

Flood resilience of river catchments

Report 16: 2015–16



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April 2016

The Honourable P Wellington MP
Speaker of the Legislative Assembly
Parliament House
BRISBANE QLD 4000

Dear Mr Speaker

Report to Parliament

This report is prepared under Part 3 Division 3 of the *Auditor-General Act 2009*, and is titled Flood resilience of river catchments.

In accordance with s.67 of the Act, would you please arrange for the report to be tabled in the Legislative Assembly.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Andrew Greaves', is written over a light grey rectangular background.

Andrew Greaves
Auditor-General

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Summary

Queensland's rivers provide economic, social and health benefits through activities such as tourism, the provision of drinking water and agricultural irrigation.

During major rainfall events, rivers can become a source of flooding. Flooding is historically the most destructive and expensive natural disaster in Australia with average losses estimated at \$377 million per year (from 1967 to 2005).

Flood events cause damage to property, disrupt local communities and economies and can lead to major injuries or loss of life. The former Department of Community Safety reported in 2011 that Queensland properties make up around 35 per cent of all Australian properties at risk of flooding. The private and social costs, both tangible and intangible, of the recent floods are significant. The intangible costs (such as loss of employment, or diminished physical and mental health) are particularly difficult to quantify, with some estimates suggesting they may be more than the tangible costs.

The most significant recent floods in South East Queensland were in 2011 and 2013. These floods inundated substantial areas of the state, including the Brisbane River catchments.

While flood events are unavoidable, natural and recurring phenomena, mitigation measures can minimise their impact. In this context, resilience means preparing for and managing potential hazards to minimise flood impacts.

The State Disaster Management Plan (SDMP) identifies the Department of Infrastructure, Local Government and Planning (DILGP) as being responsible to:

Drive the enhancement of disaster resilience throughout Queensland, ensuring that the State's resilience goals and objectives are achieved, including implementation of the Queensland Strategy for Disaster Resilience and the RACQ Get Ready Queensland program.

The *Disaster Management Act 2003* (the Act) makes councils primarily responsible for managing disaster events in their local area. The Act, however, does not solely assign the responsibility of prevention and preparedness activities to councils. It promotes the concept of shared responsibility for all disaster management groups at the local, district and state levels.

Integration of activities across river catchments is particularly important for flood resilience. This is complicated by the fact that council and catchment boundaries do not line up—one catchment can span the responsibility of two or more councils.

Since the 2011 and 2013 floods, all levels of government have invested considerable effort, funds and resources into improving flood resilience. The Queensland Government has made progress on the 2011 Queensland Floods Commission of Inquiry recommendations. This has included preparing flood studies to assist both state and local governments in understanding flood risks and managing floodplains. A floodplain is land that is prone to flooding. It is usually flat with areas of higher elevation to both sides.

In this audit we examine the effectiveness of flood resilience activities since 2011, focusing specifically on the Bremer, Lockyer, Mid and Upper Brisbane River catchments.

Conclusions

All four councils and the state government departments we audited better understand their flood risks today than they did in 2011, and all are better prepared. This is because they have acted to identify floods risks, primarily through analysis of historical and recent flood information, local knowledge, and flood maps and studies.

However, as they move further away in time from these flood events the risk arises that momentum to continue building on the improvements made and further strengthen Queensland's flood prevention and preparedness will be lost.

Given this risk the governance arrangements now required to maintain momentum require careful reconsideration. As floods have no regard to administrative boundaries, local efforts, taken alone, are not enough. What is missing under the current arrangements is a strategic approach that manages risks and that integrates and prioritises efforts and resources at the catchment scale. But the current allocation of roles and responsibilities between state and local governments works against such a catchment scale approach.

For example, a catchment approach would require some councils to contemplate spending some of their resources upstream, outside their local government boundaries, to achieve benefits to their communities.

It may also require them to subordinate their local risk assessments and priorities to wider considerations. For example, a council may need to invest in activities, such as riparian revegetation, that have little impact on flood mitigation its own area, but which could have significant benefits for the residents of councils downstream.

Presently, in the four catchments, no one entity is responsible for leading and coordinating cross-boundary activities. The concept of shared responsibility has not been realised. The absence of authority and strategic vision for managing the catchments has meant that neither the responsible agencies, nor the broader public, have had a consistent, clear and comprehensive understanding of what needs to be done, how it will be achieved and by whom.

This means that neither level of government can be reliably assured that Queensland's flood resilience activities are the most cost-effective, or that they will maximise their contribution to the goal of being the most disaster-resilient state in the country.

The Brisbane River Catchment Flood Studies (BRCFS) represent a significant step forward for government in identifying and assessing flood risks across the Brisbane River catchment. The BRCFS are however only one of many elements necessary to effectively manage flood risk for these catchments. Without appropriately assigned authority and strategic coordination, the products of the BRCFS are less likely to be realised to their full potential.

The absence of a coordinated strategic approach is also a missed opportunity to integrate mitigating flood risk with other elements of catchment management, such as water quality, biodiversity and leisure activities. The key challenge will be to promote the concept of shared responsibility and lead a coordinated, systems approach to achieving integrated management of the four catchments.

Managing the catchments

Multiple public sector and non-public sector agencies contribute to managing the catchments and building flood resilience. The Department of Infrastructure, Local Government and Planning (DILGP) is responsible under the SDMP for coordinating, monitoring and driving the enhancement of disaster resilience throughout Queensland, including floods.

With the notable exception of the BRCFS, councils focus their activities and expenditure within their boundaries and not at the catchment scale—where their collective efforts could be directed to address the greatest flood risks. The departments, councils and other agencies are all working to different understandings of what 'resilience' means. This further contributes to an uncoordinated approach to flood risk mitigation across catchments.

Similarly, state government and councils have increased expenditure on building flood resilience. However, the management and administration of the funding provided by the state is not strategic. Instead, it is fragmented, allocated on a competitive basis, and not appropriately prioritised.

Elements of better coordination are emerging, in the BRCFS (led by DILGP and the Department of Natural Resources and Mines (DNRM), the Resilient Rivers Initiative (driven by the SEQ Council of Mayors), and the Brisbane River Improvement Trust (DNRM).

But the state and local governments have no overarching strategic vision or plan for managing the catchments and building flood resilience. This further hampers coordination.

Instead, responsibility for managing flood risk and mitigation predominantly rests with councils, with guidance and some support from the state government. However, in some cases, councils are unaware of the guidance. In other cases, they have limited capacity or capability to follow it.

Councils primarily cite a lack of professional capability and the high cost of procuring specific skills as reasons for limitations in their understanding of flood risk. The Queensland Government has not assessed the capabilities of councils with respect to floodplain management. Therefore, it does not know where and how to prioritise its support for councils in this regard.

Building flood resilience

The state and councils have undertaken considerable flood mapping and studies since the recent flood events. Flood mapping is important in determining where mitigation efforts are best focused to reduce the impact of flooding across a catchment.

The \$5 million BRCFS is a significant and positive undertaking in response to a key recommendation of the Queensland Floods Commission of Inquiry. The BRCFS represents a significant step forward for government in identifying and assessing flood risks across the Brisbane river catchment.

It is unlikely that all elements of the BRCFS will be delivered to the standard intended with the funding currently in place. The Brisbane River Catchment Flood Study (the flood study) component of the BRCFS has run over its original schedule due to the scale and complexity of this undertaking. It is now expected to be completed in February 2017, more than a year later than originally scheduled.

The other deliverables of the BRCFS are:

- the Brisbane River Catchment Floodplain Management Study (BRCFMS)
- the Brisbane River Catchment Floodplain Management Plan (BRCFMP).

Despite the delay, DILGP anticipates completing the BRCFMP in December 2018, without reducing the quality and extent of the BRCFMP. This is ambitious, given it does not have the funding it originally estimated as necessary and as it is to be delivered one year earlier than previously forecast.

The four councils we audited consider each flood mitigation project on its merits and prioritise it accordingly. Without completed flood mapping, neither state government departments nor the councils can effectively identify, assess and prioritise flood mitigation to best effect across the catchments. None of the councils or catchments have floodplain risk management plans.

There are state, district and local disaster management plans, but these are high level, response and recovery focused, and cover all disasters. They are insufficiently focused to address flood risk and there are no flood-specific sub-plans, despite such plans existing for other hazards, such as bushfires, heat waves, pandemics and acts of terrorism.

The state government and the councils have strengthened their identification and assessment of flood risks, aiding in building resilience. The majority of existing residential developments that are located on the floodplains pre-date the 2011 flood and there is increased understanding of the flood risk since this event. However, there are few examples of specific flood management plans for the pre-existing at-risk communities.

All councils we examined had increased their focus on raising community awareness for flood response, but not on other aspects of resilience, such as vegetation management and their regulatory responsibilities regarding levees.

Both the state government and councils have vegetation management initiatives, but they are not coordinated across the catchments and are not strategic. They do not target revegetation efforts for greatest catchment benefit. Also, there continues to be a net loss in remnant woody vegetation due to land clearing, primarily for agriculture and settlement.

Since May 2014, councils are responsible for approving and monitoring the construction and modification of levee banks, but they are inhibited in effectively fulfilling this responsibility. This is because they have not obtained the resources, capabilities or historical data needed to fulfil their regulatory obligations for approving and monitoring levees. This means the potential for unintended negative downstream effects from poorly placed, constructed or maintained levees is unmanaged.

Recommendations

We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning:

1. fulfil its obligation under the State Disaster Management Plan to drive the enhancement of flood resilience in the four catchments by:
 - coordinating flood resilience activities and funding at a state and catchment level
 - developing strategies and plans, in consultation with the four councils and relevant entities, to effectively identify, assess, prioritise and manage catchment scale flood risks using an integrated catchment management approach
 - assessing the capacity and capabilities of the four councils and supporting them as necessary in building flood resilience in the catchments and in their local areas.
2. as a matter of priority, establish what funding is reasonably required and complete all elements of the Brisbane River Catchment Flood Studies.

We recommend that the four councils:

3. develop floodplain management plans in accordance with Recommendation 2.12 of the Final Report of the Queensland Floods Commission of Inquiry

We recommend that the Department of Natural Resources and Mines and the four councils:

4. work together to effectively and economically regulate levee banks.

Reference to comments

In accordance with s.64 of the *Auditor-General Act 2009*, a copy of this report was provided to the following entities with a request for comments.

- Department of the Premier and Cabinet
- Department of Infrastructure, Local Government and Planning
- Department of Natural Resources and Mines
- Ipswich City Council
- Lockyer Valley Regional Council
- Scenic Rim Regional Council
- Somerset Regional Council.

Their views have been considered in reaching our audit conclusions and are represented to the extent relevant and warranted in preparing this report.

The comments received are included in Appendix A of this report.

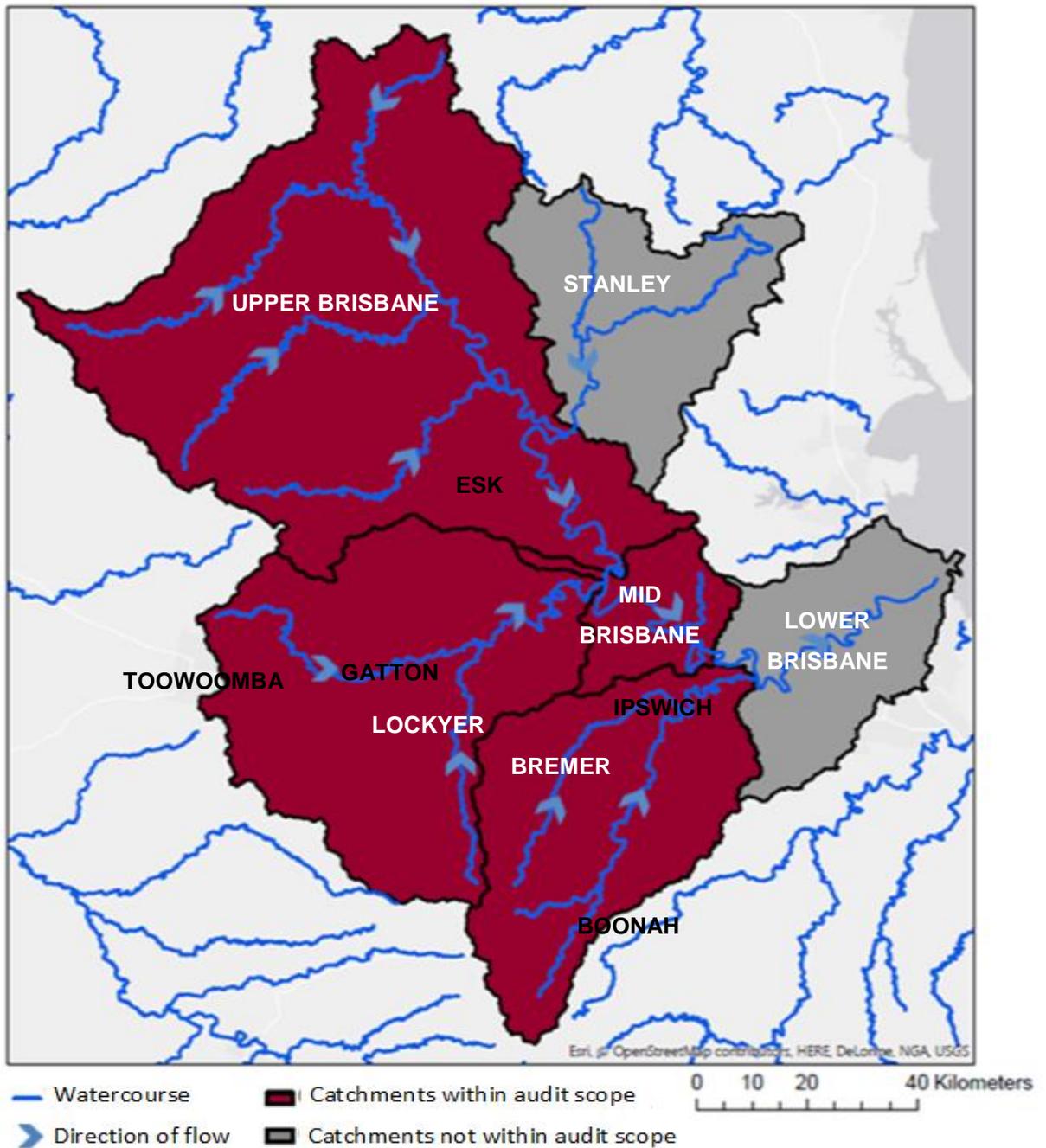
1. Context

History of flooding in the catchment

The greater Brisbane River catchment has a documented history of flooding back to the mid-1880s. Based on records from the Brisbane City gauge, the 1841 flood and multiple floods that occurred in February 1893 have been the largest since European settlement.

Figure 1A shows the six river catchments that make up the greater Brisbane River catchment.

Figure 1A
The Greater Brisbane River catchment



Source: Queensland Audit Office

More detail about the catchments within scope of this audit is provided in Appendix C.

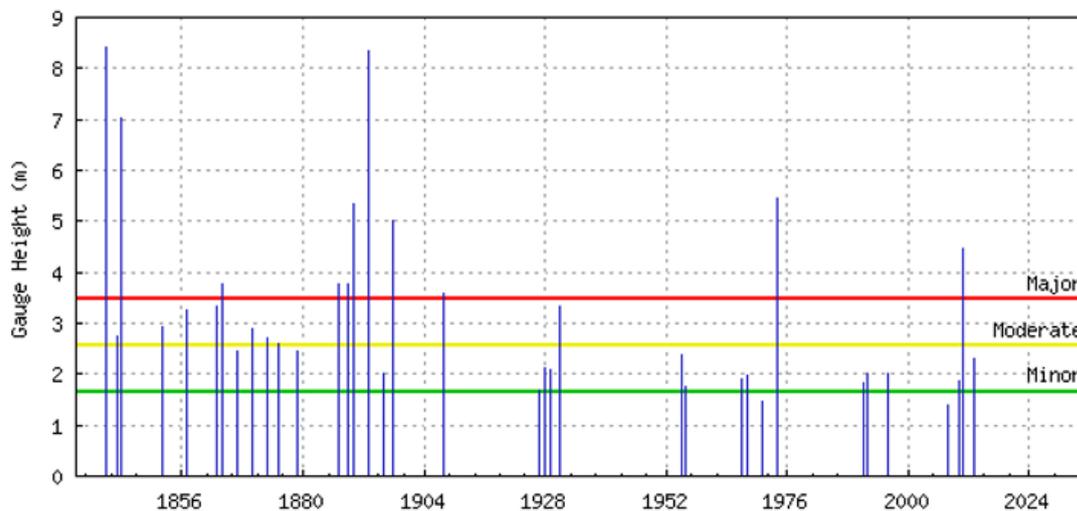
The most significant recent floods in the greater Brisbane River catchment were in 2011 and 2013. The 2011 flood was the third highest on record at Ipswich and the sixth highest on record in Brisbane. Appendix D provides more detail about the 2011 and 2013 floods.

The Bureau of Meteorology (BoM) has produced a thorough compilation of known floods in the Brisbane River and Bremer River catchments. It uses a three tier classification scheme to define flooding. The tiers are:

- **minor** flooding, which causes inconvenience, inundation of low lying areas next to water courses, minor road closures and flooding in urban areas below floor level
- **moderate** flooding, which in addition to the above, includes substantial areas of inundation. Main traffic routes are interrupted, some buildings are affected above floor level and there is possible evacuation of flood affected areas
- **major** flooding which in addition to the above, has extensive urban and rural areas inundated and many buildings affected above the floor level. In addition, major rail and road networks are closed, there is evacuation of flood areas and utility services are impacted upon.

Figures 1B and 1C illustrate the frequency and height of floods for the Brisbane and Bremer rivers respectively. They show that Brisbane experienced major flooding in 11 of the 36 flood years, and the Bremer River experienced major flooding in 24 of the 44 flood years since records began.

Figure 1B
Brisbane River City gauge peaks since recorded history

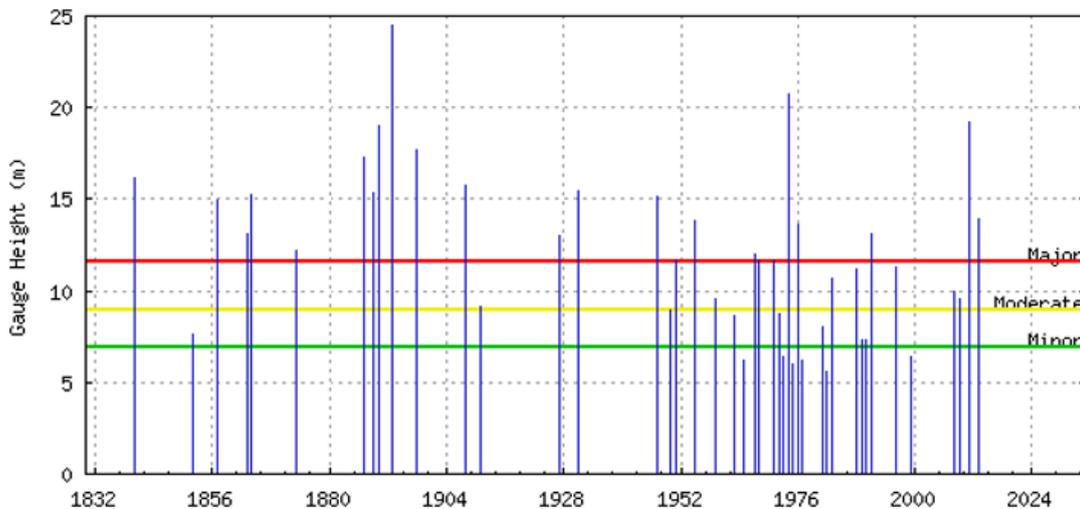


Note: In some years (e.g. 1893) there have been several floods, but only the highest peak for that year is shown.

Source: Bureau of Meteorology

The construction of large dams and the modification of the estuary have made communities in the lower Brisbane catchment less prone to flooding. However, the 2011 floods demonstrated that the populations of South East Queensland are still vulnerable to flooding.

Figure 1C
Bremer River at Ipswich gauge peaks since recorded history



Note: In some years (e.g.1893) there have been several floods, but only the highest peak for that year is shown.

Source: Bureau of Meteorology

Queensland Floods Commission of Inquiry

Following the 2011 floods, the Queensland Government established an independent commission of inquiry to examine the disaster. One focus of the inquiry was to assess all aspects of land use planning through local and regional planning schemes to minimise infrastructure and property impacts from floods.

The Queensland Floods Commission of Inquiry delivered its final report on 16 March 2012. The final report contained 177 recommendations covering:

- floodplain management
- state and local planning instruments
- flood considerations for development assessments
- building controls
- maintenance of access to essential services
- buy-backs and land swaps
- private insurer performance
- mining
- emergency response
- dam operations.

The Department of the Premier and Cabinet (DPC) reported to the Cabinet on responsible agencies' progress in implementing the final report's recommendations. State government agencies were responsible for 123 of the 177 recommendations.

DPC's last update was in October 2015, when it reported that implementation of 117 of the 123 recommendations was complete, while implementation of six of the recommendations was ongoing.

DPC did not report on the status of the 54 remaining recommendations, 45 of which were the responsibility of councils. DPC considers these council recommendations to be ongoing business as usual activities.

Seven of the remaining recommendations related to Australian Government agencies and the last two related to private enterprises.

Flood resilience

The Queensland Strategy for Disaster Resilience defines disaster resilience as:

The ability of the Queensland Government, local governments, communities, businesses and individuals to prepare for, respond to, and manage potential hazards and disasters, thereby minimising impacts and rapidly recovering to emerge stronger and better able to cope with future disaster events.

The definition focuses on preparing for and managing potential hazards to minimise flood impacts. It emphasises the need to be forward looking to build resilience, rather than acting only at the time of an event or after.

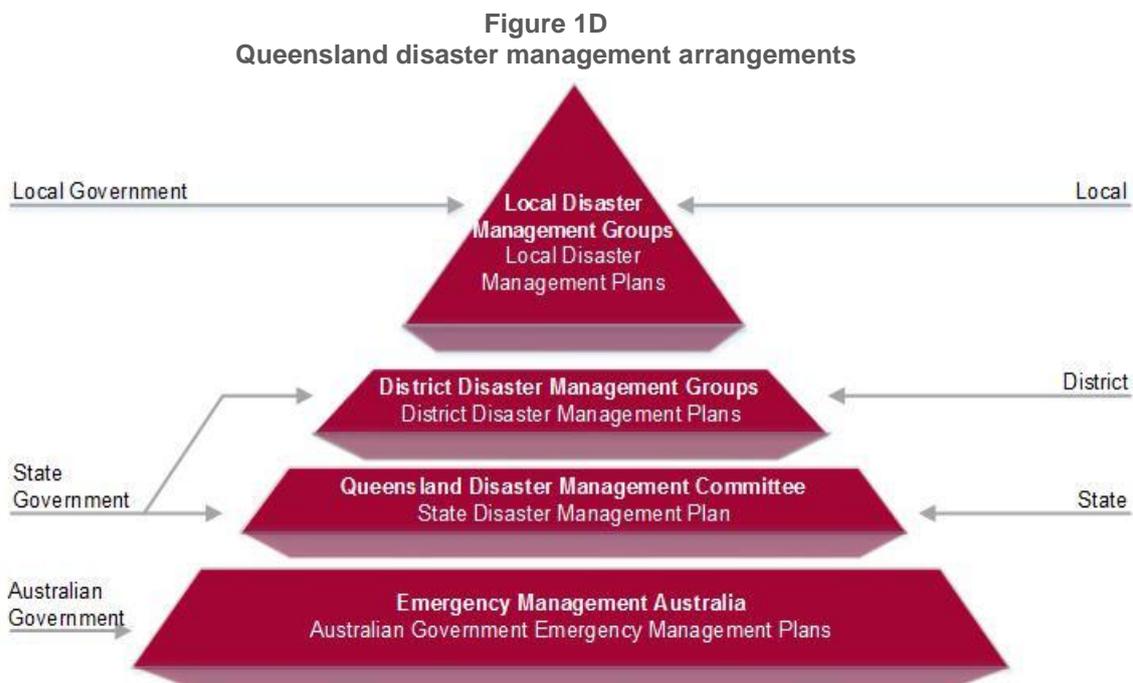
It can be challenging to sustain flood resilience building efforts during dry periods and drought. Spending public funds on flood resilience activities such as mapping, constructing levees and revegetation might seem counterintuitive, but in reality this is the most critical period to build flood resilience.

When flooding is imminent, it can be too late to achieve some of these important resilience measures. The 2011 floods, which followed a sustained period of drought, are a good example of this.

Relevant legislation and guidance

The Disaster Management Act 2003

The *Disaster Management Act 2003* (the Act) makes councils primarily responsible for managing events in their local area. The Act, however, does not solely assign the responsibility of prevention and preparedness activities to councils. It promotes a concept of shared responsibility for all disaster management groups at the local, district and state levels, as shown in Figure 1D.



Source: Queensland Audit Office from Queensland's disaster management arrangements

District Disaster Management Groups (DDMGs) and the Queensland Disaster Management Committee (QDMC) are responsible for providing councils with appropriate resources and support to help them carry out disaster operations. The QDMC, which is comprised of a core group of ministers (supported by the relevant directors-general), may approach the Australian Government for additional support in disaster events.

Each disaster management group is responsible for developing a disaster management plan that outlines potential hazards and risks, prevention and preparedness strategies and response and recovery arrangements.

The Act requires district and local disaster management plans to be reviewed annually. It also requires the Inspector-General, Emergency Management to regularly review and assess state, district and local disaster management plans. The Premier reviewed and endorsed the latest State Disaster Management Plan on 18 August 2015.

Disaster management groups within each level plan, organise, coordinate and implement activities across the four phases of disaster management: prevention, preparedness, response and recovery.

Local Disaster Management Group jurisdictional boundaries are the same as local government areas, while DDMG boundaries generally align with Queensland Police Services districts, stretching across multiple local government areas in many cases. Neither local nor district boundaries align well with the catchments.

The Sustainable Planning Act 2009

The *Sustainable Planning Act 2009* governs land use planning matters. It is a key piece of legislation used by councils to regulate developments, including development in floodplains. In this respect it is a key flood mitigation tool for the state government and councils.

National best practice

The Australian Attorney-General's Department highlights national best practice principles in *Managing the floodplain: a guide to best practice in flood risk management in Australia* (Handbook 7), which it published in 2013.

Handbook 7 comprises principles, strategies and actions specific to the management of flooding within catchments. It details a proactive approach to flood risk management to prevent inappropriate development on floodplains and to minimise risk to existing communities.

Handbook 7 and the National Disaster Resilience Strategy both state that councils are best positioned for primary responsibility of disaster resilience.

Queensland Strategy for Disaster Resilience

The Queensland Strategy for Disaster Resilience (the strategy), was released in June 2014 and is currently being revised.

The vision in the strategy is to make Queensland the most disaster-resilient state in Australia. The strategy sets out eight goals:

- Understand the risks and proactively prepare for disasters.
- Minimise disaster impacts through flexible and adaptive planning.
- The economy is able to withstand disaster events.
- Reduction of risk to the built environment.
- The natural environment is recognised in planning and decision-making.
- Essential infrastructure and transport systems are disaster-resilient.
- Governments take a proactive approach to disaster risk reduction.
- Greater disaster resilience of public infrastructure after disasters.

The strategy advocates a key role for councils. It:

- Identifies that councils have a primary role in working with communities to build their resilience to disasters.
- Promotes a cooperative approach. It acknowledges that empowering local government and communities enables them to bring their skills, knowledge and experience to the forefront of disaster preparedness.
- Promotes local ownership of disaster resilience initiatives as a partnership with councils.

The strategy also includes a number of programs, outcomes, metrics and measures.

The Department of Infrastructure, Local Government and Planning (DILGP) reports progress towards these outcomes to Cabinet every year in November.

Floodplain management guidance

The Queensland Reconstruction Authority's guide: *Planning for stronger, more resilient floodplains* provides guidance for councils to use in assessing future development applications, and in aligning floodplain management and land use planning. DILGP provides additional land use planning through its *State Planning Policy—state interest guideline for natural hazards, risk and resilience*.

In 2016, the Department of Natural Resources and Mines (DNRM) published the *Guide for Flood Studies and Mapping in Queensland (2016)* to assist local governments in carrying out their flood studies. It also produced a flood mapping implementation toolkit to inform councils on how to build resilience to floods.

The guide and toolkit provide a framework for councils on key elements and linkages to effectively identify, assess and treat flood risks to build economic and community resilience.

Understanding flood risks

Identifying and understanding the risk of flooding is a critical factor in being able to manage it appropriately.

Identifying flood risk

Effective risk management is necessary, given the likelihood and the consequences of floods occurring (Figure 1E). This involves identifying the areas of greatest risk of flooding, and prioritising and performing activities to reduce the risk to tolerable levels.

Figure 1E
Calculating risk



Source: Queensland Reconstruction Authority, *Planning for stronger, more resilient floodplains*, page 11.

Annual Exceedance Probability (AEP) describes the likelihood of a flood of a given size or larger occurring in any one year. This reflects the chance of successive major floods occurring within short periods.

For example, Figure 1F shows that, over a 70-year period, the probability of one flood occurring at the one per cent AEP level (previously referred to as a one in 100-year flood) is around 50.3 per cent. The probability of this occurring twice or more in this 70-year period is around 15.6 per cent, or roughly one in six.

Figure 1F
Likelihood of significant flooding

Annual Exceedance Probability	Previous terminology	Probability of experiencing given flood in a period of 70 years	
		At least once	At least twice
10 per cent	1 in 10 year flood	99.9 per cent	99.3 per cent
5 per cent	1 in 20 year flood	97.0 per cent	86.4 per cent
2 per cent	1 in 50 year flood	75.3 per cent	40.8 per cent
1 per cent	1 in 100 year flood	50.3 per cent	15.6 per cent
0.5 per cent	1 in 200 year flood	29.5 per cent	4.9 per cent

Source: Queensland Audit Office from Queensland Reconstruction Authority's *'Planning for stronger, more resilient floodplains'*

The occurrence of a major flood does not decrease the likelihood of a subsequent major flood. In some cases due to saturation of catchments, it may be more likely. Climate change is also considered to increase the frequency of these events.

In this context, 'consequence' relates to the impact of an event and is a function of exposure, vulnerability and tolerability.

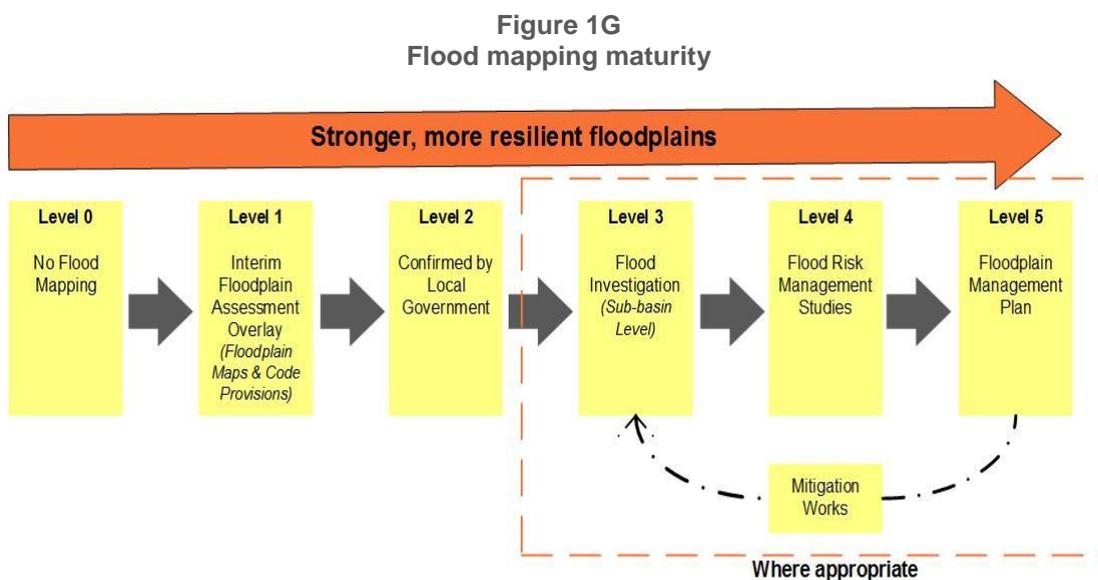
Identifying, assessing and prioritising risk in this way allows for informed planning towards building greater resilience.

Flood mapping and studies

The generation and analysis of flood maps and studies increases our understanding of flood risk. The State Planning Policy requires all councils to do fit-for-purpose mapping and risk assessments and include them in their planning scheme to ensure all risks are tolerable.

Flood maps and studies involve hydrological (to derive flows) and hydraulic (to derive flood levels and velocities) models calibrated to known historical flooding events. The output is usually a series of flood lines based on AEP or historical events that overlay on a map of the area.

Scenario analysis shows the benefits of potential project options. Flood maps and studies range in quality and can be best categorised by their flood mapping maturity levels, ranging from Level Zero for no mapping to Level Five for an implemented floodplain management plan (Figure 1G).



Source: Queensland Reconstruction Authority

The Queensland Floods Commission of Inquiry Recommendation 2.4 states:

A recent flood study should be available for use in floodplain management for every urban area in Queensland. Where no recent study exists, one should be initiated.

The Queensland Reconstruction Authority performed a large portion of the Level 1 and 2 mapping for the state through the Queensland Flood Mapping Program (QFMP). The Department of Natural Resources and Mines completed the QFMP and made the outputs available on its FloodCheck website as an interactive map.

FloodCheck also makes users aware of other existing flood studies in the area, however, these are often on individual council websites. Limited flood height information for individual properties are available on these websites. Landholders need to contact council staff if they require more information.

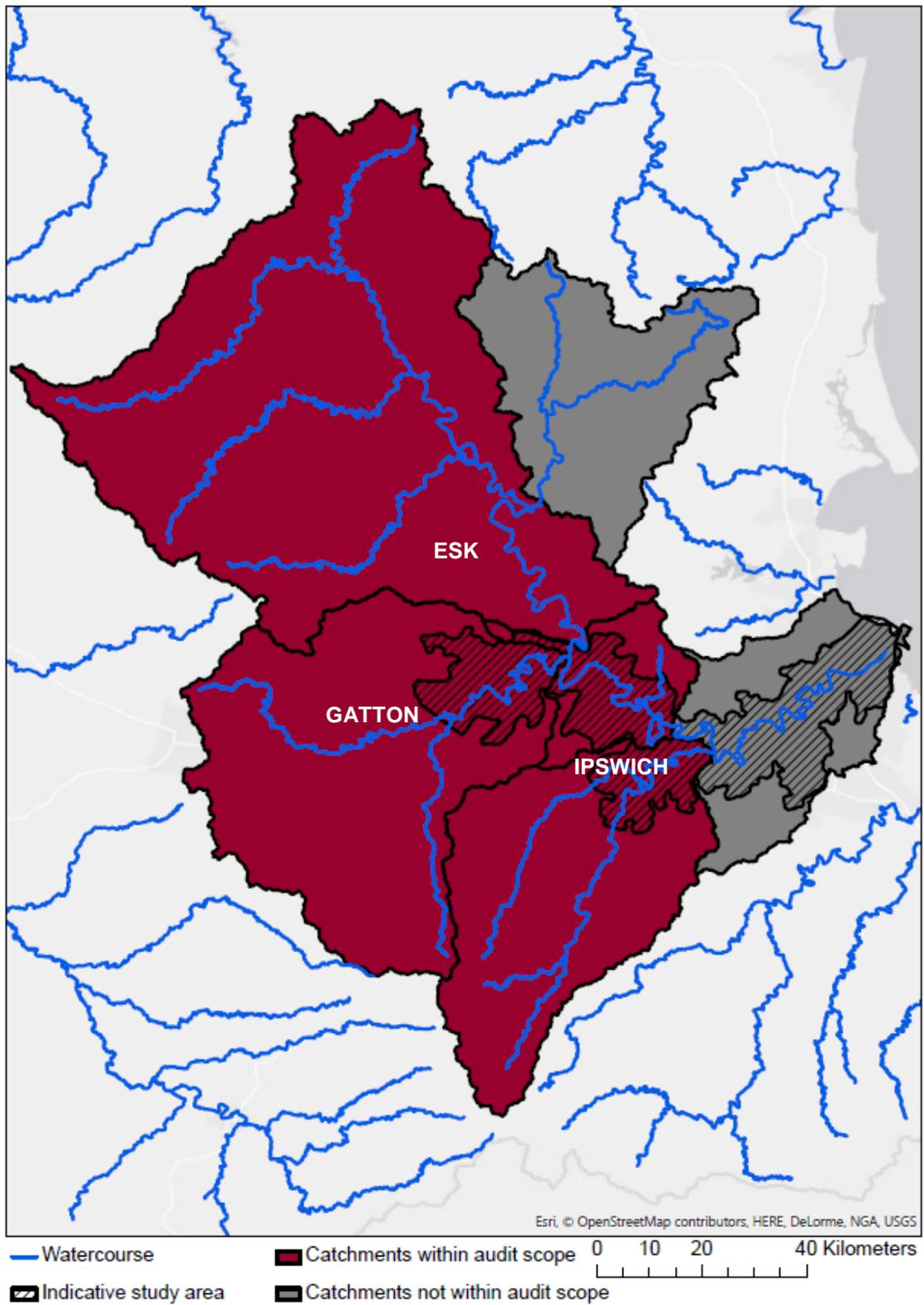
Brisbane River Catchment Flood Studies

The state government initiated the Brisbane River Catchment Flood Studies (BRCFS) in response to the Queensland Floods Commission of Inquiry, Final Report, and Recommendation 2.2.

The BRCFS is a large and complex multiagency undertaking with a significant funding outlay of \$5 million (\$3 million from Queensland Government and \$2 million from councils). Its focus is the greater Brisbane River Catchment, including areas of the Brisbane City Council, Ipswich City Council, Somerset Regional Council and Lockyer Valley Regional Council.

Figure 1H shows the extent of the Brisbane River Catchment Flood Study.

Figure 1H
Brisbane River Catchment Flood Study areas



Source: Queensland Audit Office from Department of Natural Resources and Mines

The BRCFS consists of three major components:

- the Brisbane River Catchment Flood Study, involving:
 - A hydrology study: the scientific study of how rain on catchments runs off to produce flow in the rivers and creeks.
 - A hydraulics study and modelling: an applied science and engineering assessment of the physical movement of flow along rivers, creeks and over floodplains. Hydraulic modelling can determine flood levels, velocity (speed) and flood inundation extents.
- The Brisbane River Catchment Floodplain Management Study (BRCFMS)
- The Brisbane River Catchment Floodplain Management Plans (BRCFMP).

It also considers the effects of the operation of major dams, including Wivenhoe Dam and Somerset Dam.

The finalised Brisbane River Catchment Flood Study (hydrology and hydraulics) will inform future flood risk management approaches and the BRCFMS.

The BRCFMS is intended to identify the risks and assess various floodplain management options to increase community resilience to floods. It will assess a wide range of structural and non-structural options using cost-benefit analysis techniques.

The recommendations from the study are intended to form the basis of catchment-wide and local area-specific floodplain management plans (BRCFMP) for decades to come.

Entities responsible for building flood resilience

Building Queensland's flood resilience involves a large number of state government departments, councils, and non-government entities.

Councils are the major service providers to communities and are responsible for managing local development. For this reason the responsibility for flood risk management generally rests with councils. The role of state government agencies is generally to support councils in fulfilling these responsibilities.

Management of catchments and floodplains is more complex and often crosses council boundaries. Therefore, catchment and floodplain management involves all levels of government, with responsibilities dispersed across government departments and local councils.

The departments, councils and entities involved in flood risk management for the catchments we audited and their roles and responsibilities are detailed in Appendix E.

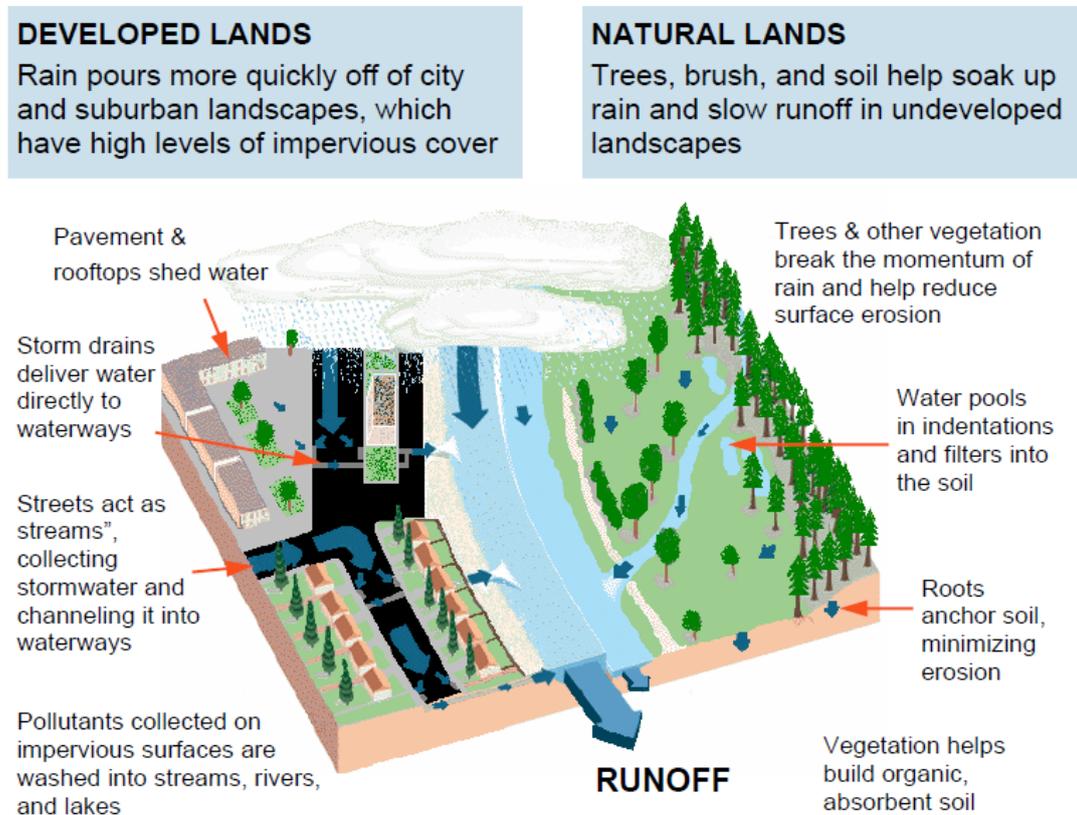
Integrated catchment management

Flood risk management is an element of integrated catchment management.

Integrated catchment management involves recognising and balancing the relationships in factors impacting on the complex ecosystems within a catchment. It acknowledges that it is often not possible to adjust one factor without affecting another.

An example would be the effect of increased urbanised development. The increase in impervious surfaces such as roads and buildings increases the amount of runoff due to the reduced absorption properties of these surfaces, as shown in Figure 11.

Figure 11
Conceptual diagram showing the hydrological differences between natural and urban land use.



Source: California Water and Land Use Partnerships' 'How Urbanization Affects the Water Cycle'

Similarly, the shutting down of the water treatment plant at Mount Crosby in January 2013, due to high levels of sediment and silt in the Brisbane River demonstrates the interrelationships of water quality, salinity and flooding. Some Brisbane suburbs were reportedly within six to 12 hours of running out of drinking water as a result of unprecedented levels of sediment.

Integrated catchment management approaches promote the need for a coordinated approach at all levels of government. They also promote community and private enterprise engagement. The inclusion of private landholders and the community is critical to the achievement of outcomes.

When approaching flood risk management, other jurisdictions within Australia have recognised the importance of this approach. Both New South Wales and Victoria have created statutory bodies called Catchment Management Authorities (CMAs) to facilitate a coordinated long-term approach to managing their catchments. For example, Victoria's CMAs manage:

- biodiversity and native vegetation
- soil health and salinity
- threatened plant and animal species
- waterway health
- fire recovery and flood response and recovery.

They do this by preparing regional catchment strategies and sub-strategies in consultation with communities. They also serve as a central point for driving investment and resources to councils, landholders and other service delivery agencies.

Each CMA has a board that is responsible for setting strategic directions for regional land and water resource management. The CMA is required to publicly report every five years on the condition of these resources.

CMAs also conduct the flood mapping and studies within their catchment boundaries to ensure consistency and better economies of scale for employment of floodplain management expertise. They provide a central point of contact for all councils within the catchment boundaries.

Natural environment

Empirical evidence has shown that deforestation increases both flood risk and severity.

In 2012, the Queensland Government developed its own synthesis on the role of natural assets in flood resilience and concluded that the evidence that human changes to the landscape impact on flooding is overwhelming.

This is because water flow speed is determined by the:

- volume of water
- size of the channel
- slope of the landscape
- roughness of the landscape and channel.

The presence or absence of vegetation affects the volume of water, speed of the water and roughness of the landscape and channel.

Vegetation affects the volume of runoff in two main ways. The presence of vegetation increases infiltration by aerating the soil and creating cracks and fissures which allow more rainfall to soak into the ground. Deep-rooted vegetation allows for water infiltration to a greater depth than shallow rooted plants.

In addition, vegetation temporarily impedes the flow of water across the landscape causing it to spread out and slow, thereby encouraging further infiltration until the point of saturation.

Vegetation increases the roughness of floodplains and channels, temporarily impeding the flow of water. Vegetation also reduces the amount of energy and the erosive and destructive power of floodwaters. High velocity water is a very hazardous aspect of flood risk and damage.

Vegetation, particularly riparian vegetation (i.e. within close proximity to creeks and rivers), delays the delivery of water into creeks and rivers. In doing so, it can reduce the size of the downstream flood peak by holding back the water so that it takes longer to flow downstream and arrives after the downstream water has drained away. Slowing and spreading the water will result in a minor or limited increase in localised flooding and is most suited to areas where there is reduced risk (that is, sparsely populated areas of the catchment).

The presence of vegetation also affects and protects the size of the channel. Riparian vegetation protects creek banks by binding soil and armouring the banks and bed of the stream, thereby preventing erosion and maintaining physical and ecological integrity.

Riparian vegetation also reduces the scour of valuable agricultural land on adjacent floodplains by slowing the flow of water and reducing the risk of channel avulsion (tearing away or eroding the river banks to create a new path). This reduces the amount of sediment that is carried downstream. This prevents drinking water supplies from becoming highly turbid (cloudy and thick with suspended matter), and protects the health of downstream environments.

Revegetation of other lands, particularly steep land, can also contribute a small but positive reduction in the rate of discharge into streams and the volume of sedimentation in water. Much of this land is privately owned and in some cases revegetation may negatively impact on the economic viability of the land. In such cases, government and council efforts are limited to land-owner engagement and education.

Audit objective, method and cost

The objective of the audit was to determine the effectiveness of flood resilience activities in the Bremer, Lockyer, Mid and Upper Brisbane River catchments.

The audit addressed the objective through the sub-objectives and lines of inquiry set out in Figure 1J.

Figure 1J
Audit scope

Sub-objectives		Lines of inquiry	
1	Effective governance arrangements are in place	1.1	Coordination and communication
		1.2	Funding, resources and capability
2	Flood preparedness is informed by an understanding of flood risks	2.1	Risk identification
		2.2	Risk assessment
3	Flood risks are effectively managed	3.1	Response to risk

Source: Queensland Audit Office

The audit cost \$315 000.

Report structure

We have structured the remainder of the report as follows:

Chapter	Description
2. Managing the catchments	Examines the existence and effectiveness of leadership, coordination and strategy for managing the catchments.
3. Building flood resilience	Evaluates the approaches used to identify, assess and manage flood risk in the catchments.

2. Managing the catchments

In brief

Flooding does not respect government boundaries, meaning that flood affected areas are often the responsibility of multiple government and non-government agencies. This heightens the need for effective leadership and coordination. We expected to find an integrated approach to building flood resilience across the catchments we examined.

Conclusions

All levels of government have increased flood resilience expenditure and activities since the 2011 and 2013 floods. While this has resulted in some increase in flood resilience, governments cannot be sure that their activities and expenditure have been directed to address the greatest risks and priorities. This is because of limited coordination and an absence of strategic vision in managing the catchments.

Findings

- The Department of Infrastructure, Local Government and Planning is responsible for coordinating, monitoring and driving the enhancement of disaster resilience throughout Queensland. It is not fulfilling this role effectively with regard to flood resilience.
- Disaster management plans are in place across all levels of government. But, government agencies have no strategic vision or plan for managing and building flood resilience in the catchments. With some notable exceptions, activities and expenditure tend to be largely discrete and localised within council boundaries.
- The state has a number of funding programs contributing to building flood resilience. However, the funding provided by the state is fragmented. In addition, councils have had to compete for it and it has not been appropriately prioritised.
- The relevant departments, councils and other agencies are all working to different understandings of what resilience means. This has contributed to an uncoordinated approach to flood risk mitigation across catchments.
- The Queensland Government has not assessed the capabilities of councils with respect to catchment and floodplain management and does not know where support is needed and how to prioritise its support to councils.
- Councils cite a lack of professional capability and the high cost of procuring specific skills as reasons for their limited understanding of flood risk.
- Neither councils nor the state know the total costs, direct and indirect, of prior flood events.
- Elements of coordination are emerging in the Brisbane River Catchment Flood Studies, the Resilient Rivers Initiative, and the Brisbane River Improvement Trust.

Recommendations

We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning:

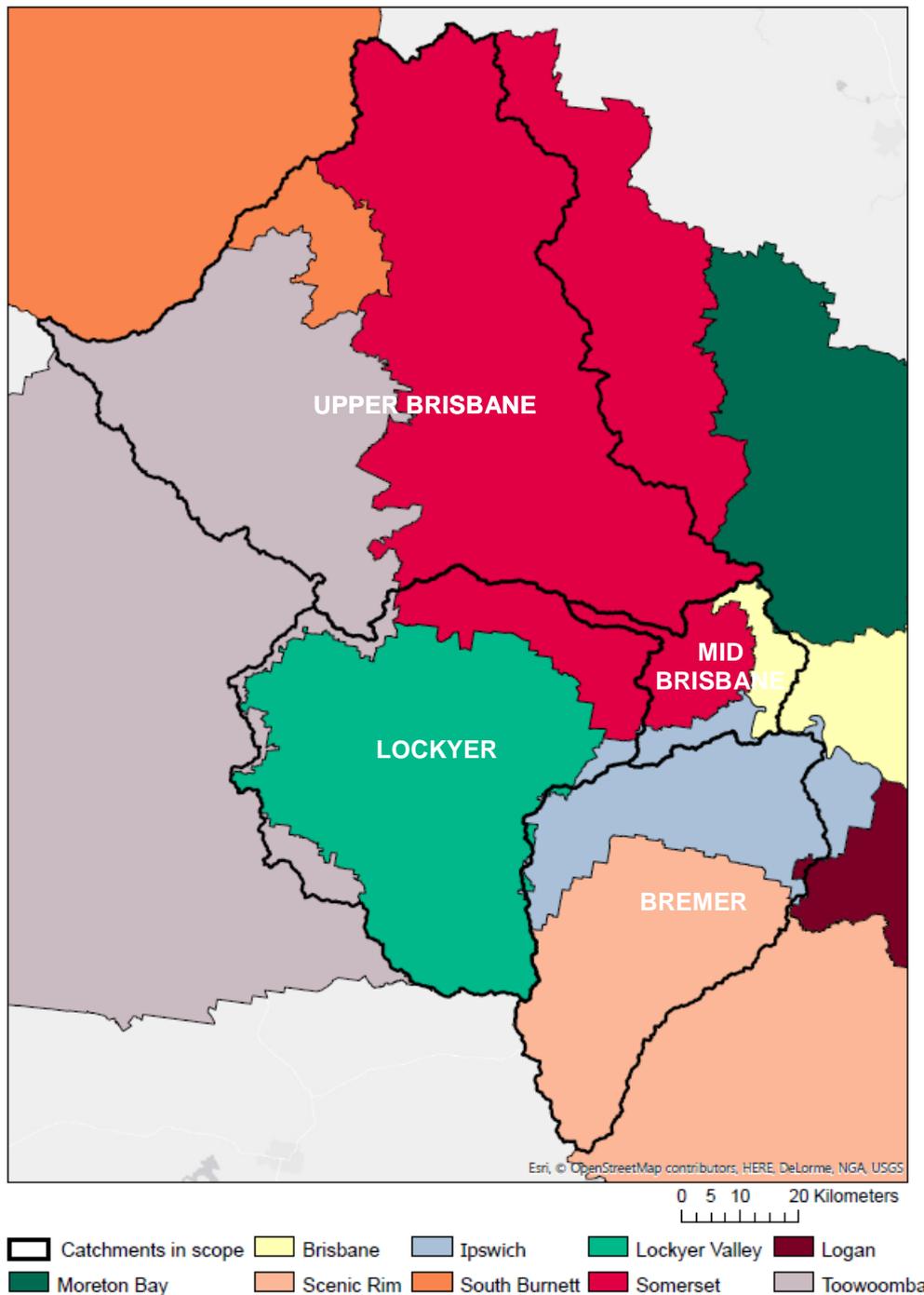
1. fulfil its obligation under the State Disaster Management Plan to drive the enhancement of flood resilience in the four catchments by:
 - coordinating flood resilience activities and funding at a state and catchment level
 - developing strategies and plans, in consultation with the four councils and relevant entities, to effectively identify, assess, prioritise and manage catchment scale flood risks using an integrated catchment management approach
 - assessing the capacity and capabilities of the four councils and supporting them as necessary in building flood resilience in the catchments and in their local areas.

Introduction

The intensity and duration of rainfall and the shape and features of the land all influence the extent of flooding and waterflow. Flooding does not respect mapped government or agency boundaries and can cover a land area under the responsibility of multiple government and non-government agencies. This heightens the need for effective leadership and coordination.

Figure 2A shows catchment and council boundaries and indicates the complexity of catchment management at a council level.

Figure 2A
Catchment and council boundaries



Source: Queensland Audit Office

In *Managing the floodplain: a guide to best practice in flood risk management in Australia* (Handbook 7), the Australian Attorney-General's Department advocates a coordinated, multidisciplinary approach across all levels of government to plan, prepare for, respond to and recover from flooding.

Queensland's floodplain risk management involves a large number of agencies, including:

- state government departments
- local government councils
- non-government organisations, such as catchment management organisations.

It also needs communities and individuals, including landholders, to engage and participating in risk management activities.

Queensland relies heavily on its councils for flood resilience management. Councils manage their portions of river catchments with different development and planning schemes. Various non-government entities also have catchment responsibilities, which means a coordinated approach is critical for the achievement of whole of catchment management outcomes.

We examined whether state government and councils are managing flood resilience activities effectively in the Bremer, Lockyer, Mid and Upper Brisbane catchments by determining whether there is:

- an integrated approach to building flood resilience by entities with the requisite authority and accountability for coordinating programs and activities
- an agreed vision for the catchments in scope, supported by an established and appropriately considered catchment management strategy
- funding and resourcing allocated to achieve the desired outcomes.

Conclusions

Since the 2011 and 2013 floods, all levels of government have invested considerable effort, funds and resources to identifying flood risk through mapping and improving flood resilience within areas of each of the four councils. As a result, there have been improvements in flood resilience, primarily to infrastructure, such as bridges.

While this increased focus on building flood resilience is encouraging, governments have collectively failed to ensure their efforts are coordinated and their resources pooled to achieve the greatest outcomes at state, catchment and council levels.

The overall absence of authority and strategic vision for managing the catchments means that neither contributing entities, nor the broader public, have a consistent and clear understanding of what needs to be achieved, how it will be achieved and by whom.

The absence of a coordinated strategic approach is a missed opportunity to integrate mitigating flood risk with other elements of catchment management, such as water quality, biodiversity and leisure activities.

Examples of integrated approaches have started to appear, such as the Brisbane River Catchment Flood Studies, but these examples tend to be the exception rather than the norm. As a result, flood resilience projects, initiatives and priorities across the catchments tend to be fragmented and largely localised within council boundaries.

Coordinated approach

Queensland's Strategy for Disaster Resilience, issued in June 2014, contains a high level vision for making Queensland the most disaster-resilient state in the country. But what this means at a state, catchment and local government level is not clear.

In the catchments we examined, state government, catchment management groups, councils and non-government entities do not have a coordinated approach to achieving this vision for flood resilience. As a result, there is a risk of gaps and overlaps in responsibility for resilience activities that makes achieving the vision uncertain.

In addition, the South East Queensland Regional Plan 2009–2031 provides a high level vision for integrated water management, including:

- total water cycle management
- water supply planning
- waterway health
- overland flow and flood management.

However, there is no strategy or plan to assign responsibilities or actions for achieving this vision. The South East Queensland Regional Plan 2009–2031 is currently under review.

Statewide leadership

It is unclear who is responsible and accountable for Queensland's flood resilience activities at a state level. The *State Disaster Management Plan 2015* (SDMP) lists the Queensland Disaster Management Committee (QDMC) as the lead agency for mitigating disasters.

A review of the minutes of the QDMC (previously also known as the State Disaster Management Group) from 2010 to 2015 showed that outside of an event, meetings to discuss disaster mitigation rarely occur. Similarly, State and Local Disaster Management Plans focus on responding and recovering, rather than mitigating and preparing for disasters.

The Department of Infrastructure, Local Government and Planning (DILGP) reports annually to Cabinet on the progress of resilience activities directed to achieving the eight goals in the Queensland Strategy for Disaster Resilience (the strategy).

The report lists activities that agencies are conducting and their progress. However, the metrics are not meaningful or measurable. For example, the report lists funding activities but not whether the funding was used effectively or efficiently. Additionally, not all of the activities have a clear link to outcomes or delivering the vision of making Queensland the most disaster-resilient state in the country.

DILGP does not coordinate or monitor these activities and cannot confirm what resilience activities still exist or how they are progressing. This makes it hard for DILGP and other agencies to demonstrate that the activities are achieving their objectives effectively and efficiently.

As a result, activities intended to build resilience are disparate, uncoordinated and lack strategic purpose.

Catchment management

It is also unclear who is responsible for coordinating flood resilience activities across catchments, which in most cases, cross multiple council boundaries. Additionally, Queensland does not have an agreed vision for effectively managed and resilient catchments. There isn't a strategy and plan to guide contributing entities on:

- what needs to be achieved at a catchment level and where
- how it will be achieved
- roles and responsibilities.

Groups and entities exist, or are proposed, to coordinate elements of catchment flood preparedness and mitigation activities. They include:

- the Council of Mayors' South East Queensland's Resilient Rivers Initiative
- Brisbane River Improvement Trust, being considered by the Department of Natural Resources and Mines
- disaster management groups (refer to Context chapter) and private catchment management enterprises, such as SEQ Catchments.

The degree and effectiveness of the flood prevention and mitigation activities of these groups varies because their primary focus is not necessarily flood resilience.

Resilient Rivers Initiative

The Council of Mayors, South East Queensland (the Council of Mayors) has attempted to fill the gap in catchment management through the Resilient Rivers Initiative (RRI). This initiative promotes an integrated catchment management approach.

The Council of Mayors has completed catchment action plans for the Lockyer and Mid Brisbane catchments. It will complete plans for the Pumicestone and Logan–Albert catchments in June 2016. It has not yet secured funding for implementing the plans, including the Lockyer and Mid Brisbane catchment action plans.

The catchment action plans aim to address four goals:

- to promote partnerships with strong leadership to deliver a coordinated approach to catchment management in SEQ
- to keep soil on our land and out of our waterways
- to help protect our region's water security so it can support the current and future population of SEQ
- to improve the climate resilience of our region.

The catchment action plans are not floodplain management plans. The goals do not specifically include floodplain management, although flooding to some extent impacts on, and is influenced by, these factors.

The RRI is to achieve these goals through catchment restoration (earthworks and revegetation), implementation of agricultural best management practice programs, and erosion and sediment control practices. All of these can have secondary flood resilience benefits.

The failure of the government to establish an agreed vision for the catchments inhibits the RRI. This lack of greater vision means that while positive works are proposed or being performed, they may not necessarily be working towards the greatest outcomes.

Uncertain funding and the total reliance on voluntary participation is another limitation. The initiative is limited to landholders who wish to participate, which means it is not necessarily occurring where the highest priorities exist. To achieve the best possible outcomes, this approach will require extensive and targeted relationship building with landholders across the catchments.

Brisbane River Improvement Trust

The Department of Natural Resources and Mines (DNRM) is exploring possible governance structures to oversee improvements in the resilience of rivers in South East Queensland.

DNRM is considering the possibility of establishing the Brisbane River Improvement Trust (BRIT) under the 2014 amendments to the *River Improvement Trust Act 1940*. The objectives in the amended legislation are:

- planning for and implementing measures that improve the protection, health and resilience of rivers and their catchments
- repairing, and preventing damage to, rivers and their catchments
- restoring natural resilience to flooding and cyclones in rivers and their catchments
- protection of water security
- improving water quality and river system function in rivers and their catchments.

To achieve these broad objectives, an integrated catchment management approach is required with effective authority, funding, collaboration and coordination across stakeholders.

DNRM has provided an options paper to relevant councils and other stakeholders for feedback on proposed governance structures for the BRIT.

DNRM and the Council of Mayors have not determined the relationship between the proposed BRIT and the RRI. There is potential for duplication and/or counterproductive activities if these two initiatives are not effectively coordinated or integrated.

Council and non-government activities

To varying degrees, councils are developing or improving flood maps, improving some infrastructure, running vegetation programs and educating communities within their boundaries to either directly or indirectly manage flood risk. These activities do not link into any broader catchment or state plan for building resilience.

While the large number of public sector and non-public sector agencies with various roles in river and catchment management are collaborating (for example, through the Brisbane River Catchment Flood Studies), their activities are largely uncoordinated. Consequently, their efforts are not as efficient or effective as they could be.

For the past decade, SEQ Catchments (a non-government entity) has mapped catchment risk factors for the greater Brisbane River catchment and floodplains, including water quality and flood risks. It brings together about 80 disparate datasets and Light Detection And Ranging (LiDAR) surveying technology.

The Brisbane River Catchment Flood Studies and a variety of councils also produce flood maps based on hydrology and hydraulic models. No one integrates these maps and uses them for coordinated decision-making purposes. This presents a missed opportunity and a risk of duplicate mapping effort.

Funding, resourcing and capability

The Queensland Government offers many avenues for councils and other agencies to access funding for building flood resilience. However, the state government's funding is fragmented, allocated on a competitive basis, and not appropriately prioritised. As a result, the Queensland Government does not know whether it has funded and resourced those activities which will maximise flood resilience. A full listing of the Queensland Government's relevant funding programs is included in Appendix F.

State resilience funding programs

The State Disaster Management Plan identifies DILGP as the lead agency for mitigating disasters, increasing community awareness and administering disaster resilience funding.

The flood and disaster resilience funding programs DILGP administers are:

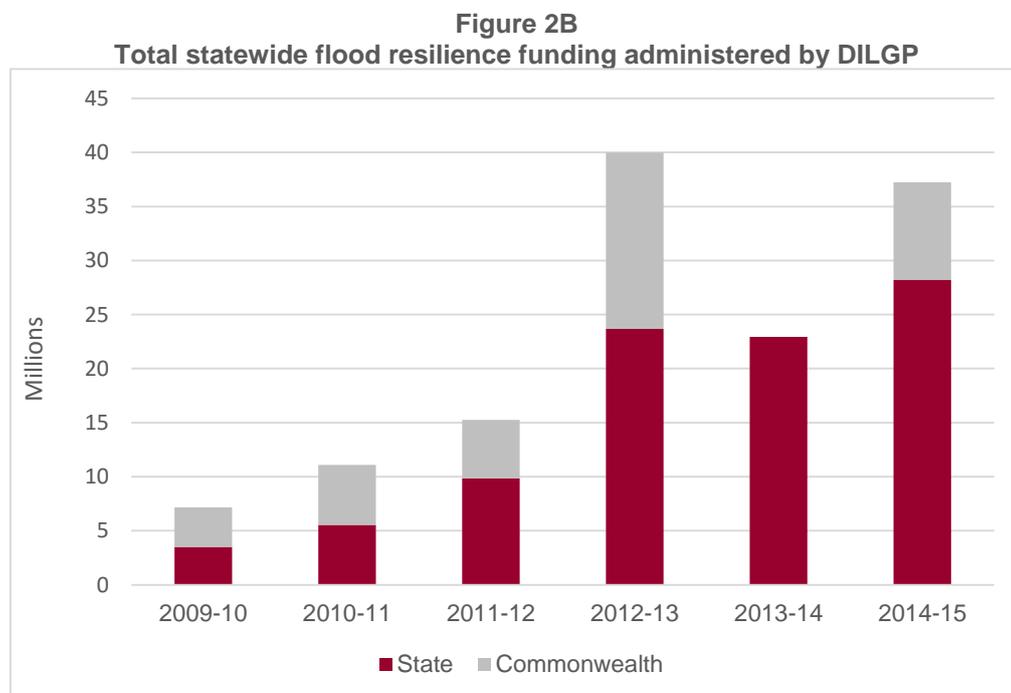
- Local Government Floods Response Subsidy. This program was a \$40 million commitment over three years commencing in 2012-13. It has been finalised.
- Natural Disaster Resilience Program (joint federal government and state government funding).
- Building our Regions (formerly the *Royalties for the Regions* program). DILGP (previously the Department of Local Government, Community Recovery and Resilience) administered the resilience part of the Royalties for the Regions funding in 2014-15. The program's funding is now solely administered by the Department of State Development.
- Community Resilience Fund. This funding program was announced in July 2015 and is to deliver \$40 million in 2015–16 to help councils mitigate against disasters, including flood.

For the 2014–15 financial year, statewide funding committed under these three programs totalled \$46.8 million (made up of \$34.8 million from the Queensland Government and \$12 million from the Australian Government).

The state government also administers community awareness grants through the *RACQ Get Ready Queensland* initiative. These grants allow councils to raise awareness of community risk to disaster events and educate them on disaster preparedness.

Statewide the combined Queensland and Australian government funding paid by DILGP for flood resilience has increased from \$7.2 million to \$37.2 million over the five years from 2010.

Figure 2B shows the statewide increased flood resilience funding administered by and through DILGP since the 2011 flood. The absence of federal funding in the 2013–2014 financial year was due to delays in finalising National Partnership Agreement funding with the Australian Government.



Note: Excludes National Disaster Relief and Recovery Arrangements Queensland Betterment Fund and National Insurance Affordability Initiative funding

Source: Queensland Audit Office from the Department of Infrastructure, Local Government and Planning

In addition to the funding administered by DILGP, the Queensland Reconstruction Authority administered a total of \$100 million of betterment funding in 2013 and 2015.

For the catchments we examined DILGP is not allocating funding to address the greatest flood risks. It provides this funding through a number of programs, spread over many entities, without considering where the highest priorities are.

Councils are required to apply for grants in a competitive process. This means that those councils that are able to produce high quality applications have a better chance of success rather than those with the highest flood risk areas.

Additionally, this practice hinders project planning because funding is uncertain and does not align with council budgeting cycles. This means that, when preparing their budgets, councils don't know what funds they will receive or when.

The short notice and lack of visibility of available funding grants means that councils are at times submitting ill-prepared applications. The state's funding is not effectively coordinated and complementary with council flood resilience expenditure.

Figure 2C shows the total flood resilience funding DILGP provided to the four councils we examined for the financial years 2010–2015.

Figure 2C
Total resilience funding provided by DILGP to councils from 2010 to 2015

Councils	Total paid (\$ million)
Ipswich City Council	1.229
Lockyer Valley Regional Council	2.782
Scenic Rim Regional Council	0.149
Somerset Regional Council	2.143
Total	6.303

Notes: Includes Australian and Queensland Government funding provided. Total approved funding was \$9.324 million.

Source: Queensland Audit Office from the Department of Infrastructure, Local Government and Planning

Council and catchment resilience expenditure

As with the state government, councils were unable to demonstrate a strategic approach to their flood resilience expenditure.

All four councils have had an improved focus on flood resilience funding since the 2011 flood. The total growth in funding by these councils was approximately 232.1 per cent from 2010–11 to 2014–15. However, determining council flood resilience funding is complicated by:

- differing views of flood resilience, and therefore what activities constitute flood resilience
- funding for activities which primarily have non-flood related purposes, but which may have indirect or secondary flood resilience benefits
- attributing business as usual activities to flood resilience improvements. This may or may not involve additional expenses
- councils not routinely or consistently capturing their aggregated expenditure on flood resilience activities.

These factors, combined with the different size, position within catchments and flood risk, make comparison of flood expenditure between councils difficult and largely meaningless.

Where multiple councils have responsibility in a single catchment, they are not pooling funds and resources to identify and address catchment-wide flood priorities.

Economic impacts of flooding

None of the four councils knew the regional economic cost of the 2011 and 2013 flood events. The councils have reasonable assessments of the direct response and recovery costs in their individual areas, but not at the catchment scale. They have not made an attempt to quantify the indirect costs, such as lost agricultural production.

This means that neither the councils nor the state know the total costs, direct and indirect, of these floods at a council, catchment or state level.

This would be a complex task and would most likely require the state government to provide leadership and support. Knowing the full costs (including indirect costs) could strengthen cost-benefit calculations for future flood resilience projects and help to better prioritise investments according to industry, community and environmental needs.

Recommendations

We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning:

1. fulfil its obligation under the State Disaster Management Plan to drive the enhancement of flood resilience in the four catchments by:
 - coordinating flood resilience activities and funding at a state and catchment level
 - developing strategies and plans in consultation with the four councils and relevant entities to effectively identify, assess, prioritise and manage catchment scale flood risks using an integrated catchment management approach
 - assessing the capacity and capabilities of the four councils and supporting them as necessary in building flood resilience in the catchments and in their local areas.

3. Building flood resilience

In brief

It is important to identify and assess flood risks in order to appropriately and effectively prioritise projects and make the greatest gains in building flood resilience. We expected to find councils identifying, documenting, assessing and communicating flood risks through fit-for-purpose floodplain management plans. We also expected to find these plans driving flood risk treatment activities.

Conclusions

Because there is not an integrated whole of government, whole of catchment approach to understanding flood risk, risk management is fragmented. Since 2011, all four of the councils in scope and the Queensland Government have increased their efforts to mitigate flood risks. There has been some localised increase in flood resilience through raising community awareness of flood response and assessing planning applications.

However, preparedness and mitigation initiatives are largely constrained within council boundaries, with inadequate assessment of affects outside these boundaries and across the catchments.

Findings

- The state and councils have done considerable flood mapping and studies since the recent flood events. The Brisbane River Catchment Flood Study is more than a year behind the original schedule and is underfunded to deliver all of its intended elements. The plan will not be available before December 2018 and will take several more years to implement.
- All four councils consider each flood mitigation project on its merits and prioritise them accordingly. However, no council had a documented rationale or process for prioritising projects relative to other risks. None of the councils or catchments have floodplain risk management plans.
- State and local disaster management planning is inadequate for building flood resilience. These plans are high level, response and recovery focused and cover all disasters.
- The majority of existing residential developments that reside on the floodplains pre-date the 2011 flood. There are few examples of specific flood management plans in place for these pre-existing at-risk communities.
- All councils we examined had increased their focus on raising community awareness for flood response, but not on other aspects of resilience, such as vegetation management and responsibilities regarding levees.
- Councils do not target revegetation efforts for greatest benefit and there continues to be a net loss in remnant woody vegetation due to land clearing, primarily for agriculture and settlement.
- Councils are responsible for regulating levee banks, but they do not have the resources, capabilities or historical data to ensure levees are appropriately placed, constructed and maintained for effective flood mitigation.

Recommendations

We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning:

2. as a matter of priority, establish what funding is reasonably required and complete all elements of the Brisbane River Catchment Flood Studies.

We recommend that the four councils:

3. develop floodplain management plans in accordance with Recommendation 2.12 of the Final Report of the Queensland Floods Commission of Inquiry.

We recommend that the Department of Natural Resources and Mines and the four councils:

4. work together to effectively and economically regulate levee banks.

Introduction

In September 2012, the Queensland Reconstruction Authority released a two-part document titled *Planning for stronger, more resilient floodplains* that provides guidance for councils to identify, assess and treat flood risks. It highlights the importance of flood maps and studies in developing floodplain risk management plans.

Additionally in *Managing the floodplain: a guide to best practice in flood risk management in Australia* (Handbook 7), the Australian Attorney-General's Department provides guidance for flood risk treatment options including:

- land use planning to avoid high flood risk areas
- undertaking infrastructure and structural works to avoid, divert or mitigate floods
- having building standards which ensure buildings have flood resilient designs and materials
- managing the natural environment to mitigate and delay flood damage
- using emergency warnings to make the community aware of the situation and evacuate if required
- fostering community awareness to ensure that the community is aware of how to react and respond to disaster events
- having insurance for residual risk.

Councils can use one or more of these activities to reduce flood risk to acceptable levels.

It is important to identify and assess risks in order to appropriately and effectively prioritise projects, funding and resources to get the greatest gains.

We assessed whether the four councils located within the catchments in scope — Bremer, Lockyer, Mid and Upper Brisbane — are identifying, documenting, assessing and communicating flood risks through fit-for-purpose floodplain management plans. We also looked at whether:

- these plans are driving flood risk treatment activities
- these councils have the capabilities to manage these risks.

Conclusions

To date, the state and local governments in Queensland have predominantly adopted a siloed approach to identifying and assessing flood risks, with councils and departments focusing almost solely on their own areas of responsibility. This approach has led to localised improvements in flood resilience, which vary in effectiveness depending on the capacity and capability of individual councils. These improvements may not be addressing the greatest risk which could be in another council's area of influence.

The state government departments and councils we audited have a better understanding of general and local flood risk as a result of mapping and their experiences from recent floods. But the full benefits of this increased understanding is not being realised and agencies are not able to demonstrate the effectiveness of the investment.

Agencies have not adopted an integrated whole of government approach to identifying, assessing and prioritising flood risk at a catchment or whole of river scale. This means they do not have a good or documented understanding of flood risk for the catchments. This leaves the state more exposed to flooding than it otherwise would be.

The Brisbane River Catchments Flood Studies (BRCFS) are significant and positive undertakings in response to a recommendation of the Queensland Floods Commission of Inquiry. There is a risk, however, of some seeing the BRCFS as the solution to flood risk.

While these studies represent a significant step forward for government in identifying and assessing flood risks across the Brisbane River catchment, they are only one of many elements in effectively managing flood risk and don't address the needs of all catchments we audited.

It is unlikely that all elements of the BRCFS will be delivered to the standard intended with the funding currently in place.

Furthermore, without government adopting a unified catchment scale approach to identifying, assessing and managing flood risks, the benefits of the BRCFS are unlikely to be realised to their full potential.

The increased focus and activity in addressing flooding is positive, particularly in raising community awareness to flood response and assessing planning applications. That said, significant gaps still exist, such as integrated catchment management, regulating levees, managing catchment vegetation and educating people to mitigate floods.

Identifying flood risks

With the exception of the BRCFS, the state government agencies and the four audited councils do not take a catchment-wide approach to identifying flood risk in the Bremer, Lockyer, Mid and Upper Brisbane catchments. Instead, they adopt an approach mainly based on council boundaries.

The four councils, with some support from state government agencies, have improved their identification of flood risks within their own boundaries since the 2011 flood. They have identified flood risks primarily through historical and recent flood information, local knowledge, and flood maps and studies.

However, the four councils have not documented their flood risks as per state and national best practice to adequately prioritise and address them. Furthermore, with each council focusing on their own areas, there is a lack of understanding of the cumulative effects of flooding.

This approach can lead to downstream councils dedicating money and resources to address the effects occurring in their boundaries, but caused by issues elsewhere in the catchment (that is, outside the council's boundaries). In such cases, a better outcome could be achieved by contributing to addressing the cause of the problem, albeit outside their council boundaries. Case study 1 shows the potential for obtaining downstream benefits.

Case study 1

Caboolture River – Upstream vegetation benefits downstream communities

The Caboolture River catchment in South East Queensland covers an area of 380 square kilometres. In 2011, a modelling exercise was performed, using a 2D hydraulic model and the three hour storm duration 1 per cent AEP event, to assess the potential impact of riparian revegetation on the urbanised floodplain in the lower part of the Caboolture River catchment. The model used a stream network length of 515 kilometres for the whole catchment: 255 kilometres in the upper catchment and 260 kilometres in the lower catchment. A considerable portion (135 kilometres) of the stream network in the upper catchment was already vegetated and this was used to establish the base case against which modelled results could be compared.

The vegetated (test) case, modelled the entire upper catchment (255 kilometres) with 20 metres of riparian vegetation on either side of the stream network. Modelled results showed that revegetation in the upper catchment delayed and slightly lowered the flood peak. It also reduced the depth of flooding by between 100 and 200 millimetres in the highly urbanised downstream part of the catchment.

While a 200 millimetres reduction in flood height may not seem significant, it can have a major beneficial impact on the urbanised floodplain areas as it can mean the difference between being flooded or not. For this reason, it has the potential to significantly reduce the flood damage bill in urbanised downstream areas of the catchment.

The investigation concluded that riparian revegetation in upstream areas of the Caboolture River can reduce downstream flood risk in urban areas and improve waterway health and amenity.

Source: Sharpe, RG. (2011) Back to Nature – Can revegetation of riparian zones benefit flood risk management? Paper to the Floodplain Management Australia Annual Conference, Batemans Bay, NSW, 2012.

Flood maps and studies are important sources of flood risk information.

All four councils, with some assistance from the Queensland Government, have dedicated substantial funds to undertaking flood mapping since the 2011 flood. This has aided them in better understanding the flood risks of individual communities.

Prior to the 2011 events, the four councils had completed minimal flood studies and maps and did not have documented flood risks. This meant that councils assessed development applications without adequate understanding of flood risk.

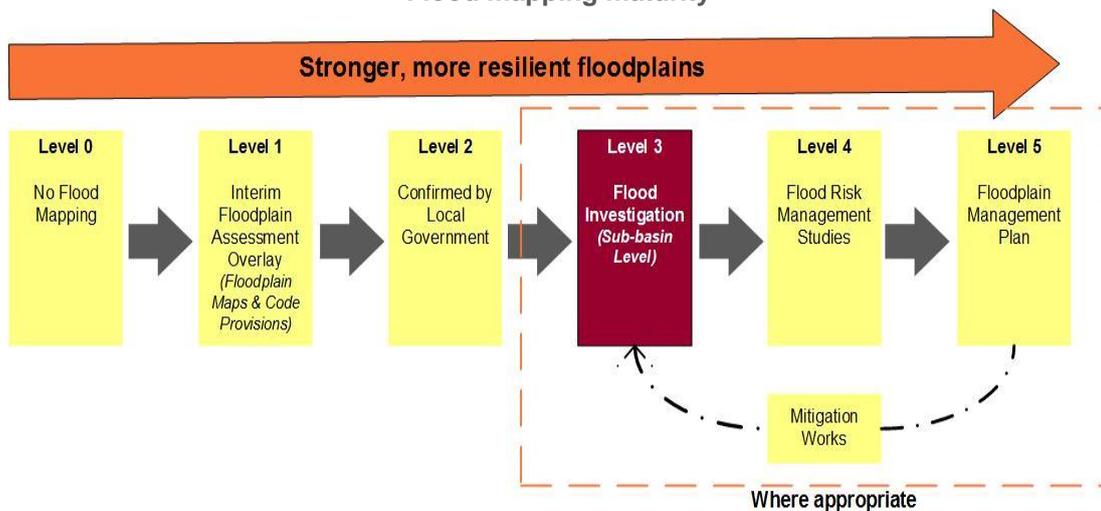
Since the 2011 floods, the Queensland Reconstruction Authority's (QRA) Queensland Flood Mapping Program (QFMP) has encouraged councils to adopt 'fit-for-purpose' flood mapping based on land uses and densities. Under this guidance, more densely urban areas require a higher maturity level of flood mapping than a low density rural area.

The Department of Natural Resources and Mines (DNRM) completed the QFMP to create Level 1 (and in some places Level 2) flood maps for the majority of the state (Figure 3A shows flood map maturity levels). The QFMP did not map some South East Queensland catchments (including Ipswich City Council boundaries) as the Brisbane River Catchment Flood Studies will include them.

These maps provide a starting point for councils in identifying areas that require more detailed flood studies. However, flood mapping involves engaging consultants with adequate expertise, which can be costly and beyond the means of some councils.

All four councils we examined have reached level 3 flood mapping maturity (as shown in Figure 3A) in many sub-basins within their areas of influence.

**Figure 3A
Flood mapping maturity**



Source: Queensland Audit Office based on Queensland Reconstruction Authority diagram of flood mapping maturity

Level 3 mapping shows the extent of various flood events overtime. It also includes water depths and velocities and risk treatment options.

QRA's guidelines propose councils base their risk assessments on fit-for-purpose mapping. According to this approach, less densely populated areas will not necessarily require Level 3 flood studies and maps, but densely populated areas do require them.

We tested this by comparing council flood maps with the Queensland Government Statistician's Office population data. All densely populated areas within the four catchments within scope of the audit had Level 3 flood maps.

Despite this, the councils responsible for these densely populated areas within scope have not analysed the information to identify risks (particularly those posed by pre-existing developments). In addition, they have not prioritised actions to address these risks.

The Somerset Regional Council and the Ipswich City Council are relying on the completion of the BRCFS to enable them to progress to Level 4 and 5 maturity. The Lockyer Valley Regional Council advised it will not rely on the BRCFS because the BRCFS is focused on urban areas downstream of the council and not rural or transport infrastructure. The Lockyer Valley Regional Council advised that its 2012 modelling in the overlap area is a better fit for their purposes.

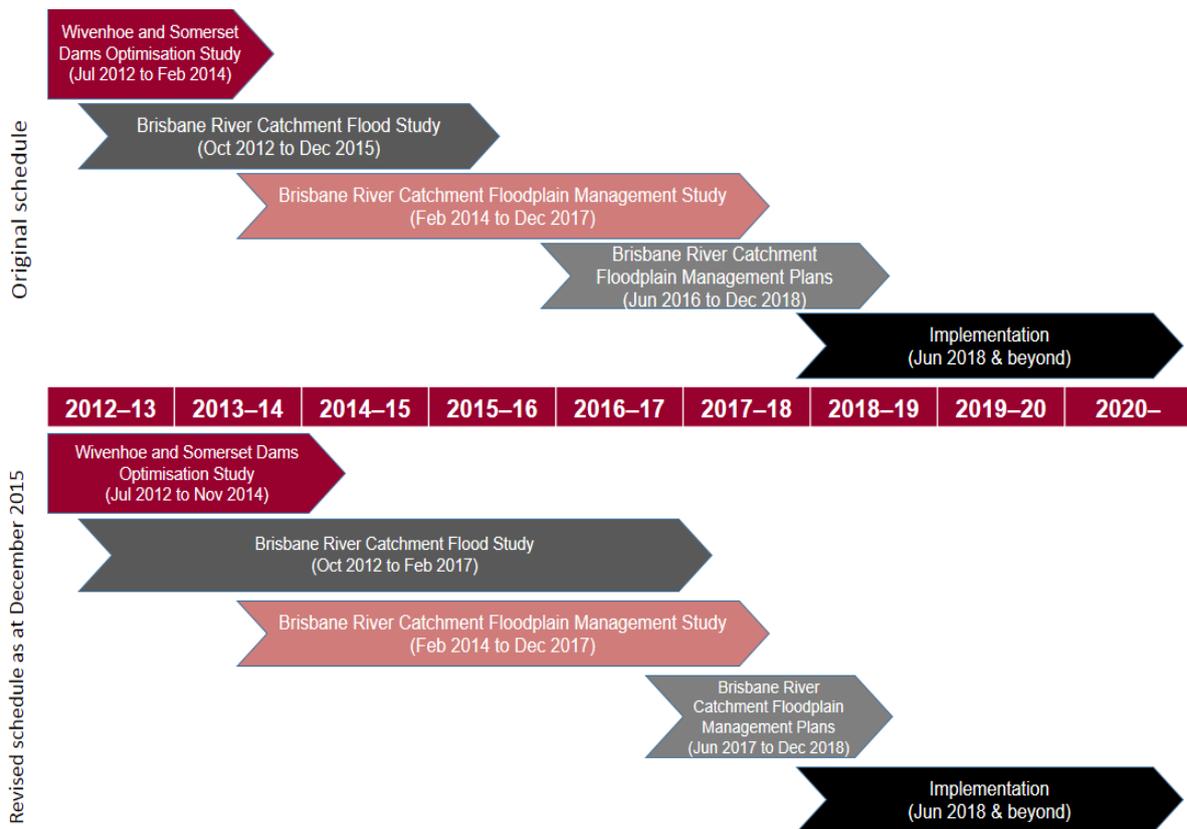
The Scenic Rim Regional Council is not a part of the BRCFS. While parts of the Bremer River are included in the studies, the Bremer River catchment within Scenic Rim Regional Council has not been included. This is in accordance with the recommendations from the Queensland Floods Commission of Inquiry. The Bremer River floodplain area within Scenic Rim Regional Council remains largely undeveloped.

Brisbane River Catchment Flood Studies

The Brisbane River Catchment Flood Study (the flood study) component of the Brisbane River Catchment Flood Studies (BRCFS) has run over its original schedule. The expert advice provided to the Queensland Floods Commission of Inquiry was that the flood study would take 'roughly three years'. Experience to date indicates it will take longer to complete to an appropriate standard.

The flood study (hydrology and hydraulics) had a scheduled completion date of December 2015. The BRCFS Implementation Committee revised the completion date on 4 December 2015 to February 2017, as shown in Figure 3B.

Figure 3B
Brisbane River Catchment Flood Studies schedules



Source: Queensland Audit Office from Department of Natural Resources and Mines

Despite the delay in the completion of the flood study, the Department of Infrastructure, Local Government and Planning (DILGP) anticipates completing the Brisbane River Catchment Floodplain Management Plan (BRCFMP) in December 2018, without reducing the quality and extent of the BRCFMP. This is ambitious, as it is shorter in duration than previously forecast. It will take several more years to implement the actions detailed in the plan.

DILGP has reported that BRCFS funding may be insufficient to deliver all components and achieve the best possible outcomes. The total budget for BRCFS is \$5 million, which includes \$3 million for the flood study and \$2 million for the BRCFMS and the BRCFMP.

The original estimated budget to do just the flood study (hydrology and hydraulics only) was \$6 112 000. This included an allowance of \$2 million to provide Light Detection And Ranging (LiDAR) aerial survey for the study, which DNRM ultimately provided.

The state government subsequently provided \$3 million and the Brisbane City Council, Ipswich City Council and Somerset Regional Councils collectively contributed \$2 million for the flood study. They made no budget allowance for the BRCFMS and the BRCFMP.

In November 2012, correspondence received by the then Director-General of DNRM from the then Director-General of the Department of State Development, Infrastructure and Planning stated that the \$5 million 'is to include the following components: the flood study, BRCFMS and the BRCFMP, and the Integrated Assessment Framework'. This was to comprise \$3 million for the flood study and \$2 million for the BRCFMS and the BRCFMP. The then Director-General of DNRM cautioned that the change in funding could have consequences for the outputs that could be produced and their quality and reliability.

As at December 2015, the flood study had cost \$3 373 679. This equates to a total overspend of \$373 679 (12.5 per cent) for the portion of the flood study completed to date. There is a risk that the scope of the BRCFS will be constrained to fit the remaining budget rather than what is needed to achieve the best outcome.

DILGP's current assessment indicates that it may not be possible to fund all three components within the \$5 million allocation. DILGP is currently seeking advice from a suitably qualified expert to gain a better understanding of the total budget likely to be required to finalise the BRCFMS and the BRCFMP to an appropriate standard.

Assessing flood risks

Councils are not assessing flood risk at a catchment scale and are not effectively prioritising risks at a local level. They consider initiatives on their merits without an adequate assessment of their priority relative to other risks.

Floodplain management plans

No floodplain management plans exist for any of the catchments we examined. Similarly, none of the four councils have developed floodplain management plans for their council area. This is despite the four councils identifying flood as a significant risk (moderate or higher) within their local disaster management plans. It is also despite the Queensland Floods Commission of Inquiry Final Report Recommendation 2.12, which stated:

Councils in floodplain areas should, resources allowing, develop comprehensive floodplain management plans that accord as closely as practicable with best practice principles.

All councils told us that they did not have the funds or resources to develop these plans. Two of the four councils plan to develop floodplain management plans relevant to their local areas after the BRFMS are completed, the Lockyer Valley and Scenic Rim Regional Councils are not relying on the BRFMS.

As long as the BRCFS project runs to schedule, the two councils will be able to complete floodplain management plans in 2018 but will take several years to implement them after that. The Scenic Rim Regional Council is not a part of the BRFMS. The Lockyer Valley Regional Council considers its 2012 modelling as a better fit than the BRFMS for its purposes.

In the absence of these plans, councils have not been able to demonstrate they are identifying, assessing and prioritising the treatment of flood risk at a local government or catchment level. This has led to an ad hoc approach to building flood resilience.

Only two councils have demonstrated that they have identified and documented all the properties within their region prone to flood at the Annual Exceedance Probability (AEP) of 1 per cent defined flood event (previously referred to as a once in a hundred years flood event) and assigned a risk rating. (AEP describes the likelihood of a flood of a given size or larger occurring in any one year.)

The remaining two councils are in the process of performing this task. However, none of the councils have used this information to drive investment to improve flood resilience.

Treating flood risks

Disaster management arrangements within Queensland adopt an all-hazards approach—a standard approach regardless of the type of disaster. However, the *Disaster Management Act 2003* requires the development of tailored (hazard-specific) plans when the hazard requires coordination and operational procedures beyond generic disaster management.

The Queensland Government has developed hazard-specific plans for some hazards (such as bushfire, heat wave, pandemic and terrorism). This is not the case for flood hazards, where the state and councils alike adopt a generic approach. The absence of a flood-specific plan is likely a symptom of the lack of lead responsibility for flood resilience, but nevertheless is surprising given:

- flooding is historically the most destructive natural hazard in Queensland
- the scale of activities and agencies needed to contribute to managing flood hazards
- the frequency of flooding in Queensland.

The conventional treatment of flood risk is through a number of controls, which are:

- land use planning, zoning and buyback/land swaps
- infrastructure and structural works, including dams, levees, roads and drainage
- building codes with minimum floor levels and flood resilient materials
- community awareness, education and communication
- environmental management, including riparian vegetation and wetland management
- emergency planning and management through warning systems, evacuation plans, and business continuity and recovery plans
- insurance to cover the residual risk.

All of these factors contribute to overall floodplain management, and responsible entities must drive a coordinated approach to mitigating risks.

We examined the land use planning, infrastructure, structural works and environmental management aspects for each council.

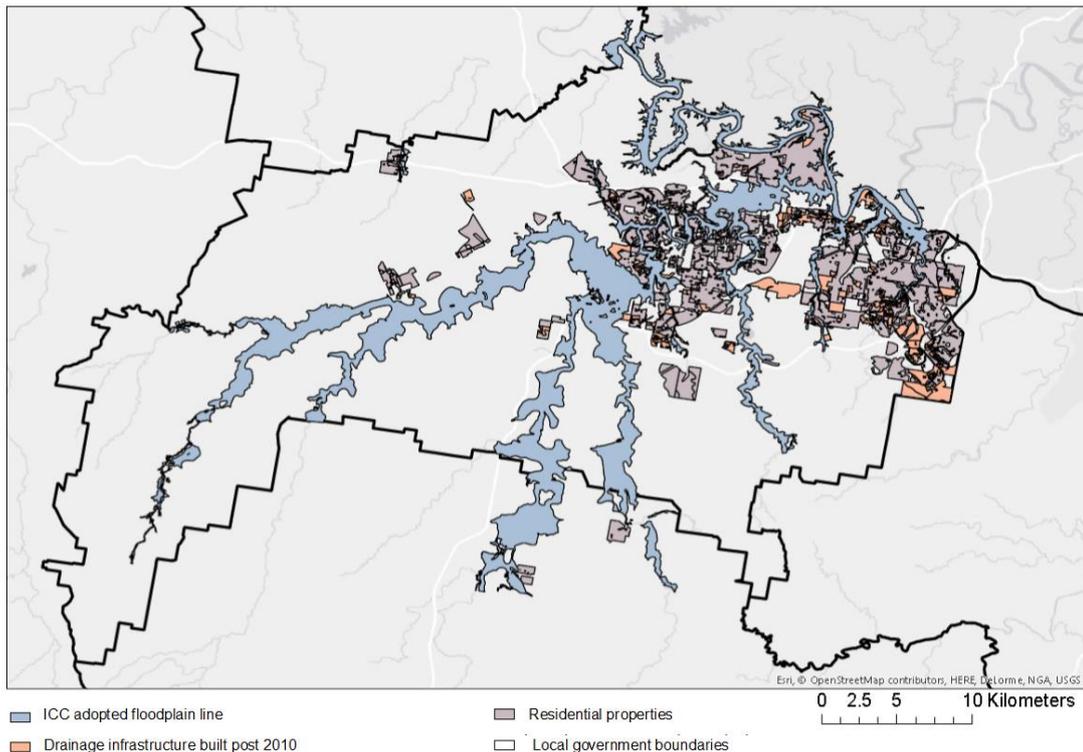
Land use planning

The most effective item in the floodplain management toolset is appropriate land use planning to ensure that development does not occur in high risk flood zones. Councils gain this understanding of risk through the production and use of flood maps and studies.

We performed a review of the existing and proposed developments at all four councils, overlaying the maps of these developments with available flood maps (showing 1 per cent AEP). We found that the majority of development that sits within this flood level were developments that occurred prior to the events in December 2010 and January 2011.

Figure 3C shows our overlays for Ipswich City Council, with the development years identified using maps of drainage assets as a proxy. We used drainage assets as an approximation, as the development maps did not identify the year residential property developments occurred.

Figure 3C
Ipswich residential developments since 1974 on the flood map overlays



Source: Queensland Audit Office from Ipswich City Council

In Ipswich City Council, there was a number of residential developments on the floodplain between 1974 and 2010. However, these developments occurred in old suburbs that had pre-existing developments, for example Booval, Goodna and Rosewood.

We examined examples of approved developments below the defined flood level. These land uses were typically low risk commercial or agricultural enterprises that had access to higher land. In all examples, councils provided adequate documentation informing the applicants for the developments of their flood risk.

We sampled current developments occurring within the defined flood levels and found development control processes in place. This was usually an engineer's certification of floor levels to resist the 1 per cent AEP and drainage/retention basins to ensure that no worsening occurs to downstream communities. The engineers use complex models to ensure that the volume and velocity of the water output from these developments are not significantly worse. We did not assess these measures to ensure that these provisions were adequate.

Councils provided us with examples of rejected developments due to the understanding of flood risk. Three of the councils cited compensation under injurious provisions of the *Sustainable Planning Act 2009* as a disincentive for councils to reject the development approvals. These councils were unable to provide examples of where the prospect of legal action had negatively influenced their decisions.

Councils we visited have exercised, or attempted, the buy-back of houses in high-risk flood-prone areas. Relocating the residents of Grantham to higher ground following the 2011 flood is a successful example of this approach.

However, constraining success of buy-back initiatives is funding (buying back houses can be expensive) and the lack of willingness of some residents to move.

Infrastructure and structural works

Infrastructure and structural works are important to ensure evacuation and supply routes are available and resilient enough to recover from floods quickly and inexpensively.

All councils we examined provided examples of levee banks, road and bridge upgrades, detention basins and drainage works. These projects involved councils building/modifying infrastructure to withstand events of the same magnitude as the 2011 flooding events.

Drainage and levees divert flood waters away from an area and can be effective in high density land uses. If not planned, managed and regulated appropriately, the diverted waters can, however, have negative downstream effects.

In extreme cases, excessive levee banks and drainage can produce higher and faster floods for downstream communities. A whole of catchment strategic approach is important to ensure resilience activities in one area of a catchment do not cause or contribute to adverse effects elsewhere.

Vegetation management

The government agencies and councils we audited have differing views on the value of vegetation management as a contributor to flood mitigation.

The Queensland Chief Scientist, in his 2011 publication *Understanding floods: Questions and Answers*, states:

Plants in a river or on its banks slow the speed of the water flowing in it. The slower the water moves, the higher the water level, and the greater extent to which the floodplain surrounding the river will be inundated. This can reduce downstream flood levels and flows. Plants also reinforce riverbanks, decreasing erosion and increasing the deposition of sediment.

Once a river overtops its banks, the maximum flood level reached depends greatly on the nature of the adjacent floodplain. For example, wide, flat floodplains can store a greater volume of floodwater than steep-sided valleys, and the resulting floods move more slowly. Modifications to floodplains such as clearing of vegetation or the construction of embankments (for example, for a flood free road or rail corridor) can impact natural drainage patterns and processes on river floodplains.

Vegetation management is not simply planting trees. To achieve the right outcomes it includes:

- understanding the effect of vegetation on water flow and quality
- regulating clearing
- removing invasive pest species, e.g. Chinese Celtis and Giant Reed
- planting the right types and mix of vegetation (grasses, shrubs and trees), in sufficient numbers and in the most appropriate locations for the circumstances
- maintaining revegetated areas.

The Queensland Chief Scientist notes that effective management of vegetation in upper and mid catchments appears to have merit in mitigating downstream flood and water quality impacts, up to a point. However, he cautions that careful consideration needs to be given to potentially adverse upstream impacts of such measures.

For these reasons, a strategic and coordinated approach to vegetation management (both clearing and revegetation) across all levels of government is important. This is not occurring.

The *Vegetation Management Act 1999* together with the *Sustainable Planning Act 2009* regulate the clearing of native vegetation which may include riparian vegetation. Clearing of assessable native vegetation within defined distances (buffers) of watercourses and drainage features is regulated to protect bank stability, water quality, aquatic habitat and terrestrial habitat. Case study 2 provides an example of the benefit of vegetation buffers along riparian corridors.

Case study 2

Genoa River, Victoria – before and after revegetation

The Genoa River rises in the alpine region of southern NSW and flows through East Gippsland, Victoria to the coast through the Mallacoota Inlet. During the 20th century, riparian and floodplain vegetation along the Genoa River was historically cleared for agriculture. Major flooding in 1975 and 1985 resulted in substantial channel widening in the floodplain reach that was devoid of riparian vegetation.

Following the 1985 flood, the East Gippsland Catchment Management Authority commenced a river restoration program along the floodplain reach of the Genoa River. The program involved riparian revegetation using native species, to minimise further channel change, and was complemented by the reintroduction of large wood to stabilise sand bars. In 2009 the outcomes of the restoration works were independently reviewed and reported as one of the best examples of river restoration in Victoria. The photographs below show the Genoa River before (1988) and after (2009) revegetation.

The Genoa River before and after revegetation



Source: East Gippsland Catchment Management Authority

The 1985 Genoa River flood was classified as a 5 per cent AEP (or one-in-20-year ARI – 80 000 megalitres per day) event, and caused approximately \$3 million damage. In 2011, a very similar flood was recorded (83 000 megalitres per day) at the same gauge, however, on this occasion the damage bill was estimated at only \$40 000.

It is difficult to quantify the benefits of riparian restoration in mitigating flood impacts because no two floods are the same. The Genoa River comparison strongly suggests that riparian revegetation reduces the impact of flooding on infrastructure by dissipating stream power and buffering against erosive floodwaters. Moreover, this reinstatement of natural assets has the added benefits of stabilising the river's banks, reconnecting previously fragmented patches of vegetation, and improving the ecological condition and biological diversity of the floodplain reach.

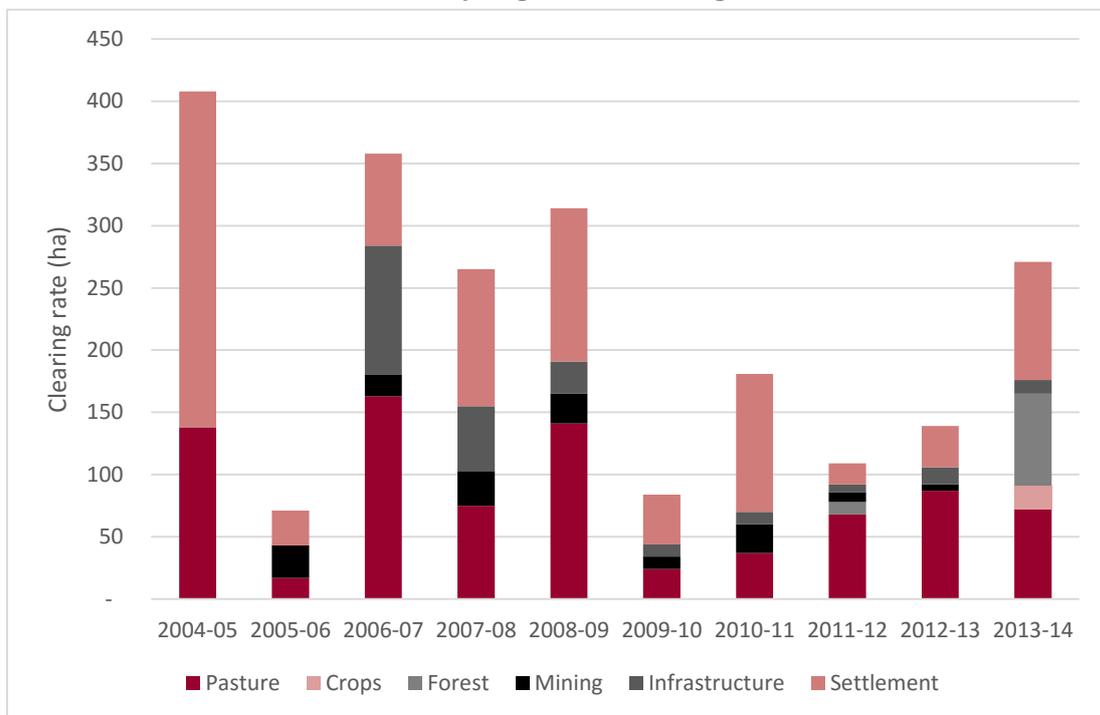
Source: "An assessment of the impact of riparian vegetation on stream erosion during floods in Victoria" from Victorian Department of Environment and Sustainability

All councils and the state government have a range of vegetation initiatives, but they are not coordinated, linked, appropriately targeted and do not provide a strategic approach to vegetation management at any level—state, catchment or council. Neither councils nor the state government were able to demonstrate that their vegetation management approaches had adequately considered all of the elements necessary for effective vegetation management.

Revegetation of other lands, particularly steep land, can also contribute a small but positive reduction in the rate of discharge into streams and the volume of sedimentation in water. Much of this land is privately owned and in some cases revegetation may negatively impact on the economic viability of the land. Government and council efforts are therefore limited to land-owner engagement and education. We found little effort or will among the four councils for investing time, resources and funding for this.

Figure 3D shows data on woody vegetation clearing rates over the past decade within the Bremer catchment.

Figure 3D
Bremer catchment woody vegetation clearing rates for a decade



Source: Queensland Audit Office from the Department of Science, Information Technology and Innovation's Statewide Landcover and Trees Study

From 2004–05 to 2013–14, total vegetation loss in the Bremer catchment was approximately 1 961 hectares, which was an average of 196.10 hectares annually. The majority of clearing occurred for settlement (45.95 per cent) and pasture (41.92 per cent).

The level of clearing in this catchment is far greater than the revegetation programs run by two of the councils in its area—the Scenic Rim Regional Council and the Ipswich City Council. Their average revegetation is 13.14 hectares annually or 6.72 per cent of what is cleared annually. This is a conservative estimate, as both councils fall within multiple catchments and not all revegetation activities occurred in the Bremer catchment.

Major reforms to vegetation management in 2013 allowed landholders to clear vegetation not cleared since 31 December 1989 or land that is suitable for economically viable agricultural development. Figure 3E shows the current extent of riparian vegetation for the four river catchments.

Figure 3E
Estimated extent of riparian vegetation 2015

River catchment	Percentage of streambank without riparian vegetation buffer (estimate)
Bremer	44 per cent
Lockyer	30 per cent
Mid Brisbane	27 per cent
Upper Brisbane	36 per cent

Source: Queensland Audit Office from *Healthy Waterways Report Card*

All four councils had revegetation initiatives. These initiatives have various, often multiple, purposes including:

- reducing sedimentation to improve water quality
- creating wildlife corridors
- mitigating the impact of floods.

This further highlights the potential benefits of integrated catchment management.

The majority of council tree planting initiatives rely on providing trees to landholders. The councils have no control over where landholders locate trees and no information or estimates of survival rates.

The Scenic Rim Regional Council is the only one that had details of the number of trees and maps the location of revegetation efforts. Its focus for revegetation is broader than watercourse and flood management, so the majority of revegetation is not along the watercourses. Nevertheless, these programs may still have watercourse benefits, such as reducing water flow off surrounding slopes. The council does not assess the extent to which its vegetation programs directly or indirectly contribute to mitigating flood risks.

Raising community awareness and preparedness

The state government and councils have been active in trying to raise community awareness through various flood resilience programs and initiatives. Their focus has understandably been on building community knowledge and awareness for the timely and appropriate response to flood events.

The state's *Get Ready Queensland* program includes a statewide advertising campaign and delivers grants for raising community awareness. Another Queensland Government initiative is the *If it's flooded, forget it* advertising campaign, which aims to raise awareness of the greatest cause of flood fatalities— driving through flooded roads.

Councils mirror these campaigns through flyers, newsletters and events. Councils identified that community awareness is one of the greatest challenges for disaster preparedness.

All councils we examined had:

- awareness events
- an increased social media presence
- early warning networks
- tourist education initiatives at major hubs.

All four councils had disaster management officers. These officers focus on ensuring communities are prepared for disaster events, including floods. While more can always be done, the councils have made good efforts to adequately engage people in their region on response to flood hazards.

While efforts to raise community knowledge and awareness to respond to flood events are prevalent, councils demonstrate little effort in educating people to mitigate floods. Two examples are vegetation management and the construction or modification of levees, both of which can have detrimental downstream effects.

There are no programs to educate landowners of the flood-related risks of land clearing along streams and to promote the potential benefits of revegetating previously cleared banks. Similarly, councils do not have programs to educate landowners about the risks, benefits and requirements for constructing or modifying levees.

The absence of these programs in favour of educating communities to respond to flood situations is not surprising. It represents state and councils prioritising their available resources and funding to ensure communities know how to respond in the event of an emerging or occurring flood event. Nevertheless, this represents a gap in building flood resilience.

In 2015, the Inspector-General, Emergency Management conducted a review of emergency warning capability and identified a number of shortcomings, namely:

- many councils do not have well documented plans for emergency warnings
- not all councils possess the capability to test the effectiveness of their warning systems
- councils have limited risk knowledge
- the current approach to warnings may result in inconsistent messages from disaster management entities
- legislation and doctrine are at times conflicting and lack clarity about roles and responsibilities for emergency warnings.

Given these are recent findings, we were not in a position to assess councils' progress in addressing these recommendations.

Council capability and capacity to manage flood risk

Since the events in 2011, the Queensland Government has assigned councils greater responsibility for identifying flood risks and building flood resilience. The Queensland Government did not assess the capability or capacity (in terms of both financial and non-financial resources) of councils to meet the requirements and expectations for building flood resilience.

In October 2015, the Department of the Premier and Cabinet provided to Cabinet its last report on the progress of implementing the Queensland Floods Commission of Inquiry recommendations. This report detailed progress in implementing actions but not effectiveness.

In addition, councils do not have a consistent or clear understanding of disaster resilience. Definitions of resilience differ across district and local disaster management plans. Some councils use definitions that are inconsistent with the definition in the Queensland Strategy for Disaster Resilience (the strategy). The definition in the disaster management plans of two of the four councils we examined was:

A measure of how quickly a system recovers from failures.

Unlike the definition in the strategy, this definition is not forward looking, but focuses on recovery after an event. This means that the definition does not address the key elements of preparedness for and management of potential flood hazards. This may be contributing to the overall lack of effective and coordinated flood risk identification.

The remaining two councils did not define resilience.

No formal review or performance indicators are in place to ensure that councils are as resilient as they could be. An example of passing responsibility to councils without adequately considering their capability and capacity is the regulation of levee banks.

Regulation of levee banks

Thousands of levees of varying builds and condition exist in South East Queensland and landholders often build new ones, with or without required approval.

The purpose of the approval process is to assess the application to avoid the risks posed by an inappropriately constructed or located levee. In some cases, landholders may build levees without required approval because they lack understanding or want to avoid the application process.

Four Queensland Floods Commission of Inquiry final report recommendations related to regulating levee banks. In 2014, the Queensland Government assigned responsibility for regulating levees to councils as assessment managers under the *Sustainable Planning Regulation 2009*. While councils are positioned well geographically to regulate new levees and modifications to existing ones, they are inhibited by:

- an absence of information on existing levees
- the significant cost and resources needed to effectively identify and assess levees
- a lack of support from the state government.

Existing levees

Councils need knowledge of pre-existing levees to effectively regulate the construction of new levees and modification of existing ones under the amended regulation.

The state government and councils have no initiative in place for identifying and assessing existing levees. As a result, they have not assessed the condition of these existing levees. Any such initiative would require significant resources, which are beyond the means of many councils. It would need coordination of state government and councils.

It means that neither the state government nor councils know:

- how many levees exist
- where they are
- what specifications they were built to (what size flood they will mitigate)
- their current condition.

One council advised us:

'... the evaluation and monitoring of the existing levee network would be a mammoth and controversial undertaking and its delivery would be far beyond the financial capacity of councils.'

DNRM also stated this would be too big a task for the Queensland Government.

The four councils are therefore unable to assess the effectiveness and potential for negative downstream effects of these levees or the cumulative effects of multiple levees.

Because of their lack of information and limited resources, councils tend to be reactive in identifying and regulating levees, relying largely on complaints. Even when reacting to complaints, their ability to effectively enforce the regulations is inhibited by limited information.

New and modified levees

The state government and councils are not effectively regulating the construction of new levees and modification of existing ones. This is because they have no process in place to gain assurance over self-assessable levees and their lack of knowledge of existing levees hampers them.

The lack of knowledge makes it impossible for councils to determine new from existing levees. It means they cannot accurately differentiate works intended to maintain the condition of an existing levee (which is not subject to regulation) from works to construct a new levee or modify an existing one (both of which are subject to regulation).

Figure 3F shows the three levee categories as detailed in DNRM's guideline documents on self-assessable codes for construction or modification of levees.

Figure 3F
Levee categories and assessment levels

Category	Definition	Level of Assessment	Assessor
One	A levee that has no off-property impact.	Self-assessment	Applicant
Two	A levee that has an off-property impact and for which the affected population is less than 3.	Code assessment	Councils
Three	A levee that has an off-property impact and for which the affected population is at least 3.	Impact assessment	Councils with Queensland Government as referral agency

Source: Department of Natural Resources and Mines

Landholders are required to identify the levee category and comply with its requirements before constructing a new levee. Landholders do not have to comply with these regulatory provisions for existing levees, unless they make modifications.

Councils are responsible for assessing applications for levees. Under the *Sustainable Planning Regulation 2009*, DILGP is responsible, along with councils, for Category Three levees that are of state interest. DNRM is the technical advisory agency to support the assessment of Category Three levees only. Councils are required to source technical support, if needed, for assessing the other categories of levees.

Applicants for Category One levees self-assess the impact of the levee. Councils do not have compliance checks in place to provide assurance that applicants are completing self-assessments appropriately.

One council advised that:

'The inability of councils to undertake Category Two assessments is due to lack of both current resources and information about the levees which currently exist. It should be acknowledged that when this new regulatory regime was established, the State provided some training to council officers to undertake the Category Two assessment process.'

DNRM has only assessed one Category Three levee since the regulations became effective and none of the four councils had completed a Category Two application.

Levees constructed without state and council knowledge could potentially impact on the accuracy of flood modelling, because they are not included in the model. Similarly, not assessing the veracity of applicant self-assessments potentially limits the accuracy of information input into flood models. Without accurate and up-to-date knowledge, flood models and studies may be less effective.

Councils provided examples of poorly constructed or maintained levees failing during periods of heavy rainfall, causing substantial flooding on properties at high velocities. For example, during the 2013 flood on the Warrill Creek, a significant discharge from a failure scoured large volumes of soil onto the Cunningham Highway. This event was costly to the landholder to replace the soil and also caused disruptions on the highway.

Recommendations

We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning:

2. as a matter of priority, establish what funding is reasonably required and complete all elements of the Brisbane River Catchment Flood Studies.

We recommend that the four councils:

3. develop floodplain management plans in accordance with Recommendation 2.12 of the Final Report of the Queensland Floods Commission of Inquiry

We recommend that the Department of Natural Resources and Mines and the four councils:

4. work together to effectively and economically regulate levee banks.

Appendices

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Appendix A—Comments

In accordance with s.64 of the *Auditor-General Act 2009*, a copy of this report was provided to the following entities with a request for comment.

Responsibility for the accuracy, fairness and balance of the comments rests with the head of these agencies.

- Department of the Premier and Cabinet
- Department of Infrastructure, Local Government and Planning
- Department of Natural Resources and Mines
- Ipswich City Council
- Lockyer Valley Regional Council
- Scenic Rim Regional Council
- Somerset Regional Council

Comments received from Chief Executive Officer, Somerset Regional Council



8 April 2016

The Auditor-General
Queensland Audit Office
PO Box 15396
CITY EAST Qld 4002



Dear Sir

Subject: performance audit report – flood resilience of river catchments

Thank you for allowing Council to comment on the above performance audit report.

- The report states (on page 16) that “the presence or absence of vegetation affects the volume of water” (during floods). The Department of Natural Resources and Mines Queensland Flood mapping implementation kit states “that restoring catchment vegetation reduces the amount of rainfall that forms runoff that in turn will have a flood reduction effect **particularly on smaller events**” (my emphasis). Council does not agree that the presence or absence of vegetation would have had any substantive impact on the volume of water experienced in south east Queensland during the 2011 or 2013 major floods. Your report however repeatedly evokes these large floods. The implication that may be drawn by some readers is that changes to vegetation management in river catchments might have appreciably reduced the volume of floodwater in 2011 or 2013. Council does not agree with this implication.
- The report describes (page 21) improvements in flood resilience to infrastructure such as bridges as “encouraging, however governments have collectively failed to ensure that their efforts are coordinated and resources pooled to achieve the greatest outcomes at state, catchment and council levels”. It is true that Council’s efforts since the 2011 and 2013 floods have focused on making local infrastructure more resilient. Council attracted funding towards local infrastructure projects because it was able to quantify the benefits of these projects. It was not necessary to either coordinate efforts or pool resources with other governments to achieve significant and measurable benefits for local communities. The other local governments that were subject to this audit similarly achieved measurable benefits for their local communities. The aggregate impact of these projects was the achievement of measurably positive outcomes at state, catchment and council levels. Councils and the State are placing considerable effort into obtaining catchment-wide data through the Brisbane River Catchment Flood Study process. This process should be concluded prior to changes being implemented to current catchment management arrangements to ensure that fully informed decisions are made.

I attach the table of recommendations containing further comments as requested.

Yours sincerely

A handwritten signature in black ink, appearing to read "R. Bain".

Robert Bain
Chief Executive Officer

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Responses to recommendations

1

WoG, Flood resilience of river catchments (Report No. 16: 2015–16)
Response to recommendations provided by Chief Executive Officer, Somerset Regional Council on 8 April 2016.

Recommendation	Agree / Disagree	Timeframe for Implementation (Quarter and Year)	Additional Comments
We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning: 1. fulfil its obligation under the State Disaster Management Plan to drive the enhancement of flood resilience in the four catchments by: <input type="checkbox"/> coordinating flood resilience activities and funding at a state and catchment level <input type="checkbox"/> developing strategies and plans, in consultation with the four councils and relevant entities, to effectively identify, assess, prioritise and manage catchment scale flood risks using an integrated catchment management approach <input type="checkbox"/> assessing the capacity and capabilities of the four councils and supporting them as necessary in building flood resilience in the catchments and in their local areas.	Disagree	NA	Changes to catchment management arrangements in south east Queensland should await the outcomes of the Brisbane River Catchment Flood Studies to ensure that any changes made are fully informed.
We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning: 2. as a matter of priority, establish what funding is reasonably required and complete all elements of the Brisbane River Catchment Flood Studies.	Agree	June 2016	Agree

Response to recommendations

Recommendation	Agree / Disagree	Timeframe for Implementation (Quarter and Year)	Additional Comments
We recommend that the four councils: 3. develop floodplain management plans in accordance with Recommendation 2.12 of the Final Report of the Queensland Floods Commission of Inquiry.	Disagree	NA	The Queensland Floods Commission of Inquiry qualified recommendation 2.12 with the words "resources allowing". Council will await the outcomes of the Brisbane River Catchment Flood Studies before committing public funds for this purpose to ensure that decisions about floodplain management plans are fully informed and represent value for money.
We recommend that the Department of Natural Resources and Mines and the four councils 4. work together to effectively and economically regulate levee banks.	Agree	June 2016	Council is uncertain as to what is being recommended. Council recommends the establishment of a technical expert unit within DNRM that would act as a referral agency for helping assess development applications for levee banks or which incorporate levee banks.

Comments received from Director-General, Department of the Premier and Cabinet



Department of the
Premier and Cabinet

For reply please quote: *ENVP/CM – TF/16/5140 – DOC/16/44306*
Your reference: 2015-9135P

14 APR 2016

Mr Andrew Greaves
Auditor-General
Queensland Audit Office
PO Box 15396
CITY EAST QLD 4002



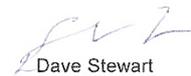
Dear Mr Greaves

Thank you for your letter of 24 March 2016 concerning your proposed report to Parliament on the performance audit on flood resilience of river catchments.

I appreciate being provided an opportunity to comment on the proposed report. Officers from my department have worked with their counterparts in relevant agencies across Government to consider your proposed recommendations.

The attached response is provided on behalf of myself and the Directors-General of the Department of Natural Resources and Mines and the Department of Infrastructure, Local Government and Planning. I trust this will be of assistance in completing your report.

Yours sincerely


Dave Stewart
Director-General

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Response to recommendations



Whole-of-Government feedback (proposed report to Parliament: performance audit on flood resilience of river catchments)

Response to recommendations provided by Director-General, Department of the Premier and Cabinet (DPC) – April 2016

Includes feedback from:

- Department of Infrastructure, Local Government and Planning (DILGP)
- Department of Natural Resources and Mines (DNRM)

Recommendation	Agree / Disagree	Timeframe for implementation (Quarter and Year)	Additional comments
We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning:			
1. fulfil its obligation under the State Disaster Management Plan to drive the enhancement of flood resilience in the four catchments by:			
<ul style="list-style-type: none"> • coordinating flood resilience activities and funding at a state and catchment level 	Agree	Planning – ongoing Funding – by 2nd quarter 2016 (Jun 2016)	Coordinating flood resilience activities through planning is ongoing and driven by State Planning Provisions process. Queensland Flood Resilience Coordination Committee (QFRCC) to be established by 30 June 2016. Whole-of-Government integrated approach to be employed to coordinate funding through QFRCC. DILGP has begun working with the Queensland Reconstruction Authority to strengthen the cross-agency coordination of resilience and mitigation activities.

1

Response to recommendations:



Recommendation	Agree / Disagree	Timeframe for implementation (Quarter and Year)	Additional comments
			<p>In addition, the current Queensland Regional Natural Resources Management (NRM) Investment Program 2013–2018 considers resilience as part of the investment in a multiple outcomes approach under the program.</p> <p>Funding from the current Queensland Regional NRM Investment Program 2013–2018 is committed until 30 June 2017.</p> <p>DNRM is currently investigating options for the governance of catchment management activities in South East Queensland (SEQ), which includes the potential for a SEQ River Improvement Trust.</p>
<ul style="list-style-type: none"> developing strategies and plans, in consultation with the four councils and relevant entities, to effectively identify, assess, prioritise and manage catchment scale flood risks using an integrated catchment management approach 	Agree	4th quarter 2018 (Dec 2018)	<p>Timing is driven by SPP review process which is scheduled for completion mid-2017. Must also be in line with the Brisbane River Catchment Flood Study (BRCFS) due for completion end 2018.</p> <p>Timing will be dependent on linking in with the four councils.</p> <p>Integrated catchment management approach interpreted as a multi-objective and coordinated approach at both levels of government and across entire catchment.</p> <p>The Statewide Risk Register is currently being developed by Queensland Fire and Emergency Services, with submission to DPC by 31 August 2016.</p>
<ul style="list-style-type: none"> assessing the capacity and capabilities of the four councils and supporting them as necessary in building flood resilience in the catchments and in their local areas. 	Agree	4th quarter 2016 (Dec 2016)	<p>Links to Recommendation 4.</p> <p>Initial assessment will be broad in nature, with more detailed assessment to be conducted upon completion of the BRCFS.</p>

Response to recommendations:



Recommendation	Agree / Disagree	Timeframe for implementation (Quarter and Year)	Additional comments
We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning:			
2. as a matter of priority, establish what funding is reasonably required and complete all elements of the Brisbane River Catchment Flood Studies.	Agree	Funding – 2nd quarter 2016 (Jun 2016) Completion of elements – 4th quarter 2018 (Dec 2018)	Scoping study of Floodplain Management Study and Plan components of the BRCFS completed, and potential funding requirements identified. Governance arrangements and work program to be established through a Memorandum of Understanding between the State and four councils.
We recommend that the four councils:			
3. develop floodplain management plans in accordance with Recommendation 2.12 of the Final Report of the Queensland Floods Commission of Inquiry.	N/A	N/A	This recommendation is directed to the councils. However, the State will continue to play a role in this activity through the BRCFS.
We recommend that the Department of Natural Resources and Mines and the four councils			
4. work together to effectively and economically regulate levee banks.	Agree	2nd quarter 2017 (Jun 2017)	DNRM will engage with the four councils in relation to the implementation of the framework. This will include identification of training needs and its delivery, compliance matters, data collection requirements and the identification of concerns in relation to the implementation of the levees framework. This will also include identification of state and local government follow up actions.

3

Comments received from Chief Executive Officer, Lockyer Valley Regional Council



Lockyer Valley Regional Council
26 Railway Street, PO Box 82, Gatton Qld 4343
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Our Ref: 2822988
Related Document: No: 2809918
Your Reference: 2015-9135P
C. McGarrity-3149 6063:
Enquiries: (07) 5468 4963

14 April 2016

The Auditor-General
Queensland Audit Office
PO Box 15396
CITY EAST QLD 4002



Dear Sir

QAO PERFORMANCE AUDIT REPORT 16: 2015-16 – FLOOD RESILIENCE OF RIVER CATCHMENTS

Thank you for your letter of 24 March 2016 inviting Council to comment on the above performance audit report.

We have given due consideration to the report but wish to note that Council is still in extended caretaker mode so is unable to commit or provide a view at this time on a number of matters within the Recommendations.

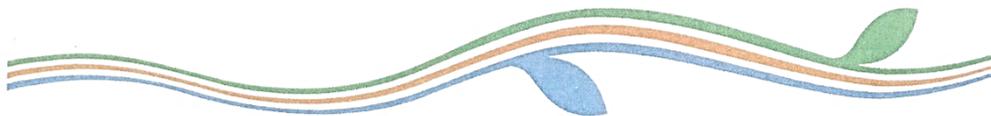
With respect to the audit report we make the following comments:

1. **Brisbane River Catchment Flood Study:** It is agreed that the Brisbane River Catchment Flood Study (BRCFS) has limitations, and caution that parties not overestimate or assume the coverage and subsequent outcomes of the work. A level of confusion has been observed in some quarters in this matter.

The BRCFS applies to a specific section of the catchment, i.e., its outcomes are confined between the upper boundaries on the Lockyer at the western edge of Somerset Regional Council (Lyons Bridge) and in the Bremer River at Walloon and Amberley to a lower bound at the Port of Brisbane.

This area thus may not cover areas of interest to enable investigation of future mitigation schemes in the catchment; its focus is on only those portions of floodplain affected by the main channel regional river flood with some discrete larger areas in Ipswich and Brisbane. It does not incorporate regional flooding above the upper bounds, or, local flooding from tributaries (the latter presenting its own set of considerations, hazards, risks and likelihood including the areas of overlap with the regional flood).

It appears for instance that due to technical limitations of the Monte Carlo strategy that have recently become apparent, our Council area aside, additional works will



Comments received from Chief Executive Officer, Lockyer Valley Regional Council

need to be undertaken for comprehensive coverage by flood study, e.g., in Somerset Regional Council area outside the valid extent of usefulness of the current study.

We caution that care is taken not to miss the opportunity in this work of moving beyond the focus on urban dwellings to look at mitigation planning strategies in relation to evacuation/ emergency routes, industry, transport network impacts, etc., that operate on a linear basis through the catchment.

- 2. Integrated approach to catchment management:** It is agreed that a comprehensive integrated approach needs to be taken to catchment mitigation activities and that vegetation can form a key element in this toolbox. We caution the use of simplistic or a "1-D" approach to this work. Moving forward, it is advised that a comprehensive review and understanding of the large body of work be completed, e.g., \$2million University of Queensland's "Big Flood" project (that we have contributed to), be understood and used along with other relevant findings to set future strategies, project and priorities for the catchment.

We also note that the Lockyer Creek Catchment action plan under the Council of Mayors **Resilient Rivers Initiative** is still under development.

On the basis of understanding similar projects in NSW where unexpected adverse impacts have occurred by widespread application of vegetation of floodplains and watercourses, we caution that failure to implement projects in such a framework, besides setting up resistance of stakeholders, could result in adverse outcomes and/or failure for all.

On a related catchment control matter, we caution the understanding/presentation of the role of Local Government in the Disaster Management Framework and clarify that Council works with the framework set up by the Act, Chairing the Local Disaster Group in its capacity as fulfilling the role and providing resources, along with multi-agencies, speaking as the Local group not Council.

- 3. Provision of resilience infrastructure within catchments:** We believe in the interest of creating more resilience infrastructure within catchments, along with effective use of the public resources, that a comprehensive review of reconstruction funding guidelines is necessary to ensure that the current "like-for-like" is replaced by a more enlightened community and intergenerationally focused policy focused on resilient construction.

We also note that resilience does not necessarily mean a quantum leap in higher material costs or increased flood immunity - the focus rather being on a smart, correctly technically informed, integrated risk management approach for the new conditions of exposure post flood event.

Table 1 and 2 show the allocation of reconstruction costs over the 2011 and 2013 events in the Council area.

Although a formal analysis has not been undertaken to date, but due to multiple failures in operation of 2011 restored "like-for-like" structures before and during the 2013 events, we believe that failure to adequately support-fund resilience re-



Comments received from Chief Executive Officer, Lockyer Valley Regional Council

construction practices during the recent flood reconstruction works has resulted in unnecessary rework, noting that subsequent failures (and future failures) have cost both the Council and the State/Federal Government, i.e., the local and wider community, potentially significant sums of money.

Table 1 – Council 'business as usual' expenditure on infrastructure works – contrast this against the relative size of reconstruction works and impacts on Council's normal operations over an extended period of time.

Infrastructure Budget \$M	Maintenance	Capital
Typical "business as usual"	\$6M	\$6-7M

Table 2 – Summary of approximate reconstruction costs (\$M) to Council and State/Federal Govts over 2011 and 2013 flood events.

Event	Emergent Works	NDRAA Recommended Value (Final Cost)	Complementary Works	Betterment Works	Ineligible Works	
Funding Source:	State	State	Council	State/Council	Council	
2011	148	21.5	140 (120)	-	n/a	6.4
2013	74.2	14.8	56 (44)	7.3	6.2/1.4	0.5

4. **Deficiency review/gap analysis of the building and planning regulations:** We believe in the interests of creating resilience within the catchment that a review of the interaction, gaps and deficiencies of the building and planning regulations are necessarily to provide better community outcomes.

Managing of these matters by Council (often by default) is resource heavy and does not necessarily lead to satisfactory outcome or remedy for those concerned.

This matter not only concerns new/future dwellings but also existing dwelling impacted or identified as vulnerable to future design flooding events.

Noting and not knowing the status of **Recommendation 2.19 of the QLD Flood Commission of Inquiry Final report** with respect to implementing a mechanism by which prospective purchasers of property are alerted to the issue of flood risk, Council can provide among others: examples of dwellings rebuilt in known flooded areas with the same vulnerability, dwellings repaired /refurbished after multiple frequent events to the same standard, vacant allotments (by inference) subject to withdrawal from construction contracts when advice was sort after engagement, developers undertaking significant planning works without asking advice on flooding



Comments received from Chief Executive Officer, Lockyer Valley Regional Council

vulnerability, development that was approved with conditions due to concerns of litigation and reliance only on hazard and risk assessment, packages with inappropriate construction /or levels in relation to flooding discovered by accident in the processing of allied applications (e.g. road access), ignoring of flood advice and proceeding with inappropriate construction.

The provision of resilient building requirements/advice/options also gives an alternative strategy where exclusion of water is not a financial reality, for those existing structures that are affected by frequent flooding and for a range of reasons cannot be moved or lifted above the flooding. Council has examples of implementation/replacement with resilience materials/strategies that to allow 'hose out' and reoccupation and restarting of operations with minimal effort. Such a strategy is also avoiding insurance difficulties (usually not practically on offer) that some of our communities suffer.

- 5. Establishment of Flood Risk Management Framework:** We advise caution in the use of the QRA cited documents in relation to flood risk management. With reference to extensive communication with then DSDIP during the development of the current Strategic Planning Policy in relation to natural hazards, Council provided technical critiques on the use of this material, in isolation of the framework represented by e.g. Handbook 7 *Managing the Floodplain: a guide to best practice in flood plain risk management in Australia* in certain situations where the use was not safe. There now may be issues of currency.

Additionally as observed in the use of, and, demonstrated by Council's Flood Risk Management Framework (and others) we caution that simplistic risk management based on the use of identified hazards is not a "1-D" operation and needs consideration of a number of factors, not being readily described in a single map or assessment table.

- 6. Establishment of costs:** We agree that effort be put in to establishment/compiling of damage costs where there is little or no information available for example: rural industry, transport disruption, infrastructure reconstruction, commercial/industrial losses, insurance impacts, social and environmental costs, etc., so that they can be used in prioritisation and comparison of mitigation options to enable not only relative comparison between like projects but direct comparison with those that are not, e.g. infrastructure mitigation projects.

We observe that charts and methods used to date mainly concern residential dwellings, this material being given casual updates from basic compilation 20 years ago, with little recognition of the gap in vulnerability between older housing stocks and housing of recent times (not resilient at all).

We also caution that without the availability of this data it will be increasingly difficult for mitigation strategies/programs to compete with other Government priorities.

We have indicated previously that it is opportune that any relevant materials generated during the 2014 WDOS study that may be subject to in confidence strictures relating to this exercise be considered for release for use by practitioners.



Comments received from Chief Executive Officer, Lockyer Valley Regional Council

Attached is the table of recommendations containing further comments as requested. We have agreed with one Recommendation, but as indicated above are constrained on other items at this time.

Should you require any further information in regards to the above please do not hesitate in contacting Infrastructure Works and Services Executive Manager

Yours sincerely



Ian Flint
CHIEF EXECUTIVE OFFICER

Enc: Response to Report No. **16**: 2015-16 recommendations provided by Chief Executive Officer, Lockyer Valley Regional Council on 13 April 2016



Response to recommendations:

WoG, Flood Resilience of River Catchments (Report No. 16: 2015–16)

Response to recommendations provided by Chief Executive Officer, Lockyer Valley Regional Council on 13 April 2016

Recommendation	Agree / Disagree	Timeframe for Implementation (Quarter and Year)	Additional Comments
<p>We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning:</p> <p>1. fulfil its obligation under the State Disaster Management Plan to drive the enhancement of flood resilience in the four catchments by:</p> <ul style="list-style-type: none"> • coordinating flood resilience activities and funding at a state and catchment level • developing strategies and plans, in consultation with the four councils and relevant entities, to effectively identify, assess, prioritise and manage catchment scale flood risks using an integrated catchment management approach • assessing the capacity and capabilities of the four councils and supporting them as necessary in building flood resilience in the catchments and in their local areas. 	<p>NA</p>	<p>NA</p>	<p>Council is still in extended caretaker mode so is unable to provide a view on which entity is suitable to drive this action.</p> <p>At this early stage however, we believe that there is merit in pursuing a coordinated integrated approach that addresses the needs (including organisation capabilities, funding sources and funding needs), the necessary strategies and projects required to implement the works, along with a formation of a practical governance structure to oversee and undertake the works.</p>

Response to recommendations:

Recommendation	Agree / Disagree	Timeframe for Implementation (Quarter and Year)	Additional Comments
<p>We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning:</p> <p>2. as a matter of priority, establish what funding is reasonably required and complete all elements of the Brisbane River Catchment Flood Studies (BRCF).</p>	<p>NA</p>	<p>NA</p>	<p>Council is still in extended caretaker mode so is unable to provide a view on which entity is suitable to drive this action.</p> <p>We understand that: (a) The BRCF is currently limited to the regional flood impacts in the middle and lower Brisbane River catchment; (b) this may necessarily limit the ability to look at mitigation/planning activities in the upper catchment (e.g. strategic revegetation, engineering works); and, (c) There is a process underway currently under the combined CEOs Implementation Committee to source funding to complete these works as currently understood.</p> <p>In terms then of the wider catchment and the inferred limited extent of the scope mitigation/planning activities, we would be seeking clarification, as it is not clear at this stage, whether this possibly limited work scope will be looking at or setting up capability beyond a base of residential planning/mapping into consideration of infrastructure, emergency and/or mitigation configurations for the catchment.</p> <p>We would in this case be supportive of the funding of a program that establishes a comprehensive scope that ensured a necessary level of works such that future projects/extension were not compromised by funding limitations at this stage.</p>

Response to recommendations:

Recommendation	Agree / Disagree	Timeframe for Implementation (Quarter and Year)	Additional Comments
<p>We recommend that the four councils: 3. develop floodplain management plans in accordance with Recommendation 2.12 of the Final Report of the Queensland Floods Commission of Inquiry.</p>	<p>Agree</p>	<p>NA</p>	<p>Council is still in extended caretaker mode so is unable to provide a view on a completion timeframe.</p> <p>Recommendation 2.12 notes that works are undertaken "resources allowing" - In the context that Council has successfully managed the fallout of two substantial floods and undertaken substantial reconstruction and completed the merger of two contrasting council areas - whilst a formal FRM plan including all the elements of <i>Handbook 7 Managing the Floodplain: a guide to best practice in flood plain risk management in Australia</i> has not been completed, Council has undertaken significant work since 2011 in flood investigation, modelling, mapping, mitigation and implemented a comprehensive risk management approach to planning, construction and other areas that are in the remit or influence of Council including planning instruments, advice/learnings to the Brisbane River Catchment Flood Study, reconstruction activities, Government policy and others, e.g., catchment projects by others in the period 2011 to date.</p>

Response to recommendations:

Recommendation	Agree / Disagree	Timeframe for Implementation (Quarter and Year)	Additional Comments
<p>We recommend that the Department of Natural Resources and Mines and the four councils</p> <p>4. work together to effectively and economically regulate levee banks.</p>	<p>NA</p>	<p>NA</p>	<p>Council is still in extended caretaker mode so is unable to provide a view on which entity is suitable to drive this action.</p> <p>Council refers to extensive correspondence with DNRM leading up to the implementation of this regulation including advice on far more effective ways of operation and control. The current scope and definitions can be interpreted widely across many floodplain situations, such as agribusiness, general rural, dense urban, scattered urban.</p> <p>Council agrees that there is no solid basis to currently manage. Council agrees that this would be expensive to set up and would need appropriate specialist advice in place. This responsibility is currently placed on any applicant on lodgement.</p> <p>Council believes that the objective of the regulation be clarified which may allow a focus and collapse of the physical footprint and resources required to currently managed/regulate satisfactorily.</p>

Comments received from Chief Executive Officer, Scenic Rim Regional Council



Response to recommendations:



WoG, Flood resilience of river catchments (Report No. 16: 2015–16) Response to recommendations provided by Chief Executive Officer, Scenic Rim Regional Council on 12 April 2016.

Recommendation	Agree / Disagree	Timeframe for Implementation (Quarter and Year)	Additional Comments
<p>We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning:</p> <p>1. fulfil its obligation under the State Disaster Management Plan to drive the enhancement of flood resilience in the four catchments by:</p> <ul style="list-style-type: none"> • coordinating flood resilience activities and funding at a state and catchment level • developing strategies and plans, in consultation with the four councils and relevant entities, to effectively identify, assess, prioritise and manage catchment scale flood risks using an integrated catchment management approach • assessing the capacity and capabilities of the four councils and supporting them as necessary in building flood resilience in the catchments and in their local areas. 	Agree		<p>Catchment management arrangements in south east Queensland should await the outcomes of the Brisbane River Catchment Flood Studies to ensure that any proposed strategies, plans and activities are fully informed.</p>
<p>We recommend that, in the absence of stand-alone catchment management authorities, the Department of Infrastructure, Local Government and Planning:</p> <p>2. as a matter of priority, establish what funding is reasonably required and complete all elements of the Brisbane River Catchment Flood Studies.</p>	Agree		<p>It is important for catchment flood studies to be completed to inform the next phase of management of the catchment.</p>
<p>We recommend that the four councils:</p> <p>3. develop floodplain management plans in accordance with Recommendation 2.12 of the Final Report of the Queensland Floods Commission of Inquiry.</p>	Agree		<p>We note that recommendation 2.12 provides that floodplain managements plans should be developed where resources allow and the requirement for floodplain management plans should be commensurate with the level of urban development within floodplain areas.</p>

4

Response to recommendations:



Recommendation	Agree / Disagree	Timeframe for Implementation (Quarter and Year)	Additional Comments
We recommend that the Department of Natural Resources and Mines and the four councils 4. work together to effectively and economically regulate levee banks.	Agree		Regulation should occur of any proposed levee banks and existing levees should be assessed in floodplain management plans.

Appendix B—Audit methodology

Audit objective

The objective of the audit was to determine the effectiveness of flood resilience activities in the Bremer, Lockyer, Mid and Upper Brisbane river catchments.

The audit addressed the objective through the sub-objectives and lines of inquiry set out in Figure B1.

Figure B1
Audit objective

Sub-objectives		Lines of inquiry	
1	Effective governance arrangements are in place	1.1	Coordination and communication
		1.2	Funding, resources and capability
2	Flood preparedness is informed by an understanding of flood risks	2.1	Risk identification
		2.2	Risk assessment
3	Flood risks are effectively managed	3.1	Response to risk

Source: Queensland Audit Office

Reason for the audit

Queensland's river catchments are crucial to the health and prosperity of the state however during major rainfall events, they become a source of flooding. Flooding is identified historically as the most destructive natural hazard in Queensland. These events cause damage to property, disrupt local communities and economies and can lead to major injuries or loss of life. Since 2002–03, over one third of the National Disaster Relief and Recovery Arrangement (NDRRA) funding allocated to the state is spent on recovery from this type of hazard alone.

Recently significant flood events have occurred throughout Queensland—the greatest financial impact occurred in South-East Queensland catchments in 2010–11. While flood events are unavoidable, natural and recurring phenomena, mitigation measures can minimise the impact of floods. In this context, resilience means preparing for and managing potential hazards to minimise flood impacts.

Performance audit approach

We conducted this audit in accordance with the Auditor-General of Queensland Auditing standards, which incorporate Australian Auditing, and Assurance Standards.

We conducted it between July 2015 and February 2016. The audit consisted of:

- interviews with officials from:
 - Department of the Premier and Cabinet
 - Department of Infrastructure, Local Government and Planning
 - Department of Natural Resources and Mines
 - Ipswich City Council
 - Lockyer Valley Regional Council
 - Scenic Rim Regional Council
 - Somerset Regional Council

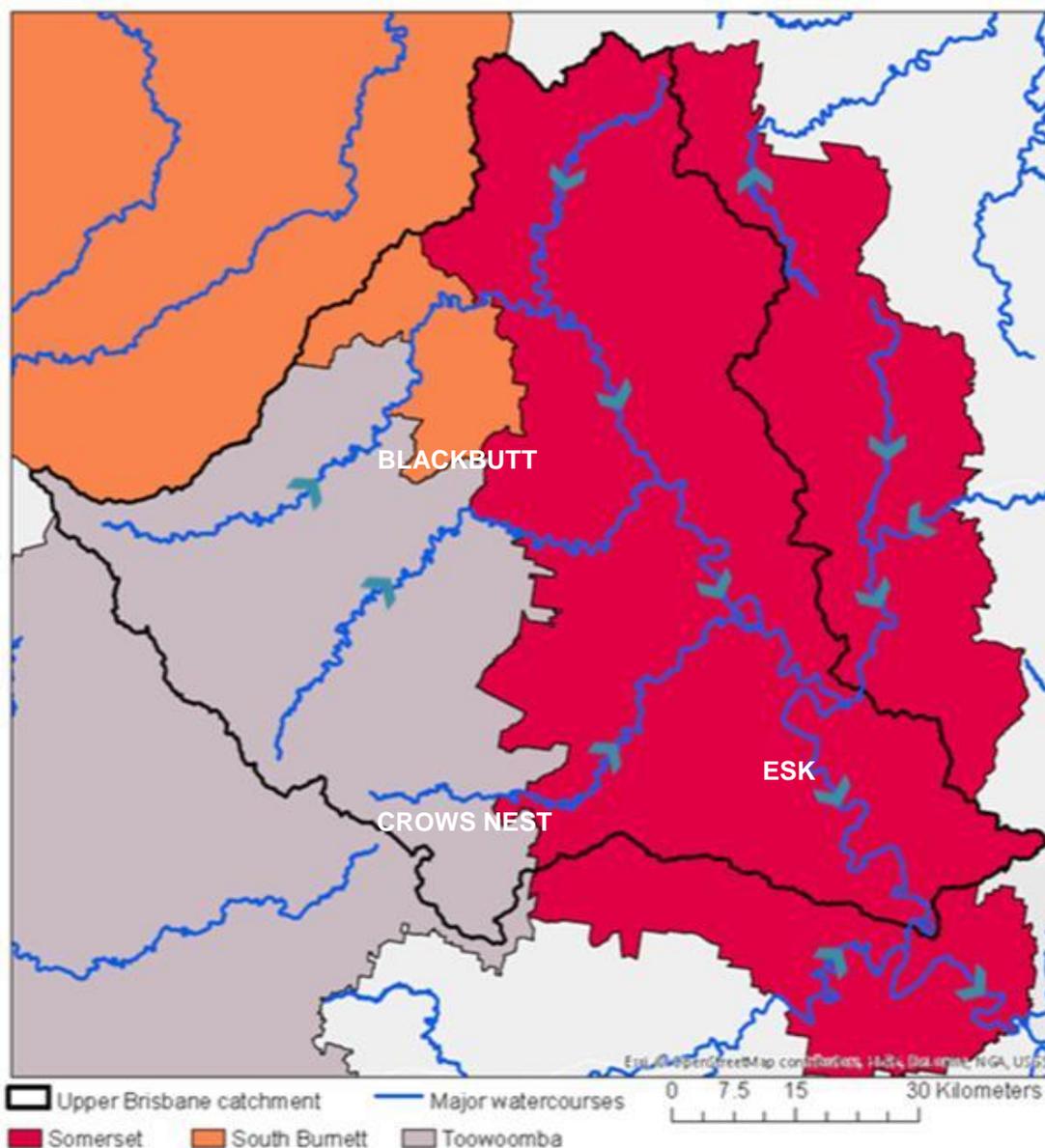
- analysis of documentation relating to flood resilience
- analysis of financial and non-financial data relating to flood resilience
- interviews with stakeholders to the audit, including:
 - Brisbane City Council
 - Queensland Reconstruction Authority
 - Inspector-General of Emergency Management
 - Local Government Association of Queensland
 - Department of Energy and Water Supply
 - Council of Mayors, South East Queensland
 - Seqwater
 - Queensland Fire and Emergency Services
 - SEQ Catchments.

Appendix C—Catchment profiles

Upper Brisbane River catchment

Figure C1 shows the Upper Brisbane River catchment, which covers an area of 5 493 square kilometres.

Figure C1 — Upper Brisbane River catchment



Source: Queensland Audit Office

The catchment extends from the Wivenhoe dam wall upstream towards the Great Dividing Range in the west, the Jimna ranges in the north and the D'Aguilar range in the east. The largest portion — the eastern part of the catchment — lies within Somerset Regional Council. The western part of the catchment falls within the Toowoomba and South Burnett council areas. Finally, a small part on the northern edge falls within Gympie Regional Council.

The total length of the stream network in the catchment is approximately 11 400 kilometres, which includes major tributaries: the Monsidale, Cooyar, Emu, Maronghi, Cressbrook and Esk Creeks. The Stanley River also flows into the Brisbane River within the Upper Brisbane River catchment approximately 12 kilometres upstream from the northern edge of Lake Wivenhoe. Flows in the Stanley River are regulated at Somerset Dam.

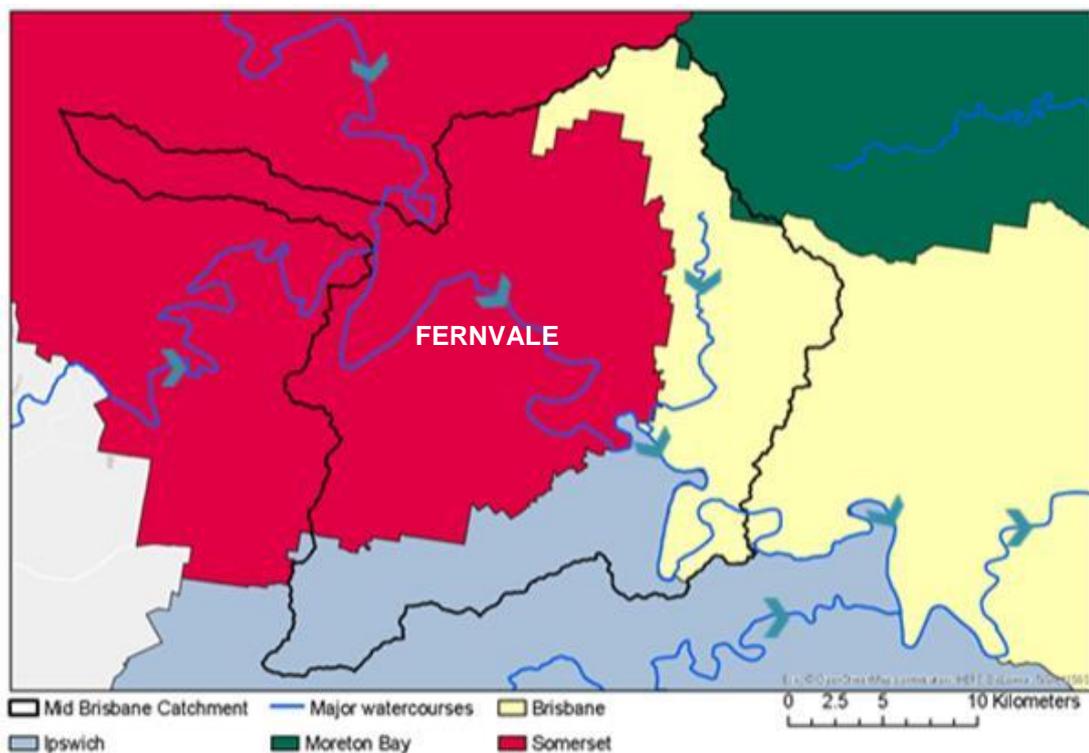
The catchment is sparsely populated, with around 15 000 people living in 36 localities across the area. Five of these townships have a population of over 1 000 people. These are Crows Nest, Esk, Blackbutt, Toogoolawah and Yarraman.

The dominant land use in the Upper Brisbane River catchment is grazing of beef cattle, with dairying and farming concentrated along fertile alluvial valleys and basalt uplands. The timber industry remains significant, with production from managed native forest and large areas of hoop pine plantations.

Mid Brisbane River catchment

Figure C2 shows the Mid Brisbane River catchment.

Figure C2 — Mid Brisbane River Catchment



Source: Queensland Audit Office

The Mid Brisbane catchment covers an area of 552 square kilometres between Wivenhoe Dam and Mt Crosby Weir. The catchment encompasses the Ipswich City Council to the south, Somerset Regional Council to the west and Brisbane City Council to the east. It also includes a very small portion (around two square kilometres) located in the Moreton Bay Regional Council.

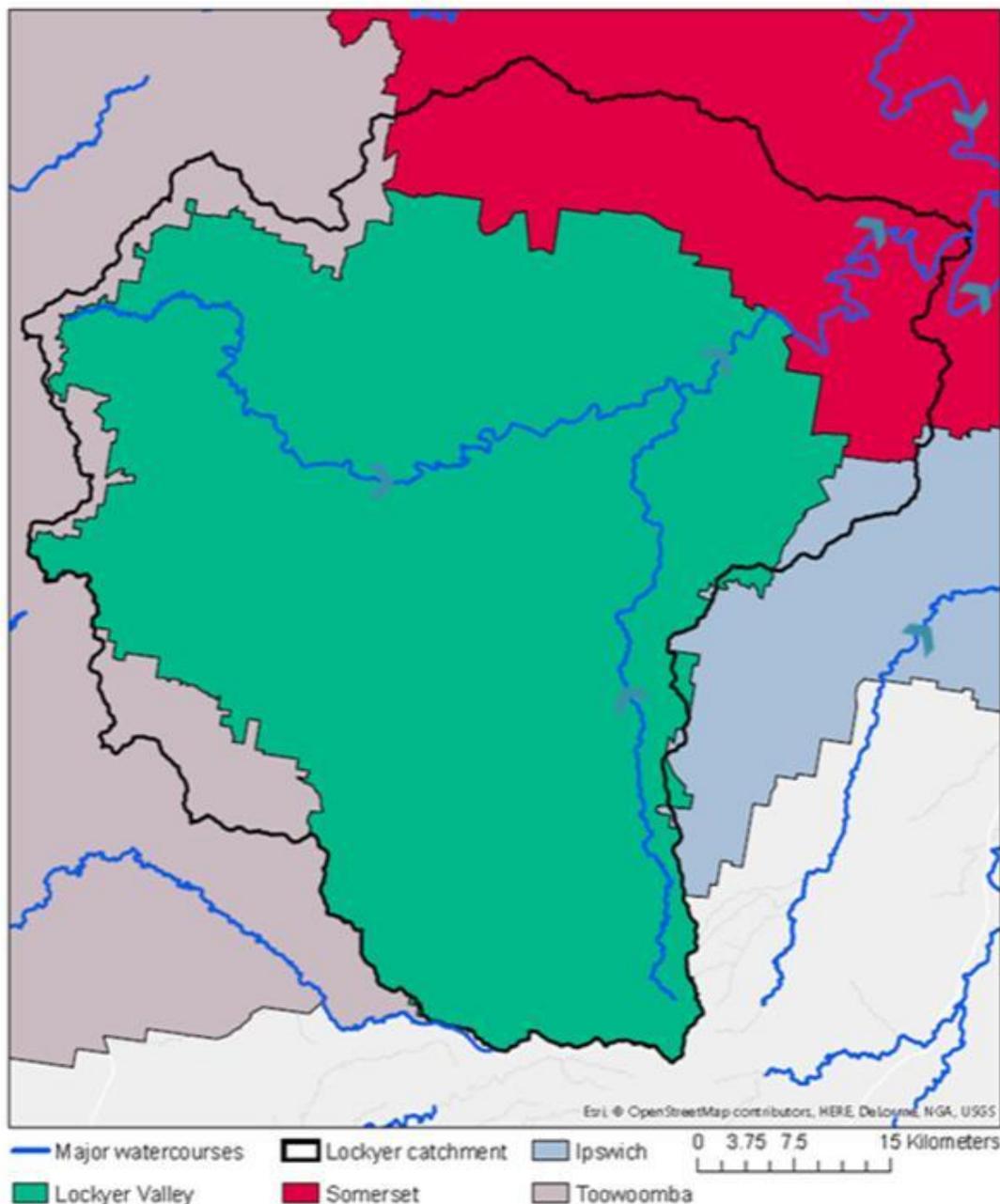
The catchment has a population of approximately 10 000 people living in the townships of Lowood, Fernvale, Marburg and Fairney View/Glamorgan Vale. Human settlement is concentrated in the south-western half of the catchment with large areas of the north-eastern part having no human population at all.

Nature conservation and grazing are the dominant land uses in the catchment, accounting for over one third of total land area. The remaining area is used for a variety of uses including intensive agriculture, managed forestry, recreation purposes, rural/residential, urban and industrial development.

Lockyer catchment

Figure C3 shows the Lockyer catchment.

Figure C3 — Lockyer catchment



Source: Queensland Audit Office

The Lockyer catchment is located approximately 55 kilometres west of Brisbane and is predominantly within the Lockyer Valley Regional Council area. The catchment also contains minor areas of the Toowoomba Regional Council, Somerset Regional Council and Ipswich City Council areas.

Lockyer Creek is the major waterway within the catchment and it rises on the eastern slopes of the Great Dividing Range before flowing in an easterly direction to join the Mid Brisbane River just above the Mt Crosby Weir.

Lockyer Creek has ten major tributaries and numerous minor tributaries. The creek and its tributaries exist within a bowl-shaped catchment of approximately 3 000 square kilometres.

The current population of Lockyer Valley Regional Council is approximately 38 000. Significant growth has been forecast for the region, with the population expected to increase to approximately 58 000 by 2031.

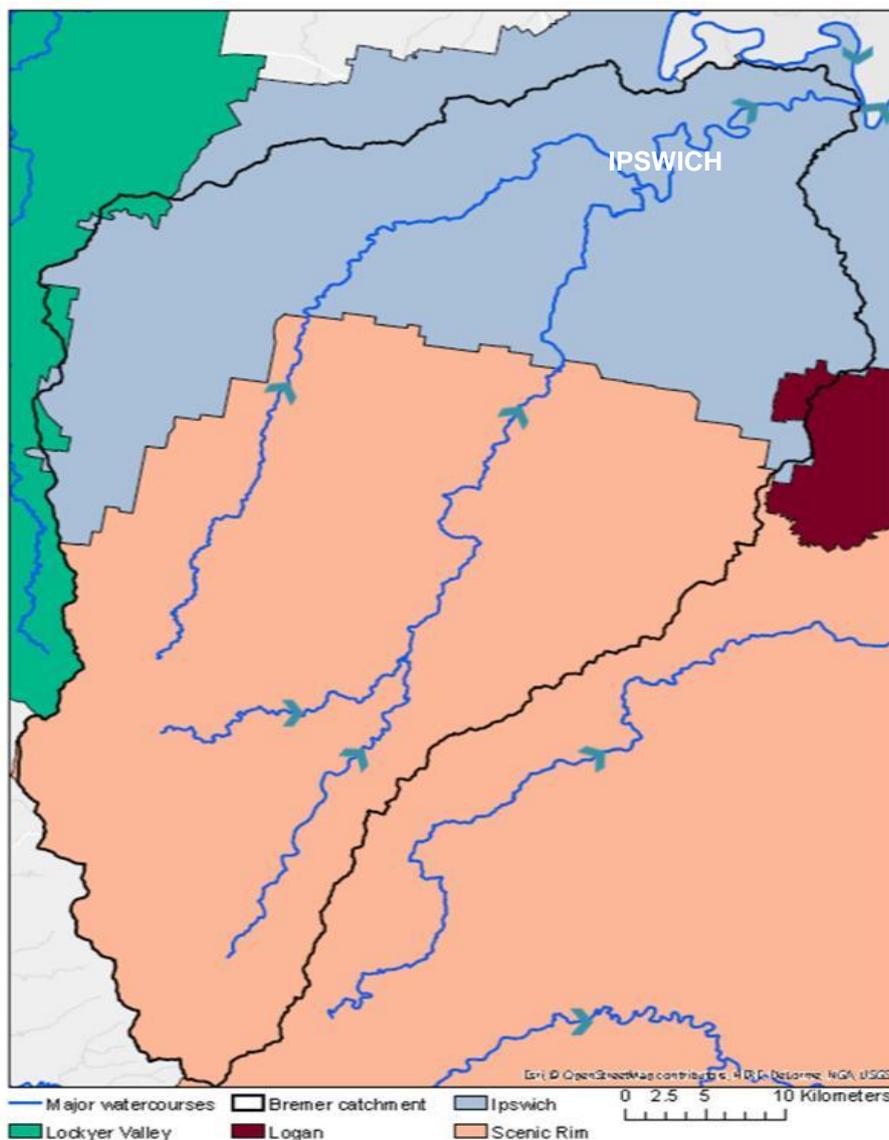
Historically, the Lockyer Valley is one of Australia's major agricultural production areas, particularly horticulture. The 3 000 square kilometres of alluvial soils of the Lockyer Valley are recognised as some of the most fertile in the world. The 13 000 hectares of irrigated land in the Lockyer produce approximately a quarter of Queensland's vegetable supply, valued at more than \$230 million annually.

The horticulture industry is a major employer within the Lockyer Valley Regional Council area and the economic contribution of the industry is far greater than just the value of crop production.

Bremer catchment

Figure C4 shows the Bremer River catchment.

Figure C4 — Bremer River catchment



Source: Queensland Audit Office

This catchment covers an area of 2 031 square kilometres extending from Ipswich in the north-east for approximately 80 kilometres south-east to Main Range National Park just north of the Queensland–New South Wales border.

The upper portion of the catchment (approximately 60 per cent) is located in the Scenic Rim Regional Council area, with the lower catchment located in the Ipswich City Council area. A very small portion is located in the Lockyer Valley and Logan City areas.

The catchment contains a total of 4 425 kilometres of creeks and rivers, with Warrill Creek, Reynolds Creek, Purga Creek and Bundamba Creek being the major tributaries of the Bremer River. The Bremer River itself flows into the Brisbane River just west of Moggill.

The Bremer River catchment is relatively flat and low lying, ranging from 200 meters in the upper reaches to 50 meters in the Ipswich plains. The western border of the catchment is formed by the Great Dividing Range, which reaches up to 1 325 meters with lower peaks in the upper reaches and along the eastern catchment border.

Grazing is the dominant land use within the catchment, with approximately 70 per cent of land being grazed. Other major land uses are irrigated agriculture (6.9 per cent), urban (5.5 per cent) and forestry (2.5 per cent).

Urbanisation of the catchment is largely concentrated in and around the city of Ipswich in the north-eastern corner of the catchment. In 2011, Ipswich had a population of almost 167 000 people, however, about 72 000 of those people live outside the Bremer catchment. The Ipswich City Council's population is forecast to grow rapidly and reach more than 350 000 by 2030.

Appendix D—Recent floods in the greater Brisbane River catchment

The 2011 flood

The 2011 flood affected the majority of central and southern Queensland. A major rain event triggered extreme flash flooding in Toowoomba and the Lockyer Valley and major flooding in the Brisbane and Bremer Rivers.

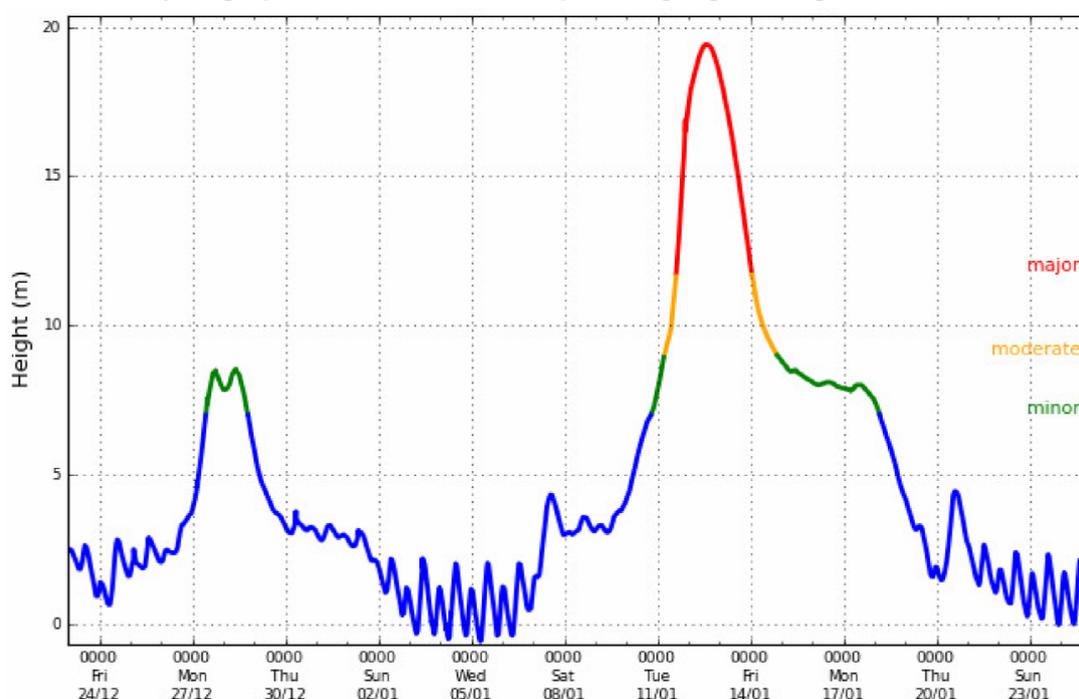
This flooding resulted in 36 deaths across Queensland (with three others presumed dead). Of these, 26 lives were lost in South East Queensland catchments.

An estimated 200 000 people were affected throughout Queensland during this period. The World Bank, in conjunction with the Queensland Reconstruction Authority, produced the only comprehensive estimate of damages and losses. They estimated damages and losses to exceed US\$15.9 billion.

Flooding in Ipswich — January 2011

Figure D1 shows that the flood peaked in Ipswich at 19.4 metres on 11 January 2011. This is Ipswich's highest level since the 1974 flood (20.7 metres), but below the record flood of 23.6 metres recorded in 1893.

Figure D1
Hydrograph for Bremer River at Ipswich gauge during 2011 flood



Source: Bureau of Meteorology

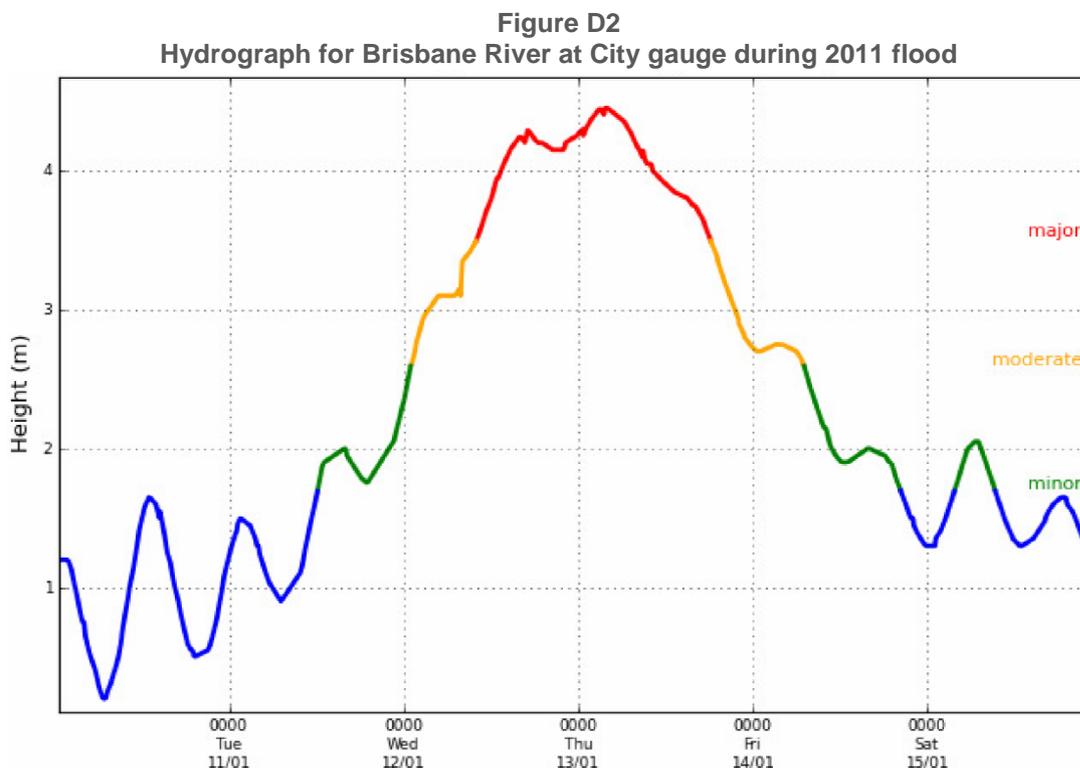
Nearly one third of the Ipswich City area of 1 090 square kilometres experienced some level of inundation during the flood event. BoM estimates that the flood event impacted on approximately 8 600 residential and business properties, with approximately:

- 1 200 homes being significantly affected
- 188 businesses being directly impacted
- 760 roads and 20 bridges sustaining some level of damage.

The flood also affected council assets, medical centres, and four local schools.

Flooding in Brisbane — January 2011

Figure D2 shows that Brisbane recorded a major flood peak of 4.5 metres on 13 January 2011. This is Brisbane's highest flood peak recorded since the 1974 flood when the Brisbane River reached 5.5 metres.



Source: Bureau of Meteorology

Approximately 26 000 homes and 5 000 businesses were flooded to varying levels during the January 2011 flood.

Flooding in Lockyer — January 2011

The Lockyer Creek has a long history of flooding, with 11 documented major floods since 1893. The 2011 flood affected most of the communities in the region to some extent.

It resulted in the deaths of 19 people within the Lockyer catchment. In contrast to other flood fatalities, only six of the 19 deaths came from people driving through flood waters. The remaining 13 people were within their homes when the flood waters hit.

There was significant damage to local and state government infrastructure within the region. The majority of bridges, floodways and roads required repair. This had significant flow-on effects to the industry in the region and severely impacted on the ability of primary producers to get their product to market.

January 2013 floods

The 2013 flood was caused by rainfall associated with ex-tropical cyclone Oswald and it primarily affected the gulf and eastern coast of Queensland.

The BoM recorded very heavy rainfall throughout the greater Brisbane River catchment from 26 to 28 January 2013. It recorded major flood levels:

- above Wivenhoe Dam in the Upper Brisbane River and in the major tributaries of the Stanley River and in Cressbrook Creek
- throughout the Lockyer Creek
- in the Bremer and Warrill Creek systems.

Laidley Creek and the neighbouring catchments of Black Duck and Tenthill Creeks recorded record flood levels. A major flood peak of about 14 metres was recorded at Ipswich and a minor flood peak of 2.3 metres was recorded in the Brisbane central business district. The then Department of State Development, Infrastructure and Planning estimated the total damage bill (including regional production losses) at \$2.5 billion.

The Wide Bay–Burnett and Fitzroy regions sustained the majority of damage, at \$1 billion and \$700 million respectively. South East Queensland's losses were estimated to be \$396 million.

On 29 January 2013, Brisbane's main water treatment plant at Mount Crosby was shut down because of high levels of sediment and silt in the Brisbane River. Seqwater and the then Queensland Premier urged residents to conserve water and to only use it for drinking, cooking and bathing.

The Queensland Government reported that some suburbs of Brisbane were within six to 12 hours of running out of water as a result of the unprecedented levels of sediment. The government used the Gold Coast desalination plant to supplement supplies.

Appendix E— Roles and responsibilities

Figure E1 shows the key entities and their roles and responsibilities in floodplain risk management for the catchments we audited.

Figure E1
Queensland floodplain management primary roles and responsibilities

Agency	Floodplain management roles and responsibilities
Department of the Premier and Cabinet	Overseeing and coordinating the implementation of the Queensland Floods Commission of Inquiry recommendations. Performing cross agency reviews and taking a lead role during catastrophic disaster events through the Queensland Disaster Management Committee, which the Premier chairs.
Department of Natural Resources and Mines	Managing and maintaining river gauging stations (primarily for water resource allocations), collating statewide flood modelling and flood studies and assisting with flood studies and flood mapping. Regulating vegetation and waterways. Undertaking Brisbane River Catchment Flood Study.
Department of Infrastructure, Local Government and Planning	Providing funding to councils, coordinating integration of state interests expressed through the State Planning Policy into local government planning schemes, and overseeing disaster resilience and recovery activities for the state. Producing the Brisbane River Catchment Management Study and the Brisbane River Catchment Floodplain Management Plan once the Brisbane River Catchment Flood Study is completed.
Department of Environment and Heritage Protection	Monitoring of riparian vegetation (vegetation of or on a waterbank), wetlands and pollution discharges during floods.
Department of Energy and Water Supply	Managing referable dams and reviewing dam Emergency Action Plans.
Queensland Fire and Emergency Services	Primarily responsible for response activities, training to Local Disaster Management Groups and operating state warning systems. Currently revising the Statewide Hazard Risk Assessment (last updated 2012).
Queensland Reconstruction Authority	Administering the Natural Disaster Relief and Recovery Arrangements funding (including the Queensland Betterment Fund). Legislated to improve the resilience of communities for potential disaster events. Lead role in implementing recent floodplain management review recommendations.
Seqwater	Operating the Wivenhoe and Somerset Dams in the Upper Brisbane River catchment. Conducting the Wivenhoe and Somerset Dam Optimisation Study, a key portion of the Brisbane River Catchment Flood Study.
Councils	Primarily responsible for managing floodplain risk (including identifying, assessing and treating risks), managing disasters through the Local Disaster Management Group, planning for land use through the development approval process and regulating levee banks.
River Improvement Trusts	Responsible for restoring natural resilience for flooding and cyclones in rivers and their catchments, as noted in the 2013 amendments to the <i>River Improvement Trust Act 1940</i> .

Note: Audited agencies are in bold text. The Lockyer Valley Regional Council, Ipswich City Council, Somerset Regional Council and Scenic Rim Regional Council were the four councils audited. We engaged all other agencies as stakeholders during the audit.

Source: Queensland Audit Office from variety of sources

A number of non-government organisations also have a role in catchment management in South East Queensland, including:

- SEQ Catchments Ltd
- Healthy Waterways Ltd.

Appendix F—Queensland Government funding programs related to flood resilience

Figure F1 lists current and past Queensland Government funding initiatives that contributed to flood resilience.

Figure F1—Queensland Government flood resilience funding programs

Funding Program	Agency	Status
Local Government Floods Response Subsidy	DILGP	Current
Natural Disaster Resilience Program	DILGP	Current
RACQ Get Ready Queensland Initiative	DILGP	Current
Community Resilience Fund	DILGP	Commenced 2015–16
Building our Regions (formerly Royalties for the Regions)	DSD	Current
Everyone's Environment grants	DEHP	Current
NatureAssist	DEHP	Current
Healthy Waterways Program	DEHP	Current
Queensland Regional Natural Resource Management Investment Program	DNRM	Current
Queensland Betterment Fund	QRA	Not ongoing — Negotiated post disaster event

Note: DILGP — Department of Local Government and Planning, DSD — Department of State Development, DEHP — Department of Environment and Heritage Protection, DNRM — Department of Natural Resources and Mines, QRA — Queensland Reconstruction Authority.

Source: Queensland Audit Office from Department of Infrastructure, Local Government and Planning

Auditor-General Reports to Parliament

Reports tabled in 2015–16

Number	Title	Date tabled in Legislative Assembly
1.	Results of audit: Internal control systems 2014-15	July 2015
2.	Road safety – traffic cameras	October 2015
3.	Agricultural research, development and extension programs and projects	November 2015
4.	Royalties for the regions	December 2015
5.	Hospital and Health Services: 2014-15 financial statements	December 2015
6.	State public sector entities: 2014-15 financial statements	December 2015
7.	Public non-financial corporations: 2014-15 financial statements	December 2015
8.	Transport infrastructure projects	December 2015
9.	Provision of court recording and transcription services	December 2015
10.	Queensland state government: 2014–15 financial statements	December 2015
11.	Management of privately operated prisons	February 2016
12.	Follow up Report 12: 2012-13 Community Benefits Funds: Grant Management	February 2016
13.	Cloud computing	February 2016
14.	Financial risk management practices at Energex	April 2016
15.	Queensland public hospital operating theatre efficiency	April 2016
16.	Flood resilience of river catchments	April 2016