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Engineers Australia Submission on:
Auditor General's report on *Flood
Resilience of River Catchments*

October 2016

Executive Summary

This paper outlines the views of Engineers Australia concerning flooding and the improvement of the flood resilience of Queensland communities to flooding, in response to the Auditor General's report *Flood resilience of river catchments* (Report 16:2015-16).

Flooding is a critical issue facing Queensland, as the major floods of the 1890's, 1970's and 2010's have amply demonstrated. Rare, severe disasters tend to occur at wide intervals and thus tend to cause surprise and shock when they occur. It is critical that government provides leadership in this area, maintaining and improving the key components of floodplain management and flood resilience as community memory of the most recent flood begins to fade.

Engineers Australia thus recommends the following key actions in reflection of the material presented in the Auditor General's report:

- With the Auditor General concluding that existing arrangements are not effectively coordinating floodplain management in Queensland, we recommend a review of the structural arrangements for addressing flooding risk in Queensland. We see significant advantages in the formation of a ***State Floodplain Management Agency*** to provide coordination, guidance, support and quality control on flood management activities around the State.
- This Agency should have a ***holistic charter*** with regard the coordination of the components and measures for ***best practice flood management***. This includes, but is not limited to: planning; education; design and construction; flood warning, operations and evacuation; environmental and water quality impacts, structural flood mitigation measures and flood insurance/ recovery arrangements.
- However we consider the two key priority areas for this state body are ***Planning*** and ***Education***. There is the most to gain from progress in these two areas in terms of reducing the risk of flooding and improving the flood resilience of Queensland communities.
- There is a critical need to assess ***the risk to human life from extreme flash floods*** in areas where insufficient lead time is available for flood warning to be effective. We do not wish to see another Clermont or Grantham the next time an extreme event occurs in a small or poorly instrumented catchment in the state.
- Basic data collection on rainfall and streamflow is the fundamental building block for flood assessment, flood warning and floodplain management. The ***extent of the gauging network and the public availability of such data*** is a key consideration in evaluating the flood resilience of each sub-catchment in the state.

Further information on the above points, and a range of other comments, are included in the body of this submission.

Engineers Australia and its members are available for further input and would welcome further discussion. Please contact:

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Preface

Engineers Australia is the peak body for engineering in Australia, representing all disciplines and branches of engineering. Engineers Australia has over 24,000 members in Queensland and over 100,000 members Australia-wide, making Engineers Australia the largest and most diverse engineering association in Australia. All Engineers Australia members are bound by a common commitment to promote engineering and to facilitate its practice for the common good.

This paper has been prepared to provide comment on the Auditor General's report *Flood resilience of river catchments* (Report 16:2015-16) and more broadly to provide Engineers Australia recommendations for improving floodplain management and flood resilience in Queensland.

Engineers Australia sees that the most important lessons to be learnt from rare but severe floods are those that go to ensuring an improvement in future floodplain management practices and the resilience of Queensland's communities to flooding. While the floods in 2010-2013 were severe, there have been greater flood events in the State in the past and these will also occur again in the future. Floods are an inherent part of Australia's natural climatic conditions. Large floods will continue to occur and it is our desire to ensure that our community is prepared and that damage and hardship are minimised.

This submission follows on from a number of previous submissions and policy papers related to flood management in Queensland, most notably Engineers Australia submissions on the interim and final reports of the Queensland Flood Inquiry. Many of the themes in the current submission echo those made in previous submissions – the issues associated with improving floodplain management and flood resilience in Queensland's modern society are complex and not simply resolved. High level technical advice will be required in order to achieve the best outcome.

Engineers Australia and its members are available for further input and would welcome further discussion.



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1. Introduction

Flooding is the most costly of natural disasters in Australia. However the areas vulnerable to flooding can be identified with reasonable confidence compared to the impact areas of other natural disasters.

We cannot remove floods or provide structural mitigation measures that will manage all flood events, so we must learn to co-exist with floods and plan to manage their impacts. Good planning can mitigate these impacts, since the extent of flooding and impacts can be understood relatively well.

The community and government must recognise that flooding is natural and is to be expected, though there may be extended periods of time between major floods. The risk of complacency must be recognised and overcome.

The Auditor General's report *Flood resilience of river catchments* (Report 16:2015-16) examines the effectiveness of flood resilience activities since the major floods in the 2011, focusing specifically on the Bremer, Lockyer, Mid and Upper Brisbane River catchments.

As a profession we have reviewed the Auditor General's report with interest given the critical importance of good flood management to the wellbeing of our communities. Please find following a series of comments focused on improving the flood resilience of Queensland communities, which we recommend for your attention.

2. State Coordination of Floodplain Management

The first recommendation of the Auditor General's report is:

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.*

The Auditor General's report finds that the Department of Infrastructure, Local Government and Planning (DILGP) is responsible for coordinating disaster resilience throughout Queensland, but is not fulfilling this role effectively with regard to flood resilience (pg 21). It also finds that government agencies have no strategic plan or vision for building flood resilience, funding and activities are fragmented and localised, and that many Councils have a lack of professional capability to effectively manage floodplains.

And these findings are some five years after a major flood hit our largest population centre, and the provision of significant additional funding into the floodplain management space. It appears

clear that the current regulatory structure for floodplain management in Queensland needs improvement.

We thus recommend that careful consideration be given to the structure of the government authorities charged with responsibility for floodplain management.

The Auditor General's report briefly discusses the use of catchment management authorities (CMA's) in other states, but makes no analysis of their potential applicability in Queensland. The Auditor General's recommendation appears to imply that CMA's will not be formed in Queensland. We agree there is a clear need for better integration of catchment management activities, and the formation of catchment management authorities is one potential way to address catchment wide issues. Consideration should be given to the potential benefits that CMA's would provide to floodplain management and the improvement of flood resilience in Queensland.

However, we do note there are some drawbacks to the potential introduction of CMA's in Queensland. Queensland has a lot of catchments, and the level of population and resources in some of these catchments may not be sufficient to adequately support the required technical expertise for best practice floodplain management. That is, the current issue with a lack of professional resources in some Councils is also likely to apply to some CMA's. Additionally, creating a separate body for each catchment does not address the requirement to share lessons learned, resourcing, etc across different catchments in Queensland. Creating separate bodies for every catchment in the state may thus not lead to the desired improvements in flood resilience.

Rather, we consider that the formation of a focused State Floodplain Management Agency is likely to be the appropriate structural change required to provide the government foundation for the improvement of floodplain resilience statewide. It is important that this body is clearly focused on the coordination, guidance, support and quality control of flood management activities around the State. It may be appropriate to incorporate elements of a range of state departments in this new agency (DILGP, DEWS, DNRM, DSITI, QRA, etc). We envisage that Councils (and a range of other parties) will remain responsible for the many of the key aspects of good floodplain management, such as planning schemes. This State body, operating under an appropriate regulatory framework, will provide the necessary coordination, guidance, support and quality control to provide assurance that best practice floodplain management is implemented. Section 4.1.1 of Handbook 7 from the Australian Emergency Management Handbook Series (published by the Commonwealth of Australia) provides a useful summary of the key State responsibilities in coordinating floodplain management policy and practice.

The State body will encourage a more consistent approach to floodplain management throughout the State. Consistency in floodplain management and particularly information systems across different areas is very important for community awareness and understanding of floods. The State Agency may prepare a range of guidance documents, such as floodplain management manual to apply throughout the state to guide policy and gradually reduce our exposure to flood risk, linked with available national guidance such as Handbook 7.

Having the State government take a more prominent role across the State will maximise the benefits from better preparedness and a reduction in damage. Cost savings to the tax payer would also result from consistency, avoiding 're-inventing the wheel' on methods, data capture, flood mapping and community education.

It is important that the State Floodplain Management Agency has a holistic charter on flood management and the options for improving flood resilience. The ability for a community to bounce back from a flood, i.e. flood resilience, is dependent on a wide range of factors including: planning; education; design and construction; flood warning, operations and evacuation; environmental and water quality impacts, structural flood mitigation measures and flood insurance/ recovery arrangements. All of these aspects are important, however the areas that we consider have the most opportunity for benefit are in planning and education, which are discussed further below. While recovery/reconstruction is critical in the immediate aftermath of an event, it is the more proactive actions in planning and education that have the greater long term benefit. We consider that the State Floodplain Management Agency should prioritise actions in planning and education over the next few years.

- With the Auditor General finding that existing arrangements for the leadership and coordination of floodplain management in Queensland unclear and ineffective, we recommend that a review of structural arrangements be undertaken.
- While other options are possible, we see significant advantages in the creation of a single State agency to provide coordination, guidance, support and quality control on floodplain management policy and practice throughout the state.
- The State Agency should have a holistic charter on the management of the components of best practice floodplain management, but we consider the key focus areas for the next few years should be in planning and education.

3. Flooding Across Queensland

Despite the broad sounding title of the Auditor General's report, the report is almost exclusively focused on parts of the Brisbane River catchment. While Queensland's largest concentration of population and infrastructure is in the South-East, floods occur throughout the State and it is important that lessons learned from large events are applied across the whole State.

The 2011 event has highlighted key flooding issues in our largest population centre, which has led to a significant amount of resources being expended on improving the understanding of flooding in the Brisbane River catchment. We should learn from this event, and apply these lessons to other centres.

- Lessons learned from the major events (such as the 2011 Brisbane flood) should be applied across the State.
- A state body should be tasked with coordinating application of best practice floodplain management across the State.

4. Development Planning

The number of properties affected by the 2011 event in Brisbane was much higher than the number of properties affected by the 1974 event. This difference was not caused by a higher flood level – the 2011 event was ~1m lower than the 1974 level at the Brisbane City gauge. Rather this difference was caused by the increased development on the Brisbane River floodplain.

Council's Planning Schemes are the key mechanism used to control development in Queensland. It is critical that Planning Schemes (along with the building and other applicable regulations) take appropriate account of flood risks in permitting development in flood prone areas and the standards of design and construction that apply in those areas.

The intention should be to not only to control future development but also to manage risk in those areas already developed or with development rights in place already.

We emphasize that it is not feasible to ban development in flood-prone areas. Our urban centres have grown up around access to fresh water sources, and Queensland's flooding range is huge. However it is critical that appropriate development is undertaken in areas subject to flood risk, and that the community understands these risks (see Section 5 on education below).

We would like to emphasize the difference between property damage and the potential for loss of life from flooding, see Sections 7 and 8. Planning Schemes should be explicitly developed considering this difference.

Building best practice floodplain management into planning schemes provides a strong mechanism to limit the silent increase in damage potential as complacency sets in during the long periods between large events.

- Prevention is often better than a cure, and a key method to prevent flood impacts is through integration of floodplain management principles into the development planning system.
- With complacency likely to set in in the long periods between major flood events, it is important that flooding provisions in the planning scheme are not inappropriately relaxed over time.

5. Education and Information Availability

The most direct action that can be taken to improve the resilience of the Queensland community to flooding is improving the community's knowledge in relation to flooding risks. Resilience has been defined as "the ability of something or someone to recover and return to normality after confronting an abnormal and alarming event". A community's ability to respond effectively to natural disasters is directly associated with the community's knowledge of the risks (likelihood and consequence) of that natural disaster.

Even if Queensland takes all feasible actions in integrating flood management into planning schemes, building structural options such as dams or levees, or upgrading of flood alert and warning systems, a residual flood risk will still remain. In fact many of these floodplain management actions will actually tend to reduce flood resilience. The construction of a dam providing flood mitigation benefits will reduce the frequency of severe flood events, increasing the period between large events, thus increasing the 'abnormality' of a flood when it does occur. This is a natural human response to rare and severe events. The opening address to the symposium organised by EA after the 1974 Brisbane Floods, by Sir Charles Barton (Coordinator General of Queensland, FIEAust), highlights this:

There can be no doubt that the flooding experienced created a wave of shock in the community and we can be very thankful that the 1893 pattern of two major floods in a fortnight was not repeated.

Resulting from the effects of the flood there has been the normal reaction of trying to apportion blame; in the main to try to pin blame on to various authorities. ...

One constant criticism is that people should have been told what might happen and have been warned how river heights would affect the various areas of the city. This information was available, it is said, and not used.

The lesson from this is, I think, that there must be a strenuous effort to get information about flood prone areas to people.

In Brisbane many people suffered from what I call Somerset Dam Syndrome. They know about the 1893 flood and the heights reached but now that we have Somerset Dam it won't happen again. I believe many of you here would have told people of flood possibilities to find them unbelieving.

With the change of a few dates, and replacing the reference to Somerset Dam with Wivenhoe Dam, the above statement would fit for a post-2011 assessment. The human reaction process of *denial – shock – blame – acceptance* occurs again and again in response to flood events.

It is thus **critical** that government takes *strenuous effort* to educate the community about flooding risks, in order to improve the flood resilience of the community. A range of measures may be applied, including public safety campaigns in traditional media, physical flood level markers and the easy availability of flood risk and climate monitoring information on line. The flood risk of a property should be clear to those proposing to develop, purchase, occupy or insure that property. Residents should have an idea of what action to take for their property when a particular level is forecast at a nearby gauge. Evacuation exercises may be appropriate in some areas. Of course flood warning and evacuation processes during actual flood events are also an important, if somewhat blunt, education tool, but are generally insufficient to maintain awareness given the long period between large events.

As discussed in Section 2, consistency in information systems across different areas is very important for community awareness and understanding of floods. Disparate systems are being developed, with smaller Councils struggling to provide sufficient resources. State support of a common platform would offer a substantial opportunity to gather and present both longer term data and operational data (pre flood and during flood operations) to the benefit of the whole community both financially and in terms of community safety. It is recommended that the State Agency should review current platforms and develop a consistent integrated system/platform for the presentation of gauged data, flood risk information and emergency management information across the state.

With better education and availability of flooding information, the degree of shock caused by a flood event may be lessened, self-reliance and self-management will be improved, and the community's progression through to acceptance and rebuilding can be hastened.

- Educating the community on flood risks is the most direct action that can be taken to build a community's resilience.
- The flood risk of a property should be clear to those proposing to develop, purchase, occupy or insure that property.

- There is a key role for state government to coordinate and support the development of a consistent, integrated system for the presentation of gauged data, flood risk information and emergency management information across the state.

6. Auditing / Report Card on Flood Resilience

This Queensland Audit Office Report is a good start, but we see a clear need for some sort of regular auditing procedure regarding floodplain management/resilience activities in all of Queensland's catchments/local government areas. Such a process would provide a significant driver for the improvement of the elements of best practice floodplain management, and regular reporting into the future would also assist in addressing the complacency that inevitably sets in the periods between major floods.

We envisage that the State Floodplain Management Agency would, on a regular basis (say every 2 to 5 years) rate each catchment (or local government area) on progress in the floodplain management space. For example, the extent of the gauging station network (see Section 10), the public provision of floodplain mapping over a range of probabilities, or the incorporation of appropriate development controls in planning scheme. The State Agency could also set out a number of goals for Queensland catchments, for example, to conduct a review of the safety of communities in events more rare than the 1% AEP event, or to review the susceptibility of the power network to interruptions in large flood events. Each catchment could then be marked against the achievement of these goals.

Goals may also be set, and progress rated, at the state level. For example, the production of a State floodplain management manual, the effectiveness of building regulations, or the provision of a standard platform for communicating property flood risks statewide.

- Institute a regular audit reporting process on the progress of the implementation of best practice floodplain management principles, including a table ranking progress in each of Queensland's catchments.

7. Risk Based Approach for Development Planning

Best practice floodplain management should apply a risk based approach that considers both risks to life and risks to property. This section focuses on the consideration of flood risks to property (both private and public).

Currently the design standards adopted are variable around the state depending on the local authority. Often a defined probability of a 1% annual exceedance probability (AEP) or similar is adopted for the control of development. A 1% AEP level has a 1 in 100 chance of being exceeded by a flood in one year. Over a longer period it is quite likely that the 1% AEP flood level will be exceeded, e.g. over a lifetime of 70 years it is 50% likely that that an AEP 1% event or larger will occur at least once.

The adoption of the 1% AEP standard is a useful first step, however for best practice floodplain management it is important to move beyond that. Larger and smaller floods will occur. The flood risk development standard adopted should vary with the implications of the flooding of that piece

of land. For example, a more common AEP might be considered acceptable for a residential house on the banks of the lower Brisbane River, because:

- The Brisbane River is well instrumented, and typically flood warning should be effective in providing sufficient notice on predicted flooding to enable valuables and persons to move to safety.
- The flooding damage is limited to the owners of the property, who are able to internalise this risk in the decision to buy/not buy the property given the benefits of the river views, etc against the risk of flooding. The owner may also take other measures to limit their costs in events, such as using water resistant materials, off-site backup of records, appropriate insurance, etc. (It is noted that this assumes that the community is sufficiently educated on the risk, see Section 5.)

A higher flood standard would be applicable for infrastructure that serves a larger number of people or has a higher cost to repair, and a higher standard again for infrastructure that serves a critical role during flood emergencies, such as evacuation routes and centres, hospitals, power stations, etc.

- A range of risk levels should be considered in the planning process to ensure a balance between the risk of flooding and the location, land use and infrastructure.

8. Flood Risk to Human Life

Section 7 discussed the management of flood risk to property and infrastructure – this section concentrates on flood risk to human life.

Engineers Australia sees two main areas where there is a significant risk to human life from flooding. The first is the issue with people driving into floodwater. While better infrastructure would help, the key action here is education - the ‘if it’s flooded, forget it’ campaign is a good step in this direction.

While level and AEP of a flood event is often sufficient for the consideration of the impact on property, the risk to human life is related to other factors besides the AEP and peak level of the event. The amount of flood warning notice likely to be available, for example, is also a critical factor for the safety of residents. However this has not often been explicitly taken into account in traditional development planning.

Queensland has a history of extreme flash floods killing people in their homes. In Clermont in 1916 an extreme flash flood killed ~60 people and the town was largely moved after the event. In Grantham in 2011 ~15 people were killed and the town was largely moved after the event (Risk Frontiers 2011). There are likely to be other towns out there where flash floods will kill people in their homes.

These events may have been more rare than the 1% AEP event, but using the 1% AEP event alone is not an appropriate standard for the loss of human life. Warning time and the availability of evacuation routes are also critical factors. In residential areas where the available flood warning time is short, and there is the possibility of people being trapped in their homes, some action is required. There are a range of possible solutions - planning scheme provisions to limit development in these areas, provision of a flood free evacuation route, structural options such as

construction of a levee, securing residences to provide safety in place, or moving the affected dwellings to higher ground.

These rare events have been assessed in some areas of the state, however it is likely that there are other Clermonts/Granthams out there. State coordination of investigations into the risk to human life from extreme events would thus be of significant benefit.

To reduce the risk to human life from flooding, Engineers Australia recommends:

- Continued public education campaigns on the significant risks associated with driving into floodwaters.
- The undertaking of a review to evaluate the risk to human life in extreme events across all of Queensland's communities, considering AEP and the practical ability of flood warning to allow evacuation of persons to safety.

9. Regulation of Levees

Levees play an important role in flood management, but they can be a serious problem if poorly planned, designed or constructed. The concern with levees covers all sizes and types of levees from major structures providing flood mitigation to towns to relatively minor levees built on farms to manage shallow overland flow.

More broadly, any sort of obstruction on the floodplain may have a significant impact on certain flood events, whether or not it is called a levee. Long linear floodplain features, such as road or rail embankments, may have very significant effect on floodplain flow distribution. In some cases, apparently minor fences or walls on relatively flat floodplains may significantly affect the distribution of floodplain flows.

The report notes (pg 31):

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.

Councils are struggling with this area, and support and guidance from the State would seem to be of great benefit. We note the call from Somerset Regional Council (pg 53) for the formation of a technical unit to provide assistance to Councils in the area of levee bank regulation. The requirements here are not completely new, the assessment of a levee bank in a rural area is similar to the assessment of filling for a residential subdivision in an urban area. However the challenges for Councils are significant – a lack of a benchmark on the current extent of development, very large rural areas to be managed, areas without sufficiently detailed flood models, and little current guidance on acceptable impacts for proposed developments in rural areas.

- We recommend the provision of additional support and coordination to assist Councils with the approval of development, such as embankments, across rural floodplains.
- The practical aspects of undertaking this task over very large areas needs careful consideration, including the clear establishment of a benchmark approved landscape for comparison and appropriate limits on impacts to protect third parties while still allowing appropriate development.

10. Data Collection and Availability

Flooding assessment and warning is critically reliant on gauging of rain and river levels. With Australia's huge range of climatic variability, long periods of record are required in order to understand the flood risk profile, as well as the effects of land use change and climate change. A number of studies have examined the benefits of water monitoring, and have shown that the benefits generally outweigh the costs by a significant margin.

The quality of stream flow data depends critically on the quality of the rating curve (or stage-discharge relationship). The existing rating curves for gauging stations should be reviewed for high-level events. Rating curves are traditionally based on historic data but during severe floods it is often impossible to reach the sites or even have sufficient hydrographers on call to undertake the necessary stream gauging. There is room for innovation and technology development to also allow for flow measurement using methods such as velocity measurements (e.g. installation of acoustic Doppler sensors and data loggers) to reduce the need (and safety hazards) for personnel attendance for gauging during events. Accordingly, Engineers Australia believes that with the increasing availability of LiDAR data and advanced hydraulic modelling, derived rating curves for higher floods can be merged with flow measurements to improve the calibration and accuracy of flood models as well as the operation of dams, and forecasts.

The recent ARR update project has identified a critical lack of quality gauges in small urban catchments. With much of our population and development occurring in such areas, this lack of fundamental data is a significant concern. We recommend that consideration is given to the establishment of additional stream gauges in such urban streams.

It is important that existing gauging networks, and any new stations, are adequately maintained in order to provide quality data of those rare, large floods that are of such importance in understanding the flood risk profile.

As discussed in Section 2, consistency in information systems across different areas is very important for community awareness and understanding of floods. There are a range of agencies collecting stream gauging data, and the historical and/or real time data may or may not be available to the community through a range of platforms and processes. As discussed in Section 5, gauging station data should be made available to the public in an integrated on-line platform with flood risk and emergency management information. Given the spatial nature of flooding, a GIS based platform may provide the appropriate framework for such a system.

- Engineers Australia supports the installation of additional stream gauges which incorporates careful consideration of the type and placement of the gauges, and adequate funding for the installation and ongoing operation.
- Innovation and advances in technology should also be considered to improve calibration and accuracy of flood models as well as the operation of dams and forecasts.
- The identified lack of gauging in small urban streams means the provision of additional gauges in these areas is a priority.
- Gauging station data, both real time and historical, should be made available to the community in an integrated manner with flood risk information and emergency management information.

11. Australian Rainfall and Runoff (ARR)

Australian Rainfall and Runoff (ARR) is Australia's principal guide to flood estimation. Engineers Australia's National Committee on Water Engineering have guided and managed the development of this key guidance document over many decades. The publication is widely respected and adopted by almost all agencies as providing technical guidance for flood assessment. The latest edition, supported by funding from Geosciences Australia and a significant in-kind contribution from the profession, is nearing completion.

The data and procedures published in the new ARR will be vital to an improvement in flood management and planning in Queensland. Over coming years it will be important to reassess flooding risk for our communities using these new procedures, and to continually improve these procedures as our knowledge and technology improves.

- The update of Australian Rainfall and Runoff (ARR) represents a significant improvement in the available professional guidance for flood assessment.
- Support for the ongoing development of ARR is critical for the ongoing improvement of flood assessment in Queensland and Australia.

12. Other Comments

A range of other brief comments relevant to the report is provided in the table below.

Table 1 - Other Comments

Topic	Comment
Catchment Management of Flooding	<p>We support the QAO view on the importance of managing flooding on a catchment basis. This requires cooperation between a number of agencies, and a focused state agency on floodplain management would provide a strong foundation for such cooperation.</p> <p>It is noted that even catchment based assessments can have limitations – the focus on the principal streams in a catchment may mean that a particular flood study is less applicable in some of the smaller side tributaries. Care will need to be taken that the results of any flood study are only implemented within their area of applicability.</p>
Vegetation Management	<p>Management of vegetation in catchments is an important task. Vegetation has a key role in stabilisation of the landscape and in maintaining/improving the quality of runoff. However the effect of vegetation on peak flood levels is complex. For smaller events riparian vegetation may increase or decrease flood levels. For larger floods the effect of vegetation on water levels tends to be small.</p>
Brisbane River Catchment Flood Study	<p>This is a critical study and we support its completion. A number of new techniques have been applied in this study, which provide an example which can be translated to other catchments.</p>

Topic	Comment
	It is noted that this study is focused on major streams and the major Somerset and Wivenhoe Dam. The results may be less applicable in some of the smaller side tributaries.
Tailored State Hazard Plan for Flooding	<p>Page 38 notes that State hazard specific plans have been developed for hazards such as bushfire and terrorism but notes there is no such plan for flooding. The report comments that this is odd given that flooding is historically the most destructive hazard in Qld.</p> <p>We agree, and believe this is a symptom of the lack of focused state leadership on this issue. The formation of a State Floodplain Management Agency, and the subsequent development of State flood management policy, plans and manuals would go a long way to addressing this gap.</p> <p>It is noted that there is a range of nationally agreed guidance material available to assist in the development of Floodplain Management Guidelines for Queensland, such as Handbook 7 of the Australian Emergency Management Handbook Series. State guidelines should be developed that use and supplement the available national material.</p>
(Council) Floodplain Management Plans	The development of floodplain management plans is supported, with such plans integrated across Council areas in the same catchment. Such plans should fit under a State Floodplain Management Policy & Manual developed and managed by the State Floodplain Management Agency.
Water Quality Impacts	<p>While the primary impacts of large floods on our communities are caused by the volume, height and velocity of the flow, water quality impacts also occur. The State Floodplain Management Agency should consider such impacts in the development of its guidance for the state. Vegetation management is a factor, as is the potential for sewage or industrial overflow/spills. While they have limited impact on the height of larger floods, water sensitive urban design principles should be applied to assist in the management of catchment water quality.</p> <p>Catchment based management arrangements should be targeted at managing both the quantity and quality of water in the catchment.</p>

13. Conclusion

Engineers contribute significantly to the community in the planning, design and management of flooding and provide this service while meeting clear ethical responsibilities to the community.

This submission has outlined the views of Engineers Australia, whose members have significant expertise in floodplain management. Many of our members have contributed to the operational management of floods and also provide professional advice on flooding and floodplain management and the improvement of the resilience of Queensland's communities to flooding. Engineers Australia and its members are available for further input and would welcome further discussion on these important issues related to the improvement of the flood resilience in Queensland.

14. References

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Institution of Engineers, Australia (1974) *Proceedings of Symposium: January 1974 Floods Moreton Region*. Symposium held at Queensland Institute of Technology, 3 & 10 April 1974.

Risk Frontiers (2011) *State-wide Natural Hazard Risk Assessment- Report 8: Major historical flash flooding in Queensland*. Qld Department of Community Safety



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