BRISBANE RIVER CATCHMENT FLOODPLAIN STUDIES: COOPERATIVE PLANNING FOR BETTER FLOOD RESILIENCE

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Disclaimer: *this paper expresses the views of the co-authors involved in the Brisbane River catchment studies and does not represent a Queensland Government or LVRC policy position.*

Background to the studies

Brisbane is located in the South East corner of Queensland with a greater metropolitan area population of approximately 2.2 million. The capital city central business district (CBD) has been built on the floodplain of the Brisbane River. The catchment of the Brisbane River system—including its tributaries the Bremer River and Lockyer Creek—has an area of 13,570 km^2. Flood records for Brisbane extend back as far as the 1840s and the city has had at least a dozen large floods as illustrated in **Figure 1**. The recent major floods occurred in January 1974 (rising to a height of 5.45 m on the Brisbane City Gauge); and in January 2011 when the river peaked at 4.46 m.

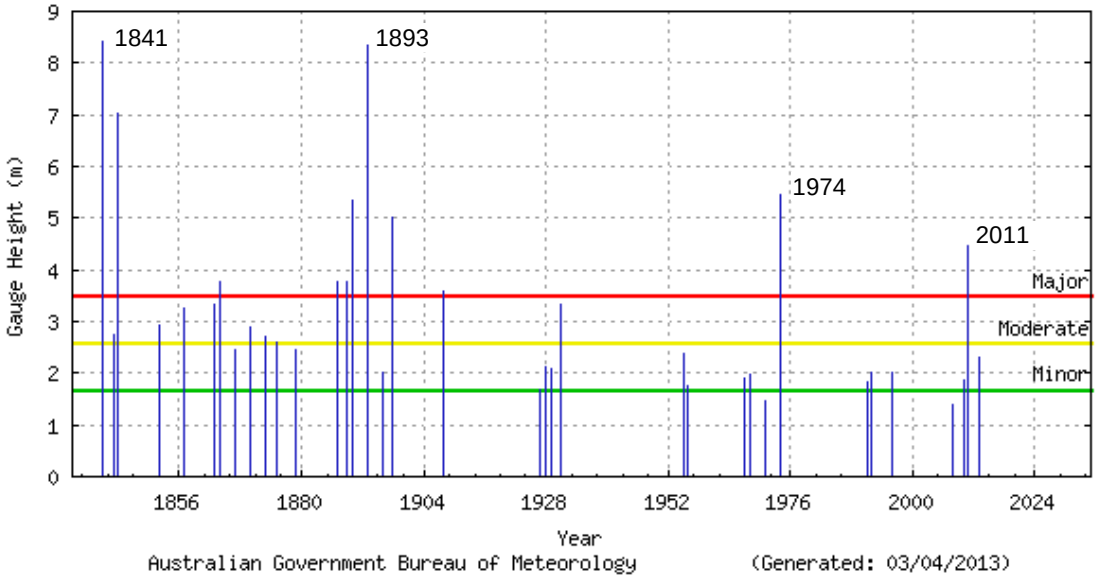

Figure 1: Highest annual flood heights at Brisbane River City Gauge

December 2010 was the wettest on record for Queensland, caused by a strong *La Nina* phenomenon. South East Queensland (SEQ) was saturated. The dams were nearing full water supply volume after the 2000s drought. As a result of prolonged rainfall into early 2011, the Brisbane River system was extensively impacted, with the peak flooding between 10-13 January, depending on the location within the catchment.

Some 14,100 Brisbane properties and major infrastructure were directly affected–the CBD closed down. Riverine and flash flooding caused damage in many suburbs of Brisbane and Ipswich, as well as to townships in the peri-urban areas of Somerset and Lockyer Valley council areas; in total approximately 30,000 properties were impacted across the catchment. Eighteen people died when devastating floodwater flowed from the Toowoomba escarpment into the Lockyer Valley, through the townships of Helidon and Grantham.

The state government immediately established the Queensland Floods Commission of Inquiry (QFCoI) to investigate and make recommendations for improvements to disaster management and planning. The Brisbane River Catchment Floodplain Studies (BRCFS) arose from the government response to recommendations made in the Final Report of the Commission in March 2012 (QFCoI 2012). Recommendation 2.2 of the Final Report dealt with the need for a flood study to be undertaken in partnership with catchment councils. The Brisbane River Catchment Flood Study (the Flood Study) is closely linked to modelling being undertaken by the Queensland Department of Energy and Water Supply (DEWS) and Seqwater in the Wivenhoe and Somerset Dams Optimisation Study (WSDOS).

The final WSDOS report was considered by government in December 2014. *Alternative Urban 3* was approved as the government's policy for the future operation of the dams. This alternative operating strategy will be incorporated into the BRCFS. The dams provide mitigation in certain circumstances (particularly timing) but cannot "flood proof" Brisbane and Ipswich from large floods due to flood volumes, damaging flows from the uncontrolled downstream rivers, which can be exacerbated by the backwater and tidal influences in the mid and lower Brisbane River.

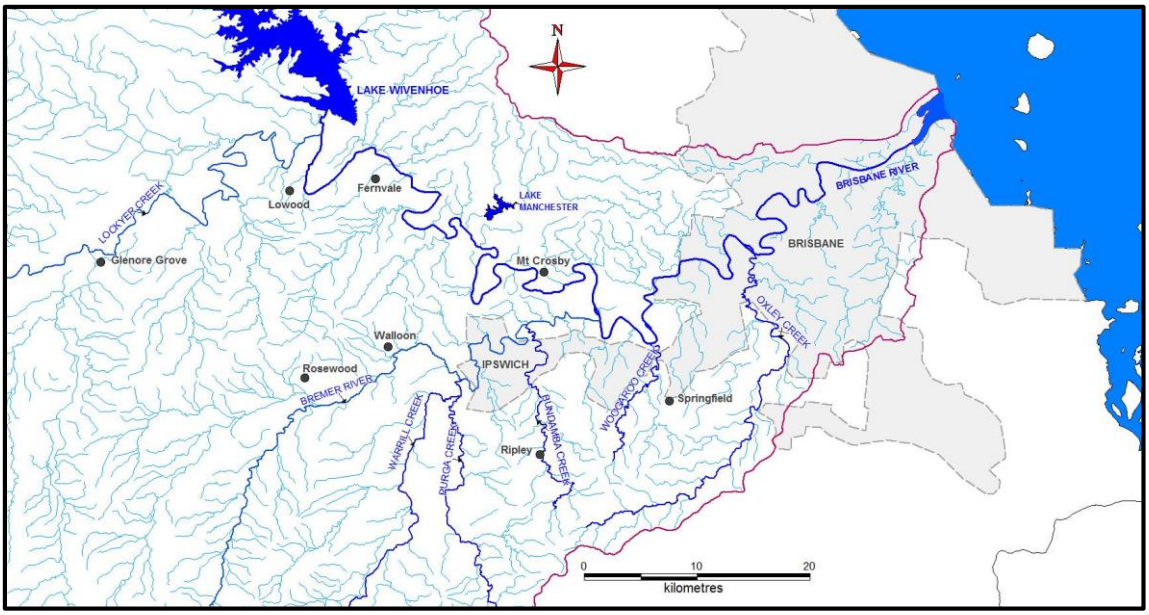

Figure 2: Part of Brisbane River and tributaries highlighting the urbanised areas

The BRCFS responds to one of the most complex technical and planning challenges in Australian floodplain management in the context of a state capital city situated at the tidal end of a large catchment containing major urban areas, a number of major tributaries and a major water supply dam. This is indicated in **Figure 2**, which shows part of the river system generally downstream of Wivenhoe Dam. The urbanised areas are highlighted in grey and the main townships are named.

This paper overviews the cooperative nature of the BRCFS. It mainly focuses on the non-technical challenges of planning for improved flood resilience across a diverse range of riverine communities. The paper does not address the technical challenges, but demonstrates how the project partners are addressing non-technical and planning related issues. Technical papers related to the BRCFS have been presented at this conference by BMT WBM, Brisbane City Council and Deltares. The administrative and governance aspects were presented by Mark Foreman to the FMA 2014 conference.

Overview of the flood studies

The BRCFS components comprise a catchment-wide technical Flood Study; a comprehensive Floodplain Risk Management Study (FMS) of structural and non-structural mitigation options using an integrated assessment framework; and a delineated catchment Floodplain Management Plan (FMP) guiding infrastructure planning and development. The studies span over a five year timeframe, but the implementation of local government management plans is likely take decades.

The Flood Study will provide an up-to-date, consistent and agreed set of hydrologic and hydraulic models and modelling analyses for the catchment. These models build on the existing work undertaken by local governments, state agencies and Seqwater. Analysis and modelling techniques used within the Flood Study are at the leading edge of science and academic research within Australia and overseas. The Commission of Inquiry recommended inclusion of a Monte Carlo Simulation (MCS) assessment. The method has the advantage over more 'traditional' approaches in flood risk analysis of explicitly considering all relevant physical processes that contribute to flood events. The study approach is to compare and reconcile the MCS with Flood Frequency Analysis and Design Event methods to deliver a robust hydrologic assessment. These models will provide the key scientific basis for assessing floodplain risk management options, strategies and action plans as part of the subsequent FMS.

It is proposed that the FMS will recommend options to be developed into a set of FMPs that will guide allocation of resources necessary to implement the nominated flood mitigation measures for the foreseeable future (20-50 years). The BRCFS will also contribute to, and benefit from, other important work such as optimisation of dam operations, water supply security, local government planning and building controls, environmental management, and of course flood emergency response management.

The comprehensive nature of the floodplain studies and the rigour required of the technical assessments means that the Flood Study will be finalised in mid-2016. As a short-term measure, a Disaster Management Tool has been developed by Brisbane City Council-City Projects Office (CPO) in collaboration with three other councils in the catchment. The tool is a calibrated large scale 2D flood model which generates emergency management maps and was presented at this conference by CPO.

The studies also seek to inform and educate the public about flood risk management that will inform early warning systems, planning, building structural mitigation measures within the catchment. A comprehensive communications and engagement strategy has been developed for study partners to convey consistent messaging about the studies; and to undertake proactive engagement during the FMS.

Governance and cooperative nature of the studies

The partners under the state governance arrangements depicted in **Figure 3** are the Departments of Infrastructure, Local Government and Planning (DILGP) together with Natural Resources and Mines (DNRM) as the lead state agencies; Energy and Water Supply (DEWS); Environment and Heritage Protection (DEHP); Science, Information Technology and Innovation (DSITI); and Seqwater. The local government partners are Brisbane City Council, Ipswich City Council, Lockyer Valley Regional Council and Somerset Regional Council. Other agencies and organisations are involved as needed. **Figure 3** shows that the BRCFS is supported by a coordinated governance structure under the oversight of an Implementation Committee comprising four state agencies Directors-General and the Chief Executive Officers of the four councils and Seqwater.

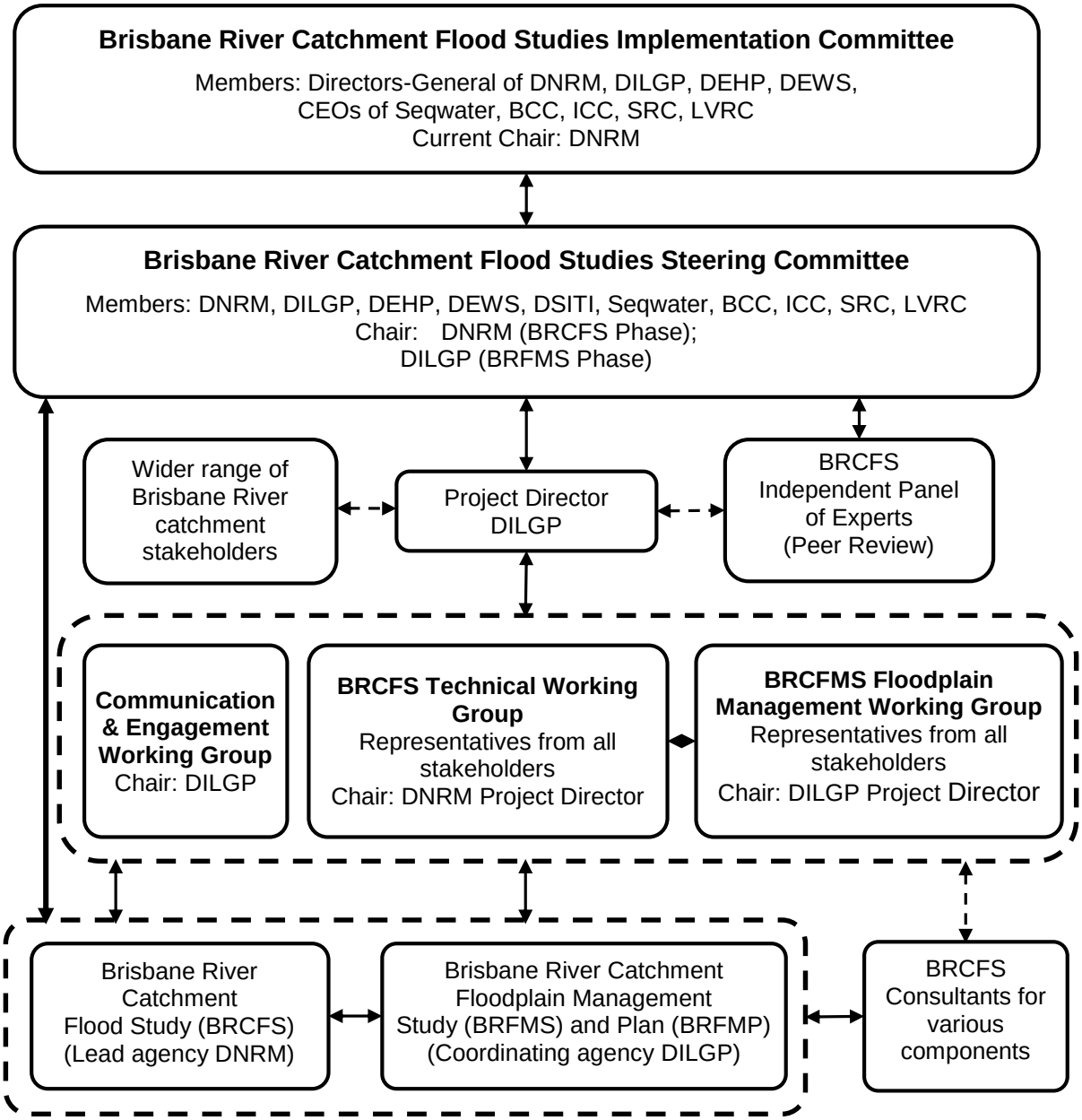

Figure 3: Brisbane River catchment flood studies governance

The BRCFS Steering Committee comprising representatives from six state agencies and the Brisbane River catchment councils currently oversees the Flood Study hydrologic and hydraulic assessments being undertaken by specialist consultants.

A cross-departmental project team is responsible for the day-to-day running of the BRCFS. This includes project planning; day-to-day project management; managing consultancies for delivery of work packages; liaison with project partners and reporting to the governance groups. DNRM leads the Flood Study and currently chairs the Steering Committee. The overall project directorate is located in DILGP and holds financial responsibility for the BRCFS under the Deputy Director-General's office.

The studies are supported by technical working groups (TWGs) to deal with the complexities of the BRCFS. The methodologies, assessment frameworks and outputs are all peer-reviewed by an independent panel of experts (IPE) to ensure best practice approaches, leading to a credible and robust suite of outcomes. The cooperative nature of the studies is reinforced in the interaction between working group members, consultants and the IPE in milestone workshops.

Valuable in-kind support to the project has been provided by the partner organisations, including the Brisbane River catchment councils, Seqwater and other state government departments. Their active involvement has engendered a shared ownership of the data and the customising of the models and outputs to meet the needs of the end users.

The use of expert advice is an important aspect of the management of the Flood Study. At the commencement of the project DNRM engaged an advisor with up-to-date knowledge of hydrological and hydraulic modelling to ensure that its specifications, contracts and deliverables minimise project risks.

Prior to the Flood Study, consultants undertook a gateway review and technical scoping framework for the BRCFS in cooperation with all the potential study partners to critically assess the technical merits, effectiveness and feasibility of the proposed study approaches. The study identified the alternative study approaches that could satisfy the specific study requirements, as well as the potential risks associated with different study approaches. The IPE review of the framework provided insight into the alternatives and the opportunities to benefit from model development work being undertaken by others—particularly Seqwater and the councils. That work has been adopted as far as possible to avoid unnecessary duplication of effort and to streamline the model development process as much as possible.

Important complementary projects being undertaken in the catchment are relevant to the BRFCS. Projects include the improvement of the Digital Terrain Model and updating the bathymetry data for the lower Bremer River and lower Brisbane River. A preliminary study in 2012 laid the foundation for the FMS scoping to deliver the FMPs. This led to an international flood risk management symposium in September 2012. It aimed to heighten the awareness of recent UK, Netherlands and Australian approaches on flood risk management into strategic flood risk planning and policy development. Subsequent flood risk management workshops and wider stakeholder forums in 2013 and 2014 have highlighted the need for a holistic approach and the contribution that can be made by other organisations such as SEQ Catchments, SEQ Healthy Waterways and research institutions such as the University of Queensland and the Griffith University Australian Rivers Institute. These forums have also revealed the disjointed approach to floodplain and riverine environmental management projects within the catchment.

In summary, the BRCFS involves multiple state and local government partners in a collaborative, large-scale catchment, technically complex project. The Flood Study is influenced by major water supply dams and two uncontrolled river tributaries flowing through diverse rural and urban areas into the heart of the Brisbane City central business district and discharging to Moreton Bay. The modelling builds on existing work undertaken by local and state governments and Seqwater. These models along with stakeholder flood observations/learnings provide the key scientific basis for assessing floodplain risk management options, strategies and action plans as part of the subsequent FMS. The recommended options will be developed into a set of FMPs that will guide allocation of resources necessary to implement the nominated flood mitigation measures for the foreseeable future (20-50 years). The key non-technical challenges are addressed in the next section of the paper.

Study challenges

The challenges in responding to the QFCoI recommendations are highly technical in relation to the Flood Study; however, the non-technical perspectives in anticipating and managing stakeholder and community expectations are the main focus of this paper.

The governance arrangements across two levels of government are challenging from an administrative and policy perspective, unlike other jurisdictions where catchment management authorities may have broad overarching responsibilities. For example each level of government has differing endorsement and approval processes that need to be taken into account in reviewing work packages and milestone reports.

A partnership developed on trust over the duration of the project has been essential to ensure that the outputs of the Flood Study have widespread support and ownership amongst the BRCFS stakeholders. This is important as the Queensland Government will not be the ultimate user of the outputs of the BRCFS, but is reliant on advice to ensure usable models and outputs are produced for councils to use in interim disaster preparation management; as well as in the FMS phase and subsequent FMPs.

The differing requirements of study partners are being managed by a collegiate approach to committee/working group activities and focusing on the study outcomes. Giving all the participants equal opportunity to be heard and make their professional and agency views known is ensuring that the study outputs have collective ownership. In addition, parallel studies and projects in the catchment are important to the holistic approach of the BRCFS.

Planning challenges of urbanised, village and rural riverine communities.

Each of the catchment councils has a mix of urbanised, village and rural riverine communities that require flood risk assessment of land use and activities, to reduce residual risk to an acceptable or tolerable level. Local governments are best placed to do so, however, the seven sub-catchments of the Brisbane River system extend beyond each of local governments, which are regarded as the floodplain management entity (FME) area. Hence development and/or flood risk management within the FMEs influence others, or potentially cause cross boundary complications for land use and environmental risk management.

The Lockyer Creek extends from Lockyer Valley Regional Council area into Somerset Regional Council area where it joins the Brisbane River just below the Wivenhoe Dam. The lower Brisbane catchment extends from the Wivenhoe Dam through the Somerset area into Brisbane City and shares part of the southern bank with Ipswich City Council area. The Bremer River and tributaries extend from Ipswich into the Scenic Rim Regional Council area.

The vast proportion of the whole 13,570 km^2 catchment is rural or natural landscape area as indicated in Figure 2. Hence while the hydrology has been assessed for the whole catchment, the hydraulic assessment is targeted for the FMS and is confined to essentially the urbanised areas below the Wivenhoe Dam.

The planning system has become more complex by extensive planning reforms, including the new single State Planning Policy and proposed new planning legislation, which has been stalled by the 2015 state elections and change of government. These reforms have delayed the completion of planning scheme reviews and an effective response to the 2011 flood event.

Most affected councils have put in place Temporary Local Planning Instruments (TLPIs) since the 2011 flood as an interim measure to manage flood risk in their communities. TLPIs normally are valid for 12 months, but the long duration of the BRCFS has required multiple time extensions.

Some of the key identified tasks in scoping the FMS include the following:

- Definition of one or more defined flood events is a standard practice in an FMS. A consideration of alternative approaches to risk management based on scenarios or zones of risk is necessary, as required by the QFCoI recommendation 2.13. There will also be a need for a combined investigation about the issues of isolation in low and high flood islands.
- Establishment of how to assess the levels of tolerable risk and acceptable risk for the various communities in the floodplain is essential. Evaluation procedures must include consideration of economic, social and environmental impacts using a developed IAF framework. The IAF is recognised as an important component of the FMS. The IAF includes a cost/benefit model that will build on previous studies undertaken by consultants and builds on the IAF for the consideration of WSDOS options. However, other development work may be required to ensure currency and allow valid comparison:
    - One of the challenges in developing the IAF for the FMS is to allocate tangible impact costs to construct the Annual Average Damage stage-damage curves for a variety of building types and other infrastructure, relevant to the Brisbane River catchment range of residential buildings, including the distinctive 'Queenslander' high-set timber and corrugated iron houses. The FMS scoping will determine the most cost effective method of capturing this information.
    - Industrial and warehousing uses are also problematic as some key flood affected areas in 2011 included the Rocklea produce markets and a large industrial area, causing significant temporary disruption to urban food security and economic life. Careful consideration and engagement with the commercial interests is needed to establish flooding costs in widely variable use types.
    - A related exercise is to develop a better understanding about flood damage—to collect historical information on the flood vulnerability and damage to the built environment which relies on public input at the local level.
- Assessment of the intangible psychological and social impacts of flooding and the likely effects of mitigation options on the community. The studies to date suggest that only limited data is available and a separate study may be undertaken to address this gap. One industry approach is to simply allocate a proportion of tangible costs in a blanket measure of impacts. However, this is not considered to be a robust assessment and will be subject to debate and public engagement.

Options for flood mitigation

Among the preliminary options for flood risk mitigation, over 165 planning related submissions made to the QFCoI were collated and reviewed in the WSDOS project, as a first cut on alternatives for structural and management measures (**Attachment A**). The wide spread of suggestions highlights both the professional and community interest in the catchment-wide flood risk management, but also in the range of structural and non-structural suggestions for mitigation and prevention options. This list was collated in the WSDOS will be reviewed with augmentation by the community engagement program.

Managing expectations

Managing expectations highlights the challenges for a floodplain study of this magnitude to manage effectively the expectations of urbanised, village and rural communities across each of the catchment council areas.

Stakeholders within the project have different responsibilities in relation to the FRM. The initial project phase has to collectively work through the needs and expectations of each group to ensure that the correct balance and efficiencies between project and local work tasks are considered and struck.

The importance of communication and engagement between all the stakeholders is paramount to reaching a desirable outcome. There is also an encapsulated need to raise and maintain flood awareness and an ability to engage in meaningful ways on the community's understanding of resilience whilst living in the catchment. The engagement focuses on an understanding of the various interests and drivers of a wide and diverse stakeholder base and balancing those needs within the plan.

A comprehensive Communications and Engagement Strategy has been developed to address the implications of the release of the various components of the Flood Study and in undertaking the Floodplain Management Study. The Strategy is anticipated to:

- guide the community communication and engagement aspects of the study
- provide consistent, accurate and well-informed state and local government responses to the findings, and ensure elected representatives and councils have the information and tools to communicate the information
- provide prompt, effective responses to any early or unintended release of information about the studies or their findings
- coordinate public consultation during the FMS within the study area to inform the community (including residents, organisations, interest groups and business) of the flood studies and subsequent FMPs early and consistently throughout the life of the project.

This strategy also needs to acknowledge that Seqwater and the councils are also undertaking studies of their own and will be releasing information within the same study timeframe. It is therefore essential that a coordinated approach is developed and implemented by the stakeholders.

Parallel studies-projects

Several parallel processes generated by the 2011 floods and the original WSDOS response to the QFCoI Final Report recommendations that are relevant to the cooperative nature of the BRCFS are overviewed below.

BRCFS Data collection

A data collection-collation research project for the BRCFS unearthed volumes of relevant hard and soft data from a wide assortment of previous studies undertaken within the catchment by various state agencies, councils and NGOs. This has effectively formed the basis for development of a BRCFS *knowledge hub*. Research remains ongoing for the study partners involved in the FMS and FMP phase in identifying the gaps in data and relating to the local government planning schemes.

Queensland Reconstruction Authority guidelines

Some of the study partners have participated in preparation of the now published AEMI series Handbook 7: *Managing the floodplain: a guide to best practice in flood risk management in Australia*. This is a valuable resource in establishing best practice for the FMS and FMPs.

The Queensland Reconstruction Authority (QldRA) also provided insights gained from the 2011 state-wide floods recovery for the largest floodplain mapping exercise undertaken in Australia. The QldRA produced *Guidelines for a stronger, more resilient Queensland* that informed the development of the natural hazards component of the 2013 Queensland State Planning Policy (Queensland 2013). These guidelines provided useful guidance in thinking about the best approach to scoping of the FMS in diverse rural and urban areas to achieve a fit-for-purpose approach and acceptable, robust outcomes.

Queensland Strategy for Disaster Resilience

In 2014 the Queensland Government released the Queensland Strategy for Disaster Resilience (QSDR), which aims to build resilience against all hazards including floods. The messaging is aims for Queenslanders to better understand the risks of disasters, proactively prepare for disaster impacts, and have the personal and financial resources to drive their response and recovery. The QSDR seeks to improve the capacity of local governments and communities to plan and manage their local disaster preparedness plans and local human and social recovery plans following a disaster. Initiatives and projects being undertaken by lead agencies to meet the vision to make Queensland the most disaster resilient state specifically include achieving improved planning and floodplain management of the Brisbane River catchment through the BRCFS.

Observations on cooperative planning for flood resilience

The responsibilities and need for cooperative planning was emphasised through the recommendations of the Flood Commission. The state and local government collective saw the benefit of cooperative planning. At this stage of the overall project the following observations can be made:

- The purpose of the studies must be able to be clearly articulated and the benefits clearly understood by the stakeholder group and the separate organisations.
- There must be a clear governance structure of responsibility and accountability.
- It is preferable if the technical issues are separated from the political issues.
- It is important to understand all the components that encompass the overall studies (the journey) and fully appreciate the ultimate deliverables and how they are to be used by the stakeholders.
- It is important to have opportunities for the stakeholders to be informed and participate in the review of technical components of the various studies through the Technical Working Groups and the Steering Committee.
- The establishment of the Independent Panel of Experts (IPE) has been essential to the successful development and robustness of the Flood Study and Floodplain Study. The membership of the IPE will vary as necessary to reflect the changing nature of the study phases.

- Issues and differences of opinion are best fully discussed and resolved at the lowest commensurate administrative/policy level, where most of the necessary related technical knowledge resides.
- Ongoing custodianship of the completed BRCFS is important to maintain the validity and usefulness of the data; and for coordination of sharing between the stakeholders, consulting industry professionals and the public at large.

The results of the Flood Study in 2016 will be used to inform the stakeholders and the public on potential impacts of flooding across the catchment. The flood study will also be the key technical input into the FMS. It is therefore essential that all the studies are robust and meet the needs and expectations of the wider stakeholder group. The studies will form a basis for cooperative planning and environmental management across the catchment.

Although the Brisbane River Flood Studies were reactive following a significant flood event in 2011, it is a once-in-a-lifetime opportunity to provide a catchment-wide approach to flooding and a coordinated mitigation response that will benefit all residential and commercial interests in the Brisbane River Catchment.

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Attachment A

Queensland Floods Commission of Inquiry submissions – Options review

Within over 165 planning related submissions made to the Queensland Floods Commission of Inquiry that were reviewed by DSDIP, BCC and ICC in 2012, the following themes seemed worthwhile for consideration in relation to flood risk management:

OPTIONS
Planning related:
▪ Resolve the difference between Wivenhoe Flood Manual W3 strategy flow limit at Moggill (4000 m3/sec) and Brisbane City Council (BCC) view (3500 m3/sec) as the threshold limit of non-damaging flows downstream of Moggill.
▪ Cease reference to 'Q100' (causes widespread confusion), and introduce 1-5 category rating, same as for cyclones.
▪ Review planning and development framework and legislation (including reviewing Regional Plans) to reduce/mitigate natural disaster impacts;
▪ Remove 'injurious affection' provision from SPA (section 703).
▪ Purchase back severely affected properties.
▪ Prohibit building development on flood prone land.
Building related:
▪ Mandate building design and standards that reflect changing weather patterns to improve resilience and minimise damage to both built (including public infrastructure) and natural environmental impacts.
▪ Design buildings with critical electrical connections above DFE level, but permit some habitable rooms below DFE Level that are flood resilient.
▪ Raise floor levels and freeboard thresholds, better basement protection - water resistant materials.
▪ Energex to seal conduits around cables into buildings (to assist in preventing water entry into basements).
▪ Promote floatable structure such as garden gazebos for use as flood refuges.
Flood mitigation infrastructure:
▪ Review the impact of large scale sand extraction (focus on Harlin - prevent further extraction). This suggestion was made in context of reducing such activities - which could have a negative unintended impact on supplies of sand/gravel.
▪ Floodgates on suburban creeks (installing barrages, flood control devices, or detention basins near mouth of Oxley Creek as an example) and in urban stormwater infrastructure.
Technical/infrastructure:
▪ Reinstate and install additional flood gauge and monitoring devices – State Govt to assist Local Govt with resourcing.
▪ Flood markers to should include historic flood and AHD information.
▪ Construct flood proof or flood protected critical infrastructure.
▪ Investigate increasing the use of green infrastructure and drought resistance (permeable materials etc.) in floodplain areas.
▪ Ensure cross river power lines protection from tall mast boats
Mapping:
▪ Improve flood mapping and modelling, including water flow impacts – increased State Govt role to resource and co-ordinate.
▪ Mapping information needs to be easily understood and accessible, and specific to local areas.

Communication/awareness/alert systems:
▪ Require council rates notices to identify flood risk data supports the community resilience concept and could lead to reduced emergency response efforts. It is therefore FRM related.
▪ Improve state and local government communication and governance arrangements – define roles and responsibilities between state agencies, local government local disaster coordination groups and NGOs – who makes decisions 'on the ground'; who is authorised to make community/media announcements? Need timely, consistent and coordinated key messages – who is responsible for this and how? Also clarify roles/'chain of command' in evacuation centres.
▪ Improve early warning and alert systems – use more diversified systems e.g. local sirens, dedicated radio frequency & 'break-in' messages, TV messages, mobile loud speaker announcements through local communities.
▪ Improve provision of community information about evacuation routes (e.g. as roads become inaccessible).
▪ Diversify methods of community information provisions & updates – improve ICT network capability and reduce over reliance on technology that is electricity dependent.
▪ Provision of multi-lingual information, especially in culturally diverse communities.
Training:
▪ State government to assist local government through better resourcing and capacity building e.g. emergency/evacuation training, developing disaster management plans, recruiting, coordinating and training volunteers.
▪ Clarify volunteer insurance/compensation entitlements, and training in emergency situations e.g. personal safety, identifying and removing/storing asbestos.

Flood mitigation infrastructure options that were considered to require detailed technical analysis and likely to have significant economic and environmental costs

Building related measures:
▪ Use clever technology to raise dwellings during flood events (e.g. hydraulic jacks for high set homes in flood prone areas).
Flood mitigation infrastructure:
▪ Relief to Wivenhoe using various tunnel / channel options / expansion of Lake Atkinson.
▪ Construct additional dam on Brisbane River (where bridge crosses the river on Esk-Kilcoy Road).
▪ Investigate installing barrages, flood control devices, or detention basins on the Lockyer Creek.
▪ Investigate installing barrages, flood control devices, or detention basins on the Bremer River
▪ Investigate new flood mitigation dam/works on Oxley Creek in Greenbank Military Training area.
▪ Redirect the mouth of the Oxley Creek to draw water out of the creek.
▪ Build more dams (consider wider and shallower dams that provide infiltration into the Artesian Basin).
▪ Construct low river bank levees with pumping stations to remove water penetrating levees.
Infrastructure:
▪ Review standards of linear (road and rail) design, construction and future corridor locations.
▪ Raise level of roads and bridges downstream of Wivenhoe Dam – e.g. Mt Crosby Weir bridge and Fernvale (Brisbane Valley Hwy) bridge to allow up to 3500 m3/sec outflows.