refers to known as the Regional Granite Creek Flood Mapping Project.

Apart from Seymour and Broadford, only four towns have known flood problems – Avenel, Nagambie, Murchison and Kilmore. Parts of Avenel are liable to flooding from Hughes Creek and a number of small creeks that run through the northern portion of the town. At Nagambie, some urban lots back onto the Lake and parts of the town can flood from the Tabilk Depression catchment.

A large portion of Murchison, including its retail shop strip and residential areas, are located within a low-lying land-locked area that experienced flooding in 1916. A levee was constructed after then to prevent overflows from the Goulburn River entering this area. Some areas to the south are still exposed to flooding as detailed in the Murchison Flood Study (Water Technology, 2014).

In 1992, parts of Kilmore flooded, flooding at least six shops. This has been attributed to local drainage inadequacies rather than mainstream flooding.

Murchison to Murray River

Between Murchison and Shepparton, the Goulburn River floodplain varies in width from 1.2 km at Murchison to 3.7 km at Shepparton. Significant tributaries for the east side of the river include Pranjip Creek (catchment area about 800 km^2), Castle Creek (catchment area about 200 km^2), Seven Creeks (catchment area about 1,500 km^2) and Broken River (catchment area about 2,500 km^2). These tributaries have substantial floodplains.

There are also a number of flow paths to the west of the Goulburn River in the Toolamba area which convey local drainage to the Goulburn, but which can also function as effluent flow paths for extreme floods.

Towns and cities at risk from flooding from the Goulburn River include Kialla West, Mooroopna and Shepparton. West of the Goulburn River, parts of the townships of Tatura and Merrigum can be flooded from Mosquito Depression and its tributaries. On the east side of the catchment, the townships of Euroa and Violet Town are subject to flooding from Seven Creeks and Castle and Honeysuckle creeks respectively. The township of Baddaginnie is subject to flooding from Folly Creek (in the Goulburn River catchment) and Baddaginnie Creek (in the Broken River catchment). West of the Goulburn River, the townships of Tongala and Kyabram were subject to flooding from local runoff, but this is now substantially managed through retardation and pumping schemes.

Downstream of Shepparton, an almost continuous system of levees has been constructed along the Goulburn River. For convenience, these are described as the northern floodplain (the "Shepparton side") and the southern floodplain (the "Mooroopna side"). The levees have been instrumental in allowing a substantial portion of the Goulburn River floodplain to be developed on both sides of the river, including intensive irrigation and dryland agriculture. The level of protection for the levees

diminishes the further downstream one goes. Even in moderate floods flow will be distributed away from the river and onto the adjoining floodplains.

The northern floodplain downstream of Shepparton starts at Loch Garry, where effluent flows pass through the Deep Creek system, which end in the Murray near Barmah. Significant effluent flow paths include Bunbartha Creek, Deep Creek, Skeleton Creek, Sheepwash Creek, Wakiti Creek and Hancocks Creek.

The southern floodplain includes the small tributary catchment of Wells Creek. Flows from the creek are supplemented by drainage flows from Rodney Main Drain, which provides irrigation drainage. The drain outfalls to Wells Creek just upstream of its confluence with the Goulburn River.

Further downstream, also on the southern floodplain, Wyuna Main Drain and Tongala Main Drain outfall to the Kanyapella Basin, which in turn outfalls through Warrigal Creek to the Goulburn River immediately upstream of the Murray River.

At the westernmost part of the Goulburn catchment lies Cornella and Wanalta Creeks. These collect local runoff into a number of lakes and swamps. In exceptionally wet years, these lakes and swamps overflow into Wanalta Depression, which splits into three directions north of the "Bay of Biscay" on the Murray Valley Highway. One branch – the Southern Cross Depression – runs north-west to the Murray River at Echuca. Another runs north east into the Kanyapella Basin and the third - Beattie's Depression – runs north to the Murray.

Large floods within the Goulburn basin, recorded since European settlement, are presented in **Table 2.**

Table 2 History of large flood in the Goulburn Basin

Date	Waterway Name	Town Affected	ARI (years) AEP (%)	Comments
1870	Goulburn River	Shepparton	>100 (1%)	600 mm higher than 1916 flood
	Campaspe River [i]	Rochester to Echuca	?	
1916	Goulburn River	Generally, Molesworth to the Murray	~100 (1%)	>100-year at Eildon
	Seven Creeks	Euroa	100 (1%)	
	Honeysuckle Creek	Violet Town	~100 (1%)	
1917	Goulburn River	Eildon	>100 (1%)	
1934	Yea River	Yea	100 (1%)	
	Goulburn River	Eildon to Molesworth	100 (1%)	
1939	Goulburn River	Shepparton	~50 (2%)	
1958	Goulburn River	Shepparton	20 (5%)	
1973	Whiteheads Creek	Seymour	>100 (1%)	One drowning. Severe storm from Yea to Seymour
	Overland flooding	Yea	>100 (1%)	
1974	Sunday Creek	Seymour	30 (3.3%)	
	Goulburn River	Shepparton	70 (1.4%)	
	Campaspe River	Rochester to Echuca		
1975	Delatite River		~100 (1%)	
	UT Creek	Alexandra	~100 (1%)	
	Ford Creek	Mansfield	~100 (1%)	

Date	Waterway Name	Town Affected	ARI (years) AEP (%)	Comments
	Corop Lakes		~100 (1%)	
1983	Campaspe River	Rochester to Echuca		
1987	Sunday Creek	Broadford	20 (5%)	
1989	King Parrot Creek	Flowerdale	~50 (2%)	Largest
1989	Yea River	Yea	30 (3.3%)	
1993	Broken Creek	Nathalia	40 (2.5%)	
	Seven Creeks	Euroa	40 (2.5%)	
	Honeysuckle Creek	Violet Town	~100 (1%)	
1998	Jamieson River	Jamieson	40 (2.5%)	
	Acheron River	Buxton to Taggerty	~30 (3.3%)	
2005	King Parrot Creek	Flowerdale	~20 (5%)	
2010	Seven Creeks	Euroa	20 (5%)	
	Delatite River		>50 (2%)	Second largest on record
	Goulburn River	Jamieson	~100 (1%)	
	Acheron River	Buxton to Taggerty	40 (2.5%)	Largest flood on record
2011	Campaspe River	Rochester to Echuca	>100 (1%)	January 2011 is the largest flood on record
2013	Overland Flooding	Shepparton East	>100 (1%)	
2016	Whiteheads Creek	Seymour	~20 (5%)	One drowning.
2016	Long Gully Creek	Violet Town	~100 (1%)	

i. The Goulburn Broken CMA has a small proportion of the Campaspe Basin in its region south of Echuca, which is rural. The Towns are within the region of the North Central CMA.

Significant identified environmental features within the Goulburn Basin

The following significant environmental values are recognised:

- Riverine floodplain wetlands in the active floodplains of the Goulburn River, including Loch Garry, Gemmills and Reedy Swamps;
- Forested areas in the active floodplains of the Goulburn River, including a continuous strip from Shepparton to the Murray River confluence, and remnant forested areas along the Deep Creek system to the Murray River, parts of which are within a Nation Park;
- Forests in Kanyapella Basin and Yambuna, parts of which are within a National park;
- Remnants of ancient salt lakes, with characteristic sand dunes or lunettes on the eastern fringe, such as the Corop Lakes system and Lake Kanyapella Basin;
- Wetlands associated with prior stream systems, such as Mosquito Depression (refer to soil maps for a useful indication of where these areas are located);
- Wetlands associated with ovoid depressions, 100 to 200 metres across and with a slightly raised sand, silt or clay rim (the remains of salt scalds resulting from salinity events that occurred thousands of years ago; they are common in the Shepparton Irrigation Region);
- Recent stream systems, particularly in the northern floodplain of the Lower Goulburn River (e.g. Yambuna Creek); and
- Large water storage reservoirs such as Lake Nagambie, Lake Eildon and Waranga Basin.

1.10.4 Broken River Catchment

This basin has a catchment area of about 5,800 km^2 comprising the catchments of Broken River (2,500 km^2), and the Broken/ Boosey Creeks (3,300 km^2).

Broken River Catchment

The Broken River and its upper tributaries, Holland Creek and Ryans Creek, rise in the hills at Mount Samaria, south of Benalla. The floodplains of these upper tributaries, and Broken River upstream of Benalla, are narrow and steep and they exhibit rapid flood responses. Just upstream of Benalla the floodplain becomes wider. About 35 km south of Benalla lies Lake Nillahcootie, a 39,950 ML storage located on Broken River.

About 15 km downstream of Benalla, Five Mile Creek (or Baddaginnie Creek) joins the Broken River.

Flow from the Winton wetlands catchment (338 km^2) drains into the Broken River via Stockyard Creek some 10 km north-west of Benalla. Formerly, the Winton wetlands were known as Lake Mokoan, which acted as a water storage supply for irrigation and was decommissioned in the late 2000s. A ten-metre section of the storage's dam embankment has been removed as part of the return to wetland program (part of decommissioning process). Today, in time of major floods, floodwater is significantly attenuated (retarded) by the modified dam embankment.

In October 1993, substantial parts of the Broken River catchment were inundated by floodwater, causing major flood damage to Benalla township. Areas affected included Holland Creek, land downstream of Lake Mokoan, substantial parts of the Broken River floodplain from Benalla to Shepparton, Honeysuckle Creek and Seven Creeks at Kialla West.

Downstream of Benalla, the Broken River floodplain becomes less defined. During major floods (as occurred in October 1993) substantial flood flows can leave northwards from Broken River, through a number of breakaways, including Broken Creek, O'Keefe Creek, Pine Lodge Creek, Daintons Creek and Congupna Creek.

Large floods within the Broken River catchment, recorded since European settlement are presented in **Table 3**.

Table 3 History of flooding in the Broken River Catchment

Date	Waterway Name	Town Affected	ARI (years) AEP (%)	Comments
1916	Broken River	Benalla	~100 (1%)	Pre-Benalla Lake
1958	Broken River	Benalla	~20 (5%)	Pre-Benalla Lake
1993	Broken River	Benalla and downstream	100 (1%)	Some 1,100 homes and business experience over floor flooding
2010	Broken River	Benalla	20 (5%)	4.46 (1958) check 2010

Significant identified environmental features within the Broken River Catchment

The following significant environmental values are recognised as follows:

- Riverine wetlands in the active floodplain of Broken River and its tributaries;
- Gum Swamp, located adjacent to Stockyard Creek near Casey Weir;
- Lake Nillahcootie and Winton Wetlands (once part of Lake Mokoan irrigation supply);
- Lake Benalla in Benalla and Kialla Lakes in Shepparton; and
- Lightly timbered areas in the Dookie Hills near Nalinga.

1.10.5 Broken Creek Catchment

Ground slopes for this catchment are generally quite flat and the catchment boundary is indistinct for the northern and western boundary. The eastern boundary is defined by the Warby Ranges and the southern boundary is defined by the lower Dookie Hills.

Floods are generated from local runoff from the Major Plains area east of Dookie, from the Dookie Hills and from Broken River break-outs. For the smaller events, floodwaters are confined to the numerous drainage lines and depressions which traverse the area such as the Muckatah Depression. For the larger events (as occurred in 1974 and 1993) floodwaters from within the catchment are supplemented with effluent flows from Broken River. Towns with known flood problems include Katamatite, Nathalia, Numurkah, Tungamah and Wunghnu. Many other smaller townships along the upper Broken and Boosey creeks are known to experience some degree of flooding including: Devenish, Lake Rowan, St James, Thoona, and Wilby.

The development of an extensive irrigation and drainage system in the western half of the catchment, together with the construction of roads and railways, channels and levees, has led to considerable changes in flood behaviour. This is discussed in some detail in the Broken Creek Waterway Management Strategy (Sinclair Knight Merz, 1998).

Large floods within the Broken Creek catchment, recorded since European settlement are presented in **Table 4**.

Table 4 History of flooding in the Broken Creek Catchment

Date	Waterway Name	Town Affected	Approx. ARI (years) AEP (%)	Comments
1916	Broken Creek	Katamatite to Nathalia	Unknown	Likely to be a 100-year type flood with contributions from the Murray River (largely before infrastructure development across floodplain areas)
1939	Broken Creek		20 (5%)	
1974	Boosey Creek	Tungamah	50 (2%)	
1993	Broken Creek	Nathalia	40 (2.5%)	
2012	Broken Creek	Katamatite, Numurkah, Nathalia to the Murray	~100 (1%)	Ranked 1 flood of record at both stream flow gauges at Nathalia and Katamatite
2012	Boosey Creek	Tungamah	~50 (2%)	Ranked 1 flood of record at the Tungamah Gauge

Significant identified environmental features within the Broken Creek Catchment

The following significant environmental values are recognised as follows:

- Remnant riparian vegetation and linear wetlands along many of the water courses in the catchment;
- Tungamah Swamps east of Tungamah;
- Dowdle Swamp south east of Yarrawonga (State Game Reserve);
- Rowans Swamp on Boosey Creek;
- Ornamental lake at Numurkah and Tungamah;
- Moodies Swamp just west of Broken Creek (about 10 km south west of Tungamah);
- Kinnairds Swamp near Numurkah;
- Black Swamp, about 3 km upstream of Wunghnu; and
- Wunghnu Common.

1.11 Role of vegetation and woody habitat

There is a great deal of information and understanding about the management of rivers and waterways for ecological health. There is also a high level of understanding around management actions and their impacts on ecology, water quality, flows, stream stability, etc. It is well understood that a mostly continuous and broad swathe of native riparian vegetation is a key component of the ecological health of a river or waterway.

Native vegetation

The benefits of riparian and instream native vegetation including retention, replanting, recruitment and management include:

- **Continual leaf fall.** This plays a critical role in the functioning of freshwater aquatic ecosystems. The composition of native leaves, including eucalypts, is known to be a key component of this.
- **Improved water quality/buffer.** The clearing of catchments for agricultural land, soil disturbance during forestry operations or urban development, and bare areas such as gravel roads and stock tracks, have led to substantial increases in the amounts of sediment (gravel, sand, silt and clay) entering ours streams and rivers. This sediment and its associated nutrients and chemicals can contaminate human and stock water supplies, smother breeding sites for fish and other in-stream animals and, by filling up stream pools, deprive these animals of the deeper waters that are a vital refuge in dry seasons and prolonged droughts. Vegetation within a riparian zone can slow the overland movement of water, and cause sediment and attached nutrients to be deposited on the land before they can reach the stream channel. Riparian vegetation can also take up and remove some of the nutrients being transported (Price & Lovett, 2002).
- **Control of light and temperature.** Riparian vegetation shades streams, decreasing the amount of direct and diffuse sunlight reaching the water surface and reducing daily and seasonal extremes of water temperature. Shading controls primary productivity within the stream to a greater extent than nutrient levels, as the growth of most aquatic plants is regulated by light availability. At sites with elevated nutrient levels, shading can therefore control the effect of nutrient enrichment. In cleared streams, water temperature can exceed the lethal limits for aquatic fauna, directly influencing local biodiversity and, at lower temperature levels, the growth and development of aquatic plants and animals. The temperature tolerance of Australian aquatic macroinvertebrate fauna is similar to that measured elsewhere in the world.

In temperate systems, a target of 21°C is recommended, and in northern systems, 29°C for stream water temperatures (Davies, Bunn, Mosisch, Cook, & Walsh, 2007).

Woody habitat

Woody habitat is the branches, trunks and whole trees found lodged in waterways. They form structures in the river and create scour pools (deep holes) in the river bed. Woody habitat usually occurs naturally from trees on the river bank either falling in or dropping their branches. This can occur because of flooding, bank erosion, wind or limb shed.

Woody habitat is the inland equivalent of coastal reefs and provide habitat for native fish and other animals such as tortoises and native water rats. Native fish use them to shelter from fast currents and sunlight and take refuge from predation. Native fish also use woody habitat as feeding and spawning sites, and as nursery areas for juvenile fish.

Removal of wood debris from Victorian streams is listed as potentially threatening processes in accordance with Section 10 of the Victorian *Flora and Fauna Guarantee Act, 1988.*

Large Woody Debris (LWD) is often thought to contribute to flooding. There is, however, little evidence that LWD increases flood frequency or reduces the capacity of a river to carry floodwaters. The removal of LWD has been shown to increase the rates of erosion affecting stream bed and bank stability, and potential loss of valuable agricultural land.

Electrofishing studies carried out over a seven year period in the Goulburn River near Shepparton found almost twice as many fish at sites with a high density of woody habitat compared to sites with a low density of woody habitat. Other fish surveys have found that 80% of Murray Cod are found within one-metre of a snag.

Past river management practices have led to the widespread and systematic removal of logs and branches, yet wood in streams performs many different roles and is a vital component of riverine ecosystems (Land & Water Australia, 2003).

Removal of this material has a large affect on the ecology of stream systems:

- Provides secure roosting and preening sites for birds as well as excellent feeding vantage points;
- Fishes are more abundant and diverse in rivers with complex LWD; and
- Affecting energy sources, essential to the food web.

Until recently, logs were thought to be significant contributors to bank erosion and flooding. However, logs can enhance stream stability — their presence can exert significant control on channel complexity in bedrock rivers and channel geomorphology in alluvial rivers (Land & Water Australia, 2003).

With the exception of large wood accumulations, there is little evidence that logs and branches have a dramatic effect on flooding. Rivers will flood irrespective of the presence of wood (Land & Water Australia, 2003). Vegetation can reduce flow velocities and can influence water depth in stream systems. However, as the vast majority of the flood flow is carried on the floodplain and not in the river, localised instream and riparian vegetation will only have a minor to negligible influence on the depth and extent of major flood events (Alluvium, 2011). Further, research by river geomorphologist, Dr Chris Gippel, found that large wood that does not exceed 10% of the river channel cross-section area and does not have a significant impact on flood levels (Gippel, 1999).

Logs and branches from Australian riparian zones are relatively immobile. Our streams tend to have a low average stream power, the wood has a high density and many riparian trees have a complex branching structure that ensures they are easily anchored in position after falling into the stream (Land & Water Australia, 2003).

There is a recognition of the need for management of woody debris in situations where flood levels are impacted and towns and infrastructure are put at risk, i.e. localised flooding from large accumulation of wood or need for realignment of wood to reduce impact on flow deviation near assets.

Management policy and guidelines

Following the 2012 ENRC Review, the policy and actions contained in Section 18 of the Victorian Floodplain Management Strategy (2016) were established to include vegetation clearing, namely:

Policy 18b: Large-scale flood mitigation activities or works on waterways must be demonstrated, through a flood study, to be cost effective, i.e. have demonstrable benefits in terms of reduced average annual damage (AAD) that are greater than any costs to waterway health.

Action 18a, The Department has developed guidelines on how to apply to a CMA for authorisation to carry out works on waterways (refer to "Guidelines for Catchment Management Authorities: Assessing applications to manage vegetation and large wood in waterways and riparian zones, 2015").

1.12 Cross border issues

The Goulburn Broken catchment borders the Murray River, and as such needs to liaise with New South Wales agencies on any proposed plans including flood studies or works. Except for emergency management services, there are no formal consultation arrangements, and progress relies on good will between agencies to coordinate activities. For NSW and Victoria State Emergency Services, emergency management arrangements have been put in place to respond to the impact from major floods.

During the development of this regional Strategy, information flow to the NSWs Department has been provided that allowed for feedback in the finalisation of the Strategy.

An example of cross border cooperation was the development of the Regional Murray Flood Study where it was purposely expanded to include both the NSW Berrigan Shire and by the then NSW Department of Environment and Climate Change. Flood intelligence, was ultimately provided in both NSWSES and VICSES emergency plans (in Victoria using the Municipal Flood Emergency Plan for Moira Shire).

Similarly, the sharing and the coordination of flood information work across borders includes the capture of aerial flood photography, coordinated by the Murray Darling Basin Authority.

Cross border issues can also occur where Victorian municipalities are located within two or more catchment management authorities. As Campaspe Shire is located within both the Goulburn Broken and North Central catchments, the two catchment management authorities have worked collaboratively to provide a single point of reference in setting collective priorities for the Shire.

Another example of a partnership approach is the regional floodplain study of the Campaspe River from Rochester to Echuca, which was supported by both North Central and Goulburn Broken CMAs.

VICSES regional service boundaries do not always align with the Goulburn Broken CMA catchment boundaries. The Shire of Campaspe and the Shire of Mitchell are within the Western VICSES region, while the remaining Shires are located in the North East VICSES region. As part of the development of this Strategy both regional VICSES regions have been engaged.

1.13 Aboriginal connection to Country – waterways and floodplains

Approximately 6,000 Indigenous Australians reside within the Goulburn Broken region, many of whom identify as Traditional Owners.

Traditional Owners in the north of the region are represented by Yorta Yorta Nation (see **Figure 6**), which includes the northern plains of the Goulburn and Murray rivers, and comprising nine clans: the Kaitheban, Wollithiga, Moira, Ulupna, Bangerang, Kwat Kwat, Yalaba Yalaba and Ngurai-illiam-wurrung.

The south of the region forms part of the traditional lands of Taungurung Clans, which includes the mountains and rivers to the Great Divide as illustrated in **Figure 6**. Taungurung Clans are defined by nine clans: Buthera Balug; Look William; Moomoom Gundidj; Nattarak Balug; Nira Balug; Warring-Illum Balug; Yarran-Illam; Yeeren-Illam-Balug and Yowung - llam Balug.

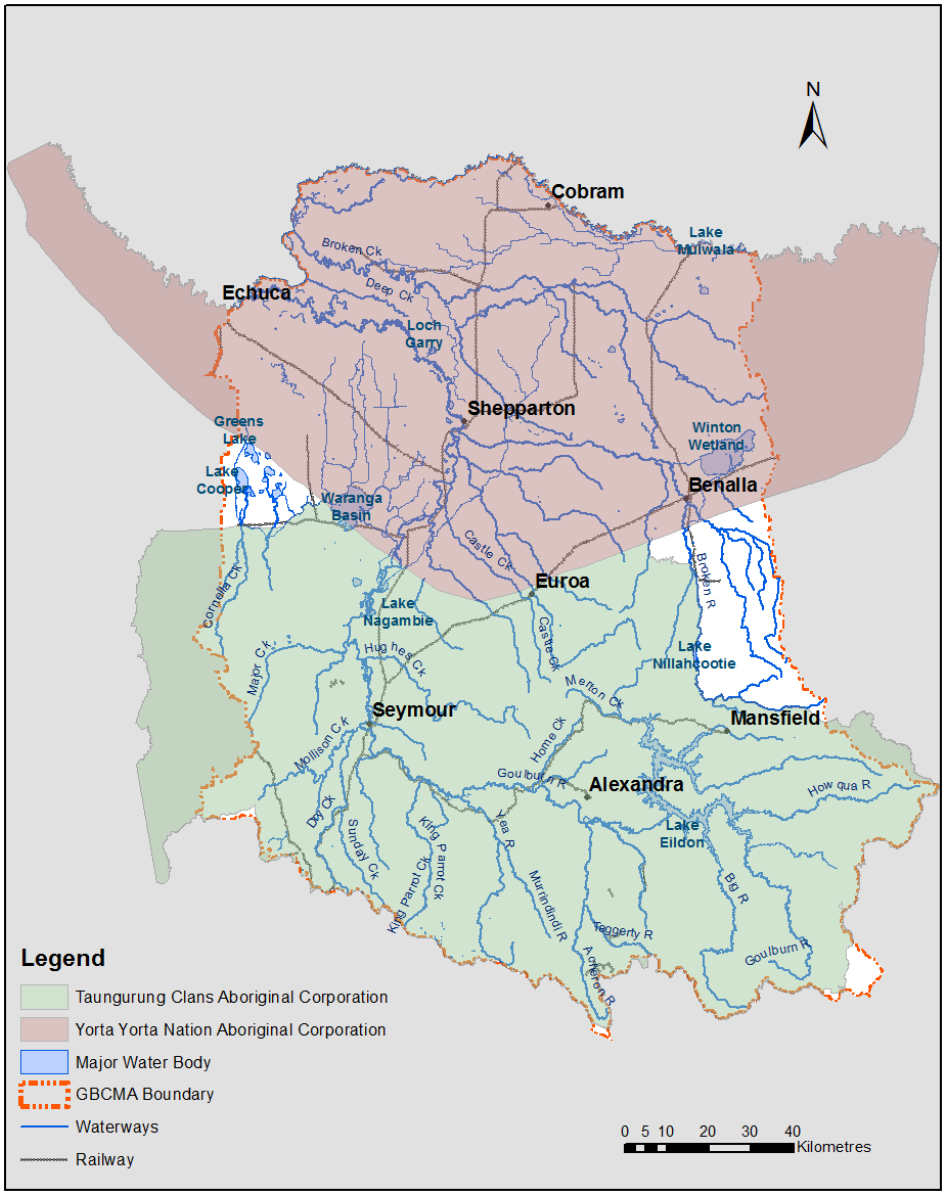
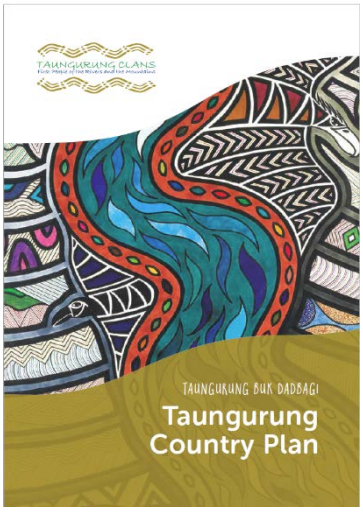


Figure 6: Registered Aboriginal Party boundaries across the Goulburn Broken region

The two following Sections contain extracts from the Country Plan prepared by each of the Registered Aboriginal Parties to highlight significant connection to waterways and their floodplains.

1.13.1 Taungurung Clans Aboriginal Corporation

As the Traditional Owners of a large part of the Goulburn Broken and North Central catchment areas, we as Taungurung People have a crucial role in managing and caring for the waterways that nourish this catchment.

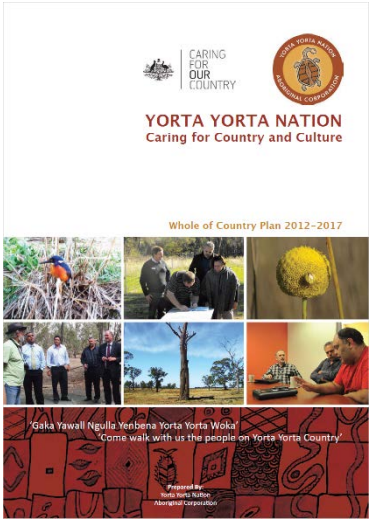


Water is the lifeblood of our Country. It keeps Country alive by nurturing and sustaining plants, animals, soils and ecosystems. As Traditional Owners, we have responsibilities handed to us by our Ancestors to continue to look after Country. As water is the source of life for our Country, we have had and will continue to have significant responsibilities relating to how water is managed now and into the future. Taungurung people have always and will always continue to look after Country.

The degradation of our waterways since European settlement is a source of great concern to the Taungurung people. Issues that we believe undermine the health of the waterways within the Goulburn Broken catchment and which need to be addressed include, amongst other things, change to the links between waterways with their floodplains.

1.13.2 Yorta Yorta Nation Aboriginal Corporation

The movement of our people within Country enabled us to use our vast resources without overuse or damage. Our Ancestors had an intimate knowledge of their environment and were able to sustain the ecology of each region. They used food and other resources to lead healthy and productive lives, without exploiting any resource.



Traditional Owners' knowledge of land and water resources and cultural heritage in the landscape is rich and unique.

The very essence of water itself - being flow - is of high spiritual importance to Indigenous peoples and represents*, The physical health of country is also directly connected to the physical, emotional and spiritual health of the Yorta Yorta People. Land, water and natural resources are not only necessary for survival, but are sacred and require protection and sustainable management under Yorta Yorta. The impact that watering regimes have on culturally significant fauna species is also one of importance. Lack of water, or lack of water to specific wetland areas, can be debilitating for species such as the Broad Shelled Turtle, the totem of the Yorta Yorta people.*

Both Country Plans features an Action Plan, which includes target areas and strategies for on-ground application.

1.13.3 Consultation requirements and partnerships

Traditional Owners have unique rights and interests under the *Aboriginal Heritage Act 2006* that differentiate them from the broader community. Accordingly, direct engagement is required when contemplating activities and works on floodplains including the preparation this Strategy.

The Yorta Yorta Nation Aboriginal Corporation (YYNAC) and Taungurung Clans Aboriginal Corporation (TCAC) are both Registered Aboriginal Parties (RAPs), under the Victoria *Aboriginal Heritage Act 2006* (the Act). The Act recognises Aboriginal people as the primary guardians, keepers and knowledge holders of Aboriginal cultural heritage. At regional and local levels, RAPs are the voice of Aboriginal people in the management and protection of Aboriginal cultural heritage.

RAPs have responsibilities relating to the management of Aboriginal cultural heritage under the Act. These include evaluating Cultural Heritage Management Plans, providing advice on applications for Cultural Heritage Permits, decisions about Cultural Heritage Agreements and advice or application for interim or ongoing Protection Declarations.

"…floodplains, rivers, wetlands, estuaries and aquifers are all part of an interconnected system that needs to be managed holistically. It is also important to note that the vast majority (95% of the 30,000 recorded significant Aboriginal places and heritage sites) are located on or near Victorian waterways". (Federation of Victorian Traditional Owner Corporations, 2014)

Waterways and their associated floodplains are a vital importance for Traditional Owners' livelihood and well-being including: cultural and spiritual connections, sustainable ecological sources for traditional foods and fibre, traditional medicines, and water resources.

The ecological and cultural values are particularly threatened by changed flow regimes, particularly in regulated water supply systems that support both potable and irrigation water supplies.

Opportunities to manage the absence of freshes and floods have been subject to environmental waterway initiatives at all levels of government. The strategic use of floodwaters, such as that originally proposed by the lower Goulburn Constraints Strategy (2016) sought to engage the wetting of the riparian ecosystems which are not only important to the flora's health but recognised as important to Aboriginal peoples.

A full range of values, rather than focusing on asset protection for urban towns for instance, is recognised as part of the decision-making process in floodplain management initiatives. Tools to undertake assessments and determine priorities need to include engaging with Traditional Owners and seek alignment with strategic documents such as: Country Plans, Regional Growth Plans, State Policy and Planning Framework.

Traditional Owners are required to be engaged in any floodplain management activities and/or works. This includes any emergency management arrangements through the Incident Control Centre during major floods.

The Goulburn Broken CMA and its partners are conscious of meaningful engagement with Traditional Owners as set out in Aboriginal Participation Guideline (Department of Environment, Land, Water and Planning, 2016) and its associated document Implementation Plan – Pathways to Participation (Department of Environment, Land, Water and Planning, 2016).

To assist in meeting these participation guidelines, a combined working committee comprising RAPs, CMAs and other guests meet three times annually to discuss issues of the day, including this regional Strategy. Also, the Goulburn Broken CMA employs two staff members representing the Traditional Owners general interest including the cultural flow initiative. The Goulburn Broken CMA coordinates the Woka Walla (land and water) program that include on-grounds work program including Traditional Owners.

The Regional Waterway Management Strategy (2014) recognises integrated management including the best available scientific information and aspiration of knowledge of Traditional Owners.

1.14 Flooding versus drainage

The boundary between drainage issues and flood issues is sometimes blurred. However, there are some noticeable differences.

Rural and urban drainage do not form part of this regional Strategy

Flooding

Flooding is a natural phenomenon that occurs when water covers land that is normally dry. Adverse flood impacts are mostly associated with flood damages and trauma from infrequent floods (generally greater than the 20% AEP or 5-year ARI event). Where appropriate, flood mitigation infrastructure is constructed to protect communities from flooding. Other non-structural options, such as land use planning and development controls, are applied to reduce the frequency and severity of flooding.

Flooding from riverine catchments has historically been a major focus in floodplain management. In recent years, the Goulburn Broken CMA has recognised the importance of overland flooding from localised severe intense thunderstorm episodes. This occurs in areas such as Kilmore, Shepparton East and Alexandra. Such overland flooding investigations have been commonplace in the Melbourne Water area of responsibility, and have been documented as having a similar flood damage profile as riverine flooding.

Overland flooding identification is particularly important within peri-urban centres close to Melbourne as there are pressures to intensify development with greenfield areas. This largely applies to Mitchell Shire and to a lesser extent to Murrindindi Shire.

Rural drainage

Rural drainage is focused on constructing infrastructure to remove water off the land to improve agricultural productivity. Without the drains, the land is frequently waterlogged. Drainage capacity is usually focussed on the more frequent (50% AEP or 2-year ARI) rainfall events. Non-structural solutions don't apply.

Irrigation drainage is managed through the Goulburn-Murray Irrigation District Drainage Program through in partnership between Goulburn-Murray Water (lead agency) and Goulburn Broken CMA. There are no existing dryland drainage schemes that were historically present under either the Drainage Areas Act 1958 or and the Drainage of Land Act 1975. These acts have been repealed and superseded by the Local Government Act 1989.

The draft Victorian Dryland Drainage Strategy is currently being developed by DELWP, and is expected to be released by the late 2017 for comment.

Urban drainage

Urban drainage is managed by LGAs and generally was historically concerned with managing localised rainfall episodes equivalents to a 20% AEP (5-year ARI) standard. Contemporary standards seek to be guided by a common document known as the Design Infrastructure Manual, which most Victoria Councils use employing a 1% AEP standard through the use of localised retardation basins, particularly for greenfield areas.

1.15 Integrated catchment management – identifying threats and opportunities

Integrated catchment management (ICM) recognises the intrinsic linkages between land-use and subsequent impacts on land, water, cultural heritage and biodiversity and seeks a holistic approach to their management.

Actions within a catchment (such as residential/commercial development, agriculture and forestry) can have significant impacts on the functions and uses of floodplains. For example, development of 'greenfield' sites on floodplains can impact a number of floodplain functions, including: habitat maintenance; cultural heritage, wetland connectivity, flood storage and conveyance; and groundwater recharge. Also refer to Section 1.10.1.

Similarly, floodplain mitigation works (such as levees) can also impact floodplain functions by constricting the floodplain area causing adverse impacts to surrounding areas, as well as effectively disconnecting the floodplain from the waterway, reducing the retention of water in wetlands, decreasing habitat diversity, and destroying riparian vegetation.

ICM opportunities for floodplain management

Opportunities for integrated outcomes will make floodplain management stronger and more resilient. They may arise from changes in government policy, community perceptions to floodplain function, emerging technology, improved stakeholder engagement and other forces relevant to floodplain management.

More tangible opportunities exist through collaboration and cooperation within CMAs, particularly waterway management. Examples include:

- Environmental watering, particularly where it includes inundation of the floodplain to mimic natural flow regimes to improve environmental and cultural values[4].
- Vegetation management e.g. willow replacement programs. Willows can choke waterways leading to in-channel constrictions and the backing up floodwaters.
- Protection of waterway assets for their environmental values e.g. Gunbower forest. When we preserve floodplains for their environmental values and the ecosystem services they offer, we are also maintaining their capacity to store and convey floodwaters.

[4] Provided that environmental watering does not impact of private land without landowner agreement

Chapter 2: Service level and previous strategy assessments

2.1 Overview

This Chapter provides commentary and documentation on the achievements in the delivery of the first regional floodplain management strategy released in 2002[5] and provides a summary of service levels for the four programs that form the basis for the four-year rolling Action-Investment Plan in **Chapter 5:**

- Flood mitigation works
- Total flood warning systems
- Land use planning
- Municipal flood emergency management plans.

The first three programs form part of the program logic, which is discussed in **Section 1.6**. The fourth program, Municipal Flood Emergency Plans, is a combination of the first three programs above and including identified regional community infrastructure and vulnerable communities.

Service levels are defined as a list of attributes or a score that enable the quality or performance of a program element to be evaluated.

2.2 Regional Floodplain Management Strategy 2002

The 2002 regional Strategy comprised nine programs. Their alignment against the four programs in **Section 1.6** is illustrated in **Table 5.**

Table 5: Alignment of programs between the 2002 and 2018 Strategy

2018 Programs	2002 Strategic Programs
Flood Mitigation	Asset Management (levees) Floodplain Management Plans
Total Flood Warning Systems	Education, Promotion and Communication. Floodplain Management Plans
Land Use Planning	Statutory Land Use Planning Development Assessment Guidelines Control of Works and Activities on Floodplain Information Management Systems Flood Studies and Floodplain Management Plans
Municipal Flood Emergency Plan	Emergency Response Planning Flood Monitoring Actions Flood Studies and Floodplain Management Plans

In the 2002 strategy, flood studies and floodplain management plans were identified as a distinct program. This is not the case for the current strategy, but they are still of vital importance. Flood studies and floodplain management plans are a means to an end that provide the necessary products to deliver on the activities identified in the Action-Investment Plan

[5] Note an Interim Goulburn Broken Regional Floodplain Management Strategy (2014-2016) was prepared where nine of the ten listed actions are either completed or underway. This Interim Strategy is available on the Goulburn Broken CMA website.

A review into all studies completed since 1997 was undertaken as part of this regional Strategy stocktake. Detailed listings are presented in **Appendix D**: Summary of Flood Studies, Plans, Work Plans and their numbers are summarised in **Table 6**.

Studies prior to 1997 (i.e. the year the Goulburn Broken CMA was established) have not been listed. They were however considered when providing information to stakeholders. Most are referenced in the stocktake in **Appendix B**: Consultation Material to Promote Stakeholder Discussions and Input.

There have been ten studies completed pre-Strategy (1997-2001). During the period of the 2002 regional Strategy (2002-2013) another 28 flood studies were completed, and another ten studies post Strategy – refer to **Table 6**: Summary of number of studies, plans and action since CMA formation (1997).

There are some 19 actions in terms of flood mitigation implementation, which are largely carried out by local government (there are numerous other supporting documents prepared by local government that are not listed).

It is important to note that information from the 48 studies completed (and another 7 underway) are utilised to action land-use planning, emergency management (MFEPs), and education and awareness initiatives (i.e. Local Flood Guides, web access to property-specific information, and the Flood Victoria website), which are numerous.

Table 6: Summary of number of studies, plans and action since CMA formation (1997)

Study Type	No of Studies and Plans
1997-2001 (Pre-2002 regional Strategy)	
Flood Scoping Studies	1
Flood Studies	4
Floodplain Management Plans	5
Flood (Mitigation) Implementation Actions	3
2002 – 2013 (2002 Regional Strategy Phase)	
Flood Scoping Studies	3
Flood Studies	17
Floodplain Management Plans	8
Flood (Mitigation) Implementation Actions	12
2013 -2017 Interim Strategy (2013-2016)	
Flood Scoping Studies	0
Flood Studies	8 [i]
Floodplain Management Plans	2
Flood (Mitigation) Implementation Actions	3

i. Plus an additional 7 studies underway.

The carrying out flood studies, floodplain management plans, mitigation schemes, emergency management plans and land-use planning controls would have not been possible without the collaboration of all stakeholders, and particularly the strong support for Local, State and Commonwealth funding over the past two decades

Appendix E: 2002 Regional Strategy Program Review provides a commentary to what extent each of the nine programs presented in the 2002 regional Strategy have been implemented.

2.3 Service levels for structural mitigation works

It is important to document information about existing structural flood mitigation works (mostly levees). The information can be documented in terms of:

- Management arrangements;
- General characteristics, such as location and height;
- Service levels (where known), such as condition, freeboard, the level of protection and management arrangements;
- The source of the information;
- A description of the infrastructure and the beneficiaries; and
- Any proposed improvements., as well as identify whether the current service levels are appropriate or should be improved. The documentation includes governance arrangements, freeboard, and assets protected.

There also needs to be consideration of whether there are *prima facie* cases for new flood mitigation infrastructure, or a need to modify existing infrastructure, or a need to bring such infrastructure under ongoing management (operation and maintenance) arrangements, preferably under a Water Management Scheme as outlined in the *Water Act 1989*.

A review has been carried out for each LGA (urban management units) and for the regional areas (rural management units) and is presented Appendix F: Service levels – structural flood mitigation works**.**

Most flood mitigation infrastructure in Victoria is not being formally managed. If no current formal management arrangements are in place, 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 will impact on emergency management planning and on land-use planning.

Where existing flood mitigation infrastructure does exist, a description is provided (usually about a levee), including the service level, the main beneficiaries and the management arrangements.

Where new flood mitigation infrastructure is desirable or whether there is a plausible case for modifying or expanding the existing flood mitigation infrastructure, the regional Strategy highlights a need for investigations for flood mitigation infrastructure options.

There are three phases of work:

- The planning phase, where information on existing or proposed flood mitigation infrastructure is reviewed;
- The decision-making phase, where LGAs, the CMA and other relevant stakeholders convene to determine what further actions should be addressed in the regional Strategy; and
- The documentation phase where findings are recorded.

2.3.1 Management arrangements for rural levees

Victorian Floodplain Management Strategy policy on Flood Mitigation Infrastructure.

Section 17 of the Victorian Floodplain Management Strategy (VFMS) sets out a policy framework for the consideration for either building and/or managing floodplain infrastructure.

Most flood mitigation infrastructure in Victoria is not being formally managed. If no current formal management arrangements are in place, 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 will impact on emergency management planning and on land-use planning.

A separate process exists for individuals (or group of individuals) wishing to carry out levee maintenance works on Crown land. Note that levee maintenance on private land is subject to planning scheme processes (in some cases, if considered "routine maintenance" under the planning scheme provisions then no planning permit is required).

Generally new levees are unlikely to be supported outside an approved process (i.e. *Water Act 1989* or *Local Government Act 1990*).

The Victorian Government prefers flood mitigation infrastructure that is to be formally managed to become Water Management Schemes. The process is outlined in the *Water Act 1989*.

The VFMS acknowledges that the processes surrounding Water Management Schemes are not perfect. An Action in the VFMS is for DELWP to prepare, for government consideration, a proposal to amend the Water Act to clarify and simplify the liability and assurance arrangements for LGAs when they construct or maintain flood mitigation infrastructure through the implementation of Water Management Schemes.

Management of rural levees by Local Government

The VFMS sets out the policy that LGAs are best placed in its role in supporting communities to manage levees (if there is the resolve to do so). Many LGAs however, articulated strong resistance to this policy during the development of the VFMS.

Section 17.2.1 of the VFMS sets out the investment criteria including, amongst other things, how community and private benefits are considered. As such LGAs are unlikely to play a role in the management of rural levees in the region.

Whilst in can be argued that there will always be some "community benefit" around "rural" levee management (i.e. major access routes being maintained, large businesses remaining operational), it is considered relatively small compared with the "private" benefits. Therefore, the beneficiary principle for rural levees, such as the lower Goulburn and the Public Works Levee[6] would remain with the rural landowners.

Cost sharing principles (both rural and urban)

The VFMS focusses on the beneficiary pays principle. The three tiers of government (Australian/State/LGA) would only invest in existing mitigation infrastructure if this met the "investment criteria" contained in Section 17.2 of VFMS. These include, amongst other things, cost effectiveness, and (specific) community criteria that needs to be met if the three tiers of government are going to invest financially. The VFMS suggest that it is unlikely that rural levee will managed into the future due to such investment criteria.

Economic prima-facie case

The VFMS requires that a *prima facie* case for economic effective be carried out for rural levees as part of the development of regional catchment management strategies. In this regard, the Goulburn Broken CMA commissioned Jacobs to carry out a rapid appraisal assessment, which found the benefits of managing the current lower Goulburn and Public Works levees are not economically viable.

Conclusion

Having regard to the above, and the workshop with DELWP, Greater Shepparton, Campaspe, Moira Councils and Goulburn Broken CMA, the conclusion reached was not only was there strong

[6] The Murray River levees extending from Cobram to Piree Creek (near Picola).

reluctance by LGAs to be part of any rural levee management largely due to legal liability and lack of resources, but the required work to bring rural levees up to a reasonable standard failed to align with the Victoria investment criteria.

Individuals (or groups of individuals) under the new Goulburn Broken CMA permitting process may be granted permission only for levee maintenance works on Crown land. This is now available on the Goulburn Broken CMA website.

2.3.2 Irrigation Infrastructure acting as levees

Goulburn-Murray Water under its Connections Project for modernising aging infrastructure, has determined many "non-backbone" irrigation channels that could be decommissioned and handed over to the landowner (i.e. irrigation channels determined as surplus for future delivery of irrigation water supply).

Goulburn-Murray Water commissioned the Goulburn Broken and the North Central CMAs to carry out an impact assessment or a traffic-light assessment (Red: channels to remain, Yellow: channels can be removed with landowner consent, Green: channels may be removed). Issues may occur where channels provide a degree of urban flood protection, which then requires a process to maintain such channels (or equivalent infrastructure) into the future. The consequences of "unmanaged private channels" once decommissioned, could be significant.

The body of work performed for GMW was reassessed with a focus of urban flood protection from "non-backbone" channels decommissioning.

If a levee (or a channel that may perform the function of a levee) is considered important, then an LGA needs to consider bringing the asset into a Water Management Scheme (or similar).

A summary of where abandoned irrigation channels could have significant flood impacts is included in **Appendix E**: 2002 Regional Strategy Program Review (Table F-32).

2.4 Service levels for total flood warning systems

DELWP commissioned Michael Cawood and Associates to develop a state-wide Total Flood Warning Assessment Tool to provide consistency across CMAs in determining existing service levels.

The results delivered by the Tool provide guidance on the service level being achieved by each element of the TFWS, as well as the TFWS as a whole, for each location or river reach analysed relative to the assessed flood risk for that location or reach. The Tool allows for the examination of potential actions to improve the TFWS to be explored.

The elements that the Tool considers are shown in **Table 7**, where the factors are broken down (sub-factors) and scored in accordance to with the Total Flood Warning System Assessment Tool – User Manual for Version A.

Table 7: TFWS Elements and Tool Factors

TFWS Elements	Tool factors
Data Collection and Collation	Factor A – Data Collection Network
Flood Forecasting (i.e. detection and prediction)	Factor B – Forecasting
Interpretation	Factor E – Interpretation
Message construction	Factor C – Dissemination/Communication
Message dissemination	
Response Planning and Response	Factor F – Response Planning
Education and Awareness	Factor D – Flood Awareness and Education
	Factor G – Social and Economic Assessment

The service levels are compared with Factor G (see **Table 7**), which is based on the work prepared by Aither through the state-wide application of the DELWP methodology for rapid appraisal of flood risk, which is the same body of work used to initiate the risk assessment and priority setting in **Chapter 3:**. However, Factor G did consider impact to key infrastructure and the loss of major access-ways that affect evacuation and other response activities during a 1% AEP type flood (refer to **Chapter 3:**).

This Tool then allows for the examination of potential actions to improve TFWS service level scores to at least match the flood risk level scores. (i.e. improve education and awareness via Local Flood Guides, improve interpretation of flood intelligence, etc.)

The assessment and action identified are presented in **Appendix H**: Service levels – Total Flood Warning System (TFWS).

2.4.1 Managing the rain and stream flow gauge network across the region

DELWP coordinates the Regional Water Monitoring Partnerships' program. The partnership approach allows data to be collected to a well-defined standard once, but used for multiple business needs, such as allocation management, compliance monitoring, flood warning, water resource assessment and river health management.

It provides a coordinated and efficient approach to the statewide collection of the information required for delivering a continuous program of water resource assessment for Victoria, as required under the *Water Act 1989*.

Any new gauge network should be managed under the regional partnership's program.

2.4.2 Maximising flood resilience within the TFWS program

Building on the resilience theme, outlined in **Section 1.7** and **Section 2.4,** most of the activities identified as TFWS improvements are aimed at assessing and collating information about flood risk and its associated consequence, and making it more widely available to at-risk communities rather than at collecting data and improving the forecast for times of major floods.

Discussions with Michael Cawood[7] and with the state-wide and regional working groups, confirmed that the reason for making access to fit-for-purpose flood risk information as a priority is threefold, as follows:

- The TFWS is a great deal more than installing gauges, collecting data and making flood forecasts. More data does not by itself imply better results in terms of the overall goal of warning systems (i.e. improved safety for those at-risk and reduced human suffering and flood damages).
- Consistent with Federal and State initiatives, there is a need to increase community resilience to flood. Key to that increase is authoritative and credible information about flood risk and local access to that information and real-time data in the lead up to and during floods. Together, that enables the at-risk community to assess individual and collective risk information, and make decisions about what to do to avoid or reduce that risk.
- There are many communities for which the Bureau of Meteorology does not provide a flood warning service, and unlikely to see change in the short term. A request for new services has to be justified on the basis of risk and benefit. Development, operation and maintenance costs also have to be met from outside the Bureau of Meteorology.

There is currently better value to be had from investing in other elements of the TFWS than in the data collection network (Cawood, 2005). There is need to think about and act on:

[7] Michael Cawood developed the TFWS Tool and earlier assessments for VFFCC.

- How to make existing data and information / flood intelligence easily accessible to at-risk communities;
- Assisting at-risk communities in how they use that data and intelligence (the "what does it mean for my home or my business");
- Developing / providing tools that add value to or drag value from available data and intelligence;
- On a location by location basis, developing a means of providing an indication of likely flooding with some lead time for the many communities that BoM does not provide a flood warning service for and is very unlikely to any time soon or even in the medium to longer term;
- Linking flood study outputs and mapping back to a local or reference gauge so that it becomes more useful to the local community;
- Focussing the existing flood warning prediction service on what is required in order to achieve a reduction in damages rather than on delivery of a technically accurate forecast (i.e. recasting so that the focus is on lead-time and a degree of accuracy rather than on precision); and
- Providing the data, information and tools to enable at-risk communities to build resilience.

In conclusion, the regional Strategy actions that are best aimed to improve the TFWS are generally focussed on:

- Identifying and mapping flood risk as part of a flood or related study;
- Identifying consequence (i.e. extracting intelligence from flood study activities and outputs);
- Sharing mapping and information about consequence through LFGs, the MFEP and other means;
- Assisting provision to at-risk communities of real-time access to all available rain, river and other relevant data;
- Developing indicative flood likelihood and severity tools for local application; and
- Refocussing forecasting attention on lead time and exceedance of critical levels rather than on the precision of the forecast peak height and time.

2.4.3 Stakeholder engagement and access to flood data to improve flood preparedness

Flood risk information that provides the pathway to improved flood preparedness and resilience not only applies to home and business owners, but to private companies and government agencies that manage assets and business operations, such a bridges, recreational activities, sand and gravel mines and caravan parks.

During the development of this regional Strategy, the recognition by stakeholders around access to data to build flood resilience is not only paramount but is the one single effective way of minimising human suffering and flood damage to the built and natural environment.

An engagement plan should consider historical flood events and improve on engagement materials and programs, communities have been exposed to in the past. An enabling way to gain interest and find out what the community wants is by identifying the already existing and successful community groups and meetings and utilising these to gain information about the community, and then understand the best ways to increase flood risk awareness.

Identifying community needs to shape type of engagement

The following are sample questions that could be used to understand the current level of community awareness and engagement for what and how flood risk information is shared.

- What is the demographic, land-use and vulnerable communities and high-risk areas of the landscape as identified by the community?

- Which specific community groups have been targeted?
- What methods would the community like to see used to address the identified gaps?
- What information has been provided and in what manner (e.g. verbal at meetings, hand-out documents, downloads from a website)?
- What actions or activities have been undertaken?
- Has there been a noticeable maintenance or increase in understanding of flood risk management due to the above?

Groups are often a support network for communities and provide ongoing contact that will be utilised in an emergency event. When there are multiple community pressures during an event, vulnerable people can be forgotten and are most at risk, which highlights the importance of maintaining a Vulnerable Persons Register.

Community values and desires

Identifying community stakeholders, their values and what they want will enable development of fit–for–purpose engagement programs and materials. A major goal of the regional Strategy is to ensure that those living and/or working in flood prone areas are aware of their flood risk and of the measures they may adopt to manage or mitigate this risk.

Communicate level of influence

Collectively agencies will document how communities are:

- Provided with information and opportunities to increase their awareness of flood risk and improve their skills at being able to assess their own level of risk;
- Empowered to share flood risk management information and skills with their community; and
- Empowered to make appropriate (fit-for-purpose) plans or decisions that benefit themselves, their family, and other community members.

Service levels for information, education and empowerment

Agencies need to support communities about the relevance of taking action before, during and after flood events. It is good engagement practice (to not only apply information found out about the community to inform management practices), but to educate and collaborate with the community to empower community resilience. Some suggested service levels include:

Information and awareness	*Education and training*	*Empowerment*

• Community profile understood and stakeholders mapped
• Community values and aspirations identified
• Websites and portals link to partner agency sites, not duplicate
• Agencies aware who is leading each specific aspect of flood management, response and recovery
• Development of community materials and tools gives opportunity to partnering with relevant agencies
• Integration of local knowledge into flood planning
	• Community are able to access and interpret information before, during and after emergencies
	• Community understand the multi-faceted nature of floodplain management, including the environmental benefits of flooding and the risks encountered by altering natural regimes, not just the risks to human life, property and economy.
	• Community understand the role of floodplain management in an integrated water management system
	• Community aware of local groups and services and are willing to be involved in emergency response actions to help others
		• Community meetings incorporating with popular outreach services
		• Communities are enabled to understand their own personal risk of flooding where they live or work
		• Community know their local members and how to put forward their opinion and values
		• Individuals aware of opportunities to mitigate flood risk by
		  • identifying vulnerable neighbours in the community who they can assist
		  • understanding the benefits and limitations of available flood warning systems
		  • taking out appropriate insurance cover

2.5 Service levels for land-use planning

Land-use planning is considered paramount to ensure that land-use and development do not unduly add to legacy flood problems, and to ensure the functions of floodplains to convey and store floodwater are not adversely compromised.

The formation of the Victoria Planning Provisions in the late 1990s provided a range of standard tools, namely:

1. Zone and Overlays that provide triggers for assessment for land-use and development proposals (Urban Floodway Zone, Floodway Overlay, Land Subject to Inundation Overlay and Special Building Overlay);
2. State Planning Policy Framework (this provides high level objectives which are determined at the State level and cannot be changed);
3. Local Planning Policy Framework (enables the LGS to provide local context about floodplain management);
4. Schedules to the flood overlay controls to remove the need for unnecessary planning permits (known as exemptions); and
5. Floodplain Development Plans (provide performance-based criteria for assessment of routine permit applications).

All of the above tools have been utilised in major planning scheme amendment for six of the eight local government authorities, namely:

- Campaspe Shire Council;
- Greater Shepparton City Council;
- Mansfield Shire Council;
- Mitchell Shire Council;
- Murrindindi Shire Council; and
- Strathbogie Shire Council.

Although Benalla Rural City Council planning scheme has zone and overlay controls, they are in urgent need of updating across the entire municipality.

The DELWP has provided a state-wide assessment tool to determine desirable service levels with the following matters to be considered:

- The quality of the flood data that presently exist (if any) in planning schemes, which is fit for purpose, i.e. rural regional areas versus growing large urban centres.
- The demand for land-use and development. This is important in terms of priority setting, particularly as the planning scheme amendment process is lengthy and resource intensive.
- Whether there is benefit in updating existing zone and overlays.

The desirable service levels were broken into five tiers as follows: 0 (Low), 1 (Low-medium), 2 (Medium), 3 (Medium-high), and 4 (High). These desirable service levels were compared against the current planning scheme information relating to floodplain management. For example, for large urban centres experiencing growth should have a desirable service level of either 3 or 4 (high service

level), whereas a rural area along a reach of floodplain may only desire a service level of 0 or 1 (low service level).

The desirable service levels and the existing floodplain management planning scheme comparisons are detailed in **Appendix G**: Service levels – Land-use planning**.**

2.6 Municipal Flood Emergency Plans

The primary purpose of the Municipal Flood Emergency Plan (MFEP) is to detail the agreed arrangements and responsibilities of agencies and communities with regard to flood. A well-informed MFEP should drive proactive flood response operations and build community resilience by enhancing the capacity of communities to effectively withstand, respond and recover from a flood emergency.

VICSES has now introduced a MFEP standard template that can be populated with relevant flood intelligence, etc. Adopting the standard template not only ensures consistency across the state, it allows for ease of use during flood emergencies.

Under the *Emergency Management Act 2013* municipal councils are required to prepare Municipal Emergency Management Plan (MEMP). A municipal council must appoint a Municipal Emergency Planning Committee constituted by persons appointed by the municipal council being members and employees of the municipal council, response and recovery agencies and local community groups involved in emergency management issues. The function of a committee is to prepare a draft municipal emergency management plan for consideration by the municipal council. Therefore, by endorsing the MEMP, the council agrees to all processes and arrangements detailed in the MEMP.

Sub plans to the MEMP, including the MFEP, do not have formal endorsement arrangements, but are prepared under the guidance material prepared by VICSES, namely: Municipal Flood Emergency Plan (VICSES, 2012) and Municipal Flood Emergency Plan Fact Sheet (VICSES).

Service levels were not identified for MFEPs across the region as the goal is always to have the best available flood information in them. They are required to be updated:

1. Following the completion of flood studies or floodplain management plans;
2. After major floods where new flood intelligence has been captured; and
3. On a three-year cycle if the above has not occurred.

Chapter 3: Priority setting

3.1 Overview

This Chapter pulls together a range of information to determine the final priority rankings for the regional Strategy, namely:

- Stakeholder feedback including community information sessions (refer to **Section 1.4**)
- Risk assessment (refer to **Section 3.2**)
- Major vulnerable communities and infrastructure (refer to **Appendix M**: Vulnerability and Infrastructure assessment)
- Review of the past Regional Floodplain Management Strategy (refer to **Section 2.2**)
- Review Service Levels for existing flood mitigation infrastructure (refer to **Section 2.3**)
- Review Service Levels for land-use planning for floodplain management (refer to **Section 2.5**)
- Review Service Levels for Total Flood Warning Systems (refer to **Section 2.4**)

The stakeholder feedback, including the information sessions, written submission and returned feedback forms together a response is presented in **Appendix I**: Comments, Issues and Feedback Received at Public Information Sessions. The final priority rankings, together with the risk assessment scores are provided in **Appendix N**: Final priority and risk assessment scores.

3.2 Risk assessment

The assessment of flood risk is an important input into the prioritisation of floodplain management activities included in the regional strategies. These activities include the delivery and operation of total flood warning services, statutory land-use planning, the construction and management of flood mitigation structures and emergency management arrangements.

Developing an evidence-based approach for effective risk assessment, and fostering consistent baseline information on flood risk will enable flood risks (and hazards) to be managed equitably across both state-wide and regional levels. Furthermore, the risk assessment will provide guidance for priority setting for investment. This is consistent with state and national emergency management reform agendas, and is aligned with the requirements of the Victorian Floodplain Management Strategy.

DELWP's rapid appraisal of flood risk methodology has been developed with the intention of providing a simplified appraisal tool that can be used to rapidly gain an understanding of flood risk with an appropriate level of reliability.

The methodology assesses flood risk associated with agriculture, property, buildings, and emergency services, where by flood risk is represented using a 1 to 5 score of relativity for the following three metrics:

- Density of damages (measured as the ADD[8] divided by the 1% AEP flood event)
- Population affected (measured as the AAPA[9] divided by the population of the town)

[8] Average Annual Damage divided by the area of inundation for the 1% AEP

[9] Equivalent to the number of houses inundated divided by the total number of houses inundated, but is expressed as population given the number of residents per house hold as provided by the ABS Census (2011)

- Absolute risk (the absolute size of the AAD[10] from the cost-probability curve)

The relative flood risk score of 1 to 5 relates 1 representing lowest risk, and 5 the highest risk. This comparative basis can be used to set flood risk management rankings. The methodology is not designed to be an absolute assessment of flood risk for the justification of flood risk mitigation expenditure at the local level, but is one tool designed to assist with priority setting for input into the Action-Investment plan (refer **Chapter 4:**).

Aither (economic consultancy) was commissioned by DELWP to assist with developing the methodology and to carry out the risk assessment for the Goulburn Broken region. Further methodology can be found in **Appendix J**: DELWP's Rapid Appraisal Methodology.

The risk assessment scores are presented in **Appendix N**: Final priority and risk assessment scores**.**

3.3 Major vulnerable communities and infrastructure

As part of the risk assessment, some consideration of community vulnerability and infrastructure was explored as part of the TFWS assessment by Michael Cawood and Associates using data sourced from: flood study reports, media reports, MFEPs, Planning Scheme Maps, the VicRoads Directory, and local knowledge and experience.

Appendix M: Vulnerability and Infrastructure assessment, which provides a summary of the number identified.

Vulnerable communities:

Vulnerable groups include schools, kindergartens, childcare and aged care facilities, hospitals and medical facilities as well as VICSES and other emergency services. The social impacts on vulnerable groups are expected to be higher than general community impacts.

Both under and over-floor flooding are considered because evacuation and danger are not confined to over-floor flooding scenarios.

Infrastructure:

This looks at key infrastructure and essential services likely to be affected by flooding in the at-risk locations.

Key infrastructure is considered to include 'A' rated highways, railways, shopping centres, sewerage treatment and water supply facilities.

It should be noted that while a major road may be affected by flooding at a number of different at-risk locations, it needs to be counted for each of those locations.

The data for this assessment was obtained from flood study reports, media reports, MFEPs, Planning Scheme maps and the VicRoads Directory combined with individual experience / knowledge.

3.4 Other factors in priority setting

This Strategy acknowledges the significant challenges of addressing flood risk across the catchment and recognises the limited ability of stakeholders to raise revenue to invest in new projects. It cannot necessarily be expected that all high priority actions be addressed in the first few years of implementation, if the cumulative cost is outside the lead agency's means.

[10] Average Annual Damage

Chapter 4: Strategy Implementation

4.1 Overview

An Action-Investment plan is presented as a stand-alone document in **Part B**. This is the culmination from the investigations and engagement presented in previous chapters and the Appendices of this Strategy. From this a four-year rolling Action Plan will be prepared, under the oversight of an Implementation Committee of relevant stakeholders.

A detailed Monitoring, Evaluation, Reporting and Improvement (MERI) Plan will be developed to accompany this strategy from the planning stages to its completion. The MERI Plan will incorporate the following principles:

- convening of the Implementation Steering Committee regularly (annually at a minimum)
- development of Key Evaluation Questions and Key Evaluation Criteria to assess strategy implementation performance
- review of progress of the work plan
- monitoring, evaluation and review of work plan actions in terms of appropriateness, effectiveness, efficiency, impact and legacy in achieving the objectives of the strategy
- monitoring, evaluation and review of the strategy implementation to alignment with other regional strategies
- reporting at a regional and state level.

This strategy supports using the best available information, science and approaches and identifies a number of good practice principles to achieve this. the Supporting Documents of this Strategy.

Community engagement processes are required for most activities in the Action-Investment Plan. Lead agencies are identified below, along with partners and other stakeholders.

Sharing flood information with the community, insurance industry and agencies required to manage flood risk, is crucial, so that decisions are made using the best available information. The Strategy is seeking to establish a regional web portal for sharing flood intelligence to supplement actions by DELWP to sharing information with the insurance industry and to manage its FloodZoom flood intelligence platform.

Local flood disputes can arise if planning permit conditions are not complied with. The Goulburn Broken CMA will continue to work with LGAs to assess and provide guidance on non-compliance issues. Processes in the Water Act enable land owners to seek rectification for works constructed before planning controls were in place.

4.2 Monitoring, evaluation, reporting, and improvement (MERI) Plan

Programs and investments that embed robust MERI processes are more resilient to change, more often return maximum value on every dollar spent, and allow for more effective demonstration of this value. Effective MERI enhances the performance of program activities themselves, but is also critical to ensuring the availability of data on outputs or outcomes that can help answer a range of critical questions for decision-makers such as:

- Did the management actions, plan or policy make a difference?
- How can things be done better, more efficiently, or more effectively?
- What should we continue doing, what should we stop doing?
- Is the overall target still achievable and appropriate?

The more embedded the MERI approach and the stronger and more immediate the feedback loops, the more value that can be delivered through the ability to adaptively manage the program over its duration. This is fundamentally important for the Goulburn Broken region because better managed programs are ultimately more effective at achieving the outcomes desired from the investment and are more cost effective.

An adaptive approach to review and implementation of this strategy will be required. This involves flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood.

Evaluation of the success of the regional Strategy will target the five areas, namely:

1. **Appropriateness** – the extent to which the investment's objectives align with the driving priorities, values and needs of stakeholders
2. **Effectiveness** – the extent to which outputs achieve desired outcomes or objectives
3. **Efficiency** – the extent to which the investments are minimised for a given level of outputs, or to which outputs are maximised for a given level of inputs
4. **Impact** – the relationship between the programs outputs and outcomes
5. **Legacy** – the likelihood that the program's impacts will continue over time, including after the program ceases

The detailed MERI Plan will be developed in 2018.

4.3 Good practice implementation of the Action-Investment implementation

In carrying out activities in the Action-Investment plan, the following principles are to be incorporated, to the extent that they are relevant:

- Communities must be consulted and given opportunities for input.
- Traditional Owners must be consulted prior to any proposed activities in accordance with the *Aboriginal Heritage Act 2006* (see Section 1.12).
- Responsibility for community engagement vests in the lead agency.
- A flood risk management approach must be followed (see Figures 4.2 and 4.3 of the 1998 Victoria Flood Management Strategy, or Figure 1.1 of Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia).
- Flood studies shall follow best practice, including allowance for climate change, the impacts of bush fire on catchment runoff and technical advice and information provided in Australian Rainfall & Runoff (Ball J, 2016).
- An Integrated Catchment Management approach must be followed (See Section 1.15 and Section 1.10.1), particularly protecting, and where possible enhancing, environmental values (see Section 1.11).
- Implementing the standards as outlined in the Infrastructure Design Manual (Local Government Infrastructure Design Association , 2017), in particularly relating to water urban sensitive design.
- The scope and priorities of activities in the Action-Investment Plan must be reviewed and updated, taking into account opportunities, constraints and changed circumstances.

4.4 Community engagement and responsibilities

Implementation responsibilities for the actions are summarised in the table below:

Table 8: Implementation responsibilities for the actions

Action	Flood Mitigation	TFWS	Land-use planning	MFEP [v]
Lead agency [i]	Local Government [ii]	VICSES / Local Government [iii]	Local Government [iv]	VICSES
Partners	Community, Traditional Owners, GB CMA	Community, VICSES, GB CMA	VICSES, GB CMA, DELWP [vi]	Local Government, TOs, GB CMA
Sharing data	Community, VICSES, EMV, DELWP, AAV, PV	Community, VICSES, EMV, DELWP, PV	DELWP	EMV, DELWP, AAV, PV

i. Although, the Goulburn Broken CMA does not generally have a leading role in any of the four programs above, it is committed to coordinate the implementation of the Strategy through leading the monitoring, evaluation, reporting and improvement (MERI) Plan, which includes a rolling four-year Investment-Action Plan.
ii. Local Government's role is generally related to urban flood mitigation. See 2.4.1 Management arrangements for rural levees (on page 34).
iii. There are a number of elements to this program where VICSES will take the lead around education and awareness, communications and dissemination and Local Government will take the lead in sharing operation and maintenance costs of the relevant gauge network components under the Northern Regional Water Monitoring Partnership.
iv. Goulburn Broken CMA is the lead agency for preparation of mapping for planning scheme amendments and may become the lead agency for rural studies and become the planning authority where studies cross multiple Local Government Areas.
v. Note that MFEPs need to be reviewed following the completion of a flood study, a major flood or part on the three-yearly review cycle.
vi. DELWP, at a regional level provides planning guidance around the preparation on proposed planning scheme amendments.

Note: DELWP, at the State level generally provides support and guidance across all programs including financial assistance. Other agencies may be a partner such as BoM, G-MW, GVW, VicRoads, and VicTrack depending on the nature of the investigation.

It is most important to engage with communities, particularly for any new flood study and particularly for the preparation of floodplain management plans. Communities have first-hand knowledge and experience that needs to be taken into on board with any new investigation.

The IAP2 International Federation has developed the IAP2 Public Participation Spectrum (2014) that sets out how groups define public's role in any participation process ranging from informing to empowering communities. The Spectrum is designed to assist with the selection of the level of participation that defines the public's role in any community engagement program. The Spectrum show that differing levels of participation are legitimate depending on the goals, time frames, resources and levels of concern in the decision to be made (International Association for Public Participation Australasia, website).

4.4.1 Community-based committees under the *Water Act 1989*

Floodplain management plans may include mitigation options that require community input. The Water Management Scheme process under the *Water Act 1989* includes appointing a community-based committee to carry out investigations. This approach may ultimately lead to a Ministerially Approved Scheme, and should be utilised for new investigations that are likely to include mitigation measures.

4.5 Sharing information

Individuals and communities at risk of future flooding need to be aware of the risks. Access to insurance provides one form of reducing their potential flood damages. Other mitigation strategies include flood mitigation works and total flood warning system improvements.

Having the best available flood information on flood risk and flood behaviour, and sharing this information, with all stakeholders is of paramount importance. People, with access to shared flood information, should be able to choose where they live in an informed way, where the relative size of flood insurance premiums in different locations provide an important signal of exposure to flood risk. Through gathering flood intelligence from future flood studies information should be accessible to able insurers to price flood insurance premiums.

As part of the whole of region Action-Investment plan, the Strategy is seeking to establish regional web portal for sharing flood intelligence, which is part of the Total Flood Warning program.

DELWP will also work with the insurance industry to facilitate exchange of mapping and other flood risk information in order to ensure fair pricing of insurance.

Recently work by DELWP on its flood intelligence platform, known as FloodZoom will be the one source of truth for all flood information across the State. Approved access to the one source of truth will be utilised for regional web flood portal to facilitate the sharing of flood information publicly.

4.6 Activities and works controls (compliance) – region wide

Currently, across all LGAs within Victoria, there is a reliance on sound planning controls to manage flood risk. This relies on developers complying with their conditions of permit. Experience has shown that local flood issues (often associated with poor drainage) drive most complaints. Land owners often seek government assistance to resolve the issue.

Compliance activities under planning schemes and VCAT are complex, cumbersome, and expensive, but remain the best available tool to manage breaches to the planning scheme.

The Goulburn Broken CMA has and will continue to provide significant resources and support to LGAs in providing assessment and guidance to resolve breaches to the planning scheme.

In many cases local flood issues occur as a result of works that were constructed before effective planning controls were in place.

Free flow principle – liability under the Water Act 1989

Aggrieved individuals, under Section 16 of the Act, can exercise their right through VCAT to have matters resolved associated with works that create an unreasonable flood of water or interferes with a reasonable flow of water whereby nuisance or damage has or may result in the future (through an interlocutory order). Section 20 of the Act list those matters that VCAT should consider.

Glossary

Above floor flooding
Where floodwater rises and enters a building above the floor height of a building.

Adaptive management
Policy and programs are part of a broader framework of adaptive management, supported by effective monitoring, reporting, evaluation and research, to ensure continuous improvement.

Climate 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 m3/s has an AEP of 5%, it means that there is a 5% (one-in-20) chance of a flow of 500 m3/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) of a flood and the amount of assets exposed, 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 (Ball J, 2016) is a national guideline for the estimation of design flood characteristics in Australia published by Geoscience Australia and is available through its website. 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. There are associated 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.

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. VICSES has EMCOP warnings in place to deliver warnings where observations of actual flash flooding exist.

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 levels
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/d) or cubic metres per second (m3/s). 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 design flood level 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 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.

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.

Local Flood Guide
A guide for a local community summarising flood information (usually historical floods linked to known streamflow gauge) and their consequences. The plan also provides Information to help individuals plan for floods and provides a list of resources and contact details. Existing guide can be found on VICSES's website.

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.

Probable Maximum Flood
The largest flood that could conceivably occur at a particular location. Generally, it is not physically or financially possible to provide general protection against this event. This flood defines the maximum extent of land liable to flooding. The extent, nature and potential consequences of flooding associated with the PMF event should be assessed in a Flood Study. The PMF event may form the basis of evacuation planning and the identification of refuge areas. Considerations should be given to adopting the PMF event as the design flood event for emergency services planning and for determining the location and floor levels of facilities such as telephone exchanges, police stations and hospitals. The PMF event may also be used to develop land-use development guidelines in the floodplain management plan

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.

Storm surge
The increases in coastal water levels above the predicted tide level resulting from a range of location dependent factors such as wind and waves, together with any other factors that increase tidal water level.

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 under a ministerially appointed community-based committee.

Acronyms

AAD Average Annual Damage

AEP Annual Exceedance Probability

ARI Average Recurrence Interval

ARR Australian Rainfall and Runoff

BCA Building Code of Australia

BoM Bureau of Meteorology

CMA Catchment Management Authority

DELWP Department of Environment, Land, Water and Planning

DFE design flood event

EMCOP Emergency Management Common Operating Picture (Web-based platform)

LGA Local Government Authority

LFS Local Flood Guide

LPPF Local Planning Policy Framework

MFEP Municipal Flood Emergency Plan

PMF Probable Maximum Flood

SPPF State Planning Policy Framework

TFWS Total Flood Warning System

TOs Traditional Owners

VCS Victorian Coastal Strategy

VFD Victorian Flood Database

VFMS Victorian Floodplain Management Strategy

VICSES Victoria State Emergency Service

VPP Victoria Planning Provisions

WMS Water Management Scheme

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Part B: The Action-Investment Plan

Chapter 5: Action-Investment Plan

The Action-Investment Plan forms the business case for investment by all tiers of government to implement floodplain management actions. Implementation of the Strategy will firstly, be reliant on funding initiatives such as the Natural Disaster Resilience Grants Scheme, and secondly, through the monitoring, review, reporting and improvement plan process. Implementation is dependent on the availability of funding.

The rolling Action-Investment plan will be prepared and annually reviewed by an Implementation Committee under the monitoring, evaluation, review and improvement process to ensure it remains adaptive and flexible.

Reading the following tables.

Five sets of tables are presented:

1. Implementation responsibilities for actions
2. Investment summary – all Local Government Areas
3. Individual Local Government Investment Summaries
4. Individual Local Government Action-Investment Plans
5. Whole of region actions.

Implementation responsibilities for the actions

Action	Flood Mitigation	TFWS	Land-use planning	MFEP [v]
Lead agency [i]	Local Government [ii]	VICSES / Local Government [iii]	Local Government [iv]	VICSES
Partners	Community, Traditional Owners, GB CMA	Community, VICSES, GB CMA	VICSES, GB CMA, DELWP [vi]	Local Government, TOs, GB CMA
Sharing data	Community, VICSES, EMV, DELWP, AAV, PV	Community, VICSES, EMV, DELWP, PV	DELWP	EMV, DELWP, AAV, PV

i. Although, the Goulburn Broken CMA does not generally have a leading role in any of the four programs above, it is committed to coordinate the implementation of the Strategy through leading the monitoring, evaluation, reporting and improvement (MERI) Plan, which includes a rolling four-year Investment-Action Plan.
ii. Local Government's role is generally related to urban flood mitigation. See 2.4.1 Management arrangements for rural levees (on page 34).
iii. There are a number of elements to this program where VICSES will take the lead around education and awareness, communications and dissemination and Local Government will take the lead in sharing operation and maintenance costs of the relevant gauge network components under the Northern Regional Water Monitoring Partnership.
iv. Goulburn Broken CMA is the lead agency for preparation of mapping for planning scheme amendments and may become the lead agency for rural studies and become the planning authority where studies cross multiple Local Government Areas.
v. Note that MFEPs need to be reviewed following the completion of a flood study, a major flood or part on the three-yearly review cycle.
vi. DELWP, at a regional level provides planning guidance around the preparation on proposed planning scheme amendments.

Note: DELWP, at the State level generally provides support and guidance across all programs including financial assistance. Other agencies may be a partner such as BoM, G-MW, GVW, VicRoads, and VicTrack depending on the nature of the investigation.

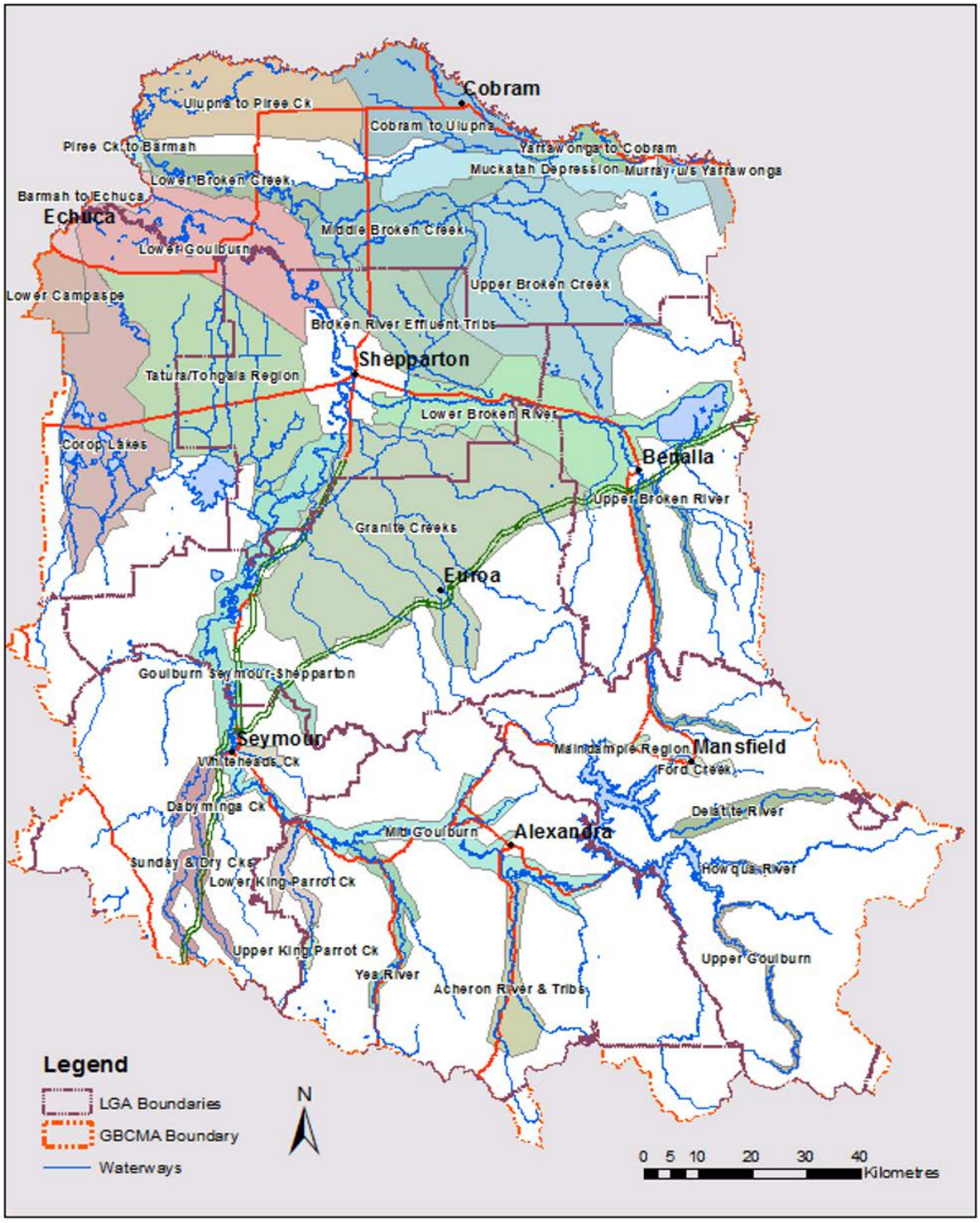
Investment Summary – all Local Government Areas by Action type and Priority

	High	Medium	Low	Very low	Total
Mitigation	$18,880,000	$820,000	$5,195,000	$-	$24,895,000
TFWS	$642.500	$690,000	$107,500	$-	$1,440,000
Land-use Planning	$595,000	$240,000	$1,425,000	$50,000	$2,310,000
MFEP	$160,000	$120,000	$165,000	$15,000	$460,000
	$20,277,500	**$1,870,000**	**$6,892,500**	**$65,000**	**$29,105,000**

Approximately $22.5 million of the total investment figure is due to three large proposed Mitigation projects: two for Moira Shire, Numurkah (High priority) $16 million and Barmah (Low priority) $5 million and one for Strathbogie Shire, Violet Town (High priority) $1.5 million. It excludes funding for implementing works to provide flood protection in Seymour.

Separate investment summaries for each local government area are shown with the Action-Investment Plans on the following pages.

Where a town locality is named in the following Tables, it represents the urban centre, and generally does not include the surrounding areas. The coverage for the regional (rural) areas is shown below.



5.1 Benalla Rural City

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$15,000	$15,000
TFWS	$25,000	$300,000	$22,500	$347,500
Land-use Planning	$100,000	$120,000	$-	$220,000
MFEP	$5,000	$25,000	$-	$30,000
	$130,000	**$445,000**	**$37,500**	**$612,500**

Table 9: Benalla Rural City Action-Investment Plan

Terminology: **-** = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Baddaginnie	**Actions**	nil	Deliver a Local Flood Guide following the completion of the Granite Creeks Regional Flood Mapping Study.	Introduce flood overlay controls following completion of the Granite Creeks Regional Flood Mapping Study (part of the LGA-wide planning scheme amendment).	Update MFEP using intelligence from Granite Creeks Regional Flood Mapping Study	
	Cost	-	$7,500	$40,000 [i]	$5,000	$52,500
	Priority	-	Low	High	High	
Benalla	**Actions**	Maintain the Benalla Water Management Scheme. Review decommissioned Mokoan Inlet embankments if they need to be maintained for Benalla flood protection.	Improve dissemination and communication, awareness and education (Local Flood Guide). Share site-specific property information using web portal.	As part of LGA-wide amendment, prepare UFZ, FO and LSIO mapping based on the reference 1993 flood together with Cardno's modelling work of 2009.	Review as part of the three-year cycle or following a major flood.	
	Cost	$15,000	$25,000	-	-	$40,000
	Priority	Low	High	High	High	
Devenish	**Actions**	nil	nil	As part of LGA-wide amendment, prepare rudimentary mapping. In the longer term, utilise mapping if and when the Upper Broken Creek Regional Flood Study becomes available.	Utilise flood intelligence from the proposed Upper Broken Creek Regional Flood Study.	
	Cost	-	-	See Upper Broken Creek	$10,000 [ii]	$10,000
	Priority	-	-	High	Medium [ii]	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Granite Creeks	**Actions**	nil	Deliver Fact Sheet for the Granite Creeks, following the completion of the Granite Creeks Regional Flood Study.	Revise flood overlay controls from the completed Granite Creeks Regional Flood Study, which include numerous towns	Incorporate flood intelligence from Regional Flood Study.	
	Cost	-	$10,000	$40,000	$15,000	$65,000
	Priority	-	Low	Medium	Medium	
Lower Broken River	**Actions**	nil	Part of new Goulburn and Broken River Regional Flood Study.	Introduce and revised flood overlay control from Goulburn and Broken Rivers Flood Study.	Incorporate flood intelligence from Regional Flood Study.	
	Cost	-	Funded	$60,000 [iii]	-	$60,000
	Priority	-	Low	High	High	
Tatong	**Actions**	nil	nil	As part of LGA-wide amendment adopt the FDTP flood mapping, and seek any new information.	Subject to identification any flood risk, update MFEP.	
	Cost	-	-	In-house by GB CMA	-	-
	Priority	-	-	Medium	Low	
Thoona	**Actions**	nil	nil	Prepare rudimentary mapping. In the longer term, utilise mapping if and when the Upper Broken Creek Regional Flood Study becomes available.	Subject to identification of any flood risk, update MFEP.	
	Cost	-	-	In-house by GB CMA	In-house	-
	Priority	-	-	Medium	Low	
Upper Broken Creek	**Actions**	nil	Undertake a Regional Flood Study covering numerous Towns	Introduce and revised flood overlay controls from Regional Study	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	$300,000	$40,000 [ii]	See TFWS	$340,000
	Priority	-	Medium	Medium	Medium	
Upper Broken River	**Actions**	nil	Part of new Goulburn and Broken River Regional Flood Study	Introduce and revised flood overlay control from Goulburn and Broken Rivers Flood Study	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	Funded	See [iii]	-	See [iii]
	Priority	-	Medium	High	Medium	
Winton	**Actions**	nil	Prepare a Local Flood Guide	A scoping flood is required to inform rudimentary mapping.	nil	
	Cost	-	$5,000	$40,000	-	$45,000
	Priority	-	-	Medium	-	

[i] Cost for a LGA-wide planning scheme amendment

[ii] Upper Broken Creek Regional Flood Study includes Moira Shire Council (longer term action). Cost is for planning scheme amendment.

[iii] Coordinated by the Goulburn Broken CMA across five LGAs. Cost of $60,000 is to implement a planning scheme amendment coordinated by the CMA as the proposed planning authority.

5.2 Campaspe Shire

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$-	$-
TFWS	$-	$-	$-	$-
Land-use Planning	$120,000	$-	$40,000	$160,000
MFEP	$-	$-	$30,000	$30,000
	$120,000	**$-**	**$70,000**	**$190,000**

Table 10: Campaspe Action-Investment Plan

Terminology: **-** = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Colbinabbin	**Actions**	nil	Goulburn-Murray Water continue to host information about Waranga Western Channel operations.	nil	Link G-MW material to MFEP.	
	Cost	-	In-house by G-MW	-	In-house by VICSES	-
	Priority	-	Medium	-	Medium	
Kyabram	**Actions**	See land-use planning.	nil	Carry out a new flood study to review the current mitigation scheme and to improve flood intelligence and mapping.	See land-use planning.	
	Cost	-	-	$120,000	-	$120,000
	Priority	Low	-	High	Medium	
Lower Goulburn	**Actions**	1. Re-evaluate options on an opportunistic basis 2. Investigate impact on Cultural Heritage Values [i]	nil	Revise flood overlay controls from the completed Lower Goulburn Floodplain Rehabilitation Scheme Study.	Incorporate flood intelligence from Scheme Study.	
	Cost	-	-	$40,000 [ii]	$30,000	$70,000
	Priority	-	-	Low	Low	

[i] Cultural Heritage Impact assessment – $50,000 shared cost with Greater Shepparton and Moira Shire

[ii] Indicative costs associated with planning scheme amendment process

5.3 Greater Shepparton City

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$520,000	$-	$520,000
TFWS	$10,000	$-	$47,500	$57,500
Land-use Planning	$100,000	$-	$40,000	$140,000
MFEP	$-	$-	$45,000	$45,000
	$110,000	**$520,000**	**$132,500**	**$762,500**

Table 11: Greater Shepparton Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Broken Creek Tribs [i]	**Actions**	nil	Improve education and awareness, interpretation, dissemination and communication	nil	Incorporate any flood intelligence from TWFS	
	Cost	-	$20,000	-	$15,000	$35,000
	Priority	-	Low	-	Low	
Bunbartha		nil	nil	See Lower Goulburn Regional Flood Study	nil	
Katandra West	**Actions**	nil	(Local Flood Guide prepared and delivered)	Carry out rudimentary flood mapping	nil	
	Cost	-	-	$25,000	-	$25,000
	Priority	-	-	High	-	
Goulburn Seymour to Shepparton	**Actions**	nil	Prepare a Fact Sheet for the Goulburn and Broken Rivers, following the completion of the Goulburn and Broken Rivers Flood Study.	Revised flood overlay controls from Goulburn and Broken Rivers Flood Study	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	Funded	See [ii]	Funded	-
	Priority	-	High	Medium	Medium	
Lower Broken River	**Actions**	nil	Part of new Goulburn and Broken River Regional Flood Study	Revised flood overlay controls from Goulburn and Broken Rivers Flood Study.	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	Funded	See [ii]	-	-
	Priority	-	Low	High	High	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Lower Goulburn	**Actions**	1. Re-evaluate options on an opportunistic basis 2. Investigate impact on Cultural Heritage Values [iv]	nil	Revise flood overlay controls from the completed Lower Goulburn Floodplain Rehabilitation Scheme Study.	Incorporate flood intelligence from Scheme Study.	
	Cost	$50,000	-	$40,000 [iii]	$30,000	$120,000
	Priority	Medium	-	Low	Low	
Merrigum	**Actions**	nil	Proposed education and awareness material such a Local Flood Guide	nil	Review MFEP	
	Cost	-	$10,000	-	Funded	$10,000
	Priority	-	Low	-	Low	
Murchison	**Actions**	Investigate bringing existing levees under maintenance arrangements. Refer to **Appendix F**: Service levels – structural flood mitigation works	Update Local Flood Guide using Murchison Flood Study	Update planning scheme with new flood mapping from the Murchison Flood Study. Do as part of Goulburn and Broken Rivers Flood Study.	MFEP has been updated	
	Cost	$50,000	$10,000	$20,000	-	$80,000
	Priority	Medium	Low	High	-	
Shepparton East	**Actions**	nil	Prepare a Local Flood Guide for Area	Update planning scheme with new flood mapping from the Shepparton East Overland Flood Study. Do this together with Shepparton/ Mooroopna.	Update intelligence from Shepparton East Overland Flood Study	
	Cost	-	$10,000	See Shepparton/ Mooroopna	Funded	$10,000
	Priority	-	High	High	High	
Shepparton & Mooroopna	**Actions**	Investigate bringing existing levees under maintenance arrangements. Refer to **Appendix F**: Service levels – structural flood mitigation works	Improve education and awareness, access to shared flood intelligence (property specific data), and improve communication and dissemination.	Update planning scheme with new flood mapping from the Shepparton Mooroopna Flood Intelligence and Mapping Study.	Update MFEP with intelligence from the Shepparton Mooroopna Flood Intelligence and Mapping study.	
	Cost	$150,000	funded	$40,000	Funded	$190,000
	Priority	Medium	High	High	High	
Surplus Irrigation Channels	**Actions**	Investigate bringing existing levees under maintenance arrangements. Refer to **Appendix F**: Service levels – structural flood mitigation works	nil	nil	nil	
	Cost	$150,000	-	-	-	$150,000
	Priority	Medium	-	-	-	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Tallygaroopna	**Actions**	Carry out a flood study to determine viable flood mitigation solutions.	(Local Flood Guide prepared and delivered)	Update following completion of a Flood Study. In the short term carry out broad brush mapping.	nil	
	Cost	$120,000	-	$15,000	-	$135,000
	Priority	Medium	-	High	-	
Tatura	**Actions**	nil	Propose education and awareness material such a Local Flood Guide	nil	nil	
	Cost	-	$7,500	-	-	$7,500
	Priority	-	Low	-	-	
Toolamba	**Actions**	nil	nil	Revised flood overlays following completion of the Goulburn and Broken Rivers Flood Regional Flood Study	Update flood intelligence following completion of the Goulburn and Broken Rivers Flood Study	
	Cost	-	-	funded	funded	-
	Priority	-	Low	Medium	Medium	

[i] Includes: Pine Lodge, Daintons, Congupna Guilfus & O'Keefe Creeks

[ii] Coordinated by the Goulburn Broken CMA across five LGAs. Cost of $60,000 is to implement a planning scheme amendment coordinated by the CMA as the proposed planning authority.

[iii] Includes Shire of Campaspe and Moira Shire

[iv] Cultural Heritage Impact assessment – $50,000 shared cost with Campaspe and Moira Shires

5.4 Mansfield Shire

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$-	$-
TFWS	$-	$-	$-	$-
Land-use Planning	$-	$-	$410,000	$410,000
MFEP	$-	$20,000	$45,000	$65,000
	$-	**$20,000**	**$455,000**	**$475,000**

Table 12: Mansfield Shire Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning [i]	MFEP	Total Cost
Delatite River	**Actions**	nil	nil	Hydrology completed. Carry out a Regional Flood Mapping Study.	Incorporate flood intelligence from Regional Flood mapping Study.	
	Cost	-	-	$50,000		$50,000
	Priority	-	-	Low	Low	
Ford Creek	**Actions**	nil	nil	Carry out regional flood study (include Mansfield)	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	-	$80,000	$15,000	$95,000
	Priority	-	-	Low	Low	
Howqua River	**Actions**	nil	nil	Hydrology completed. Carry out a Regional Flood Mapping Study.	Incorporate flood intelligence from Regional Flood mapping Study	
	Cost	-	-	$60,000	$15,000	$75,000
	Priority	-	-	Low	Low	
Jamieson	**Actions**	nil	(Local Flood prepared and delivered). Update following Upper Goulburn and Jamieson Rivers Flood Mapping Study	Introduce and revise flood overlay controls following the completion of the Upper Goulburn River Flood Mapping Project.	Provide intelligence following completion of Upper Goulburn River Flood Mapping Project.	
	Cost	-	See Upper Goulburn	See Upper Goulburn	See Upper Goulburn	-
	Priority	-	Low	Low	Low	
Mansfield	**Actions**	nil	nil	Carry out an overland flood study. Seek LiDAR Capture.	Update flood intelligence from Mansfield Flood Mapping and Overlay Studies. Include targeted floor level survey.	
	Cost	-	-	$150,000	$20,000	$170,000
	Priority	-	-	Low	Medium	

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning [i]	MFEP	Total Cost
Upper Goulburn	**Actions**	nil	nil	Hydrology completed. Carry out a Regional Flood Mapping Study – include Jamieson.	Incorporate flood intelligence from Regional Flood mapping Study	
	Cost	-	-	$70,000	$15,000	$85,000
	Priority	-	-	Low	Low	

[i] Complete regional mapping programs before introducing planning scheme amendments

5.5 Mitchell Shire

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$-	$-
TFWS	$57,500	$7,500	$17,500	$82,500
Land-use Planning	$40,000	$-	$100,000	$140,000
MFEP	$70,000	$20,000	$-	$90,000
	$167,500	**$27,500**	**$117,500**	**$312,500**

Table 13: Mitchell Shire Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning [i]	MFEP	Total Cost
Broadford	**Actions**	nil	Improve interpretation of data based on completion of the Sunday and Dry Creeks Regional Flood Intelligence and Mapping Study. Prepare Local Flood Guide.	Revise flood overlay controls following the completion of the Sunday and Dry Creeks Regional Flood Intelligence and Mapping Study.	Update flood intelligence following completion of the Sunday and Dry Creeks Regional Flood Intelligence and Mapping Study.	
	Cost	-	$7,500	Funded	Funded	$7,500
	Priority	-	Medium	High	High	
Dabyminga Creek	**Actions**	nil	nil	Carry out a Regional Flood Study covering three Towns (Reedy Creek, Tallarook, and Tyaak).	Incorporate flood intelligence from Regional Flood Study.	
	Cost	-	-	$100,000	-	$100,000
	Priority	-	-	Low	Low	
Goulburn Seymour to Shepparton	**Actions**	nil	Prepare a Fact Sheet, following the completion of the Goulburn and Broken Rivers Flood Study.	Revised flood overlay controls from Goulburn and Broken Rivers Flood Study.	Incorporate flood intelligence from Regional Flood Study.	
	Cost	-	$10,000	Funded [ii]	Funded	$10,000
	Priority	-	Low	Medium	Medium	
Kilmore	**Actions**	Utilise Flood modelling (Kilmore Flood Study) to determine overland mitigation options (e.g. retardation basins)	Prepare a Local Flood Guide.	Introduce flood overlay controls following the completion of the Kilmore Creek Flood Intelligence and Mapping Study.	Update flood intelligence following completion of the Kilmore Creek Flood Intelligence and Mapping Study.	
	Cost	Underway	$7,500	Funded	Funded	$7,500
	Priority	Low	Low	High	High	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning [i]	MFEP	Total Cost
Kilmore East		nil	nil	See Sunday and Dry Creeks Regional Study	See Sunday and Dry Creeks Regional Study	
Mid Goulburn	**Actions**	nil	Prepare a Fact Sheet, following the completion of the Goulburn and Broken Rivers Flood Study.	Use data from Regional Goulburn and Broken Rivers Regional Flood Study	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	-	Funded [ii]	Funded	
	Priority	-	Low	Medium	Medium	
Pyalong		nil	nil	See Sunday and Dry Creeks Regional Study	See Sunday and Dry Creeks Regional Study	
Reedy Creek		nil	nil	See Dabyminga Creek Regional Flood Study.	See Dabyminga Creek Regional Flood Study	
Seymour	**Actions**	Implementation of Town levee - ongoing	Revise flood intelligence with levee in place – see MFEP. Prepare a new Local Flood Guide.	See MFEP. From post levee flood modelling revise zone & overlay controls.	Revise flood intelligence with levee in place. Require post levee flood modelling.	
	Cost	Funded	$7,500	Part of MFEP	$70,000	$77,500
	Priority	High	High	High	High	
Sunday & Dry Creeks	**Actions**	nil	Complete Regional Study.	Complete Regional Study.	Complete Regional Study.	
	Cost	-	Funded	Funded	Funded	
	Priority	-	Medium	Medium	Medium	
Tallarook	**Actions**	nil	nil	Revise flood overlay controls from the completed Tallarook Flood Mapping Investigation unless Dabyminga Creek Regional Flood Study is completed.	Identify vulnerable buildings in the MFEP.	
	Cost	-	-	-	$20,000	$20,000
	Priority	-	-	Medium	Medium	
Tyaak		nil	nil	See Dabyminga Creek Regional Flood Study.	See Dabyminga Creek Regional Flood Study.	
Whiteheads Creek	**Actions**	nil	Improve education and awareness (e.g. Local Flood Guide). Look at warning systems for low culvert crossing.	Revise flood zones and overlay controls following the completion of the Whiteheads Creek Flood Intelligence and Mapping Study.	Update flood intelligence following completion of the Whiteheads Creek Flood Intelligence and Mapping Study, including threats to Seymour Town Levee.	
	Cost	-	$50,000	$40,000	Funded	$90,000
	Priority	-	High	High	High	

[i] Package flood mapping from flood studies into a single planning scheme amendment.

[ii] Coordinated by the Goulburn Broken CMA across five LGAs. Cost of $60,000 is to implement a planning scheme amendment coordinated by the CMA as the proposed planning authority.

5.6 Moira Shire

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$16,575,000	$150,000	$5,000,000	$21,725,000
TFWS	$145,000	$340,000	$20,000	$505,000
Land-use Planning	$90,000	$40,000	$530,000	$660,000
MFEP	$15,000	$10,000	$45,000	$70,000
	$16,825,000	**$540,000**	**$5,595,000**	**$22,960,000**

Table 14: Moira Shire Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Barmah	**Actions**	Implement Barmah Township Flood Mitigation Functional Design (levees)	Prepare Local Flood Guide.	nil	Review MFEP following 2016 Murray River flood.	
	Cost	$5 million	$7,500	-	$10,000	$5.01M
	Priority	Low	Medium	-	Medium	
Broken Creek Tribs [i]	**Actions**	nil	Improve education and awareness, interpretation, dissemination and communication.	nil	Incorporate any flood intelligence from TFWS.	
	Cost	-	$20,000	-	$15,000	$35,000
	Priority	-	Low	-	Low	
Cobram	**Actions**	Carry out flood mitigation design and implement works to prevent flooding from the east. Functional design (Funded).	Improve education and awareness, dissemination and communication. Prepare Local Flood Guide (NSWSES & VICSES).	See Murray Regional Study.	See Murray Regional Study.	
	Cost	$500,000	$25,000	-	-	$525,000
	Priority	High	Medium	-	-	
Katamatite	**Actions**	nil	(Local Flood Guide prepared and delivered)	Revise overlay controls when Upper Broken Creek Regional Flood Study becomes available.	Part of Upper Broken Creek Regional Flood Study when available.	
	Cost	-	-	See Regional Areas.	See Regional Areas.	
	Priority	-	-	Low	Medium	
Koonoomoo		nil	nil	See Murray River Regional Flood Study Cobram to Ulupna.	nil	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Lake Rowan		nil	nil	See Regional Upper Broken Creek Flood Study.	nil	
Lower Broken Creek	**Actions**	nil	nil	Revise flood overlay controls with data from the completed Nathalia and Numurkah Floodplain Management Plans.	Finalise flood intelligence from the completed Flood Studies.	
	Cost	-	-	$40,000	-	$40,000
	Priority	-	-	Low	Low	
Lower Goulburn	**Actions**	1. Re-evaluate options on an opportunistic basis 2. Investigate impact on Cultural Heritage Values [ii]	nil	Revise flood overlay controls from the completed Lower Goulburn Floodplain Rehabilitation Scheme Study.	Incorporate flood intelligence from Scheme Study.	
	Cost	-	-	$40,000	$30,000	$70,000
	Priority	-	-	Low	Low	
Mid Broken Creek	**Actions**	nil	nil	Revise flood overlay controls with data from the completed Numurkah Floodplain Management Plan.	Finalise flood intelligence from the completed Flood Study.	
	Cost	-	-	See Numurkah	See Numurkah	
	Priority	-	-	Low	Low	
Muckatah Depression	**Actions**	nil	nil	Carry out a regional flood study.	Part of regional flood study.	
	Cost	-	-	$200,000	-	$200,000
	Priority	-	-	Low	Low	
Murray Barmah to Echuca		nil	nil	See Lower Goulburn.	See Lower Goulburn.	
Murray Cobram to Ulupna	**Actions**	See Cobram	See Cobram	Revise flood overlay controls from the completed Murray River Regional Flood Study – Cobram to Ulupna.	Incorporate flood intelligence from Regional Study – drafted.	
	Cost	-	-	$30,000	-	$30,000
	Priority	-	-	High	Medium	
Murray Ulupna to Barmah	**Actions**	nil	nil	Carry out a regional flood study.	Incorporate flood intelligence from Regional Study.	
	Cost	-	-	$250,000	-	$250,000
	Priority	-	-	Low	Medium	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Murray Yarrawonga to Cobram East	**Actions**	nil	nil	Use amended minor anomalies for LGA-wide shire for revised flood overlay controls	Part of three-year review cycle	
	Cost	-	-	In-house	-	
	Priority	-	-	Low	Low	
Nathalia	**Actions**	Maintain and renewal of town levees	Revise Flood Class Level at Walshs Bridge and Nathalia	nil	nil	
	Cost	Funded	In-house	-	-	
	Priority	High	High	-	-	
Numurkah	**Actions**	Finalise Stage 1 flood mitigation functional design (Funded), Implement works ($1M), and then Stage 2 design and works ($15M).	Implement new flood prediction service with Flood Class levels and augment rain and stream gauge network. Prepare a revised Local Flood Guide.	Revise zones and flood overlay controls following the completion of the Numurkah Floodplain Management Plan.	Update flood intelligence following completion of the Numurkah Floodplain Management Plan.	
	Cost	$16 M	$145,000	40,000	Drafted	$16.18 M
	Priority	High	High	High	High	
Strathmerton		nil	nil	See Murray River Regional Flood Study Cobram to Ulupna.	nil	
Tungamah	**Actions**	Undertake a new floodplain management study as part of Upper Broken Creek Flood Study				
	Cost	See Regional Upper Broken Creek Flood Study				
	Priority	High	High	High	High	
Upper Broken Creek	**Actions**	nil	Undertake a Regional Flood Study covering numerous Towns.	Introduce and revised flood overlay controls from Regional Study.	Incorporate flood intelligence from Regional Flood Study.	
	Cost	-	$300,000	$40,000	See TFWS	$340,000
	Priority	-	Medium	Medium	Medium	
Waaia	**Actions**	nil	nil	Introduce significant drainage line data as a FO as part of LGA-wide amendment	nil	
	Cost	-	-	-	-	
	Priority	-	-	Low	-	
Wilby		nil	nil	See Regional Upper Broken Creek Flood Study.	nil	
Wunghnu	**Actions**	Carry out a new flood study.	Prepare a Local Flood Guide.	Part of new flood study.	Update MFEP from study	
	Cost	$150,000	$7,500	-	-	$157,500
	Priority	Medium	Medium	Medium	Medium	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Yarrawonga	**Actions**	LGA to determine mitigation options.	nil	Introduce flood overlay controls from the completed Yarrawonga Drainage Study.	Update flood intelligence following completion of the Study.	
	Cost	$75,000	-	$20,000	$15,000	$110,000
	Priority	High	-	High	High	
Yarroweyah		nil	nil	See Murray River Regional Flood Study Cobram to Ulupna.	nil	

[i] Includes: Pine Lodge, Daintons, Congupna Guilfus & O'Keefe Creeks, and include Greater Shepparton City Council

[ii] Cultural Heritage Impact assessment – $50,000 shared cost with Greater Shepparton and Campaspe Shire

5.7 Murrindindi Shire

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$180,000	$180,000
TFWS	$5,000	$35,000	$-	$40,000
Land-use Planning	$40,000	$40,000	$230,000	$310,000
MFEP	$25,000	$30,000	$-	$55,000
	$70,000	**$105,000**	**$410,000**	**$585,000**

Table 15: Murrindindi Shire Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Acheron River	**Actions**	nil	See Buxton	Complete hydrology and carry out flood mapping along the Acheron & Steavenson valleys.	Incorporate flood intelligence from flood mapping study.	
	Cost	-	-	$20,000	-	$20,000
	Priority	-	Low	High	Low	
Alexandra	**Actions**	Undertake a combined overland and riverine flood management study. Require LiDAR and Survey.	Prepare a Local Flood Guide.	Part of new study – see mitigation.	Part of new study – see mitigation.	
	Cost	$180,000	$7,500	-	-	$187,500
	Priority	Low	Medium	High	High	
Buxton	**Actions**	Part of Buxton Flood Study	Improve flood intelligence, education and awareness, communication and dissemination (Local Flood Guide).	Revise flood overlay controls when Buxton, Marysville and Taggerty Flood Studies are completed.	Import flood intelligence into MFEP when Buxton Flood Study is completed.	
	Cost	Funded	$20,000	$20,000 [i]	$15,000	$55,000
	Priority	Medium	Medium	High	High	
Flowerdale		nil	nil	See Upper King Parrot Creek Regional Study.	nil	
Lower King Parrot Creek	**Actions**	nil	nil	Carry out a Regional Flood Study.	Incorporate flood intelligence from Scheme Study.	
	Cost	-	-	$80,000	-	$80,000
	Priority	-	-	Low	Low	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Marysville	**Actions**	nil	nil	Revise flood overlay controls when Buxton, Marysville & Taggerty Flood Studies are completed.	Import flood intelligence into MFEP when Marysville Flood Study is completed.	
	Cost	-	-	$20,000	$15,000	$35,000
	Priority	-	-	Medium	Medium	
Mid Goulburn	**Actions**	nil	Prepare a fact sheet similar to Local Flood Guide	Revised flood overlay controls from Goulburn and Broken Rivers Flood Study.	Incorporate flood intelligence from Flood Study.	
	Cost	-	$5,000	Funded	Funded	$5,000
	Priority	-	High	Medium	Medium	
Strath Creek		nil	nil	See Lower King Parrot Creek Regional Flood Study.	nil	
Taggerty	**Actions**	nil	nil	Revise flood overlay controls when Taggerty, Buxton Marysville Flood Studies are completed.	Import flood intelligence into MFEP when Taggerty Flood Study is completed.	
	Cost	-	-	$20,000	$15,000	$35,000
	Priority	-	-	Medium	Medium	
Thornton		nil	Part of new Goulburn and Broken River Regional Flood Study [ii]	Introduce and revised flood overlay control from Goulburn and Broken Rivers Flood Study [ii]	nil	
Upper King Parrot Creek	**Actions**	nil	nil	Update flood overlay control from completed Flowerdale Study Intelligence and Mapping Study.	Update MFEP	
	Cost	-	-	Part of LGA-wide	-	
	Priority	-	-	High	High	
Yea	**Actions**	nil	A revised Local Flood Guide to be prepared consistent with new gauge. Review Flood Class Levels	nil	Update MFEP with addendum Yea Flood Study.	
	Cost	-	$7,500	-	$10,000	$17,500
	Priority	-	Medium	-	High	
Yea River	**Actions**	nil	Review Flood Class Levels at Devlins Bridge.	Carry out a regional Flood Mapping Study.	Incorporate flood intelligence from Regional Study.	
	Cost	-	-	$150,000	-	$150,000
	Priority	-	Low	Low	Low	

[i] allow $60,000 for planning scheme amendment process for Buxton, Marysville and Taggerty.

[ii] Coordinated by Goulburn Broken CMA across five LGAs.

5.8 Strathbogie Shire

Investment summary by Action type and Priority

	High	Medium	Low	Very low	Total
Mitigation	$2,305,000	$150,000	$-	$-	$2,455,000
TFWS	$65,000	$7,500	$-	$-	$72,500
Land-use Planning	$105,000	$40,000	$75,000	$50,000	$270,000
MFEP	$45,000	$15,000	$-	$15,000	$75,000
	$2,520,000	**$212,500**	**$75,000**	**$65,000**	**$2,872,500**

Table 16: Strathbogie Shire Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TWFS	Land-use Planning	MFEP	
Avenel	**Actions**	Floodplain Management Plan required to determine flood mitigation options, flood intelligence and mapping.	See Mitigation	See Mitigation	See Mitigation	
	Cost	$150,000	-	-	-	$150,000
	Priority	Medium	Medium	High	Medium	
Euroa	**Actions**	Augment Castle Creek levee in accordance with Euroa Flood Intelligence and Mapping Study and Urban Levee Audit. Continue maintenance of the Levee Scheme.	Improve dissemination and communication, and education awareness (e.g. Local Flood Guide and property specific data on web based portal).	Revise zones and flood overlay controls with data from the completed Euroa Flood Intelligence and Mapping Study.	Incorporate flood intelligence from the completed Euroa Flood Intelligence and Mapping Study.	
	Cost	$180,000	$40,000	$40,000 [i]	$15,000	$275,000
	Priority	High	High	High	High	
Goulburn Seymour to Shepparton	**Actions**	nil	nil	Revised flood overlay controls from Goulburn and Broken Rivers Flood Study.	Incorporate flood intelligence from Flood Study.	
	Cost	-	-	Funded [ii]	Funded	
	Priority	-	-	Medium	Medium	
Granite Creeks	**Actions**	nil	Deliver Fact Sheet, following completion of the Granite Creeks Regional Flood Study	Revise flood overlay controls from the completed Granite Creeks Regional Flood Study, which include numerous towns.	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	-	$40,000	15,000	$55,000
	Priority	-	Low	Medium	Medium	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TWFS	Land-use Planning	MFEP	
Graytown	**Actions**	nil	nil	Undertake a scoping study. May require survey.	Consider intelligence data from scoping study.	
	Cost	-	-	$50,000	$15,000	$65,000
	Priority	-	-	Very Low	Very Low	
Locksley		nil	nil	See Granite Creeks Regional Area.	nil	
Longwood		nil	nil	See Granite Creeks Regional Area.	nil	
Mangalore	**Actions**	nil	nil	Undertake a scoping study. May require survey.	Consider intelligence data from scoping study.	
	Cost	-	-	$50,000		$50,000
	Priority	-	-	Low	Low	
Nagambie	**Actions**	1. Provision of permanent electric pumps and rising main from Industrial Estate basin to former borrow pit ($555,000) 2. Removal of informal levee and redundant bridge approach ramp at Western end of the Old Chinamans Bridge, and provide abutment protection ($50,000).	Improve education awareness, prepare a Local Flood Guide.	Revise zones and Introduce flood overlay controls with data from the completed Nagambie Flood Intelligence and Mapping Study.	Incorporate flood intelligence from the completed Nagambie Flood Intelligence and Mapping Study.	
	Cost	$605,000	$7,500	$40,000	$15,000	$667,500
	Priority	High	Medium	High	High	
Old Longwood		nil	nil	See Granite Creeks Regional Area.	nil	
Strathbogie	**Actions**	nil	nil	Undertake a scoping study.	Consider intelligence data from scoping study.	
	Cost	-	-	$25,000	-	$25,000
	Priority	-	-	Low	Low	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TWFS	Land-use Planning	MFEP	
Violet Town	**Actions**	1. Finalise the Violet Town Water Management Scheme $160,000) and construct the proposed levee ($1,260,000) 2. Upgrade the Murray Street rural drain and provide localised bunding or floor raising of houses ($100,000)	Improve dissemination and communication, and education awareness (e.g. Local Flood Guide and property specific data on web based portal.	Revise zones and flood overlay controls with data from the completed Violet Town Flood Study.	Incorporate flood intelligence from the completed Violet Town Flood Study.	
	Cost	$1,520,000	$25,000	$25,000	$15,000	$1.585 M
	Priority	High	High	High	High	

[i] Package flood mapping from flood studies into a single planning scheme amendment.

[ii] Coordinated by the Goulburn Broken CMA across five LGAs. Cost of $60,000 is to implement a planning scheme amendment coordinated by the CMA as the proposed planning authority.

5.9 Whole of region

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$-	$-
TFWS	$135,000	$-	$-	$135,000
Land-use Planning	$-	$-	$-	$-
MFEP	$-	$-	$-	$-
	$135,000	**$-**	**$-**	**$135,000**

Table 17 Whole of region Action-Investment Plan

Proposed Actions, Priorities and Indicative Costs (subject to funding)					
Actions	Lead	Partners	Priority	Objective	Cost
Update **Goulburn Broken CMA flood information online** to assist with decision making process for land-use planning proposals.	GB CMA		High	Land-use planning	GB CMA
Prepare regional Development Floodplain Management Principles and Assessment Practices for Land-use and Development.	GB CMA	All LGAs, DELWP	Medium	Land-use planning	GB CMA
Investigate options to improve community access to **website flood risk information** to allow communities (and business) to better plan, prepare and respond to major floods.	GB CMA	VICSES, all LGAs	High	TFWS	$200,000
Update and maintain **flood intelligence** in line with State-wide protocols.	GB CMA	DELWP	High	TFWS	GB CMA
Investigation options to improve flood intelligence gathering during and after major floods.	GB CMA	VICSES, all LGA	Medium	All	GB CMA
Develop community flood education and awareness products/programs relating to flood risk for high priority areas, to build and maintain community resilience. Examples may include individual flood awareness property charts, pre-recorded flood education videos, interactive interpretational products such as animations of flood behaviour, community signs, gauge boards and local flood guides or other initiatives as identified.	VICSES	VICSES, all LGAs, DELWP	High	TFWS	$65,000
State Community Observers Network Website enabling the community to provide local knowledge during a flood event using smartphones to collect flood data via an app. Photos can be instantly uploaded to the web page, viewed and shared between agencies and the community. A source of valuable information where there are gaps in telemetered stream data.	VICSES	DELWP, all CMAs	High	TFWS	$70,000
Update MFEPs to incorporate school bus runs impacted by flooding where flood mapping is available. Determine approaches to manage changes to school bus routes.	VICSES	Dept. of Education, GB CMA, all LGAs	Medium	MFEP	VICSES
Undertake exercising of **MFEPs**	VICSES	CMA, all LGAs	High	MFEP	VICSES
Investigate methods to recognise Aboriginal values before any new proposed floodplain management works, and flood activities, which may include but is not limited to risks to cultural assets after floods, and notification of flood events to relevant Traditional Owner corporations (e.g. **MFEPs** could include information regarding these risks, including notifying the relevant RAP).	VICSES	All LGAs, GB CMA	Medium	MFEP	VICSES

Part C: Supporting Documents

Appendix A: Flood and Floodplain Management

Flood Management

Flood management is used in the broad context of Emergency Management as described in the Emergency Management Manual Victoria (EMV 2016). The objectives are to ensure that the following components of emergency management are organised to facilitate planning, preparedness, operational coordination and community participation:

> **Prevention**: the elimination or reduction of the incidence or severity of emergencies and the mitigation of their effects, which are part of the work plans and Strategy Action Plan requirements under the under the *Emergency Management Act 2013*.
>
> **Response**: the combating of emergencies and the provision of rescue and immediate relief services. Note that the Victoria State Emergency Service is the combating agency for floods.
>
> **Recovery**: the assisting of people and communities affected by emergencies to achieve a proper and effective level of functioning.

The **Figure A-7** below (adapted from the Emergency Management Manual 2016) shows this model as it relates to flood management. It should be noted that prevention, response and recovery activities overlap. These are not necessarily phases or stages of emergency management, as the relevant activities are carried out as needed and not always sequentially.

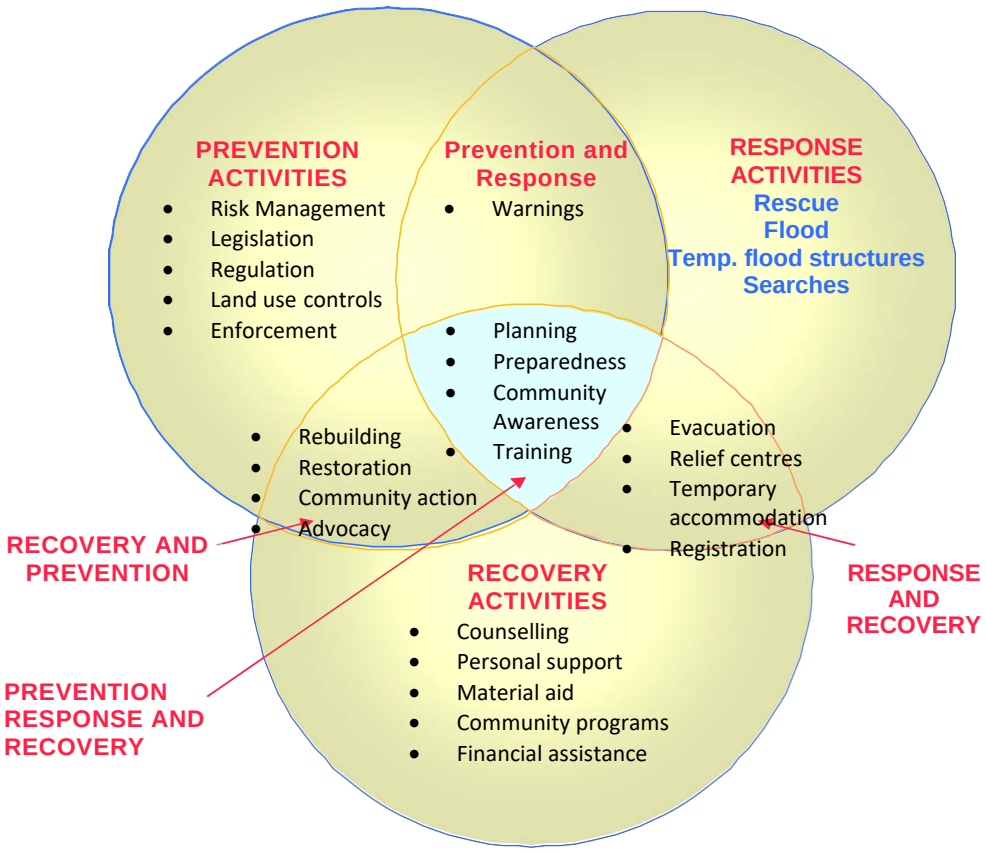
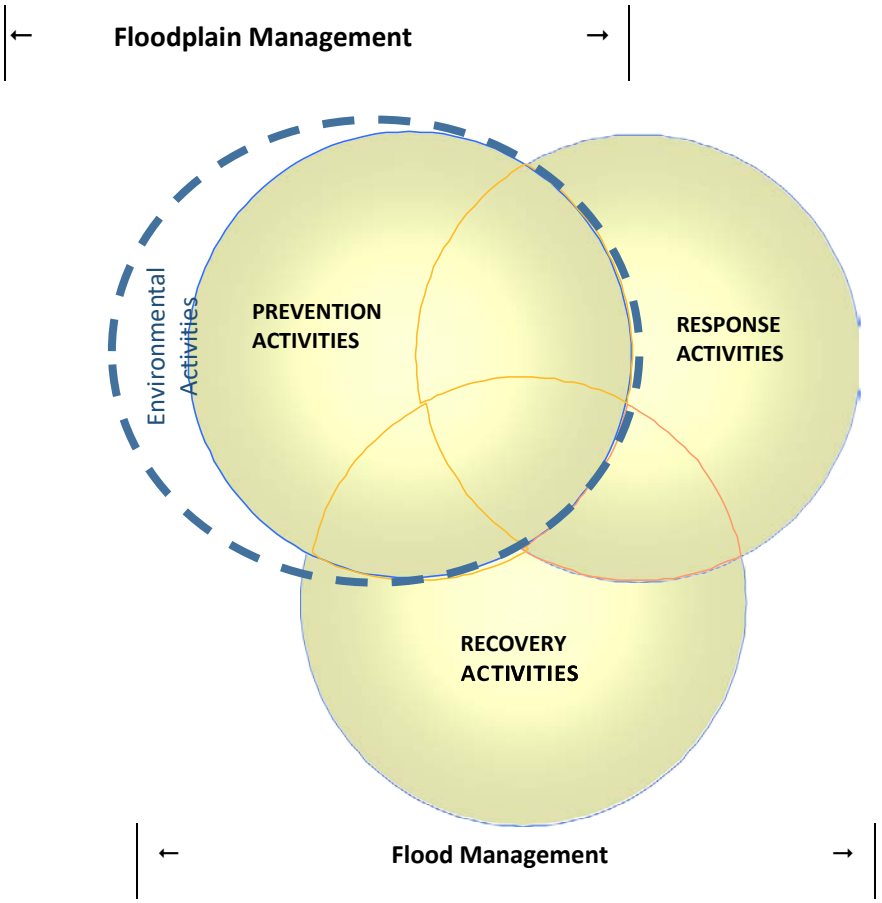


Figure A-7: Flood Management in the Emergency Management Context

Floodplain management

Floodplain management comprises the *prevention activities* of flood management together with related environmental activities as illustrated in **Figure A-8** (adapted from Victoria Flood Management Strategy 1998). The significance of the distinction between flood management and floodplain management is that various lead agencies, such as CMAs, have key roles in floodplain management activities while other agencies such as Emergency Management Victoria, Victoria State Emergency Service and Department of Health and Human Services have key roles in response and recovery activities.



Prevention Activities

- Victorian Floodplain Management Strategy
- Regional Catchment Strategies
- Regional Floodplain Management Strategies
- Floodplain Management Plans
- Best Practice Guidelines
- Flood Information & Maps
- Flood Mitigation Works
- Land Use Planning Controls
- Building Controls
- Flood Warning
- Community Awareness
- Education & Training
- Research

Environmental Activities

Preservation and Enhance of:

- Flora & Fauna
- Wetlands
- Landscape interest areas
- Traditional Owner interest areas
- Archaeologic interest areas
- Flood conveyance
- Flood storage
- Stream stability
- Water quality

Figure A-8: Floodplain Management in the Flood Management Context

Appendix B: Consultation Material to Promote Stakeholder Discussions and Input

Consultation material was prepared for stakeholder consultation in two formats: firstly by local government areas (for urban centres), and secondly by one single whole of region area (for rural areas along large river/creek reaches).

A stocktake of past studies and achievements was summarised for urban centres and rural areas, including an assessment of information gaps and potential flood risks in tabular format. A first "best" assessment rankings were applied to the four tools used to enhance flood resilience (i.e. Flood mitigation, Total Flood Warning System, Land-use Planning and Municipal Flood Emergency Plans)

The same background wording was applied to the eight local government/regional areas with locality plans that was distributed at the 15 community workshops and placed on the Goulburn Broken CMA's website, allowing opportunities for submissions.

Below is a copy of the introductory wording used for each local government/regional area followed by specific tables providing information on rankings, stocktakes and priorities.

Flood risk assessment and draft priority rankings for stakeholder discussion

Community input is needed to prioritise where flood knowledge needs to be improved through flood studies and flood mapping in (LGA/region) and to determine actions to reduce the risk of flooding.

This summary provides a list of studies for towns in (LGA/region) and draft priorities for flood mitigation actions.

How to read the table below

The column to the left ranks flood risks (1: low, and 5: high), taking into account the possible damage from different sized floods and how often they are expected to happen. The measure of the yearly average cost of floods is known as Annual Average Damage (AAD).

The two columns in the centre of the table show:

- Flood studies that have been (or soon will be) completed for towns in your local government area.
- Recommendations from these studies that have been implemented (or are under way) and other relevant comments or observations.

The columns to the right of the table show DRAFT priority rankings [Low (L), Medium (M), High (H) and No Action (-)] for actions that reduce risk of flooding such as:

- Mitigation works (e.g. levees, retardation basin, and floodways)
- Flood warning systems (e.g. flood watch, flood warning broadcasts and action plans)
- Land use planning (e.g. flood overlay control in planning schemes)
- Municipal flood emergency plans (developed by council, VICSES and other agencies with flood-management responsibilities)

Please review this summary and provide feedback by:

- attending one of the community sessions being held across the catchment during February; or
- completing the feedback form on the website www.gbcma.vic.gov.au

Terminology

Annual Average Damage (AAD), expressed in dollar terms, is the average damage per year that would occur in a particular area from flooding over a very long period of time. This provides a basis for comparing the economic effectiveness of different projects. For more information on risk assessment methodology, please see the Regional Floodplain Management Strategy section of the website.

Annual Exceedance Probability (AEP) is the likelihood of occurrence of a flood of given size or larger occurring in any one year.

FloodSafe is a whole community program designed to prepare and empower the community with the skills and knowledge to appropriately prepare for, respond to, and recover from floods.

Municipal Flood Emergency Plan (MFEP) is a plan prepared and maintained by each municipal council, under the *Emergency Management Act 1986*, which identifies the municipal resources available, and how they are to be used, for flood prevention, response and recovery.

Regional Floodplain Management Strategy (RFMS) (under development) will replace the previous regional strategy (2002) and aims to help manage flood risk by seeking community input to prioritise where flood knowledge needs to be improved. The priorities will be detailed in a rolling three-year regional work plan that can be used by local communities to secure funding for various flood management activities.

Specific Local Government/Regional area tables and maps

Benalla Rural City Council

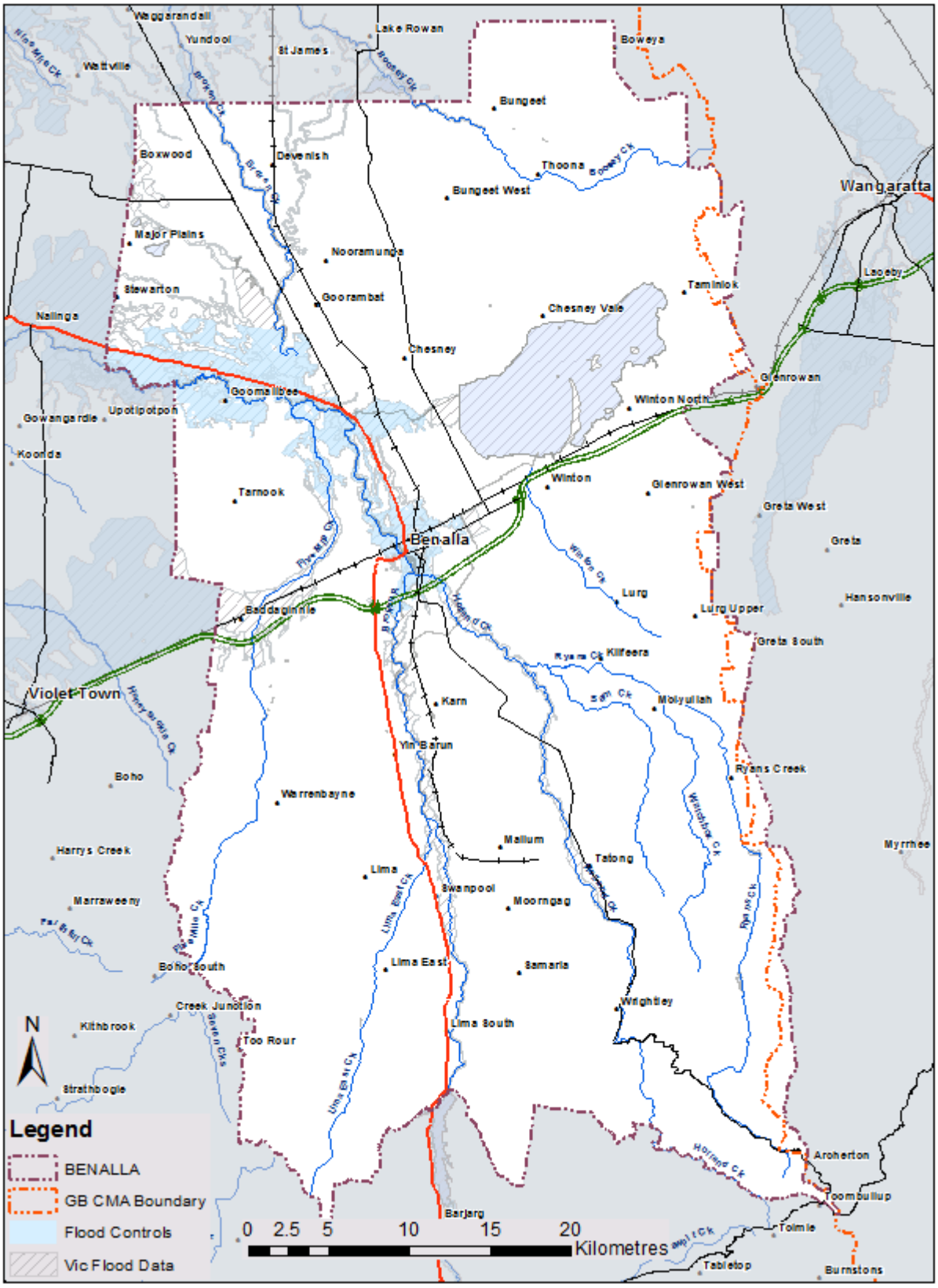


Figure 1. Benalla Rural City Council area showing towns and planning scheme flood overlay controls

Table 1. Benalla Rural City risk assessment (ranking 1: low, and 5: high)
Draft priority rankings for stakeholder discussion: Low (L), Medium (M), High (H) and No Action (-) (for urban centres)

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Baddaginnie	2	• Documentation & Review of the 1993 Victorian Floods Volume 4 Broken River Catchment Floods (Hydro Technology, 1995) • Granite Creek Regional Flood Study (Water Technology, nearing completion)	• No flood zone or overlay controls exist • Upload mapping products from study into planning scheme • Prepared 1% flood contour in Flood Atlas online • Update MFEP • Consider possible flood warning arrangements. Likely to rely on BoM flood warning products such as Flood Watch	-	L	H	H
Benalla	5	• Benalla Floodplain Management Study (SR&WSC, 1984) • Benalla Flooding Investigation: Flood of 3-4 October 1993 (Willing & Partners, 1994) • Documentation & Review of the 1993 Victorian Floods Volume 4 Broken River Catchment Floods (Hydro Technology, 1995) • Total Flood Warning System (CT Management, 1997) • Flood Response Guidelines, Benalla Township and Surrounds (Delatite Shire (1997) • Benalla Floodplain Management Study (Cardno Willing, 2002). • Benalla Waterway Management Scheme (Benalla Steering Committee, 2004) • Benalla Floodplain Management Study – Flood Study (Willing & Partners, 2005) • Lake Nillahcootie Flood Study (Cardno, 2008) • Benalla: Review of Floodplain Management Works (Cardno, 2009) • Benalla Flood Risk Review of Flood Cut Option (Cardno 2009) • Benalla Flood Information Portal Report (Cardno, 2016)	• 1% AEP flood levels declared • Total Flood Warning System implemented • Benalla Water Management Scheme Implemented including vegetation thinning. Additional installation of railway culverts proved ineffective and impracticable and on hold indefinitely • Flood Smart property information rolled out in 2009. • Benalla Flood Information System web portal (Cardno, 2016) is being developed • FloodSafe Guide drafted • Property Information Statements prepared • Need new flood zone and overlay controls for planning scheme • Council remains commitment to manage water management scheme	-	-	H	H
Devenish	0	• Nil	• Approx. 60 buildings identified (from 2015 aerial photography) • Flood overlay controls are required as evident by captured 2012 peak flood levels • Suspect that flooding occurs from Broken Creek overflow • Scoping Study is required to at least to provide flood mapping • No LiDAR or detailed ground information exists	-	-	M	M
Glenrowan (Rural City of Wangaratta)	0	• Nil	• Town has a number of deeply incised waterways commending very small catchments in the order of 100 ha. • There may be some overland drainage issues beyond the scope of this RFMS	-	-	-	-
Swanpool	1	• Nil	• LiDAR shows that the town is on a significant high terrace above the floodplain by some three to four metres • No further action	-	-	-	-
Tatong	1	• Nil	• LiDAR shows that the bulk of the town is several metres above the adjacent floodplain. • Town has two localised waterways • Dwellings located west of town are relatively low • Consider scoping flood study to improve flood mapping. This will assist to identify any further work	-	-	M	L
Thoona	0	• Nil	• The bulk of the buildings are on land significantly above the Boosey Creek floodplain • Several buildings could be exposed to flood risk • Desktop investigation required to prepare flood overlay controls to safeguard from flood risk for new buildings	-	L	M	L

Campaspe Shire

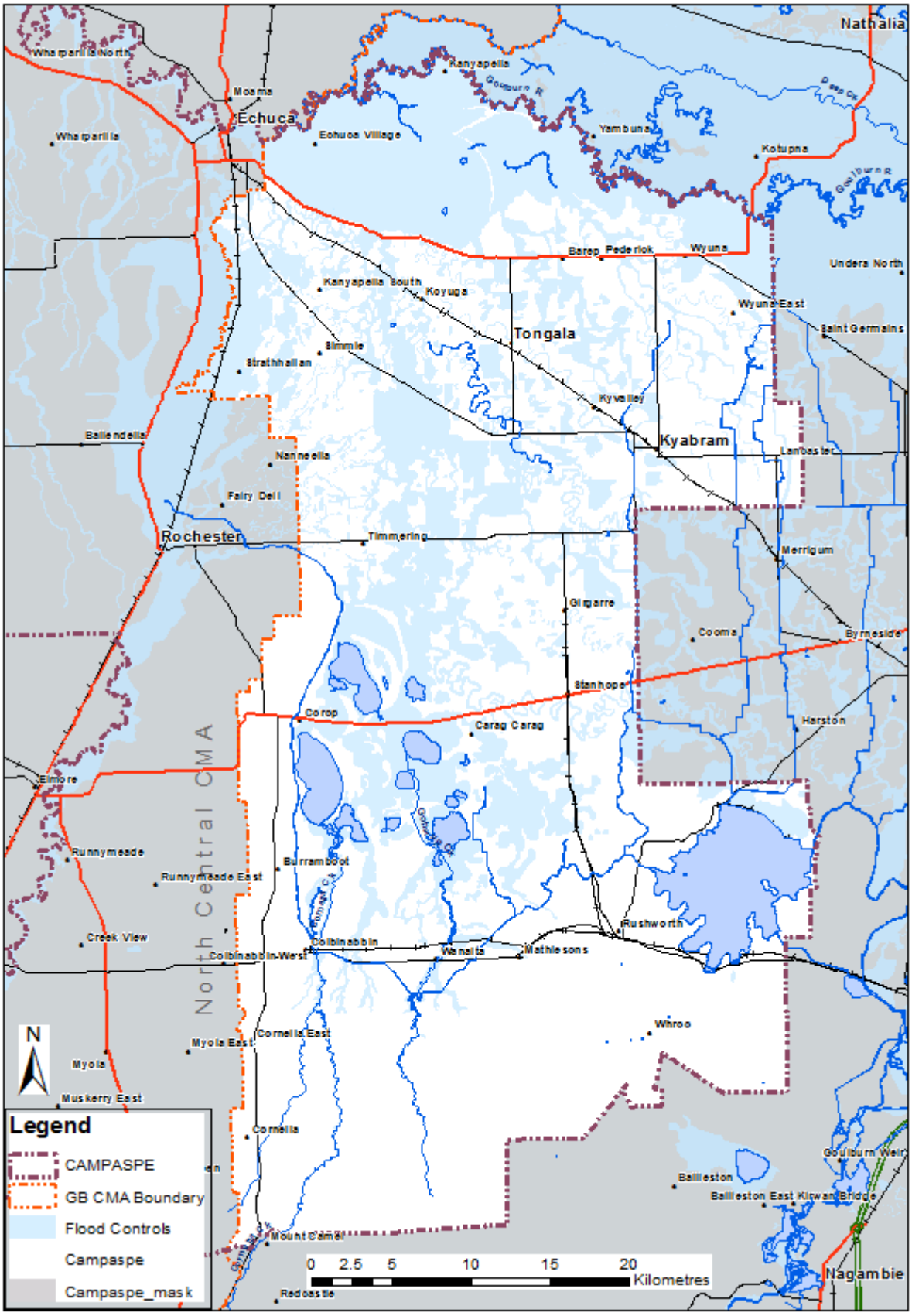


Figure 1. Campaspe Shire area showing towns and planning scheme flood overlay controls

Table 2. Campaspe Shire risk assessment (ranking 1: low, and 5: high)
Draft priority rankings for stakeholder discussion: Low (L), Medium (M), High (H) and No Action (-) (for urban centres)

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Colbinabbin	1	• Corop Lakes Scoping Study (GHD, 2012)	• Cornella Creek and its floodplain lies east of town • The land upon which the primary school is located is subject to flooding. A house east of town is reported to have water under it. Recent Shire works have resolved flooding issues for other houses • GMW has operational procedures for the Waranga Channel and a number of flood doors • Improvement in communications about flood operations between GMW and communities is ongoing (a recommendation of scoping study) • Parts of the town is known to be subject to overland flooding from the Camel Ranges that lie to the west. However, no knowledge of any above house floor flooding	-	M	L	M
Girgarre	0	• Flooding of Tongala-Stanhope Irrigation District - March 1950 & Recommendations for Improving the Surface Drainage (SR&WSC, 1951)	• No known flooding issues to date. Shire has no records of any above house floor flooding over the past 40 years. • Shire has recently installed a retardation basin, which is designed to cater for a 1% AEP flood	-	-	-	-
Kyabram	5	• Kyabram Drainage System – Design Basis Report on Kyabram Drainage Improvement Works (GHD, 1995) • Kyabram Drainage System – Surface Drainage Strategy (GHD, 1996) • Flood Contour Review (GBCMA, 2011) Shire is currently designing 1% AEP upgrade to McEwen Road east and west retardation basins •	• Low-lying areas are subject to overland flooding from localised intense rainfall • Study recommendations implemented including pump station to remove excess floodwater to storage areas to the south of town • Other recommendations from the 1994 report still remain outstanding, i.e. upgrade of McEwen Road sumps and construction of Waratah Street are still to be completed. Once completed there will still be a number of houses inundated by a 1% AEP flood. • Require scoping study to review old study assumptions against new methods contained in Australian Rainfall and Runoff, and to identify any further work. For instance, the setting of floor levels could be based on pump failure (i.e. no pumps) • Flood overlay controls need updating (partly completed by GB CMA)	L	-	H	-
Rushworth	0	• Rushworth Overland Flood Study comprising the following: o Southern catchment design (Moore and Esmonde Streets) o Western Catchment Design (Parker and Esmonde Streets) o Norther Catchment Design (Moore and High Streets) o CBD – High Street o These studies and designs were all finalised in 2014	• Mitigation works implemented to reduce exposure from over floor flooding to some commercial buildings • Need overlay flood controls for identified overland flow paths in planning scheme • Rely on available BoM flood warning products such as Flood Watch	-	-	M	M
Stanhope	1	• Stanhope Drainage Scheme 1973 • Flood Data Transfer – Flood Mapping (NRE, 1998)	• Low-lying depression exists south of the town. However, there is no known history of flooding within the township boundary • Further studies are not warranted at this time	-	-	-	-
Tongala	1	• Tongala Drainage Scheme (Proposed Drainage Master Plan) (GHD, 1984)	• The edge of the town (to the north) lies within a natural depression, which is shown in the flood overlay controls in the planning scheme • Elsewhere, a significant number of recorded peak 1974 flood levels exist but without any flood overlay controls. However: o The Shire of Campaspe has advised (during the preparation of the 2002 RFMS) that the area is served by a drainage scheme incorporating Retardation Basins that caters for the 1% AEP storm o Drainage works since that time has meant that areas outside the retardation basin do not flood. In 2012 water in the basin reached the boundaries of the 1% AEP storage • No further study is envisaged other than for the Shire to monitor the performance of the drainage system	-	-	M-H	M

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Wyuna	1	• Nil	• Localised drainage path identified to the west of town • No known flooding issues identified	-	-	-	-

Greater Bendigo City Council

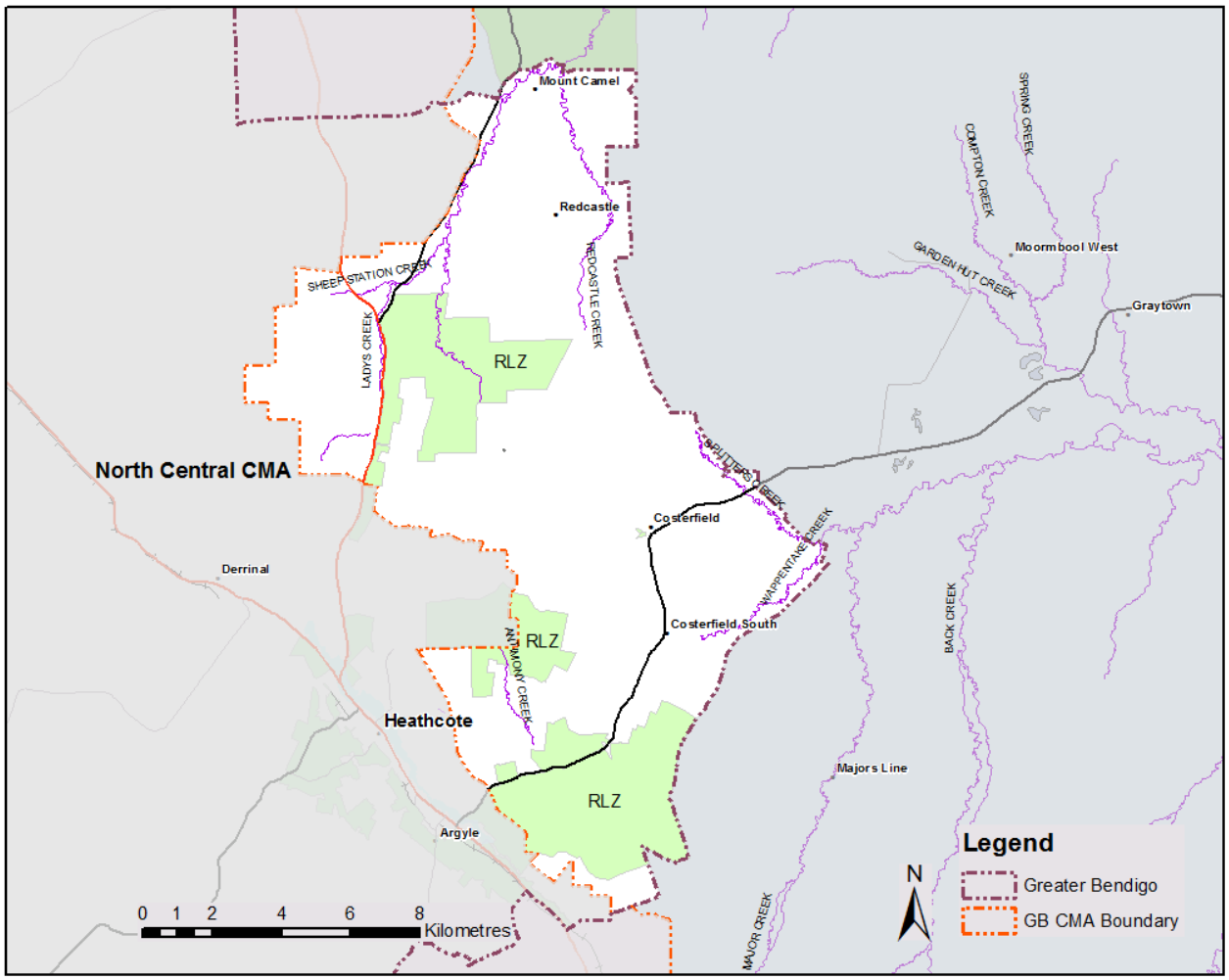


Figure 1. Greater Bendigo City Council area showing towns and planning scheme Rural Living Zone (RLZ)

Table 1. Greater Bendigo City Council risk assessment (ranking 1: low, and 5: high)
Draft priority rankings for stakeholder discussion: Low (L), Medium (M), High (H) and No Action (-) (for urban centres)

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Costerfield	0	• Nil	• There is approx. 20 buildings scattered throughout the area • This location is on top of the catchment and has two minor drainage lines • No further action	-	-	-	-
Costerfield South	0	• Nil	• Similar to Costerfield • Several small tributaries meet south of the area and suspect some minor flash flood issues	-	-	-	-
Heathcote East (Rural Living)	0	• Nil	• The area zoned Rural Living has transformed the area into a significant number of lots and dwellings. • There are a significant number of waterway with relatively small catchment of few square kilometres. • No known flooding issues, but possibly subject to flash flooding	-	L	-	-
Heathcote North (Rural Living)		• Nil	• The area zoned Rural Living has transformed the area into a significant number of lots and dwellings • There are a significant number of waterway with relatively small catchment of few square kilometres • No known flood issues, but possibly subject to flash flooding	-	L	-	-
Mount Camel	0	• Nil	• Several buildings identified • Available LiDAR indicates building are located on high land above the Cornella Creek floodplain	-	-	-	-
Redcastle	0	• Nil	• Some 90 small lots exist (approx. 1,000 square metres) with some 15 buildings • Redcastle Creek flows to the west of the subdivision and has a catchment area of some 18 square kilometres • No known flood issues • No ground information exist to assess possible flood impact.	-	L	L	L

Greater Shepparton City Council

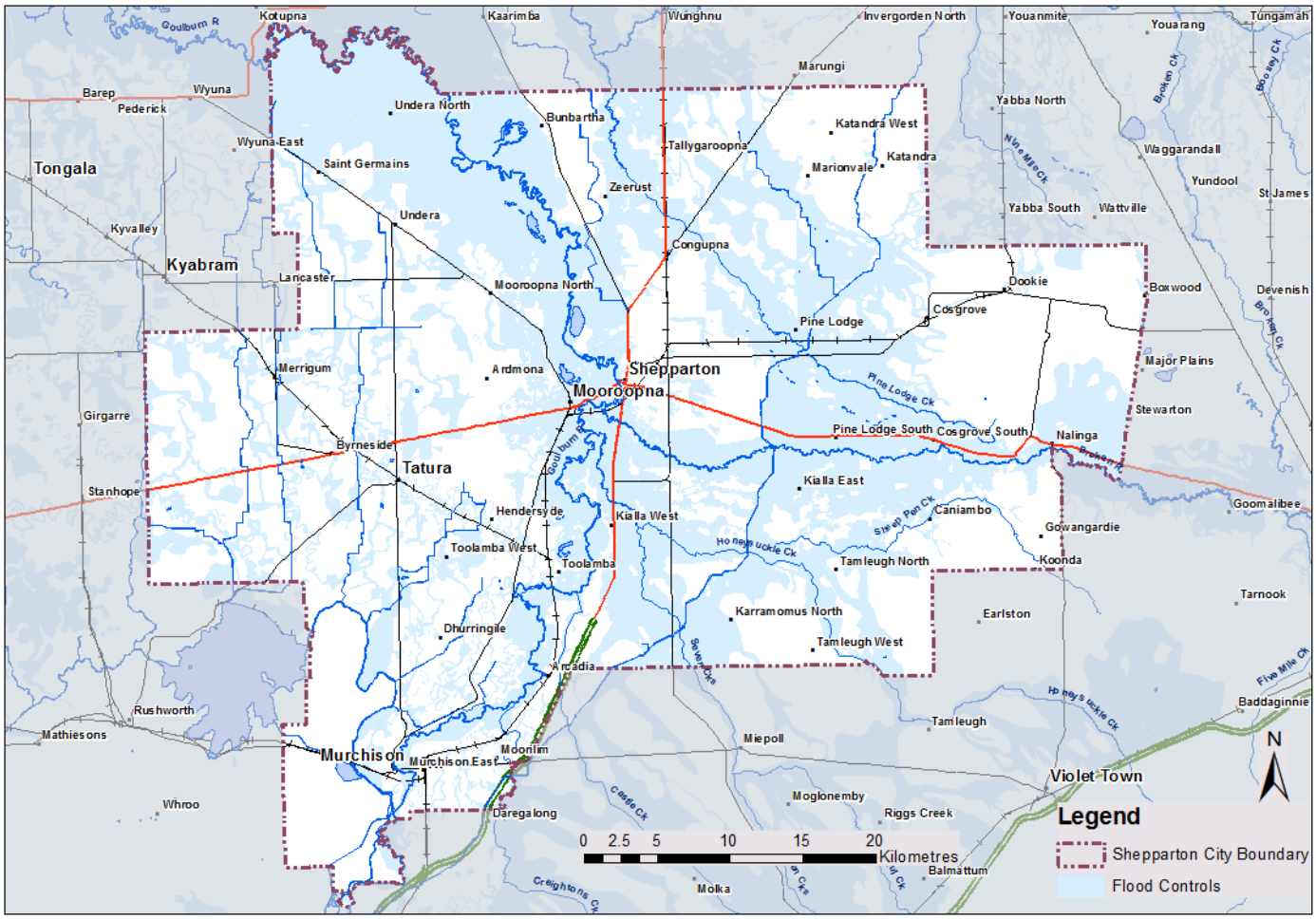


Figure 1. Greater Shepparton area showing towns and planning scheme flood overlay controls

Table 2. Greater Shepparton risk assessment (ranking 1: low, and 5: high)
Draft priority rankings for stakeholder discussion: Low (L), Medium (M), High (H) and No Action (-) (for urban centres)

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Bunbartha	1	• Documentation and Review of the 1993 Victorian Floods Volume 5 Lower Goulburn River Floods (Hydro Technology, 1995) • Lower Goulburn Floodplain Rehabilitation Scheme (Water Technology, 2005)	• Potential flood impact from levee failure/overtopping upstream of town • Potential flood impacts from Loch Garry boards being removed • Flood warning arrangements augmented by Goulburn Murray Water. Also from Greater Shepparton to Daintons Bridge (Shepparton Gauge provide the triggers for Loch Garry board removal operation)	-	-	L	-
Cooma	1	• Flooding of Tongala-Stanhope Irrigation District - March 1950 & Recommendations for Improving the Surface Drainage (SR&WSC, 1951)	• Available data indicates Mosquito Depression (to the west of Cooma) does not impact on the Cooma • No further action	-	-	-	-
East Murchison	1	• Murchison Flood Mapping Study Report (Water Technology, 2015) • MFEP update provided (Water Technology)	• New flood controls need to be incorporated into planning scheme • MFEP update • FloodSafe Guide prepared • Flood Warning Services to Murchison in place	-	L	H	-
East Shepparton	5	• Peak 2013 flood levels captured • Shepparton East Flood Study (BMTWBM) final draft completed	• Nil	-	-	H	H
Katandra West	0	• Nil	• Not subject to riverine flooding • Flood overlay controls are required as evident by captured 2012 peak flood levels • Scoping flood study is required with a focus of improved flood mapping • FloodSafe Guide prepared • Flood intelligence in MFEP	-	-	H	-
Kialla West	1	• This now part of the Shepparton Mooroopna Flood Intelligence Study	• See Shepparton Mooroopna	-	-	-	-
Merrigum	3	• Merrigum Flood Study (WBM, 2005)	• Planning flood controls, incorporated into planning scheme • 1% AEP flood levels declared • MFEP updated • Flood warning relies on BoM products such as flood watch • FloodSafe Guide should be considered	-	-	-	L
Murchison	1	• See “East Murchison” above	• See East Murchison	-	L	H	H
Shepparton/ Mooroopna	5	• Shepparton-Mooroopna Flood Study 2 volumes (Sinclair Knight Partners, 1982) • Shepparton-Mooroopna Flood Mitigation Design – Report on Works Options, Draft Discussion Document on Options, and Assessment of Levee Options – Summary Report and Appendices (Sinclair Knight & Partners (1986, 1987 & 1989) • Mooroopna Flood Mitigation Scheme (RWC, 1989) • Documentation and Review of the 1993 Victorian Floods Volume 5 Lower Goulburn River Floods (Hydro Technology, 1995) • Mooroopna Water Management Scheme: Proposed Mooroopna Levees – Report on Submissions to Exhibited Scheme Document (NRE, 1997) • Shepparton-Mooroopna Floodplain Management Scoping Study – Final Report (Sinclair Knight Merz, 1998). • Shepparton Mooroopna Floodplain Management Study – Stage 1 Technical Report (SKM, 2002) • Shepparton Mooroopna Floodplain Management Study – Stage 2 Technical Report (SKM, 2002) • Greater Shepparton City Council Flood Warning and Emergency Management Project (Water Technology, 2007) • Shepparton Mooroopna Flood Intelligence and Mapping Study (Water Technology – ongoing)	• Large length of GMW Irrigation Channel 19/12 along Wanganui Road has been placed underground (circa mid 1980s) • Several properties purchased by RWC within low-lying areas along River Road between Shepparton and Mooroopna • Proposed new urban levees abandoned in 1997 due to lack of agreement • Total Flood Warning System implemented in 2007 – including flood warning service by BoM and community information • MFEP updated 2007 • Flood zone and overlay controls incorporated into planning scheme in 2004 • 1% AEP flood levels declared. • MFEP, mapping, flood levels and community intelligence require updating upon completion of the latest study. • FloodSafe Guide prepared in 2014.	-	-	H	H

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Tally-garoopna	1	• Documentation and Review of the 1993 Victorian Floods. Volume 4 – Broken River Catchment Floods (Hydro Technology, (1995) • Recorded 2012 peak flood levels	• FloodSafe Guide prepared • Flood intelligence in MFEP • Flood controls needs updating	M	-	H	-
Tatura	5	• Mosquito Drain 36 (Tatura Bypass Drain) Concept Report (SKM, 1999) • Tatura Floodplain Management Plan (WBM, 2006)	• Flood control integrated into planning scheme • 1% AEP flood levels declared • Civil mitigation works implemented (railway culverts, Undera Road culvert, lowering pathway and Retardation Basin embankment) • Council remains committed is managing civil works • Mapping in MFEP • No specific flood warning – rely on Flood Watch products from BoM	-	-	-	-
Toolamba	1	• Nil	• Desktop review of LiDAR (ground level) data indicates a low-lying depression exist that would flood from the Goulburn River, otherwise the town is well above flood level • Require new flood overlay controls • Further desktop study to determine need for TFWS, MFEP	-	L	M	M

Mansfield Shire

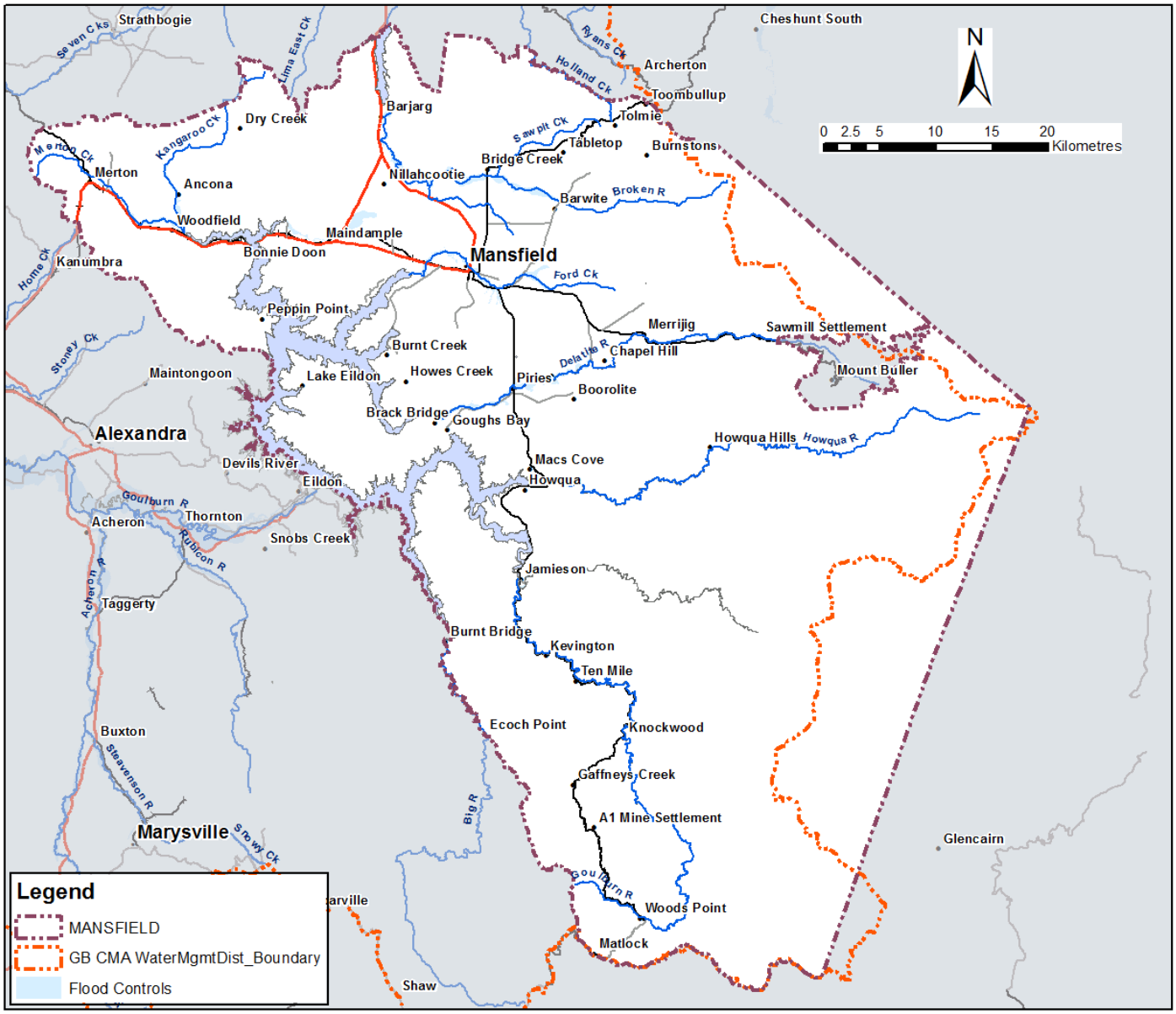


Figure 1. Mansfield Shire Council area showing towns and planning scheme flood overlay controls

Table 1. Mansfield Shire risk assessment (ranking 1: low, and 5: high)
Draft priority rankings for stakeholder discussion: Low (L), Medium (M), High (H) and No Action (-) (for urban centres)

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Bonnie Doon	1	• Nil	• LiDAR ground level information indicates that the land is well above both the Full Supply Level of Lake Eildon and the 1% AEP flood level. • No further action.	-	-	-	-
Castle Point (A1 Mine Settlement)	0	• Design Flood Hydrographs for the Goulburn and Broken River Catchments (Jacobs, ongoing)	• Three buildings have been identified (from 2015 aerial photography) for the area. • The Raspberry Creek flows to the east of the development and has a catchment of some twelve square kilometres • No detailed ground level information exists. However, from past site visits, the buildings appear elevated above the floodplain level • No further action	-	-	-	-
Howqua	1	• Design Flood Hydrographs for the Goulburn and Broken River Catchments (Jacobs, ongoing)	• The site essentially includes buildings and works associated with a school camp • LiDAR ground level information indicates that the site of the buildings are well above Howqua Valley floodplain. • Need to confirm that the above judgement by undertaking a regional floodplain hydraulic modelling assessment with input from the hydrologic study (flow estimates) findings	-	L	L	L
Jamieson	2	• Jamieson Flood Scoping Study (SKM, 2002) • Design Flood Hydrographs for the Goulburn and Broken River Catchments (Jacobs, ongoing)	• This town is possibly the most at risk community in the Mansfield Shire • Flood overlay controls now incorporated into planning scheme; however, the mapping methodology is somewhat arbitrary • Several homes have been identified as potentially at risk of over floor flooding, including significant flood risk at the caravan park • At the very least the town needs a further hydraulic modelling assessment based on new LiDAR capture and river surveys (to determine flood extents etc.) with input from the hydrologic study (flow estimates) findings • Scoping study into possible flood warning improvement is required – the BoM flood warning products such as Flood Watch is currently the only tool available	-	H	H	H
Maindample	1	• Nil	• Field reconnaissance carried out by GB CMA staff mapped the floodplain extents for the newly adopted flood overlay controls. This assessment suggests a small proportion of buildings maybe exposed to flood risk.	-	-	L	L
Mansfield	3	• Mansfield Flood Study – Final Report (Earth Tech, 2005) • Mansfield Flood Study Extension – Supplementary Report (Earth Tech, 2006) • Mansfield Flood Intelligence and Mapping (GB CMA, 2014) • Design Flood Hydrographs for the Goulburn and Broken River Catchments (Jacobs, ongoing)	• Flood zone and overlay controls have been updated to reflect latest mapping. • There are approx. three dwellings at risk of over floor flooding and a further 50 properties subject to flood inundation for a 1% AEP type flood • Suggest a review of possible flood warning needs • Carry out floor level survey to determine appropriate property listing in the MFEP	-	M	-	M
Merrijig	1	• Design Flood Hydrographs for the Goulburn and Broken River Catchments (Jacobs, ongoing)	• Approx. 75 buildings exist in Merrijig which are elevated above the Delatite River floodplain • No further Action	-	-	-	-
Merton	0	• Nil	• Approx. 30 buildings exist in the town and located well above the floodplain areas. • No further action	-	-	-	-
Woods Point	0	• Design Flood Hydrographs for the Goulburn and Broken River Catchments (Jacobs, ongoing)	• Field reconnaissance carried out by GB CMA staff mapped flood extents for newly adopted flood overlay controls in the Mansfield Planning Scheme. Mapping suggests that a small proportion buildings maybe exposed to flood risk. • LiDAR ground level information is consistent with the above findings. • This town should be included as part of the regional study area for upper Goulburn	-	-	L	L

Mitchell Shire

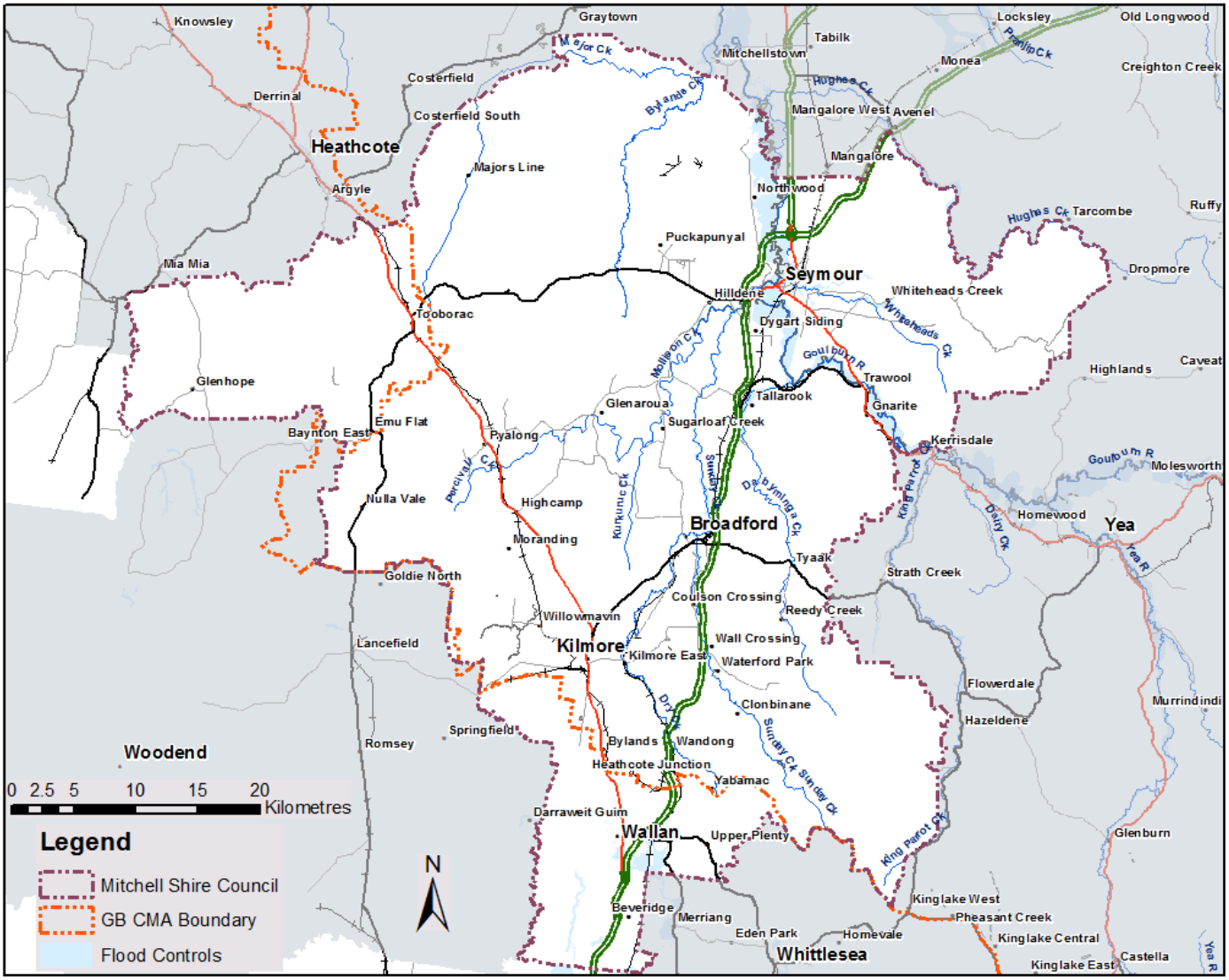


Figure 1. Mitchell Shire Council area showing towns and planning scheme flood overlay controls

Table 1. Mitchell Shire risk assessment (ranking 1: low, and 5: high)
Draft priority rankings for stakeholder discussion: Low (L), Medium (M), High (H) and No Action (-) (for urban centres)

Name	AAD	Summary of past and existing studies	Summary of completed activities (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Broadford	2	• Nil	• Flooding from both Sunday and Dry creeks has some flood impacts on the town as well as overland flooding issues • Requires a flood study (a study could be coupled with other towns and regional areas along Dry and Sunday creeks)	-	M	H	H
Kilmore	0	• Kilmore Flood Study and Intelligence Study (BMT WBM, ongoing)	• Update MFEP • Place flood overlay controls in planning scheme • Flash flood warning services to be considered	L	L	H	H
Kilmore East	0	• Nil	• Dry Creek flows along the eastern side of the town and railway. LiDAR ground information indicates that the town is well above Dry Creek • Several small drainage lines traverse through the town and may have some overland flooding issues • Investigate flooding in a regional approach along Dry and Sunday creeks including its towns	-	L	M	L
Pyalong	0	• Nil	• Approx. 170 buildings have been identified (from 2015 aerial photography) • The town has developed as two distinct areas, namely to the north (Township Zone) and in the south (Rural Living Zone). • Mollisons Creek flows through the northern portion of town • LiDAR ground information indicates that Mollisons Creek is deeply incised and flooding of the urban areas is unlikely • Carry out a desktop study (or scoping study) to confirm or otherwise any flooding issues	-	-	L	L
Reedy Creek	0	• Nil	• Approx. 65 buildings have been identified (from 2015 aerial photography) • Dabyminga Creek flows along the east of the developed areas and commands a catchment area of approx. 38 square kilometres. • LiDAR ground information indicates that Dabyminga Creek is deeply incised and flooding of the urban areas is unlikely • Investigate flooding in a regional approach along Dry and Sunday creeks including its towns • Flood warning rely on BoM flood warning products such as Flood Watch	-	-	H	L

Name	AAD	Summary of past and existing studies	Summary of completed activities (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Seymour	5	• Seymour – Report on Flooding from Goulburn River (SR&WSC, 1981) • Appendix F: Lake Eildon – Effect on Flood Frequencies at Eildon (SR&WSC, 1981) • Seymour Floodplain Management Study (SR&WSC, 1984) • Seymour Flood Mapping Study – Final Report (WBM Oceanics Australia, 2001) • Total Flood Warning System–Goulburn River to Seymour • Seymour Flood Mitigation Communication Investigation – Final Consultants Report to Council (WBM Oceanics Australia, 2006) • Seymour Flood Mitigation Project - Preliminary Design Report (John Webb Consulting, 2009) • Seymour Flood Mitigation Project - Draft Report (GHD, 2013) • Letter report on the cost of compensation to landowners for land acquisition (PW Newman P/L, 2013) • Archaeological Assessment of a Proposed Levee at Seymour (Heritage Insight, 2013) • Seymour Flood Mitigation Project – Preliminary Cost Estimate (Flagstaff Consulting Group, 2013) • Letter report on the outcomes of flood modelling (BMT WBM, 2013) • Seymour Flood Mitigation Project – Preliminary Construction Methodology (Flagstaff Consulting Group, 2013) • Letter report on increase in land values from rezoning (PW Newman P/L, 2014) • Memorandum – Seymour Flood Mitigation Cost Benefit Analysis (Aither, 2014) • Terrestrial and aquatic assessment for the proposed Seymour levee – proposed realignment (Ecology and Heritage Partners, 2015) • Proposed Flood Levee, Seymour – Draft Cultural Heritage Management Plan (Heritage Insight, 2014)	• Total Flood Warning System has been delivered • MFEP has been updated to reflect existing conditions without proposed levees • Information Guides prepared in 2001 has been updated with FloodSafe guides by VicSES (2015) • Flood zone and overlay controls have been updated to reflect existing conditions without proposed levees. • Functional levee design is underway • A planning scheme amendment for the levee is in preparation and consideration.	H	M	H	H
Tallarook	1	• Tallarook Flood Investigation (GB CMA, 2008)	• Dabyminga Creek flows along the eastern side of town and commends a catchment of some 145 square kilometres. • Approx. 60 buildings have been identified from 2015 aerial photography, with the bulk of them above the 1% AEP flood level • Flood overlay controls require updating • Flood Warning needs to rely of BoM flood products such as Flood Watch • MFEP need to ensure buildings in low-lying land are documented – This can be done using LiDAR and field visits	-	-	M	M
Tyaak	0	• Nil	• Approx. 25 buildings have been identified (from 2015 aerial photography) • Dabyminga Creek flows through the town and commands a catchment area of approx. 60 square kilometres. • LiDAR ground information indicates that Dabyminga Creek is deeply incised and flooding of the urban areas is unlikely • Investigate flooding in a regional approach along Dry and Sunday creeks including its towns	-	-	H	L
Whiteheads Creek	1	• Whiteheads Creek and Overland Flood Mapping Study (Cardno, ongoing)	• Update MFEM • Flood zone and overlay controls required in planning scheme • Flash flood warning services needs consideration – Whitehead Creek Gauge exists	M	H	H	H

Moira Shire

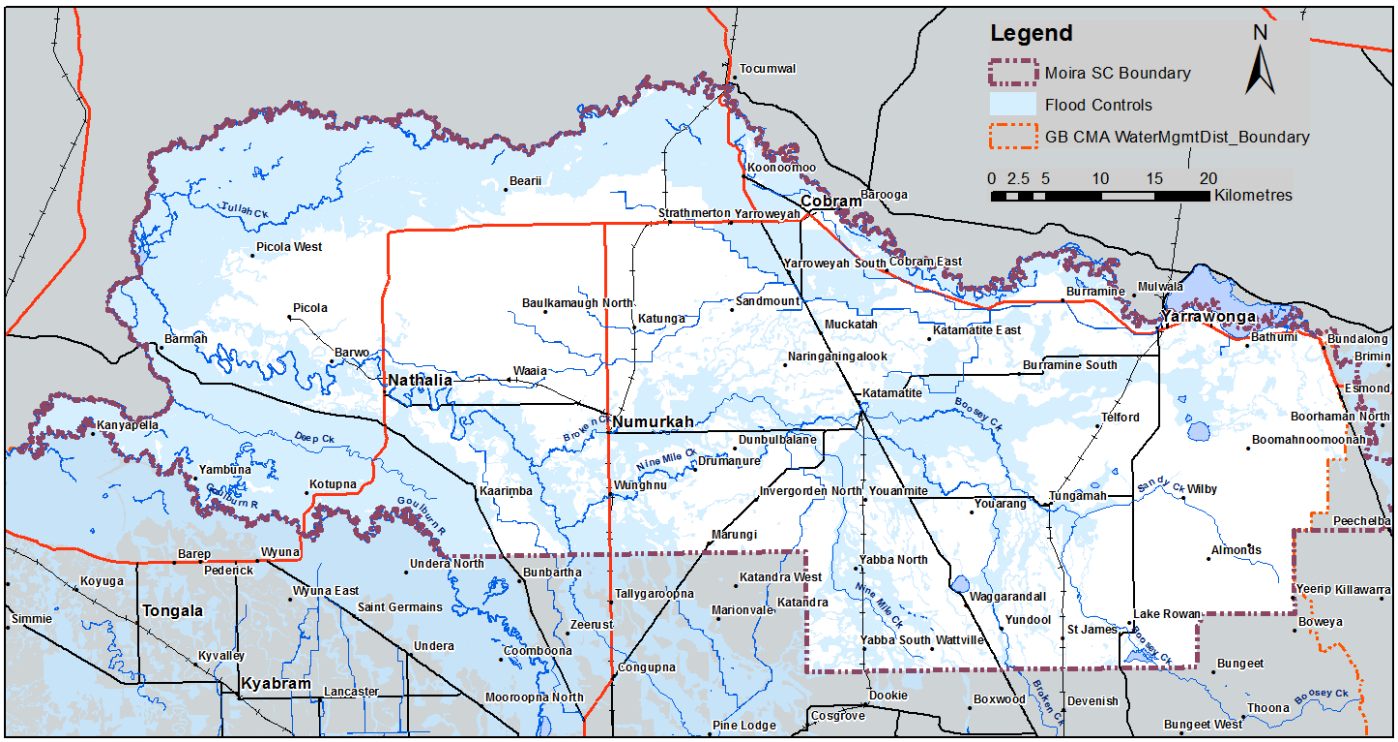


Figure 9. Moira Shire Council showing towns and planning scheme flood overlay controls

Table 1. Moira Shire risk assessment (ranking 1: low, and 5: high)
Draft priority rankings for stakeholder discussion: Low (L), Medium (M), High (H) and No Action (-) (for urban centres)

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Barmah	5	• Murray River Floodplain Management Study (GHD, 1986) • Flood Mitigation Study (GHD, 1994) • Lower Goulburn Floodplain Rehabilitation Scheme – Assessment of Flood Risk to the Township of Barmah and preliminary flood mitigation review (SKM, 2008) • Barmah Township Flood Mitigation – Functional Design (Water Technology, 2012) • 1% AEP Flood Contour Atlas available	• Flood mitigation unlikely to proceed given cost and impracticalities • Flood overlay controls are in the planning scheme • Prepare a FloodSafe Guide • Check to see MFEP requires updating with property listing available (use floor levels to assessment possible above floor flooding) • River gauge established with flood class levels and BoM flood warning service	L	-	-	-
Bearii	1	• Nil	• Approx. 60 buildings identified (from 2015 aerial photography) • Current flood overlay controls are of low reliability and new flood mapping would be part of combined regional flood mapping study, i.e. part of rural levee review • May consider future FloodSafe Guide	-	L	L	L
Cobram	5	• Murray River Floodplain Management Study (GDH, 1986) • Cobram Town Levees Study Final Design (CMPSF 1993) • Cobram Flood Mitigation Proposals Water Management Scheme Approved Scheme Document (NRE, 1996) • Murray River Regional Floodplain – Dicks/Seppelts levees to downstream of the Ulupna Creek Confluence Study Report (WT, 2011)	• Levee system constructed in mid-2000 to protect the Town from a 1% AEP flood • Further work required to explore flood protection options to protect town from overland flooding from the East • Flood overlay controls require updating (at regional level) • MFEP has been updated • Council recommitted to operate and maintain the levee scheme	H	-	-	-
Katamatite	2	• Documentation and Review of the 1993 Victorian Floods Volume 4 (HT, 1995) • FloodSafe Guide prepared (VicSES, 2015)	• Flood scoping study required	-	M	L	M
Koonoomoo	1	• Documentation and Review of the 1993 Victorian Floods Volume 4 (Hydro Technology, 1995) • Murray River Regional Floodplain – Dicks/Seppelts levees to downstream of the Ulupna Creek Confluence Study Report (WT, 2011)	• Approx. sixty buildings have been identified (from 2015 aerial photography) • MFEP has been updated • New food controls need to be implemented from regional flood study • Flood contour Atlas needs to be revised • Prepare FloodSafe Guide	-	-	L	L
Lake Rowan	0	• Nil	• Approx. 15 buildings have been identified (from 2015 aerial photography) • Located on the Boosey Creek floodplain • Flood overlay controls are required as evident by captured 2012 peak flood levels • Scoping flood study is required with a focus of improved flood mapping	-	-	H	L
Marungi	1	• Nil	• Approx. 10 buildings identified (from 2015 aerial photography) • No riverine type flooding identified • Limited low-lying land subject to localised drainage inundation shown in flood overlay controls in planning scheme • No further action	-	-	-	-
Nathalia	2	• Nathalia Flood Mitigation Report (SR&WSC, 1978) • Documentation and Review of the 1993 Victorian Floods Volume 4 (Hydro Technology, 1995) • Nathalia Flood Mitigation Scheme Audit Report (FIDS, 1996) • Broken Creek Management Strategy (SKM, 1998) • Nathalia Floodplain Management Plan (SMEC Victoria, 2005) • Detailed design (SKM?) • TFWS Investigation CT Management?	• Approx. eight kilometres of levees constructed in the late 1980s. • The levees system was upgraded and augmented in late 2000s, including temporary flood barriers • Council remains committed in managing the flood protection system • TFWS Implemented including new flow gauges, and new BoM prediction services • MFEP has been updated • FloodSafe Guide to be prepared • New flood mapping required in planning scheme (rural study area)	-	-	-	-

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Numurkah	5	• Documentation and Review of the 1993 Victorian Floods Volume 4 (Hydro Technology, 1995) • Broken Creek Management Strategy (SKM, 1998) • Numurkah Flood Study (WT, 2012) • Numurkah Floodplain Management Study (ongoing)	• Flood study component completed in 2014 • Further work to extend modelling is now underway • Mitigation options are currently being explored including structural works and TFWS • The MFEP has been updated and proved useful during 2016 floods • New flood zone and overlay controls are required • Flood contour Atlas needs updating	H	H	H	H
St James	1	• No flood study	• Approx. 45 buildings identified (from 2105 aerial photography) • New flood overlay controls are required as evident by captured 2012 peak flood levels • Scoping flood study is required	-	-	H	M
Tungamah	3	• 1% AEP Flood Declaration Project (RWC, 1984)	• Floodplain management study required	H	H	H	H
Waaia	0	• Nil • Significant Drainage Line Mapping within the SIR (GBCMA, 1998)	• Approx. 55 buildings have been identified (from 2015 aerial photography) • Not identified prone to riverine type flooding • Part of Waaia subject to drainage issues along natural drainage lines	-	L	L	L
Wilby	0	• Nil	• Approx. 55 buildings have been identified (from 2015 aerial photography) • Located on the Sandy Creek Floodplain • Flood overlay controls are required as evident by captured 2012 peak flood levels • Scoping Study is required	-	-	H	L
Wunghnu	3	• Nil	• Flood scoping study required	MH	M	M	M
Yarrawonga	4	• Murray River Floodplain Management Study (GDH, 1986) • Overland Drainage and Flood Study (BMT WBM, 2015)	• Local drainage options are being explored • New flood overlay controls are required • Flood contour Atlas needs updating	H	-	H	H

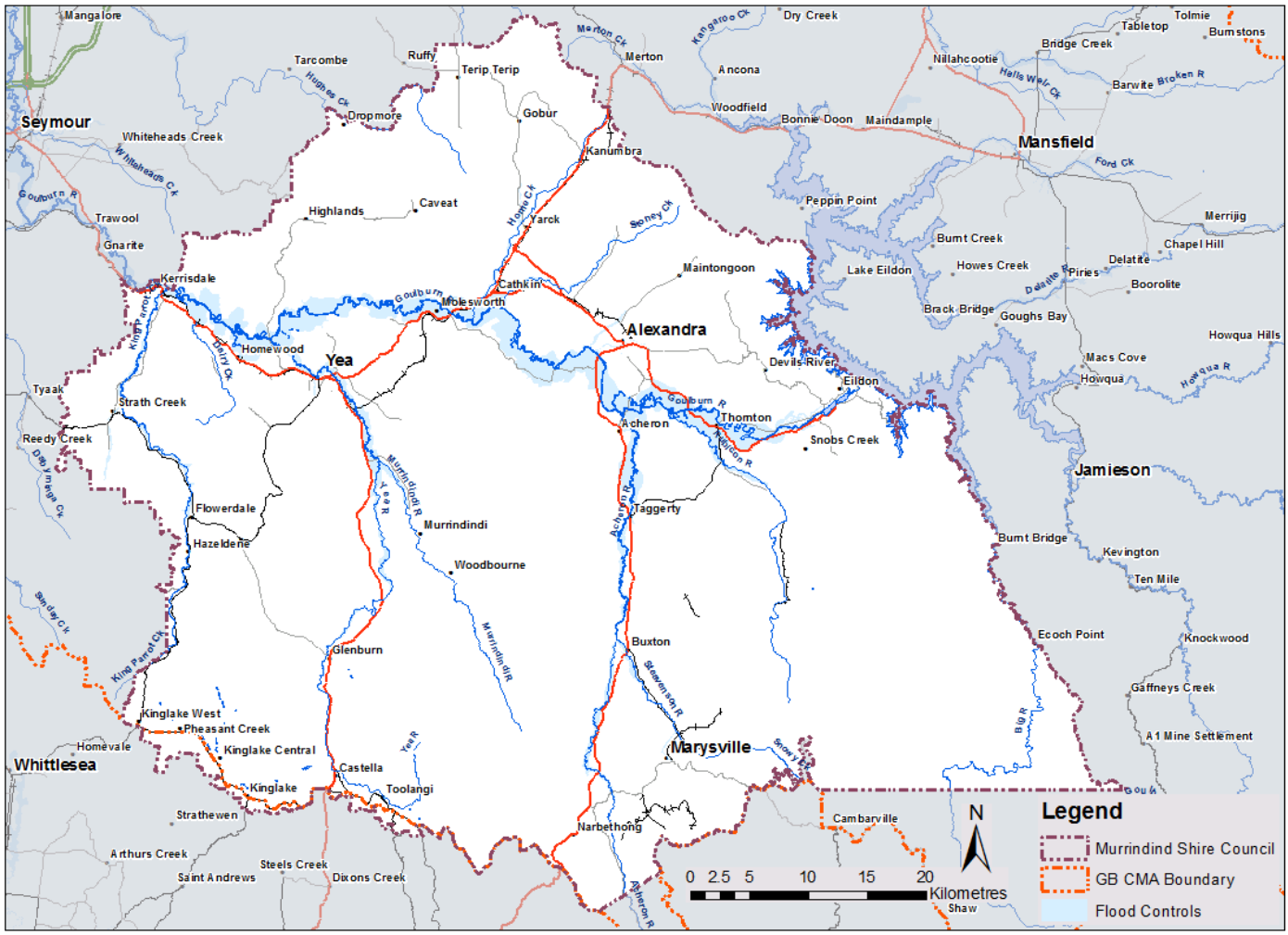


Figure 1. Murrindindi Shire Council area showing towns and planning scheme flood overlay controls

Table 1. Murrindindi Shire risk assessment (ranking 1: low, and 5: high)
Draft priority rankings for stakeholder discussion: Low (L), Medium (M), High (H) and No Action (-) (for urban centres)

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Alexandra	2	• Nil	• Flooding occurred from UT creek in 1975 that forms the bench mark for land use planning. This is the current basis of overlay controls in the planning scheme • Overland flooding has been experienced in the town particularly from a tributary north west of town • Riverine and overland flood study required	L	-	H	H
Buxton	3	• Acheron River Flood Hydrology Study (BMT WBM, ongoing)	• Floodplain Management Study required	M	M	H	H
Eildon	0	• Nil	• There are two waterways that flow through the town that have catchments under five square kilometres. Furthermore, the waterways traverse through wide open-spaced corridors. • There are some minor drainage lines that feed stormwater to the waterways • There are no current identified riverine flooding issues • Overland flooding associated with drainage lines is unknown • Consider overland flood study • BoM flood warning products such as Flood Watch is possibly the only feasible product given no warning times	-	-	L	L
Kinglake Central	0	• Nil	• The town is located at the very top of the Great Dividing Range, and has some minor waterways have small catchments that are deeply incised. As such, there are no identified riverine or overland type flooding issues. • No further action	-	-	-	-
Kinglake East	0	• Nil	• The town is located at the very top of the Great Dividing Range, and has waterways commanding small catchments that are deeply incised. As such, there are no identified riverine or overland type flooding issues. • However, several drainage lines have been identified that drain into the waterways • These drainage lines may have some overland flood issues • Overland flood study should be considered • BoM flood warning products such as Flood Watch is possibly the only feasible product given no warning times	-	-	L	L
Marysville	1	• Acheron River Flood Hydrology Study (BMT WBM, ongoing)	• Floodplain Management Study required	-	-	M	M
Molesworth	1	• Eildon to Murchison Flood Modelling Project - Goulburn River GPU Model Documentation (Water Technology, 2015 – internal document)	• Approx. 25 buildings have been identified (from 2015 aerial photography) in the town and a caravan park located on further north adjacent to the Goulburn River and are affected by depths of flooding up to 500 mm for a 1% AEP type flood. • Scoping study required (with floor level survey), with finding linked to the MFEP • Flood warning opportunity needs to be explored	-	L	M	M
Narbethong	0	• Nil	• This town is largely undeveloped and rural in nature with approx. 20 buildings • Minor deeply incised waterways traverse the town, which commands catchment areas of around five square kilometres. • There are no identified riverine or overland flooding issues • No further action	-	-	-	-
Pheasant Creek & Kinglake West	0	• Nil	• Both towns are located at the very top of the Great Dividing Range • There are numerous waterways throughout the towns and likely to be associated some overland flooding. • Overland flood study required • BoM flood warning products such as Flood Watch is possibly the only feasible product given little or no warning times	-	-	L	L
Strath Creek	1	• Nil	• The waterway of Strath Creek runs along the western edge of the hamlet and commands a catchment of approx. 62 square kilometres.	-	-	L	L

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
			• Approx. 25 buildings have been identified (from 2015 aerial photography) in the town that appears to be somewhat elevated. Flood risk is not clear • Carry out a regional flood mapping study that includes this town				
Taggerty	1	• Acheron River Flood Hydrology Study (BMT WBM, ongoing)	• Floodplain Management Study required	-	L	H	M-H
Thornton	3	• Eildon to Murchison Flood Modelling Project - Goulburn River GPU Model Documentation (Water Technology, 2015 – internal document)	• Approx. 30 out of an estimated 110 buildings (from 2015 aerial photography) are affected by depths of flooding up to 500 mm for a 1% AEP type flood. Also, the caravan park is partial impacted • Scoping study required (with floor level survey) to inform the MFEP i.e. property listings relating to over floor flooding	-	-	-	M
Toolangi	0	• Nil	• Yea River runs north of the town and is deeply incised • There are no identified riverine of overland flooding issues • No further action	-	-	-	-
Yea	2	• Yea Flood Study (Water Technology, 2005)	• Flood zone and overlays incorporated into planning scheme • MFEP has been updated • The main issue for Yea is the caravan park exposed to flood hazard • Flood Warning Prediction Service is now available at Yea's new gauge (2016). Further work is now required to link new gauge to flood mapping intelligence to MFEP • FloodSafe Guide has been released (check) • In 1973 a major storm over the town created major overland flooding issues • Carry out an overland flood study	-	-	-	H

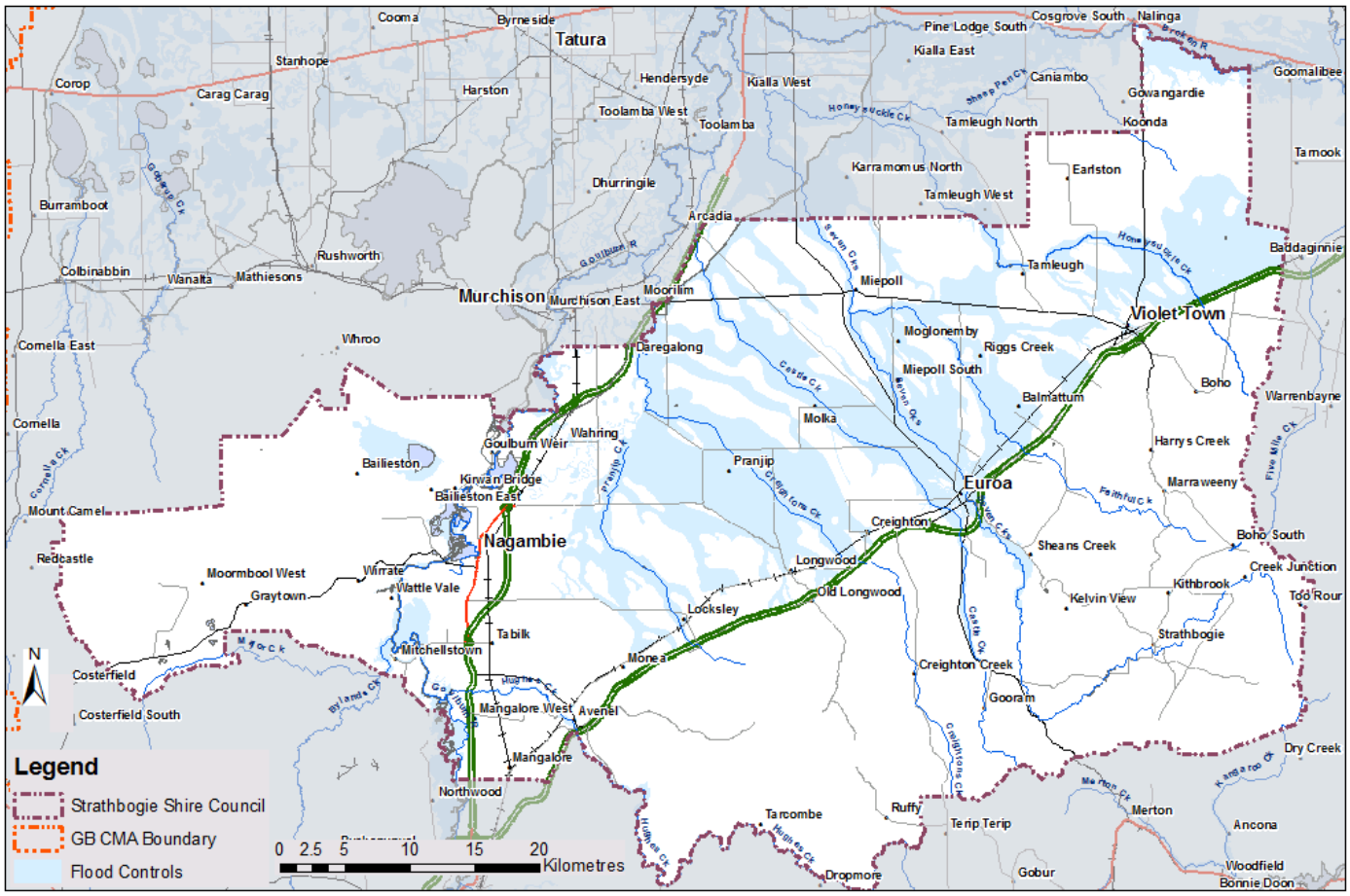


Figure 1. Strathbogie Shire Council area showing town localities and existing flood controls

Table 1. Strathbogie Shire risk assessment (ranking 1: low, and 5: high)
Draft priority rankings for stakeholder discussion: Low (L), Medium (M), High (H) and No Action (-) (for urban centres)

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Avenel	2	• Internal Rural Water Commission file used by GB CMA to prepare 1% AEP flood contours (Flood Atlas) for Hughes Creek together with infield flood overlay controls for planning scheme inclusion. • Granite Creek Regional Flood Mapping Study (check name) (Water Technology, ongoing)	• Update flood zone and overlay controls in planning scheme • Update 1% AEP flood contours in Flood Atlas • Flood scoping study required to assess flood warning needs and emergency planning	M	M	H	M
Euroa	4	• Euroa Flood Study – Final Report (CMPSF, 1993) • Euroa Flood Study – Hydraulic Assessment (Lawson & Treloar 1997) • Euroa Floodplain Management Study - 2 volumes (SKM, 1997). • Total Flood Warning System (CT Management 1997) Check • Euroa Water Management Scheme (Steering Committee, 1999) • Urban Levee Review (SKM, 2013) • Euroa Post Scheme Flood Mapping Study (Cardno, 2014) • Levee Upgrade Report (GMR, 2016 – ongoing)	• Total Flood Warning System implemented (need better access to flood data by community) • Flood warning services are provided by BoM • Water Management Scheme Implemented by Council including formalising the Castle Creek levee and waterway/floodplain vegetation thinning. Note that vegetation thinning along the Seven Creeks were achieved by significant exotic tree and weed removal as part of river health program by GB CMA • Flood zone and overlay controls in place but require some revision based on latest Study • 1% AEP flood contours declared and part of Flood Atlas but need to be revised based on latest Study • Property-specific flood information should be rolled out • Castle Creek levee refurbishment required to ensure 1% AEP performance • Monitoring action plan required to manage sand slugs under rail and Old Hume bridge structures • Council remains committed for manage the water management scheme	H	H	H	H

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Graytown	0	• Nil	• A waterway, with a 26 square kilometre catchment, flows west of the town with small localised drainage lines through the settlement • The area is largely undeveloped and rural in nature • Less than ten buildings identified from available aerial photography • Possible scoping study required	-	-	L	L
Locksley	1	• Granites Creek Regional Flood Mapping Project (Water Technology, ongoing)	• Pranjip (Burnt) Creek commends a catchment of some 36 square kilometres • LiDAR ground level data and flood mapping indicates some 25 buildings (identified from 2015 aerial photography) are on high land above the estimated 1% AEP flood levels. • Update flood overlay controls in planning scheme • Flood warning requirements may rely on BoM flood watch products	-	-	M	L
Longwood	2	• Nil	• Some 100 building exists (from 2015 aerial photography) • LiDAR ground level data suggest some possible exposure to flood risk • Some broad-brush mapping included in planning scheme • Scoping flood Study required	-	-	L	L
Mangalore	0	• Nil	• Eight Mile Creek commands a catchment area of some 10 square kilometres that passes the town to the north. A smaller waterway flows south of the town • No detailed ground level information is available • Major storms passed over the area in early 2016 but the flood impact is unknown • Scoping study is required	-	L	M	L
Nagambie	1	• Flood Risk Assessment for Chinaman's Caravan Park (SKM, 1999) • Nagambie Flood Study – Draft Hydraulics Report (BMTWBM – ongoing)	• Flooding of Low-lying areas including Tabilk Depression identified • Flood zone and overlay controls are required in planning scheme • MFEP needs updating • Flood warning requirements may rely on BoM's Flood Watch products	-	-	H	H
Old Longwood	0	• Nil	• Largely undeveloped with few buildings • Winding Creek flows west of town commanding a catchment of some ten square kilometres • A small drainage line identified through the town flowing west to east • Rely on available BoM's products such as Flood Watch • Possible scoping study	-	-	L	L
Ruffy	0	• Nil	• Small waterway flows east of town commending a catchment of some three square kilometres • Possible localised drainage issues rather than riverine type flooding • No further action	-	-	-	-
Strathbogie	0	• Nil	• Some sixty buildings exist in the town (identified from 2015 aerial photography) • Spring, Magiltans and Seven Creeks flow through the town. • LiDAR ground level data reveals that these creeks are deeply incised and unlikely to create flooding issues. • Possible scoping study require to determine flood extents	-	-	L	L
Violet Town	4	• Violet Town Flood Scoping Study – Final Report (GHD/GEO ENG, 2002) • Violet Town Flood Study (Water Technology, 2007) • MFEM Updated Drafted (2011) • Flood Warning arrangements (GMR, 2011) • Violet Town Floodplain Management Plan (2012, Water Technology) • Violet Town Floodplain Management Scheme (2012, Water Technology) • Detail design for civil mitigation works (GMR Engineering – ongoing) • FloodSafe Guide prepared	• Flood zone and overlay controls prepared and not yet in planning scheme (await the implementation of mitigation works) • 1% AEP flood in Flood Atlas online • Flash flood arrangements have been formulated but not implemented • FloodSafe guide distributed • Community negotiation on civil mitigation works are continuing • MFEM updated	H	H	H	-

Regional (rural study) areas

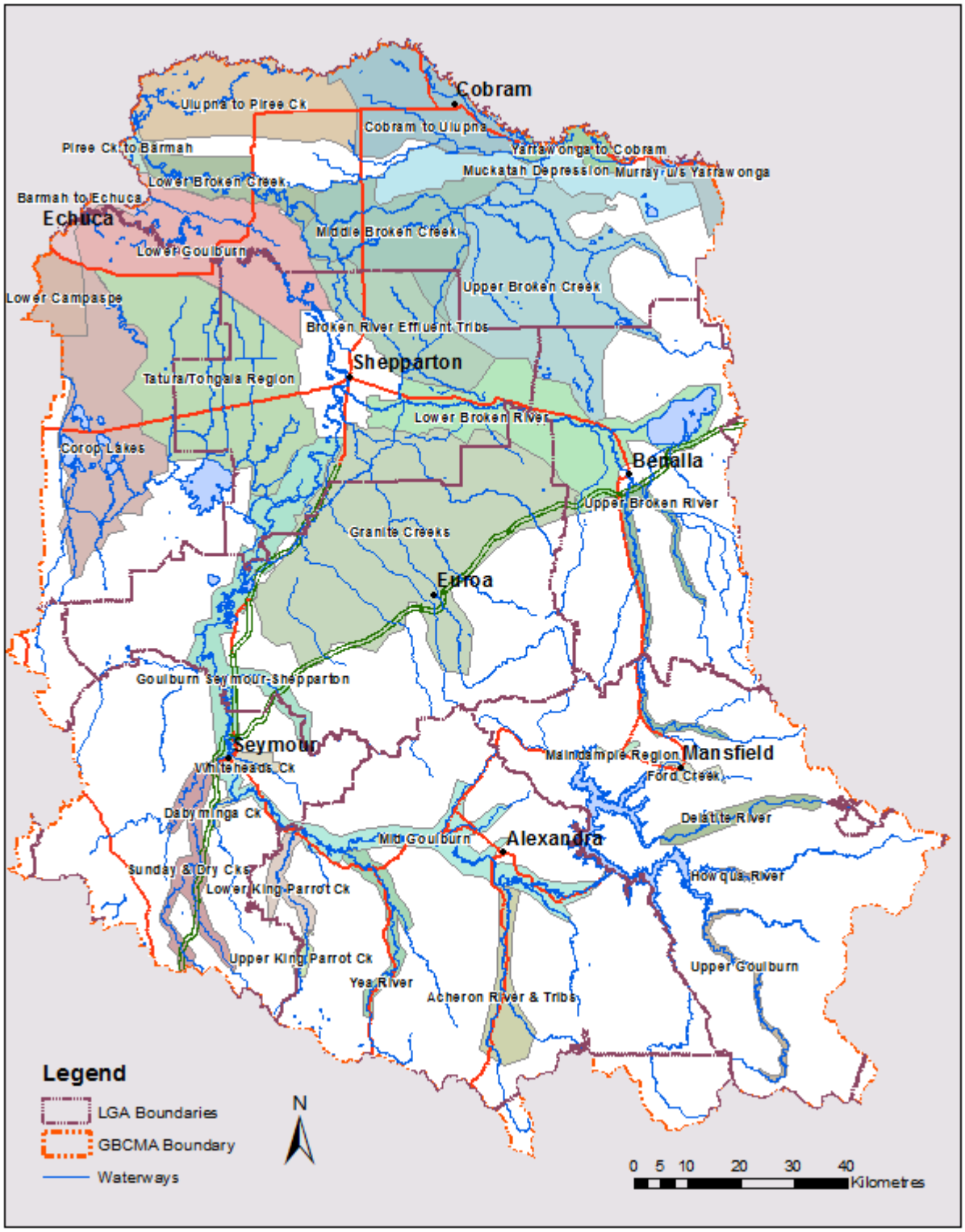


Figure 1. Showing rural study areas

Table 2. Rural study areas risk assessment (ranking 1: low, and 5: high)
Draft priority rankings for stakeholder discussion: Low (L), Medium (M), High (H) and No Action (-)

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Broken Creek							
Broken Effluent Tributaries (Pine Lodge, Daintons, Congupna Guilfus & O'Keefe Creek)	5	• Documentation and Review of the 1993 Victorian Floods Volume 4 (Hydro Technology, 1995) •	• Flood overlay controls exist in the planning scheme based on flood information from 1993, which is a reference flood for the 1% AEP flood • MFEP updated for towns within the regional area (Congupna and Tallygaroopna) • A regional flood study is unlikely to improve flood knowledge for the 1% AEP type flood. However, it may be warranted to explore flooding patterns for a range for flood magnitudes to improve flood intelligence and mapping warning information	-	M	L	M
Lower Broken Creek	5	• Documentation and Review of the 1993 Victorian Floods Volume 4 (Hydro Technology, 1995) • Broken Creek Management Strategy Part 1 - 2 volumes (Sinclair Knight Merz, 1996) • Broken Creek Management Strategy Part 2 - 2 volumes (Sinclair Knight Merz, 1996) • Nathalia Floodplain Management Plan (SMEC Victoria, 2005) include regional mapping from Walshs Bridge to Narioka • Nathalia Floodplain Management Study (SMEC, 2005)	• New mapping to be incorporated into the planning scheme. • Inventory of levees completed in 2005 as part of Nathalia Floodplain Management Study • Regional mapping between Narioka and the Murray River could be carried out but considered a low priority. • Implication of flood warning to Nathalia will be of a benefit to downstream areas regional areas to the Murray.	-	M	H	H
Mid Broken Creek	5	• Broken Creek Management Strategy Part 1 - 2 volumes (Sinclair Knight Merz, 1996) • Broken Creek Management Strategy Part 2 - 2 volumes (Sinclair Knight Merz, 1996) • Numurkah Floodplain Management Study – Includes regional mapping from Broken Creek Katamatite to Walshs Bridge stream gauges (Water Technology, ongoing)	• Flood overlay controls exist in planning schemes that require updating • New flood height prediction services are currently being explored by the BoM to Numurkah • Draft MFEP has been prepared	H	H	H	H
Muckatah Depression	3	• Documentation and Review of the 1993 Victorian Floods. Volume 4 – Broken River (HydroTechnology, 1995) • Broken Creek Management Strategy Part 1 - 2 volumes (Sinclair Knight Merz, 1996) • Broken Creek Management Strategy Part 2 - 2 volumes (Sinclair Knight Merz, 1996)	• Flood overlay controls exist in planning scheme • Could carry out a rural flood study to better define flood intelligence and mapping • See further comments in the "Upper Broken Creek"	-	L	L	L
Upper Broken Creek	4	• Broken Creek Management Strategy Part 1 - 2 volumes (Sinclair Knight Merz, 1996) • Broken Creek Management Strategy Part 2 - 2 volumes (Sinclair Knight Merz, 1996)	• A regional study is required that will include numerous townships – refer to Moira Shire risk assessment for "urban centres" • Stream gauge exist in Tungamah • The 1996 Study highlights land management practices has altered drainage within the region. Land management practices needs to be managed • Rural drainage plan required to address both drainage and water quality (not necessary part of the floodplain management strategy)	-	M	H	M
Broken River							
Lower Broken River	5	• Documentation and Review of the 1993 Victorian Floods Volume 4 (Hydro Technology, 1995)	• Flood mapping is poor downstream of Benalla to Stewarton • New flood study required to improve flood intelligence and mapping. This would provide information of flow patterns (including flow distribution into both the upper and lower Broken Creek study areas, and provide intelligence for flood warning and emergency management	-	L	H	H
Upper Broken River	2	• Some rural flood mapping and flood level capture • Design Flood Hydrology for the Goulburn and Broken River Catchments (Jacobs, ongoing)	• This rural study area includes Holland Creek • Some flood overlay controls exist in planning schemes • A regional flood intelligence and flood mapping study is required, which can include the towns outlined in the "urban centres" Note the assessment of urban centre at a regional rural scale may provide preliminary insight before deciding to carry out a full flood study	-	M	H	M
Goulburn System							
Acheron River	2	• Acheron River Flood Hydrology Study (BMT WBM, ongoing)	• Some flood overlay controls exist in the planning scheme but based on limited information • Stream gauge is established in Buxton with flood prediction services provided by BoM	-	L	H	L

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Goulburn System (cont.)							
Corop Lakes	5	• Corop Lakes Scoping Study (GHD, 2012)	• Flood overlay controls exist in the planning. Minor improvements could be included east of Colbinabbin. • Flood warning arrangements between GMW and community are in place	-	-	L	L
Dabyminga Creek	1	• Tallarook Flood Study (GB CMA, 2008) extends into this regional area	• Flood mapping required to be updated in the planning scheme • New regional flood study may be carried out but should be extended to include Tyaak and Reedy Creek • No current buildings known to be at risk to over floor flooding	-	L	H	L
Delatite River	2	• Design Flood Hydrology for the Goulburn and Broken River Catchments (Jacobs, ongoing) • Desktop flood mapping completed for 2016 flood overlays using limit recorded peak 2010 flood level and LiDAR ground information	• Regional flood study required to improve flood intelligence and flood mapping utilising hydrologic data from current Jacobs study	-	L	L	M
Ford Creek	1	• Mansfield Flood Intelligence and Mapping Study (GB CMA, 2014) • Design Flood Hydrology for the Goulburn and Broken River Catchments (Jacobs, ongoing)	• Regional flood mapping required to improve flood intelligence and mapping to assist with future long-term growth around Mansfield	-	L	H	M
Seymour to Shepparton	5	• Documentation and Review of the 1993 Victorian Floods. Volume 1 – Summary Report (Hydro Technology, (1995) • Declaration of 1% AEP flood level	• Flood mapping exists in planning schemes but found to be inaccurate in some areas • Requires regional flood study including operations of Nagambie Weir	-	M	M	M
Granite Creeks	5	• Granite Creeks Regional Flood Study (Water Technology, ongoing)	• Flood overlay mapping exist in planning schemes • Planning schemes will need to be updated following completion of the regional flood study	-	L	M	M
Howqua River	1	• Design Flood Hydrology for the Goulburn and Broken River Catchments (Jacobs, ongoing)	• Regional flood modelling required following the completion of design hydrology report	-	L	L	L
Lower Goulburn	5	• Inquiry into the Lower Goulburn River (Parliamentary Inquiry, 1968) • Lower Goulburn Floodplain Management Study – 2 volumes (Cameron McNamara (1987) • Documentation and Review of the 1993 Victorian Floods Volume 5 (Hydro Technology, 1995) • Lower Goulburn Waterway and Floodplain Management Plan – 2 volumes (Sinclair Knight Merz, 1996) • Lower Goulburn Levee Audit (SMEC, 1998) • Lower Goulburn Business Case Summary (PricewaterhouseCoopers, 1998) • Lower Goulburn Modified Findlay Scheme (SMEC, 1999) • Lower Goulburn Floodplain Rehabilitation Scheme – 2 Volumes (Water Technology, 2005) • Rural Levee Assessment (Water Technology, 2013)	• Flood mapping products exist that should be integrated into planning schemes. • A flood intelligence map exists relative to the Shepparton and McCoys Bridge river gauges. • The Lower Goulburn Floodplain Rehabilitation Scheme project was abandoned in 2005 following no funding agreement • Requires community workshop to specifically address its willingness to re-examine management options including operation and maintenance costs associated with the lower Goulburn levees • Flood warning arrangements are in place at the Shepparton Gauge that provides adequate warning to the lower Goulburn. Also, Goulburn Murray Water has arrangements in place for those within the Loch Garry Flood Protection District	M	-	H	H
Lower King Parrot Creek	1	• Nil • 1% AEP flood levels has been estimated based on a limited number of recorded peak flood levels. Rural flood.	• Flood overlay controls exist in the planning scheme, based on limited information. • A regional flood study would improve flood intelligence and mapping. Ground LiDAR exists that would be used to carry out such a study • The area is mostly rural in nature with pockets of rural living along the creeks	-	L	L	L
Maindample Region	1	• Nil	• Flood mapping was carried out by on-site inspections around Maindample • Inspection of aerial photograph indicate few buildings within the rural areas that surrounds Maindample • A regional flood study is not considered warranted	-	-	-	-
Mid Goulburn	5	• Goulburn Broken Flood Atlas of 1% AEP flood contours (GB CMA, 2005) • Memo - Eildon to Murchison Flood Mapping Project (Water Technology, 2015) • Total Flood Warning System	• Flood overlay controls exist in planning schemes that requires updating • Flood Atlas requires updating • Total Flood Warning System implemented in 2000 with forecasts to Seymour. Community guides were also prepared • Review flood guides to new FloodSafe format	-	M	H	M

Goulburn System (cont.)

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Sunday & Dry Creeks	1	• Some rural flood mapping and peak flood level capture • No detailed flood studies	• Some flood overlay control exist in the planning scheme • This regional study area would include the townships of Wandong, Heathcote Junction, Kilmore East, Coulson Crossing, Waterford Park and Broadford	-	H	H	H
Tatura/ Tongala Region	5	• Flooding of Tongala-Stanhope Irrigation District – March 1950	• The nature of flooding is largely contained within a series of depression systems • Flood overlay controls exist in planning schemes • A regional flood study is not warranted as it would be unlikely to provide any significant new flood knowledge	-	L	L	L
Upper Goulburn	1	• Design Flood Hydrology for the Goulburn and Broken River Catchments (Jacobs, ongoing)	• This area is between Jamieson to Woods Point • Regional flood study could be carried out using hydrologic data from study	-	M	M	M
Upper King Parrot Creek	1	• Flowerdale Flood Study – Flood Intelligence and Mapping (GB CMA, 2014)	• Flood overlay controls exist in planning schemes, but should be updated to reflect flood study findings • MFEP should also reflect study findings • Flood warning requirements needs to be explored	-	M	H	H
Whiteheads Creek	1	• Whiteheads Creek Flood Study (Cardno, ongoing)	• Flood mapping controls exist in the planning scheme • The current study includes overland flood mapping • Flood warning is less than 6 hours. A local warning system needs to be explored	-	H	H	H
Yea River	1	• Yea Flood Study (Water Technology, 2005) • 1% AEP flood levels are currently estimated by adding a margin (determined by NRE) to historic profiles of a moderate flood.	• Regional Flood Study would greatly improve flood intelligence and mapping	-	I	M	M
Murray System							
Barmah to Echuca	4	• Murray River Floodplain Management Study (GHD, 1986) • Lower Goulburn Floodplain Rehabilitation Scheme (Water Technology, 2005) • 1% AEP Flood Contour Atlas available	• Stream gauges are established in Barmah and Echuca with flood class levels • Flood overlay controls exist in planning schemes, but needs to be updated with new mapping from the 2005 study • The regional study area includes Echuca Village and Lower Moira (Woodbine Drive) • Further work around flood warning products would be useful	-	M	L	M
Cobram to Ulupna	5	• Murray River Floodplain Management Study (GHD, 1986) • Murray River Regional Floodplain Study – Dicks/Seppelts levees to downstream of Ulupna Creek Confluence Study Report (Water Technology, 2011) • Rural Levee Assessment (Water Technology, 2013)	• Flood overlay controls exist in the planning scheme, but needs to be updated with new information • A number of stream gauges exist where the BoM will issue flood warnings. Need to review MFEP for regional study area in light of 2016 floods – document weak levees • Require community workshop to specifically address its willingness to examine a project to include operation and maintenance costs of the rural levees	M	M	H	M
Piree Creek to Barmah	1	• Murray River Floodplain Management Study (GHD, 1986) • Barmah-Millewa Hydrodynamic Model (Water Technology 2005) • Rural Levee Assessment (Water Technology, 2013)	• Flood overlay control exists in the planning scheme • Extend the Murray River Regional Floodplain Study from Ulupna to Barmah to improve flood intelligence and mapping • Require community workshop to specifically address its willingness to examine a project to include operation and maintenance costs of the rural levees	-	M	L	M
Ulupna to Piree Creek	3	• Murray River Floodplain Management Study (GHD, 1986) • Rural Levee Assessment (Water Technology, 2013)	• Join this regional study area with Murray Piree Creek to Barmah				
Upstream of Yarrawonga	1	• Murray River Floodplain Management Study (GHD, 1986)	• Flood overlay control exists in planning scheme • This section of the river is mostly within the confines of Lake Mulwala • Regional flood study would be unlikely to bring substantial new flood knowledge	-	L	L	L
Murray System (cont.)							

Name	AAD	Summary of past and existing studies	Summary of implemented study recommendations (Other comments)	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Yarrawonga to Cobram	2	• Murray River Floodplain Management Study (GHD, 1986) • No detailed flood study exists	• Flood overlay control exists in the planning scheme • Flooding is largely confined within the Murray Valley until Cobram East • Regional flood study required to gained flood intelligence and mapping	-	H	M	H

Appendix C: Program logic for program delivery

The logic for the four long-term programs outlined in **Section1.5** are

- Flood Mitigation (refer to **Figure C-10**);
- Total Flood Warning Systems (refer to **Figure C-11**);
- Land-use Planning (refer to **Figure C-12**); and
- Emergency Management and Access to Flood Information (refer to **Figure C-13**).

In preparing this regional Strategy with stakeholders it has become apparent that the four programs considerably overlay. For instance, the access to flood information not only applies within the emergency management program but is very much a large part of TFWS where access to fit for purpose flood information can provide important education and awareness material to ensure flood resilience. As such, a new program logic for the access to, and sharing of flood information has been developed (see **Figure C-14**).

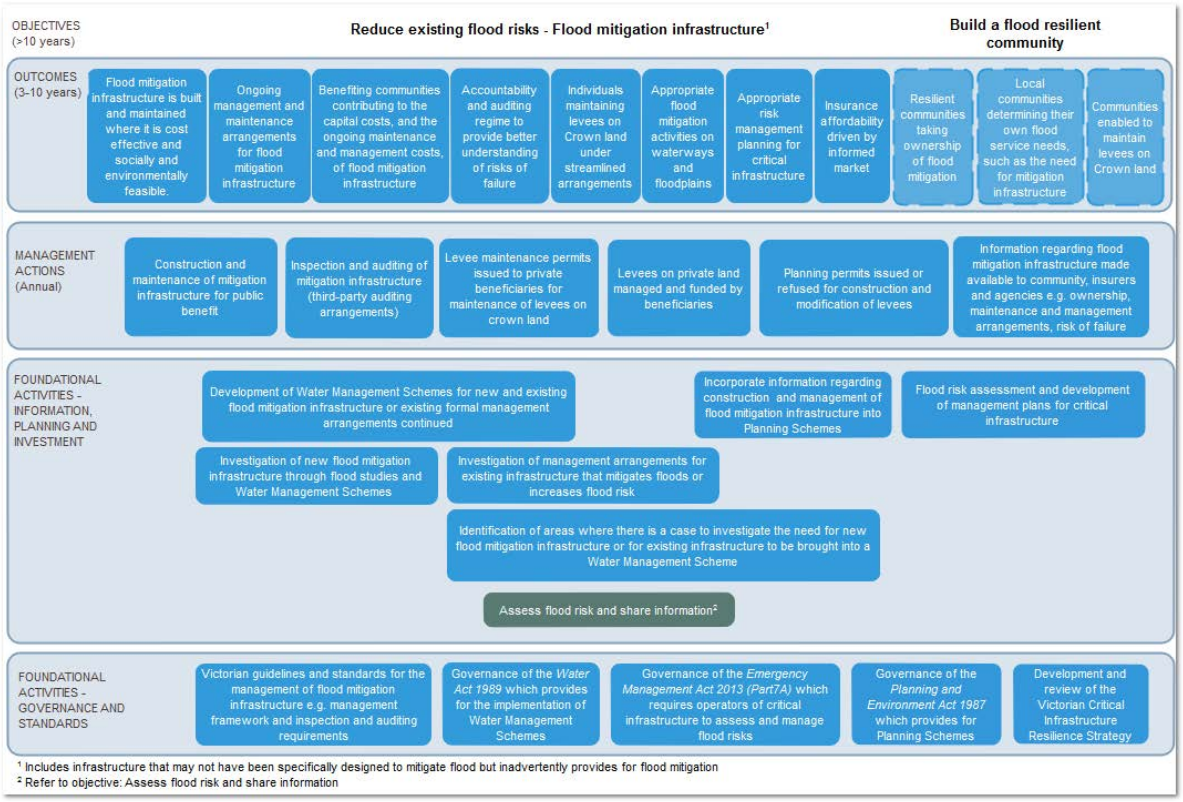


Figure C-10: Program logic for flood mitigation program

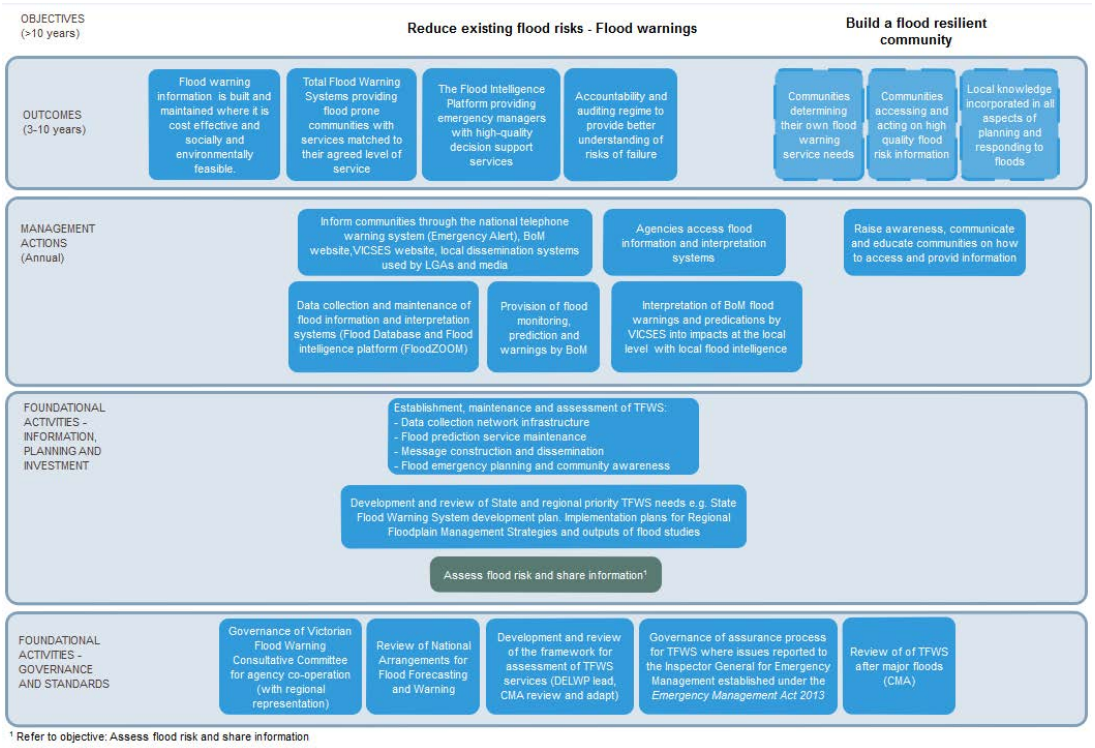


Figure C-11: Program logic for Total Flood Warning Systems

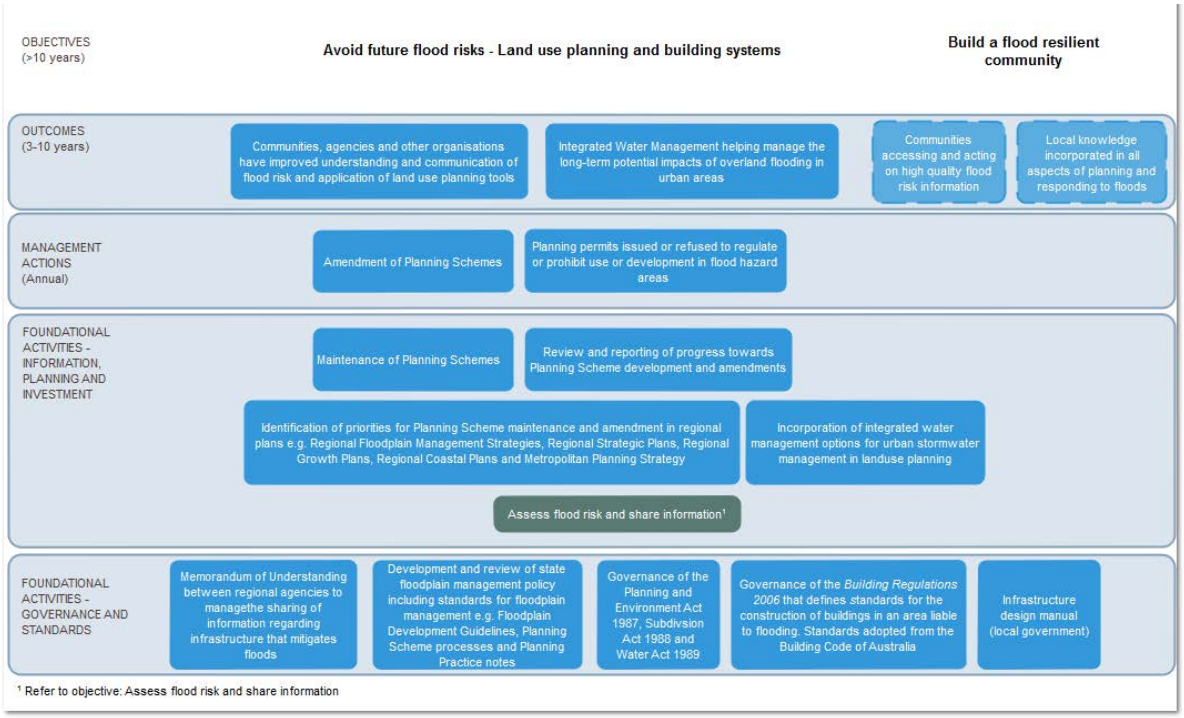


Figure C-12: Program Logic for land-use planning

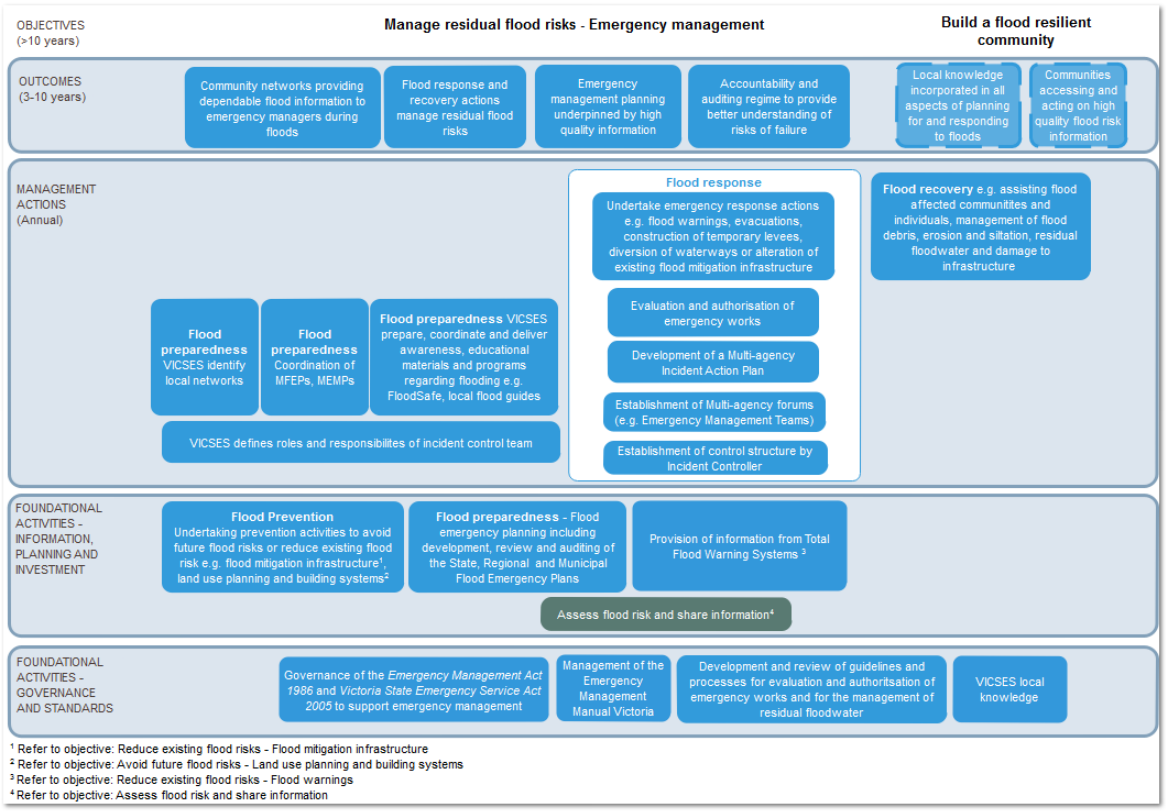


Figure C-13: Program logic for emergency management

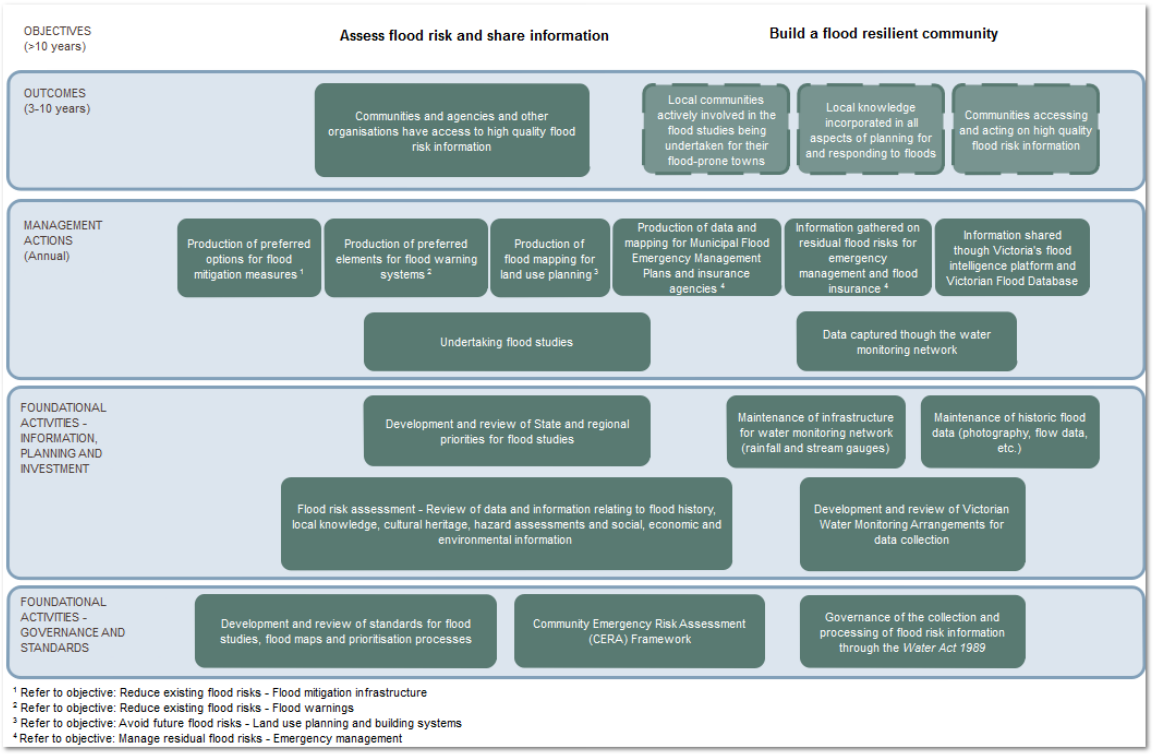


Figure C-14: Program logic for sharing of flood information

Appendix D: Summary of Flood Studies, Plans, Work Plans

Table D-18: List of completed scoping studies

Scoping Studies

1. Shepparton Mooroopna Flood Scoping Study (1998)
2. Jamieson Flood Scoping Study (SKM, 2003)
3. Violet Town Flood Scoping Study (GHD, 2002)
4. Corop Lakes Flood Scoping Study (GHD, 2012)

Table D-19: List of completed flood studies

Flood Studies

1. Broken Creek Management Study Stages 1 & 2 (SKM, 1998)
2. Flood Risk Assessment for Chinaman's Bridge Caravan Park (1999)
3. Seymour Floodplain Mapping Study (WBM Oceanics Australia, 2001)
4. Seymour Floodplain Mapping Study Addendum to Final Report – Whiteheads Creek Flood Mapping (WBM Oceanics Australia, 2001)
5. Lower Goulburn Rehabilitation Project Socio-economic Issues Assessment (Earth Tech, 2002)
6. Yea Flood Study (Water Technology, 2005)
7. Merrigum Flood Study (WMB Oceanics Australia, 2005)
8. Mansfield Flood Study (Earth Tech, 2005)
9. Barmah-Millewa Forest Hydrodynamic Model Study (Water Technology, 2005)
10. Lower Goulburn Floodplain Rehabilitation Project Hydraulic Modelling Report (Water Technology, 2005)
11. Lower Goulburn Floodplain Study Geomorphology (SKM, 2006)
12. Lower Goulburn Floodplain Rehabilitation Scheme Addendum A Hydraulic Performance of the Engineered Option 2 (Water Technology, 2006)
13. Mansfield Flood Study Extension (Earth Tech, 2006)
14. Tatura Floodplain Management Study (WBM Oceanics Australia, 2006)
15. Violet Town Flood Study (Water Technology, 2007)
16. Lake Nillahcootie Flood Study (Cardno, 2008)
17. Tallarook Flood Investigation (Goulburn Broken CMA, 2008)
18. Barmah-Millewa Hydrodynamic Modelling Model Re-calibration (Water Technology, 2009)
19. Goulburn River Environmental Flows Hydraulics Study (Water Technology, 2010)
20. Murray River Regional Flood Study - Dicks/Seppelts levees to downstream of the Ulupna Creek confluence (Water Technology, 2011)
21. Rural Levee Assessment (Water Technology, 2013)
22. Flowerdale Flood Intelligence and Mapping Study (GBCMA, 2014)
23. Mansfield 1% AEP Flood Mapping Project (GBCMA, 2014)
24. Murchison Flood Mapping Study Report (Water Technology, 2014)
25. Eildon to Murchison Flood Modelling Project GPU Documentation (Water Technology, 2015)
26. Flood Assessment of Irrigation Infrastructure in the Goulburn Murray Irrigation District (Goulburn Broken & North Central CMAs, 2016).
27. Shepparton East Overland Flow Urban Flood Study (BMT WBM, 2017)
28. Design Flood Hydrographs for the (Upper) Goulburn and Broken River Catchments (Jacobs, 2017)
29. Nagambie Flood Study (BMT WBM, 2017)
30. Shepparton Mooroopna Flood Mapping and Intelligence Study (Water Technology, Ongoing)

31. Granite Creeks Regional Flood Mapping Study (WT, Ongoing)
32. Kilmore Flood Study (BMT WBM, Ongoing)
33. Flood Study of the Goulburn and Broken Rivers (Ongoing)
34. Whiteheads Creek Catchment Flood Mapping Project (Cardno, Ongoing)
35. Acheron River Flood Hydrology Study (Jacobs, Ongoing)
36. Sunday and Dry Creek Regional Flood Mapping Study (yet to be announced)

Table D-20: List of completed Floodplain Management plans

Floodplain Management Studies

1. Euroa Floodplain Management Study (1997)
2. Lower Goulburn Waterway and Floodplain Management Plan and Supporting Document (SKM, 1998)
3. Lower Goulburn Floodplain Rehabilitation Scheme Modified Findlay Scheme (SMEC, 1998)
4. Lower Goulburn Floodplain Rehabilitation Scheme Business Plan (Summary) (PcW, 1999)
5. Lower Goulburn Levee Audit Report Main Report and Appendices (1999)
6. Shepparton Floodplain Management Study (Stage 1 and 2) (SKM, 2002)
7. Benalla Floodplain Management Study (Cardno Willing, 2002)
8. Nathalia Floodplain Management Plan (SMEC, 2005)
9. Seymour Flood Mitigation Communication Investigation (WBM Oceanics Australia, 2006)
10. Assessment of Flood Risk to the Township of Barmah and Preliminary Flood Mitigation Review (Water Technology, 2008)
11. Benalla: Review of Floodplain Management Works (2009)
12. Violet Town Floodplain Management Scheme (Water Technology, 2012)
13. Yarrawonga Flood Management & Drainage Master Plan (BMT WBM, 2013)
14. Euroa Post Flood Mapping and Intelligence Project (Cardno, 2015)
15. Numurkah Floodplain Management Study (Water Technology, 2017)

Table D-21: List of flood (mitigation implement actions

Flood (Mitigation) Implementation Actions

1. Murray River Levee Works Program Design and Construct Programs (1998-2002)
2. Euroa Water Management Scheme Technical Report (1999)
3. Euroa Water Management Scheme (FPM Plan) (2000)
4. Cobram urban levees upgrade (SKM, 2003)
5. Water Management Scheme Benalla Revision 1 – April 2003
6. Nathalia Floodplain Management Plan (Webb Consulting, 2005)
7. Benalla Water Management Scheme: Vegetation Management Plan (CT Management, 2006)
8. Shepparton Mooroopna Flood Warning and Emergency Management Project (Water Technology, 2007)
9. Flood Atlas (on website) (Goulburn Broken CMA, 2008)
10. Nathalia Mitigation Scheme Implementation (Moira Shire, 2009-2012)
11. Seymour Flood Mitigation Project – Preliminary Design Report (Webb Consulting, 2009)
12. Seymour Pre-Detailed Flood Mitigation (2010 Consultation Plan)
13. Euroa Mitigation Plan Implementation Castle Creek Levee (2011)
14. Barmah Township Flood Mitigation Functional Design (2012)
15. Violet Town Functional Mitigation Design (GMR Engineering, 2012 to date)
16. Tatura Floodplain Mitigation (Railway Culverts and floodway works - 2012)
17. Violet Town Levee Upgrade Report (GMR, 2016 to date)

18. Benalla Flood Information Portal Report (Cardno, 2016)
19. Seymour Levee Detailed Design (Mitchel Shire, 2016)

Table D-22: List of Local Flood Guides

Local Flood Guides

1. Katamatite
2. Nathalia
3. Numurkah
4. Muckatah Depression Fact Sheet
5. Tungamah
6. Congupna
7. Katandra West
8. Mooroopna Shepparton
9. Murchison
10. Tallygaroopna
11. Violet Town
12. Seymour
13. Yea
14. Jamieson
15. Benalla

Table D-23: List of 1% AEP flood level declarations

Declaration of 100-year flood levels (*Water Act 1989*)

Location	Date of Declaration
Broken River – Benalla	**19 July 2001**
Euroa – Seven Creeks and Castle Creek	**7 March 2002**
Seymour – Goulburn River	**22 August 2002**
Shepparton - Mooroopna	**22 August 2002**
Tatura - Mosquito Depression	**18 January 2007**
Murray River – Lake Mulwala to Echuca (15 Sheets)	**19 August 2004**
Merrigum - Mosquito Depression	**18 January 2007**
Nathalia District – Broken Creek	**18 January 2007**
Yea – Yea River (Boundary Creek)	**18 January 2007**
Mansfield – Ford Creek	**18 January 2007**
Jamieson – Goulburn River	**18 January 2007**

Appendix E: 2002 Regional Strategy Program Review

Asset Management - Program 1

Table E-24: 2002 Regional Strategy Delivery – Asset Management (below) documents in detail the extent to which this program has been delivered.

The Asset Management program has largely been addressed and remains ongoing in terms of operation and maintenance of urban levees. Consistent with the VFMS, operation and maintenance of urban levees is carried out by local government.

Any maintenance works on 'private' levees that are located on Crown land fall under the new permitting system managed by the Goulburn Broken CMA (otherwise such works may be subject for permits under planning schemes).

Other levees of significance are those currently being planned for Numurkah, Seymour and Violet Town.

Table E-24: 2002 Regional Strategy Delivery – Asset Management

Ref	Task	Status at 2017
Asset Register		
AR1	Upgrade and Maintain Asset Register by Goulburn Broken CMA	The Goulburn Broken CMA plays a support role, as required, and does not hold or maintain any asset register in terms of mitigation infrastructure such as town or rural levees. The construction authority is responsible maintaining an asset register, and particularly an operation and maintenance plan. Therefore, not relevant to CMAs.
PWD Levees		
PWD1	Resolve legal liabilities	Despite lobbying groups such as the Cobram and Strathmerton over the past two decades, no traction has ever been reached to have the PWD levees maintained. This is a statewide issue that has not been resolved and subject to recent Parliamentary Inquiry into mitigation infrastructure review (Parliament of Victoria, 2012). The Victorian Floodplain Management Strategy has now clarified roles and responsibilities, accountabilities, and policies that specifically address rural levees.
PWD2	Resolve arrangements for funding for O&M	
PWD3	Prepare a management plan	
PWD4	Maintain levees	
Lower Goulburn Levees – includes part of Beattie Depression levees along the Murray		
LG1	Resolve legal liability issues	The levees do not form part of any formal scheme that has an O&M authority, so the levees remain unmanaged. See comments in PWD Levees above in relation to the VFMS.
LG2	Resolve arrangements for funding for O&M	See LG4 below
LG3	Formalise agreement with G-M Water over future arrangements for managing assets they currently maintain	Discussions with GMW confirm it only operates and maintains Loch Garry regulation and associated nine kilometres of levee around the Loch Garry wetland. This is largely funded through rates from beneficiaries within the Deep Creek floodplain. No agreement is required as this is an obligation under the legislative transitional arrangements under the Water Act when GMW was established in 1994.
LG4	Prepare a management plan	A significant number of past studies and plans have been carried out as part of a project called the Lower Goulburn Floodplain Rehabilitation Scheme (2005). This was prepared following the 1993 floods, as a result of the State Government request to find a solution to managing the rural levees. The plan relied 100% capital funding from State and

Ref	Task	Status at 2017
		Commonwealth with ongoing O&M provided by beneficiaries. It was never implemented.
LG5	Maintain levees	See LG4 above
Beattie Depression Levees		
BD1	Maintain as required	These levees form part of the irrigation drainage network arrangement where the Beattie Depression receives drainage water from the Deakin Main Drain and Mosquito Depression. The levees minimise flooding of low lying areas including backwater flooding from the Murray River (near Echuca) in times floods. GMW continue to manage the Beattie Depression and the associated levees
Cobram Town Levees		
CTL1	Prepare a management plan	Completed by Moira Shire Council
CTL2	Maintain the levees	Carried out by Moira Shire Council
Nathalia Town Levees		
NTL1	Prepare a management plan	Completed by Moira Shire Council
NTL2	Maintain the levees	Completed by Moira Shire Council
NTL3	Acquire easement rights for levees	Preference to negotiate agreement rather using easements
Private Strategic Rural Assets		
PSR1	Allow self-management either individually or through community or advisory committees via a floodplain management plan.	There has been virtually no request for assistance to maintain private levees or any other assets. The flood overlay control captures most floodplain areas where new works require a permit. Under the new arrangements permits for maintenance works for levees on Crown land can be granted by the CMAs (since 2017), which was an action from the VFMS.
Asset Management Review		
AMR1	Review/audit asset management plans every 5 years	This is part of the O&M by the asset manager and is ongoing. There have been two state-wide urban levee audits carried out

Flood Studies and Floodplain Management Plans – Program 2

The 2002 regional Strategy adopted a systematic, risk management approach for the conduct of studies, as outlined in the Victoria Flood Management Strategy (1998). Community engagement, including community reference groups, are important steps and have been largely employed during the life of the studies. This allows for the sharing flood knowledge and the vetting of study outputs such as flood mapping, mitigation measures and recommendations.

Table E-25 (below) documents the extent to which this program has been delivered.

Table E-25: 2002 Regional Strategy Delivery – Flood Studies and Floodplain Management Plans

Ref	Task	Status at 2017
Abbreviations Completed	☑ = Study/Plan Completed	☑ = Study/Plan Mostly
USS = Urban Scoping Study	UFMS = Urban Floodplain Management Study	L = Low Priority
RSS = Rural Scoping Study	RFMS = Rural Floodplain Management Study	M = Medium Priority
UFS = Urban Flood Study	UFMP = Urban Floodplain Management Plan	H = High Priority
RFS = Rural Flood Study	RFMP = Rural Floodplain Management Plan	
Murray River Basin		
MU1 ☑	Barmah Urban Study (UFMS) (L)	Two studies have been completed. Assessment of Flood Risk to the Township of Barmah and Preliminary Flood Mitigation Review (Water Technology, 2008) and Barmah Township Flood Mitigation Functional Design (Water Technology, 2012). Outcome is the cost of mitigation infrastructure greatly outweigh the benefits and therefore unlikely to proceed.
MU2 ☑	Yarrawonga Urban Study (UFS) (M)	Yarrawonga Flood Management & Drainage Master Plan (BMT WBM, 2013). This study was carried out to inform Moira Shire on future drainage management and at the same time produce 1% AEP overland flood mapping.
MR1-1 ☑	Murray River: Dick's Levee to Piree Creek Stage 1 (RSS) (H)	The Murray River Regional Flood Study - Dicks/Seppelts levees to downstream of the Ulupna Creek confluence (Water Technology, 2011) was a departure from the three-staged approach as set by the 2002 regional Strategy. This is an example of a partnership approach. New technology (LiDAR) became available and both NSW and Victoria formed a partnership to look at an important reach of Murray River from Cobram East to downstream of Ulupna Creek and Murray River confluence. This study investigated the performance on urban flood mitigation schemes at Cobram and Tocumwal (NSW) and was used to seek further mitigation works. It also covered the more populated areas including Koonoomoo and Strathmerton. Flood intelligence has been updated to the MFEP. It was not possible to extend this study to Piree Creek as budget did not allow for additional LiDAR Capture. The completed study did address most of the three stages, but did not consider future arrangements around the PWD levees maintenance. See earlier comments in the Asset Management Program 1.
MR1-2 ☑	Murray River: Dick's Levee to Piree Creek Stage 2 (RFS) (H)	
MR1-3 ☑	Murray River: Dick's Levee to Piree Creek Stage 3 (RFMP) (H)	
MR2-1	Murray River: Piree Creek to Barmah Stage 1 (RSS) (L)	This was considered a low priority, which indicates no further action.
MR2-2	Murray River: Piree Creek to Barmah Stage 2 (RFMP) (L)	This was considered a low priority, which indicates no further action.
Goulburn River Basin		
GU1 ☑	Avenel Urban Study (UFS) (L)	This was considered a low priority, which indicates no further action. However, this town sits inside an ongoing Granite Creek Flood Mapping Study and not only maps Hughes Creek but the northern tributary waterways through the north of Town.
GU2	Buxton Urban Study (UFS) (L)	This was considered a low priority. Following major floods in recent years the priority to fully understand the nature of flooding is high. This forms part of the ongoing Acheron River Flood Hydrology Study (Jacobs, Ongoing) and a flood study is currently being prepared by Goulburn Broken CMA.

Ref	Task	Status at 2017
Abbreviations Completed	☑ = Study/Plan Completed	☑ = Study/Plan Mostly
USS = Urban Scoping Study	UFMS = Urban Floodplain Management Study	L = Low Priority
RSS = Rural Scoping Study	RFMS = Rural Floodplain Management Study	M = Medium Priority
UFS = Urban Flood Study	UFMP = Urban Floodplain Management Plan	H = High Priority
RFS = Rural Flood Study	RFMP = Rural Floodplain Management Plan	
GU3 ☑	Jamieson Urban Study (USS) (M)	The Jamieson Flood Scoping Study (SKM, 2003) has been utilised and incorporated into Mansfield Planning Scheme and Flood Intelligence for MFEP.
GU4	Kilmore Urban Study (UFS) (M)	The Kilmore Flood Study (BMT WBM) is well advanced.
GU5 ☑	Mansfield Urban Study (UFS) (M)	Mansfield Flood Study (Earth Tech, 2005), Mansfield Flood Study Extension (Earth Tech, 2006) and Mansfield 1% AEP Flood Mapping Project (GBCMA, 2014) have been utilised and incorporated into Mansfield Planning Scheme and Flood Intelligence for MFEP.
GU6 ☑	Merrigum Urban Study (UFS) (M-H)	Merrigum Flood Study (WMB Oceanics Australia, 2005) has been completed and utilised and incorporated into Mansfield Planning Scheme and Flood Intelligence for MFEP.
GU7	Molesworth Urban Study (UFS) (L)	This was considered a low priority, which indicates no further action. However, broad regional flood mapping work carried out under the Eildon to Murchison Flood Modelling Project GPU Documentation (Water Technology, 2015).
GU8 ☑	Murchison Urban Study (UFS) (L)	Murchison Flood Mapping Study Report (Water Technology, 2014) has been completed and utilised and incorporated into Mansfield Planning Scheme and Flood Intelligence for MFEP.
GU9 ☑	Nagambie Urban Study (UFS) (M)	Nagambie Flood Study (BMT WBM, 2017) just recently completed. Information need to be translated into actions.
GU10	Rushworth Urban Study (UFS) (L)	This was considered a low priority, which indicates no further action. Campaspe Shire has carried out drainage improvements in recent years
GU11 ☑	Seymour Urban Study (UFMP) (H)	Seymour Floodplain Mapping Study (WBM Oceanics Australia, 2001), Seymour Flood Mitigation Communication Investigation (WBM Oceanics Australia, 2006), Seymour Flood Mitigation Project – Preliminary Design Report (Webb Consulting, 2009), have been completed and Seymour Levee Detailed Design (Mitchel Shire, 2016) is underway.
GU12	Stanhope Urban Study (USS) (L)	This was considered a low priority, which indicates no further action. A depression exist south of town and no known flood issues are known with the township of Stanhope.
GU13 ☑	Tallarook Urban Study (UFS) (L)	Tallarook Flood Investigation (Goulburn Broken CMA, 2008) completed but flood mapping not incorporated into Mitchell Planning Scheme. The investigation concludes that the bulk of building are well above the 1% AEP flood extent.
GU14 ☑	Tatura Urban Study (UFMP) (H)	Tatura Floodplain Management Study (WBM Oceanics Australia, 2006) and Tatura Floodplain Mitigation (Railway Culverts and floodway works - 2012) are completed
GU15	Thornton Urban Study (USS) (M-H)	Broad regional flood mapping work carried out under the Eildon to Murchison Flood Modelling Project GPU Documentation (Water Technology, 2015). No study on Thornton carried out.
GU16	Toolamba Urban Study (UFMS) (L)	This was considered a low priority, which indicates no further action.

Ref	Task	Status at 2017
Abbreviations	☑ = Study/Plan Completed	☑ = Study/Plan Mostly Completed
USS = Urban Scoping Study	UFMS = Urban Floodplain Management Study	L = Low Priority
RSS = Rural Scoping Study	RFMS = Rural Floodplain Management Study	M = Medium Priority
UFS = Urban Flood Study	UFMP = Urban Floodplain Management Plan	H = High Priority
RFS = Rural Flood Study	RFMP = Rural Floodplain Management Plan	
GU17-1 ☑	Violet Town Study - Stage 1 (USS) (H)	Violet Town Flood Scoping Study (GHD, 2002) completed, revised flood overlay should be incorporated into planning scheme.
GU17-2 ☑	Violet Town Study - Stage 2 (UFMP) (H)	Both the Violet Town Flood Study (Water Technology, 2007), and the Violet Town Flood Study (Water Technology, 2007) are completed. Detailed design now underway by Strathbogie Shire Council.
GU18 ☑	Yea Urban Study (UFS) (M-H)	Yea Flood Study (Water Technology, 2005) and has been completed and utilised and incorporated into Mansfield Planning Scheme and Flood Intelligence for MFEP.
GR1-1 ☑	Goulburn River: Eildon to Seymour Stage 1 (RSS) (L)	This was considered a low priority, which indicates no further action. However, broad regional flood mapping work carried out under the Eildon to Murchison Flood Modelling Project GPU Documentation (Water Technology, 2015).
GR1-2	Goulburn River: Eildon to Seymour Stage 2 (RFMS) (L)	This was considered a low priority, which indicates no further action.
GR2-1 ☑	Goulburn River: Seymour to Shepparton Stage 1 (RSS) (L)	This was considered a low priority, which indicates no further action. However, broad regional flood mapping work carried out under the Eildon to Murchison Flood Modelling Project GPU Documentation (Water Technology, 2015).
GR2-2	Goulburn River: Seymour to Shepparton Stage 2 (RFMS) (L)	This was considered a low priority, which indicates no further action.
GR3-1 ☑	Goulburn River: Shepparton to Murray River – Stage 1 (RFS) (VH)	These stages have been completed through the completion of: Lower Goulburn Waterway and Floodplain Management Plan and Supporting Document (SKM, 1998), Lower Goulburn Floodplain Rehabilitation Scheme Modified Findlay Scheme (SMEC, 1998), Lower Goulburn Floodplain Rehabilitation Scheme Business Plan (Summary) (PcW, 1999), Lower Goulburn Levee Audit Report Main Report and Appendices (1999), Lower Goulburn Rehabilitation Project Socio-economic Issues Assessment (Earth Tech, 2002), and Lower Goulburn Floodplain Rehabilitation Project Hydraulic Modelling Report (WT, 2005), Lower Goulburn Floodplain Study Geomorphology (SKM, 2006), Lower Goulburn Floodplain Rehabilitation Scheme Addendum A Hydraulic Performance of the Engineered Option 2 (WT, 2006). The scheme was ultimately abandoned as not agreement could be reached on funding arrangement for 100% of capital works from the State and Commonwealth governments with O&M being proposed from beneficiaries.
GR3-2 ☑	Goulburn River: Shepparton to Murray River – Stage 2 (RFS) (VH)	
GR4 ☑	Castle & Seven Creeks downstream of Euroa (RFS) (M-H)	Now underway as part of the Granite Greeks project (Water Technology) which is an extensive regional flood mapping study to provide good indicative intelligence for emergency management and land-use planning. The study extends over many catchments from Avenel (Hughes Creek) to Baddaginnie (Folly Creek).

Ref	Task	Status at 2017
Abbreviations Completed	☑ = Study/Plan Completed	☑ = Study/Plan Mostly
USS = Urban Scoping Study	UFMS = Urban Floodplain Management Study	L = Low Priority
RSS = Rural Scoping Study	RFMS = Rural Floodplain Management Study	M = Medium Priority
UFS = Urban Flood Study	UFMP = Urban Floodplain Management Plan	H = High Priority
RFS = Rural Flood Study	RFMP = Rural Floodplain Management Plan	
GR5 ☑	Corop Lakes (RFS) (L-M)	The Corop Lakes Flood Scoping Study (GHD, 2012) has provided a recommendation around GMW operations to be shared with the Community. It study found the current flood overlay controls within the Campaspe Planning Scheme are mostly sound. Some minor inclusion could be carried out at Colbinabbin Primary School site but is of low priority.
GR6 ☑	King Parrot & Strath Creeks (RFS) (L)	This was considered a low priority, which indicates no further action. However, the Flowerdale Flood Study Flood Intelligence and Mapping Project (GBCMA, 2014) covered some of the area. The study mapped some 20 kilometres of King Parrot Creek, including Hazeldene, Flowerdale and several other areas. .
GR7	Murrindindi River and Yea River (RFS) (L)	This was considered a low priority, which indicates no further action.
GR8	Sunday and Dry Creeks, including Broadford (RFS) (L)	This was considered a low priority, which indicates no further action. However, these areas are now considered a high priority given the peri-urban demands for growth due close nature to Melbourne. A proposed for this study is ready to start pending commitment under the Natural Disaster Funding Program.
Broken River Basin		
BR1 ☑	Broken River: Benalla to Shepparton (RFS) (M)	Not yet carried out. Some Internal GBCMA work was carried out as part of Greater Shepparton Planning Amendment (in field intelligence with community) and further work using LiDAR and 1% historical flood surface to update flood mapping for Benalla Rural City Planning Scheme Amendment. The area now has a very high priority.
Broken Creek Basin		
BCU1	Katamatite (USS) (L-M)	Not yet carried out.
BCU2 ☑	Numurkah (UFMP) (H)	A flood study was underway prior to the significant flood of 2012. This was abandoned in favour of carrying out the Numurkah Floodplain Management Study (Water Technology, 2017) that has explored large array of mitigation options. The preferred options are to be presented for community input as the time of writing this Strategy. A preferred mitigation scheme will be considered by Moira Shire Council for adoption.
BCU3 ☑	Nathalia (UFMP) (VH)	The Nathalia Floodplain Management Plan (SMEC, 2005) and Nathalia Flood Mitigation Scheme Implemented (Moira Shire, 2009-2012). The upgraded levee system was tested by the highest flood of record (2012), and included the flood warning prediction services was also completed and used during 2012 flood.
BCU4	Tungamah (UFMP) (H)	Not yet carried out. LiDAR has been commissioned (2017) for this catchment to allow the study to proceed in near future.
BCU5 ☑	Wunghnu (USS) (L)	No scoping study carried out. However, flood mapping has been completed as part of the extended Numurkah Floodplain Management Study, which will adequate for scoping purposes.

Ref	Task	Status at 2017
Abbreviations Completed	☑ = Study/Plan Completed	☑ = Study/Plan Mostly
USS = Urban Scoping Study	UFMS = Urban Floodplain Management Study	L = Low Priority
RSS = Rural Scoping Study	RFMS = Rural Floodplain Management Study	M = Medium Priority
UFS = Urban Flood Study	UFMP = Urban Floodplain Management Plan	H = High Priority
RFS = Rural Flood Study	RFMP = Rural Floodplain Management Plan	
BCR1	Pine Lodge, Daintons, Congupna and O'Keefe Creeks (RFS) (L)	This was considered a low priority, which indicates no further action.
BCR2-1	Nine Mile, Boosey, Muckatah Creeks. – Stage 1 (RFS) (L-M)	Not yet carried out.
BCR2-2 (RFMS)	Nine Mile, Boosey, Muckatah Creeks. – Stage 2 (L-M)	Not yet carried out.

Table E-26: 2002 Regional Strategy Delivery - Floodplain Work Delivery

Ref	Task	2017 Status
Water Management Schemes – Urban Areas		
FPW1	Benalla	Waterway Management Scheme completed, which was largely about removal of selected vegetation. Continued operation and maintenance is carried out by Benalla Rural City Council. Total Flood Warning System implemented separately in the mid-2000s.
FPW2	Euroa	Water Management Scheme completed which was largely about augmentation of Castle Creel and removal of selected vegetation along creek corridors. Continued operation and maintenance is carried out by Shire of Euroa. Total Flood Warning System implemented separately in the mid-2000s.
FPW3	Shepparton	Shepparton Mooroopna Flood Warning and Emergency Management Project was delivered as the recommended scheme. Structural mitigation measures were dismissed following community consultation.
FPWU	Implement works for future urban studies and FPM Plans	Additional work included: Cobram levee augmentation, Tatura railway culverts and floodway works, Nathalia levee augmentation and TFWS, and detailed design of levees for Seymour and Violet Town.
Rural Areas		
FPW4	Upgrade PWD (Murray River) levees	The Department funded repairs of known levee defects, based on the Levee Audit (Coffey, 1997), primary from Cobram to Koonoomoo. See **Table E-25**.
FPW5	Lower Goulburn Floodplain Rehabilitation Scheme	See **Table E-25** for further background. No works are currently planned
FPWR	Implement works from future rural studies and FPM plans	No works are currently planned.

In conclusion, this program delivery has been successful because of strong stakeholder partnership and financial commitment by all levels of government.

Statutory Land Use Planning – Program 3

At the outset of the development of the 2002 regional Strategy, the statutory land-use planning program was considered one of the most important of all programs because of the need to ensure that land-use and development proposals do not unduly add to legacy flood problems.

At the time of the formations of CMAs across Victoria, the new format planning schemes were being prepared using the standard set of zones and overlay contained in the Victoria Planning Provisions. The 2002 regional Strategy was conscious to utilise the new tools that were specifically made available for floodplain management to management the "future" flood problem (not making things worse).

The tools in the Victoria Planning Provisions, for floodplain management have not (for the most part) changed since its introduction in the mid-1990s, and include using:

- Urban Floodway Zone (UFZ), (Rural) Floodway Overlay (RFO or FO), Land Subject to Inundation Overlay (LSIO) and Special Building Overlay (SBO).
- Schedules to the FO, LSIO, and SBO that specifically allow for exemptions for unnecessary planning permit referrals.
- Local Floodplain Development Plans that provides a performance-based risk management criteria for those most common types of applications.
- Local Planning Policy Framework to sign post local issues relevant to LGAs and other prepared incorporated documents such as the Local Floodplain Development Plans.

All LGAs have zone and overlay controls within their planning schemes. Five of the eight LGAs have included the full suite of zone and overlay controls, schedules, local floodplain development plans and local planning policy.

Table E-25 and Table E-28 present the status of this program. Note that updating planning controls is never static and should always incorporate the best available information. Considerable effort is required under this Strategy to carry out a significant number of planning schemes amendments.

Table E-27 2002 Regional Strategy Delivery – Implementation program for statutory planning

Ref	Task	Status at 2017
SP1	Draft VPP amendments. Shires of Murrindindi & Mitchell only	Completed and include the full suite of VPPs tool for floodplain management.
SP2	Incorporate FDT maps into planning schemes	Completed for all LGAs except Benalla Rural City Council where maps need updating beyond the FDT (Flood Data Transfer Project from Victoria to Shires and CMAs).
SP3	Improved flood maps. These are only where required.	On-going following completion of flood mapping studies.
SP4	Incorporate improved flood maps into planning schemes	Many updates from Studies incorporated and many have not and subject to priorities for the 2017 regional Strategy.
SP5	Review performance of planning measures every 5 years. Audit a representative selection of statutory planning responses across all municipalities and check for consistency in conditions.	Standard set of conditions has been established in a GIS Planning Database Platform known as IPAWs, which all CMAs are using across the State. No audits have been carried out except on processes and time performance in the Goulburn Broken CMA internal Audit in 2013.

Ref	Task	Status at 2017
	Audit a smaller selection of developments across all municipality and test compliance of approved works against conditions of permit.	Never carried out by Goulburn Broken CMA. Some audits carried out by LGAs
SP6	Inform VicRoads, V-Line, Goulburn-Murray Water & Power Authorities of recommended referral and consultation arrangements when appropriate	This is achieved by the planning scheme requirements and deemed unnecessary.

Table E-28: 2002 Regional Strategy Delivery – Flood mapping

Task/(Priority)	2017 Status
Murray Catchment	
Murray/Ovens River confluence near Bundalong (Low Priority)	Completed as part of Murray River Mapping for MDBA.
Goulburn River tributaries between Eildon and Seymour (e.g. Rubicon River, Acheron River, Home Creek, Dabyminga Creek, Yea River, Murrindindi River, King Parrot Creek, Strath Creek) (Low Priority)	About 20% complete and some incorporated into planning scheme. Low priority given due to other higher priorities
Goulburn River tributaries between Seymour and Shepparton (e.g. Major Creek, Sugarloaf Creek, Mollison Creek, Gardiner Creek, Hughes Creek, Castle Creek, Seven Creeks, Pranjip Creek, Honeysuckle Creek, Stony Creek) (Medium Priority)	The current Granite Creek Flood Mapping Project will address most of the named tributaries
Toolamba/Stanhope area generally north of Waranga Basin covering the numerous drainage lines and depressions through this area (update of 1950 flood extent information required)	The Corop Lake Scoping Study (GHD, 2012) indicates that the overlay controls are sound following a review of capture 2010 LiDAR information. No further detailed modelling is not warranted for this Strategy.
Cornella Creek, Wanalta Creek and Corop Lakes	The Corop Lake Scoping Study (GHD, 2012) indicates that the overlay controls are sound following a review of capture 2010 LiDAR information. No further detailed modelling is not warranted for this Strategy.
Broken River Catchment	
Broken River and Holland Creek upstream of Benalla (cleared areas only)	Flood Data Transfer Flood Mapping available but considered poor. LiDAR will assist in improving flood planning.
Baddaginnie Creek	Currently part of the Granite Creeks Flood Mapping Project
Broken River effluents between Benalla and Lake Mokoan and Stockyard Creek.	Preliminary work completed.
Broken Creek Catchment	

Task/(Priority)	2017 Status
Upper reaches of Broken and Boosey Creeks, including effluent flow paths from Broken River between Broken Creek and Nalinga, and also near the Dookie Hills	This work has not been addressed. The first task is to study the hydrology and model the nature of flooding along the Broken River and its effluents into the Broken Creek catchment. This work in eminent and part of the Goulburn and Broken Flood Mapping Project. The upper reaches of the Boosey and Broken then be ready to be investigated as part of the Upper Broken Study Flood Mapping Study into the future. This is required as there are little overlay controls
Muckatah Depression and nearby depressions and areas of low lying land	Overlay exist in the planning scheme. However, improved understanding is required
Natural depressions between Broken Creek and the Murray River, north of Numurkah and Nathalia, including Drain 13 area near Nathalia	Need to include significant drainage line mapping into planning scheme as Floodway Overlay (FO) controls.
Broken Creek, downstream of Nathalia.	

Development Assessment Guidelines – Program 4

The guidelines are intended to link with Program 3 – Statutory Planning. The aim is to ensure that land-use and development assessments are consistent.

The major achievement is the incorporation of Local Planning Policy, Local Floodplain Development Plans and schedules to the flood provision in five of the eight planning schemes within the Goulburn Broken CMA, which form the bulk of the decision guidelines. It of note that incorporating decision guidelines into planning scheme provides transparency for all stakeholders.

The 2013 Internal Audit (Partners, 2013) recommended that the decision guidelines and processes be formally structured into the Goulburn Broken CMA Policy and Procedures to ensure all staff are aware of how to make decisions.

A review of the 2002 regional Strategy indicates that the guidelines align with the:

- State Planning Policy Framework
- Local Floodplain Development Plans
- Planning Practice Note 11 (Department of Environment, Land, Water and Planning, 2015)
- Urban Floodway Zone (Clause 37.03)
- Floodway Overlay (Clause 44.03)
- Land Subject to Inundation (Clause 44.04)
- Goulburn Broken CMA Policies and Procedures

Currently, Department of Environment, Land, Water and Planning are coordinating Development Guidelines on Flood Prone Land in conjunction with all CMAs and Melbourne Water.

Control of Works and Activities – Program 5

This program looked at seven possible ways to managed works and activities and seeks to identify and document procedures, particularly under the Victoria Planning Provisions (planning schemes),

Water Act declarations and By-laws. The latter is limited to the confines of waterways rather than floodplain areas. Declarations could however be applied to floodplain areas.

No action has been carried out for this program in this matter in preference of the planning controls in planning schemes.

The Goulburn Broken CMA has provided significant resources to support LGAs resolve "illegal" works. There are however, no formal documented arrangements in place.

Further discussion around this program is provided in the Strategy in **Section 4.6**.

Emergency Response Planning – Program 6

A large portion of this program has been delivered by LGAs and VICSES with support from the Goulburn Broken CMA.

This program is heavily reliant on the availability of good flood data. Many flood studies include components where emergency and flood warning considerations are examined.

Table E-29 provides a description of completed tasks that mostly been advanced.

The proposed elements of the TFWS for each basin and priorities are discussed in **Section 2.4**. Only two Charters (which were agreements on how flood warning arrangements were to be delivered) exist - for Nathalia and Shepparton. There has been a significant number of flood warning prediction services implemented however, namely:

- Benalla (Benalla Rural City Council);
- Euroa (Strathbogie Shire);
- Seymour (and mid Goulburn Mitchell and Murrindindi Shires);
- Shepparton Mooroopna (Greater Shepparton);
- Lower Goulburn – Loch Garry Scheme (Goulburn Murray Water);
- Nathalia (Moira Shire);
- Numurkah (in development); and
- NSW provide forecasts for the Murray River at the Yarrawonga and Tocumwal gauges.

Service Level Specification for Flood Forecasting and Warning Services for Victoria are documented by the BoM (Bureau of Meteorology, 2013)

Table E-29: 2002 Regional Strategy Delivery – Emergency response planning

Task/(Priority)	2017 Status
Identify Flood Warning System Needs.	
• Develop flood warning service charter (for each Basin with LGAs and VICSES)	Not attempted. Currently, VICSES implementing catchment footprint EMCOP warning distribution.
• Establish prioritised program based on needs	This has been considered in Program 2: Flood Studies and Floodplain Management Plans
• Advise BoM of requirements	This has been carried out as part of study recommendations
• Review & update service charter as required	Not attempted

Task/(Priority)	2017 Status
• **Identify funding opportunities**	
Data Network Management	
• **Developed Policy for CMA involvement in flood network management**	This is done through the establishment of the Northern Regional Water Monitoring Partnership. The CMA has some role in water quality monitoring
• **Facilitate the development and implementation of a regional monitoring partnership (in consultation with NRE).**	This is done through the establishment of the Northern Regional Water Monitoring Partnership, which is coordinated by the Department of Environment, Land, Water and Planning.
Empower Community.	
Explore opportunities for public dissemination of BoM "Flood Advice" warning/information	This has been delivered through EMCOP where it value adds to BoM's flood warnings
Develop Community Flood Response Guides (Consultancy)	Four flood guides were prepared as part of TFWs for Seymour, Shepparton, Benalla and Euroa prior to the FloodSafe initiative led by VICSES. A list of 15 guides are shown in **Appendix D**: Summary of Flood Studies, Plans, Work Plans
Help raise and maintain community awareness by contributing to media articles, preparing brochures, speaking to community groups, etc.	The initiate in led by VICSES with support from LGAs and CMA. Note improved websites now available.
Review and document actions undertaken by municipalities with improved flood warning systems to ensure all elements of the flood warning system are ready for future flood events.	This initiative is carried out by LGAs with review by VICSES and CMAs. The new Municipal Flood Emergency Plan standard template has most been applied across Victoria, which has led to greater ease of use.
Resolve Anomalies in Roles and Responsibilities.	
Work with G-M Water and BoM to resolve anomalies in existing roles and responsibilities for flood forecasting and warning activities.	Completed. This service is now solely carried out by BoM.

Flood Monitoring Action – Program 7

The implementation of this program has been significantly advanced. Five initiatives were completed, namely:

- State-wide Flood Response Action Plan template (Coordinated by Goulburn Broken CMA);
- Data needs for each of the four catchments in the Goulburn Broken region;
- Goulburn Broken CMA Flood Response Plan;
- Policy and Practice Procedures (internal); and
- GIS Platform

The GIS platform is a consolidation of the first three bullet points above, which provides rapid access to the actions that the Goulburn Broken CMA is required to perform in terms of flood data capture including: peak flood levels, aerial flood photography, and hydrographic flow measurements. At the same time, the Goulburn Broken CMA performs its role in the Intelligence Cell at the Incident Control Centres, assist VICSES in managing potential flood consequences.

A State-wide initiative known as FloodZoom, which is a web based platform of key flood intelligence products has been advanced over the past five years by DELWP in conjunction with CMAs and VICSES. This platform provides flood intelligence that is accessible by emergency management personnel.

The Goulburn Broken CMA role during recent major floods has been tested during 2010, 2011, 2012 and 2016. Debrief sessions have been carried out to improve procedures following each flood, particularly the Goulburn Broken CMA Internal Policy and Practice Procedures.

The Goulburn Broken CMA seeks to test its action plan and/or attend state-wide or regional incident control centre exercises coordinated by DELWP/VICSES since the recent floods, and in most part worked effectively.

The Strategy seeks to re-evaluate the data needs for flood data capture. Review of the performance of levee systems also needs to be addressed.

Information Management Systems – Program 8

This program is focused on the Goulburn Broken CMA internal processes that were of utmost priority to ensure effective and efficient functioning of the statutory planning and floodplain management program.

The Goulburn Broken CMA Information Communication Technology (ICT) team has provided significant support in addressing the requirements of this program. The IPAWS (Integrated Planning and Works System for statutory referrals, advices and permits) system and the Flood Response Action Plan GIS Platforms have been significantly affective in this program where significant resources have been employed. The Goulburn Broken CMA in fact led to the development of the Platform and its delivery to all CMAs.

Other activities include file management of both plans and documents (linkages via GIS), remote applications (to enable to use the CMA's corporate computer platforms away from the office), hydrology and hydraulic software, and a floodplain library.

This program included the future needs for flood data that is mostly covered in the flood action plan, but should be reviewed and joined to Program 7.

This program has been successfully implemented. However, ICT seeks to remain current and requires ongoing management.

Education, Promotion and Communication – Program 9

This program suggests a range of training programs, which are ongoing and mostly well attended. Professional development of staff has also been coordinated by the Goulburn Broken CMA's Human Resources Team including conflict management, taking evidence, interview techniques, etc.

The program set out community workshops to be carried out twice a year to raise flood awareness, which has been led by VICSES through the FloodSafe program.

Appendix F: Service levels – structural flood mitigation works

Table F-30: Service levels (urban centres) – Structure flood mitigation works

Name	Existing Flood Mitigation Infrastructure (levees)	Proposed Flood Mitigation Infrastructure (Levees)
Benalla Rural City Council		
Baddaginnie	• None identified and not required	•
Benalla	**Description** • The Approved Water Management Scheme (2003) was implemented (circa 2006-08) comprising vegetation thinning (largely exotics) and management. The works extends from through the City. • Also, TFFS in place. **Management Authority** • Benalla Rural City Council maintains the Scheme and contributes to the maintenance of the rain and stream gauge network for the TFWS	No other flood infrastructure proposed. Review should be carried out following the next major flood greater than 2% AEP flood. Banks associated with the old Mokoan Channel should be reviewed if they provide a service in protecting parts of Benalla – refer to **Table** F-32 at the end of this Appendix.
Devenish	None identified and not required	•
Lima South	• None identified and not required	•
Glenrowan (Rural City of Wangaratta)	• None identified and not required	•
Swanpool	• None identified and not required	
Tatong	None identified and not required	
Thoona	None identified and not required	•
Campaspe Shire		
Colbinabbin	None identified and not required	•
Girgarre	None identified and not required	•
Kyabram	**Description** • A pumping scheme and a retention basins have been implementation to reduce stormwater flooding. This is detailed in a report prepared by GHD (1995). **Management Authority** Shire of Campaspe	•
Rushworth	**Description** • Northern, southern and western catchment stormwater plans were implemented in 2014 to reduce exposure of overland stormwater inundation. **Management Authority** Shire of Campaspe	•

Name	Existing Flood Mitigation Infrastructure (levees)	Proposed Flood Mitigation Infrastructure (Levees)
Stanhope	**Description** • Stanhope drainage scheme implemented in the mid-1970s to reduce exposure of overland stormwater inundation. **Management Authority** Shire of Campaspe	•
Tongala	**Description** • A drainage scheme, including retardation basins was implemented in the mid-1980s 2014 to reduce exposure of overland stormwater inundation. **Management Authority** Shire of Campaspe	• -
Wyuna	None identified and not required	•
Greater Bendigo City Council		
Costerfield	None identified and not required	• -
Costerfield South	None identified and not required	• -
Heathcote East (Rural Living)	None identified and not required	• -
Heathcote North (Rural Living)	None identified and not required	• -
Mount Camel	None identified and not required	• -
Redcastle	None identified and not required	• -
Greater Shepparton City Council		
Bunbartha	**Description** • The unmanaged rural levees, which forms part of the lower Goulburn levee system protects Bunbartha from flooding up to 2% AEP type flood. However, this cannot be relied upon as there are no operation of maintenance arrangements in place. **Management Authority** Nil	• There is no proposal to have the lower Goulburn levees managed into the future.
Cooma	None identified and not required	• -
East Murchison	None identified and not required	• -
East Shepparton	None identified and not required. However, overland stormwater flooding may be further scoped as part of Greater Shepparton drainage review, which is currently underway.	• Possible local drainage solutions
Katandra West	None identified and not required until a scoping stormwater study is carried out.	• -
Kialla West	None identified and not required	• -
Merrigum	None identified and not required	• -

Name	Existing Flood Mitigation Infrastructure (levees)	Proposed Flood Mitigation Infrastructure (Levees)
Murchison	**Description** • North of the Murchison-Bendigo Bridge crossing a levee has been constructed along the eastern bank of the Goulburn River, which is approximately one-metre in height • This levee in some 200 metres in length and is thought to have been constructed following the 1916 flood where floodwaters entered into the town impacted on retail and residential areas. **Management Authority** • Nil **Levee condition and level of protection** • Despite no formal management arrangement, the levee in visually in very good condition and well grassed and mowed. • Based on the Murchison Flood Study (WT, 2014) the height of the levee (determined from new survey information) is more than 610 mm above the 1% AEP flood level.	• The levee and associated infrastructure (i.e. penstocks or values if they exist) need to be formally maintained in the future by Greater Shepparton City Council. A levee audit would provide information on the quality of the levee. • Consideration to construct a permanent short levee upstream of town to prevent backdoor flooding should be given rather than the option of relying on sandbagging efforts – refer to the Murchison Flood Mapping Study (WT, 2014).
Shepparton/ Mooroopna **(Part 1 of 4)**	**<u>PRINCESS PARK LEVEE (Shepparton)</u>** **Description** • Approximately 1100 metres in length and around 2-3 metres in height. This levee protects two sporting ovals, club rooms and recreation buildings. **Management Authority** • Nil Levee condition and level of protection • Despite no formal management arrangements, the levee is visually in very good condition and well grassed with its crest sealed forming part of the bicycle path network. The crest and levee batters meet contemporary standards. • The levee will begin to overtop at a peaked of **11.66 metres** on the Shepparton gauge. Without freeboard, the level of protection is 5 cm below the 1993 flood, or level of protection of around 4% AEP (25-year ARI). Note the 1993 flood photograph take 0.01 m of the peak show little inundation. Assuming that 600 millimetre freeboard is required to determine the level of service, then it reduces to equivalent to the September 2010 flood or 14% AEP (7-year ARI) type flood.	• A decision will need to be made if the benefits of the levee outweigh the long-term maintenance cost, particularly given the low level of protection provided. • Greater Shepparton could commission an economic evaluation of the levee prior to deciding on taking on any formal management arrangements • Refer to Murchison for further actions if management is likely to proceed.

Name	Existing Flood Mitigation Infrastructure (levees)	Proposed Flood Mitigation Infrastructure (Levees)
Shepparton/ Mooroopna **(Part 2 of 4)**	**<u>MACGUIRE RESERVE (Shepparton) Levee</u>** **Description** • Approximately 900 metres in length and around 2-3 metres in height this levee protects Shepparton's Lawn Tennis Courts, and open Crown land partly used for car parking. **Management Authority** • Nil **Levee condition and level of protection** • Despite no formal management arrangements, the levee is visually in fair good condition and grassed with its crest sealed forming part of the bicycle path network. The levee batters are relatively steep compared with contemporary standards. During the September 2010 flood, the levee marginally overtopped (stopped by sandbagging) and floodwater piped through the levee flooding parts of the tennis courts near Goulburn Valley Water's treatment plant. • The levee will begin to overtop south of Daintons Bridge at 1**0.98 metres** on the Shepparton Gauge. Without freeboard, the level of protection is around 17% AEP (or 6-year ARI). Assuming that 600 millimetre freeboard is required to determine the level of service, then it reduces 10.4 metres on the Shepparton Gauge that equates to around the 25% AEP (<4-year ARI) type flood.	• A decision will need to be made if the benefits of the levee outweigh the t long-term maintenance cost, particularly given the low level of protection provided. • Greater Shepparton could commission an economic evaluation of the levee prior to deciding on taking on any formal management arrangements • Refer to Murchison for further actions if management is likely to proceed.
Shepparton/ Mooroopna **(Part 3 of 4)**	**<u>Balmoral Estate Levee (Kialla)</u>** **Description** • Approximately 300 metres in length and around 300 millimetres in height this levee protects a number of rear backyards (west and of Furphy Avenue) from nuisance flooding. The floor levels are well above the height of the levee. **Management Authority** • Nil **Levee condition and level of protection** • Visually, the levee is low and narrow and of ad hoc construction. • During the September 2010 flood (11.09 metres on the Shepparton Gauge), the levee was eminent of overtopping. • The levee will begin to overtop at 11.10 metres on the Shepparton Gauge. Without freeboard, the level of protection is around 17% AEP (or 6-year ARI). Assuming that 600 millimetre freeboard is required to determine the level of service, then it reduces 10.4 metres on the Shepparton Gauge that equates to around the 25% AEP (<4-year ARI) type flood.	• Given that the level of service protects several rear yards, there is no merit in formally maintaining this level. In fact, Greater Shepparton should limit any further modification to the levee in terms of its height and length.

Name	Existing Flood Mitigation Infrastructure (levees)	Proposed Flood Mitigation Infrastructure (Levees)
Shepparton/ Mooroopna **(Part 4 of 4)**	**<u>VICTORIA PARK LEVEE (Shepparton)</u>** **Description** • Approximately 430 metres in length and around 600-800 millimetres in height this levee protects camping grounds associated with Victoria Lake Caravan Park. **Management Authority** • Nil **Levee condition and level of protection** • Visually, the levee is in poor to fair condition with varying crest widths and varying levee batters, and partially grassed with the presence of some trees. • During the September 2010 flood, the levee marginally overtopped (stopped by sandbagging) and floodwater piped through the levee flooding parts of the tennis courts near Goulburn Valley Water's treatment plant. • The levee will begin to overtop at 11.18 metres on the Shepparton Gauge. The September 2010 flood photography indicates that the camping grounds were protected. • Without freeboard, the level of protection is around 14% AEP (or 7-year ARI). Assuming that 600 millimetre freeboard is required to determine the level of service, then it reduces 10.58 metres on the Shepparton Gauge that equates to around 25% AEP (<4-year ARI) type flood.	• The levee only provides protection from nuisance type flooding. The camping ground should rely on evacuation procedures as part of the Park's operation. • Refer to Murchison for further actions if management is likely to proceed.
(East, North and Orrvale) Shepparton	**<u>Non-backbone Irrigation Removal along Wanganui Road Shepparton North, Shepparton East and Orrvale</u>**	• Greater Shepparton City Council will need to ensure that flooding is not transferred to the urban areas Greater Shepparton City Council to consider bringing the channels into a Water Management Scheme – refer to detailed • **Table** F-32 at the end of Appendix
Tallygaroopna	None identified	• Mitigation measures could be explored as part of the floodplain management plan for Tallygaroopna as large parts are significantly impacted by flooding
Tatura	None identified and not required	• -
Toolamba	None identified and not required	• -
Mansfield Shire Council		
Bonnie Doon	None identified and not required	• -
Gaffney's Creek (A1 Mine Settlement)	None identified and not required	• -

Name	Existing Flood Mitigation Infrastructure (levees)	Proposed Flood Mitigation Infrastructure (Levees)
Howqua	None identified and not required	• -
Jamieson	None identified and not required	• -
Maindample	None identified. Local drainage issues identified in the west of the township.	• Shire to investigate drainage solutions
Mansfield	None identified and not required	• -
Merrijig	None identified and not required	• -
Merton	None identified and not required	• -
Woods Point	None identified and not required	• -
Mitchell Shire Council		
Broadford	None identified and not required	•
Kilmore	None identified. Overland stormwater management options are currently being explored by Council	• Stormwater management implementation proposed by Council
Kilmore East	None identified and not required	• -
Pyalong	None identified and not required	• -
Reedy Creek	None identified and not required	• -
Seymour	None identified and town levee scheme is in detailed design phase	• Town Levee to protect against riverine flooding from Goulburn River and Sunday and Whiteheads Creek catchments.
Tallarook	None identified and not required	• -
Tyaak	None identified and not required	• -
Whiteheads Creek	None identified and not required	• -
Moira Shire Council		
Barmah	**<u>Barmah Town Levees</u>** **Description** • The commencement of inundation by floodwater occurs around the low-lying outskirts of the town at around 96.0 metres AHD. Which is around the 50% AEP (or 5-year ARI) type flood. • A system of levees (combined with the connecting roads) in the Barmah township has been constructed over the years, which appears to be carried out of on a needs basis privately. The standard of construction varies. Despite the town levees, the threat from flooding when river levels rise is still about the 96.0 metre AHD level or higher. The particularly levee heights are discussed below. *Barmah Forest levee to Corry Street (north of Town)* • The Barmah Forest levee extends some 39 kilometres to the north to Piree Creek. The levee elevation north of Barmah Township is generally around 96.6 metres AHD. *Corry Street levee*	• The existing ad hoc levees, with the interconnecting road network does provide some benefit against low level flooding. • The current ad hoc levees are not owned or managed by Moira Shire Council, and unlikely to be managed into the future.

Name	Existing Flood Mitigation Infrastructure (levees)	Proposed Flood Mitigation Infrastructure (Levees)
	• Approximately 330 metres in length and around 800 millimetres in height, this levee runs along the northern side of Corry Street at the general elevation of around 97.0 metres AHD from Barmah Bridge Road. *Shier to Evans Street Levee (Barmah Caravan Park)* • Approximately 480 metres in length and around 600 millimetres in height this levee, which is runs through the Barmah Caravan Park, is at the general elevation of around 96.2 metres AHD. *Evans Street Levee* • Approximately 380 metres in length and around 500 millimetres in height, this levee, which is runs behind seven residential properties adjacent to the Murray River, is at a general elevation of around 96.5 metres AHD. *Murray Street* • The Murray Street itself acts as a levee at a general effective elevation of 96.7 metres AHD, which connects the Evans Street levee with the Riverview Drive Levee. *Riverview Drive Levee* • Approximately 600 metres in length and around 400-600 millimetres in height, this levee, which is runs from Murray Street to Swan Court, behind 18 properties adjacent to the Murray River, is at a general elevation of around 96.6 metres AHD. **Management Authority** • Nil **Levee condition and level of protection** • Visually, the levees are in poor condition with narrow crest widths with steep batters. The Caravan Park is at the most venerable to flooding. • Leaving the Caravan Park levee aside, without freeboard, the level of protection for the town is around 3% AEP (or 30-year ARI) or 96.6 metres AHD. Assuming that 600 millimetre freeboard is required to determine the level of service, then it reduces 96.0 metres AHD that equates to around 20% AEP (5-year ARI) type flood.	
Bearii	None identified and not required	• -
Cobram	1% AEP Approved Water Management Scheme (Water Act 1989) implemented. Further augmentation now identified as determined by the Regional Murray Flood Study (Water Technology, 2011)	• Moira Shire currently investigation augmentation options.
Katamatite	None identified and not required	•
Koonoomoo	None identified and not required	•
Lake Rowan	None identified and not required	•
Marungi	None identified and not required	•

Name	Existing Flood Mitigation Infrastructure (levees)	Proposed Flood Mitigation Infrastructure (Levees)
Nathalia	The 1978 Flood Study (SR&WSC) recommendations of some eight kilometres were completed in the mid-1980s and were tested during the 1993 flood where overtopping was documented. Since then, the Nathalia Floodplain Management Plan (SMEC, 2005) was completed leading to the augmentation levee works, temporary demountable barriers, completed in 2011. These proved successful during the highest flood in record in March 2012.). Aither (2014) economic review indicates that the damage avoided was in the order of $35 million.	• On-going maintenance and renewal work have been carried out since 2012 and will continue by Moira Shire Council
Numurkah	Following the 1974 and 1993 floods, as series of low level levees were put in place, typical 300-450 millimetres in height to protect floodwater entering the northern portion of the town and several residential homes and a Numurkah Caravan Park to the west of Melville Street. These were overwhelmed during the 2012 flood, which was the flood of record. The AAD is some $730,000 pa.	• The Numurkah Floodplain Management Study and Plan has been investigating a range of flood mitigation options, which is nearing completion for the community consideration. Refer to • **Table** F-32 at the end of this Appendix highlights irrigation channel along Kinnairds Road that would ultimately need to be part of the final scheme to be managed by Moira Shire Council.
St James	None identified and not required	•
Strathmerton	None identified	• • **Table** F-32 at the end of this Appendix highlights irrigation channels south-east of the Town may provide urban flood protection. If decommissioned, Moira Shire Council should consider that these levees form part of a Water Management Scheme (or similar).
Tungamah	None identified. There is a community desire to look at options for mitigation	• There is a need to determine mitigation needs through a Floodplain Management Plan
Waaia	None identified and not required	• -
Wilby	None identified and not required	• -
Wunghnu	None identified and not required	• -
Yarrawonga	None identified and not required	• There are stormwater management investigation and implementation option currently being carried out by Moira Shire Council
Murrindindi Shire Council		
Alexandra	None identified. Unknown if mitigation is required or effective. Suspect a low priority to determine if any mitigation is warranted.	• Low priority

Name	Existing Flood Mitigation Infrastructure (levees)	Proposed Flood Mitigation Infrastructure (Levees)
Buxton	None identified. Unknown if mitigation is required or effective. Suspect a medium priority to determine if any mitigation is warranted given the significant number of floods since 1990s.	• Medium priority
Eildon	None identified and not required	• -
Kinglake Central	None identified and not required	• -
Kinglake East	None identified and not required	• -
Marysville	None identified and not required	• -
Molesworth	Molesworth Caravan Park levee is privately managed. This levee in located adjacent to the Goulburn River and some 600 millimetres in height.	• -
Narbethong	None identified and not required	•
Pheasant Creek & King Lake West	None identified and not required	•
Strath Creek	None identified and not required	•
Taggerty	None identified and not required	•
Thornton	None identified and not required	•
Toolangi	None identified and not required	•
Yea	None identified and not required	•
Strathbogie Shire Council		
Avenel	None identified and not required	•
Euroa	The existing Castel Creek is being augmented, upgraded and extended to the 1% AEP (100-year ARI) standard, as part of a Ministerial Approved Water Management Scheme	• Ongoing maintenance, renewal work and vegetation and sediment management will be undertaken by Strathbogie Shire council.
Graytown	None identified and not required	•
Locksley	None identified and not required	•
Longwood	None identified and not required	•
Mangalore	None identified and not required	•
Nagambie	1. The existing Industrial Estate is inundated by floodwater from the Tabilk Depression above the 5% AEP (20-year ARI) event. 2. A rural levee located on the former Nagambie-Heathcote road reserve, together with a disused approach ramp to the Western side of the Old Chinamans Bridge, are restricting flood flows and raising flood risk at the Nagambie Regatta Centre and Chinamans Bridge Caravan Park.	1. Pumping of the floodwater to the former VicRoads borrow pit is proposed. 2. Removal of the levee and the Western part of the approach ramp, both located within Municipal Road, is proposed.
Old Longwood	None identified and not required	•
Ruffy	None identified and not required	•
Strathbogie	None identified and not required	•

Name	Existing Flood Mitigation Infrastructure (levees)	Proposed Flood Mitigation Infrastructure (Levees)
Violet Town	1. A rural drain, acting to divert floodwater away from an elevated section of the Old Hume Highway at Violet Town has been overtopped by flash flooding. 2. There is a community desire to implement the proposed Violet Town Floodplain Management Scheme which proposes a new flood levee to reduce above floor flooding in a 1% AEP (100-year ARI) type event from 63 to 17 properties.	1. Upgrading and management of the Murray Street rural drain, together with localised bunding or floor raising of houses, needs to be considered. 2. Council intends to proceed with the establishment of a Water Management Scheme under the *Water Act (1989),* when workable improvements are made by the State Government in relation to Councils legal liability under the Act.

Table F-31: Regional (rural) Service levels – Structure flood mitigation works

Name	Existing Flood Mitigation (Levees)	Proposed Flood Mitigation Infrastructure (Levees)
Broken Creek Catchment		
Broken Effluent Tributaries	None identified and not required	
Lower Broken Creek	Miscellaneous private levees along Nine Mile and Broken Creeks downstream of Walshs Bridge Road, which have been surveyed as part of the Nathalia Floodplain Management Plan (SMEC, 2005). No formal management arrangements and quality is unknown. The height of the levee around the 1993 flood height (~5% AEP flood or 20-year ARI)	Nil
Mid Broken Creek	Miscellaneous private levees along Nine Mile and Broken Creeks downstream of Katamatite. No formal management arrangements and quality is unknown. The height of the levee around the 1993 flood height (~5% AEP flood or 20-year ARI)	Nil
Muckatah Depression	Some miscellaneous private levees exist along this system, extending from Dowdles Swamp to Numurkah. No information exists to their quality and level of service.	Nil
Upper Broken Creek	Miscellaneous private levees exist along several locations of the Broken and Boosey Creeks. No formal management arrangements and quality is unknown. The height of the levee are generally 300-600 millimetres in height.	Nil
Broken River Basin		
Lower Broken River	None identified and not required	
Upper Broken River	None identified and not required	
Goulburn Basin		

Name	Existing Flood Mitigation (Levees)	Proposed Flood Mitigation Infrastructure (Levees)
Acheron River	None identified	Nil
Corop Lakes	Miscellaneous private levees exist throughout the area. No formal management arrangements and quality is unknown. The height of the levees are generally 450 – 1,000 millimetres in height.	Nil
Dabyminga Creek	None identified and not required	
Delatite River	A large private levees identified.	nil
Ford Creek	None identified and not required	
Seymour to Shepparton	None identified and not required	
Granite Creeks	Some miscellaneous private levees is suspected identified by the Granite Creeks Regional Flood Mapping Study.	Nil
Howqua River	None identified and not required	
Lower Goulburn	Collectively some 170 kilometres of levees exists that flanks both sides of the Goulburn River from Bunbartha to the Murray River, and along the Deep Creek system, Wells Creek and Kanyapella Basin.	Nil unless opportunities arise to integrate environmental outcomes, such as the rehabilitation scheme (or similar)
Lower King Parrot Creek	None identified and not required	
Maindample Region	None identified and not required	`
Mid Goulburn	Miscellaneous private levees exist throughout the area. Some survey locations are shown on the 1936 River Survey Plan (Molesworth to Eildon). No formal management arrangements and quality is unknown.	
Sunday & Dry Creeks	None identified and not required	
Upper Goulburn	None identified and not required	
Upper King Parrot Creek	None identified and not required	
Whiteheads Creek	None identified and not required	
Yea River	None identified and not required	
Murray Riverina		
Murray River Levees (Cobram to Barmah)	**Description** • Uncoordinated construction of levees by private land owners commenced as early as 1870 but coordinated construction began in 1895 by the Public Works Department (PWD) from Cobram to Piree Creek (near Picola). Levees continue from Piree Creek to Barmah by uncoordinated construction. **Management Authority** • Nil **Levee condition and level of protection**	Landowners may carry out routine maintenance works under a permit process coordinated by Goulburn Broken CMA where levees are located on Crown land. Permits for levee maintenance on private land are subject to the provision of the planning scheme.

Name	Existing Flood Mitigation (Levees)	Proposed Flood Mitigation Infrastructure (Levees)
	• Variable condition and largely poor. The level of service is less than 20% AEP (20-year ARI), particularly accounting for a 600 millimetre freeboard. In the 2016 freeboard, in places, was zero.	
Murray River Echuca Village to Echuca	**Description** • History of the levee construction is unknown. **Management Authority** • Nil **Levee condition and level of protection** Variable condition unknown. The level of service is some 33% AEP (30-year ARI), particularly accounting for a 600 millimetre freeboard.	

Where possible flooding impact to urban areas from non-backbone irrigation removal has been identified, LGAs will review whether such irrigation channels should be managed under a Water Management Scheme (or similar) – refer to **Table F-32.**

Table F-32: Possible flood impact to urban areas from irrigation channel removal

Name	Urban Impact from Channel Removal
	Benalla Rural City Council
Benalla	Yes. CH014612 & CH014611 near parallel to Price Rd, CH014610 parallel to Morey Rd, CH014609 & CH014608 crossing Kilfeera Rd.
	Campaspe Shire Council
	-
	Greater Bendigo City Council
	-
	Greater Shepparton City Council
Shepparton East	Yes, CH002406, CH002405, CH008700, CH008699, CH0017290, CH0017291, CH0017292, CH008701, CH0017289, along Channel Road area.
Shepparton/ Mooroopna	Yes, CH015154, CH001663 and CH001666 near Wanganui Rd
Orrvale	Yes, CH002423 near Midland Hwy, CH001594 & CH014537 meet at the corner of Central Av and Poplar Av, CH008702 near Channel Rd, CH008686 parallel to Prentice Rd, CH008688 & CH008689 near Prentice Rd, CH014227, CH014226 & CH008685 meet near Orrvale Rd, CH008680 & CH014225 near Prentice Rd, CH017289 near Doyles Rd.
	Mansfield Shire Council
	-
	Mansfield Shire Council
	-
	Moira Shire Council
Numurkah	Yes, CH005353 parallel to Kinnairds Rd, CH014530 crossing Kinnairds Rd
Yarroweyah	Yes, CH009937 crossing Singapore Rd, CH009938 crossing Kokoda Rd
	Murrindindi Shire Council
	-
	Strathbogie Shire Council
	-

Appendix G: Service levels – Land-use planning

Terminology

DSL: Desirable Service Level
FDTP: Flood Data Transfer Project (SKM, 1999
LFDP Local Floodplain Development Plan (incorporated doc)
LUP: Land Use Planning
- No further action

L: Low
M: Medium
H: High
UFZ: Urban Floodway Zone
FO: Floodway Overlay
LSIO: Land Subject to Inundation Overlay

The following Table provides a guide (tool) to assign existing and desirable Service Levels for LGAs planning schemes in relation to floodplain management.

Service Level	Descriptor	Flood Information	Guiding Policy	Flood Zone and Overlays (and schedules)	LFDP
0 (Low)	Little to no development or future growth potential, e.g. Crown land, land with low-intensity rural uses and broad-acre cropping, livestock farming.	No mapping is available. Some anecdotal evidence available.	Unlikely to be addressed in MSS. Unlikely to have a local policy on flooding	Nil	No
1 (Low-medium)	Some development potential, but not designated for growth. E.g.: rural land, land abutting townships.	Flood extents available from past flood events. Some anecdotal evidence available.	May be addressed in MSS. May have local policy on flooding.	LSIO (base-level schedule). Potentially UFZ.	No
2 (Medium)	Designated for high-intensity rural uses and low levels of urban development and growth. Typical areas: Small towns, peri-urban areas and lifestyle farms.	Flood extents available from past flood events. Some anecdotal evidence available. Rudimentary, low accuracy flood mapping, often based on historic floods, or non-calibrated 1D modelling.	Addressed in MSS at a minimum. May have a local policy on flooding. May have a LFDP (depending on expected level of development in flood prone areas).	LSIO and FO (base-level schedules). Potentially UFZ.	Maybe
3 (Medium-high)	Designated for modest levels of low-density urban development, growth and possible urban expansion (large towns).	Flood extents available from past flood events, or calibrated 1D or 2D flood modelling.	Addressed in MSS. Likely to have a local policy on flooding. Usually includes a LFDP.	LSIO, FO and SBO (detailed locally specific schedules).	Maybe
4 (High)	Designated for high-density urban development, high growth and urban expansion (major regional centres).	Calibrated 2D flood modelling.	Addressed in MSS. Includes a local policy on flooding. A LFDP exists to guide applications and decisions.	LSIO, FO and SBO (detailed locally specific schedules).	Maybe

The following Tables provide an assessment and actions to address Service Level scores to improve planning schemes in terms of land-use planning relating to floodplain management for urban centres (for each LGA) and regional (rural) area. Also, an overall LGA-wide assessment is included against the tools available in planning schemes.

Benalla Rural City Council

LGA-wide Assessment

Local Planning Policy Framework	Schedule to the flood Overlay Controls	Other	Zone and Overlays	Priority for LGA-wide amendment (-, L, M, H)
Clause 21.02-1, 21.04-1 21.05-1, and 21.08 provides good coverage of floodplain management matters	Nil	Agreement in place until Schedules are incorporated into planning scheme	Poor coverage in current planning Scheme	Very High

Specific locations (urban centres)

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Baddaginnie	2	Nil	Parts of the town are known to be subject to flooding as documented in the FDTP. Introduce flood overlay controls using following completion of the Granite Creek Regional Flood Mapping Study.	Nil	0
Benalla	4	UFZ, LSIO	Mapping based on 1993 flood information and early flood study by Willing and Partners in 1994. Benalla is subject to widespread flooding during large floods and continues to grow.	Nil	3
Devenish	2	Nil	Evidence of flooding from recorded peak flood levels	Nil	0
Swanpool	-	Not Required	Town is located on a high terrace some three metres above the Broken River floodplain.	-	-
Tatong	1	Nil	Bulk of the Town is elevation. The eastern portion of the Town is however suspected to be liable to flooding from the Holland Creek.	Nil	0
Thoona	1	Nil	Bulk of the Town is elevation above the Boosey Creek floodplain. The southern end of Town maybe subject to flooding	Nil	0
Winton	1	Nil	The Town has landlocked area and subject to flooding from Winton and Seven Mile Creeks	Nil	0

Actions to address Service Level Scores – Benalla Rural City Council

Benalla Rural City Council	
Baddaginnie	**LUP DSL = 2; Service Level = 0** As part of LGA-wide amendment adopt the FDTP flood mapping and check mapping from the Granite Creek Regional Flood Mapping Study. This lifts the service level above 2.
Benalla	**LUP DSL = 4; Service Level = 3** As part of LGA-wide amendment, the Goulburn Broken CMA, in conjunction with Benalla Rural City Council, will prepare UFZ, FO and LSIO mapping based on the reference 1993 flood together to Cardno modelling work of 2009. This lifts the service level to 4.
Devenish	**LUP DSL = 2; Service Level = 0** As part of LGA-wide amendment, the Goulburn Broken CMA, in conjunction with Benalla Rural City Council, will prepare rudimentary mapping based on 2017 LiDAR and historic flood information. In the longer term, utilise mapping if and when the Upper Broken Creek Regional Flood Study becomes available. This lifts the service level to 2.
Tatong	**LUP DSL = 1; Service Level = 0** As part of LGA-wide amendment adopt the FDTP flood mapping and check against available LiDAR. This lifts the service level above 2.
Thoona	**LUP DSL = 1; Service Level = 0** As part of LGA-wide amendment, the Goulburn Broken CMA, in conjunction with Benalla Rural City Council, could prepare rudimentary mapping based on 2017 LiDAR and a 1% flood level estimate. This lifts the service level to 2.
Winton	**LUP DSL = 1; Service Level = 0** There is currently no available detailed ground or flood information to allow any flood mapping. A scoping flood study could be carried out that may inform rudimentary mapping. This lifts the service level above 1.

Campaspe Shire Council

LGA-wide Assessment

Local Planning Policy Framework	Schedule to the flood Overlay Controls	Other	Flood Zone and Overlays	Priority for LGA-wide amendment (-, L, M, H)
Clause 21.03-1, 21.03-3, 21.04-1, 21.04-2, 21.04-5, 21.05-2, 21.05-3, 21.09-1, 21.09-3, 21.09-6 provides good coverage of floodplain management matters.	Yes	Six LFDP have been incorporated into the planning scheme. They require a review	Generally good.	Low

Specific locations (urban centres)

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Colbinabbin	2	FO and LSIO	Mapping based on 1973, 1974 flood information. Overlays could be extended over east of town (school site).	Yes	2
Girgarre	-	Not Required	The Town is not known to be subject to flooding.	Yes	-
Kyabram	3	LSIO	Broad brush LSIO exist, which requires a review as part of a flood study	Nil	2
Rushworth	-	Not Required	Local overland flooding is managed with stormwater works.	-	-
Stanhope	1	Nil	No known history of flooding in Town.	Nil	0
Tongala	1	Nil	Local overland flooding is managed with stormwater works.	Nil	0
Wyuna	1	Nil	Localised drainage path has been mapped.	Nil	0

Actions to address Service Level scores – Campaspe Shire Council

Campaspe Shire Council	
Kyabram	**LUP DSL = 3; Service Level = 2** Carry out a new flood study to review the current mitigation scheme and to improve flood intelligence and mapping. This lifts the service level above 3. .

Greater Bendigo City Council

Specific locations

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Costerfield	-	Not required	These areas lie on very small isolated catchment and therefore little benefit of introducing overlay controls	-	-
Costerfield South	-	Not required		-	-
Heathcote East (RLZ)	-	Not required		-	-
Heathcote North (RLZ)	-	Not required		-	-
Mount Camel	-	Not required		-	-
Redcastle	0	Mapping would be useful	Catchment through this area is some 18 square kilometres and there would be some merit of having rudimentary overlay controls but not likely to be implemented during the course of this Strategy.	Nil	-

Actions to address Service Level scores – Greater Bendigo Shire Council

Greater Bendigo City Council	
Redcastle	**LUP DSL = 0; Service Level = -** Rural land mapping at a rudimentary scale would be required to address the desirable service level but is regarded as a low priority, and unlikely to be implemented during the course of this Strategy. No further action. This lifts the service level above 0.

Greater Shepparton City Council

LGA-wide Assessment

Local Planning Policy Framework	Schedule to the flood Overlay Controls	Other	Flood Zone and Overlays	Priority for LGA-wide amendment (-, L, M, H)
Provides good coverage of floodplain management matters.	Yes	Six LFDPs have been incorporated into the planning scheme. They require an update	Generally good.	Low

Specific locations (urban centres)

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Bunbartha	1	FO and LSIO	Minor updates are available as part of the lower Goulburn regional flood study	Yes	1
Cooma	-	Not Required	The Town is not known to be subject to flooding.	-	-
Katandra West	2	Nil	Some aerial 2012 oblique photography available that could be used for broad-brush mapping. No detailed ground level information is currently available	Nil	-
Merrigum	2	Not Required	Flood mapping is based on a detailed flood study (2005)	Yes	3
Murchison / Murchison East	2	FO and LSIO	Flood mapping is based on limited historical information. New detailed mapping available from the Murchison Flood Mapping Study, which needs to be utilised to update planning scheme.	Yes	1
Shepparton East	4	Limited LSIO	LSIO based on limited 1993 aerial photography. Shepparton East Overland Flow Urban Flood Study, is now available and should be utilised to update the planning scheme.	Nil	-
Shepparton Mooroopna	4	UFZ, FO and LSIO	Based on floodplain management study (2002). Requires updating based on the latest Flood Intelligence and Mapping Study.	Yes	3
Tallygaroopna	1	Mostly Nil	Recorded peak flood levels available but no ground level information. Only broad-brush overlays could be prepared at this stage, until a floodplain management plan is carried out.	Nil	0

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Tatura	3	UFZ, FO and LSIO	Based on Tatura Flood Study.	Yes	3
Toolamba	1	FO and LSIO	Some minor improvement is required that will be part of the Regional Goulburn and Broken Flood Mapping project.		1

Actions to address Service Level Scores – Greater Shepparton City Council

Greater Shepparton City Council	
Katandra West	**LUP DSL = 2; Service Level = -** Only rudimentary low level mapping could be prepared, based on available flood photography. This lifts the service level to 2.
Murchison/ Murchison East	**LUP DSL = 2; Service Level = 1** Update planning scheme with new detailed flood mapping from the Murchison Flood Mapping Study This lifts the service level to 4.
Shepparton East	**LUP DSL = 4; Service Level = -** Update planning scheme with new detailed flood mapping from the Shepparton East Overland Flow Urban Flood Study This lifts the service level to 4.
Shepparton Mooroopna	**LUP DSL = 4; Service Level = 3** Update planning scheme with new detailed flood mapping from the Shepparton Mooroopna Flood Intelligence and Mapping study. This lifts the service level to 4
Tally-garoopna	Only rudimentary low level mapping could be prepared, based on available flood photography.

Mansfield Shire Council

LGA-wide Assessment

Local Planning Policy Framework	Schedule to the flood Overlay Controls	Other	Zone and Overlays	Priority for LGA-wide amendment (-, L, M, H)
Provides good coverage of floodplain management matters	Yes	Shire-wide LFDP in place	Yes including UFZ through Mansfield.	-

Specific locations (urban centres)

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Bonnie Doon	–	–	–	–	–
Gaffney's Creek / A1 Mine Settlement	-	-	-	-	-
Howqua	1	FO	Fair flood mapping has been placed into planning scheme using recent valley LiDAR data. Detailed hydrology recently completed should be utilised to provide improved flood mapping and intelligence.	Yes	1
Jamieson	2	LSIO and FO	Flood mapping is based on hydraulic mapping as part of Jamieson Scoping Study. Detailed hydrology recently completed that may be utilised to provide improved flood mapping and intelligence.	-	2
Maindample	1	LSI0	Rudimentary mapping has been placed into planning scheme	Yes	1
Mansfield	3	LSIO and FO	Flood mapping based on detailed 2D-hydraulic modelling.	Yes	3
Merton	-	-	-	-	-
Merrijig	-	-	-	-	-
Wood's Point	0	LSIO	Rudimentary mapping has been placed into planning scheme	Yes	1

Actions to address Service Level Scores – Mansfield Shire Council

Mansfield Shire Council	
Jamieson	**LUP DSL = 2; Service Level = 2** GB CMA will seek to improved regional flood mapping and intelligence for major floodplain valleys in the Shire including Jamieson due to availability of completed hydrologic study. This lifts the service level above 2.

Mitchell Shire Council

LGA-wide Assessment

Local Planning Policy Framework	Schedule to the flood Overlay Controls	Other	Zone and Overlays	Priority for LGA-wide amendment (-, L, M, H)
Provides good coverage of floodplain management matters	Yes	A LFDP is incorporated in planning scheme for the Goulburn River but requires a review.	Overall fair to good coverage. Five major areas will require updating. over the next few years	Medium

Specific locations (urban centres)

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Broadford [i]	3	LSIO and FO	Parts of the town are known to be subject to flooding. New flood mapping and intelligence project will provide revised flood mapping for the planning scheme.	Nil	2
Kilmore	4	Nil	New flood mapping and intelligence project will provide new flood mapping for the planning scheme.	Nil	-
Kilmore East [i]	0	Nil	Extent of flooding has yet to be defined. New flood mapping and intelligence project will provide new flood mapping for the planning scheme.	Nil	3
Pyalong	0	Nil	Flooding is unlikely given the incised nature of the waterways relative to the developed areas. A check could be carried out using approximate modelling techniques	Nil	-
Ready Creek [ii]	1	Nil	Extent of flooding is unknown and yet to be defined. New flood mapping and intelligence project will provide new flood mapping for the planning scheme as part	Nil	-

			of the regional study for Dabyminga Creek.		
Seymour (Goulburn River)	4	Nil	Current flood mapping is sound along the Goulburn River – refer Whiteheads Creek	Yes	4
Tallarook	1	Nil	Rudimentary low accurate broad-brush mapping has been used in the current planning scheme. More accurate mapping is available from the Tallarook Flood Mapping Project that should be used if the regional Dabyminga Creek Regional Study is delayed.	Nil	1
Tyaak [ii]	0	Nil	Extent of flooding is unknown and yet to be defined. New flood mapping and intelligence project will provide new flood mapping for the planning scheme as part of the regional study for Dabyminga Creek.	Nil	-
Whiteheads Creek	4	UFZ, FO and LSIO	Current mapping is broad-brush along Whiteheads Creek and its tributaries. Planning scheme requires updating once Whiteheads Creek Flood Mapping Study is completed.	Nil	2

[i] Part of Sunday Creek and Dry Creek Regional Study

[ii] Part of the Dabyminga Creek Regional Study

Actions to address Service Level Scores – Mitchell Shire Council

Mitchell Shire Council	
Broadford	**LUP DSL = 4; Service Level = 2** Introduce new UFZ, and revise FO and LSIOs from the Sunday Creek and Dry Creek Flood Mapping and Intelligence Study (funding approved late 2017). This lifts the service level above 4.
Kilmore	**LUP DSL = 4; Service Level = 0** Introduce new UFZ, FO and LSIOs from the Kilmore Flood Mapping and Intelligence Study. This lifts the service level above 4.
Whiteheads Creek	**LUP DSL = 4; Service Level = 2** Update the UFZ, FO and LSIOAs from the Whiteheads Creek Flood Mapping Study. This lifts the service level above 4.
Pyalong	**LUP DSL = 0; Service Level = -** A low priority. Plan to carry out approximate mapping methods to provide rudimentary mapping. This lifts the service level to 0.

Moira Shire Council

LGA-wide Assessment

Local Planning Policy Framework	Schedule to the flood Overlay Controls	Other	Zone and Overlays	Priority for LGA-wide amendment (-, L, M, H)
Provides fair coverage of floodplain management matters	Yes but requirement updating	LFDPs drafted but not incorporated in planning scheme	Overall good coverage but require updating along the Murray River, Broken Creek and lower Goulburn areas	High

Specific locations (urban centres)

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Barmah	3	LSIO and FO	Mapping based on estimated 1% AEP flood heights against accurate ground level data.	No	3
Bearii	1	LSIO and FO	Rudimentary brush mapping based on estimated 1% AEP flood heights and one-foot ground contours.	No	1
Cobram[1]	2	LSIO and FO around protected areas	There is scope to improve overlay controls from the Murray River Regional Flood Study - Dicks/Seppelts levees.	No	2
Katamatite [ii]	1	LSIO and FO	Mapping based on estimated 1% AEP flood heights and aerial flood photography against one-foot ground level information. May improve mapping from the Upper Broken Creek Regional (Rural) Study	No	1
Koonoomoo [i]	1	LSIO and FO	Mapping based on estimated 1% AEP flood heights and aerial flood photography against one-foot ground level information. May improve flood mapping from the Murray River Regional Flood Study - Dicks/Seppelts levees.	Nil	1
Lake Rowan [ii]	1	Nil	Introduce FO and LSIO into planning scheme following completion of the Upper Broken Creek Regional (rural) Flood Study	No	-
Marungi	-	No required	-	-	-
Nathalia	2	LSIO and FO	Current mapping is fair. Mapping can be updated on a Shire-wide basis from the Nathalia Floodplain Management Study	No	2

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Numurkah	3	UFZ, LSIO and FO	Current mapping overall is fair but inaccurate in sections. Mapping can be updated on a Shire-wide basis from the Numurkah Floodplain Management Study.	No	2
St James [ii]	1	Nil	Introduce FO and LSIO into planning scheme following completion of the Upper Broken Creek Flood Regional (Rural) Flood Study.	No	-
Strath-merton [i]	-	Nil	Introduce new LSIO and FO into the planning scheme prepared from the Murray River Regional Flood Study - Dicks/Seppelts levees to downstream of the Ulupna Creek confluence.	No	1
Tungamah [ii]	2	LSIO and FO	Mapping based on estimated 1% AEP flood heights (from 1974 peak flood heights) against accurate ground level data. A floodplain management plan is required – possibly as part of the Upper Broken Creek (Rural) Study. Revised flood mapping to be utilised for planning scheme.	No	1
Waaia		Not required	Not subject to riverine flooding, but a significant drainage line has been identified that can be shown in the planning scheme. Such effort would be Shire-wide.	-	-
Wilby [ii]	1	Nil	Introduce new LSIO and FO following completion of the regional upper Broken Creek Regional	-	0
Wunghnu	2	UFZ, LSIO and FO	Rudimentary mapping based on estimated 1% AEP flood heights and foot ground contours.	No	1
Yarrawonga	3	Nil	Flood mapping from Yarrawonga Overland Drainage and Flood Study be introduced into planning scheme	No	-
Yarroweyah [i]	2	LSIO	Introduce revised LSIO and FO into the planning scheme from the Murray River Regional Flood Study - Dicks/Seppelts levees to downstream of the Ulupna Creek confluence.	No	1

[i] Murray River Regional Study Cobram to Ulupna Area

[2] Upper Broken Creek (Rural) Area

Actions to address Service Level scores – Moira Shire Council

Moira Shire Council	
Numurkah	**LUP DSL = 3; Service Level = 2** Update flood mapping from findings from the Numurkah Floodplain Management Plan This lifts the service level above 3.
Tungamah	**LUP DSL = 2; Service Level = 1** Carry out a floodplain management Study with its finding utilised to update planning scheme flood overlays. This lifts the service level above 3.
Cobram to Ulupna (Urban) Area	**LUP DSL = 2; Service Level 1** Used the finding from the Murray River Regional Flood Study - Dicks/Seppelts levees to downstream of the Ulupna Creek confluence to update planning scheme flood overlay including: • Cobram; • Koonoomoo; • Strathmerton; • Yarroweyah; and • Associated rural areas This lifts the service level to 2.
Upper Broken Creek (Rural) Area	**LUP DSL = 1; Service Level = 0** Carry out new Regional Upper Broken Creek Flood Study. The finding will be used to update the planning scheme flood overlay including: • Lake Rowan • St James • Tungamah (possibly part of the regional study) • Wilby • Associated rural area primary along Boosey, Broken, Sandy Creeks This lifts the service level above 2.

Murrindindi Shire Council

LGA-wide Assessment

Local Planning Policy Framework	Schedule to the flood Overlay Controls	Other	Zone and Overlays	Priority for LGA-wide amendment (-, L, M, H)
Provides good coverage of floodplain management matters	Yes	A LFDP is incorporated in planning scheme for the Goulburn River but requires a review.	Zone and Overlay used that are mostly based on broad-brush mapping with low accuracy but which significant ground truthing (exception is Yea which is based on Yea Flood Study)	-

Specific locations (urban centres)

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Alexandra	3	LSIO	Broad mapping along UT based on account from the 1975 flood. Many other overland flow paths and tributaries identified. A riverine and overland flood study is required. Findings of the study to be used to introduce new overlay controls in the planning scheme (if warranted).	Nil	1
Buxton [i]	3	LSIO	Broad inaccurate mapping used. Following the completion of the Buxton flood mapping study revise overlay controls in the planning scheme.	Nil	1
Eildon	1	Nil	Possible minor overland flooding. Could carry out an overland flood mapping study but is unlikely to be a priority over the next ten-years	Nil	-
Flowerdale	2	LSIO and FO	Planning scheme overlay controls require updating based on completed Flowerdale Flood Intelligence and Mapping Study.	Nil-	1
Kinglake Central	-	No required	Minor drainage lines are deeply incised and unlikely to create major flooding problems.	-	-
Marysville [i]	3	LSIO	Broad inaccurate mapping used. Following the completion of the Maryville flood mapping study revise overlay controls in the planning scheme.	Nil	1

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Molesworth [ii]	1	LSIO and FO	Fair representation. Seek to update the planning scheme following completion of the Goulburn and Broken River Regional Study.	Yes	1
Narbethong		Not required	Some small deeply incised waterways are unlikely to create major flooding problems	-	-
Kinglake East, Pheasant Creek and King lake West	1		Numerous waterways traverse through these areas and some minor overlay flooding may be possible. If an overland flood study is carried out, introduce new flood overlay control in planning scheme	Nil	-
Strath Creek	1	LSIO	Broad inaccurate mapping used. Parts of the town subject to possible flooding but severity of flooding is unknown. Introduce new overlay controls when the regional study for lower King Parrot Creek is undertaken	Nil	1
Taggerty	3	LSIO and FO	Broad brush mapping used but modified based on community input. Revise overlay controls when Taggerty Flood Mapping Study is completed	Nil	1
Thornton [ii]	3	FO	Fair representation. Seek to update the planning scheme following completion of the Goulburn and Broken River Regional Study.	Yes	1
Toolangi	-	Not required	Yea River runs north of the town, which is deeply incised and unlikely to create any flooding issues.	Nil	-
Yarck	0	LSIO	Broad-brush mapping used along Home Creek (along the western edge of town). Some minor waterways (with a catchment area of around 2 square kilometres) are not likely to pose flooding issues.	Nil	0
Yea	3	UFZ, LSIO and FO	Accurate mapping exists for riverine type flooding from the Yea River and Boundary Creek and the SL score is 3. However, overlay flooding has been identified as an issue. Introduce new flood overlay controls in the planning scheme following a completion of an overland flood study.	Nil	- (Overland flooding)

[i] Complete Buxton, Marysville and Taggerty together

[ii] Undertake as part of the Goulburn and Broken River Regional Studies (new initiative for 2018)

Actions to address Service Level Scores – Murrindindi Shire Council

Murrindindi Shire Council	
Alexandra	**LUP DSL = 3; Service Level = 1** Carried out a riverine and overland flood intelligence and mapping study. Revise and introduce new overlay controls in the planning scheme This lifts the service level to 3.
Buxton	**LUP DSL = 3; Service Level = 1** Complete the current Buxton Flood Mapping Study and revise overlay controls in the planning scheme. This lifts the service level to 3.
Flowerdale	**LUP DSL = 2; Service Level = 1** Introduce revised flood overlay controls into the planning scheme. This lifts the service level to 3.
Marysville	**LUP DSL = 1; Service Level = 0** Carried out a flood mapping study. Revise and introduce new overlay controls in the planning scheme. This lifts the service level above 2.
Thornton	**LUP DSL = 3; Service Level = 1** Complete the Goulburn and Broken Rivers Regional Flood Study and revise flood overlay controls in the planning scheme. This lifts the service level to 3.
Yea	**LUP DSL = 3; Service Level = -** Carried out an overland flood mapping study. Introduce new overlay controls into the planning scheme. This lifts the service level to 3.

Strathbogie Shire Council

LGA-wide Assessment

Local Planning Policy Framework	Schedule to the flood Overlay Controls	Other	Zone and Overlay	Priority for LGA-wide amendment (-, L, M, H)
Provides good coverage of floodplain management matters	LSIO and FO	Agreement in place until Schedules are incorporated into planning scheme	Poor to fair coverage and requires LGA-wide improvements to the UFZ, FO & LSIO	High

Specific locations (urban centres)

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Avenal [i]	2	UFZ, LSIO and FO	Broad-brush flood mapping used. Revise and introduce flood overlay controls following the completion of the Granite Creek Regional Flood Study.	Nil	1

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Euroa	4	UFZ, LSIO and FO	Mapping based on a 1997 flood study, which has some mapping anomalies. Revise flood zone and overlay controls from the completed Euroa Flood Intelligence and Mapping Study.	Yes	3
Graytown	-	Not required	Possible minor flooding possible through this largely undeveloped area. This is a low priority and if a scoping study provides flood mapping information, then introduce into the planning scheme.	Nil	-
Locksley [i]	2	LSIO	Broad-brush mapping used. Town is mostly high. Revise and introduce flood overlay controls following the completion of the Granite Creek Regional Flood Study.	-	0
Longwood [i]	1	LSIO	Broad-brush mapping used. Some possible is suspected. Revise and introduce flood overlay controls following the completion of the Granite Creek Regional Flood Study.	Nil	0
Mangalore	1	Not required	Flooding is suspected based on the past major storm of 2016. If a scoping study is carried out, then introduce flood overlay controls into the planning scheme.	Nil	-
Nagambie	3	Nil	Introduce zone and overlay controls into the planning scheme from the completed Nagambie Flood Study.	Nil	-
Old Longwood [i]	2	Nil	Town is mostly high. Introduce flood overlay controls following the completion of the Granite Creek Regional Flood Study.	Nil	-
Ruffy	-	Not required	-	-	-
Strathbogie	-	Not required	Creeks are deeply incised and unlikely to create major flood issues.	-	-
Violet Town	3	UFZ, LSIO and FO	Broad-brush mapping used. Revise zone and flood overlay controls into the planning scheme for the completed Violet Town Flood Study.	Yes	1

[i] Part of the Granite Creeks Regional Flood Study

Actions to address Service Level Scores – Strathbogie Shire Council

Strathbogie Shire Council	
Euroa	**LUP DSL = 4; Service Level = 3** Revise flood zone and overlay controls from the completed Euroa Flood Intelligence and Mapping Study. This lifts the service level to 4.
Granite Creeks Area	**LUP DSL = 2; Service Level = 1** Revise and introduce zone and flood overlay controls following the completion of the Granite Creeks Regional Flood Study for: • Avenal; • Locksley • Longwood • Old Longwood • And associated rural areas from the Hume Freeway to the Goulburn River. This lifts the service level above 2.
Nagambie	**LUP DSL = 3; Service Level = -** Introduce zone and flood overlay controls following the completion of the Nagambie Flood Study. This lifts the service level above 3.
Violet Town	**LUP DSL = 3; Service Level = 1** Revise zone and flood overlay controls into the planning scheme for the completed Violet Town Flood Study. This lifts the service level above 3.

Regional (rural centres)

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Broken Creek					
Broken Creek Tributaries	1	LSIO and FO	Mapping is mostly good, which has been based on 1993 flood information and available imperial ground contours. Unlikely that a regional flood study will be justified in the short.	Yes	1
Lower Broken Creek	2	LSIO and FO	Mapping is mostly good, which has been based on 1974 and 1993 flood information and available imperial ground contours. Revise flood overlay controls from the Nathalia and Numurkah Floodplain Management plans.	No	1
Mid Broken Creek	1	LSIO and FO	Mapping is mostly good, which has been based on 1974 and 1993 flood information and available imperial ground contours. Revise flood overlay controls from the Numurkah Floodplain Management plans.	No	1
Muckatah Depression	1	LSIO and FO	Mapping is mostly good, which has been based on 1974 and 1993 flood information and available imperial ground contours. Unlikely that a regional flood study will be justify overlay control amendments. However, 2012 historical data would assist in updating flood maps	No	1
Upper Broken Creek	2	Nil, LSIO and FO	Many towns are known to be impacted by major floods and have no overlay controls. A regional flood study is required to improve flood mapping and intelligence. Revise and introduce zone and overlay controls following completion of the study.	No	-
Broken River					
Lower Broken River	2	LSIO and FO	Flood mapping from Benalla to Nalinga is poor missing substantial parts of the floodplains. Revised historical mapping underway for BRCC. In the longer-term, the Goulburn and Broken River Regional flood study will provide high quality flood mapping and intelligence information.	No	1

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Upper Broken River	0	Nil	The FDTP (available via the VFD) data is available but is broad-broad based on limited aerial photography interpretation but should be utilised. In the longer-term, the Goulburn and Broken River Regional flood study will provide high quality flood mapping and intelligence information.		
Goulburn System					
Acheron River	1	LSIO and FO	Broad-brush inaccurate flood mapping used. From the current Acheron hydrology work being carried the GB CMA will developed revised mapping based on 2D hydraulic modelling based on LiDAR and surveyed features (bridges). This work will provide revised flood mapping for the planning scheme.	No	0
Corop Lakes	1	LSIO and FO	Available 1973, 1974 and 1975 aerial flood photography together with imperial contours were utilised in the current flood mapping for this area. The Corop Scoping study found that the overlay controls are mostly sound.	Yes	1
Dabyminga Creek	1	LSIO and FO (in part for Tallarook)	Dabyminga regional flood study, would include the small towns of Reedy Creek, Tallarook and Tyaak.	No	-
Delatite River	1	FO (partial)	Flood overlay is based on valley survey data from LiDAR and is a fair presentation of the floodplain. Detailed hydrology recently completed should be utilised to provide improved flood mapping and intelligence	Yes	1
Ford Creek	1	Nil	Detailed hydrology recently completed, which could be utilised to provide improved flood mapping and intelligence for rural areas and for Mansfield urban centre.	Yes	-
Goulburn Seymour to Shepparton	1	LSIO and FO	1974 RAAF aerial flood photography, peak flood level (1974, 1916) and limit imperial contours utilised. In the longer-term, the Goulburn and Broken River Regional flood study will provide high quality flood mapping and intelligence information, which should be used to update planning schemes (Mitchell, Strathbogie and Greater Shepparton Councils)	Yes	1

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Granite Creeks	1	LSIO and FO	Mostly broad-brush mapping based on aerial photography, oblique 1980s aerial photography. The Regional Granite Creek Flood Mapping and Intelligence Study should be utilised to refined planning schemes (BRCC and SSC).	Yes (for SCC)	1
Howqua River	1	FO	Flood overlay is based on valley survey data from LiDAR and is a fair presentation of the floodplain. Detailed hydrology recently completed should be utilised to provide improved flood mapping and intelligence.	Yes	0
Lower Goulburn	2	LSIO and FO	Flood mapping bases on 1987 flood study, ground contours and historical peak flood heights and is considered a fair representation. Revised flood mapping from the Lower Goulburn Floodplain Rehabilitation Project could be used to revise flood overlay controls for Campaspe, Greater Shepparton City and Moira Shire Councils.	Yes (for CSSC and GSCC)	2
Lower King Parrot Creek	0	LSIO and FO	Broad-brush mapping used based on aerial photography but modified based on ground truthing.	Yes	0
Maindample Region	1	LSIO	Broad-brush mapping used initially based on aerial photography but modified based on ground truthing with community input.	Yes	1
Mid Goulburn	1	FO	Broad-brush mapping used initially based on aerial photography with some ground truthing. In the longer-term, the Goulburn and Broken River Regional flood study will provide high quality flood mapping and intelligence information, which should be used to update planning schemes (Mitchell, and Murrindindi Councils)		
Sunday & Dry Creeks	1	LSIO and FO	Broad-brush mapping used initially based on aerial photography. Utilise the Sunday and Dry Creek Regional flood study to introduce and revise zone and flood overlay flood controls in the planning scheme (Mitchell Shire).	No	0
Tatura/ Tongala Region	1	LSIO and FO	Historical data used including 1950 flood and imperial ground data. Detail studies unlikely to add meaningful information at this time.	No	1

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Upper Goulburn	1	Nil (excluding Jamieson)	Flood overlay is based on valley survey data from LiDAR and is a fair presentation of the floodplain. Detailed hydrology recently completed should be utilised to provide improved flood mapping and intelligence.	Yes	1
Upper King Parrot Creek	2	LSIO and FO	Broad-brush mapping based on aerial photography interpretation, and ground truthing with community input. Update flood overlay control; using the Flowerdale Flood Intelligence and Mapping Study	No	1
Whiteheads Creek	1	UFZ, FO and LSIO	Reasonable flood mapping used based on limited ground contours and recorded historical data. Update zone overlay flood controls following the completion of the Whiteheads Creek flood intelligence and Flood Mapping Study.	No	1
Yea River	3	UFZ, LSIO and FO	Mapping is up to date including mapping from the Yea Flood Study.	No	4
Murray System					
Murray Barmah to Echuca	1	LSIO and FO	Mapping based on a range of flood studies (historical peak flood levels and sound ground level data). Could update mapping using outputs from the Lower Goulburn Floodplain Rehabilitation Scheme Study	Yes	1
Murray Cobram to Ulupna	2	LSIO and FO	Mapping based historical peak flood levels, aerial flood photography (including satellite) and imperial ground level data. Should update mapping using outputs from the Regional Murray Flood Study to include rural towns: Koonoomoo, Yarroweyah and Strathmerton.	No	1
Murray Ulupna to Barmah	0	LSIO and FO	Mapping based historical peak flood levels, aerial flood photography (including satellite) and imperial ground level data. A regional flood study for this area unlikely given the low priority compared with other areas at this point of time	No	0
Murray Upstream of Yarrawonga	0	LSIO and FO	Mapping based on a historical peak flood levels and imperial ground level data but some errors have been found. Could update mapping as part of the global LGA upgrade.	No	0

Location	Land Use Planning DSL	Existing Planning Scheme Information			
		Zone/Overlay	Description of flood mapping use and location	Incorporated LFDP	Service Level
Murray Yarrawonga to Cobram East	0	LSIO and FO	Mapping based on a historical peak flood levels and imperial ground level data. Could update mapping as part of the global LGA upgrade (in part, includes the Regional Murray Flood Study).	No	1

Appendix H: Service levels – Total Flood Warning System (TFWS)

Background

There are two service level report cards produced, the first (RS1) based on all known variables aligned with the above, and the second (RS2) where the adjusted flood risk scores (for Factor G) are assigned based on stakeholder experience and input. In this regard, there are very few adjustments made to the flood risk scores that are documented below.

The service level comparisons with the flood risks are presented below. The following colour codes visually aid where the Flood Warning Service (as a whole) are commensurate with the flood risk as follows:

Red:	Service level of the TFWS is less than level of flood risk
Yellow:	Service level of the TFWS is same as the level of flood risk
Green:	Service level of the TFWS is greater than the flood risk

Further, the elements (the factors) that make up a TFWS system are coded:

Pink:	Element (factor) is less than the flood risk

The Tool has been "gamed" (a trial and error process) allowing possible improvements to some of the elements to elevate the score of the TFWS service level against the adjusted flood risk that is largely guided by the initial actions in the priority assessment in **Chapter 3:**. The detailed methodology is presented in **Appendix K**: TFWS assessment Tool methodology

The following approach, key considerations and assumptions was carried out:

1. Using the (TFWS Tool) existing catchments Excel workbook:
    a) Update Tool input data to reflect regional Strategy actions identified following the input from stakeholder input.
    b) Review Factor G (Social and Economic Assessment – flood risk score) following the input from stakeholder input.
    c) For those management units where TFWS levels remain less than the adjusted score, "game" (trial) the Tool input data to achieve service level commensurate with the flood risk level.
2. Benefits to the TFWS arising from delivery of proposed detailed flood studies have been placed through the Tool where flood intelligence can be incorporated into planning schemes, response plans and the like.
3. Where the service level of a TFWS element is less than the adjusted flood risk level, opportunities exist to initiate action to improve that element. It is important to note as a number of elements (factors) within the Tool have a time component that acts to reduce their value to the overall TFWS as time pass (e.g. last major flood, Local Flood Guide, LFG, flood study and mapping, flood intelligence and MFEP) it is important to recognise that service levels for Factor D, E and F will continue to decline unless renewal or update activity occurs.
4. The reworked Tool has been extended to July 2017

The TFWS service levels are presented on the local government areas for urban centres, and followed by regional rural areas across the Goulburn Broken CMA region. Under each assessment, a summary of action/improvements are provided to match to flood risk scores.

Benalla Rural City Council (Urban Centres)

Location/ River Reach	Service Levels						Service Level Tier (Factors A-F)	Factor	Location/ River Reach
	A	B	C	D	E	F		G	
	DCN	Forecasting	Dissemination & Communication	Awareness & Education	Interpretation	Response Planning		Adjusted Flood Risk Score	
Baddaginnie	1	0	0	0	3	0	1	1	Baddaginnie
Benalla	2	2	2	2	4	4	3	4	Benalla
Devenish	1	0	0	0	0	0	1	0	Devenish
Glenrowan (Rural City of Wang)	0	0	0	0	0	0	1	0	Glenrowan (Rural City of Wang)
Swanpool	2	0	0	0	0	0	1	1	Swanpool
Tatong	1	0	0	0	0	0	1	1	Tatong
Thoona	0	0	0	0	0	0	0	0	Thoona

Note Flood Risk Levels are the same as the Adjusted Flood Risk Score

Risk Level Colour Coding
TFWS Element Service Level is less than Level of Risk
Overall TWFS Service Level is greater than the Level of Risk
Overall TWFS Service Level is equal to the Level of Risk
Overall TWFS Service Level is less than the Level of Risk

Benalla Rural City Council	
Benalla	**TFWS SL = 3; Flood risk score = 4** Improve dissemination and communication, awareness and education including introduction of planning scheme mapping from available flood data. Share site-specific property information - seek option using HydroNET hoisting. This lifts the TFWS SL above 3, which is still a little lower than the flood risk score

Campaspe Shire Council (Urban Centres)

Location/ River Reach	Service Levels						Service Level Tier (Factors A-F)	Factor	Location/ River Reach
	A	B	C	D	E	F		G	
	DCN	Forecasting	Dissemination & Communication	Awareness & Education	Interpretation	Response Planning		Adjusted Flood Risk Score	
Colbinabbin	0	0	0	0	4	0	1	1	Colbinabbin
Girgarre	0	1	0	0	0	0	1	0	Girgarre
Kyabram	1	1	0	0	0	0	1	2	Kyabram
Rushworth	0	1	0	0	4	0	1	0	Rushworth
Stanhope	0	1	0	0	0	0	1	1	Stanhope
Tongala	0	1	0	0	0	0	1	1	Tongala
Wyuna	0	1	0	0	0	0	1	1	Wyuna

Note Flood Risk Levels are the same as the Adjusted Flood Risk Score

Risk Level Colour Coding
TFWS Element Service Level is less than Level of Risk
Overall TWFS Service Level is greater than the Level of Risk
Overall TWFS Service Level is equal to the Level of Risk
Overall TWFS Service Level is less than the Level of Risk

Campaspe Shire	
Kyabram	**TFWS SL = 1; Flood risk score = 2** Improve service level factors C, D, E and F through the completion of a new overland flood study. This lifts the TFWS SL above 2 which is still a little lower than the flood risk score

Greater Bendigo City Council

Location/ River Reach	Service Levels A DCN	B Forecasting	C Dissemination & Communication	D Awareness & Education	E Interpretation	F Response Planning	Service Level Tier (Factors A-F)	Factor G Adjusted Flood Risk Score	Location/ River Reach
Costerfield	1	1	0	0	0	0	1	0	Costerfield
Costerfield South	1	1	0	0	0	0	1	0	Costerfield South
Heathcote East (Rural Living)	1	1	0	0	0	0	1	0	Heathcote East (Rural Living)
Heathcote North (Rural Living)	0	0	0	0	0	0	0	0	Heathcote North (Rural Living)
Mount Camel	0	0	0	0	0	0	0	0	Mount Camel
Redcastle	0	0	0	0	0	0	0	0	Redcastle

Note Flood Risk Levels are the same as the Adjusted Flood Risk Score

Risk Level Colour Coding
TFWS Element Service Level is less than Level of Risk
Overall TWFS Service Level is greater than the Level of Risk
Overall TWFS Service Level is equal to the Level of Risk
Overall TWFS Service Level is less than the Level of Risk

No identified priorities in terms of overall TFWS services.

Greater Shepparton City Council (Urban Centres)

Location/ River Reach	Service Levels A DCN	B Forecasting	C Dissemination & Communication	D Awareness & Education	E Interpretation	F Response Planning	Service Level Tier (Factors A-F)	Factor G Adjusted Flood Risk Score	Location/ River Reach
Bunbartha	0	1	0	0	0	0	1	1	Bunbartha
Cooma	0	1	0	0	0	0	1	1	Cooma
East Murchison	1	1	0	0	4	4	2	1	East Murchison
East Shepparton	1	1	0	1	4	4	2	2	East Shepparton
Katandra West	0	0	0	0	0	4	1	0	Katandra West
Kialla West	3	3		3	4	0	2	1	Kialla West
Merrigum	0	1	0	2	4	0	1	2	Merrigum
Murchison	4	3	0	1	4	4	3	1	Murchison
Shepparton/Mooroopna	3	2	0	4	4	4	3	4	Shepparton/Mooroopna
Tallygaroopna	0	0	0	2	0	4	1	3	Tallygaroopna
Tatura	1	1	0	2	4	0	1	2	Tatura
Toolamba	1	1	0	0	0	0	1	1	Toolamba

Note Flood Risk Levels are the same as the Adjusted Flood Risk Score except for Shepparton/Mooroopna where it has been increase from 3 to 4.

Risk Level Colour Coding
TFWS Element Service Level is less than Level of Risk
Overall TWFS Service Level is greater than the Level of Risk
Overall TWFS Service Level is equal to the Level of Risk
Overall TWFS Service Level is less than the Level of Risk

Greater Shepparton City Council	
Merrigum	**TFWS SL = 1; Flood risk score = 2** Improve awareness and education (Local Flood Guide) and Response Planning (MFEP). This lifts the TFWS SL to 2, the same as the adjusted flood risk score
Shepparton/ Mooroopna	**TFWS SL = 3; Adjusted Flood risk score = 4** Improve dissemination and communication (SMS Service), awareness and education (property-specific flood information on web portal) and including revised planning scheme mapping from floodplain management study. This lifts the TFWS SL above 3, nearing the same as the adjusted flood risk score of 4.
Tally-garoopna	**TFWS SL = 1; Flood risk score = 3** A full flood study would be required to provide appropriate flood intelligence to improve interpretation, education and awareness. Improve dissemination and communication would also be required to be improved. This lifts the TFWS SL to 3, the same as the adjusted flood risk score
Tatura	**TFWS SL = 1; Flood risk score = 2** Improve awareness and education (Local Flood Guide) and Response Planning (MFEP). This lifts the TFWS SL to 2, the same as the adjusted flood risk score

Mansfield Shire Council

Location/ River Reach	Service Levels						Service Level Tier (Factors A-F)	Factor	Location/ River Reach
	A	B	C	D	E	F		G	
	DCN	Forecasting	Dissemination & Communication	Awareness & Education	Interpretation	Response Planning		Adjusted Flood Risk Score	
Bonnie Doon	1	0	0	0	0	0	1	1	Bonnie Doon
Gaffneys Creek (Castle Point/A1 Mine)	0	0	0	0	0	0	1	0	Gaffneys Creek (Castle Point/A1 Mine)
Howqua	1	0	0	0	0	0	1	1	Howqua
Jamieson	1	0	0	3	3	4	2	2	Jamieson
Maindample	0	0	0	0	0	0	1	0	Maindample
Mansfield	1	0	0	2	4	4	2	1	Mansfield
Merrijig	0	1	0	0	0	0	1	1	Merrijig
Merton	0	0	0	0	0	0	1	0	Merton
Woods Point	0	0	0	0	0	0	1	0	Woods Point
Jamieson adjusted to include FloodSafe and new overlay control and lifted Factor D from 1 to 3									

Risk Level Colour Coding
TFWS Element Service Level is less than Level of Risk
Overall TWFS Service Level is greater than the Level of Risk
Overall TWFS Service Level is equal to the Level of Risk
Overall TWFS Service Level is less than the Level of Risk

No identified priorities in terms of overall TFWS services.

Mitchell Shire Council (Urban Centres)

Location/ River Reach	Service Levels						Service Level Tier (Factors A-F)	Factor	Location/ River Reach
	A	B	C	D	E	F		G	
	DCN	Forecasting	Dissemination & Communication	Awareness & Education	Interpretation	Response Planning		Adjusted Flood Risk Score	
Broadford	1	0	0	2	0	4	1	2	Broadford
Kilmore	0	0	0	0	4	0	1	1	Kilmore
Kilmore East	1	0	0	0	0	0	1	0	Kilmore East
Pyalong	2	0	0	0	0	0	1	0	Pyalong
Reedy Creek	1	0	0	0	0	0	1	0	Reedy Creek
Seymour	4	3	0	2	4	4	3	3	Seymour
Tallarook	1	0	0	0	4	4	2	1	Tallarook
Tyaak	1	0	0	0	0	0	1	0	Tyaak
Whiteheads Creek	2	0	0	2	4	0	1	1	Whiteheads Creek
Note Adjusted Flood Risk Scores are unchanged from Flood Risk Scores									

Risk Level Colour Coding
TFWS Element Service Level is less than Level of Risk
Overall TWFS Service Level is greater than the Level of Risk
Overall TWFS Service Level is equal to the Level of Risk
Overall TWFS Service Level is less than the Level of Risk

Mitchell Shire	
Broadford	**TFWS SL = 1; Flood risk score = 2** Flood study is proposed for Broadford as part of the Sunday Creek Flood Intelligence and Mapping Study. This will provide flood intelligence to improve interpretation and flood overlay controls for the planning scheme. This lifts the TFWS SL above 2 which meets the flood risk score

Moira Shire Council (Urban Centres)

Location/ River Reach	Service Levels						Service Level Tier (Factors A-F)	Factor	Location/ River Reach
	A	B	C	D	E	F		G	
	DCN	Forecasting	Dissemination & Communication	Awareness & Education	Interpretation	Response Planning		Adjusted Risk Score	
Barmah	3	3	0	2	4	4	3	3	Barmah
Bearii	3	1	0	2	0	4	2	1	Bearii
Cobram	3	1	0	0	4	4	2	3	Cobram
Katamatite	1	0	0	2	4	4	2	2	Katamatite
Koonoomoo	2	1	0	2	3	4	2	1	Koonoomoo
Lake Rowan	1	0	0	2	0	0	1	1	Lake Rowan
Marungi	0	0	0	2	0	0	1	1	Marungi
Nathalia	3	2	1	3	4	4	3	2	Nathalia
Numurkah	1	0	0	2	4	4	2	4	Numurkah
St James	1	0	0	2	0	0	1	1	St James
Tungamah	2	0	0	2	0	4	1	3	Tungamah
Waaia	0	0	0	1	3	0	1	1	Waaia
Wilby	1	0	0	1	0	0	1	1	Wilby
Wunghnu	0	0	0	2	4	4	2	3	Wunghnu
Yarrawonga	2	2	0	2	3	4	3	1	Yarrawonga
Lake Rowan & Wilby scores were increased to 1									Lake Rowan & Wilby scores were increased

Risk Level Colour Coding
TFWS Element Service Level is less than Level of Risk
Overall TWFS Service Level is greater than the Level of Risk
Overall TWFS Service Level is equal to the Level of Risk
Overall TWFS Service Level is less than the Level of Risk

Moira Shire Council	
Cobram	**TFWS SL = 2; Flood risk score = 3** Improve dissemination and communication, awareness and education including introduction of planning scheme mapping from floodplain management study • This lifts the TFWS SL to 3, the same as the adjusted flood risk score
Numurkah	**TFWS SL = 2; Flood risk score = 4** Implementation of Data Collection Network in-train together with new flood warning services (ERRTS). Numurkah floodplain management study will provide flood intelligence for all service level factors. • This lift the TFWL SL to near 4, the same as the adjusted flood risk score
Tungamah	**TFWS SL = 1; Flood risk score = 3** A full floodplain management study is flagged as a high priority that will assist with service level factors C, D and E. Flood Warning Services requirements will be reviewed as part of the study. This lifts the TFWL SL to 3, the same as the adjusted flood risk score
Wunghnu	**TFWS SL = 2; Flood risk score = 3** Improved dissemination and communication. • This lifts the TFWL SL to 3, the same as the adjusted flood risk score

Murrindindi Shire Council (Urban Centres)

Location/ River Reach	Service Levels						Service Level Tier (Factors A-F)	Factor	Location/ River Reach
	A	B	C	D	E	F		G	
	DCN	Forecasting	Dissemination & Communication	Awareness & Education	Interpretation	Response Planning		Adjusted Flood Risk Score	
Alexandra	1	1	0	0	0	0	1	1	Alexandra
Buxton	1	1	0	0	4	0	1	2	Buxton
Eildon	1	0	0	2	2	0	1	0	Eildon
Kinglake Central	1	0	0	0	0	0	1	0	Kinglake Central
Kinglake East	1	0	0	0	0	0	1	0	Kinglake East
Marysville	1	0	0	0	4	0	1	1	Marysville
Molesworth	1	1	0	2	0	0	1	1	Molesworth
Narbethong	1	0	0	0	0	0	1	0	Narbethong
Pheasant Creek & Kinglake West	1	0	0	0	0	0	1	0	Pheasant Creek & Kinglake West
Strath Creek	1	0	0	2	0	0	1	1	Strath Creek
Taggerty	3	2	0	2	4	0	2	1	Taggerty
Thornton	1	0	0	2	0	0	1	2	Thornton
Toolangi	1	0	0	0	0	0	1	0	Toolangi
Yea	1	0	0	2	4	4	2	2	Yea

Note Adjusted Flood Risk Scores are unchanged from Flood Risk Scores

Risk Level Colour Coding
TFWS Element Service Level is less than Level of Risk
Overall TWFS Service Level is greater than the Level of Risk
Overall TWFS Service Level is equal to the Level of Risk
Overall TWFS Service Level is less than the Level of Risk

Murrindindi Shire	
Buxton	**TFWS SL = 1; Flood risk score = 2** Flood study is underway for Buxton. This will provide flood intelligence to improve Factors C, D, E and F including overlay controls for the planning scheme, Local Flood Guide and inclusion into MFEP. This lifts the TFWS SL above 2 which meets the flood risk score.
Thornton	**TFWS SL = 1; Flood risk score = 2** Scoping flood study has been identified with a focus of improve flood intelligence around TFWS elements (Factors C, D, E and F). This lifts the TFWS SL above 2 which meets the flood risk score.

Strathbogie Shire Council (Urban Centres)

Location/ River Reach	Service Levels						Service Level Tier (Factors A-F)	Factor	Location/ River Reach
	A	B	C	D	E	F		G	
	DCN	Forecasting	Dissemination & Communication	Awareness & Education	Interpretation	Response Planning		Adjusted Flood Risk Score	
Avenel	1	1	0	0	4	4	2	1	Avenel
Euroa	3	2	0	2	4	4	2	3	
Graytown	1	1	0	0	0	0	1	0	
Locksley	1	1	0	0	3	0	1	1	
Longwood	1	1	0	0	3	0	1	1	Longwood
Mangalore	1	1	0	0	0	0	1	0	Mangalore
Nagambie	2	2	0	0	4	4	2	2	Nagambie
Old Londwood	1	1	0	0	3	0	1	0	Old Londwood
Ruffy	1	0	0	0	0	0	1	0	Ruffy
Strathbogie	2	1	0	0	0	0	1	0	Strathbogie
Violet Town	2	1	0	2	4	4	2	3	Violet Town

Note Adjusted Flood Risk Scores are unchanged from Flood Risk Scores, except for Euroa and Violet Town where the scores been increased from 2 to 3.

Risk Level Colour Coding
TFWS Element Service Level is less than Level of Risk
Overall TWFS Service Level is greater than the Level of Risk
Overall TWFS Service Level is equal to the Level of Risk
Overall TWFS Service Level is less than the Level of Risk

Strathbogie Shire	
Euroa	**TFWS SL = 2; Adjusted Flood risk score = 3** Flood intelligence is available to improve awareness and education by providing site-specific property flood information via the web portal initiative, and improved dissemination and communication. This lifts the TFWS SL above 3 which meets the adjusted flood risk score.

Violet Town	**TFWS SL = 2; Flood risk score = 3** Flood intelligence is available to improve awareness and education by providing site-specific property flood information via the HydroNET initiative, and improved dissemination and communication. This lifts the TFWS SL above 3 which meets the flood risk score.

Regional (rural) areas

Location/ River Reach	Service Levels A	B	C	D	E	F	Service Level Tier (Factors A-F)	Factor G	Location/ River Reach
	DCN	Forecasting	Dissemination & Communication	Awareness & Education	Interpretation	Response Planning		Adjusted Flood Risk Score	
BROKEN CREEK SYSTEM									BROKEN CREEK SYSTEM
Broken Effluent Tributaries	0	0	0	2	0	4	1	2	
Lower Broken Creek	2	1	0	2	0	0	1	1	
Mid Broken Creek	1	1	0	2	4	4	2	1	Mid Broken Creek
Muckatah Depression	1	0	0	2	0	4	1	1	Muckatah Depression
Upper Broken Creek	1	0	0	2	0	0	1	1	Upper Broken Creek
BROKEN RIVER SYSTEM									BROKEN RIVER SYSTEM
Lower Broken River	1	0	0	0	0	0	1	0	Lower Broken River
Upper Broken River	2	1	0	0	0	0	1	0	Upper Broken River
GOULBURN RIVER SYSTEM									GOULBURN RIVER SYSTEM
Acheron River & Tribs	1	0	0	2	4	0	1	1	Acheron River & Tribs
Corop Lakes	0	0	0	0	4	0	1	1	Corop Lakes
Dabyminga Creek	1	0	0	0	4	0	1	1	Dabyminga Creek
Delatite River (at Delatite Rd)	0	0	0	0	0	4	1	1	Delatite River (at Delatite Rd)
Ford Creek	1	0	0	2	4	0	1	1	Ford Creek
Goulburn R (Seymour to Shepparton)	3	2	0	1	2	0	1	1	Goulburn R (Seymour to Shepparton)
Granite Creeks	1	1	0	0	3	0	1	1	Granite Creeks
Howqua River	1	0	0	0	0	0	1	1	Howqua River
Lower Goulburn (d/s of Sheppaton)	2	2	0	2	4	0	2	1	Lower Goulburn (d/s of Sheppaton)
Lower King Parrot Creek	1	0	0	2	0	0	1	1	Lower King Parrot Creek
Maindample Region (at Dry Creek Road)	0	0	0	0	0	0	1	1	Maindample Region (at Dry Creek Road)
Mid Goulburn	1	2	0	0	0	0	1	1	Mid Goulburn
Sunday & Dry Creeks	1	0	0	0	0	0	1	1	Sunday & Dry Creeks
Tatura/Tongala Region	0	1	0	0	0	0	1	1	Tatura/Tongala Region
Upper Goulburn (u/s of Elidon)	1	0	0	0	0	0	1	1	Upper Goulburn (u/s of Elidon)
Upper King Parrot Creek	2	0	0	0	4	0	1	1	Upper King Parrot Creek
Whiteheads Creek	2	0	0	2	4	0	1	1	Whiteheads Creek
Yea River	1	0	0	2	4	4	2	1	Yea River
MURRAY RIVER SYSTEM									MURRAY RIVER SYSTEM
Barmah to Echuca	3	2	0	2	3	4	2	1	Barmah to Echuca
Cobram to Ulupna	3	1	0	2	3	4	2	1	Cobram to Ulupna
Piree Creek to Barmah	3	2	0	2	3	4	2	1	Piree Creek to Barmah
Ulupna to Piree Creek	2	1	0	2	3	4	2	1	Ulupna to Piree Creek
Upstream of Yarrawonga	2	2	0	0	4	0	1	1	Upstream of Yarrawonga
Yarrawonga to Cobram	3	1	0	2	3	4	2	1	Yarrawonga to Cobram

Note Adjusted Flood Risk Scores are unchanged from Flood Risk Scores

Risk Level Colour Coding
TFWS Element Service Level is less than Level of Risk
Overall TWFS Service Level is greater than the Level of Risk
Risk Level Colour Coding
Overall TWFS Service Level is less than the Level of Risk

Regional (rural) Areas	
Broken Effluent Tributaries (Pine Lodge, Daintons, Congupna, Guilfus and O'Keefe Creeks)	**TFWS SL = 2; Flood risk score = 3** Improvements to Factors D, E and F may be gained from a regional study This lifts the TFWS SL above 2 which meets the flood risk score.

Appendix I: Comments, Issues and Feedback Received at Public Information Sessions

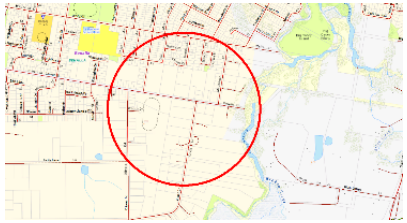
Note an "x" has been placed in the relevant four RHS columns to signify topic under consideration

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Seymour – 6th Feb 2017, 12 noon to 2pm				
1	Goulburn River (Seymour to Shepparton) – higher priority for land-use planning. Although flood overlays do exist in planning schemes along this river reach, they are based on limited information. New flood mapping will improve the accuracy in terms of flood extent. **Response 1** *Medium priority is already appropriate*			x	
2	The urban centres prioritisation for Mitchell Shire suggests that a flood assessment of Tyaak will be part of the Sunday Creek study. It is not in that catchment. **Response 2** *The rural towns of Tyaak and Reedy Creek are within the Dabyminga Creek catchment. Correct error in Main report but leave original in Appendix.*			x	
3	Johnsons Lane Northwood • Built new house, floor height 700-800mm above 1% flood level, and decommissioned old house. • During the 2010-2011 floods, the home was isolated for 5 days, as access is cut by floodwater. • Flood levels, via the computer, are checked which is very important. • When Goulburn River reaches just below minor flood level, floodwater will start back flowing and filling local lagoons. • Owners have been on the property for 8 years and established a good level of flood awareness.		x		

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Response 3 *This is a good example of self-resilience and the good use of information on the web. Access to fit-for-purpose flood information is an important priority for the Regional Floodplain Management Strategy.*				
4	 Reedy Creek (north-east of Avenal) is a perched waterway, where maintenance is constantly required by VicRoads to reduce the change of flooding over the Hume Freeway. Should look at re-vegetation opportunities to assist with reducing run-off. Suggestion was made in relation to ongoing maintenance cost, for instance for a town levee, should be Bourne by the beneficiaries. Like fire – provide good quality information improve flood resilience **Response 4** *Opportunities for an integrated catchment management approach, such as re-vegetation of upstream catchments is supported.* *The beneficiary pay principle for on-going maintenance cost should apply in line with the Victorian Floodplain Management Plan.*		x		x

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Access to fit-for-purpose flood information is important priority for the Regional Floodplain Management Strategy				
5 FF	- Whiteheads creek affects their area, Goulburn River is a worry for main part at Seymour and tourism business - Local agencies should put signs when they know Whiteheads Creek is flooding. Don't want another death – use radio, Facebook and social media as well as TV if enough time - Difficult to balance flood risks and environmental/cultural heritage considerations - hasn't liked loss of old (heritage) buildings in the past **Response 5** *New flood intelligence and mapping study is advanced and should assist with fit-for-purpose flood information for communities and MFEP. Also VICSES are looking at ways to improve community messaging for flash flood areas.*		X	X	X
	Nagambie – 6th Feb 2017, 5pm to 7pm				
6	High Street Nagambie – once a year water is not able to drain, which can be in the order 500mm deep. Land has a drainage easement along the southern boundary that collects water from upstream areas. Eight trees grown in easement. Two trees have died in the drought. The floor of the dwelling is level with the ground, and at risk of over floor flooding. Part of office recently flooded due to poor drainage. Park Street has septic issues. End of Park Street has a retardation basin that requires to be emptied by pumping *Group meeting of Issues* Drainage was a key issue. In particularly over Council requirements for new development (subdivision) that doesn't include old infrastructure (retrospective drainage needs). **Response 6** *Depending on priority of Council a drainage implementation plan for Nagambie could be an option. The new flood model may be utilised by Strathbogie Shire Council to consider drainage management options.*	Drainage			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Possibly explore strategic approach such of Contribution Plans and Master Strategic Plan to address a raft of matters to be resolved. *This issue is acknowledged but not part of the RFMS.*				
7	Nagambie - drainage from east of High Street down Vickers Road, and drainage from the east Tabilk Depression around the Barwon Street area. **Response 7** *See **Response 6***	Drainage			
8 FF	Minor flooding caused by bad drainage of High Street, Nagambie at southern end of town – affects her home, driveway and street past front gate. A new drainage system needs to be implemented to address this. **Response 8** *See **Response 6***				
9 FF	- Flood impacts include fencing, access and stock loss - Need more water level stations - Have concerns for catchment area concerning native forest habitat for native animals and birds, fish survival - Assessments at regular intervals of damage caused by clear felling of catchment areas to water supply, erosion, etc. **Response 9** *See **Response 6*** *The matter of clear felling impacts on water supply rest with the water authorities. Furthermore, operator must comply with the Code of Practice for Timber Production (2014)* *Note the comment of more water stations. Warning for Nagambie will be looked at a part of TFWS Assessment tool being prepared by Michael Cawood and Associate.*	Drainage	X		

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Benalla – 8th Feb 2017, 12noon to 2pm				
10	Hollands Creek – 3 km upstream of Tatong. Impact of Handcocks timber plantations on sedimentation in creek and hence fish habitat. Impact on flooding. **Response 10** *Plantation operations must adhere to the Code of Practice for Timber Production (2014)*	x			
11	Issue of Council potentially cutting urban drainage channels through the alluvial ridge of the Broken River and letting floodwater into new subdivision areas. Example is around Cowan Street.  **Response 11** *This can be managed by the use of flood-gates and penstocks, which should be documented in the MFEP*	x			x
	Euroa – 8th Feb 2017, 5pm to 7pm				
12	Low vegetation (understorey vegetation) planted on the floodplain and the impact on flooding. Part of the water management scheme is to remove vegetation regrowth on the floodplain. Also has discussions around vegetation within the channel and on the floodplain along Honeysuckle Creek. **Response 12**	x			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	This matter is noted. Need to ensure that such proposed works are vetted by Strathbogie Shire Council to ensure planting programs are not counter to Euroa Water Management Scheme.				
13	Railway culverts/bridges have substantial sediment accumulation impacting on capacity. Also spoke broadly about catchment management activities….and what can be done upstream. **Response 13** *Cardno Consulting has made recommendation on management, particularly around managing the colonisation of vegetation that "locks" the sediment. Loose sediment is likely to be scoured during the height of major floods.* *Integrated Catchment Management opportunities, including planning/fencing programs are encouraged in upstream catchment areas to assist within improved waterway health and assisting somewhat for "slowing" floodwaters – but limited to smaller floods.* *Euroa has a high ranking for all four themes.*	x			x
14	Dam construction should be considered in terms of providing multiple benefits such as flood mitigation, tourism, water of agriculture. **Response 14** *The sheer size required and thus the enormous cost would never see the economic benefit. In addition, new large dams would likely be counter with the MDBA water cap.*	x			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
15	The Seven Creeks is constricted at butter factory bridge. The bridge abutments on the east side of the bridge is the cause of the constriction.  **Response 15** *The butter factory bridge flood modelling was loaded and shown to the audience. Flood depth over this bridge is in the order of 900-1200mm deep for a repeat of a 100-year ARI flood. Also the flood mapping for the 5-year ARI was presented. The floodwater is contained upstream of the bridge and disperses across the floodplain downstream. The flood surface profile did show some minor afflux (increase in flood level) in the 5-year flood that could be attributed by the butter factory bridge. The complete removal of the bridge/abutment would have very limited benefit (and only extend meters upstream) in reducing the impacts of flooding.*	x			
16	More community information for better understanding. Good data assists people to make informed decisions. **Response 16** *Access to fit-for-purpose flood information for the community is important priority for the RFMS.*		x		x
17	Honeysuckle Creek – Moved to include with 12.				
	Colbinabbin – 9th Feb 2017, 12noon to 2pm				

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
18	Homes on the Bendigo-Murchison Road and on the Wanalta-Corop Road were threatened by flooding in the 2011(?) flood. Two on Wanalta Creek. Approximately 5-6kms north of Bendigo-Murchison Rd there's around 15 houses at risk. Colbinabbin School is difficult to manage/evacuate in a flood. **Response 18** *Need to review MFEP*		x		x
19	Issues with landholders blocking the floodplain via earthworks/levees and issues with the raised Midland Highway. Important to maintain flood paths. Levee constructed in the past may need to be removed to restore functioning floodplains. Comments were made about LGA enforcement processes to deal with illegal activities on the floodplain. Management of the planning overlay. **Response 19** *Very difficult to manage if the works are a decade old or so (even more so if pre-planning scheme of 1998) as works are considered part of the landscape. Further if works are be removed, compensation is likely to be paid to the beneficiary of the works. For new works the planning system can be used but this approach is complex and expensive.* *If there is an overwhelming community desire to have particular works removed, then the Water Management Scheme (Water Act 1989) process should be followed that is likely to include a detailed flood study to determine the impacts and benefits.*	x		x	
20	Lack of information available to landholders on the operation of the irrigation system, including the western channel, flood gates, Groves Weir, the lakes to manage flooding. The "operation of the system" during last year floods were beneficial. Comments made around strengthen community relationships. **Response 20**		x		x

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Noted. However, the benefits may not always transpire due to the size of the flood and due to capacity constraints of the Waranga Channel and during times when Lake Cooper is already at full supply level. Summary of GMW operation is as follows: • *GMW will divert water from Wanalta Creek or Cornella Creek or both into the Waranga Western Channel (WWC) whenever possible. GMW diverts the water into the WWC for disposal to the Campaspe River, Greens Lake or Lake Cooper (in this order of priority). Diversions for offsite disposal are not permitted if the disposal causes or adds to flooding at the discharge point.* • *Diversions from Cornella Creek in Colbinabbin occurred in 2016 because the Campaspe River was below the Minor Flood Classification at Rochester. Disposal to the Campaspe River, Greens Lake or Lake Cooper did not occur in January 2011 because the Campaspe River at Rochester was in flood and both Greens Lake and Lake Cooper were full to capacity. Under these circumstances, the standard GMW procedure is to lower the level of the WWC as much as possible, close all regulators and allow creeks to follow natural drainage lines.* • *GMW does not currently publish the WWC operating rules for Wanalta Creek and Cornella Creek on its website. GMW did publish material describing channel operations during floods following the flooding in 2011 and 2012, but this material was removed at an unknown time. GMW will investigate reinstating material for the general public, although it notes that landholders should not rely on the channel system to act as a flood management device. The channel systems provide very limited protection against floods and are not designed for flood protection.* *Consider the need for a Local Flood Guide. Follow up recommendation from the Corop Lakes Scoping Study. Medium priority for TFWS has been applied for Colbinabbin.* *Community relationships are encouraged to build community resilience. Flood warden approach within MFEP may be considered in the MFEP. However see* ***Response 27(b)***				
21	Lack of focus by GMW on drainage infrastructure/operations. GMW not maintaining their drainage infrastructure. GMW won't pump floodwater out of Greens Lake to assist with drainage. Landholders not getting anything for their drainage rates.	Drainage			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Response 21 *GMW uses Greens Lake as a water storage and captures catchment inflows wherever possible. It is not designed to act as a flood detention basin.* *The Goulburn Broken Catchment Management Authority received new Victorian government funding to restart the surface drainage program across the Shepparton Irrigation Region. The priority for investment in new drainage systems will be decided by GMW and the GBCMA in consultation with stakeholders and beneficiaries.* *Some new government money is available for community drainage. Priority for investment is determined by GMW (check this). In terms of drainage rates this is GMW matter and is beyond the scope of the RFMS.*				
22	A few years ago there was a proposal to clean the Cornella Creek out. **Response 22** *Noted. However, this is of limited benefit during major floods.*	x			
23	Comments concerning development of a compositing operation. Discussion about existing use rights land forming etc. Concern with communications between agencies such as LG, CMA, and GMW. For example, the Shire undertaking road works that will influence flood flows. **Response 23** *Planning permits are required for such activities.*			x	
24	1973, 1974, 1975 were the worst floods in the Corop Lakes district lasting many months/years severely impacting of agriculture. Also have significant drainage problems **Response 24** *Noted.*				

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
25	Should identify opportunities where positive things can be achieved in the rural landscape, such as managing minor floods with appropriate levee protection. **Response 25** *New levees, particularly, in rural areas would need to cost effective, and not create adverse impacts to neighbouring property. New levee programs would been to follow the Water Management Scheme process outlined in the Water Act 1989.*	x			
26 EC	I understand from your comments (at the Colbinabbin community meeting) that GBCMA is not prepared to bite the bullet when it comes to dealing with levee bank or other obstructions to what are clearly 'natural' water courses where these have been in existence for more than a few years. This is largely due to a fear of expensive litigation - hardly a good (if practical) reason looking at the big picture. I find this disappointing, as it means that the declaration of drainage courses is somewhat meaningless if the natural flow is impeded by un-natural barriers. **Response 26(a)** *Refer to response to **Response 19**. Further experience in these matters are complex and the recommended approach under the Victorian Floodplain Management Strategy suggests a Water Management Scheme approach would be process.* *If the community has a particular levee, or a group of levees in mind that should be removed to create a prima facie benefit to the community than the matter could be explored further. Refer to Section 17 of the Victorian Floodplain Management Strategy.* We discussed the need for closer co-ordination between authorities - specifically GBCMA, GMW, VicRoads, and Shire of Campaspe. There were examples cited where there was little evidence of this, and I wonder what plans are in place to remedy the problem. Maybe they are already in place, and it would be helpful to us to know how this will be done. The catchment between Colbinabbin and the Midland Highway is very flat, and even quite low obstructions such as road formations can cause significant flooding if culverts are not properly designed and maintained, or road re-sheeting is done without an understanding of drainage paths. This may not be a big issue as far as the built infrastructure is concerned, but even a few centimetres of water can damage or destroy a valuable	x	x	x	x

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	crop. In this regard we are of the opinion that the 2012 GHD flood study was too limited in its scope, and more needs to be done to develop a real understanding of floods, their impact, and their management. **Response 26(b)** *In relation of co-ordination of authorities, the Campaspe Planning Scheme requires particular requirements in relation to approvals.* *It is noted that low works in the flat terrain may cause adverse flood impacts. If not designed correctly.* *In terms of the 2012 GHD report, its purpose was to scope out fundamental matters and recommend further actions. The recommendations did not warrant further hydrologic or detail hydraulic flood modelling. This is because such effort and cost (many $100,000s) would provide little benefit in terms of managing legacy flood risk. It is agreed, that such further work in this area would provide insightful knowledge in understanding the nature of flooding, including how made-made features influence flooding, but the cost is prohibited. Furthermore, the current flood mapping serves land-use and development assessment process well.* We talked about the value of local knowledge, and particularly where early action on flood mitigation can be effective. Are there any plans to implement any form of local advisory system such as flood monitors or the like? **Response 26(c)** *Local knowledge, during both flood studies and the preparation for floodplain management plans, is considered paramount.* *At the outset of significant rainfall, and during major floods, the use of local "flood observers" is being addressed by the Control Agency for flood which is VICSES. Such arrangements may add significant intelligence, particularly where gauge networks are lacking.* *Flood inquiry acknowledged the importance of local flood knowledge. Such knowledge is built into the Municipal Flood Emergency Management Plan.*				

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	There was no discussion on the deployment and use of environmental water while I was there. Is there any current policy and/or strategy regarding the Corop wetlands overall? I gather the control structure planned for the Willoughby's Bridge location is now off the agenda, but an alternative lower-cost option for putting water into Gaynor Swamp is to proceed. Are there any other plans in this regard? I assume One-Tree and Two-Tree Swamps are now forgotten. Perhaps this was outside the scope of the meeting. **Response 26(d)** *Environmental watering is more aligned with the river health strategy and is beyond the scope of Regional Floodplain Management Strategy.*				
	Kyabram – 9th Feb 2017, 5pm to 7pm				
27	Statements made by a Wyuna farmer: Has good awareness of river heights, relating to minor, moderate and major flood class levee predictions which are very positive and assist with flood response, i.e., shutting gates etc. The predictions are accurate, with a good amount of time to prepare i.e. 3-4 days lead time. Offset pump into river at the end of Alfred Road operated by GMW and works well. Management of water storages e.g. Eildon Weir should include flooding management outcomes **Response 27(a)** *GMW has target filling curves that are applied to manage storage operations. Storages are primary used for the provision of water responses. There is some flexibility in the operations with rainfall forecast (check with GMW).* Flood wardens was in place, but doesn't seem to be as active anymore. More flood awareness is required across the community. There need to be a better liaising emergency structure in Campaspe Shire. Campaspe Shire should come out to the community and engage	x	x	x	x

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Response 27(b) *The use of local "flood observers" is being addressed by the Control Agency for flood which is VICSES. Such arrangements may add significant intelligence, particularly where gauge networks are lacking.* *Flood inquiry acknowledged the importance of local flood knowledge. Such knowledge is built into the Municipal Flood Emergency Management Plan.* Whole Farm Plans - structural grades of the landscape need to be properly considered with neighbours to be considered. **Response 27(c)** *Whole farm plans are considered under the planning scheme process* GMW take over private drainage schemes. **Response 27(d)** *This is considered beyond the scope of the RFMS. Whole farm plans are considered under the planning scheme process.* Access during flood emergencies should require the maintenance of existing gravel road systems. Such road maintenance must be taken into consideration by local governments to ensure the right roads are passable. **Response 27(e)** *The maintenance of key roads may be considered under the Municipal Flood Response Plan, in concert with flood warning arrangements, where flood consequences are significant.* There has been no maintenance along to tracks within the Lower Goulburn National Park this season, which impacts on the ability for emergency response (e.g. end of Alfred Rd has been an issue, which has flood access implications).				

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Response 27(f) *This park falls under the management of Parks Victoria. There should be no access into the park during times of major floods. However, key well maintained tracks may assist during evacuations. This is a matter for Parks Victoria.* Levee system has a lot of low spots due to 4WDs and motor bikes, which cause unnecessary damage. Levee maintenance is required. How do you pay for it and who does? **Response 27(g)** *The beneficiary pay principle for on-going maintenance cost should apply in line with the Victorian Floodplain Management Plan. Otherwise landowners may carry out maintenance works under the new permitting where levees are on Crown land.*				
28 FF	1. *Flood impacts - How does flooding across the floodplain affect you and your community? Does flooding impact on your livelihood such your home, business and/or agriculture use?* It greatly affects the community by causing loss of livelihood, inconvenience, damage to property, pastures, crops and plants. As a member of the Kyabram Urban Landcare Group, our areas are greatly affected by flood. We plant and revegetate two areas that have been affected by flood in the last six years: firstly in the 2010/11 floods and secondly with flooding that took place in the Spring of 2016. In these two events many plants – thousands of trees and shrubs that we had planted and grown in the Ern Miles Reserve and the Grey Box Reserve were inundated by water. If that were a fairly short time of inundation, e.g. 1 week to 10 days, plants and trees would mostly cope and recover. However in both 2010/11 and 2016, water lay in a stationary state for several weeks and hundreds of shrubs and trees were lost - a/ because in 2010/11 of the uncleared drain running along the north side of South Boundary road which runs west into the Parkland Golf course and then north until it meets the concrete drain running west to McEwen Rd. This prevented water draining off the Ern Miles Reserve (formerly known as the South Boundary Rd. Drainage Basin) three times during the Summer of 2010/11.	X(d)			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	b/ because in 2016 excess water was released west from the Fauna Park along the concrete drain to McEwen Rd, but due to the capacity of water exceeding the capacity of the drain, much water overflowed into Grey Box Reserve, causing water to lie stationary for many weeks. In both cases hundreds of new and older shrubs, planted and cared for by our Group and many members of the Kyabram Community, with much time, cost and energy being spent on the work, were lost. 2. *Flood protection, management and preparation - How can your floodplain be better protected or managed from the impacts of flooding? How do you think flood warnings for your community could be improved? Are you and your community well prepared for the next flood? How could preparation be improved? What flood information would be most useful?* The South Boundary Rd. drain is in MUCH need of a clean, right along its length, from the north-east corner of Ern Miles Reserve, west and all the way to the Parkland Golf Course until it reaches the concrete drain which runs further west to McEwen Rd. Even at present the large dam in the Ern Miles Reserve is at capacity and drainage water runs at a trickle along this clogged drain all the way to the concrete drain. Flooding occurs on the Ern Miles Reserve when it shouldn't because of this clogged and uncleaned drain. I should add that Campaspe shire, after much encouragement and persuasion from our group and Kyabram's Drainage Committee, did clean a small section of this drain west of Lake Rd in about 2014. However this did not solve the drainage problem as so most of the drain was not cleaned. If this above mentioned drain were cleaned much of the drainage problem in the Ern Miles Reserve would be alleviated. The drain that runs north from the large dam in the Ern Miles Reserve into the South Boundary Rd. drain also needs to be cleaned but as we are a volunteer group and lack financial resources to pay for its cleaning we would be grateful if Council or NCCMA could clean it for us. Both the above mentioned drains are in urgent need of cleaning and consequently the drainage issue that we face would be mitigated. 3. *Environmental and cultural heritage considerations - How do you see the balance between managing flood risks and protecting the cultural heritage and environmental values of waterways and wetlands?* I believe flood mitigation enhances biodiversity within our wetlands and waterways.				

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	As I have stated many hundreds of trees and shrubs were lost in an area that has benefited greatly from our Landcare group's effort to revegetate over 30 ha of land within the Kyabram precinct. Numerous birds have reappeared in our town due to our planting program at Ern Miles Reserve and the Grey Box Reserve e.g. The Singing honeyeater, Red-capped robin, White-tailed warbler (gerygone), Golden whistler, Jacky winter, White-winged chough, to name a few. Revegetating with indigenous species brings about a great result! Well over 100 native bird species, a great indicator of the health of the environment, have now been recorded in the Ern Miles Reserve with only 40 species prior to revegetation in 2001. Excess flooding, without sufficient drainage ruins this biodiversity. Good drainage is vital to the health and vitality of wetlands. **Response 28** *The lie of the land makes these areas vulnerable to overland flooding from localised storms. All the recommendations of the GHD report are yet to complete. Given the age of the GHD report and the release of Australian Rainfall and Runoff (2016) a review into flooding is considered a priority.* *Local drainage works rests with the priorities of local government.*				
	Shepparton – 10th Feb 2017, 12 noon to 2pm				
29	Improved flood information & better community information is welcomed **Response 29** *Access to fit-for-purpose flood information is important priority for the RFMS*		x		
	Congupna – 10th Feb 2017, 5pm to 7pm				
30	Drain 12 Issues over blockage – South of Boundary Road. Recent flooding such as August 2016. Offer to meet landowners to explore that matter further. **Response 30**	x			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	A site meeting was carried out with concerned community members. A background review revealed that approval for the works have been granted. It is therefore difficult to alter the works without the landowner's agreement. Also see item 70.				
	Alexandra – 11th Feb 2017, 11am to 1pm				
31	Concerned with potential impact of the proposed environmental floods in the Acheron River valley. That is, water backing up the Acheron River from the Goulburn River. **Response 31** *The environmental flow proposal is beyond the scope of the Regional Floodplain Management Strategy. However, the concern is noted and must be addressed as part of the constraints management strategy.*				
32 EC	- Need to understand the impact of tributaries, not just the Goulburn River - High annual rainfall is variable in nature and impacts flood forecasting - Impact of Eildon Weir when full - Community confusion with Constraints – need to make clear to community that this flood strategy is not from MDBA or associated with Constraints (states that Constraints proposal will cause a 1993 size flood to the area every 2 years) - Believes that floodplain strategy work will be wasted effort if constraints project goes ahead **Response 32** *See **Response 31**. Further, TFWS may require further rain and river gauge networks to take into account of variable rainfall. The Regional Floodplain Management Strategy's vision is to assist with flood resilient communities as opposed to the MDBA objective around environmental watering.* *Environmental watering downstream of Eildon would see flows up to 9,500 ML/d (made up from natural flows with the balance from Eildon), which significantly lower than the 1993 flood of 48,000 ML/d (Check number)*		x		x
	Yea – 11th Feb 2017, 3pm to 5pm				

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
33	Concerned with the lack of flood warning for the Yea valley and the township downstream. **Response 33** *Link the flood mapping to the new gauge in Yea. This is considered a priority. Such knowledge should be uploaded into the MFEP and Local Flood Guide.* *If flood warning prediction services are to be arranged, the telemetered river and rain gauging network would need to be augmented. This is considered a low to medium priority given that there is limited consequence in Yea. The impacts are largely limited to the Caravan Park.*		x		x
34	Review the Minor flood level for Devlins Bridge. It is currently 1.8m and should be 1.5m. **Response 34** *The initial review of available flood photography indicates that there is merit is reviewing the Minor Flood Class level.* *The Bureau of Meteorology has recently prepared standard forms that allows a request for such a change. This will be looked into by the GBCMA and Murrindindi Shire Council.*		x		
35	The AAD should consider the cost of on-farm damage including fencing and pasture, loss of trees, erosion of banks. **Response 35** *The risk assessment is a first-cut rapid approach to set regional/statewide consistent priorities and has damage estimates for agricultural losses.*				
36	Flood risk to dwellings in the township of Reedy Creek is potentially an issue. **Response 36** *Noted. This is part regional study along Dabyminga Creek.*	x		x	x
37	Reduce the risk of flooding by reducing environmental flows to in-stream flows under the Constraints Strategy. **Response 37**				

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Environmental flow proposal in beyond the scope of the Regional Floodplain Management Strategy. However, the concern is noted and must be addressed as part of the constraints management strategy.				
38 WL	- Believes Yea river gauge flow level of 1.5 represents actual minor flood level, not the current 1.8m level at which a minor flood level warning is issued (photos supplied of flooding at lower gauge height) - Supplied a number of photos of flooding in 2010 with notes as to times/dates/gauge heights – believes flooding in Goulburn River has significant impacts upstream in tributaries and that impacts of flooding at various gauge heights are under estimated in official records/maps. **Response 38** *See **Responses 34** and **37.***		x		x
	Tungamah – 13th Feb 2017, 10am to 12noon				
39	Warning is provided (~2 days) but it is only by word of mouth. There is a lack of warning and information on ABC radio about Boosey Creek. Despite the potential for good warning times, in 2012 there was not much warning time for doing sand bagging. Some people in town were given only 1 hours warning to protect houses in 2012. Major issue with Tungamah is complete isolation for 48 hours in all directions, i.e. the town becomes completely isolated. Warning is important to the town and for the emergency response. **Response 39** *This town is considered a high priority for all four themes to build flood resilience.*	x	x		x
40	Rural drainage is a problem after the flood. Causeways have been built up and culverts are sometimes blocked (3 Chain Road recently). Elvin Street, Tungamah pipes recently blocked and causing flooding issues. **Response 40**	x			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	These need to be reviewed as part of a floodplain management study.				
41	Banks and levees in the landscape push water onto other landholders and reduce flood storage. **Response 41** *Refer to **Response 19**.*				
42	Wilby and Almonds soil conservation scheme was never completed. Currently ends at Creek Road. Lack of drainage downstream of this point. **Response 42** *Generally local drainage is beyond the scope of the Regional Floodplain Management Strategy.*				
43	The weir in Tungamah was recently turned into a permanent structure and that influences flooding. In floods before 2012 the boards were pulled out of the structure prior to the flood and this reduced levels in town. The rail line is important for ponding/ storing flood water and protecting the town. **Response 43** *These need to be reviewed as part of a floodplain management study.*	x			x
44	Tungamah sewerage infrastructure - pumping stations and treatment plant are probably at risk of flooding. Need to ensure information is provided to NE Water. **Response 44** *These need to be reviewed as part of a floodplain management study. Flood information would be shared with the asset owners.*				x
45	Milk Bar and Post Office in Tungamah are the best places to notify the community of public meetings. Need to consider putting notices up in towns for next meetings. **Response 45** *Noted. Seek to utilised for future meetings*				

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
46	Drainage once the flood is over is a major problems. There were five minor floods last season. Levee around house and sheds have been constructed in rural areas. Local floodplain development plans allow for ring levees to be constructed to protect homes. Moira planning scheme may not have this. **Response 46(a)** *Flood recovery response may assist with the impacts of floods during their recession.* *It is usual practice to allow ring levees around a home if over floor flooding is evident.* Emergency response- if an emergency alert is set off will trigger the siren at the local CFA shed to inform people about sand bagging. A lot of the people in town are unaware where the relief centre/ evacuation centre is **Response 46(b)** *Centres will be established depending on the nature of the emergency. Circumstances will dictate where centres will be established.* It would be better to have flood warning services for Tungamah. An upstream gauge of the town would be better. A suggestion was made at the confluence of Sandy and Boosey Creek. **Response 46(c)** *Warning is considered a high priority.* *Could be linked with operations around permanent levees and/or temporary levees, sandbagging etc. through emergency response. The greater the warning time means the better opportunity for the community response.* *As part of a total flood warning system flood and floor level data can be linked to gauge heights.* Tungamah has a sewerage scheme (sewerage pumps at Alvin St and Barr Streets). Failure of the ponds following a flood and associated problems with contamination and health problems. Critical infrastructure is an issue.	x	x	x	x

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Response 46(d) *These need to be reviewed as part of a floodplain management study. Flood information would be shared with the asset owners.* Comments from the community meeting suggested the flood overlays aren't that accurate as its flood extent was "undergone". **Response 46(e)** *These needs to be reviewed as part of a floodplain management study.*				
	Strathmerton – 13th Feb 2017, 1.30pm to 3.30pm				
47	A lot of irrigation channels have been piped due to the connections project and this is likely to change the extent of flooding. **Response 47** *GMW has been working with both the Goulburn Broken and North Centre CMAs to assess non-back irrigation channels across the Goulburn Murray Irrigation District to ensure that the nature of flooding remain is not unduly altered.*				
48	Strathmerton was flooded in 1975 due to the levee breaching at Koonoomoo. The Koonoomoo Road was closed for over a fortnight. **Response 48** *Noted and has been documented.*				
49	NSW levees failing in the October 2016 potentially redirected 65,000 ML/day into NSW and helped prevent a major levee failure in Victoria. NSW levees are being built up in response to the recent failures – funding announced by Barnaby Joyce. **Response 49** *Noted and damaged levees may be repaired following flood.*	x			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
50	Emergency response and need for the evacuation for campers on the Ulupna Island. The threat of a levee breaching/flooding closing Ulupna Bridge Road. **Response 50** *Parks Victoria played a major role in managing campers. The MFEP may be reviewed in terms of Ulupna Bridge Road.*				X
51	Better management of the levees is the key strategic flood management issue for the Strathmerton/Murray River area. **Response 51** *The potential management arrangements for rural levees have been documented in the Victorian Floodplain Management Strategy (VFMS).* *However, some commentary was made as follows:* • *Levees for urban centres has been clear with the lead agency being local government* • *Rural levees- private benefits as been the logic. Now the Victorian Floodplain Management Strategy indicates that all the beneficiaries play are part (not just private). This could include the broader community, VicRoads, LGAs etc.* • *Councils do not have the capacity to manage rural levees. There would be many things that would need to be considered. There are serious questions about the condition of the existing rural levees. Difficult to prioritise works. Question around legal liability is a major issue because of the unknown condition of the levels.* • *Council would be looking for external funding support.* • *The Road Management Act allows for the creation of a road management plan, which gives some parameters around what can be done based on available resources/priority. The VFMS is suggesting the used of the Water Act process known as Water Management Scheme. DELWP are reviewing legal liability.* • *Levee permitting process for individuals/groups is now available through the GB CMA for levees on Crown land. This is strictly for maintenance of levees. This is now on the GBCMA's website.* • *1996 a levee audit was undertaken along the Murray levees.*	X			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
52	Concerns were expressed in the huge community effort in defending the levee. On this basis the community group believe that there would be interest in management arrangements. **Response 52** *The potential management arrangements for rural levees have been documented in the Victorian Floodplain Management Strategy (VFMS). Refer to item 51 for further response.*	x			
53	A number of weak spots/issues with the PWD levees that were issues in October 2016, including Ulupna Island, have not been fixed. **Response 53** *There are Natural Disaster Relief Arrangements whereby failed infrastructure may be repaired. This is usually done via a sponsoring authority e.g. the lower Goulburn levees were repaired via the local government on behalf of the community. The Goulburn Broken CMA will raise this with the CEOs.*	x			
54	Yarroweyah and Strathmerton should be on the prioritisation list for towns in the strategy. **Response 54** *These towns have been included in the Murray River Regional Floodplain Management Study.*		x	x	x
55	Question about the lack of notice of community meetings: how can that be done better. Better use of posters in shops. **Response 55** *Noted. Need to improve engagement.*				
56	Asked questions about the use of drones in emergency response **Response 56** *VICSES are using drones.*				x
57	Raised issues with the operating rules of Hume Weir. Need to consider a concept of declaring a “wet year”. Request for better operating rules.				x

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Response 57 *Floods can occur at any time of the year and as such there is no flood season or no ability to declare a wet year.* *Target filling curves are applied to manage storage operations. Storages are primary used for the provision of water responses. There is some flexibility in the operations with rainfall forecast. (check with GMW)*				
	Nathalia – 13th Feb 2017, 5pm to 7pm				
58	Sandbagging concerns as follows: • More communication – last floods there was poor information at north of Barmah, near the Murray. Told 2 weeks before that the flood was coming, bought sand bags and sand. • Sand bags could not be sent back to NSW. • Landholder between Numurkah and Walshs Bridge - sand bags were not available in Numurkah when required. • 2016 flood – public meeting in Cobram said there was only 5,000 sandbags available from VICSES. Important to have them available early so people don't have to work 24 hours a day. • Sandbags were made available too late in Barmah on a Sunday night after volunteers had left. **Response 58** *The communication and coordination of sand, sandbagging, resourcing is complex. Need to rely on multi-agency approach and good ICC communications. Understand that communication can be improved. Always seeking to improve the Municipal Flood Emergency Plan.*				x
59	Potential to improve flood mapping and warning for the lower Broken Creek, below the Nathalia town study. **Response 59** *There are flood warning services to Nathalia that can be used downstream of Nathalia. Flood mapping extends to Narioka linked to the Nathalia gauge. Further mapping is considered a low priority in this particular point of time.*		x		x
60	Showing the flood mapping to the community may help reassure them.		x		

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	Response 60 *Agreed. Mapping would assist with flood resilience, but would need to be fit-for-purpose.*				
61	A priority to do a flood study on the Murray River downstream of Ulupna Creek. **Response 61** *Agreed. This work is required particularly if the question of levee management is to be addressed. Otherwise this is a low priority at this particular point of time.*	x	x	x	x
62	Identify weak links in the PWD levee and the potential consequences (flood extent) of such a failure for the public to understand the risk. Otherwise there is a lot of unnecessary stress. **Response 62** *Some of this information does broadly exist but is complex to understand. The Water Technology – Rural Levee Assessment Report will be placed on to GB CMA's website.*		x		x
63	On Broken Creek in 2012 a lack of information caused a lot of grief, need accurate information at Numurkah. **Response 63** *Significant improvements have been made to the Municipal Flood Emergency Plan. Furthermore, the Bureau of Meteorology is investigating a new flood prediction service for Numurkah.*				x
64	Landholder highlighted the need for a river gauge at Yambuna Bridge. **Response 64** *Flood warning are provided to McCoy Bridge and the need for further river gauge needs to be explored.*		x		
65	The beneficiaries for levees include the infrastructure adjacent the levee, including the major roads, VicTrack, Telstra, Environmental Water Holder, Power infrastructure. **Response 65**	x			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	The potential management arrangements for rural levees have been documented in the Victorian Floodplain Management Strategy (VFMS) that includes the beneficiary pay principle. Refer to item 51 response for further background reading.				
66	Need to access local knowledge to inform the flood plan and monitor flood heights/extent. **Response 66** *Local knowledge, during both flood studies and the preparation for floodplain management plans, is considered paramount.* *At the outset of significant rainfall, and during major floods, the use of local "flood observers" is being addressed by the Control Agency for flood which is VICSES. Such arrangements may add significant intelligence, particularly where gauge networks are lacking.* *Flood inquiry acknowledged the importance of local flood knowledge. Such knowledge is built into the Municipal Flood Emergency Management Plan.*		x		x
67	Concern that environmental flows in combination with rain events will cause flooding. **Response 67** *This is a matter of operation procedures for managing environmental flows which is beyond the scope of this Regional Floodplain Management Strategy.*				
68	2012 flood was bigger than 1993. Authorities need to refer to historic information. Raised issues with the way the 2012 flood was managed. Flood awareness local information and input is critical… **Response 68** *Flood inquiry acknowledged the importance of local flood knowledge. Such knowledge is built into the Municipal Flood Emergency Management Plan.*		x		x
69	Four critical issues: 1. Information 2. communication	x	x	x	x

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	3. Authorities take more note of local knowledge 4. Who will implement the issues **Response 69** *The above, to a large extent has been delivered through floodplain management plans and its implementation. The Regional Floodplain Management Strategy is seeking to prepare an ongoing three year rolling plan to deliver flood mitigation, total flood warning systems, land-use planning and municipal flood emergency plan to make community flood resilient. The Victorian Floodplain Management Strategy sets out accountabilities for delivery.*				
	Mansfield – 18th Feb 2017, 11am to 1pm				
70	Big flood risk above Jamieson and Goulburn – what about a risk assessments on the camping grounds. Howqua river has ability to rise pretty quickly, e.g. of campers having problems. **Response 70** *Camping grounds are managed by Parks Victoria. There would be some merit in establishing flood levels within the camp grounds. This can be built into the regional flood study. Works has been done in this space for fire. Limited communication in the camping sites.* *EM has Camp Sites for fire evacuation in GIS that could be useful for the MFEP*		x	x	x
71	Mansfield needs targeted forecasting information (2011 event is an example). Individuals that need rainfall information are likely to already have it built in resilience. **Response 71** *Flood warning systems need to be fit for purpose. E.g. relying on rainfall information maybe one approach suitable for Mansfield rather than an expensive rain and river gauge network. This example would be different if there were dozens of over floor flooding problems.* *Weather underground stations (ground) – created by weather enthusiasts could be a good source of unofficial rainfall data, particularly during major storms. Also CFA Shed Weather gauges.*		x		x

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
72	Maindample drainage issue, suggested two or three houses could be impacted by flooding  **Response 72** *Noted. Worth doing a visual inspection. There is no ground level information for this area.*			x	x

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
73 FF	1. *Flood impacts - How does flooding across the floodplain affect you and your community? Does flooding impact on your livelihood such your home, business and/or agriculture use?* The flooding of Guilfus Creek has caused a lot of paddock damage and caused cattle to get sick due to water hanging around longer than usual and grass won't grow where water laid for a long time. 2. *Flood protection, management and preparation - How can your floodplain be better protected or managed from the impacts of flooding? How do you think flood warnings for your community could be improved? Are you and your community well prepared for the next flood? How could preparation be improved? What flood information would be most useful?* The flooding would be better managed if the outfall of Guilfus Creek was made so it starts to run as soon as the water gets to the drainage channel rather than having to build up and rely on it being released into the drainage channel manually. 3. *Environmental and cultural heritage considerations - How do you see the balance between managing flood risks and protecting the cultural heritage and environmental values of waterways and wetlands?* (nil) 4. *Other comments* As there has been a permit for the structure at the end of the creek. If it can't be made bigger and automated or removed to drain all the upstream properties, approx. 1000 acres. Suggest clean out the drain on left hand side of Boschetti Road going north and bring the water in at the front of the bank as there is a pipe across the road. All that needs doing is earthworks as the work that has been done will not fix the problem this may help a little. **Response 73** Refer to item 30. Further Greater Shepparton City Council is actively managing this complex matter with the local community.			x	
74 FF	1. *Flood impacts - How does flooding across the floodplain affect you and your community? Does flooding impact on your livelihood such your home, business and/or agriculture use?* We own a farm at Strathmerton that borders the Ulupna Creek. Approx. 100 acres of our farm was under water in the flood as this could not get into the creek. Loss of crop was a major issue.	x			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	2. *Flood protection, management and preparation - How can your floodplain be better protected or managed from the impacts of flooding? How do you think flood warnings for your community could be improved? Are you and your community well prepared for the next flood? How could preparation be improved? What flood information would be most useful?* The levee along the Ulupna Creek needs to be topped up in a number of places. The flaps on some pipes need to be fixed up to keep the water in the creek. The levee from Ulupna Island road downstream needs topping up to the junction of Ulupna Creek to Murray River junction. 3. *Environmental and cultural heritage considerations - How do you see the balance between managing flood risks and protecting the cultural heritage and environmental values of waterways and wetlands?* You must protect farmers from flood over environmental. The water is flooding Barmah Forest more now that 20 years ago, not always a benefit to the environment. 4. *Other comments* (nil) **Response 74** The Victorian Floodplain Management Strategy sets out the framework for existing mitigation infrastructure (namely levees). This includes a permitting process for individuals or the collection of individuals to carry out maintenance works. The Victorian Floodplain Management Strategy sets out policy about the three tiers of government will on invest in existing flood mitigation infrastructure if the investment criteria can be met. Given the "primary benefits" (VFMS wording) relate to private land, and given a strong reluctance of local government to manage such infrastructure (due to legal liability, particularly as the standard of levees are poor), then the levees may be maintained privately under the permitting process (if on Crown land) or planning permit process (if on private land).				
75 EC	Our property borders the river roughly between Koonoomoo and Strathmerton and the main issue which I think should be dealt with is the general maintenance of the banks which have been allowed to deteriorate to such a state that they couldn't cope with a small event such as October's flood. A more specific issue is the weir on the Sheepwash Creek just prior to where it flows into the Ulupna Creek. During the flood, while we were frantically sandbagging the levees on both sides of the Ulupna Creek we were flooded from the South side of the bank by water which flowed up the Sheepwash from the Ulupna creek and onto our land. This resulted in	x			

Item & Response	issue / location / comments	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
	about 100ha of pasture being inundated and 60ha of crop resulting in the loss of about 100t of wheat and 50t of barley. My proposal is to alter the structure on the Sheepwash to allow drop boards to be put in to prevent water from the Ulupna Creek backing up when the river rises above 100,000ML/day. At the moment there is nothing stopping water flowing up the Sheepwash from the Ulupna and flooding our property. I can't see there being any problems with preventing the creek backing up at Farrell's Rd. This also removes the pressure on the levees upstream of the weir and the need to maintain them (not that anyone does this now). I have attached a photo of the weir.  **Response 75** There is a long history associated with this structure. The structure built on Sheepwash Creek controls further propagation of a head cut and the function of the bed control. The invert on the downstream side of the creek is lower compared with the upstream side. As such the structure prevents backwater flooding for minor Murray River flow by virtue of the height of the upstream invert. Larger floods create further backwater flooding over lands as described in the above comments. As part of the works, an flood easement was created over the land – check files The Goulburn Broken CMA would not endorse the proposal of block this backwater due to unintended consequences, with doing detailed studies into third party impacts. In terms of maintenance of levees the comments provided in Response 74 are relevant.				

Appendix J: DELWP's Rapid Appraisal Methodology

Key data requirements

The data required to estimate damages using DELWP's rapid appraisal of flood risk methodology is publicly available as explained in **Table J-33** and includes flood hazard data and asset datasets.

Table J-33: Datasets used in the rapid appraisal of flood risk methodology

	Type	Source	Layer Name
Asset Datasets - used to identify which assets are at risk of inundation.	Land use	Vic Map Catchments (obtained from the DEPI CSDL data)	Varies with Region
	Rural buildings	Vic Map features of interest (FOI)	BUILDING_POINT.shp
	Cadastre	Vic Map Properties (VMPROP) (obtained from the DELWP CSDL data)	V_PROPERTY_MP.shp
	Planning Zones	Vic Map Planning zones (VMPLAN)	PLAN_ZONE.shp
Flood Hazard Data - required to determine the probability and extent of inundation.	100 year flood extent (indicative)	Victorian Flood Database	extent_100yr_ari.shp
	Floodway	Victorian Flood Database	floodway.shp

These data sources are used to determine the inventory at risk and assess flood damages using a loss probability curve as explained in the following section.

Approach

The rapid appraisal of flood risk methodology is comprised of three core tasks:

1. Establishing management units
2. Quantifying assets at risk
3. Quantifying flood damages and developing risk metrics.

1. Establishing management units

The region under the management of a CMA can occupy a very substantial area and it is sensible to consider flood damages and floodplain management measures for sub-regions. A CMA's region usually consists of the catchments of several rivers and smaller streams, and will contain a varied mix of urban and rural areas with differing characteristics. It is thus necessary to define smaller management units that allow the rapid appraisal to be applied systematically.

How management units are established is a matter of judgement for the analyst and those who are formulating management strategies and programs. The critical task is to define study areas which allow flood risk to be assessed in a manageable and systematic way. The broad criterion that should be used to guide the definition of study areas is that areas where the effects of a given cause are felt should be combined into a single study area.

As a general guide:

- Urban flooding is separated from rural flooding. An individual town may be further divided, depending on whether flood mitigation is best managed separately in discreet management units.

- Rural flooding should be divided into practical management units where the assets at risk and the available flood warning time are comparable.
    - Rural study areas should be determined separately where significant land-uses (e.g. intensive animal or horticultural industries) are identified
    - Rural study areas should commence (or terminate) at a major waterway confluence where additional inflows and/or stream capacity can result in substantial changes in the annual exceedance probability of a single rainfall event
    - Rural study areas should be separated where flood warning is substantially different. Flash flooding (less than 6 hours), should be assessed separately from areas with between 6-12 hours of warning, and areas with greater than 12 hours.

Similarly, with regard to the strategic output from the appraisal, the analyst may wish to consider how the findings can be communicated most effectively to engage with affected communities. The following may be taken into account:

- Local Government Area (LGA) boundaries – defining management units along LGA boundaries may be used to better rationalise local government contribution to flood risk mitigation.
- Communities of interest – where a cohesive community group are reflected in a homogenous geographic unit, support for a specific risk mitigation strategy may be leveraged.

2. Quantifying assets at risk

Flood damages can be grouped as follows:

- Direct (tangible) damages comprise the physical impact of the flood, for example, damages to structure and contents of buildings, agricultural enterprises and regional infrastructure.
- Indirect (tangible) damages comprise losses from disruption of normal economic and social activities that arise as a consequence of the physical impact of the flood; for example, costs associated with emergency response, clean-up, and disruption to transport and commerce.
- Intangibles, or 'non-market' impacts, comprise losses which cannot readily be quantified in monetary terms (since market prices cannot be used). For example, loss in biodiversity, physical injury or increased stress levels for residents following a major flood event.

For the purpose of DELWP's rapid appraisal of flood risk methodology, only the following damages are quantified.

- Direct damage to buildings and contents (residential and non-residential)
- Direct damages to agriculture
- Indirect damages, resulting from the cost of emergency response (measured as a % of direct damage to buildings).
- Building and contents

The assumptions for determining the number of urban and rural building assets at risk are shown in **Table J-34**.

Table J-34: Property at risk assumptions

	Urban Areas	Rural Areas
Dataset used	Vic Map properties	Vic Map features of interest
Property count Assumptions	For a property to have a building and/or be suited for development, the cadastre must be > 100 m2 and < 10,000 m2	One rural building is inundated for every two FOI (points) inundated
Planning assumptions	Properties (buildings) were classified based on the planning zones outlined below: Residential – TZ, GRZ, GRZ1, LDRZ, MUZ, NRZ1 Commercial – C1Z, C2Z Industrial – IN1Z, IN2Z, IN3Z	

- Agriculture

The digital flood datasets are overlayed on the land-use dataset to produce estimates of the exposure of each land-use to inundation. Data estimating the duration of inundation is also required.

3. Quantifying flood damages and developing risk metrics

- Damage to buildings

State-wide depth grids are not available with the flood extents in the VFD. Therefore in developing assumptions for the depth of flooding across the flood extent, an analysis was undertaken of 30 Victorian depth grids. The distribution of depth of flooding was used to determine unit damages for residential, commercial and industrial buildings (**Table J-35**).

Table J-35: Distribution of flood depth by flood annual exceedance probability (AEP)

AEP	Flood depth above ground (m)							Total
	<0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0	1.0-1.2	>1.2	
10%	49.4%	40.9%	5.7%	1.3%	0.5%	0.2%	2.0%	100.0%
1%	29.4%	39.1%	17.2%	5.3%	2.3%	1.2%	5.4%	100.0%

Source: DELWP depth grids from 30 Victorian flood studies (Aither 2015)

- Residential buildings

Unit damages for each flood extent were calculated using depth damage data that is provided by the NSW Office of Environment and Heritage (OEH)[11]. Damage assumes generic losses for a single storey slab/low set residence. The calculation is shown in **Table J-36**.

[11] A file from which residential damages can be adjusted for local conditions can be found at http://www.environment.nsw.gov.au/floodplains/StandardFloodplainRiskManagement.htm.

Table J-36: Weighted damage calculation per property (residential, commercial and industrial) by flood frequency

AEP	Flood Depth	% distribution	Damage	Weighted damage
10%	<-0.1	52%	$10,921	$5,690
	-0.1-0.1	42%	$29,159	$12,358
	0.1-0.3	4%	$67,445	$2,599
	0.3-0.5	1%	$73,685	$774
	0.5-0.7	0%	$79,924	$280
	0.7-0.9	0%	$86,164	$75
	>0.9	0%	$100,000	$175
		100%		**$21,951**
1%	<-0.1	30%	$10,921	$3,298
	-0.1-0.1	40%	$29,159	$11,780
	0.1-0.3	18%	$67,445	$11,886
	0.3-0.5	5%	$73,685	$3,392
	0.5-0.7	2%	$79,924	$1,702
	0.7-0.9	1%	$86,164	$947
	>0.9	4%	$100,000	$3,951
		100%		**$36,955**

The weighted unit damages for each flood extent are therefore:

Floodway – $21,951

1% AEP flood extent – $36,955

These weighted unit damages are then applied as part of DELWP's rapid appraisal of flood risk methodology to assess the damage to residential buildings within each flood extent. For example, where 10 properties (identified using Vic Map data) were inundated within the floodway, then residential damages were estimated at $210,000. Furthermore, the damages for 100 properties inundated by the 1% AEP flood event were assessed at $3,700,000.

- Non-residential buildings

Damage for commercial and industrial buildings are estimated using the United States of America's Federal Emergency Management Agency (FEMA) relative depth damage curves. These curves are relative curves, meaning that they specify damage as a percentage of building replacement value (BRV). Given that no data is available for BRV, the following assumptions were made (**Table J-37**).

Table J-37: Assumed building replacement value for commercial and industrial buildings

	Building footprint (m^2)	Unit cost ($/$m^2$)	BRV ($)
Commercial	250	$1,400	$350,000
Industrial	1,000	$1,200	$1,200,000

The BRV for industrial and commercial buildings is calculated by multiplying assumed building costs (Rawlinsons 2012) by the assumed building footprint of 1,000 m^2. The weighted unit damages for each flood extent that are calculated are shown in **Table J-38**.

Table J-38: Weighted average damages for commercial and industrial buildings

Flood extent	AEP	Commercial	Industrial
Floodway	10%	$5,584	$8,489
1% AEP flood extent	1%	$18,362	$55,352

Damages to Agriculture

The assumptions for assessing damages to agriculture are summarised in **Table J-39**.

Table J-39: Estimated agricultural losses

	Unit	Annual Damages	Establishment Costs	Land Clean-up and Rehab	Total	
					Less than 5 days inundation	More than 5 days inundation
Dryland pastures	$/ha	-	$90	$40	$40	$130
Dryland broadacre crops	$/ha	$100	$60	$40	$140	$200
Orchard	$/ha	$4,600	$5,000	$500	$5,100	$10,100
Grapes	$/ha	$2,300	$1,500	$500	$2,800	$4,300
Vegetables	$/ha	$9,500	-	$500	$10,000	$10,000
Irrigated pastures	$/ha	$110	$430	$40	$150	$580
Irrigated broadacre crops	$/ha	$220	$220	$40	$260	$480

When certain perennial land-uses are inundated for longer than 5-7 days, waterlogging causes plant death and it becomes necessary to re-establish the plant species. The number of "threshold days" varies according to the land-use and time of year, but for modelling purposes is assumed to be 5 days.

DELWP's rapid appraisal of flood risk methodology assumes that no losses in production are attributed to flooding of dryland pastures less than 5 days. In addition to losses of production, flooding will generally require expenditure to repair erosion, repair fences, remove debris, rocks or silt deposits from fields, and replace soil. The following clean-up costs are added to production losses:

- pastures and broadacre crops, $25 per hectare
- horticulture, $350 per hectare.

No assumptions for livestock losses are made given the typically long warning times in Victoria.

Indirect damages

For the purpose of DELWP rapid appraisal of flood risk methodology, the main indirect tangible losses as a result of a flood event are the cost of the emergency response and repair. This includes the cost of clean-up, evacuation and emergency response.

Limited data is available from where indirect impacts can be quantified. For this reason, it is typical to account for all indirect impacts as a ratio of “direct” damage. Indirect damages are estimated as 25% of direct damage to both urban and rural buildings.

Using the loss probability curve

Flood risk is calculated using a loss probability curve. The curve plots damages against their probability of occurrence. The loss probability curve is based on three known points:

- Damages based on areas of inundation shown on the flood maps for the 1% AEP flood extent;
- Damages based on areas of inundation shown on flood maps for the floodway area (assumed to represent a 10% AEP event); and
- The flood event where damages are judged to commence (20% AEP event is assumed).

As demonstrated in **Figure J-15** below, the large damages from low probability events are combined with lower damages from more frequent flood events using data for probability and calculated damage.

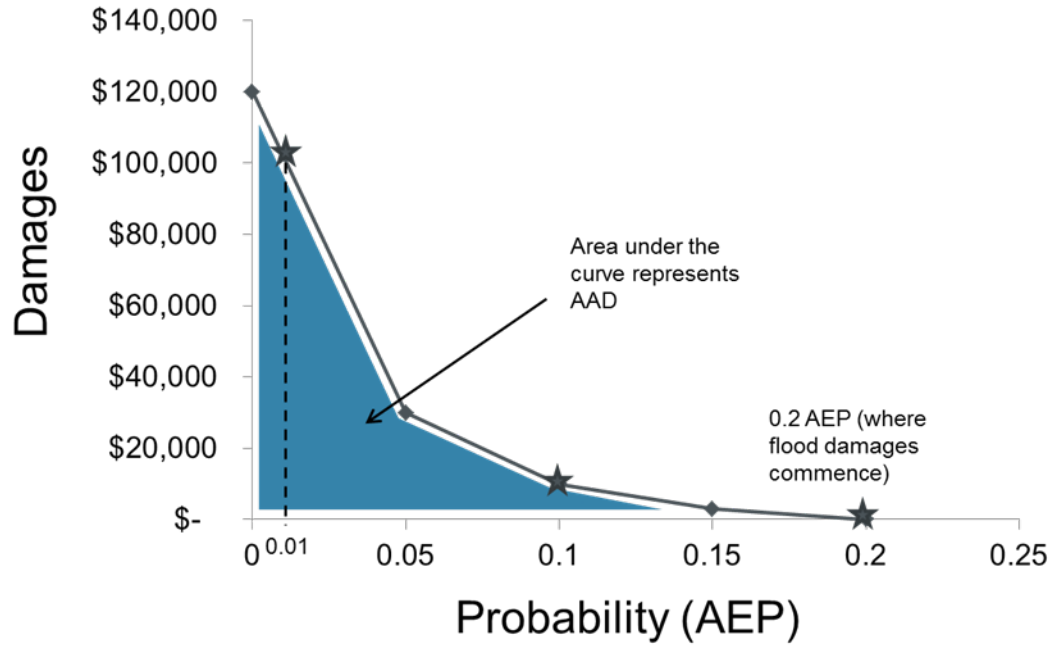


Figure J-15 Loss probability curve

The integral, or area under a loss probability curve, represents the annual average damage (AAD) resulting from all flood events over a long period of time. This risk metric is used to assess the benefit of mitigation options.

Population at risk

The population at risk is estimated by assuming the average number of people living in an inundated house. The population at risk is estimated by multiplying 2.6 residents per household (derived from the Australian Bureau of Statistics) by the estimate of buildings affected during each flood extent.

Developing comparable risk metrics

Given differences in the size of each study area, it is necessary to develop consistent flood risk metrics so that damages can be compared. There is no one risk metric that is likely to best capture the importance of flood risk within a study area.

The DELWP flood risk assessment methodology assesses flood risk within each management unit using the following metrics:

- Density of damages (measured as the ADD divided by the AEP of hundred year flood event)
- Absolute risk (the absolute size of the AAD from the cost-probability curve)
- Population affected (measured as the AAPA divided by the population of the town)

A summary of each metric and its relative flood risk severity ranking is provided in **Table J-40**.

Table J-40: Comparable risk metrics used in the rapid appraisal of flood risk methodology

Flood Risk Severity	Density of Flood Damages[1]	Absolute risk[2]	Population affected[3,4]
0	No Data	No Data	No Data
1	0	0	0
2	$500	$100,000	4
3	$1,000	$200,000	10
4	$2,500	$500,000	30
5	$5,000	$1,000,000	60

Notes:
1. Measured as the AAD divided by the area of inundation for the 1% AEP flood extent.
2. The absolute size of the AAD.
3. Measured as AAPA divided by a town's population (multiplied by 1,000).
4. No population has been determined for "rural" study areas. They are given a score of 1.

Other things to consider

- The rapid appraisal of flood risk methodology does not capture:
- The presence of critical infrastructure (roads, hospitals, utilities)
- More at risk populations (retirement homes, hospitals etc.)
- Flood risk where flood hazard data is absent
- The potential risk to life (where flood depth and velocity is high for flash flooding)
- The potential for regional growth (i.e. need for new planning overlays).

Appendix K: TFWS assessment Tool methodology

The process followed by CMAs and Melbourne Water included:

- Assess and rank regional flood risks (see **Chapter 3:**);
- Determine existing TFWS service levels;
- Identify those locations in need of TFWS improvements;
- Identify a scope of works that will deliver the improvements sought for each identified location; and
- Establish priorities for improvements.

Establishing Regional Flood Risk

DELWP has developed a flood risk assessment methodology that can be used to assess and rank regional flood risks (refer to Section 4 of the VFMS and the Guidance Notes for "Using DELWP's Rapid Appraisal Methodology", "Identifying important regional and community infrastructure"). It is applied at the location and river reach scale and delivers relative risk rankings for different locations based primarily on annual average damages and the population at risk. More specifically, the methodology focuses on the social impacts of flooding at different locations in the region and uses available flood and asset information to assess flood likelihood and associated consequences. Secondary issues include the potential for key infrastructure to be damaged or disrupted by flooding (up to and including the 1% AEP event), the relative vulnerability of the population at risk, and any access or egress issues that may limit safe evacuations.

The TFWS Service Level Framework

A TFWS service level can be thought of in terms of the complexity or completeness of the information that support that particular element of the TFWS and is provided (or available) to an agency and / or community before and during a flood.

The TFWS Service Level Framework comprises five (5) service level tiers – from zero (0) to four (4) where Tier 0 designates a simple or basic service level and Tier 4 a complex / comprehensive level of service.

TFWS element service levels are detailed in Attachment A. The descriptors for each TFWS element deliver a broad level narrative of the features / level of development / sophistication expected to be present for each of the service level tiers. Service level tier descriptors are also provided for the sub-factors with due regard for what is measurable, scalable, and relevant and appropriate. The descriptors facilitate a quantifiable (deterministic) discrimination between the service level tiers.

It is generally not a trivial task to determine service levels for either a TFWS element or the system as a whole by considering the Framework descriptors alone without using the Tool. It is also likely to result in some inconsistencies as well as a subjective bias, particularly in the case where a number of sub-factors contribute to a service level score. It is therefore suggested that the service level descriptors are used to:

- Confirm Tool results (i.e. do Tool results match expectations and if not why not);
- Inform discussions about an existing TFWS and its elements;
- Verify or adjust perceptions of the service level being delivered by an existing TFWS, or its elements;
- Guide adjustment of Tool results if and as required; and

- Inform discussions and decisions regarding improvements to or development of a TFWS.

The TFWS Assessment Tool

The current version of the TFWS Assessment Tool is described in the Tool Version 4A User Manual. The User Manual is available from DELWP.

Attachment 1: TFWS Service Level Framework and Tiers (as at May 2015)

Data Collection Network

The data collection network refers to the detection, collection and transfer of rainfall, river heights and streamflow data. This data supports other activities associated with the other building blocks of the Total Flood Warning System. The more extensive the data network and the more automated the data collection processes, the higher the value of the data collection element within the total system. Typically, locations with a greater flood risk benefit from a higher DCN service level.

Service Level Tier	Service Level Descriptor	TWFS Assessment Tool A Sub factors							
		A1 Rain Gauge Sub factor	A2 Event Reporting RG Sub factor	A3 Stream Gauge Sub factor	A4 Rated Sites Sub factor	A5 Elevation Sub factor #1	A6 Elevation Sub factor #2	A7 Distance Sub factor #1	A8 Distance Sub factor #2
0	No real time rainfall or river data available. Manual gauges only, if any.	Manual rain gauges only, if any.	No event reporting rain gauges in catchment	Manual stream gauges only within catchment, if any.	No rated sites in catchment.	No (or negative) elevation difference between the most remote TBRG and the first forecast location.	Large elevation difference between the closest forecast location and the at-risk location (or reach) or the forecast location is downstream of the at-risk location (or reach).	No (or negative) distance between most remote TBRG and first upstream forecast location.	Large distance between at-risk location (or reach) and closest forecast location or forecast location is downstream of at-risk location (or reach).
1	Real time rainfall and river height data available from sites upstream of the at-risk location within the basin.	Few rain gauges in the catchment.	A low number of event reporting rain gauges in catchment. No event-reporting rain gauges at the at-risk location or reach.	A low number of stream gauges within catchment.		Little elevation difference between the most remote TBRG and the first forecast location.	Medium elevation difference between the closest forecast location and the at-risk location (or reach).	Very little distance between most remote TBRG and first upstream forecast location.	Medium distance between at-risk location (or reach) and closest upstream forecast location.

Service Level Tier	Service Level Descriptor	TWFS Assessment Tool A Sub factors							
		A1 Rain Gauge Sub factor	A2 Event Reporting RG Sub factor	A3 Stream Gauge Sub factor	A4 Rated Sites Sub factor	A5 Elevation Sub factor #1	A6 Elevation Sub factor #2	A7 Distance Sub factor #1	A8 Distance Sub factor #2
2	Real time and rainfall river height data available from sites upstream of the at-risk location within the basin. River level information available for the agreed forecast location during rain / flood events.	Some rain gauges in catchment, including upstream. No gauges at the at-risk location or reach.	A low number of event reporting rain gauges in catchment. No event-reporting rain gauges at the at-risk location or reach.	A low number of stream gauges within catchment including a non-telemetered gauge at the at-risk location or reach.	There is a rated site downstream of the at-risk location or reach.	Low to medium elevation difference between the most remote TBRG and the first forecast location.	Small to medium elevation difference between the closest forecast location and the at-risk location (or reach).	Small to medium distance between most remote TBRG and first upstream forecast location.	Small to medium distance between at-risk location (or reach) and closest upstream forecast location.
3	Real time and rainfall river height data available from sites upstream of the at-risk location within the basin. Permanent telemetered river level gauge operational for the agreed forecast location.	Some rain gauges in catchment, including at the at-risk location or reach and upstream.	A moderate number of event reporting rain gauges in catchment including upstream of the at-risk location or reach. No event-reporting rain gauges at the at-risk location or reach.	A moderate number of stream gauges in the basin. Permanent telemetered stream gauge at the at-risk location or reach.	There is a rated site upstream of the at-risk location or reach, but the at-risk location (or reach) itself is not rated.	Moderate to high elevation difference between the most remote TBRG and the first forecast location.	Very small elevation difference between the closest forecast location and the at-risk location (or reach).	Large distance between most remote TBRG and first upstream forecast location.	Very small distance between at-risk location (or reach) and first upstream forecast location.

Service Level Tier	Service Level Descriptor	TWFS Assessment Tool A Sub factors							
		A1 Rain Gauge Sub factor	A2 Event Reporting RG Sub factor	A3 Stream Gauge Sub factor	A4 Rated Sites Sub factor	A5 Elevation Sub factor #1	A6 Elevation Sub factor #2	A7 Distance Sub factor #1	A8 Distance Sub factor #2
4	Real time and rainfall river height data available from sites upstream of the at-risk location within basin. Permanent telemetered and rated river level gauge operational for the agreed forecast location. Information available for storm surge and tidal flooding for coastal flood risk locations.	Multiple rain gauges in catchment upstream, downstream and at the at-risk location or reach.	A high number of event reporting rain gauges in the basin, including at the at-risk location or reach.	A high number of stream gauges in the basin. Telemetered stream gauge at the at-risk location (or reach) and upstream.	Rated site at the at-risk location or reach.	Large elevation difference between the most remote TBRG and the first forecast location.	The closest forecast location and the at-risk location (or reach) are at the same elevation (co-located).	Medium to large distance between most remote TBRG and first upstream forecast location.	The at-risk location (or reach) and closest upstream forecast location are at the same location.

Notes:

i) Stream gauges include manually read staff gauges

ii) The Service Level descriptors provide a qualitative description rather than quantitative to avoid conflict with the TWFS Assessment tool and ensure that the service level of a location is being considered relative to the size of the basin it is within.

iii) Negative elevation or distance means that the forecast location is downstream of the at-risk location or river reach.

Prediction (Forecasting)

Prediction (forecasting) refers to the approaches, processes and models that use the data collected for predicting or forecasting the characteristics, behaviour and lead time of flooding in watercourse reaches and at at-risk locations.

Service Level Tier	Service Level Descriptor	TWFS Assessment Tool C Sub factors				
		B1 Forecast Sub factor	B2 Model Sub factor	B3 FWS Charter Sub factor	B4 Significant Storage Sub factor	B5 Response to Need Sub factor
0	Generic basic flood watch and severe weather / flash flood warning services only provided by BoM. No real time data available. No real time flood forecasts provided across the catchment.	Generic flood watch and severe weather / flash flood warning services only. No formal or informal flood forecast methods in catchment.	No forecast methods or models available. No real time data available.	No FWS charter in catchment.	Storages exist upstream and would benefit from being forecast through but are not forecast through.	Not needed if breaking down to locations.
1	No formal prediction service. Rainfall and / or river height data available in near real time at or near the location of interest (available locally or from BOM website).	Generic basic service only from BoM (flood watches, flash flood warnings). No formalised forecast service however informal forecast techniques may exist.	No formal forecast methods or models available. Informal models or methods may be available at local level. Real or near real time data may be available.	No FWS charter in catchment.		
2	Non-location specific qualitative forecasts may be provided by BoM. Rainfall and river height data available from BoM website in near real time, at or near the location of interest. Flood class levels or trigger levels determined for information locations or monitored sites.	Generic basic service from BoM (flood watches, flash flood warnings). Non-location specific formal qualitative forecast may be provided by BoM based on exceedance of flood class levels or trigger levels for	Forecast is based on observed behaviour against flood class levels or (rainfall or river) trigger levels. Rainfall and river height data available in near real time.	FWS charter exists downstream of the at-risk location (or reach).		

Service Level Tier	Service Level Descriptor	TWFS Assessment Tool C Sub factors				
		B1 Forecast Sub factor	B2 Model Sub factor	B3 FWS Charter Sub factor	B4 Significant Storage Sub factor	B5 Response to Need Sub factor
	Flood charter may exist downstream of the at-risk location or reach.	information locations or monitored sites.				
3	Location specific qualitative flash or riverine flood warnings provided by BoM or local entity (e.g. LG, RWA, etc.). Flood class or trigger levels determined for that location. Flood charter may exist upstream of the at-risk location or reach.	Generic basic service from BoM (flood watches, flash flood warnings). Location specific qualitative flood (riverine, flash) warnings are issued based on observed exceedance of flood class levels or flows at river sites or exceedance of trigger levels at monitored rain or river sites.	Observed behaviour coupled with analogue or qualitative assessment (e.g. peak height / flow correlations, flood curves, IFD assessments, rates of rise, etc.). Rainfall and river height data available in near real time.	FWS charter exists upstream of the at-risk location (or reach).	Storages exist at or upstream and the nearest storage is forecast through. No storages upstream that require forecasting through.	
4	Quantitative river height and timing forecasts (rise, fall, peak, critical levels) across flood event duration at the location of interest within agreed and specified accuracy bounds. Flood class or trigger levels determined for the at-risk location. Flood charter exists for the at-risk location or reach.	Generic basic service from BoM (flood watches, flash flood warnings). Quantitative forecasts (riverine, flash) are issued for the duration of the flood.	Rainfall / Runoff model available for at-risk location (or reach). Rainfall and river height data available in near real time.	FWS Charter exists for the at-risk location (or reach).		

Notes:

i) Formal forecasts refer to those issued by the BoM or a LG-owned flash flood warning system while informal forecasts refer to those issued by others (e.g. RWA, local group, etc.).
ii) Significant storages refers to storages that would benefit from being considered in forecasting models because of the impact they may have on flooding.
iii) It is assumed that even if a location does not have a FWS Charter, there will be a benefit to that location if an upstream or downstream location does have a FWS Charter.

iv) Locations that have no upstream storages requiring forecasting are assigned the same rating as those locations that have storages upstream with forecasting. This is aimed at avoiding any skewing or biasing of results, particularly for locations without an upstream storage.
v) Forecasting through refers to the practice of developing and disseminating a downstream forecast ahead of outflows from a storage being confirmed either through head / tail gauge readings or gate operations.

Dissemination (Dissemination and Communication)

Dissemination (and Communication) accounts for the various methods and technologies used to disseminate flood warning information between agencies and to at-risk communities.

Service Level Tier	Service Level Descriptor	TWFS Assessment Tool C Sub factors
		C1 Dissemination Sub factor
0	Standard arrangements only. No specific flood related messaging and thus no specific dissemination.	Generic messaging: included in weather forecasts and disseminated via standard dissemination arrangements.
1	General messaging at area / basin scale using standard arrangements via website and media outlets. May include local government websites or social media. At least one dissemination method of Faxstream, phone tree, recorded message.	Generic messaging: included in weather forecasts and disseminated via standard dissemination arrangements. At least one of Faxstream, phone tree, recorded message.
2	General messaging at area / basin scale using standard arrangements via website and media outlets. May include local government websites or social media. At least one dissemination method of Local Wardens, FM-88, limited manual dissemination methods such as non-automated SMSing.	Generic messaging: included in weather forecasts and disseminated via standard dissemination arrangements. At least one of local wardens, FM-88, limited manual dissemination method (e.g. non-automated SMSing).
3	Specific and targeted messaging to at-risk location or river reach from authorities using standard arrangements. Either direct non-automated (i.e. manual) mass dissemination methods such as social media or limited automated dissemination.	Generic messaging: included in weather forecasts and disseminated via standard dissemination arrangements. Either manual mass dissemination (e.g. social media) or limited automated dissemination.
4	Specific and targeted messaging to at-risk location or river reach from authorities using standard arrangements. A combination of different dissemination methods are used, both automated and non-automated. At least one direct automated dissemination method, such as mass automated SMS, is used to disseminate warning information to individuals / communities.	Generic messaging: included in weather forecasts and disseminated via standard dissemination arrangements. A combination of different dissemination and communication methods used. Automated mass dissemination method.

Notes:

i) It is assumed that the higher service levels will include multiple different dissemination methods. The sub factor lists the minimum requirements to achieve that service level.

Interpretation and Consequences Assessment (Interpretation)

Interpretation is the use of historic and modelled flood data (e.g. past events, flood study outputs and mapping) to identify consequences including likely flood extents, depths, velocities and properties affected. Studies may deliver detailed assessments of risk and flooding consequences, including details of infrastructure, properties and floors affected.

Service Level Tier	Service Level Descriptor	TWFS Assessment Tool E Sub factors	
		E1 Flood Study Sub factor	E2 Mapping Sub factor
0	No flood studies, mapping or historical recorded data. May be anecdotal evidence.	No flood studies undertaken for the at-risk location or reach.	No flood mapping undertaken for the at-risk location or reach.
1	Flood extent mapping limited to where historical data available. Consequences assessment at region / basin scale.	No flood studies undertaken for the at-risk location or reach. Flood information is based on historical data.	Flood mapping for the at-risk location (or reach) is based on historic events and may be incomplete. Any flood mapping was undertaken more than 20 years ago.
2	Limited flood study completed for the location / river reach. Flood extent mapping for some river heights using old modelling methods and / or historical data. Some at-risk properties may be identified. Consequences assessment at district / river reach scale.	A flood study for the at-risk location (or reach) was undertaken more than 20 years ago. Flood information and river heights are based on old modelling methods or historical data. Some interpretation may be required to determine properties at risk.	Flood mapping for the at-risk location (or reach) was undertaken more than 20 years ago. Any flood mapping has been undertaken at a low resolution or modelling (that requires some interpretation) has been completed for cross sections. May include mapping of historic flood extent(s).
3	Flood study and / or floodplain management plan completed for the location / river reach. Flood mapping for a river height range showing extent, depths (possibly velocity) at a street scale. The likelihood of isolation and depth of flooding of at-risk properties identified. Consequences assessment at at-risk location or reach scale.	A flood study for the at-risk location (or reach) has been undertaken within the last 20 years. Flood information including extents and river heights are based on contemporary modelling methods and historical data. At-risk properties are identified along with issues such as isolation, egress and high risk areas.	Flood mapping for the at-risk location (or reach) has been undertaken within the last 20 years. Flood mapping has been undertaken at a high resolution showing extent at the property scale. Depth information can be interpreted.

Service Level Tier	Service Level Descriptor	TWFS Assessment Tool E Sub factors	
		E1 Flood Study Sub factor	E2 Mapping Sub factor
4	Comprehensive flood study and / or floodplain management plan completed for the at-risk location / river reach. Flood mapping for a range of river heights and historical events showing extent, depths (possibly velocity) at a property / street scale. Building floor levels surveyed and at-risk properties and floors identified. Likelihood of isolation identified. Comprehensive consequences assessment at property / street scale.	A flood study for the at-risk location (or reach) has been undertaken within the last 20 years. Detailed flood information including extents and river heights are based on contemporary and appropriate modelling methods and historical data. All at-risk properties are identified along with issues such as isolation, egress and high risk areas. Depths, velocities, depth of over-floor flooding of affected properties and other intel exists and is available.	Flood mapping at the at-risk location has been undertaken within the last 20 years. Flood mapping has been undertaken at a very high resolution showing extent at the property scale. Depth, velocity, roads, properties and buildings affected are easily identifiable on the flood map.

Notes:

i) Although the service levels are specific in relation to flood studies and mapping, the Tool does not as yet discriminate further in terms of (say) the number of properties affected or consequences at various AEPs, etc.

Flood Response (Response Planning)

Flood response planning is currently biased towards the preparation of a Municipal Flood Emergency Plan (MFEP).

Service Level Tier	Service Level Descriptor	TWFS Assessment Tool F Sub factors
		F1 MFEP Sub factor
0	No region / basin MFEP or actions.	No MFEP for region or basin.
1	Actions at the region / basin scale as per action column in MFEP Flood Information Card.	An MFEP was developed for the region more than 10 years ago. An MFEP exists. It has many gaps but is competent at the regional / basin scale.
2	Actions at the district / river reach scale as per action column in MFEP Flood Information Card.	An MFEP was developed for the region more than 10 years ago. An MFEP exists. It has some gaps but is competent at the catchment / reach scale. Action column in Flood Information Card completed for district / river reach.
3	Actions at the at-risk location or reach as per action column in MFEP Flood Information Card. Includes an assessment of areas that will (and won't) be affected by flooding.	An MFEP has been developed for the location or reach in the last 10 years. An MFEP is available and competent at the at-risk location / reach or community scale. Action column in Flood Information Card completed for at-risk location.
4	Detailed MFEP. Actions at the property / street scale as per action column in MFEP Flood Information Card. Includes an assessment of areas that will (and won't) be affected by flooding. Includes identification of and delineation between different flood sources / types and the extents.	An MFEP has been developed for the location or reach in the last 10 years. An MFEP is available and competent at the at-risk location / reach or community scale. The MFEP includes actions at a detailed street and property scale in the Flood Information Card. The MFEP may include indicative flood prediction tools.

Notes:

i) Although the service levels are specific in relation to the state of development of the MFEP, the Tool does not as yet discriminate in terms of scale and the level of detail present in flood information cards.

ii) Flood Action Guides (FAGs) are prepared as part of the MFEP development process. Ideally, FAGs will assist both community flood awareness and flood response. However, the availability or sophistication of a FAG has not been consider in any of the Flood Response sub-factors as it is considered unlikely that a FAG will actively drive an individual's response.

Community Awareness & Education

Education and Awareness tools are used or applied to improve the awareness of a community's flood risk and in relation to flood safety, risk minimisation and flood action plans.

Service Level Tier	Service Level Descriptor	TWFS Assessment Tool D Sub factors				
		D1 Time since last major flood Sub factor	D2 FloodSafe Program Sub factor	D3 Planning Scheme Sub factor	D5 Individual Property Flood Chart Sub factor	D4 Flood Class Level Sub factor
0	No formal awareness of flood risk at a local or regional scale. No flood awareness or education programs.	Has no recorded major flood.	No FloodSafe Program run at any scale through the catchment.	No identification of flood prone land in planning scheme.	No individual property flood charts.	Removed - does not contribute sufficiently to education or awareness of community to justify inclusion as a factor.
1	Community awareness program / material at region / basin scale. (No FloodSafe program at location or within reach). Community awareness material updated and refreshed on a greater than 5 year basis.	Last major flood was more than 10 years ago.	No community or township FloodSafe Program. A catchment or basin scale FloodSafe Program (with no or minimal individual engagement) was run more than 5 years ago.			
2	Community awareness program, / material at district / river reach scale (e.g. FloodSafe brochures). Flood awareness is at a general level. Community awareness material updated and refreshed approximately every 5 years.	Last major flood was less than 10 years ago.	Generic community or township FloodSafe Program has been run and the local Flood Action Guide updated within the last 5 years.	Flood extents identified in Planning Scheme zones and / or overlays to low resolution and are either not based on flood mapping or do not reflect most up-to-date flood mapping extents.		

Service Level Tier	Service Level Descriptor	TWFS Assessment Tool D Sub factors				
		D1 Time since last major flood Sub factor	D2 FloodSafe Program Sub factor	D3 Planning Scheme Sub factor	D5 Individual Property Flood Chart Sub factor	D4 Flood Class Level Sub factor
3	Specific and targeted community awareness program / material at at-risk location or river reach scale (e.g. up to date FloodSafe brochures and other materials). Flood awareness is good. Local community awareness material updated and refreshed more frequently than every 5 years. Development of individual and business flood plans actively encouraged.	Last major flood was less than 10 years ago.	FloodSafe Program has been run within the last 5 years for the at-risk community. Involved update of the local Flood Action Guide as well as engagement at the street scale.	Flash and / or riverine flood extents identified in Planning Scheme zones and / or overlays to a high resolution such that extents on individual properties can be identified.	Individual Property Flood Charts for at-risk location or river reach.	
4	Locally specific and targeted community awareness program / material at property / street scale (e.g. up to date FloodSafe brochures and other materials). Excellent flood awareness. Local community awareness updated and refreshed on an annual basis. Development of individual and business flood plans actively encouraged and assisted. Planning Scheme delineations reflect current flood mapping and flood risk.	Last major flood occurred within the last year.	FloodSafe Program run for the at-risk community during the last 12 months. Involved update of the local Flood Action Guide as well as engagement at the street scale. Development of individual and business Flood Action Plans actively encouraged with assistance / guidance provided.	Flood extents identified in Planning Scheme overlays / zones to a high resolution consistent with latest flood mapping, such that extents on individual properties can be identified.	Individual Property Flood Charts for at-risk location or river reach. Meter box stickers distributed to all at-risk properties.	

Notes

i) Not all MFEPs are publicly available. Thus, while an MFEP does provide a source of local flood intelligence and can have an influence on community flood awareness, the MFEP does not feature in any of the Community Awareness and Education sub-factors.

Appendix L: Goulburn Broken regional population statistics

The following population is sourced from 2016 census data.

Municipality / Town	2016 Urban	2016 Total	2011 Urban	2011 Total	2006 Total	2001 total
Benalla		13,861		13,252	13,252	13,319
Campaspe		37,061		35,747	35,452	34,611
Colbinabbin	304		106			
Echuca	14,043		1,2596			
Girgarre	561		191			
Gunbower	551		260			
Kyabram	7,331		5,477			
Lockington	808		347			
Rochester	3,113		2,551			
Rushworth	1,335		950			
Stanhope	828		470			
Tongala	1,926		1,216			
Greater Shepparton		63,827		59,648	56,115	55,210
Arcadia downs / South	292		284			
Dookie	328		233			
Katandra west	476		215			
Kialla west	431		203			
Merrigum	679		396			
Mooroopna	7,942		7,813			
Murchison	925		737			
Shepparton east	31,197		218			
Shepparton	1,138		29,553			
Tallygaroopna	579		252			
Tatura	4,669		3574			
Toolamba	769		289			
Mansfield		8,584		8,791	7,739	8,515
Bonnie Doon	570		166			
Goughs Bay	261		168			
Jamieson	301		114			
Mansfield	4,787		3,151			

Municipality / Town	2016 Urban	2016 Total	2011 Urban	2011 Total	2006 Total	2001 total
Sawmill Settlement	88		365			
Mitchell		40,918		34,405	30,629	27,544
Beveridge	2,330		468			
Broadford	4,319		3,342			
Kilmore	7,958		6,189			
Pyalong	660		439			
Seymour	6,327		5,871			
Tallarook	736		204			
Wallan	11,074		7,643			
Wandong-Heathcote junction	2,179		1,618			
Waterford Park	-		201			
Moira		29,112		27,923	26,525	25,475
Barmah	282		175			
Bundalong	428		312			
Cobram	6,01		5,370			
Katamatite	401		218			
Katunga	996		177			
Nathalia	1,880		1,434			
Numurkah	4,477		3,745			
Strathmerton	1,052		477			
Tungamah	408		282			
Wunghnu	334		239			
Yarrawonga	7,930		6,824			
Murrindindi		13,732		12,852	13,387	13,111
Alexandra	2,695		2,245			
Buxton	492		234			
Eildon	974		678			
Hazeldene			250			
Kinglake	1,536		1,031			
Kinglake West-Pheasant Cks	1,488		818			
Marysville	394		246			

Municipality / Town	2016 Urban	2016 Total	2011 Urban	2011 Total	2006 Total	2001 total
Thornton	299		136			
Yea	1,587		1,087			
Strathbogie		10,274		9,333	9,064	9,169
Avenel	1,048		762			
Euroa	3,275		2668			
Longwood	240		173			
Nagambie	1,886		1513			
Violet Town	874		661			

Appendix M: Vulnerability and Infrastructure assessment

Summary table:

At risk locations	Vulnerability (no. of groups)	Key Infrastructure (no. of assets)
Acheron River & Tribs		
Alexandra		
Avenel		
Baddaginnie		
Barmah	2	
Bearii		
Benalla	7	4
Bonnie Doon		
Broadford	1	
Broken Effluent Tribs		2
Broken River Shep -Benalla	1	
Bunbartha		
Buxton		
Castle Point		
Cobram	5	
Colbinabbin		
Cooma		
Corop Lakes Area		
Costerfield		
Costerfield South		
Dabyminga Ck		
Delatite River (at Delatite Rd)		
Devenish		
East Murchison		
East Shepparton		
Eildon		
Euroa		
Ford Creek		
Girgarre		
Glenrowan		
Goulburn River Seymour- Shep		
Goulburn u/s Eildon		

At risk locations	Vulnerability (no. of groups)	Key Infrastructure (no. of assets)
Granite Creek		
Graytown		
Heathcote East		
Heathcote North		
Howqua		
Jamieson		
Katamatite	1	
Katandra West		
Kialla West		
Kialla West (Orrvale)	7	2
Kilmore		
Kilmore East		
King Parrot Ck & Strath Ck d/s Flowerdale		
King Parrot Ck u/s Flowerdale		
Kinglake Central		
Kinglake East		
Koonoomoo		1
Kyabram		
Lake Rowan		
Locksley		
Longwood		
Lower Broken Creek		
Lower Goulburn d/s Shep		
Maindample		
Maindample Region (at Dry Ck Rd)		
Mangalore		
Mansfield		
Marysville		
Merrigum		
Merrijig		
Merton		
Mid Broken Creek		
Mid Goulburn		
Molesworth		
Mt Camel		

At risk locations	Vulnerability (no. of groups)	Key Infrastructure (no. of assets)
Muckatah Depression		
Murchison		
Murray Barmah-Echuca		
Murray Cobram-Ulupna		
Murray Piree Ck-Barmah		
Murray u/s Yarrawonga		
Murray Ulupna-Piree Ck		
Murray Yarrawonga-Cobram		
Marungi		
Nagambie	1	
Narbethong		
Nathalia	3	
Numurkah	4	2
Old Longwood		
Pheasant Creek & Kinglake West		
Pyalong		
Redcastle		
Reedy Creek		
Ruffy		
Rushworth		
Seymour	2	
Shepparton/Mooroopna	1	2
St James		
Stanhope		
Strath Ck		
Strathbogie		
Sunday & Dry Ck		
Swanpool		
Taggerty		
Tallarook		
Tallygaroopna	2	2
Tatong		
Tatura	1	
Tatura/Tongala Rural		
Thoona		

At risk locations	Vulnerability (no. of groups)	Key Infrastructure (no. of assets)
Thornton		
Tongala		
Toolamba		
Toolangi		
Tungamah	1	1
Tyaak		
Upper Broken River		
Upper Broken, Boosey & Majors Creeks		
Upper Howqua River (historical area)		
Violet Town	1	
Waaia		
Whiteheads Creek		
Wilby		
Woods Point		
Wunghnu	1	1
Wyuna		
Yarrawonga		
Yea	2	
Yea River		

Appendix N: Final priority and risk assessment scores

Terminology: **H** = High Priority, **M** = Medium Priority, **L** = Low Priority, **-** = No further action

Benalla Rural City

Name	Density of damages	Absolute damages	Proportion population affected	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plan
Baddaginnie	2	2	3	-	L	H	H
Benalla	5	5	4	L	H	H	H
Devenish	0	0	0	-	-	H	M
Glenrowan (Rural City of Wangaratta)	1	1	0	-	-	-	-
Swanpool	0	0	0	-	-	-	-
Tatong	1	1	0	-	-	M	L
Thoona	1	1	0	-	-	M	L
Winton [i]	0	0	0	L	-	M	-

i. New town area introduced following stakeholder consultation

Campaspe Shire

Name	Density of damages	Absolute damages	Proportion population affected	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plan
Colbinabbin	1	1	0	-	M	-	M
Girgarre	0	0	0	-	-	-	-
Kyabram	5	5	4	L	-	H	M
Rushworth	0	0	0	-	-	-	-
Stanhope	5	1	2	-	-	-	-
Tongala	4	1	0	-	-	-	-
Wyuna	1	1	0	-	-	-	-

Greater Bendigo City Council

Name	Density of damages	Absolute damages	Proportion population affected	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Costerfield	0	0	0	-	-	-	-
Costerfield South	0	0	0	-	-	-	-
Heathcote East (Rural Living)	0	0	0	-	-	-	-
Heathcote North (Rural Living)				-	-	-	-

Mount Camel	0	0	0	-	-	-	-
Redcastle	0	0	0	-	-	-	-

Greater Shepparton City Council

Name	Density of damages	Absolute damages	Proportion population affected	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Bunbartha	1	1	0	-	-	L	-
Cooma	1	1	0	-	-	-	-
Katandra West	0	0	0	-	-	H	-
Kialla West	3	1	2	-	-	-	-
Merrigum	4	3	4	-	L	-	L
Murchison / Murchison East	2 / 3	1	2 / 3	M	L	H	-
Shepparton East	4	5	3	-	H	H	H
Shepparton/ Mooroopna	3	5	4	M	H	H	H
Surplus Irrigation Channels				M	-	-	-
Tallygaroopna	1	1	1	M	-	H	-
Tatura	5	5	3	-	L	-	-
Toolamba	4	1	3	-	-	M	M

Mansfield Shire

Name	Density of damages	Absolute damages	Proportion population affected	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Bonnie Doon	1	1	0	-	-	-	-
Gaffney's Creek / A1 Mine Settlement [ii]	0	0	0	-	-	-	-
Howqua [i]	1	1	0	-	-	-	-
Jamieson	4	2	3	-	L	L	L
Maindample	3	1	3	-	-	-	-
Mansfield	4	3	1	-	-	L	M
Merrijig	3	1	2	-	-	-	-
Merton	0	0	0	-	-	-	-
Woods Point [ii]	0	0	0	-	-	-	-

i. Include in Howqua River (Rural) Area
ii. Include in Upper Goulburn (Rural) Area

Mitchell Shire

Name	Density of damages	Absolute damages	Proportion population affected	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Broadford [i]	3	2	1	-	M	H	H
Kilmore	0	0	0	L	L	H	H
Kilmore East [i]	0	0	0	-	L	L	L
Pyalong	0	0	0	-	-	L	L
Reedy Creek [ii]	0	0	0	-	-	L	L
Seymour	5	5	3	H	H	H	H
Tallarook [ii]	3	1	2	-	-	M	M
Tyaak [ii]	0	0	0	-	-	L	L
Whiteheads Creek	1	1	0	M	H	H	H

i. Include in the Sunday and Dry Creeks (Rural) Flood Study
ii. Include in the Dabyminga Creek (Rural) Flood Study.

Moira Shire

Name	Density of damages	Absolute damages	Proportion population affected	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Barmah	5	5	5	L	M	-	M
Bearii [i]	1	1	0	-	-	-	-
Cobram	5	5	4	H	M	-	-
Katamatite	3	2	4	-	-	L	M
Koonoomoo [ii]	1	1	0	-	-	L	-
Lake Rowan [iii]	0	0	0	-	-	L	-
Marungi	1	1	0	-	-	-	-
Nathalia	2	2	2	H	H	-	M
Numurkah	4	5	3	H	H	H	H
St James [iii]	2	1	1	-	-	-	-
Strathmerton [ii]				-	-	-	-
Tungamah	4	3	4	H	H	H	H
Waaia	0	0	0	-	-	L	-
Wilby [ii]	0	0	0	-	-	-	-
Wunghnu	3	3	4	M	M	M	M
Yarrawonga	3	4	1	H	-	H	H
Yarroweyah [ii]				-	-	-	-

i. Include in the Murray Ulupna to Piree Creek (Rural) Area
ii. Include in Murray Cobram to Ulupna (Rural) Area
iii. Include in Upper Broken Creek (Rural) Area

Murrindindi Shire

Name	Density of damages	Absolute damages	Proportion population affected	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Alexandra	3	2	2	L	M	H	H
Buxton	4	3	5	M	M	H	H
Eildon	0	0	0	-	-	-	-
Flowerdale [i]				-	-	-	-
Kinglake Central	0	0	0	-	-	-	-
Marysville	3	1	1	-	-	M	M
Molesworth [ii]	1	1	0	-	-	-	-
Narbethong	0	0	0	-	-	-	-
Kinglake East, Pheasant Creek & Kinglake West	0	0	0	-	-	-	-`
Strath Creek [iii]	1	1	1	-	-	-	-
Taggerty	3	1	2	-	-	M	M
Thornton [ii]	4	3	5	-	-	-	-
Toolangi	0	0	0	-	-	-	-
Yarck [iii]				-	-	-	-
Yea	3	2	2	-	M	-	H

i. Include in the Upper King Parrot Creek (Rural) Area
ii. Include in Mid Goulburn (Rural) Area
iii. Include in Lower King Parrot Creek (Rural) Area

Strathbogie Shire

Name	Density of damages	Absolute damages	Proportion population affected	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Avenel	3	2	3	M	M	H	M
Euroa	5	4	5	H	H	H	H
Graytown	0	0	0	-	-	L	L
Locksley	1	1	0	-	-	L	L
Longwood	3	2	3	-	-	M	L
Mangalore	0	0	0	-	-	L	L
Nagambie	4	1	1	H	M	H	H
Old Longwood	0	0	0	-	-	L	L
Ruffy	0	0	0	-	-	-	-
Strathbogie	0	0	0	-	-	L	L
Violet Town	4	4	4	H	H	H	H

Rural Study areas

Name	Density of damages	Absolute damages	Proportion population affected	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Broken Creek							
Broken Creek Tributaries (Pine Lodge, Daintons, Congupna Guilfus & O'Keefe Creek)	1	5	0	-	L	-	L
Lower Broken Creek	1	5	0	-	-	L	L
Mid Broken Creek	1	5	0	-	-	L	L
Muckatah Depression	1	3	0	-	L	M	L
Upper Broken Creek	1	4	0	-	M	M	M
Broken River							
Lower Broken River	1	5	0	-	L	H	H
Upper Broken River	1	2	0	-	M	H	M
Goulburn System							
Acheron River	1	2	0	-	L	H	L
Corop Lakes	1	5	0	-	-	L	L
Dabyminga Creek	1	1	0	-	-	L	L
Delatite River	1	2	0	-	-	L	L
Ford Creek	1	1	0	-	-	L	L
Goulburn Seymour to Shepparton	1	5	0	-	-	M	M
Granite Creeks	1	5	0	-	L	M	M
Howqua River	1	1	0	-	-	L	L
Lower Goulburn	1	5	0	-	-	L	L
Lower King Parrot Creek	1	1	0	-	-	L	L
Maindample Region	1	1	0	-	-	-	-
Mid Goulburn	1	5	0	-	L	M	M
Sunday & Dry Creeks	1	1	0	-	H	H	H
Tatura/ Tongala Region	1	5	0	-	-	-	-
Upper Goulburn	1	1	0	-	L	L	L
Upper King Parrot Creek	1	1	0	-	-	H	H
Whiteheads Creek	1	1	0	-	H	H	H
Yea River	1	1	0	-	-	L	L
Murray System							
Murray Barmah to Echuca	1	4	0	-	M	H	M
Murray Cobram to Ulupna	1	5	0	-	-	H	M
Murray Ulupna to Barmah	1	1	0	-	-	L	M
Murray Upstream of Yarrawonga	1	1	0	-	-	L	L

Name	Density of damages	Absolute damages	Proportion population affected	Mitigation Works	Total Flood Warning System	Land Use Planning	Municipal Flood Emergency Plans
Murray Yarrawonga to Cobram East	1	2	0	-	L	L	L