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HB:kb

4 April 2011

The Honourable Justice Catherine Holmes (Commissioner)
Queensland Floods Commission of Inquiry
PO Box 1738
BRISBANE QLD 4001

Your Honour

QUEENSLAND FLOODS
SUBMISSION TO THE COMMISSION OF INQUIRY

Kellogg Brown & Root Pty Ltd (KBR) writes to make the following submission to the Commission of Inquiry, and we appreciate the opportunity to put forward some thoughts we hope may help the state advance its management of floods and floodplains. Engineers within KBR have decades of experience in water engineering.

This includes:

- providing assistance to local authorities in Queensland, in particular for floodplain planning and management. This assistance has included providing expert witness services to councils defending their floodplain planning codes in the Planning and Environment Court
- some of our senior staff providing assistance to governments in other countries with flood risk management and emergency response activities.

We therefore feel we have a sound basis from which to offer the following comments.

By way of background, KBR has been practising engineering in Australia for over 50 years as successors of the Brisbane firm of Cameron McNamara & Partners and Kinhill Pty Ltd in Adelaide. We have offices in the five mainland states and we are headquarters of the global KBR Infrastructure and Minerals Business Unit with over 1800 staff in Australia, 400 of which are based in Brisbane.

WHY A SUBMISSION?

Some of our senior engineers have worked in the field of flood risk management in Queensland and elsewhere for most of their careers. As the flood circumstances unfolded through December and January, the mindsets of these engineers were probably very much different to those of the vast majority of the population. Of course we felt the same shock at the fatalities. There was some measure

of surprise at the widespread nature of the fairly infrequent events but, with the knowledge that we are expected to have, we could see these events as floods predicted to occur infrequently and happening now, in comparison to much of the population who understandably perhaps were totally surprised by the severity and consequences.

Flooding is the most predictable of natural disasters. The range and extent of flooding are reasonably predictable. With modern computer modelling, the consequences of flooding on what has been built are also reasonably predictable. Only the timing of the various severity events is not.

Thus we feel we owe a duty to present a view that might be of some value to a community searching for improved circumstances in the future. Our views might propose measures to mitigate future flooding disasters, but they might also come at a cost (economic and amenity) that the community decides needs to be ameliorated. Our profession has the expertise to assist and we should be used.

We should emphasise though that current technologies and expertise of engineering for flooding in this state, across government, universities and industry, are very high. There is no other country that we know of where one could say that broadly its capacities exceeded Australia's. In contrast therefore, in a modern technological society, it is with much misgiving that we saw the media profile of the flood responses focusing on sandbags as a prime response to avert damage. A day did not pass without a news report discussing sandbagging in another area of the state. We are sure there were many other measures put in place that were both more technologically advanced and effective, but just not visible. The contrast hopefully is evident.

While sandbags may have their place, we hope that current engineering and innovation can be applied to deliver 21st century alternatives for future flood risk management. We see a need for greater community involvement in decision making, for improvements in flood education and warning systems, and demonstration of greater social responsibility in our decision-making processes.

As flood engineers, we also are aware that there have been numerous flood mitigation / assessment studies undertaken for most river catchments across the state. Often, they have followed major floods (e.g. in the late 1970s following the series of floods around 1974). These studies have produced cost-benefit analyses for various flood mitigation options and no doubt some of these have been implemented, but we are confident many of these have not. Memories of the anguish of the flood damage fade and the costs of schemes can cause them to be put aside.

It would be instructive to:

- review now the recommendations that were put forward in those numerous studies
- undertake a reality check on the costs and benefits then calculated
- determine now whether improvements in the techniques for those types of studies are appropriate, taking a statewide view

and then decide whether a consistent appraisal and funding approach should be adopted.

It was also of interest to observe the cases where levees provided protection but where concern of levee stability rightly received critical attention; and to compare this to areas where no levees existed and damage ensued. Levees can have a place in risk management but there are many technical, risk

and social issues that need to be addressed. Again, current engineering and technologies can support these evaluations and implement protection measures where deemed appropriate.

Finally by way of background to the detail of the submission, the issue of transport links is a major one and evident from the flooding events. Transport links in our modern society are very important and there is a case for higher standards of immunity than evident from the events. Also, alarmingly, the fatalities from vehicles entering floodwaters continue and highlight the need for behavioural management as well as technical design opportunities to reduce the consequences of risk-taking behaviour, which in turn puts others at risk.

With that background as to why we considered a submission was appropriate, the following is provided as a compilation of views from some of our senior flood engineers. It is structured such that the relevance of each topic is briefly outlined, and supporting information is provided in a series of appendices.

NEED FOR A STATE FLOOD RISK MANAGEMENT POLICY

We believe a state Flood Risk Management Policy is required to engender greater consistency in policy application through our three levels of government. The federal government provides national guidance through its Emergency Management Australia (EMA); it is also the final bastion of resources if an emergency overwhelms the state's and local governments' abilities to respond. It is in the national interest to assist all the states to mitigate potential disasters. Without a state formal policy direction and a coordinated approach to floodplain management, approaches to the federal government for a larger slice of the 'disaster mitigation cake' may not be as successful as a coordinated approach.

At present there does not appear to be a single and holistic vision document for the state that guides floodplain management, flood risk management and emergency response activities. Without such guidance, floodplain planning, development and the means to measure and quantify the state's and local governments' flood risk profiles are missing. Effective budget planning would benefit from assessments of the likely average annual damage of flooding and the average annual population affected.

The state government has devolved floodplain planning policy to local government with guidance being provided through State Planning Policy to Mitigate the Adverse Impacts of Bushfire, Flooding and Landslide (SPP 1/03), the Queensland Urban Drainage Manual (QUDM) and Emergency Management Queensland (EMQ). SPP 1/03 outlines matters that need to be included in town planning decisions, QUDM describes the technical methods for drainage, and EMQ guidance is directed to planning for flood response. It is considered that these documents should be supported by an additional and overarching policy document. The advantages of having such documents are set out in Appendix A.

STATE PLANNING POLICY 1/03

It is our view that this policy document can be improved in a number of ways, foremost being its extension to an all-hazards approach, which would bring it into line with the new disaster management

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legislation and the *Sustainable Planning Act 2009* and the terminology and recommendations of the risk management standard AS/NZS ISO 31000.

However, there are a number of matters pertaining to flooding that are outlined in Appendix B.

We believe SPP 1/03 should be modified to reflect international changes in floodplain policy, governance integration, defining floodplain planning objectives, duty of care, the cumulative impacts of development, hazard and resilience, levels of immunity, and climate change.

These thoughts are expanded in Appendix B.

LAND USE PLANNING DIRECTION

Our research and involvement in expert witness cases has revealed considerable inconsistencies among various local government planning schemes. In our view most of the local government planning schemes in Queensland (and in the rest of Australia for that matter) could be strengthened with respect to improving resilience and the needs of flood emergency management. Many schemes seem to rely on the 100 year Average Recurrence Interval (ARI) flood frequency as the benchmark for all types of development. A scheme should consider development applications in the context of whether they will be a burden during a flood emergency, or assist the flood response and recovery effort, or accept the implications of behavioural responses of residents on flood-affected access roads. Planning schemes should not permit such circumstances to occur.

A discussion point is whether a common flood code applicable to all local authorities could be adopted. Discussion of flood code enhancements for potential inclusion in a state flood code is provided in Appendix C.

DEVELOPMENT OF DECISION SUPPORT SYSTEMS FOR FLOOD RESPONSE

Decision support systems are needed to integrate data flow and information in an accurate, spatially oriented and timely manner within an emergency management resource structure. Without sound information systems, decision makers may find themselves under increasing pressure and fail to adequately manage an unfolding flood emergency. Such systems are also useful tools to present flood information as part of a risk communication program, but the needs and requirements are much different to those of emergency managers.

A decision support system is defined as a collection of data, information and processes, which, when combined, amplifies the value of the data and enables rapid judgements. The processes are applied to improve and/or transform the data to an information-set in a vertical ladder of technology, improving the value of the data to the end users. To be fully effective they must also integrate with the lateral set of instructions from decision makers to their emergency teams.

Further views on decision support systems are provided in Appendix D.

ESTABLISH MINIMUM STANDARDS FOR HYDRAULIC REPORTS

Local government officers examine development application reports that include flood impact analyses to ensure that development shall not cause, or have the cumulative potential to cause, real

damage to premises or worsen flooding during a flood emergency. Where extensive areas of existing urbanisation are already at risk from flooding, a conservative approach is essential.

In many sensitive floodplains, the submission of a flood study report is potentially the most important technical document upon which a government authority can rely to make a decision to disturb, or not disturb, an existing waterway or floodplain. Decisions that will change flood flows and the way floodplains behave cannot be taken lightly, particularly when premises are thought to be at risk from flooding.

If hydraulic reports are unclear, incomplete or do not address those matters that development planners are required to consider, or should consider, then decisions regarding development may be inappropriate. Our views on the nature of reports for development applications are contained in Appendix E.

ACCELERATED LEARNING PROCESSES

Decision makers who manage emergencies have a great deal to remember, from the requirements of EMA's emergency management manuals and guidelines, state law, the policies and practices of the local authority, as well as the technical, logistic and human resource, sociological and psychological processes associated with management in stressful situations.

An accelerated learning process is needed and further research is required to see how such a learning process can be developed and be applicable to emergency planning. Training methods should be able to be modified to develop emergency management 'patterns' within the brain in younger emergency managers, in order to achieve accelerated learning, avoid stress, and improve confidence in both technical and political decision makers. These thoughts are expanded in Appendix F.

NEED FOR FLOOD EMERGENCY PLANNING SPECIALISTS

There appears to be a need for teams of flood emergency specialists located in each part of the state who are experts in their respective river basins. Regional specialists of one or two people moving between flood-prone areas could support each team. They would work with a local authority and the Bureau of Meteorology's specialist hydrologists to understand local flood situations, the scope of potential flood disasters, trigger points, models and expertise available. The mobile specialists would be required to establish linkages and work with local counter disaster centres and the communities involved, both learning and providing training. There is no reason why they could not be supplemented by experienced engineers from other sources. Further information is provided in Appendix G.

QUALITY ASSURANCE

There may be gaps in quality assurance systems with respect to hydrologic and hydraulic modelling and if so, there is a need to codify the state government's requirements with regard to quality assurance and its application to hydraulic reports submitted to local authorities.

Views with respect to flooding at the various levels of government are outlined in Appendix H.

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Should your commission wish to explore any of the above elements in more detail, we would be pleased to respond to any requests.

Thank you for your consideration and we look forward to reading your findings.

Yours faithfully

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Haydn Betts
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on behalf of
KBR Infrastructure and Minerals

Appendix A
Need for a state Flood Risk Management Policy

We believe a state Flood Risk Management Policy is required to engender greater consistency in policy application through our three levels of government. Its absence poses a limitation of the management of flooding and flood risk in Queensland. Some of the damage from the recent floods was unavoidable given the magnitude of the flood and past development decisions. However flooding extent is generally predictable and floodplain managers and planners have to weigh the consequences of flooding with the benefits of floodplain use. With guidance from the state, the adverse consequences of flooding could be limited or reduced over time and the best use of flood-prone land planned accordingly. (Flood-prone land is defined as land that would be inundated during the maximum possible flood).

The state government has devolved floodplain planning policy to local government with guidance being provided through State Planning Policy to Mitigate the Adverse Impacts of Bushfire, Flooding and Landslide (SPP 1/03), the Queensland Urban Drainage Manual (QUDM) and Emergency Management Queensland (EMQ). SPP 1/03 outlines matters that are to be included in town planning decisions, QUDM describes the technical methods for drainage, and EMQ provides guidance directed to planning for flood response.

Such a policy could build on these, the Total Management Plan concepts (c.1993), the document Floodplan Management in Australia – Best Practice Guidelines in which Queensland was represented on the working group and more recent changes to the state's Disaster Management Act.

A state Flood Risk Management Policy would:

- define local and state government roles
- provide minimum standards for local authority planning schemes for the allocation of flood-prone land to development and the setting of minimum floodplain development standards
- facilitate floodplain management implementation and encourage consistency between local government areas
- provide guidance for consistent assessment criteria for flood mitigation proposals
- provide guidance in flood immunity levels for various transport related infrastructure
- provide standardised levels of service for uses in flood-prone land

- provide guidance on the levels of immunity to be provided for community and government assets
- provide guidance to developers and their consultants regarding matters that need to be considered in hydraulic reports presented in support of development applications thereby reducing much wasted intellectual effort
- establish a framework for determining the degree of residual risk that the state is prepared to accept (residual risk being the risk that remains after all other risk management measures have been put into place)
- facilitate linkages to flood emergency planning
- provide for specialist hydrologists and flood emergency planners to work with local governments
- define linkages between land uses and emergency risk management activities
- provide the impetus to improve resilience measures within communities and the structures built in vulnerable areas
- provide for the joint consideration of hazards (e.g. cyclone followed by flooding, storm surge / riverine flooding, bushfire followed by flooding)
- establish a framework for 'recording' flood information that should include planning permissions/decisions linked to a library of flood studies with the primary database key being a cadastral land description
- provide separation of policy and implementation by the allocation of roles and responsibilities between government departments (through the Department of the Premier) and local authorities as major implementation agencies
- articulate climate change adaptation strategies as they affect flooding
- develop consistency across local government areas on how flood information is presented to the public in a crisis
- facilitate community involvement in floodplain decision making
- describe how the above could be implemented.

Appendix B
Modernisation of State Planning Policy SPP 1/03

A fundamental precept of SPP 1/03 is to avoid or minimise the risks to life, injury and property from a flood hazard.

> Flood management is defined as the management of flood risk by integrated measures of legislation, economy, administration, structures, technologies and education (Simonovic[1], 2009).

Making space for water

The United Kingdom in the last few years has changed its flood management strategy under its Making Space for Water Programme. This title has been chosen to recognise that flood flows are a natural phenomenon, require designated flow paths and sufficient space to temporally store floodwater. The comprehensive strategy includes risk mapping, identification of barriers and incentives to delivery, risk management guidance, stakeholder involvement in decision processes and resilience pilot programs.

Local authority planning schemes in Queensland do not reflect this strategy to the same level and rely on building/development lines that are intended to match a planning scheme's defined flood event and maintaining flood storage. Some flood maps upon which the schemes rely are outdated and do not identify safe evacuation routes. Some local authority planning schemes have extensive planning codes but rarely do they take into consideration the magnitude of residual risk (i.e. the risk that remains after all other risk management measures have been put into place).

Governance integration

Land use planning is a matter for state governments, which set the legislative framework, and overall planning policies. The Queensland government, like many others in Australia, has devolved the management of development to local authorities. If local authority strategies are not appropriate for local hydrologic conditions and development applications, and assessment processes are not done well, more frequent than planned flood emergencies will arise. Emergency responses by both a local authority and state government agencies occur and, in severe floods, financial and

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[1] Simonovic, S.P., (2009), 'Managing Flood Risk, reliability and vulnerability', Editorial, *Journal of Flood Risk Management* 2 (2009) 230–231.

other assistance will be provided under the federal government's Natural Disaster Relief arrangements with the states.

To minimise the adverse consequences of flooding, the federal government's Emergency Management Australia has published a series of manuals and guidelines that focus on disaster management, community engagement, and emergency response. Earlier state and local government land use policies have provided a legacy of high residual risk in many areas. Residual risk is defined by the national best practice guidelines as the exposure to flooding when all other flood management measures have failed. SPP 1/03 seeks to minimise the future risk, i.e. to minimise future development on flood-prone land and existing communities that do not have adequate resilience programs in place.

Whilst the emergency and disaster management arrangements are integrated through the three levels of government, there is no seamless integration with respect to land use planning. Hazard management areas defined in planning schemes are to be managed by codes but there are few formal policy linkages that require councils to integrate community education and resilience building programs and emergency management with their land development strategies.

The review of SPP 1/03 provides an opportunity to develop a seamless planning policy framework for flooding for all levels of government that integrates land use planning, development and accompanying resilience programs for newly created vulnerable communities. These new communities have no voice in the governance structure except through the participants within the development framework.

The revised SPP could require the implementation of resilience programs that would be conducted in accordance with Emergency Management Australia's (EMA) manuals and guidelines.

Floodplain planning objectives

Land use planning is but one flood hazard reduction measure and needs to be accompanied by complementary programs to increase resilience and improve response efforts. Exposure to flood risk is spatially restricted to flood-prone land where 'flood-prone' means land that will be inundated during the probable maximum flood. The benefits of land use management as a tool in flood mitigation has been well documented.

The community and government have recognised that it is not practical to prohibit all development on flood-prone land and instead permit development only above a defined flood event (SPP 1/03). The current United Kingdom approach allows for different levels of immunity in different areas.

The key objectives for floodplain planning must aim:

- to not increase, and preferably reduce, any reasonable expectation of flood risk, flood damage and flood hazard to existing properties
- to not place floodplain occupants or users at unreasonable risk of flood damage or hazard
- to not adversely affect flooding so as to reduce the development potential of other landowners within the floodplain

- to not impose any additional burden on, and if possible improve, the local authority's counter disaster response efforts during a flood emergency.

Duty of care

We consider two fundamental and important principles in planning policy application are:

- Developers that propose and/or construct developments, and the authority that approves development, have an obligation to ensure that future residents are not exposed to unreasonable risks.
- Such developers and the approving authority have a duty of care to inform future residents of the risks they face.

This requires significant interaction between planning codes and other forms of preventative mitigation that should be determined at the time of development approval, preferably during a Material Change in Use application. Developers should comply with the modern approach of building resilience in communities and integrating emergency planning with development.

The development industry and local governments may not generally realise during the development design and assessment process that they have a responsibility to the future occupiers of the land.

Whilst there seems to be no statutory obligation on a local authority to provide flood level information, it probably is the only entity able to hold a single repository of flood information for its locality. Given that it requires developments to be constructed having regard to flood levels, and there are few statutory requirements for builders to construct dwellings above a designated flood level, flood information has to be made available to the public. A local authority then has a duty of care when issuing flood information to those who might reasonably expect to rely on it.

Cumulative impact of development

A revision to the SPP should make recommendations regarding the implications of approving a series of smaller developments without consideration of the cumulative impacts of development on a wider catchment. This was a matter considered by the Planning and Environment Court in 1996. The Court stated that where extensive areas of urbanisation are already at risk from flooding, a conservative approach is essential and in such cases any increase in peak flood levels from one contributing development would be unacceptable.

It is the intent of the *Sustainable Planning Act 2009* that an application for a Material Change of Use should consider the regional context and how a new development would relate to areas outside the development footprint. This can be interpreted as requiring answers to the following questions that would be asked in the development assessment process.

- What is the impact of individual developments over a wider catchment area?
- What is the impact of implementing similar development strategies over a wider catchment area?

In floodplains, the first stage of development should be overly conservative in mitigating any adverse impacts so that future stages of the development are not compromised. It is not appropriate to approve an early stage without any study of the wider impacts, as subsequent stages may not occur, in which case the cumulative effect of a number of independent spatially disparate early development stages would not be known.

Hazard and resilience

The SPP 1/03 assumes that local authorities have undertaken a risk management process to define hazard management areas in accordance with a Defined Flood Event (DFE). As far as the state's interest is concerned, a DFE hazard area corresponds to the area of inundation from a 100 year ARI flood. This level of immunity is considered inadequate for many types of development which will be discussed in the next section. Some local authorities have required different levels of immunity for different asset types, e.g. 500 year ARI immunity plus freeboard for hospitals.

The DFE approach is but one part of a community resilience continuum that must span from vulnerability to as high a level of resilience as possible. Local government will need guidance from the State and Commonwealth governments as to a desirable level of resilience to formulate their resilience planning and implementation. At the local government level, we believe additional resilience measures should be identified and provided at the Material Change of Use (MCU) stage of a development application. These must be sufficiently adequate to support a defined level of protection that needs to be set in collaboration with the community as a level of protection above the nominated flood recurrence interval that is the DFE.

To paraphrase Arnstein's 'Ladder of citizen participation' (Arnstein[2], 1969), land use and emergency planners require a 'ladder of community resilience' particularly with respect to flooding. Each rung of the ladder is an incremental improvement in resilience. Defining flood planning levels for a 'green fields' development and nominating flood evacuation routes should be considered as the bottom rungs of the ladder. The next ladder rung is incorporating water and flood resistant dwellings. Educating communities and training them how to respond to a flood warning would be the next step.

Further steps would include developing intra-community mutual assistance programs, involvement in community consultation programs, and at the highest rung (a measure of last resort), the need to seek outside assistance (rescue and recovery). Each rung also needs its own supporting attributes: the level of the development platform, housing codes, evacuation by which route to where, how safe is 'where', who will feed, clothe, and keep evacuees safe, etc, to ultimately who will rescue and how safe is rescue.

The above requires a fundamental cultural change to floodplain management but it can be initiated within the parameters of a revised state planning policy.

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[2] Arnstein, S. (1969), 'A ladder of citizen participation', *Journal of the American Institute of Planners*, 35 (4) 216-224.

For larger developments, as a first step, developers could be required to present the flood resilience measures proposed for the development, how they intend to ensure those resilience measures are to be achieved (including financial support), and how they are to be executed in a manner that refer to and accord with specific provisions within the manuals and guidelines published by Emergency Management Australia.

Levels of immunity

The 'one size fits all' approach to setting a defined flood event (the 100 year ARI flood) is considered inappropriate as it exposes critical infrastructure to the same level of hazard as a residential dwelling.

A revised SPP should specify different levels of immunity for different facilities and infrastructure.

Each local authority will have a number of developments at or slightly above the 100 year ARI flood level. This imposes a significant residual risk and potentially devastating financial burden on governments and communities in the event of a flood larger than the DFE. A revised SPP could encourage local authorities to determine the flood exposure profiles (average annual damage, average annual population affected, people, dwellings, and potential damage for each flood return period for its area of jurisdiction). At a state level, each local authority's profiles should be aggregated and the state should then determine its appropriate level of 'interest' (SPP 1/03).

Each local authority could then determine each catchment's flood mitigation cost profile by flood probability to determine its optimum levels of flood immunity. These can be matched with the probability level of mitigation the local authority considers it can afford to guide the level of immunity it considers desirable.

This may mean the defined flood event might have a different probability than the 100 year ARI event.

Other matters that could be considered in setting levels of immunity for facilities and buildings are whether the building or facility will:

- be of particular significance or importance to the community
- be an aid or hindrance during a flood emergency
- be an attractor to people that will expose people to hazard during an emergency
- have safe and/or flood free access with specific hazard provisions for each land use type
- will continue to be served with power, water, sanitation, etc
- be designed with safety-in-place provisions.

Climate change adaptation strategies

Queensland's climate is changing (IPCC 2007[3], CSIRO & BOM 2007[4]) and it is likely that damaging floods will not only be more frequent but the impact of extreme events will be much greater. The issue for designers is how to respond to the increased design loads that are increasing over time. Internally, KBR is proposing a number of options to our clients:

- providing for the load that would be expected at the end of a design life
- providing for effectively an 'average' load over the expected life (actually targeted at the same cumulative risk level over the expected life)
- providing for the current or modified design loading and designing future adaptation into the asset during its life to accommodate further increases in loading
- providing for the current or modified design loading now, in the expectation that the asset will have to be modified or rebuilt.

As to which strategy is chosen will depend on the risks associated with the development over its design life, the respective economics of each strategy, the purpose of the structure/facility and the social and environmental impacts of future disruption if upgrading takes place. When applying this to floodplain management, there are few options:

- selecting the level of land to which development platforms are built
- providing (additional) flood storage volume as a future flood mitigation measure (either upstream or within the vulnerable areas)
- making provision for the demolition of vulnerable properties and relocating their inhabitants
- making provision in the building structure to allow the addition of high level living areas while making the vulnerable lower level more resistant to flooding
- flood-proofing the housing stock.

In terms of land use planning, it is probably easier and more economic to construct building platforms at a higher level (the first adaptation strategy). The cost of placing an additional 300 mm to 1000 mm of fill when constructing new developments is relatively less expensive and less disruptive that the other options.

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[3] Intergovernmental Panel on Climate Change (IPCC, 2007), 'Climate Change 2007: Synthesis Report, An Assessment of the Intergovernmental Panel on Climate Change,' IPCC Plenary XXVII, Valencia, Spain, 12–17 November 2007.

[4] CSIRO & Australian Bureau of Meteorology (CSIRO & BOM, 2007), 'Climate change in Australia Technical Report 2007', CSIRO November 2007.

Appendix C
Land use planning direction

The major factors affecting community vulnerability and by extension the resilience of communities are the quantum of exposure to flooding, the degree to which communities are exposed, personal mobility and safety, intelligence, awareness of flooding and education. For people, their assets and businesses to be so exposed means that floodplain managers and land use planners have been subject to historic circumstances, or are basing their decisions on faulty paradigms, or have not had the opportunity or support to be effective, or have been ineffective.

Community vulnerability can be lessened by improving land use planning in floodplains.

This appendix considers

- the assumptions and methodologies adopted by governments in determining design floods and how the now much greater residual flood risk might be managed by including land use planning provisions that would assist emergency management
- how a future planning scheme might be formulated.

The current use of a 100 year ARI flood level by most flood-prone communities in Australia should be reconsidered. Climate does vary, it is cyclical, and the current perceptions of flood frequency may underestimate the current risks of flooding and the consequent damage. Additionally, the quantum of residual risk is generally not known and the state and local authorities should review the overall risk profile and question whether the continued use of the 100 year ARI event is still an appropriate 'flood standard'.

If damage results from an event having a higher frequency than currently perceived, the total annual damage of an exposed community must be higher and therefore current thinking understates community vulnerability. Accordingly, to reassess the resources needed for both non-structural and structural mitigation measures, it is incumbent upon the disaster manager to review the flood risk management paradigms, and seek variations to the local planning scheme to avoid future flooding misery.

Where people choose to live is their own decision. However, they may not be aware of the flood risk and hazard to which they are exposed. Many residential areas were developed before rigorous floodplain planning laws were introduced, or before the authorities were aware of the potential for flooding. Planning schemes are a key element to prevent increasing the number of people, businesses and assets exposed to flooding from events less than the design flood event.

Land use planning is a key element of the prevention component of flood mitigation. While emergency managers generally concentrate their activities on planning for, and dealing with, emergencies, they also have a role in shaping or influencing the

preventative aspects of disasters, i.e. taking a more proactive approach to land use planning, understanding why and how floods occur and increasing the effectiveness of disaster mitigation.

The level of protection provided by planning schemes should be a consequence of an analysis of the risks and consequences of flooding and the opportunities provided by sustainable land uses.

Local authorities in all states are caught between the competing needs of encouraging development and maintaining a minimum liability position before a flood emergency occurs. Local authorities need not only to ensure that their planning and development policies are at best practice standards, but also ensure that the other equally vital aspects of flood mitigation such as disaster planning, emergency management and structural measures are not forgotten.

Floodplain management encompasses more than the setting of development levels and allocating appropriate land uses. The scope and thrust of floodplain planning will depend on the degree of confidence with which the local authority can provide the complementary aspects of flood mitigation (physical, emergency management, and public education and awareness measures).

Sustainable land use planning aims to reasonably minimise the adverse consequences of future flooding and, where alternate strategies are available, some of the more stringent land use planning measures may be relaxed.

Land development has increased dramatically in South East Queensland since the 1967 and 1974 floods but it was not until later that design flood levels were set at the 100 year ARI level. The following questions need to be considered given the scale of development:

- Is the 100 year ARI flood level still an appropriate reference for land development?
- Are the assumptions and methodologies used to derive the current 100 year ARI flood levels still appropriate?
- Are the margins of safety (freeboard) still appropriate?

Whatever flood exceedance probabilities are chosen by local authorities, there will always be a 'residual flood problem'. In a major flood, residents have to decide whether to remain in place or evacuate. For those more exposed, or where sensible evacuation would be impossible, and rescue could be dangerous if the flood developed into a more serious event, early evacuation is the only solution.

The first component of the 'residual' problem is those communities or individuals who are exposed to flooding more frequently than the design flood. Given the extent of terraced development in reclaimed floodplains resulting from building above the last highest flood level (before the adoption of the 100 year ARI 'flood standard'), their levels of exposure will vary depending on the anticipated flood depths and available warning time before a flood arrives.

The second component of residual risk is those communities (and suburbs) that are exposed to flooding above the design flood level. There are likely to be localities where under the acceptance of changed hydrological circumstances, design flood

levels might be raised and those communities would be relegated to the first component.

Whatever the design flood level recommended by the state, we contend that each local authority has to determine the cost of future exposure to flooding from all flood magnitudes, and then determine the future financial burden that it can afford, and then set revised flood planning levels. We are of the view that the 100 year ARI 'standard' has been adopted without analysis of the full costs and implications of flooding. Nevertheless, the state should set minimum standards for development unless a local government can sustain an argument for a lower standard. In such situations, it would be incumbent upon both the state and local authority to ensure that future owners, occupiers and users are informed of the reduced planning standard.

Flood code proposal

We contend that development should be in accordance with sustainable development principles. Accordingly, new development should be aimed:

- to not increase, and preferably reduce any reasonable expectation of flood risk, flood damage and flood hazard to existing properties
- to not place their occupants or users at unreasonable risk of flood damage or hazard
- to not adversely affect flooding so as to reduce the development potential of other landowners within the floodplain
- to not impose any additional burden on, and if possible improve, a local authority's counter disaster response efforts during a flood emergency.

There are three main elements required in local authority flood codes:

- flood hazard
- the setting of 'freeboard'
- the nature of a development during a flood emergency

Flood hazard

Section 5.1.2 of the former *Integrated Planning Act 1997* defined the 'desired standard of service' for a network of development infrastructure items. The 'desired standard of service' for development in flood-prone areas is defined by the desired degree of flood hazard a person might experience during a flood emergency.

The approach recommended is to:

- define flood hazard in terms of the safety of the user having regard to the depth and velocities of floodwater, whether safety-in-place is a realistic option, evacuation distance and evacuation time
- for each of these relative flood hazards, consider the land use appropriate to various degrees of hazard
- apply a sustainable risk management strategy for each likely land use in a floodplain. This will include a two-fold consideration of annual flood probability and required freeboard.

Factors that affect flood hazard are predominantly related to accessibility. They include:

- flood behaviour – severity, depth, velocity, rate of rise and duration
- topography – evacuation routes, islands
- population at risk – number, fitness and mobility of people, number of developments, type of land use, flood awareness
- emergency management – flood forecasting, warning, defence plans, evacuation plans and recovery plans.

In accordance with best practice, appropriate land uses can be categorised by the hazard that a reasonable person would experience during a flood. There is an over-riding proviso, that ultimate users of the land or facilities should reasonably expect to be able to evacuate to a place of refuge appropriate to the time of day and weather conditions.

Freeboard

'Freeboard' as it is used in floodplain management is the amount of increase in level of a vulnerable facility (floor level, levee height) above the flood level – estimated for the design event. Freeboard usually has been selected as a nominal amount – usually 300 mm for setting the floor levels of residential buildings as indicated in Australian Rainfall and Runoff (1997). It provides for inaccuracies of flood level prediction and can include an allowance for additional protection against wind wave, bow-waves from boats or vehicles, or local increases in flood levels from currents.

In some instances, freeboard has also been used to provide additional protection for more important public facilities such as hospitals, ambulance, police and fire stations etc. A weakness is that the setting of freeboard is usually without regard to the different catchment or river system characteristics.

Floodplain managers sometimes forget the nautical origins and purpose of freeboard, and to a certain extent, forget risk management principles and appropriate factors of safety.

Taking the nautical analogy further, decision makers can ask the ship owners for a bigger boat if the weather doesn't look good, or if some of the passengers need special care, or if the cargo is valuable or potentially nasty. For floodplain management it might be possible to increase flood storage, or set higher development standards for vulnerable communities or assets such as telephone exchanges, hospitals, places of refuge, and emergency services.

Ship owners should be able to choose the cargo that would not be affected by water or have the owners use another ship to take their cargo. In floodplain terms that would mean assigning hazardous materials to land that would not be affected, or less likely to be affected, by flooding.

Decision makers can educate their communities and potential buyers about the risks they face, what they can do to minimise their potential losses, and 'lifeboat' procedures. Decision makers have been taught how to get good weather information,

but may not have been taught how to determine the implications: how quickly waters can rise, how many people to evacuate, and what sustenance and shelter are required.

Adopting a nominal freeboard across greatly different catchment types is not logical. Wide floodplains experience much smaller increases in flood levels for the same change in event recurrence intervals than do smaller valley constrained streams. Also, if it is considered that an appropriate factor of safety for flooding is say 2, then for a desired level of protection against overfloor flooding for habitable rooms of 100 year ARI events, floor levels should be set at the 200 year ARI design flood level. Freeboard is then the difference between the 200 and 100 year ARI design flood levels. Where this still does may not appear to provide a comfortable margin (having regard to wind and vehicle bow-wave action etc.) then the freeboard recommended would be set higher depending on the type of stream (whether a slow moving floodplain, or a steeper creek where debris blockages and/or loadings can more easily affect peak flood levels).

Reclamation levels are set for each land use type based on the peak flood level of a nominated flood severity; each local authority will set a flood standard appropriate to its conditions and magnitude of its overall flood damage exposure.

Nature of a development during a flood emergency

A further development is proposed that considers the use or burden to which a facility might be endowed during a flood emergency.

The use of emergency use codes is proposed as a means of classifying various types of uses and their probable function in a flood emergency. They can be used to distinguish different functional requirements for what might otherwise be considered an identical land use and used as prompt to consider whether or not it is appropriate to locate that type of development as located. Examples would include a school gymnasium that might be used as an evacuation centre during a flood emergency, an aged care facility that would require significant assistance if there was a need to evacuate.

EM1 Uses essential for the city's future that should not be located on flood-prone land.

EM2 Uses that would provide 'lifelines' during a flood emergency.

EM3 Uses that support the cultural identity of the city.

EM4 Uses that would support flood emergency and recovery operations.

EM5 Uses that would add to the overall operational burden during a flood emergency.

EM6 Other development which may add to the operational burden if the flood magnitude is above the defined flood.

Floodplain planning by local and state governments needs to become more sophisticated if duties of care obligations are to be met. This aspect of governance appears to have lagged in urban and regional planning with the unfortunate consequence of a sometimes uninformed development industry.

It is considered that higher development standards are required if future misery is not to be 'built into' urban settlement. Failure to do so in an increasingly litigious

community will result in governance resources being diverted from pro-active planning to legal defences and the heartache that accompanies the aftermath of a flood.

If this scenario ensues, floodplain planners would need to discuss their obligations with their legal advisors and undertake floodplain master planning as a matter of course. They would also be encouraged to look at development standards and take on board new approaches to matters such as freeboard as has been suggested above. Whether this can occur efficiently across the planning industry is an issue for discussion.

Appendix D
Development of decision support systems for flood response

Decision support systems (DSS) are needed to integrate data flow and information in an accurate, spatially oriented and timely manner within an emergency management resource structure. Without sound information systems, decision makers may find themselves under increasing pressure and fail to adequately manage the unfolding flood emergency. DSS are also useful tools to present flood information as part of a risk communication program but the needs and requirements are much different to those of emergency managers.

A Decision Support System (DSS) is defined as a collection of data, information and processes, which, when combined, amplifies the value of the data and enables rapid judgements.

The following meanings are ascribed for the purposes of this section:

- data: variable information that can change rapidly
- information: static data, knowledge
- process: a means of changing data and combining that with information.

A series of processes are applied to improve and/or transform the data to an information-set in a vertical ladder of technology, improving the value of the data to the end users. To be fully effective they must also integrate with the lateral set of instructions from decision makers to their emergency teams.

To determine the features of a DSS, the needs of the end users are defined. In a common case, such as buying a car, basic information is collected and sorted. The first level of enquiry might be the size of vehicle and price. The next level of enquiry might be serviceability, fitness for purpose and running costs. Finally, a decision might be made on features supplied and value for money. A DSS in this example might be a set of three tables and a list of suppliers.

A floodplain DSS needs to represent the nature of its particular floodplain and the different threat types will dictate the information needs, processes and information to be collected, sorted, processed and provided. The method of delivery will also differ in accordance with the type of threat.

For example, the nature and perceptions of flooding for the Nerang River at Gold Coast, the Darling River system in western NSW and the Yangtze River in China are all different. The means of collecting, transferring and processing data and information is similar, but the needs of the end users are totally different. This means decision support systems should be designed to support the needs for each river.

The Darling River has a very large catchment but, in flood, is relatively slow moving, where a flood wave can take weeks or even months from the onset of heavy rain to reach its confluence with the Murray River at Wentworth, NSW. A DSS that would serve pastoralists along the Darling River might be limited to the collection of rainfall data, hydrologic modelling and a river monitoring system that records water levels at various points along the river.

This information, in conjunction with the 'bush telegraph', is likely to be sufficient for graziers to move stock to higher ground, stockpile feed and provision their own properties. Townships along the river will rely on predicted peak flood levels, estimated times of arrival and based prediction of flood extent on previous experience.

Contrast this with the very steep slopes of the streams in the Lockyer Valley or in Brisbane, where the response time is a few short hours. Very little warning time is available, but the local authorities are developing internal response systems whenever severe weather warnings are issued by the Bureau of Meteorology. Brisbane city has an SMS warning messages system.

The Bureau typically issues its flood advices in the following sequence:

- Alert, Watch or Advice of possible flooding if flood producing rain is forecast
- Generalised flood warning that flooding is occurring or is expected to occur
- Warnings of minor, moderate or major flooding
- Predictions of expected height of a river.

Strategically a DSS should operate at several levels:

- To provide decision makers with a quick overview of the current flood situation; whether there are any problems; where those problems are; what to do about the problem; and the consequences of flood management decisions.
- Analysts and decision makers should be able to examine in detail, current hydro-meteorological information, flood forecasts, and undertake flood analyses including (excess) flood volume calculations. Flood forecasters should be able to use an interactive and fully integrated hydrological and hydraulic modelling system to produce water level and flow forecasts.
- Operators should be able to undertake database checks and perform database queries using a purpose designed database table query system. They should also be able to examine hydro-meteorological data from manual and automatic stations and compare it with similar data from other stations.

Wikipedia defines a DSS in the following terms:

> **Decision support systems** (DSS) are a specific class of computerized information systems that supports business and organizational decision-making activities. A properly-designed DSS is an interactive software-based system intended to help decision makers compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions.

The experience of the February 2009 Victorian bushfires has shown that authorities were unable to provide timely and accurate advice to all people. Therefore it is essential to provide similar information to members of the public via a DSS as well as

to decision makers and emergency managers. This would enable them initially to make purchase decisions based on readily available information so that they might choose not to reside on floodplains. Secondly, prior to a flood emergency, they can determine their levels of risk exposure and determine if their vulnerability is such they will have to act. Thirdly, they can also determine appropriate threshold levels for action and then finally, when to leave.

Such a DSS would need to be tailored for community and school use but rely on the same certified quality assured data as the local authority and its decision makers. Each set of data would need to be accompanied by its own metadata system, backed up and lodged with a secure agency (say Archives Office) in the event of an established post flood disaster enquiry.

Such a system would fall within the recommendations of Emergency Management Australia's Evacuation Planning Manual. This also accords with EMA's Schools Education and Disaster Resilience program.

Appendix E
Establishing minimum standards for hydraulic reports used for floodplain planning decision making

Local government officers examine development application reports that include flood impact analyses to ensure that development shall not cause, or have the cumulative potential to cause, real damage to premises or worsen flooding during a flood emergency. Where extensive areas of existing urbanisation are already at risk from flooding, a conservative approach is essential.

In many sensitive floodplains, the submission of a flood study report is potentially the most important technical document upon which a government authority can rely to make a decision to disturb, or not disturb, an existing waterway or floodplain. These decisions can not be taken lightly, particularly when premises are thought to be at risk from flooding.

Authority needs

Flood impact assessment reports are submitted to support applications where land below the designated flood level is to be reshaped, works are to be constructed in or over waterways, or the hydraulic characteristics below the designated flood level are to be modified. It should be remembered that works above the designated flood level have the potential to worsen flooding in extreme events, which should initiate changes in development policies.[5]

Government authorities need to be confident that a hydraulic report is accurate, competent and unambiguous, and is a document that can be relied upon without any uncertainties. The report must state its purpose, outline the development context, state the scope of works within the floodplain, explain how their impacts were assessed, the extent and magnitude of impacts, the findings of the flood study, and flood mitigation strategies adopted or recommended to the authority to counteract any adverse impacts.

Report evaluation

Hydraulic reports should be written so as to be understood without requiring the reader to consult other files or reports. They may be read by people with a diverse

[5] Many floodplains have residential development with only 150 mm of freeboard at the 100 year average recurrence interval (ARI) flood level. Should 'standard design' flood levels rise, then the stage-damage profile will change, and the community risk will increase. In such circumstances a local authority may raise its designated ARI design event and/or flood levels for new development.

range of skills and backgrounds and should be understandable by technical and non-technical readers. Non-technical readers could include non-technical managers, political leaders and community representatives.

Reports containing minimal information are generally considered poor reports. Whilst they might be the least expensive to produce, they often do not demonstrate the rigour or competence of any background work. 'Minimalist' reports often do not discuss matters that might lead to more awkward questions and often lead the reader to ask 'what does the report not say?'

In evaluating a development proposal, a report should address:

- whether the development is likely to cause damage that would adversely affect land and/or premises to an extent likely to be actionable
- whether the development would compromise evacuation strategies
- whether the cumulative impact of development is likely to cause or worsen damage
- whether the development is likely to cause or worsen flood hazard through a range of floods that might exceed the design flood
- whether the risks associated with the development are fully known, quantifiable and capable of being dealt with to the government's satisfaction, without any uncertainties
- whether flood mitigation works, intended to reduce flood risk, hazard and damage, do so without adversely impacting upon other land and/or premises
- whether the development will create any adverse environmental impacts.

Statutory floodplain policies vary with local conditions, the development culture and a state's legislative environment. Contributing factors for local authorities include: history of flooding, development patterns, rate of development, intensity of community debate, topography and threats to the community and its assets.

Qualifications and certifications

The qualifications and limitations statement should be clear, but where the implications of the qualifications may not be evident to a sophisticated reader, supporting comments may be necessary.

Certifications may be required for hydraulic studies and calculations of compensatory cut and fill from each of their respective authors. Certifications should state:

- the purpose for which the hydraulic report or earthworks calculations were provided
- details of plans/drawings of the proposed works used as the basis of the analysis/calculations
- the authority's performance objectives for each case
- that the proposal does, or does not, comply with government requirements
- the context in which the work was commissioned, and any limitations, qualifications, or reservations of the certifier

- that the certifier is aware that the authority will be relying on this certification in its assessment of the proposal

Some authorities may require the certifier to indemnify the authority from any legal liability arising from errors or omissions in the information or recommendations provided by the certifier.

Appendix F
Accelerated learning process

Decision makers who manage emergencies have a great deal to remember, from the requirements of EMA's emergency management manuals and guidelines, state law, the policies and practices of the local authority, as well as the technical, logistic and human resource, sociological and psychological processes associated with management in stressful situations.

This is a daunting prospect and the role is often awarded to a local authority's engineering manager or operations engineer, who may not have had a 'full measure of life's experiences' to guide decision making or provide 'reality checks'.

These stressful situations may only occur once in a person's lifetime and any prior experience is likely to be vicarious.

An accelerated learning process is needed and further research is required to see how such a learning process can be developed and be applicable to emergency planning. Training methods should be able to be modified to develop emergency management 'patterns' within the brain in younger emergency managers, in order to achieve accelerated learning, avoid stress, and improve confidence in both technical and political decision makers.

There is a particular advantage if the cognitive expertise, experience and competency of the mature brain can be taught to those younger persons who still have the mental processing ability of the frontal cortex[6]. This would result in a younger brain being trained to 'grow wisdom' much earlier through pattern recognition, while still having the processing/problem solving ability normally attributed to persons in a much older age group.

The conundrum so far is that flood specialists are usually hydraulic engineers with a background in hydrology and hydraulic numerical modelling. If they are fortunate they will also have some background in the local government development approval process. At the other end of the flood emergency spectrum is the specialist disaster manager who may not have local government development approval experience, nor have a background in flooding. Each needs to understand the other's knowledge. This requires a coordinated approach to training.

One question remaining is how to imprint flood emergency patterns typical of an experienced and mature brain into a younger person. Research indicates this can only be achieved by repeated exposure and/or intensive training. The repeated exposure

[6] A finding from a recent PhD thesis on floodplain management submitted to Griffith University: Betts , H. (in review), 'Factors that affect a decision maker prior to and at the onset of a flood emergency'.

implies a career path choice by the individual, who is supported in that career path by a flood emergency aware employer that understands the imperatives.

Obviously, providing exposure to actual floods is difficult unless there is mobility to experience a series of major floods. An employment structure is needed where the person is allowed to observe and preferably participate by travelling from flood to flood. This would seem to be beyond the resources of all but the biggest local authorities but not beyond the resources of a state counter disaster organisation.

If real floods can't be observed, the other method of imprinting patterns can only be through a series of intensive training programs. The training options appear to be employer sponsored in-house courses, simulation exercises organised by local authorities, and high-intensity courses similar to those used to train specialist service personnel. At present, the only agency that offers emergency training is EMA's emergency training college at Mount Macedon in Victoria, but it could be linked with the Royal Military College at Duntroon or with the Queensland Police Academy.

Appendix G
Need for flood emergency management specialists

There appears to be a need for teams of flood emergency specialists around the country, each team being state based, having one or two people moving between flood-prone areas. They would work with a local authority and the Bureau of Meteorology's specialist hydrologists to understand local flood situations, the scope of potential flood disasters, trigger points, models and expertise available. The mobile specialists would be required to establish linkages and work with local counter disaster centres and the communities involved, both learning and providing training. There is no reason why they could not be supplemented by experienced engineers from other sources.

The flood specialists must be available to assist local authorities in an emergency. Depending on the rate of onset, seriousness and consequences, these mobile teams of one or two specialists could relocate to the flood site and become part of the Disaster Management Group. To a certain extent, this protocol existed some years ago within Queensland's Emergency Services and its local area coordinators. However, it is considered that their profile should be raised, and their role should be set to a higher level of authority.

This implies the specialists should be competent communicators and trainers with a wider range of professional skills. This educational aspect could be delivered through universities and coordinated through Cooperative Research Centres and Emergency Management Australia. Certificates of competency would provide some degree of surety when inserting regional specialists into a local disaster management group.

Appendix H
Quality assurance

In recent years the need for quality assurance systems in accordance with the ISO 9000 and ISO 9001 has become more important. They form part of a series of international standards that contain the requirements for a quality assurance system, *i.e.* the need for management systems to be documented.

The ISO 9000 standard sets out eight quality management principles for a quality management system. The most important standard in the series is ISO 9001, which adds requirements to ensure not only that the system be updated, but internal and external audits and for continual monitoring. It also sets out the requirements for a certification process.

For an organisation to have quality management systems and meet the requirements of (s.4.1 AS/NZS ISO 9001:2000) it must:

(a) identify the processes needed for the quality management system and their application throughout the organisation

(b) determine the sequence and interaction of these processes

(c) determine criteria and methods needed to ensure that both the operation and control of these processes is effective

(d) ensure the availability of resources and information necessary to support the operation and monitoring of these processes

(e) monitor, measure and analyse these processes, and

(f) implement actions necessary to achieve planned results and continued improvement of these processes.

The Queensland Government's Quality Assurance Policy (2001) requires its departments and agencies to purchase items over $10,000 from companies that are quality assured in accordance with its policies. This requirement may be waived if the goods or services carry low risk.

Quality assurance involves checking and verification at a standard that is commensurate with the level of risk.

Given the potential flood damage and risk of injury or death to residents, all local authorities and any government agencies that support them should provide their services in accordance with the ISO standards. This may mean more rigour in the development of models, the development of decision support systems, and the planning and organisation of emergency management groups and tasks.

This is particularly important for the development of decision support systems (DSS) where, in conjunction with system development, each process needs to be documented

including raw data (source and type), how it is processed, converted and stored along with its metadata. This documentation needs to be accompanied by maintenance instructions, code explanations (written into the program code), and operating instructions.

Finally, training materials and course work should be developed contemporaneously with the DSS development. All documentation may need to be reworked after project completion and verification testing. Testing needs to be in three phases, testing by the system developers and modellers, testing during training of those who will be involved during a flood emergency and then again during 'dry runs'. These dry runs should be designed by different persons to those who have been closely involved in the project, the design being discussed with the development team leader and project reviewer before the dry run. A review of the dry run in combination with the senior decision makers and political leaders should be undertaken. This is desirable as it begins to build the political constituency, support for further improvements and builds confidence, in the minds of political leaders and flood emergency decision makers, in the system that has been developed. The 'dry run' should be recognised as an opportunity for flood engineering specialists to educate both the emergency and political fraternities in flood behaviour and what the community can expect from a flood. Done well, this will promote clearer explanations to the community during a flood crisis and hopefully engender higher levels of community acceptability and response.