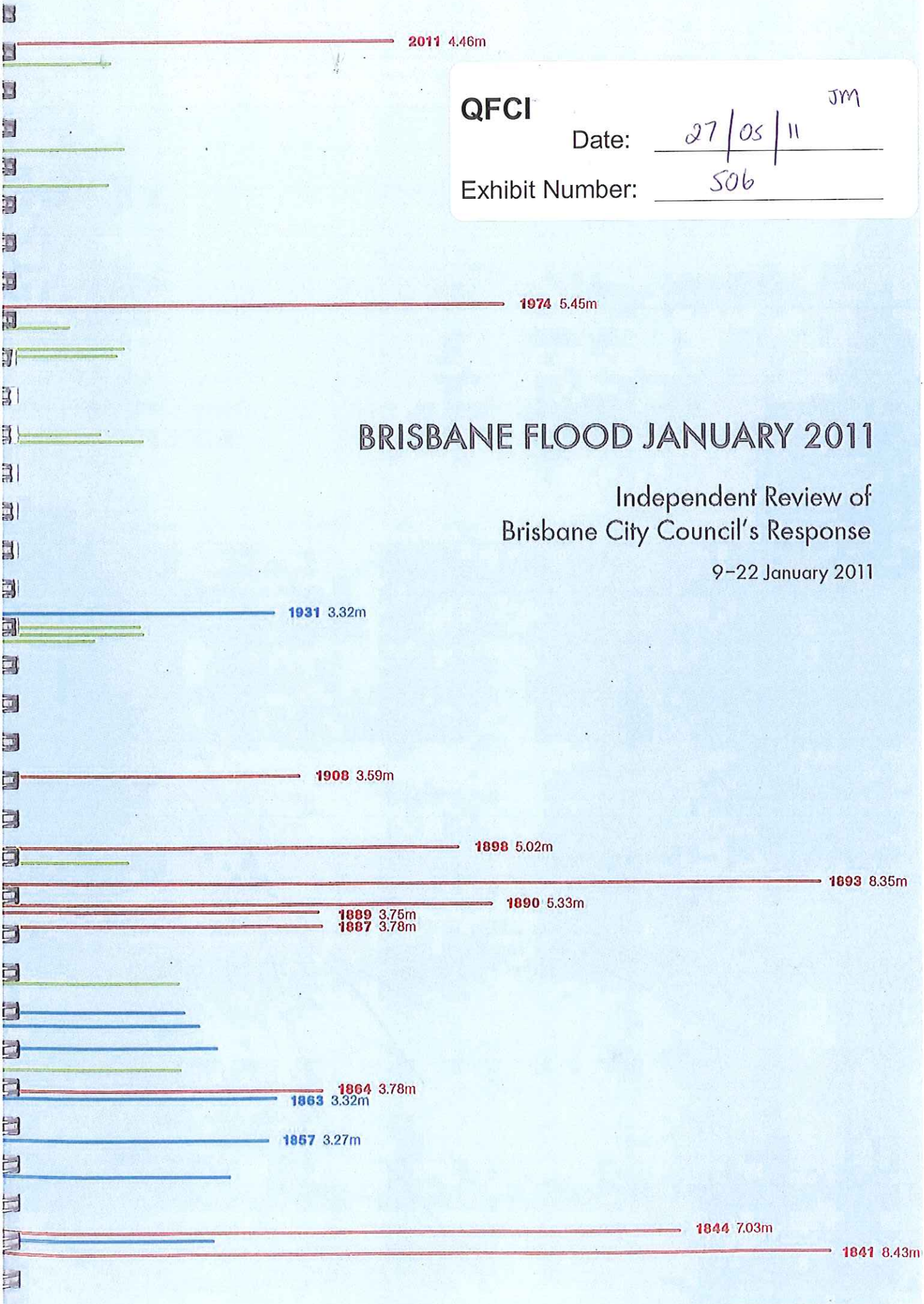

BRISBANE FLOOD JANUARY 2011

Independent Review of Brisbane City Council's Response

9–22 January 2011

Erratum

On pages 8 and 41 the recommendation in relation to Flood Maps for a larger set of scenarios should be deleted and replaced with the recommendation below.

The Board recommends that Council further develop its capabilities to produce flood maps for a larger set of scenarios based on a range of 2000 to 20,000 m^3/s in electronic and hard copy format.

The graph on the cover is based on the Bureau of Meteorology's record of Highest Annual Flood Peaks as estimated or recorded at the Brisbane River City Gauge for the period covering 1840 to 2011. In some years, particularly in 1893, there were several large floods; however the graph shows only the largest flood for each year.

The Bureau classifies floods as Major, Moderate or Minor. Major floods are represented in red, Moderate in blue and Minor in green.

In the graph, for the period 1840 to 1900 there were 15 floods which were classified as Moderate or Major.

By contrast, in each of the periods 1901 to 1960 and 1961 to 2011 there were only two floods which were classified as Moderate or Major.

BRISBANE FLOOD JANUARY 2011

INDEPENDENT REVIEW OF BRISBANE CITY COUNCIL'S RESPONSE

9 - 22 JANUARY 2011

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FOREWORD

The Board was established in late January 2011 and requested to present its report by the middle of May 2011. With the benefit of support from many people, the Board has been able to conduct the review and produce its report within this timeframe.

The Board consists of Major General Peter Arnison AC, CVO (Retd), Mr Robert Gotterson QC and Emeritus Professor Colin Apelt.

The Board wishes to acknowledge the particular assistance given by the following:

From within Council

Lord Mayor Graham Quirk and former Lord Mayor Campbell Newman;

Councillor Shayne Sutton, Leader of the Opposition;

Councillors Abrahams, Griffith, Johnston, Matic and Owen-Taylor with all of whom the Board held discussions;

Other Councillors who made submissions to the Board; and

Council officers who briefed the Board on a wide range of Council activities and provided information relevant to the review, and who assisted the Board administratively.

External to Council

Mr Jim Davidson and Mr Peter Baddiley of the Bureau of Meteorology;

Mr Terry Effeney of ENERGEX Ltd;

Mr Greg Goebel of Australian Red Cross (Qld);

Mr David Edwards, Mr Phil Kirby, Ms Robyn McCullouch and Mr Michael Whitelaw of GHD;

Ms Sandra Fields of Fieldworx; and

Members of the public who made written submissions to the Board or who were interviewed by GHD and Fieldworx.

The Board also acknowledges George Patterson Y & R for the analysis of the use of social media channels.

The Board is grateful for the assistance of Ms Joanne Jeckeln in producing this Report.

Major General Peter Arnison, AC, CVO (Retd) served in the Australian Army for 37 years, retiring as Land Commander Australia. He was Governor of Queensland from 1997 to 2003 and is currently Chancellor Queensland University of Technology.

Robert Gotterson QC has practised at the Queensland Bar since 1976, having taken silk in 1988. He is a former President of the Law Council of Australia; the Australian Bar Association and the Bar Association of Queensland.

Emeritus Professor Colin Apelt is a Civil Engineer with extensive professional experience in design, research and specialist consulting in water and coastal engineering. He was a member of the Civil Engineering Department at the University of Queensland for 37 years and was Head of Department for twelve of these. He was a member of the Independent Panel that reviewed the 2003 Brisbane River Flood Study for Brisbane City Council and was Chair of the Lord Mayor's Taskforce on Suburban Flooding for Council in 2005.

GLOSSARY OF TERMS

ABS	Australian Bureau of Statistics
ADF	Australian Defence Force
AEP	Annual Exceedance Probabilities
AHD	Australian Height Datum
AR&R	Australian Rainfall & Runoff
ARI	Average Recurrence Interval
BCC	Brisbane City Council
BCLDMG	Brisbane City Council Local Disaster Management Group
BCP	Business Continuity Plan
BoM	Bureau of Meteorology
CARS	Compliance and Regulatory Services
CBD	Central Business District
CD	Collection Districts
CEO	Chief Executive Officer
CIPMA	Critical Infrastructure Protection Modelling and Analysis
CSA	Community Service Announcements
CWS	City Waste Services
DDCC	District Disaster Coordination Centre
DDMG	District Disaster Management Group
DDMP	District Disaster Management Plan
DERM	Department of the Environment and Resource Management
DFE	Defined Flood Event
DFL	Defined Flood Level
DIG	Disaster Intelligence Group
DMP	Disaster Management Plan
DOM	Disaster Operations Manager
EMA	Emergency Management Australia

EMQ	Emergency Management Queensland (of Department of Community Safety)
EWAS	Early Warning Alert Service
EWN	Early Warning Network
EWS	Early Warning Systems
FIC	Flood Information Centre
Flood COP	Dynamic web-based mapping tool developed by Esri Info
FOG	Field Operations Group
FPG	Forward Planning Group
FSL	Full Supply Level
GHD	GHD Pty Ltd
GIS	Geographic Information System
GL	1GL = one million cubic metres
IPND	Integrated Public Number Database
ISG	Incident Support Group
LAS	Local Asset Services (Brisbane City Council)
LDCC	Local Disaster Coordination Centre
LDMG	Local Disaster Management Group
LM	Lord Mayor
LO	Liaison Officer
MSQ	Maritime Safety Queensland
NEWS	National Emergency Warning System
NFRAG	National Flood Risk Advisory Group
Q100	Q100 is a theoretical flood that has a 1 in 100 (1%) chance of being equalled or exceeded in each and every year at a particular location.
QFRS	Queensland Fire and Rescue Service
QPS	Queensland Police Service
RIMT	Regional Incident Management Team
SDCC	State Disaster Coordination Centre

SDMG	State Disaster Management Group
SES	State Emergency Service
SITREP	Situation Report
SKM	Sinclair Knight Merz Pty Ltd
SLA	Statistical Local Area
SMS	Short Message System
SOP	Standard Operating Procedures
SPA	Sustainable Planning Act
TLPI	Temporary Local Planning Instrument

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EXECUTIVE SUMMARY

In January 2011, Brisbane experienced the second-highest flood in the past 100 years, after the January 1974 flood. There was major flooding through most of the Brisbane River catchment, most severely in the Lockyer and Bremer catchments where many flood height records were set. The flooding caused substantial loss of life in the Lockyer Valley and thousands of properties were inundated in metropolitan Brisbane.

Seqwater, in its review of the magnitude of the January 2011 flood, concluded that the river flood volumes indicated that the volume of the January 2011 flood was almost double that of the January 1974 flood and similar to the February 1893 flood and that peak water levels at gauging stations in the Brisbane River above Wivenhoe Dam were the highest on record.

The Lord Mayor of Brisbane, the Right Honourable Campbell Newman, on 21 January 2011, appointed a Board of Enquiry to review the response to the flood event in Brisbane during the period Sunday 9 January to Saturday 22 January 2011. The Board consists of Major General Peter Arnison AC, CVO (Retd), Mr Robert Gotterson QC and Emeritus Professor Colin Apelt. The Board's Terms of Reference are contained in the List of Attachments.

The Report addresses the Terms of Reference in five Sections. Section One examines the characteristics of the flood and the resultant levels including a comparison against the Q100 flood level and an explanation of terms relating to the probability of flooding occurrence and defined flood events and levels. Section Two deals with the effectiveness of Brisbane City Council's disaster management arrangements including preparation, response and recovery. Section Three considers the effectiveness of Brisbane City Council's response to the flood event including the actions in inundated areas, the establishment of evacuation centres, the organising and tasking of volunteers for the clean up, and waste and debris collection and disposal. Section Four looks at the impact of the existing planning regulations in flood affected areas. Section Five deals with the effectiveness of flood prevention and stormwater infrastructure and the reasons for Brisbane City Council's riverine infrastructure failures.

Section One – The Characteristics of The Flood

Following a record period of drought, the annual rainfall in 2010 caused the wettest year on record for Queensland and the wettest year since 1974 for Brisbane City. The catchment of the Brisbane River system was saturated and most of the rain that fell on it in January 2011 ran off rapidly to produce the flood event. The distribution of the flood-producing rainfalls and the behaviour of the flood that they caused are described in this Section. The mitigating effect of Wivenhoe Dam is noted but the Brisbane River flood was joined by floods from Lockyer Creek and the Bremer River downstream from the dam and their impacts are described. The pattern of rainfall caused little, if any, significant creek flooding in Brisbane, though creeks were flooded by backwater from the river.

The peak flood levels along the Brisbane River are given for Moggill, Bellbowrie, Jindalee, Oxley Creek mouth and Brisbane City. For each location, the times are given for when the water rose above moderate then major flood levels to reach heights greater than the Defined Flood Level, together with the lengths of time that the flooding lasted above these levels.

The technical terms, "Defined Flood Event", "Defined Flood Level" and "Q100" used to describe the nature and level of a flood event and its probability and to inform planning and policy for dealing with floods, are explained. Since all measured flood levels throughout greater Brisbane for the January 2011 flood event, except towards the river mouth, are higher than the Defined Flood Levels and these have been calculated for a flood with the same characteristics as the January 1974 flood but after its effects have been reduced by Wivenhoe Dam, it is considered that the January 2011 flood event, as actually experienced, was larger than a flood similar to that of 1974 after mitigation by Wivenhoe Dam. The flood was therefore larger than the theoretical Q100 flood which, for Brisbane, is a little smaller than the flood corresponding to the Defined Flood Levels.

The history of flooding in Brisbane since the 1840s shows clearly that periods of frequent flooding can occur as well as long intervals with few floods and that the timing of flood events is variable. Comparison with records of historical floods shows that the January 2011 flood was a rare and large flood event.

Section Two – Brisbane City Council's Disaster Management Arrangements including Preparation, Response and Recovery

The Board's analysis of Council's response to the January 2011 flood event indicates that it performed at a highly creditable level. Fatalities were minimised with only one death recorded in the greater Brisbane area that was linked to the flood event, compared to around 14 people who died in the Brisbane and Ipswich areas during the January 1974 flood.

While early public warnings during November and December were issued and alerts in January worked reasonably well, many citizens, and particularly those who had not experienced the 1974 flood, developed little understanding of the size and scale of the impending threat.

Council has developed a very effective set of arrangements to enable it to deal with a major flood event. These arrangements reflect and follow the various Commonwealth and Queensland Government Acts, policies and best practice guidelines pertaining to disaster management. Council has ensured that appropriate disaster management organisational structures are in place and that facilities, equipment and systems are available and most importantly, individuals are nominated for duties and prepared to undertake them through training and exercises. The Report indicates that Council performed very well in this regard, with some areas requiring minor additional effort.

Council demonstrated a very good appreciation of the major risks associated with flooding and has a good capability to detect, monitor and respond to flood events. The importance of an education strategy aimed at improving community knowledge and resilience was well understood by Council and implemented, although there are opportunities for further improvement.

Council's conduct of the flood disaster operations through the Brisbane City Local Disaster Management Group (BCLDMG) chaired by the Lord Mayor provided clear, high level strategic direction to the Local District Coordinating Centre (LDCC). Council's Chief Executive Officer coordinated disaster operations as determined by the BCLDMG through the LDCC and its subordinate entities. Effective strategic level forward planning was undertaken by the Forward Planning Group, including developing the response and recovery concepts. The Field Operations Group was responsible for the conduct of response and recovery operations either directly or through the Regional Incident Management Teams active in each of Council's regions (Central, North, South, East and West). The Disaster Intelligence Group supported the LDCC with the provision of information and intelligence analysis across a range of areas and worked closely with the Flood Information Centre as it provided forecasts, based on analysis of the Bureau of Meteorology (BoM) forecasts and Seqwater data. The Incident Support Group provided communications, administrative and logistics planning and support to the LDCC. The Board assessed that these arrangements worked very well with some scope for minor improvement.

Before and during the flood event Council sought to provide the public with both general and detailed, specific to property, information. All available communication channels were used including print media: newspapers, Council bulletins and notes and large poster displays; electronic media: radio, television and the internet and most significantly social media including Facebook and Twitter which proved remarkably successful in rapidly disseminating information. Council's Call Centre played a very significant role in responding to caller's questions and requests for information. Council's website collapsed under an avalanche of contacts, particularly for flood flag maps for individual properties, and because of band-width limitations. The site was re-established in a more limited fashion within 24 hours, hosted off shore using cloud computing.

In an attempt to provide flood information to a wide range of individuals in a very short time period Council, along with Townsville City Council, had contracted the Early Warning Network System to deliver pre-prepared Short Message System (SMS) messages to the mobile phones of those who had subscribed. Despites Council's efforts to widely publicise the availability and utility of this free system, the take up prior to the flood was disappointing.

All Council staff made an enormous contribution prior to, during and after the flood to ensure that the disaster was properly managed, that safety considerations were a priority, and that the care of people, their property and communities was of paramount importance. Similarly, the contribution by the Lord Mayor and Councillors was highly commendable.

Section Three – Brisbane City Council's Operational Response in the Field

Council's operational response in the suburbs and the Central Business District (CBD) was coordinated and well managed. Decision making authority was delegated so the regionally-based staff could deploy local assets effectively in dealing with local problems. Dedicated operations rooms at the regional level are suggested.

The volunteer response by the citizens of Brisbane was a truly amazing example of the City's spirit. Council's management of the Mud Army, as these volunteers became known, was impressive. The Board's review has identified some matters which should be addressed in future planning. They relate to briefing of volunteers, liaison with residents concerning their wishes and health care arrangements.

Council established two large scale evacuation centres at very short notice. About 2400 evacuees registered at these centres. They were well managed by Red Cross with participation of other Agencies. In a future flood event, evacuation centres should be more decentralized, with arrangements made for areas isolated by flood waters. Issues relating to security, diversity and suitability for handling donated goods need to be addressed in future planning.

The large volume of debris produced by the flood and the major disruption to waste disposal systems posed significant health risks. The use of temporary waste disposal sites, the placement of skips for food waste, and the support of waste disposal contractors, industry volunteers and the broader waste industry were instrumental in the successful response,

Section Four – The Impact of Existing Planning Regulations in Flood Affected Areas

Council is progressively implementing the "Key Actions" recommended by the Lord Mayor's Taskforce on Suburban Flooding (2005). Council does not have a free hand in setting planning regulations for the city. It has to work within the legal framework created by State legislation.

Council's planning regulations and guidelines have been influenced to a significant degree, by the Defined Flood Level (DFL) adopted in 1978. It has been, in part, responsible for guiding development away from flood-prone areas. Almost 90% of residential properties in Brisbane that were flood affected are in areas that had been predominantly developed prior to 1978.

However, the adopted DFL is not without limitations. The time has come to undertake a complete Flood Risk Management analysis of flood affected areas in the city. Though very expensive, the analysis should be seen as vital for an important metropolis. It needs to be constantly borne in mind that large floods do occur in Brisbane; that they occur with unpredictable frequency; and that when they have occurred, great loss and hardship has been caused to the city and its citizens.

Section Five – Flood Prevention, Stormwater and Riverine Infrastructure

The most important infrastructure items for mitigation of flooding from the Brisbane River are the Wivenhoe and Somerset Dams but Council has no statutory role in dam releases or flood mitigation operations. In this Section the engineering options that Council could consider for

flood prevention in Brisbane are reviewed but only two measures, backflow prevention devices and use of levees to protect specific high value infrastructure, are found to be appropriate for further consideration. Detailed review of their feasibility including a full risk analysis would be required to determine whether the use of either would be suitable for specific application.

The flood event in January 2011 was essentially a river flood, with little run-off in Brisbane from local rainfall. The stormwater network system did not add to flood levels. Some flooding was caused by backwater flooding from the river that entered low lying areas through stormwater pipes and open drains. The main impact of the flood on the stormwater system was from the large amounts of silt and debris deposited within the network. Council's rapid response in cleaning all gully pits within the flood affected areas and initiating the major program of works required to remove silt from all of the stormwater system affected by the flood is commended.

The flood caused substantial damage to much of Council's riverine infrastructure. Nearly half of the Floating Riverwalk was washed away. Thirty of Council's 97 river walls failed. At least 34 bank slips occurred on Council sites and six of these are assessed as Very High Risk, four as High Risk and five as Medium Risk. Six stormwater outlets were damaged by scouring or slumping during the flood and require repair. Council owns 23 ferry terminals, four moorings/refuelling stations and 25 pontoons and jetties. Eight of the ferry terminals, two of the moorings and 15 pontoons were significantly damaged. In some cases the damage arose because of the need to locate these facilities to meet their functional requirements in places where they were subject to the full force of the river flood. Reports from independent engineering consultants commissioned to provide advice to Council on reasons for the failure of riverine infrastructure assets is expected to be presented in May 2011. Fortunately, the entire fleet of City Cats and cross river ferries was saved by Council's prompt actions in removing it to safe locations.

Commendations, Affirmations and Recommendations

The Board has arrived at a number of Commendations, Affirmations and Recommendations arising from its consideration of the circumstances relating to the January 2011 Brisbane Flood. The Commendations indicate those actions and activities which the Board considers Council performed at a very high standard. The Affirmations refer to those actions and activities which the Board considers Council performed at a high standard and include Recommendations for further improvement. The Recommendations refer to actions and activities which the Board considers Council should adopt to further improve Council's capability to respond to another such flooding emergency. The Commendations, Affirmations and Recommendations follow.

Commendations

The Board highly commends the actions of Council staff in their preparation for, and response to, the flooding disaster which may appropriately be characterised as well above and beyond that usually expected.

The Board commends Brisbane City Council's disaster management approach and in particular for:

Its compliance with, and implementation of, the various Commonwealth and Queensland Government legislative and policy parameters which direct and inform disaster management arrangements.

,Its integrated response through the BCLDMG with other Queensland and Federal Government agencies and Non-Government Organisations.

Its alignment with the State Disaster Management Plan, and the District Disaster Management Plan.

The Board commends Council's approach to preparing for a possible disaster event over the summer months and, in particular, for the general public warnings and advice in the November - December 2010 period, and for the conduct of readiness training and exercises.

The Board commends Council's approach, during the flood event, in providing public information, advice and alerts using a multi-channel broadcast approach, for print and electronic media, the internet including website, email and social media, telecommunications including Council's Call Centre, mobile SMS and the Early Warning Alert Service (EWAS) and off-line, including the "Living in Brisbane" newsletter, fact sheets, other community newsletters, posters, and outdoor advertising.

The Board commends the efforts of Council's Call Centre and Social Media staff for their untiring efforts to respond, in a calm and helpful manner, to the thousands of requests for information and advice during the flood event.

The Board commends Council's coordination and management of the field operations response through the Field Operations Group (FOG), the Regional Incident Management Teams (RIMTs) and other appropriate Council business units.

The Board commends Council for developing and implementing at short notice a citizens' volunteer management strategy, including establishing the capacity to register, brief, equip and deploy the volunteers to priority recovery locations, and for coordinating and deploying business and professional volunteers (including trades people, contractors and plant operators) and community groups to enhance the pace and efficiency of the cleanup.

The Board commends Council for undertaking a major waste collection and disposal effort for vast quantities of flood debris and household waste, in conjunction with waste disposal contractors, industry volunteers and the broader waste industry.

The Board commends Council's transition to recovery policies and procedures including the establishment of the various Council sub-committees as recommended in the Concept for Recovery document prepared by the Forward Planning Group (FPG), the formation of the Joint Flood Taskforce and the engagement of engineering consultants.

The Board commends Council for its Growth Planning Strategy which envisages growth centres and transport corridors outside potentially flood affected areas and notes that 89.5% of all flood affected residential properties were in areas developed predominantly prior to 1978.

The Board commends Council for its progressive implementation of the recommendations of the Lord Mayor's Taskforce on Suburban Flooding (2005) which has resulted in a reduction in the risk of flooding in recently developed areas.

The Board commends the initiative of Council through its Town Planning Sub-Committee in developing strategies and effective planning instruments to encourage development of flood resilient building design and construction.

The Board commends Council for the rapid response in cleaning gully pits within the flood affected areas and for initiating the major program of works required to remove silt from all of the stormwater system affected by the flood.

The Board commends Council's prompt actions in relocating the entire fleet of City Cats and cross river ferries to safe locations.

The Board commends Council for commissioning independent engineering consultants to provide advice on reasons for the failure of certain riverine infrastructure assets.

Affirmations

The Board affirms Council's approach to its business as usual and risk management policies. The Board **recommends** that:

In relation to Council activities, Information Services Branch reviews its Business Continuity Plans (BCPs) to ensure the capacity exists to maintain the data centre, including an alternative site capable of taking over without delay and to maintain Council's website at all times, particularly during significant disasters.

Line of business managers review BCPs to ensure their ongoing robustness and to capture any lessons learnt from the flood event.

Contracts and arrangements be reviewed to ensure that the business continuity plans for key external outsourced service and infrastructure providers are understood, robust and able to support Council during times of emergency and disaster.

In relation to the Brisbane Central Business District and high-rise residential building inundation, that Council consider hosting a symposium for all affected parties with a view to identifying best practice approaches to ensure improved flooding resilience.

The Board affirms Council's approach to training, exercising and workforce planning in relation to disaster management preparation. The Board **recommends** that further emphasis be placed on:

Individual and team training, including opportunities to attend Emergency Management Australia Disaster and Emergency Response courses;

Workforce planning to reflect a needs analysis including disaster management related job descriptions, and a specific Council term be developed to describe "internal volunteers" to avoid confusion and to reflect the professional nature of the training and tasks; and

Annual exercises continue to be conducted with a theme of "Brisbane Ready for Summer".

The Board affirms the operations and workings of the Local Disaster Coordination Centre (LDCC) and, in particular, the integration of operations (tasking), intelligence, public information, logistics and the coordination with external supporting agencies. The Board **recommends** that:

Further training and development occur for senior appointments including LDCC Incident Controllers and group leaders as well as for more junior appointments.

The Disaster Intelligence Group's structure, manning and core competencies be reviewed and further staff training be conducted.

The Forward Planning Group's responsibilities to the Brisbane City Local Disaster Management Group (BCLDMG) and to the LDCC be examined to remove ambiguity.

Enhancements to process be implemented including:

Ensuring that Situation Reports are well drafted and widely distributed on a regular basis using multiple communications channels;

Developing a readily accessible database of frequently asked questions to address "who does what" to support the LDCC staff and agencies (this could also include information available on Council's Call Centre database);

Synchronising the shifts of Council and agencies staff working in the LDCC to better facilitate handover briefings;

Improvements to logging incoming and outgoing information and tasking; and

Formalising the written briefing processes for handovers between shifts.

The Board affirms Council's flood intelligence management and information dissemination arrangements. The Board **recommends** that Council undertake upgrades to the Flood Information Centre (FIC) along the following lines:

Review and update Standing Operating Procedures (SOPs), including a major update of selected Brisbane River and Creek Flooding SOPs, river flood maps and storm tide maps, property counts and critical infrastructure lists;

Upgrade the Brisbane River Flood Forecast Reporting System to the most extreme flood event (Probable Maximum Flood) and to include a flood forecast system for Brisbane creeks;

Conduct additional training and exercises including with the LDCC and Queensland Government agencies, and develop better communications protocols;

Provide computers capable of GIS modelling tasks and 3D visualisation analysis; and

Provide a dedicated flat screen television for situation awareness and news monitoring.

The Board affirms Council's approach to implementing a range of early warning systems and alert measures across a number of delivery channels. The Board **recommends** that Council examine and develop the range and variety of early warning systems and alert measures; including the proposed National Emergency Warning System, social media platforms and further improve the effectiveness of door knocking.

The Board affirms the contribution of region-based RIMTs noting that they provide a critical layer in the command and control structure for dealing with the on ground situation, managing local resources and coordinating external resources allocated to them. The Board **recommends** that:

A senior officer be assigned to mentor each Regional Incident Management Team Manager and conduct high level discussions with the LDCC;

Dedicated Regional Incident Management Team operations rooms be established; and

Planning for alternative Regional Incident Management Team sites, in the event that the primary sites become unusable, be conducted.

The Board affirms Council's planning for and implementation of evacuation centres as detailed in the Disaster Management Plan. The Board **recommends** that further consideration be given to refining Council's evacuation centre planning to address:

Greater decentralisation of evacuation centres, particularly for communities that are known to be prone to isolation by flooding;

Early and close liaison with Red Cross, particularly in regard to registration of evacuees and vetting of volunteers;

Early and close liaison with Queensland Police Service (QPS) in regard to exclusion of persons not suitable to be in a general public evacuation centre;

The special needs of frail, aged, incapacitated, nursing home and oxygen-dependant evacuees for whom separate and special arrangements need to be made;

Social, cultural and religious diversity of evacuees, including those with a non-English speaking background; and

Purchase and supply of special items such as personal hygiene kits and baby requisites.

The Board affirms Council's action in rapidly increasing sandbag production to a total of more than 390,000. The Board **recommends** that estimates be developed of likely sandbag demand for regions during future flood events and that the best situated potential sites for filling and distribution points in each region be identified.

The Board affirms Council's collaborative efforts with QPS and the Australian Defence Force (ADF) in providing a workable framework for overall traffic management. The Board **recommends** that the Council consider developing advanced plans, in consultation with QPS, to improve traffic flow in flood recovery congested areas including converting some streets into one way, route designation for heavy vehicles and identification for residents' vehicles.

Recommendations

The Board recommends that the term, DFL, be used exclusively in public documents concerning flood planning levels for Brisbane, regardless of the cause of the flooding.

The Board recommends that Council use a more readily understandable description of flood levels (to reflect BoM descriptions).

The Board recommends that effort continue to be put into providing more localised (property, street, suburb and Ward) information regarding inundation and flood level forecasts through a range of channels including the Early Warning Alert Service EWAS, Floodwise Property Report and Flood Flag Maps (including rate notices to draw attention to the existence of the Floodwise Property Report) and flood markers.

The Board recommends that the Flood Flag Map be further developed to enable NearMap data obtained on the morning of 13 January 2011 to be included and accessed.

The Board recommends that Council investigate the Flood COP system and examine its utility, in conjunction with hand held devices, to improve the efficiency and effectiveness of data collection, the provision of information, the prioritisation of tasks and the deployment of resources.

The Board recommends that Council further develop its capabilities to produce flood maps for a larger set of scenarios based on a range of 2 to 20 m^3/s in electronic and hard copy format.

The Board recommends that Council review the disaster management arrangements for a major flooding situation as they apply to Pullenvale Ward.

The Board recommends that Council review the disaster management arrangements for a major flooding situation as they apply to Tennyson Ward to ensure the ongoing provision of a flood-free Ward Office.

The Board recommends that Council examine appropriate ways for Councillors to assist during disaster events, particularly given their community leadership responsibilities and their detailed local knowledge of circumstances and capabilities that exist in their Wards, in a way which does not cut across the existing and appropriate arrangements detailed in Council's disaster management arrangements.

The Board recommends that permanent flood markers be installed on key roads that are known to become flood affected to complement other public awareness and safety campaigns.

The Board recommends Council develop a process for handling donated goods separately from evacuation centres.

The Board recommends Council implement strategies in relation to volunteer clean up activities for:

Development of a proforma briefing sheet for volunteers based on experience gained in this flood event;

Identification of house team leaders to liaise with residents so that clean up activity is in accordance with the residents' wishes;

Ensuring the provision of appropriate health care arrangements to accompany deployed volunteer groups;

In conjunction with QPS, developing processes to ensure the security of flooded residents' dwellings during volunteer cleanup activity; and

Making provision for a co-ordination cell within the LDCC particularly for individual volunteers.

The Board recommends that Council develop a comprehensive single list of potential sites suitable for temporary waste collection, incorporate a liaison officer from the CWS team into the LDCC; and strengthen the link between procurement and waste management during a disaster by establishing a dedicated liaison officer position in the City Waste Services (CWS) team.

The Board recommends that, in relation to planning, Council undertake a complete Flood Risk Management analysis for the area of Brisbane affected by flooding from the Brisbane River and associated tributaries in line with National Flood Risk Advisory Group (NFRAG) and other relevant guidelines. This would require a detailed assessment of the benefits and costs of a full range of flood mitigation options.

The Board recommends that:

Council investigate the feasibility of the installation of devices to prevent backflow from river flooding in locations such as in parts of the Central Business District (CBD) and in high rise buildings which would not have been flooded otherwise, where all those potentially affected by backflow flooding have responsibility for oversight of the maintenance of the device in working order; and

No backflow prevention device should be incorporated into the stormwater network system unless a complete risk based flood management analysis has confirmed that this is the best option.

The Board recommends that Council investigate the feasibility and appropriateness of establishing local levees to protect areas of strategic significance such as the Rocklea Markets. This will require a complete risk based flood management analysis.

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INTRODUCTION

In January 2011, Brisbane experienced the second-highest flood in the past 100 years, after the January 1974 flood. There was major flooding through most of the Brisbane River catchment, most severely in the Lockyer and Bremer catchments where many flood height records were set. The flooding caused substantial loss of life in the Lockyer Valley and thousands of properties were inundated in metropolitan Brisbane.

Seqwater, in its review of the magnitude of the January 2011 flood, concluded that the flood volumes indicated that the volume of the January 2011 flood was almost double that of the January 1974 flood and similar to the February 1893 flood and that peak water levels at gauging stations in the Brisbane River above Wivenhoe Dam were the highest on record.

The Lord Mayor of Brisbane, the Right Honourable Campbell Newman, on 21 January 2011, appointed a Board of Enquiry to review the response to the flood event in Brisbane during the period Sunday 9 January to Saturday 22 January 2011. The Board consisted of Major General Peter Arnison AC, CVO (Retd), Mr Robert Gotterson QC and Emeritus Professor Colin Apelt. The Board's Terms of Reference are given in the List of Attachments.

The primary purpose of the review is to provide Council with an external independent assessment of its flood preparedness and disaster responses to assist it in achieving best practice standards in the future. Council has also indicated that the review will form an integral part of its submissions to the Queensland Government's Commission of Inquiry.

Brisbane City Council is Australia's largest local government authority and serves a population of more than one million people. Council's revenues for financial year 2010 were $2.152 billion and its assets were $21.606 billion (Brisbane City Council Annual Report 2009-10). While the Council's size and financial strength enables it to devote the resources to planning and preparation for a range of emergency contingencies, there is always an overriding need for leadership to ensure that planning and preparation occurs. Such leadership was demonstrated at both the political and organisational levels in Brisbane City Council by the Lord Mayor and his Councillors and by the Chief Executive Officer and his staff.

The Report will address the Terms of Reference in five Sections. Section One examines the characteristics of the flood and the resultant levels including a comparison against the Defined Flood Level and an explanation of terms relating to the probability of flooding occurrence and Defined Flood Levels and events. Section Two deals with the effectiveness of Brisbane City Council's disaster management arrangements including preparation, response and recovery. Section Three considers the effectiveness of Brisbane City Council's response to the flood event, including the actions in inundated areas, the establishment of evacuation centres, the organising and tasking volunteers for the clean up, and waste and debris collection and disposal. Section Four looks at the impact of the existing planning regulations in flood affected areas. Section Five deals with the effectiveness of flood prevention and stormwater infrastructure and the reasons for Brisbane City Council's riverine infrastructure failures. The Terms of Reference require the Board to consider events in the period from Sunday 9 to Saturday 22 January 2011.

The Board has arrived at a number of Commendations, Affirmations and Recommendations arising from its consideration of the circumstances relating to the January 2011 Brisbane Flood. The Commendations indicate those actions and activities which the Board considers Council performed at a very high standard. The Affirmations refer to those actions and activities which the Board considers Council performed at a high standard and include Recommendations for further improvement. The Recommendations refer to actions and activities which the Board considers Council should adopt to further improve Council's capability to respond to another such flooding emergency. The Commendations, Affirmations and Recommendations follow each Section of this Report.

SECTION ONE - THE CHARACTERISTICS OF THE FLOOD

Description of the January 2011 flood event

In January 2011, Brisbane experienced the second-highest flood of the past 100 years, after January 1974. There was major flooding through most of the Brisbane River catchment, most severely in the Lockyer and Bremer catchments where many flood height records were set. The flooding caused substantial loss of life in the Lockyer Valley and thousands of properties were inundated in metropolitan Brisbane, Ipswich and elsewhere. The catchment for the Brisbane River and its tributaries is shown in Map 1.

The Board's approach has been to describe the characteristics of this flood without entering the debate concerning whether these characteristics were affected by human intervention. This description is based on information from the following sources:

Joint Flood Taskforce Report March 2011 (refer List of References)

January 2011 Flood Event - Report on the operation of Somerset Dam and Wivenhoe Dam (refer List of References)

Bureau of Meteorology (BoM) records of flood heights measured at the Alert Water Level gauges along the Brisbane River at the Brisbane City Gauge, Oxley Creek mouth, Jindalee and Moggill and interpolated flood heights at Bellbowrie.

The numerical values of the characteristics of the flood, including rainfall statistics, peak flow rates, peak levels and extents of inundation were still subject to review at the time when this Report was completed, because much of the detailed checking and analysis of data was still in progress. The description provided here is based on the best data available at the time. Nevertheless, it is not intended to be a definitive statement and it is recognised that some details provided here may be revised in the light of further analysis by other authorities.

Antecedent Conditions

Following a record drought period, the annual rainfall for Queensland in 2010 was exceptional, with the year being the wettest on record for the State. Brisbane City recorded the highest annual total since 1974 (BoM) (refer List of References). After such a wet year the catchments of the Brisbane River system and of many other Queensland river systems were saturated and their conditions were such that heavy rainfall would cause rapid run-off of most of the rain that fell. In the 25 days prior to Thursday 6 January, above average levels of rainfall occurred in the catchments of Wivenhoe Dam and Somerset Dam. Further rain fell on those catchments on the morning of 6 January and a flood event was declared. The flood event continued until Wednesday 19 January, the critical period being from 11 to 14 January 2011 when the major flooding occurred in the urban areas of Ipswich and Brisbane.

Rainfall

For the January 2011 flood event, the heaviest rains were inland on the western fringe of the Brisbane River catchment and on the Great Dividing Range.

The estimated average five-day rainfall (from 9am on Friday 7 to 9am on Wednesday 12 January) over the Brisbane River catchment as a whole, based on rainfall captured by the BoM Enviromon rain gauges, was 322mm, with the major sub-catchments of Wivenhoe Dam, Bremer River and Lockyer Creek receiving 370mm, 223mm and 268mm respectively in the same period. However, calculations based on the recorded releases from Wivenhoe Dam and water levels in the dam suggest that significantly more flood-producing rainfall occurred over part of the Wivenhoe catchment, and particularly over the dam storage area, than was recorded in existing rain gauges. Much of this appears to have occurred during an extremely

intense rainfall event beginning early on Tuesday 11 January and lasting for about six hours or more.

The preliminary assessment by Seqwater (refer List of References) indicates that the average rainfalls for the Wivenhoe Dam catchment for durations between 72 hours and 120 hours had Annual Exceedance Probabilities (AEPs) between 1% and 0.5%, i.e. the risk of their being equalled or exceeded in any year is between 1 in 100 and 1 in 200. This highlights the significance of the flood-producing rainfall event. The rainfall intensities varied significantly in the catchment areas above the Dams and at some locations, especially around Wivenhoe Dam, the short duration rainfalls appear to have been extreme with AEPs significantly rarer than 1%.

The rainfall measurements by the rain gauges do not explain all of the recorded inflows and, at the date of this report, analysis by BoM of rainfall was still ongoing, as advised by the Regional Director (Qld) of BoM on 7 April 2011.

For the same period the 5-day rainfall in Brisbane was 193mm. For the three days ending at 9am on Wednesday 12 January, the peak three-day rainfall in Brisbane was 166mm while the peak one-day total was 110mm for the 24 hours ending at 9am on Monday 10 January. The rainfall over Brisbane caused little, if any, flash flooding in Brisbane's suburban creeks. The flooding that did occur in Brisbane's creeks was essentially due to backing up from the flood waters in the Brisbane River.

Flood Resulting from Rainfall

The January 2011 flood event caused a significant river flood in Brisbane. The flow down the upper Brisbane River above Wivenhoe Dam and Stanley River was mitigated substantially by Wivenhoe Dam. However, the pattern of rainfall caused significant flows from the upstream catchments of the Lockyer Creek and Bremer River into the Brisbane River, and Brisbane felt the full force of the flows down these streams. The resulting Brisbane River flood caused thousands of properties to be inundated in metropolitan Brisbane. As noted above, the pattern of rainfall experienced caused little, if any, significant creek flooding within Brisbane, although creeks were flooded by backwater from the river.

The flood levels recorded at Savages Crossing were higher than in 1974. The peak level recorded there was 24.17 metres above Australian Height Datum (m AHD) at 3.40am on Wednesday 12 January 2011, somewhat higher than the peak level of 23.77 m AHD in the January 1974 flood, but not as high as estimated for the 1893 flood event.

The peak level recorded at the Brisbane City Gauge of 4.46m AHD at 4am on Thursday 13 January was higher than the Defined Flood Level (DFL) there of 3.7m AHD but less than the level of 5.45m AHD recorded in 1974. As explained below, the DFLs for the areas of Brisbane where the worst flooding is caused by the river are the peak levels that have been calculated for a flood with the same characteristics as the January 1974 flood but after its effects have been reduced by Wivenhoe Dam.

All the measured flood levels throughout the greater Brisbane area for the January 2011 flood event are higher than the DFLs at the corresponding locations, except towards the river mouth. These flood levels in Brisbane in January 2011 were reduced by the mitigating effect of Wivenhoe Dam. Although some of the relevant data are still to be checked, the Joint Flood Taskforce (refer List of References) concluded that the evidence available shows that the flood runoff caused by the rainfall event of January 2011 was greater than that for the January 1974 flood event and that the January 2011 flood event, as actually experienced, was larger than a flood similar to that of January 1974 after mitigation by Wivenhoe Dam.

Impact of the Bremer River and Lockyer Creek

Floods in Lockyer Creek and the Bremer River added to the flood in the Brisbane River downstream from Wivenhoe Dam. The effects on the Brisbane River flood of these tributary inflows depend on their magnitudes and their timing relative to the peak flow releases from

Wivenhoe Dam. The recorded flood levels in both tributaries indicate that major flood flows occurred in each tributary. Peak water levels in the Lockyer Creek area were the highest on record at Gatton, Glenore Grove and Lyons Bridge, easily exceeding the levels reached in the January 1974 and perhaps even the 1893 flood (Seqwater, refer List of References). The Bremer River also experienced major flooding though the peak water level at Ipswich was lower than that in 1974.

The releases from Wivenhoe Dam were increased rapidly on Tuesday 11 January from 2990 m^3/s at 9am to a peak of 7460 m^3/s at 7pm; they were held at this peak for two hours and then were reduced rapidly to 2550 m^3/s over the next 11 hours. The peak flood level in Lockyer Creek at Lyons Bridge, about 28km upstream from the junction with the Brisbane River, occurred at 5.27pm on 11 January and the peak of the flood in Lockyer Creek would have entered the Brisbane River some time later. This confluence is a short distance downstream from Wivenhoe Dam and the peak of the Lockyer flood would have reached it about the same time that the peak releases from Wivenhoe were passing. These flood peaks may not have been coincident but they were very close in time.

The peak of the flood in the Bremer River would have entered the Brisbane River some time after its peak level at Ipswich at 12.58pm on Wednesday 12 January. The peak level in the Brisbane River at Moggill occurred at 3pm on Wednesday 12 January. The confluence of the Bremer with the Brisbane River is about 20km downstream from Ipswich near Moggill and the peak of the Bremer River flood would have entered the Brisbane River at a time close to that of the occurrence of the Brisbane River peak flow at the confluence.

Although further analysis is required to establish the times of arrival in the Brisbane River of the peak floods from Lockyer Creek and the Bremer River relative to the flood peak as it passed down the Brisbane River, it is clear that the floods from these tributaries contributed substantially to the magnitude of the flood that impacted on Brisbane.

Impact of Wivenhoe Dam

The calculated dam inflow hydrographs show two peaks. The first peak of 10,100 m^3/s at 8.00am on Monday 10 January was similar in magnitude to that of 1974 and the second of 11,600 m^3/s at 1pm on Tuesday 11 January was even greater. The estimated flood volume inflows to Wivenhoe Dam based on these calculations total 2650 GL, as compared to a total of 1410 GL for that location in 1974 and 2744 GL in February 1893. (Note: 1GL = one million cubic metres).

At Full Supply Level (FSL), 67.0m AHD, the storage capacity of Wivenhoe Dam is 1165 GL. The temporary flood storage capacity above FSL is 1450 GL. Thus, the maximum total storage of the Dam is 2615 GL, slightly less than the total flood volume inflows during the January 2011 flood event. As required by the current policy settings, Wivenhoe Dam was at FSL at the beginning of the flood event and only the temporary flood storage capacity above FSL was available for flood mitigation. The operation of the dam mitigated the flood inflows and limited the peak releases to 7460 m^3/s for two hours from 7pm on Tuesday 11 January 2011, a reduction to 64% of the inflow peak.

Specific Situations along the River

The times when the flood peak reached particular locations along Brisbane River and the peak level at each location are given in Table A. These locations are shown in Map 2. The time lapse from the start of the peak releases from Wivenhoe Dam to the time of the peak flood level at the Brisbane City Gauge was about 32 hours. The LDCC received details of actual and predicted releases from Wivenhoe Dam at 3.48am on Wednesday 12 January 2011.

Gauge Location along river	Peak Flood Level m AHD	Time of occurrence of peak level
Moggill	17.86	3pm, 12 January
Bellbowrie	14.86	6pm, 12 January
Jindalee	12.89	7.59pm, 12 January
Oxley Ck mouth	9.27	11.41pm, 12 January
Brisbane City	4.46	4am, 13 January

Table A. Times of occurrence of peak flood levels

The flood level hydrographs, the time histories of flood levels as metres above AHD, at the locations in Table A are shown in Figure 1 below. The hydrograph at each location shows how the flood level rose continually as the flood wave travelled down the river, reached its peak and then receded. The tidal variations appear superimposed on the flood wave and this is particularly noticeable in the hydrograph for Brisbane City. The set of hydrographs show the relative timing of the arrival of the flood peak and the reductions in the absolute and in the relative flood levels as the flood travelled down the river. As the flood wave moved downstream these changes occurred largely because the river bed becomes lower, the main river channel widens and increasing proportions of flood waters spread out over the widening flood plains.

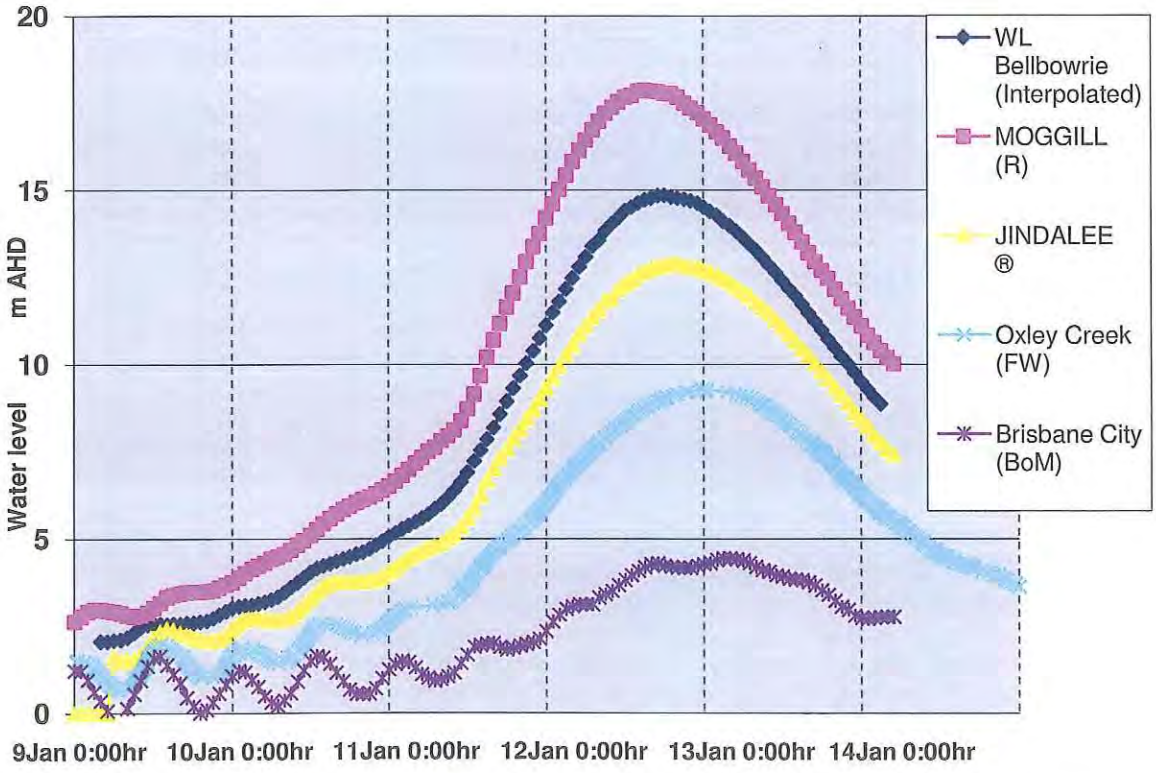


Figure 1. Flood level hydrographs for January 2011 flood event at locations along the Brisbane River

For residents affected by flooding, the more important information is the time when flooding becomes a matter of concern to them and the duration of that flooding. This information is given in Table B for the same locations as those in Table A. The flood levels corresponding to 'Moderate' and 'Major' flooding as defined by BoM are shown together with the time when

each level was exceeded and the length of time during which the flood was above that level. In addition, the local DFL is given with the times and durations when it was exceeded. The DFL is higher than the level for a 'Major' flood at each location. The flood level in the January 2011 Flood Event was above the DFL for about one day in each of the locations in Table B. The durations of flooding at lower levels were considerably longer. A detailed explanation of the DFL and related concepts is given below.

Gauge Location	Moggill	Bellbowrie	Jindalee	Oxley Ck mouth	Brisbane City
Moderate flood; m AHD	13.00 m	11.00 m	8.00 m	3.50 m	2.60 m
Time start Date	9.06pm 11/01	11.39pm 11/01	7.33pm 11/01	11.07am 11/01	0.57am 12/01
Duration; hrs:min	43.30	42.00	54.00	95.00	52.30
Major flood; m AHD	15.50 m	12.00 m	10.00 m	5.50 m	3.50 m
Time Start Date	3.12am 12/01	2.32am 12/01	2.13am 12/01	9.32pm 11/01	10.00am 12/01
Duration; hrs:min	28.00	35.00	39.00	56.00	32.00
DFL; m AHD	16.20 m	13.80 m	11.40 m	8.00 m	3.70 m
Time start Date	5.13am 12/01	8.51am 12/01	7.16am 12/01	9.36am 12/01	11.15am 12/01
Duration; hrs:min	23.30	20.30	27.00	29.00	29.30

Table B. Times and durations of exceedances of flood level thresholds

The definitions of Minor, Moderate and Major flooding, as used by BoM are:

Minor flooding: causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded.

Moderate flooding: low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered.

Major flooding: appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.

The extent of flooding during the January 2011 Flood Event and the line of DFLs for the whole of Brisbane are shown in Map 3. This information is given in greater detail for South Brisbane, Tennyson, Rosalie Area, Rocklea and Bellbowrie in Maps 4 to 8 respectively.

Defined Flood Event, Defined Flood Level and Q100

Planning requirements for land use and development in Brisbane for areas that can be affected by flooding make use of the Defined Flood Level and related concepts, explained below.

The Defined Flood Event (DFE) is the flood event from which the Defined Flood Levels are calculated to establish the flood control lines for land planning and development.

The Defined Flood Level (DFL) is the peak flood level calculated for the Defined Flood Event at a particular location. It is used to inform land planning and development at that location.

Q100 is a theoretical flood that is commonly used to inform planning and policy. It is not a 'real flood' but, rather, it is a theoretical, probability-based design flood event that is chosen to reflect typical combinations of flood producing and flood modifying factors that act together to produce a flood event that has a 1 in 100 (1%) chance of being equalled or exceeded in each and every year at a particular location of interest. It is also described as the flood with 1% Annual Exceedance Probability (1% AEP), or with an Average Recurrence Interval of 100 years (ARI 100).

In many jurisdictions in Australia, the DFE for a particular location is chosen to be the Q100 for that location and the DFL is the peak flood level calculated for that theoretical flood.

It must be stressed, however, that Brisbane City Council has adopted a DFE that is larger than Q100 in the areas where the worst flooding is due to Brisbane River floods, rather than creek flooding, and the corresponding DFL is higher than that associated with Q100. The DFE for Brisbane, initially adopted in 1978, corresponds to the flood event of January 1974 after it has been mitigated (i.e. reduced) by the effects of Wivenhoe Dam and the corresponding DFLs are the peak levels that were calculated for this mitigated flood. The DFL at the Brisbane City Gauge was set then at 3.7m AHD.

In 2003, Council commissioned an Independent Review Panel to provide independent expert advice on estimates of the Q100 flow and level at the City Gauge, sometimes referred to as the Brisbane Port Office. The final outcome from the Independent Review Panel Report (2003) (refer List of References), drawing on the SKM 2003 flood study (refer List of References) was that, for a flood with 1% AEP, the best current (i.e. 2003) estimates give a Q100 flow of 6000 m^3/s at the Brisbane City Gauge and a corresponding flood level of 3.3 m AHD.

This estimate of the Q100 is, in general, a slightly lesser flood than the DFE that was adopted in 1978. The Independent Review Panel stressed the inevitable degree of uncertainty in estimates of this kind and it considered the possible range for Q100 at this location to be 5000 to 7000 m^3/s and the associated range of levels to be 2.8 to 3.8m AHD. It advised that the DFL adopted in 1978 should not be lowered. Council subsequently resolved to continue to use the DFE and DFL that were adopted in 1978 and these have been maintained unchanged since then.

The DFL increases progressively in level with increasing distance upstream from the City Gauge. The DFL is shown as a red line in for the whole of Brisbane and in greater detail for South Brisbane, Tennyson, Rosalie Area, Rocklea and Bellbowrie in Maps 3 to 8. The orange hatchings show the areas that would be inundated by creek flooding if there was no simultaneous river flooding. This is for local 100 year ARI floods in the creeks. At varying distances from the Brisbane River, the levels of flooding caused by the 100 year ARI creek floods are higher than the DFL that is associated with the river flood.

Defined Flood Level for Creek Flooding

In many areas of Brisbane, the worst flooding is caused by local creeks, not by flooding from the Brisbane River. In these areas, the 100 year ARI flood has been adopted as the DFE and DFLs have been calculated from Q100. Consequently, for each particular location, the DFL is the higher of the level that has been adopted for Brisbane River flooding and that calculated

for creek flooding. This can be a continuing cause of confusion that would be reduced if all reference to 'Q100' were eliminated from public documents and the description 'Defined Flood Level' were used exclusively, regardless of the cause of flooding and of the degree of immunity associated with it.

Summary Comments on the Magnitude of the January 2011 Flood Event

Historical comparisons

Flood records for Brisbane, held by the BoM and Queensland, extend back as far as the 1840s. These records show that Brisbane is a city built on the flood plain of a river with a history of flooding. The flood peaks are referenced to the Brisbane City Gauge and the flood levels reached upstream are significantly higher. Table C below shows flood levels on the Brisbane and Bremer Rivers and Lockyer Creek for a selected number of river flood events.

River Height Station (m AHD)	Feb 1893	Feb 1931	Jan 1974	Jan 2011
Gatton (Lockyer)	16.33	9.14	14.63	> 16
Ipswich (Bremer)	24.50	15.50	20.70	19.25
Mt Crosby	32.00	21.78	26.74	n/a
Moggill	24.50	15.40	19.93	17.86
Jindalee	17.90	9.60	14.10	12.89
Brisbane City Gauge	8.35	3.32	5.45	4.46

Table C. Peak levels for selected flood events

The floods of 1841 and 1893 reached over 8m AHD in Brisbane City. This represents a depth of approximately 6.5m above the highest tide level. Since 1893, the largest flood in the Brisbane - Bremer systems was in 1974. In Brisbane, the January 1974 flood rose to a height of 5.45m at Brisbane City Gauge while Ipswich reached a height of 20.7m. As the Brisbane River flooded, it backed up the Bremer River resulting in four to five days of record heights in Ipswich.

The history of flooding in Brisbane is illustrated in Figure 2 below. The graph is based on BoM's record of Highest Annual Flood Peaks as estimated or recorded at the Brisbane City Gauge for the period since 1840. The January 2011 flood (4.46m at Brisbane City Gauge) has been added to the original BoM graph that was prepared in 2009. In some years, particularly in 1893, there were several large floods but the graph shows only the largest flood for each year.

As shown in the graph, for the period 1840 to 1900, there were 15 floods which were classified as Moderate or Major. By contrast, in each of the periods 1901 to 1960 and 1961 to 2011, there were only two floods which were classified as Moderate or Major.

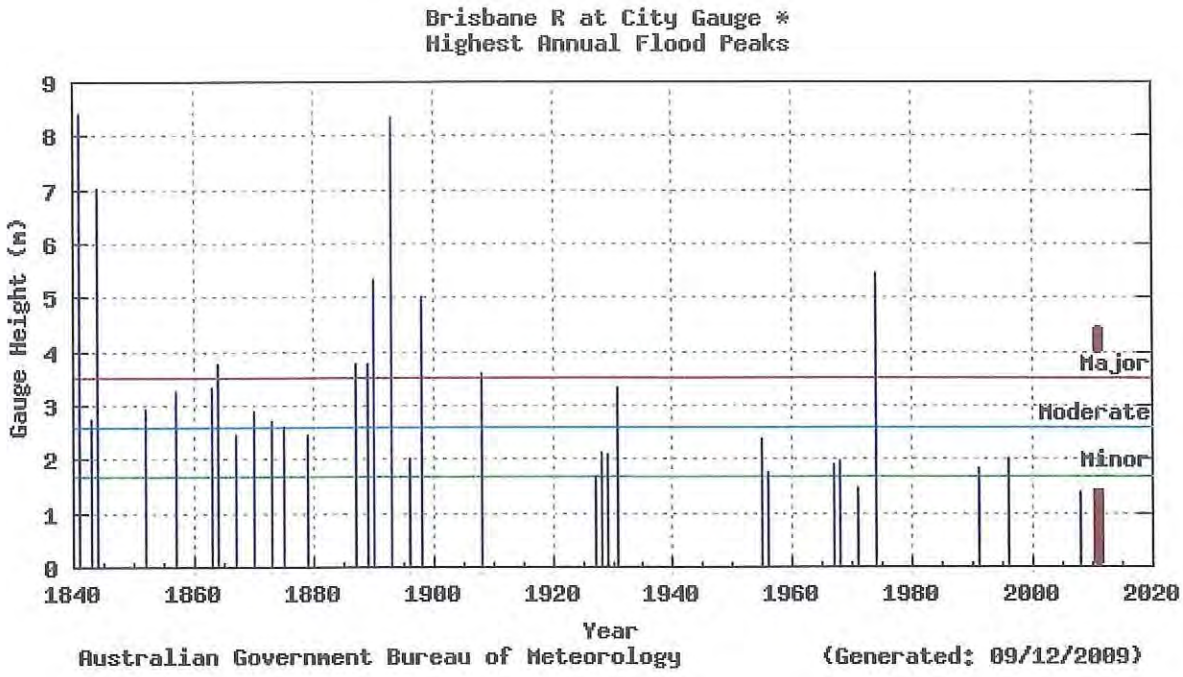


Figure 2. History of flooding in Brisbane – original by BoM with 2011 data added

Seqwater Summary

In its review of the magnitude of the January 2011 flood event the Seqwater Report (refer List of References) concludes that

> The flood volumes indicate the volume of the January 2011 flood event was almost double that of the January 1974 flood and similar to that of the February 1893 flood;
>
> Peak water levels at gauging stations in the Brisbane River above Wivenhoe Dam were the highest on record. In the Lockyer Valley, peak water levels exceeded the 1974 levels and may well have been larger than those of 1893;
>
> The recorded peak flows, volumes and peak levels at Somerset and Wivenhoe Dams indicate the January 2011 flood event was much more extreme than one with 1% AEP; and
>
> Overall, the January 2011 flood event is considered to represent a 'rare event' as defined by Australian Rainfall & Runoff (AR&R) in terms of rainfall, flood peaks, inflow volume and peak heights.

Both the historical comparisons and the Seqwater Report clearly show that the January 2011 flood was a rare and large flood event.

Recommendation

The Board recommends that the term, Defined Flood Level, be used exclusively in public documents concerning flood planning levels for Brisbane, regardless of the cause of the flooding.

SECTION TWO - BRISBANE CITY COUNCIL'S DISASTER MANAGEMENT ARRANGEMENTS INCLUDING PREPARATION, RESPONSE AND RECOVERY

This section of the Report examines Brisbane City Council's preparation for, and response to, the major flood event in Brisbane during the period 9 to 22 January 2011. It discusses the legislative and policy settings which inform local authorities' duties and responsibilities, examines Council's preparation in relation to its policies, procedures and organisational structures and facilities, and explores the efficacy of Council's response to the flooding disaster.

Legislative and Policy Settings

Australian Emergency Manual Series (Commonwealth) This series of manuals, produced by the Federal Government Attorney General's Department through Emergency Management Australia, provide planning advice and operational guidance for a range of natural disasters including floods. The relevant manuals for this disaster include: Managing the Floodplain (Manual 19), Flood Preparedness (Manual 20), Flood Response (Manual 22), and Evacuation Planning.

From an analysis of these manuals against Council's response to the flood, it is apparent that Council has a very good appreciation of the risks associated with flooding, has in place a good capability to detect, monitor and respond to flood events and has a high order understanding of the importance of an education strategy aimed at improving community knowledge and resilience. Council performed well against the criteria for effective management of flood response operations identified in the manuals.

Disaster Management Act 2003 (Qld) The *Disaster Management Act 2003*, amended on 1 November 2010, forms the legislative basis for disaster management activities within all levels of Government in Queensland. The 2010 amendments focused on the delegation of District Disaster Coordination responsibilities to the Queensland Police Service (QPS), adjusting the authorities and criteria for declaration of a disaster and refining Local Disaster Management structures.

The key legislative requirements for Council involve establishing and providing the Chairperson for the Brisbane City Local Disaster Management Group (BCLDMG) which is required to meet at least six-monthly, and is responsible for maintaining a current and endorsed local Disaster Management Plan, a disaster response capability, for ensuring the District Disaster Coordinator is informed of events, and for appointing an appropriate senior and experienced Council officer as the Local Disaster Coordinator.

Council has a current, detailed Disaster Management Plan with appropriate supporting structures comprising the BCLDMG and the Local Disaster Coordination Centre (LDCC).

It is assessed that the legislative requirements in the *Disaster Management Act 2003* are supported by the disaster management arrangements maintained by Council and that the State-level disaster management legislation and guidelines were all supportive of the response arrangements in place for Brisbane.

Stakeholders indicated the powers invested in Council's disaster management organisation and those available to civil authorities and emergency services are more than adequate for an incident of this scale and nature. As a result, there were no issues regarding the impact of legislation, policies or guidelines on Council's ability to manage the disaster effectively.

Public Preservation Safety Act 1986 (Qld) The *Public Preservation Safety Act 1986* is an Act to provide protection for members of the public in terrorist, chemical, biological, radiological or other emergencies that create, or may create danger of death, injury or

distress to any person, loss of or damage to any property or pollution of the environment and for other related purposes.

The operational activities undertaken by Council in response to the January 2011 flood are assessed as being consistent with the *Public Preservation Safety Act (1986).*

State Planning Policy (SPP) 1/03 – Mitigating the Adverse Impacts of Flood, Bushfire and Landslide This policy is aimed at ensuring that the natural hazards of flood, bushfires and landslides are adequately considered when making decisions about development. The application of this policy at local government level is achieved through specific building codes and regulations as well as wider town planning mechanisms. For Council, City Plan provides one of the strategic mechanisms for guiding development. The current City Plan was adopted in 2000 and has been updated every six months since.

State Disaster Management Group (SDMG) Guidelines Analysis of SDMG documents indicates that Council disaster management documentation, plans and response structures aligned with the various guidelines and that Council officers had a very good to good understanding of these guidelines, especially those who had undertaken formal training conducted by Emergency Management Australia (EMA).

Council Policy Settings

Business as Usual Activities An analysis of Council policies in relation to Council's preparation for, and response to, the flood event indicated that they were relevant, appropriate and well understood. Policies considered included the Environmental Policy, Sustainability Policy, and the Media Relations Policy.

During the response and recovery phases sensible flexibility was shown, particularly in relation to the Environmental Policy, where the sheer volume of flood debris and waste and the possible adverse impact on public health, required expedient measures to be adopted. As the crisis eased, these measures were no longer required or used.

Risk Management Framework and Business Continuity Plans An examination of Council's Risk Management and Business Continuity Plans (BCPs) indicated that Council rated flooding as an extreme risk. Following the Lord Mayor's Task Force on Suburban Flooding (2005) and analysis of various local storm water flood events, and The Gap Storm in 2008, Council implemented a continual improvement process in relation to Risk Management and Business Continuity Plans.

In December 2010, risk managers were tasked to review their BCPs and adjust policy and practice as appropriate. This proved to be both sensible and prudent.

During the January 2011 flood, Council maintained corporate level BCPs for critical community services including; the customer Call Centre, flood warnings, regulatory services, the road network, transport bus services and waste management. At the divisional level, BCPs are maintained for critical support functions including; cash flow, commercial services, corporate accommodation, human resources, information communications technology, and media and communications.

An area of concern which emerged related to entities delivering outsourced functions to Council. In some cases the existences or otherwise of BCPs for entities providing outsourced services was not well understood. This is worthy of further investigation by Council, particularly as it relates to outsourced backup wireless communications.

Other unanticipated issues that arose during the flood event related to the Brisbane Square site power supply and Council's data centres. While a backup power supply system with diesel powered generators was in place at Brisbane Square, there were some uncertainties relating to fuel availability and supply. In relation to the data centres, Council servers are located in two sites at Brisbane Square and Holland Park. Concern was expressed that if the

Brisbane Square was evacuated or if its data centre failed, it could take several days to have the alternate server site at Holland Park fully operational.

While the Business Continuity program may be regarded as close to best practice as it is well aligned with industry standards in terms of governance, development and maintenance, testing and training, there are some areas, as discussed above, worthy of further examination.

Council Disaster Management - Policies and Plans

Council's Disaster Management Arrangements Council's disaster management arrangements are expressed through the Disaster Management Plan and the Concept of Operations for Disaster Management. The Disaster Management Plan details the arrangements undertaken by Council to meet its obligations under the *Disaster Management Act 2003 (Qld)*. The plan outlines the disaster management system and specifies roles and responsibilities. It describes how the system works during an emergency, provides a framework of sub-plans for the most likely threats and for the recovery phase. The Concept of Operations for Disaster Operations adds detail to the Disaster Management Plan by outlining the manner in which Council will undertake the various tasks to respond to the emergency. Essentially it details the structures, functions, and responsibilities necessary to deal with the emergency and transition to recovery and business as usual.

Disaster Management Plan (DMP) Council's DMP was reviewed in October 2010 and provides the methodology by which Council responds to natural disasters, detailing structures, responsibilities and procedures across the organisation. Part 2 of the plan includes specific operational plans covering evacuation and emergency human services, bushfires, inundation from river floods and storm surge, pandemics, environmental health and the evacuation of Moreton Bay Islands. The Inundation Plan was updated in June 2010.

The DMP is a dynamic document with the current version updated recently and approved by Council while this report was being drafted. The DMP is assessed as well structured and the content has a very high degree of correlation with the extant risk assessment for natural hazards. The inclusion of specific operational plans enhances the utility of the DMP. The four 'Levels of Activation' that govern the degree of response are assessed as appropriate, allowing sufficient flexibility to scale internal and external response mechanisms.

The DMP proved to be very effective in guiding the Council response to the flood. Specifically, the Inundation Operational Plan indicates that the Council mission "was to coordinate the deployment of internal and external resources to reduce or eliminate potential loss of life or property and restore pre-inundation services as quickly as possible".

Analysis of the response indicates this mission was achieved for the January 2011 floods with a high degree of success. Fatalities were minimised (only one death recorded in the greater Brisbane area that was linked to the flood event, compared to around 14 people who died in the Brisbane and Ipswich areas during the January 1974 flood), (Bureau of Meteorology Report 1974) (refer List of References). The overall coordination of internal and external resources was extremely effective and Council undertook all actions that were feasible to protect property given the level of the flood and timeframes experienced.

The principles and priorities identified in the DMP are deemed appropriate and were consistently reflected in operational activities by Council during the flood.

Concept of Operations for Disaster Management The Concept of Operations was revised in November 2009 and details the structures, functions and responsibilities required to respond to an emergency. It conforms with, and reflects, the Queensland disaster management arrangements with a focus on Brisbane City disaster management arrangements. It details the roles and responsibilities of the BCLDMG and the LDCC, outlines the flexible and scalable approach for activations, provides for the appointment of the

Disaster Operations Manager (DOM) and the Disaster Management Group (DMG) and provides guidance on concepts for recovery and transition to business as usual.

Disaster Management – Structures and Arrangements

Brisbane City Council Local Disaster Management Group (BCLDMG) The BCLDMG is chaired by the Lord Mayor. The role of the BCLDMG is to manage the disaster response to an event to the recovery phase in order to minimise adverse effects on the community, the natural environment, the built environment and the economy. The BCLDMG maintains a strategic approach by setting priorities and assigning resources to ensure the efficient and effective recovery of the disaster-affected community.

The BCLDMG is responsible for ensuring that disaster management and disaster operations in the Brisbane area are conducted consistently with the legislative and strategic policy framework for disaster management as enunciated by the State.

Local Disaster Coordination Centre (LDCC) The LDCC coordinates and prioritises the use of resources and assets to support Council's response and recovery operations. The LDCC is responsible for the implementation of BCLDMG priorities and reports directly to the BCLDMG. At higher levels of activation, the LDCC contains a number of specialist groups that undertake the detailed work in relation to the incident or event. These groups include the Forward Planning Group, the Field Operations Group (FOG), the Disaster Intelligence Group and the Incident Support Group. LDCC activities are coordinated by the LDCC Incident Controller, a senior Council Officer experienced in disaster management.

Forward Planning Group (FPG) The FPG is the strategic planning and advisory unit for the BCLDMG. The FPG supports the BCLDMG's decision making process, formulates strategic guidance on behalf of the BCLDMG, develops and delivers forward planning options (response and recovery considerations) to the BCLDMG, develops and manages the BCLDMG response and recovery agenda including consideration of agenda issues, provides a forum for consultation between the BCLDMG and other appropriate government departments, including State and Federal, undertakes consequence analysis and management, provides a strong communication network between the business community, responding agencies and non-government organisations at the strategic level, and provides a 'think tank' capacity beyond current operations.

Field Operations Group (FOG) The FOG coordinates and manages Council's operational response and internal logistical support to a disaster event, operating under the control of the LDCC Incident Controller. It assigns tasks to the Regional Incident Management Teams or other appropriate Council business units for implementation or action and provides information to the LDCC Incident Controller on the progress of Council's on-ground response as well as highlighting emerging issues. Further, the FOG establishes a close operational relationship with the Disaster Intelligence Group to ensure shared situational awareness and relevant information collection as well as identifying resource shortfalls and the requirement for additional Council or external support using Council procurement guidelines. Finally it conducts current operational planning for the 0-72 hours planning horizon.

Disaster Intelligence Group (DIG) The DIG has prime carriage of the intelligence function within the LDCC. It is responsible for collecting, collating, assessing, analysing and disseminating information in a timely manner to support the LDCC's planning, operations and logistics activities. The DIG develops an Intelligence Support Plan to inform LDCC current and future operations. It identifies critical information requirements and information gaps and ensures that key reporting requirements are met. It manages the collection of information through Rapid Assessment Teams (RAT) and other Council sources and verifies open source information from all sources. The RAT are provided by the five Compliance and Regulatory Services (CARS) regional offices and are coordinated and tasked by, and report back to, the DIG. The DIG undertakes analysis and assessment on information provided to identify key issues and priorities, disseminates intelligence to the LDCC, maintains a high level of

situation awareness and ensures that the LDCC Incident Controller is advised of emerging issues.

Incident Support Group (ISG) The ISG provides administrative, logistics and crisis communications support functions to the LDCC. Its administrative support function involves monitoring staff rosters and fatigue management, coordinating Liaison Officers assigned for logistics purposes, managing shift handover and briefings and ensuring appropriate catering arrangement are in place. Its logistics support function includes managing contract support, coordinating resources augmentation and actioning requests for assistance from external sources. In relation to crisis communications, it develops messages for dissemination to Council's key stakeholders, manages messages and perceptions regarding the event and maintains liaison with the Council's Call Centre regarding key flood event messages.

Regional Incident Management Teams (RIMT) The RIMT conduct activities at the regional level in accordance with tasks allocated by the FOG (LDCC). RIMTs exercise command, control and coordination of Council assets within their respective region and provide feedback information to the LDCC.

Activation Four levels of activation are detailed in the Concept of Operations to provide a flexible and scalable response. At Level One, the response is managed through Council business functions and normal incident response reporting. At Level Two, the response relates to a localised situation and is managed by the appropriate Council business unit manager as determined by circumstances and who is appointed the Disaster Operations Manager (DOM). The DOM notifies and informs key internal and external stakeholders of the incident and provides advice regarding the likelihood of incident escalation and the requirement for subsequent activation to Levels Three and Four. At Level Three, the response relates to a more serious situation requiring Council-wide actions and triggers the activation of the LDCC, including expanded functions being placed on standby for possible activation to Level Four. At Level Four, the response requires high level coordination of a complex range of issues and requires the full activation of the LDCC functions.

Flood Information Centre (FIC) The FIC, unlike the BCLDMG and the LDCC and its components, operates on a permanent basis providing river state and flooding information to Council and especially to Council's Call Centre, for advice to the general public, during the more regular storm and flash flooding events that occur across the Brisbane River and its tributaries. During a major event, and when the LDCC is stood up, it provides all flood information to the LDCC in the form of situation reports, flood inundation maps and flooding interpretation to provide local flood levels. To inform its deliberations, the FIC is advised by BoM on weather predictions and modelling, and by Seqwater in relation to dam operations including their operating strategies and their view of downstream impacts. Based on this analysis, flood maps are provided both in hard copy and soft copy (PDF formats).

Council's disaster management structures and arrangements are shown diagrammatically at Figure 3 opposite.

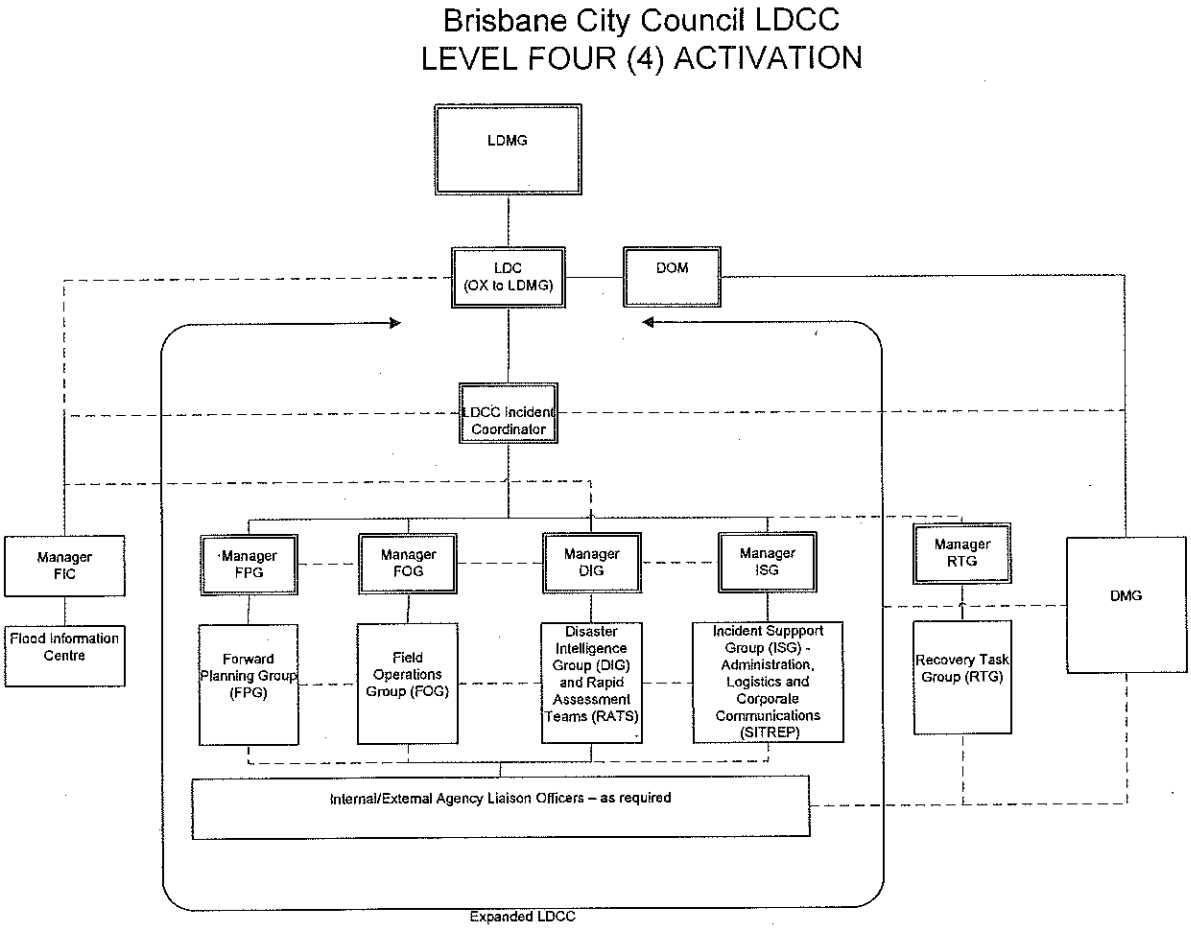


Figure 3. Council's disaster management structures and arrangements

Disaster Management Preparation

Emergency Management Australia Disaster management training conducted by Emergency Management Australia has been invaluable, particularly in building understanding and confidence regarding the division of responsibilities between command (management) aspects and operations, plans, intelligence, logistics, and administrative functions as well as gaining an overview of the capabilities of various external agencies. This training was particularly beneficial to Council staff operating the RIMTs.

Council Training Prior to the flood, Council had a number of staff experienced in disaster management who provided the basis for disaster management preparation and training and who were supported by other staff from various Council Divisions and Business units, trained in additional duties to provide support in emergency situations on an as-required basis. Such additional staff members are informally referred to by Council, as "internal volunteers". Selected internal volunteer staff are recruited from Council Divisions and Business units and trained across all roles in the LDCC including the senior leadership roles of Incident Controller and Group Managers for the FPG, FOG, DIG and ISG.

Council's DMG designs a training strategy and framework using both internal and external trainers to develop the individual skills for LDCC and RIMT staff across all required roles and tasks. An important element of the framework is the Incident Controllers' development program which is conducted by Council disaster management staff supported by Emergency Management Australia and Emergency Management Queensland. Incident Controllers may be assessed by the Australian Institute of Emergency Management to advise on their level of proficiency. Training completed prior to the January 2011 flood event included an Incident Controller development program and workshops for Incident Controllers, Situation Report Writers, and Motorola radio training.

The term "internal volunteer" caused confusion, particularly when community volunteers were being sought for the cleanup operations and as it is also applied to State Emergency Service (SES) volunteers and those volunteering plant and equipment to support Council's response operations.

Readiness Exercises In the lead up to the summer storm period, Council implements an annual storm awareness program to highlight the importance of being prepared for major storms and potential flooding, based on recommendations from the Lord Mayor's Taskforce on Suburban Flooding (2005).

Training, testing and scenario planning programs and procedures have continued to evolve over a long period of time using the learnings from events such as The Gap storm. Each time the LDCC is activated, there has been a process implemented to review and identify opportunities for improvements.

In October 2010, and cognisant of long-range weather forecasts, the exercise program was modified to emphasise potential major river flood events. The emphasis and direction provided by the Lord Mayor, the CEO and senior management facilitated an increased focus on training, testing and scenario planning. Details were widely communicated internally to Council staff to ensure Council more generally was also ready for any potential major natural disaster.

Overall, the training and exercises conducted within Council, coordinated by the Disaster Response and Recovery Group, is assessed as very effective and timely in preparing Council for the flood disaster. A particular characteristic of the January 2011 flood response was the provision of significant external to Council resources, such as the ADF, SES, NGO's and heavy plant and equipment resources voluntarily provided by industrial contractors. Based on this experience, scope would seem to exist for a wider training program and progression to more complex exercises in which external agencies play an active role.

Along with larger exercises, desktop exercises are a very good mechanism for team skill development. It was particularly prescient that the desktop exercise conducted in December 2010 for the Executive Management Team and elements of the LDCC had major river flooding in Brisbane as one of its scenarios.

Workforce Planning Council uses an expression of interest process to attract internal volunteers to staff the LDCC and other disaster management organisations. While this worked well during the January 2011 flood event, a combination of the duration and the highest level of activation created stresses and indicated that a more formal approach to disaster workforce planning is required, particularly as in some instances staff worked both in the LDCC and also in their business as usual Council role resulting in very long hours on duty.

It is understood that Council is developing a new workforce plan to address the complex issues of training, fatigue and staff turnover and the requirement to step into other roles as well as to ensure best practice Industrial Relations policies and procedures are facilitated. This decision is commended and recommended to be implemented as a high priority.

Finally, the Board wishes to express the view in the strongest possible terms that Council staff made a very significant commitment in time and effort to ensure the flooding disaster was properly managed, that safety considerations were a priority, that the care of people, their communities and their property was the paramount consideration, and that Council services were delivered appropriately. This was a most commendable effort and particularly so against a backdrop where a number of Council staff were personally affected by flooding.

Conduct of the Flood Disaster Operations

Background Chronology Heavy rainfall during the week prior to the flood crisis between Sunday 2 and Sunday 9 January 2011, together with advice from the FIC led to the decision to activate the LDCC at 9pm on Sunday 9 January 2011. Subsequently, on Tuesday 11 January 2011, the LDCC was raised to its highest level of activation (Level Four) where it remained until 25 January 2011 and then continued at lower levels of staffing until Friday 1 April 2011. The LDMG was convened for its first meeting at 10am on Tuesday 11 January 2011 and met daily until Saturday 22 January 2011. On Tuesday 11 January 2011, the Premier of Queensland, the Honourable Anna Bligh MP, under the *Public Preservation Safety Act 1986 (Qld)* declared flood affected areas of Queensland, including Brisbane, a "disaster zone". This declaration remained in force until 10am on Tuesday 25 January 2011.

A more detailed chronology is provided after the Conclusion of this Report.

High Level Relationships The BCLDMG provided strong leadership and strategic direction setting for the response to the floods, establishing clear priorities and effectively utilising resources available from internal sources and external agencies. The BCLDMG undertook broad strategic analysis and provided clear direction to the LDCC.

Following the daily BCLDMG meetings, key communication messages for the public were developed and disseminated to all media sources. The Lord Mayor's sound leadership and clear and direct communication style were very effective and drew positive comments in response to interviews and in the feedback received from the residents and businesses community engagement survey.

The CEO, as the Local District Coordinator, under Section 36 of the *Disaster Management Act 2003 (Qld)* is charged with coordinating disaster operations for the BCLDMG. He does this by ensuring that the LDCC is properly established and functioning effectively and by making himself available to the LDCC Incident Controllers and other LDCC staff as appropriate. He also represents the BCLDMG at the Brisbane District Disaster Management Group and the State Disaster Management Group (SDMG) as appropriate and when required.

To further ensure sound working relationships, senior staff from the LDCC attend the BCLDMG meetings and this enables them to gain a clear understanding of the considerations behind the various decisions, thus avoiding problems of ambiguity and misinterpretation.

The Board assessed that the BCLDMG set a very high standard for responding to natural disasters at the strategic level.

The Board assessed that the relationship between the BCLDMG and the LDCC was both appropriate and effective, and ensured that strategic directives and plans emanating from the LDCC were well understood and effectively implemented.

Close and constructive relationships were established between the BCLDMG and the District Disaster Management Group (DDMG) and the SDMG. At the State level, the Deputy Premier, the Honourable Paul Lucas MP attended the BCLDMG meetings which ensured that the Queensland Government was abreast of, and able to support, the Council's response. At the District Level, Assistant Commissioner Peter Martin Queensland Police Service (QPS), the District Disaster Coordinator, also attended the BCLDMG meetings. While support from the Commonwealth Government, particularly from the Australian Defence Force (ADF), was both invaluable and highly effective, especially during the recovery phase of the operation, Council was generally able to meet most of its needs, due to its size and resource availability, thus allowing scarce, high-value resources to be directed to other disaster areas outside of Brisbane.

The Board assessed that relationships between the BCLDMG and the DDMG and SDMG were appropriate and effective, displaying high levels of cooperation. Unfortunately, the

Board was unable to confirm this opinion directly with Queensland Government representatives or agencies as they declined the Board's invitation to discuss these matters.

Command, Control, Coordination, Communications and Leadership As discussed earlier, the *Disaster Management Act 2003 (Qld)* provides for the establishment of the BCLDMG and other disaster management groups for the purpose of managing the effects of a disaster event. The Act further appoints the Lord Mayor as Chair of the BCLDMG and Council's Chief Executive Officer (CEO) as the Local Disaster Coordinator. The Lord Mayor, as Chair of the BCLDMG, ensured that a clear and unambiguous chain of command was established. He provided strategic leadership and oversight of the disaster event. The CEO coordinated Council's disaster operations for the BCLDMG by ensuring that that the LDCC was functioning effectively and efficiently, by ensuring that the BCLDMG's strategic decisions were implemented and by reporting regularly to the BCLDMG.

The Board is of the view that both the Lord Mayor and the CEO displayed very high levels of leadership the Lord Mayor in relation to the overarching strategic direction and public information and the CEO in both the high level outcomes achieved across a wide range of flood disaster activities as well as by his style which demonstrated commitment and support to staff including encouraging them to make decisions and to take actions "to get things done". This empowerment and delegation of authority and decision making was a key factor in the successful response to the January 2011 flood event.

Control Measures A wide range of appropriate control mechanisms were established and included the use of operational sectors as the focus for warning and recovery activities. The Brisbane City Council area is divided into five regions: North, South, East, West and Central, with each having an RIMT established within.

During the response phase, affected wards and suburbs were grouped into response sectors. Response sectors were created based on the Australian Bureau of Statistics (ABS) Census Collection Districts (CD) and Statistical Local Area (SLA) boundaries.

The use of response sectors for tasking and information gathering provided a clear understanding of the affected areas by Council and external agencies. This facilitated the coordinated and effective utilisation of Council and external agency resources and improved the ability to rapidly assess and provide accurate and timely reporting.

The use of ABS Census collection boundaries was appropriate as they already exist and can be easily accessed by all agencies. A Census CD provides a sound basis for high level impact assessment as each contains an average number of dwellings and data remains consistent and available across all agencies. Further, SLAs can be separated or combined to reflect the scale or severity of event, while tasking and communication is supported by a unique naming protocol for each SLA and Census CD. Finally, boundaries can be easily adopted by operational units.

Coordination Mechanisms A range of coordination measures were included in the LDCC structure where desks were provided for internal Council officers and external liaison staff representing the QPS, Queensland Fire and Rescue Service (QFRS), the SES, the ADF, and utility providers. This enabled all to attend regular briefings and be informed by the dissemination of periodic situation reports. Feedback from external agencies consistently highlighted that coordination with Council throughout the disaster was very successful. In a number of cases, agencies commended Council on how they managed inputs from, and links to, their respective agencies.

Liaison Officers (LOs) LOs provided by the relevant Council Business units were very effective to ensure sound information flows and inputs to planning, and the conduct of activities which added significantly to the overall coordination effort. In those instances where liaison gaps were identified they were quickly remedied. In the cases where the RIMTs deployed LOs to the LDCC they proved extremely effective. Further, it is assessed that there is an opportunity to enhance overall performance by both the establishment of dedicated LOs

to manage queries and requests and to take local information detail from Councillors, and the inclusion of a waste management liaison officer for direct access to technical waste advice.

Communications Council fixed telephone lines including voice and facsimile, email and internet facilities supported by the mobile telephone system including voice and SMS provide the primary communications network. In the event of the failure of some or all of the primary network, hand-held radios provide a more limited capability, as did the small number of recently introduced hand held tasking devices. Communications between the LDCC, FOG and the RIMTs use mobile phones as the primary means, backed up by the hand held radio network.

Email communication issues arose with the LDCC email account whereby users used their individual (business as usual) GroupWise email addresses for operational communications between elements in the disaster management structure. This provided difficulties following shift changes if the new incumbent was not aware of a previous email address or, in the "heat of battle", forgot or failed to recognise the email address as pertaining to them. This had the effect that some emails were delayed in being answered or were ignored. A possible solution could be to establish email addresses for key roles or teams in the LDCC and its associated elements such as 'LDCC OPS', 'LDCC Incident Controller', 'DIG Watchkeeper', "FPG Planner" and so on.

In relation to telephones and to ease congestion, consideration should be given to implementing a phone system which allows incoming calls to be queued during busy times to achieve an orderly management of calls. The mobile phone system degraaded in part due to local congestion and the failure of mains power supplies to some towers.

Local District Coordination Centre (LDCC) Command and control was exercised by the LDCC in accordance with the broad directives from the BCLDMG. RIMTs were established based on Council's five Local Asset Services (LAS) existing areas and were given control of in-location LAS and Compliance and Regulatory Services (CARS) assets with additional resources allocated as required and available from both within Council resources and from external sources as available. High value (ADF, SES and specialist equipment) and scarce resources (such as street sweepers) were generally managed centrally.

The LDCC was operational from early on Monday 10 January 2011 at Level Three. Initial tasks centred on supporting the public information effort, coordination of limited local resources (such as sandbags) and activities in preparation for an escalation to Level Four. This included contacting and rostering Incident Controllers, supporting the activation of BCPs within Council, engaging external agencies in initial planning discussions and enhancing situation awareness.

On Tuesday 11 January 2011, when it appeared the Brisbane River was going to flood to levels approximating the January 1974 floods, the Activation Level was raised to Level Four and the full complement of disaster management structures was established.

The structure of the LDCC was validated during the conduct of disaster operations. The scale of the disaster necessitated a Level Four activation that resulted in an enhanced LDCC and component groups to manage the volume of information and the range and scale of emerging tasks. The enhanced structure ensured key functional areas with associated responsibilities were appropriately tasked and utilised throughout the disaster.

The upgrade and refurbishment of the LDCC facility on Level 1 at 266 George Street Brisbane was both timely and effective in enhancing the capacity of the LDCC. It is noted that further upgrades scheduled for this year include a dedicated small briefing room within the LDCC to allow update briefs and meetings to occur in an area close to, but separate from the centre of operations.

Comments from Council staff and other external agencies involved indicated that the new facilities, improved layout and the additional equipment greatly enhanced the efficiency of LDCC's operations during the January 2011 flood.

It is assessed that the LDCC performed exceptionally well in managing and coordinating Council's response to the flood crisis. Some enhancements to process have been identified including the creation of a dedicated citizen volunteer management team, formalising the written briefing processes for handovers between shifts, improvements to logging incoming and outgoing information and jobs/tasks, particularly noting when jobs have been completed to avoid duplication of effort (there may be some smart technologies available to assist), developing a readily accessible database of frequently asked questions to address "who does what type issues" to support the LDCC staff and agencies (this could also include information available on Council's Call Centre database), synchronising the shifts of agencies and Council staff working in the LDCC to better facilitate handover briefings, and ensuring that Situation Reports are used on a regular basis and are widely distributed using multiple communications channels.

LDCC Activation The process for activation of the LDCC worked well with a graduated response by selected elements within the disaster management structure. The early decision to move to Level Three at 9pm on Sunday 9 January 2011 and then escalate to Level Four at 8am on Tuesday 11 January, as a clearer understanding of the emerging situation emerged, is evidence of a considered and deliberate response to the rapidly emerging situation.

Forward Planning Group (FPG) The FPG functioned well, particularly given the fast moving nature of the flood event. Consideration could be given to standing it up earlier in the proceedings as planning will always be required. While contrasting views were expressed regarding the extent and nature of the FPG's responsibilities to the BCLDMG and to the LDCC, its major effort was directed by the BCLDMG as outlined in Council's DMP.

Forward Planning Throughout the response the high quality of forward planning played a significant role in ensuring effective outcomes. The FPG focused on strategic planning to allow for efficient management and resource allocation to commence recovery considerations. The FPG identified the need for additional multi-agency assistance and involvement, as well as indicating where such additional resources may be sourced or procured. Specifically, the FPG supported the BCLDMG decision making process, formulated strategic guidance on behalf of the BCLDMG, developed forward planning options (response and recovery considerations) for the BCLDMG and provided a forum for consultation between the BCLDMG and other appropriate State and Federal departments and agencies and Non-Government Organisations (NGOs).

The Concept of Operations (for response) was produced by the FPG on 13 January and provided the basis for response operations over the coming days. It established priorities and provided for an intelligence and preliminary damage assessment phase, followed by the re-establishment of essential services, facilitation of the return of evacuees, an assessment of Council infrastructure and the transition to recovery and business as usual.

During the response, a "next day priorities" briefing was conducted (reflecting LDCC requirements and other considerations) each afternoon which allowed the coming 24 hours plans to be formulated and related instructions issued.

The FPG prepared and delivered the Response Concept, the Recovery Concept and the Recovery Plan. The FPG also undertook volunteer management planning.

On Friday 14 January 2011 the FPG initiated planning "The Brisbane River Flood Disaster January 2011 Concept for Recovery" to commence once the Response Phase to the flood event was completed. This document provided for a high level, strategic approach to recovery within the Council area and signalled the transition from the disaster response phase to a business as usual approach. The approach centred around the establishment of the Lord Mayor's Recovery Task Group and six recovery sub-committees, each chaired by a councillor, with a focus on the community, finance and economic activity, infrastructure matters, environmental matters, ward recovery matters and town planning considerations.

Field Operations Group (FOG) The FOG was successfully led by experienced senior managers who directed and managed operations in the field. Noting that leadership roles were demanding and fatigue was a potential issue due to the duration of the flooding event and the nature and range of operations, it is recommended that consideration be given to increasing the number of managers, splitting the group into two elements with one focussing on current operations and the other focussing on future operations (72 hours and beyond); and to introducing IT tools to allow improved scheduling and prioritisation of tasking.

Further discussion of the FOG is contained in Section Three.

Disaster Intelligence Group (DIG) The DIG played a vital role supporting the LDCC and other component groups through the facilitation of situational awareness and the provision of specific intelligence products such as maps, infrastructure data and contact lists. The DIG managed large volumes of information associated with the disaster which demanded a very clear process for receiving, collating, analysing and disseminating information as well as tasking assets to collect information. These tasks require training in, and an understanding of, intelligence processes. While leveraging the skills of the Council's business analysts was effective, sensible and worked well, further training in these specialist skills is recommended.

Given the critical nature of intelligence, particularly in a rapidly developing and fast moving incident, the seniority and experience level of the DIG Manager should be commensurate with that of the other component managers. Comment was made about the reduced staffing levels during the night shifts which were not sufficient to enable appropriate analysis of information gained earlier in the day to be processed in readiness for the next day.

Incident Support Group (ISG) The ISG provided administrative, logistical, procurement, internal communications and the preparation of Situation Report (SITREP) support to the LDCC. The ISG performed well and some minor enhancements have been identified to further improve efficiency including the development of panel arrangements for the procurement of emergency goods and services that fall outside of Council's standard procurement needs.

Administrative and logistic support was coordinated by the ISG, which liaised with Council Business units, strategic procurement officers and contractors. The system worked well given the circumstances with general items being provided from within Council resources, primarily from the Stafford Depot and externally from commercial suppliers such as Coles for food supplies, although there were some issues regarding delays in payment by Council.

Council's procurement staff provided very high levels of support particularly as the requirement for items was usually determined during the early to mid-evening for supply the following day. Panel contracts were found to provide flexibility for unusual items such as clothing and equipment for civilian volunteers and outdoor signage. The provision and control of scarce resources, such as traffic controller teams and helicopters for emergency food stuff drops provided challenges. Suggested improvements include the development of up-to-date contact lists for panel suppliers and other likely specialist providers.

Regional Incident Management Team (RIMT) The RMITs were responsible for undertaking a variety of tasks within their sectors in accordance with directions from the LDCC and in response to emerging local requirements. The knowledge and insights of the LAS and CARS staff at each of the RIMTs ensured available resources were used to best effect with local initiatives and solutions to problems being addressed in a timely and effective manner.

In RIMT regions where there were minimal flood impacts, support was offered to other RIMTs where increased coordination and field support were required due to the level of inundation. This reflected the professional and flexible approach of Council staff in the field during the disaster. Mutual support between the regions was a local initiative resulting in an efficient Council-wide use of resources.

The RIMTs provide a critical component in Council's response, providing a local, on-the-ground perspective and enabling local managers and staff to effectively manage local resources as well as coordinating the use of those external resources allocated to them. There appears to be scope for further delegation of responsibility from the LDCC to RIMTs.

RIMT leaders identified the need for a dedicated RIMT operations room within the regional offices to be activated for disaster management and to include around four telephone ports, computer connectivity for three to four computers and a printer, a projector and screen for update briefings and planning, and a television set for situational awareness.

Further discussion of RIMT is contained in Section Three.

Intelligence Management and Dissemination

The components of Council's intelligence system comprised the DIG including the Rapid Assessment Teams, the FIC (flood modelling), and Council's GIS mapmaking elements, business intelligence tools, damage assessment procedures and intelligence methodology, procedures and practices.

Rapid Assessment Team The Rapid Assessment Team is the primary means of information collection for the LDCC. The teams collect information to meet critical information requirements and reported on hazards, debris and public safety issues.

Flood Information Centre (FIC) The lead elements of the enhanced FIC were activated on the evening of Sunday 9 January 2011 and then transitioned to 24 hour operations on Monday 10 January 2011 as the BoM and Seqwater provided updated weather forecasts, and information on anticipated water levels and the release strategy from Wivenhoe Dam. The FIC continued 24 hour operations until Monday 17 January 2011.

The focus of the FIC was to interpolate the flood profile at the six gauges through analysis of BoM data and Seqwater reports. The primary tasks undertaken by the FIC included forecasting the extent of affected properties and damage (including CBD infrastructure), the development of inundation mapping throughout the flood event, development of recovery map products, monitoring and disseminating Seqwater reports, BoM updates, tidal data and flood water level data and the provision of on-call advice across the organisation.

The Federal Government's Attorney General's Department, through the Critical Infrastructure Protection Modelling and Analysis Program (CIPMA), maintains a national level database of critical infrastructure, and has an advanced capability to model the impacts of certain events within a defined area. The models consider both critical infrastructure impacts and the impacts on dependencies and may be useful to enhance the FIC's capabilities.

The FIC performed very effectively during the January 2011 flood event including the maintenance of good communications with, and access to, BoM and Seqwater and the provision of sound advice and user friendly geospatial products that assisted in planning and operations both within Council and for other agencies. While the FIC modelling system has recently been updated, the Board was advised that it will need to be replaced in the near future to include the capacity to forecast flooding in Brisbane creeks and for 3D visualisations.

The staff performed very well despite some minor deficiencies in the number and skill levels of staff trained to use FIC systems.

Intelligence Plan The Intelligence Plan was developed to enable the efficient provision of detail to the LDCC to support planning for current and future operations. It identified critical intelligence requirements and information gaps, coordinated the collection of information and assigned collection tasks to the Rapid Assessment Teams which assessed damage and reported debris, hazards and public safety issues to the DIG. The plan also ensured key reporting requirements to the LDCC and the BCLDMG were met, and monitored the accuracy and timeliness of information.

Intelligence Requirements comprised those items of intelligence required by the LDCC Incident Controller or the FPG to enable planning for current and future operations. Examples included the locations and status of utilities including severity of inundation and damage, communications systems, transportation modes, roads and bridges, community facilities, population issues, including safety hazards, threats and risks.

The DIG provided information for Situation Reports, BCLDMG briefs, media briefs and LDCC shift handovers and displayed information priorities and requests for information, the current situation and operations, impacted areas shown on maps and GIS screens, contact lists (telephone, facsimile and email addresses), resources allocated and resources available but not committed, weather situation and forecasts including hazards and warnings, topographical and road maps of the affected area, lists and copies of publicly released information, staff rosters and timings, and details of briefings and reporting requirements.

Systems and Data

One of the most challenging tasks in dealing with a multi-jurisdictional response to a major disaster incident is the effective communication and sharing of information and data between agencies. To help address this issue during the flood, and following the collapse of Council's website, a dynamic web-based mapping solution was fielded using web mapping technology shared with all emergency response agencies to provide an up-to-date common operating picture. This application, known as Flood COP, was developed and funded by Esri Info (www.esri.com), a private enterprise provider for Council, at very short notice.

The web service was published using cloud computing technologies and made available within a matter of hours after the initial request. The system is scalable and allowed for LDCC operations and for significant growing use by the public. Flood COP proved to be a vital tool in disseminating information, and coordinating and publishing flood response efforts and progress. It is understood a similar approach to web mapping is being used by the Queensland Government to support the work of the Queensland Reconstruction Authority.

Based on the benefits that Flood COP provided during the floods, the provision of a readily available, scalable capability for Council should be considered. The adoption of this technology within Council will also complement the fast and effective publication of field data capture information that can now be undertaken using mobile mapping and data capture technology and hand-held devices recently acquired by Council.

Public Information.

Commencing in October 2010, the Lord Mayor undertook a series of initiatives to raise awareness in the community regarding the increased risk of flooding during the coming summer, using media opportunities and Council meetings to highlight the potential for a flooding event similar to the January 1974 flood. The challenge was to convince people of the need to prepare for flood after what had been an extended period of drought, and this was an obstacle to delivering key flood warning and information messages.

While the Lord Mayor and Council sought to engender a "sense of urgency", many in the public seemed not to be convinced and this was demonstrated by the relatively low level of registrations for the Early Warning Alert Service promoted extensively by Council.

Significant resources have been expended by Council on developing public education, awareness and information access relating to flooding over the last five years. Council has implemented many of the recommendations from the Lord Mayor's Task Force on Suburban Flooding (2005) and the Review of Council Response to Brisbane Storm Events 16-22 Nov ember 2008.

During the January 2011 flood event, public information was provided and accessed through a variety of channels including television, radio, print media, newsletters, the Council's Call Centre, website, and social media.

Print and Electronic Media, Newsletters, Posters and Outdoor Advertising Council's use of print, radio and electronic media was considered very effective in providing general flood information to residents and businesses in the days preceding, and then during, the flood event. The role of the electronic media was particularly significant with television and radio stations broadcasting Community Service Announcements (CSAs) and other vital information in an extremely timely and efficient manner.

Significant use was made of newsletters and posters and included 30 fact sheets, eight community newsletters, evacuation centre newsletters, posters in prominent locations and outdoor advertising. Special flood editions of "Living in Brisbane" covering the period 31 December 2010 – 4 February 2011 were produced for all residents.

Council Call Centre Council's Call Centre worked very well over the period and provided a consistently high level of service. More than 81,000 calls were dealt with between Sunday 9 January and Saturday 22 January 2011, of which 32% were flood related. This was a 70% increase on the same period in 2010. On Tuesday 11 January, the Call Centre took 12,209 calls, which was the highest volume ever received and was handled by more than 100 staff. The Call Centre was able to maintain an Average Speed of Answer of 30 seconds over these two weeks and demonstrated a most commendable commitment to the general public.

During this period Call Centre staff worked very long hours, established additional Call Centre phones in other areas of council to allow for extra phone consultants, regularly updated the Queue Message to keep customers informed and extending the opening hours of regional sites at Carindale and Chermside. Fatigue levels were well managed using scheduled breaks. Staff from other areas of Council provided assistance, and were trained to take SES calls. Additional consultants were used to handle calls remotely from their homes.

Call Centre staff are to be highly commended on their committed and flexible approach to ensuring that this essential communications channel remained open and effective during the peak crisis period.

Council Website Unprecedented demand and bandwidth restrictions overwhelmed Council's website which was designed for a business as usual approach with capacity to cope for around a doubling in demand. The flood event, however, created an exponential increase in demand and resulted in the collapse of Council's website for around 24 hours. In the void that was created by the collapse, Council's Information Services Branch, in conjunction with the Marketing and Communications team, showed great commitment and initiative in ensuring there were other website options for residents and businesses to seek and receive key information. They played a key role in arranging access to an externally hosted website to reinstate web access. This matter is worthy of a more detailed examination than the Board can conduct and should be undertaken separately.

While the collapse of the website, caused by an unexpected torrent of hits and bandwidth limitations, was a major failing, Council staff and vendors are to be commended for their initiative in addressing the failure. The impact of the failure was significant as it removed a key communication channel for the community to access flood maps and critical information on the impact of the floods. This failure also impacted on Council's internal and external email system and remote access to Council's data systems by Council staff.

To address the failure, Council's website was converted to a static website to reduce the demand on processing power and bandwidth. The solution to reduce the high demand on Council's iInternet connection was to move the website operation to third parties to host the flood maps and the static website. IReckon.com, based in the USA, hosted the PDF flood maps and Amazon web services based out of Singapore, hosted the static website.

There were two other constraints noted by the community. Once mains power was lost they were unable to use the Internet, reducing the effectiveness of this communication channel and the use of mobile phones and other devices became an issue as batteries ran down and needed recharging.

Social Media An unintended consequence of the collapse of the website was an increased and extensive use of social media channels such as Facebook and twitter. It is interesting to note that the increased demand for, and use of, the social media tools has continued after the flood event. George Patterson Y&R completed an analysis of social media during the period Monday 10 to Sunday 16 January 2011 and noted that "Overall, the Council and Queensland Police Service (QPS) Facebook pages demonstrated best in class response and continuity over other Local and State Government sites."

Facebook was used to convey official information such as CSAs and responses to residents' questions. It is estimated by that more than 4.5 million people were reached by this medium during the flood event.

Twitter was used to broadcast information, for re-tweeting information from trusted sources such as QPS, Energex and BoM and for responding to questions from residents. There were around 3000 twitter followers prior to the flood event with significantly more followers during and after the flood event. With re-tweets, during the flood it is estimated that more than 8 million people were twitter followers. (Radian 6 Social Media Tracking Tool).

The increased role of social media also highlights the need for Council Marketing and Communications staffing structures to better reflect these skill sets and the need to better integrate traditional communications functions and on-line communications functions within Council's structure.

Council's Marketing and Communications Branch staff are to be commended on their preparation for the flood event. A targeted and integrated communications strategy was developed and implemented using a variety of media presenting clear and consistent messages. The strategy focused on external communications as well as the development of a detailed Crisis Communications Manual with the objective of assisting staff to manage and operate in a natural disaster environment.

Warnings, Alerts and Advice

Early Warning Systems Multiple systems and media are available for the dissemination of warnings and alerts to the public for imminent or current disasters. Council uses the Early Warning Network (EWN), a system where individuals register online for email and SMS alerts relevant to locations entered in the database (generally residential addresses).

The EWN requires individuals to voluntarily register their details in order to receive the alerts. The system is hosted by an external service provider and requires a Council administrator to login, draft the alert message and release it to a pre-set distribution list based on registered users' data.

General observations from the community and internal stakeholders were that the EWN alerts for this disaster were too generic, inconsistently received across different locations and telecommunications carriers and were late in delivery, reducing their overall relevance and effectiveness. The Board was advised that delays in delivery were caused by a combination of network congestion and a degradation of mobile phone tower capacity due to mains power loss.

It was also commented that the take up rate for residents registering with the EWN system was relatively low (estimated at one in 10 households), despite active encouragement to do so over the last six to 12 months. It is understood that following this disaster, a spike in registrations was experienced but that overall proportion of residents registered is still insufficient to gain critical mass for cascading alerts to the community.

A further observation regarding warning and alert messages was the expectation by the public that warnings would be specific to streets or individual properties, impacting on their ability to determine relevance and appropriate actions. A wide range of stakeholders indicated a need for the ability to localise and personalise alert messages.

Again the use of mobile phones and other devices became an issue as batteries ran down and needed recharging in circumstances where mains power was disconnected.

The Board understands that in response to the findings of the Victorian Bushfire Royal Commission following the events of Black Saturday in February 2009, the Federal Government commenced the development of a National Emergency Warning System (NEWS). It is understood that this system does not require registrations by individuals. Rather it extracts land line and mobile phone numbers from the Integrated Public Number Database (IPND), a national database maintained by Telstra on behalf of the Australian Communications and Media Authority.

The IPND contains all land line and mobile phone service details for Australia (phone numbers, billing address and type of service). The NEWS would allow SMS to be sent to mobile phones and pre-recorded messages to be disseminated to landline phones within a selected geographic area. In the event that this system becomes operational, a more detailed examination of its potential by Council is recommended.

Door Knocking While doorknocking occurred in a number of flooded suburbs by Council Officers, QPS Officers, SES volunteers and others, it was limited in some suburbs by restrictions to access due to the rapidly rising waters and by limitations to the number of people available to undertake door knocking. This matter is worthy of further consideration by Council.

Flood Maps. Flood maps and other associated information are invaluable tools in assisting residents and businesses to understand the potential impacts of flood events. In analysing the available information and in conducting community engagement, feedback indicated that enhancements in the manner in which information is presented would enable residents and businesses to better understand the impact of various flood event scenarios on individual properties and surrounding areas.

The implementation and recent enhancements to the FloodWise and FloodMap initiatives by Council allow an increased awareness by the public of risks associated with individual properties. A solid base of fact sheets, flood maps and CSAs are available on line for individuals and businesses, providing valid and simple advice on preparing for, and responding to, a flood event. When combined with data available on BoM's website, increasing amounts of information are becoming available for the public to better determine their risk exposure.

With the available technology and the growing desire for tailored information presented in simple, easy-to-understand language, the opportunity exists to further invest in such technology to develop a web-based tool that allows individuals and businesses in the community to better understand the risk of flooding to particular properties. With enhanced flood modelling, geospatial mapping systems (eg. Google Maps, NearMap), combined with property, essential services and infrastructure data, it is feasible that members of the public could access a website and click on a map or enter their address and be presented with an image of their property with an overlay of recent flood inundations and other flood information.

Supporting data could also be presented as and if available, indicating the height above ground level for the ground floor or inhabited floors. This would allow residents to quickly determine the level of inundation expected for their property, facilitating preparation and the decision to evacuate if necessary. It is feasible that such a web tool could also be made available as an application for mobile devices, in the widest range of mobile device formats. An approach like this would enable individuals to access current information specific to them and to their property in a timely fashion.

Flood Alerts General flood alerts provide background information to the community and need to be crafted in a way that avoids the use of technical terms such as Q100, DFL, City gauge level above AHD and so on. BoM uses terms such as "major", "moderate" and "minor" to describe river flooding together with a colour coding. It would be beneficial to conduct a

public information program to educate the public about this system and then use it to alert the community.

During and prior to the flood event, alerts broadcast by the electronic media, with references to the city gauge, were generally confusing and not well understood. As flood levels vary along the river, the common practice to talk about the flood level at the Brisbane City Gauge has little relevance for those who only have lay knowledge and live up river. This issue is important in informing the public of what to expect during a major flood. In future, if reference is made to a flood level at the Brisbane City Gauge, it must be advised that flood levels will be higher than this level further up the river. Similarly general references to the January 1974 flood provided little information to those who had no experience of that flood event.

There was a desire expressed by members of the community for suburb specific flood information which could be broadcast regularly, say each hour, providing a suburb by suburb summary of flooding issues, and perhaps also including major road closures.

Internal Council Communications

Communications with Council staff not directly involved in the management of the disaster were affected by the collapse of the website and email. To enhance the effectiveness of internal communications, consideration should be given to greater usage of social media and SMS messaging in these circumstances.

Management and Integration of Response with other Supporting Agencies

Feedback sessions with external agencies consistently highlighted the relative ease of coordination with Council throughout the disaster. In a number of cases, agencies commended Council on how well it managed communications and information relationships. It may be assumed that this was due to training, confidence, strong relationships and experience of Council staff leading the response in the BCLDMG and LDCC.

The conduct of a very successful briefing session with the ADF commanders prior to their deployment was flagged as an example where Council proactively informed external agencies, ensuring that operational coordination was established very early. In general, Council was viewed as having an extremely good appreciation of the situation, a clear intent and well established priorities within a sound disaster management framework.

The SES is represented at the BCLDMG by a Council employee as acting Local Controller, supported by an administration officer, part-time training coordinator and a trainee. The demands on the acting Local Controller were high due to the number of SES volunteers in the field. There were reports of issues associated with the tasking and prioritisation of SES volunteers in the field but a complete analysis was not possible in this review as Emergency Management Queensland advised that it was not permitted to participate in discussions with Council's Review Board.

Pullenvale and Tennyson Wards

Pullenvale Ward Severe river flooding along Pullenvale Ward's south-eastern boundary resulted in Moggill, Bellbowrie and neighbouring suburbs being isolated for around two days causing a severe diminution of services. During this period, mains power was disrupted, as was fixed line, mobile and internet telecommunications. Mobile phones cell towers switched to battery backup and the system became congested, thus reducing capacity. As mobile phone batteries failed, there was limited scope to recharge them. This degradation of communications resulted in the LDCC not having a good understanding of the local situation in Pullenvale Ward during the early stages which appears to have led to a delay in its response.

A number of issues emerged including a declining availability of foodstuffs and general personal requisites (as the only supermarket had flooded) and the inaccessibility of the two Council-designated Evacuation Centres. When supplies were airlifted in, the further distribution across the Ward was an ongoing challenge. While two small evacuation centres were established in Moggill and Karana Downs, they were not "officially recognised" by the LDCC and relied on the efforts of church groups, service clubs and volunteers.

Given the location of the local RIMT in Indooroopilly and the flooding impact of the Brisbane River which isolates many suburbs in Pullenvale Ward, the current arrangements should be reconsidered to ensure improvements.

Tennyson Ward The Tennyson Ward Office was flooded and not able to be used by the Councillor and her staff. While temporary accommodation was provided in the adjacent Moorooka Ward Office, this appeared to be a less than satisfactory arrangement, particularly as it impacted significantly on the availability and quality of communications and information available to the Councillor, restricting her ability to support and assist her Ward constituents. A functioning alternative temporary Ward Office should be available in the eventuality that the primary Ward Office is rendered unusable due to flooding.

The Role of Councillors in a Disaster Situation

Councillors in flood affected Wards worked very hard, over long hours, to provide support and comfort to their constituents. They were subject to a consistently high number of queries from residents regarding a range of issues including specific flood information relating to their properties and neighbourhoods, guidance on evacuation locations and processes, availability and access to local resources such as sandbags, advice on recovery processes including the availability and prospect of support and assistance for clean up and including how to deal with food waste and dangerous goods including asbestos. In those areas where mains power had been disconnected the lack of information during the flood event and the recovery phase was a particular issue.

The flow of formal information and advice from Council LDCCs to Councillors was via a dedicated Council email system which terminated at desktop computers in their respective Ward Offices. Given that Councillors in flood affected Wards were "out and about" responding to the needs of their constituents, their ability to remain abreast of the situation, and particularly the "big picture", was severely constrained. A mobile communication system, using social media (Facebook and twitter) and SMS, complementing the dedicated email system, may help to obviate these difficulties.

Issues such as the particular needs and situation of the frail aged, people with disabilities, and those from non-English speaking backgrounds could have more readily been made known to the LDCC with a better communication, briefing and reporting system. Councillors had a very good understanding of the particular needs and issues obtaining in their Wards and were potentially a significant source of local and timely information and intelligence.

While there were some instances of Councillors seeking to redirect the response effort as organised by Council through the LDCC, by and large, the principle that Councillors should not inject themselves into the formal tasking (command) structure was acknowledged and supported.

The Board formed the view that some Councillors did not have a good understanding of Council's disaster management arrangements. A program for Councillors including briefings and the opportunity to observe LDCC exercises may be useful in remedying this situation.

A further issue related to Councillors seeking information and assistance, especially in flood affected Wards. Invariably they would seek to contact Council officers they knew who worked in their local area, or the CEO if this proved problematical. Many Council officers had additional tasks assigned as part of the disaster management arrangements and were not available for their business as usual responsibilities. Understandably, and although the CEO was fully occupied with "whole of Council" issues, he sought to provide advice and support as

he could, as did the LDCC Incident Controller. Given this, it would seem appropriate for a dedicated "Councillor Liaison Officer" to be appointed in the LDCC to operate as a clearing house for requests, issues and concerns as raised by Councillors. Tasks could include the dissemination of relevant situation reports and other information (newsletters, CSAs, and media releases) directly to Councillors as well as ensuring that requests are actioned by the LDCC or FOG, commensurate with their priority.

Naturally, none of this is designed to impede the normal relationship between Councillors and the Lord Mayor.

Commendations

The Board highly commends the actions of Council staff in their preparation for, and response to, the flooding disaster which may appropriately be characterised as well above and beyond that usually expected.

The Board commends Council's disaster management approach and in particular for:

Its compliance with, and implementation of, the various Commonwealth and Queensland Government legislative and policy parameters which direct and inform disaster management arrangements.

Its integrated response through the BCLDMG with other Queensland and Federal Government agencies and Non-Government Organisations.

Its alignment with the State Disaster Management Plan, and the District Disaster Management Plan.

The Board commends Council's approach to preparing for a possible disaster event over the summer months and, in particular, for the general public warnings and advice in the November, December 2010 period and for the conduct of readiness training and exercises.

The Board commends Council's approach, during the flood event, in providing public information, advice and alerts using a multi-channel broadcast approach, for print and electronic media, the internet including website, email and social media, telecommunications including Call Centre, mobile SMS and the Early Warning Alert Service and off-line including the "Living in Brisbane" newsletter, fact sheets, other community newsletters, posters, and outdoor advertising.

The Board commends the efforts of Council's Call Centre and Social Media staff for their untiring efforts to respond, in a calm and helpful manner, to the thousands of requests for information and advice during the flood event.

Affirmations

The Board affirms Council's approach to its business as usual and risk management policies. The Board **recommends** that:

In relation to Council activities, Information Services Branch reviews its Business Continuity Plans (BCPs) to ensure the capacity exists to maintain the data centre, including an alternative site capable of taking over without delay, and to maintain Council's website at all times, particularly during significant disasters.

Line of business managers review BCPs to ensure their ongoing robustness and to capture any lessons learnt from the flooding event.

Contracts and arrangements be reviewed to ensure that BCPs for key external outsourced service and infrastructure providers are understood, robust and able to support Council during times of emergency and disaster.

In relation to the Brisbane Central Business District and high-rise residential building inundation, that Council consider hosting a symposium for all affected parties with a view to identifying best practice approaches to ensure improved flooding resilience.

The Board affirms Council's approach to training, exercising and workforce planning in relation to Disaster Management Preparation. The Board **recommends** that further emphasis be placed on:

Individual and team training, including opportunities to attend Emergency Management Australia Disaster and Emergency Response courses,

Workforce planning to reflect a needs analysis-including disaster management related job descriptions, and a specific Council term be developed to describe "internal volunteers" to avoid confusion and to reflect the professional nature of the training and tasks, and

Annual exercises continue to be conducted with a theme of "Brisbane Ready for Summer".

The Board affirms the operations and workings of the Local Disaster Coordination Centre (LDCC) and, in particular, the integration of operations (tasking), intelligence, public information, logistics and the coordination with external supporting agencies. The Board **recommends** that:

Further training and development occur for senior appointments including LDCC Incident Controllers and group leaders as well as for more junior appointments.

The Disaster Intelligence Group's structure, manning and core competencies be reviewed and further staff training be conducted.

The Forward Planning Group's responsibilities to the Brisbane City Local Disaster Management Group and to the LDCC be examined to remove ambiguity.

Enhancements to process be implemented including;

Ensuring that Situation Reports are well drafted and widely distributed on a regular basis using multiple communications channels.

Developing a readily accessible database of frequently asked questions to address "who does what" to support the LDCC staff and agencies (this could also include information available on Council's Call Centre database).

Synchronising the shifts of Council and agencies staff working in the LDCC to better facilitate handover briefings.

Improvements to logging incoming and outgoing information and tasking.

Formalising the written briefing processes for handovers between shifts.

The Board affirms Council's flood intelligence management and information dissemination arrangements. The Board **recommends** that Council undertake upgrades to the Flood Information Centre (FIC) along the following lines:

Review and update Standing Operating Procedures (SOPs), including a major update of selected Brisbane River and Creek Flooding SOPs, river flood maps and storm tide maps, property counts and critical infrastructure lists.

Upgrade the Brisbane River Flood Forecast Reporting System to the most extreme flood event (Probable Maximum Flood) and to include a flood forecast system for Brisbane creeks.

Conduct additional training and exercises including with the LDCC and Queensland Government agencies, and develop better communications protocols.

Provide computers capable of GIS modelling tasks and 3D visualisation analysis.

Provide a dedicated flat screen television for situation awareness and news monitoring.

The Board affirms Council's approach to implementing a range of early warning systems and alert measures across a number of delivery channels. The Board **recommends** that Council examine and develop the range and variety of early warning systems and alert measures; including the proposed National Emergency Warning System, social media platforms and further improve the effectiveness of door knocking.

Recommendations

The Board recommends that Council use a more readily understandable description of flood levels (to reflect BoM descriptions).

The Board recommends that effort continue to be put into providing more localised (property, street, suburb and Ward) information regarding inundation and flood level forecasts through a range of channels including the EWAS, Floodwise Property Report and Flood Flag Maps (including rate notices to draw attention to the existence of the Floodwise Property Report), and flood markers.

The Board recommends that the Flood Flag Map be further developed to enable NearMap data obtained on the morning of 13 January 2011 to be included and accessed.

The Board recommends that Council investigate the Flood COP system and examine its utility, in conjunction with hand held devices, to improve the efficiency and effectiveness of data collection, the provision of information, the prioritisation of tasks and the deployment of resources.

The Board recommends that Council further develop its capabilities to produce flood maps for a larger set of scenarios based on a range of 2 to 20 m^3/s in electronic and hard copy format.

The Board recommends that Council review the disaster management arrangements for a major flooding situation as they apply to Pullenvale Ward.

The Board recommends that Council review the disaster management arrangements for a major flooding situation as they apply to Tennyson Ward to ensure the ongoing provision of a flood-free Ward Office.

The Board recommends that Council examine appropriate ways for Councillors to assist during disaster events, particularly given their community leadership responsibilities and their detailed local knowledge of circumstances and capabilities that exist in their Wards, in a way which does not cut across the existing and appropriate arrangements detailed in Council's disaster management arrangements.

SECTION THREE - BRISBANE CITY COUNCIL'S OPERATIONAL RESPONSE IN THE FIELD

This section of the Report contains the Board's assessment of Council's operational response in the field to the flood event. There is specific consideration of the responsibilities of the Field Operations Group (FOG) and the Regional Incident Management Teams (RIMT), and of evacuation centres, disposal of debris and waste and management of volunteers. The assessment concludes with a brief review of arrangements for the Transition to Recovery.

Field Operations Group (FOG)

The role of the FOG is to co-ordinate and manage Council's operational response to a disaster event. It provides information to the Local Disaster Coordination Centre Incident Controller on the progress of Council's on-ground response and communicates emerging issues. The detailed Standard Operating Procedures for the FOG provide for preparatory work to be done within the Local Disaster Coordination Centre to establish the FOG at Level 3. Upon a Level 4 activation, the FOG transitions from an operational team within the Local Disaster Coordination Centre (LDCC) to a dedicated group which assumes responsibility from the LDCC for the co-ordination of event response operations and task management. The FOG is located within the Level 4 LDCC.

The FOG is intended to conduct operational planning for a 0-72 hour planning horizon. It assigns all tasks that have been prioritised by the LDCC Incident Controller to the Regional Incident Management Teams (RIMTs) or other Council business units for implementation or action.

The Board is of the view that the FOG was successfully led by experienced senior managers and that it provided the necessary direction and management, and made appropriate task allocations, for a truly effective operational response overall to the flood event. Leadership roles in the FOG were demanding. Fatigue was a potential issue. The workload for the FOG was compounded by a need, at times, to extend the operational planning horizon beyond 72 hours.

These aspects of the functioning of the FOG suggest to the Board that the following steps be taken to address them. With an eye to a lessening of the risk of fatigue, a greater number of managers should be identified from Council ranks and trained for leadership roles in the FOG. Secondly, as the likelihood is that the FOG will have a longer operational planning horizon than 72 hours, consideration should be given to forming two groups within the FOG, one with a focus upon the 0-72 hour period; and the other upon the period beyond 72 hours.

Regional Incident Management Teams (RIMTs)

Decentralisation and localisation in response operations is achieved principally through the RIMTs. A team is formed at Level 4 activation for each Council region (North, South, East, West and Central). The membership for each RIMT is drawn from the Local Assets Services (LAS) and Compliance and Regulatory Services (CARS) branches for that region. Each Regional Incident Management Team is based in Council offices or at a Council depot within the region.

The RIMT receives its tasks from the FOG only. It is responsible for the performance of operational tasks as allocated by the FOG. Council assets within the region fall under the command and control of the RIMT thereby enabling it to manage operations directly related to the event response within the region. However, in this instance, some "high value" resources, for example, street sweepers, were managed and deployed centrally by the LDCC.

The effort and combined knowledge of the LAS and CARS staff at each RIMT base, and in the field, ensured that available resources were used optimally and that initiatives and solutions to problems were devised locally in a timely and effective manner. The local

knowledge held by RIMTs and field staff proved indispensible in prioritizing and co-ordinating local tasks.

SOPs for the FOG contain guidance on specific aspects of RIMT response to a disaster event. The Board has identified one area in which these guidelines should be developed. Allocation of Australian Defence Force (ADF) personnel and volunteers to Regions is made at the LDCC level. RIMT have detailed knowledge of local problems and their relative urgencies. There needs to be a clear description of the respective roles that the LDCC and RIMT are to have with respect to the co-ordination and, in the case of volunteers, the management, of these resources once they are deployed. Also, arrangements for liaison, as may be required, between RIMTs and Agencies should be outlined. This could be conveniently done within these guidelines.

The Board perceives a need for higher level Council officer representation at RIMTs. To that end, the Board recommends that a senior officer be assigned to each Regional Incident Management Team and tasked with a multi-faceted role of mentoring the Regional Incident Management Team manager and conducting higher level discussions with LDCC.

The siting and equipping of RIMT bases are factors which the Board has identified for comment. It is vital that these facilities remain functional during the currency of a disaster event. Future planning should identify alternative RIMT sites for a region if there is a risk that the primary site may become unusable, including risk through flooding.

Currently, the offices or depots that are used as RIMT bases do not have dedicated operations rooms. This is a significant shortcoming which, in the Board's view, should be rectified. The Board therefore recommends that a suitable room be equipped and fitted out at each RIMT base so that it can be activated as needed for disaster management.

There are two particular aspects to field operations which the Board proposes to discuss separately. They relate to sandbags and traffic management respectively.

Sandbags: Brisbane City Works was requested by Brisbane City Local Disaster Management Group on 10 January 2011 to commence the production of sandbags for use by residents and businesses. As reported to the BCLDMG meeting on the following day, production was at the rate of 4,000 sandbags per day. Direction was given by the meeting to increase the rate of production to 70,000 per day with four Council depots being used as distribution points.

Due to demand, the number of Council depots used was increased to six. They were located at Balmoral, Darra, Eagle Farm, Newmarket, Stafford and Zillmere. As well, a further seven locations were used for filling and distribution of sandbags. The locations are shown in Map 9. The Board observes that only one of these 13 distribution points was located in the south-western suburbs. The Council workforce at these distribution points, assisted by volunteers, addressed an escalating demand for filled bags. While the participation of volunteers reduced the potential for fatigue for Council staff, it did introduce other potential workplace health and safety risks.

In total, 395,878 sandbags were filled, with some 313,478 distributed. Distribution peaked on Wednesday 12 January when 174,510 sandbags were distributed. To have arranged for the production and distribution of such a large quantity of sandbags in so short a time was a commendable achievement.

The demand for, and availability of, sandbags did, however, have significant implications for traffic management with long queues at distribution points at times. With that in mind, the Board suggests that, drawing on recent experience, Council prepare estimates of likely sandbag demand for regions during future flooding events and identify the best situated potential sites for filling and distribution points in each region. In doing so Council should give consideration to how the number of distribution points in the western suburbs might be increased.

Traffic Management: The sheer number of volunteers and agencies involved in the cleanup did impact upon traffic management, particularly in areas where access was limited due to geographical location and road closures. Collaborative efforts between Council, Queensland Police Service and the Australian Defence Force achieved as good a result at ground level as was reasonably achievable in the circumstances. Pro-active decisions by Council, particularly in using buses for ferrying volunteers from registration points to affected suburbs and blocking off badly impacted streets significantly reduced the number of vehicles on the road.

The volume of unregistered volunteers arriving in vehicles, uncertainty as to which streets would open when waters receded, the desire of residents of affected areas to return home, and the co-ordination of heavy vehicle and plant and equipment in suburban streets all added to the complexity of the issue. There is now a body of recent experience within Council and Queensland Police Service from which advanced plans to improve traffic flow in flood recovery congested areas can be developed. Such plans could include converting some streets to one-way, route designation for heavy vehicles, and identification for residents' vehicles.

A disturbing phenomenon noted by the Board is that despite extensive public awareness campaigns and media warnings, instances do occur of vehicles being caught as they attempt to cross streets which are inundated by rising flood water. The consequences for the occupants can be tragic. The problem is magnified by a "follow the leader" reaction on the part of some other drivers. Emergency rescue teams have to become involved, sometimes at significant risk to their own lives.

The Board considers that further public awareness measures must be taken. The installation of flood markers on key roads that are known to become flood affected needs to be considered by Council.

Council Evacuation Centres

Council is responsible for providing disaster evacuation centres and emergency shelters within its boundaries. An evacuation centre provides basic human needs including overnight accommodation, food and water, and assistance with recovery for those who are disaster affected. Emergency shelters are on a lower scale and do not provide overnight accommodation.

To discharge this responsibility, Council had in place a framework for handling evacuation prior to the 2011 flood event. Council's Disaster Management Plan 2005 covers the topic of Evacuation and Emergency Human Services and incorporates a set of Standard Operating Procedures for responding to it. The second edition of the Standard Operating Procedures (2010) was the version current at the time. Preparation of this version had been informed by Council experiences during The Gap storm.

As envisaged by the Disaster Management Plan, Council had entered into a Memorandum of Understanding with Australian Red Cross (Qld) for the management by Red Cross, as lead agency, of evacuation centres established by Council. Further, as provided for in the Standard Operating Procedures, by March 2009, Council had identified and registered a range of some 47 locations suitable for use as emergency shelter/evacuation centres in the event of river and creek flooding, and storm surge. The locations, their capacities and contact details, are listed in the Council document Emergency Shelters Riverflood dated 6 March 2009. These locations are sited across all Brisbane Regions and are categorized as large (to accommodate more than 100 people), medium (50 to 100 people) and small (less than 50 people). The Disaster Management Plan, Standard Operating Procedures, Memorandum of Understanding and the location register are key elements of the response framework.

The registered sites included RNA Showgrounds, QEII Queensland Sport and Athletic Centre and Suncorp Stadium. However, by the evening of Monday 10 January 2011 it was clear that due to the potential severity of the flood, Suncorp Stadium would not be suitable.

At 8am on Tuesday 11 January 2011 RNA Showgrounds were confirmed by the Local Disaster Coordination Centre as the potential first port of call for evacuees. Later that morning, the Lord Mayor directed the commencement of operational evacuation planning and evacuation centre establishment, initially for 2500 evacuees to go up to 3500. At 6.30pm that day the requirement was increased by 10,000 evacuees. Ultimately, planning for evacuations involved a worst-case scenario of up to 16,000 people needing accommodation.

Establishment of two large evacuation centres was undertaken rapidly and at short notice with management at potentially suitable locations being contacted that day to assess immediate availability and accessibility. Considerations for location selection included, but were not limited to:

Location of centres and of potential evacuees;

Accessibility for evacuees and emergency services/agencies and volunteers;

Capacity to function, immediately and in the long-term; and

A need for containment of site numbers given human resourcing limitations in the initial stages, arising from agency responsibilities in Toowoomba, the Lockyer Valley and elsewhere in Queensland.

The two evacuation centres which were established by Council were:-

at the RNA Showgrounds, on Wednesday 12 January 2011; and

at QEII on Wednesday 12 January 2011,

in each case with the cooperation and support of the respective owners. The locations of these two centres and Council assets activated during the flood are shown in Map 10.

RNA Showgrounds evacuation centre was in operation from Wednesday 12 January 2011 until Wednesday 19 January 2011. More than 1650 evacuees registered over the period at the centre with a peak of 1450 in the early evening of Thursday 13 January 2011. QEII was operational from Wednesday 12 January 2011 until Friday 21 January 2011. There were more than 700 registrants over the period for this centre with a peak of about 480 also in the early evening of Thursday 13 January 2011. At each centre, not all registrants slept overnight. Peak usage in the early evenings was for meals and showers.

For each centre, the numbers of registrations were within capacity. There was no unmet demand for evacuation centre accommodation from evacuees who sought it. All registrants who required some form of short term accommodation thereafter were successfully rehoused: over 250 households from the RNA Showgrounds; and over 70 households from QEII.

Council remains the responsible entity for an evacuation centre. Conformably with the Memorandum of Understanding, the responsibility is exercised by a Red Cross Centre Management Team as soon as possible. An integrated discharge by Council of its continuing overall responsibility for evacuation centres and by Red Cross of its management responsibilities requires a high degree of co-operative interaction between staff of each organization throughout the operation of an evacuation centre. That occurred for each evacuation centre on this occasion.

In addition to Red Cross and Council, a large number of government and community agencies, building contractors and service providers and other volunteer workers assisted with the operational aspects of an evacuation centre. By way of illustration, the operation of an evacuation centre involves:

Council providing beds;

Salvation Army providing the food;

Lifeline providing counselling services;

Save the Children providing entertainment/activities for children;

Red Cross managing the centre and maintaining the National Registration of Inquiry System of all evacuees;

St John's Ambulance providing First Aid,

and active participation by other community-based and government agencies.

As provided for in the Disaster Management Plan, Council acted in a co-ordination role for the agencies involved. The Queensland Police Service and Australian Defence Force also fulfilled significant and much-appreciated co-ordination roles.

The Board notes that Council formed a small team from its staff to oversee its responsibility for the evacuation centres. The team worked within a short timeframe and with commendable dedication and commitment during both the peak demand period and as demand declined. Fatigue management was an issue but was eased by the involvement of a greater number of Council staff than that envisaged in the Standard Operating Procedures.

The participation at the BCLDMG by the senior Council manager accountable for the supervision of the evacuation centres was an advantage as this provided firsthand knowledge of the response across all work streams and provided the opportunity to give daily reports on the demands and challenges at the centres. The delegation of authority by the BCLDMG to the teams responsible for the centres greatly assisted in meeting tight deadlines for getting the centres open and functioning.

As with other units in the field, there were some minor communications issues with the timelines and flow of information in and out of the Local Disaster Coordination Centre but this did not impact adversely upon the overall management of these centres.

The Board has identified a number of aspects to site selection, operations and donated goods, for incorporation into Council evacuation centre planning for the future.

Site Selection: While the considerations that played a part in site selection here were appropriate, they did lead to a centralisation of evacuation centres. Flooding and closure of roads did restrict some access to those centres for evacuees. Notable in this context are the Bellbowrie/Karana Downs areas for which both of the established evacuation centres were inaccessible. A site at Bellbowrie and another at Karana Downs had been identified and registered by Council but neither was selected for activation. A local community-organised response centre was set up at a school.

Consideration should be given to selecting sites on a more decentralised basis. In particular, is this so for communities that is known to be prone to isolation by flooding. Planning should include a strategy for logistical arrangements to supply these sites with personnel and emergency supplies during a flood.

An additional advantage of greater decentralisation is less reliance upon a few very large-scale centres which can present security and logistical challenges for the management of an evacuation centre on account of sheer size and a dispersed location of facilities.

Operations: There are several aspects to operations which warrant consideration in future planning. The Board was informed of instances where what might be termed "non bona fide use" was made of evacuation centres by registrants or by volunteers. These included registrations by "unhoused" persons who were not flood victims, and an instance of alleged predatory sexual behaviour by a non-vetted volunteer. The latter incident is of particular concern.

The Standard Operating Procedures recognise that registration of evacuees in a disaster is the responsibility of Red Cross. A reliable system for vetting volunteers also needs to be in place. Given Council's overall responsibility, there should be early and close liaison with Red Cross to confirm arrangements for the registration of evacuees and the vetting of other personnel, and with Queensland Police Service with respect to the exclusion of persons who are not suitable to be in a general public evacuation centre.

Separate consideration needs to be given to the capacity of evacuation centres to accommodate persons with special needs arising from frailty, significant incapacity, or oxygen dependency on their part. Time and resourcing constraints will usually mean that it is not possible to cater satisfactorily for such persons at evacuation centres. It is desirable that there be an arrangement in place for a system or systems for transferring persons with such needs to a facility more suited to their needs, when they report at, or are brought to, an evacuation centre.

Registrants at evacuation centres were representative of a wide cross-section social, cultural, language and religious groups. A sizable number were from non-English speaking backgrounds. Planning decisions on locations, sleeping arrangements within an evacuation centre, and provision of food and arrangements for services, need to take account of this wide diversity. Particularly, sleeping facilities for single men should not be placed near those for families.

To equip an evacuation centre with consumables will require purchase at very short notice of significant quantities of types of goods which Council does not purchase on a "business as usual" basis, for example, personal hygiene products and baby care products. The Council team managed to make arrangements for this. Planning should involve compilation of a list of such consumables and sources of ready supply of them in an emergency.

Donated Goods: Many people responded to the plight of flood affected persons by donating goods to be distributed to them. The Board recognises the generosity and sincerity of the donors. Without wishing in any way to discourage this commendable practice, the Board has concluded that the use of evacuation centres as a place for receipt and distribution of donated goods is not appropriate and should be discouraged.

In the first place, evacuation centres do not have the set-up for that function. Secondly, often goods that are donated do not match up with the immediate needs of registrants while they are in an evacuation centre. Their immediate needs are for items such as torches, personal hygiene products, clean new underwear, and towels. Thirdly, the receipt and distribution of donated goods imposes an additional burden upon the centre staff whose primary concern is for the immediate needs of registrants.

The Board considers that Council should develop a process for handling donated goods which is separated from evacuation centres and that the process should incorporate a public awareness strategy to inform the public on what types of goods are most useful to those who need assistance.

The Board understands that the Disaster Management Plan and Standard Operating Procedures will be revised in light of the experience with this recent disaster and suggests inclusion of detail for dealing with those aspects which the Board has identified for comment.

Management of Volunteers

The Board has reviewed the effectiveness of Council's management of volunteers, ranging from individual citizens through to large commercial support. The Board notes, by way of preface, that the Disaster Management Plan did not contain either a documented strategy for managing volunteering across the range or Standard Operating Procedures for the management of volunteers. Notwithstanding, in the Board's opinion, volunteering at all levels was successfully managed by Council.

The range of volunteers extended across:

Individuals who offered their labour, in many instances as part of a community group;

Trades people who offered their skilled labour;

Plant and machinery owner/operators; and

Owners of businesses not involved in the construction industry.

The need for co-ordination and management of volunteering was foreseen early and discussed by BCLDMG on the morning of Tuesday 11 January 2011. An initial strategy involving the engagement of Volunteering Queensland for that role, particularly in relation to non-plant and equipment and business volunteering, was overtaken. The swiftness and scale of citizen volunteers seeking to assist flood victims overwhelmed the capacity of Volunteering Queensland to register and co-ordinate them. It quickly became evident that Council required its own mechanisms for managing the volunteer workforce based on a core role for it of coordinating resources across the city in response to the disaster.

At the BCLDMG level, decisions were made during the following days to develop Community Service Announcements calling for individual volunteers, and for plant and specialist trades volunteers. These announcements were publicised widely and complemented by the Lord Mayor's press releases.

Individual volunteers comprised the corps of what became known as the "Mud Army". It was raised and managed separately from the other categories of volunteered resources. The Mud Army was a very significant initiative of Council and is remarkable not only for the assistance given by it to flood victims but also for the civic spirit it inspired.

A small team of Council staff was engaged to develop a volunteer management strategy and establish a capability for registering, equipping and deploying volunteers to where support was most needed. To this team's credit, within 24 hours of engagement, a strategy was in place, registration points established, details advertised through the media and transport organized.

The Mud Army was mobilized on the weekends Saturday 15 to Sunday 16 January 2011 and Saturday 22 to Sunday 23 January 2011 and operationally managed from the Field Operations Group. Four volunteer co-ordination centres were established at each of:

Mount Coot-tha Botanic Gardens;

Boondall Entertainment Centre;

Doomben Racecourse; and

MacGregor State High School.

Volunteers were urged to register at these centres for morning shifts (7.30am–11.30am) and afternoon shifts (1pm–4pm). To even out registrations, volunteers were asked by the Lord Mayor to report on an "odds and evens" address basis for Saturdays and Sundays respectively. Volunteers were supplied with gloves, sunscreen and water.

Approximately 23,000 volunteers registered for the first weekend. Upon registration, they were allocated to sectors and then transported from the registration point to their allocated sector by Council bus. Council volunteer registration centres and drop off points are shown in Map 11.

These volunteers were co-ordinated on the ground by officers from Council's Libraries and Brisbane Transport. Notwithstanding some reported instances of buses being directed to streets that had already been cleaned, overall, the matching of resources to need was highly effective.

The volunteers assisted householders and business owners with debris removal and cleanups. On the second weekend, a large number of parks were cleaned. Council's call for assistance was also answered by many volunteers who did not register. It is thought that, in all, there were between 50,000 and 60,000 volunteers who assisted over the first weekend.

For Council staff, managing spontaneous volunteerism on such a large scale presented challenges not encountered in the usual course of Council business. The Board's review of the experience of dealing with these challenges has identified a number of aspects to organization for, and management of, individual volunteers for which strategies should be developed and documented. Those aspects are listed immediately below. It may well be appropriate to incorporate the strategies within a separate section on volunteer management in the Disaster Management Plan itself, supplemented by appropriate Standard Operating Procedures.

Volunteer Co-ordination: There is good reason to expect that a future disaster in Brisbane would generate a powerful volunteer response on a similar scale. The Board considers that readiness for such a response is likely to be enhanced by the provision within the Local Disaster Coordination Centre of a cell of suitably experienced personnel with responsibility for co-ordinating volunteers. Positioning a representative from an agency such as Volunteering Queensland within the cell should be considered.

Briefing Sheet: A proforma briefing sheet for volunteers should be developed now, based upon experience in the recent flood event. A briefing sheet would be useful in preparation of Community Service Announcements and delivery of onsite briefings to volunteers at registration points.

The briefing sheet should be prepared with a consciousness that participation by volunteers adds a new dimension to legal risk management for Council. Perceived risks could arise, for example, from injury to, or conduct by, volunteers. Protocols for risk management in this regard need to be in place at the time of registration and briefing. Such protocols should be established in consultation with Council's legal advisers and, where appropriate, Council's insurers.

Health Care: Debris cleanup does expose volunteers to the risk of injury. Some 330 injuries were treated by St John's Ambulance. The Board notes that vaccination was offered to volunteers at registration points and that they were encouraged to wear protective clothing. Health care arrangements are needed first and foremost in the field where injuries occur. Planning should be directed towards arrangements which are to accompany deployed volunteer groups on site.

Residents' Wishes: The Board has been informed of instances of distress on the part of residents arising from the disposal of items of property of value to them. In an environment of enthusiastic volunteerism, care needs to be taken to ensure that where property is disposed of, it is disposed of with the consent and approval of the owner, and to recognise that residents who are in a state of some shock, may not be ready for decision making. To minimise the risk of distress on this account, the Board considers that "house team" leaders be identified within volunteer groups and that they be given the responsibility of liaising with residents so as to ensure that debris removal and clean up activity are carried out in accordance with the wishes of residents.

Security of Dwellings: Protection of the security of dwellings of flooded residents during volunteer cleanup activity is a priority consideration. The Board encourages Council to develop processes in conjunction with Queensland Police Service directed towards maintaining security of dwellings over that period.

Plant and equipment and skilled trades' assistance were volunteered in answer to the Community Service Announcements and the Lord Mayor's press releases to which the Board has referred. The response was very substantial. For example, some 700 offers of plant and equipment from owner/operators were recorded and logged. These offers were subsequently verified and refined.

Receipt of offers of assistance from plant and equipment owner/operators, tradespeople and non-construction businesses was managed principally by the Forward Planning Group. As well, Council officers liaised directly with large contractors and industry representative bodies who provided assistance. Heavy plant and equipment made available to Council, was co-ordinated by the Major Infrastructure Project Office and was used for removal of debris from temporary debris sites to landfill. Working groups of smaller plant and equipment were allocated to RIMTs and the Australian Defence Force to assist with the removal of debris from streets in flood-affected areas.

The Board is of the view that the co-ordination and management of volunteering at all levels was successfully undertaken. The Board endorses, as a model, the separate management of different categories of volunteers, particularly individuals. Operational management arrangements for volunteers ought not depend overly upon Forward Planning Group personnel whose focus is upon planning.

Waste and Debris Management and Disposal

The volume of debris produced by the flood was prodigious and its diversity extensive. Routine waste disposal systems were significantly disrupted, particularly in flood-affected areas. Both waste and debris posed significant public health risks.

Council has outsourced its waste management function, retaining a relatively small City Waste Services (CWS) team on staff. CWS co-ordinated the logistic requirements of the response to the waste and debris issue. Functionally, Council received strong support from the waste industry and contractors alike and was thereby enabled to provide a responsive, flexible and efficient approach to clearing flood debris and household waste.

Council adopted a strategy of using localised temporary waste disposal sites for holding waste and debris on a short-term basis pending transfer to a number of Council and commercially operated transfer stations and landfill sites. In excess of 60 temporary sites were used in the aftermath of the flood. They included parks, playing fields and vacant pieces of land. These sites were identified through a range of methods, namely:

Existing sites: Council utilised pre-existing sites, especially its four transfer stations and Rochedale landfill;

Pre-identified sites: CWS with Local Asset Services, had previously developed a list of potential temporary disposal sites which had been identified after the 2008 Gap storm;

Post-flood identified sites: CSW and Local Assets Services also identified other sites immediately after the flood that would provide suitable space for disposal and access for collection;

Naturally occurring sites: There were also a number of sites across Brisbane that by virtue of their natural features were suitable. These sites were used primarily by community volunteers and the Australian Defence Force.

These temporary waste disposal sites were established generally in the vicinity of flood-affected areas for immediate accessibility. They were cleared using heavy plant and equipment and larger capacity trucks on a priority basis. Some sites became waterlogged and required gravel drops. Those occurrences need to be taken into account in future site selection and in consideration of potential surface upgrades.

These sites enabled the rapid removal of debris and waste from streets and contributed significantly to the speed of the clean up. By Saturday 22 January 2011, some 126,700 tonnes of debris and waste had been removed from temporary waste disposal sites to landfill. The sites were cleaned up within a few weeks of the flood.

Unquestionably, the temporary waste disposal sites served their purpose. Significant efficiencies in waste and debris disposal were achieved through their use, notably by making unnecessary the immediate transfer of all such material from the streets to the transfer stations in the outer suburbs. The Board considers that the temporary dump site strategy was very effective and is most suitable for incorporation into future flood disaster planning.

Council now has a substantial body of recent experience in selecting and operating temporary waste disposal sites. The Board believes that drawing upon that experience, Council should now prepare a comprehensive single list of sites suitable for use as temporary dumps in the event of a disaster. Core criteria should guide site selection. Those criteria ought to include:

Accessibility (road surface);

Size (capable of holding the required volume of waste);

Physical integrity (surface hardness, drainage);

Location (from a health, safety and convenience perspective); and

Impact (minimal direct and indirect impact on the environment and the community).

The locations of the temporary and permanent waste disposal sites (except for two located to the west of Brisbane) is shown in Map 12.

As has happened in the past, aerial reconnaissance is likely to play a key role in identifying temporary waste disposal sites. As well, planning arrangements should clearly designate where decision making on site selection is to reside.

Public health and safety was an issue with significant potential to impact upon the population of Brisbane. It was decided to use skip bins for food waste and to communicate that message to the community. This resulted in a separation of waste and a more effective method for clearing food waste from the streets. A shortage of skip bins across Brisbane placed limitations upon this resource. Notwithstanding it was managed and co-ordinated carefully through Local Disaster Coordination Centre, Field Operations Group and RIMTs. Approximately 220 skip bins were sourced for the disaster clean up and were allocated equitably across the five regions. The locations of skip sites were notified to the public; however, there were some instances where skips were not delivered to notified sites because roads were blocked by debris.

The need to inform the community of hazards associated with some of the waste was quickly identified and addressed through Community Service Announcements and information published on Council's website. CWS co-ordinated the collection of hazardous waste material during the period under review. Many requests for removal of hazardous waste were received. CWS also experienced a heavy inquiry load about safe disposal of asbestos. Requests for its removal were also received. Having regard to the level of public concern for it, Council should give further consideration to the asbestos issue from both planning and communications perspectives.

Given the jurisdiction and responsibility that Queensland Government Department of Environment and Resource Management (DERM) also has with respect to hazardous waste, effective outcomes required close cooperation between Council and DERM officers. That did occur on this occasion on the many practical aspects involved in hazardous waste removal and disposal.

There are several aspects to staffing which the Board considers ought to be incorporated in future planning arrangements. First, within the first one to two days of Local Disaster Coordination Centre activation, there was no waste representative at that centralized level. Once the nature and scale of the waste management issue became apparent, that omission was rapidly rectified. The Board's view is that a liaison officer from CWS should be incorporated into the Local Disaster Coordination Centre structure to facilitate integration of

planning and decision making on this critical function early within the Local Disaster Coordination Centre processes.

Secondly, the engagement of contractor services was managed on an "as need arose" basis by a procurement specialist who was assigned to the CWS team. The procurement system that was adopted proved to be flexible and allowed local solutions to be sourced quickly. This experience suggests that Council should strengthen the link between procurement and waste management during a disaster by establishing a dedicated position within the CWS team tasked with the role of liaising with respect to procurement.

Transition to Recovery

The Forward Planning Group prepared a Concept for Recovery document which envisioned that the Lord Mayor's Recovery Task Group would lead Council's recovery effort and assist State agencies with broader recovery responsibilities. The Concept document proposed the formation of a number of sub-committees within Council to oversee, subject to Lord Mayor's Recovery Task Group governance, important aspects of Council's response to the flood event beyond the immediate aftermath. They are as follows:

Community Recovery Co-ordination Sub-committee;

Finance and Economic Recovery Sub-committee;

Infrastructure Sub-committee;

Environmental Recovery Sub-committee;

Ward Recovery Sub-committee; and

Town Planning Recovery Sub-committee.

The Board notes that these sub-committees were established promptly. Each of these sub-committees is chaired by a Councillor. Their work has been substantially undertaken after the Board's reference period. Notwithstanding, the Board records its endorsement of these sub-committees and governance arrangements as most appropriate for the circumstances.

Additionally, Council formed the Joint Flood Taskforce on Tuesday 11 February 2011 which was tasked to investigate the January 2011 flood event and make recommendations on interim flood immunity standards and certain development guidelines. The valuable work of the Joint Flood Taskforce is referred to in the Board's discussion of planning issues. Council has also commissioned the provision of external expert engineering advice by engaging engineering consultants in March 2011 to perform a Failure Analysis on the 12 worst affected asset categories (by estimate of cost damage) to determine the mode(s) of failure.

Other aspects of Council's response in the period immediately following the subsidence of the flood waters have already been mentioned in preceding observations in this report, notably, those with respect to evacuation, management of volunteers and debris and waste management and disposal. It is within those contexts that the Board has made the comments which it considers appropriate to make concerning the successful management by Council of relationships with its contractors and supporting agencies. There was a marked degree of reciprocal goodwill which plainly created a co-operative environment for producing good outcomes over a wide spectrum of Council functions and services.

Commendations

The Board commends Council's coordination and management of the field operations response through the Field Operations Group, the RIMTs and other appropriate Council business units.

The Board commends Council for developing and implementing at short notice a citizens' volunteer management strategy, including establishing the capacity to register, brief, equip and deploy the volunteers to priority recovery locations; and for coordinating and deploying business and professional volunteers, (including trades people, contractors and plant operators) and community groups, to enhance the pace and efficiency of the cleanup.

The Board commends Council for undertaking a major waste collection and disposal effort for vast quantities of flood debris and household waste, in conjunction with waste disposal contractors, industry volunteers and the broader waste industry.

The Board commends Council's transition to recovery policies and procedures including the establishment of the various Council sub-committees as recommended in the Concept for Recovery document prepared by the Forward Planning Group, the formation of the Joint Flood Taskforce, and the engagement of engineering consultants.

Affirmations

The Board affirms the contribution of region-based RIMTs noting that they provide a critical layer in the command and control structure for dealing with the on ground situation, managing local resources and coordinating external resources allocated to them. The Board **recommends** that:

A senior officer be assigned to mentor each Regional Incident Management Team Manager and conduct high level discussions with the Local Disaster Coordination Centre;

Dedicated Regional Incident Management Team operations rooms be established; and

Planning for alternative Regional Incident Management Team sites, in the event that the primary sites become unusable, be conducted.

The Board affirms Council's planning for and implementation of evacuation centres as detailed in the Disaster Management Plan. The Board **recommends** that further consideration be given to refining Council's evacuation centre planning to address:

Greater decentralisation of evacuation centres particularly for communities that are known to be prone to isolation by flooding;

Early and close liaison with Red Cross particularly in regard to registration of evacuees and vetting of volunteers;

Early and close liaison with Queensland Police Service in regard to exclusion of persons not suitable to be in a general public evacuation centre;

The special needs of frail, aged, incapacitated, nursing home and oxygen dependant evacuees for whom separate and special arrangements need to be made;

Social, cultural and religious diversity of evacuees, including those with a non-English speaking background; and

Purchase and supply of special items such as personal hygiene kits and baby requisites.

The Board affirms Council's action in rapidly increasing sandbag production to a total of more than 390,000. The Board **recommends** that estimates be developed of likely sandbag demand for regions during future flooding events and that the best situated potential sites for filling and distribution points in each Region be identified.

The Board affirms Council's collaborative efforts with the Queensland Police Service and the Australian Defence Force in providing a workable framework for overall traffic management. The Board **recommends** that the Council consider developing advanced plans, in

consultation with Queensland Police Service, to improve traffic flow in flood recovery congested areas including converting some streets into one way, route designation for heavy vehicles and identification for residents' vehicles.

Recommendations

The Board recommends that permanent flood markers be installed on key roads that are known to become flood affected to complement other public awareness and safety campaigns.

The Board recommends that Council develop a process for handling donated goods separately from evacuation centres.

The Board recommends Council implement strategies in relation to volunteer clean up activities for:

Development of a proforma briefing sheet for volunteers based on experience gained in this flood event;

Identification of house team leaders to liaise with residents so that clean up activity is in accordance with the residents' wishes;

Ensuring the provision of appropriate health care arrangements to accompany deployed volunteer groups;

In conjunction with Queensland Police Service, developing processes to ensure the security of flooded residents' dwellings during volunteer cleanup activity; and

Making provision for a co-ordination cell within the Local Disaster Coordination Centre, particularly for individual volunteers.

The Board recommends that Council develop a comprehensive single list of potential sites suitable for temporary waste collection, incorporate a liaison officer from the CWS team into the Local Disaster Coordination Centre; and strengthen the link between procurement and waste management during a disaster by establishing a dedicated liaison officer position in the CWS team.

SECTION FOUR - THE IMPACT OF EXISTING PLANNING REGULATIONS IN FLOOD AFFECTED AREAS

This section of the Report outlines the statutory framework that regulates Council's planning powers. The use by Council of the Defined Flood Level adopted in 1978 as an important planning tool and its impact upon development in Brisbane are examined. Flood risk management in the future is considered and issues relating to basements, building services and the Voluntary House Purchase Scheme are discussed.

Council's Planning Jurisdiction

Council derives its jurisdiction in the field of town planning from State legislation. The jurisdiction is a limited one being regulated in many significant respects by statute. The *Sustainable Planning Act 2009 (Qld) (SPA)* (refer List of References) enables State planning instruments, such as State planning policies and standard planning scheme provisions, which have application to the City of Brisbane, to be made at State level. The SPA also empowers Council to make local planning instruments. These may be a planning scheme, a temporary local planning instrument or a planning scheme policy. Core matters for the preparation of a planning scheme are land use and development, infrastructure and valuable features.

A broadly similar planning law regime had also prevailed during the currency of the predecessor to the SPA, the *Integrated Planning Act 1997 (Qld)* (refer List of References) and the predecessor *City of Brisbane Act 1924 (Qld)* (refer List of References). State Planning Policy 1/03 (refer List of References), to which the Board has referred, is a product of that regime. The way in which the intent of that Policy is achieved at local government level, as outlined, is an illustration of how the regime operates in practice.

In making planning instruments, and in local law-making generally, Council is regulated, at numerous levels, by provisions in State legislation. At a very general level, local planning instruments must be consistent with State planning instruments. More specifically, and by way of example, the *City of Brisbane Act 2010 (Qld)* (refer List of References) prohibits Council from making a local law setting up an alternative process for development applications to that in the SPA; and the SPA itself forbids a council planning scheme from including provisions about building work to the extent that it is regulated under statutory building assessment laws and documents unless excepted by the *Building Act 1975 (Qld)* (refer List of References).

The CityPlan has limitations regarding the regulation of new development and/or rebuilds. Local government planning instruments are unable to cover a number of building and design issues as other pieces of legislation such as the Building Code of Australia and the Queensland Development Code are responsible for addressing these elements. This applies principally to single detached housing as Council has more control over the design of multi-unit dwellings. A rebuild or repair of a dwelling house to "as was" standard and design prior to flood damage requires neither development approval or building approval, provided that the "as was" was itself lawful.

Similarly, regulating the retro-fitting of commercial buildings with flood-proof design measures will be difficult from a Council perspective as the planning scheme primarily deals with triggers for new development (or changes to the intensity and scale of uses). These restrictions make it extremely difficult to channel modification of existing development through the Council approvals process. Accordingly, changes to Queensland Government legislation and statutory codes are likely to be the primary mechanism to achieve these aims.

The appropriateness of town planning and building codes in assisting residents and businesses in potentially flood affected areas to mitigate the effects of flooding was an issue raised in the community engagement process for this report and in media commentary. The reality is that whilst Council can take the lead on town planning reforms, many of the major planning issues can only be addressed comprehensively through changes to legislation, policies and codes at state government level. Bearing that in mind, the Board has not

undertaken a detailed analysis of all aspects to town planning and building codes which impact upon flood risk.

Lord Mayor's Taskforce on Suburban Flooding

In December 2004, the Lord Mayor established the Taskforce on Suburban Flooding. This Taskforce reported in August 2005 (refer List of References). It identified a number of areas in which Council could enhance mitigation strategies for the impact of flood events and recommended 24 "Key Actions" of which seven are of a planning nature. Many of these action items directly contribute to minimizing the risk to people and property as specified in SPP1/03. There has been a progressive implementation by Council of the recommendations including amendments to CityPlan and significant upgrade of Council's subdivision and development guidelines to address particular risks for flood affected land and stormwater flow issues.

A high level review of the Taskforce's report and the status (as at December 2010) of each of the "Key Actions" indicated that while a number of the town planning mitigation measures have been fully delivered, several remain "in progress", partial delivery only having been achieved. The legal and legislative complexity of some action items and the planning review cycle are assessed as having impacted upon progress. These issues are being addressed through a variety of Council's deliberative bodies including the Joint Flood Taskforce and the Town Planning Sub-committee.

Defined Flood Level Planning Tool

The planning tool that has had the most impact upon Council's planning decisions for a number of decades now is the Defined Flood Level (DFL). In summary, the DFL at a particular location is the peak flood level calculated for the Defined Flood Event (DFE) for that location. The DFL establishes the flood control lines for the location and plays a fundamental role in planning and development decision making. A more full description of the DFL and an explanation of its derivation from the concept of a DFE are given in Section One of this report.

The habitable floor levels that Council requires for particular developments are prescribed by Codes in the City Plan. These levels are set by reference to the DFL, the relationship to the DFL being dependent upon the building classification and use proposed for that development. For example, for houses and multi units along the Brisbane River, the required level for habitable floors is DFL + 500mm; and for non-habitable commercial buildings similarly situated, it is DFL.

Council's Subdivision and Development Guidelines set flood immunity levels for new subdivisions also by reference to DFL. For Brisbane River flooding risk, the minimum lot level for residential land is DFL + 300mm and for land other than residential, it is DFL.

In 1978, and in response to the January 1974 flood, Council adopted a DFE and a DFL which correspond with the flood event of January 1974 as mitigated by the Wivenhoe Dam. The DFL was set at 3.7mAHD at the Brisbane City Gauge, progressively increasing with distance upstream of that measurement point. Council has continued to use the same DFE and DFL since 1978.

As the Board has already noted, for areas which are subject to the worst flooding in Brisbane, the adopted DFL is somewhat higher than a DFL that would apply for a DFE constructed upon a Q100 theoretical flood probability. Markings on the aerial photograph of the suburb of Tennyson (Map 5) depict the adopted DFL relative to a Q100-based flood line. The depiction shows the former as being more conservative.

The adopted DFL has had a beneficial influence upon land development within the city from a flood risk perspective. In line with Council's growth planning strategy which envisages growth centres and transport connections outside potentially flood affected areas, development has generally been away from such areas. Statistical estimates provided to the Board by Council

illustrate this development pattern. In older suburbs and the Central Business District that were developed predominantly prior to 1978, some 24,696 properties, with an aggregate area of 13,175 hectares, were completely or partially inundated in the January 2011 flood. Of these, 19,786 were residential properties with an aggregate area of 2559 hectares. They represent about 89.5% of all flood affected residential properties in the city. By contrast, for suburbs developed predominantly after 1978, 1243 properties, with an aggregate area of 1422 hectares, were flood affected. Of these, 1017 were residential properties with an aggregate area of 251 hectares.

It is a chilling statistical fact that across the whole of Brisbane, 22,097 residential properties were wholly or partially inundated in the recent flood. Council does not have accurate or consistent records of floor heights for dwellings located on these properties and is not able to develop statistics which measure the extent of impact on these dwellings. However, it is evident that the impact, in many instances, was profound and the adverse consequences for the health, living arrangements, property and financial wellbeing for those concerned, were severe.

Throughout the whole of the city, some 7671 properties classified as non-residential were flood affected. This classification includes properties used for economic activity such as commercial office work, retail, industry, warehouses/bulk stores, and rural. Together, they represent 11.7% of all non-residential properties in the city. It is estimated that the land surface of 2940 of these properties was completely inundated while the land surface of the other 4731 properties was partially inundated. Here, also, the properties are concentrated in older areas. The impacts for the owners of these premises and of businesses carried on at them and for workers, differed from those for residents but, for some, were no less disruptive, injurious to health and/or financially devastating.

A total of 7926 properties were recorded in the CBD as at February 2011. Of these, 6680 properties, including their on-site facilities, (84.3%) were directly affected, by complete or partial inundation. The disruption to commercial and professional activity resulting from building closures and temporary relocations was extensive, particularly in the immediate aftermath of the flood.

Whilst the adopted DFL has had a demonstrably positive effect, it has in no way guaranteed a flood-proof Brisbane. It could not do so; nor was it designed to do so. In the January 2011 flood, an approximate area of 67.48km^2, 5.1% of the total city land area, was flood affected. Of this area, approximately 16km^2 (approximately 23.7%) has been identified as being above the adopted DFL. Map 5 also depicts areas within established suburban development, railway lands and infrastructure, and the newer tennis centre development where the January 2011 flood exceeded the adopted DFL for Tennyson.

It is in these circumstances that Council formed the Joint Flood Taskforce on 11 February 2011. In accordance with its mandate, the Taskforce delivered its report within 30 days. The Taskforce's report is a technical study which investigates and provides answers to several questions put to it by Council. The Taskforce was asked in light of the January 2011 flood event, what interim standard should be used to enable new development and redevelopment to proceed with confidence and certainty, until the Commission of Inquiry Reports.

The Taskforce recommended a number of strategies for the development of a long term plan for dealing with all aspects of flooding up to the most extreme event. A key recommendation was:

> "That a complete Flood Risk Management analysis for the area of Brisbane affected by flooding by Brisbane River and its tributaries be carried out. It is essential to move from the Q100 mentality and to adopt a risk management approach in line with National Flood Risk Advisory Group (NFRAG) and other relevant guidelines. The risk management approach would require a detailed assessment of the benefits and costs of a full range of flood mitigation options."

The Board fully supports this strategy. While this analysis would be very costly, it would provide significant long term benefits. The cost should be seen as one that ought to be incurred for an important metropolis that has a significant flood risk. It needs to be borne constantly in mind that large floods do occur here; that, as the cover to this report depicts, they occur with an unpredictable frequency; and that when they have occurred, great loss and damage has been caused to the city and its citizens.

The Taskforce also recommended that the actual January 2011 flood, as observed during the event, be used as an interim standard for new development and redevelopment, with the essential condition that wherever a higher level has been set as the current DFL, the higher level must apply. The Board notes that Council has accepted this recommendation and acted promptly with a view to the formal adoption of the interim standard.

The interim standard sets the DFL at the City Gauge at 4.46m AHD compared with 3.7m AHD. According to the Joint Flood Taskforce Report, the re-set DFLs at other locations along the river are:

West End ferry, 7.42m AHD (from 5.79mAHD);

Tennyson Tennis Centre, 9.84m AHD (from 7.79mAHD);

Centenary Bridge, 12.91m AHD (from 10.8mAHD); and

Karana Downs, 22.98m AHD (from 21.1mAHD).

These levels may be revised as more accurate data becomes available.

The interim habitable floor level at each of these locations under the interim standard is therefore set at 500mm above the DFL based upon the 2011 flood experience, and significantly above the corresponding level that had previously applied at that location.

Basements and Building Services

The Board has received submissions which describe particular difficulties arising from flooding of basements. The disabling of machinery located in basements, including emergency electricity generators, for provision of necessary services to buildings, such as lifts, lighting and ventilation, was a recurrent serious problem. Many buildings became inaccessible and uninhabitable for protracted periods as a result. The Board notes that presently there are limited regulatory mechanisms that require developers to provide a flood-proof location for ENERGEX assets located on customer premises. During the recent flood, the incidence of adverse consequences arising from the siting of such assets in flood vulnerable locations was pronounced in the CBD.

Another serious problem was caused by the presence of thick layers of mud that remained on basement floors after flood waters had receded. Conventional basement design which does not provide for drainage at the lowest basement level, meant that mud, in a slurried form, had to be pumped upwards for extraction and could not be simply hosed away. The extraction was time consuming and costly for building owners and residents.

Council has taken measures to address basement flooding difficulties, principally through the Town Planning Sub-committee. These measures are detailed in Section Five of this report.

Voluntary House Purchase Scheme

The Board has been briefed on the Voluntary House Purchase Scheme. This scheme was a major strategy proposed by the Lord Mayor's Taskforce on Suburban Flooding Taskforce (2005). It provides for the removal of residences from the flood hazards identified in the Taskforce's report, on a voluntary basis.

There are approximately 525 properties in the city that could be adversely affected during a two year Average Recurrence Interval (ARI) creek flood event. Council has approached in excess of 200 owners of these properties to participate in the scheme. The average annual budget allocation to the scheme has been $5 million. The limited budget and a modest acceptance rate have resulted in only 46 houses having been purchased under the scheme.

The Board regards the strategy as a good one for assisting residents who are affected by frequent flooding and suggests that Council consider an extension of the scheme to cover less frequent flooding. A very substantial increase in the budget allocation to the scheme would be needed to adequately fund a significant extension of it. This would most probably require additional financial assistance from the State and Commonwealth Governments.

Commendations

The Board commends Council for its Growth Planning Strategy which envisages growth centres and transport corridors outside potentially flood affected areas and notes that 89.5% of all flood affected residential properties were in areas developed predominantly prior to 1978.

The Board commends Council for its progressive implementation of the recommendations of the Lord Mayor's Taskforce on Suburban Flooding (2005) which has resulted in a reduction in the risk of flooding in recently developed areas.

Recommendations

The Board recommends that, in relation to planning, Council undertake a complete flood risk management analysis for the area of Brisbane affected by flooding from the Brisbane River and associated tributaries in line with National Flood Risk Advisory Group (NFRAG) and other relevant guidelines. This would require a detailed assessment of the benefits and costs of a full range of flood mitigation options.

SECTION FIVE - FLOOD PREVENTION, STORMWATER AND RIVERINE INFRASTRUCTURE

This section discusses the types of flood mitigation infrastructure and identifies two types that may have limited application in Brisbane. It reviews the impact of the flood on the stormwater infrastructure and describes the damages sustained by Council's riverine infrastructure.

Flood Prevention Infrastructure

The most important infrastructure items for mitigation of flooding from the Brisbane River are the Wivenhoe and Somerset Dams. Council has a vital interest in the operations of the dams during river flood events but it has no statutory role in dam releases or flood mitigation operations for Wivenhoe and Somerset Dams. Seqwater has that role and responsibility and issues relating to these dams are outside the scope of this review.

In any consideration of the effectiveness of the Council's flood prevention and stormwater infrastructure in a particular flood event, it is essential to recognise that there are many different causes of flooding in Brisbane. This review has been commissioned because of the January 2011 flood event, a Brisbane River flood caused by heavy, sustained rainfalls over the catchments of the Brisbane River. The following discussion must be read in that context. A large river flood such as that of January 2011 causes extensive flooding in many low-lying areas close to the river. Such a flood is a relatively infrequent event and much more frequent flooding is caused by creek and by overland flow throughout much of Brisbane. This flooding can be as severe as that caused by a river flood, although the extent on each occasion is much smaller. Any infrastructure for prevention/mitigation of the effects of a Brisbane River flood must not cause unacceptable increases in flooding due to other causes.

Even when the effects of Brisbane River flooding are considered in isolation, it is necessary to recall that all river floods differ from each other to varying degrees. During the January 2011 flood event, the flooding was caused virtually everywhere by the river. The rainfall over Brisbane itself caused little, if any, flash flooding in Brisbane's suburban creeks. The flooding that did occur in Brisbane's creeks was essentially due to backing up from the flood waters in the river. In contrast, in the January 1974 flood event, extensive and severe flash flooding occurred in the suburban creeks before the flood peak in the Brisbane River arrived and caused a second flooding in many low-lying areas.

Some of the flooding during the January 2011 flood event caused by backwater flooding from the river may have been prevented by some form of engineering device such as flood gates, one-way valves and levees. While such infrastructure could have been beneficial during the January 2011 flood event, it would have caused increased flooding in many areas during the January 1974 flood event.

So that balanced consideration is given to strategies for flood prevention or mitigation by engineering works, Council commissioned GHD to investigate and evaluate all engineering options for Brisbane. The outcome is given in the report, "Engineering Solutions for Flood Mitigation in Brisbane", Discussion Paper prepared for Brisbane City Council by GHD, February 2011 (refer List of References).

Six types of engineering structural measures have been used for flood prevention or mitigation in Australia and overseas:

River barriers;

Flood gates;

Backflow prevention valves;

Levees and flood walls;

Dredging; and

Flood mitigation storages.

The first three of these could be used in Brisbane only to prevent backwater flooding. The second group of three have general application.

After detailed consideration of the applicability of these options to Brisbane and of their advantages and disadvantages, the GHD report concludes that:

> There are no "silver bullets" to mitigate flood levels in Brisbane. The 2011 flood was characterised by high flows and water levels in the Brisbane River at a time of minimal flows in urban tributaries and most of the flooding was caused by "backflow" from the river. This was more pronounced than in 1974, for example, where flooding of tributaries such as Oxley Creek by local rainfall was also significant.
>
> The major difficulty in planning for infrastructure to mitigate flooding in Brisbane is that flood events are rarely the same. A variety of structural measures exist that could potentially be used to reduce the impacts of "backwater" flooding in Brisbane, but none of these measures comes without other impacts and risks.

"Engineered" or structural measures with the highest potential for application in Brisbane are:

> The use of backflow prevention devices such as flap valves and "duck-bill" valves, provided suitable maintenance regimes are implemented;
>
> The use of levees around specific, high-value infrastructure (such as the Brisbane Markets), but not along waterways; and
>
> Construction of flood mitigation dams on Lockyer Creek the Bremer River upstream of Ipswich.

The last two of these in particular would require further, more detailed, investigation to establish if they are viable and would provide a net benefit to the community. Construction of levees in flood prone areas of Brisbane would be under the control of Council. However, possible sites for flood mitigation dams would in areas where Council has no authority and this matter is outside the scope of this review.

Backflow Prevention Devices

A backflow prevention device is intended to ensure one-way flow downstream and prevent water from backing up from downstream into stormwater systems. Backwater valves must be designed and constructed to minimise clogging.

A wide range of backwater valve designs is in use, from simple flap valves through to more complex devices. The most common backflow prevention valves are the simple flap valve - used extensively in Australia and the rubber "duck-bill" valve. In both of these, the intention is that the valve will remain closed until there is flow from upstream and that it will then open to release the flow from upstream, closing again when flow stops and the downstream water level is higher than the upstream level. Issues of concern with these types of valve include the relatively high potential for them to be stuck open (e.g. by debris or accumulated sediment) and rendered ineffectual, and the potential for increased pressure losses in the system causing less effective drainage. Regular maintenance of these devices is essential to ensure their effective operation.

In Brisbane, Council has a range of backflow devices along tidal reaches of the Brisbane River, creeks (primarily Breakfast/Enogerra Creek) and along Moreton Bay. The only backflow device in the South Region is a flood valve located at Brisbane Corso in Yeronga.

The purpose of these devices is to stop the inflow of tidal water at high tides into low lying streets and adjacent properties. They cannot reduce creek or river flooding if they are overtopped by flood waters that break over the banks of the river or creek. During the January 2011 flood event, backflow devices were engaged when water reached the height of a high tide and they stopped the inflow of water through the stormwater network. However, when the Brisbane River and creeks over-topped bank heights near these devices, flood waters flowed overland behind them. The backflow devices performed effectively to their stated purpose, which is to stop tidal ingress and not for stopping flooding of a higher magnitude.

While these backflow devices are stopping tidal water ingress they can cause a problem from local flooding behind them by preventing stormwater produced by local rainfall from flowing downstream through the stormwater pipes to the receiving waters, once the backflow device is engaged. The Board was informed that very minor flooding of local roads and properties did occur during the January 2011 flood event in the tidal reaches of Breakfast/Enoggera Creek, near Breakfast Creek, where Sandgate Road is higher and the area slopes back to Albion Park. This happened because, when it rained, the gates were shut by the tide and the runoff was dammed until the tide started to recede and the height of the runoff could open the gate. This happens only from time to time. Council has an SMS service and signage on-site to alert motorists of this risk.

The Board was informed that, during the January 2011 flood event some areas, such as parts of New Farm, were flooded by backflow from the river without the river banks being breached. In such cases the installation of backflow prevention devices might have prevented flooding on this occasion. However, this does not provide sufficient grounds for installation of such devices and extensive investigation would be required to assess whether they would have unacceptable impacts during other possible types of flood events. This is discussed further in the section below on the effectiveness of the stormwater infrastructure.

As noted above, regular maintenance of backflow prevention devices is essential to ensure their effective operation. In some situations, the impact of backwater flooding is restricted to a particular body or to a limited, identifiable group. If such interested parties accepted responsibility for oversight of this maintenance, this would reduce substantially the risk of failure in the time of need.

Levees

Levees have been proposed by some for flood protection in a number of locations in Brisbane and it is appropriate that this matter be given due consideration. Important issues that must be weighed before the decision is made to construct levees include:

Levees will need to extend over long distances since the river has a small longitudinal gradient in its lower reaches;

They will increase flood levels in the river because flood plain storage is reduced;

Levees will cause a major safety hazard if they are breached during a flood;

Dangerous failures will certainly result in a flood event that is larger than the "design" flood when the levee will be over-topped; and

Levees may form a barrier to overland flow paths and may need underground drainage structures across them to allow for normal drainage.

Nevertheless, levees may be found to be a suitable option to protect specific areas, such as areas with a high population density, some critical infrastructure installations or important industrial areas. One example might be the cold stores at the Brisbane Markets at Rocklea. Each case would require careful consideration of a range of design issues to assess its applicability and whether the benefits outweigh the costs.

Flood Resilient Buildings

When buildings have been flooded, the time required for recovery and the costs of repairs depend on the degree of damage suffered. Appropriate design and the use of flood resilient construction can ensure that the damage caused to buildings by flooding and the recovery time after flooding is reduced very much. The Board has been advised that Council's Town Planning Sub-Committee has been actively considering the issues of flood resilient design for buildings. A Temporary Local Planning Instrument (TLPI) encompassing preliminary recommendations has been drafted. After approval by Council, it will require endorsement by the State.

Key elements of the TLPI relating to basements and services include recommendations that:

New building work uses waterproof materials and corrosion free components;

Essential services are located above the Interim Residential Flood Level (January 2011 flood event) and any electrical services, including photovoltaic panels, are easily isolated;

Basement car parks must be suitably waterproofed and all air vents, air conditioning ducts, pedestrian access and entry/exit ramps at the car park entrance must have appropriate flood immunity; and

Where essential services are proposed in a basement below the specified flood immunity level, a fully watertight basement design is required to prevent floodwaters entering the basement to ensure flood immunity for the essential services.

A Draft Code for Basements and Building Services is expected to be completed in May 2011. This will include design requirements that reduce the susceptibility of building basements to flooding and it will recommend mandatory design requirements for building services locations that reduce susceptibility to flooding.

A draft design code for resilient building design is being developed. The Board understands that designs will be available eventually through Council's website and other planning documents, such as Neighbourhood Plans for flood affected areas, as well as being promoted through peak industry bodies.

Effectiveness of Stormwater Infrastructure

For the period from 9am Friday 7 January to 9am Wednesday 12 January 2011, the five day rainfall in Brisbane was 193mm. Apart from a one day total of 110mm for the 24 hours ending at 9am on Monday 10 January 2011, Brisbane itself did not receive heavy rainfall during the January 2011 flood event and there was little, if any, flash flooding in Brisbane's suburban creeks and overland flow paths. The flooding that did occur in Brisbane's creeks was essentially due to backing up from the flood waters in the Brisbane River.

The essential purpose and function of the stormwater network is primarily to prevent or reduce flooding due to creek and overland flow flooding. Brisbane's stormwater system, shown in Map 13, is very extensive and complex. Only a relatively small proportion is in the flooded area. It is estimated that 17% (451km) of the Council's 2640km of enclosed pipe was significantly silted from the flood.

Noting these two factors, the effectiveness of the stormwater network system in the context of the January 2011 Brisbane River flood event is largely unrelated to the flood event. However, where the system was affected by flood water from the Brisbane River, its performance can be assessed from how well it functioned in the face of the large amounts of debris and silt deposited into the system by the Brisbane River.

The stormwater network system requires continual maintenance and repair to ensure that it performs to desired standards of service. Council undertakes planned maintenance and

repair work on a yearly basis and that part of the work relating to the pipe network and to bank maintenance appears to have been proceeding more or less on schedule prior to the January 2011 flood event.

Some of the flooding during the January 2011 flood event was caused by backwater flooding from the river that entered low-lying areas through stormwater pipes and open drains, and some of this could have been prevented by some form of engineering device such as flood gates on drains or one-way valves in pipes. This issue is discussed above in the context of backflow prevention devices. Noting that the primary, essential function of the stormwater network is to prevent or reduce flooding due to creek and overland flow flooding, any proposal to incorporate backflow prevention devices in it to prevent some river flooding must be assessed with care to ensure that the effectiveness of the system is not thereby compromised during more frequent flood events due to local rainfall.

Impact of Flood on Stormwater Infrastructure

The major impact of the flood on the stormwater system was from the large amounts of silt and debris deposited within the network including, but not limited to, enclosed pipes, gully inlets and grates, open drains and waterways. The flood caused some damage to elements of the system but this is not likely to have impacted on its effectiveness during the flood. The damage is described under riverine infrastructure failures.

It is not known whether blocked storm water drains or inlets caused higher local flooding levels than those due to river flooding but this is considered unlikely. There was no significant rainfall in Brisbane while the Brisbane River peaked and blockages of stormwater infrastructure at or near the flood peak line would not have received additional stormwater of a significant enough volume to heighten the flood line.

It is not known whether blockages delayed the recession of flood waters locally but Council has not received any particular comment that warrants further investigation of this matter. It is thought that recession of flood waters may have been partially delayed in some instances but that the time period associated with a delay would be less than a few hours and that the effect of this was not a significant factor in the damage caused by the flood waters.

Maintenance of Stormwater Infrastructure Following the January 2011 Flood Event

As noted above, about 451km of the enclosed stormwater pipe system was significantly silted from the flood. The clean-up efforts after the flood added to the siltation deposited by the flood when large amounts of mud and debris were washed into stormwater drains.

Immediately after the flood receded, Local Asset Services (LAS) managed the process of cleaning all gully pits within the flood affected area. This was to ensure the stormwater network would be able to receive stormwater in the event of a storm or local rainfall event following the January 2011 flood.

Following this, LAS have been undertaking a planned maintenance program to clean the entire affected stormwater infrastructure.

To the end of March, 39.4km of enclosed pipe lines including associated manholes, inlets and outlets had been inspected. Of the 9.3km found to require cleaning, 3.5km have been cleaned and re-inspected. A total of 780 kilolitres of silt and debris has been removed from the stormwater network through line cleaning.

Eleven major open drainage lines in Toowong, Milton, St Lucia, New Farm, Yeronga and Rocklea have been identified as requiring cleansing and will be treated as individual projects.

This has been, and continues to be, a significant effort and the program of works started in February is not due for completion until at least the end of June 2011.

Brisbane City Council's Riverine Infrastructure

Council has commissioned engineering consultants to provide independent advice on reasons for the failure of certain riverine infrastructure assets. The brief for this commission was prepared on 2 March 2011 and the Board notes that the consultant's final report is due to be delivered towards the end of May, which will be too late for the Board to consider its findings.

Although the Board is not able at this time to provide an analysis of the reasons for failures of Council's riverine infrastructure, it can provide comment on some aspects.

Council's Ferries

On the evening of Monday 10 January 2011, the ferry operators noted the difficulty in operating the ferries because of the increased velocity of the river and the increasing quantity of debris floating down the river. Ferry operations were terminated early on Monday night.

On Tuesday morning, the operators reported on the dangers associated with trying to continue to run the ferry service. It was decided then to move all ferries as far downstream and as close to the mouth of the river as possible.

The ferries are only licensed to operate in the Brisbane River. Approval from Maritime Safety Queensland (MSQ) and Council's insurer was required prior to removing the ferries beyond the river. Because of the unusual circumstances, MSQ supported Council's request.

At approximately 11am on Tuesday 11 January 2011 and after MSQ and insurance approval, seven vessels were moved to the Wynnum Manly boat harbour for safe mooring. Two other ferries were protected on hardstand at Council's maintenance facility at Bulimba. The remaining eight were moored at River Gate moorings in the vicinity of the Gateway Bridge. On Wednesday morning, nine mono-hull vessels were relocated from River Gate to the Wynnum Manly boat harbour.

The River Gate moorings are a protected mooring at a location where the river widens and there is lower river velocity. One of the City Cats moored at River Gate was struck by a loose pontoon. The hull of the vessel was punctured and it broke free from its mooring. The City Cat was recaptured by one of the tugs in the area and it was secured.

Floating Riverwalk

As flood levels rose and debris began to be carried down the river, the gate of the Floating Riverwalk was opened by Council in accordance with design requirements before any significant amounts of debris built up. With the gate open, debris was able to flow through to the downstream gangway/section. However, debris gathered on the lookout and on the leading edge of the downstream section of the Floating Riverwalk. Debris also gathered on the upstream approach structures. The Riverwalk floated upwards on its piles as the water level rose.

At about 4am on Thursday 13 January 2011, the downstream portion of the Floating Riverwalk broke free and floated down the river. A length of about 380m was washed away at this time and about 400m remained. A little before this time the peak flood level was recorded at the Brisbane City Gauge, about 2km upstream from the Floating Riverwalk.

The study being undertaken by consulting engineers is expected to report on the mechanism and causes of the failure of the Floating Riverwalk.

The location of the Floating Riverwalk is shown in Map 14.

Ferry Terminals

Council owns 23 ferry terminals and four moorings/refuelling stations. Eight of the ferry terminals and two of the moorings were significantly damaged in the flood. The locations of the ferry terminals and moorings are shown in Map 14. The terminals and moorings which suffered significant damage are identified.

It is thought that the location of each of the ferry terminals, which is determined by their functional requirement, was the main reason that some of them were severely damaged while others suffered little damage and were able to be re-opened quickly after minor maintenance works.

Some terminals were exposed to the full force of the river flood flow, e.g., at the Terminal at QUT Gardens Point where the pontoon was never recovered and two spans of its gangway were damaged. In contrast, others in more sheltered locations, such as the South Bank Terminal, suffered little damage and were reopened after minor works.

Since the engineering assessment of the causes of failure is still awaited, it is not within the competence of the Board to make any recommendation at this time. However, it is suggested that any review of the design standards for the terminals should consider whether different design standards need to be developed for exposed and for sheltered locations.

Pontoons and Jetties

Council owns 25 pontoons and jetties and fifteen of these were found to be significantly damaged in the floods. In most cases sections of the damaged pontoons have been washed away.

It has not been possible to identify clearly the difference in the circumstances associated with degrees of damage to pontoons without the input of the pending engineering assessment. The locations of pontoons are shown in Map 14. The pontoons which suffered significant damage are identified.

Stormwater Outlets Damaged During the Flood

The most recent information provided to the Board on 13 April 2011 is that, at that time six stormwater outlets had been identified as damaged during the flood and requiring remedial treatment. Generally, failure was due to scouring or slumping of the surrounding supporting material. Much of the cost of remediation is expected to be associated with scour and erosion repair rather than with the cost of repair of the pipe and headwall.

Stormwater Drainage and Enclosed Pipes

Approximately 17% (451km) of the Council's 2640km enclosed stormwater drainage pipe was significantly silted from the flood.

Where failures occurred, most were due to the unavoidable location which resulted in erosion or slumping of support. A minor proportion of failures were caused by the physical capacity being exceeded. For example, some joints were popped by internal pressure.

River Walls

Thirty of Council's 97 river walls failed from damage by the flood. Approximately half of the failures were considered to be due to the physical capacity being exceeded or to the unavoidable location of the wall.

River Banks

As at 1 March 2011, a visual survey of the Brisbane River from Story Bridge to Colleges Crossing by the Ground Engineering Team in City Design recorded 399 instances of bank slip. Of these, 34 have been identified as Council sites, 238 as sites owned by the State, Ipswich Council or privately. Ownership of the remaining 127 sites was being investigated.

The bank slips on Council sites have been assessed by Council officers according to the risk associated with them. Six bank slips are assessed as Very High Risk, (Orleigh Park, Rocks Riverside Park, Sir John Chandler Park, Priors Pocket Road Park no. 300A, Spinkbrae Street Park and Ormsby Street Park), four bank slips are assessed as High Risk (Wolston Creek Bushland Reserve, Barcoorah Street Park, Kookaburra Park West and Moggill Ferry Reserve), and five bank slips are assessed as Medium Risk (Illawong Reserve, Howard Smith Wharf Precinct, Botticelli Street Park, Booker Place Park and Kurilpa Point Park).

Expectations for Riverine Infrastructure

It is not realistic to demand that riverine infrastructure of the kind that Council owns should be able to withstand the worst possible flood that could occur, nor would it be justifiable economically, particularly since the infrastructure normally has a replacement cycle. Each item should be designed to a standard that is appropriate to their importance and normal 'life expectancy'.

Commendations

The Board commends the initiative of Council through its Town Planning Sub-Committee in developing strategies and effective planning instruments to encourage development of flood resilient building design and construction.

The Board commends Council for the rapid response in cleaning gully pits within flood affected areas and for initiating the major program of works required to remove silt from all of the stormwater system affected by the flood.

The Board commends Council's prompt actions in relocating the entire fleet of City Cats and cross river ferries to safe locations.

The Board commends Council for commissioning independent engineering consultants to provide advice on reasons for the failure of certain riverine infrastructure assets.

Recommendations

The Board recommends that:

> Council investigate the feasibility of the installation of devices to prevent backflow from river flooding in locations such as in parts of the Central Business District (CBD) and in high rise buildings which would not have been flooded otherwise, where all those potentially affected by backflow flooding have responsibility for oversight of the maintenance of the device in working order, and
>
> No backflow prevention device should be incorporated into the stormwater network system unless a complete risk based flood management analysis has confirmed that this is the best option.

The Board recommends that Council investigate the feasibility and appropriateness of establishing local levees to protect areas of strategic significance such as the Rocklea Markets. This will require a complete risk based flood management analysis.

CONCLUSION

The Queensland Government (Department of Emergency Services) has enunciated concepts and principles for disaster management that is in accordance with the Federal Government and accepted international guidelines. These concepts and principles detail the requirement for a "Comprehensive and Integrated" approach to disaster management.

The Comprehensive approach recognises that dealing with the risks to community safety and sustainability requires a range of strategies that provide a balanced approach to prevention, preparedness, response and recovery.

The Integrated approach recognises that no single agency has the capacity to deal with the disruption to community life and infrastructure that can result from a disaster event. As such, an integrated approach requires the effective coordination of activities of a large number of organisations and agencies within and across all levels of government and of Non Government Organisations. The Integrated approach also recognises the importance of a prepared community which can take measures to increase resilience during the prevention and preparedness phases, as well as provide self help and help to others during the response and recovery phases.

The Board is of the view that Council has a well developed set of disaster management arrangements, which are congruent with Commonwealth and Queensland Government legislative and policy requirements and accord with the principles of best practice disaster management. The Council's disaster management arrangements are well resourced and reflect the application of very sound personnel and training policies.

Council's response to the second worst Brisbane flood in more than 100 years can be described as of a very high order including a consistent pre-flood public information program which had commenced in 2006 following the acceptance of the Recommendations by the Lord Mayor's Taskforce on Suburban Flooding, and was reiterated with urgency in November 2010; the development of clear and effective set of strategic directions as the flood loomed; the implementation of a broad based public information program during the flood; the provision of vast quantities of sandbags to assist with prevention; and the establishment of two large evacuation centres to shelter and care for those forced from their homes.

The arrangements fostered flexibility and the use of initiative at the local level. Council staff and assets were deployed efficiently in the Central Business District and in the suburbs, except initially in Pullenvale Ward while it was isolated. The mutual cooperation with other agencies at numerous localities throughout the city deserves commendation.

As the waters subsided Council organised a volunteer cleanup program for private dwellings, small business premises and Council Parks. The people of Brisbane came forward in their thousands to assist in cleaning up homes and streets, while Council arranged a massive waste collection and disposal effort to remove hundreds of tonnes of waste and debris. During this time Council developed and implemented a strategy for recovery which is ongoing.

Parts of Brisbane have been settled on the river's flood plain where a large number of residential commercial and industrial buildings have been built. The majority of these buildings were constructed prior to the January 1974 flood and the adoption of the Defined Flood Level in 1978. It is sobering to realise that no matter how comprehensive Brisbane's flood disaster management arrangements are, or how effective the response to a flood event is, flooding will occur in the Brisbane River. Floods similar in magnitude to and even greater than, the January 2011 flood will probably occur in the future and will inundate these areas again.

In this context, Council's pre-flood public warnings regarding the possibility of serious flooding, its robust disaster management arrangements, together with their regular updating and refinement, are essential elements of Council's continuing service to the citizens of Brisbane.

LIST OF ATTACHMENTS

Terms of Reference (including Glossary)

Chronology

List of References

List of figures and tables

List of Maps

Terms of Reference (including Glossary)

REVIEW OF THE BCC RESPONSE TO BRISBANE FLOOD EVENT

Brisbane City Council (BCC) will review its response to the flood event in Brisbane during the period Sunday 9 January – Saturday 22 January 2011. BCC is establishing a Flood Response Review Board to undertake this review.

The Board will consist of:

- Major General (Retd) Peter Arnison AC, CVO
- Mr Robert Gotterson QC
- Emeritus Professor Colin Apelt

Context
The review is to establish the characteristics of the flood and the resultant levels (including a comparison against the Q100 flood level). These characteristics will provide the context against which the review is to be undertaken.

The review will focus on:

- Effectiveness of BCC's disaster management arrangements (including the Local Disaster Management Group and Local Disaster Coordination Centre)
- The impact of the existing planning regulations in flood affected areas
- Command, control, coordination & communications
- Effectiveness and timeliness of public warnings and advice
- Information management (including GIS, flood modelling and monitoring systems) and ICT arrangements
- Effectiveness of flood prevention and stormwater infrastructure
- Analysis of the reasons for BCC's riverine infrastructure failures
- Integration of Council's response with other agencies
- Effectiveness of the response, including:
    - Field operations
    - Evacuation
    - Intelligence management and dissemination
    - Forward planning
    - Management of supporting agencies
    - Logistics planning and procurement arrangements
    - Contractor support and management
    - Management of volunteers (individuals through to large commercial support)
    - Waste and debris management and disposal
    - Transition to recovery
- Other issues (ie activation & escalation) are to be noted in the report.

Internal aspects are to include consideration of:

- Clarification of roles & responsibilities
- Systems & data (for collecting, modelling, collating and sharing data)
- Emergency shelters / one-stop-shops and recovery centres and
- Communications between the LDCC and operationally deployed elements (multiple RIMT's)
- Interaction between LDCC (FOG, DIG and ISG), FPG, RIMT's and Recovery Committees

External aspects are to include consideration of:

- Systems & data - (for collecting, collating and sharing data with other agencies)
- The division of responsibilities for emergency shelters / one-stop-shops and recovery centres
- Council's relationship with LDMG and the wider disaster management system (including the DDCC and SDCC)

The review activities are to include:

- Facilitated debrief sessions
- Review of LDCC information (logs and other documentation)
- Briefing reports from business units if available
- Interviews of BCC persons (including LM, CEO, Incident Controllers & LDCC personnel, RIMT commanders and peer executives)
- Interviews of key external stakeholders
- Attendance at CEO debrief session
- Limited interviews with a representative sample of residents across the inundation area

The Final Report will be produced by early May 2011.

The report is to summarise the key findings regarding Council's response to the flood events that occurred from Sunday 9 – Saturday 22 January 2011, to document observations and to make recommendations on amendments to plans, procedures, roles and responsibilities, and on improvements that will enhance BCC's disaster management arrangements and the response to future events.

Glossary

BCC	Brisbane City Council
CEO	Chief Executive Officer
DDCC	District Disaster Coordination Centre
DIG	Disaster Intelligence Group
FOG	Field Operations Group
FPG	Forward Planning Group
GIS	Geospatial Information Services
ICT	Information and Communication Technology
ISG	Incident Support Group
LDCC	Local Disaster Coordination Centre
LDMG	Local Disaster Management Group
LM	Lord Mayor
RIMT	Regional Incident Management Team
SDCC	State Disaster Coordination Centre

Chronology of Key Events

A chronology of events and key dates is listed below

Sunday 9 January 2011

Heavy rainfall being experienced across the catchment

Local Disaster Coordination Centre (LDCC) activated at 9pm to Level 3

Monday 10 January 2011

Council Warning Order issued outlining situation, likely tasks and organisational structures

5000 letters sent to potentially flood-affected households

High demand for sandbags

River ferry operations ceased at 8.15pm

Call Centre recorded 10,000 calls

Council website experiencing difficulties due to significantly increased demand

Tuesday 11 January 2011

Premier's Announcement of Disaster Declaration

Brisbane City Council Local Disaster Management Group (BCLDMG) convened for first meeting

LDCC activation raised to Level 4

Approximately 53,000 sandbags distributed

Lord Mayor directs commencement of evacuation planning and RNA confirmed as first evacuation centre

Temporary Council website available

Council media release, sandbag availability and flood map detail

Community Service Announcements (CSAs) relating to street flooding, closure of Council libraries and residents encouraged to assist neighbours and friends

Letterbox drops commenced

Floating Riverwalk closed

LDCC discussions with Volunteering Queensland to coordinate volunteer effort

Lord Mayor directs flood modelling for very severe flood event

Wednesday 12 January 2011

Brisbane River prediction is 9,500m^3/s at Brisbane City Gauge

Approximately 23,300 properties estimated to be inundated

Approximately 67,100 sandbags distributed

Evacuation centres situation: RNA: 305 evacuees, QE2: 105 evacuees

BCLDMG briefed on possibility of Floating Riverwalk breaking free

Lord Mayor's media release, residents likely to be affected by flooding urged to evacuate

Final prediction of flood peak advised by Bureau of Meteorology (BoM) at 5.5m AHD at the Brisbane City Gauge for Thursday 13 January 2011 at around 4am

Thursday 13 January 2011

The peak flood level of 4.46m AHD at the Brisbane City Gauge was reached at approximately 4:00am.

Floating Riverwalk breaks free

Arrangements confirmed for aerial photography of Brisbane River and inundated areas

Regional Incident Management Team (RIMT) West unable to access the far western regions

Approximately 4am a downstream section of the Floating Riverwalk broke free

Council media release about waste services update

Community Service Announcements relating to advice for residents in isolated areas of the western suburbs

River peak level revised down by BoM to under 5m

CEO indicated the start of the recovery effort

Forward Planning Group (FPG) identifies priorities for recovery: Phase 1 re-establish essential services, information gathering and debris clearance of main thoroughfares, Phase 2 evacuees commence to return home, assess and repair Council assets and move to recovery.

Friday 14 January 2011

Australian Defence Force (ADF) deployed across Brisbane

Lord Mayor's media releases regarding hazardous material, waste and debris disposal, and volunteer support

Trans Link announces free public transport for one week

Rapid Assessment Teams deployed to assess damage and inform priorities

Evacuation Centres: RNA Showgrounds: 994 evacuees, QEII Stadium: 419 evacuees

Flood waters receding to below 2.2m at the Brisbane City Gauge with a few hundred properties continuing to be flooded

Saturday 15 January 2011

Around 12,000 volunteers registered for cleanup tasks

Council transfer stations free for waste disposal

Food drops to Mt Crosby area in the western suburbs

Approximately 28,500 customers without electricity

Sunday 16 January 2011

10,389 registered volunteers for cleanup tasks

Rocklea Markets scene of major cleanup effort

Evacuation centres: RNA Showgrounds: 277 evacuees, QEII Stadium: 200 evacuees

Monday 17 January 2011

800 soldiers deployed across Brisbane for cleanup and associated tasks

Brisbane ferry operations suspended until further notice due to infrastructure damage

Bus and train services recommenced

Evacuation centres: RNA Showground: 180 evacuees, QEII Stadium: 120 evacuees

Tuesday 18 January 2011

Vaccination clinics set up at recovery centres

Rapid damage assessments continue by Queensland Fire and Rescue Service (QFRS) and Council Rapid Assessment Teams

Approximately 12,535 customers without electricity

Wednesday 19 January 2011

Bridge inspections commence

Evacuation centres: RNA Showground: closing 5pm, QEII Stadium: 87 evacuees

Thursday 20 January 2011

2500 volunteers vaccinated since 15/1

Approximately 3700 customers without electricity

Friday 21 January 2011

Approximately 885 customers without electricity

107,000 tonnes of flood-related waste deposited in landfills

31,300 insurance claims submitted to date across Queensland, approximately 50% from Brisbane

Navy sweeping for obstacles in Moreton Bay

Saturday 22 January 2011

Final BCLDMG meeting held

Coronation Drive being scanned by radar following formation of sink-hole

17 land slips identified across Brisbane

Evacuation centres closed

Navy completes survey of Moreton Bay

LDCC to Level 3 on Monday 25 January 2011

References

The following documentation was referenced during this review:

Title	Document Owner/Author	Date/Version	Source
Disaster Management Act 2003 (Qld)			Office of Queensland Parliamentary Counsel Website
Public Preservation Safety Act 1986 (Qld)			Office of Queensland Parliamentary Counsel Website
Sustainable Planning Act 2009 (Qld)			Office of Queensland Parliamentary Counsel Website
Integrated Planning Act 1997 (Qld)			Office of Queensland Parliamentary Counsel Website
City of Brisbane Act 1924 (Qld)			Office of Queensland Parliamentary Counsel Website
Building Act 1975 (Qld)			Office of Queensland Parliamentary Counsel Website
City of Brisbane Act 2010 (Qld)			Office of Queensland Parliamentary Counsel Website
The Australian Emergency Manual Series (Cwth)			Commonwealth Attorney General's Department
The State Planning Policy 1/03 – Mitigating the Adverse Impacts of Flood, Bushfire and Landslide	Queensland Government Department of Emergency Services	June 2003	Queensland Department of Community Safety Website (10 Feb 2011)

Title	Document Owner/Author	Date/Version	Source
The State Disaster Management Group Guidelines			Queensland Government
Brisbane Floods January 1974 –	Australian Government Publishing Service Canberra	January 1974	Bureau of Meteorology
Annual Climate Summary for Queensland 2010		4 Jan 2011	Bureau of Meteorology
Annual Climate Summary for Brisbane Metro 2010		4 Jan 2011	Bureau of Meteorology
January 2011 Flood Event – Report on the operation of Somerset Dam and Wivenhoe Dam		2 March 2011	Seqwater
Review of Brisbane River Flood Study – Report to Brisbane City Council		3 Sept 2003	Independent Review Panel
Joint Flood Taskforce Report March 2011		8 March 2011	Brisbane City Council
Brisbane River Flood Study: Further investigation of flood frequency analysis, incorporating dam operations and CRC-FORGE rainfall analysis – Brisbane River (Final issue)		December 2003	SKM
Lord Mayor's Taskforce on Suburban Flooding Report	Brisbane City Council	Aug 2005	Brisbane City Council
January 2011 Flood Disaster Draft Performance Review		17 March 2011	GHD
Engineering Solutions for Flood Mitigation in Brisbane		February 2011	GHD
Summary Report Brisbane City Council Flood Response: Resident and Business Perceptions		28 February 2011	Fieldworx
George Patterson Y & R – Report on Social Media		9 February 2011	George Patterson Y & R

Figures and Tables

Tables

Figures

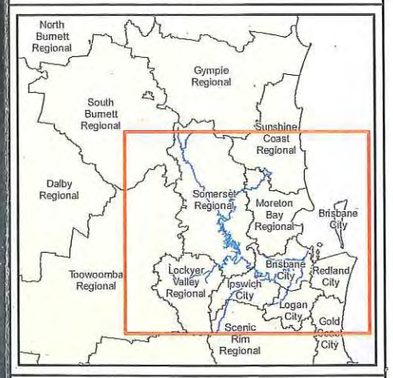
List of Maps

Map 1
Brisbane River and its
Tributaries

Map 1

Brisbane River and its Tributaries

- Flood Gauge Maximum Height Along Selected Waterways
- Web Gauge Hydrograph Along Selected Waterways
- Major Waterways
- Wivenhoe and Somerset Dams



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0 10 20 30
Kilometers

1 cm = 5.5 kilometers 1:550,000 at A3

Publisher : Spatial Information Services
Publication Date : 09 May 2011
Reference : BM081421
Filename : Bm081421_Map_01.mxd
Projection : Map Grid of Australia, Zone 56
Horizontal Datum : Geocentric Datum of Australia 1994

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Map 2
Location of Flood Gauges
Along Brisbane River

Map 2

Location of Flood Gauges Along Brisbane River

Web Gauge Hydrograph Along Selected Waterways

Major Waterways

Wivenhoe Dam

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0 2 4 6 8 10

Kilometers

1 cm = 2 kilometers

1:200,000 at A3

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Map 3
Defined Flood Level (DFL) and
Flooding Extent January 2011
Brisbane

Map 3

Defined Flood Level (DFL) and Flooding Extent January 2011 Brisbane

Flood Inundation Brisbane River Defined Flood Level (DFL) 3.7m at City Gauge

Flood Inundation Creek 100 Year Average Recurrence Interval (ARI)

January 2011 Flood

Ward Boundary

N

0 1 2 3 4

Kilometers

1 cm = 1.1 kilometers

1:110,000 at A3

Publisher : Spatial Information Services
Publication Date : 09 May 2011
Reference : BM081421
Filename : Bm081421_Map_03.mxd
Projection : Map Grid of Australia, Zone 56
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Map 4
Defined Flood Level (DFL) and Flooding Extent January 2011
South Brisbane

Map 4

Defined Flood Level (DFL) and Flooding Extent January 2011 South Brisbane

- South Brisbane Suburb
- Flood Inundation Brisbane River Defined Flood Level (DFL) 3.7m at City Gauge
- January 2011 Flood

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0 100 200 300 400
Meters

1 cm = 90 meters

1:9,000 at A3

Publisher : Spatial Information Services
Publication Date : 09 May 2011
Reference : BM081421
Filename : Bm081421_Map_04_SouthBrisbane.mxd
Projection : Map Grid of Australia, Zone 56
Horizontal Datum : Geocentric Datum of Australia 1994

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Map 5
Defined Flood Level (DFL) and
Flooding Extent January 2011
Tennyson

Map 5

Defined Flood Level (DFL) and Flooding Extent January 2011 Tennyson

- Tennyson Suburb
- Flood Inundation Brisbane River Defined Flood Level (DFL) 3.7m at City Gauge
- Flood Inundation Creek 100 Year Average Recurrence Interval (ARI)
- January 2011 Flood

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0 100 200 300
Meters

1 cm = 60 meters

1:6,000 at A3

Publisher : Spatial Information Services
Publication Date : 09 May 2011
Reference : BM081421
Filename : Bm081421_Map_05_Tennyson.mxd
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Map 6
Defined Flood Level (DFL) and
Flooding Extent January 2011
Rosalie Area

Map 6
Defined Flood Level (DFL) and Flooding Extent January 2011 Rosalie Area

- Suburbs Around Rosalie
- Flood Inundation Brisbane River Defined Flood Level (DFL) 3.7m at City Gauge
- January 2011 Flood

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0 100 200 300 400
Meters

1 cm = 80 meters

1:8,000 at A3

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Publication Date : 09 May 2011
Reference : BM081421
Filename : Bm081421_Map_06_Rosalie.mxd
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Map 7
Defined Flood Level (DFL) and
Flooding Extent January 2011
Rocklea

Map 7
Defined Flood Level (DFL) and Flooding Extent January 2011 Rocklea

Rocklea

- Rocklea Suburb
- Flood Inundation Brisbane River Defined Flood Level (DFL) 3.7m at City Gauge
- Flood Inundation Creek 100 Year Average Recurrence Interval (ARI)
- January 2011 Flood

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0 100 200 300 400 500 600 700 800 900
Meters

1 cm = 182 meters | 1:18,200 at A3

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Publication Date : 09 May 2011
Reference : BM081421
Filename : Bm081421_Map_07_Rocklea.mxd
Projection : Map Grid of Australia, Zone 56
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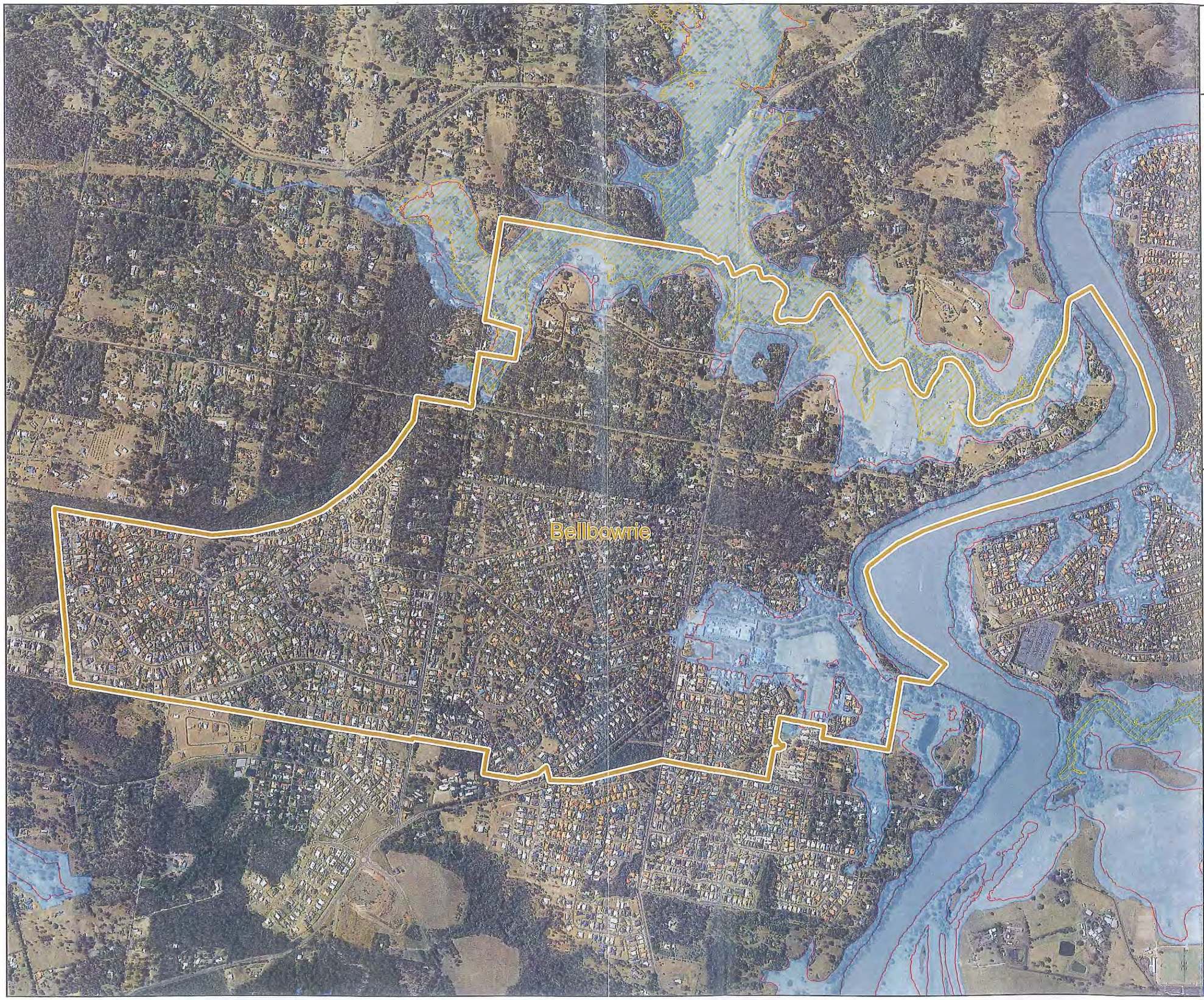
Map 8
Defined Flood Level (DFL) and
Flooding Extent January 2011
Bellbowrie



Map 8
Defined Flood Level (DFL) and Flooding Extent January 2011 Bellbowrie

- Bellbowrie Suburb
- Flood Inundation Brisbane River Defined Flood Level (DFL) 3.7m at City Gauge
- Flood Inundation Creek 100 Year Average Recurrence Interval (ARI)
- January 2011 Flood

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0 100 200 300 400 500 600 700
Meters

1 cm = 145 meters 1:14,500 at A3

Publisher : Spatial Information Services
Publication Date : 09 May 2011
Reference : BM081421
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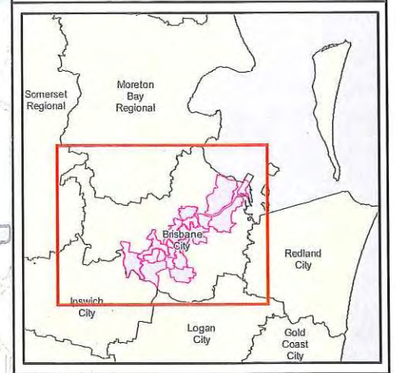
Map 9
Sandbag Delivery
and Depot Points

Map 9

Sandbag Delivery and Depot Points

- Sandbag Delivery and Depot Points
- Sector
- January 2011 Flood
- Ward Boundary



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0 1 2 3 4
Kilometers

1 cm = 1.1 kilometers 1:110,000 at A3

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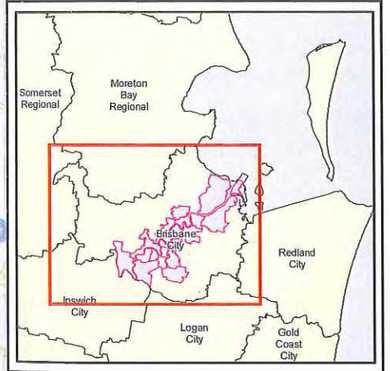
Map 10
Evacuation Centres and
Activated Brisbane
City Council Assets

Map 10
Evacuation Centres and Activated Brisbane City Council Assets

- Sector
- January 2011 Flood
- Regional Service Boundary
- Local Disaster Coordination Centre (LDCC) and Flood Information Centre (FIC)
- Evacuation Centre



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0 1 2 3 4
Kilometers

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1:110,000 at A3

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Map 11
Brisbane City Council
Volunteer Registration Centres
and Drop Off Points
15 - 16 January 2011

Map 11
Brisbane City Council Volunteer Registration Centres and Drop Off Points 15 - 16 January 2011

Sector

January 2011 Flood

Volunteer Registration Centres

- Brisbane Entertainment Centre, Melaleuca Drive, Boondall
- Doomben Racecourse, Hampden Street, Ascot
- Mount Coot-tha Botanical Gardens, Mt Coot-tha Road, Mount Coot-tha
- MacGregor State High School, Blackwattle Street, Macgregor

Volunteer Drop off Points

- Registered at Boondall
- Registered at Doomben
- Registered at Mt Coot-tha
- Registered at Macgregor

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0 1 2 3 4
Kilometers

1 cm = 1.1 kilometers

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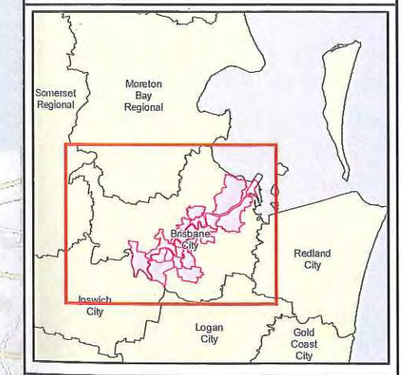
Map 12
Waste Disposal Sites

Map 12

Waste Disposal Sites

- Sector
- January 2011 Flood
- Permanent Waste Disposal Site
- Commercial Waste Disposal Site
- Commercial Transfer Station
- Temporary Waste Disposal Site



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0 1 2 3 4
Kilometers

1 cm = 1.25 kilometers

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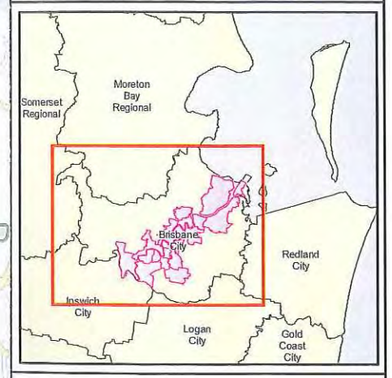
Map 13
Brisbane City Council
Stormwater Infrastructure

Map 13

Brisbane City Council Stormwater Infrastructure

Stormwater Pipe - Diameter (mm)

- 500 - 775
- 776 - 1125
- 1126 - 1525
- 1526 - 2225
- 2226 - 4800
- Stormwater Open Drain
- Sector
- January 2011 Flood
- Ward Boundary



N

0 1 2 3 4

Kilometers

1 cm = 1.1 kilometers

1:110,000 at A3

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Publication Date : 09 May 2011
Reference : BM081421
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Map 14
Brisbane City Council
Riverine Infrastructure

Map 14

Brisbane City Council Riverine Infrastructure

- Ferry Terminal
- Pontoon
- Jetty
- Mooring
- Riverwalk
- January 2011 Flood

Infrastructure Damaged During January 2011 Flood

- Ferry Terminal
- Pontoon
- Mooring
- Floating Riverwalk

N

0 0.5 1 1.5 2 2.5
Kilometers

1 cm = 0.5 kilometers | 1:50,000 at A3

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Filename : Bm081421_Map_14.mxd
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