SOUTH AUSTRALIAN FLOOD HAZARD PLAN

Hazard Leader: Department for Environment and Water

Government

STATE EMERGENCY MANAGEMENT PLAN STRUCTURE

The State Emergency Management Plan (SEMP) is a four-part plan containing a range of documents that detail strategies for dealing with emergencies in South Australia. The parts are outlined in Figure 1.

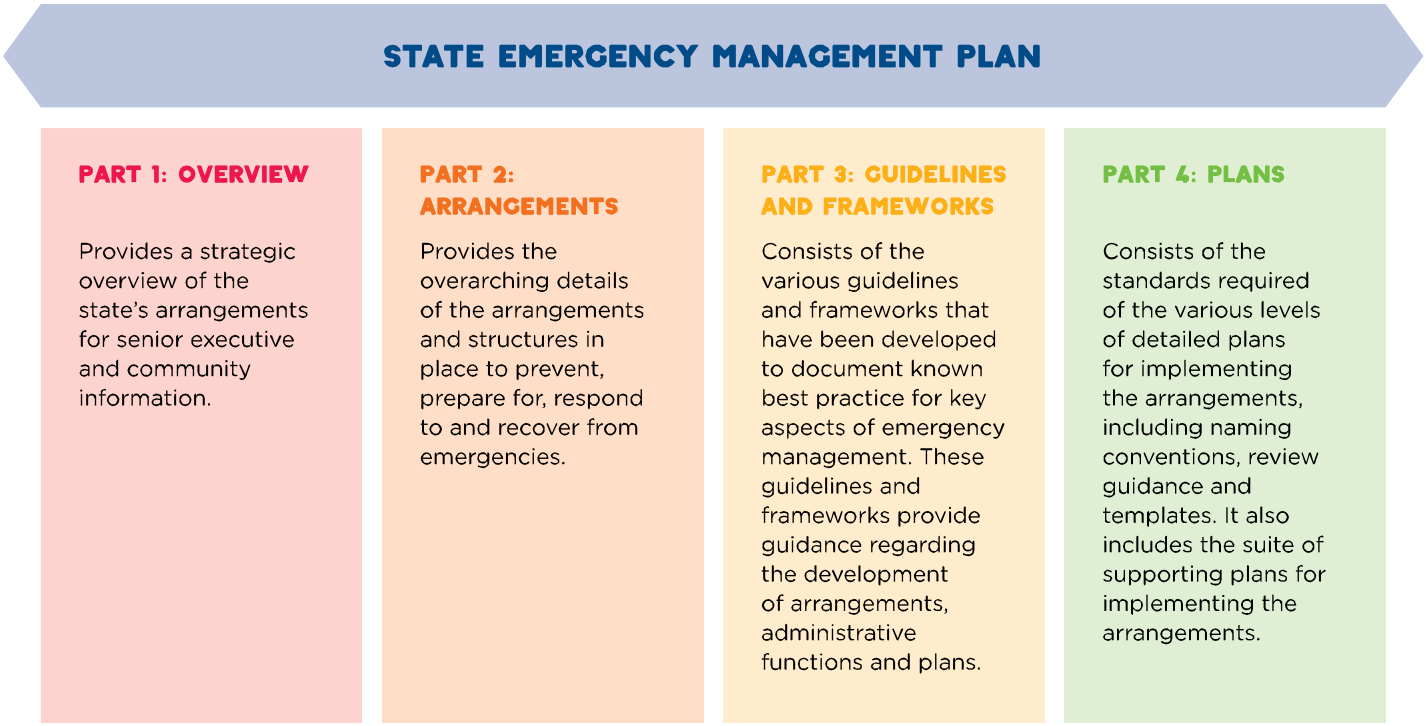
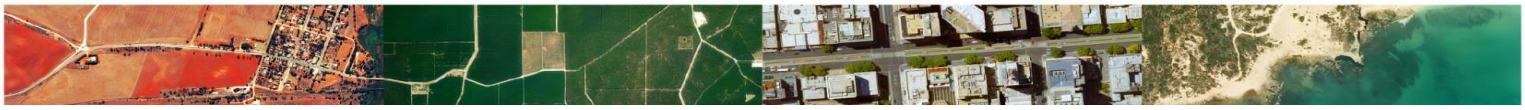


Figure 1: The parts of the South Australian State Emergency Management Plan

This Flood Hazard Plan is an Annex to Part 4 of the SEMP.

As specified in the SEMP, the Flood Hazard Plan includes the following:

- a full description of the hazard and the potential impacts across people, economy, social setting, public administration and the environment within South Australia (Sections 5 and 6, and Appendix A)
- key stakeholder roles, responsibilities and strategies in South Australia for the prevention, preparedness, response to and recovery from hazard events (Section 9)
- identification of sectors of the community vulnerable to the hazard event (Appendix C)
- a risk assessment summary for the hazard using the National Emergency Risk Assessment Guidelines (Section 6)
- recommended strategies to mitigate priority risks (Section 10)
- processes to support control agencies obtaining information about potential events (Section 7 and Appendix D)
- guidance specific to the hazard for control agencies in evacuations (Appendix B)
- identification of issues where the approach to the hazard is not sufficiently coordinated, and strategies to improve that coordination (Section 10).



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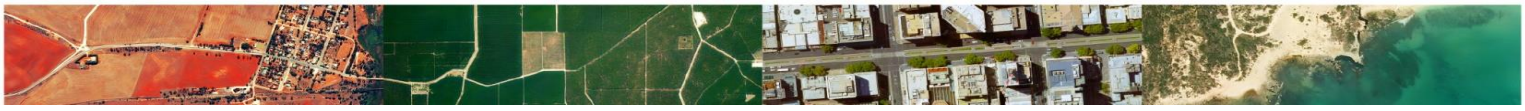

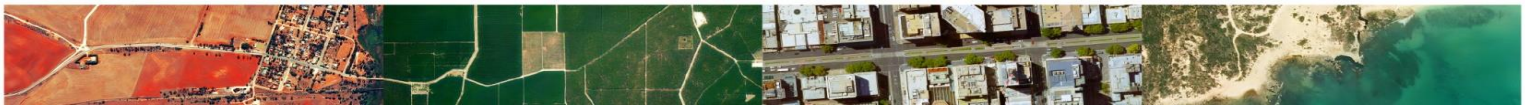

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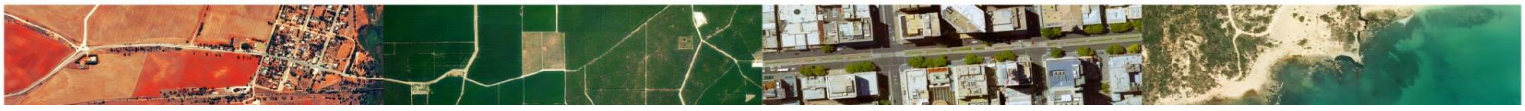
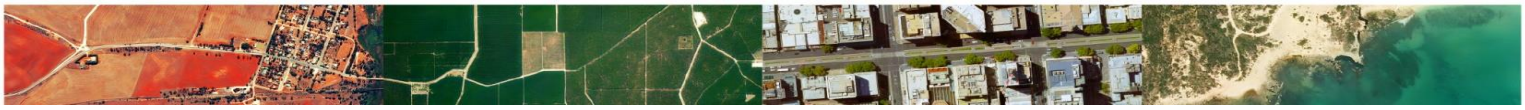




1. AUTHORITY

The Australian Constitution states that each of the states and territories is responsible for the protection of its citizens. The Australian Government has a role to assist where a state or territory is unable to meet a need or seeks assistance, but the primary responsibility lies with the respective states/territories.

All emergency management arrangements in South Australia are governed by the *Emergency Management Act 2004* (the Act). The Act establishes the State Emergency Management Committee (SEMC) and lists its functions and powers.

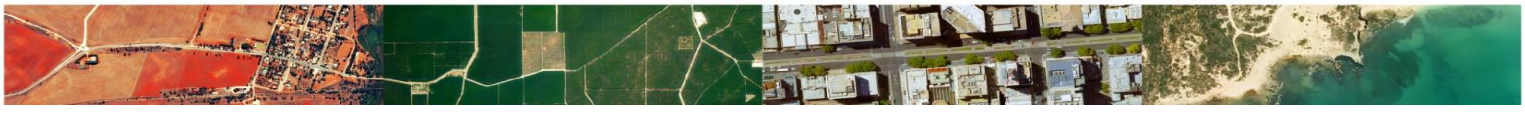
The SEMP is prepared under section 9(1)(b) of the Act to manage all emergencies. It is a function of the SEMC to prepare and keep this plan under review, and to ensure arrangements reflect best practice.

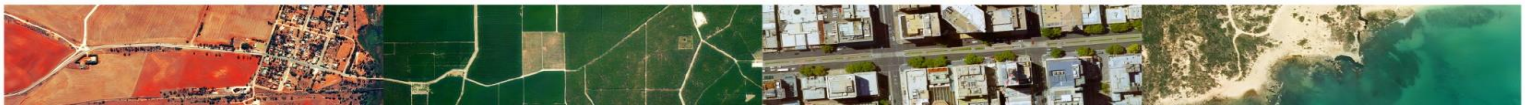
This Flood Hazard Plan is prepared under Part 4 of the SEMP.

2. PURPOSE AND AUDIENCE

The purpose of the Flood Hazard Plan is to set out arrangements and provide information for effective, efficient and coordinated flood management in South Australia. It includes state government flood management priorities for the coming years.

The primary audience for the Flood Hazard Plan is the SEMC, the emergency management sector, other relevant state government agencies, local councils, and local government authorities and boards. The Flood Hazard Plan is a publicly available document that is also relevant for landscape boards, the Stormwater Management Authority (SMA), flood and stormwater engineers and consultants, industry groups and interested members of the public.





3. FOREWORD AND AUTHORISATION

Flood management in South Australia is a shared responsibility between the Australian Government, the South Australian government, local government, community and industry. The Department for Environment and Water is the flood hazard leader in South Australia.

In 2019, the SEMC endorsed the paper *Priorities for Improved Flood Management in South Australia*, which identifies four priority areas for improvement:

- understanding flood risk
- accountable decisions and clarity in roles and responsibilities
- improved integration of flood management with other areas of land and water management
- enhanced investment in flood management.

Flooding can have significant economic, social and environmental impacts. Factors such as urban infill, new developments on floodplains, more intense rainfall events and rising sea levels are leading to an increasing risk of flood impacts and compounding natural disasters in South Australia.

The state government is responding to these flood management risks in several ways, for example:

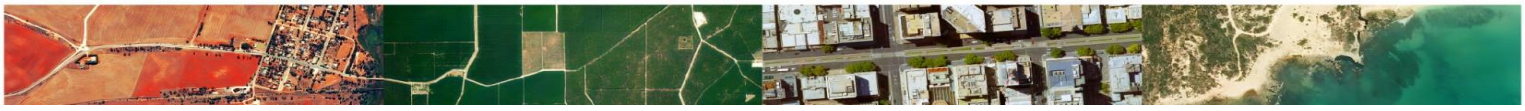
- investing $9 million in Gawler River flood mitigation projects
- investing $7 million in the Patawalonga Lake system gates
- investing $3 million for flood hazard mapping and policies in the Planning and Design Code
- implementing SEMC-endorsed position papers to improve levee bank and dam safety management
- investing in and managing the flood warning infrastructure network through optimisation, targeted additions and improvements to water level and rainfall gauges and the clarification of roles and responsibilities for existing gauges
- developing flash flood forecasting and warning services and improving the riverine flood forecasting and warning services for the River Torrens and Gawler River.

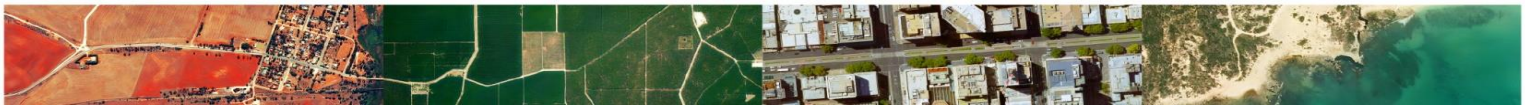
As the flood hazard leader, the Department for Environment and Water will continue to work with other state government agencies, local government, industry, community and other partners to deliver on existing work and focus on future priorities to reduce risks and improve overall flood management in South Australia.

John Schutz

Chief Executive
Department for Environment and Water

Date: 4 November 2021





4. REVIEW

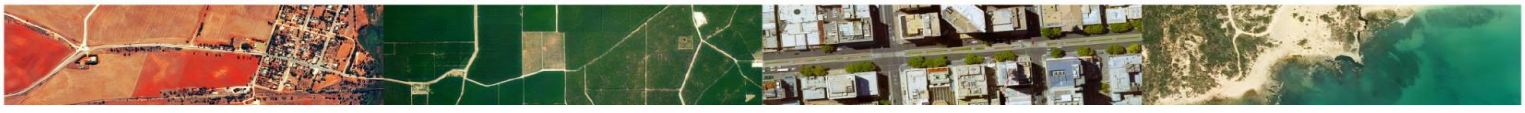
Part 4 of the SEMP requires hazard plans to be reviewed and updated at least once every two years.

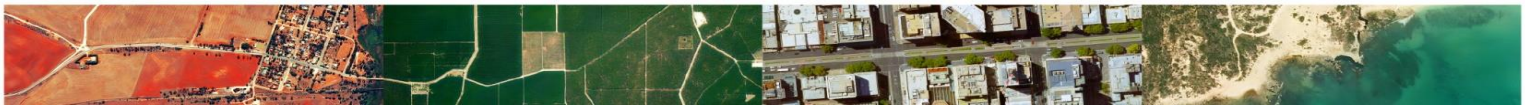
This Flood Hazard Plan was approved in 4 November 2021.

The plan is to be reviewed and updated prior to 4 November 2023.

The review process will consider progress on priority areas and actions outlined in section 10, new information on flood hazard and risk in South Australia, improvements in flood intelligence and flood warnings as well as any lessons learnt from exercises and flood incidents during the period 2021-2023.

The Flood Management Advisory Group (see section 9.1.1) will keep the progress on priority areas and actions under review as part of its work plan.





5. FLOOD DEFINITIONS AND IMPACTS

This section provides a definition of flood for the purpose of this plan (Section 5.1) and discusses types of flooding (Section 5.2), timing of flooding (Section 5.3) and potential impacts (Section 5.4).

5.1. DEFINITION

Flood is defined as:

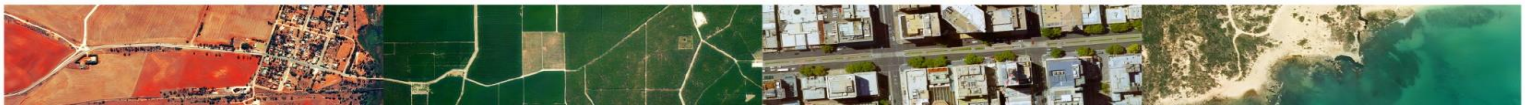
the covering of normally dry land by water:

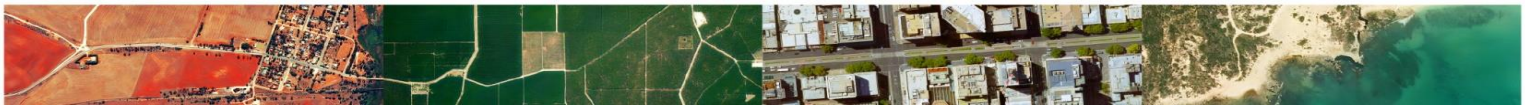
- *that has escaped or been released from the normal confines of*
  - *any lake, river, creek or other natural water course, whether or not altered or modified*
  - *any reservoir, canal or dam*
  - *coastal or marine waters on to land*
  - *groundwater aquifers*
  - *pipes, dams, levees or other infrastructure due to structural failure, operations, malfunction, accident or other reasons*
- *flowing overland*
  - *towards a watercourse, lake, coast/marine water or other water body, and/or*
  - *from a watercourse or drain.*

5.2. TYPES OF FLOODING

The main types of flooding are:

- Riverine flooding – caused by prolonged or severe rain in the upper reaches of the catchment of a watercourse. Floodwaters travel through the channel, resulting in flooding where the volume of water is too great for the size of the channel and the water breaks out. Riverine flooding can occur very soon after rain in small catchments (within hours), but in large catchments (such as the Murray–Darling Basin) floods can take many weeks to travel down a river.
- Flash flooding – caused by high intensity storm events. Flash floods can occur very quickly (in less than six hours and often considerably less time) and can generate fast-moving water. They occur in small catchments that respond quickly to rainfall. In urban areas, flash flooding is characterised by overland flows and ponding of water. As there is little opportunity to warn and prepare people, flash flooding can be very destructive.
- Infrastructure failure flooding – caused by the failure of infrastructure that controls, conveys or stores water, such as pipes, pumps, dams or levees.
- Coastal flooding – caused by elevated sea levels due to tidal and/or wind-driven events, including storm surges in open coastal or estuarine waterways. This type of flooding is relatively uncommon in South Australia but may occur at the same time as—or soon after—riverine or flash flooding from the same storm weather system. Future sea level rise because of climate change may increase the frequency and severity of coastal flooding.
- Groundwater flooding – caused by groundwater emerging at the surface. This can be caused by aquifers being recharged until they are full (by persistent rainfall and/or other recharge processes,





such as managed aquifer recharge) or by high river levels or elevated sea levels driving water through near-surface deposits.

- Managed flooding for environmental outcomes – caused by environmental flow releases and the operation of wetland regulators, weirs or other infrastructure to create managed flooding for environmental outcomes in wetlands and floodplains.

5.3. TIMING OF FLOODING

Flooding in South Australia can occur at any time of the year following significant rainfall and/or storm surge conditions or after rainfall in upstream catchments interstate (Murray–Darling Basin, Lake Eyre Basin, Glenelg River). Flooding in the far north of South Australia can occur because of cyclone activities during summer in northern Australia.

Riverine flooding is more likely to occur in late winter and spring, when headwater catchments are saturated. Flash flooding in urban areas is less dependent on catchment saturation and season. Floods in the Murray–Darling Basin generally occur in late winter and spring and can extend into early summer due to the time it takes for water to travel from the upper slopes of the catchment through to South Australia.

Flood events occur irregularly in South Australia. **Appendix A** provides a summary of key historic flood events in South Australia.

5.4. IMPACTS AND COSTS OF FLOODING

The impacts of a flood event are a function of several characteristics of the event:

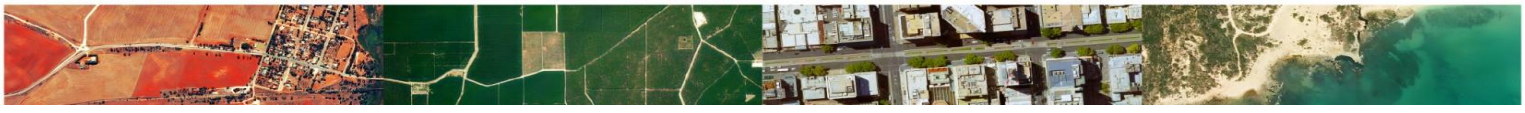
- flood type
- location and extent, relative to assets at risk from damage or loss
- timing and duration
- magnitude (resulting flood depth and velocity)
- available warning time
- community vulnerability preparedness and response.

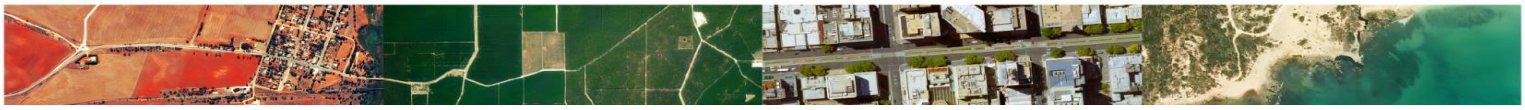
Table 1 provides the range of flood impacts under different categories.

An analysis by the Australian Business Roundtable for Disaster Resilience and Safer Communities in 2017[1] estimated that flooding in South Australia contributed to average annual damages of $26.6 million. The damage represents 13 per cent of total damages from natural hazards in South Australia, which is the third highest contribution (after bushfire and hail) over the period 1987–2016. These estimates did not include the 2016 flood damage or the 2019–2020 bushfires in South Australia. A 2021 update, released in October 2021, has taken these recent events into consideration, as well as climate change scenarios from the United Nations' Intergovernmental Panel on Climate Change (IPCC). It estimates that the total economic costs of natural disasters in South Australia between 2020 and 2060 will be $30-$32 billion and highlights the City of Charles Sturt and Port Adelaide as two regions most at risk from new disaster threats in a high emissions scenario.[2]

[1] Deloitte Access Economics (2017) *Building resilience to natural disasters in our states and territories*. Report for the Australian Business Roundtable for disaster resilience and safer communities.

[2] Deloitte Access Economics (2021) *Special report: Update to the economic cost of natural disasters in Australia*. Report for the Australian Business Roundtable for disaster resilience and safer communities.





The 2016 flood event caused an estimated $51 million worth of damage to agriculture and more than $20 million worth of damage to local government infrastructure, as estimated by Primary Industries and Regions SA (PIRSA) and the State Recovery Office.

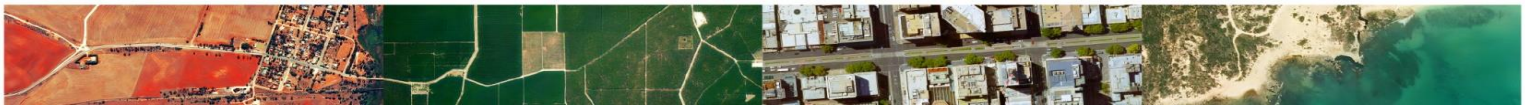
An earlier analysis of disaster losses from natural hazards in Australia over the period 1967–2013[3] estimated that the cost of significant flood events in South Australia was $2.5 billion (in 2013 dollars). This study found that floods were responsible for 50 per cent of the costs of natural hazards in South Australia and an average annual damage cost of $48 million, and that floods were the costliest natural hazard in that period.

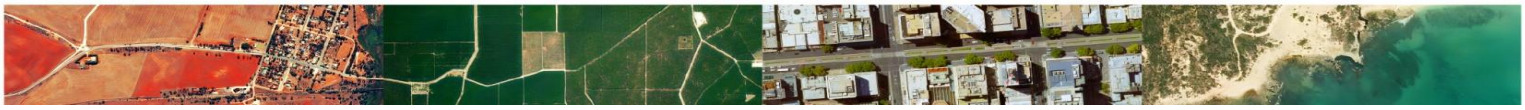
Table 1: Flood impact categories

Category	Impacts
People	• Physical injury, illness or death from fast-moving, deep or contaminated water, and secondary impacts such as mosquito-borne diseases from floodwaters • Impacts on mental health and wellbeing from any losses or impacts experienced
Economy	• Inundation and damage to, or loss of, homes and their contents, vehicles, public buildings, businesses, physical infrastructure and cultural sites • Loss of access to transportation routes, and isolation of communities • Loss of crops and livestock • Interruption to the local economy (e.g. businesses and industries)
Environment	• Injury to or death of wildlife by drowning or isolation from food sources • Physical change to watercourses, deposits of silt and refuse, reduced water quality and elevated risk of erosion • Loss of or damage to native vegetation • Damage to soils • Impacts on groundwater
Public administration	• Disruption to utilities and government services • Disruption to communication networks
Social setting	• Disruption to community (sporting and cultural events) • Damage to culturally and socially significant sites

A significant portion of the total economic cost is in relief and recovery expenditure by Australian and state governments. Currently, the main mechanism for recovery support is the Natural Disaster Relief and Recovery Arrangements (NDRRA) – a cost sharing approach to manage the individual, community recovery costs after large disasters. Much of this funding is for restoring essential public infrastructure. In addition, Australian Government Disaster Recovery Payments, delivered through Centrelink, provide emergency

[3] Handmer J, Ladds M, and Magee L (2016) *Disaster losses from natural hazards in Australia, 1967-2013*. RMIT University.



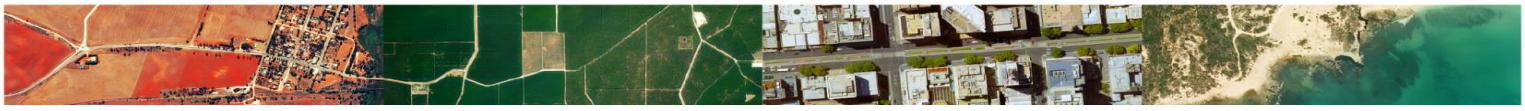


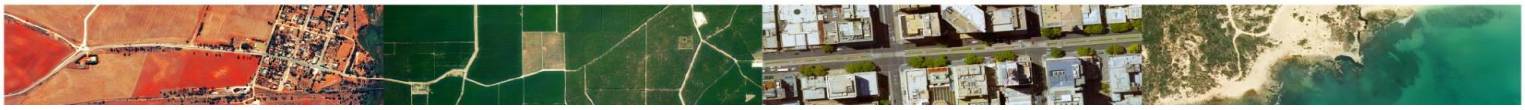
assistance to those in need.[4] While floods represent a significant portion of the costs of natural disasters in South Australia, the scale of the flood events are rarely large enough to trigger recovery support from the NDRRA.

Within South Australia, the Local Government Disaster Recovery Assistance Arrangements[5] outlines the arrangements for local councils to apply for funding from the state government to assist with managing the costs of disaster recovery activities following a natural disaster.

[4] Deloitte Access Economics (2017) *Building resilience to natural disasters in our states and territories*. Report for the Australian Business Roundtable for disaster resilience and safer communities.

[5] LGDRAA-Guidelines.pdf (treasury.sa.gov.au)





6. FLOOD HAZARD AND RISK

A hazard is a source of potential harm or a situation with a potential to cause loss. In relation to this plan, the hazard is flooding, which has the potential to cause loss of life, injury and economic loss.[6] Flood risk is a combination of the likelihood of occurrence of a flood event and the consequences of that event. The flood risk varies with the frequency of exposure to the flood hazard, the severity of the hazard, and the vulnerability of communities and infrastructure to the hazard.[7] The elements of flood risk are explained in Sections 6.1 to 6.3 and the flood hazard and risk in South Australia are outlined in in Section 6.4.

6.1. FREQUENCY OF EXPOSURE

The frequency of exposure is often expressed as the chance or probability of occurrence of a flood event. The Australian Rainfall and Runoff Guide to flood estimation[8] highlights two approaches to describing probabilities of flood events:

- Annual Exceedance Probability (AEP) – the probability of an event being equalled or exceeded within a year, usually expressed as a percentage. For example, if a peak flood flow of 200 m^3/s has an AEP of 5%, it means that there is a 5% chance of a flow of 200 m^3/s or more within a given year.
- Average Recurrence Interval (ARI) – the average time period between occurrences equalling or exceeding a given value. For example, if a peak flood flow of 400 m^3/s has an ARI of '1-in-100 year', it means that, on average, a flow of 400 m^3/s will occur once every 100 years.

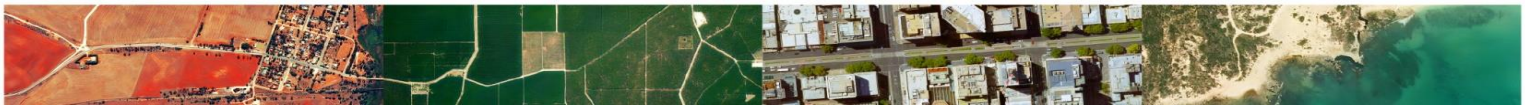
The National Emergency Risk Assessment Guidelines (NERAG)[9] use AEP to express the likelihood of a flood, expressed as a percentage chance of an event equal or greater occurring. This Flood Hazard Plan also refers to AEP rather than ARI.

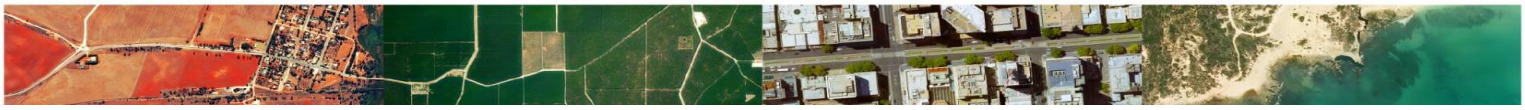
Table 2 provides a conversion between ARI and AEP.

Table 2: Conversion between AEP and ARI

ARI	AEP %
20 year	5
50 year	2
100 year	1
200 year	0.5
500 year	0.2

[6] Commonwealth of Australia (2017) *Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*.
[7] Ibid.
[8] Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M and Testoni I (Editors) (2019) *Australian Rainfall and Runoff: A Guide to Flood Estimation*.
[9] https://knowledge.aidr.org.au/media/2030/handbook-10-national-emergency-risk-assessment-guidelines.pdf





6.2. SEVERITY OF FLOOD HAZARD

The severity of flood hazard varies with each flood event and its location and is a function of the velocity, depth, rate of rise and duration of the flood. Flood hazard is usually expressed in hazard categories[10], which are important for consideration of flood response and evacuation. For more information see **Appendix B** 'Guidance specific to the flood hazard for the South Australian State Emergency Service in undertaking evacuations'.

The level of flood hazard of a 1% AEP flood event in one location can differ greatly from that of a 1% AEP flood event in another location.

For example, flooding on the River Murray in South Australia generally has a slow rate of rise (over days or weeks) and a long duration but can have a rapid decline and varying depths and velocities. The slow rate of rise allows time for response, thereby reducing the consequences of such an event. This contrasts with a catchment in which the rise is more rapid (over hours). Flooding in the Gawler River catchment can have a rapid rate of rise and varying depths and velocities. The ability of existing Gawler River flood mitigation infrastructure, including the levee banks along the river, to protect against a flood event can be uncertain, which reduces the predictability of flood behaviour. Also, because of the nature of the floodplain, floodwaters from the Gawler River can remain on the land long after the flood has receded, which increases the impacts of the flood event.

6.3. EXPOSURE AND VULNERABILITY OF THE COMMUNITY

Vulnerability depends on many factors, including housing stock; population characteristics; level of preparedness; extent of exposure; isolation risk; the flood resilience of supporting infrastructure such as schools, hospitals, roads and utilities; and emergency management arrangements (refer also to **Appendix C** 'Sectors of community vulnerable to floods').

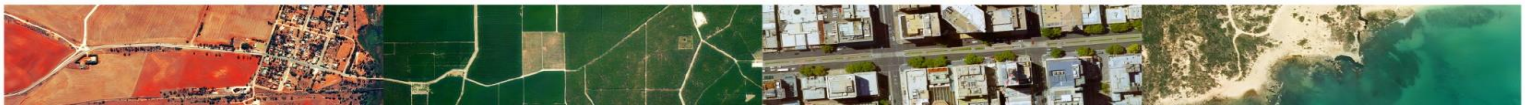
Along the River Murray, the exposure of buildings and people on the floodplain is relatively low due to longstanding development and building rules. Communities along the floodplain generally have good resilience, because they are aware of water levels and flows into South Australia and understand how to access this information. There is also good awareness of the extent of the River Murray floodplain and past flood extents. Managed inundation for environmental benefit along the River Murray is accompanied by community education and awareness programs to reduce the risk and inconvenience to the community. However, visitors to the River Murray may not have the same level of awareness and can be more vulnerable.

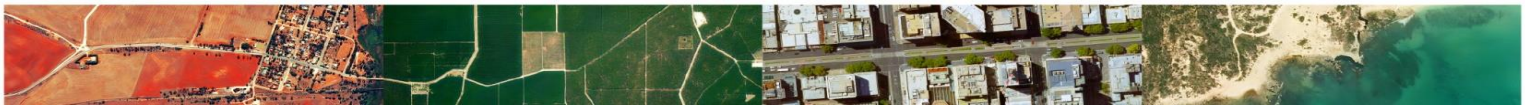
Along the Gawler River, there are many new residents and businesses with limited experience in previous flood events and these communities and businesses are, therefore, less aware and less resilient.

6.4. FLOOD HAZARD AND RISK IN SOUTH AUSTRALIA

South Australia has known areas with a high flood risk, identified using expert knowledge, historic evidence and flood studies. These high flood risk areas include the Gawler River catchment, the Brown Hill and Keswick Creeks catchment, Port Adelaide, the lower Onkaparinga River, the Numbered Creeks in the River Torrens catchment, and below Lock 1 on the River Murray.

[10] Australian Institute for Disaster Resilience (2017) *Australian Disaster Resilience Guideline 7-3: Technical flood risk management guideline: Flood hazard.* Australian Institute for Disaster Resilience.





To date, the understanding of flood hazard and flood risk in South Australia has been biased towards areas with recent flood events and areas with good flood studies and monitoring. However, areas with limited data and no recent history of flooding can still face significant risks.

For example, the 2016 flood event highlighted flood risk in towns in the Mid North of South Australia, due to a combination of exposure to flood and a lack of flood forecasting and warnings. This risk is now being addressed through the completion of more detailed flood studies for some towns and the development of a flood warning network (rainfall and flow gauges) and a flood forecasting and warning service for the Light and Wakefield Rivers.

Other areas with unknown flood risk or with outdated flood studies are being addressed through the capture of new and enhanced flood hazard mapping as part of the Flood Hazard Mapping and Assessment Project, led by the Attorney-General's Department – Planning and Land Use Services (AGD-PLUS).

The Department for Environment and Water (DEW) is investing in the development of a statewide data-driven flood risk assessment to provide a more objective assessment of flood hazard and risk.

6.4.1. 1% AEP FLOOD LAYER FOR RISK ASSESSMENT

The first step in the statewide flood hazard and risk assessment is developing an understanding of flood extent and depth across South Australia for a range of flood events. The 1% AEP flood event was chosen to pilot the risk assessment process as it is the most frequently modelled flood event and the most frequently used protection standard in land use planning and building regulations.

The 1% AEP flood layer was developed from a range of existing data sources, including detailed flood study data developed primarily by local councils (53 studies), a commercially available broad-scale mapping product (30 m x 30 m rainfall on grid), and a small number of emergency alert (EA) polygons that are used during incidents to identify the areas where warnings are provided to the community. Together, these data sources can describe the expected maximum extent and depth of a 1% AEP flood event across South Australia. The flood layer covers riverine flooding across South Australia and flash flooding where data is available.

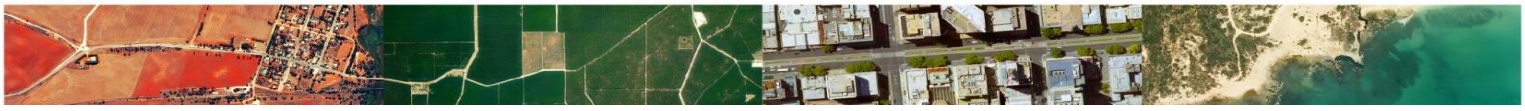
The flood study data is considered the most accurate of these data sources, followed by the EA polygons and then the broad-scale flood data.

Flood studies usually provide both flood extent and depth, as does the broad-scale mapping. Where flood studies and the EA polygons do not provide flood depth, the broad-scale mapping is used to estimate flood depth for those locations.

Expert judgement is used to select the most appropriate scenario from each flood study to represent the 1% AEP flood extent and/or depth.

There are some limitations to the 1% AEP flood layer, which will serve as a focus for future improvements:

- The flood layer shows flood extent and depth for the 1% AEP event; however, to get a complete picture of flood risk, more frequent and less frequent events should also be considered.
- The flood layer does not consider velocity, which is a key driver for risk to people and damage to property.
- The flood layer does not consider coastal inundation.



- The flood layer does not consider all flood mitigation infrastructure: where flood studies are used, stormwater infrastructure, flood detention dams and levee banks have been considered, but in the broad-scale flood data, this is not considered.
- Flash flood risk is only considered where flood studies are available, which means that flood risk in built up areas without flood studies will be underestimated.
- The flood layer cannot be used to make planning decisions as it does not factor in the climate change or future development scenarios, community preparedness or warning times.

Figure 2 outlines the data sources and process used to collate the 1% AEP flood hazard layer.

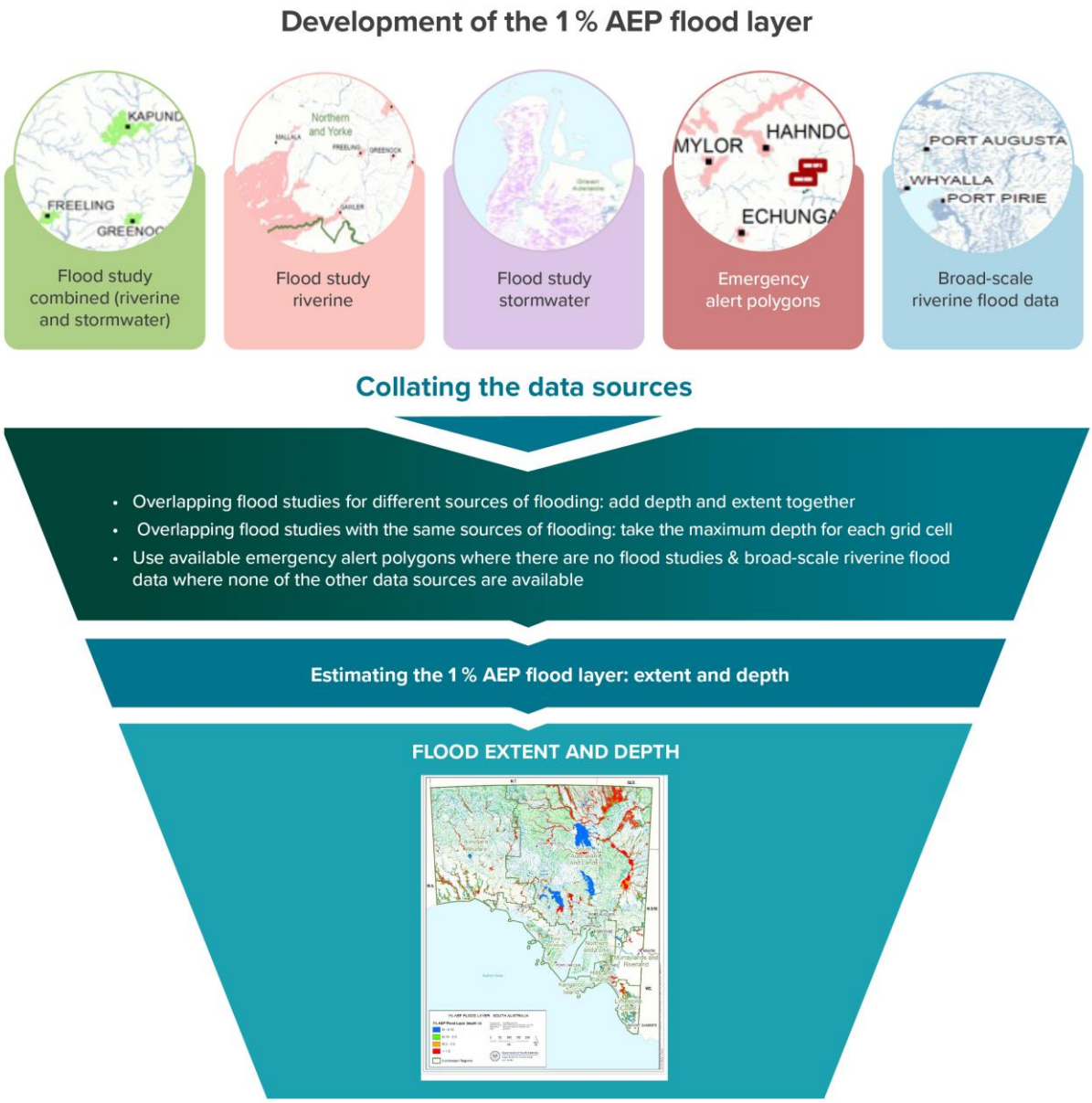
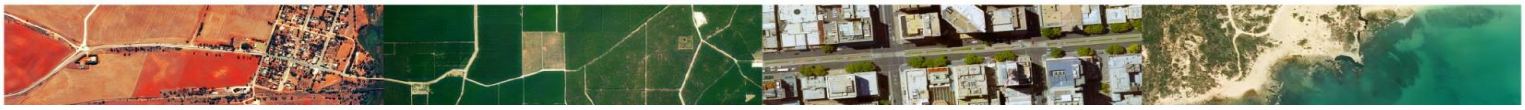


Figure 2: Process to construct a layer of extent and depth of a 1% AEP flood event

Figure 3 demonstrates the geographical distribution of the data sources used in the metropolitan Adelaide area and surrounding region. Significant parts of the metropolitan Adelaide area are covered by riverine and stormwater flood studies, several EA polygons were used, and the remainder of the region is covered by the broad-scale flood mapping.

Figure 3: Geographical distribution of data sources used to develop the layer of a 1% AEP flood event in the metropolitan Adelaide area and surrounding regions

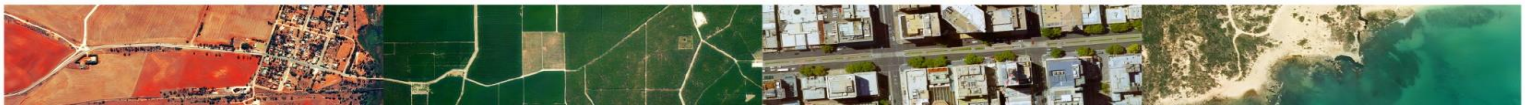


The depth information in the flood hazard layer is grouped into four categories relating to on-ground impacts, as outlined in Table 3.

Table 3: Depth categories and related rationale

Depth category	Rationale
0–150 mm	For roads: unsafe to drive in flood waters For property: over-floor flooding unlikely
150–500 mm	For roads: not trafficable by most vehicles, as advised by authorities For property: over-floor flooding likely to be occurring, power points may be inundated, impacts may be reduced with sand-bagging
500 mm – 1 m	For roads: not trafficable by any vehicles For property: approximate depth of still water unsafe for children and elderly, power points inundated, unlikely to be managed with sand-bagging
>1 m	For property: approximate depth of still water unsafe for all people

Figure 4 provides the statewide 1% AEP flood and extent layer separated into the depth categories outlined in Table 3. Figure 5 provides the same information for the metropolitan Adelaide area and surrounding regions and Figure 6 shows an example of the depth and extent layer for the Town of Gawler.



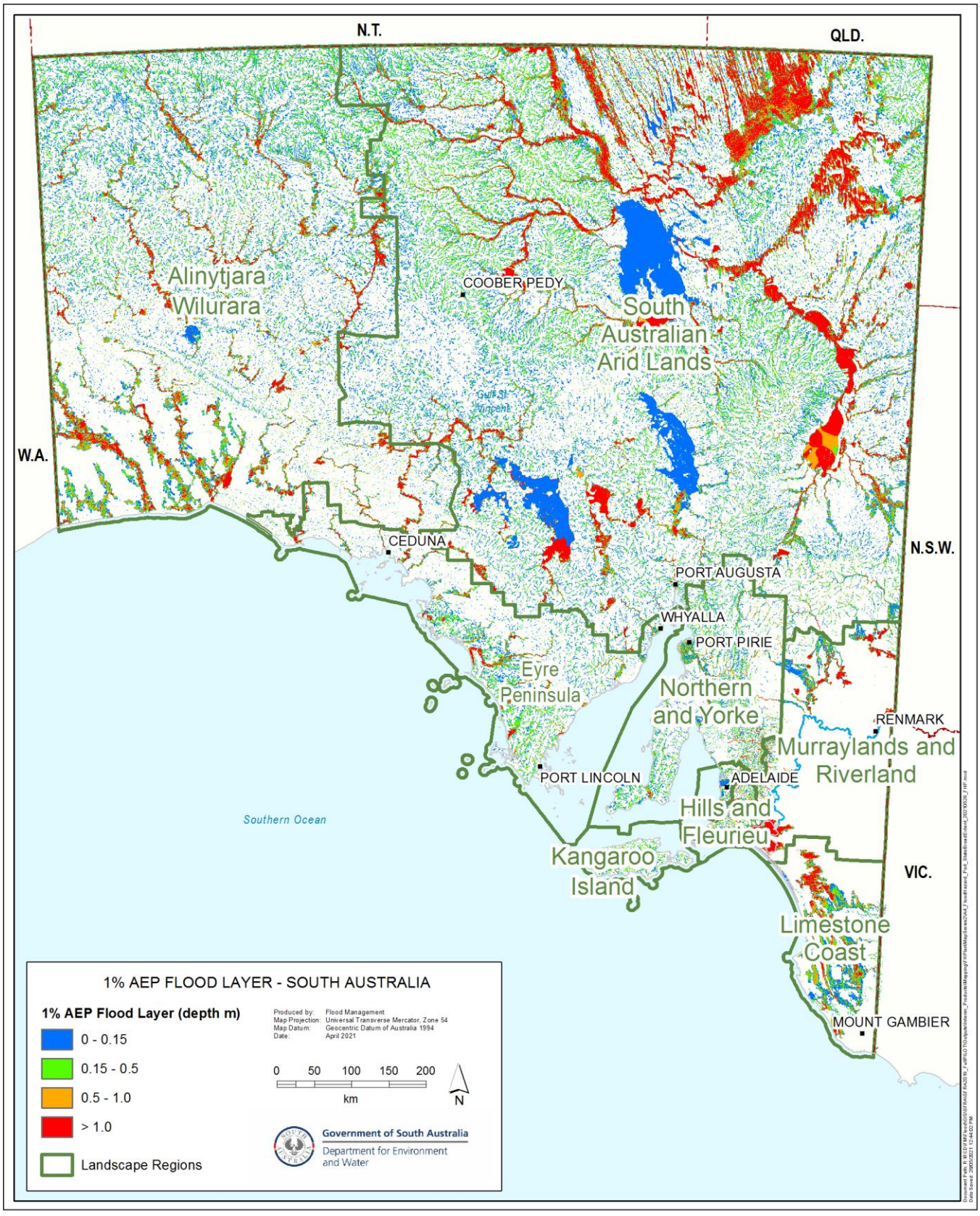


Figure 4: Extent and depth of a 1% AEP flood event - statewide

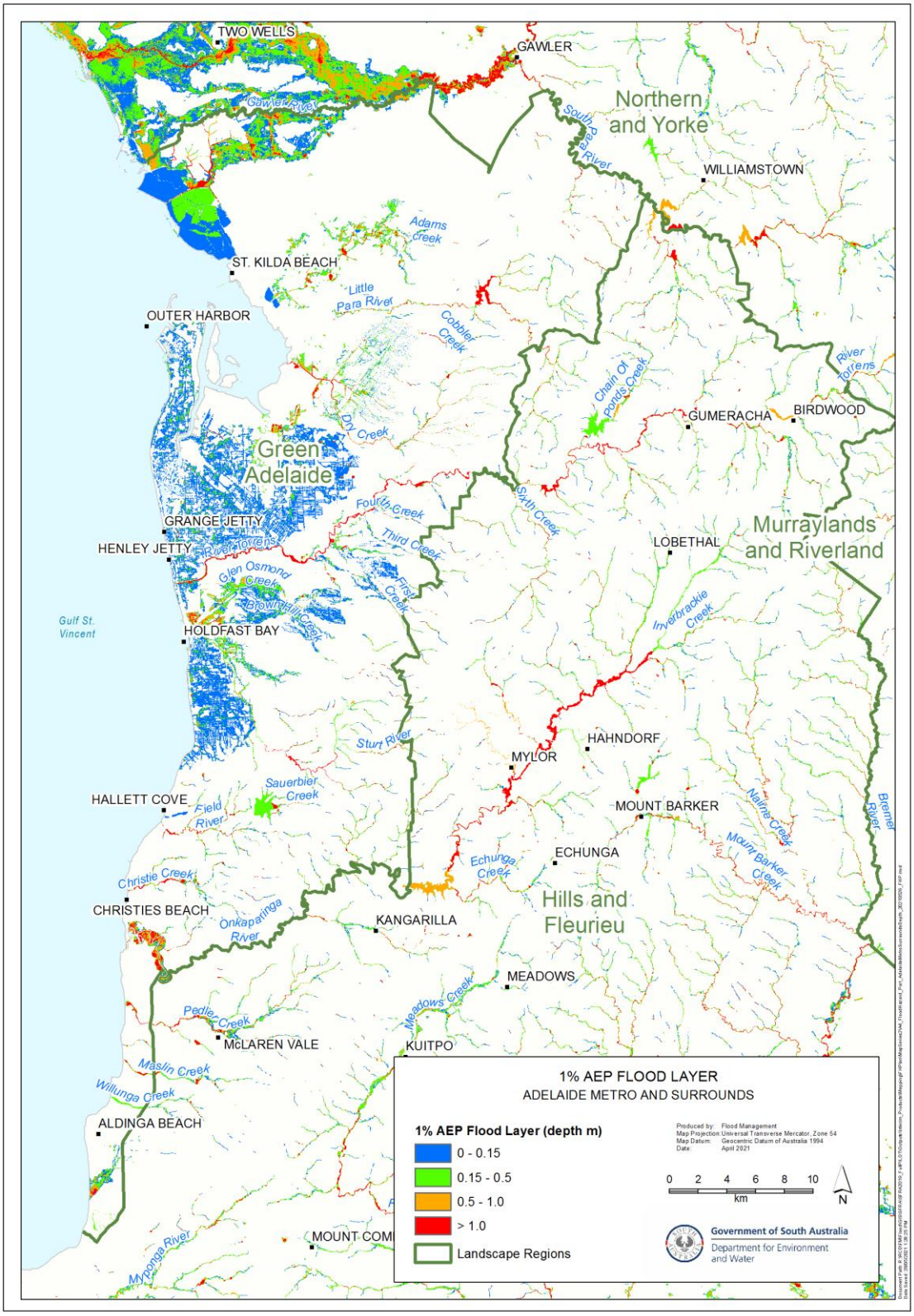


Figure 5: Extent and depth of a 1% AEP flood event - the metropolitan Adelaide area and surrounding regions

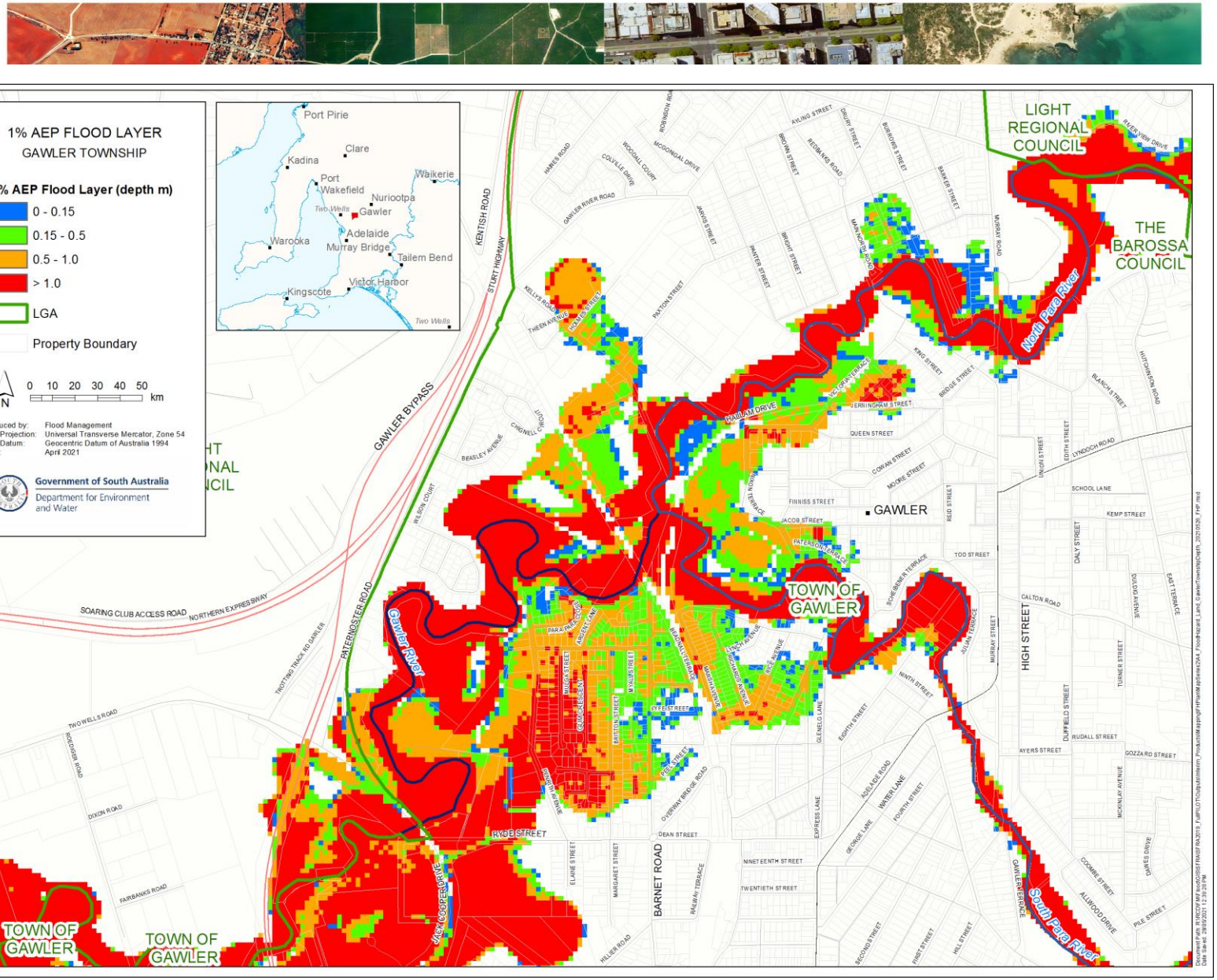
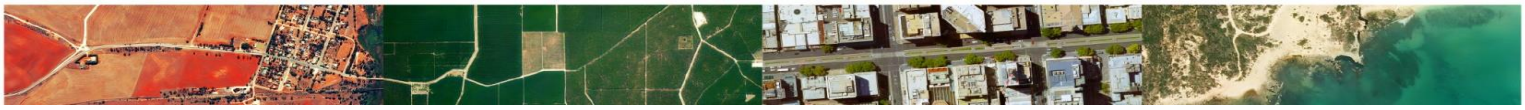


Figure 6: Extent and depth of 1% AEP flood event - Town of Gawler



6.4.2. INDICATIVE RISK OF A 1% AEP FLOOD EVENT

To provide an indication of actual flood risk, the 1% AEP flood depth and extent layer must be combined with information about exposure, including exposure of buildings, assets and people.

The National Emergency Risk Assessment Guidelines (NERAG)[11] provide an emergency-related risk assessment method that is consistent with Australian Standard *AS/NZS ISO 31000:2009 Risk management – principles and guidelines* and is applicable for all hazards. The primary objective of NERAG is to enable the consistent application of emergency-related risk assessment practices, to enable comparison and prioritisation of risks at a range of scales throughout Australia.

NERAG outlines the following consequence categories:

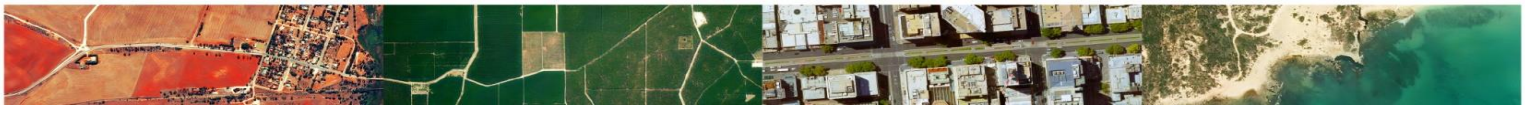
- death of, or injury or illness to, people
- loss in economic activity and/or asset value and/or a negative effect on important industries in the economy
- loss of species and/or landscapes and/or environmental values
- loss or destruction of community wellbeing and/or loss or destruction of culturally important objects and activities in the social setting
- inability of governing bodies to deliver their core functions.

To obtain an initial indication of the 1% AEP flood exposure, the flood extent and depth layer was combined with layers of buildings, roads and agricultural production areas, to provide an indication of the number and type of buildings, roads and agricultural areas impacted by the 1% AEP flood event.

The residential buildings impacted are combined with Average Household Size data from the Australian Bureau of Statistics to provide an indication of the number of people impacted. The 2016 census data displays the number of people usually resident in occupied private dwellings and does not account for the fact that people may be impacted at other locations such as work, school, hospitals or nursing homes.

Table 4 provides a summary of the indicative 1% AEP flood exposure in South Australia.

[11] https://knowledge.aidr.org.au/resources/handbook-national-emergency-risk-assessment-guidelines/



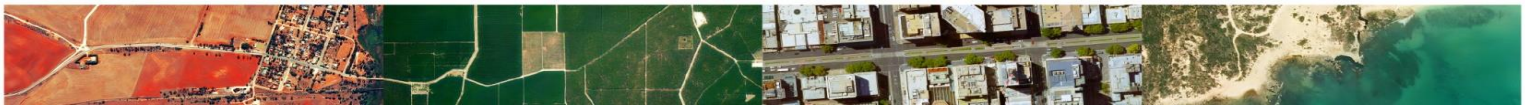


Table 4: Indicative 1% AEP flood exposure in South Australia

Assets/people	Indicative exposure across South Australia	Key observations
Buildings	69,000	• 39,800 buildings experience less than 0.15 metres of flood depth, with minimal impact expected • Impacts on buildings in metropolitan Adelaide are mostly minimal • Impacts on buildings in the Mid North, Riverland and Adelaide Hills are generally more significant, with higher flood depth categories
People	152,500	• 42% of people experience impacts with flood depths above 0.15 metres, with over-floor flooding likely
Roads	27,000 kilometres	• 30% of roads impacted are in the far north of South Australia
Agriculture	1 million hectares	• Excludes pastoral lands, where an estimated 6 million hectares would be impacted • An estimated 470,000 hectares in the South East, but further analysis of impact of the drainage system is required

The information in Table 4 provides a first indication of exposure and risk resulting from a 1% AEP flood event across South Australia. To determine a more accurate description of the risk of a 1% AEP flood, it is essential to consider:

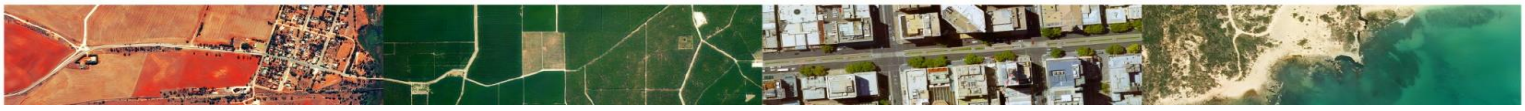
- economic cost of damage to buildings (in dollar values)
- impacts on services
- economic cost of impacts on agriculture and infrastructure (such as roads, railway lines, power and telecommunications)
- environmental impact of flooding and risk of pollution
- social and cultural tangible damages
- intangible damages.

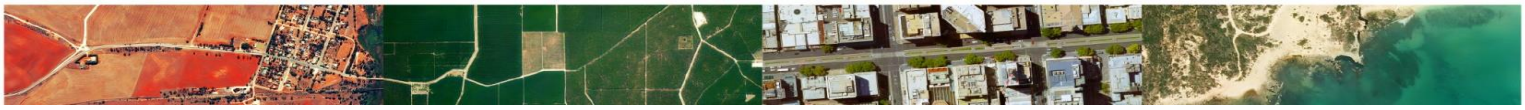
Further analysis and collection of South Australian data on these elements is required to provide a full risk assessment.

6.5. COASTAL FLOOD RISK

Coastal flood risk is determined by factors such as elevation, currents, tides, weather events and interactions with riverine or flash flood events.

A common first-step modelling approach to identify areas potentially exposed and at risk of coastal flooding is to undertake ‘bathtub’ modelling, which simply assumes that all ground levels that are lower





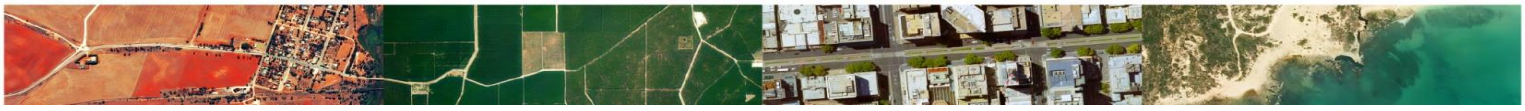
than a prescribed elevation will be inundated. However, this approach does not factor in the dynamic components that can affect the extent of sea level inundation, including shoreline erosion and sediment movement, and ocean and meteorological processes such as wave run-up and storm surge. Recent LIDAR flood mapping for Eyre Peninsula and the South East is an example of bathtub modelling and is available on the Coastal Flood Mapping viewer.[12]

The bathtub modelling shows coastal areas impacted under mean high water (spring tide) conditions, normal astronomic tidal condition and a 1% AEP storm event. For each of these conditions, current and future scenarios (including those for 2050 and 2100) have been modelled. In accordance with state government policy, a sea level increase of 0.3 metres has been assumed for the 2050 scenario and 1.0 metres for the 2100 scenario.

Figure 7 shows coastal inundation in the South East near Robe, including current and future (2050) mean high water conditions.

Figure 8 shows coastal inundation in the same region, including current and future (2050) scenarios for a 1% AEP storm event.

[12] https://data.environment.sa.gov.au/Coast-and-Marine/Data-Systems/Coastal-Flood-Mapping-Viewer/Pages/default.aspx



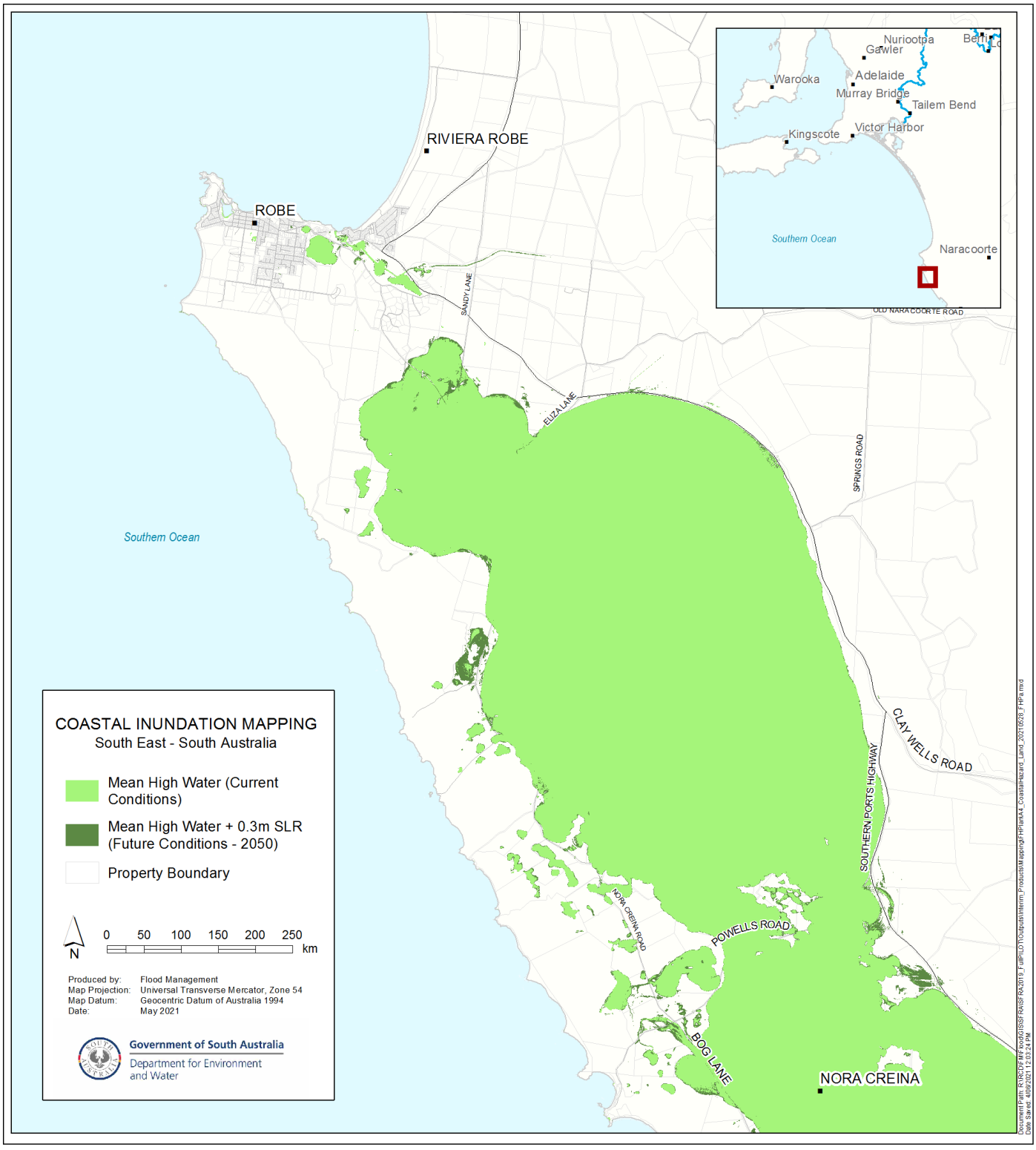


Figure 7: Coastal inundation including current and future (2050) scenarios at mean high water in an area near Robe, South East of South Australia

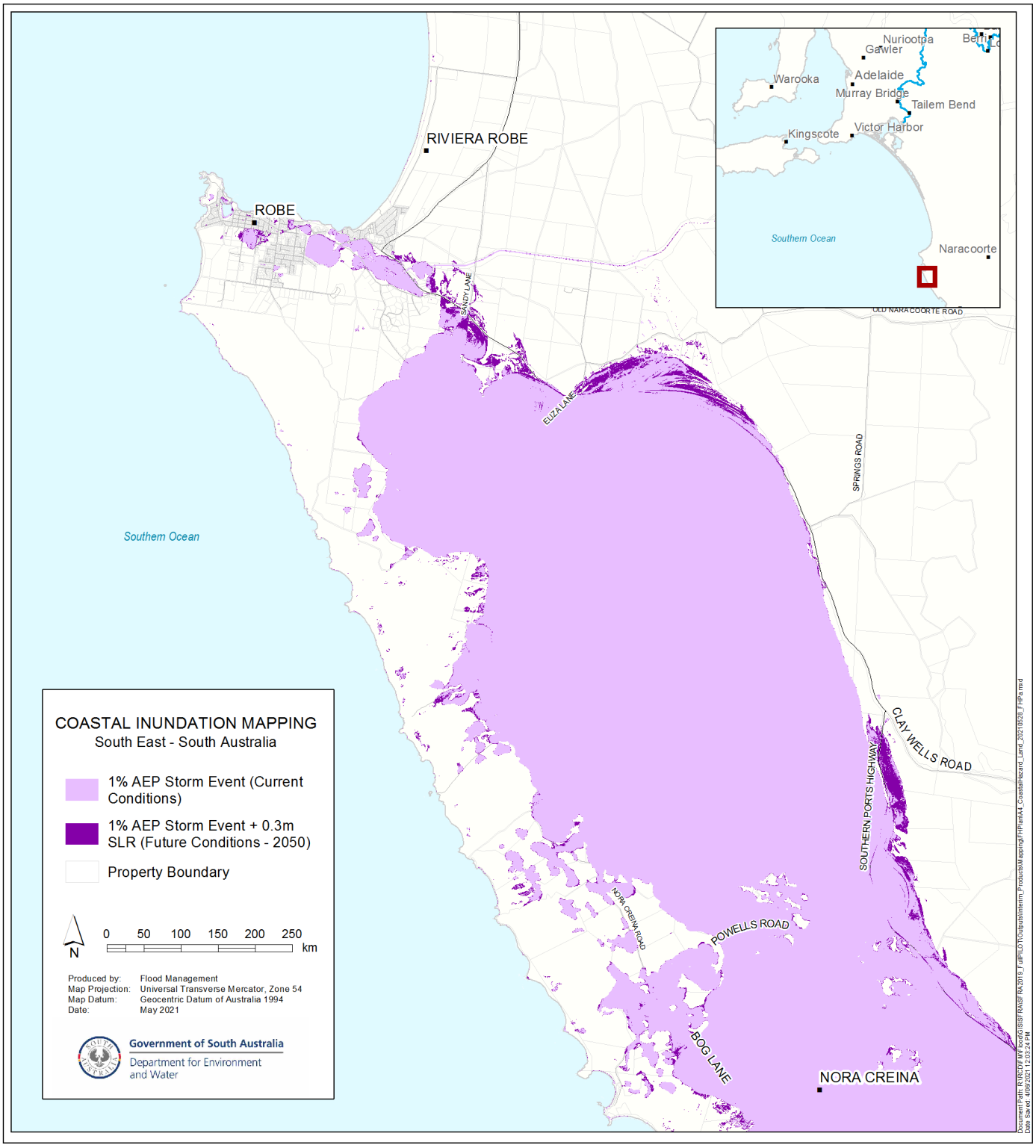
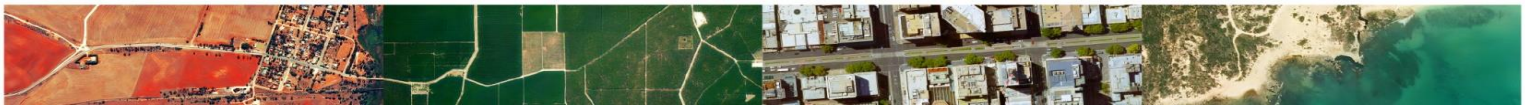


Figure 8: Coastal inundation including current and future (2050) scenarios of a 1% AEP storm event in an area near Robe, South East of South Australia



6.6. FUTURE FLOOD RISK

There are many factors that can contribute to future flood risk, as outlined in Sections 6.6.1 to 6.6.4.

6.6.1. URBAN INFILL

Most of the metropolitan Adelaide area is a floodplain. Infill development is the largest provider of new housing in this area, with a net increase of about 2500 residential dwellings per year between 2012 and 2018, which is around 40 per cent of the metropolitan housing supply growth.

Infill development increases housing density and can create allotments with up to 90 per cent hard surfaces, which is twice the area of hard surfaces for which most existing minor stormwater drainage networks were designed and built.

Increasing the area of hard surfaces increases peak stormwater flows and the frequency and volume of runoff, thereby increasing the potential for flood damage.

6.6.2. GREENFIELDS DEVELOPMENT

Some of the major new urban development is occurring on floodplains and in coastal areas. On a floodplain, a residual flood risk will always be present. Requirements in the Planning and Design Code ensure that new development considers flood risk, such as requiring higher floor levels or flood-free access in a defined flood event.

New greenfields development on floodplains may require additional flood management measures. These may include flood-resilient land use and building controls, flood forecasting and warning, community information, watercourse management, drainage infrastructure, flood detention, floodways and levee banks.

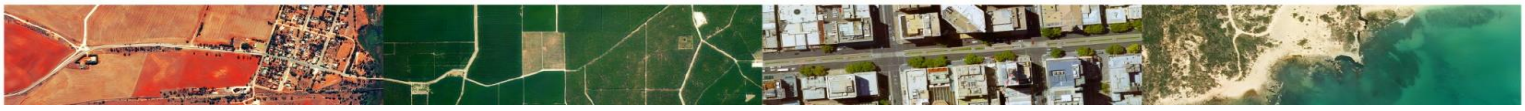
6.6.3. FLOOD MITIGATION INFRASTRUCTURE

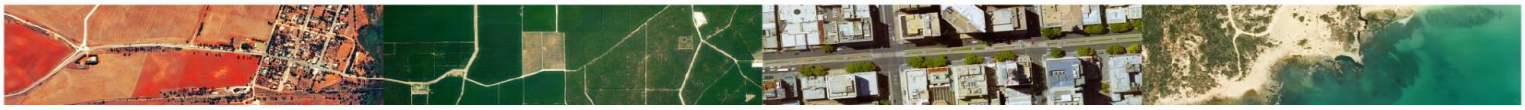
Flood mitigation infrastructure includes flood control dams, flood detention basins, stormwater infrastructure, seawalls, drainage systems and levee banks. The dependability of flood mitigation infrastructure is a function of its design, construction and maintenance. Well-designed and well-maintained flood mitigation infrastructure means that residual flood risk is reduced and flood behaviour is more predictable.

For example, SA Water sets a high standard in the maintenance of its assets. It aims to ensure its reservoir dams are fully compliant with the Australian National Committee on Large Dams guidelines and has made significant investments in the upgrade of the South Para Dam and the Kangaroo Creek Dam.

Another example of good flood mitigation infrastructure management practices is the City of Salisbury, who recently obtained funds from the National Disaster Resilience Program to complete an assessment of all of its flood detention basins and to consider where upgrades may be required.

With some infrastructure, there is a lack of clarity on the flood protection provided, due to factors such as changes in land use after construction or inadequate maintenance of assets. Further complexities around the management and reliability of flood mitigation infrastructure can arise from issues with land, waterways and asset ownership, access arrangements, and lack of clarity on roles and responsibilities for operation and maintenance.





6.6.4. CLIMATE CHANGE

The *Guide to Climate Projections for Risk Assessment and Planning in South Australia*[13] states that annual rainfall will decline across all South Australian regions but that the amount of rain falling in extreme rainfall events will increase across South Australia and the frequency of extreme rainfall events will increase. As the atmosphere warms, it holds more water vapour, with a rate of increase of approximately 7 per cent more water holding capacity per degree Celsius of warming. This relationship has been shown to translate into a similar or greater percentage increase in rainfall intensity; therefore, for heavy rain events, total rainfall could increase by around 7 per cent or more per degree of warming.[14] Some studies have found that the occurrence and magnitude of riverine floods are mostly decreasing in Australia despite increasing extreme storm events, as a result of lower soil moisture linked to declining annual rainfall.[15] However, the risk of flash flood events is likely to increase with the increased frequency and intensity of extreme rainfall events.

When these rainfall changes are combined with rising sea levels, the risks of flooding in low-lying coastal areas are further increased. This will increase flood impacts on buildings, people, infrastructure and communities and can also cause coastal erosion and loss of beaches.[16]

The probability of seawater inundation of low-lying areas at times of seasonal high tides and during coastal storm surges significantly increases with even a relatively small rise in sea level. Average sea level rise around the Australian coastline is projected to be 26–55 cm by 2090 relative to 1986–2005 under a very low emissions scenario. Under a very high emissions scenario, sea level is projected to rise by 45–82 cm. A much greater sea level rise is possible, depending on the dynamics of continental ice such as Antarctic ice sheets.[17]

The 2014 *Stormwater Management Plan – Coastal Catchments between Glenelg and Marino*[18] showed that sea level rise combined with urban stormwater flows from upstream catchments could increase flood risk associated with the Patawalonga Lake system.

Other urban coastal communities face similar challenges. For example, flood modelling and impact studies have been undertaken by the City of Port Adelaide-Enfield, with support from the Australian and South Australian governments.[19]

Climate change also increases the risks of compounding natural disasters, such as bushfires followed by floods, or floods combined with a storm surge.

Regional Climate Change Adaptation Plans[20] have been developed across South Australia and regional partnerships have been established to deliver local adaptation and mitigation projects. Consideration of changes in flood risk will be an important element for many regions.

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[13] https://data.environment.sa.gov.au/Climate/Science-and-Knowledge/Pages/default.aspx

[14] Guerreiro SB, Fowler HJ, Barbero R, Westra S, Lenderink G, Blenkinsop S, Lewis E and Li, XF (2018) Detection of continental-scale intensification of hourly rainfall extremes. *Nature Climate Change* Vol 8.

[15] Wasko C and Nathan R (2019) Influence of changes in rainfall and soil moisture on trends in flooding. *Journal of Hydrology*.

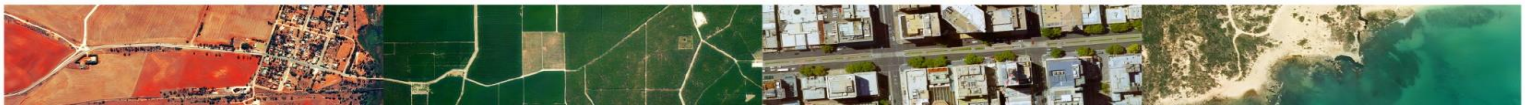
[16] Climate and Disaster Resilience: Technical Reports (2020) CSIRO, Australia.

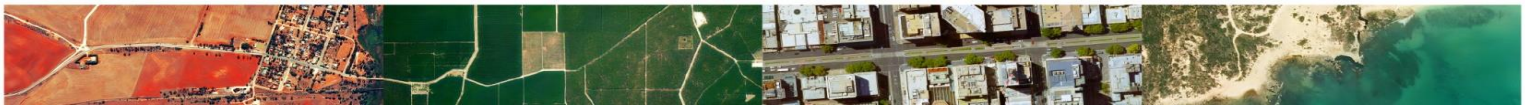
[17] Ibid.

[18] Stormwater Management Plan – Coastal Catchments between Glenelg and Marino (2014).

[19] https://www.adaptwest.com.au/sites/adaptwest/media/pdf/western-adelaide-region-coastal-inundation-modelling---phase-3-report---final.pdf

[20] https://www.environment.sa.gov.au/topics/climate-change/programs-and-initiatives/adapting-to-climate-change/regional-adaptation-plans





7. FLOOD WARNING AND INTELLIGENCE

7.1. FLOOD WARNING

The purpose of flood warning is to provide advice about impending flooding events so that people and organisations can act to protect their own safety and the safety of others. Individuals who can take appropriate personal actions to avoid or minimise flood impacts can also reduce the burden on response agencies.

Flood warning relies on the ability to detect environmental conditions, predict future events with confidence, and rapidly disseminate information that is easy to understand, interpret and apply. Timely and targeted flood warning is an effective flood mitigation tool. Each element of a Total Flood Warning System (*Australian Emergency Management Manual 21, Flood Warning*[21]) must be effective and timely (refer to Table 5).

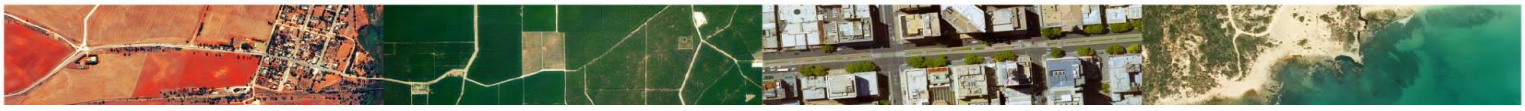
Table 5: Components of a Total Flood Warning System (source: *Australian Emergency Management Manual 21, Flood Warning*)

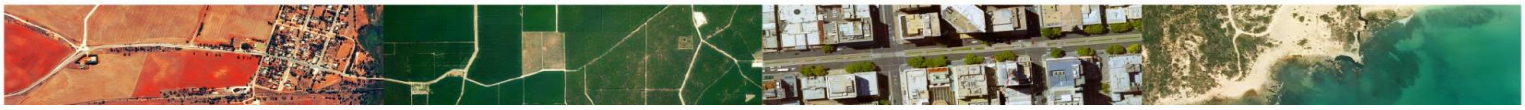
1. Monitoring and prediction	Detecting environmental conditions that lead to flooding, and predicting river levels during the flood
2. Interpretation	Identifying in advance the impacts of the predicted flood levels on communities at risk
3. Message construction	Devising the content of the message which will warn people of impending flooding
4. Communication	Disseminating warning information in a timely fashion to people and organisations likely to be affected by the flood
5. Protective behaviour	Generating appropriate and timely actions and behaviours from the agencies involved and from the threatened community
6. Review	Examining the various aspects of the system with a view to improving its performance

7.1.1. FLOOD WARNING SERVICES

Under the SEMP, the South Australian State Emergency Service (SASES), as the control agency for flood emergency incidents, is responsible for ensuring that the public is adequately informed and warned of actual or potential flooding.

[21] https://www.aidr.org.au/publications/manual-collection/





The role of the Bureau of Meteorology (the Bureau) in flood forecasting and warning is set out in a Service Level Specification for each state, which describes the services provided by the Bureau in detail.[22] In South Australia, the Bureau provides Flood Watches and Flood Warnings for **riverine** flooding for systems with adequate rainfall and river gauge networks.

SASES provides flood warnings for all other sources of flooding and refers to the Bureau's warnings for riverine flooding in its advice to the public.

The types of flood prediction provided by the Bureau are outlined in Table 6. The flood prediction is more precise when more data is available from water and rainfall monitoring sites in South Australia.

Table 6: Types of flood prediction provided by the Bureau of Meteorology

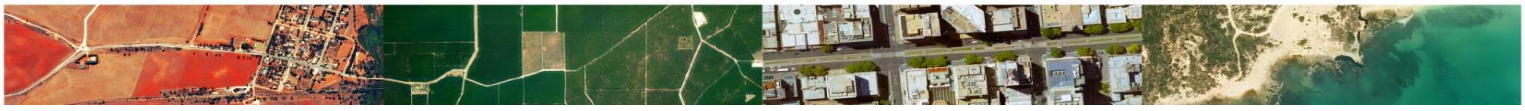
Types of prediction	Target prediction accuracy	
	Flood magnitude	Flood timing
Quantitative	Expected peak height (typical)	Within 3–6 hours of peak (typical)
Qualitative	Class of flood	Range of times (6, 12 or 24 hour blocks)
Generalised	Trend only (rising or falling)	Range of times (24 hour blocks)

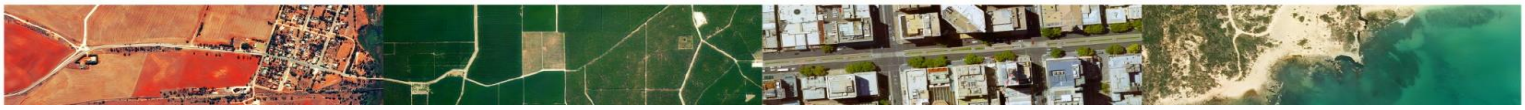
For flood warning services, it is important to determine the water level that causes certain impacts both upstream and downstream of the monitoring location. The determination of these water levels is referred to as flood classification. These levels are determined based on standard descriptions of flood effects, historical data and relevant local information. Table 7 provides the descriptions used by the Bureau for minor, moderate and major flood levels in qualitative warnings. The descriptions relate to the impact of a flood, not necessarily to the area flooded.

Table 7: Descriptions of minor, moderate and major flooding

Minor flood	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 flood	As for minor flooding but 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 flood	As for moderate flooding but 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.

[22] Bureau of Meteorology (2020) *Service Level Specification for Flood Forecasting and Warning Services for South Australia—Version 3.3*. Commonwealth of Australia, Canberra.





Other more specific trigger levels may be identified for a monitoring location, such as the level at which the water leaves the banks of a river or floods a road crossing. **Appendix D** sets out the roles and responsibilities in developing flood classification levels for river height gauges.

The Bureau also issues storm surge warnings that indicate when coastal water levels will be above normal tidal levels. These are used in coastal areas such as Port Adelaide and Glenelg and inform local councils, DEW, SASES and the community of the need to undertake coastal flooding preparedness activities.

7.1.2. FLASH FLOOD WARNING PROCESS

Catchments that respond quickly to rainfall (i.e. rain-to-flood times less than six hours) are categorised as flash flood catchments. The responsibility for providing flood forecasting and warning for flash flood catchments lies with SASES and DEW, in partnership with local councils. The Bureau does not provide a flood warning service in these catchments. The Bureau may mention 'localised heavy falls which may cause flooding' as part of its Severe Weather and Severe Thunderstorm Warnings. The Bureau also supports an alerting system to some councils and DEW for rainfall rate and river height thresholds.

The FloodMon™ web-based flood intelligence system that provides near real-time rainfall and stream level data can be used to provide timely flood warnings in flash flood catchments. The flash flood forecasting component of FloodMon™ is being used successfully in various locations in Queensland. The tool identifies areas that are likely to be impacted by flash flooding and sends alerts to relevant people in advance. The FloodMon™ has not yet been customised in South Australia, although a pilot is underway in the Pedler Creek catchment to test the flash flood forecasting capability of the FloodMon™ system in this state.

7.1.3. WARNING DISSEMINATION

Flood warnings prior to a flood event are distributed to the community via:

- free-to-air broadcast media (radio and television)
- public internet, including SASES and Alert SA websites
- social media.

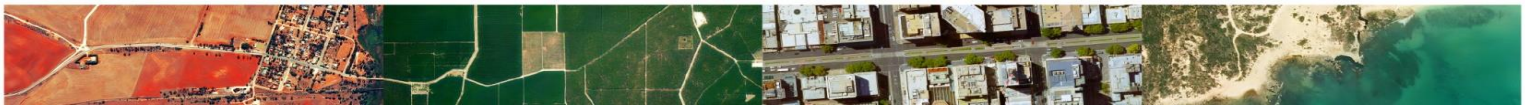
The Bureau also provides advice directly to SASES. Following the issuing of any warning products, SASES State Headquarters will maintain regular contact with the Bureau until the potential flood event has eventuated or passed.

Specific arrangements are in place for SASES as the control agency relating to issuing public flood warnings during flood events, as guided by the SEMP.

7.2. FLOOD INTELLIGENCE

Flood intelligence refers to the totality of data and information that describes the behaviour of a flood and its likely effects upon a community. Flood intelligence is especially important in identifying areas of potential:

- inundation (leading to a need for evacuation, property protection and/or rescue)
- isolation (creating risk to life and the need for resupply and/or rescue).



Flood intelligence is gathered before, during and after flood events from:

- flood studies
- historical observations and records
- real-time observations
- damage assessments and surveys.

Flood intelligence is used to facilitate operational decision-making and the provision of warnings and information to agencies and the public.

Flood studies are mostly commissioned by local councils as part of the development of stormwater management plans (SMPs). DEW and the SASES collate historical observations and records from previous flood events.

The primary source of real-time information about potential flood events is through weather forecasts by the Bureau, which has an arrangement with the Government of South Australia to have an embedded meteorologist available to SASES to provide predictions and warnings for weather-related emergencies (including floods, storms and hailstorms).

DEW also has an agreement with SASES to provide hydrology support to the State Control Centre during activations. DEW hydrologists assist SASES staff to gather, validate, interpret and record flood intelligence and to provide advice to SASES about likely impacts based on observed water levels, rainfall and the Bureau's warnings. Mapping support is provided by DEW to assist in interpreting and displaying flood mapping and intelligence information during incidents.

SASES and DEW are developing catchment summaries, with information such as:

- a locality map and flood maps
- type of flooding risk
- key impact areas
- historical events
- key infrastructure impacted
- major roads that would be cut
- known triggers or indicators of impact
- known breakout points
- gauge locations and key ground observation points.

Organising and maintaining flood intelligence is an ongoing operation that maximises available data and incorporates new data or modelling information as it becomes available.

As flood hazard leader, DEW collects and manages flood study data to inform the community of their potential flood risk and as a source of intelligence during flood events. Flood study data is often provided by local councils under a data sharing arrangement. The data requires ongoing maintenance to ensure currency and applicability in flood-related projects across South Australia.

A flood information management plan is being developed by DEW to ensure flood study data and intelligence information is consolidated to facilitate its use in emergency management and land use planning.

7.2.1. FLOOD MONITORING

In South Australia, real-time monitoring of watercourses and rainfall is undertaken by DEW, the Bureau, landscape boards, SA Water and local councils. Flood monitoring data is collected from specific flood monitoring infrastructure and from monitoring sites installed and operated for other purposes, such as water resource management and infrastructure operations.

The Bureau has identified the monitoring sites it uses for flood warning purposes and categorised these according to the information that they provide (Table 8).

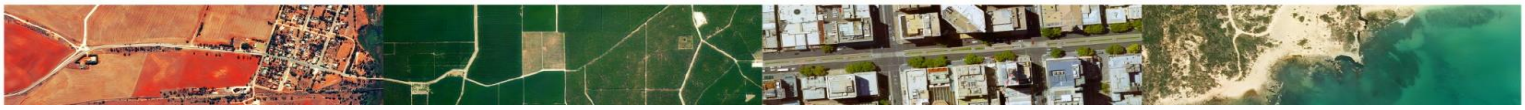
Table 8: Categories of flood monitoring locations used by the Bureau of Meteorology

Location category	Monitoring location description	Number and owner				
		Bureau of Meteorology	DEW, landscape boards	SA Water	Local government	TOTAL
Forecast	The observed water level, predicted water level and predicted flood class are provided (predictions can be quantitative or qualitative)	7	9	6	0	22
Information	Only the observed water level and predicted flood class are provided	5	13	1	7	26
Data	Only observed water level is provided	9	55	8	1	73
TOTAL		21	77	15	8	121

Further sites will be added when the Flood Forecasting and Warning Services for River Murray, Light River and Wakefield River are fully developed.

Mobile telecommunications, the internet and open-data policies have greatly improved the accessibility of hydro-meteorological data for flood warning. In addition to the monitoring sites identified by the Bureau as flood warning sites, other sources of real-time and near real-time water observation data are available.

In 2019, DEW completed a Flood Warning Infrastructure Assessment as part of the development of a National Framework for Flood Warning Infrastructure. The assessment identified several recommendations for improved management of the flood warning infrastructure network in South Australia. This included the need to develop and maintain a flood warning infrastructure plan that sets out investment priorities, time frames and cost estimates.

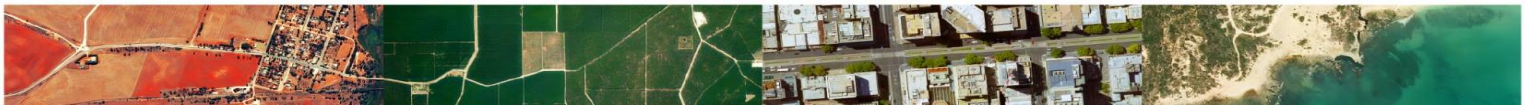


8. LEGISLATION, AGREEMENTS AND PLANS

Flood management arrangements are determined and informed by various plans, agreements and legislation. Table 9 outlines key legislation, Table 10 outlines agreements and memoranda of understanding (MoUs), and Table 11 outlines relevant plans, strategies and frameworks.

Table 9: Legislation relevant to flood management

Legislation	Relevance to flood management
Emergency Management Act 2004	Sets out emergency management arrangements in South Australia and provides for the SEMP.
Landscape South Australia Act 2019	Sets out arrangements for water resource and watercourse management and provides for approvals for construction of dams and levee banks and any other water affecting activities.
Local Government Act 1999	Outlines responsibilities of local councils to consider risks (including emergency risks) as follows: • make informed decisions (section 6) • take measures to protect their area from natural hazards (section 7) • provide infrastructure for community and for development (section 7) • assess the maintenance, replacement or development needs for infrastructure (section 122) • identify anticipated or predicted changes in any factors that make a significant contribution to the costs of the council's activities or operations (section 122). Schedule 1A establishes the SMA and sets out some of the arrangements for stormwater management.
Planning, Development and Infrastructure Act 2016	Provides for State Planning Policies (completed 2019), Regional Plans (under development), and the Planning and Design Code (completed in 2021). Construction of levee banks and dams may require approval under this Act. The Planning and Design Code includes policies for coastal areas, flood hazard overlays and policies for stormwater management and water sensitive urban design.
Coast Protection Act 1972	Establishes the Coast Protection Board, with powers to provide direction for development in coastal areas and to assess and support proposals for coast protection works.
Fire and Emergency Services Act 2005	Sets out powers for SASES in relation to management of emergencies.



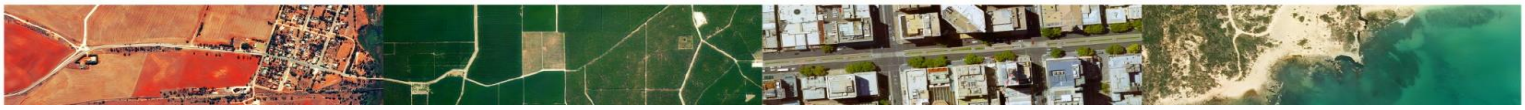
Legislation	Relevance to flood management
Water Industry Act 2012	Sets out arrangements and responsibilities for SA Water and other water service providers. Provides for independent pricing regulation and a Safety, Reliability, Maintenance and Technical Management Plan to cover all SA Water assets, including dams.
Meteorology Act 1955 **(Cwlth)**	Sets out functions of the Bureau, including the issuing of warnings of gales, storms and other weather conditions likely to endanger life or property; this includes weather conditions likely to give rise to floods or bushfires.

Table 10: Agreements and MoUs relevant to flood management

Agreement or MoU	Relevance to flood management
Intergovernmental Agreement on the Provision of Bureau of Meteorology Hazard Services to the States and Territories	Sets out the responsibilities of the Bureau for the provision of flood forecasting and warning services to the states and territories.
Agreement on stormwater management	Establishes an agreement between the State of South Australia and the Local Government Association of South Australia, setting out collaborative arrangements for stormwater management; managed by the SMA.
Memorandum of understanding between the SASES and DEW for a collaborative approach to incident management	Sets out arrangements for hydrology and mapping support to the SASES during flood incidents.
Memorandum of understanding between SA Water, SASES, DEW and the Bureau regarding the sharing of reservoir information to support flood mitigation	Outlines the agreement on, and mechanism for, data and information sharing between stakeholders and strategies to manage water levels in reservoirs, including spill management, during floods into water catchments.

Table 11: Plans, strategies and frameworks relevant to flood management

Plan or framework	Relevance to flood management
State Emergency Management Plan	Outlines emergency management arrangements and defines hazard leaders and control agencies. Outlines requirements for hazard plans.

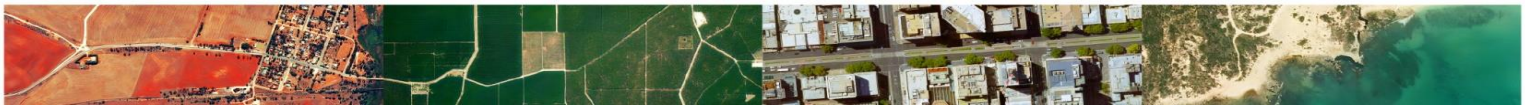


National Disaster Risk Reduction Framework 2018	Provides a national framework and priorities for disaster risk reduction. The framework for flood management outlined in this Flood Hazard Plan is aligned to this Framework.
South Australian State Emergency Service Control Agency Plan	Outlines the arrangements for SASES to undertake its responsibilities as a control agency under the SEMP.
State Flood Plan 2019	Provides strategic and operational guidance to SASES in the management of floods in the response to and management of flood events.
SA Disaster Resilience Strategy 2019–2024	Sets out key strategies to build disaster resilience in South Australia.
National Framework for Flood Warning Infrastructure 2019	Provides a principle-based roadmap for maturing Australia's flood warning infrastructure network and arrangements.
Local Government Emergency Management Framework 2019	Provides clarity and direction to the local government sector in South Australia regarding emergency management. Outlines vision, principles, and roles and responsibilities for local government in emergency management.
South Australian Government Climate Change Action Plan 2021–2025	Outlines a practical approach to help build a strong, climate smart economy, further reduce greenhouse gas emissions, and support South Australia to adapt to a changing climate. Acknowledges and sets actions on flood risk from both sea level rise and more extreme storm events.

In addition, the Australian Institute for Disaster Resilience has developed a series of handbooks and guidelines, available on the AIDR website[23], that outline national principles and practices for disaster resilience. The handbook collection:

- provides an authoritative, trusted and freely available source of knowledge about disaster resilience principles in Australia
- aligns national disaster resilience strategy and policy with practice, by guiding and supporting jurisdictions, agencies and other organisations and individuals in their implementation and adoption
- highlights and promotes the adoption of good practice in building disaster resilience in Australia
- builds interoperability between jurisdictions, agencies, the private sector, local businesses and community groups by promoting use of a common language and coordinated, nationally agreed principles.

[23] https://knowledge.aidr.org.au/collections/handbook-collection/



9. FLOOD MANAGEMENT ROLES AND RESPONSIBILITIES

Flood management in South Australia is a shared responsibility between the Australian Government, South Australian government, local government, community and industry.

Figure 9 outlines the key organisations and entities with roles and responsibilities for flood management in South Australia, across prevention, preparedness, response and recovery.

Flood Management

Prevention

- Attorney-General's Department – Planning and Land Use Services
- Coast Protection Board
- Local government
- Department for Environment and Water
- Department for Infrastructure and Transport
- Stormwater Management Authority
- Engineers, consultants, research organisations
- SA Water
- Landscape boards

Preparedness

- Bureau of Meteorology
- South Australian State Emergency Service
- Department for Environment and Water
- Environment Protection Authority
- Local government
- Landholders
- Businesses
- Communities
- Zone Emergency Management Committees
- Engineers, consultants, research organisations

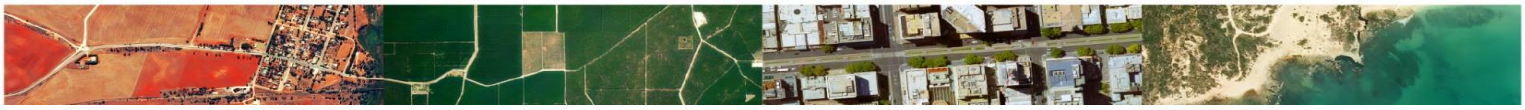
Response

- South Australian State Emergency Service
- Department for Environment and Water
- Bureau of Meteorology
- Department for Premier and Cabinet
- Local Government Functional Support Group
- Mapping Functional Support Group
- SA Water
- Environment Protection Authority
- Zone Emergency Support Teams
- Landscape boards
- Landholders
- Businesses
- Communities
- South Australia Police

Recovery

- Security, Emergency and Recovery Management Team
- South Australian State Emergency Service
- Local government and Local Government Functional Support Group
- Primary Industries and Regions SA
- Environment Protection Authority
- SA Health
- Department for Infrastructure and Transport
- Landscape boards
- Coast Protection Board
- Landholders
- Businesses
- Communities
- Insurance industry
- Engineers, consultants, research organisations

Figure 9: Roles and responsibilities in flood management in South Australia



Section 9.1 outlines the responsibilities of the hazard leader and control agency and Section 9.2 outlines key roles and responsibilities in flood prevention, preparedness, response and recovery.

9.1. HAZARD LEADER AND CONTROL AGENCY ROLES AND RESPONSIBILITIES

9.1.1. FLOOD HAZARD LEADER

Under the SEMP, DEW is the flood hazard leader.

The hazard leader facilitates and oversees the planning process (prevention, preparedness, response and recovery) relating to its assigned hazard. Hazard leaders have the authority of the SEMC to bring together any required government or non-government entities to undertake this planning and coordination role. This includes working with the various advisory groups, control agencies, functional support groups, and other roles and functions within the emergency management arrangements.

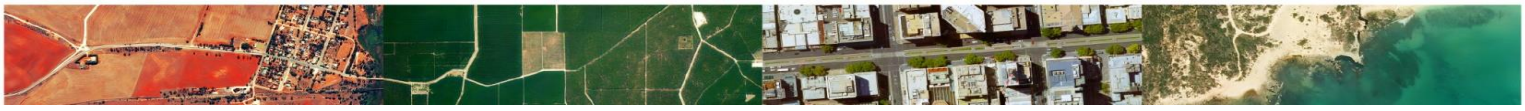
The SEMP outlines the following role for a hazard leader (Section 5.1.2, p. 14):

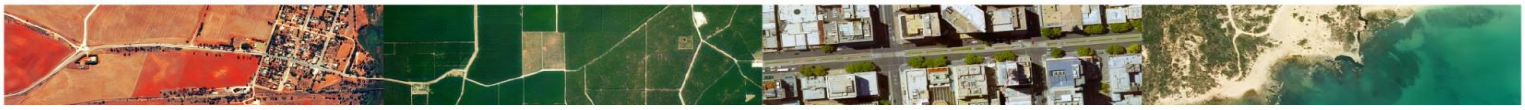
1. *Undertake a leadership role for the planning of emergency management activities pertaining to its appointed hazard*
2. *Prepare, review and maintain a Hazard Plan for its assigned hazard according to Part 4 of the SEMP*
3. *Review other plans prepared under the SEMP to ensure that all aspects of their assigned hazard have been addressed*
4. *Identify issues where:*
    a. *the approach to mitigating the risks from the assigned hazard is not coordinated*
    b. *work with agencies to ensure appropriate coordination occurs*
5. *Report its activities to the State Emergency Management Committee (SEMC) via the relevant sub committees*
6. *Undertake a review as part of the regular update of its Hazard Plan of the continuing need for the hazard to remain listed within the SEMP and provide advice to SEMC on any proposals to amend or remove the listing.*

The SEMP also states that actions of the hazard leader may include, but are not limited to (Section 5.1, p. 13):

- risk assessments for the state for their assigned hazard
- advice and/or preparation of land use planning policies and/or codes of practice
- advice and/or implementation of engineered preventative actions
- participating or leading coordinated projects to address the risks from their assigned hazard
- specific training for response agencies
- advice to control agencies on public information
- specific recovery needs relating to their assigned hazard.

DEW collaborates with other agencies in delivering the flood hazard leader role**,** through the Flood Management Advisory Group. Membership of the Flood Management Advisory Group includes representatives from the Local Government Association of South Australia, SA Water, the Bureau, AGD-PLUS, SASES and the Environment Protection Authority.





The Flood Management Advisory Group (the Advisory Group), established as the Flood Working Group in late 2017, provided strategic advice and oversight to the implementation of state government responses to the *Independent Review of the Extreme Weather Event South Australia 28 September – 5 October 2016* ('the Burns review'). The Advisory Group was instrumental in developing the position papers for improving dam safety and levee bank management and development of the *Guidelines for maintenance and management of private dams in emergencies*[24] in response to the Burns review. The Advisory Group developed the *Memorandum of Understanding Regarding the Sharing of Reservoir Information to Support Flood Mitigation*, established between SA Water, SASES, DEW and the Bureau in response to the Burns review recommendations.

The Advisory Group maintains an active work plan with key priorities for improving flood management and provides advice on the review of the Flood Hazard Plan.

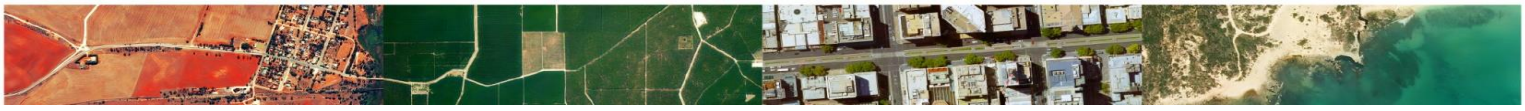
9.1.2. FLOOD CONTROL AGENCY

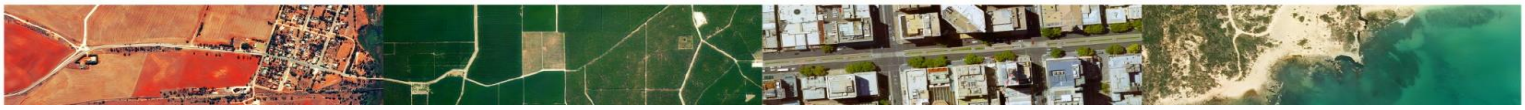
The SEMP assigns the role of flood control agency to SASES and outlines the following (Section 5.4.3, p. 18–19):

> *The responsibilities of the control agency in resolving an emergency are, so far as is reasonably practicable:*
>
> 1. *Take control of the response to the emergency (including the appointment of an incident controller and incident management structure)*
> 2. *Ensure a safe working environment and safe systems of work*
> 3. *Ensure effective liaison, communication and cooperation with all involved*
> 4. *Continually assess the situation, identify risks and share information with all involved*
> 5. *Develop and share plans and strategies that meet the requirements of all agencies responding to the emergency (an incident action plan)*
> 6. *Implement and monitor the incident action plan*
> 7. *Ensure the effective allocation and use of available resources*
> 8. *Ensure the public is adequately informed and warned so as to enhance community safety*
> 9. *Facilitate the investigation of the emergency and review of response activities*
> 10. *Ensure transition from response to recovery, including the coordinated handover to the state recovery arrangements.*

The SASES Control Agency Plan and State Flood Plan set out the roles and responsibilities of SASES.

[24] https://www.environment.sa.gov.au/files/sharedassets/public/water/hazard-management/dams-in-emergency-guidelines.pdf





9.2. KEY ROLES AND RESPONSIBILBITIES IN FLOOD PREVENTION, PREPAREDNESS, RESPONSE AND RECOVERY

9.2.1. BUREAU OF METEOROLOGY

The Bureau of Meteorology is the Commonwealth agency responsible[25] for the provision of weather forecasting and climate data. The *Intergovernmental Agreement on the Provision of Bureau of Meteorology Hazard Services to the States and Territories* was signed on 2 February 2017 and outlines the Bureau's roles and responsibilities for services to the states (Table 10).

Within South Australia, flood warning services provided by the Bureau are described in the *Service Level Specification for Flood Forecasting and Warning Services for South Australia*.[26] Broadly, the Bureau has a responsibility to issue:

- general warnings of extreme weather and weather with the potential to cause flooding
- specific warnings for actual or potential flooding in catchments with a response time of greater than six hours.

The Bureau also provides live data on rainfall and river levels for locations throughout South Australia, using data collected by multiple agencies, including the Bureau, DEW, SA Water and local government.

9.2.2. LOCAL GOVERNMENT

Local councils have a legislated function (section 7 of the *Local Government Act 1999*) to protect their areas from natural hazards and to mitigate the effects of natural hazards, including, where relevant, through the provision of infrastructure.

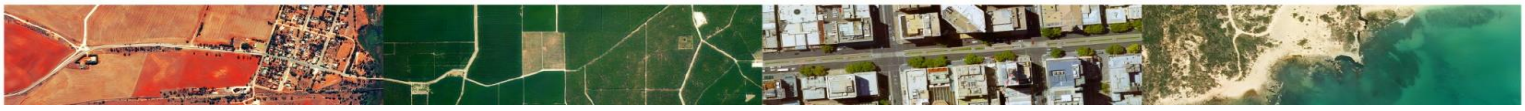
Local government discharges this responsibility primarily through:

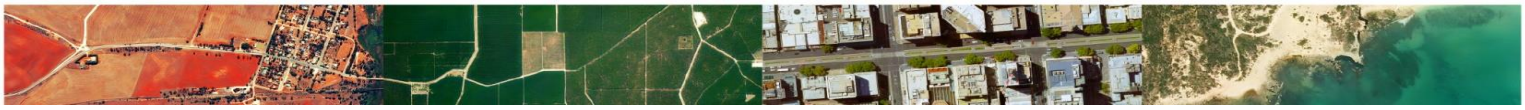
- assessing development proposals against the Planning and Design Code, which identifies areas where development is inappropriate or where development needs to meet specific requirements to manage risk, such as assigning finished floor levels. Local government can also review and propose amendments to the Planning and Design Code
- the design, construction, operation and maintenance of drainage infrastructure and coastal flood protection infrastructure, including both street drainage (major and minor) and specific flood mitigation works
- provision or augmentation of flood monitoring services and community awareness programs.

Local councils construct and maintain most of the public drainage and flood mitigation infrastructure in South Australia. This includes stormwater infrastructure and flood detention basins. Local councils can seek funding from the SMA for the preparation of SMPs and the implementation of complying projects, and from the Coast Protection Board for coastal management projects.

Flood inundation mapping underpins these mechanisms and is used to define areas of flood risk and to prioritise mitigation works and development conditions. A partnership approach is taken between local

[25] https://www.legislation.gov.au/Details/C2008C00066
[26] http://www.bom.gov.au/sa/flood/SA_SLS_current.pdf





councils, the SMA and/or the Coast Protection Board to commission flood studies and develop flood inundation maps.

Flood inundation mapping also has secondary uses, such as providing flood intelligence to the emergency services.

The local government sector is a key stakeholder in providing resources for response activities and recovery from flood and other emergencies. The Local Government Functional Support Group provides support in management of the impacts following a flood.

9.2.3. LANDSCAPE BOARDS

The landscape boards established under the *Landscape South Australia Act 2019* facilitate the sustainable management of the landscape in their region.

Management of water resources and coastal areas forms part of the landscape boards' role. The work undertaken by landscape boards has many connections with flood management. Landscape boards work with industry, landholders and traditional owners on floodplains, in coastal areas and along watercourses, and in restoration and management of landscapes; therefore, they can play a key role in flood prevention, response and recovery.

Landscape boards, and in particular the Green Adelaide Landscape Board, provide advice on stormwater management, urban watercourse management and water sensitive urban design.

Landscape boards develop water allocation plans that, in areas where surface water and watercourse water are prescribed, include policies regulating the take of water using farm dams and/or directly from watercourses. These policies are implemented by DEW.

Landscape boards develop policies and issue permits for water affecting activities such as construction, enlargement or modification of farm dams, removal of vegetation from a watercourse, levee bank construction, and other activities in or on the floodplains of watercourses that have the potential to impact on the water resource. These policies are contained in either a Water Affecting Control Policy or, where surface water and watercourse water are prescribed, a Water Allocation Plan.

Landscape boards also manage water monitoring sites to support water allocation planning. The data from these sites is often also used for flood forecasting and warning.

9.2.4. STORMWATER MANAGEMENT AUTHORITY

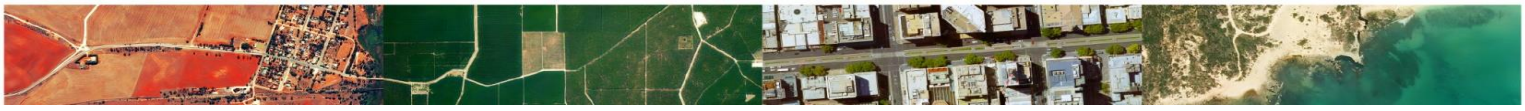
The Stormwater Management Authority was established on 1 July 2007 and operates under Schedule 1A of the *Local Government Act 1999.*

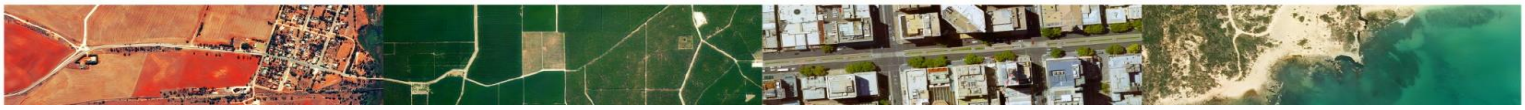
The SMA acts as a stormwater planning and prioritisation body for South Australia. It promotes the development of integrated SMPs by local government and administers the Stormwater Management Fund to assist local government with the costs of stormwater management planning. Flood studies are a key component of SMPs and the SMA is a significant funder of flood studies in South Australia.

9.2.5. DEPARTMENT FOR ENVIRONMENT AND WATER

In addition to its role as flood hazard leader DEW also operates infrastructure that provides flood protection, including:

- the Patawalonga Lake system





- levees on Crown land in the lower River Murray
- the South East Drainage Network (supporting the South Eastern Water Conservation and Drainage Board).

DEW maintains a network of water monitoring sites, collecting climatic and streamflow data, and manages the data collected to support the function of the Minister for Environment and Water under the *Landscape South Australia Act 2019* to monitor, evaluate and audit the state and condition of South Australia's natural resources, coasts and seas.

While not specifically designed for flood forecasting and warning, the data from this monitoring network is a significant source of knowledge for flood risk in many catchments. The Bureau, landscape boards, SA Water and local councils also contribute to the flood warning infrastructure network for South Australia.

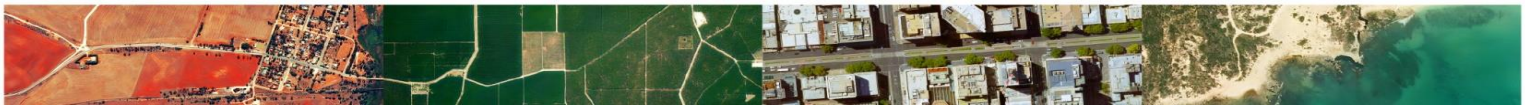
DEW hosts the Flood Awareness website. In addition, the Department has developed flood guidelines, a rapid risk assessment template and an emergency action plan template for private dam maintenance and management in emergencies (available on the Department for Environment and Water website).

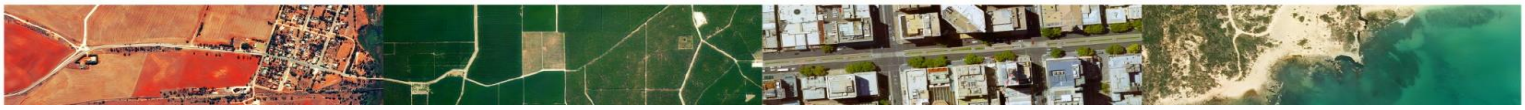
9.2.6. SECURITY, EMERGENCY AND RECOVERY MANAGEMENT TEAM

The Security, Emergency and Recovery Management Team is an administrative unit of the Department of the Premier and Cabinet that works across government and non-government sectors to oversee or lead functions relating to the state's disaster recovery. This team develops and maintains disaster recovery policies, plans and arrangements and undertakes practice improvement initiatives arising from lessons learned from emergencies, exercises and research. During and after an emergency, the Security, Emergency and Recovery Management Team provides management and administrative support to the assigned recovery leaders and consultative bodies at the national, state and local levels.

Parts 2 and 3 of the SEMP describe the broad all-hazard roles and responsibilities in relief and recovery. Issues relevant to flood hazard include:

- Temporary accommodation may be required for residents unable to access their properties due to inundation and isolation.
- Flooding can cause large quantities of waste, which requires management in accordance with the Disaster Waste Management Plan.
- Floods can cause several environmental health issues (e.g. contaminated floodwater, overflowing septics and mosquito-borne disease). SA Health has a responsibility to respond to and manage these issues.
- Animals and crops with long exposure to flood waters are susceptible to a range of health issues. PIRSA will monitor and action as required to ensure that risk to agriculture from disease is minimised.
- Road and rail networks are susceptible to flood damage. Assessment and repair of such damage is often prioritised to facilitate relief and recovery following a flood and is coordinated through the Transport Functional Support Group.
- Local roads, parks, recreation facilities, sewage treatment facilities and stormwater management infrastructure can all be impacted by floods.





9.2.7. ATTORNEY-GENERAL'S DEPARTMENT – PLANNING AND LAND USE SERVICES

The Attorney-General's Department – Planning and Land Use Services (AGD-PLUS) manages the planning and land use system for South Australia. It supports the State Planning Commission and collaborates with other agencies in administering and improving the planning system.

Consideration of flood hazard in land use planning is an important tool in managing flood risks, as it focuses on prevention. It can avoid or reduce flood risk for proposed new developments as well as consider and minimise flood risk for existing developments arising from land use change.

South Australia has undergone the biggest modernisation of its planning system in 20 years with the implementation of the *Planning, Development and Infrastructure Act 2016*, which introduced several new instruments that play a role in providing guidance on managing flood risk in the land use planning system.

State Planning Policies provide the land use planning vision for South Australia and State Planning Policies 15 (Natural Hazards, pp. 68–69) and 13 (Coastal Environment, pp. 64–65) are of particular relevance to flooding[27]. They state:

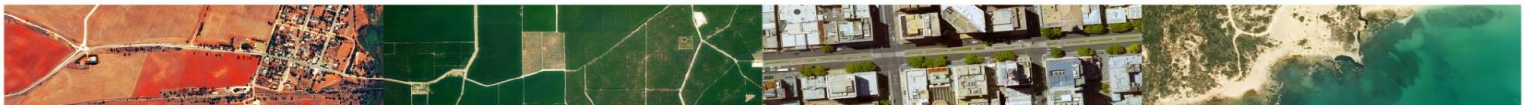
> *The costs to community, business and government in responding to and recovering from natural hazard events is significant. Land use planning has an important role to play in guiding development to reduce the impact of natural hazards, rather than relying solely on 'response and recovery'.*
>
> *Sound planning and development decisions, together with disaster reduction strategies, can help reduce the severity and impact of natural hazards. This approach can also help support the activities of emergency services and public safety agencies and build the resilience of affected communities.*

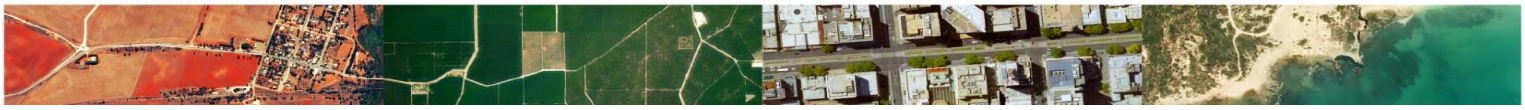
The **Planning and Design Code** (the Code) is the electronic delivery of a single set of consistent and simple statewide planning rules. The Code is the set of rules against which new developments are assessed (except for impact assessed developments) and has replaced development plans.

In relation to flooding, the Code includes the following provisions:

- Hazard (Flooding) Overlay for high risk areas – avoids new development and intensification and is performance assessed.
- Hazard (Flooding-General) Overlay for low to medium risk areas – development needs to meet finished floor levels and Deemed-to-Satisfy pathway available for some development.
- Hazard (Evidence Required) Overlay for areas where the flood risk is unknown (e.g. areas where there is no flood mapping) – development needs to meet finished floor levels and Deemed-to-Satisfy pathway available for some development.
- No Overlay applies for areas outside the 1% AEP in areas where flood mapping has been produced – these are assumed to be flood free.
- Stormwater Management Overlay for the capture and re-use of stormwater to assist in managing peak flows in metropolitan Adelaide.
- Coastal Flooding Overlay to apply to areas subject to coastal hazard risk but where the Coastal Areas Overlay does not apply.
- Water Resources Overlay, which includes provisions regarding avoiding development that impacts flows in watercourses.

[27] https://plan.sa.gov.au/__data/assets/pdf_file/0005/552884/State_Planning_Policies_for_South_Australia_-_23_May_2019.pdf





- River Murray overlays, which include provisions regarding flooding associated with the River Murray.

New re-zonings must be consistent with the State Planning Policies, including:

- Identify and minimise the risk to people, property and the environment from exposure to natural hazards including terrestrial and coastal flooding; including considering the impacts of climate change.
- Locate and design development in accordance with a risk hierarchy of 'avoid', 'accommodate' and 'adapt'.
- Avoid locating sensitive developments and communities in areas at high risk of hazards—namely hospitals, telecommunication towers, major transport infrastructure, energy base stations and water services—or ensure that these developments are subject to a higher level of assessment.

The Coastal Areas Overlay in the Planning and Design Code advances State Planning Policy 13 by broadly capturing areas subject to potential coastal flooding hazard risks; the boundary may be adjusted in future, as further flood modelling studies become available.

The intent of the Coastal Areas Overlay flood hazard policies is to avoid the current and future need for public expenditure on the protection of a development. Development is to be protected from the standard sea flood risk level[28] and 0.3 metres of sea level rise and is to be capable of being protected from a further 0.7 metres of sea level rise. Zones can be more specific; for example, the shack relocation subzone applies to land where a retreat strategy is in place in response to coastal hazard risks.[29]

Flood mapping in reference layers of the South Australian Planning and Property Atlas can assist in the preparation of Regional Plans, which will ensure that planning for future urban growth areas and infrastructure considers flood hazard.

9.2.8. SOUTH AUSTRALIAN WATER CORPORATION (SA WATER)

SA Water's primary function is to provide water supply and sewerage services. SA Water maintains and operates significant water infrastructure that has a primary or secondary flood mitigation function, including:

- locks and weirs of the River Murray
- reservoirs
- the Sturt River Flood Control Dam

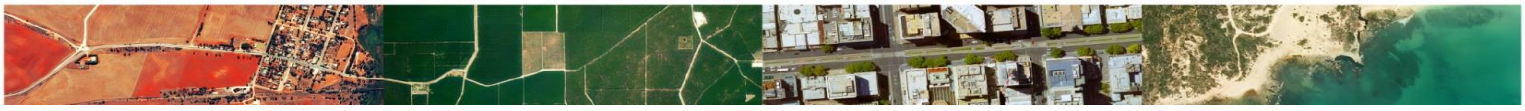
SA Water must also ensure flood-prone areas of Adelaide watercourses under the *Metropolitan Drainage Act 1935* and the *South Western Suburbs Drainage Act 1959* are properly drained, including parts of the River Torrens (including levee banks), Brownhill Creek, Keswick Creek and Sturt River.

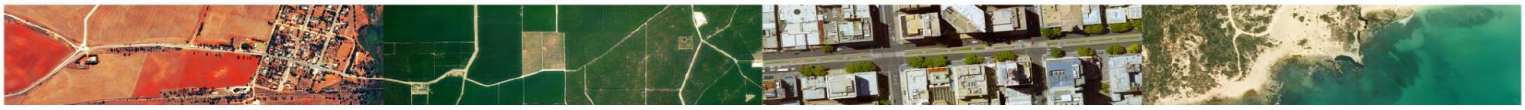
9.2.9. COAST PROTECTION BOARD

The Coast Protection Board administers grant programs with the support of DEW and funds detailed flood modelling investigations, adaptation strategies and flood protection works. The modelling and adaptation

[28] Sea flood risk level means the 1% AEP sea flood level (tide, stormwater and associated wave effects combined) plus an allowance to accommodate 100 years of land subsidence.

[29] Allowing for sea level rise (SLR) is a longstanding, key coastal planning consideration for South Australia. The Planning and Design Code allows for 0.3 metres of SLR to the year 2050 and a further 0.7m to 2100; this is commensurate with the Coast Protection Board's policy since 1991.





studies assist local councils to plan for sea level rise, prioritise protection works and consider adaptive solutions and planning to accommodate risk.

The Coast Protection Board is a referral agency for developments in the Coastal Areas Overlay, to ensure coastal flood risk and other coastal matters are considered, and can provide direction to the planning authority on these matters.

9.2.10. INDIVIDUALS

Part 2 of the SEMP (Section 2.4) stresses the role of individuals in emergency management:

> *Individuals can assist in the emergency management process by taking responsibility to draw on the guidance, resources and policies of government and the community groups working toward the reduction of emergencies in the community.*

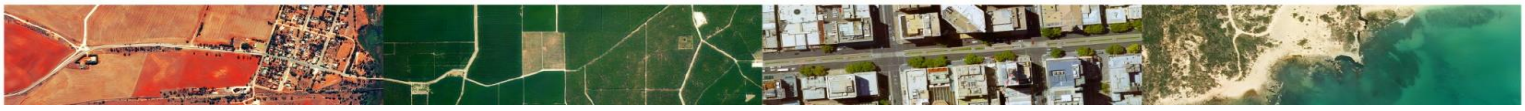
In the context of flood management, guidance for individuals is available on the sa.gov.au website[30], where information is available to assist with:

- preparation for flooding
- reduction of risk during floods
- understanding how best to recover after floods
- understanding potential health effects of flooding.

The South Australian State Emergency Service website[31], the Department for Environment and Water website[32] and the Flood Awareness website[33] provide useful information for individuals for flood preparedness and management of risks during floods. The Flood Awareness website is designed to facilitate the open and transparent sharing of flood risk information between state and local government and the community; DEW publishes data and information on this website only after negotiating a data sharing agreement with the custodian(s) of the relevant flood study.

Other sources of information on flood risk for the public include local government websites, the South Australian Planning and Property Atlas[34] and the Australian Flood Risk Information Portal.[35]

[30] https://www.sa.gov.au/topics/emergencies-and-safety/types/flood
[31] https://www.ses.sa.gov.au/flood/
[32] https://www.environment.sa.gov.au/topics/water/hazard-management
[33] https://www.waterconnect.sa.gov.au/Hazard-Management/Flood-Awareness/SitePages/Home.aspx
[34] https://sappa.plan.sa.gov.au/
[35] https://www.ga.gov.au/scientific-topics/community-safety/flood/afrip



10. FLOOD MANAGEMENT PRIORITIES, STRATEGIES AND ACTIONS

10.1. OBJECTIVES OF FLOOD MANAGEMENT IN SOUTH AUSTRALIA

Flood management aims to reduce the economic, social and environmental risks and costs of floods in South Australia. This requires communities, business and government to be aware of flood risk and responsive and resilient to flood events. It requires an understanding of how flood risk may change in the future due to climate change impacts and land use change. Collaborative action is needed to manage flood risk.

Flood management recognises that flooding is a natural process in a floodplain and can have important environmental and economic benefits. Flood risk can be reduced to agreed acceptable levels, although not all flood risk can be eliminated.

10.2. FLOOD MANAGEMENT PRIORITIES

10.2.1. PREVIOUS FLOOD HAZARD PLAN PRIORITIES

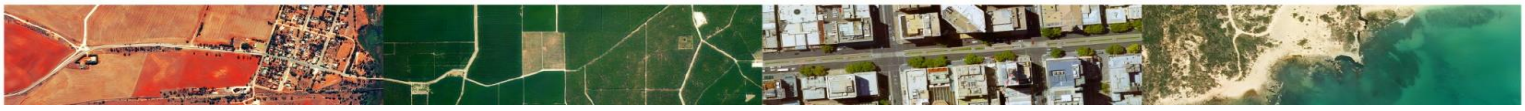
The previous Flood Hazard Plan focussed on the implementation of the South Australian Government response to the flood related recommendations from the Burns review. The South Australian Government published its final report of the South Australian Government's response to the Burns review in 2018[36] and reported all recommended actions relating to flood risk as completed. The completed actions are:

- Development of the Improving Dam Safety position paper
- Development of a guideline and rapid risk assessment tool for the management of private dams in danger of losing their structural integrity or spilling
- Development of the Improving Levee Bank Management position paper
- Development of the Memorandum of understanding between SA Water, SASES, DEW and the Bureau regarding the sharing of reservoir information to support flood mitigation
- Investment in flood warning classification of stream gauges and additional flood warning infrastructure

10.2.2. FLOOD MANAGEMENT PRIORITIY AREAS 2021-2026

The strategies to be pursued in the next five years (2021–2026), reflect the initial framework in the *Position Paper Priorities for Improved Flood Management in South Australia*[37] and are outlined in Table 12. This position paper was developed as part of the South Australian government response to the Burns review and was endorsed by SEMC. It considered stakeholder input during the 2019 consultation on three discussion papers on dam safety management, levee bank management, and priorities for flood management. The initial framework seeks to reflect stakeholder feedback and the priorities in the National Disaster Risk Reduction Framework.[38]

[36] Keeping-South-Australians-Safe-Final-Report.pdf (dpc.sa.gov.au)
[37] https://www.environment.sa.gov.au/files/sharedassets/public/water/hazard-management/priorities-for-improved-flood-management-ips://www.en-sa-position-paper-jun-20-gen.pdf
[38] https://www.homeaffairs.gov.au/emergency/files/national-disaster-risk-reduction-framework.pdf



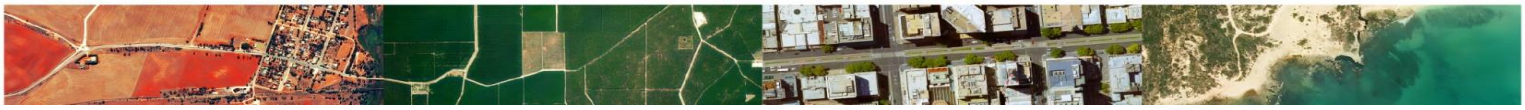
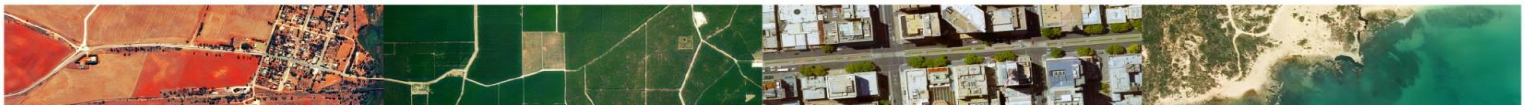


Table 12: Priority areas and strategies for improved flood management for 2021–2026

Priority area	Strategies
1. Understanding flood risk	• Overcome barriers to producing, maintaining and sharing flood information, including data, maps and intelligence • Undertake flood risk assessments to create transparency about risk and residual risk and to support investment decisions • Identify flood conveyance, flood storage and flood fringe areas of floodplains[39] to support land use planning and development decisions • Provide guidelines for, and contribute to, future predictive flood studies, maps and models that consider climate change and land use change to plan and prepare for floods • Develop a dam risk register and levee bank database • Develop and improve flood forecasting and warnings • Build and maintain flood management capacity in state and local government, business and community • Improve communication and collaboration with the research and consulting community and with flood management agencies in other states and territories • Strengthen community engagement and use of local knowledge in flood management
2. Accountable decisions and clarity in roles and responsibilities	• Clarify roles and responsibilities of, and improve legislative cohesion and coordination between, all parties involved across flood prevention, preparedness, response and recovery • Improve consideration of flooding in land use planning to achieve more appropriate development on floodplains, considering the hierarchy of controls: 'avoid', 'accommodate' and 'adapt' • Clarify processes, roles and responsibilities for the management of flood mitigation infrastructure • Develop a flood warning infrastructure plan for South Australia • Develop guidelines for the evaluation of mitigation options • Develop tools and arrangements for the management of dam safety
3. Improved integration of flood management with other areas of water and land management	• Improve alignment with management of stormwater and urban watercourses and with water sensitive urban design initiatives • Clarify the intersection between water resource management, catchment management, flood management and land use planning • Consider alignment with climate change and climate change adaptation strategies • Clarify flood management strategies and priorities in the context of floodplain management and beneficial flooding

[39] https://knowledge.aidr.org.au/resources/handbook-managing-the-floodplain/



Priority area	Strategies
	• Improve the interface between inland and coastal flooding and coastal erosion management • Improve alignment with management and improvement of primary production
4. Enhanced investment in flood management	• Leverage existing and future government programs to fund priority risk reduction measures • Identify additional current and future funding streams • Consider collaborative commercial financing options for flood risk reduction initiatives • Explore availability and uptake of insurance and insurance premium reductions as part of risk management strategies

10.2.3. PRIORITIES FOR 2021–2023

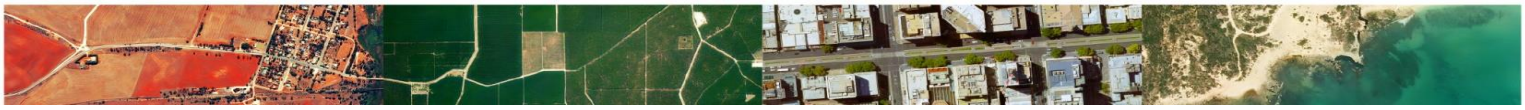
To address the four priority areas and strategies for the next five years (Table 12), the priorities for the next two years (2021–2023) are outlined in Table 13. The priorities are informed by available funding, opportunities for alignment with existing work, and further prioritisation of potential future work identified in Table 12.

Table 13: Flood management priorities for 2021–2023

Priority	Actions

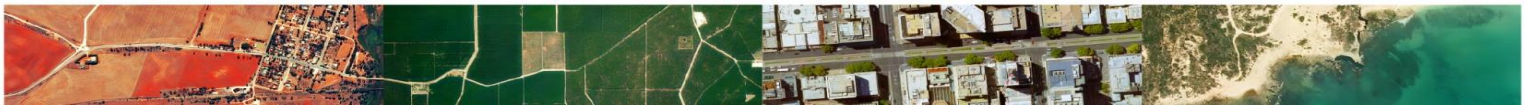
Gawler River flood management
 	
Lead: DEW
	• $9 million South Australian government investment in short-term economic stimulus actions to improve flood management:
	  ○ removal of trees deposited in Gawler River from the Hillier bushfire
	  ○ new flood warning infrastructure and improvement of flood forecasting and warning service
	  ○ levee bank and river surveys and condition assessments, and targeted levee bank repair work
	  ○ improved drainage infrastructure to reduce impacts of flooding on the horticultural industry
	• Development of a business case for long-term solutions
	• National Flood Mitigation Infrastructure Program funding for Two Wells levee bank construction
	• Development of a Gawler River Stormwater Management Plan

Flood hazard mapping and Planning and Design Code Lead: AGD-PLUS	• $3 million South Australian government investment in additional flood studies, expanded outputs from existing flood studies, LIDAR, and improved flood policies in the Planning and Design Code (the Code): ○ Provide a more contemporary and consistent approach for planning decisions and emergency management. The mapping

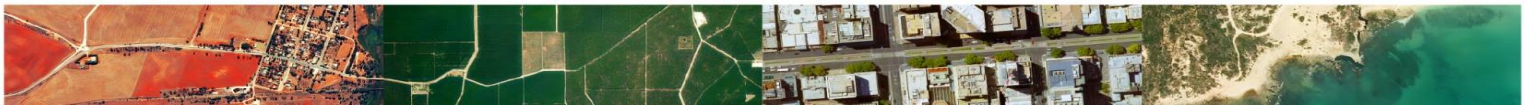


Priority	Actions
	will be fit for purpose and easily understood, enabling the planning process to be quicker and simpler and ensuring that developments are cognisant of the risk of flood ○ Two Code Amendments ▪ Stage 1 – An interim Code Amendment to update the current spatial layers of the Code where mapping was not finalised in time for implementation to the Phase 3 Code ▪ Stage 2 – This Code Amendment will progress after the completion of the mapping project; it will replace the current Flood (Hazard) overlays with new overlays supported by detailed reference layers in the South Australian Planning and Property Atlas. This includes a revised policy construct. The new overlays will be supported by relevant fact sheets ○ Guidance for flood mapping that is intended for use in land use planning in South Australia
Flood forecasting and warning services Leads: The Bureau and DEW	• Improve the Bureau service for River Murray • Further develop Light and Wakefield Rivers flood forecasting and warning service • Improve the Bureau service for River Torrens and Gawler River • Pilot flash flood forecasting services
Patawalonga Lake system upgrade Leads: DEW and SMA	• Upgrade Glenelg gates • Improve flood modelling and flood forecasting and warning for: ○ Brown Hill and Keswick Creek catchment ○ Sturt River catchment • Support implementation of flood mitigation works informed by the SMP
Flood warning infrastructure plan Lead: DEW	• Develop a state flood warning infrastructure plan that clearly outlines roles and responsibilities for flood warning infrastructure and provides a statewide management framework
Dam safety and levee bank management Lead: DEW	• Implement proposed actions in the position papers *Improving Dam Safety Management in South Australia*[40] and *Improving Levee Bank Management in South Australia*[41], subject to available funding

[40] https://www.environment.sa.gov.au/files/sharedassets/public/water/hazard-management/improving-dam-safety-management-in-sa-position-paper-jun-20-gen.pdf
[41] https://www.environment.sa.gov.au/files/sharedassets/public/water/hazard-management/improvng-levee-bank-management-in-sa-position-paper-jun-20-gen.pdf

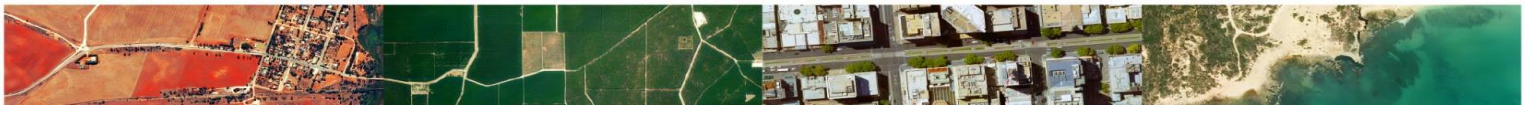


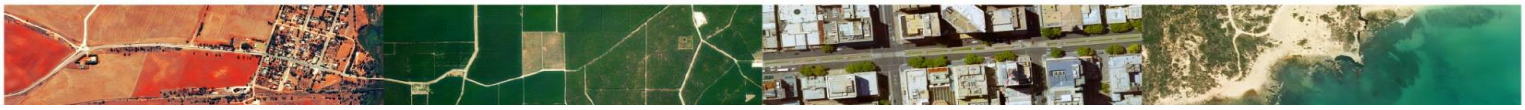
Priority	Actions
Flood intelligence and hydrology support Leads: DEW and SASES	• Improve and document procedures and processes for hydrology support • Implement capacity building and training for SASES and DEW staff and volunteers • Develop and improve rapid access to flood intelligence
Implementation of flood-related actions in the *South Australian Government Climate Change Action Plan 2021–2025* Lead: DEW and SAFECOM	• Support Regional Climate Partnerships to deliver local adaptation and mitigation projects • Integrate future climate change risk into flood studies and mapping and provide information on climate change impacts on flood risk to the emergency management sector and to communities • Seek support from the Australian Government to deliver practical actions to reduce disaster risk and build community resilience as part of the National Flood Mitigation Infrastructure Program and the Natural Disaster Risk Reduction Framework implementation funding • Develop partnerships with research organisations, such as Natural Hazards Research Australia and the SmartSat Cooperative Research Centre, to improve understanding of flood risk and impacts of climate change and to deliver practical tools to improve the availability of information to support flood management



11. ABBREVIATIONS AND ACRONYMS

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARI	Average Recurrence Interval
CALD	Culturally and Linguistically Diverse
DEW	Department for Environment and Water
NERAG	National Emergency Risk Assessment Guidelines
NDRRA	Natural Disaster Relief and Recovery Arrangements
PIRSA	Primary Industries and Regions South Australia
SA Water	South Australian Water Corporation
SASES	South Australian State Emergency Service
SEMC	State Emergency Management Committee
SEMP	State Emergency Management Plan
SMA	Stormwater Management Authority
SMP	Stormwater Management Plans





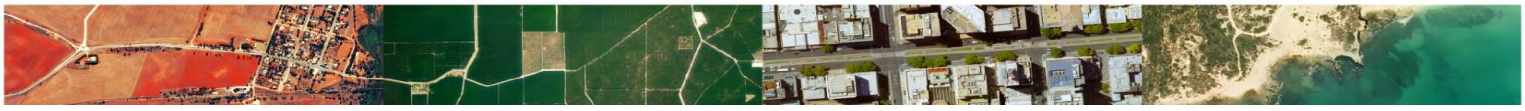
APPENDIX A: HISTORY OF FLOOD EVENTS IN SOUTH AUSTRALIA

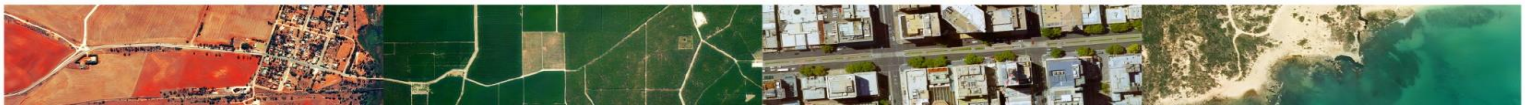
Table A1: Selected floods in South Australia[42]

Year	Description	Damage estimate
1953	On 18 May, a 110 km/h gale whipped up the highest tide on the Adelaide coast 'for 38 years' (i.e. since 1915). Four metropolitan jetties were badly damaged and two in the country were totally destroyed. At the time, the damage bill was estimated at £1 million.	$31m (2013 dollars)
1956	Heavy rains in Queensland, New South Wales and Victoria led to exceptional flooding along the length of the River Murray in South Australia. Riverside communities were inundated and floodwaters in some places were many kilometres wide. While the flood peak was reached in late August, some places remained underwater for six months.	$225m (2012 dollars)[43]
1967	Central Australian flooding Between 5 February and 8 March 1967, central Australia received some of its heaviest rains on record. Derived from three separate southward intrusions of monsoonal weather, the rains totalled 120–350 mm, with some stations receiving overnight falls of over 150 mm. The ensuing floods were the most devastating in living memory in the western Lake Eyre basin.	$671m (2013 dollars)
1983	On 2 and 3 March 1983, the thunderstorm rains that broke one of the most severe recent droughts caused flood and storm damage estimated (at the time) at about $10m in Adelaide suburbs and in the Barossa Valley and its neighbourhood.	$56m (2013 dollars)
1992	17–19 December 1992 Widespread flooding stretched from Gawler to Mt Pleasant, through the eastern Adelaide Hills and down to Goolwa. One life was lost, dozens of homes were evacuated and at least thirty homes were flooded. Crops in the Mid North were also damaged by storms. The total costs were estimated at the time as being up to $750m.	$2,398m (2013 dollars)

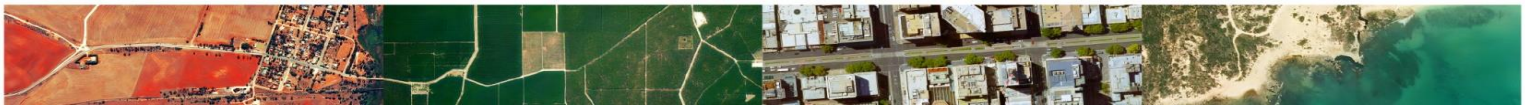
[42] This list is not intended to be exhaustive but provides an illustration of the nature of flood events in South Australia.

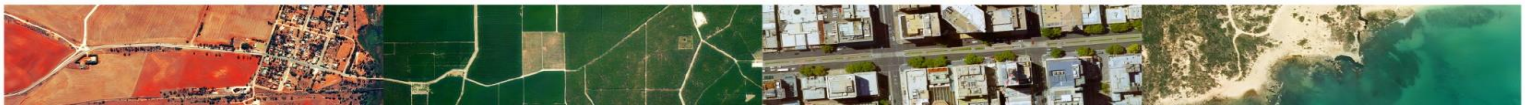
[43] Bloss CM, Eckert G and Cetin L (2015) *River Murray flood mitigation planning: Assessment of flood consequences*. DEWNR Technical report 2015/56, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide.



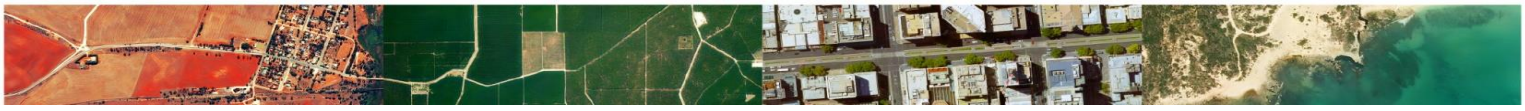


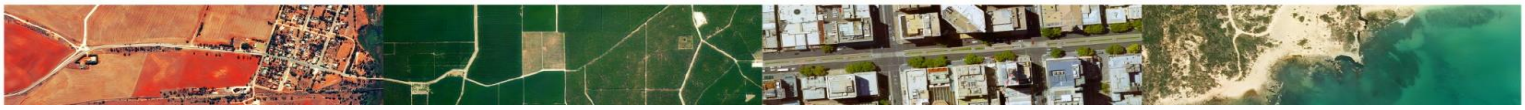
Year	Description	Damage estimate
2003	On 27 June 2003, heavy rainfall and a malfunction in the weir led to stormwater raising the water level in the Patawalonga at Glenelg North and flooding the homes of local residents. A local newspaper report suggested that 160 homes were affected. 145 residents made 150 claims and at least $1.4m was paid by the private weir operator.	$38m (2013 dollars)
2005	On 8 November 2005, the Gawler River burst its banks and spilled out onto the Adelaide Plains, destroying millions of dollars' worth of homes, crops, greenhouses and machinery. The South Australian government estimated more than 1500 hectares were flooded. More than 300 almond, grape, olive, herb, potato and onion growers were affected and Gawler Caravan Park was inundated.	$61m (2013 dollars)
2016	The largest storm event on the Adelaide coast for several decades occurred on 9 May 2016. The combination of spring tides and sustained storm force winds caused a peak water level at Outer Harbor of 2.35 m Australian Height Datum (AHD) at high tide (which occurred at 5:33 pm). This equates to a storm surge of 1.2 m above the predicted astronomic tide. This was the highest water level recorded at Outer Harbor since records began in 1943. The losses from this storm were significantly less than the 1953 coastal storm, which was of similar size. A second severe storm occurred on 11 July 2016. The main area of impact was in the South East.	$3.5m (2016 dollars)
2016	On 28 September 2016, an anticipated intensifying low pressure system moved across the state, bringing strong winds and heavy rain. Major flooding occurred in the Northern Adelaide Plains, including Virginia, causing significant impact to primary industries in the area. PIRSA completed impact assessments of approximately 190 land parcels, including 250 affected growers within the flood zone, and estimated the losses to exceed $51 million. In addition, around 75% of the local government areas across South Australia suffered some impact. The damage to local government infrastructure was estimated to exceed $20 million.	More than $71m (2016 dollars)





Year	Description	Damage estimate
2020	On 31 January 2020, Port Lincoln experienced an extreme rainfall event resulting in flash flooding throughout the entire city. The event was caused by a weather pattern that included a monsoonal trough extending from the Northern Territory that was picked up by a cold front passing through South Australia. The thunderstorm pattern was very isolated, with many areas on Eyre Peninsula recording little or no rain. Analysis of the anecdotal evidence on recorded rainfall intensities suggests that the event experienced in Port Lincoln was a 0.05% AEP rainfall event.	Not assessed





APPENDIX B: GUIDANCE SPECIFIC TO FLOOD HAZARD FOR THE SOUTH AUSTRALIAN STATE EMERGENCY SERVICE IN EVACUATIONS

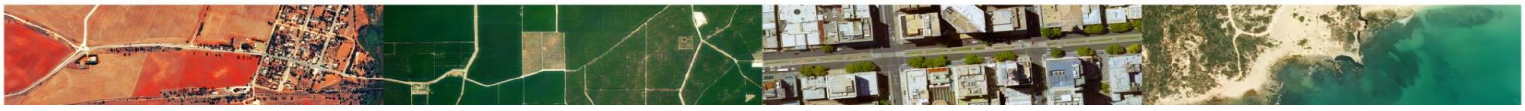
SAFETY

Flood hazard is quantified by considering the flood depth (D) and velocity (V) in combination (D × V product). When quantifying and classifying flood hazard, it is important to understand the relative degree of hazard and the underlying flood behaviour causing the hazard (e.g. high depth, high velocity, and high depth and velocity combined), as these may require different management approaches.

The vulnerability of the community and its assets can be described by using thresholds related to the stability of people as they walk or drive through flood waters or shelter in a building during a flood.

Figure B1[44] shows flood hazard vulnerability curves that plot the vulnerability of the community when interacting with floodwaters (against the dimensions velocity and depth). The curves are divided into hazard classifications (H1 to H6) that relate to specific vulnerability thresholds (as listed in the plot in Figure B1).

[44] https://knowledge.aidr.org.au/media/3518/adr-guideline-7-3.pdf



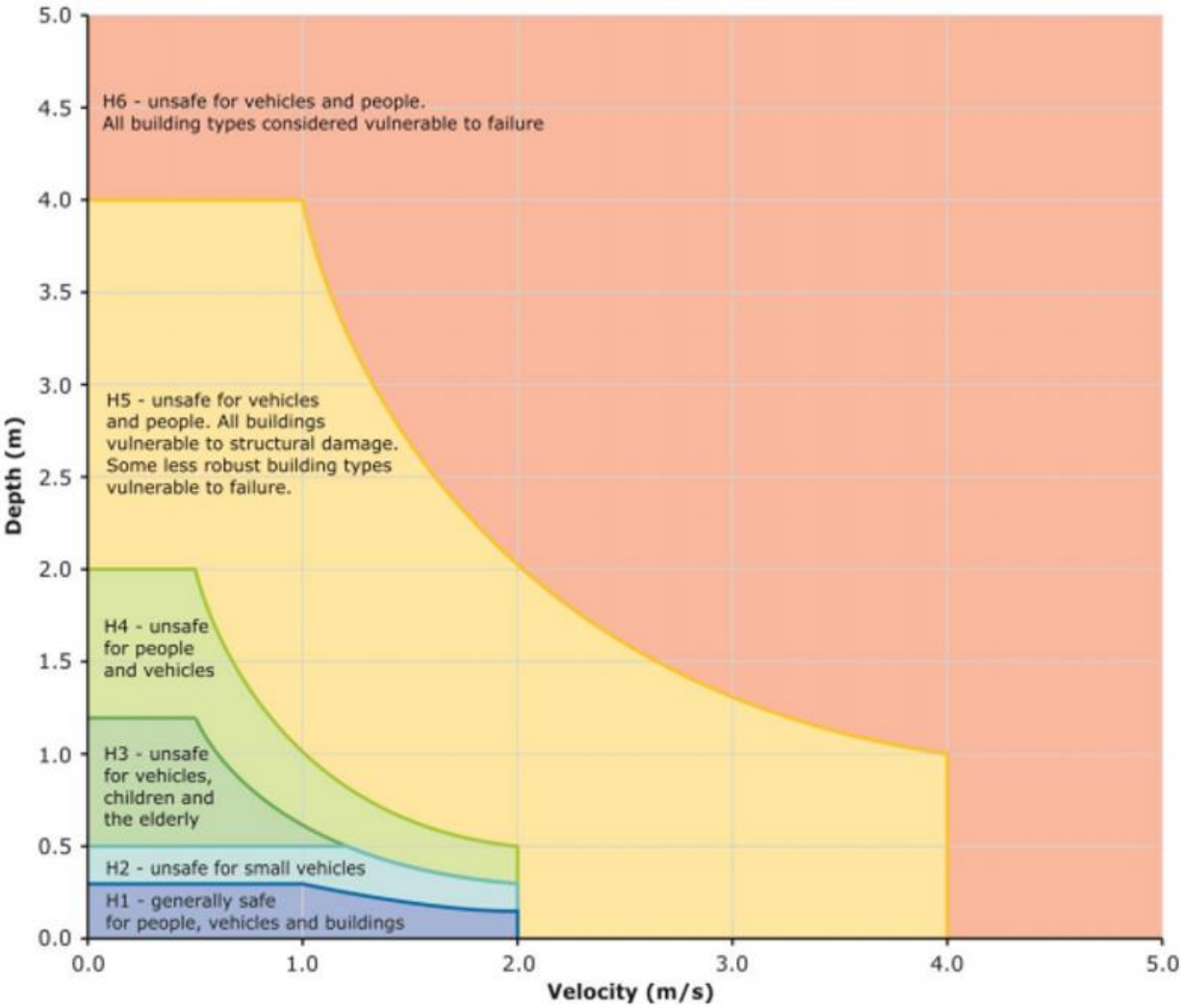
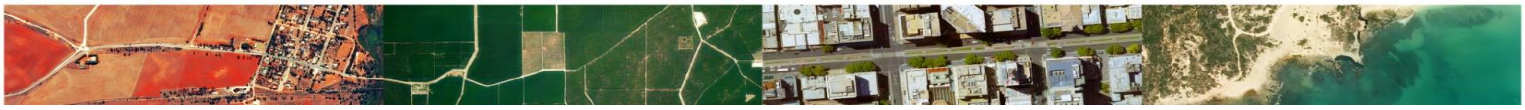


Figure B1: Flood hazard vulnerability curves



EVACUATIONS

DECISION TO EVACUATE DURING A FLOOD

As the flood control agency, SASES will identify and initiate the need for evacuation. The incident controller may make the decision to evacuate a community at risk under the following circumstances:

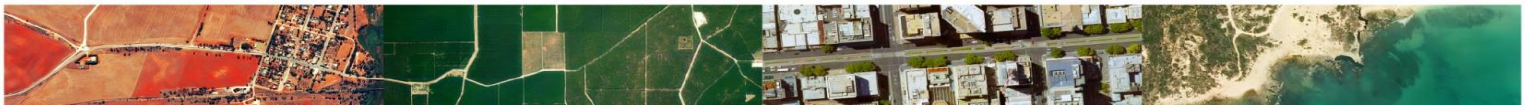
- properties are likely to become inundated
- properties are likely to become isolated, which may place occupants at risk
- public health is at threat as a consequence of flooding and evacuation is considered the most effective risk treatment; the role of the Health Commander is to assess, manage and make recommendations to the control agency
- essential services have been damaged and are not available to a community and evacuation is considered the most effective risk treatment.

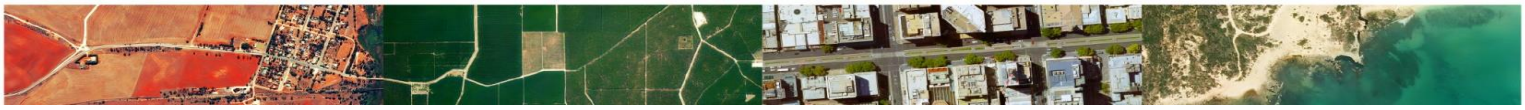
The following should be considered when planning for evacuation:

- anticipated flood consequences and their timing, and the reliability of predictions
- size and location of the community to be evacuated
- likely duration of evacuation
- forecast weather
- flood models
- predicted timing of flood consequences
- time required to conduct the evacuation
- time available to conduct the evacuation
- evacuation priorities and evacuation planning arrangements
- access and egress routes available and their potential flood liability
- current and likely future status of essential infrastructure
- resources required to conduct the evacuation
- resources available to conduct the evacuation
- resources and capacity to clearly engage and inform the community
- shelter, including emergency relief centres and assembly areas
- vulnerable people and facilities
- transportation
- registration
- people of culturally and linguistically diverse (CALD) backgrounds and transient populations
- safety of emergency service personnel
- different stages of an evacuation process.

DECISION TO SHELTER IN PLACE

If full or partial evacuation is deemed unsafe or there are insufficient time frames to proceed without risk to life, a recommendation should be given to shelter in place.



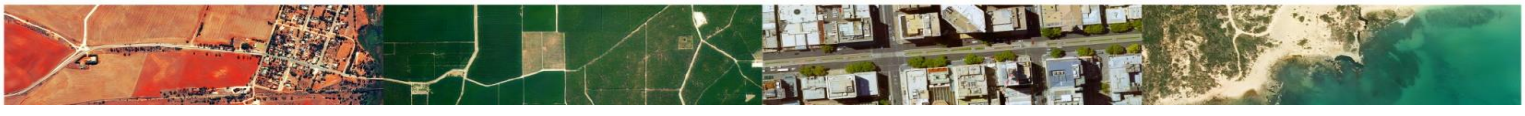


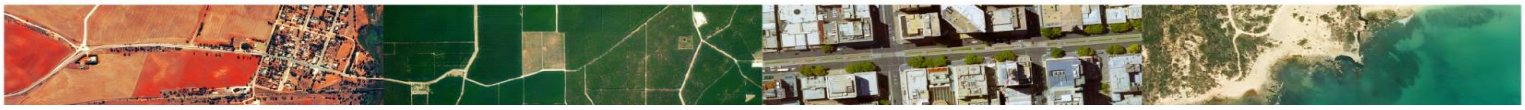
The shelter building must be sufficiently high relative to the maximum possible depth of flooding over floor levels and requires an emergency egress for the rescue of trapped occupants. Single storey slab-on-ground buildings are unlikely to be suitable.

Any buildings identified as suitable for sheltering in place should have sufficient habitable floor space that will be flood free in a probable maximum flood (PMF) to comfortably house the likely number of occupants. Sufficient stock supplies for the likely duration of shelter and an emergency kit[45] should be available.

Pre-flood planning by the building owner or occupant should identify whether buildings are structurally sound and suitable to withstand lateral flood flow, buoyancy and suction effects, and debris impact load.

[45] https://www.sa.gov.au/topics/emergencies-and-safety/prepare-for-an-emergency/emergency-kit





APPENDIX C: SECTORS OF THE COMMUNITY VULNERABLE TO FLOODS

SA Health identifies on its website[46] the following factors that may impact on a person's ability to prepare for, respond to and recover from a major incident:

- geographical and/or social isolation
- limited access to transport, requiring assistance to relocate to safer areas or access resources
- physical ability
- cognitive ability
- people with pre-existing mental health conditions
- people who have previously experienced trauma
- chronic illness
- socio-economic disadvantage
- limited support networks
- carers of older people or people with a disability, particularly if carers are older and financially disadvantaged themselves
- people who are experiencing, or are at risk of, family violence
- people who are homeless or at risk of homelessness
- people with existing health conditions which may be exacerbated by the effects of a major incident, for example loss of power, loss of water, difficulties in accessing health services, difficulties in accessing medicines or other supplies
- limited financial means, which impacts on insurance for losses, or limited savings to rely on if their income is impacted due to interruptions in employment.

An essential step towards effective emergency management is the gathering of knowledge of vulnerable groups, their distribution in the community and their circumstances. Research[47] has highlighted that people from low socio-economic communities and from CALD populations are more likely to be exposed to natural hazards and have the least resilience.

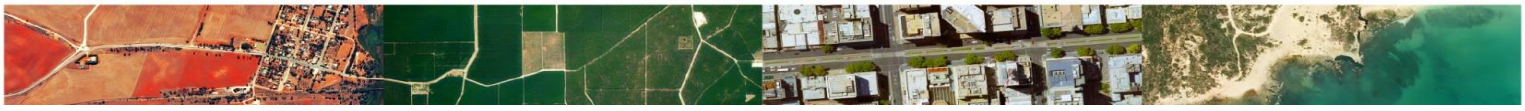
The Australian Disaster Resilience Index[48] provides a snapshot of the capacities for disaster resilience in Australian communities and identifies the factors that contribute to disaster resilience or vulnerability

Table C1 shows the sectors and categories of the community that are vulnerable to flood.

[46] SA health website

[47] Teo M, Lawie M, Goonetilleke A, Ahankoob A and Deilami K (2018) Engaging vulnerable populations in preparedness and response: a local government context. *Australian Journal of Emergency management*, Australian Institute for Disaster Resilience. Link

[48] https://adri.bnhcrc.com.au/#!/



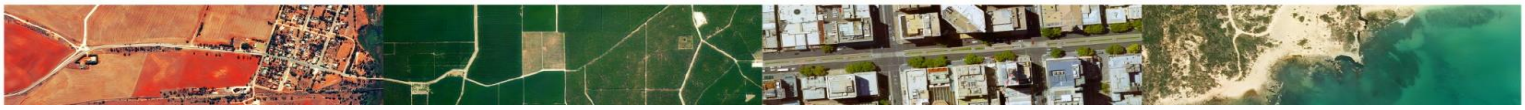
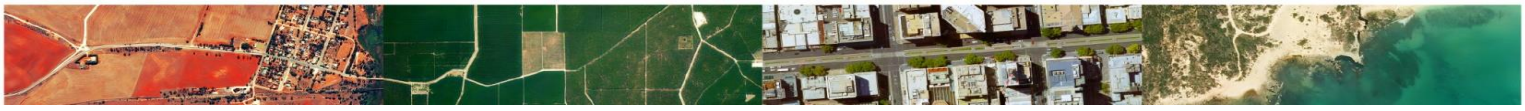


Table C1: Sectors of the community vulnerable to flood

Category	Sector
Facilities	Hospitals Nursing homes Corrective facilities Children in schools Children in childcare facilities Residents of health care facilities and caravan parks
Mobility limitations and health issues	Older people People who have a disability or are frail People who have lower level of health and wellbeing Caregivers of family members Families with young children People dependent upon medical care People who have mental health issues People who have a chronic illness
Logistics of flood warning and emergency response	People who have less warning time People who have less time to evacuate People who have less assistance due to lack of resources When more limitations on evacuation routes
Isolated people	People in regional, remote or isolated areas People in coastal areas (coastal inundation) People from non-English speaking backgrounds Economically disadvantaged people Socially isolated people People from minority groups People who lack access to transport Newcomers



APPENDIX D: FLOOD CLASSIFICATION OF GAUGES

Table D1 outlines the process, roles and responsibilities in undertaking flood classification.

Table D1: Process, roles and responsibilities in flood classification

Activity	Description	Lead[49]	Support
Investigation	Initial: • identify sources of flood intelligence • collate all existing sources of information • consider if additional information is required.	DEW	The Bureau, SASES, gauge owners and stakeholders depending upon capacity
	Supplementary – coordinate the procurement of additional data as required, which could include the following: • interview long-term residents • survey community assets, gauge outlets and cross-sections for input to 1D model • build and run 1D models and procure information from engineering consultants (e.g. extract data from existing models or commission additional runs of flood models).		
Draft levels	• Compare the information on flood impacts to the flood classification definitions (minor, moderate and major) to determine the appropriate threshold for each flood class. The SASES must be involved in this process and it is preferable that relevant stakeholders are included. • Document the draft levels, gauge reference area(s), flood impacts, source of data and method(s) used to link the flood impacts to the draft levels.	DEW	SASES, the Bureau, other stakeholders

[49] *For gauges not linked to a Bureau of Meteorology service, the Bureau participation is optional*

Activity	Description	Lead[49]	Support
Nomination and acceptance	*For all gauges*		
	1. Complete the appropriate flood classification template and provide to all relevant stakeholders 2. Sign-off by the control agency indicates acceptance 3. Flood class levels entered into FloodMon™ and Bureau website.	1. DEW 2. SASES 3. SASES, the Bureau	
	Additional steps for gauges linked to a Bureau of Meteorology service		
	Flood class levels are reflected in operational flood products and are updated in the regional Service Level Specification.	The Bureau	
Storage	Documentation of the flood class thresholds and how the thresholds were determined (including data sources and assumptions) must be stored so that it can be easily retrieved.	SASES	
Stakeholder education	When thresholds are set or updated, stakeholders should be informed, including the rationale for change.	SASES via Zone Emergency Management Committees The Bureau via the Flood Warning Consultative Committee	DEW

Activity	Description	Lead[49]	Support
Review	Periodically, flood classifications should be reviewed. Timing will depend on the following considerations: • post-flood event, are the impacts that were experienced consistent with the flood classification definitions? • have there been changes to the contributing catchment? • have there been changes to the site (e.g. new location, bridge works, or significant siltation)? • have there been changes to the area at risk (e.g. levee construction or increased urbanisation)? • are there new sources of information (e.g. flood studies or changes to underlying data/methods)?	DEW	SASES and all stakeholders who have relevant flood intelligence