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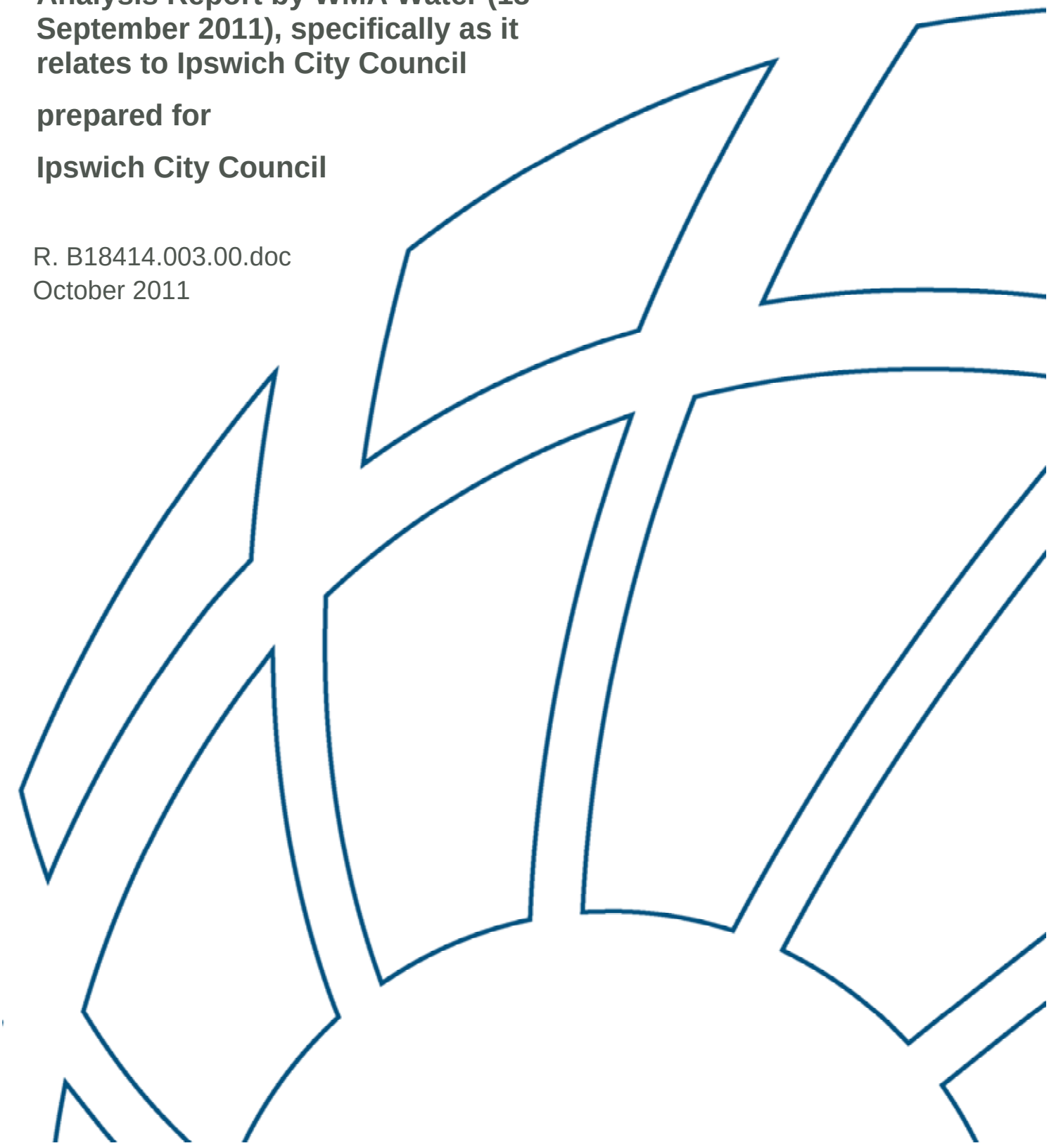
QUEENSLAND FLOODS COMMISSION OF INQUIRY

Technical Review of Flood Frequency Analysis Report by WMA Water (18 September 2011), specifically as it relates to Ipswich City Council

prepared for

Ipswich City Council

R. B18414.003.00.doc
October 2011



QUEENSLAND FLOODS COMMISSION OF INQUIRY

Technical Review of Flood Frequency Analysis Report by WMA Water (18 September 2011), specifically as it relates to Ipswich City Council

prepared for

Ipswich City Council

14 October 2011

Prepared For:	Ipswich City Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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1 PURPOSE AND SCOPE OF THE REPORT

This report has been prepared by Neil Collins. A copy of his CV is included as Appendix A.

This report describes my desktop review of a report prepared by Mark Babister of WMA Water dated 18 September 2011 for the Queensland Floods Commission of Inquiry (Brisbane Frequency Report). The review is limited to those aspects of the Brisbane Frequency Report that are of relevance to flooding in Ipswich City, i.e. Brisbane River flooding of Redbank and Goodna. In the time available for the review, I have been unable to fully test the conclusions reached by WMA Water.

In my opinion, it is premature for WMA Water to reach the conclusions they have (specifically paragraph 145 where the 1% AEP flood flow of 9500m^3/s is adopted, and paragraph 146, where the 1% AEP flood line is said to be 1m higher at the Port Office and 3m higher at Moggill than previous estimates) because those conclusions are not underpinned by a consideration of all relevant factors. The analysis conducted by WMA Water:

(a) Is reliant on a single point flood frequency analysis that is itself subject to considerable uncertainty;

(b) Does not incorporate a probabilistic framework to assess natural variability across the catchment;

(c) Does not use both the statistical flood frequency analysis and simulation modelling of design flood events as previously used and recommended by independent expert panel reviews [1]; and

(d) Most importantly, the analysis has been prepared in isolation of the Wivenhoe and Somerset Dams Optimisation (WS DOS) study that is underway, and these works need to be completed before definitive conclusions of event frequency and the ARI 100 year flood line are reached.

The WS DOS study will carry out flood frequency analysis for several gauges, will update hydrologic and hydraulic models and will use these models to conduct simulation modelling of design flood events as a cross-check on the frequency analyses. In order to update the hydrologic and hydraulic models, new bathymetric survey is required of the river system, as significant scour and siltation occurred during the January 2011 flood event. WMA Water has relied on the existing MIKE11 hydraulic model to translate flood levels for the ARI 100 year event along the river despite significant discrepancies between actual and predicted flood levels for the January 2011 event having already been identified (WMA Water's July 2011 'Review of Hydraulic Modelling' Report).

Given that flood frequency analysis has not been carried out for other gauges and that simulation modelling of design flood events as a cross-check has not been completed, there is a high level of uncertainty with the conclusions drawn because additional work could affect the accuracy of conclusions.

On 13 October 2011 the Commission provided Ipswich City Council with a Report by WMA Water on Ipswich Flood Frequency Analysis. This report does not address the Ipswich Flood Frequency Analysis Report. However, WMA Water has made comment on flooding from Brisbane River in

[1] Independent Review Panel 'Review of Brisbane River Flood Study, to Brisbane City Council' September 2003, and 'Joint Flood Taskforce Report', to Brisbane City Council, March 2011

Redbank and Goodna, within Ipswich City and therefore we provide comment on this aspect of the Brisbane Frequency Report.

2 GENERAL REVIEW

My general review comments regarding the Brisbane Frequency Report are as follows:

1 The results of the frequency analysis are related only to Brisbane River flooding in Brisbane City and are specifically related to the Port Office Gauge. As such, it is of relevance to sections of Ipswich that are immediately adjacent to the Brisbane River. To translate the Port Office Gauge findings to Redbank and Goodna, WMA Water has relied on the existing MIKE11 hydrodynamic model, which is recognised from their July 2011 'Review of Hydraulic Modelling' Report to have a number of limitations and inaccuracies (refer Chapter 4).

2 WMA Water's Flood frequency analysis is based on the Port Office gauge in Brisbane. Whilst this gauge has over 170 years of record, there are many reasons why the use of this gauge has associated with it a considerable degree of uncertainty in results (refer paragraph 113 of the Brisbane Frequency Report). These include river changes including dredging, the extent and timing of dredging, removal of bars, and the construction of Somerset and Wivenhoe Dams. So whilst WMA Water concludes that the January 2011 flood event was a 1 in 120 year event for the current situation, the uncertainty based on 90% confidence limits (e.g. Figure 9 of the Brisbane Frequency Report) means that it could have been anything between a 50 to 100 year event, up to greater than a 200 year event but less than a 500 year event. This is before uncertainties of changes in river bathymetry and changes in catchment land use are taken into account.

3 River dredging was and still is carried out for shipping navigation. Both capital dredging to increase draft, and regular maintenance dredging has been carried out progressively, since the 1860's. In my view, it would be impossible to determine the exact river bathymetry at the commencement of specific flood events, because of the limited bathymetric survey available, and because the extent of siltation is unknown. In relation to the effects of both Somerset and Wivenhoe Dams on flood mitigation, it is not clear how the analysis has been adjusted for the flood mitigation effects for the period when Somerset Dam was in place, prior to the construction of Wivenhoe Dam.

4 The relevance of the results to Ipswich City are dependent upon the MIKE11 model used, which has considerable uncertainty (and is unsuitable for reliable level and flow predictions upstream of Moggill River). I discussed these limitations in Chapter 4 of my report included as Appendix B and these are summarised as follows. WMA Water also has identified shortcomings of the MIKE11 model in their July 2011 Report (Chapter 4).

- Floodplain representation with artificial vertical wall sections is poor in places.
- Channel roughness representing vegetation cover is abnormally high and unrealistic.
- Less than desirable model calibration to historic events.
- Lumping of catchments upstream of Mt Crosby.
- Over-prediction of Brisbane River flood levels.
- Under-prediction by one metre of flood levels in Ipswich CBD.
- Inadequate modelling of the Bremer River.

5 Paragraph 146 of the Brisbane Frequency Report says that the 1% AEP (Q100) flood line is approximately 3 metres higher at Moggill and one metre higher at the Port Office than previous estimates. WMA Water has not commented on many anomalies between the previous ARI 100 year flood line and the January 2011 flood slope. Whilst in many places the January 2011 level was higher than the previous ARI 100 year flood level, there are some places where it is either much higher or lower, which may be due to changes in bathymetry, effects of new bridges and effect of tide and tailwater conditions. These discrepancies are discussed in Brisbane City Council's 'Joint Flood Taskforce Report' of March 2011 (Section 2.2.3, 4th dot point). Changes to river bathymetry may have been substantial, and require re-survey and revision of the hydraulic model to provide accurate predictions along the river. This work is to be undertaken as part of WS DOS study. The MIKE11 model also uses bathymetry from a variety of sources all of which predate the January 2011 flood which changed the river bathymetry. The report would benefit from a comment on these factors.

6 Paragraph 147 of the Brisbane Frequency Report says that there is major uncertainty in the rating relationship at the Port Office gauge. This conclusion is supported, in terms of uncertainty. In relation to improving the Port Office rating, it is difficult to see how the uncertainties discussed above can be significantly reduced, but a review as proposed is supported.

7 WMA Water relies on statistical analysis of a single gauge at the Brisbane Port Office to predict the frequency of the January 2011 flood event, and as the basis of ARI 100 year flood predictions along the river including at Redbank and Goodna.

Previous estimates were based on two methods being statistical flood frequency analysis of a number of gauges, and simulation modelling of design flood events (refer Independent Review Panel Report, 2003 and Joint Flood Taskforce Report, March 2011). In particular, Savages Crossing Gauge data was the focus of flood frequency analysis.

In order to reduce the considerable uncertainty in WMA Water's predictions, further work is still necessary, both for additional gauge flood frequency analysis, and for simulation modelling of design flood events. The current WS DOS study is intending to carry out this additional work, and will address a number of specific recommendations from the Floods Commission Interim Report recommendation.

In my opinion, it is not appropriate to rely upon the findings of WMA Water unless they are verified and supported by the further additional work needed. WMA Water's conclusion in paragraph 146 should be qualified in terms of uncertainty bands. An example of an error on existing ARI 100 year flood level estimates is in the upper river reaches, including Moggill, Redbank and Goodna (refer Chapter 3 of this report), with previous level estimates being over a metre higher.

WMA Water has also not stated why they do not agree with the detailed reviews by recognised experts in the 2003 Independent Review Panel Report, or in the March 2011 Joint Flood Taskforce Report.

8 WMA Water has previously concluded in their report to the Commission in May 2011 that there should not be reliance on a single design hydrograph to determine flood frequency 'but rather a probabilistic framework that incorporates the natural variability of key characteristics from

observed storms/floods'. This suggests that WMA Water supports the need for two methods of analysis.

3 REVIEW OF ASSESSMENTS OF REDBANK AND GOODNA BRISBANE RIVER FLOODING

Because of all the uncertainties identified, the following is an example of differences identified between WMA's assessments and information from Ipswich City Council.

In Figure 12 of the Brisbane Frequency Report, WMA Water shows what they refer to as 'Existing 1% AEP Design Level – 2011 Review Panel' levels for two properties at 13 Bridge Street, Redbank and on the corner of Ryan Street and Woogaroo Street, Goodna, which are located in the area of the City of Ipswich. It is not clear from the Report how the plotted levels have been derived as the March 2011 Joint Flood Taskforce Report (which appears to have been used to identify the existing 1% AEP Design Level) does not include reporting at these locations. It is probable that interpolation has been used, but this should be explained more clearly in the Report.

Figure 12 of the Brisbane Frequency Report also shows surveyed and MIKE11 estimated levels for the January 2011 flood event for these sites.

Figure 13 shows the Figure 12 data plus WMA Water's estimate of the 1% AEP design level based on the WMA Water flood frequency analysis at the Brisbane Port Office gauge.

Advice from Ipswich City Council is as follows:

1. 13 Bridge Street, Redbank

   1% AEP: 15.33m

   2011 flood level: 16.8m

   1974 flood level: 19.22m

2. 20 Woogaroo Street (Cnr Ryan Street and Woogaroo Street), Goodna

   1% AEP: 14.78m

   2011 flood level: 16.92m

   1974 flood level: 17.67m

Extracts of Council's flood maps which supplement this data are included in Appendix C.

Set out below are two Tables which compare the levels determined by WMA Water and referred in the Brisbane Frequency Report for the Ipswich properties to the levels that have been advised by the Council.

13 Bridge Street, Redbank

Flood Event	Ipswich City Council Flood Level (mAHD)	WMA Water * Plotted flood level (mAHD)
1% AEP	15.33	14
Recorded 2011 peak flood level	16.8	17.55

*** Estimated from Figure 13, WMA Water, September 2011**

20 Woogaroo Street, Goodna

Flood Event	Ipswich City Council Flood Level (mAHD)	WMA Water * Plotted flood level (mAHD)
1% AEP	14.78	13.2
Recorded 2011 peak flood level	16.92	16.85

*** Estimated from Figure 13, WMA Water, September 2011**

From the above, it can be concluded that:

1. The existing 1% AEP Design Level used by WMA Water for the two Ipswich properties is over one metre lower than the 1% AEP design levels as advised by Ipswich City Council.

2. The 2011 surveyed flood level for the Bridge Street property do not accord with Ipswich City Council's reported level.

3. Given the 90% uncertainty range in the determination of the 1% AEP flood estimate by WMA Water, too great a reliance may be placed on the WMA Water 1% AEP design level line. I am strongly of the view that further review ought to be carried out before any conclusions as to the accuracy of the existing Council 1% AEP design levels are reached. In particular, the WS DOS study needs to be completed and the results considered.

4. Traditionally, the 1% AEP flood line has relied on the results of combined hydrologic and dynamic hydraulic flood modelling using historic and theoretical design storms rather than placing sole reliance on a statistical analysis of a single gauge. Hence, the WMA Water 1% AEP flood estimates require testing against refined hydrologic and hydraulic modelling results. The refinement of these models has already been recommended by the Commission.

4 LIMITATIONS OF THE REVIEW

This review is based solely on the published report and I have not had the opportunity to review the data relied upon.

The assumptions made by WMA Water for the actual state of the river, in terms of bathymetry on an annual basis over 170 years, and also how the impact of first Somerset Dam and then Somerset and Wivenhoe Dams were addressed, is critical to the conclusions made.

APPENDIX A: CURRICULUM VITAE OF NEIL IAN COLLINS

A part of BMT in Energy and Environment

Neil Ian Collins

Position	Principal Hydraulic Engineer – Expert Services
Years of Experience	32
Professional Affiliations	PIANC NPER-3 RPEQ
Qualifications	Master of Science Engineering, University of Queensland Bachelor of Engineering (Civil) University of Queensland
Recent Employment Profile	2010 to Present BMT WBM Pty Ltd – *Principal Hydraulic Engineer - Expert Services* 2007 to 2010 Gilbert & Sutherland Pty Ltd – *Principal Hydraulic and Water Resources Engineer* 2004 to 2007 Cardno Lawson Treloar – *Director*, *Queensland Manager* 1993 to 2004 Lawson Treloar - *Director*

Areas of Expertise

Hydraulics, Hydrology and Water Resources

Provision of Expert Witness Services in Flooding, Stormwater, Quality Control and Coastal Engineering

Career Overview

Neil is BMT WBM's Principal Hydraulic Engineer; part of the Expert Services team, based in the Brisbane office. He has 31 years experience and is an acknowledged expert in the P+E, Land Court and Supreme Court of Queensland in flooding, water quality and coastal processes. He was also the independent hydraulic expert to the Queensland Government for the North Bank project. Neil has worked on major infrastructure projects as an Hydraulic Specialist including Sydney Third Runway, Sydney Harbour Tunnel, Gateway Bridge and Arterial and several coal ports in Queensland and in Indonesia, power stations in Queensland and Thailand, hydro-electric schemes in PNG and port dredging management at Cairns, Townsville, Weipa and Mackay.

Summary of Major Projects

- Lauderdale Quay, Hobart – Coastal Hydraulics, Water Sediment Quality for IIS on a Major Marina Residential Reclamation Project.
- Brisbane Airport - International Terminal Drainage Design.
- Sydney Harbour Tunnel - Hydraulics Engineer for Immersed Tube Tow and Placement.
- Sydney Third Runway - Hydraulic Model Testing, Sea Wall Design and Environmental Management.
- Gateway Arterial - South East Freeway to Lytton Road - Civil and Hydraulic Design Manager.
- Gateway Bridge - Hydraulics and Approaches Services Relocations.
- Trade Coast Central - Flooding Review for BCC.
- Oak Flats to Yallah RTA Freeway Hydraulics.
- Kedron Brook Flood Impacts due to Airtrain.
- Tully and Murray River Floodplains Hydraulic Analysis and Modelling, for Drainage Scheme Design includes Large MIKE11 Modelling, with over 40 Bridges and 200 Channels.
- Expert Review - Mossman Daintree Road, Saltwater Creek Crossing: Independent Review of the Hydraulic Design of two Large Bridges.
- Hydraulic Design of Rock Armouring Works for the Barron River Bend at Cairns Airport.
- Eastern Corridor Study - Hydraulics and Hydrology investigation for Department of Transport.
- Relief Drainage Scheme Design for Albion Windsor Area Brisbane (Capital cost $2 million).
- Tarong Power Station - Design of Earthfill Dam (max. 23m height), Ash trench, Stormwater Diversion Channels.

Professional History

BMT WBM Pty Ltd

Principal Hydraulic Engineer providing expert witness services in flooding, stormwater, quality control and coastal engineering.
2010-2011: Over 25 appeals completed or still in progress
2010-2011: Flooding Commission of Inquiry – Technical expert for LGAQ and Ipswich City Council
2010-2011: Cairns Airport – Review of Airport Flood Immunity and Risk

Gilbert & Sutherland Pty Ltd

Wet 'n' Wild, Sunshine Coast – site and soil assessments, input to and review of AGE groundwater assessment, conceptual stormwater quality assessment, hydraulic and flooding assessments including yield, medli modelling for onsite and input to S&B water balance, contamination investigation.

- Stockland, Twin Waters – Flooding Assessment
- Mackay Boat Harbour – Wave Investigation
- Bourton Road, Alkira – Flooding and Stormwater Management Plan
- The Glades, Robina – Water Quality Compliance and Inspection Report

Expert Services:
2007: Truloff Pty Ltd -v- Gold Coast City Council
2008: Jimboomba Turf Co Pty Ltd -v- Logan City Council
2008: Lechaim -v- Gold Coast City Council
2008: Sunnygold International Pty Ltd -v- Brisbane City Council
2008: Bon Accord -v- Brisbane City Council
2008: Blue Eagle -v- Beaudesert Shire Council
2008: Brian Paddison -v- Redland Bay Shire Council
2008: Monarch Nominees -v- Brisbane City Council
2008: Kunda Park Pty Ltd -v- Maroochy Shire Council
2008: Owl Projects & Hyder -v- Gold Coast City Council
2008: Port Pacific Estates Pty Ltd -v- Cairns Regional Council
2008: Joanne Shepherd & Ors -v- Brisbane City Council
2009: Lenthalls Dam, Hervey Bay
2009: Testarossa -v- Brisbane City Council
2009: Heritage Properties & Ausbuild -v- Redland City Council
2009: Samantha Skippen -v- Miriam Vale Shire Council
2009: Anthony Wan Pty Ltd -v- Brisbane City Council
2010: Over 25 appeals in progress this year

Professional History (cont)

Cardno Lawson Treloar
Sovereign Waters, Wellington Point - flooding, tidal exchange and water quality management.

EMP Water Quality Management Plan preparation and site stormwater management, including hydrodynamic, advection/ dispersion and catchment pollutant yield modelling for:
- Emerald Lakes Project, Carrara
- Glenwood Estate, Mudgeeraba
- 'The Glades' (Greg Norman Design Course), at Robina
- Sovereign Waters, Wellington Point
- Pacific Palisades, Gavin
- Freshwater Valley Estate, Cairns
- Carrara Golf Course Re-development, Carrara
- The Broadwater Development, Mudgeeraba
- Over a Dozen Major Residential Development Projects.

- Full Two-dimensional (MIKE 21) Floodplain Modelling for Cairns Airport Inundation, Nerang River Floodplain and Martins Creek, Maroochydore.
- Noosa River System Flood Study: Includes full G.I.S. Interfacing, Colour Inundation Plan Production and MIKE11 Modelling.
- Detention Basin Design for Development Consulting, Calamvale, Brisbane: Hydrologic and Hydraulic Design using RAFTS.
- Hydraulic and Water Quality Design, Lucinda Drive Main Drain, Port of Brisbane, including Catchment Pollutant Runoff Management.
- Moreton Bay College Flood Investigation: MIKE11 Analysis of Flooding, Including Culvert and Channel Diversion Options.
- Input on EIS Report on Water Quality for Freshwater Valley Development, including EMP.
- Townsville Port Road and Rail Access Study - Hydraulics.
- Freshwater Creek Flooding, for Main Roads, included Bridge and Culvert Sizing and Positioning of Channel Training Works. (RORB/RUBICON).
- Mountain Creek Flooding Investigation Examination of 1992 Floods using detailed Hydrologic/Hydraulic Modelling and Design of Mitigation Works.

Expert Services:
2004: T.M. Burke Appeal
2004: East Point Mackay
2004: Dore Appeal
2004: 900 Hamilton Road, McDowall
2004: Milton Tennis Centre
2005: P&E Appeal Mount Samonsvale
2005: BCC & George Pasucci
2005: P&E Appeal 48 Comley Street Sunnybank
2005: P&E Appeal 398 Wondall Road, Tingalpa
2005: Cabbage Tree Creek Appeal
2006: 35 Suscatand Street, Rocklea Appeal
2006: Leong - v- Redland Shire Council Appeal
2006: Barry Hilson & Bach Pty Ltd - v- GCCC Appeal
2006: 57 Longhill Road Appeal
2006: 699 Bargara Road Appeal
2006: Chevellum Road Appeal
2006: 10 Karridawn Street, Nudgee Appeal
2006: Australian Hardboards Limited Appeal
2006: Dell Road and Hawkin Drive, St Lucia Appeal
2006: 106 Munro Street, Auchenflower Appeal
2006: 10 Adsett Road, P&E Appeal
2006: Saunders Creek Appeal
2006: 64, 70 & 74 Washington Avenue, Tingalpa

Professional History (cont)

Lawson Treloar

- Coastal Data Gathering and Analysis for Projects in Bali, Lombok and Malaysia.

- Pandorah Gas Project, Gulf of Papua. Neil was Responsible for Project Management of all Coastal and Oceanographic Aspects of this Project, including Preparation of the Relevant Components of EIS. This included Extreme Climate, Wind/Wave and Current Modelling.

Chevron PNG to Cape York Gas Pipeline Project, Gulf of Papua
Neil Carried out Project Management for all Coastal/Oceanographic Components of this Project, including:

- Wind/Wave Modelling
- Extremal Climate
- Bed Current Prediction
- Kumul Platform Berthing
- Endeavor Passage Landfall
- Wave, Current and Wind Data Gathering.

- Tidal Lagoon, Breakwater/Groynes, Water Quality and Quantity Management at Pecatu Indah Resort, Lombok.
- Marina and Reclamation, S-W Bali, (Putri Nyale) including Coastal Investigations and Hydraulic Design of Breakwaters and Revetments.
- Sediment Sampling and Monitoring Program for the Albatross Bay Dumpsite, Weipa, for Dept. of Transport. Job Manager for this Investigation which includes Monitoring of Movement of Material Following Dumping, and its Impact on Water Quality and Benthic Communities.
- Wellington Point Canal Estate - Coastal Hydraulic Investigation of Proposed Marina and Dredged Channel.
- Weipa, Embley Inlet Environmental Monitoring: Review and Planning for Long Term Monitoring and Assessment of Water Quality (for Comalco).
- Full 2D flooding assessments for Dept of Main Roads using MIKE 21 on Yarrabah, Cairns and Warrego Highway at Marburg.
- Current Profiling, Warrego River (1994).
- Sovereign Waters, Wellington Point - Flooding, Tidal Exchange and Water Quality Management.
- Responsible for all Flood and Water Quality aspects for several Gold Coast Projects, including Emerald Lakes, Nifsan's Glenwood and Broadlakes, including Lake, Wetland and EMP Design.
- Stream Diversion, including Sloping Drop Structure, Hydraulic Design, at 'Coops' Development, Brisbane (1993).
- Northumbria Lakes Estate, Flooding, Drainage, Gross Pollutant Trap and Trash Rack Modelling and Design (1994).
- Barron River Delta Prawn Farm I.A.S., including Flooding and Water Quality Monitoring and Modelling, using MIKE11 (1995).
- Hydraulic Manager for Cairns Airport Master Drainage Study, 1995, including Complex Hydrodynamic Flow and Catchment Management Analysis.

Expert Services:

1993: for Mulgrave Shire Council; Land Resumption Compensation Case in Land Court. (Flooding)
1993: for Mulgrave Shire Council; Development Appeal (Kamerunga Villas) in Planning and Environmental Court. (Flooding)
1994: for Pullenvale Residents Action Group, on Rezoning Appeal. (Flooding and Water Quality)
1994: for Development Consulting, on Rezoning Appeal for a Development with a Large Detention Basin at Calamvale. (Flooding and Drainage)
1994: for an Earthworks Contractor Regarding a Disputed Claim Over Levee Bank Construction at Mungindi. (Flooding)
1995: for a Developer on Bohle River Works. (Flooding and Water Quality)
1995: for Residents on Flooding, Murrumba Downs. (Flooding)
1995: for Residents on Flooding, Dayboro. (Flooding)

Connell Wagner

- Current Profiling, Warrego River (1994).
- Sovereign Waters, Wellington Point - Flooding, Tidal Exchange and Water Quality Management.
- Responsible for all Flood and Water Quality Aspects for several Gold Coast Projects, including Emerald Lakes, Nifsan's Glenwood and Broadlakes, including Lake, Wetland and EMP Design.
- Stream Diversion, including Sloping Drop Structure, Hydraulic Design, at 'Coops' Development, Brisbane (1993).
- Northumbria Lakes Estate, Flooding, Drainage, Gross Pollutant Trap and Trash Rack Modelling and Design (1994).
- Barron River Delta Prawn Farm I.A.S., including Flooding and Water Quality Monitoring and Modelling, using MIKE11 (1995).
- Hydraulic Manager for Cairns Airport Master Drainage Study, 1995, including Complex Hydrodynamic Flow and Catchment Management Analysis.
- Tarong Power Station. Design of earthfill dam (max. 23m height), Ash trench, Stormwater Diversion Channels.
- Callide B Power Station. Evaporation Ponds Simulation; Hydraulic Design and Stormwater Bypass Channel. Design of (25m) Ash Dam.
- Hay Point Multi-User Coal Export Facility. Design of Dams, Stormwater Drainage, Water Supply and General Civil.
- Townsville Container Terminal. Design of Stormwater Drainage and General Civil.
- Abbot Point Coal Terminal. Design of an Offshore Causeway.
- Subdivisional Design and Supervision, on over a dozen Projects.
- Bulk Sugar Terminal - Brisbane. Feasibility Studies, including Flooding.
- Gladstone Power Station. Ash Handling including Piping.
- Stanwell Power Station. Design Check on General Civil.
- Patrick Container Terminal - Port of Brisbane. Flooding and General Civil.

Expert Services:

1993: for Mulgrave Shire Council; Land Resumption Compensation Case in Land Court. (Flooding)
1993: for Mulgrave Shire Council; Development Appeal (Kamerunga Villas) in Planning and Environmental Court. (Flooding)
1994: for Pullenvale Residents Action Group, on Rezoning Appeal. (Flooding and Water Quality)
1994: for Development Consulting, on Rezoning Appeal for a Development with a Large Detention Basin at Calamvale. (Flooding and Drainage)
1994: for an Earthworks Contractor Regarding a Disputed Claim Over Levee Bank Construction at Mungindi. (Flooding)
1995: for a Developer on Bohle River Works. (Flooding and Water Quality)
1995: for Residents on Flooding, Murrumba Downs. (Flooding)
1995: for Residents on Flooding, Dayboro. (Flooding)

Expert Services for Phillips Fox; Caboolture Shopping Centre Extension Appeal in Planning and Environment Court. (Flooding)

Expert Services for Mulgrave Shire Council; Land Resumption Compensation Case in Land Court. (Flooding)

Expert Services for Mulgrave Shire Council; Development Appeal (Kamerunga Villas) in Planning and Environmental Court. (Flooding).

Papers/Publications

May 2007 QELA Conference Presentation – The Approval and Appeal Process in QLD and NSW, Experts view on soil and water issues.

Nov 2004 Publication - 'Application of Australian Runoff Quality Draft Chapter 6 – A model approach', Water Sensitive Urban Design Conference, 2004, Adelaide.

Jul 2004 'Integrated High Order Water Quality and Hydrodynamic Analysis', 8th National Conference on Hydraulics in Water Engineering, July 2004.

Nov 2002 Publication - 'Hervey Bay Storm Surge', 30th PIANC Congress, Sydney 2002.

Nov 2001 'The Use of Runoff Event Monitoring in Validating Sediment Control Measures', 9th Annual Conference, International Erosion Control Association, Nov 2001.

Nov 2001 'Specialist 2D Modelling in Floodplains with Steep Hydraulic Gradients', 6th Conference on Hydraulics in Civil Engineering, Nov 2001.

Mar 2001 'Planning Implications of New Technology in Floodplains', RAPI Conference, Gold Coast, 2001.

Nov 1999 'Best Management Practices for Water Quality Control', and 'Zero Flooding Impact Assessments; the need for full two dimensional analysis', 8th International Conf. on Urban Stormwater Drainage, 1999.

Jul 1999 'Desktop Ship Simulation for a new Port Facility in The Gulf of Papua', Coasts and Port '99.
Mar 1997 'Implications of the Nifsan -v- G.C.C.C. ruling on floodplain hydraulics', Qld Envir. Law Assoc., 1997.

Jul 1994 'What the Community Needs to Know – Approaches to Community Construction for Water Engineering Projects', I.E. Aust., Queensland Division, 1994.

Nov 1993 'Hydraulic Assessment of Floodplain Development: Case Studies', The Institute of Municipal Engineering, Goondiwindi, 1993.

Jul 1993 'Long Term Environmental Planning – Weipa Port Dredging', 11th Australasian Conf on Coastal and Ocean Engineering. Townsville, 1993.

Mar 1993 Integrated Hydrologic and Hydraulic Modelling', WATERCOMP '93. The Second Australasian Conference on Technical Computing.

Mar 1992 'Russell and Mulgrave River Catchment Management', Invited Guest speaker for Queensland River Trusts Conference, Cairns, 1992.

Nov 1990 'Recent Studies of Port Dredging and Offshore Spoil Dumps', Third Australasian Port and Harbour Conference 1990, IE Aust.

Aug 1990 'Barron River Airport Bend Study - An Exercise in Joint Numerical and Physical Modelling', Conf. on Hyd. in Civil Eng., 1990, IE Aust.

May 1989 'Comparison and Evaluation of Current Dynamic Flow Models', WATERCOMP '89. The First Australasian Conference on Technical Computing in the Water Industry, Melbourne, 1989.

May 1989 Publication - Dynamic Flow Modelling : Comparison and Evaluation of Current Models - final Report', ACADS International publication No. U-249, May 1989.

May 1988 'Comparison of Dynamic Flow Models', ACADS 2D Modelling of Flood Plains, Melbourne, 1988.

Jun 1985 'ACADS Project on Comparison of Unsteady Flow Models', ACADS workshop, Brisbane 1985.

APPENDIX B: TECHNICAL REVIEW OF HYDRAULIC MODELLING REPORTS BY WMA WATER (28 JULY 2011) AND SKM'S (5 AUGUST 2011) SPECIFICALLY AS THEY RELATE TO IPSWICH CITY COUNCIL – SUPPLEMENTARY REPORT PREPARED FOR IPSWICH CITY COUNCIL, SEPTEMBER 2011

A part of BMT in Energy and Environment

BMT WBM

QUEENSLAND FLOODS COMMISSION OF INQUIRY

Technical Review of Hydraulic Modelling Reports by WMA Water (28 July 2011) and SKM (5 August 2011), specifically as they relate to Ipswich City – Supplementary Report

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Ipswich City Council

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1 PURPOSE OF THE REPORT

This report updates and replaces our 12 September 2011 report. The report corrects minor referencing and grammatical errors, and corrects some factual matters detected in review. Additional comment has also been added in relation to recommendations. The report has been prepared to provide a technical review of a report dated 28 July 2011 by Mark Babister of WMA Water for the Queensland Floods Commission of Inquiry, entitled 'Review of Hydraulic Modelling' (WMA, 2011). That report was prepared for the Commission to answer four specific questions related to the operation of Somerset and Wivenhoe Dams and the January 2011 floods.

In preparing his report, Mr Babister has relied on hydrologic and hydraulic models supplied by Sinclair Knight Merz (SKM), hence, we provide technical review comment on relevant components of the associated SKM report of August 2011 (SKM, 2011).

On 3 August 2011, the Floods Commission wrote to Ipswich City Council inviting comment from Council on the WMA Water and SKM reports. This review is intended to assist Ipswich City Council in providing a response to that request.

Hydrologic (URBS) and hydraulic (MIKE11) model files to allow us to complete a review were provided in late August 2011.

In conducting this review, we have focussed on issues of relevance to flooding the Ipswich City area.

To that end, additional information on flooding in Ipswich and of specific interest to Ipswich has been extracted from the previous work by Mr Babister, SEQ Water and SKM. A further hypothetical dam release option has also been analysed beyond those considered by SKM or Mr Babister, being a delayed release 12 to 24 hours later than actually occurred in the January 2011 floods. Such a strategy is not possible without enlarging the dam and was only carried out to determine whether a delay in releases from the dam could have a significant effect on flooding in Ipswich.

This report is **not** intended to be critical of actual releases made by SEQ Water, or of the hydrologic or hydraulic analysis by SEQ Water, SKM or WMA Water. It must be stressed that the presence of Wivenhoe and Somerset Dams prevented a much more severe flood occurring in the Brisbane River and in Ipswich City. Also, had the Strategy W4 not occurred when it did, a much larger flood could have also occurred, due to fuse plug spillways being activated.

The aim of this report is that, by focussing on Ipswich City flooding and results of the recent analysis work post the floods, a greater understanding of what affects flooding in Ipswich, and on what flood modelling predictions are based, may be achieved. This should assist in future reviews of the flood warning and flood management systems and approach, within the tight limitations of actual dam flood storage capacity and capability and operating rules. Flood warning, including the interpretation of forecasts into predicted impacts and appropriate responses, is of major importance to Ipswich City Council.

Limitations in the flood modelling tools have already been identified by others, and this report looks closely at whether additional limitations in relation to Bremer River flood predictions can be identified.

2 SPECIFIC QUESTIONS BY THE COMMISSION CONSIDERED BY WMA WATER

Section 2.1 of WMA Water's report details the scope of work, as reproduced below:

18 WMA Water's work scope is defined by a letter from the Commission dated 17 June 2011 (ref: DOC20110617), as quoted below:

I write to confirm the Commission requests that you review the hydrodynamic model being developed by SKM for SEQ Water. Further the Commission requests that if possible, you use the model to answer the following questions:

1. *To what extent was flooding (other than flash flooding) in the mid-Brisbane River, the Lockyer Valley, Ipswich and Brisbane during January 2011 caused by releases from the Somerset and Wivenhoe Dams?*

2. *To what extent did the manner in which flood waters were released from the Somerset and Wivenhoe Dams avoid or coincide with peak flows from the Bremer River and Lockyer Creek?*

3. *Had the levels in Somerset and Wivenhoe Dams been reduced to 75 percent of full supply level by the end of November 2010 (both with and without amendments to the trigger levels for strategy changes in the Wivenhoe Manual) what impact would this have had on flooding?*

4. *What effect would the implementation of different release strategies (to be identified by you) have had on flooding?*

Please include in your report a detailed assessment as to any difficulties with the model, together with suggestions as to how (if at all), those difficulties may be remedied.

Please also provide a detailed explanation as to the limitations upon any results which you may obtain using the model.

3 SPECIFIC ISSUES FOR IPSWICH CITY ARISING FROM THE REVIEW

The specific issues for Ipswich City, which we have considered in this Review, are as follows:

1. Timing of dam releases as it may affect flooding in Ipswich and Bremer River flooding.

2. How satisfactory is the calibration of the models are for Lockyer Creek and the Bremer River and therefore how reliable are the predictions in the WMA report for Ipswich City.

3. The benefits or disadvantages of alternative dam operating strategies for Ipswich, such as avoiding coincident Wivenhoe Dam release peaks with Bremer River peaks in Ipswich.

4. Why the release strategies for Wivenhoe Dam were not adjusted when assessing the 75% full supply level strategy and what effect such an adjustment would have had on flooding in Ipswich and Bremer River flooding.

4 REVIEW OF SKM'S MIKE11 AND URBS MODELS FROM PUBLISHED REPORTS

4.1 MIKE11 Model

Section 4 of WMA Water's report describes Version 1 and Version 2 by SKM, as well as the original 2005 SEQ Water MIKE11 model. Since Mr Babister completed his review, a Version 3 of the SKM report has been finalised and that version of the report is dated 5 August 2011.

We concur with Mr Babister's findings regarding serious shortcomings of the 2005 MIKE11 model used previously by SEQ Water, in Section 4.2 of his report.

We also agree with the shortcomings of the Version 1 model described by Mr Babister in Section 4.3 of his report. The prediction of 10m/s velocities in the Brisbane River is not credible and the model results are therefore unlikely to be reliable.

We have not reviewed Version 2 of the model in detail as we have focussed our review on Version 3 which is the most up to date version (SKM, 2011). Based on our review, the MIKE11 hydraulic model used has a number of assumptions and limitations, which could undermine the accuracy of the results for Ipswich City. These include:

- The floodplain has been represented using extended Sections. This may not always be appropriate;
- The extended Sections do not always extend far enough to capture the full extent of the January 2011 flood event, i.e. the model is represented by an artificial vertical wall at the end of Sections, which may cause an over prediction of water levels; and
- Channel roughness parameters (representation of channel and floodplain vegetation state) are abnormally high, which would again over predict water levels. This is more relevant to the upper reach (upstream of chainage 1,002,785) close to Mount Crosby. In the vicinity of the Bremer River (chainage 1,006,200) to Moreton Bay the roughness parameters are more within a normal range.

The calibration exercise of the MIKE11 is also less than desirable, for the following reasons:

- The model is used to create a rating curve at Mount Crosby. However, there is no discussion on how the rating curve was developed. The rating curve results in a good match for peak level at Mount Crosby, but flood levels are under predicted during the rise and ebb of the flood;
- The MIKE11 model does not attempt to individually represent tributary flows upstream of Mt Crosby (such as Lockyer Creek). All upstream inflows (excluding Wivenhoe Dam releases) are lumped together as a point source and inputted into the model immediately upstream of Mt Crosby. In version 3 of the SKM Joint Calibration Report, Figures 6-2 shows the peak flow at Mt Crosby as about 10,000m3/s with the routed Wivenhoe contribution of 6,000m3/s (suggesting that the contribution from the non-Wivenhoe flows are 4000 m3/s. Figure 6-3 shows a comparison of the difference between the two hydrographs in Figure 6-2 (red line) and the estimate from the URBS model (blue line) for the same interstation area. This suggests that the peak contribution of the catchment area between Wivenhoe and Mt Crosby, including the

Lockyer, is about 5,000 m3/s. The differences in the non Wivenhoe flow requires further investigation;

- If the model is generally over predicting water levels, the flow determined from the Mount Crosby rating curve will be overestimated and vice versa. However, the fact that the modelled and measured velocity at the Jindalee gauge are similar, gives the exercise credibility (with a small under prediction – velocities in the order of 2.6m/s);
- MIKE11 model underestimates the peak water level at the Ipswich CBD gauge by approximately 1m (Figure 6-1) when compared to the gauge level and URBS prediction. Whereas the peak flow is slightly overestimated by the URBS model but is reasonably matched by the MIKE11 flow. These discrepancies could be a result of inadequate schematisation of the model.

Most importantly for Ipswich, however, is the fact that there has been no revision to the model to correct issues identified above with the 2005 SEQ Water model and the Version 3 model, in relation to Bremer River and Lockyer Creek flooding. This leads to considerable uncertainty over the accuracy of flood wave timing and magnitude in the Ipswich area.

A major limitation to improving the flood modelling of the Bremer River and Lockyer Creek is the lack of suitably accurate survey data of the streams and floodplain.

In Section 1.3.9 (WMA, 2011) there is no quantification of the effects on flooding in Ipswich, which is required.

4.2 URBS Model

The URBS Model used by SKM was prepared by SEQ Water and has been calibrated to closely match the timing and flood heights that occurred during the January 2011 flood. From our review, a very close match for Ipswich City has been achieved with this model, and the URBS model, therefore, represents the most reliable flow, level and flood wave timing tool currently available.

5 DESKTOP REVIEW OF WMA WATER REPORT OF 28 JULY 2011 (WMA, 2011)

5.1 Introduction

Our review recognises that this exercise undertaken by WMA Water was undertaken in a short time frame.

An important consideration from the WMA Water analysis is that the calibrated model uses peak flow at Mount Crosby of 9,500m³/s. The Bremer confluence is 17km downstream of the Mount Crosby gauge. At Jindalee (which is a few kilometres upstream of Brisbane) the measured peak discharge is 10,000m³/s. This suggests that the Lockyer Creek flow is contributing a significant proportion of flow and that the flow in the Brisbane River is largely driven by flow from upstream of Mount Crosby, with lesser contribution from the Bremer River and other local catchments. More detailed analysis is required to determine the proportion of contributions from other local catchments.

We acknowledge that there was a significant rainfall event in the Bremer catchment which would have filled much of the Bremer floodplain before the Brisbane River peak from the Wivenhoe releases arrived. The Bremer River had a shallow gradient, which indicates that water was flowing down the Bremer River during the peak. Therefore it is not a purely backwater flood event in Ipswich. We believe that the flooding is due to a combination of high water levels in the Brisbane River and flows in the Bremer River on the receding limb of the flood. The inundation maps produced for the ICA Volume 3 report support this assumption (see Appendix A). They show the flood extent outline at 1800hours on 11 January 2011 (i.e. after cessation of the last rainfall event over the Bremer catchment) and the total maximum flood extent outline for the catchment up to 14 January 2011.

5.2 Contribution of Wivenhoe Dam Release Flows and Non-Wivenhoe Flows

With regards to the discussion on contribution of Wivenhoe Dam release flows and non-Wivenhoe flows on page 24 of WMA Water's report, the analysis does not isolate out the impacts of the Bremer River and Lockyer Creek. Our analysis of the URBS model suggests that the Lockyer Creek flow (4,796m^3/s) was a larger contributor to overall flow compared to the peak Bremer River flow (2,277m^3/s). This further supports the view that the flooding in Ipswich was contributed to by the backwater effect from the Brisbane River. The fact that in SKM's Case 3 a negative flow up the Bremer occurred (see paragraph 62 WMA, 2011) further supports the finding that Bremer River flood levels are significantly influenced by Brisbane River flooding. This has long been recognised by Ipswich City Council, SEQ Water and SKM. These figures require further analysis and review, , as the local catchment between Lockyer Creek and the Bremer River has an area of about 600km^2 and SEQ Water estimate that it generated a peak of about 3500m^3/s during the January 2011 flood.

5.3 Bremer River and Brisbane River Peaks

With regards to the comment in paragraph 65 of WMA Water's report that the Bremer River and Brisbane River peak occur at the same time, it is not reported how flows on the Bremer River were derived. The modelling carried out as part of this report (see Chapter 6) indicates that the peak water

level from the Bremer only flow occurred at around 0440hours on 12 January 2011, whereas the peak in the Brisbane River occurred at the Moggill gauge at approximately 1400hours on 12 January. Figure 5-1 illustrates the timeline summarising rainfall, peak flood release from Wivenhoe Dam and associated warning information.

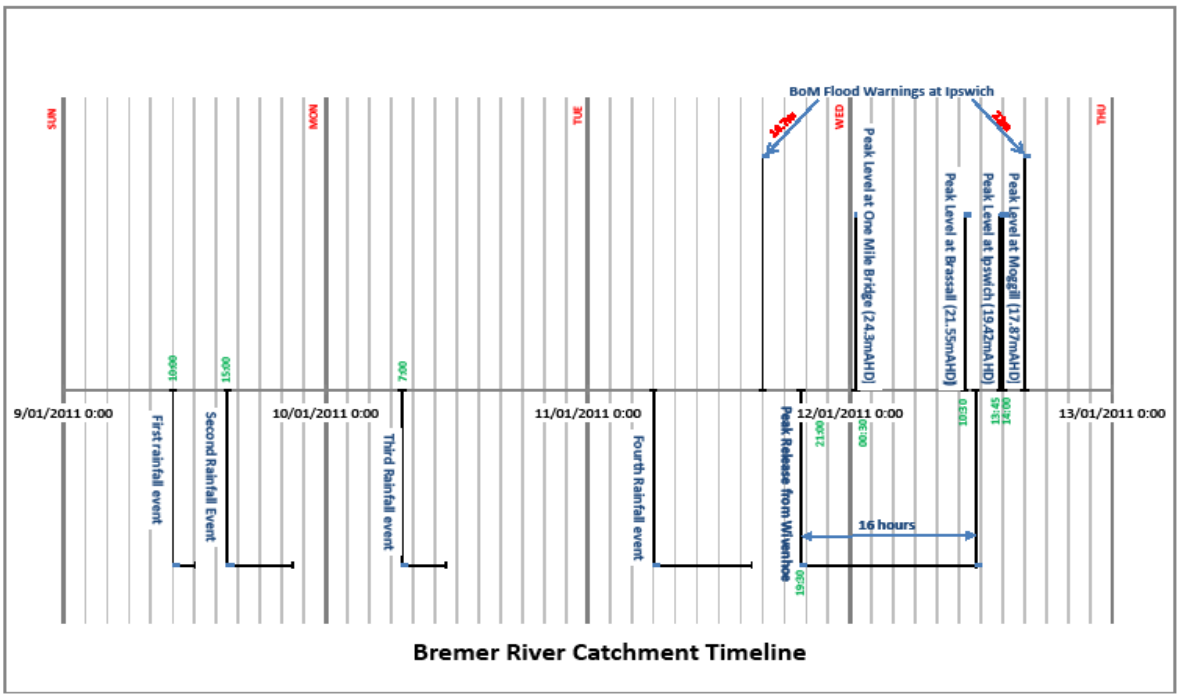

Figure 5-1 Bremer River Timeline

Peak flooding in Ipswich was significantly influenced by back-up flooding from the Brisbane River. Peak flooding in the Brisbane River at the confluence of the Bremer River was a result of runoff from the upper Brisbane River catchment system including major discharge from Wivenhoe Dam (which peaked at 1930 hours on 11 January 2011), combined with significant runoff from the Lockyer Creek catchment, with the peaks of dam discharge and Lockyer Creek coinciding. Hence, flooding in Ipswich was at least in part influenced by the timing of releases of water from Wivenhoe Dam but was exacerbated by the major flood event in Lockyer Creek, which was coincident with dam release flows.

There was also a significant flood event down the Bremer River due to Bremer River catchment rainfalls. The relative contributions to flooding in Ipswich from Brisbane River flooding, dam releases, Lockyer Creek flooding and Bremer River flooding are discussed in more detail in Chapter 7.

5.4 Option B Release Strategy

Paragraph 82 of WMA Water's report (Option B release strategy) does not address how this option may have affected the flood in Ipswich, including that the timing of peak releases would have changed, which could have reduced the coincidence of dam releases and Bremer River discharge to the Brisbane River. We consider this further in Section 6.3 of this report.

6 REVIEW OF MODELLING RESULTS USING SEQ WATER'S MIKE11 AND URBS MODELS

6.1 The January 2011 Event

The MIKE11 model estimates the peak water level at Ipswich to be 17.931mAHD. The recorded peak water level was 19.42mAHD as illustrated in Figure 6-1 below.

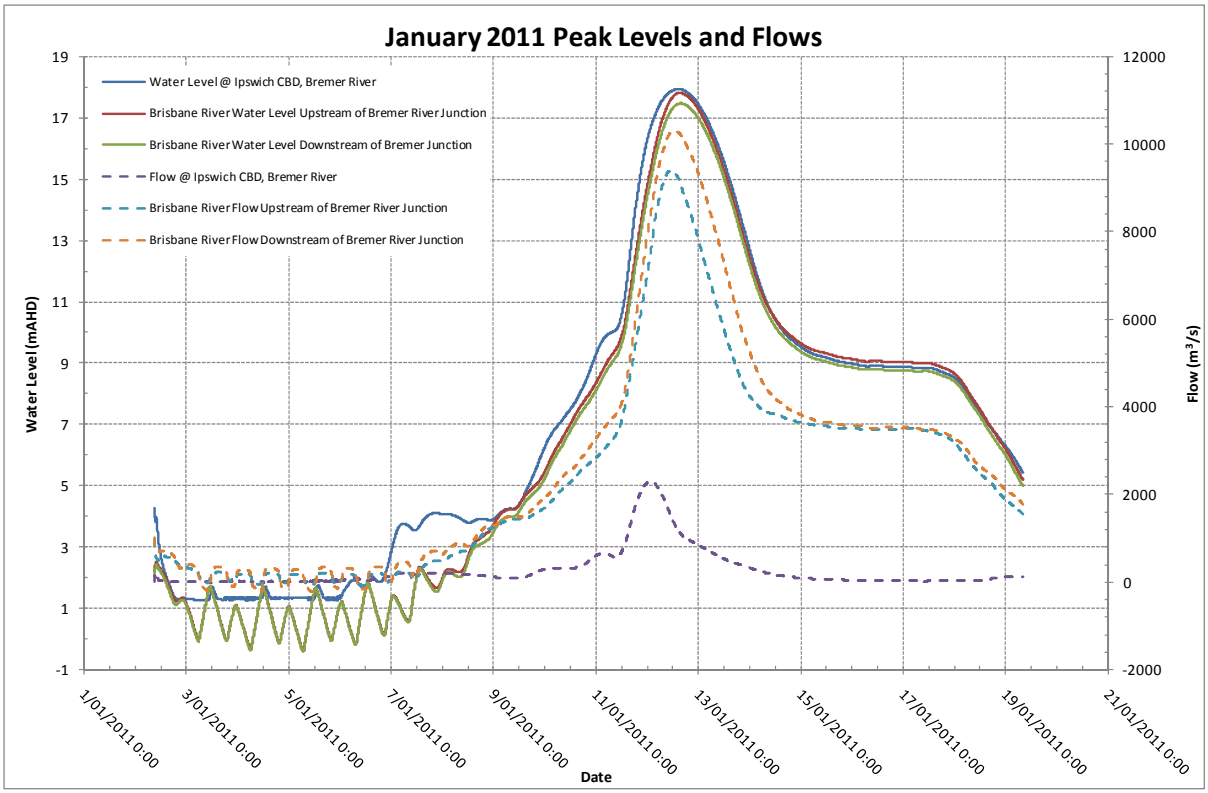

Figure 6-1 SKM Modelled Water Levels and Flows

URBS slightly overestimates the peak flow by approximately 150m^3/s (which is around 1% of the total flow). **The MIKE11 modelled peak flow of 2,300m^3/s equates to a design flow of between 20 and 50 year Average Recurrence Interval (ARI) (Sargent, 2006).** The actual measured peak flow at Ipswich was 2,277m^3/s.

6.2 Earlier Transition to Strategy W4 (Option A)

This scenario involves an earlier transition to Strategy W4 for the Wivenhoe Dam releases at 1600 hours 10 January 2011 instead of 0800 hours on 11 January 2011. Two cases were actually considered within this Option:

- Option A4 – to quickly escalate the outflows to match inflow and stabilise the level in the dam; and
- Option A5 – to increase outflow at a slower but steady rate to make more use of the remaining mitigation storage.

We have compared the output for both options against the January 2011 modelled results discussed in Section 6.1 of this report specifically for Ipswich City. Notwithstanding the inaccuracies described, the following results are presented.

Option 4A Scenario

Our analysis indicates the following for Ipswich Option A4 scenario as shown in Figure 6-2.

Results show that:

- Peak water level at Ipswich CBD increases over that predicted for the actual flood event (Figure 6-1) by 0.64m; and
- Peak flow at Ipswich CBD is 2,238m^3/s.

i.e. Option A4, if technically possible, could have worsened flooding in Ipswich by 0.64m.

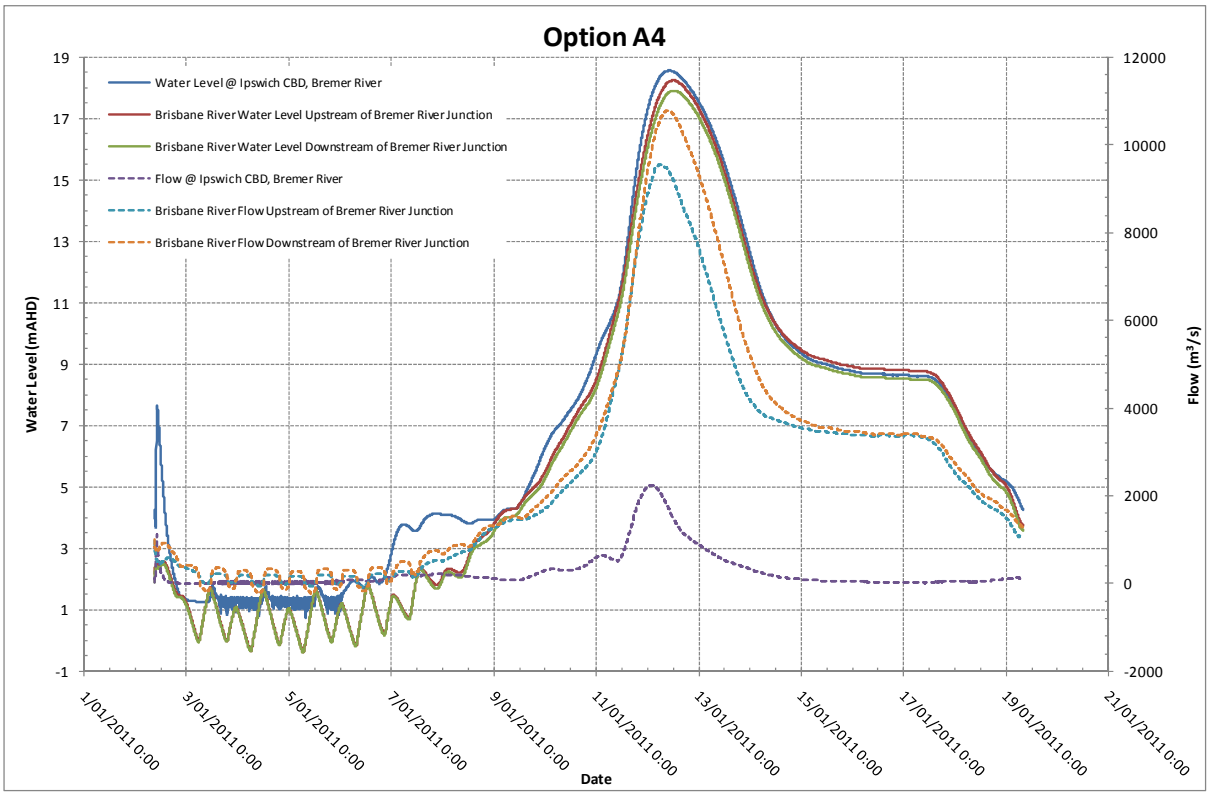

Figure 6-2 Option A4 Water Levels and Flow

Option 5A Scenario

Our analysis indicates the following for Ipswich Option A5 scenario as shown in Figure 6-3.

Results show that:

- Peak water level at Ipswich CDB decreases by 0.83m; and
- Peak flow at Ipswich CBD is 2,310m^3/s.

i.e. Option A5, if technically possible, could have reduced flooding in Ipswich by 0.83m.

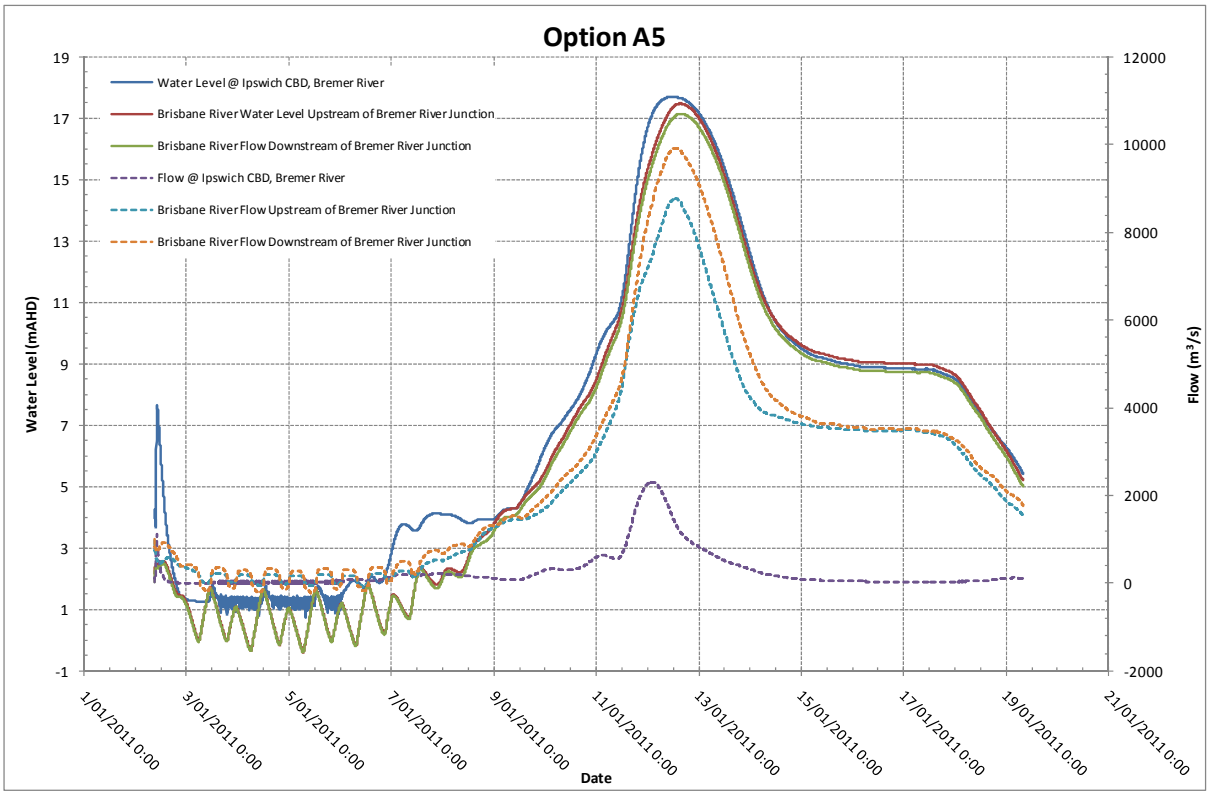

Figure 6-3 Option A5 Water Levels and Flow

For both Option A4 and A5, the impact of the earlier transition affects the peak water level in Ipswich but has little effect on the peak flow.

6.3 Wivenhoe Dam at 75% of Full Storage Level Prior to the Flood (Option B)

This scenario involves the storage level in Wivenhoe Dam being assumed to be at 75% of FSL prior to the onset of the flood but retaining current operating rules.

We have compared the output against the January 2011 modelled results discussed in Section 6.1 of this report. Notwithstanding the inaccuracies described, the following results are presented.

Our analysis indicates the following as shown in Figure 6-4.

Results show that:

- Peak water level at Ipswich CBD is decreased by 0.68m; and
- Peak flow at Ipswich CBD is 2,330m^3/s.

i.e. Option B could have reduced flooding in Ipswich by 0.68m.

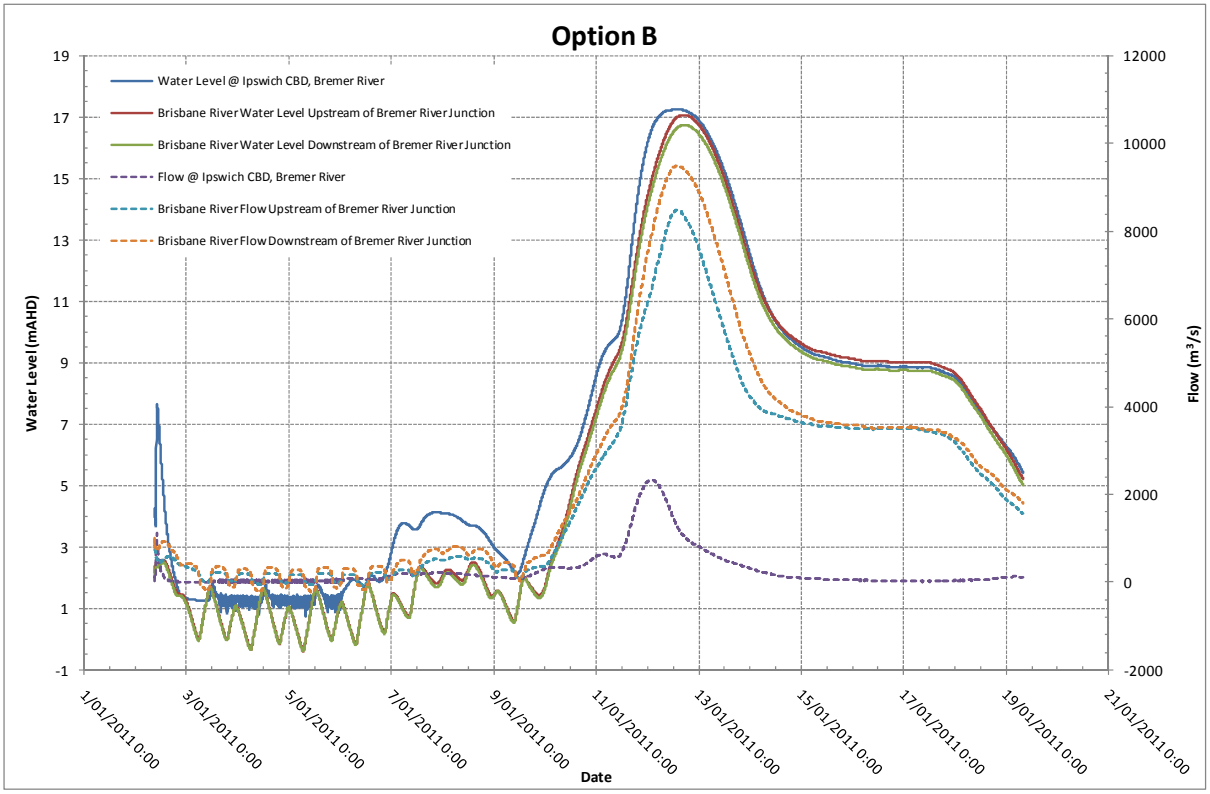

Figure 6-4 Option B Water Levels and Flow

6.4 Discharge at Upper Limit during Strategy W3 (Option C)

This scenario explores the effects of increasing flows immediately after entering Strategy W3 to the upper allowable limit.

We have compared the output against the January 2011 modelled results discussed in Section 6.1 of this report. Notwithstanding the inaccuracies described, the following results are presented.

Our analysis indicates the following as shown in Figure 6-5.

Results show that:

- Peak water level at Ipswich CBD decreased by 0.67m; and
- Peak flow at Ipswich CBD is 2,331m^3/s.

i.e. Option C, if technically possible, could have reduced flooding in Ipswich by 0.67m.

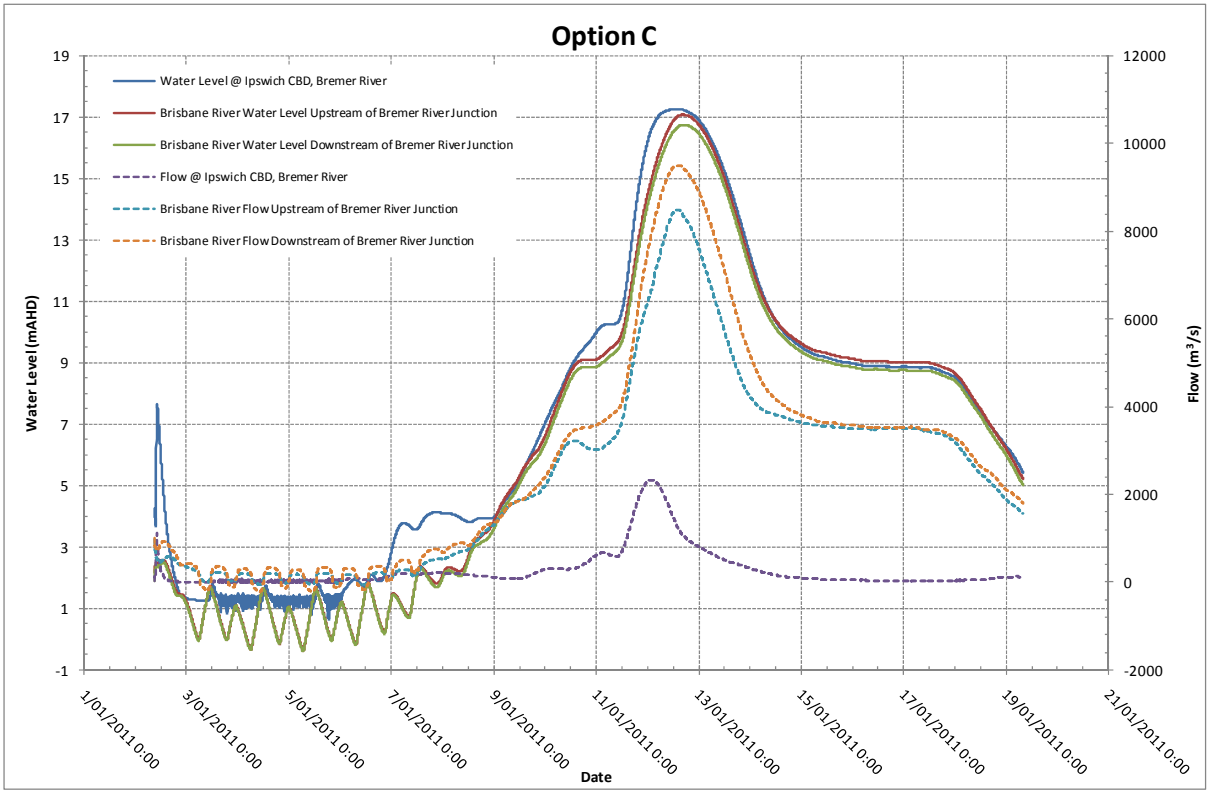

Figure 6-5 Option C Water Levels and Flow

6.5 WMA Water's 'Optimised' Release Strategy (Option D)

This scenario explores the effects of an optimum release strategy with full benefit of hindsight and ignoring restrictions from the Wivenhoe Dam Operating Manual on total flow at Moggill.

We have compared the output against the January 2011 modelled results discussed in Section 6.1 of this report. Notwithstanding these inaccuracies and assumptions described, the following results are presented.

Our analysis indicates the following as shown in Figure 6-6.

Results show that:

- Peak water level at Ipswich CBD decreases by 0.6m; and
- Peak flow at Ipswich CBD is 2,334m^3/s.

i.e. Option D, if technically feasible, could have reduced flooding in Ipswich by 0.6m, noting WMA Water's comments that, in reality, this option is not plausible.

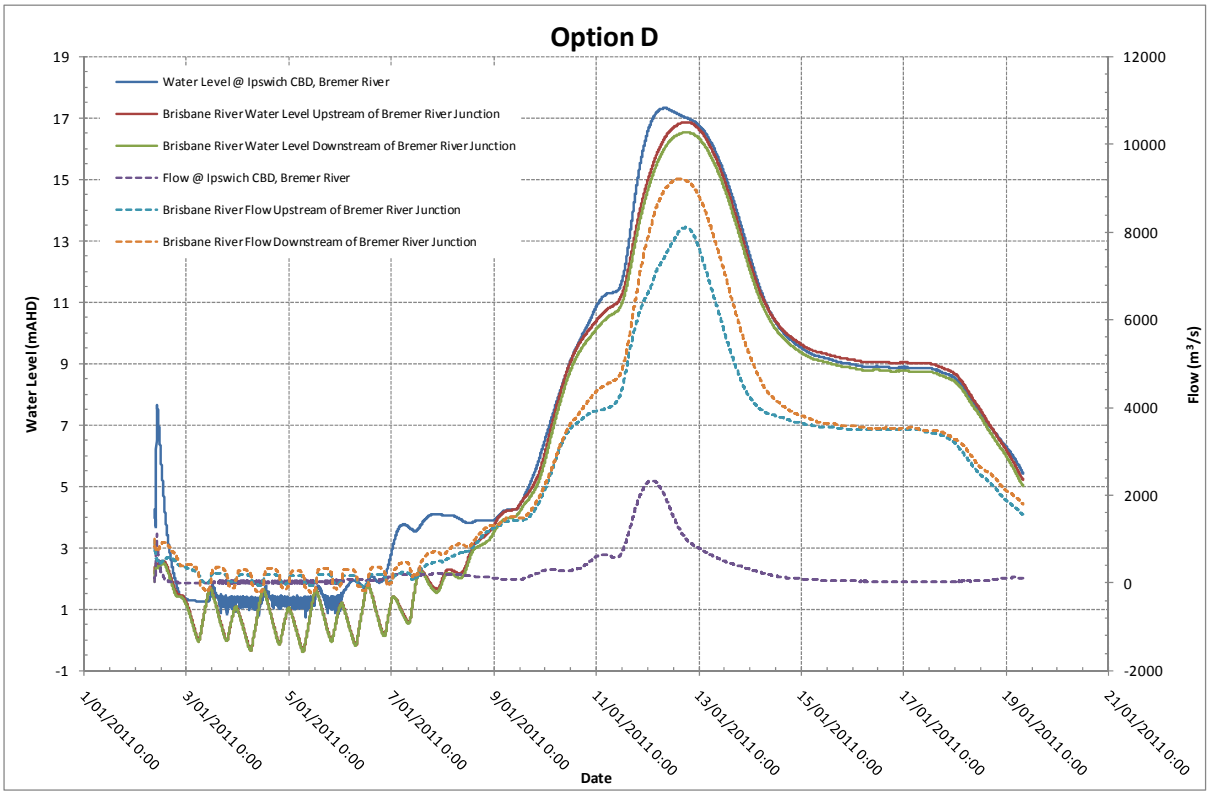

Figure 6-6 Option D Water Levels and Flow

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6.6 BMT WBM's Hypothetical Delayed Release Strategy (Option E) (enlarged dam option)

This scenario explores the effects of delaying the actual peak release from Wivenhoe Dam by 12 hours and by 24 hours. This option is not possible without increasing significantly available flood storage capacity in the dams through dam enlargement. It has only been assessed to allow a quantification of the interdependence of the timing of dam releases as they affect Ipswich and Bremer River flooding.

We have compared the output against the January 2011 modelled results discussed in Section 6.1 of this report. Notwithstanding the inaccuracies described, the following results are presented.

Our analysis indicates the following as shown in Figure 6-7.

Results show that:

- Peak water level at Ipswich CBD decrease by 0.1m for the 12 hour scenario; and
- Peak water level at Ipswich CBD decreases by 0.98m for the 24 hour scenario.

The longer the delay in dam release, the greater the reduction in flood levels in Ipswich.

A delay of 24 hours in Strategy W4 release would have reduced flooding in Ipswich by about a metre. This would not be possible without major dam flood storage compartment increases and dam raising.

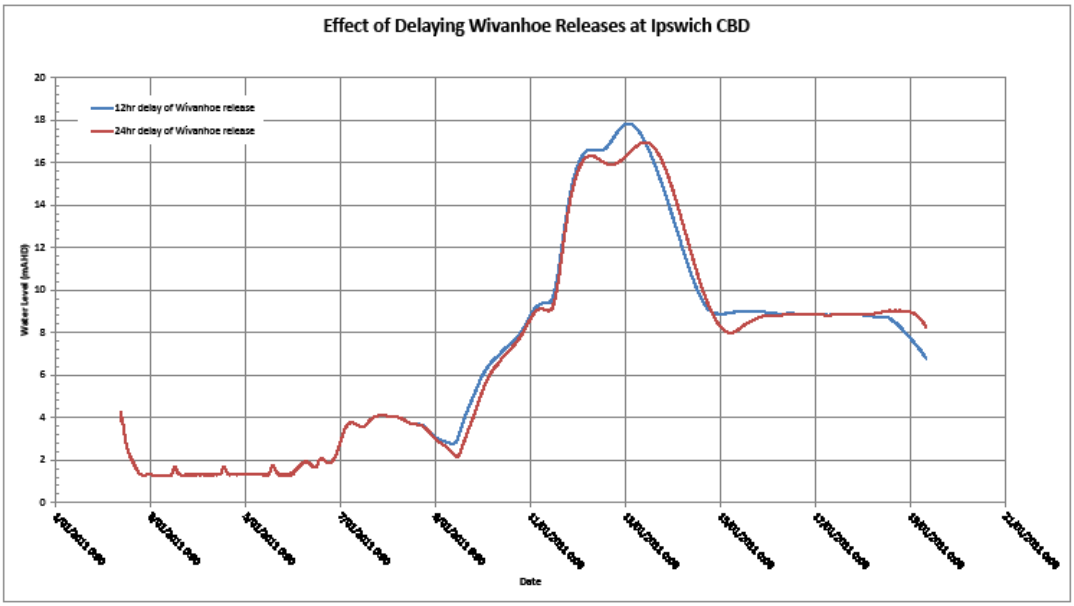

Figure 6-7 Delayed Release Scenarios

7 SUMMARY OF FINDINGS SPECIFIC TO IPSWICH CITY

7.1 Bremer River 2011 Flood Levels and Flows

A summary of model results is as follows in Table 7-1 and Table 7-2:

Table 7-1 Peak Water Levels

Location	Case1	Option A4	Option A5	Option B	Option C	Option D	Option E (12hr Delay)	Option E (24hr Delay)
	Peak Water Level (mAHD)	Peak Water Level (mAHD)	Peak Water Level (mAHD)	Peak Water Level (mAHD)	Peak Water Level (mAHD)	Peak Water Level (mAHD)	Peak Water Level (mAHD)	Peak Water Level (mAHD)
Ipswich CBD	17.931	18.566	17.699	17.250	17.259	17.325	17.836	16.949
Upstream of Bremer River Junction	17.816	18.246	17.484	17.075	17.081	16.862	17.799	16.967
Downstream of Bremer River Junction	17.472	17.914	17.149	16.741	16.748	16.534	17.585	16.749

Table 7-2 Peak Flows

Location	Case1	Option A4	Option A5	Option B	Option C	Option D	Option E (12hr Delay)	Option E (24hr Delay)
	Peak Flow (m^3/s)	Peak Flow (m^3/s)	Peak Flow (m^3/s)	Peak Flow (m^3/s)	Peak Flow (m^3/s)	Peak Flow (m^3/s)	Peak Flow (m^3/s)	Peak Flow (m^3/s)
Ipswich CBD	2299	2238	2310	2330	2331	2334	2361	2373
Upstream of Bremer River Junction	9394	9549	8784	8483	8484	8119	9305	8458
Downstream of Bremer River Junction	10304	10782	9914	9495	9501	9218	10464	9500

Table 7-3 summarises the changes in water levels and peak flows at Ipswich corresponding to the various options assessed within this report.

Table 7-3 Summary of Impacts at Ipswich

	Option A4	Option A5	Option B	Option C	Option D	Option E (12hr Delay)	Option E (24hr Delay)
Water Level (m)	-0.63	0.23	0.68	0.67	0.61	0.10	0.98
Peak Flow (m3/s)	61	-11	-31	-32	-35	-62	-74

7.2 What caused the January 2011 Flooding in Ipswich City?

Our analysis has clearly illustrated the effect of the Brisbane River flows at the Ipswich CBD. By isolating the effects of the Bremer River only flow, we have demonstrated that the peak Bremer River flow was between the ARI 20 year and 50 year ARI event based on design flood flow estimates by Sargent (2006). When the corresponding water level of 14.09mAHD derived for this design flow (in the absence of significant Brisbane River flooding) is compared to the Ipswich flood level classification from the BoM, it can be seen that this event is within the lower end of the major category.

When the effects of the flood in the Brisbane River, the releases from the Wivenhoe Dam and the flow from Lockyer Creek are taken into account, the measured peak was 19.25m AHD.

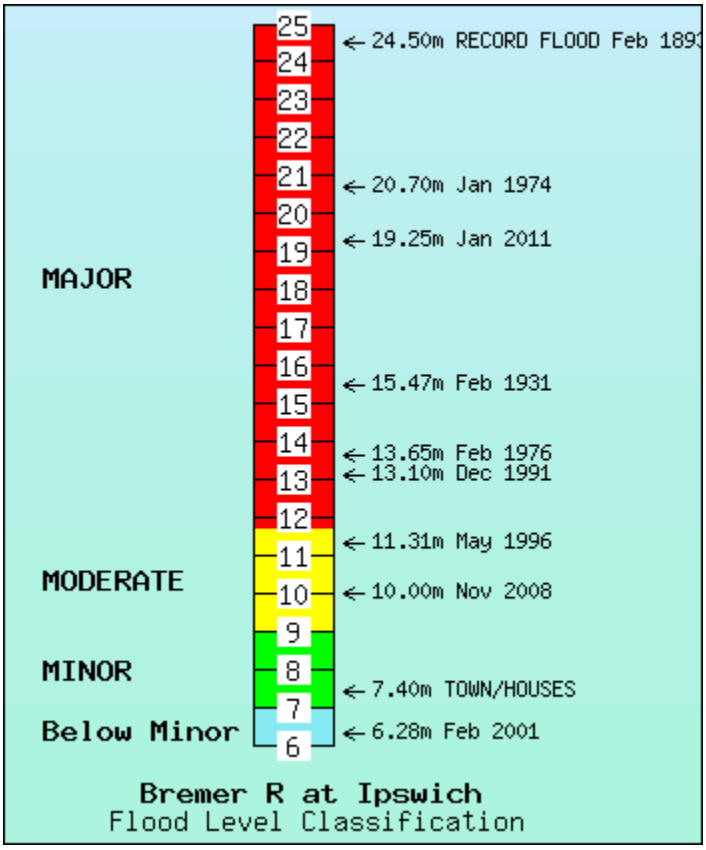

Figure 7-1 Flood Level Classification (BoM, 2011)

Flooding in Ipswich in the January 2011 event in the absence of major flooding (assumed Brisbane River level at Moggill of RL13.4m) in the Brisbane River, would have resulted in an ARI 20 to 50 year flood in the City, with water levels in the CBD reaching RL 14.1mAHD (using the work of Sargent, 2006).

Very large flooding occurred in the Brisbane River during this event, including in the Lockyer Creek catchment.

The sensitivity testing carried out by WMA Water and the delayed release strategy represented in this report, show that, under the scenarios tested in this report, at best, flood levels in Ipswich may have been able to have been able to have been reduced by about a metre for a January 2011 type event.

Further reductions in flooding in Ipswich, could be achieved with major capital works (e.g. bridge raising or dam raising) to allow further flexibility in either early or delayed releases.

Hence, we conclude that flooding in Ipswich was caused by a combination of a 20 to 50 year ARI event in the Bremer River, major to extreme rainfall events and flooding in Lockyer Creek and in the Brisbane River catchment, and the timing of the release strategy to move to Strategy W4. The rainfall event and its associated severity across the entire Brisbane and Bremer River catchments caused the flooding. Without Wivenhoe and Somerset Dams, flooding in Ipswich and Brisbane would have been many metres higher.

8 RECOMMENDATION OF ADDITIONAL WORK TO ASSIST IN ADDRESSING IPSWICH CITY COUNCIL'S CONCERNS

We recommend that additional work is required to address Ipswich City Council's concerns. These works include:

- A review and update of Lockyer Creek and Bremer River branches of the SKM MIKE11 model (acknowledging the limited survey data currently available for Lockyer Creek and Bremer River main channel);
- Review of calibration of the model for Bremer River reach and recalibration using the January 2011 flood event;
- Re-modelling of Option B with associated adjustments to operating rules to maintain 75% capacity - how these adjustments are made also needs to be subject to review. Such review should include, as a priority, not only reducing Wivenhoe Dam storage to 75% full storage level, but also adjusting the dam operating rules to attempt to maintain this level throughout the wet season;
- Further investigation of early or delayed release strategies independent of operating rules to assess the benefits and consequences of such strategies. Detailed and specific reporting for Ipswich for all options and strategies tested; and
- Consideration of what works or actions are required to allow early or delayed release strategies to be adopted, e.g. downstream bridge upgrades or dam storage compartment increases.

9 CONCLUSIONS

In conclusion, we find the following:

1 There is no specific reporting in the WMA Water report on the effects of the various strategies and options considered by WMA Water on the City of Ipswich and this report attempts to address those and other matters of concern for Ipswich.

2 Our analysis of the current models shows that flooding in Ipswich was influenced by Brisbane River flood back-up on the falling limb of Bremer River flooding.

3 Flooding in Ipswich in the January 2011 event in the absence of major flooding (assumed Brisbane River level at Moggill of RL 13.4m) in the Brisbane River, would have resulted in an ARI 20 to 50 year flood in the City, with water levels in the CBD reaching around RL 14.1mAHD (based on the work by Sargent, 2006). This requires further analysis and review to test the work of Sargent against current knowledgeWhen the effects of the flood in the Brisbane River, the releases from the Wivenhoe Dam and the flow from the Lockyer Creek are taken into account, the measured peak was 19.25mAHD.

4 We conclude that flooding in Ipswich was caused by a combination of a 20 to 50 year ARI event in the Bremer River, major to extreme rainfall events and flooding in Lockyer Creek and in the Brisbane River catchment, and the timing of the release strategy to move to Strategy W4. The rainfall event and its associated severity across the entire Brisbane and Bremer River catchments caused the flooding. Without Wivenhoe and Somerset Dams, flooding in Ipswich and Brisbane would have been many metres higher.

5 Despite the short time available and the limitations of available models, the modelling work by WMA Water has been useful is determining the potential significant positive benefits of adopting alternate strategies, including a 75% full supply strategy at the start of the next wet season. Flood levels reductions of up to 0.7m for a January 2011 event are predicted for Ipswich City. The strategy also needs to be expanded to determine the benefits of revised operating rules adjusted to maintain the 75% supply level, rather than maintaining the existing operating rules, that are designed around the 100% level.

6 The modelling work by WMA Water also shows that, subject to technical feasibility, options for gradual early release from the dam could reduce predicted flood levels in Ipswich by up to a metre for a January 2011 event.

7 By delaying the W4 release strategy by 24 hours, flood level reductions of about a metre for a January 2011 event may be feasible in Ipswich; however, this option would require a significant expansion of the dam flood storage compartment, and associated raising of the dam.

8 There are still significant shortcomings of the MIKE11 model in its representation of Lockyer Creek and the Bremer River that requires additional refinement and correction. It is acknowledged that insufficient survey data exists for Lockyer Creek and for the Bremer River main channel. Without accurate modelling of these two waterways, some uncertainty still exists over the timing of flood waves and coincidence of flood peaks.

9 Additional testing of the benefit of early or delayed release strategies, particularly on what benefit this could achieve to reduce peak flooding in Ipswich, ought to be carried out. This should include additional options for early release, beyond current operating rule restrictions, and

consideration of what additional dam storage may be required, to determine the benefits and dis-benefits to the entire system of such strategies.

10 Review of the costs and benefits of works required (e.g. bridge raising) to allow more flexibility in early and delayed release strategies is recommended.

11 All modelling work of alternative dam operation strategies tested to date as discussed in this report relate to the effect on a January 2011 type flood event. Any review of dam operating strategies, downstream capital works or increase in dam flood storage compartment require consideration of the consequences of these changes under a range of historic and design flood events, including those such as the 1974 flood where very different rainfall distribution patterns occurred, including events where the majority of the rainfall fell below the dam.

10 QUALIFICATIONS

This report must be read jointly with WMA Water's 24 July 2011 report and SKM's 5 August 2011 (Version 3) report. Terminology and definitions used are consistent with those of WMA Water.

No URBS input files were reviewed. No spreadsheets containing gate operations rating curves were provided or reviewed.

The review utilises the published reports quoted, and the SKM Version 3 MIKE11 model files, URBS results files, as provided by SEQ Water in August 2011, and model files as reported by WMA Water in their 5 July 2011 report.

The accuracy of this report is limited to the accuracy of this information and no independent verification of results from SEQ Water 's URBS modelling, SEQ Water's gate operational releases or from modelling work completed by WMA Water has been carried out.

11 REFERENCES

Sargent, 2006 Ipswich Rivers Flood Study Rationalisation Project Phase 3 Re-estimation of Design Flood Levels, Ipswich Rivers Improvement Trust

SKM, 2011 Joint Calibration of a Hydrologic and Hydrodynamic Model of the Lower Brisbane River, Technical Report, Version 3, August 2011

WMA, 2011 Queensland Floods Commission of Inquiry, Review of Hydraulic Modelling, Final Report

BOM, 2011 Flood Warning System for Bremer River to Ipswich

ICA, 2011 Flooding in Brisbane River Catchment January 2011 Volume 3 Flooding in Ipswich City LGA, Insurance Council of Australia Hydrology Panel

APPENDIX A: ICA 2011 INUNDATION MAPS

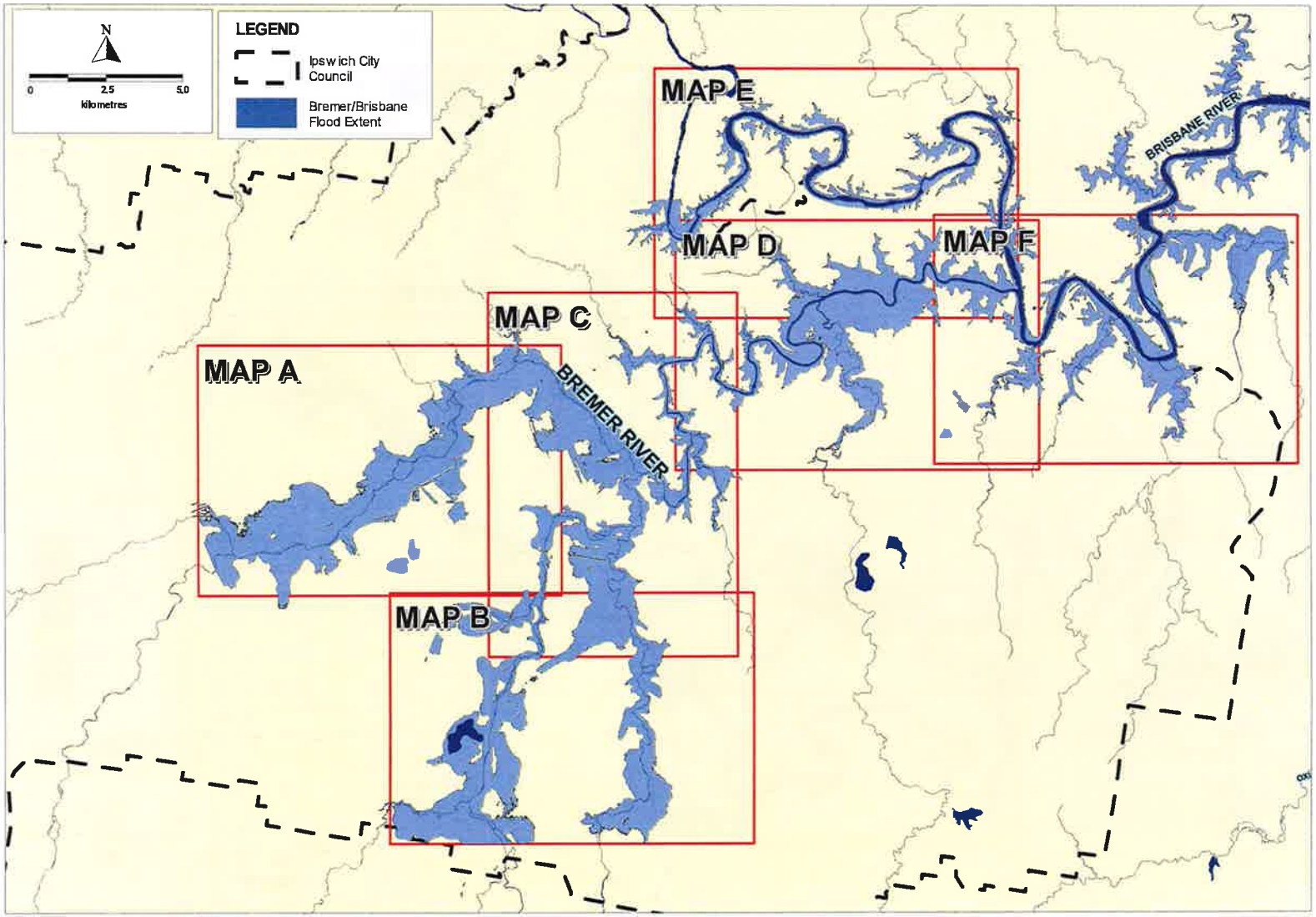

Figure 8.19 Maximum Extent of Inundation, Ipswich City LGA, 10-14 January 2011

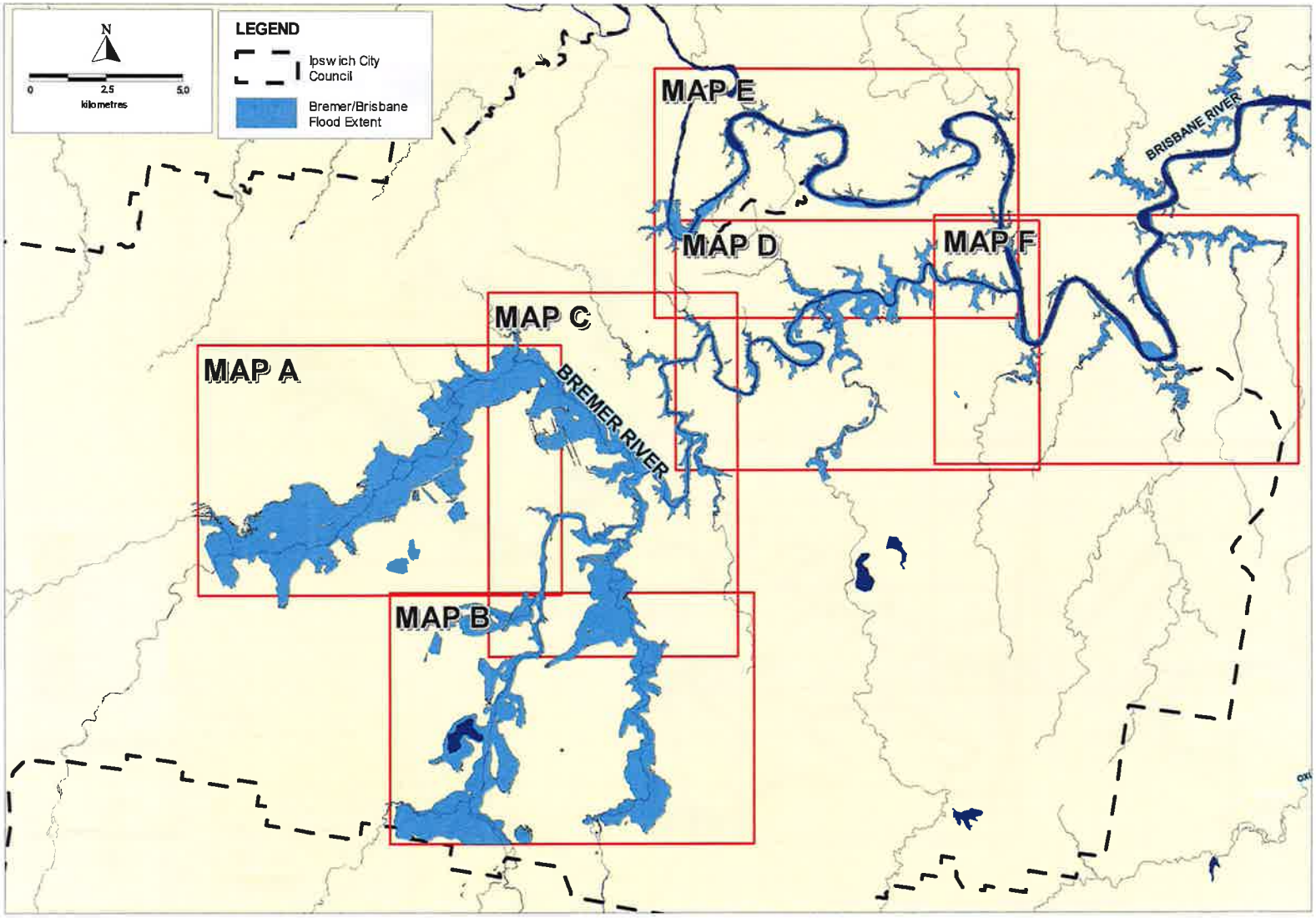

Figure 8.21 Extent of Inundation at 1800 Hours on 11 January 2011, Ipswich City LGA

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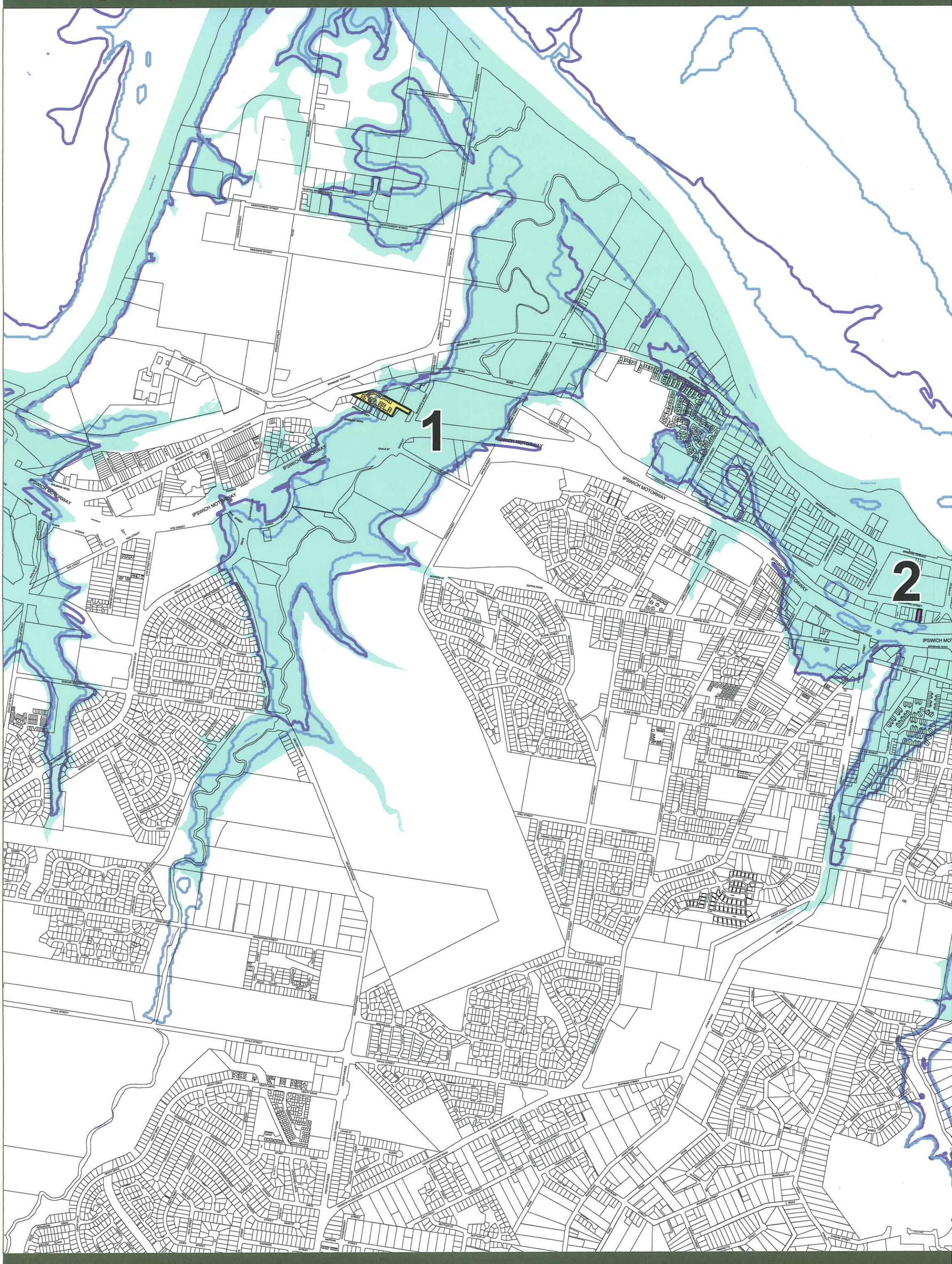
APPENDIX C: FLOOD LEVELS AND MAPPING DATA IN CURRENT IPSWICH CITY COUNCIL PLANNING DOCUMENT

Flooding Comparision Map



13/10/2011

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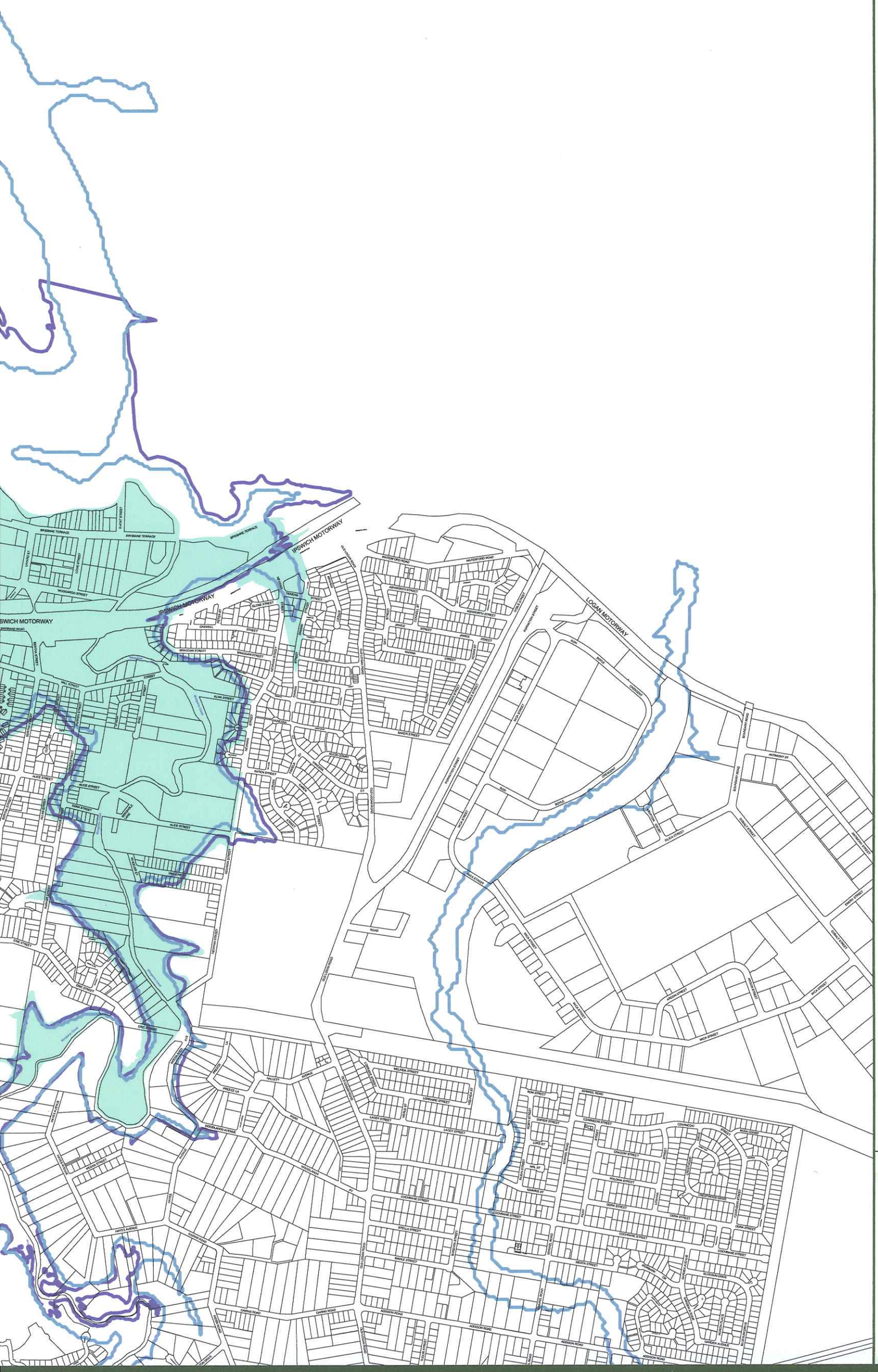

- Property Boundaries
- 1 in 100 Flood Line
- 2011 Flood Event
- 1974 Flood Event
- 1 — 13 Bridge Street, Redbank
- 2 — 20 Woogaroo Street, Goodna

Legend

DISCLAIMER: Ipswich City Council Data

While every care is taken by the Ipswich City Council (ICC) to ensure the accuracy of this data, ICC makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaim all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which may be incurred as a result of the data being inaccurate or incomplete in any way and for any reason. Based on Data provided with permission of the Council.

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N

GDA

Map Grid : Geocentric Datum of Australia (G.D.A.)
Level Datum : Australian Height Datum (A.H.D.)

500 0 m

Scale 1:15,000

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