Brisbane River Strategic Floodplain Management Plan

Australian Government

Lockyer Valley Regional Council

Somerset Regional Council

City of Ipswich

Brisbane City — Dedicated to a better Brisbane

Queensland Government

The *Brisbane River Strategic Floodplain Management Plan* project is a joint initiative of the Australian Government, Queensland Government, Brisbane City Council, Ipswich City Council, Lockyer Valley Regional Council, Somerset Regional Council and Seqwater.

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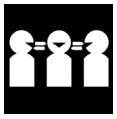

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The Brisbane River Strategic Floodplain Management Plan (Strategic Plan) is a non-statutory guide for delivering a coordinated approach to managing flood risk across the Brisbane River floodplain, now and into the future. It sets out a range of strategies and actions for state and local governments to consider in order to strengthen the flood resilience of the region. The strategies and actions can be applied to a range of floodplain management measures that include but are not limited to land use planning, disaster management, building controls and structural mitigation options.

This Strategic Plan is a resource for state and local governments to enable the coordinated implementation of flood resilience actions over time. Its purpose is to facilitate regionally consistent flood risk management outcomes for the region, with flexibility in local implementation approaches and processes. It does not alter the statutory effect of existing legislation and policy.

The Strategic Plan provides the basis from which local governments will further their understanding of flood risks and impacts at the local level through the development of Local Floodplain Management Plans.

Our Shared Vision

residents, businesses, community groups and governments working together to better manage flood risk and strengthen the resilience of our communities, our economy, our infrastructure and our environment

Foreword

The Brisbane River Strategic Floodplain Management Plan provides the blueprint for how we will better prepare for and manage flood risk across the Brisbane River floodplain.

This plan has been developed in proud partnership between the Queensland Government, the four local governments of Brisbane, Ipswich, Somerset and Lockyer Valley, and Seqwater.

It builds on 2017's Brisbane River Catchment Flood Study, which was the largest study of its kind to be undertaken in Australia, and I commend all the stakeholders who have contributed.

Floodwaters hold no regard for local government boundaries, which is why it's so important we take a whole-of-catchment, regional approach to identify more efficient ways to strengthen our flood resilience.

The Queensland Government is committed to keeping communities safe, and this strategic plan will play a major part in that for the Brisbane River floodplain area.

This work contributes to the *Queensland Strategy for Disaster Resilience and Resilient Queensland 2018-2021 – Delivering the Queensland Strategy for Disaster Resilience* vision of making Queensland the most disaster resilient state in Australia.

Professionals seeking guidance from this strategic plan are encouraged to join us in our efforts to ensure we build flood resilience in ways that support this regional plan.

Cameron Dick MP
Minister for State Development, Manufacturing,
Infrastructure and Planning

Introductory statements

Brisbane's subtropical climate makes our city a great place to live, work and relax.

Defined by its river, it's important that Brisbane is a resilient New World City that can plan for, respond to and recover from floods.

Brisbane City Council is committed to building a more liveable, resilient city – a city that is safe, confident and ready to respond to natural disasters.

The WaterSmart City priority actions in Council's Brisbane. Clean, Green, Sustainable 2017-2031 is our long-term approach to managing and reducing the risks of flooding for Brisbane residents, businesses and infrastructure.

The challenge of managing floods also needs a whole-of-catchment approach that transcends local government boundaries. The Brisbane River Strategic Floodplain Management Plan embodies this approach, outlining actions that support resilience across the Brisbane River catchment.

In combination with the Council of Mayor's Resilient Rivers Initiative, this work provides a coordinated approach that helps us work together to improve community safety and reduce the impacts of flooding.

While we cannot prevent flooding altogether, we now have the best possible information and framework to ensure our community is prepared, adaptable and can recover more quickly after a flood.

Adrian Schrinner
Lord Mayor
Brisbane City Council

Ipswich City and its region is no stranger to river flooding having experienced significant events in 1893, 1974 and 2011.

The flood of 2011 was a stark reminder that we live, work and play in the Brisbane and Bremer River floodplains, and given the right climatic conditions, flooding can and will occur again.

Despite these events we witnessed incredible examples of community resilience, determination and mateship in the aftermath.

Flooding in the Brisbane and Bremer River catchment is not just an issue that affects Ipswich. It is a regional issue determined by a single large catchment that also affects the council areas of Somerset, Lockyer Valley and Brisbane.

The Strategic Floodplain Management Plan is the outcome of the Brisbane River Catchment Flood Studies in response to the Queensland Floods Commission Inquiry.

The catchment studies encompass an extensive body of work which required a strong collaborative partnership across state and local governments, and many other entities involved in the Brisbane and Bremer River floodplains.

The plan provides a framework for the four local governments (and other entities) to strategically assess and develop regionally consistent approaches to improving community resilience to the impact of future floods.

Ipswich City Council will refer to the Brisbane River Strategic Floodplain Management Plan when formulating a Local Flood Management Plan for the Bremer River.

Major floods will happen again.

By adopting a coordinated regional approach it will be possible to better manage flood risks in the future.

David Farmer
Chief Executive Officer
Ipswich City Council

Living with flooding is a part of life in the Brisbane River catchment. We live in a sub-tropical climate so from time to time we will experience flooding and as a community we need to be informed, ready and resilient.

The floods experienced across Queensland in 2010/11 was the catalyst for change in how we understand our flood risk and plan for the future.

Flood waters cross local boundaries and taking a whole-of-catchment approach allows us to understand the bigger picture and better manage flood risk together.

Local governments will now use the Brisbane River Strategic Floodplain Management Plan to inform local floodplain management plans to apply regionally consistent approaches to increase flood resilience in their communities.

Cr Graeme Lehmann
Mayor
Somerset Regional Council

Following the historic floods of 2011, it was vital for Lockyer Valley Regional Council to take action and ensure we were doing everything possible to protect our community.

While it's impossible to avoid flooding events altogether, the Brisbane River Catchment Flood Study is a key part of the puzzle in providing the information we need to strengthen the resilience of our growing community.

Using the data from the Study, the Brisbane River Strategic Floodplain Management Plan will be instrumental in undertaking local flood risk assessments for residential properties as well as new infrastructure projects.

It has been a challenging, but rewarding journey since 2011 and a pleasure to partner with State Government and other key organisations on projects such as this and the Resilient Rivers Initiative to protect the future of the Lockyer Valley.

Cr Tanya Milligan
Mayor
Lockyer Valley Regional Council

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Introduction

The floods experienced across Queensland in 2010-11 demonstrated the impact flooding can have on our community. The events reinforced that floods do not respect local government boundaries and regional-scale and multi-disciplinary approaches are necessary to better coordinate efforts to identify and respond to flood risk.

The *Brisbane River Catchment Flood Studies* (Flood Studies) responds to recommendations from the Queensland Floods Commission of Inquiry (QFCoI), including undertaking a comprehensive flood study of the Brisbane River Catchment and other (floodplain management) matters relating to land use planning, building controls and emergency management that assist us in managing the flood risk of the Brisbane River floodplain.

The Flood Studies are a partnership between the Queensland Government, Seqwater and the four local governments of Brisbane City Council, Ipswich City Council, Somerset Regional Council and Lockyer Valley Regional Council. The Flood Studies are a major program of work, which encompasses a new approach to integrated management of the Brisbane River floodplain. They represent a firm commitment between the Queensland Government and local governments to deliver on a long-term plan that will further manage the impact of future floods and enhance community safety and resilience in the Brisbane River floodplain. The Flood Studies comprises four phases and are illustrated in **Figure 1** and listed below:

Phase 1 Data Collection (2013)

Phase 2 Brisbane River Catchment Flood Study (2017)

Phase 3 Brisbane River Strategic Floodplain Management Plan and Technical Evidence Report (2018)

Phase 4 Local Floodplain Management Plans (2018-19).

The Brisbane River floodplain is the most flood impacted area in Australia. Some 1.2 million[†] people live within the Brisbane River catchment. The Brisbane River floodplain has a population of more than 280,000 people and almost $300 million in annualised damages. As our population grows, this will increase.

Increasing our flood resilience is necessary to improve community safety and reduce the costs of floods.

[†] Geoscience Australia 2016.

Figure 1 – Phases of the Brisbane River Catchment Flood Studies

The peer reviewed *Brisbane River Catchment Flood Study (*Flood Study) took four years to complete using industry leading modelling techniques. The Flood Study modelling provides a better understanding of flood behaviour based on a range of scenarios looking at the location of rainfall, ground conditions, sea levels and dam water levels. While we can't prevent flooding from occurring, a greater understanding of catchment behaviour can help us improve how we prepare and respond to the various flood events that may come our way.

This *Brisbane River Strategic Floodplain Management Plan* (Strategic Plan) has been informed by more than 18 months of work by a range of key stakeholders. It outlines our shared understanding of current and future flood risk in the Brisbane River floodplain. It also identifies the desired outcomes and strategies for the ongoing management of the floodplain and contributing catchment, and identifies a suite of actions that the Queensland Government, Seqwater and the four local governments will work towards to improve community safety and reduce the costs of floods.

This Strategic Plan focuses on flooding from the Brisbane and Bremer Rivers (referred to as riverine flooding), and is the first time flood risk has been explored on a regional scale across the Brisbane River floodplain. This Strategic Plan provides guidance to a range of professions across all levels of government for more detailed consideration and implementation of consistent regional scale strategies to flood risk over time.

The Brisbane River floodplain is located within a dynamic region encompassing multiple community, environmental and economic interests. A holistic, integrated and collaborative approach, which engages these interests in decision making and action, will ensure floodplain management is effective and sustainable. An integrated planning approach involves:

- collaboration with the community and all levels of government
- capturing the connections between key strategic planning processes and building on the extensive work already undertaken
- acknowledging that a range of interests need to be considered in floodplain management
- recognising that floodplain management strategies and actions can offer multiple benefits in addition to flood risk reduction
- identifying how floodplain management strategies and actions may impact the delivery of other strategic plans.

The *Brisbane River Strategic Floodplain Management Plan Technical Evidence Report* (Technical Evidence Report) assessed the consequences which may occur for the full range of flood events, now and in the future, and how they can be managed. The Technical Evidence Report considered potential regional-scale flood management measures including structural options, land use planning, building controls, landscape management, disaster management and community resilience. This analysis provided the evidence base for making decisions about ways we can collectively manage current and future risks, informed by integrated and whole-of-floodplain considerations.

This Strategic Plan builds on the extensive work already undertaken since 2011 by the four local governments, Seqwater and the Queensland Government to better manage flood risk in the catchment. This work will continue to develop through the implementation of this Strategic Plan and the development and implementation of subsequent Local Floodplain Management Plans.

Implementation of the floodplain management strategies and actions outlined in **Section 4**, will work towards achieving these outcomes, supported by governance arrangements as detailed in **Section 5** of this Strategic Plan.

Local Floodplain Management Plans will be delivered as the fourth and final phase of the Flood Studies program of work. The Local Floodplain Management Plans will build on the Strategic Plan to establish more detailed floodplain management approaches within each of the local government areas.

This Strategic Plan provides guidance for a range of professionals involved in building flood resilience in the Brisbane River floodplain.

Supporting information contained in the Appendices includes a glossary of terms, list of acronyms and a reference list to assist in interpreting and applying this Strategic Plan.

Our shared vision for the Brisbane River floodplain

Residents, businesses, community groups and governments working together to better manage flood risk and strengthen the resilience of our communities, our economy, our infrastructure and our environment.

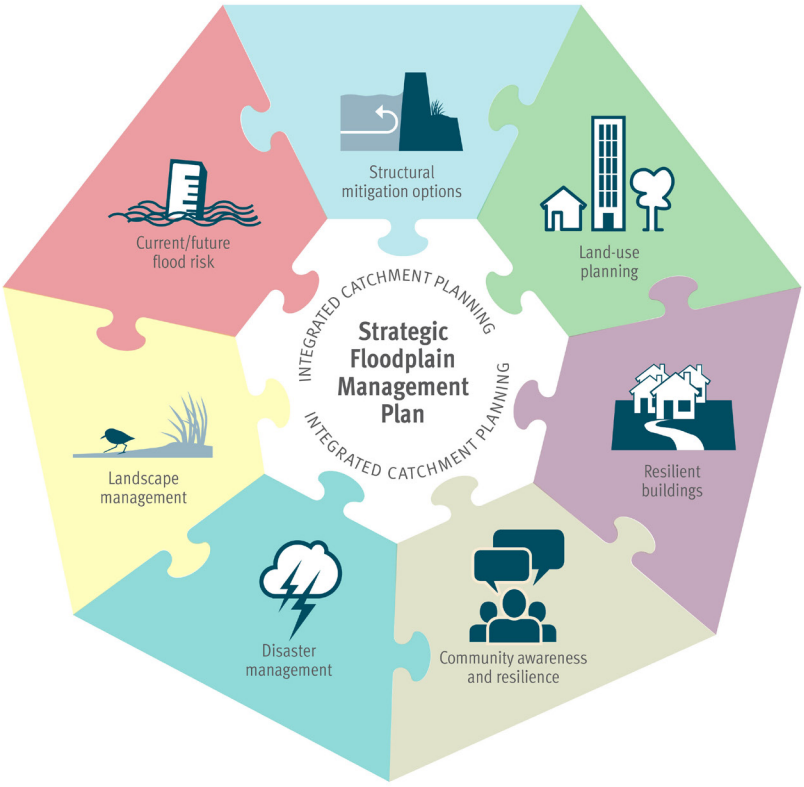


Figure 2 – An integrated approach to managing the Brisbane River floodplain

1.1 Working together to achieve our shared vision

Effective floodplain management requires an integrated and whole-of-catchment approach. Floods do not respect local government boundaries and there may be cause and effect impacts experienced in different parts of the catchment. **Figure 2** illustrates the coordinated approach across a range of disciplines for delivering flood resilience.

This Strategic Plan has been developed as a partnership between the Queensland Government, Seqwater and the four local governments located within the Brisbane River floodplain. Collaboration and engagement within each of these organisations has been critical to the successful development of this Strategic Plan and has involved a range of professions including engineering, planning, community development, disaster management, transport, environment and communications.

A coordinated approach to each (flood resilience) measure shown in **Figure 2** helps to reduce the impact of flooding in different ways and enhance the flood resilience of communities in the catchment. Measures such as land use planning and structural options focus on the reduction of exposure to flooding whereas community awareness and resilience are aimed at improving how we prepare for, respond to, and recover from floods.

This multi-disciplinary approach has informed the development of nine desired outcomes for flood risk management. When implemented these outcomes will support the delivery of our shared vision and guide the regionally consistent and integrated response required for robust floodplain management of the Brisbane River floodplain. The nine desired outcomes are:

1. floodplain management initiatives are delivered using a holistic, integrated and collaborative approach
2. floodplain management initiatives are informed by a regional understanding of current flood risks
3. future climate change impacts are recognised and planned for through adaptation and resilience building
4. community awareness, understanding and response is the foundation for community resilience
5. land use is planned, located and considers design elements to ensure development appropriately responds to the level of flood risk
6. building design and construction improves community resilience and reduces property damages
7. infrastructure is used to reduce flood risks where appropriate
8. landscape management is planned across the catchment in a way that contributes to flood risk reduction
9. disaster management planning and response applies a regionally consistent approach whilst recognising local flood risks.

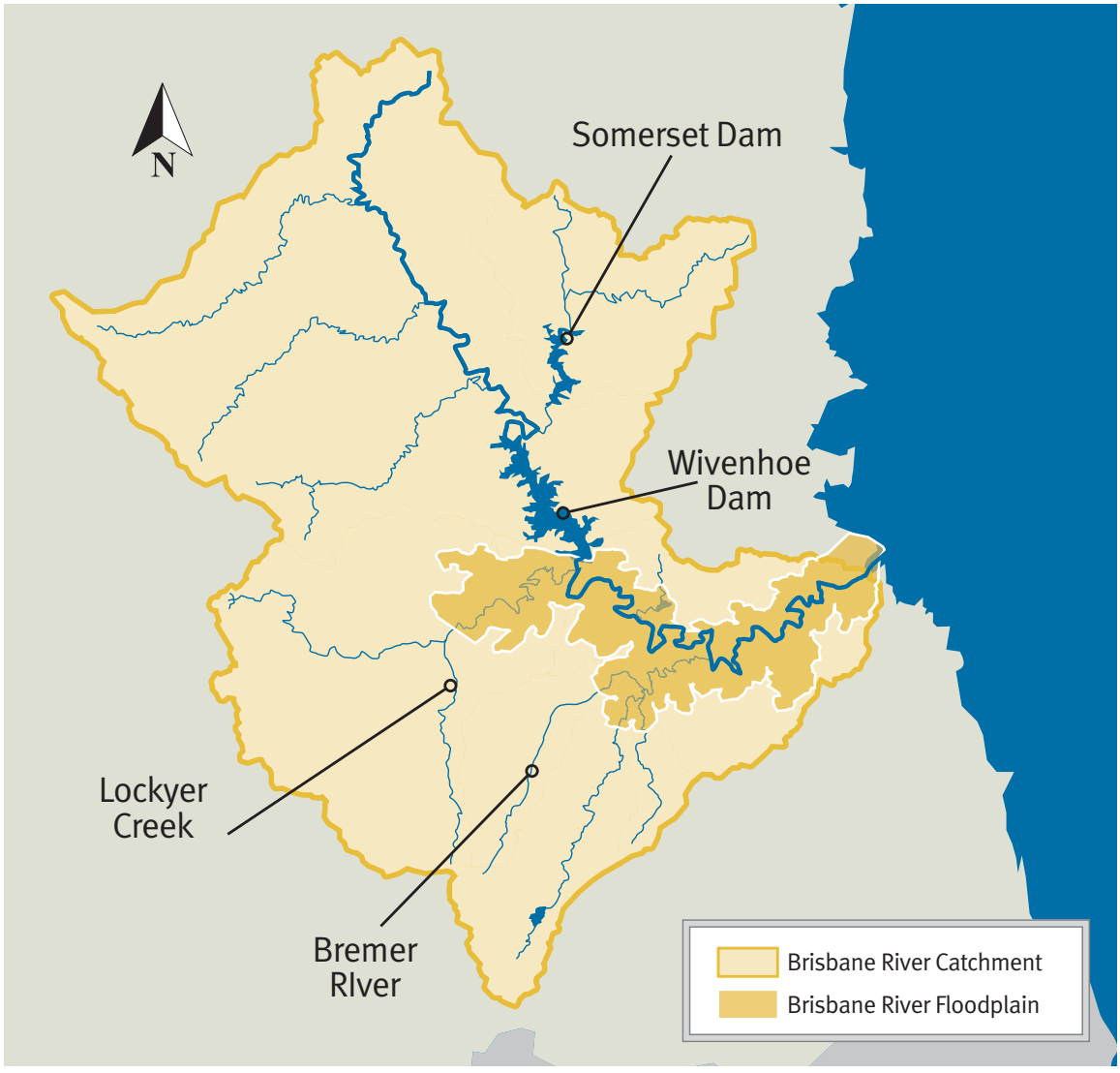
1.2 About the study area

The Brisbane River Catchment spans approximately 13,570 square kilometres and is home to the largest river in South East Queensland. Approximately half of the catchment drains into the Wivenhoe and Somerset Dams, providing the primary source of water supply for communities located in the region.

The focus for the Flood Studies is on flooding in the Brisbane River floodplain downstream of Wivenhoe Dam to Moreton Bay, as well as the lower reaches of the major tributaries of Lockyer Creek, Oxley Creek and the Bremer River. However, flooding from local creeks and tributaries within the study area are not addressed.

The Flood Study investigated regional-scale flooding on the Brisbane River floodplain that would be caused by substantial rainfall across the Brisbane River Catchment. The Brisbane River floodplain extends into parts of the four local governments of Brisbane, Ipswich, Somerset and the Lockyer Valley (refer **Figure 3**). The Flood Studies also included a five kilometre buffer area around the floodplain to consider any indirect implications of flooding from the Brisbane River.

Figure 3 – Brisbane River catchment and floodplain



1.3 Key influences on the development of this Strategic Plan

Queensland Floods Commission of Inquiry recommendations

In January 2011, Queensland experienced widespread flooding that caused extensive damage to both public and private property, the evacuation of towns and the loss of more than 30 lives.

The *Queensland Floods Commission of Inquiry (QFCoI) Final Report* was released in March 2012 and recommended a comprehensive flood study of the Brisbane River Catchment be completed to identify the probability and extent of various floods occurring. Key recommendations included:

- Recommendation 2.2 – *'as soon as practicable, a flood study of the Brisbane River catchment should be completed.'*
- Recommendation 2.12 – *'councils in floodplain areas should, resources allowing, develop comprehensive floodplain management plans that accord as closely as practicable with best practice principles.'*

In addition, a range of other recommendations were made relating to land use planning, development regulation, building controls, emergency management, community awareness and other matters relevant to managing the Brisbane River floodplain.

The 2011 floods and outcomes of the QFCoI represent a benchmark against which future major flood events in the Brisbane River catchment will be compared.

Queensland Audit Office review of flood resilience since the 2011 floods

In 2016, the Queensland Audit Office (QAO) undertook a review of the effectiveness of flood resilience activities since the 2011 floods, focusing specifically on the four local governments covering the Bremer, Lockyer, Mid and Upper Brisbane River Catchment; namely Ipswich, Somerset, Lockyer Valley and Scenic Rim. The findings concluded that a coordinated strategic approach that manages risk at a whole-of-catchment scale is required. It also recognised that the absence of such an approach is a missed opportunity to undertake integrated catchment management, incorporating flood risk mitigation with other elements of catchment management such as water quality, biodiversity and recreational activities.

A key recommendation of QAO (2016) was that the Queensland Government coordinate flood resilience activities and funding on a catchment scale in collaboration with local governments and other relevant entities, to effectively identify, assess, prioritise and manage catchment scale flood risks.

Local government

Each local government within the floodplain is continuously refining responses to flood risks as resources permit, through the integration of best practice floodplain management principles in their community engagement, disaster management, land use planning and other floodplain management activities. Collaboration at a whole-of-catchment level and guidance for the preparation of Local Floodplain Management Plans for the Brisbane River catchment will enhance the effectiveness, integration and consistency of these local scale initiatives.

Queensland State Planning Policy - adoption of a risk-based planning approach

The QFCoI recommendations relating to land use planning have been incorporated into a range of state planning instruments including the *Queensland Planning Act 2016* and the *State Planning Policy July 2017*.

The Natural Hazards, Risk and Resilience policies and guidance material was updated as part of the State Planning Policy July 2017 review. This update incorporates a risk-based land use planning approach as recommended by the QFCoI. This approach has been further supported by the *2015 Productivity Commission Report into Natural Disaster Funding (Volume 1*) and is recognised as best practice by the Planning Institute of Australia in supporting community resilience to natural hazards as outlined in the *National Land Use Planning Guidelines for Disaster Resilient Communities (2016)*.

SEQ Regional Plan – aspirations for flood resilience

The *ShapingSEQ – South East Queensland Regional Plan 2017* (*ShapingSEQ*) identifies this Strategic Plan as an action for natural hazard management (flood risk) within the Brisbane River Catchment, for the purpose of ensuring *'the resilience of SEQ communities to flooding through a coordinated approach to management of risk to acceptable levels'*.

Queensland Disaster Resilience Policy

The *Queensland Strategy for Disaster Resilience* was updated in 2017 to incorporate climate change risk and deliver a comprehensive 'all hazards' approach to building disaster resilience throughout Queensland. Further to this, the *Queensland Strategic Policy Framework for Riverine Flood Risk Management and Community Resilience* was developed in 2017, which also informs this Strategic Plan.

Queensland State Natural Hazard Risk Assessment 2017

The Queensland Disaster Management Committee endorsed the *Queensland State Natural Hazard Risk Assessment* (Risk Assessment) on 28 August 2017 as an 'all hazards' assessment of natural hazard risks to the state of Queensland. The Risk Assessment identifies that *"riverine flooding is of equal highest priority (natural hazard risk) for Queensland. However a range of climate influences, as indicated within this report, may give rise to riverine flooding, thereby making it a more frequently manifesting hazard."*

The approach to flood risk management underpinning this Strategic Plan aligns with the risk management approach of the *Queensland State Natural Hazard Risk Assessment 2017* and the *Queensland Emergency Risk Management Framework*.

Queensland Climate Adaptation Strategy 2017

The *Queensland Climate Adaptation Strategy 2017* (Q-CAS) provides a framework for the Queensland Government to lead action on adaptation to climate change. The Q-CAS acknowledges the risks associated with a changing climate and is an important point of reference in understanding and responding to climate change related impacts on future flood risks within the Brisbane River floodplain.

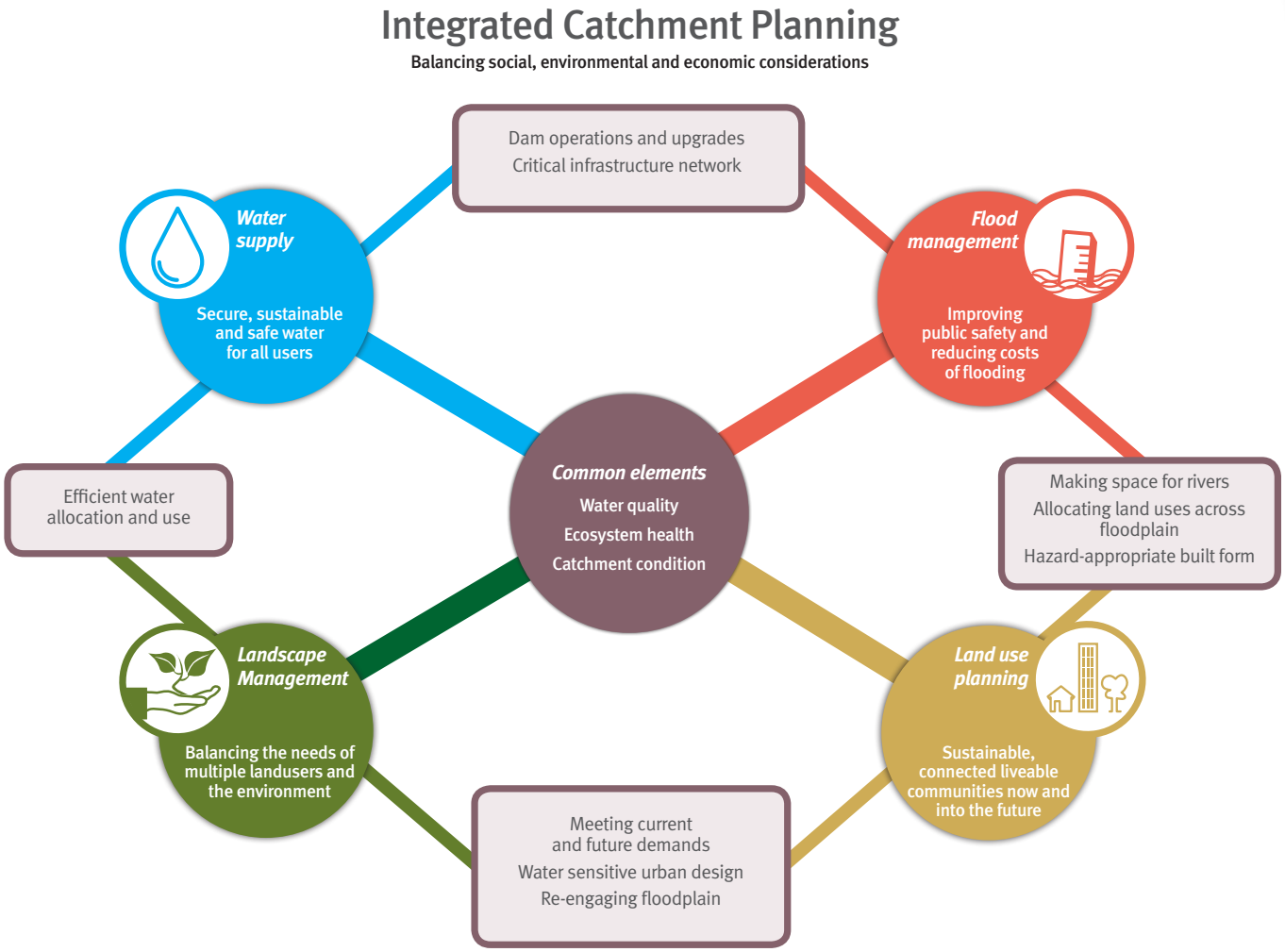
1.4 An integrated catchment planning approach

An integrated catchment planning approach will ensure appropriate linkages are made with other planning processes to deliver multiple benefits for the region and avoid unintended outcomes. **Figure 4** provides a visual representation of this approach and shows how the common elements between the planning processes occurring in the catchment are considered. Refer to Section 3.1 of the Technical Evidence Report for further detail about this collaborative approach.

The success of integrated catchment planning is influenced by several key elements as discussed in QAO report, including:

- recognising and balancing the relationships between cause and effect impacting on people, property, infrastructure and ecosystems within a catchment
- a coordinated approach from all levels of government
- community and private enterprise engagement.

Figure 3 – Integrated Catchment Planning components



Strategic planning processes for the Brisbane River Catchment include:

- **Land use planning** – the Queensland Government's *ShapingSEQ* sets out a regional framework for sustainable growth, global economic competitiveness, world-class infrastructure, ecological and social sustainability and high quality living. *ShapingSEQ* was developed through extensive community engagement and collaboration between all levels of government. It considers the need to protect our natural environment and lifestyle in addition to managing future growth. Local governments are required to reflect the relevant outcomes of *ShapingSEQ* through their local planning instruments.

- **Floodplain management** – the focus of the Flood Studies is to deliver complementary regional and local structural and non-structural measures that improve public safety and reduce flood damages across the Brisbane River Catchment.

- **Water supply** – Seqwater is responsible for providing 'a safe, secure and reliable water supply' to South East Queensland. Seqwater has adopted a whole-of-catchment approach to water quality and recognises that water treatment begins at the source. In addition to being South East Queensland's primary bulk water provider, Seqwater offers public recreation facilities as well as essential flood mitigation services through the operation of Wivenhoe and Somerset dams for flood storage. Of particular relevance to this Strategic Plan is the planning work underway for upgrades to the Somerset and Wivenhoe dams.

- **Landscape management** – the South East Queensland Resilient Rivers Initiative aims to improve the resilience and health of the region's waterways through the development of Catchment Action Plans for key catchments throughout South East Queensland. Catchment Action Plans aim to enhance investment collaboration across local government boundaries by a number of investors. Catchment Action Plans have been completed for the Lockyer, Mid Brisbane, Lower Brisbane/Redlands and Bremer catchments. Local Floodplain Management Plans will be incorporated into revisions of the Catchment Action Plans as appropriate.

'reflect the local context and integrate with other planning processes'

Sayers et. al 2014: *10 Golden Rules for managing floods*

Understanding our flood risk

2.1 Landscape characteristics that influence flood behaviour

The Brisbane River valley was carved out of bedrock over millions of years as waters drained from the catchment into Moreton Bay. This river valley is relatively narrow with steep sides in some places, and has a generally flat base that has been infilled by sediment washing off the catchment over millennia. The Brisbane River Catchment is capable of generating large volumes of floodwaters depending on the magnitude and extent of a major rainfall event and the condition of the catchment (e.g. soil moisture). Just 1 millimetre of run-off across the whole catchment is sufficient to fill over 5000 Olympic-size swimming pools.

Most floodplains contain three functional areas as follows:

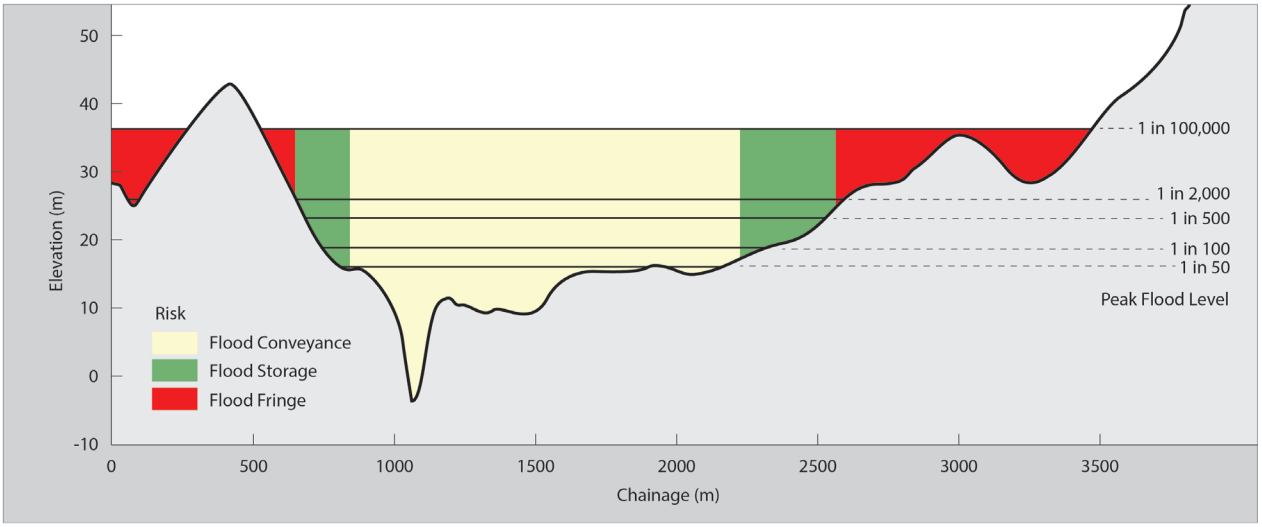
- **Flood conveyance** is where the vast majority of water flows and where flood waters are typically deep and fast flowing during big floods
- **Flood storage** areas are parts of the floodplain that fill up with floodwaters, and are then temporarily detained during a flood. (Flood waters in these areas are typically deep and slow moving)
- **Flood fringe** represents the remainder of the floodplain, which features generally shallower flooding.

The function of the floodplain varies between different flood events, i.e. flood fringe areas in smaller floods may become flood storage areas in larger, rare events.

Downstream of Wivenhoe Dam, the Brisbane River valley is very incised – meaning the riverbed is bounded by a steep floodplain, with several points of restriction. When flooding occurs, water quickly fills the lowest-lying parts of the floodplain. During larger floods, the spread of water is constrained by the narrow width and steep edges of the floodplain. This means that as floods get bigger, the waters rise upwards rather than dispersing sideways. In comparison, areas upstream of Amberley in the Bremer Catchment and within the Lockyer Creek Catchment have more extensive and broad floodplains that capture and temporarily store floodwaters during significant flood events.

Given it has mostly steep valley sides, there are very few areas within the Brisbane River floodplain that can be considered flood fringe (refer **Figure 4**). This means that for most of the floodplain, floodwaters in the Brisbane River can potentially be quite deep, while areas closer to the river can also flow relatively fast during big floods. This unique topography also means the floodplain is sensitive to changes in landform as most of the floodplain has an important natural function during a flood.

Figure 4 – Example river cross section showing the physical characteristics of the Brisbane River floodplain



The Technical Evidence Report introduces the concept of Potential Hydraulic Risk (HR), which has been defined based on the hydraulic behavior of floods and their likelihood of occurring. This concept was the first step in identifying flood risk however it does not define the overall flood risk. Flood risk considers a range of factors in addition to potential hydraulic risk and is best suited to be determined at the local level to reflect local context. The HR is determined by grouping similar hydraulic risks into five bands, with HR1 being the highest risk and HR5 the lowest (refer to **Appendix C** of this Strategic Plan, and Section 4.2 of the Technical Evidence Report). The HR categories broadly correlate to, and help visualise, the level of risk associated with flood conveyance, flood storage and flood fringe areas. This information can be used, along with other factors, to inform risk assessments.

Flood conveyance areas, within the Brisbane River floodplain shown in **Figure 2**, generally align with those defined as HR1 and HR2. These are the most potentially hazardous parts of the floodplain and are critical for transporting floods downstream. Flood storage areas generally align with those defined as HR3 and HR4. Changes in the topography of these flood storage areas can cause increased flood levels elsewhere in the catchment. A detailed discussion and mapping of HR areas is provided in the Section 4.2 of the Technical Evidence Report.

2.2 Terminology describing floods

Floods are described in terms of the probability of their occurrence as expressed by the term Annual Exceedance Probability (AEP). AEP refers to the probability of a flood of the nominated size or larger occurring in any given year. For example, a 1% AEP flood describes an event that has a 1 in 100 chance of being equalled or exceeded in any given year.

The 1% (1 in 100) AEP is commonly used to identify areas at risk from large-scale flooding. However, it is important to understand the risks and potential consequences of the full range of floods, from the small and frequent to the very large and rare.

The Flood Study provided estimates for 11 different likelihoods of flood events, ranging from a frequent 50% (1 in 2) AEP, to extremely unlikely with a 0.001% (1 in 100,000) AEP. The 0.001% (1 in 100,000) AEP flood inundation extent is considered the notional extreme event and in the context of the Flood Studies has been used to define the full extent of the Brisbane River floodplain.

Table 1 compares the likelihood of a range of floods occurring in an 80-year lifetime and their corresponding flood levels at Brisbane City and Ipswich gauges.

Table 1 – Likelihood for a range of flood AEPs occurring in an 80-year lifetime in the Brisbane River floodplain derived from the Flood Study

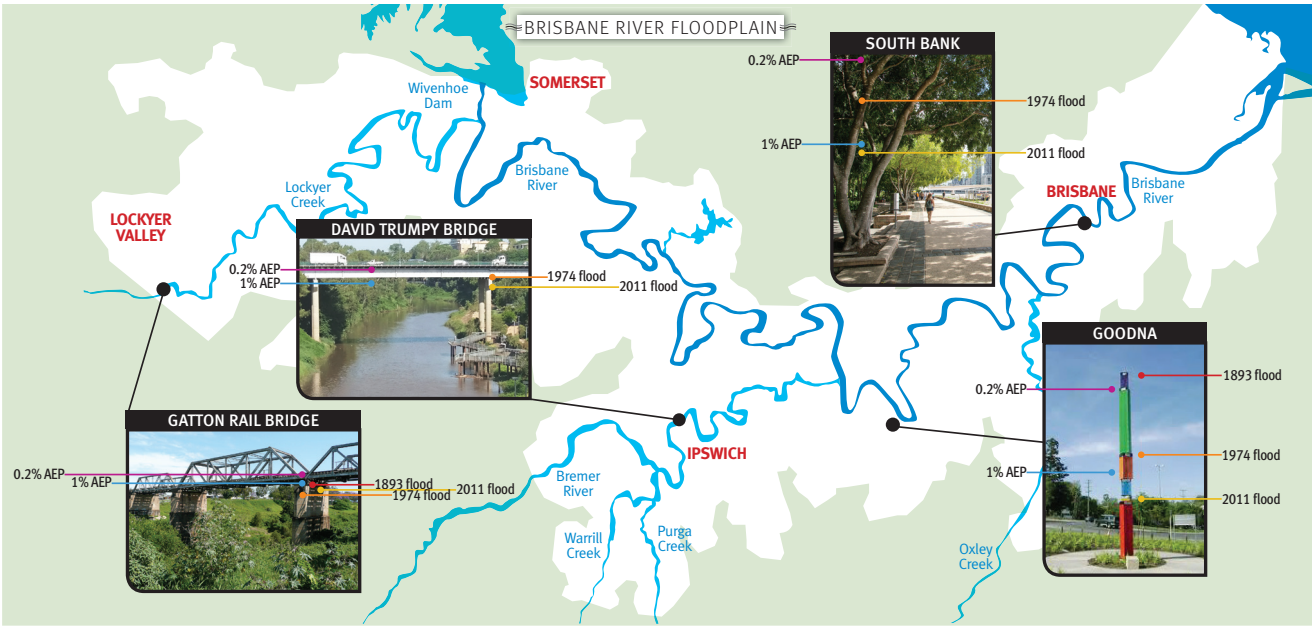
AEP	At least once in 80 years	At least twice in 80 years	Brisbane City gauge (m, AHD)	Ipswich CBD (m, AHD)
10% (1 in 10)	100%	100%	1.8	14.8
5% (1 in 20)	98%	91%	2.2	16.1
2% (1 in 50)	80%	48%	3.2	18.7
1% (1 in 100)	55%	19%	4.5	20.1
0.2% (1 in 500)	15%	1%	7.3	23.4
0.05% (1 in 2000)	4%	0.1%	9.9	25.7
0.001% (1 in 100,000)	0.1%	‹ 0.1%	23.7	36.1

2.3 History of flooding in the Brisbane River floodplain

Brisbane River flooding has occurred for millennia. Since formal records began 170 years ago, there have been a number of significant floods including in 1841, 1844, 1893 (two events), 1974 and 2011. **Figure 4** highlights the peak flood levels for the 1% (1 in 100) AEP and the 0.2% (1 in 500) AEP floods at key locations compared to major recorded floods. Modelling carried out for the Flood Study shows the 1% (1 in 100) AEP flood event is higher than the 2011 and 1974 floods in some areas, while in other parts of the floodplain it is lower. A number of factors contribute to floods inlcuding rainfall variability, ground conditions, tidal conditions and dam operations. These factors vary between flood events, meaning that no two floods are the same, and similar or larger sized floods could occur in the future.

Over an 80 year period, there is a 55 per cent chance that a 1% (1 in 100) AEP event will occur at least once.

Figure 6 – Historical flooding in the Brisbane River floodplain



Flood behaviour varies across the floodplain as a result of different combinations of rainfall across the catchment (amounts, timing and location), ground and tidal conditions, and dam operations. The level of flooding experienced in parts of the floodplain is particularly influenced by the location of rainfall, which can occur in the Bremer, Lockyer or Upper Brisbane sub-catchment areas, or a combination of any or all of these. History also shows that the occurrence of major floods does not prevent other major or moderate floods from occurring in short succession.

Localised flooding in creeks and tributaries are the result of high rainfall occurring in an isolated area of a creek catchment over a short period of time. In contrast, the majority of regional floods in the lower Brisbane River have almost always been the result of ex-tropical cyclones that delivered persistent rainfall to the region over a number of days. This Strategic Plan focuses on regional riverine floods and associated risks. Localised flooding and overland flow issues are investigated and managed separately by local governments.

Figure 7 – Flood AEPs experienced during the 2011 floods

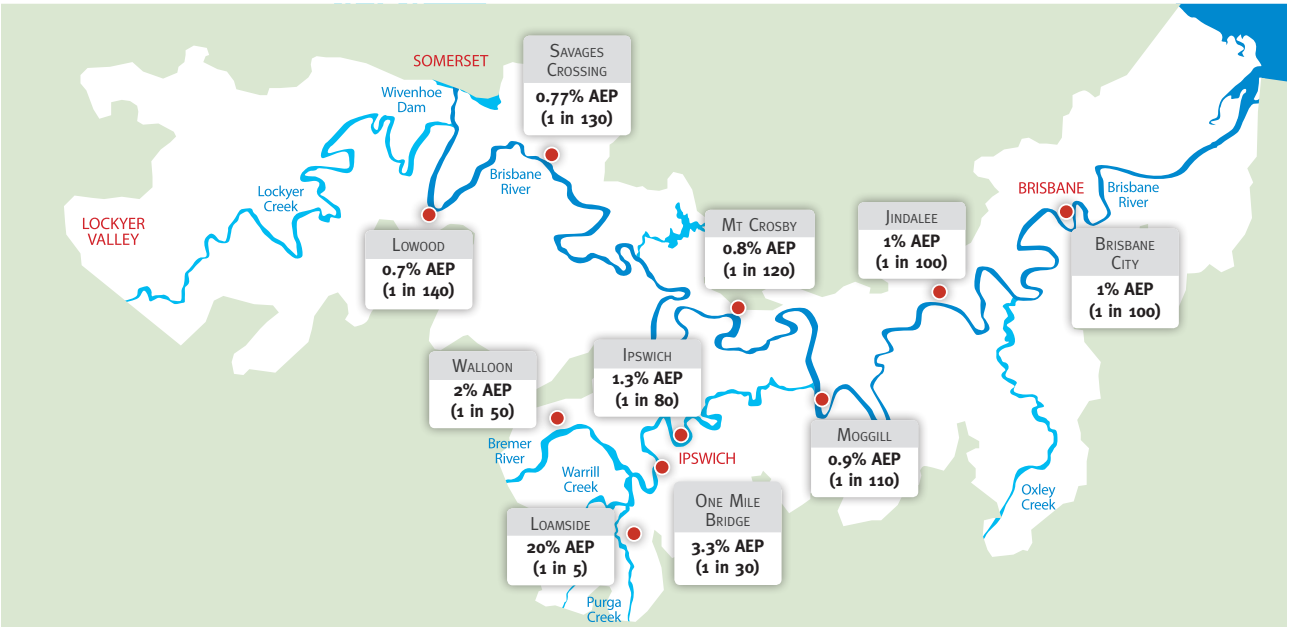


Figure 7 shows the AEPs of the peak flood levels experienced throughout the Brisbane River floodplain during the 2011 floods.

Flood levels in the Brisbane CBD were estimated to be a 1% (1 in 100) AEP, while flood levels in other areas such as Lowood reached a 0.7% (1 in 140) AEP and for Ipswich a 1.3% (1 in 80) AEP. Although significant, it was not the largest flood experienced in the floodplain.

2.4 How flood risk is determined

Risk occurs when a community is potentially affected by a hazard, such as flooding. In accordance with leading practice risk standards, including the *Queensland Emergency Risk Management Framework (QFES, 2017)*, risk is defined as the combination of the likelihood of the hazard occurring and the consequence once the hazard occurs. Likelihoods can range from very frequent to very rare, while consequences can range from insignificant to catastrophic.

Risk = Likelihood x Consequence

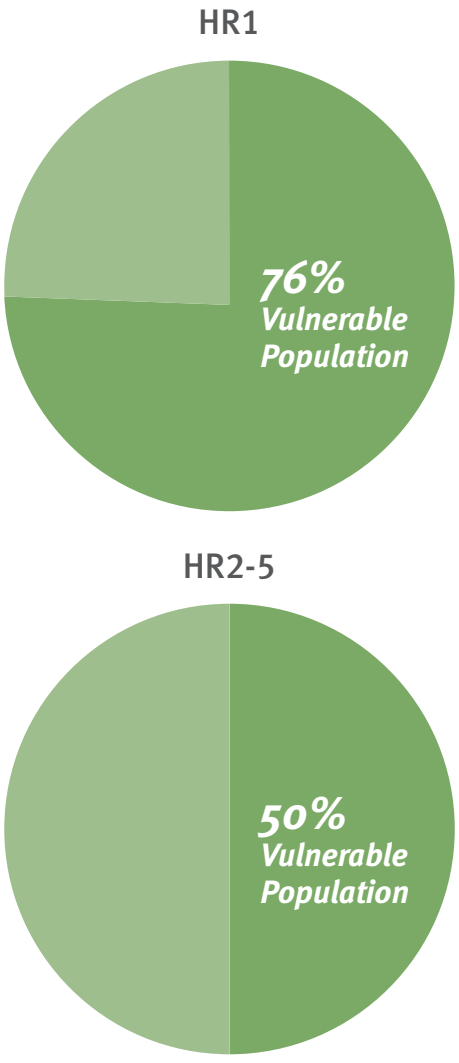
Understanding both the likelihood and consequence of a range of possible floods will inform decisions for appropriate flood risk management including assessment and selection of flood risk management measures. Risk reduction can be achieved by lowering the chance of the hazard occurring or reducing the potential consequences when it does occur.

In the context of flooding, the likelihood of a flood hazard occurring is relatively straightforward to determine (e.g. a 1% (1 in 100) AEP). The consequence of flooding is more complex and dependent on a number of factors including:

- **hydraulic behaviour** – where the flood waters will go (such as depths and velocities)
- **exposure** – land uses, buildings and population in the path of the flood
- **vulnerability** – susceptibility or sensitivity of land uses and populations to flooding
- **tolerability** – the degree to which a level of flooding is considered acceptable for the land uses and populations in the path of the flood.

Socio-economic drivers often dictate that the more vulnerable members of our community have a higher degree of exposure to hazards as these may be the only convenient and affordable areas to live. Within the Brisbane River floodplain, an estimated 2000[1] people live in the highest potential hydraulic risk category (HR1), of which three-quarters (1700 people) are considered to be highly vulnerable. However, across the remainder of the floodplain (HR2 – HR5) less than half of the population is considered highly vulnerable (130,000 of the estimated 280,000 people). Refer to **Figure 6** and Section 4.5 of the Technical Evidence Report for further detail.

Figure 7 - Vulnerable population within hydraulic risk categories



Risk-based approach

Consideration of the full range of flood risks has become embedded in best practice, as described in key flood management guidelines for Australia (Ball et al., 2016, AIDR, 2017). The SPP also requires floodplain management to adopt a risk-based approach and Queensland Fire and Emergency Services (QFES) has incorporated this approach in its *State Natural Hazards Risk Assessment 2017* and the *Queensland Emergency Risk Management Framework 2017*. This means that rather than considering hazards for a single likelihood such as a 1% (1 in 100) AEP, the total risk covering a suite of flood likelihoods and resulting hazards is to be considered, ranging from small and frequent events up to the most extreme and unlikely event.

A risk-based approach also requires judgement on what is considered to be an acceptable, tolerable or intolerable risk. The *SPP Natural Hazards, Risk and Resilience (Flood) Guidance Material* (DSDMIP, 2017) defines these as follows:

Acceptable risk is a risk that, following an understanding of the likelihood and consequence, is sufficiently low to require no new treatments or actions to reduce risk further. Individuals and society can live with this risk without feeling the necessity to reduce the risk any further.

Tolerable risk is a risk that, following an understanding of the likelihood and consequence, is low enough to allow the exposure to continue, and at the same time high enough to require new treatments or actions to reduce risk. Society can live with this risk but believes that, as much as reasonably practical, steps should be undertaken to reduce the risk further.

Intolerable risk is a risk that, following an understanding of the likelihood and consequence, is so high that it requires actions to avoid or reduce the risk. Individuals and society will not accept this risk and measures are put in place to reduce the risk to at least a tolerable level.

[1] Population numbers are indicative only based on building footprint counts (which in some areas does not identify multi-storey or multi-unit dwellings) and census averages.

Tolerability of flooding will vary along the risk spectrum from individual to individual, land use to land use, and community to community. Tolerability is largely driven by a community's awareness of flooding and resilience to impact. Tolerability may also change over time as a community changes. Tolerability cannot be assessed at a regional scale and should be determined at the local scale to establish levels of flood acceptance. The Local Floodplain Management Plans to be developed as part of the Flood Studies will establish acceptable, tolerable and intolerable risk on a local government scale.

Risk treatment involves an array of approaches including:

- **avoidance** – keeping inappropriate land use and development away from certain areas to minimise risk to life
- **accommodation** – using controls and measures to increase flood resilience and minimise damage to property
- **protection** – changing flood behaviour through structural measures such as dams, levees and floodgates
- **awareness** – ensuring the community understands their risk and can respond accordingly to maintain community safety.

2.5 Current flood risk and impacts

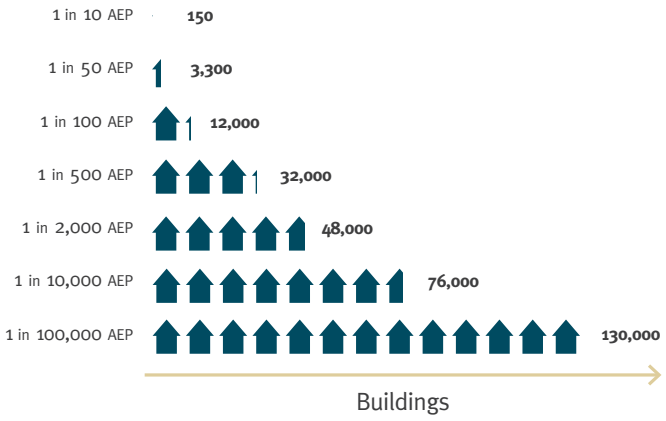
Urban development has been extensive throughout the Brisbane River floodplain over the past century (refer **Figure 4**). As of 2017, an estimated 134,000[2] buildings were located in the Brisbane River floodplain. Approximately 75 per cent of these buildings were located in Brisbane, 22 per cent in Ipswich, 3 per cent in Somerset and 0.5 per cent in the Lockyer Valley (refer Chapter 6 of the Technical Evidence Report). Existing development in the Brisbane River valley is the result of evolution from the original colonial settlements and infrastructure, as well as taking advantage of the continuing social and amenity values provided by living near water.

For a 10% (1 in 10) AEP flood, 51 buildings would flood above floor level in Brisbane, 74 buildings in Ipswich, 10 buildings in the Lockyer Valley and 15 buildings in Somerset.

For a 1% (1 in 100) AEP flood, about 17,300 buildings across the floodplain would experience flooding, two thirds of these are located in the Brisbane City Council area. Of these properties, about 12,000 are expected to be flooded above the main habitable floor level (refer **Figure 8**).

For the 0.2% (1 in 500) AEP flood, the number of buildings flooded above floor level increases to 32,000. For the extreme 0.001% (1 in 100,000) AEP flood, an estimated 130,000 buildings would be flooded above floor level.

Figure 9 – Number of existing buildings in Brisbane that would flood above the lowest habitable floor level for different sized floods



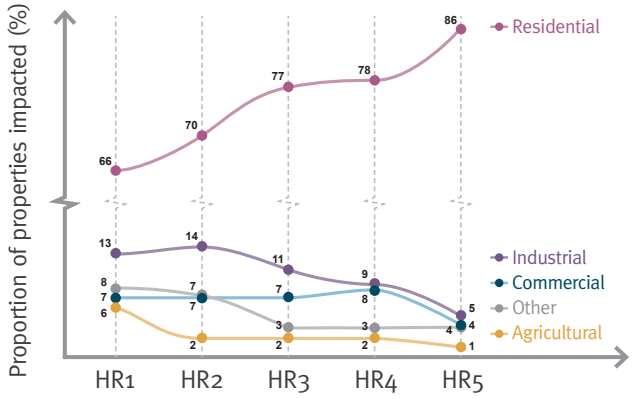
The Brisbane River floodplain is estimated to have the largest number of existing buildings of any floodplain in Australia.

[2] Building numbers are indicative only based on the limitations of the Flood Study modelling and building database as described in Section 6.3.8 of the TER.

Flood levels for different AEP events at the Brisbane City and Ipswich gauges are presented in **Table 1**. Sensitivity of the floodplain to changes in flow means that flood levels increase significantly from one AEP to the next. In the mid reaches of the Brisbane River and the lower reaches of the Bremer River, a 1% (1 in 100) AEP flood is approximately three to four metres higher than a 2% (1 in 50) AEP flood. A 0.2% (1 in 500) AEP flood is approximately four to five metres higher than a 1% (1 in 100) AEP flood.

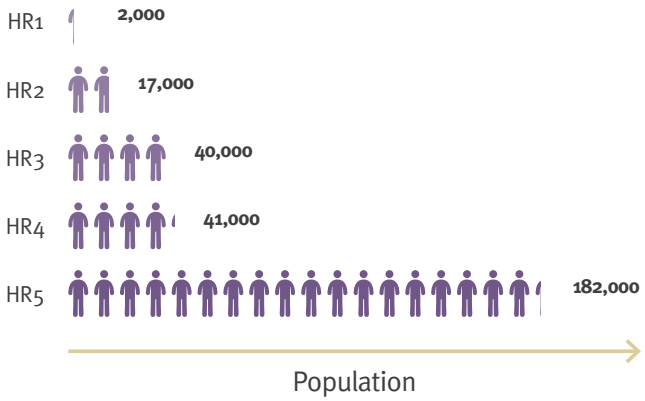
Most properties located within the Brisbane River floodplain are residential. Within HR1 areas, two-thirds of the properties are residential. The remaining properties are mostly industrial, commercial and agricultural. For lower risk areas HR2 to HR5, the proportion of residential properties progressively increases and the proportion of industrial, commercial and agricultural properties progressively decreases (refer **Figure 9**).

Figure 19 – Proportion of property types impacted by flooding in each HR area



Approximately 2000[1] (see previous page) people live within the HR1 area, which is the highest hydraulic risk area (refer **Figure 10**). Residents living in these areas may experience flooding on a regular basis, with larger less frequent floods resulting in financial losses, substantial disruption to their lives and emotional stress. Approximately 19,000[1] people live within the combined HR1 or HR2 areas.

Figure 10 – Approximate population[1] by HR areas



It is not just the occupants of directly affected properties that are impacted by flooding. A much larger section of our community can be indirectly impacted as a result of services and facilities affected by floods such as key transport network linkages, loss of power and communications and essential community services such as health and welfare support. Loss of these services and facilities can have cascading effects including an inability to work, get to school, supply shops with goods for consumption or impact on the ability to evacuate.

An estimated 280,000 people live in the Brisbane River floodplain as at 2018.

2 Population numbers are indicative only based on building footprint counts (which is some areas does not identify multi-storey or multi-unit dwellings) and census averages

2.6 Economic impacts

The *Queensland Strategy for Disaster Resilience (2017)* notes that Queensland is the most disaster impacted state in Australia. The frequency of tropical and ex-tropical cyclones and storms in Queensland means that storm and flood damage can be significant, requiring enormous disaster relief and reconstruction efforts. The Australian Government invests approximately $50 million each year in disaster adaptation funding and in the last decade spent more than $8 billion on post-disaster relief and recovery (Productivity Commission, 2014).

Economic impacts of flooding in the Brisbane River floodplain are detailed in Chapter 6 of the Technical Evidence Report. The cost of flooding in the Brisbane River floodplain has been estimated by including both tangible and intangible damages as outlined in **Table 2**.

Table 2 – Definition of tangible and intangible damages

Tangible (measurable) damages		Intangible damages
Direct	**Indirect**	
Includes costs to repair or replace damaged property, goods, perishables and infrastructure; or the loss in value if it is not repaired or replaced.	Includes the estimated loss in production or revenue, loss of wages, additional accommodation and living expenses, and any other additional expenses incurred by society due to floods. Indirect damages are estimated by adding a factor to direct residential and business losses in accordance with *Guidance on the Assessment of Tangible Flood Damages* by the Department of Natural Resources, Mines and Energy (2002).	Includes the 'social costs' of flooding reflected in increased levels of emotional stress and psychological and physical illness including loss of life. Intangible damages also includes environmental, cultural and heritage losses incurred. Intangible damages have been estimated by reviewing the social costs of catastrophic events in Australia and overseas, including the 2011 Brisbane River floods and the 2009 Black Friday bushfires in Victoria.

Refer to Section 6.1 of the Technical Evidence Report for further information

This Strategic Plan includes intangible damages in the assessment of overall economic costs.

Intangible damages are difficult to measure and meaningfully quantify in dollar terms. Nevertheless, these are very real, significant and often enduring 'costs' that emerge as a result of disasters such as floods.

Estimated damages (tangible and intangible) resulting from floods in the Brisbane River floodplain are summarised in **Table 3**.

Table 3 – Estimated cost of flooding in the Brisbane River floodplain for different size floods

AEP	Tangible ($million)	Intangible ($million)	Total ($million)
10% (1 in 10)	$39	$0	$39
2% (1 in 50)	$1,560	$190	$1,750
1% (1 in 100)	$5,150	$1,610	$6,760
0.2% (1 in 500)	$14,360	$11,050	$25,410
0.05% (1 in 2,000)	$22,960	$24,500	$47,460
0.001% (100,000)	$73,650	$127,100	$200,750

For a 1% (1 in 100) AEP flood, the total damage cost is estimated at approximately $6.8 billion ($1.6 billion intangible and $5.2 billion tangible). Refer to **Figure 11**. These costs are comparable to actual damages incurred in the Brisbane River floodplain as a result of the 2011 floods.

When considering the likelihood of all floods, the total cost of flooding can be calculated on an annual average basis , which is referred to as the Average Annual Damages (AAD). This is the cost incurred by flooding each year when averaged over a significant period of time.

The AAD in the Brisbane River floodplain is $289 million per year, comprising $187 million for tangible damages and $102 million for intangible damages.

Average annual damage

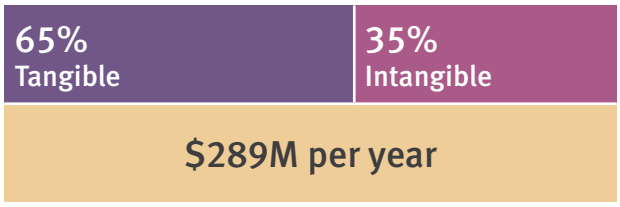
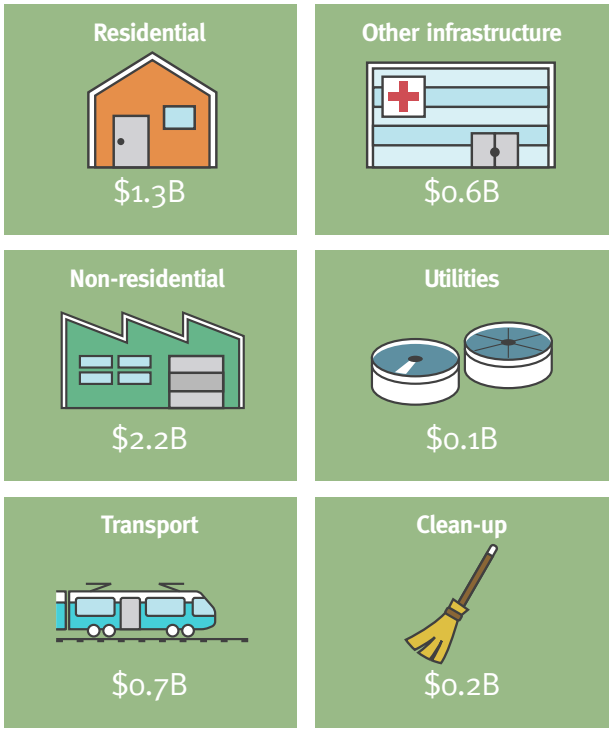


Figure 12 - Expected tangible costs for a 1% (1 in 100) AEP flood



= $5.2B total

By comparison, tangible damages in the Hawkesbury-Nepean River are estimated at approximately $80 million per year. The Hawkesbury-Nepean River has its own strategic plan and is a catchment somewhat comparable to the Brisbane River in its size. Located on the outskirts of Sydney, it has long been regarded as one of the most dangerous for flooding due to the significant flood depths and evacuation difficulties for local communities.

The Brisbane River has the highest potential flood damages of any floodplain in Australia.

The high flood damage costs for the Brisbane River floodplain is due to the large number of properties potentially affected by rare but devastating events. More than 70 per cent of the total AAD is due to floods that are rarer and larger than the 1% (1 in 100) AEP flood (refer **Figure 12**).

Figure 12 – Percentage of Average Annual Damages for AEP floods

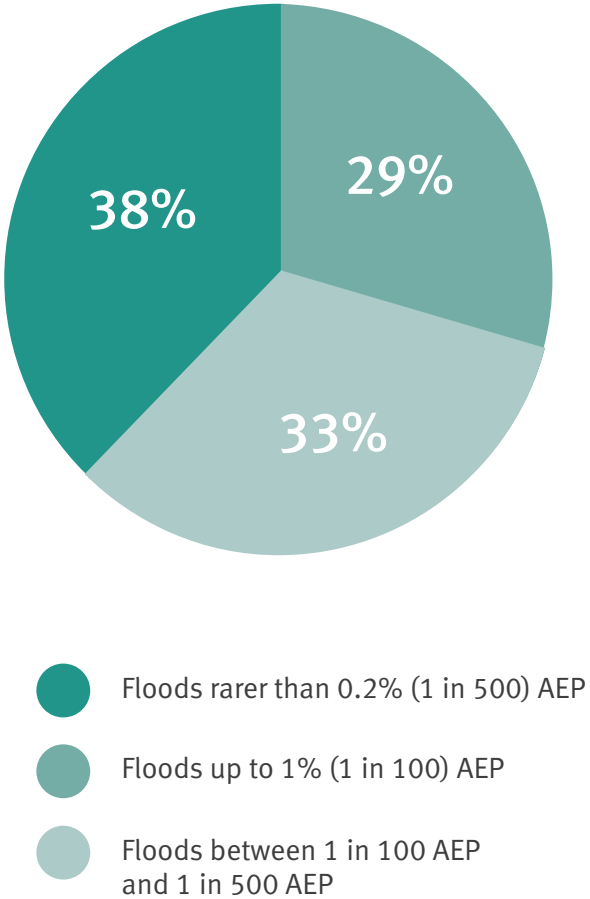
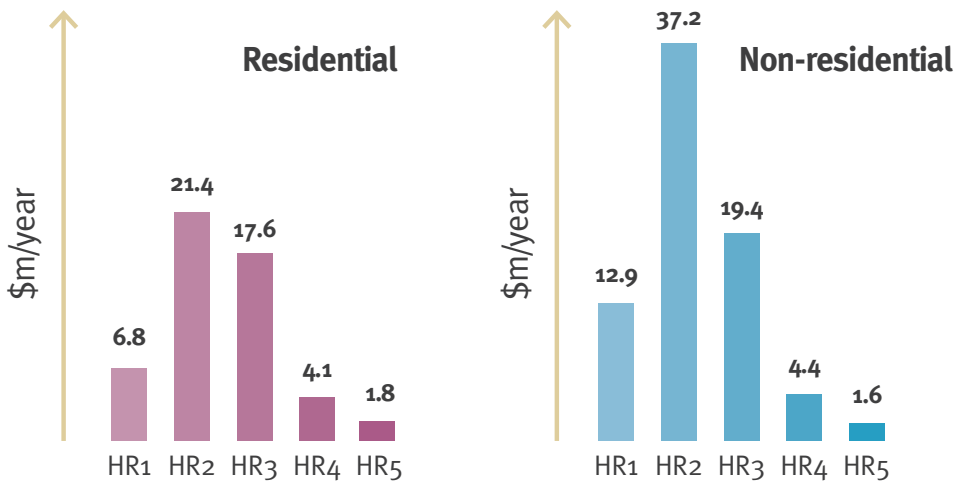


Figure 13 – Estimated property damage costs by Hydraulic Risk categories



The AAD for the Brisbane River floodplain has also been calculated for residential and non-residential properties across different Hydraulic Risk areas. HR1 is the highest risk area and contains 880 residential and 460 non-residential buildings, from which tangible damages of $6.8 million per year and $12.9 million per year would be derived, respectively (refer **Figure 13**).

Impacts to property within HR2 contribute the most to the AAD for both residential and non-residential damages due the high frequency of flooding.

HR5 contains by far the largest population and largest number of buildings (approximately 83,000). However, its contribution to the AAD is minor as it is very rare for these properties to be impacted.

2.7 Existing dam flood operations

Both Somerset and Wivenhoe dams include purpose-designed flood mitigation capacity and are well located within the Brisbane River catchment to provide significant flood mitigation during many flood events.

Impacts from floods in 1999 and 2013 were mitigated to the extent that potentially Major flood conditions were reduced to only Minor flood levels. In 2011, the dams effectively reduced peak flood levels by 2.8 metres at Ipswich, 2.3 metres at Fernvale, 3.2 metres at Moggill and 2 metres at Brisbane City. These estimated flood levels are relative to the equivalent 'no dams' scenario modelled in the Flood Study.

Central to the dams' ongoing flood mitigation effectiveness is the ability to establish flood operation procedures that reduce adverse impacts downstream. Planning for the reduction of flood impacts requires an understanding of potential damages across the range of Brisbane River flood flows.

Estimates of the number of flooded properties and buildings (based on 2017 development) for various Brisbane River flow rates are shown in **Figures 14 and 15**. These figures show the impacts for flow rates at Moggill up to 10,000 cubic metres per second.

The impact bands shown in **Figures 14 and 15** are based on consideration of:

1. AEP flood impacts (for Brisbane River and tributary inflows) incorporated in the Technical Evidence Report

2. additional modelling of constant Brisbane River flows downstream of Wivenhoe Dam with no inflow contributions from downstream tributary catchments.

Figure 14 – Number of properties flooded above ground level

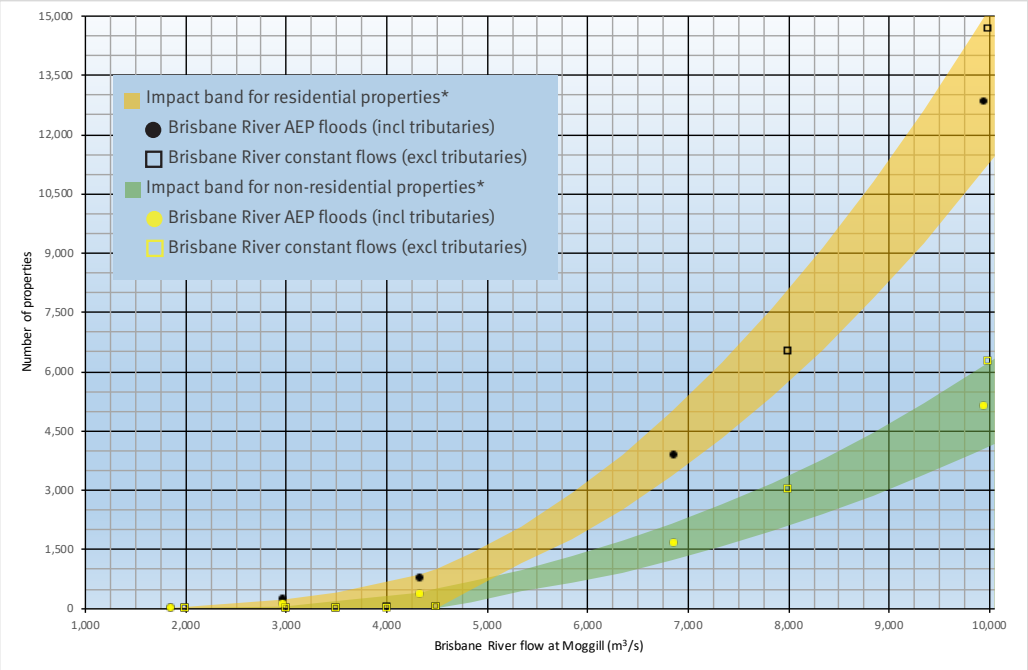
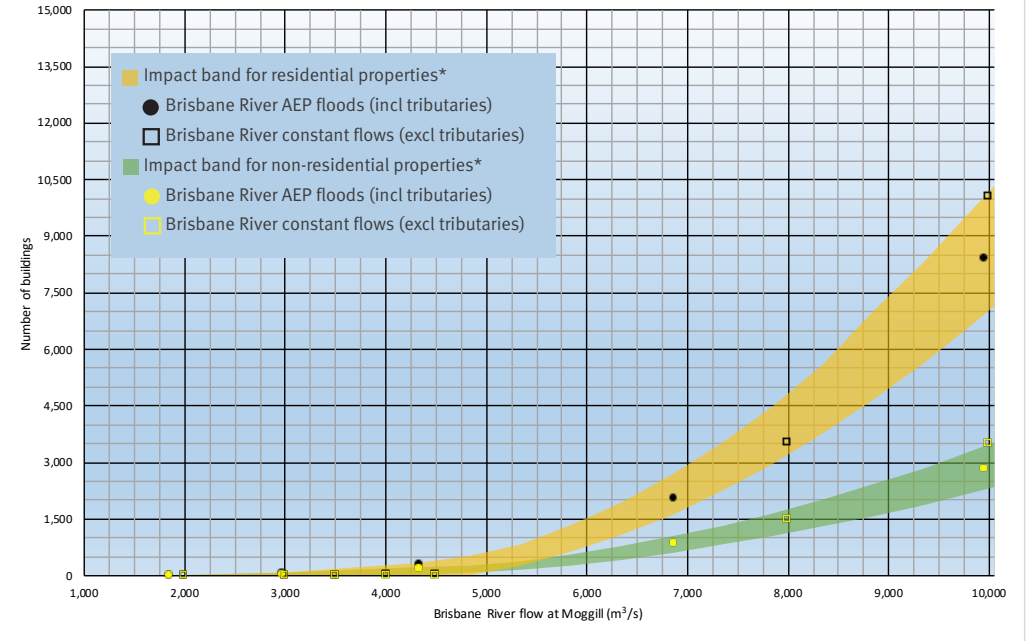


Figure 15 – Number of buildings flooded above floor level



2.8 Environmental benefits

Risks to community safety and property from flooding are significant. However, the environmental and economic benefits of floods should also be acknowledged in the context of floodplain management as highlighted in *Understanding Floods: Questions and Answers* (State of Queensland, 2011) as follows.

"In many natural systems, floods play an important role in maintaining key ecosystem functions and biodiversity. They link the river with the land surrounding it, recharge groundwater systems, fill wetlands, increase the connectivity between aquatic habitats, and move both sediment and nutrients around the landscape, and into the marine environment. For many species, floods trigger breeding events, migration, and dispersal. These natural systems are resilient to the effects of all but the largest floods.

The environmental benefits of flooding can also help the economy through things such as increased fish production, recharge of groundwater resources, and maintenance of recreational environments."

The natural variation in the flow regime is required to sustain freshwater ecosystems. This includes flood events where water flows out onto floodplains or down waterways to wetlands. The flood characteristics determine the amount and quality of habitat created for different organisms to complete their life cycles, as well as providing opportunities for carbon and nutrients to be exchanged between the river and floodplains. The importance of this natural cycle for the Moreton Bay area was considered in the preparation of the Queensland legislation *Water Plan (Moreton) 2007*.

Flooding can also contribute positively to the rural economy through the replenishment of groundwater aquifers and the deposition of nutrients onto floodplains used for primary production.

Section 2.2.4 of the Technical Evidence Report provides further detailed analysis of the environmental benefits of floods.

2.9 Future flood risk

Future flood risk may be impacted by urban development as well as possible changes to our climate. There is still much uncertainty regarding conditions of the Brisbane River floodplain over the long term. Sensitivity assessments have been carried out to help understand the impact that potential future changes may have on flooding in the Brisbane River floodplain if measures aimed to mitigate such changes are not adopted.

The results of these sensitivity assessments are described below.

2.9.1 Urban development

ShapingSEQ, the regional plan for South East Queensland, indicates that the South East Queensland population is expected to grow by an additional 1.8 million people over the next 25 years. While some of this growth includes expansion of urban areas including some new areas within the floodplain, much of it will be accommodated through consolidation of existing areas. An increase in the density of existing development within the floodplain will increase the population exposed to floods, and without mitigation measures such as through appropriate land use treatments, could potentially increase flood risk in the future.

Flood levels in the Brisbane River floodplain are sensitive to filling in the floodplain as well as the anticipated changes in rainfall and sea level due to climate change.

As well as increasing the population that would be exposed to flood risk, future development within the floodplain could modify flood behaviour. This could occur through changes to landform such as filling of land in order to elevate the area above a known flood level, and introducing built structures and impervious areas. Such changes may lead to increased flood risk in nearby areas, especially if development occurs within flood conveyance areas (refer **Section 2.1** of this Strategic Plan).

Section 5.1 of the Technical Evidence Report explains how flood modelling was used to assess the sensitivity of flooding to filling areas identified for future urban development. This work was based on two scenarios considered to represent the lower and upper bounds of flooding. The results of the modelling demonstrate that cumulative impacts across these future urban areas could potentially lead to sizeable increases in flood levels across the floodplain. For example, in the 1% (1 in 100) AEP flood event the upper bound impacts result in flood level increases of 0.9 metres at David Trumpy Bridge (Ipswich), 0.4 metres at Jindalee, 0.3 metres at Moggill and 0.1 metres at Brisbane (City Gauge).

2.9.2 Climate change

Australian Rainfall and Runoff (Ball et. al., 2016) recommends climate change be considered as part of flood investigations in accordance with recommendations of the Intergovernmental Panel on Climate Change (IPCC). The IPCC provides a range of projections for future climate conditions based on an understanding of global climate and weather models. Researchers have taken these global projections and downscaled them to local areas. For the Brisbane River Catchment, local estimates for future sea level rise and changes to rainfall have been sourced from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Bureau of Meteorology (the Bureau) and the Queensland Government. These local estimates are discussed in detail in Section 5.2 of the Technical Evidence Report.

Sensitivity testing of future climate change conditions has been carried out looking at 2050 and 2090 timeframes for two IPCC scenarios that relate to different emission levels. The IPCC's Representative Concentration Pathway (RCP) 8.5 for 2090 aligns with the *Queensland Climate Adaptation Strategy 2017–2030 (Q-CAS)*. It identifies an increase in rainfall intensity of

20 per cent for the Brisbane River Catchment as well as sea level rise of 0.8 metres for adjacent marine waters. The Q-CAS states the following:

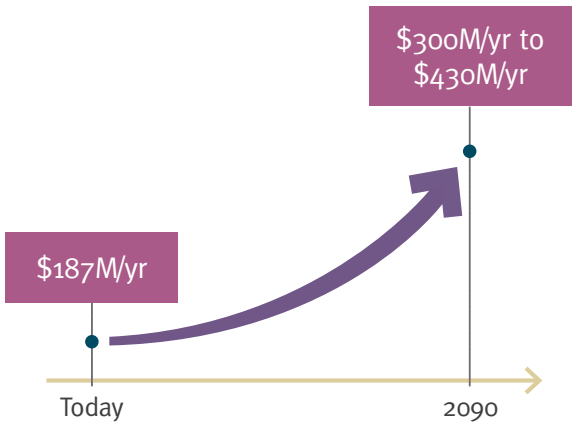
"in 2030, under a high greenhouse gas emissions scenario [i.e. IPCC's RCP 8.5 scenario], Brisbane's climate is projected to be more like the current climate of Bundaberg".

Further information about the impact of climate change on the risks posed by natural hazards in Queensland is included in the *Queensland State Natural Hazard Risk Assessment 2017*.

Flood modelling results from the projected climate changes indicate the Brisbane River floodplain is particularly sensitive to changes in rainfall, with flood levels increasing significantly in some locations. In the 1% (1 in 100) AEP event, flood levels at the Brisbane City Gauge increase between 1.2 metres to 2.5 metres across the scenarios tested. A similar trend is observed in Ipswich at David Trumpy Bridge, with flood levels increasing by 0.9 metres to 2.4 metres. As a result, the estimated average annual cost of tangible damage in the year 2090 (under RCP 8.5 and RCP 4.5 conditions) more than doubles that of current flood conditions (refer **Figure 16**).

Under the higher RCP 8.5 scenario, by 2050 the 1% (1 in 100) AEP flood level is projected to be comparable to a current day 0.5% (1 in 200) AEP level. From a risk-based perspective, if unmanaged this increase in flood severity and magnitude for a given likelihood will increase the overall risk profile across the floodplain.

Figure 16 – Climate change impacts on tangible average annual damages



Desired outcomes of this Strategic Plan

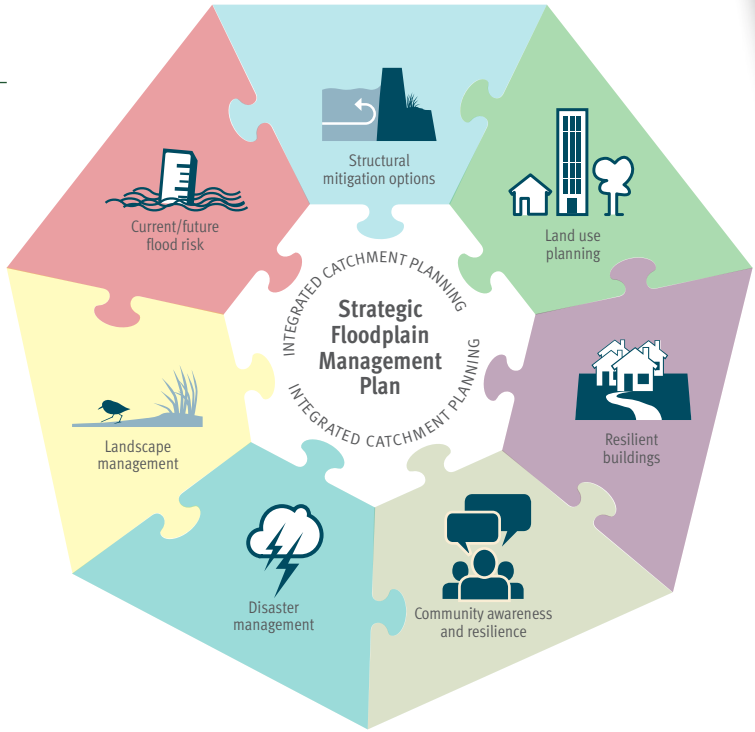
Desired outcome 1

Floodplain management initiatives are delivered using a holistic, integrated and collaborative approach

The principles of integrated catchment planning are outlined in **Section 1.4** of this Strategic Plan. It is essential that this collaborative and coordinated approach is applied within the catchment to achieve integrated outcomes for water supply, landscape management, land use planning and floodplain management. This rationale is expanded in Chapter 3 of the Technical Evidence Report.

Opportunities for information and resource sharing, and continuous improvement will be explored by stakeholders and overseen by the governance arrangements identified in **Section 5** of this Strategic Plan. The governance arrangements will support improved coordination of flood resilience actions across the floodplain and between agencies.

Outcome 1 will be achieved using the following key strategies.



Strategy 1.1 – Integrated catchment planning principles adopted in this Strategic Plan are carried forward in all future floodplain management initiatives

Future floodplain management initiatives will be delivered using integrated catchment planning principles.

Stakeholders will work collaboratively to identify opportunities and embed integration principles into the range of flood management initiatives identified within this Strategic Plan.

Stakeholders will continue to recognise other planning processes underway and engage with relevant entities to identify where projects can complement each other and avoid duplication.

Strategy 1.2 – Learnings from effective awareness and resilience activities and new research findings are shared throughout the catchment via collaborative professional forums

Evaluating the effectiveness of resilience activities more regularly and systematically across the floodplain will enable results to be shared regionally to support shared learnings for continuous improvement.

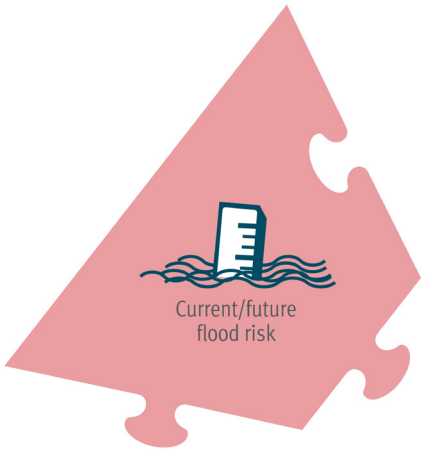
Ongoing research into emerging areas of resilience will help inform the implementation of resilience building activities. This includes consideration of the effectiveness of psychological preparedness before a flood and ongoing mental health outcomes in recovery. Research into new technologies is also a key area for consideration, including innovations such as virtual reality tools. New technologies provide opportunities to deliver more informative and persuasive visualisations, and to deliver personalised information and warnings that could more effectively contribute to attitude and behaviour change. Volunteer coordination and education programs through schools is another area of influence that can be investigated further.

To support this strategy, a program of evaluations can be undertaken and incorporated into the resilience activity compendium (part of **Strategy 4.1**) in addition to an ongoing program of evaluations and research on flood resilience. The findings of any evaluation and research program can be shared through ongoing collaborative regional arrangements with local government and state agency representatives. Representatives of peak business, professional groups, community, real estate and insurance bodies can also be involved (where required) to facilitate collaborative approaches to activities that build community resilience.

Strategy 1.3 – Consistent information sharing at a regional-scale is emphasised and supported through a cycle of continuous improvement

A key challenge identified by stakeholders is sharing information and data between agencies both during and outside of flood events. Opportunities for improved and ongoing interagency information sharing includes the following:

- Continue the approach used to develop regional-scale flood analysis and information for the development of Local Floodplain Management Plans. Delivery of a consistent approach and outputs will facilitate simpler data sharing and collation mechanisms across the region.
- Investigate opportunities to enhance information sharing, including development of standard information requests at the commencement of each wet season, regular meetings of disaster management groups across the catchment, and investigation into platforms which enhance interoperability between incident management systems.
- Adopt new products, services and findings into disaster management processes as they become available, including updated flood forecast products from the Bureau.
- Investigate options for a regional, real-time flood forecasting / modelling system to improve the ability of disaster management officers to forecast flood behaviour and impacts during a flood. This can be pursued in a staged manner such as the short-term development of simpler approaches followed by longer-term planning for a world-class, real-time flood modelling system for the region.
- Communicate implications of any upgrades to the Wivenhoe and Somerset Dams on flood risk and modelling.



Desired outcome 2

Floodplain management initiatives are informed by a regional understanding of current flood risks

A key driver for the Brisbane River Catchment Flood Studies was to develop a regional understanding of flood behaviour and consequences that is consistently considered across the catchment and not constrained by administrative boundaries.

The modelling undertaken in the Flood Study, combined with the comprehensive analysis of current flood risks within the floodplain provides this regional understanding. Refer to Chapter 4 of the Technical Evidence Report for further detail.

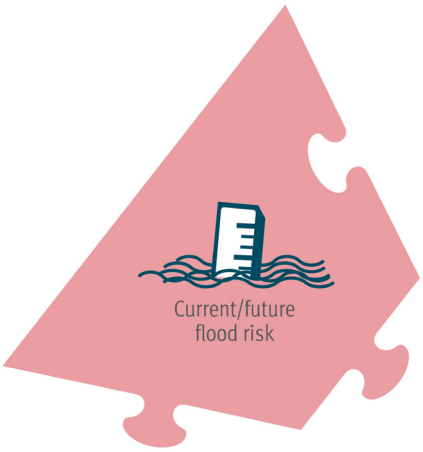
A shared understanding of Potential Hydraulic Risk (refer **Appendix C**) has been established as a common foundation for representing and comparing the hydraulic behavior across multiple flood likelihoods. Potential Hydraulic Risk in combination with other flood risk factors such as community exposure, vulnerability and isolation, provides the basis for complete flood risk assessments.

The methodology used to undertake the regional flood risk assessment, including the agreed definition of Potential Hydraulic Risk as one of the risk assessment factors, can be applied by all authorities across the Brisbane River floodplain to maintain this consistent understanding of flooding.

Outcome 2 will be achieved using the following key strategy.

Strategy 2.1 – Floodplain management initiatives incorporate a shared definition of Potential Hydraulic Risk across the floodplain

Floodplain management initiatives undertaken within the Brisbane River Catchment, which adopt the same definition of Potential Hydraulic Risk as agreed and applied in this Strategic Plan (refer **Appendix C**) will maintain a consistent, catchment-wide approach to understanding flood behaviour. This shared understanding then becomes the common basis from which locally tailored floodplain management processes are undertaken.



Desired outcome 3

Future climate change impacts are recognised and planned for through adaptation and resilience building

"There is now widespread acceptance that human activities are contributing to observed climate change. Human induced climate change has the potential to alter the prevalence and severity of rainfall extremes, storm surge and floods. Recognition of the risk associated with climate change is required for better planning"

Bates, et al., 2016, Climate Change Considerations, Chapter 6 in Book 1 of Australian Rainfall and Runoff - A Guide to Flood Estimation, Commonwealth of Australia

Section 5.2 of the Technical Evidence Report analyses the results of climate change modelling undertaken as part of the development of this Strategic Plan. Whilst the investigations undertaken are considered a sensitivity analysis, they are in line with the recommendations of *Australian Rainfall and Runoff* (Ball et al., 2016), and conclusively demonstrate that climate change has the potential to significantly alter flood behaviour in the catchment, including notable increases in flood levels (and hence flood risks) across most of the floodplain.

To achieve adaptable and resilient communities, floodplain management actions should be prioritised based on the 'no regrets' principle. That is, measures are taken with the aim of responding to possible negative impacts before they intensify, which improves the quality of life today as well as helping to mitigate future adverse conditions.

Outcome 3 will be achieved using the following key strategies.

Strategy 3.1 – Climate change is incorporated into the preparation and implementation of the Strategic Plan actions

Given the scale of potential changes to flood behaviour in the Brisbane River Catchment, climate change will require a multi-faceted response if long-term safety and resilience is to be achieved. As such, the potential impacts of climate change should be considered in the implementation of all actions of this Strategic Plan.

Ongoing monitoring of climate change and its impacts within the Brisbane River Catchment will be essential for future adaptation planning and response.

The sensitivity approach adopted to date is appropriate for use and remains consistent with best practice guidance (Ball et al., 2016). Sensitivity analysis supports decision making in the face of uncertainty by providing an understanding of the potential impacts from a range of climate change scenarios. Where analysis shows there is potential for a significant increase in impacts and/or there is limited scope for mitigation, a conservative climate change scenario should be adopted such as that outlined in RCP 8.5.

As part of the Local Floodplain Management Plans, 'no regrets actions' can be identified for immediate implementation whilst a longer-term climate change adaptation plan is established. These 'no regrets actions' provide immediate benefit, as well as helping to mitigate against adverse future changes.

Some possible actions could include:

- Adopting a managed adaptive approach, whereby action is taken when particular trigger points are observed. It is most appropriate in cases where ongoing responsibility can be assigned to tracking the change in risk, and managing that risk through pre-determined interventions. For example, incorporating larger structural foundations that would allow for future upgrades should the climate trigger unfold.

- Incorporating an allowance for climate change when considering built form. For example, using a Defined Flood Event that incorporates an additional climate change factor allowance or resilient building design to accommodate some of this exposure. This would not only reduce the consequences of larger floods (assuming no changes in climate conditions), but also future floods which may be influenced by climate change.

Strategy 3.2 – A coordinated and holistic approach is undertaken to respond to a changing climate in the future

Adapting to changes in climate will require long-term and flexible planning that is built on the best available science and linked to observable triggers. It involves collaboration and monitoring, and should consider opportunities as well as risks. Climate change adaptation planning within the Brisbane River Catchment will extend well beyond floodplain management and is best undertaken within an integrated catchment planning framework and at a regional scale.

Desired outcome 4

Community awareness, understanding and response is the foundation for community resilience

Community awareness and resilience is discussed in detail in Chapter 11 of the Technical Evidence Report. Flood resilient communities have the knowledge, skills and capacity to prepare, respond and adapt to floods. Community resilience activities focus on awareness and education, building and maintaining strong community and agency networks, and community-led actions.

Section 11.3 of the Technical Evidence Report identifies a variety of activities currently being undertaken throughout the floodplain by the Queensland Government, local governments, other agencies and communities. These activities range from broad awareness-building advertising campaigns for multiple hazards using traditional and new media, to programs targeting specific vulnerable groups using one-to-one engagement.

Whilst community awareness and resilience activities should be tailored to suit individual communities, there are opportunities for improved regional alignment, planning and coordination.

To achieve adaptable and resilient communities, stakeholders will work together to become a more flood resilient community by progressing the community flood resilience outcome of a risk-informed, appropriately-prepared and adaptable community.

Outcome 4 will be achieved using the following key strategies.

Strategy 4.1 – Regionally consistent flood terminology and approaches to resilience building activities are supported through the development of a Communication and Engagement Framework Compendium

To avoid confusion, resilience building activities require regionally consistent information and messaging. This includes consistent key messages, language and terminology, flood-risk categories, mapping outputs and mapping functionality. Regionally consistent explanations of key concepts and terminology will assist residents and visitors to understand flood-risk information and support appropriate preparedness actions.

This strategy is supported by the proposed development of a regional information resource consisting of a communication and engagement framework compendium of evaluated resilience activities and a toolkit of effective activities for local implementation. Local governments and agencies will continue to lead and implement locally responsive activities, while utilising this resource to ensure regionally consistent approaches and terminology.

Strategy 4.2 – Regionally consistent flood risk data is made available throughout the catchment to inform risk assessments and preparedness actions

Consistent flood-risk mapping data will be supported by referencing the regional Communication and Engagement Framework Compendium (part of Strategy 4.1). Regionally consistent flood risk categories, design elements (for example, the colours used for flood risk categories) and mapping functionality used for flood awareness purposes across the floodplain will increase the community's ability to easily reference and understand their flood risk.

Where not currently available, flood risk mapping should be available for property-specific enquiries and continue to be updated, improved and shared over time. This includes using new technologies to provide more targeted and geographically-specific risk information to support attitudes to flood risk and create positive behaviour change.

Strategy 4.3 – A range of engagement approaches are used to increase community involvement and strengthen social networks

Strong community networks contribute to community resilience by building the social connections between community members and governments. Awareness and educational activities that aim to strengthen social networks may be more effective at creating attitudinal and behaviour change than those without social involvement.

As well as awareness and educational resilience activities, a range of engagement approaches should be undertaken to:

- involve and empower the community in planning and decision-making related to flood risk and disaster management
- use and strengthen social networks
- support community-led initiatives.

Community involvement may also include workshops with networks of organisations to undertake continuity planning and community champion programs. This strategy may also be supported by community development training for disaster management officers.

Desired outcome 5

Land use is planned, located and considers design elements to ensure development appropriately responds to the level of flood risk

Land use planning plays a key role in avoiding or mitigating flood risk to new development, particularly in respect to managing future risk. The Queensland land use planning system requires land use planning authorities to adopt a risk-based approach for managing flood risk in local planning instruments and new development. This involves understanding flood behaviour across the full spectrum of flood hazard conditions and likelihoods, as well as the implications for future development, to determine its acceptability or tolerability to current and future flood risk.

Analysis undertaken to inform this Strategic Plan has identified that the Brisbane River floodplain is sensitive to the impacts of any future development which relies on filling. The floodplain is also sensitive to the projected effects of climate change.

Land use planning therefore has a key role to play in supporting resilience of the region's settlement pattern to current and future flood risk by ensuring a 'no worsening' of existing flood risk arises from new development. The four local government planning schemes regulate much of the development in the floodplain. However, there are other planning mechanisms such as Priority Development Area – Development Schemes, which apply in specific areas of the floodplain.

Consistent approaches to the way flood risk is identified, evaluated and treated, are proposed to support floodplain wide land use planning outcomes.

Outcome 5 includes strategies to address regionally consistent responses in the following areas:

- a regional impact assessment and 'no worsening' of flood risk as a result of cumulative land form change in the floodplain
- avoidance of vulnerable land uses involving vulnerable persons in areas of increased flood risk
- regional assessment of flood evacuation capability and evacuation networks.

Other strategies supporting regionally consistent land use planning outcomes are addressed elsewhere in this Strategic Plan as follows:

- Strategy 2.1 addresses the adoption of an agreed definition of Potential Hydraulic Risk as a key input to flood risk assessments
- Strategy 3.1 identifies a common approach to responding to the anticipated impacts of climate change
- Strategy 4.2 aims to provide regionally consistent flood risk data.

Local integration of these elements of regional consistency through local planning instruments will be informed by Local Floodplain Management Plans and local flood risk assessments which may identify the potential to evaluate planning changes against regional growth assumptions. Local governments can collaborate with the Queensland Government to understand these implications and improve the resilience of future development to future flood risks.

The role of this Strategic Plan in land use planning

This Strategic Plan provides a framework to guide flood responsive land use planning for planning authorities and local governments in the Brisbane River floodplain. It supports the outcomes of *ShapingSEQ* and the SPP state interest for natural hazards, risk and resilience (flood).

The purpose of the land use planning components of this Strategic Plan is to provide regional context for flood risk management and strategic land use planning. It is not statutory in its effect. However, it supports the implementation of the SPP state interest (flood) through local land use planning.

This Strategic Plan seeks to achieve regionally consistent flood risk management outcomes assessment and decision making processes implemented by local jurisdictions and institutions. It does not alter the statutory effect of the SPP (including the need to balance other state interests) or the statutory effect of *ShapingSEQ*. It does however provide potential for review of regional strategies for flood risk management in future iterations of local planning instruments and *ShapingSEQ*.

Land Use Planning Guidance material has been developed. *The Brisbane River Strategic Floodplain Management Plan Technical Evidence Report –Land Use Planning Guidance Material Addendum (Land Use Planning Guide)* is non-statutory and intended as a resource to assist planning authorities achieve key outcomes of this Strategic Plan when undertaking local land use planning processes.

The *State Planning Policy Natural Hazards, Risk and Resilience (Flood) Guidance Material*, in conjunction with the Land Use Planning Guide are non-statutory resources designed to assist planning authorities assess and treat flood risk through land use planning methods.

Analysis and discussion of land use planning and its role in managing flood risk is discussed in detail in Chapter 9 of the Technical Evidence Report.

Outcome 5 will be achieved through the following key strategies.

Strategy 5.1 – Planning instruments across the floodplain are informed by local flood risk assessments

The requirement for local flood risk assessments to inform local planning instruments is embedded in the SPP. Development of Local Floodplain Management Plans across the Brisbane River floodplain may be used to inform local planning instruments. Local Floodplain Management Plans should consider the requirements of the SPP, with regards to the scope of local flood risk assessments where they are intended to inform the review of local planning instruments.

Strategy 5.2 – Local Floodplain Management Plans, local flood risk assessments and local planning instruments consider the following:

- **potential hydraulic risk and hazard classification**
- **regional evacuation capability**
- **‘no worsening’ of flood risk from new development**
- **regional assessment of cumulative land form changes across the floodplain**
- **regional climate change adaptation.**

Evacuation capability is a key input to a range of floodplain management initiatives including land use planning. An assessment of regional evacuation capacity and capability and the region's evacuation network is a recommendation of this Strategic Plan. The outcomes of this analysis will provide important insights that will inform local flood risk and risk based land use planning in the floodplain.

'No worsening' of flood risk is defined in the Glossary of terms (refer **Appendix A**) and requires the assessment of development at both the strategic and lot scales. This is to consider the impact that developments may have on neighbouring sites and elsewhere on the floodplain.

A regional assessment of the cumulative impacts of landform change across the floodplain is proposed as a recommendation of this Strategic Plan. The outcomes of this analysis will determine at a floodplain scale, the extent and location of filling or land form change to support new development that is possible without causing unacceptable cumulative impacts on flood risk. This analysis can inform the development of Local Floodplain Management Plans, local risk assessments and cascade into the land use allocation, provisions and policy under local and other planning instruments.

Strategy 5.3 – Local planning instruments incorporate consistent approaches that protect vulnerable people from increased flood risk

Vulnerable land uses are those most impacted if subject to flooding. The Land Use Planning Guidance contained in the Technical Evidence Report describes these uses. A key factor affecting land use vulnerability is whether it performs functions that support vulnerable people, who due to physical, cognitive or other constraints have reduced resilience to floods and are therefore at greater risk.

When developing land use responses and particularly in allocating land uses, as well as considering the risk and risk treatment to determine the acceptability and tolerability, consideration should also be given to the vulnerability profile of the community where known.

Vulnerable land uses involving vulnerable persons should not occur in areas of high flood risk or where evacuation risk is assessed as moderate, serious or intolerable. Local planning instruments should apply this principle when planning for vulnerable land uses supporting vulnerable persons.

Strategy 5.4 – Local Floodplain Management Plans, flood risk assessments and the review of local planning instruments consider implications for regional planning assumptions

The review of planning instruments informed by a refined understanding of flood risk may identify a need to adjust regional planning assumptions about dwelling and employment supply, its distribution and infrastructure considerations. These should be undertaken collaboratively by the region's local governments and the Queensland Government to inform the annual land supply assessments of the SEQ Growth Monitoring Program and future reviews of *ShapingSEQ*.

Desired outcome 6

Building design and construction improves community resilience and reduces property damage

The interface between planning and building systems is recognised as an area of uncertainty for natural hazard practitioners in terms of policy development, regulation and practical implementation.

The *Queensland Development Code MP 3.5* is triggered when building work is carried out within a local government declared flood hazard area with a defined flood level. The purpose of this code is to ensure minimum flood immunity of habitable areas and the structural integrity of buildings located in flood hazard areas. This is designed to safeguard people from illness and injury caused by flood water affecting buildings and to ensure utilities are protected from the effects of floodwaters.

The *Queensland Development Code MP 3.5* does not specifically cover flood resilient design principles. However, Acceptable Solution A1 relies on Section 2.8 of the National Flood Standard – *Construction of Buildings in Flood Hazard Areas* Version 2012.2 (2012) for the structural element. The National Flood Standard does not provide information on materials, appropriate uses or the expected benefits and costs associated with flood resilient design.

Reducing the physical damage to possessions, whilst enabling people to return to their homes and workplaces sooner, improves the resilience of a community to floods. Flood resilient construction principles extending beyond structural integrity have the ability to reduce the intangible and tangible damages from floods.

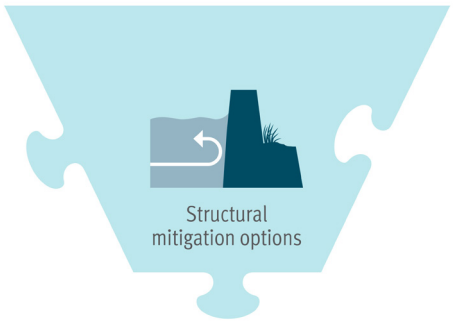
Outcome 6 will be achieved through the following key strategies.

Strategy 6.1 – Develop guidance on how flood resilient building design principles can be applied, assessed and built

Targeted and specific guidance for planners, engineers, homeowners, architects, builders and certifiers about wet-proofing new and renovated residential properties, will provide greater clarity on how built form can increase flood resilience under current legislation and arrangements. This guidance should be developed specifically for the Queensland context and housing stock, and where possible provide a compendium of materials currently on the market that are appropriate in various applications.

Strategy 6.2 – Further encourage and support the uptake of flood resilient built form through greater clarity in legislative arrangements

In Queensland, the distinction between planning and building systems is an identified source of uncertainty for practitioners, particularly about what can and cannot be achieved under current arrangements. Specific information about how the wide range of professions can interact with the current system will provide greater certainty. Furthermore, given the move towards risk based approaches, consideration should also be given to whether modifications to the current building arrangements are required.



Desired outcome 7

Infrastructure is used to reduce flood risks where appropriate

Infrastructure located within the floodplain can modify flood behaviour. This generally involves heavily engineered works and can encompass a range of structural options for flood risk management including dams, levees, detention basins and flood gates. As flood behaviour in the Brisbane River is sensitive to flow and floodplain conditions, infrastructure can be used to alter flood behaviour and potentially mitigate adverse impacts. It is due to this sensitivity that infrastructure may also have detrimental effects to other areas within the floodplain.

Wivenhoe and Somerset dams provide significant flood mitigation within the Brisbane River Catchment (refer **Section 2.7**). Despite this, dams and other infrastructure cannot prevent or eliminate flood risk downstream caused by extreme flood events.

A large number of possible structural solutions to flooding in the Brisbane River Catchment have been suggested in recent years. These have covered large-scale and regional solutions ranging from new dams in the upper catchments to smaller more localised solutions. More than 300 options were submitted to the QFCoI by the public and stakeholders. In addition, the Queensland Government carried out targeted investigations into additional flood storage within the Brisbane River Catchment (*Prefeasibility Investigation into Flood Mitigation Storage Infrastructure,* Department of Energy and Water Supply, 2014).

Seqwater is progressing feasibility planning for options to upgrade Wivenhoe Dam to safely pass a Probable Maximum Flood event. A preferred upgrade concept for Wivenhoe Dam may increase the flood mitigation benefit, although this is yet to be determined. Given investigations are already progressing on Wivenhoe Dam options, this Strategic Plan focuses on other infrastructure works that can provide regional benefits to flood risk in the Brisbane River floodplain that are congruent with possible future dam upgrades.

A range of infrastructure options for the Brisbane River Catchment are discussed in Chapter 8 of the Technical Evidence Report. Infrastructure can involve high capital costs as well as ongoing maintenance costs. Economic benefits can be measured in terms of reductions in future flood damages, for both tangible and intangible damages. Feasibility of new infrastructure for flood mitigation purposes should not be judged solely on financial merit. It should also consider a range of social and environmental factors including potential benefits to integrated catchment planning outcomes. This Strategic Plan has adopted a multi-criteria assessment to evaluate and compare the merits of various structural options across a selection of criteria including community safety, economic viability, technical feasibility, community attitudes, infrastructure and transport, environmental impact and natural resource management.

Outcome 7 will be achieved through the following key strategies.

Strategy 7.1 – Feasibility assessment of regional opportunities and linkages with other regional projects

Warrill Creek Dry Flood Mitigation Dam (refer Technical Evidence Report Section 8.6.2)

Preliminary investigations of this option were carried out by the Department of Energy and Water Supply in 2014. The Commonwealth's Inland Railway project is proposing to construct a high level embankment across Warrill Creek (on the alignment of the Southern Freight Railway Corridor). With appropriate design of the wall and outlet structure, the new railway infrastructure could be used to provide temporary flood storage (flood detention) upstream, providing significant benefit to downstream properties, as well as providing critical road immunity for the Amberley Royal Australian Air Force Base. It is anticipated that concept design refinement could optimise detention benefits and minimise infrastructure costs. A detailed benefit-cost analysis should be carried out on the optimised design using the most up-to-date flood model and property database developed through the Flood Studies. Re-evaluation of catchment hydrology under a dry flood mitigation dam condition for Warrill Creek will be required to identify an appropriate ensemble of specific events that produces peak flood levels throughout the Brisbane River floodplain.

Cooperation between all levels of government will be required to achieve the integrated and multiple potential benefits possible for this structural option. Such cooperation and coordination between governments is central to the integrated catchment planning principles advocated by the QAO (2016).

Strategy 7.2 – Further consideration of local opportunities through Local Floodplain Management Plans

Brisbane CBD and South Brisbane temporary flood barriers (refer Technical Evidence Report Sections 8.5.2 and 8.5.3)

The Brisbane CBD and South Brisbane (Southbank) are special interest areas with substantial economic, tourism and cultural uses. Whilst these locations are not suitable for permanent levees, temporary flood barriers can be an effective means of protecting small areas of inundation that have relatively confined connections to the main watercourse. The temporary nature of the barriers means that they can be deployed in locations that are normally used for other purposes such as roadways. The practical size of the barriers limits the extent to which floods are excluded from areas of interest, while they need to be complemented with other measures to prevent backflow of floodwaters through stormwater systems and other flow paths. Initial assessments suggest temporary flood barriers could provide flood immunity potentially up to the 1% (1 in 100) AEP flood for South Brisbane and 0.5% (1 in 200) AEP flood for the Brisbane CBD. Further investigation is required.

Ipswich CBD flood gate (refer Technical Evidence Report - Section 8.4.6)

The Ipswich CBD is low-lying and parts are impacted by 5% (1 in 20) AEP floods. Flood waters passing through the Marsden Parade Rail Underpass inundate mostly commercial properties in the CBD. Marsden Parade is an important local access route across the rail line. Further consideration should be given to installing flood gates that can be closed relatively quickly across Marsden Parade to prevent the backwater inundation from the Bremer River. When the flood gates are closed, the rail embankment would act as a temporary dam wall and prevent flooding of low-lying land, being the Ipswich CBD. The rail embankment is approximately eight metres high and overtopped by 2% (1 in 50) AEP floods. The integrity of the rail embankment to support a water differential of eight metres with potential overtopping is unknown, and must be established before this option is assessed further.

Fernvale levee (refer Technical Evidence Report Section 8.4.2)

A number of properties within Fernvale are inundated by a 1% (1 in 100) AEP flood and a larger number of properties are isolated through flooding of a single access road. A levee located within an existing road reserve to the immediate north of the village could prevent floodwaters from the adjacent rivers deviating into residential areas and isolating residents, for selected flood events. Further feasibility investigations are required to progress flood management at Fernvale including optimisation of a levee.

Amberley Royal Australia Air Force (RAAF) Base (refer Technical Evidence Report - Section 8.4.3)

Under present day conditions, low-lying areas of the RAAF base at Amberley are inundated by 10% (1 in 10) AEP flood levels. For a 1% (1 in 100) AEP event, most of the runway, apron and hangers are inundated which would significantly compromise base operations and access. Works to improve the flood immunity (i.e. up to the 1 in 100 AEP flood level) of the base would include a ring levee around the operational sections of the base, including the runway, aprons, taxiways and instrumentation. Road access works in and out of the base would also be required, including the Cunningham Highway. Construction of the Warrill Creek Dry Flood Mitigation Dam (refer to **Strategy 7.1**) would achieve critical road immunity for the RAAF Base. In the absence of the Warrill Creek Dry Flood Mitigation Dam, a ring levee may have impacts on downstream properties which would need to be considered through further feasibility assessments. This option requires further investigation to understand the practicality of the solution and any potential impacts.

Goodna Major Centre (refer Technical Evidence Report Section 8.4.5)

During 2011, Brisbane River floods impacted large areas within Goodna, including the CBD. There is potential for the Goodna CBD to be protected from Brisbane River floods up to about a 1% (1 in 100) AEP level through the installation of a flood wall levee along the Ipswich Motorway. This may prevent overtopping of the motorway, as occurred in 2011, as well as closure of the motorway underpass roadway via a very large flood gate structure. The feasibility and practicality of this solution requires further assessment.

Desired outcome 8

Landscape management across the catchment contributes to flood risk reduction

Landscape management is discussed in detail in Chapter 7 of the Technical Evidence Report. Landscape management actions such as targeted catchment and riparian revegetation, rural landscape management practices and water sensitive urban design can be effective tools that contribute to enhanced floodplain management particularly in terms of improving resilience to the damaging effects of floods. At the same time, due to the importance of the timing of flows from the major tributaries in the Brisbane River, landscape management could have an adverse impact on flood behaviour.

Sustainable management of natural and built landscape provides environmental, social and economic benefits to the community. The Department of Environment and Science undertook a scientific review about the affect natural landscapes can have on flooding in the report '*Natural Assets for Flood and Cyclone Resilience – Synthesis of scientific evidence on the role of natural assets to reduce the human impacts of floods and cyclones' (DEHP, 2012)*. The report found that while *'there is a clear link between vegetation clearing and an increase in rainfall runoff … vegetation is not likely to noticeably affect extreme flood events but has the potential to reduce local runoff and small-scale floods.'*

In addition, landscape management can have significant benefits to ecosystem health and habitat, a reduction in landscape salinity, improved groundwater recharge and a reduction in erosive capacity.

This Strategic Plan aims to recognise and support the significant amount of landscape management activities already underway. Projects within the catchment incorporating landscape management options include:

- Resilient Rivers Initiative Catchment Action Plans identify priority actions based on an integrated catchment risk assessment of each catchment and includes strategies to improve the health of waterways within South East Queensland.
- Sapling Pocket Floodplain Stabilisation Project (Ipswich City Council and Seqwater) investigates landscape management activities to stabilise riverbanks, improve water quality and reduce water treatments costs.
- The Big Flood Project (ARC, 2016) identifies priority locations for riparian restoration.
- Catchment Stories (compiled by DEHP, 2015) investigates the complexity of catchments throughout Queensland including water flow, geology, topography, rainfall and runoff, natural features and human modification.

Healthy catchments are fundamental in supporting our regional economy and provide social and recreational benefits for the community. Considering landscape management options in combination with other floodplain management activities will provide a holistic and integrated approach to flood risk management for the Brisbane River floodplain.

Outcome 8 will be achieved through the following key strategies.

Strategy 8.1 – Catchment wide research into the effect of landscape management actions on flood behaviour

Currently, it is not possible to quantify the effects landscape management actions have on flood behaviour. This means it is not possible to model the impacts these actions have on flood hydrology and subsequently it becomes difficult to assess these options for flood mitigation purposes.

Physical testing is required to understand on-the-ground impacts that different types of vegetation and other landscape management activities have on flood hydrology. This will create the necessary link between revegetation practices and changes in flood behaviour, which can then inform the most appropriate location and scale of landscape management options in order to achieve the desired outcomes.

Strategy 8.2 – Stakeholders continue to collaborate and identify landscape management opportunities in the catchment

A number of planned and ongoing catchment management initiatives are currently underway within the wider Brisbane River Catchment. These initiatives, such as catchment revegetation, rural landscape management practices and water sensitive urban design, each have the potential to make a contribution to improving flood management outcomes, particularly for smaller floods where these initiatives help to slow catchment runoff and reduce flood peaks.

Considering landscape management options in future floodplain management studies and plans will continue to support current projects looking at landscape management opportunities such as the Big Flood Project (ARC, 2016) and the Catchment Action Plans (RRI, 2016 a,b).

Strategy 8.3 – Recognise benefits in addition to flood mitigation when assessing landscape management opportunities

Landscape management opportunities have the potential to provide flood mitigation benefits for small-scale flood events. However, where these activities may have significant benefit is in improving ecosystem health including by reducing salinity, improving water quality, increasing habitat and reducing in soil erosion. Stakeholders will consider and where possible, endeavour to quantify these benefits, supported by the work currently under development through the Land Restoration Fund (DES) to establish a co-benefit valuation method.

Desired outcome 9

Disaster management planning and response applies a regionally consistent approach whilst recognising local flood risks

Disaster Management is detailed in Chapter 10 of the Technical Evidence Report. Disaster management is a unique combination of advance planning and real-time decision making. Managing flood disasters relies on a sound understanding of flood behaviour, the nature of communities at risk and the potential for flooding to be worse than previously experienced. This understanding is built upon past experience and information derived from the hydrologic and hydraulic models, intersected with flood exposure data, which is interpreted to local conditions.

While there are key response agencies across government with responsibility for disaster management planning, effective disaster management requires input and action from the entire community. Critical to the success of disaster management is information sharing between agencies and engagement of the community to empower them to understand and respond to flood emergency warnings. The disaster management outcome in this Strategic Plan aligns closely with those of community awareness and resilience.

Queensland's disaster management arrangements encompass a multi-tiered system of committees and coordination centres at state, district and local levels, as shown in **Figure 17**.

Local Disaster Management Groups are coordinated at the local government level. Within the Brisbane River floodplain, Local Disaster Management Groups exist for the four local government areas of Brisbane, Ipswich, Somerset and the Lockyer Valley.

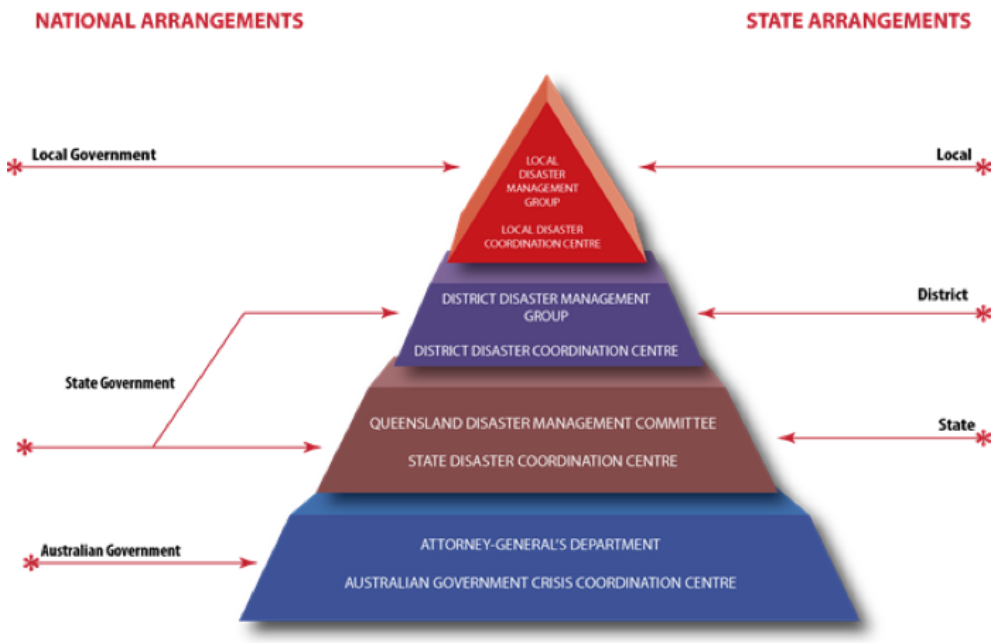
District Disaster Management Groups tend to encompass multiple local government areas. Three disaster districts are located within the Brisbane River floodplain. Disaster Districts and Local Disaster Management Groups are based on administrative boundaries and as they address all hazards do not necessarily align with catchment boundaries related to flood hazards.

Disaster management is most effective at the local level when it is tailored to local conditions, risks and communities. However, when floods become too large for local governments to manage on their own, additional support may be provided by other government areas at the district or state level. Queensland's disaster management arrangements enable a progressive escalation of support and assistance through four tiers as required (refer **Figure 17**). These arrangements comprise several key management and coordination structures for achieving effective disaster management in Queensland. During a flood, resources can be limited and any unnecessary inefficiencies in communication and response systems can have critical impacts on community safety.

Effective disaster management also relies on an appropriate community response to flood warnings and evacuation notices. With increased reliance on delivering critical information through online channels such as social media, disaster managers need to ensure the community is receiving consistent messages from all sources.

Outcome 9 will be achieved through the following key strategies.

Figure 17 – Queensland Disaster Management arrangements (source: www.disaster.qld.gov.au)



Strategy 9.1 – Regional-scale flood analysis and consequence information is shared and maintained across all agencies

A range of digital data has been developed for this Strategic Plan as described in Section 10.3 of the Technical Evidence Report. This information and analysis builds on the regional-scale flood model to expand the suite of tools all stakeholders can use to inform disaster management planning and response. The data includes:

- analysis of major road network flood immunity that identifies low points in the road network and provides inundation timings for a range of flood AEPs
- assessment of flood exposure and isolation risk for residents, properties, and sensitive and critical infrastructure
- provision of catchment-wide 'time-to-inundation' mapping
- analysis of available flood data at forecast stream gauge locations to identify data gaps, as well as advice about how to fill the gaps with sufficient data to improve disaster management applications.

There is an opportunity for disaster managers in the Brisbane River Catchment to continue to build on the outputs of this Strategic Plan to develop a 'world class' data-driven solution to flood management in the region.

Strategy 9.2 – Disaster management analysis informs community awareness and resilience building with property-scale flood risk information

Personalised and localised information is essential for community directed emergency planning and resilience. This includes providing the community with the information they need to plan for flooding and act on real-time and forecast information during floods. Information and data developed for this Strategic Plan is described in Sections 10.3 to 10.5 of the Technical Evidence Report, and supports the development of community resilience through the following information:

- A surveyed property database for the Brisbane River floodplain that includes information about ground level, building level, property type, image and address, as well as a range of flood risk information including flood depth-at-ground for a range of flood sizes.

- Identification of floodplain 'zones' for each stream gauge, which the Bureau uses to report actual and forecast flood levels. These zones would support emergency managers and help the community to understand what stream gauges should be reviewed when seeking real-time and flood forecast information relevant to their location or property (i.e. their 'reference' gauge).

- Information relating property levels to the reference stream gauge that will enable emergency managers and the community to better understand how actual and forecast stream gauge flood levels relate to their property. For example, 'my house will likely become flooded when my reference stream gauge reaches between 4.2 metres and 4.5 metres AHD'.

Strategy 9.3 – Regionally consistent communication supports disaster management operations with consistent language and messaging

The community works, lives and travels throughout the catchment (and beyond) on a daily basis and is therefore exposed to flood awareness and warning messaging issued by a range of local governments and entities (especially the media). Inconsistent language and messaging may introduce confusion and result in poor uptake of the messages and alerts.

Guidelines for a consistent approach to communication and engagement across the floodplain, building on the work being developed by the Bushfire and Natural Hazard Cooperative Research Centre titled '*Effective risk and warning communication during natural hazards*', will support regionally consistent language and messaging. This includes areas of flood warning, local interpretation of warnings and forecasts provided by the Bureau.

Actions supporting improved flood risk management in the Brisbane River floodplain

A series of actions are outlined in the table below to achieve the flood management desired outcomes and strategies (Section 3) of this Strategic Plan. The actions have been developed from a flood risk management perspective and are subject to standard agency prioritisation and funding processes prior to commitment for implementation.

The actions take into account the constraints and opportunities relevant for the Brisbane River based on an understanding of current and future flood risks and an appreciation of existing knowledge, resources and capabilities across the communities and stakeholders that have an interest in the Brisbane River floodplain.

The tables include links to the relevant outcomes and strategies in this Strategic Plan, as well as the more detailed discussions in the Technical Evidence Report.

Refer to **Appendix B** for list of acronyms including Queensland Government departments.

4.1 General floodplain management actions

ID	Relevant strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
FM1.1	1.1 1.2 1.3	3.4 13.1	Establish suitable governance arrangements for implementation of this Strategic Plan and the development of the Local Floodplain Management Plans.	Regional	QRA	High
FM1.2	1.1 1.2 1.3	10.7.2.1 11.6.3.1 13.1	Investigate opportunities and mechanisms for ongoing resource and knowledge sharing.	Regional	QRA	Medium
FM2	1.1 1.2 1.3	13.1	Review this Strategic Plan every five years (or in response to relevant triggers) including updates of significance to regional models.	Regional	QRA	Medium

ID	Relevant strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
FM3	1.1 1.2 1.3 2.1	1.2 5.1 5.2 5.3 9.5.1 13.8	Develop Local Floodplain Management Plans based on the findings, outcomes, strategies and approaches identified in this Strategic Plan.	Local	Local governments	High
FM4.1	1.1 1.2 1.3	6.10.2 10.7.2.4 13.2	Pre-plan collection of post event data including requirements, specifications, approaches, and the development of templates.	Regional	QRA	Medium
FM4.2	1.1 1.2 1.3	6.10.2 10.7.2.4 13.2	Coordinate and collaborate with the insurance industry, QFES, QRA, Geoscience Australia and universities to collect standardised post event data.	Regional	QRA	Medium
FM5	1.1 1.2 1.3	8.11.1 13.1	Establish a state policy on the assessment, prioritisation and funding of state-funded flood mitigation works.	State	QRA	High
FM6	1.1 1.2 1.3	9.2.3 11.2.4 11.5.7 13.2	Collaborate with the insurance industry to share the most current floodplain risk management information.	State	DNRME	Medium
FM7	1.1 1.2 1.3	6.7 13.1	Extend the economic framework established in this Strategic Plan and Technical Evidence Report to include community awareness and resilience, disaster management and land use planning.	Regional	QRA	Medium
FM8	3.1	5.2 5.3.2 13.1	Use the climate change sensitivity analysis approach applied in this Strategic Plan to support the implementation of actions and the development of Local Floodplain Management Plans.	Regional	All relevant lead agencies	High

ID	Relevant strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
FM9	3.1	9.6 13.5	Local Floodplain Management Plans to identify 'no regrets' actions to improve resilience to climate change related flood risks now and into the future.	Local	Local governments	High
FM10.1	3.1	5.2 13.8.3	Ongoing monitoring of climate change research, science and modelling advances.	Regional	DES	High
FM10.2		13.1 13.8.3	Findings from FM10.1 should be considered and incorporated into future reviews of this Strategic Plan and Local Floodplain Management Plans.	Regional and local	State and local governments	High
FM11	3.2	5.2.1 13.1	Coordinate and link in with existing climate change adaptation planning processes across state and local governments, ensuring a holistic response to climate change for the Brisbane River Catchment.	Regional	DES	Medium
FM12.1	9.1	10.7.2.3 13.6	Coordinate an assessment of regional evacuation capability with support from LDMGs, DDMGs, DTMR, QFES, QRA and DSDMIP.	Regional and local	QPS	High
FM12.2	9.1	10.7.2.3 13.6	Findings from FM12.1 should inform any works required to upgrade local evacuation route networks for safe evacuation of local communities or escalate as required (for state-controlled routes).	Regional	Local governments	High
FM12.3			Develop state guidelines to support the identification of 'fair and reasonable' immunity for evacuation routes.	Regional	DTMR	High

4.2 Structural / Infrastructure (SO) actions

ID	Relevant Strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
SO1.1	7.1	8.1.8.2 8.11.1 13.4	**Wivenhoe and Somerset Dam upgrades and operations** Review and incorporate relevant findings of the Brisbane River Catchment Flood Studies into ongoing planning and investigations for upgrades to the Somerset and Wivenhoe dams.	Regional	Seqwater	High
SO1.2	7.1	8.1.8.2 8.11.1 13.4	**Wivenhoe and Somerset Dam upgrades and operations** Upon completion of SO1.1, DNRME to consider the incremental costs of any dam upgrade works associated with flood mitigation benefit compared to options to increase operational release rates through downstream land rezoning or buy-back.	Regional	DNRME	Medium
SO2	7.1	8.6.2 8.11.1 13.4	**Warrill Creek dry flood mitigation dam** Undertake a feasibility study for a dry flood mitigation dam at the Southern Freight Railway crossing of Warrill Creek.	Regional	DNRME	High
SO3	7.1	8.6.1 8.11.2 13.4	**Upper catchment dry flood mitigation dams** Investigate potential for other locations for regional-scale dry flood mitigation dams at new floodplain crossings of the Southern Freight Railway or other major linear infrastructure. Any potential locations to be referred to the state for consideration in conjunction with SO2.	Regional	ICC LVRC	High

ID	Relevant Strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
SO4	7.2	8.5.2 8.5.3 8.11.1 13.4	**Brisbane CBD / South Brisbane temporary barriers** Undertake a feasibility study into temporary barriers in the Brisbane CBD and South Brisbane as part of the Brisbane Local Floodplain Management Plan.	Local	BCC	Medium
SO5	7.2	8.4.6 8.11.1 13.4	**Ipswich CBD flood gate** Undertake a feasibility study for a flood gate at Marsden Parade as part of the Ipswich Local Floodplain Management Plan.	Local	ICC	Medium
SO6	7.2	8.4.2 8.11.1 13.4	**Fernvale levee** Undertake a local options assessment for the Fernvale levee as part of the Somerset Local Floodplain Management Plan.	Local	SRC	High
SO7	7.2	8.4.5 8.11.1 13.4	**Goodna CBD levee** Undertake a local options assessment for the Goodna CBD levee as part of the Ipswich Local Floodplain Management Plan.	Local	ICC	Low
SO8	7.2	8.4.3 8.11.1 13.4	**Amberley levee** Consult with the Department of Defence regarding a levee for the Amberley RAAF Air Base.	Regional	DSDMIP	Medium

4.3 Disaster management (DM) actions

ID	Relevant Strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
DM1	9.1	10.7.2.1 13.6	Relevant LDMGs and DDMGs consider the information provided by this project in developing practices to address cross-boundary and cross-district implications for preparation, planning, response and recovery arrangements across the Brisbane River region.	Regional	LDMGs DDMGs	High
DM2	9.1	10.7.2.4 13.6	Recognise and use the existing disaster management arrangements for information requests.	Regional	All Disaster Management stakeholders	Medium
DM3.1	9.1	10.7.2.5 13.6	Identify (rainfall and stream) gauges to be included in the Bureau's forecast network based on the Queensland Flood Gauge Network Review.	Local	Local governments	High
DM3.2	9.1	10.7.3.4 13.6	Review stream gauge classifications and amend where necessary.	Local	Local governments	Medium
DM4.1	9.1 9.2 9.3	10.7.3.2 13.6	Develop a disaster data information framework to provide all stakeholders with access to consistent and up-to-date disaster data for the region.	Regional	QFES	Medium
DM4.2	1.3 9.1 9.2 9.3	10.6 13.6	Lead discussions with the Bureau to develop a real-time regional hydraulic modelling system and incorporate outputs into a regional flood intelligence system to share information.	Regional	QRA	High

4.4 Land use planning (LU) actions

ID	Relevant Strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
LU1	5.2	9.5.4.2 13.5	Coordinate a floodplain-scale cumulative impact assessment to inform decisions relating to regional and local infrastructure and land use planning in the Brisbane River floodplain.	Regional	QRA	High
LU2.1	5.1	9.5.1 13.5	Align the scope of local flood risk assessments undertaken within the Local Floodplain Management Plans with the SPP requirements.	Local	Local governments	High
LU2.2	2.1 3.1 5.2 5.3	9.6 13.5	Incorporate the following actions into Local Floodplain Management plans to ensure regional consistency: • assessment of 'potential hydraulic risk' in line with the approach undertaken to inform this Strategic Plan. • consideration of local and regional evacuation capability and evacuation networks (within a risk/hazard framework). • consideration of findings from the cumulative impact assessment (LU1). • Consider climate change scenario RCP8.5 in informing land use planning within the floodplain where there is potential for significant ramifications and/or limited scope for mitigation. Where land use longevity or resilience to increasing flood risk warrants, a range of other climate change scenarios may be appropriately applied. • Consider vulnerable land uses involving vulnerable people in higher flood risk circumstance across the full known extent of the floodplain.	Local	LGAs	High
LU2.3	5.4	13.5	Consider the outcomes of this Strategic Plan and the Local Floodplain Management Plans when amending local planning instruments (noting that any amendments identified would occur following Phase Four of the Flood Studies).	Local	Local governments EDQ	High

ID	Relevant Strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
LU3.1	5.4	13.5	Consider relevant land use planning related findings from the Local Floodplain Management Plans, in accordance with the SPP and *ShapingSEQ* state interest policy requirements, when undertaking state interest review of local planning instruments.	Regional	DSDMIP	Medium
LU3.2	5.4	9.5.6 13.5	As part of reviewing Local Floodplain Management Plans and any proposed local planning scheme amendments, investigate implications of flood risk for regional land use, land supply and outcomes under *ShapingSEQ*.	Regional	DSDMIP	High

4.5 Community awareness and resilience (CAR) actions

ID	Relevant Strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
CAR1	4.3	11.6.3.1 13.7	Work with local governments to establish or utilise an existing community awareness and resilience working group to facilitate coordinated awareness and resilience activities within the Brisbane River floodplain.	Regional	QRA	High
CAR2.1	4.1 4.2 4.3	11.6.3 13.7	Develop regional reference material including a compendium of current activities and learnings, toolkit of activities and guidelines for communication and engagement.	Regional	QRA	High
CAR2.2	4.3	11.6.5 13.7	Evaluate community awareness and resilience activities relating to flood, and share learnings from the evaluation to inform continual improvement in suitability and effectiveness.	Regional	IGEM	Medium
CAR2.3	4.1 4.2 4.3 9.2 9.3	11.6.3 13.7	In strong collaboration with local governments, develop regional guidance for delivering consistency in local provision of online flood awareness mapping, property-scale flood information, place-based installations, and community facing language and messaging.	Regional	QRA	High

ID	Relevant Strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
CAR3	4.1 4.3	11.6.4.8 13.7	Support, identify and upskill community leaders as part of a community led program to assist with disseminating information, resilience planning and activities, and communication of local conditions.	Local	Local governments	Low

4.6 Landscape management (LM) actions

ID	Relevant Strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
LM1	8.2	7.5 13.3	Coordinate and share landscape management information within a consistent regional framework.	Regional	DNRME	High
LM2	8.1	7.5 13.3	In collaboration with local governments, coordinate, conduct and share landscape management research, in particular the relationship between broad scale revegetation and catchment hydrology.	Regional	DES	Medium
LM3	8.1	7.5 13.3	Undertake local geomorphological studies to identify key catchment processes and issues, and assess current conditions and pressures.	Local	DES	Medium
LM4	8.1 8.3	7.5 13.3	Using the outcomes from LM2, update hydrology and hydraulic modelling to reflect research results and prioritise locations for landscape management within the catchment.	Local	DES	Medium
LM5	8.2 8.3	7.5 13.3	Update catchment and receiving water quality modelling to estimate other (non-flood) benefits to waterways.	Regional	DNRME	Medium

4.7 Building design and construction (BC) actions

ID	Relevant Strategies in the Strategic Plan	Technical Evidence Report page references	Description	Implementation	Lead agency	Priority
BC1	6.1 6.2	12.3	Consider the development of a working group to manage future updates and amendments to the resilient building materials database.	Regional	HPW	Medium
BC2	6.1 6.2	12.3	Investigate arrangements that allow resilient design to be considered as a flood risk management measure.	Regional	HPW	Medium
BC3	6.1 6.2	12.3	Consider creation of a development guideline similar to MP3.5 to provide a standard for construction of buildings in 'flood resilient areas'.	Regional	HPW	Medium
BC4	6.1 6.2	12.3	Provide feedback to the Australian Building Codes Board to include guidance on the principles and performance requirements of flood resilient materials.	Regional	HPW	Medium

4.8 Local Floodplain Management Plans

Preparation of the Local Floodplain Management Plans by the four local governments in the floodplain, represents the fourth and final phase of the Brisbane River Flood Studies. The Local Floodplain Management Plans will provide a more detailed level of assessment of flood risks and floodplain management responses to address community specific issues and opportunities.

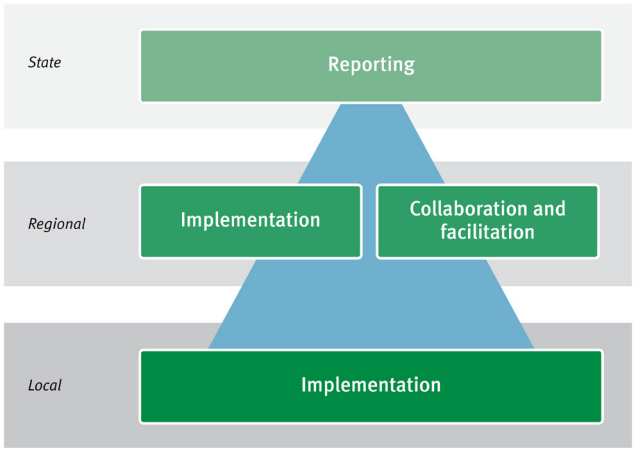
Guidance for local governments in preparing Local Floodplain Management Plans has been provided in Section 13.8 of the Technical Evidence Report. Funding support has been made available to all four local governments as part of the 2017-18 Natural Disaster Resilience Program.

Implementation and monitoring arrangements

The *Queensland Strategy for Disaster Resilience* (QSDR) and *Strategic Policy Framework for Riverine Flood Risk Management and Community Resilience* (SPF) sets the key objectives, guiding principles and implementation framework for flood risk management and resilience activities in Queensland.

These key policies provide context for the implementation and monitoring of this Strategic Plan through the principles of catchment-scale collaboration, shared responsibility, multi-disciplinary approaches, and locally-led implementation.

As the lead agency responsible for disaster recovery, resilience and mitigation policy in Queensland, QRA has a strong interest in ensuring the flood risk management initiatives and actions under this Strategic Plan draw from and achieve the objectives of these policies to help make Queensland the most disaster resilient state in Australia.



Key to the successful implementation of this Strategic Plan is the ongoing commitment of the four local governments and state agencies to provide updates on the progress of future actions, and to ensure alignment with the outcomes, strategies and actions identified in this Strategic Plan. This will require local governments and state agencies to continue to work together to discuss and resolve issues and opportunities that may arise. The project partners are committed to working together and will continue to convene on a regular basis as part of the overall monitoring and reporting of actions and outcomes of this Strategic Plan.

QRA will play a support and coordination role to maintain the collaborative approach required for ongoing implementation of this Strategic Plan. It will ensure alignment with various policies, plans and activities that this Strategic Plan interfaces with such as *ShapingSEQ*, and other disaster resilience policies and projects. QRA will also provide a reporting function to Queensland Government on the progress of implementation of this Strategic Plan.

Consistent with the intent of the QSDR and SPF, QRA will also play a regional-scale coordination and facilitation role to support catchment-scale collaboration between partners. QRA will Chair half-yearly stakeholder meetings with partners to monitor the progress of the recommendations, and facilitate ongoing lines of communication. These meetings will provide an opportunity for stakeholders to formally update one another on the development of Local Floodplain Management Plans being delivered as the final phase of the project.

Appendices

Appendix A – Glossary of terms

All-hazards approach	This approach assumes that the functions and activities applicable to one hazard are most likely applicable to a range of hazards and consequently planning captures the functions and activities applicable to all hazards.
Annual Exceedance Probability	The chance that a flood will reach or exceed a particular level in any given year. For example a 1% (1 in 100) AEP.
Average Annual Damage	The cost incurred by flooding on an annual basis for a nominated development situation, when averaged over an extended period of time. This takes account of the probability of smaller more frequent floods, as well as very rare but catastrophic floods.
Backflow prevention device	Structures installed within stormwater systems (usually at the downstream end) that prevents backflow of elevated river levels into the stormwater pipes (and hence inundation of lands that are lower than the natural riverbank). Backflow prevention devices have been installed at a number of locations around Brisbane since 2011.
Catchment Action Plan	Strategic documents outlining action and initiatives targeting works across a whole-of-catchment. A number of catchment action plans have been developed for parts of the Brisbane River catchment by the Resilient Rivers Initiative.
Community resilience	A community's ability to rapidly accommodate and recover from the impacts of hazards, restore essential structures and desired functionality, and adapt to new circumstances. Community resilience is closely linked to the awareness of the community regarding flooding and the potential for impacts and damages from different sizes of events.
Brisbane River Catchment Flood Studies	The full package of investigations of the Brisbane River carried out on behalf of the Queensland Government since 2013 covering data collection, hydrological and hydraulic modelling, the Strategic Floodplain Management Plan and Local Floodplain Management Plans.
Exposure	The land use and population that exists within the floodplain, and hence is exposed to flood hazards.
Filling of land	An increase in ground level to elevate the land in an attempt to reduce the frequency of flood inundation. Filling of land within sensitive parts of a floodplain, such as flood conveyance areas, may worsen flood conditions elsewhere.
Flood conveyance	Where the vast majority of flood water flows through a floodplain, and is typically deep and fast flowing during big flood events. Even partial blockage of flood conveyance areas would likely cause significant redistribution of flood flow, or significant increase in flood levels.

Flood fringe	Parts of the floodplain that are farthest from the main river channel and flood conveyance areas. It is the remainder of the floodplain once flood conveyance and flood storage areas have been defined. Removal of flood fringe areas from the floodplain would have little overall impact on flood behaviour.
Flood function	Floodplains are differentiated based on flood behaviour or floodplain function during events. This includes flood conveyance areas, flood storage areas and flood fringes.
Flood risk management outcomes	The desired outcomes achieved through delivering the strategies and recommendations of this Strategic Plan in achieving the overall shared vision for the Brisbane River floodplain.
Flood storage	Parts of the floodplain that fill up with floodwaters during a flood and temporarily detain the floodwaters, thereby slowing the progress of the flood and potentially lowering peak levels downstream.
Flood Study	Brisbane River Catchment Flood Study (Flood Study), comprising hydrologic and hydraulic modelling and assessment of the Brisbane River.
Habitable floor	Consistent with Building Code of Australia, Volume 2, Part 1.1, for residential properties - the habitable floor level should be taken at the lowest entrance point to the property or the lowest habitable floor area. Habitable areas are used for normal domestic activities and; (a) include a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom (b) exclude a bathroom, laundry, pantry, lobby, clothes drying room, vehicle parking area or storage. For other land uses, a habitable area refers to that used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
Hydraulic behaviour	Where and how flood waters flow across a floodplain. This includes flood depths, levels, velocities and flows.
Hydraulic Risk / Potential Hydraulic Risk	A combination of the likelihood of a flood event and the hazard level occurring. This is defined over a broad spectrum of likelihoods and hazards via a two-dimensional risk matrix. This represents the flood risk independent of use or occupancy of the land. Refer to **Appendix C** for further information.
Hydrologic and hydraulic models	Computer modelling of rainfall and surface runoff to simulate real world flood conditions and therefore estimate likely flood extents and flood behaviour for theoretical future conditions and events. These models are calibrated to historical events to ensure they provide an adequate representation of actual conditions.

Integrated catchment planning / management	Integrated Catchment Management (ICM) is a well recognised practice that aims to improve and integrate the management of land, water and related biological resources in order to achieve the sustainable and balanced use of these resources. Integrated Catchment Planning is a term used in the context of this Strategic Plan to describe holistic multi-disciplinary planning, consideration of other planning activities in the local context, and identification of mutually beneficial outcomes.
Landscape management	Includes land-based activities such as targeted catchment and riparian revegetation, rural land management practices and Water Sensitive Urban Design.
Localised flooding / overland flow	Flooding generated from rainfall occurring over a local area only. Localised flooding is concentrated in small creeks and ephemeral waterways, while overland flow is the surface runoff following rainfall, concentrated in natural lower lying areas and swales across the landscape. Flooding is usually 'flashy' with peaks occurring shortly after rainfall.
'no worsening' of flood risk	Development including filling and land form change, when assessed against the full range of flood event AEP's outlined this Strategic Plan: • does not result in an increase in flood hazard conditions (flood levels, flood velocities, evacuation conditions and capability, flood hazard categories and potential hydraulic risk categories) for surrounding properties • does not increase the level of flood risk of surrounding properties • does not result in a total impact from cumulative filling across the floodplain of greater than 10mm • does not alter the flood hydrographs, and timing of the flood wave/s • does not impact on flood warning times.
Queensland Emergency Risk Management Framework	A new framework developed in 2017 by QFES, for assessment and management of risks from natural hazards.
Re-engaging floodplain	Removal of artificial structures within a floodplain that create a barrier to the natural flow of waters across a floodplain. This could include levees, road embankments and flood gates.
Reference gauge	The flood gauge that is used by flood warning authorities to announce predicted flood levels for a general locality.
Regionally consistent approaches and understanding	The same methods, definitions and terms used to assess and describe flooding across the region. This applies to consistent definition and consideration of hydraulic behaviour, flood damages, land use planning, disaster management requirements, language and messaging to the community and stakeholders.
Relative time to inundation mapping	Mapping of relative time to inundation (› 0.3m) for properties exposed to inundation once the flood level at the reference gauge exceeds the minor flood level.

Risk-based land use planning	The principle of land use allocation based on ensuring that only uses appropriate to the level of risk are placed on that land.
Riverine flooding	Flooding within large river systems where floods increase and break out of the riverbanks to inundate adjacent floodplains. Flooding is generated from rainfall across the broad catchment area. It may take many hours, or even days, for peak flood levels to occur as rainfall slowly drains from the catchment.
ShapingSEQ	Queensland Government's Regional Plan for South East Queensland (2017).
Tangible damages / intangible damages	Tangible damages are flood damages that can be measured in economic terms such as financial loss. Intangible damages cannot be directly linked to financial measures and include impacts such as stress and anxiety, as well as loss of life.
Technical Evidence Report	The Technical Evidence Report that supports this Strategic Plan. The Technical Evidence Report was developed over the course of 18 months as a series of milestone reports covering key work packages of the floodplain management assessment process.
Temporary flood barriers	Artificial walls that are temporarily erected to prevent inundation of flood waters into some sections of a floodplain. These can include interlocking vertical or inclined panels or flexible water-filled tubes.
Tolerability	Tolerability is the community's readiness to bear the risk of flooding, after risk treatment. Risk tolerance can be influenced by legal or regulatory requirements, as well a community's awareness and experience of floods, knowledge of previous flooding history, what type of uses are exposed, extent of social and community cohesiveness. A range of demographic and socio-economic characteristics of a community may also affect current and future community views on flood risk.
Vulnerability	A measure of the sensitivity of the land use and/or population exposed to flooding. Vulnerability can relate to physical, socio-economic, mobility or flood-awareness factors.
Whole-of-catchment approach	Consideration of processes and interactions occurring throughout the whole Brisbane River Catchment, rather than just in discrete locations, such as within local government boundaries. Natural processes do not recognise governance boundaries, so management of land, water and environmental values needs to occur on a more holistic catchment scale.

Appendix B – Acronyms and abbreviations

AAD	Average Annual Damage
AEP	Annual Exceedance Probability
ARR	Australian Rainfall and Runoff
Bureau	Bureau of Meteorology
BCC	Brisbane City Council
CAP	Catchment Action Plan
CSIRO	Commonwealth Scientific Investigation Research Organisation
DES / EHP	Department of Environment and Science (replacing Environment and Heritage Protection)
DEWS	Department of Energy and Water Supply
DLG	Department of Local Government
DNRME	Department of Natural Resources, Mines and Energy
DSDMIP	Department of State Development, Manufacturing, Infrastructure and Planning
EDQ	Economic Development Queensland
HLW	Healthy Land and Water
DHPW	Department of Housing and Public Works
HR	(Potential) Hydraulic Risk
ICC	Ipswich City Council
IGEM	Inspector General of Emergency Management
IPCC	Inter-governmental Panel on Climate Change
LFMP	Phase 4 (Local Floodplain Management Plan)
LVRC	Lockyer Valley Regional Council
QAO	Queensland Audit Office
Q-CAS	Queensland Climate Adaptation Strategy
QERMF	Queensland Emergency Risk Management Framework
SEQ	South East Queensland
QFCoI	Queensland Floods Commission of Inquiry
QFES	Queensland Fire and Emergency Services
QRA	Queensland Reconstruction Authority
RCP	Relative Concentration Pathway (8.5 or 4.5)
SFMP	Phase 3 (Strategic Floodplain Management Plan) (this Strategic Plan)
SPP	State Planning Policy
SRC	Somerset Regional Council
TER	Technical Evidence Report
WSUD	Water Sensitive Urban Design

Appendix C – Potential Hydraulic Risk Matrix

The concept of Potential Hydraulic Risk (HR) is used throughout this Strategic Plan to represent the hydraulic behaviour of floods and their likelihood of occurring in the Brisbane River floodplain. Potential Hydraulic Risk is one of the inputs used to determine overall flood risk from riverine flooding. It represents the risk resulting from the flood conditions (likelihood of the flood occurring, and the depths and velocities of the floodwaters) independent of the actual use or development of the land within the floodplain.

Flood risk considers a range of factors in addition to potential hydraulic risk and is best suited to be determined at the local level to reflect local context. It does not replace local government risk mapping and is not comparable to local government risk categorisations.

Potential Hydraulic Risk has been derived through consideration of different flood event likelihoods, and the corresponding depths and velocities across the floodplain.

Consideration was given to a wide range of flood likelihoods, from the more frequent to the very rare events. Seven flood likelihoods are incorporated into the Potential Hydraulic Risk matrix developed for the Brisbane River catchment, namely:

- 1 in 10 AEP
- 1 in 20 AEP
- 1 in 50 AEP
- 1 in 100 AEP
- 1 in 500 AEP
- 1 in 2000 AEP
- 1 in 100,000 AEP

For each flood event, the floodwaters have also been classified based on their 'flood hazard'. This is determined by considering the flood depth and flood velocity in combination, as recommended by AIDR Guideline 7-3, Flood Hazard - Supporting document for the implementation of Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia (AIDR, 2017). This results in six classifications of flood hazard for each flood likelihood:

- H1 – generally safe for people, vehicles and buildings.
- H2 – unsafe for small vehicles.
- H3 – unsafe for vehicles, children and the elderly.
- H4 – unsafe for people and vehicles.
- H5 – unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust building types vulnerable to failure.
- H6 – unsafe for vehicles and people. All building types considered vulnerable to failure.

The Potential Hydraulic Risk has been determined by grouping flood likelihoods and hazards in to five bands of similar and relative 'risk', ranging from HR1 (highest potential risk) to HR5 (lowest potential risk). These potential hydraulic risk bands have been derived using the established risk matrix approach based on the combination of likelihood and hazard as described above. A gradation of potential hydraulic risk is captured across both increasing flood likelihood and increasing hazard categories. For example, combinations of low likelihood, such as a 0.001% (1 in 100,000) AEP event, and low consequence

produce the lowest potential risk. Whereas, combinations of high likelihood, such as a 10% (1 in 10) AEP event, and high consequence produce the highest potential risk. Areas of the floodplain that are subject to other combinations of likelihood and hazard are considered to experience potential hydraulic risk across the full spectrum of risk between these two extremes.

For any given likelihood, the potential hydraulic risk becomes greater as the hazard increases. For a 10% (1 in 10) AEP event, the potential hydraulic risk will be higher for areas with higher hazard levels (e.g. H5 or H6) than areas with lower hazard areas (e.g. H1). The same applies for a given hazard category, as the likelihood of flooding increases the potential hydraulic risk will also increase.

The potential hydraulic risk does not increase in equal increments as the level of hazard and likelihood increase. Consideration should be given to the level of consequence associated with different hazard and likelihood categories. Hazard categories of H3 to H6 represent areas of the floodplain that pose a serious threat to people's lives and therefore the level of potential hydraulic risk in these areas should be considered more significant. Similarly, areas of the floodplain that experience frequent flooding will also have a higher potential hydraulic risk. Conversely, areas of the floodplain subject to flooding from only extremely rare events, such as the 0.001% (1 in 100,000) AEP), are considered to have a low potential hydraulic risk regardless of the level hazard as the per cent chance of this flood event occurring in any given year is so remote.

This potential hydraulic risk classification is further described in Section 4.2. of the TER and has been represented using a risk matrix to illustrate the combinations of hazards and likelihoods resulting in each potential hydraulic risk band.

This classification is then used to spatially map the floodplain, grouped by HR category, as shown in **Figure 4-6** in Section 4.2.7 of the TER.

Potential hydraulic risk mapping of the lower Brisbane River floodplain has the following limitations:

- It represents flooding from the major rivers and tributaries only, based on the design flood events identified in the Flood Study. The risk mapping does not reflect flooding from local sub-catchments, creeks and overland flowpaths, or other scenarios such as erosion or changes in geomorphology; and
- It does not take into consideration non-hydraulic risk factors. A comprehensive assessment of flood risk (beyond potential hydraulic risk) should also consider non-hydraulic flood risk factors, outside of this Strategic Plan such as:
    - land use or development exposure to flooding
    - vulnerability of the community at risk
    - specific challenges associated with evacuation or isolation during flooding
    - the community's tolerability to risk
    - risks associated with loss of essential services during a flood.

Potential hydraulic risk, as defined in this Strategic Plan, does not represent the total flood risk and should not be interpreted as such. The limitations outlined above should be taken into account when applying this potential hydraulic risk outside of the parameters of the Strategic Plan.

Appendix D – Reference list

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