

North Central Floodplain Management Strategy

PUBLIC CONSULTATION DRAFT

October 2017

**Acknowledgements**

The North Central Catchment Management Authority acknowledges Aboriginal Traditional Owners within the region, their rich culture and spiritual connection to Country. We also recognise and acknowledge the contribution and interest of Aboriginal people and organisations in land and natural resource management.

A Steering Committee involving key regional partners was established to oversee the development of this Floodplain Management Strategy. The committee was chaired by David Clark, North Central CMA Board Chair, and had representation from: the North Central CMA, Shire of Campaspe, Mount Alexander Shire Council, Gannawarra Shire Council and VICSES. The project was also supported by the management and staff of the North Central MA, with technical input from many partner agencies.

**Have your say on the future management of our floodplains**

The North Central Catchment Management Authority is inviting feedback on this Draft North Central Floodplain Management Strategy; a key planning document for the region that sets priorities for the future management of our floodplains.

You can download a copy of the Draft Strategy from the North Central CMA website at [www.nccma.vic.gov.au](http://www.nccma.vic.gov.au), or contact us to request a printed copy be sent to you.

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**How to submit your comments**

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**Submissions close on Friday 17 November, 2017.**

**Executive Summary**

The purpose of this strategy is to provide a single, regional planning document for floodplain management and a high-level regional work program to guide future investment priorities.

The strategy has been developed by the North Central Catchment Management Authority (NCCMA) in collaboration with local councils, water authorities, VICSES, Traditional Owners, Parks Victoria and local communities. Our collective vision for floodplain management in the region is one where:

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

To this end, four objectives of the strategy have been defined:

1. **Build resilient communities** – through collating and sharing flood risk information.
2. **Reduce existing flood risk** – by implementing and maintaining flood mitigation infrastructure.
3. **Avoid future risk** – through effective strategic and statutory land use planning and building controls.
4. **Manage residual risk** – by improving and coordinating flood warning and response arrangements.

A region-wide risk assessment has been undertaken, based on the probability and magnitude of flooding and its economic and social impact. The North Central region has a general trend of higher risk in the lower rural catchment areas, although risks to townships are experienced evenly across the catchment.

The existing treatment service levels have also been assessed. This included planning schemes, mitigation infrastructure and total flood warning systems. These assessments, alongside the risk profile, have enabled deficiencies to be identified and priorities for floodplain management actions to be determined equitably.

Common floodplain management themes arising throughout this process included:

* inadequate coverage of high-quality flood mapping to inform planning scheme amendments and Municipal Flood Emergency Plans, and provide timely and meaningful warnings to the community
* varying expectations of the management of flood flow distributions and their interaction with the environment
* uncertainty about the roles and responsibilities of both agencies and the community
* management of residual floodwaters (including works by landholders)
* vegetation removal and waterway management
* cultural heritage
* safe access / transport routes.

These issues, along with the risk and treatment service level assessments, have culminated in the eight regional priorities listed on the next page.

Regional priorities:

1. ***Updating planning controls to reflect the best available information.***
2. ***Resolving flood mitigation infrastructure ownership and maintenance accountabilities.***
3. ***Addressing gaps in flood knowledge through flood mapping projects.***
4. ***Raising flood awareness and improving warning systems.***
5. ***Developing an understanding and awareness of flood flow distributions.***
6. ***Communicating roles and responsibilities of agencies and individuals in floodplain management activities.***
7. ***Incorporating Traditional Owner knowledge into floodplain management activities.***
8. ***Identify flood safe arterial transport routes.***

A regional work plan has been developed, assigning local actions across the catchment that contribute to addressing the regional priorities. The Regional Work Program addresses actions in three-year intervals. All the actions listed are expected to be carried out over the life of the strategy (nominally 10 years). Actions that do the most to reduce risk have been prioritised.

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# PART 1 – PURPOSE AND SCOPE

## Introduction

The purpose of this strategy is to provide a single, regional planning document for floodplain management and a high-level regional work program to guide future investment priorities.

The strategy has been developed by the North Central Catchment Management Authority (NCCMA) in collaboration with local councils, water authorities, Victorian State Emergency Services (VICSES), Traditional Owners, Parks Victoria and local communities. Our collective vision for floodplain management in the region is one where:

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

Four objectives for the strategy have been defined:

1. **Build resilient communities** – through collating and sharing flood risk information.
2. **Reduce existing flood risk** – by implementing and maintaining flood mitigation infrastructure.
3. **Avoid future risk** – through effective strategic and statutory land use planning and building controls.
4. **Manage residual risk** – by improving and coordinating flood warning and response arrangements.

This strategy has assessed the flood risk of the North Central region and identified actions and accountabilities for managing these risks. Priority has been given to measures that do the most to narrow the difference between existing flood risks and the community’s willingness to accept those risks.

## The North Central region

The North Central region covers 13% of Victoria’s land area and encompasses a diverse range of land types, from the foothill forests of the Great Dividing Range to the riverine plains of the north. The region has four major river catchments – the Campaspe, Loddon, Avoca and Avon-Richardson (see Figure 1). The catchments extend across 14 local government authorities (LGAs) and seven Traditional Owner Groups.

The region supports many significant and important natural assets, ranging from internationally recognised wetlands such as the Gunbower Forest to the complex ecosystems of the river floodplains, which support a diversity of native flora and fauna.

Waterways and floodplains are central to Aboriginal cultural identity, and there are many sites of cultural significance throughout the region. Despite extensive changes to the landscape since European settlement, the region holds important physical evidence of Aboriginal activity. Of those places noted in the Victorian Aboriginal Heritage Register, more than half are within 500 metres of a waterway. Aboriginal groups continue to have a strong affiliation with the region’s waterways.

The region supports a range of industries, but the predominant land use is agriculture, with extensive areas of irrigation in the north, productive cropping and mixed farming in the west, and cropping and grazing country in the mid and upper catchments.

The region’s population is roughly 250,000, with rural living continuing to expand. It is projected that there will be significant population growth in urban areas such Bendigo, Castlemaine, Kyneton, Echuca and Woodend.

Social and economic factors will continue to drive the region’s growth and change, but the catchments also include areas where flooding has historically caused substantial damage to both the natural and built environment. Flooding is a natural hazard in the region. Whether floods are caused by high rainfall, inland storms or inadequate drainage, they can severely disrupt communities, causing injury, loss of life, property damage, personal hardship and disruptions to regional economies.

More than 750,000 hectares of rural and urban land across the region under public and private ownership is subject to inundation by a 1% Annual Exceedance Probability (i.e. a 1–in-100 year average recurrence interval) flood.

River regulation works and inappropriate development in the past have had a significant impact on the natural floodplains by changing the flood frequency and flooding patterns, causing deterioration in the natural riverine, floodplain and wetland environments. The region is threatened both from the absence of flooding to promote ecological and cultural values at specific sites across the landscape, and from the devastating social and economic impacts when floods do occur.



Figure 1 North Central Catchment Management Authority region

## A short history of flooding in North Central region

Early river regulation, including river gauging stations, has provided a long history of recorded floods during the region’s European occupation, with gauge records as far back as the 1890s for floods on the Loddon River. Major and widespread floods were recorded in 1909, 1916-17, 1923, 1933, 1956, 1973-76, 1983, 1988, 1993, 1998 and, more recently, during the summer of 2010-11 and again in February 2012 and September 2016.

The January 2011 flood was the largest on record for most river systems in the region, inundating an estimated 780,000hectares (more than 25% of the region). The intensity and amount of rainfall that saturated areas of Victoria in 2010–11 resulted in the largest, or close to the largest, floods recorded on many of the state’s major river systems. Water storages and wetlands were filled, minimising opportunities to mitigate flood impacts. Some affected areas had not previously been identified as subject to flooding, while other places had been impacted multiple times.

The response to these floods included the *Review of 2010-11 Flood Warnings and Response* and the *Environment and Natural Resources Committee Inquiry into Flood Mitigation Infrastructure in Victoria* and was the catalyst for the development of the 2016 Victorian Floodplain Management Strategy, in which the Regional Floodplain Management Strategies are a priority action. Learnings and memories from the 2010-11 floods are a strong influence on the development of this document and the September 2016 floods reinforced the need for additional action within the region.



Figure 2 Mapped 1% AEP flood extents across the North Central region

## Roles and responsibilities

Everyone has a role to play in managing the risks associated with floodplain management, and a coordinated and cooperative approach is required.

This strategy is a collaborative document and is intended to help all agencies across the North Central region involved in floodplain and flood emergency management to work towards aligned priorities. It is important to recognise the roles and responsibilities of each agency, and how they function within the broader context of floodplain management. These are summarised in Table 1.

Table 1 Roles and responsibilities

| Partners | Roles and responsibilities |
| --- | --- |
| National government agencies |
| Bureau of Meteorology | The Bureau of Meteorology is responsible for providing weather, rainfall and flood warning predictions. It does not own, and is not responsible for, the maintenance and management of the network gauges. |
| Attorney-General’s Department – Emergency Management Australia | Emergency Management Australia is responsible for developing national standards and policies for emergency management and assistance to the states and territories. It provides financial assistance under the Natural Disaster Resilience Grants Scheme (NDRGS) and the Natural Disaster Relief and Recovery Arrangements (NDDRA). |
| State government agencies and statutory bodies |
| Department of Environment, Land, Water and Planning (DELWP) | DELWP is responsible for the development of flood policy, and coordination and repository of the Victorian Flood Database, and maintaining and continually improving Victoria’s Flood Intelligence Platform (FloodZoom). It provides financial assistance through NDRRA, and technical advice and support to assist Incident Controllers during an emergency. |
| Victoria State Emergency Service (VICSES) | VICSES is responsible for flood response planning, and is the control agency during significant floods and storms. It manages community education, through engagement exercises, and produces educational material to support flood preparedness. |
| VicRoads | VicRoads is responsible for highways and main roads throughout Victoria. In a flooding context, It is responsible for opening/closing road access, and maintaining an online register of the status of its roads. |
| Parks Victoria | Parks Victoria is a statutory authority created under the *Parks Victoria Act 1998*. Its functions include providing services to Victoria and its agencies for the management of parks, reserves, and other land under control of the State, and providing land management services to the owner of any other land used for public purposes, where approved by the Minister.Parks Victoria is the land manager for the majority of Murray River frontage in the North Central region, along with a number of other rivers, wetlands and tributaries, such as the Gunbower and Kerang Ramsar Sites, that protect important ecological and cultural values of the floodplain. |
| North Central Catchment Management Authority (NCCMA) | The NCCMA was established under the *Catchment and Land Protection Act 1994* as the designated responsible manager of waterways, drainage and floodplains. In the context of floodplain management, the NCCMA’s key functions include authorising works on waterways, acting as a referral body for planning applications, identifying regional priorities for floodplain management, collating flood risk information, and providing technical advice and support to assist Incident Controllers during an emergency.The CMA is enabled, through legislation, to undertake priority waterway management activities via its funded programs, but does not have a responsibility to carry out flood mitigation activities or regular maintenance on waterways. |
|  |  |
| Water corporations |
| Goulburn Murray Water, Coliban Water, Central Highlands Water, Lower Murray Water, and Grampians Wimmera Mallee Water | Water corporations in Victoria are established under the *Water Act 1989* and provide a range of water services to customers within their service areas. Water corporations provide a combination of irrigation services, domestic and stock services, bulk water supply services and urban water and wastewater services in the North Central Region.Water corporations have a responsibility to ensure water is available to paying customers and to protect their supply infrastructure. It is a common misconception that reservoirs/water supply dams can to be used as flood mitigation, however they are constrained by their relatively small storage volumes compared to floods, their ability to actually control release volumes with existing infrastructure, and their standard operating rules, which acknowledge that all water within a reservoir is owned by a specific stakeholder, i.e. it is not the water corporations’ water to release. Water authorities seek advice from Incident Controllers during emergencies as to how best operate their infrastructure to reduce risk and provide benefit to the environment, within the operational constraints of each reservoir. |
| Local Government |
| Councils | Councils are involved in floodplain management in Victoria through their role as responsible planning authorities, managers of stormwater drainage, land managers and emergency management bodies.Councils usually lead the preparation of flood studies, with technical support from CMAs. The studies are usually prepared for a particular purpose, such as updating planning schemes or to provide intelligence to emergency services that provide communities with flood warnings and advice.Some existing flood mitigation infrastructure schemes are managed by councils on behalf of their communities, e.g. the Kerang township levee. Councils may also elect to build new flood mitigation infrastructure where flood studies determine that the benefits outweigh the costs and where communities are willing to pay the ongoing maintenance for such services, e.g. levees in Creswick. Councils are not obligated to own or maintain any existing levees, but may elect to do so in consultation with their communities where the benefits of doing so can be demonstrated through a flood study.Councils are accountable for applying the planning requirements of the Victorian Planning Provisions, incorporating flood mapping and controls into their local planning schemes, and the operation and maintenance of local total flood warning service infrastructure.As emergency management bodies, councils undertake a range of activities to prevent, respond to and provide relief/recovery from floods, with support from other agencies. Some councils have a defined ‘Emergency Management Coordinator’ role to undertake these activities.  |
| Traditional Owners |
| Traditional Owner Boards/Councils | Traditional Owner Corporations are recognised as having a primary responsibility for the management of Aboriginal cultural heritage, through their role as Registered Aboriginal Parties under the *Aboriginal Heritage Act 2006*, as well as through engagement by Government and Local Authorities and other organisations, including under the *Traditional Owner Settlement Act 2010*. |
| Community |
| Flood Observers | Local members of the community can be called upon as ‘flood observers’ in recognition of the wealth of historical and local knowledge of flooding that is held within the community.Flood observers can play an advisory role during a flood event, but have no authority or responsibility in floodplain management. Flood observers are usually identified through Municipal Flood Emergency Planning. |
| Landholders and Individuals | Landholders and individuals are responsible for their own actions and safety during a flood event. The Victorian Floodplain Management Strategy states clearly that individuals (including communities and businesses) must act to manage their own risks. |
| Landcare | Landcare is a community-based conservation movement. Landcare groups undertake a variety of on-ground activities on both private and public floodplains, including revegetation, fencing waterways and weed and erosion control.  |

## Scope and policy context

The North Central Floodplain Management Strategy fits within a national and state framework for floodplain management, and has been developed to meet that framework’s principles and objectives. The strategy also sits alongside a number of other regional strategies for North Central Victoria, and aligns with their objectives where there is overlap.

Table 2 summarises the relevant strategy and policy documents that sit alongside this regional floodplain management strategy.

Table 2 National, state and local strategies and policies relating to floodplain management in North Central Victoria

|  |  |
| --- | --- |
| **Federal Strategy and Policy** | *National Strategy for Disaster Resilience (Council of Australian Governments, 2011)*This strategy acknowledges that a coordinated and cooperative approach is needed across the country to withstand and recover from emergencies and disasters (such as floods). Building resilience is a shared responsibility between governments, communities, business and individuals. The strategy focuses on seven priority areas to build disaster resilient communities, all of which are directly applicable to floodplain management. The seven areas are: leading change and coordinating effort; understanding risks; communicating with and educating people about risks; partnering with those who effect change; empowering individuals and communities to exercise choice and take responsibility; reducing risks in the built environment; and supporting capabilities for disaster resilience. |
| **Victorian State Legislation** | *Water Act 1989*The Victorian *Water Act 1989* provides the framework for managing Victoria’s water resources. In relation to floodplain management, the Act refers to the adoption of flood levels based on a probability of 1% of a flood occurring in any one year. The Act also allows for the declaration of land as liable to flooding as well as land declared a floodway area.  |
| *Planning and Environment Act 1987*The *Planning and Environment Act 1987* establishes objectives for planning in Victoria and outlines the planning process and requirements for planning schemes. One of the objectives of the Act is to “provide for the fair, orderly, economic and sustainable use and development of land”. The Act provides for “planning schemes to regulate or prohibit any use or development in hazardous areas or in areas which are likely to become hazardous areas” (e.g. flood-prone land). In this context, land use planning involves strategic planning, statutory planning and building regulations.CMAs are referral authorities under this Act, however, since 2013, their role has become as a ‘recommending authority’. Referral advice is therefore not binding on the LGA. |
| *Traditional Owner Settlement Act 2010*Under the *Traditional Owner Settlement Act 2010,* the Victorian Government and the Dja Dja Wurrung Clans Aboriginal Corporation entered into a Recognition and Settlement Agreement in October 2013. The agreement formally recognises the Dja Dja Wurrung people as the Traditional Owners for part of Central Victoria, and gives legal recognition of their connection to Country and rights as Traditional Owners, including access to, use and management of the natural and cultural resources on Country. |
| **Victorian Strategy and Policy****Victorian Strategy and Policy** | *Victorian Floodplain Management Strategy (Victorian State Government, 2016)*After the devastating 2010-11 floods, the challenges with floodplain management were recognised as institutional rather than technical. The State Floodplain Management Strategy (VFMS) aims to clarify the roles and responsibilities of government agencies and authorities involved in flood management arrangements to ensure continual improvement in all aspects of floodplain management. It also sets out actions and policies that will help implement the Victorian Government’s response to the Victorian Floods Review and the Parliamentary Environment and Natural Resources Committee Inquiry into Flood Mitigation Infrastructure.The VFMS sets out a systematic approach to the evaluation of Victoria’s flood risks. It also provides a systematic approach to sharing information between the individuals, communities, government agencies and other organisations responsible for managing the various aspects of flood risk. Most importantly, it clarifies which agency is accountable for each aspect of floodplain management. |
| *VICSES Community Resilience Strategy 2016-2019 (VICSES, 2016)*This strategy outlines the way the VICSES will work with communities and partners to achieve more aware, informed and prepared communities; supporting them to understand their risk and the relevance of taking action before, during and after emergency events (including floods). It has the objectives of: building capacity, increasing collaboration and fostering connections to promote positive behaviour change. |
| *State Flood Emergency Plan – Flood Sub-Plan (Victorian Government, 2016)*The objective of the sub-plan is to provide sources of information and to outline the arrangements for ensuring an integrated and coordinated approach to the State’s management of floods in order to reduce the impact and consequences of these events on the community, infrastructure and services. |
| **Regional Strategies and Plans** | *North Central Regional Catchment Strategy 2013-2019 (NCCMA, 2013)*The NCRCS provides the long-term vision for natural resource management in the North Central CMA region. It sets regional priorities for managing natural assets and also the overall direction for investment and coordination. It recognises floodplains as complex ecosystems that support a diversity of native flora and fauna. The vision of the strategy, with respect to waterways and floodplains, is to manage them sustainably to protect and enhance their diversity and ecological function while also supporting the regional community’s recreational use. The inherent functions of the floodplains to convey and store floodwater should be recognised and preserved to minimise the deterioration of environmental values and the long-term flood-risk to floodplain production, assets and communities. |
| *North Central Waterway Strategy 2014-2022 (NCCMA, 2014)*The NCWS is an integrated strategy for managing and improving the region’s waterways (rivers, streams and wetlands). |
| *Regional Growth Strategies / Plans*Regional growth plans provide broad direction for land use and development across the state. They consider the region, economy, environment and heritage and transport and infrastructure. The also direct settlement growth to avoid areas of high risk from natural hazards such as flooding. |
| *Regional Flood Emergency Plans*Regional flood emergency plans contain information on the coordination of flood responses between municipalities, provision and allocation of resources, operational structure, inter-agency coordination and control arrangements. |
| **Local Strategies and Plans** | *Municipal Flood Emergency Plans*Municipal Flood Emergency Plans contain information on the risk of flooding within a municipality, including what needs to be done to reduce flood impacts, and detail flood prevention, preparedness, response and recovery planning arrangements. |

## Review of previous regional strategy

The region’s previous Floodplain Management Strategy (April 2000) has been formally reviewed to measure the progress of the actions listed and to identify key learnings to inform this new strategy.

The 2000 strategy identified nine programs for flood management and established performance indicators, targets and timeframes to meet the set of detailed objectives against each program over the document’s 10 year life. The focus was predominately on developing plans to manage the impacts of rural inundation, with only a small number of towns identified as high priority for undertaking flood studies.

With the devastating floods in 2010-11, the focus shifted somewhat, and led to the development of flood management plans for 11 townships within the region, providing valuable information for input to statutory planning, flood mitigation and response.

A broad review of the objectives and tasks identified in the nine programs identified that 41% of the tasks have been completed, 37% remain outstanding and a further 22% of tasks are still ongoing. Two of the tasks related to declaring flood levels and are no longer required.

Of the outstanding actions, most relate to asset management, likely due to the uncertainty around roles and responsibilities for ongoing maintenance and management of floodplain assets prior to 2010-11. The 2016 Victorian Floodplain Management Strategy has provided clarity in relation to the roles and responsibilities and these outstanding issues are addressed in this strategy.

The previous strategy noted that an ongoing review of the strategy was to be undertaken with the stakeholders identified during the development stage. This was to be undertaken at three-yearly intervals, however no formal or ongoing reviews have been undertaken or documented.

Key learnings identified through the review process that are incorporated into this strategy include:

* the importance of defining clear and measurable performance indicators
* documenting a collective agreement of roles and responsibilities among stakeholders, and a willingness to complete management actions allocated in this strategy
* provision for ongoing review of this strategy and the ability to adapt or amend management actions over time as priorities shift.

## Floodplain management strategy development

The development of this regional strategy has been led by the North Central CMA, and overseen by a Steering Committee, made up of executive members of the North Central CMA, VICSES and councils.

A technical working group, with representatives from all stakeholder agencies (all 14 LGAs, VICSES North West Region, DELWP Loddon Mallee Region, Parks Victoria – Northern Rivers, VicRoads – Northern Region and the regional water authorities) convened regularly during the development of this strategy to discuss flood risks and define local and regional priorities.

In developing the regional floodplain management strategies across Victoria, a consistent approach has been taken to assess the flood risk and efficacy of existing treatments (i.e. mitigation infrastructure, planning controls and flood warning systems) to ensure an equitable prioritisation of flood management priorities.

Figure Floodplain management strategy development

A thorough process has been followed to ensure engagement with all stakeholders. This has included public consultation, workshops with stakeholder agencies and Traditional Owner groups.

The release of this draft version of the strategy is a further opportunity for public comment. Feedback will be incorporated into the final strategy.

## Document structure

This document has been structured into three parts:

* Part 1: provides the scope and regional context of the strategy.
* Part 2: identifies and assesses flood risks and opportunities within the catchment.
* Part 3: documents the actions, roles and responsibilities in delivering the strategy.

Given the broad reach of the North Central region, the body of this document does not attempt to address the local risks and opportunities for each area. These have been addressed in consultation with each LGA.

# PART 2 – ASSESSMENT OF REGIONAL FLOODING

In order to equitably determine priorities for floodplain management actions, we must first understand our flood risk. A region-wide, systematic flood risk assessment and review of the existing risk treatments has been undertaken, following the processes developed by DELWP, as part of its delivery of the Victorian Floodplain Management Strategy (VFMS Action 26a).

The approach has been adopted consistently across Victoria, providing an evidence-base for effective risk management decisions and fostering consistent baseline information collection. It is important to note that some LGAs extend across multiple catchments, and as such will be subject to multiple regional floodplain management strategies. Consideration has been taken to ensure the flood risk assessment undertaken for this strategy is consistent with that for neighbouring CMA regions, such that the risk metrics can be used to prioritise management actions within each area.

This section summarises the flood risk assessment methodology, identifies areas with the highest risk, assesses the service level of existing risk treatments and discusses key risk themes.

1. **??????**

## Risk assessment methodology

DELWP’s rapid appraisal of flood risk methodology was used to assess flood risks at a regional level. The methodology identifies areas of similar land use and flood causation. The assessment then considers existing information for these areas (probability of flooding, potential cost of damages, and population density) as a means of quantifying risk. The result is a relative measure of risk between the areas.

Acknowledging the limitations of this methodology (e.g. the reliance on documented information, and inability to identify local or critical infrastructure), individual workshops were held with relevant officers from each LGA to review the results and identify risks that had not been considered. This involved identifying infrastructure and assets that are essential for the ongoing functionality of a town, locality, region or broader area, whether at risk of inundation or indirectly affected by flooding. For example, many regional industries rely on access to storage or processing facilities. While these facilities themselves may not be at risk of flooding, if access to/from them is impeded, it can have a significant impact on the operation of the industry.

For the assessment, the North Central region was divided into 213 areas of similar land use and flood causation. Of these areas, 16 had no flood risk information, 96 had a low flood risk (predominately rural areas), 67 were considered at moderate risk and 34 were considered at high risk (94% of which were township/urban areas).

The region’s risk profile is shown in Figure 4. Generally, there is a trend of rural areas in the lower catchments having a moderate flood risk. Only the rural areas surrounding Swan Hill and on the Loddon River upstream of Bridgewater are considered high risk. Risks in the upper catchment areas are confined to township areas.

The risk assessment found the 10 towns with the greatest flood risk are:

|  |  |
| --- | --- |
| * Koondrook
* Rochester
* Charlton
* Quambatook
* Dunolly
 | * Inglewood
* Kangaroo Flat / Golden Square
* Echuca
* Woodend
* Maryborough
 |

A number of these areas have recently been the subject of flood studies and proposed mitigation options (e.g. updates to planning schemes, construction of structural mitigation options and development of a flood warning system) will help reduce these risks.



Figure 4 North Central flood risk

## Existing risk treatment service levels

Flood risk treatments can be structural (i.e. mitigation infrastructure such as levees) and non-structural (i.e. statutory planning tools, flood education programs, flood warning systems and emergency response). An appropriate mix of structural and non-structural treatments is often required to manage flood risk.

The service level of existing flood risk treatments in the North Central region have been assessed based on the methodologies provided by DELWP. The service level of a risk treatment should be compatible with flood risk. Where treatments have been found to be insufficient, an action has been proposed for improvement and incorporated into the work plan.

### Planning scheme controls

Planning schemes set out the policies and provisions for the use, development and protection of land, and are enabled under the *Planning and Environment Act, 1987.* The Victorian Planning Provisions (VPP) contain a number of controls that can guide the use and development of land that is affected by floodwaters. These controls include the Floodway Overlay (FO), the Land Subject to Inundation Overlay (LSIO), the Special Building Overlay (SBO), the Urban Floodway Zone (UFZ) and the Environmental Significance Overlay (ESO). The presence of these flood-related planning overlays triggers a flood assessment of proposed developments.

Flood-related planning controls are typically based on the 1% Annual Exceedance Probability (AEP) design flood extent. This is a flood that has a 1% chance of occurring (or being exceeded) every year. The extent and depth of the 1% AEP flood for an area can be determined through flood modelling, recorded flood extents and levels, and on-ground verification. This flood extent is then incorporated into the relevant planning scheme in the form of local policy and zones or overlays applying to affected land.

Historically, however, detailed flood modelling has not been available, and planning controls have been based on the best available information at the time. An example is the Design Development Overlay in Avoca, which is based on alluvial soil mapping. The overlay has been effective, in that it provided some control over development within the floodplain, however an update is recommended, based on more accurate information.

Similarly, many of the existing planning controls across the North Central region are based on historic information that may no longer be relevant (because of physical changes across the floodplain or by updated flood mapping using improved information/techniques). In some instances, a lack of information has meant that no planning controls have been applied, despite sufficient flood risk to warrant them.

The service levels of planning scheme controls across the North Central region have been assessed against the flood risk level*.* Where the planning controls were inadequate, an action has been identified in the work plan.

A common theme throughout the North Central region is a delay in the development of flood mapping and incorporation into the planning scheme. Detailed information exists for many areas, however it is yet to be incorporated into an overlay, probably because LGAs lack the capacity to undertake the amendment.

In some instances, the existing information has not been sufficient to allow for a planning scheme amendment. In these cases, a flood study has been proposed.

**REGIONAL PRIORITY 1 – Update planning controls to reflect the best available information**

Updating planning schemes has been identified as a regional priority. DELWP and the North Central CMA will collaborate with LGAs to overcome capacity issues. Further, the CMA will help identify and use any potential economies of scale in the processes that are necessary as part of planning scheme amendments.

### Flood mitigation infrastructure

Flood mitigation infrastructure includes treatments such as levees, channel modifications, bypass floodways, retention basins, dams and floodgates. Structural treatments can be effective in reducing flood risk at specific locations, however, if not managed and maintained, they are liable to fail during a flood.

The 2010–12 floods revealed serious deficiencies in the management arrangements for flood mitigation infrastructure. Responsibilities were either non-existent or blurred between catchment management authorities and local government authorities, and accountabilities were not assigned consistently across the state. This was particularly relevant in the Lower Loddon catchment, where only a small number of assets were subject to appropriate management arrangements and therefore performed effectively (e.g. Kerang Township Levee). A large number of rural levees were breached, resulting in unexpected flooding and contributing to a public narrative of uncertainty and blame.

The Victorian Floodplain Management Strategy has provided clarity around maintenance and management arrangements to remove this uncertainty and inconsistency. Section 17 of the state strategy sets out a number of policies relating to flood mitigation infrastructure, including its management and recognition. Of note are the following:

* Existing flood mitigation infrastructure that is not formally managed should remain that way unless the local government authority determines that it should be brought into formal management arrangements.
* Infrastructure that is not formally managed should not be recognised as being functional in planning schemes (including flood overlay mapping) and Municipal Flood Emergency Plans must allow for the potential failure of that infrastructure.
* The three tiers of government will only invest in building or upgrading flood mitigation infrastructure if the accountability arrangements for ongoing management, maintenance and assurance are agreed and clearly documented.

The first step to achieving this clarity, and adopting these arrangements, is to understand the service level provided by existing infrastructure, and assess the appropriateness of existing management.

The North Central region has the highest concentration of levees in the state; there are hundreds of structural works that perform flood mitigation functions within the region. It is impractical to assess the service level for each structure within this strategy, indeed even to document their existence. It was determined during the development of this strategy that there is a need to develop categories of flood mitigation infrastructure and prioritise their future assessment.

As a first step in achieving this, a regional action has been identified to define appropriate categories, in consultation with stakeholders. Various structures throughout the region control the distribution of floodwaters, many were constructed without that intention (e.g. irrigation channel banks and roads) and many are unknown (i.e. illegal works). The appropriate categorisation will enable appropriate future management actions to be determined.

The issue of flood mitigation infrastructure within the region is largely concentrated on the Lower Loddon, Lower Avoca and Murray Rivers, where the floodplain is expansive, and there is a legacy of undocumented landscape changes that control the distribution of floodwaters. Many levees were built during, or in response to, historical flood events and their benefits and construction standards are uncertain. Further, irrigation channel banks often act as ‘levees’ and their decommissioning needs to be closely managed.

**REGIONAL PRIORITY 2 – Resolve flood mitigation infrastructure ownership and maintenance accountabilities**

The documentation of existing flood mitigation infrastructure and assessment of the associated service level and maintenance and management arrangements will be an ongoing task for the North Central region. Agencies will work together to identify key mitigation infrastructure that needs to be brought into formal maintenance and management arrangements, and improve service levels where warranted. This may include development of a register of flood mitigation infrastructure.

It is expected that management actions for flood mitigation infrastructure will fall into one of three categories: (a) no action; (b) investigate the benefits; or (c) confirm management and maintenance arrangements (where benefits are already known).

Despite the need to appropriately categorise flood mitigation infrastructure (predominately in the northern part of the region), this strategy has identified a number of strategic levees that exist specifically for flood mitigation purposes. The service level and maintenance/management arrangements for these levees have been assessed. The levees include:

* Murray River levees
* Pental Island levees
* Tyntynder Flats levee
* Torrumbarry-Gunbower Creek levee system
* Loddon River levees
* Avoca River levees
* Various urban levee systems, including: Bendigo, Castlemaine, Echuca, Kerang, Koondrook, Woodend, Creswick, Pyramid Hill, Boort, Carisbrook, Donald and Swan Hill.

New flood mitigation infrastructure identified through this strategy must provide both community and environmental benefits. The ‘beneficiary pays’ principle will determine the management and funding arrangements. Large-scale flood mitigation infrastructure is not considered best practice, but there may be limited circumstances where it may be supported after a thorough evaluation of the social, cultural, economic and environmental costs and benefits.

An example of a successful flood mitigation infrastructure can be found within the North Central region at Creswick.

Three separate flooding events during late 2010 and early 2011 caused considerable damage to residences, businesses and sporting facilities, and significant distress and hardship to the Creswick community.

Recognising the need to reduce the future risk of flooding in the town, a Flood Mitigation and Urban Drainage Plan was developed by the North Central CMA in partnership with the Hepburn Shire Council and the local community. The proposed plan sets out mitigation actions to provide a greater level of protection from future flooding.

The plan protects against a 2% Annual Exceedance Probability flood event, which will provide greater protection than a flood the size of the September 2010 and January 2011 events. Works included increasing the capacity of two bridges, minor channel deepening and levee construction.

A wide range of options was considered during the pre-feasibility stage of the plan’s development before five options were analysed in greater detail.

A community-based steering committee was formed to guide the process and engagement activities, and ensure strong community input to the plan. A technical working group of representatives from various key industry stakeholders provided support to the steering committee.

An intensive community engagement process meant that the Creswick community was aware of the available options and their benefits and impacts. A brochure outlining all options considered and highlighting logical reasons for the preferred option was delivered to all Creswick residents.

After several public meetings and additional one-on-one consultation for concerned residents, there was overall strong community support for the Plan. The majority of flood-affected residents who made a submission supported the plan.

The management actions from the plan have been implemented and their efficacy was validated in the September 2016 flood. There has been strong positive feedback from the community regarding the plan’s success.

It is anticipated that this process can be replicated and similar flood management outcomes can be achieved for the priority areas listed in this strategy.

### Total Flood Warning System services

Flood warning systems provide a way to gather information about impending floods, communicate information to those who need it (those at risk) and facilitate an effective and timely response. Flood warning systems aim to enable and persuade people and organisations to take action to minimise their risk and reduce the damage caused by flooding.

Within Victoria, the physical components of the flood warning system (i.e. rainfall and streamflow gauges) are owned by local governments, with data relayed to the Bureau of Meteorology to provide forecast and warning services. The Victorian Floodplain Management Strategy clearly states that the capital costs for new rain or stream gauges will be shared between the Victorian and Australian Governments. The local community, through its LGA, will fund ongoing maintenance costs for gauges.

The Total Flood Warning System (TFWS) concept encompasses all the elements required to maximise the effectiveness of flood responses by the community and emergency services, and can include:

1. Data collection network (rain gauges and stream gauges).
2. Forecast (prediction) services.
3. Lines of communication to disseminate flood warning information to the community.
4. Community flood awareness and education.
5. Interpretation (a means of predicting consequences of forecast floods).
6. An action plan for responding to floods (e.g. a Municipal Flood Emergency Plan).

In the North Central region, streamflow gauges have been placed throughout the catchment for water management purposes rather than for flood forecasting and are therefore not optimal for planning and co-ordinating the responses of some communities to predicted flooding.

All communities within the North Central region currently receive the Bureau of Meteorology’s *Flood Watch* and *Severe Weather* warnings, as well as messaging from VICSES. While these warnings and messages are important, they have been described as too broad and therefore not very useful.

The service levels of the TFWSs within the North Central region have been assessed for adequacy against the associated flood risk level for areas across the region. A number of locations were identified where the flood risk exceeds the TFWS level. In most of these locations, it was determined that the service level is low due to the lack of flood mapping, and that the development of detailed flood maps that are disseminated to the relevant communities is the most effective response to address the risk.

**REGIONAL PRIORITY 3 – Address gaps in flood knowledge through flood mapping projects**

A common theme for inadequate service levels of the TFWS was the lack of available flood mapping. Accurate flood mapping feeds in to many components of the TFWS, as it allows a better understanding of potential flood consequences, enables better communication and awareness, and assists with coordinating emergency response.

Councils, with assistance from NCCMA and DELWP, will prioritise flood mapping studies in high-risk areas where information is lacking. Actions have been identified individually and are presented in the work plan.

Raising flood awareness is a cost-effective way to reduce the impacts of flooding. Detailed flood risk information will empower individuals to evaluate their options, take action and remove valuables or protect their houses before the flood arrives, reduce confusion, frustration and anxiety. This work will also enable the community to be more aware of flooding so that they can actively take measures to manage their flood risk to minimise damages, leading to faster recovery and more resilient communities.

**REGIONAL PRIORITY 4 – Raise flood awareness and improve warning systems**

Raising flood awareness will be enacted through various VICSES priority projects, including improving the Emergency Victoria webpage to include all flood mapping and developing a state Community Observers Network website. Where warranted, improved awareness may require the installation/improvement of a Total Flood Warning System service.

Priority projects for the VICSES include improving the Emergency Victoria webpage to include all flood mapping for each ARI and developing a State Community Observers Network Website. This website will enable 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. This website will provide a source of valuable information where there are gaps in telemetered stream data.

The VICSES is also working with DELWP, CMAs and local councils to develop a range of products and community engagement activities to raise the flood awareness. Some of these products include:

* Property-specific flood warning charts for individual properties that relate forecast peak flood levels to a height above or below an individual floor level
* community education signs at stream gauge board locations that both educate the community and provide an opportunity for the community to provide local knowledge to an Incident Control Centre during a flood event
* use of pre-recorded flood education videos.

The delivery of a series of community education products in conjunction with targeted community engagement activities with people regularly affected by flooding will go a long way to fulfilling key aspects of the Regional Floodplain Management Strategy.

## Other factors influencing priority setting

Despite the expansiveness of the region, and the different causes and consequences of flooding across the catchments, several common themes arose during the stakeholder engagement process. These are discussed further below and have been considered in the setting of regional priorities.

### Flood flow distributions

Community members have expressed concerns regarding the current distribution of floodwaters through the catchment. Illegal structures, neglected flood management schemes, irrigation modernisation, road upgrades and general misinformation have resulted in floodwater flows to locations that do not align with community expectations.

Management of flood flows is often difficult and complex. Re-distribution of flows needs to be managed to ensure that the impacts of flooding aren’t moved from one landowner to another.

The impacts of unplanned flows on the environment must also be considered in what are now highly managed and long-term, goal-oriented environmental flow regimes, e.g. managing vegetation growth, bird breeding and international legal obligations (e.g. RAMSAR).

In the development of this strategy, it was evident that all agencies share a common goal to manage floodwaters in a way that minimises harm and maximises environmental/cultural benefits. The intentions are the same, but a lack of understanding between agencies and the community has been perceived as poor management. It is important to understand the constraints of the floodplain operating system. Often, natural wetlands can remain dry (or at least not fill) in a flood because the delivery infrastructure to direct flows is limited.

**REGIONAL PRIORITY 5 – Develop an understanding of flood flow distributions**

To provide clarity to agencies and communities, the North Central CMA, in conjunction with water authorities, will develop guiding principles for flood flow distributions that consider social and environmental impacts.

### Residual floodwaters

Residual floodwaters lingering in the landscape pose risks to human health, community wellbeing and the functioning of regional economies. Coordinated management of the removal of floodwaters needs to align with community expectations so as to prevent illegal works (e.g. cutting of banks) and additional damage, and to avoid litigation between individuals. Solutions may be permanent (e.g. new infrastructure) or reactive (e.g. managed interventions such as pumping or cutting banks). DELWP is accountable for maintaining guidelines for managing residual floodwaters to help Incident Controllers and Recovery Managers to manage the risks of human intervention in draining the floodplain.

### Illegal works

Concerned community members have raised the issue of illegal works within our waterways and floodplains. Illegal levees, in particular, and farm channel infrastructure are a constant issue. These structures displace floodwaters to other unexpected locations, damaging housing, agriculture and farm land.

Illegal works often go unnoticed (or unreported) and, after a period of time without any action, become an inherent part of the landscape. These works can greatly alter the course of flood waters affected those residing both upstream and downstream. For example, in the 2016 floods, areas near Gunbower Forest suffered flooding greater than the 2011 floods.

Many community members are unsure as to what works they can do within their own property on a floodplain. Clear specifications are difficult to come by, which results in unpermitted works by some individuals and frustration for other individuals about whether works by a neighbour are legal or not.

The ramifications of illegal works are assessed either via the *Planning and Environment Act 1987*, with the outcome being the removal of the works or the issuing of a permit for them, or the *Water Act 1989,* where neighbours can sue each other for culpability if they are able to prove damages are a result of the works. A proactive approach to prevention and mitigation by agencies (and where possible collaborative action) will provide a greater service to the community as it will prevent legal works that have the potential to divide communities.

### Waterway management

North Central CMA consistently receives requests from the community to remove vegetation or debris from waterways to alleviate an actual or perceived risk of flooding. Blockages can be human or environmentally induced. In many situations, the vegetation has little to no impact on the extent of flooding, however, in some circumstances clearing of the waterway and regular maintenance may be warranted.

DELWP is preparing the Victorian Rural Drainage Strategy that will provide strategic guidance for matters relating to rural drainage but also for management of waterways as ‘drains’. This will include consideration of clearing a stream of debris, vegetation or sediment that may have multiple mutual benefits, e.g. flood mitigation, rural drainage and best practice waterway management.

**REGIONAL PRIORITY 6 – Clarify roles and responsibilities of agencies and individuals in floodplain management activities**

During the development of this strategy, it has become evident that the roles and responsibilities of agencies and individuals with respect to managing residual floodwaters and waterway management are not well understood. There is a regional action to develop a communication plan and promotional material to assist the education of agencies and individuals on the various roles and responsibilities for floodplain and waterway management activities.

### Cultural values/assets

Waterways and floodplains continue to hold deep physical, social, environmental, spiritual and cultural significance to the indigenous populations. The vast majority of cultural assets identified in the Aboriginal Heritage Register are within waterways and floodplains.

Historically, floodplain management has been largely independent of cultural heritage management, however, given their inter-dependence, it would be negligent to maintain these disparate management arrangements.

Issues identified in these existing arrangements include:

* an absence of cultural knowledge in Municipal Emergency Management Plans
* absence of Traditional Owner input to flood management plans
* absence of Traditional Owner roles in the Incident Control structure during emergencies
* impacts on cultural heritage by emergency flood works.

Floodplain management should occur in a way that minimises the impact to cultural heritage and provides opportunities to promote cultural values (e.g. by managing flows in a way that benefits the environment that supports cultural values).

As Registered Aboriginal Parties, Traditional Owner Groups are entitled to speak on and for Country. In discussion with Traditional Owner Groups in the North Central region, the following opportunities were identified:

* fostering a partnership approach to floodplain management activities
* incorporating Cultural Heritage Assessments in flood management plans
* incorporating cultural knowledge into Municipal Emergency Management Plans
* sharing of flood risk information with Aboriginal communities
* incorporating cultural knowledge into Incident Control arrangements
* avoiding impacts on cultural heritage by emergency works (e.g. through pre-defining locations for borrow-pits free from cultural heritage sensitivity)
* cultural heritage surveys undertaken in the flood planning phase (e.g. before the flood) to determine sensitive areas (e.g. areas with cultural assets that could be disturbed by floodplain management activities or erosion from floodwaters), and provide guidance to Incident Control Centre decision making.

**REGIONAL PRIORITY 7 – Incorporate Traditional Owner knowledge into floodplain management activities**

As an initial action, Traditional Owners will be incorporated into Municipal Flood Emergency Committees. It is anticipated that the relationship between Traditional Owners and floodplain management agencies will mature and evolve over time. This first action will ensure consistent conversations and be a starting point for longer-term involvement in the other identified initiatives.

### Access

The disruption to major transport routes was a recurring theme in the risk identification process. In large floods, major highways (such as the Calder, Pyrenees and Midland Highways) can become inundated and close, and railways can be damaged and become unstable. In the lower catchments, roads can remain closed for months as a result of inundation from slow-moving expansive floodwaters. In the upper catchment, where flooding occurs more rapidly, the impact can be felt not only through roads being closed due to inundation, but also the damage that floodwaters cause, and the lengthy process of repairing roads. This is exacerbated by the need to access funding to repair infrastructure, which can often take months.

In some instances, this can place additional pressure on alternative routes. For example, when the Calder Highway is flooded and closed, drivers detour via local roads, which have not been built to withstand heavy-access or over-dimension vehicles.

The loss of major transport routes has implications for new developments within the large floodplains of the northern part of our region. Demonstrable safe access is a requirement of all development applications. Typically, the North Central CMA has deemed ‘safe access’ to be to the nearest major road. In the lower catchment, however, the major road itself may be closed, and so the criteria for ‘safe access’ may need to be reconsidered if arterial transport routes are not made more resilient. This could result in the denial of future development permits in areas with already low levels of development or that are experiencing population decline, which is undesirable.

A further level of complexity is added if the criteria are to consider potential isolation of townships. Kerang, for example, could be considered a ‘safe’ area due to its well-maintained township levee, but it becomes isolated for long periods of time, placing pressure on emergency services to either further evacuate populations or maintain supplies to them. Several townships within the North Central region become isolated during flood events, including Dunolly, Charlton and Boort.

**REGIONAL PRIORITY 8 – Develop and maintain flood-safe arterial transport routes**

It is important to maintain major access linkages between towns and regions during major flood events. An initial region-wide project will identify key transport linkages across the region and determine priorities for upgrades to ensure safe access during floods.

### Local Government Capacity

Of the 14 LGs within the North Central region, population varies from 8000 to 110,000 and geographical size varies from 6,000 square kilometres to 110,500 square kilometres. The resulting population densities range from less than one person per square kilometre to over 130 people per square kilometre, which presents a diversity of challenges in providing even the basic services expected by our communities. The size and population of LGAs heavily underpins their ability to raise revenue and this is exacerbated by the recent introduction of legislation that limits annual increases to property rates.

This Strategy acknowledges the those challenges of the North Central region’s LGAs and recognises their limited ability to raise revenue to invest in new flood studies, new flood mitigation infrastructure and/or new community services. It cannot necessarily be expected that all high priority actions be addressed in the first three years of implementation, if the cumulative cost is outside the lead agency’s means. With that in mind, the Strategy has been developed in partnership with LGAs to realistically account for their capacity to address flood risk within their administrative boundaries. This is reflected in the priority, cost and timeframe of each identified action in the work plan.

Recognising the limitation on LGAs to respond to flood risks, collaborative and innovative approaches in thinking and delivery of identified projects will reduce pressure on individual LGAs and result in improved outcomes across the region. As an example, planning scheme amendments have been identified as an action for the majority of LGAs. The North Central CMA will lead a regional action to identify and use any potential economies of scale in pursuing these actions in a collaborative way. Similar opportunities exist within the draft work plan and the North Central CMA, as coordinator of this Strategy, will actively work with LGAs and agencies to achieve any regional efficiencies.

# PART 3 – IMPROVEMENT PLAN

The Development and Improvement Plan identifies priority actions that meet the objectives of the strategy. The intention is to match regional management priorities with regional flood risks. The work plan provides information on the implementation of these priority management tasks, identifying accountabilities, costs and timeframes. In this way, the ambiguity of accountabilities that have hindered effective floodplain management in the past will not be continued.

It is acknowledged that floodplain management issues are rarely contained, and hence this strategy and its actions will be applied using a ‘no-borders’ approach, to ensure the most appropriate actions are considered across Council, CMA and State (in the case of the Murray River) borders.

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## Regional priorities and actions

### Determining regional priorities

Regional priorities have been identified through the discussion in Part 2 of this document, and are summarised as:

**REGIONAL PRIORITIES:**

1. Update planning controls to reflect the best available information (page 19).
2. Resolve flood mitigation infrastructure ownership and maintenance accountabilities (page 20).
3. Address gaps in flood knowledge through flood mapping projects (page 23).
4. Raise flood awareness and improving warning systems (page 23).
5. Develop an understanding and awareness of flood flow distributions (page 24).
6. Clarify roles and responsibilities of agencies and individuals in floodplain management activities (page 25).
7. Incorporate Traditional Owner knowledge into floodplain management activities (page 26).
8. Identify flood safe arterial transport routes (page 27).

These regional priorities have been paired against each area’s flood risk. Local actions have been designated as contributing to the achievement of a single or multiple regional priorities and therefore contribute to the overall reduction of flood risk across the region. Actions included within the Regional Work Program are those that:

* address a significant risk identified through the risk assessment process
* address a risk where existing treatments are inadequate
* are financially, socially and environmentally feasible
* have commitment from the relevant authorities.

The actions have been documented in the Regional Work Program below and grouped to align with the most relevant regional priority. All suggested actions are subject to feasibility, which may require further detailed investigation, and the availability of funding. The proposed actions have been prioritised over the Local Government scale, and may not address some specific localised issues including stormwater flooding, which are more appropriately dealt with through other processes.

| **REGIONAL PRIORITY 1: Update Planning Controls to reflect the best available information** |
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| *Aligns with objective:****3. Avoid future risk*** *– through effective strategic and statutory land use planning and building controls* |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** | **Cost** | **Priority** | **Expected Completion** |
| R.101 | NCCMA | LGAs | Identify and coordinate a region-wide collaborative approach to updating planning schemes. |  Low  | High | 1-3 years |
| CoB.101 | City of Ballarat | NCCMA | Extend the Environmental Significance Overlay to all waterways within the NCCMA boundaries of the City of Ballarat. |  Low  | High | 1-3 years |
| CGB.101 | City of Greater Bendigo | NCCMA | Update planning controls for Bendigo urban area. |  Medium  | High | 1-3 years |
| CGB.102 | City of Greater Bendigo | NCCMA | Update planning controls for Heathcote. |  Low  | High | 1-3 years |
| CGB.103 | City of Greater Bendigo | NCCMA | Update planning controls for Marong. |  Low  | High | 1-3 years |
| CGB.104 | City of Greater Bendigo | NCCMA | Update planning controls from rural flood studies. |  Low  | Low | 6+ years |
| CGB.105 | City of Greater Bendigo | NCCMA | Update planning controls after flood mitigation works have been implemented. |  Low  | Low | 6+ years |
| CGB.106 | City of Greater Bendigo | NCCMA | Undertake high-level gap analysis of rural flood mapping in City of Greater Bendigo region. |  Low  | Low | 6+ years |
| B.101 | Buloke Shire | NCCMA | Update planning controls for Charlton. |  Low  | High | 1-3 years |
| B.102 | Buloke Shire | NCCMA | Update planning controls for Donald. |  Low  | High | 1-3 years |
| C.101 | Campaspe Shire | NCCMA | Update planning controls for Rochester and Echuca. |  Low  | High | 1-3 years |
| C.102 | Campaspe Shire | NCCMA | Review controls of Rural Activity Zone in Campaspe Shire. |  Low  | High | 1-3 years |
| C.103 | Campaspe Shire | NCCMA | Review and update existing planning controls and schedules for Campaspe Shire. |  Low  | High | 1-3 years |
| CG.101 | Central Goldfields Shire | NCCMA | Update planning controls for Maryborough. |  Low  | High | 4-6 years |
| CG.102 | Central Goldfields Shire | NCCMA | Update planning controls for Carisbrook. |  Low  | High | 1-3 years |
| CG.103 | Central Goldfields Shire | NCCMA | Update planning controls for Dunolly. |  Low  | High | 1-3 years |
| G.101 | Gannawarra Shire | NCCMA | Update planning controls for Quambatook. |  Low  | High | 1-3 years |
| G.102 | Gannawarra Shire | NCCMA | Update planning controls for Lower Loddon and Avoca floodplains, based on regional flood mapping. |  Low  | High | 4-6 years |
| G.103 | Gannawarra Shire | VICSES | Incorporate intelligence from Lower Loddon and Avoca regional flood studies into MFEP. |  Low  | High | 4-6 years |
| H.101 | Hepburn Shire | NCCMA | Update planning controls for Creswick and Clunes. |  Low  | High | 1-3 years |
| L.101 | Loddon Shire | NCCMA | Update planning controls to incorporate Lower Loddon regional mapping. |  Low  | Medium | 4-6 years |
| L.102 | Loddon Shire | NCCMA | Update planning controls to incorporate Avoca regional mapping. |  Low  | Medium | 4-6 years |
| L.103 | Loddon Shire | NCCMA | Update planning controls to incorporate Bridgewater Flood Study information. |  Low  | High | 1-3 years |
| MR.101 | Macedon Ranges Shire | NCCMA | Update planning controls for Woodend. |  Low  | High | 4-6 years |
| MAS.101 | Mount Alexander Shire | NCCMA | Update planning controls for Newstead. |  Low  | Medium | 4-6 years |
| MAS.102 | Mount Alexander Shire | NCCMA | Update planning controls for Harcourt. |  Low  | Medium | 4-6 years |
| MAS.103 | Mount Alexander Shire | NCCMA | Update planning controls for Campbells Creek (rural). |  Low  | Medium | 4-6 years |
| MAS.104 | Mount Alexander Shire | NCCMA | Update planning controls for Muckleford Creek (rural). |  Low  | Medium | 4-6 years |
| MAS.105 | Mount Alexander Shire | NCCMA | Update planning controls for Castlemaine, Campbells Creek and Chewton. |  Low  | High | 1-3 years |
| NG.101 | Northern Grampians Shire | NCCMA | Update planning controls for St Arnaud. |  Low  | High | 4-6 years |
| NG.102 | Northern Grampians Shire | NCCMA | Update planning controls for Avon River upstream of Rich-Avon Weir. |  Low  | Low | 6+ years |
| SH.101 | Swan Hill Rural City | NCCMA | Update planning controls for Tyntynder Flats, Swan Hill and Pental Island. |  Low  | High | 4-6 years |
| SH.102 | Swan Hill Rural City | NCCMA | Update planning controls to incorporate Lower Loddon regional flood mapping. |  Low  | High | 1-3 years |
| SH.103 | Swan Hill Rural City | NCCMA | Update planning controls to incorporate Avoca regional flood mapping. |  Low  | High | 1-3 years |

| **REGIONAL PRIORITY 2: Resolve flood mitigation infrastructure ownership and maintenance accountabilities** |
| --- |
| *Aligns with objective:****2. Reduce existing flood risk*** *– by implementing and maintain flood mitigation infrastructure* |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** | **Cost** | **Priority** | **Expected Completion** |
| R.201 | NCCMA | LGAs | In conjunction with Councils, undertake a review of existing flood mitigation infrastructure across the region to determine existing service levels and future management arrangements. |  Medium  | High | 1-3 years |
| CGB.201 | City of Greater Bendigo | NCCMA | Formalise management arrangements for Epsom-Huntly levees. |  Low  | High | 1-3 years |
| CGB.202 | City of Greater Bendigo | NCCMA | Formalise management arrangements for the constructed (lined) section of Bendigo Creek. |  Low  | High | 1-3 years |
| B.201 | Buloke Shire | NCCMA | Construction of Charlton flood mitigation levee treatments and associated works (this may include improvements to town drainage to ensure the integrity of the levees). |  High  | High | 1-3 years |
| B.202 | Buloke Shire | NCCMA | Construction of Donald flood mitigation levee’s 1 and 4 and associated works. |  High  | High | 1-3 years |
| C.201 | Campaspe Shire | NCCMA | Define ownership and management arrangements for Torrumbarry levees. |  Low  | High | 1-3 Years |
| CG.201 | Central Goldfields Shire | Central Highlands Water | Investigate feasibility of reinstating Carisbrook reservoir. |  Low  | Medium | 1-3 years |
| CG.202 | Central Goldfields Shire |   | Undertake ongoing management of drains through Carisbrook. |  Low  | High | ongoing - as required |
| CG.203 | Central Goldfields Shire |   | Undertake ongoing management of waterways through Carisbrook. |  Low  | High | ongoing - as required |
| CG.204 | Central Goldfields Shire |   | Complete implementation of flood mitigation works at Carisbrook. This includes: (1) western floodway and levee to divert overland flows to the west of the township, (2) a smaller levee near Williams road to divert additional overland flow into McCallums Creek, and (3) a non-return valve on culverts under Landrigan Rd near Camp St. |  High  | High | 1-3 years |
| CG.205 | Central Goldfields Shire |   | Construct priority flood mitigation works as per Dunolly Flood and Drainage Management Plan. |  Medium  | High | 1-3 years |
| H.201 | Hepburn Shire |   | Undertake further investigations into the local drainage issues and potential stormwater mitigation works for Clunes. |  Low  | Medium | 4-6 years |
| H.202 | Hepburn Shire |   | Undertake a detailed investigation into drainage issues in Creswick. |  Medium  | Medium | 4-6 years |
| L.201 | NCCMA | Loddon Shire | Review Serpentine to Boort floodplain management plan, including an extension of the plan to include floodways and road crossings in the Yando area, and to include a review of the impacts of changes to the Flume Creek bridge on Boort-Pyramid Road (near Durham Ox). |  Low  | High | 1-3 years |
| L.202 | Loddon Shire |   | Investigate protection of old Inglewood reservoir. |  Medium  | High | 1-3 years |
| L.203 | Loddon Shire |   | Implement mitigation works at Pyramid Hill. |  High  | Medium | 1-3 years |
| L.204 | Loddon Shire |   | Implement mitigation works at Serpentine. |  High  | Low | 4-6 years |
| L.205 | Loddon Shire |   | Implement mitigation works at Boort. |  High  | High | 1-3 years |
| MR.201 | Macedon Ranges Shire | NCCMA | Define ownership and maintenance obligations for Woodend levee. |  Low  | High | 1-3 years |
| MR.202 | Macedon Ranges Shire |   | Complete construction of Woodend Detention dam. |  High  | High | 1-3 years |
| MAS.201 | Mount Alexander Shire |   | Implement recommend mitigation options of Castlemaine, Campbells Creek and Chewton flood management plan (levees and minor creek improvement works). |  High  | High | 1-3 years |
| MAS.202 | Mount Alexander Shire |   | Upgrade and resolve ownership and maintenance arrangements for Newstead levee. |  High  | High | 1-3 years |
| NG.201 | Northern Grampians Shire |   | Re-construct retention dam upstream of St Arnaud. |  High  | High | 4-6 years |
| SH.201 | NCCMA | Swan Hill Rural City | Investigate and determine responsible agency for Murray River, Tyntynder and Pental Island levees and Pental Island floodway. |  Low  | High | 1-3 years |

| **REGIONAL PRIORITY 3: Address gaps in flood knowledge through flood mapping projects** |
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| *Aligns with objective:****1. Build resilient communities*** *– through collating and sharing flood risk information* |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** | **Cost** | **Priority** | **Expected Completion** |
| CGB.301 | City of Greater Bendigo | NCCMA | Undertake a flood mitigation study for the Bendigo urban area. |  Medium  | Medium | 4-6 years |
| CGB.302 | Campaspe Shire | NCCMA, City of Greater Bendigo | Conduct regional flood mapping study for Axe Creek and Campaspe River downstream from Eppalock to Rochester, including Mt Pleasant Ck and the townships of Axedale and Elmore. |  Medium  | High | 1-3 years |
| CGB.303 | City of Greater Bendigo | NCCMA | Undertake a high-level (rapid) flood study for Redesdale. |  Low  | Medium | 4-6 years |
| CGB.304 | NCCMA | City of Greater Bendigo | Develop a consolidated rural flood model. |  Medium  | Low | 6+ years |
| CGB.305 | City of Greater Bendigo | NCCMA | Undertake flood study for Axe Creek and tributaries. |  Medium  | Low | 6+ years |
| B.301 | Buloke Shire | NCCMA | Undertake a flood study to cover gaps in Charlton flood mapping for Gowar and Yeungroon Creeks via railway line to Avoca River. |  Medium  | Medium | 4-6 years |
| B.302 | Buloke Shire | NCCMA | Undertake a flood study, including irrigation channel and informal levees, for Gowar Creek. |  Medium  | Medium | 4-6 years |
| B.303 | Buloke Shire | NCCMA | Undertake a flood study, including irrigation channel and informal levees, for Yeungroon Creek. |  Medium  | Medium | 4-6 years |
| B.304 | Buloke Shire | NCCMA | Undertake a flood study, including irrigation channel and informal levees, for Tyrrell Creek. |  Medium  | Medium | 4-6 years |
| B.305 | Buloke Shire | NCCMA | Undertake a flood study, including irrigation channel and informal levees, for Lalbert Creek. |  Medium  | Medium | 4-6 years |
| B.306 | Buloke Shire | NCCMA | Undertake a flood study, including irrigation channel and informal levees, for Marmal Creek. |  Medium  | Medium | 4-6 years |
| B.307 | Buloke Shire | NCCMA | Undertake a flood study, including irrigation channel and informal levees, for Mosquito Creek/North-East floodplains Stream. |  Medium  | Medium | 4-6 years |
| B.308 | Buloke Shire | NCCMA | Undertake a flood study, including irrigation channel and informal levees, for Cooroopajerup Creek. |  Medium  | Medium | 4-6 years |
| B.309 | Buloke Shire | NCCMA | Undertake a flood study, including irrigation channel and informal levees, for Dunmunkle Creek. |  Medium  | Medium | 4-6 years |
| B.310 | Buloke Shire | NCCMA | Undertake a rapid flood study for Wooroonook Lakes and Wycheproof and incorporate flood intelligence into MFEP. |  Low  | Medium | 4-6 years |
| C.301 | Campaspe Shire | NCCMA | Undertake a flood study for Echuca. |  Medium  | High | 1-3 years |
| C.302 | Campaspe Shire | NCCMA | Undertake a flood study for Torrumbarry. |  Medium  | High | 1-3 years |
| C.303 | Campaspe Shire | NCCMA | Conduct a rapid flood study for the area between the Campaspe River and Mt Hope Creek north of Rochester to the Murray River. |  Low  | Medium | 4-6 years |
| C.304 | Campaspe Shire | NCCMA, City of Greater Bendigo | Conduct a regional flood mapping study for Axe Creek and Campaspe River downstream from Eppalock to Rochester, and including Mt Pleasant Creek and the townships of Axedale and Elmore. |  Medium  | High | 1-3 years |
| CG.301 | Central Goldfields Shire | NCCMA | Undertake flood study for Maryborough. |  Medium  | High | 1-3 years |
| CG.302 | Central Goldfields Shire | NCCMA | Undertake coarse rural flood mapping across whole of Central Goldfields Shire to determine priorities for new mapping projects. |  Low  | High | 1-3 years |
| GC.303 | Central Goldfields Shire | NCCMA | Undertake a flood study for Bealiba. |  Medium  | Medium | 4-6 years |
| CG.304 | Central Goldfields Shire | NCCMA | Undertake a rapid flood study for Timor-Bowenvale. |  Low  | Medium | 4-6 years |
| G.301 | Gannawarra Shire | NCCMA | Undertake study on Koondrook Township levee. |  Medium  | High | 1-3 years |
| G.302 | Gannawarra Shire | NCCMA | Investigate opportunity to produce Murray Flood Plan in partnership with NSW Office of Environment and Heritage and Murray Shire. |  Medium  | High | 1-3 years |
| G.303 | Gannawarra Shire | NCCMA | Review flood information for Murrabit. |  Low  | High | 1-3 years |
| H.301 | Hepburn Shire | NCCMA | Review and finalise draft Clunes flood study and recommended actions. |  Low  | High | 1-3 years |
| H.302 | NCCMA | Hepburn Shire | Undertake flood mapping of Coomoora. |  Low  | Medium | 4-6 years |
| H.303 | Hepburn Shire | NCCMA | Undertake a rapid flood study for Daylesford/Hepburn Springs. |  Low  | Medium | 4-6 years |
| H.304 | Hepburn Shire | NCCMA | Undertake a rapid flood study for Newlyn North and Smeaton. |  Low  | Medium | 4-6 years |
| H.305 | Hepburn Shire | NCCMA | Undertake a flood and drainage study for Trentham. |  Medium  | Low | 6+ years |
| L.301 | Loddon Shire | NCCMA | Undertake flood modelling for Wedderburn. |  Medium  | Medium | 4-6 years |
| L.302 | Loddon Shire | NCCMA | Undertake flood modelling for Inglewood. |  Medium  | Medium | 4-6 years |
| L.303 | DELWP | NCCMA | Complete regional mapping for Lower Loddon. |  Medium  | High | 1-3 years |
| L.304 | Loddon Shire | NCCMA | Undertake a rapid flood study for Korong Vale. |  Low  | Low | 6+ years |
| L.305 | Loddon Shire | NCCMA | Undertake a regional flood mapping project for Borung Hills. |  Low  | Low | 6+ years |
| L.306 | Loddon Shire | NCCMA | Undertake a rapid flood study for Tarnagulla. |  Low  | Low | 6+ years |
| L.307 | Loddon Shire | NCCMA | Incorporate flood intelligence from Bridgewater Flood Management Plan into MFEP. |  Low  | High | 1-3 years |
| MR.301 | NCCMA | Macedon Ranges Shire | Undertake preliminary flood risk assessment/study for Kyneton and determine if flood warning system is warranted. |  Low  | High | 1-3 years |
| MR.302 | Macedon Ranges Shire | NCCMA | Consider rapid flood modelling for areas with little information to determine areas of risk. |  Low  | Medium | 4-6 years |
| MR.303 | Macedon Ranges Shire | NCCMA | Undertake flood mapping for urban waterways in Woodend (excluding Five Mile Creek) and investigate if a flood warning system is warranted. |  Medium  | High | 1-3 years |
| M.301 | Mitchell Shire | NCCMA | Undertake rapid flood modelling of the North Central CMA region to determine flood risk. |  Low  | Medium | 4-6 years |
| MAS.301 | Mount Alexander Shire | NCCMA | Undertake flood mapping for Newstead. |  Medium  | High | 1-3 years |
| MAS.302 | Mount Alexander Shire | NCCMA | Undertake flood mapping for Harcourt. |  Medium  | High | 1-3 years |
| MAS.303 | NCCMA | Mount Alexander Shire | Undertake flood mapping for Muckleford Creek. |  Low  | High | 1-3 years |
| MAS.304 | NCCMA | Mount Alexander Shire | Undertake flood mapping for Campbells Creek (rural). |  Low  | High | 1-3 years |
| MAS.305 | Loddon Shire | NCCMA | Undertake a regional flood mapping study for Bullock Creek (including Calivil and Nine Mile Creeks). |  Medium  | Low | 6+ years |
| MAS.306 | Mount Alexander Shire | NCCMA | Undertake a rapid flood study for Sutton Grange. |  Low  | Low | 6+ years |
| MAS.307 | Mount Alexander Shire | NCCMA | Undertake a rapid flood study for Baringhup. |  Low  | Low | 6+ years |
| MAS.308 | Mount Alexander Shire | NCCMA | Undertake a flood and drainage study for Maldon. |  Low  | Low | 6+ years |
| MAS.309 | Mount Alexander Shire | NCCMA | Undertake a rapid flood study for Guildford. |  Low  | Low | 6+ years |
| MAS.310 | Mount Alexander Shire | VICSES | Configure and implement a flash flood warning system for Chewton, Campbells Creek and Castlemaine. |  Low  | High | 1-3 years |
| MAS.311 | Mount Alexander Shire | NCCMA | Undertake rapid flood study for Taradale. |  Low  | High | 1-3 years |
| NG.301 | Northern Grampians Shire | NCCMA | Undertake local flood study for Marnoo. |  Medium  | Low | 6+ years |
| NG.302 | Northern Grampians Shire | NCCMA | Undertake local flood study for St Arnaud. |  Medium  | High | 1-3 years |
| NG.303 | Northern Grampians Shire | NCCMA | Undertake rapid flood study for Avon River to Rich-Avon Weir. |  Low  | Medium | 4-6 years |
| NG.304 | NCCMA | Northern Grampians | Undertake Richardson River regional flood study. |  Medium  | Medium | 4-6 years |
| NG.305 | NCCMA | Northern Grampians | Undertake regional flood mapping study for Avon River. |  Medium  | High | 1-3 years |
| P.301 | NCCMA | Pyrenees Shire | Undertake preliminary flood study of Lexton. |  Low  | High | 1-3 years |
| P.302 | Pyrenees Shire | NCCMA | Undertake detailed flood management plan for Lexton. |  Medium  | Medium | 4-6 years |
| P.303 | Pyrenees Shire | NCCMA | Undertake Upper Avoca River flood study to inform flood intelligence and planning scheme maps for Amphitheatre, Avoca and Nattee Yallock (rural areas), and potential flood mitigation for Avoca recreation Reserve. |  Medium  | High | 1-3 years |
| P.304 | Pyrenees Shire | NCCMA | Undertake flood study for Waubra (to include planning scheme amendments). |  Medium  | High | 1-3 years |
| SH.301 | NCCMA |   | Undertake flood study for Tyntynder Flats (also to include Swan Hill). |  Medium  | High | 1-3 years |
| SH.302 | Swan Hill Rural City | NCCMA | Review flood mapping and planning controls for Woorinen. |  Low  | Medium | 4-6 years |

| **REGIONAL PRIORITY 4: Raise flood awareness and improve flood warnings** |
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| *Aligns with objectives:****1.Build resilient communities*** *– through collating and sharing flood risk information****4. Manage residual risk –*** *by improving and coordinating flood warning and response arrangements* |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** | **Cost** | **Priority** | **Expected Completion** |
| R.401 | VICSES |   | Investigate options to improve community access to website flood risk information to allow people to better plan, prepare and respond to flooding. |  Medium  | High | 1-3 years |
| R.402 | VICSES | DELWP | Secure ongoing funding for two positions (ROEM and CRC) to implement sustainable community engagement and operational support to municipalities and communities that are at risk of flooding that have yet to be engaged (e.g. all communities along the Murray River, Bendigo, Swan Hill, Huntly, Bridgewater, Inglewood and Mildura). |  High  | High | ongoing |
| R.403 | VICSES | LGAs, DELWP, NCCMA, CFA | Undertake operational readiness training/exercising for all local flood guides that incorporates MFEP in operational response (in Incident Control Centres) Using a risk based approach to prioritise within current SES resources. |  Medium  | High | 1-3 years |
| R.404 | VICSES | LGAs | Investigate flash flood warning systems tailored for relevant towns/communities, if VICSES funding application is successful. |  Low  | High | 1-3 years |
| R.405 | VICSES |   | Pre-develop community messaging tailored for relevant towns/communities with known impacts for various AEPS. Using a risk based approach to prioritise within current SES resources. |  Low  | High | 1-3 years |
| R.406 | VICSES |   | Develop a strategy for sustainable community engagement programs (for flood risk), including community education, engagement and community led planning for the Greater City of Bendigo. |  Low  | Various | ongoing - as required |
| R.407 | VICSES |   | Develop community engagement activities and or awareness products, relating to high flood risk townships and communities. This may include: Installing community signs, gauge boards or community led response plans, if VICSES funding application is successful. |  Low  | Various | ongoing - as required |
| R.408 | VICSES |   | Incorporate updated flood mapping, flood intelligence and local knowledge into MFEP for all flood affected communities, incorporating new flood studies, townships, levees, survey required, etc., if VICSES funding application is successful. |  Low  | High | ongoing - as required |
| R.409 | VICSES |   | Develop a 10-year regional strategy for sustainable community engagement programs (for flood risk), including community education, engagement and community led planning. |  Low  | High | 1-3 years |
| R.410 | VICSES | NCCMA | Develop catchment plans to summarise main points out of Municipal Flood Emergency Plans. |  Low  | High | 1-3 years |
| CGB.401 | NCCMA | VICSES, City of Greater Bendigo | Investigate a local flash flood warning system for Bendigo Creek. |  Low  | High | 1-3 years |
| CGB.402 | NCCMA | VICSES, City of Greater Bendigo | Investigate a local flash flood warning system for McIvor Creek upstream Eppalock (to inform Heathcote). |  Low  | High | 1-3 years |
| CGB.403 | City of Greater Bendigo | VICSES | Secure funding for a three-year period for the City of Greater Bendigo, to support implementation of community engagement in high-risk areas. |  High  | High | 1-3 years |
| B.401 | Buloke Shire | VICSES | Install gauge board within Donald township (e.g. at Bullocks head or Sunraysia Highway). |  Low  | Medium | 1-3 years |
| B.402 | Buloke Shire | BoM, DELWP | Finalise TFWS/prediction services for high risk communities of Charlton, Donald, Coonooer Bridge and Culgoa. |  Low  | High | 1-3 years |
| C.401 | Campaspe Shire | VICSES | Implement flood warning system for Mt Pleasant Creek. |  Low  | Medium | 4-6 years |
| C.402 | NCCMA | Campaspe Shire, VICSES, | Staged implementation of a flood warning system for Rochester. |  Low  | High | 1-3 years |
| C.403 | NCCMA | BoM | Review flood class levels for the Campaspe River gauge at Echuca. |  Low  | High | 1-3 years |
| C.404 | NCCMA | BoM | Request flood forecasts for Campaspe at Echuca (e.g. levels at the Campaspe River gauge at Echuca) based on rainfall-runoff and routing modelling. |  Low  | High | 1-3 years |
| C.405 | Campaspe Shire | VICSES | Develop an indicative flood likelihood and severity tool for local application using Campaspe upstream river levels/flows and Murray at Echuca levels/flows. |  Low  | High | 1-3 years |
| CG.401 | VICSES | Central Goldfields Shire | Upgrade flood warning service for Carisbrook. |  Low  | High | 1-3 years |
| CG.402 | Central Goldfields Shire | VICSES | Develop flash flood warning system for Dunolly and communicate warnings. |  Low  | Medium | 4-6 years |
| CG.403 | Central Goldfields Shire | VICSES | Installation of a gauge board within Dunolly Township. |  Low  | High | 1-3 years |
| G.401 | NCCMA | Gannawarra Shire | Investigate the installation of a permanent streamflow gauge at Durham Ox. |  Low  | Low | 6+ years |
| G.402 | Gannawarra Shire | VICSES | Flood intelligence from Quambatook flood study to be incorporated into MFEP. |  Low  | High | 1-3 years |
| H.401 | NCCMA | Hepburn Shire | Installation of gauge board upstream of the Water Street bridge to assist in future flood warning for Creswick. |  Low  | High | 1-3 years |
| MR.401 | Macedon Ranges Shire | VICSES, NCCMA | Review Macedon Ranges MFEP. |  Low  | High | 1-3 years |
| NG.401 | Northern Grampians Shire | VICSES | Implement flash flood warning service for St Arnaud. |  Low  | High | 1-3 years |
| P.401 | Pyrenees Shire | VICSES | Explore best options for improving TFWS data collection network. Potential options are: (a) telemeting Bet Bet Creek at Lillicur gauge, (b) add telemetry to Forrest Creek at Amphitheatre Reservoir head gauge; (c) add rain gauge to the existing telemetered gauge at Avoca River at Amphitheatre. |  Low  | High | 1-3 years |
| **REGIONAL PRIORITY 5: Develop an understanding of flood flow distributions** |
| *Aligns with objectives:****1.Build resilient communities*** *– through collating and sharing flood risk information****4. Manage residual risk –*** *by improving and coordinating flood warning and response arrangements* |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** | **Cost** | **Priority** | **Expected Completion** |
| R.501 | NCCMA | Water Corps, LGAs | Develop guiding principles for flood flow distributions that consider social and environmental impacts to inform the management of floodwaters (refer to section 2.3 of the strategy). |  Low  | High | 1-3 years |
| L.501 | VICSES | Loddon Shire | Include operational rules for Lake Boort in the Loddon MFEP. |  Low  | High | 1-3 years |
| NG.501 | Northern Grampians Shire | NCCMA | Investigate use of Lake Batyo Catyo for flood storage. |  Low  | High | 1-3 years |

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| **REGIONAL PRIORITY 6: Clarify roles and responsibilities of agencies and individuals in floodplain management activities** |
| *Aligns with objective:****2. Reduce existing flood risk*** *– by implementing and maintaining flood mitigation infrastructure* |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** | **Cost** | **Priority** | **Expected Completion** |
| R.601 | NCCMA | LGAs, VICSES, Water Corps | Develop communication plan and promotional material for the education of LGAs, authorities and individuals on floodplain and waterway management policies, accountabilities and actions. |  Low  | High | 1-3 years |

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| **REGIONAL PRIORITY 7: Incorporate Traditional Owner knowledge into floodplain management activities** |
| *Aligns with objectives:****1. Build resilient communities*** *– through collating and sharing flood risk information****4. Manage residual risk*** *– by improving and coordinating flood warning and response arrangements* |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** | **Cost** | **Priority** | **Expected Completion** |
| R.701 | VICSES | LGAs, CMA | Incorporate Traditional Owner knowledge into Municipal Flood Emergency Management Plans. |  Low  | High | 1-3 years |
| R.702 | NCCMA |   | Develop regional guidelines for how to include Traditional Owner interests and knowledge into flood emergency and planning response. |  Low  | High | 1-3 years |

| **REGIONAL PRIORITY 8: Develop and maintain flood-safe (i.e. low hazard) arterial transport routes** |
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| *Aligns with objectives:****1. Build resilient communities*** *– through collating and sharing flood risk information****2. Reduce existing risk*** *– by implementing and maintaining flood mitigation infrastructure* |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** | **Cost** | **Priority** | **Expected Completion** |
| R.801 | VicRoads/VicTrack | LGAs | Identify key access routes between townships to determine priorities for road upgrades. |  Low  | High | 1-3 years |
| B.801 | VicRoads | Buloke Shire | Construct major culvert at Calder Highway floodway over Yeungroon Creek. |  High  | Medium | 4-6 years |
| CG.801 | Central Goldfields Shire | VicRoads | Upgrade London Bridge in Talbot. |  High  | Medium | 4-6 years |
| CG.802 | Central Goldfields Shire |   | Upgrade Vinecombes Ford. |  High  | Low | 6+ years |
| CG.803 | VicRoads | Central Goldfields Shire | Consider elevating bridges to provide access during a major flood event for any future bridge upgrades in Dunolly. |  High  | Low | 6+ years |
| MAS.801 | VicRoads | Mount Alexander Shire | Investigate options for Pyrenees and Midland Highway floodways (multiple sites). |  Medium  | Medium | 4-6 years |
| MAS.802 | Mount Alexander Shire |   | Investigate broader project to assess economic impacts of road closures across the shire. |  Low  | Medium | 4-6 years |

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| **Targeted actions that align with the objectives of the strategy** |
| *Aligns with objectives:****2. Reduce existing risk*** *– by implementing and maintaining flood mitigation infrastructure****4. Manage residual risk*** *– by improving and coordinating flood warning and response arrangements* |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** | **Cost** | **Priority** | **Expected Completion** |
| R.901 | NCCMA | LGAs | Undertake discussions with neighbouring councils for cost-sharing arrangements for flood warning infrastructure. |  Low  | High | ongoing - as required |
| C.901 | Campaspe Shire |   | Invest in mobile pumps. |  Medium  | High | 1-3 years |
| C.902 | Campaspe Shire |   | Upgrade flood valves around Echuca and Rochester to automated system. |  Medium  | High | 1-3 years |
| C.903 | Campaspe Shire | NCCMA | Undertake feasibility assessment for identified flood mitigation works at Rochester as per Rochester Flood Management Plan. |  Low  | High | 1-3 years |
| CG.901 | VicRoads |   | Replace highway bridge with a clear-span structure when bridge is due for replacement (or when funding becomes available) for Carisbrook. |  High  | Low | 6+ years |
| NG.901 | Northern Grampians Shire | NCCMA | Investigate operating controls for structures in Avon upstream of Rich-Avon Weir. |  Low  | Low | 6+ years |

### Regional Work Program

The Regional Work Program provides detail of regional priority actions for the life of this strategy (nominally 10 years). It is a rolling three-year work plan, which will be reviewed annually. It has been developed assuming ‘typical years’, however, if events such as extreme floods occur during the life of the regional strategy, agencies may be required to adapt delivery of specific actions within the Work Plan in light of changed conditions and/or risk, in a seasonally adaptive approach.

The regional priorities identified in this document encapsulate the work plan actions, and have been identified as such in the regional work program. It is important to acknowledge the interrelation between actions and how they deliver the priority outcomes. For example, a flood study has been assigned under the regional priority of ‘addressing gaps in flood knowledge through flood mapping projects’, however the study outcomes will enable follow-on actions of updating the planning scheme, raising flood awareness, and possibly construction of flood mitigation infrastructure to reduce the existing risk.

## Monitoring, evaluation, review and improvement plan

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.

To support this approach, a detailed Monitoring, Evaluation and Reporting (MER) Plan will be developed to accompany this strategy from planning to regional strategy completion.

The MER Plan will incorporate the following guiding principles:

* convening of a 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.

**GLOSSARY**

**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 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).

**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.

**Development**

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

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

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

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

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

**Flash flooding**

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

**Flood**

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

**Flood awareness**

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

**Flood class 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-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 readiness**

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

**Flood risk**

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

**Flood severity**

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

**Flood study**

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

**Flood warning**

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

**Floodplain**

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

**Floodplain management**

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

**Flow**

The rate of flow of water measured in volume per unit time, for example, megalitres per day (ML/day) or cubic metres per second (m3/sec). Flow is different from the speed or velocity of flow, which is a measure of how fast the water is moving, for example, metres per second (m/s).

**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).

**Likelihood**

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

**Likelihood of occurrence**

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

**Local overland flooding**

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

**Mitigation**

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

**Municipal Flood Emergency Plan**

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

**Planning scheme zones and overlays**

Planning schemes set out the planning rules – the state and local policies, zones, overlays and provisions about specific land uses that inform planning decisions. Land use zones specify what type of development is allowed in an area (e.g. urban (residential, commercial, industrial), rural, environmental protection). Overlays specify extra conditions for developments that are allowed in a zone. For example, flooding overlays specify that developments must not affect flood flow and storage capacity of a site, must adhere to freeboard requirements, and not compromise site safety and access.

**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).

**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.

**River Regulation**

The act of controlling river water level or the variability of river flows to meet human demands (e.g. for domestic supply, irrigation, navigation etc.)

**Runoff**

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

**Service Level**

The performance of a system. For example, a levee which has a 1% AEP service level, will be of sufficient height and quality to provide protection in a 1% AEP flood event.

**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).

# ACRONYMS

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| AEP | Annual Exceedance Probability |
| ARI | Average Recurrence Interval |
| CMA | Catchment Management Authority |
| DELWP | Department of Environment, Land, Water and Planning |
| ESO | Environmental Significance Overlay |
| FO | Floodway Overlay |
| LGA | Local Government Authority |
| LSIO | Land Subject to Inundation Overlay |
| MFEP | Municipal Flood Emergency Plan |
| NCCMA | North Central Catchment Management Authority |
| NCRCS | North Central Regional Catchment Strategy |
| NCWS | North Central Waterway Strategy |
| NDRRA | Natural Disaster Relief and Recovery Arrangements |
| NDRGS | Natural Disaster Resilience Grants Scheme |
| SBO | Special Building Overlay |
| TFWS | Total Flood Warning System |
| UFZ | Urban Floodway Zone |
| VFMS | Victorian Floodplain Management Strategy |
| VICSES | Victorian State Emergency Services |