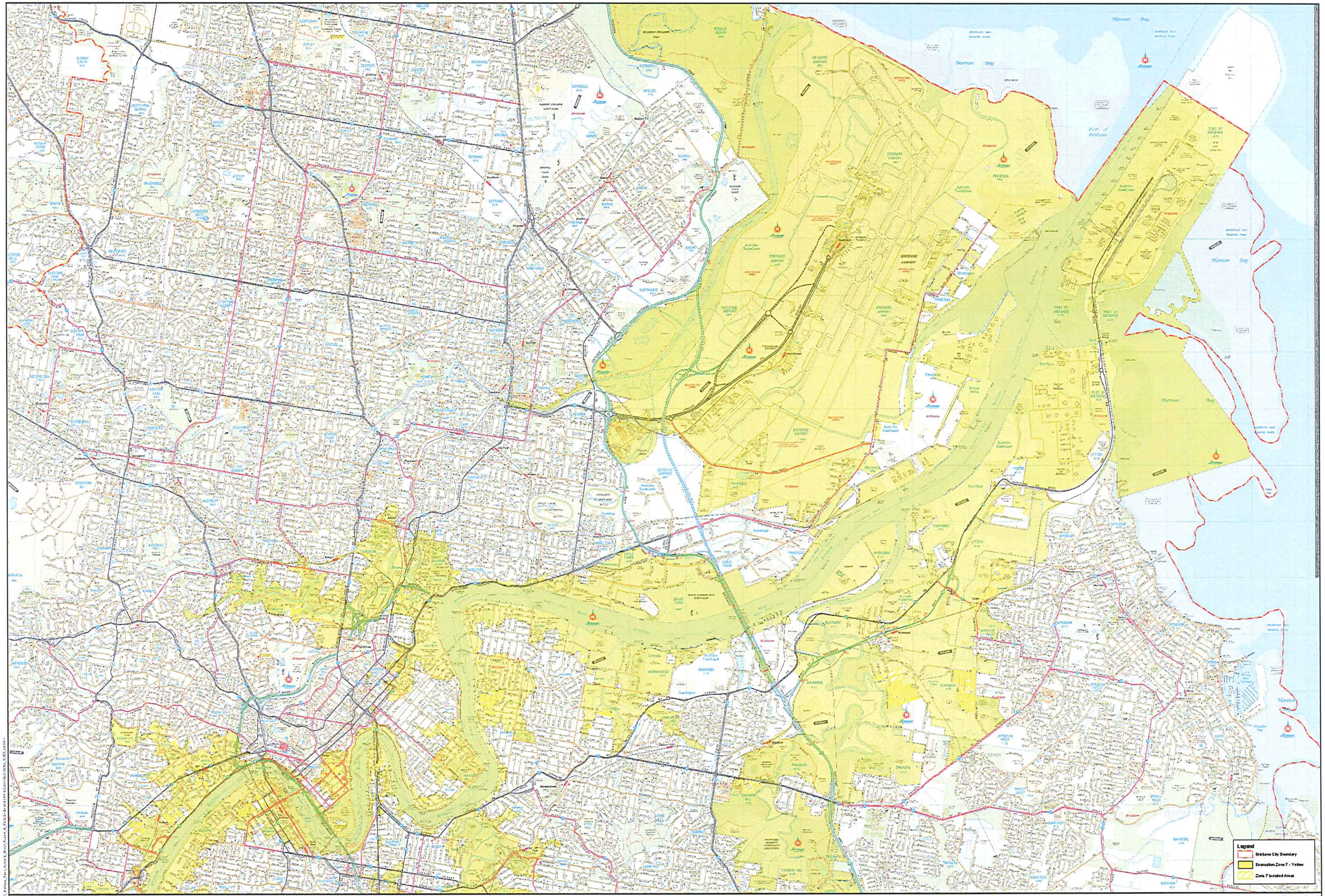
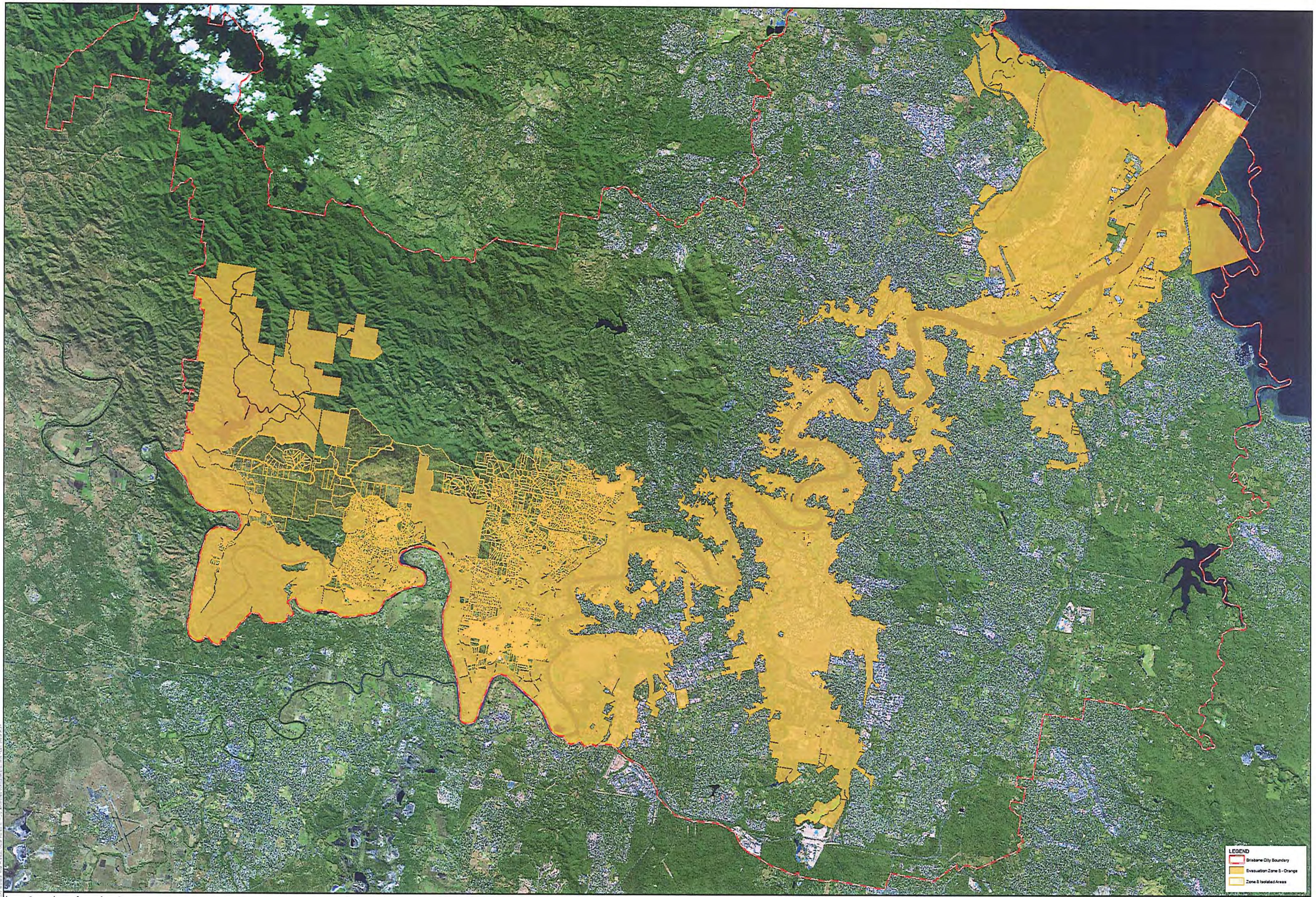


12,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone - East

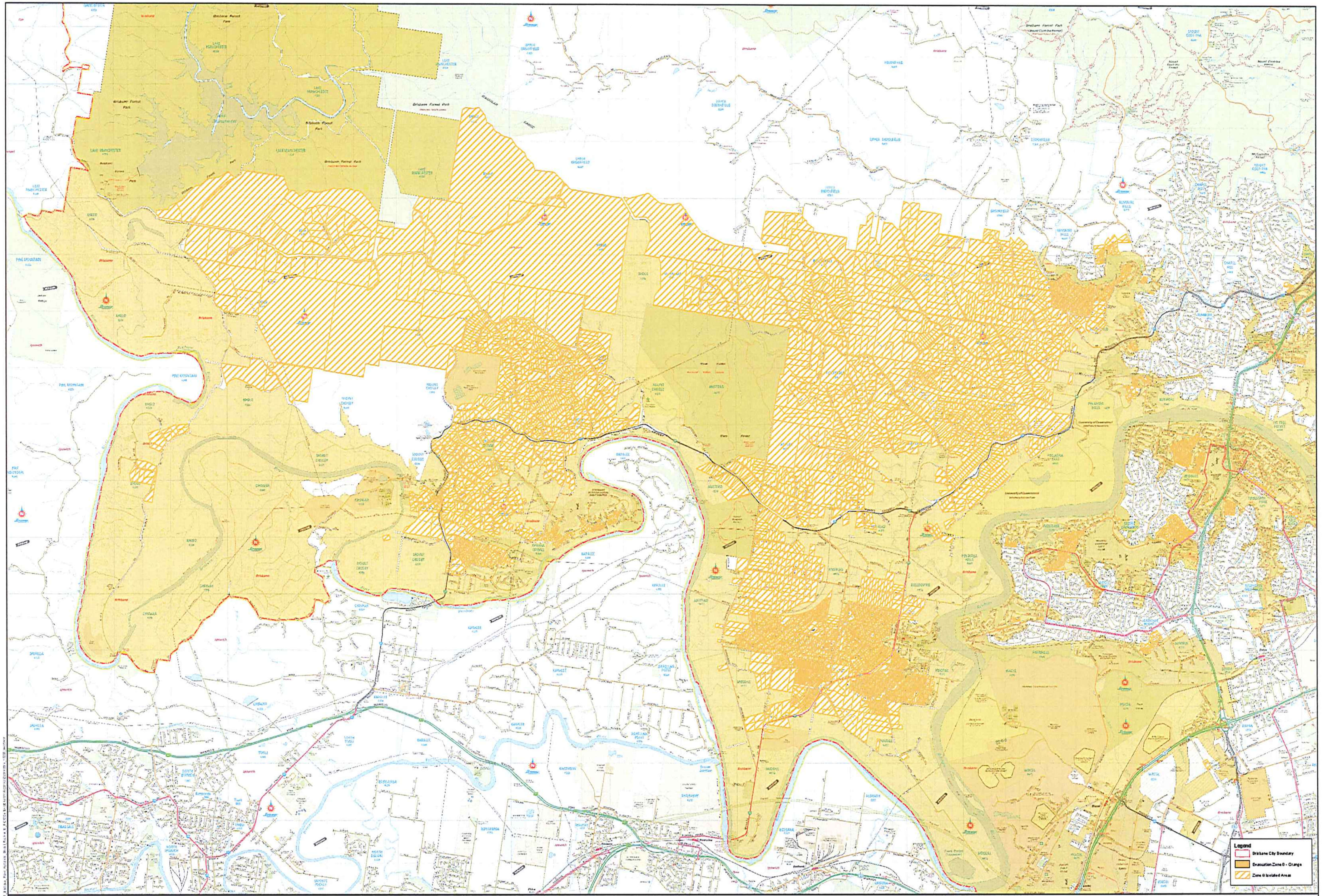
Figure 172

080547 Brisbane River Hydraulic Model to PMF



15,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone

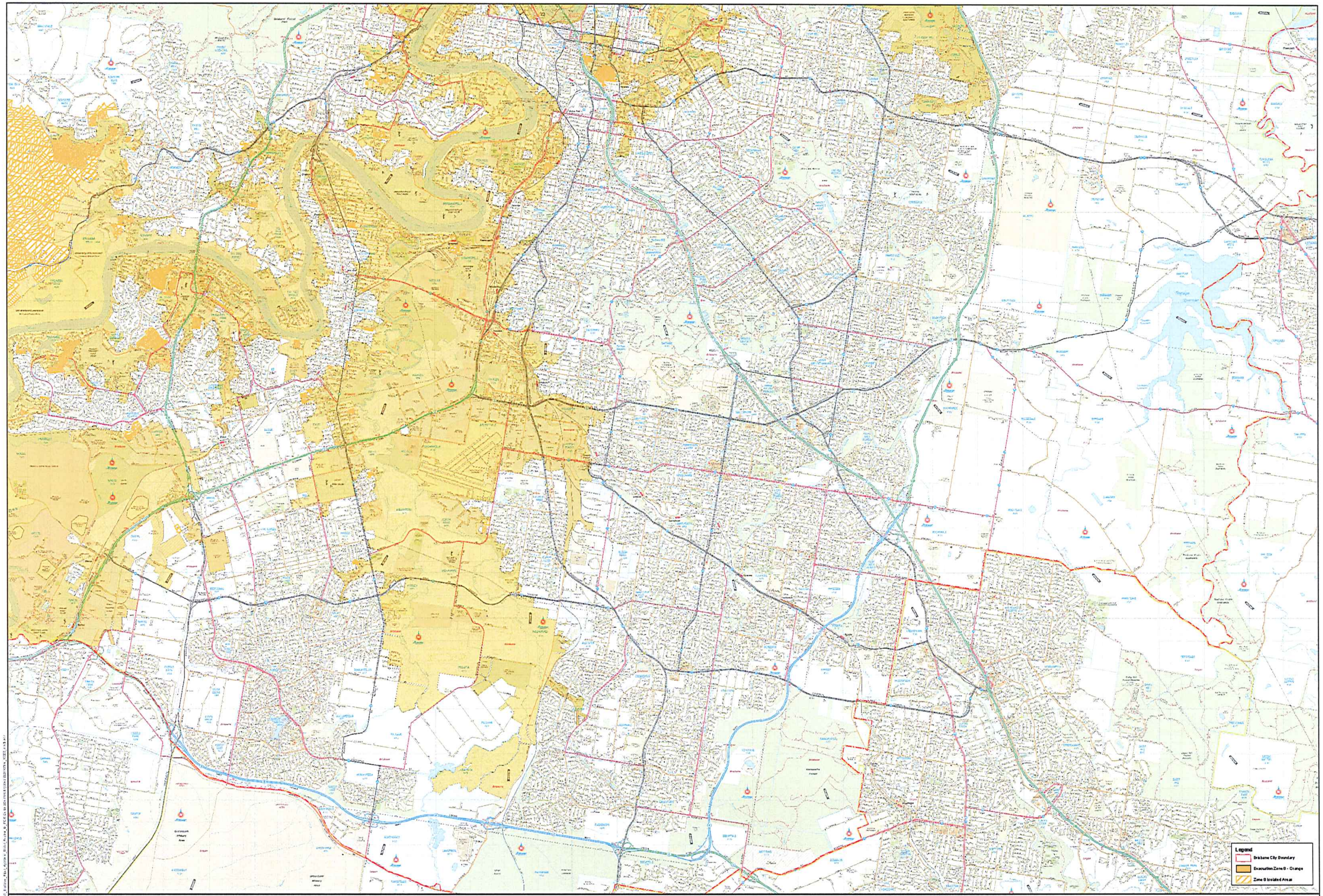
Figure 173



15,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone - West

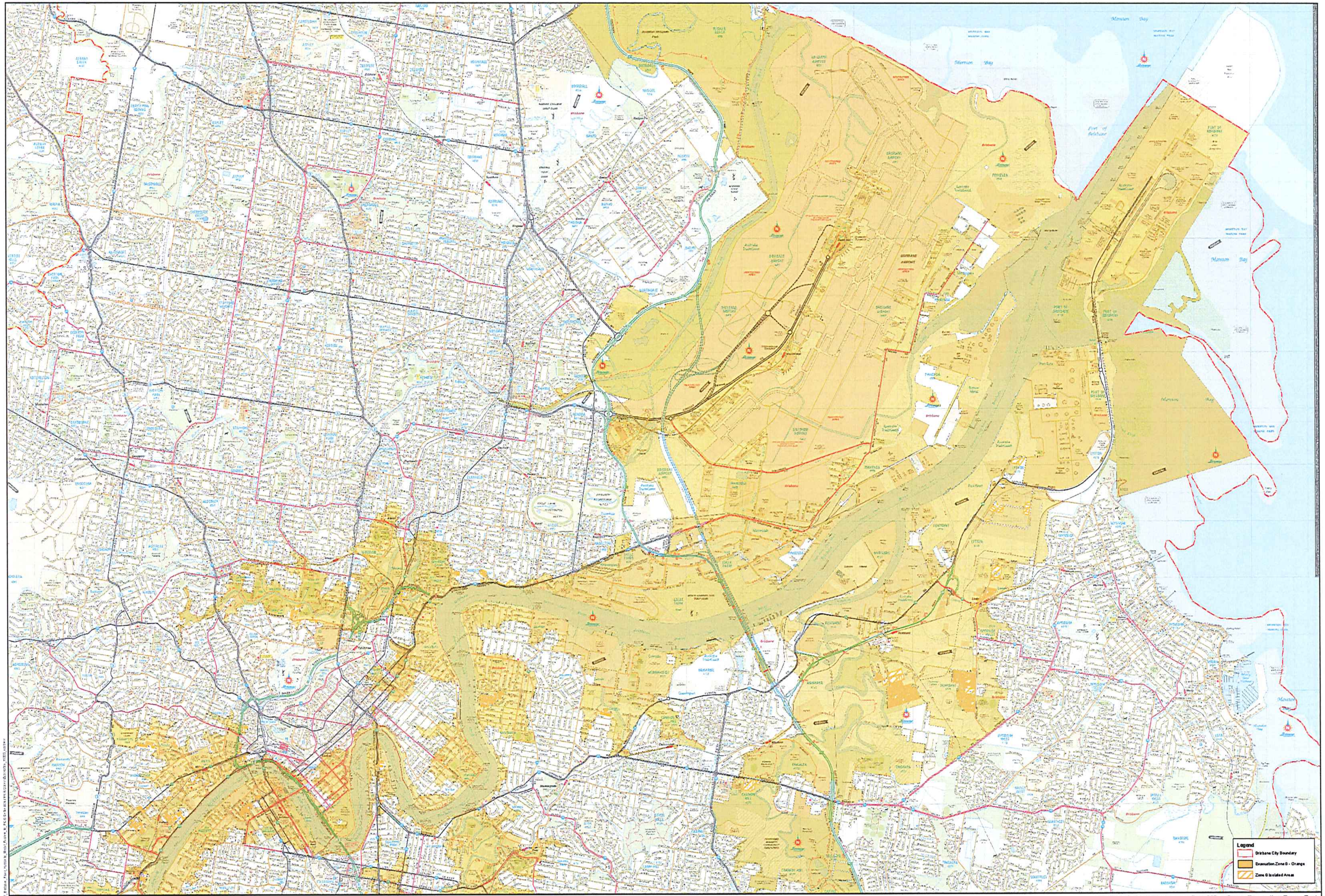
Figure 174

#CCJ2096538



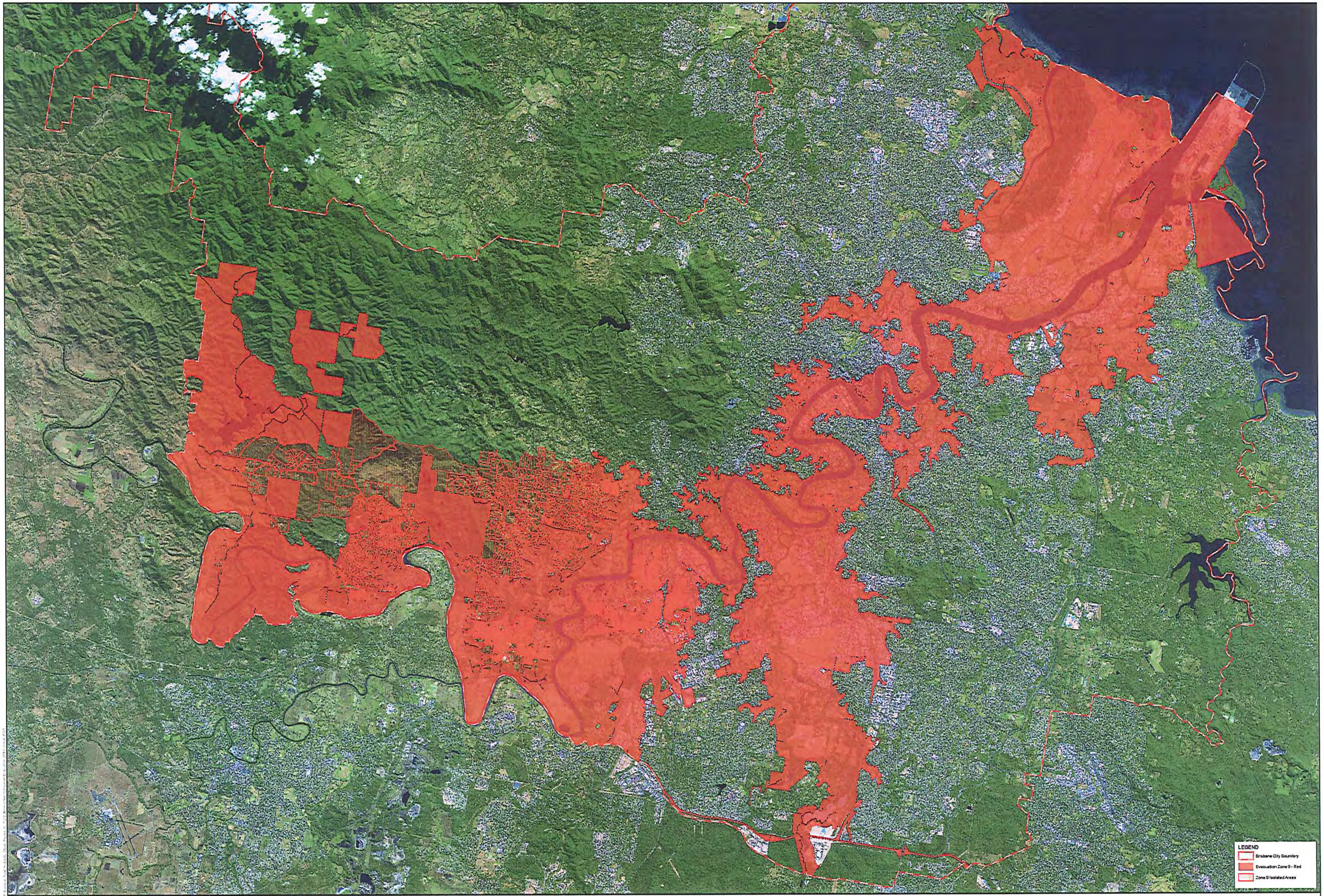
15,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone - South

Figure 175



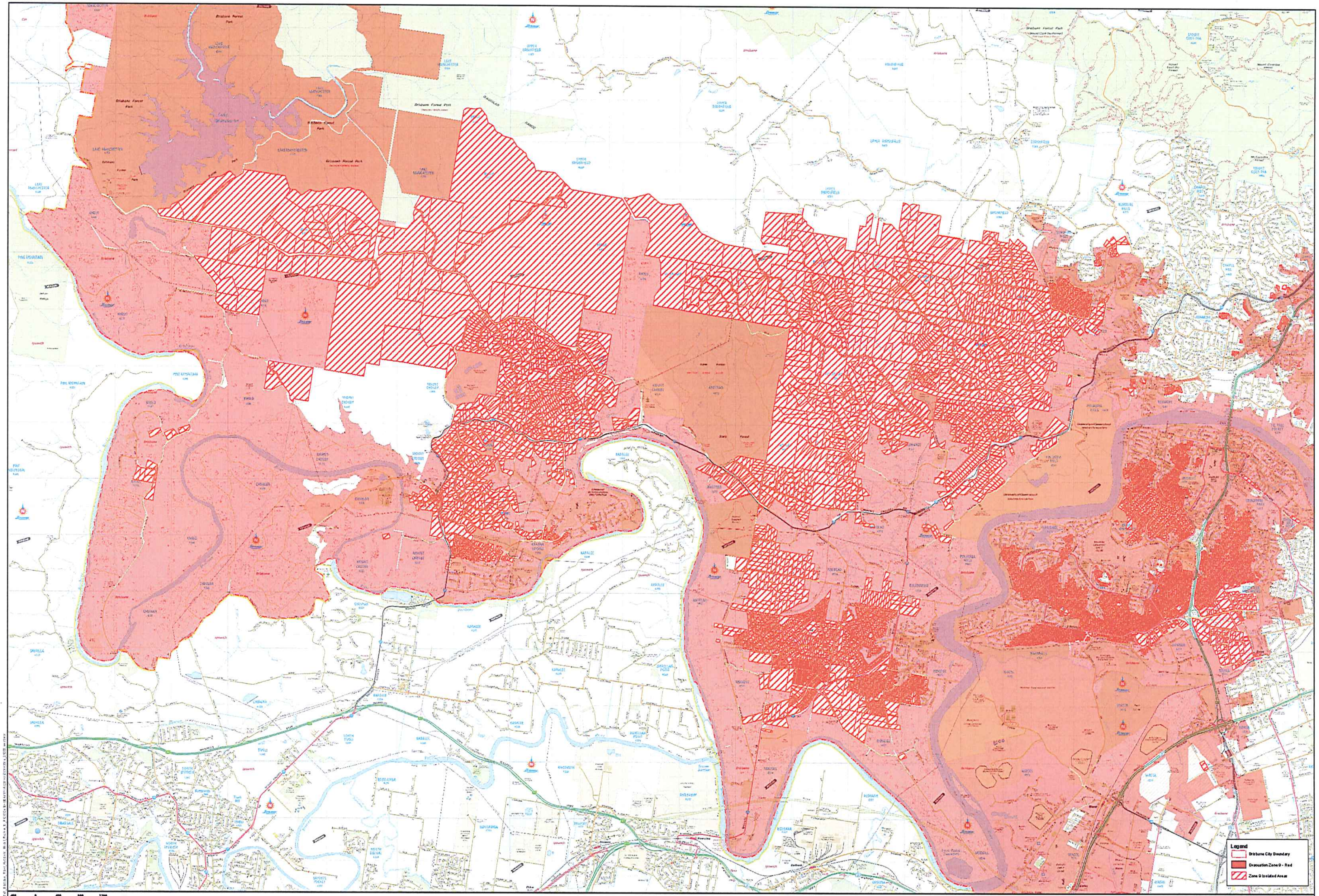
15,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone - East

Figure 176



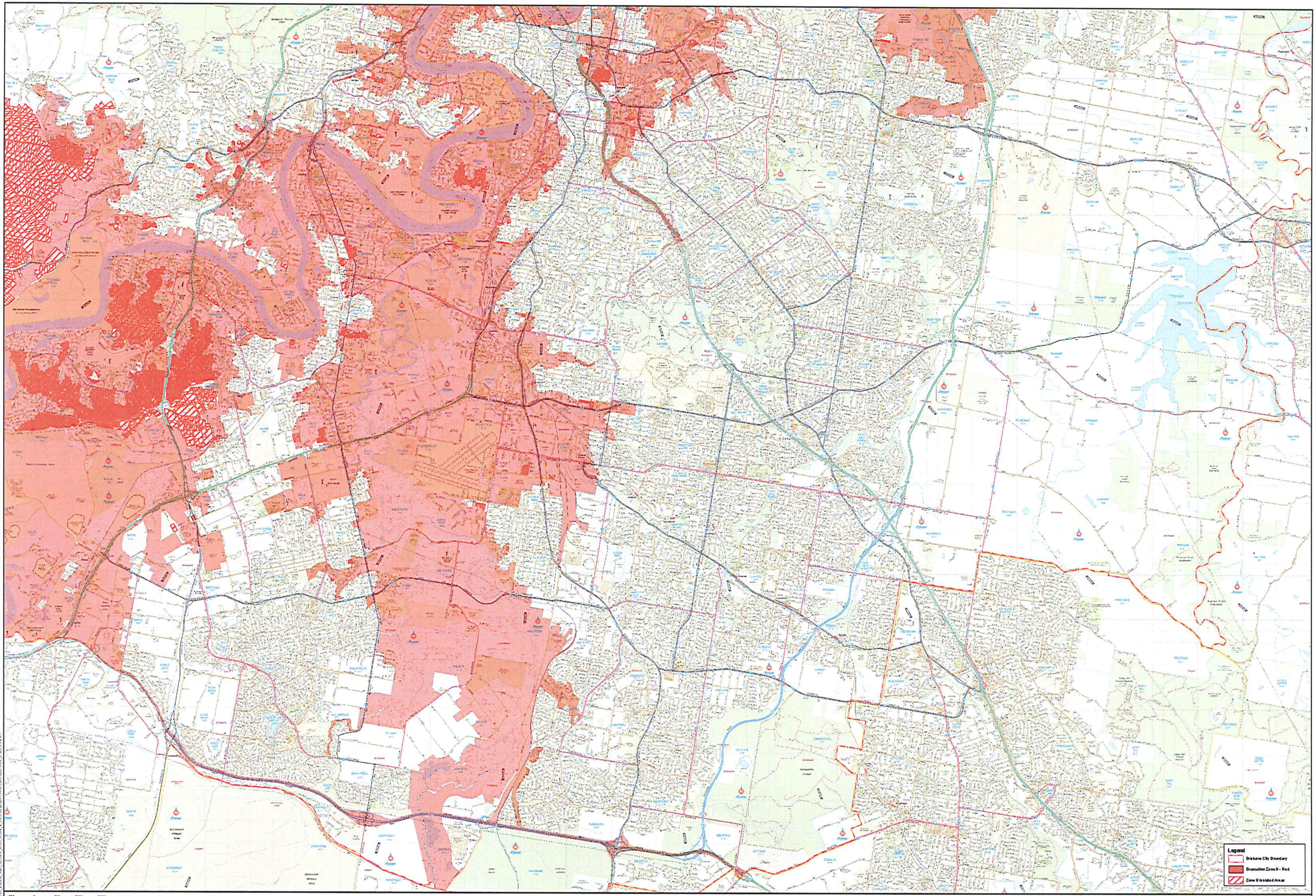
21,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone

Figure 177



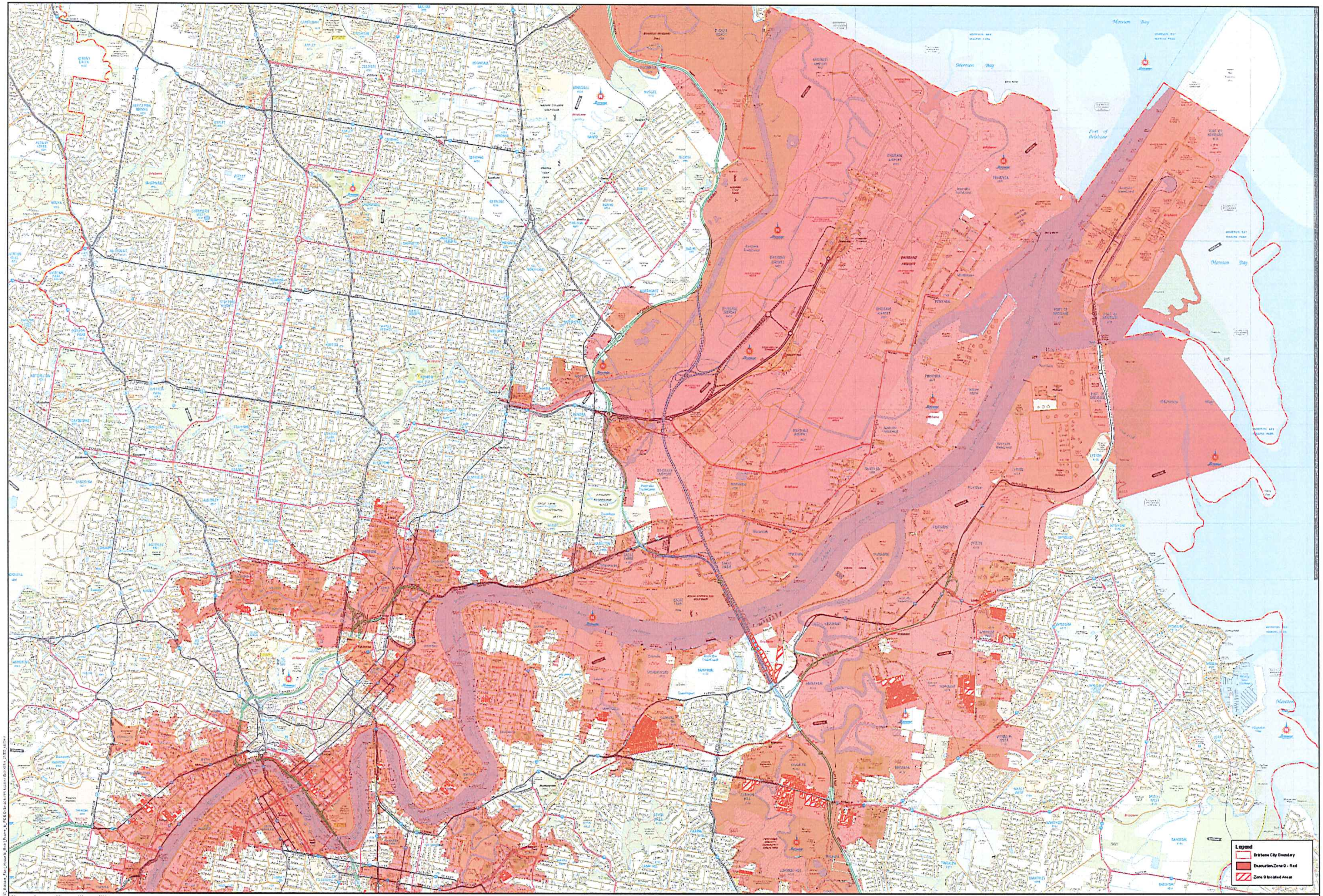
21,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone - West

Figure 178



21,000 m^3/s Peak Discharge at Port Office Gauge Evacuation Zone - South

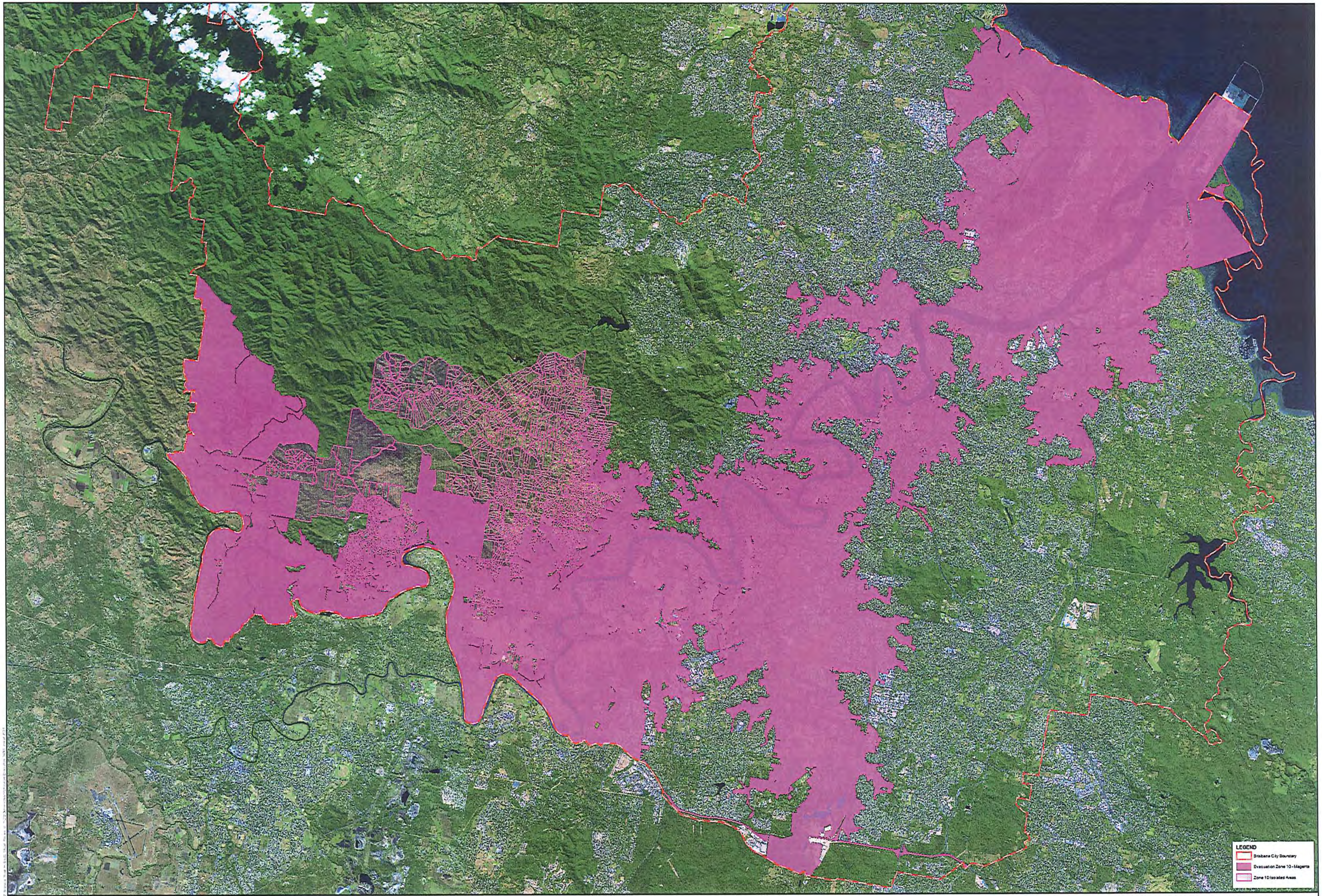
Figure 179



21,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone - East

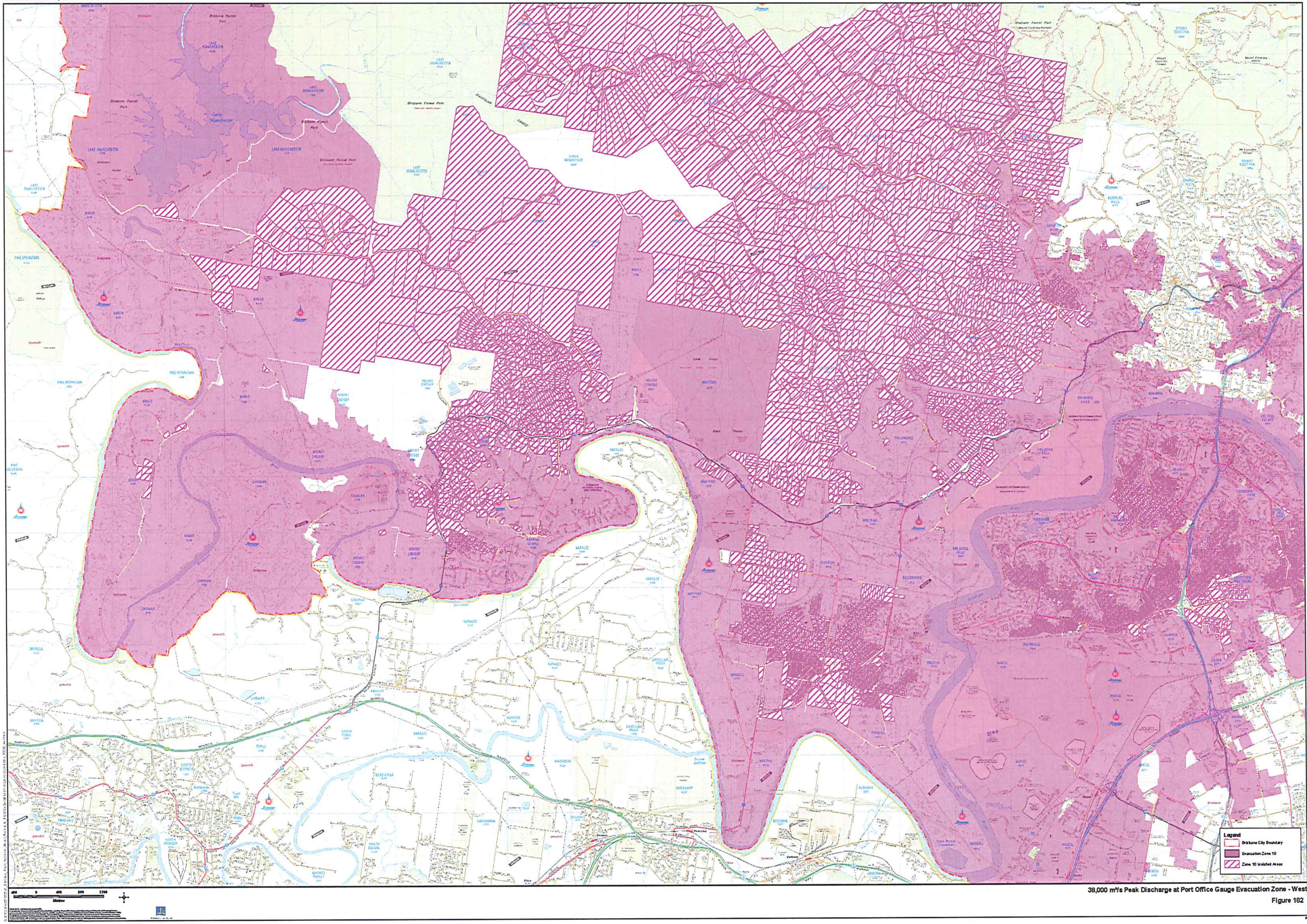
Figure 180

080547 Brisbane River Hydraulic Model to PMF



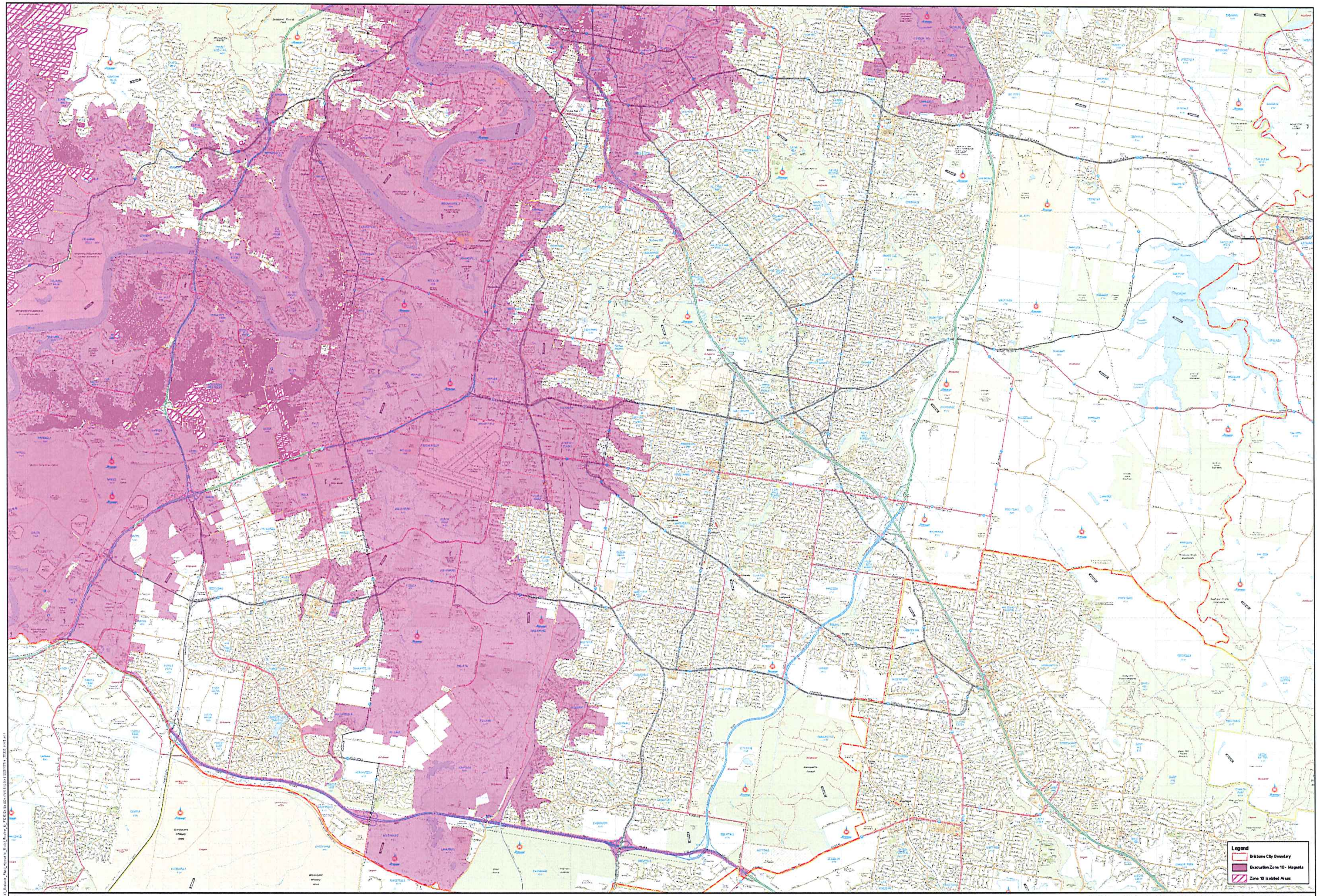
38,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone

Figure 181



38,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone - West

Figure 182

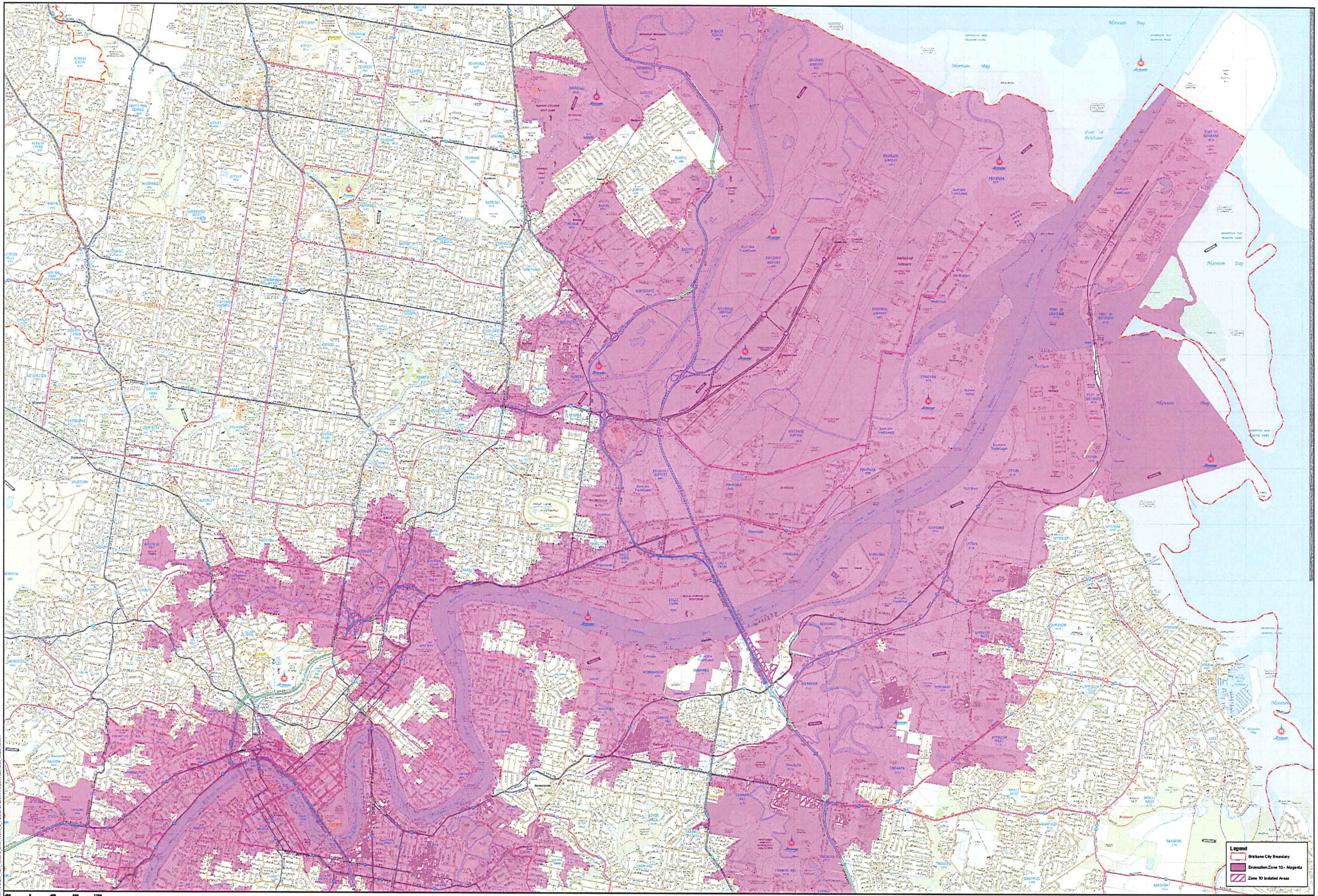


38,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone - South

Figure 183

#CCJ009.6547

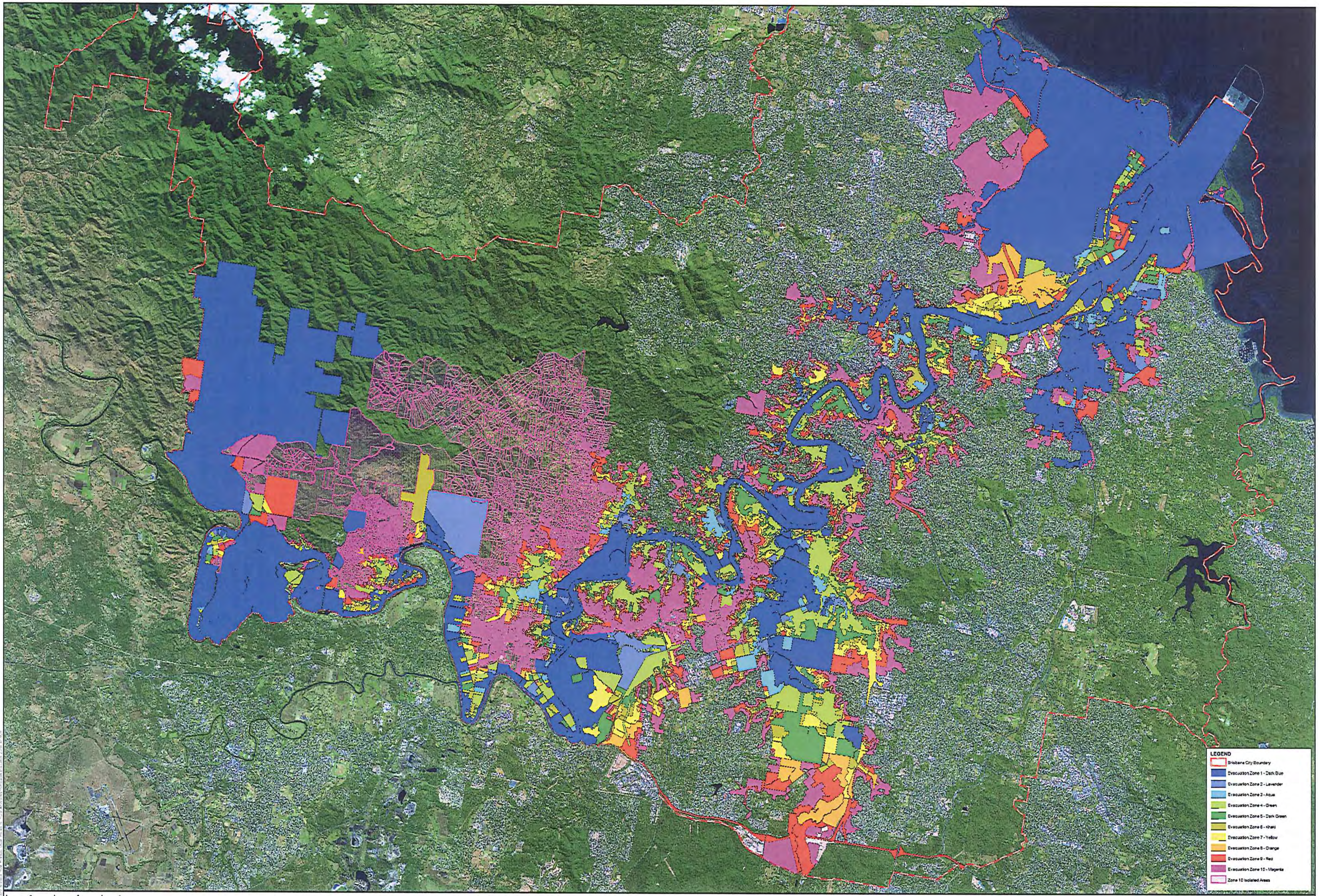
060547 Brisbane River Hydraulic Model Review to PMF



38,000 m³/s Peak Discharge at Port Office Gauge Evacuation Zone - East

Figure 184

080547 Brisbane River Hydraulic Model to PMF



All Evacuation Zones

Figure 185

activities that contribute to safer, sustainable communities better able to withstand the effects of natural disasters.

All three spheres of government provide funding under the NDMP (Natural Disaster Mitigation Program). Generally, the Australian Government contributes up to one third of approved project costs. State and Territory governments are required to match this funding. The individual funding contribution from each participating Local Government was calculated using current and future population projections to ensure an equitable distribution of project costs.

In February 2007, the Council submitted an application for funding under the Natural Disaster Mitigation Program (NDMP) 2007 – 2008 to the State Department of Emergency Services (DES) and the Commonwealth Department of Transport and Regional Services (DoTaRs) for the Brisbane River Hydraulic Model Review to Probable Maximum Flood (PMF) Project.

On 14 September 2007, Jude Munro, CEO, BCC, received written advice from the Hon Jim Lloyd MP, Minister for Local Government, Territories and Roads, that he had approved the application for Australian Government funding under the 2007-08 round of the NDMP. The Australian Government had approved $120,000 representing its third contribution to the overall Project cost of $360,000.

On 9 November 2007, Jude received written advice from Allan White, Director, Disaster Mitigation, Emergency Management Queensland (EMQ) from the Department of Emergency Services (DES) approving the State funding for the Project under the 2007-08 round of the NDMP. The total funding to be received by the State for the Project is $120,000.

On 15 January 2008, Jude received written advice from the DES that the Project Management Plan (PMP) had been approved and that the Funding Agreement was ready for her signature. On 30 January 2008, BCC executed the Funding Agreement and returned both signed copies to the DES for processing.

Appendix C Data

C1 Introduction

The data collection phase for this project was comprehensive and can be summarised as follows:

1. DTM Development
2. Hydrology Data
3. Recorded Data

Data was collected from various sources of government and across the private sector as follows:

Commonwealth:

- Bureau of Meteorology (BOM)
- CSIRO (Commonwealth Scientific and Industrial Research Organisation)

State Government:

- Department of Natural Resources and Water (DNRW)
- Port of Brisbane (POB)
- Sunwater
- Seqwater
- SEQ Catchments
- Maritime Safety Queensland

Local Government:

- Brisbane City Council (BCC)
- Ipswich (ICC)
- Somersert Regional Council (SRC)
- Logan City Council (LCC)

Private Sector:

- WRM Water and Environment P/L
- BMT WBM P/L

C2 Digital Terrain Model (DTM) Development

The collection of data and development of the DTM is a key task for this project. Data sources for the DTM include and are listed below and illustrated in Figure 3:

- Brisbane City Council – Airborne laser scanning (ALS) survey data (2002)
- Brisbane City Council – Brisbane River cross-sections (circa 1995)
- Ipswich City Council – ALS survey data (circa 2002)
- Port of Brisbane – Brisbane river channel bathymetry (1995-2009 depends on reach)

- Somerset Regional Council – ALS survey data 2008 undertaken for the Fernvale Lowood Flood Study (City Design, 2009)
- DNRW 5m Contours (circa 1980's)
- Port of Brisbane and BMT WBM P/L - Moreton Bay Data (chart data date unknown)
- NASA Shuttle Radar survey data (circa 2000)

The DTM has been developed on the best information available. Whilst every endeavour was made to construct a DTM representative of the river's bathymetry and floodplains, some areas have been identified as requiring a further improvement in accuracy. The Council expects to receive new ALS survey data in late 2009 that will be of a better vertical accuracy than the ALS data available for this study. Areas identified that would benefit from improved representation or will become available in the future include:

- Interpolation between bathymetry and ALS survey data sets in the inter-tidal zones
- Bathymetry of the Bremer River
- NASA Shuttle Radar (survey data extents are detailed in Figure 3)

Therefore it is highly recommended that the DTM and hydraulic model be updated upon receipt of this information.

The DTM was further analysed by 'sensitivity tests'. Refer to Section I9 for the results of these tests.

C3 Hydrology Data

1974 Calibration Event Data

The primary source of 1974 data was the 1994 Brisbane River and Pine Rivers Flood Study. These reports form part of the series of 27 reports produced for the South East Queensland Water Board (SEQWB) and are an integral part of this study. The reports utilised from this series include:

- Report 7A: Brisbane River Flood Hydrology
- Report 7B: Brisbane River Flood Hydrology
- Report 7C: Brisbane River Flood Hydrology
- Report 13: Brisbane River Flood Hydrology
- Report 19A: Brisbane River Flood Hydrology
- Report 19B: Brisbane River Flood Hydrology
- Report 23A: Brisbane River System Wivenhoe Dam – Moreton Bay Hydraulic Models
- Report 23B: Brisbane River System Wivenhoe Dam – Moreton Bay Hydraulic Models
- Report 23C: Brisbane River System Wivenhoe Dam – Moreton Bay Hydraulic Models
- Report 23D: Brisbane River System Wivenhoe Dam – Moreton Bay Hydraulic Models
- Report 23E: Brisbane River System Wivenhoe Dam – Moreton Bay Hydraulic Models

In addition to the above, digital or electronic information from the 1994 flood study was collected as follows:

- WT42D 'hydrology model' (hydrology model for the 1974 event)
- WT42D 'hydrology model' 1974 rainfall files
- 'Rubicon Flows' spreadsheet obtained from Sunwater (26 June 2008)
- RUBICON 'hydraulic model' cross-sections
- 1974 survey spots levels
- 1974 coverages or inundation extents
- 1974 rating curve data
- Discharge hydrograph and water level hydrograph spreadsheet

Additional reports specifically collected for the 1974 event also include:

- Proceedings of Symposium, January 1974 Flood Moreton Region, The Institution of Engineers, Australia, Queensland Division, August 1974.

- Brisbane River Flood Investigations Final Report, Snowy Mountains Engineering Corporation November 1975.

1996 Calibration Event Data

The May 1996 flood event was utilised as a 'verification' event for this study. In contrast to the 1974 event where there was quite a collection of existing data and previous hydrology works undertaken, this was not the case for the 1996 event. Consequently a significant data collection and rainfall analysis exercise was required for this event.

Rainfall data was collected primarily from State and Commonwealth government agencies. The primary source of 1996 rainfall data was made available by the BOM for use in their URBS rainfall-runoff models for the Flood Warning Centre (FWC). This rainfall data formed the basis of a spatial analysis downstream of the Wivenhoe Dam supplemented where necessary with the Council's rainfall station records.

Since there was essentially no discharge from Wivenhoe Dam during the 1996 event (10 m^3/s), the contribution of rainfall falling upstream of the dam was ignored and collation of rainfall data was limited to downstream of the dam. This rainfall data was then spatially located so that a Thiessen (Voronoi) polygon analysis could be undertaken. Thiessen (Voronoi) polygons define individual areas of influence around each of a set of points (rainfall stations). They are mathematically defined by the perpendicular bisectors of the lines between all points.

In addition to the above, further 1996 event data was collected as follows:

- Miscellaneous data for the 1996 event from DNRW
- 1996 survey spots levels from DNRW
- 1996 BOM May 1996 Report

C4 Additional Data

In addition to the event-specific information for the 1996 and 1974 flood events, data was collected from a number of different sources to allow hydrologic and hydraulic modelling to be undertaken. This includes:

- Gauge location and gauge zero data from:
  - BOM - Index of Queensland River Height Stations: (http://www.bom.gov.au/hydro/flood/qld/networks/section3.shtml)
  - BOM - Queensland and Flood Warning River Height Stations- survey details (http://www.bom.gov.au/hydro/flood/qld/networks/section6.shtml)
  - DRNW - Queensland and Flood Warning River Height Stations- survey details (http://www.nrw.qld.gov.au/watershed/precomp/nf_tsi/143_bris.htm)
- Brisbane River Extreme Flood Estimation Study by WRM Water and Environment P/L, 2007 for the development of the Flood Profile Series
- ICC Reports
  - Ipswich Rivers Flood Studies – Phase One and Phase Two, 2007
  - Ipswich River Flood Studies – Phase Three Report, 2002.
  - Ipswich River Flood Study Rationalisation Project – Phase Three Report 2006.

Appendix D History of Brisbane River 1D Models

D1 1996-2000

Sinclair Knight Merz (SKM) originally developed the 1D MIKE11 model which was completed in 1998 as a component of the Brisbane River Flood Study. SKM subsequently extended the model in 2000 for the Ipswich Rivers Flood Study to include the lower reaches of the Bremer River and tributaries referred to as the Ipswich Rivers. The work was undertaken for Ipswich City Council (ICC).

During the study, many additional rivers and creeks were added to the hydraulic model. This model is referred to as the Ipswich Rivers model. These additional rivers/creeks changed the Brisbane River routing characteristics and as a consequence the model needed to be re-calibrated. Re-calibration was only performed within the Ipswich City Council boundary.

D2 2003-2004

Further work was required to re-calibrate the Ipswich Rivers model within the Brisbane City boundary. This work was undertaken in the later half of 2003 and completed in February 2004 and included input from an Expert Panel of Review (EPR) with in regard to the hydrology. The 1974 and 1955 flood events were used to calibrate the hydraulic model. These events were chosen because they provided an adequate calibration range so that the 1 in 100 year design event (estimated to be 6,000m^3/s) could be accurately modelled.

The EPR works constitute the latest calibrated 1D model for lower Brisbane River. This 2004 calibrated model of the Brisbane River is referred to as the 'SKM model'. It is calibrated to a maximum discharge of approximately 10,000 m^3/s corresponding to the 1974 flood event.

D3 2004-2005

In 2004, 2005 the Ipswich Rivers model was extended further by the Wivenhoe Alliance as part of the Wivenhoe Spillway Augmentation Study. The additional works included extending cross-sections and providing link branches in the lower reaches of the model. The primary focus of this work was the design of the dam with respect to the augmentation of the existing spillway to cater for the new discharge estimate of the PMF (Probable Maximum Flood) and its anticipated impact on downstream flood levels.

The Wivenhoe Alliance model represents the latest changes undertaken to the model, however the model is not calibrated nor the results verified against previous model results. The development of the Wivenhoe model occurred in stages by various organisations and has resulted in a range of alternative modelling techniques being adopted throughout the model. This has progressively contributed to a number of stability issues occurring within the model and the progressive reduction of the model time step in order to maintain numerical stability.

D4 Summary

As discussed in Sections D1-D3, the current Brisbane River hydraulic model is a one-dimensional (1D) MIKE11 model used for floodplain management purposes. This 1D model is only calibrated up to a maximum discharge of approximately 10,000m^3/s (1974 historical event) at the city gauge.

Due to the inherent characteristics of the 1D model (through its use of cross-sections) the modelling of extreme floods is not possible. This is because the schematisation of 1D flood model does not easily represent overland flow otherwise known as 'channel breakouts'. Furthermore the accuracy of these 'channel breakouts' (illustrated in Figure 4) if schematised using a 1D model can be questionable as they rely on the hydraulic modeller's interpretation of flood behaviour in the river.

Appendix E Scoping Exercise and Model Appraisal

E1 Introduction

Advances in computer technology primarily relating to speed of the 'microprocessor' otherwise known as the central processing unit (CPU) have allowed the conceptualisation of this project. Ten years ago it would not have been possible to develop a 2D 'mega' model for Brisbane River, however with the improvements in the CPU technology it is now possible.

Accordingly one of the first tasks of this project was to appraise the available modelling software and determine a suitable modelling platform. So in early 2008 a scoping exercise was undertaken. Two software packages were evaluated:

- MIKE21 (Council's existing 2D modelling platform)
- TUFLOW

In order to evaluate the software a 'test' model was developed. This involved developing a coarse digital terrain model (DTM) approximating the study area as defined in Section 9.0.

E2 MIKE21 'Test' Model

A MIKE21 'test' model was developed. The study area was not as large as that defined in Section 9.0. The MIKE21 model consisted of a 67.7 km (Easting length) by 38.4 km (Northing length). This represented a model calculation area of approximately 2600 square kilometres

The model set-up was as follows:

- PMF simulation
- 120 hr simulation time
- time-steps:
  - 1 second for 45m grid
  - 2 seconds for 90m grid
- 'tapered' boundaries were adopted at the top and bottom ends
- 'top-end' inflow and tailwater boundary conditions only
- constant Manning's n roughness and eddy viscosity were adopted for the model.
- model extents were limited to Teneriffe in order to provide a 'constrictive termination' (and therefore explaining the smaller study area extents)

E3 TUFLOW 'Test' Model

A TUFLOW 'test' model was also developed. The study area was as per that defined in Section 9.0. being an area approximately 83.4 km (Easting length) by 53.8 km (Northing length). The area used for model calculation purposes is 1800 square kilometres based on the approximate PMF inundation extents. In comparison to MIKE21 this is a 30% reduction in model calculation area.

The model set-up was as follows:

- PMF simulation
- 150 hr simulation time
- time-steps:
    - 15 seconds for 45m grid
    - 20 seconds for 90m grid
- 'top-end' inflow and tailwater boundary conditions only
- constant Manning's n roughness were adopted for the model.
- model extends to Moreton Bay

The 30% reduction in the TUFLOW model calculation area (when compared to MIKE21) is counterbalanced by the 25% increase in simulation runtime. Therefore for comparative purposes an equivalent assessment has been achieved.

E4 CPU Time

The CPU processing time results of the 'test' models are presented in Table 5. The results indicated that TUFLOW is between 3-6 times faster than MIKE21 depending upon the grid resolution.

Table 5: Model CPU Processing Time

	CPU Processing Time (hrs)	
	MIKE21 (2600 km^2) (model simulation time: 120 hrs)	**TUFLOW (1800 km^2) (model simulation time: 150 hrs)**
90m grid	9.1	2.7
45m grid	93.8	14.7

E5 Assessment Criteria

The criteria for evaluation of the software for the scoping study included (detailed in Table 6):

- Model stability and speed
- Boundary set-up and stability
- Model flexibility and structures
- Availability of technical support
- Industry acceptance

Table 6: Comparison of MIKE21 and TUFLOW Software – Scoping Study Results

Criteria	Objective Assessment (Ranking 1-10)	
	MIKE21	TUFLOW
1. Model stability and speed	5	8
2. Boundary set-up and stability	5	8
3. Model flexibility and structures	6	8
4. Availability of technical support	8	8
5. Industry acceptance	8	8
Total	32	40

E6 Outcome

The development of a 2D 'mega' model for the Brisbane River required a scoping exercise and development of a 'test' model to appraise the available modelling platforms.

It was found that the TUFLOW model provided a superior processing speed and model stability when compared to MIKE21. In addition TUFLOW offered greater flexibility with regard to boundary set-up/definition and multiple 2D domains and structures.

As a result, after evaluating the best software available on the market in an objective manner, the outcome of the scoping study was that TUFLOW offered the superior modelling platform for this project.

Appendix F Hydraulic Model Development

F1 Introduction

The initial development of the TUFLOW 2D hydraulic model involved:

- DTM development - evaluation and confirmation of available data sources
- Set-up of model area (active cells for model calculation)
- Set-up of boundary conditions (refer to Section F5)
- Base Manning's 'n' values (TUFLOW materials file)
- Additional base case items:
  - Set-up of arterial roads (BCC area only to allow extreme flood passage)
  - Set-up of arterial railways (BCC area only to allow extreme flood passage)
  - Set-up of 1D culverts layer in relation to items 5 and 6 above
  - Set-up of Central Business District (CBD) bridge structures

F2 DTM Development

The DTM development is covered in Appendix C.

F3 Grid Size

The initial development of the 2D TUFLOW model was undertaken primarily using 90m and 45m grids. Final model simulations used for the flood profiles series were undertaken using a 30m grid.

F4 Model Area

The model area (1700 km^2) used for calculation purposes is illustrated in Figure 5.

F5 Boundary Conditions

The boundary conditions for the hydraulic are categorised as follows:

1. Primary inflow boundary and tidal boundary conditions
2. 2D Source over Areas (otherwise referred to as SA's) or lateral inflows

Primary Inflows and Tidal Boundary Conditions

There are (6) six primary inflows and one (1) tidal boundary condition respectively in the model. These are illustrated in Figure 6 as inflow 'polylines' (mapinfo layer)

Table 7: Boundary Conditions

Primary Inflows and Tidal Inflow Boundary Condition (number)	
Upper Brisbane River	Wivenhoe or Middle Creek (for historical events before 1983) inflow (1)
Lockyer Creek	Lyons inflow (1)
Bremer River	Walloon, Amberley and Purga inflows (3)
Tidal	Bar (1)

The boundary conditions detailed in Table 7 above remain unchanged in number and location for both the calibration and design hydrology.

2D Source over Areas (SA's) - Lateral Inflows

The 2D SA's are TUFLOW layers defining the polygons of sub-catchment areas for applying a source (flow) directly onto 2D domains. The 2D SA's are based on the Brisbane River and Pine Rivers Study (1994) with minor modifications reflecting improvements in sub-catchment definition based on the latest survey information.

Refer to Table 8. Figure 7 and Figure 8 illustrate the calibration model and flood profile model SA's respectively.

Table 8: 2D Source over Areas – Lateral Inflows

Calibration Model (Sub-catchment level)		**Flood Profile Model (Sub-region level)**
1.SPR: Spring Creek 2.BUA: Buaraba Creek 3. PLA: Plain Creek 4. LOW: Lower Lockyer 5.VER: Vernor 6.ENG: New England Creek 7. BAN: Banks Creek 8.BLA: Black Snake Creek 9. SAN: Sandy Creek 10. CAB: Cabbage Tree Creek (Lake Manchester) 11. UPM: Upper Mt Crosby 12.DEE: Deebing Creek 13.BUN: Bundamba Creek 14.WUL: Wulkaraka Creek 15. IRO: Ironpot Creek	16. MIH; Mihi Creek 17.KAD: Karana Downs 18. KAR: Karalee 19. SIX; Six Mile Creek 20.WOO; Woogaroo Creek 21. WOL: Wolston Creek 22. PUL; Pullen Pullen Creek 23. MOG: Moggill Creek 24.OXL: Oxley Creek 25. CUB: Cubberla Creek 26. TOO: Toowong Creek 27. ENO: Enoggera Creek 28. BUL: Bulimba Creek 29.NR1: Norman Creek Sub-area #1 30.NR2: Norman Creek Sub-area #2 31.NR3: Norman Creek Sub-area #3	1.Savages 2.MtCrosby 3.Ipswich 4.Jindalee 5.PortOfficeGauge 6.Enoggera 7.Bulimba 8.Norman

F6 Manning's 'n' Values

Landcover data from SEQ Catchments was utilised to assign Manning's 'n' values and create a 'materials file' or roughness map in TUFLOW.

The landuse categories from this data set and associated Manning's 'n' value are detailed in Table 9.

Table 9: SEQ Catchments Landcover Data - Landuse Categories June 2008

SEQ Catchments – Landcover Data Categories	Adopted Manning's 'n' Values
1. Non-forest native vegetation	0.08
2. Non BUA- Non-vegetated	0.03
3. Grass	0.03
4.Sand / Mud Bank	0.025
5. Plantation	0.10
6. Water Body	0.025
7. Non Built Up Area (BUA)-Impervious road surface	0.02
8. Tree Crop	0.10
9. Native Forest	0.12
10. Ocean	0.02
11.Mine/Quarry	0.05
12. Irrigated Crop and Pasture	0.08
13. BUA - Non-vegetated	0.10
14. BUA - Impervious road surface	0.02
15. Canal	0.02
16. Natural Rock/Cliff	0.06
17.Dryland Crop	0.08
18. Blank	0.03

F7 Bridges

Only six (6) CBD bridge structures have been represented in the model to date; the reason being that the primary focus of this project is the development of maps for flood disaster and emergency response planning.

Accordingly the intent of this study was to use readily available data. Therefore bridge representation in the 2D model was limited to the CBD reach, aligning with the ***Northbank Flood Impact Analysis (NFIA) and Property Flood Damages Analysis (PFDA)*** undertaken in 2008.

In order to create a rigorous 'flood study' model of SEQ, it is then recommended that all major bridge structures are included in the model in the future. Such work is beyond the scope of this study.

Table 10 lists the CBD bridges 'coded' into TUFLOW for the calibration and flood profile model.

Table 10: Central Business District (CBD) Bridges

Bridge	Included in Calibration Model (1974 and 1996)	Included in Flood Profile Model
1. Merivale Bridge	Yes	Yes
2. William Jolly Bridge	Yes	Yes
3. Victoria Bridge	Yes	Yes
4. Goodwill Bridge	No (circa 2001)	Yes
5. Captain Cook Bridge	Yes	Yes
6. Story Bridge	Yes	Yes

In addition to the Northbank (2008) study, Table 11 contains details of 'as constructed drawings' and other data that was also used to code the bridges.

Table 11: As Constructed Drawings

Bridge	As Constructed Drawings and Other Data
1.Merivale Bridge	W5601
2.William Jolly Bridge	General Arrangement Drawings
3.Victoria Bridge	117888
4.Goodwill Bridge	Arup Memorandum and Drawings – dated 1999
5.Captain Cook Bridge	117408
6. Story Bridge	General Elevation Plan – 1935

Appendix G WT42D

G1 Overview

The computer program WT42D was written in September 1987 by Warren Shallcross, Surface Water Group, Water Resources Division. The program was written in Fortran on a Univac 1192 computer at the Centre for Information Technology and Communications (CITEC).

The object of the program is to simulate the non-linear runoff-routing model for flood estimation described by Mein, Laurenson and McMahon (1974). Program WT42 produces similar results to program WT87 although the internal setup is quite different. Further information can be found in the manual entitled:

Queensland Water Resources Commission
Water Resources Division
Surface Water
Hydrology Section

Computer Program WT42
Flood Estimation by Runoff Routing
Water Assessment Natural Resources and Mines
November 1987

Appendix H 1974 Historical Event – Base Data

H1 Introduction

The basis of the 1974 hydrology used in this study is the ***Brisbane and Pine Rivers Flood Study*** (1994). Therefore the objective for this study was to adopt or reproduce the 1974 hydrology from the 1994 study. This is because a significant amount of work had been undertaken in 1994 on this event.

Initially it was hoped that the boundary conditions for the 1974 event could be traced to a spreadsheet and that these could be simply input into the 2D TUFLOW hydraulic model.

H2 'RubiconFlows' Spreadsheet

A spreadsheet was located in June 26, 2008 by the State and provided to City Design. It was called 'RubiconFlows' (Note: 'Rubicon' was the hydraulic model used in the 1994 flood study.) At that point in time the 'RubiconFlows' spreadsheet was assumed to be the basis of the 'calibration hydrology' for the 1994 flood study. It contained the following events (boundary conditions for 1994 Rubicon hydraulic model)

- February 1893
- July 1973
- January 1974
- April 'A' 1989
- April 'B' 1989

Closer inspection of the 'January 1974' event data contained within the 'RubiconFlows' spreadsheet indicated that of the required 37 boundary conditions (refer to Appendix F, Section F5 for a complete listing), only 31 were available with six missing. The six (6) missing 1974 boundary conditions included:

1. Wivenhoe
2. Lyons
3. Buaraba
4. Norman Creek sub-catchment 1
5. Norman Creek sub-catchment 2
6. Norman Creek sub-catchment 3

These were critical and therefore it was necessary to rerun the WT42D model to reproduce the missing boundary conditions.

H3 WT42D 1974 Calibration Model

Further data collection exercises were undertaken on the 22 September 2008 and 9 October 2008 with the State providing City Design with a working WT42D model and associated data for the 1974 event.

The 'original' WT42D 1974 calibration model consisted of the following:

- batch file
- river catchment files 'rcf' and
- rainfall files (*.J74) - referring to January 1974.

Table 12: WT42D 1974 Batch File

	1974 RUN.BAT						
Executable	**River Catchment File**	**Rainfall**	**Delay Time**	**Storage Index**	**Initial Loss**	**Continuing Loss**	**Output Hydrograph**
WT42D	COO.RCF (Cooyar)	COO.J74	43.6	0.8	0	2.7	COO.HYD
WT42D	LIN.RCF (Linville)	LIN.J74	20.6	0.8	30	5.6	LIN.HYD
WT42D	EMU.RCF (Emu)	EMU.J74	37.2	0.8	5	3.5	EMU.HYD
WT42D	GRE.RCF (Gregors)	GRE.J74	20.1	0.8	10	0.1	GRE.HYD
WT42D	CRE.RCF (Cresbook)	CRE.J74	34.3	0.8	0	4	CRE.HYD
WT42D	SOM.RCF (Somerset)	SOM.J74	80.7	0.8	0	0.2	SOM.HYD
WT42D	MID.RCF (Middle)	MID.J74	108.5	0.8	0	5.2	MID.HYD
WT42D	HEL.RCF (Helidon)	HEL.J74	15	0.8	0	2.5	HEL.HYD
WT42D	TEN.RCF (Tenthill)	TEN.J74	19	0.8	0	2.5	TEN.HYD
WT42D	LYO.RCF (Lyons)	LYO.J74	75	0.8	0	2.5	LYO.HYD
WT42D	WAL.RCF (Walloon)	WAL.J74	44	0.8	0	2.5	WAL.HYD
WT42D	KAL.RCF (Kalbar)	KAL.J74	34	0.8	65	2.6	KAL.HYD
WT42D	AMB.RCF (Amberley)	AMB.J74	35	0.8	65	2.6	AMB.HYD
WT42D	PUR.RCF (Purga)	PUR.J74	49	0.8	30	2.1	PUR.HYD
WT42D	IPS.RCF (Ipswich)	IPS.J74	15.7	0.8	10	2	IPS.HYD
WT42D	SAV.RCF (Savages)	SAV.J74	45	0.8	20	3.5	SAV.HYD
WT42D	MTC.RCF (Mt Crosby)	MTC.J74	47	0.8	0	2.5	MTC.HYD
WT42D	JIN.RCF (Jindalee)	JIN.J74	20.8	0.8	10	2.6	JIN.HYD
WT42D	POG.RCF (Port Office Gauge)	POG.J74	19.3	0.8	10	2	POG.HYD

A review of the river catchment files or 'rcf' files listed above, indicates the model has been set-up at a regional level illustrated in Figure 10. Therefore, it was necessary to modify a number of the river catchment files to produce the localised sub-catchment inflows for each of the 37 boundary conditions. Specifically this would require 'print statements' being added to the following river catchment files:

- SAV.RCF (Savages)
- MTC.RCF (Mt Crosby)
- IPS.RCF (Ipswich)
- JIN.RCF (Jindalee)
- POG.RCF (Port Office Gauge)

These river catchment files predominantly refer to locations in the lower Brisbane River catchment and align with the hydraulic model study area extents as displayed in Figure 10. In addition to the above works river catchment files needed to be created for:

- ENO.RCF (Enoggera)
- BUL.RCF (Bulimba)
- NRM.RCF (Norman)

This was because the provided WT42D 1974 model terminated at Port Office Gauge.

H4 WT42D 1974 Verification Process

To ensure the consistency of results with the original model provided, a verification process was undertaken by City Design. The verification process included:

- Comparison of local hydrograph inflows (peak and shape) to the 'RubiconFlows' spreadsheet
- Comparison of regional hydrographs (peak and shape)

The verification process above confirmed that the discretisation of the original model into local inflows or the 37 boundary conditions had been undertaken successfully. As this process was quite involved a region by region analysis was undertaken as listed below.

Table 13: WT42D 1974 – Verification Process

River Catchment File	Print Statements Added	Final Results Simulation	Original Peak (m^3/s)	Verification Peak (m^3/s)	Verification Output Hydrograph
SAV#1.RCF (Savages)	6	'Run2'	6362	6369	SAV#1.HYD
MTC#1.RCF (Mt Crosby)	5	'Run2'	7033	7045	MTC#1.HYD
IPS#3.RCF (Ipswich)	5	'Run4'	4188	4292	IPS#3.HYD
JIN#1.RCF (Jindalee)	7	'Run2'	8278	8312	JIN#1.HYD
POG#1.RCF (Port Office Gauge)	3	'Run1'	9495	9495	POG#1.HYD

The peak values from the verification process outlined in Table 13 illustrate that the 'print statement' changes to the original 'rcf' files have made little difference to the total hydrograph values. In any case the local inflows and not the total hydrographs detailed in Table 13 were input to the hydraulic model as boundary conditions. These local hydrographs were plotted against the original 'RubiconFlows' spreadsheet and were generally verified as being a correct match or in the right order of magnitude.

In summary the checking process detailed above has provided suitable inputs for the purposes of this 1974 calibration exercise. Further details of this verification process (including local hydrograph graphical and peak comparisons) can be found in the project directory itself and extend beyond the scope of this report. The spreadsheet is located under the WT42D directory and is named: 'RubiconFlows_SW26June2008_WT42DRerunComparison'. Refer to Figure 11 for the directory layout.

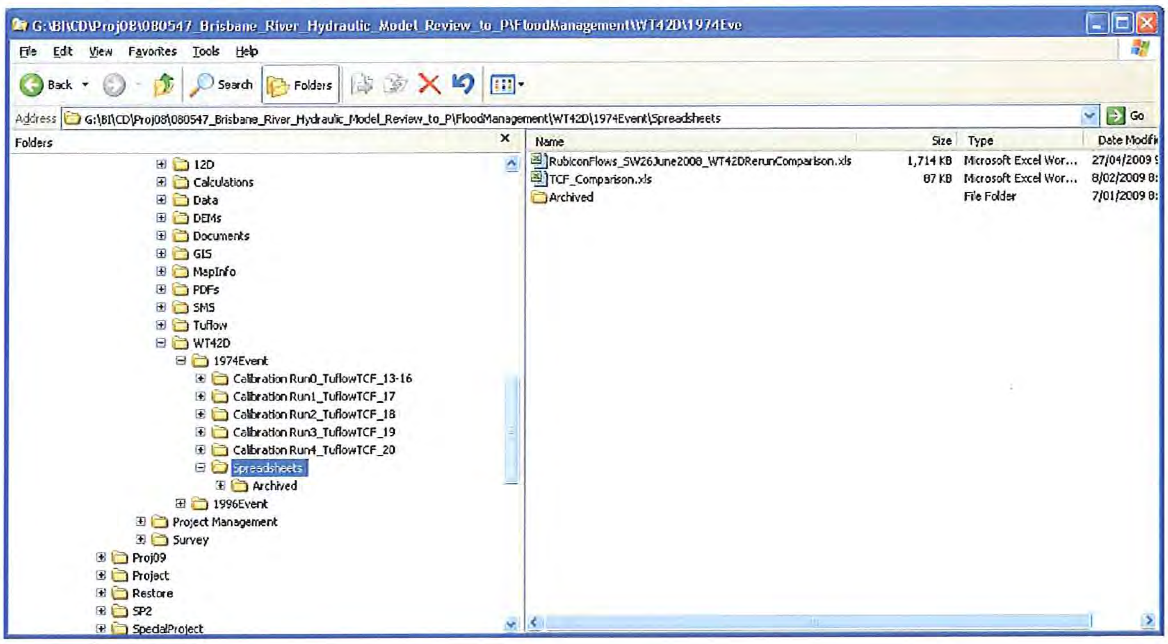


Figure 11: 'RubiconFlows' Spreadsheet Location

H5 Review of 1974 Primary Inflows

Once the verification process had been completed, a review of the primary inflows was undertaken as part of improving the model calibration. The primary inflows have been identified previously in Table 7 and comprise:

- Wivenhoe (Middle Creek)
- Lyons
- Walloon, Amberley and Purga

The review process above indicated that calculated inflows from the WT42D model had not been adopted in the 'RubiconFlows' spreadsheet. Instead it was determined that recorded or actual inflow hydrographs (*.ACT) had been used at these locations and in the WT42D model computations, see Table 14. This was verified later following discussions with the State.

Table 14: WT42D 1974 – Comparison of Recorded and Calculated Peak Discharges

River Catchment File	WT42D Actual Hydrograph	WT42D Actual Peak (m^3/s)	Calculated Hydrograph	Calculated Peak (m^3/s)	Difference to Actual (%)
Wivenhoe	WIV.ACT	4813	WIV.HYD	5438	+13
Lyons	LYO.ACT	2075	LYO.HYD	2611	+26
Walloon	IPS.ACT	2920	WAL.HYD	1521	-52%
Amberley	PUR.ACT	1942	PUR.HYD	2272	+17
Purga	AMB.ACT	466	PUR.HYD	551	+18

The above table illustrates that there are significant differences between the recorded or actual hydrographs and those calculated hydrographs from the 1974 WT42D model particularly at Walloon and Lyons.

Further investigation and discussions with the State regarding these differences revealed that a significant amount of work had been undertaken during the Brisbane and Pine Rivers Flood Study (1994) for the 1974 flood event. The work was undertaken in order to resolve the complex floodplain characteristics of Lockyer Creek (where significant storage effects and two-dimensional flow characteristics are evident) as well as matching the timing of the flood flow through the Bremer River. Furthermore in both the Lockyer Creek and Bremer River systems gauge failures at O'Reilly's Weir and Walloon (143107A gauge overtopped) respectively complicated the calibration process.

In summary, previous work by the State involved supplementing the WT42D calculated outputs with recorded data (*.ACT hydrographs) at the five (5) primary inflow locations in order to achieve a better calibration. This explained why the 'RubiconFlows' spreadsheet contained both calculated and recorded inflow data. This finding as well as a number of 'hold point reviews' (detailed in Appendix K) led to significant works on the 1974 hydrology being undertaken as part of this study. The work was necessary in order to achieve a satisfactory calibration result. Refer to Appendix I for a description of the 1974 hydrology extension works undertaken as part of this project in order to improve the calibration of the model.

H6 Summary

Initially it was hoped that the boundary conditions for the 1974 event could be based on available data from the Brisbane and Pine Rivers Flood Study (1994). Upon a detailed review of the available information from the 1994 study and in consultation with the 'peer review team' further works were deemed necessary to achieve the objectives of this project. These works are detailed in Appendix I.

Appendix I 1974 Historical Event – Extension Works

I1 Introduction

The 1974 'extension works' build upon the original 1974 hydrology from the Brisbane and Pine Rivers Flood Study (1994) and were undertaken in order to improve calibration of the model to the 1974 event. These works align with the scope of work in Section 5.1 and can be categorised as follows:

1. Coarse Calibration – 45m Grid
2. Detailed Calibration – 30m Grid

I2 Coarse Calibration Overview (45m Grid)

The coarse calibration works involved a number of hydrology scenarios for a TUFLOW 45m grid model. The 1974 hydrology scenarios investigated as part of this study are listed in Table 15 and discussed in detail in the following paragraphs.

Table 15: Coarse Calibration - 1974 Hydrology Scenarios

Description of Works and Simulation Name	Hydrology Description		Comments
	Five (5) Primary Inflows (Wiv, Lyo, Wal, Amb, Pur)	Lateral Inflows (31 locations)	
Phase 1: Initial Works			
TCF15a/b	Recorded ('*.act' files)	WT42D calc	Attempts to match 'RubiconsFlows.xls'
TCF16a/b	WT42D calc	WT42D calc	100% calculated from WT42D
Phase 2: Remove Rosevale Gauge			
TCF17a/b	WT42D calc	WT42D calc	Trial 1 of 4: Removal of the Rosevale gauge40183.
TCF18a/b	WT42D calc	WT42D calc	Trial 2 of 4
TCF19a/b	WT42D calc	WT42D calc	Trial 2 of 4
TCF20a/b	WT42D calc	WT42D calc	Trial 3 of 4
Phase 3: Incorporate Report 23E Inflows			
TCF21a/b	Report 23E primary inflows Wiv, Lyo, Wal, Amb & Pur	TCF20	Incorporates comments from State to digitise and adopt primary inflows from Report 23E
TCF22a/b	TCF20: Wiv & Lyo Report23E: Wal, Amb, Pur	TCF20	Incorporates a combination of TCF20 and Report 23E
TCF22a1/b1	TCF20: Wiv & Lyo Report23E: Wal, Amb, Pur	TCF20	Incorporates a combination of TCF20 and Report 23E Final DTM for study. **TCF22a1 – Final iteration for the 1974 historical event coarse (45m grid) calibration.**

Reference in Table 15 is made to TUFLOW control file (TCF) number and 'a' /'b' runs (Section I3)

These scenarios comprised three key phases of work and are based on a number of key technical meetings, listed in Appendix K.

1. Initial Works
2. Rosevale Rainfall Gauge
3. Incorporate Report 23E(1994) primary boundary conditions inflows (five in total)

Phase One - Initial Works

The initial works involved reproduction of inflows matching the 'RubiconFlows' spreadsheet. Refer to Appendix H, Section H4 for further information. The initial works indicated that predicted values were lower than recorded (Section I4) so rather than embarking upon major changes to the hydraulic model the 'sensitivity' of the input hydrology was investigated through phases two and three.

Phase Two - Removal of the Rosevale Rainfall Gauge 40183

Following a technical meeting conducted on the 22 January 2009 (listed in Appendix K) and investigation into the rainfall used in the 'original' WT42D 1974 calibration model, it was found that there was likely to be an anomaly. This assertion was based on the rainfall distribution from Figure 5.8 from Report 7a (1994) which has been reproduced in Figure 12 and Figure 13 of this report. The anomaly relates to the Rosevale gauge.

Including the Rosevale gauge in the 'rainfall isohyets' as per Figure 5.8 Report 7a (1994) produces a significant reduction in the rainfall totals (for the 83 hour period) to less than 200mm. This is compared to rainfall totals in the adjacent regions of around 400 to 500mm. Therefore the purpose of this phase of works was to remove the 'influence' of the Rosevale gauge (TCF 17-20 in Table 15) by adjusting the rainfall totals at Helidon, Tenthill, Lyons and Walloon.

The original rainfall depths and final trial (TCF22) are illustrated in Figure 13 and Figure 14 respectively. Table 16 lists the comparison in peak calculated discharges.

Table 16: WT42D 1974 – Comparison of Calculated Peak Discharges

	WT42D Calculated Peak Discharge (m^3/s)				
River Catchment File	**Original**	**Trial 1 TCF17**	**Trial 2 TCF18**	**Trial 3 TCF19**	**Trial 4 TCF20**
Wivenhoe	5438	5438	5438	5438	5438
Lyons	2611	4969	3697	3463	3463
Walloon	1521	2128	2146	2439	2691
Amberley	2272	2272	2272	2272	2272
Purga	551	551	551	551	551

Phase Three – Report 23E (1994)

Following completion of phase two a hold point review meeting was conducted on the 5 February 2009 (detailed in Appendix K). The outcome of this meeting was:

1. Acceptance that the Rosevale gauge represented an anomaly in the data
2. The primary inflows used for calibration purposes should be based on Report 23E (1994).

Accordingly these hydrographs were digitised and supplemented the lateral inflow hydrographs from the phase two works. Further sensitivity analysis was also undertaken in this phase using a combination of Report23E and WT42D calculated primary inflows. Refer to Table 17, Figure 15 and Figure 16 which details the comparisons.

Table 17: Primary Inflow Comparison

	Primary Peak Discharge Comparions (m³/s)			
River Catchment File	**Original**	**TCF20 (Trial 4)**	**TCF 21 (Report 23E)**	**TCF22 (Combination of TCF 20 & Report 23E)**
Wivenhoe	5438	5438	5108	5438
Lyons	2611	3463	3850	3463
Walloon	1521	2691	2251	2251
Amberley	2272	2272	2103	2103
Purga	551	551	495	495

I3 Coarse Calibration (45m Grid) Manning's 'n' Adjustments

The 'a' and 'b' naming convention (suffixes) in Table 15 refers to the calibration process where two sets of Manning's n values were investigated simultaneously for each scenario. No other adjustments to other categories were made. Refer to Table 18 for details of the adjustments. The 'Water Body' category represents the channel of the Brisbane River and has the most influence on flood levels.

Table 18: 1974 Coarse Hydrology Scenarios (45m Grid) -Suffixes

Naming Convention	SEQ Catchments Category	Coarse Calibration Manning's 'n' Values	Adjustment from base value in Table 9	Global adjustment to other Table 9 categories
'a'	6. Water Body	0.030	+0.005	None
'b'	6. Water Body	0.035	+0.010	None

I4 Coarse Calibration Results (45m Grid)

During the coarse calibration process results were compared to recorded 1974 data as follows:

1. Peak water levels
2. Water level hydrographs (for evaluation of timing and volume of hydrograph)
3. Rating curves
4. Discharge rating at Jindalee (January 1974 Floods Moreton Region, Engineers Australia, 1974) pp 46
5. 1974 recorded flood inundation extents and spot levels.

Comprehensive reporting of all iterations for the coarse calibration is beyond the scope of this report however a peak water level summary and peak rating comparison is provided in Table 21 and Table 22 respectively. The comparisons are made against Table 19 and Table 20 with gauge locations illustrated in Figure 17.

Table 19: 1974 Historical Event – Recorded Peak Water Level (m AHD)

Location and Gauge Reference	1974 Water Level
Lyons Bridge – BOM 040662/040740	64.07
Lowood – BOM 040441	45.70
Savages – NRW 143001C	42.25
Mt Crosby – NRW 143003A	26.69
Amberley (Warrill Creek) – NRW 143108A	28.69
Loamside (Purga Creek) – NRW 143113A	27.64
Walloon (Bremer River) - 143107A	27.96
Ipswich – BOM 040101	20.72
Moggill – BOM 040545/040812	19.93
Jindalee Bridge – BOM 040713	14.10
Port Office – DOT 040690	5.44
Brisbane Bar – BOM 040647/AWRC-143935	1.12

Table 20: 1974 Historical Event – Recorded Peak Rating (m^3/s)

Location	Rating
Jindalee	9514

Table 21: 1974 Historical Event – Coarse Calibration Results (45m Grid) Peak Water Level Comparison (m AHD)

Location	TCF 15a	TCF 15b	TCF 16a	TCF 16b	TCF 17a	TCF 17b	TCF 18a	TCF 18b	TCF 19a	TCF 19b	TCF 20a	TCF 20b	TCF 21a	TCF 21b	TCF 22a	TCF 22b	TCF 22a1	TCF 22b1
Lyons	62.70 (-1.37)	62.67 (-1.40)	63.25 (-0.82)	63.26 (-0.81)	64.73 (+0.66)	64.73 (+0.66)	64.18 (+0.11)	64.18 (+0.11)	64.05 (-0.02)	64.06 (-0.01)	64.06 (-0.01)	64.06 (-0.01)	64.28 (+0.21)	64.27 (+0.20)	64.06 (-0.01)	64.07 (0.00)	**64.12 (+0.05)**	64.12 (+0.05)
Lowood	44.13 (-1.57)	44.20 (-1.50)	44.85 (-0.86)	44.91 (-0.79)	46.37 (+0.67)	46.41 (+0.71)	45.63 (-0.07)	45.69 (-0.01)	45.45 (-0.26)	45.52 (-0.19)	45.45 (-0.26)	45.52 (-0.19)	45.57 (-0.13)	45.66 (-0.04)	45.45 (-0.25)	45.52 (-0.18)	**44.96 (-0.75)**	45.02 (-0.68)
Savages	41.05 (-1.20)	41.14 (-1.11)	41.90 (-0.35)	41.99 (-0.26)	44.01 (+1.76)	44.08 (+1.83)	42.85 (0.60)	42.93 (+0.68)	42.64 (+0.39)	42.71 (+0.46)	42.64 (+0.39)	42.71 (+0.46)	42.82 (+0.57)	42.90 (+0.65)	42.64 (+0.39)	42.72 (+0.47)	**41.73 (-0.52)**	41.82 (-0.43)
Mt Crosby	25.85 (-0.84)	26.02 (-0.67)	26.21 (-0.48)	26.34 (-0.35)	28.68 (+1.99)	28.85 (+2.16)	27.40 (+0.71)	27.54 (+0.85)	27.15 (+0.46)	27.32 (+0.63)	27.19 (+0.50)	27.35 (+0.66)	27.49 (+0.80)	27.64 (+0.95)	27.24 (+0.55)	27.41 (+0.72)	**26.45 (-0.24)**	26.60 (-0.09)
Amberley	29.29 (+0.60)	29.29 (+0.60)	29.49 (+0.80)	29.49 (+0.80)	29.50 (+0.82)	29.50 (+0.82)	29.51 (+0.82)	29.51 (+0.82)	29.51 (+0.82)	29.51 (+0.82)	29.52 (+0.83)	29.52 (+0.83)	29.36 (+0.67)	29.36 (+0.67)	29.36 (+0.67)	29.36 (+0.67)	**29.39 (+0.70)**	29.39 (+0.70)
Loamside	28.34 (+0.70)	28.34 (+0.70)	28.57 (+0.94)	28.57 (+0.94)	28.59 (+0.96)	28.59 (+0.96)	28.59 (+0.96)	28.60 (+0.96)	28.61 (+0.98)	28.61 (+0.98)	28.64 (+1.00)	28.64 (+1.00)	28.38 (+0.75)	28.38 (+0.75)	28.38 (+0.75)	28.38 (+0.75)	**28.31 (+0.68)**	28.31 (+0.68)
Walloon	28.13 (+0.17)	28.13 (+0.17)	27.00 (-0.96)	27.01 (-0.96)	27.55 (-0.41)	27.55 (-0.41)	27.56 (-0.40)	27.56 (-0.40)	27.78 (-0.18)	27.78 (-0.18)	27.94 (-0.03)	27.94 (-0.02)	27.57 (-0.39)	27.57 (-0.39)	27.57 (-0.39)	27.57 (-0.39)	**27.56 (-0.40)**	27.56 (-0.40)
Ipswich	22.25 (+1.53)	22.32 (+1.60)	20.57 (-0.15)	20.66 (-0.06)	21.26 (+0.54)	21.33 (+0.61)	21.27 (+0.55)	21.34 (+0.62)	21.58 (+0.86)	21.67 (+0.95)	21.85 (+1.13)	21.91 (+1.19)	20.98 (+0.26)	21.07 (+0.35)	21.06 (+0.34)	21.17 (+0.45)	**21.45 (+0.73)**	21.55 (+0.83)
Moggill	18.62 (-1.31)	18.94 (-0.99)	17.22 (-2.71)	17.56 (-2.37)	18.99 (-0.94)	19.31 (-0.62)	18.13 (-1.80)	18.48 (-1.45)	18.22 (-1.71)	18.55 (-1.39)	18.37 (-1.56)	18.69 (-1.24)	18.57 (-1.37)	18.91 (-1.02)	18.81 (-1.12)	19.16 (-0.77)	**18.99 (-0.95)**	19.33 (-0.60)
Jindalee	13.26 (-0.84)	13.66 (-0.44)	12.06 (-2.04)	12.48 (-1.62)	13.54 (-0.56)	13.86 (-0.24)	12.86 (-1.24)	13.24 (-0.86)	12.93 (-1.17)	13.30 (-0.80)	13.04 (-1.06)	13.43 (-0.67)	13.17 (-0.93)	13.59 (-0.51)	13.33 (-0.77)	13.73 (-0.37)	**13.37 (-0.73)**	13.75 (-0.35)
Port Office	5.51 (+0.07)	5.94 (+0.50)	4.79 (-0.65)	5.22 (-0.22)	5.54 (0.10)	6.03 (+0.59)	5.23 (-0.22)	5.59 (+0.15)	5.28 (-0.16)	5.61 (+0.17)	5.35 (-0.09)	5.70 (+0.26)	5.36 (-0.08)	5.79 (+0.35)	5.45 (+0.01)	5.91 (+0.47)	**5.44 (0.00)**	5.89 (+0.45)
Bar	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	**1.12 (0.00)**	1.12 (0.00)

Table 22: 1974 Historical Event – Coarse Calibration Results (45m Grid) Peak Rating Comparison (m^3/s)

Location	TCF 15a	TCF 15b	TCF 16a	TCF 16b	TCF 17a	TCF 17b	TCF 18a	TCF 18b	TCF 19a	TCF 19b	TCF 20a	TCF 20b	TCF 21a	TCF 21b	TCF 22a	TCF 22b	TCF 22a1	TCF 22b1
Jindalee	9150 (-364)	9102 (-412)	8156 (-1358)	8080 (-1434)	9490 (-24)	9376 (-138)	8838 (-676)	8748 (-766)	8901 (-613)	8789 (-725)	8995 (-519	8911 (-603)	9157 (-357)	9089 (-425)	9346 (-168)	9287 (-227)	**9452 (-62)**	9350 (-164)

I5 Detailed Calibration Overview (30m Grid)

The detailed calibration works builds upon the coarse calibration Phase 3 'hydrology works' detailed in Sections I1-I4. These are detailed in Table 23.

Table 23: Detailed Calibration - 1974 Hydrology Scenarios

Description of Works and Simulation Name	Hydrology Description		Comments
	Five (5) Primary Inflows (Wiv, Lyo, Wal, Amb, Pur)	Lateral Inflows (31 locations)	
TCF22a/b	TCF20: Wiv & Lyo Report23E: Wal, Amb, Pur	TCF20	Incorporates a combination of TCF20 and Report 23E
TCF22a1/b1	TCF20: Wiv & Lyo Report23E: Wal, Amb, Pur	TCF20	Incorporates a combination of TCF20 and Report 23E Final DTM for study.
TCF23a/b/c/d	TCF20: Wiv & Lyo Report23E: Wal, Amb, Pur	TCF20	Incorporates a combination of TCF20 and Report 23E Final DTM for study. **TCF23d – Final iteration for the 1974 historical event detailed (30m grid) calibration.**

I6 Detailed Calibration (30m Grid) Manning's 'n' Adjustments

The Manning's 'n' adjustments used for the 30m grid modelling are listed in Table 24 and Table 25 according to the two simulation iterations being TCF22 and TCF23, respectively. The adjustments relate to the original set of Manning's 'n' values detailed in Table 9 (Section F6).

Table 24: 1974 Detailed Hydrology Scenarios (30m Grid) – TCF 22 Suffixes

Naming Convention	SEQ Catchments Category	Coarse Calibration Manning's 'n' Values	Adjustment from base value in Table 9	Global adjustment to other Table 9 categories
'a'	6. Water Body	0.030	+0.005	None
'b'	6. Water Body	0.035	+0.010	None

Table 25: 1974 Detailed Hydrology Scenarios (30m Grid) –TCF23 Suffixes

Naming Convention	SEQ Catchments Category	Coarse Calibration Manning's 'n' Values	Adjustment from base value in Table 9	Global adjustment to other Table 9 categories
'a'	6. Water Body	0.0275	+0.0025	+0.0025
'b'	6. Water Body	0.030	+0.005	+0.0050
'c'	6. Water Body	0.0325	+0.0075	+0.0025
'd'	6. Water Body	0.035	+0.010	+0.0025

I7 Detailed Calibration Results (30m Grid)

Criteria from Section I4 were also used to evaluate the detailed calibration results as follows:

1. Peak water levels: As per section I4 a peak water level summary and peak rating comparison is provided in Table 26 and Table 27 respectively (for all detailed calibration iterations).

2. Water level hydrographs: Figure 18 to Figure 29 (TCF23d)

3. Rating curves: Figure 30 to Figure 40 (TCF23d)

4. Discharge rating: Figure 40 (TCF23d)

5. 1974 flood inundation extents and spot levels: Figure 42 to Figure 46 (TCF23d).

I8 Rating Curve Data

Rating curve data for the comparison detailed above was provided by:

- Sunwater
- BOM and
- NRW.

Table 26: 1974 Historical Event – Detailed Calibration Results (30m Grid) Peak Water Level Comparison (m AHD)

Location	TCF 22a	TCF 22b	TCF 22a1	TCF 22b1	TCF 23a	TCF 23b	TCF 23c	TCF 23d
Lyons	64.06 (-0.01)	64.06 (-0.01)	64.06 (-0.01)	64.07 (0.00)	64.11 (+0.04)	64.15 (+0.08)	64.11 (+0.04)	**64.11 (+0.04)**
Lowood	45.23 (-0.47)	45.31 (-0.39)	44.75 (-0.95)	44.85 (-0.85)	44.88 (-0.83)	45.05 (-0.65)	44.95 (-0.75)	**44.99 (-0.72)**
Savages	42.43 (+0.18)	42.52 (+0.27)	41.49 (-0.76)	41.57 (-0.68)	41.64 (-0.61)	41.86 (-0.39)	41.72 (-0.53)	**41.76 (-0.49)**
Mt Crosby	26.78 (+0.09)	26.95 (+0.26)	26.18 (-0.51)	26.38 (-0.31)	26.21 (-0.48)	26.43 (-0.26)	26.40 (-0.29)	**26.49 (-0.20)**
Amberley	29.46 (+0.77)	29.46 (+0.77)	29.46 (+0.77)	29.46 (+0.77)	29.51 (+0.82)	29.55 (+0.87)	29.51 (+0.82)	**29.51 (+0.82)**
Loamside	28.23 (+0.59)	28.23 (+0.59)	28.23 (+0.59)	28.23 (+0.59)	28.26 (+0.62)	28.29 (+0.65)	28.26 (+0.62)	**28.26 (+0.62)**
Walloon	27.54 (-0.43)	27.54 (-0.42)	27.54 (-0.42)	27.54 (-0.42)	27.60 (-0.36)	27.67 (-0.30)	27.60 (-0.36)	**27.61 (-0.36)**
Ipswich	21.28 (+0.56)	21.45 (+0.73)	21.54 (+0.82)	21.70 (+0.98)	21.43 (0.71)	21.68 (+0.96)	21.33 (+0.61)	**21.70 (+0.98)**
Moggill	18.28 (-1.65)	18.69 (-1.24)	18.40 (-1.53)	18.81 (-1.12)	18.22 (-1.71)	18.48 (-1.45)	18.65 (-1.28)	**18.84 (-1.09)**
Jindalee	12.71 (-1.39)	13.21 (-0.89)	12.75 (-1.35)	13.26 (-0.84)	12.49 (-1.61)	12.76 (-1.34)	13.02 (-1.08)	**13.26 (-0.84)**
Port Office	4.91 (-0.53)	5.47 (+0.02)	4.94 (-0.51)	5.46 (+0.02)	4.69 (-0.75)	4.93 (-0.51)	5.19 (-0.25)	**5.45 (+0.01)**
Bar	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	1.12 (0.00)	**1.12 (0.00)**

Table 27: 1974 Historical Event – Detailed Calibration Results (30m Grid) Peak Rating Comparison (m^3/s)

Location	TCF 22a	TCF 22b	TCF 22a1	TCF 22b1	TCF 23a	TCF 23b	TCF 23c	TCF 23d
Jindalee	9567 (+53)	9481 (-33)	9657 (+143)	9584 (+70)	9652 (+138)	9547 (+33)	9557 (+43)	**9528 (+14)**

I9 Sensitivity Analysis

Sensitivity analyses were undertaken using the 1974 final calibration run (TCF23d). The sensitivity tests were completed after the calibration of the model and the flood profile series. Two scenarios were investigated (see Table 28) based on uncertainties in the DTM data as discussed in Section C2:

1. Remove 'Dredge Holes'
2. Remove 'Smoothing Algorithms'

Accordingly the purpose of these sensitivity analyses was to determine the influence of each scenario on the calibration process, particularly Manning's n values.

Table 28: Detailed Calibration - 1974 Sensitivity Analysis

Description of Works and Simulation Name	Hydrology Description		Comments
	Five (5) Primary Inflows (Wiv, Lyo, Wal, Amb, Pur)	Lateral Inflows (31 locations)	
ST01_023d (30m and 45m grids)	TCF20: Wiv & Lyo Report23E: Wal, Amb, Pur	TCF20	Incorporates a combination of TCF20 and Report 23E Final DTM for Study Sensitivity Test 01: Removes 'dredge holes' from the bathymetry in order to determine the effect of dredging on the Brisbane River during the 1970s
ST02_023d (30m and 45m grids)	TCF20: Wiv & Lyo Report23E: Wal, Amb, Pur	TCF20	Incorporates a combination of TCF20 and Report 23E Final DTM for study. Sensitivity Test 02: Removes smoothing algorithm applied to the lower Brisbane River reach due to poor DTM data along river bounds.

The results of the sensitivity analysis or sensitivity tests ST01 and ST02 are presented in Table 29.

ST01- Sensitivity Test 01 - Remove Dredge Holes

The results indicate that removing the influence of dredge holes (filling them) could account for significant calibration differences at the Jindalee and Moggill gauges (refer to Table 26) and to a lesser extent the Ipswich gauge for the 1974 calibration event.

The sensitivity results suggest the dredging undertaken from the 1970's to the 1990's in the lower Brisbane River reach (downstream of the Bremer River confluence to the City gauge) would reduce flood levels by around 200mm to 600mm if a comparative 1974 event were to occur again. This would also explain the slightly higher Manning's 'n' values adopted during the calibration process.

ST02- Sensitivity Test 02 - Remove Smoothing Algorithm

The results indicate that removing the smoothing algorithm (TUFLOW model function) will generally reduce results in the lower Brisbane River reach by 50mm to 250mm. The use of the smoothing algorithm which was utilised to remove the deficiencies in the DTM, would again also help explain the need for slightly higher Manning's n values for the 1974 calibration.

Summary

Due to time constraints the results of both sensitivity tests could not be used for the final flood profile series model runs however it is recommended that these results be incorporated into any future recalibration works, particularly the removal of the smoothing algorithm.

Table 29: 1974 Historical Event – Sensitivity Results (30m Grid) Peak Water Level Comparison (m AHD)

Location	TCF 23d	ST01 23d	ST02 23d
Lyons	64.11	**64.11 (0.00)**	**64.11 (0.00)**
Lowood	44.99	**44.99 (0.00)**	**44.99 (0.00)**
Savages	41.76	**41.76 (0.00)**	**41.76 (0.00)**
Mt Crosby	26.49	**26.63 (+0.14)**	**26.57 (+0.08)**
Amberley	29.51	**29.51 (0.00)**	**29.51 (0.00)**
Loamside	28.26	**28.26 (0.00)**	**28.26 (0.00)**
Walloon	27.61	**27.61 (0.00)**	**27.61 (0.00)**
Ipswich	21.70	**21.83 (+0.13)**	**21.48 (-0.22)**
Moggill	18.84	**19.37 (+0.53)**	**19.09 (+0.25)**
Jindalee	13.26	**13.86 (+0.59)**	**13.42 (+0.16)**
Port Office	5.45	**5.65 (+0.20)**	**5.49 (+0.04)**
Bar	1.12	**1.12 (0.00)**	**1.12 (0.00)**

Appendix J 1996 Historical Event

J1 Introduction

The May 1996 event was used as a 'verification event' and was not a significant flooding event in regard to Brisbane River and the operation of the Wivenhoe Dam. However, the 1996 flooding in the Lockyer and Laidley Creeks was significant, in fact the worst recorded since 1974.

J2 WT42D 1996 Calibration Model

The WT42D models for the 1996 event were collected from:

- Sunwater
- WRM Water and Environment P/L

The 1996 WT42D model includes relevant changes to the Savages Crossing subregion due to the inclusion of Wivenhoe dam and minor differences in the Ipswich subregion when compared to the 1974 WT42D model. A comparison was undertaken between the two model sets supplied above. From this comparison a 1996 'verification event' model was developed and the following works undertaken:

1. Coarse Calibration – 45m Grid
2. Detailed Calibration – 30m Grid

J3 Coarse Calibration Overview (45m Grid)

The coarse calibration works involved the following hydrology scenarios. These scenarios are linked to the 1974 calibration process and are listed in Table 30.

Table 30: Coarse Calibration - 1996 Hydrology Scenarios

Description of Works and Simulation Name	Hydrology Description	Comments
Phase 1: Initial Works		
TCF15a/b	WT42D calc	Initial attempt of 1996 calibration
Phase 2: Final Run		
TCF15a1	WT42D calc	Final 1996 run for coarse calibration. Adopts Manning's n 'a' adjustments as per Table 18 (as per 1974 calibration) and utilises final DTM

Reference in Table 30 is made to TUFLOW control file (TCF) number and 'a'/'b' runs consistent with Appendix I, Section I3.

J4 Coarse Calibration Results (45m Grid)

During the coarse calibration process results were compared to recorded 1996 data as follows:

1. Peak water levels
2. Water level hydrographs (for evaluation of timing and volume of hydrograph)
3. 1996 flood inundation extents and spot levels.

Comprehensive reporting of all iterations for the coarse calibration is beyond the scope of this report however a peak water level summary is provided in Table 32 and comparisons made against Table 31 with gauge locations illustrated in Figure 17.

Table 31: 1996 Historical Event – Recorded Peak Water Level (m AHD)

Location and Gauge Reference	1996 Water Level
Lyons Bridge – DNR40662/040740	63.93
Rifle Range Road – NRW143210B	60.84
O'Reilly's Weir – NRW 143207A	39.47
Wivenhoe Tailwater – NRW143035A	37.05
Lowood – BOM 040441	34.99
Savages – NRW 143001C	31.07
Mt Crosby – NRW 143003A	14.10
Amberley (Warrill Creek) – NRW 143108A	25.18
Loamside (Purga Creek) – NRW 143113A	26.47
Walloon (Bremer River) - 143107A	25.64
Three Mile Bridge- BOM 040838	21.04
Ipswich – BOM 040101	11.29
Moggill – BOM 040545/040812	7.10
Jindalee Bridge – BOM 040713	4.55
Port Office – DOT 040690	2.00
Brisbane Bar – BOM 040647/AWRC-143935	1.29

Table 32: 1996 Historical Event – Coarse Calibration Results (45m Grid) Peak Water Level Comparison (m AHD)

Location	TCF 15a	TCF 15b	TCF 15al
Lyons	60.56 (-3.37)	60.56 (-3.37)	61.17 (-2.76)
Rifle Range	58.27 (-2.57)	58.27 (-2.57)	58.93 (-1.91)
O'Reilly's	39.35 (-0.13)	39.37 (-0.10)	38.89 (-0.58)
Wivenhoe TW	36.48 (-0.57)	36.58 (-0.47)	35.60 (-1.45)
Lowood	34.04 (-0.95)	34.15 (-0.84)	33.16 (-1.83)
Savages	31.51 (+0.44)	31.60 (+0.53)	30.16 (-0.91)
Mt Crosby	18.16 (4.06)	18.22 (+4.12)	15.10 (+1.00)
Amberley	26.48 (+1.30)	26.48 (+1.30)	26.61 (+1.43)
Loamside	26.82 (+0.36)	26.82 (+0.36)	26.71 (+0.25)
Walloon	25.37 (-0.27)	25.37 (-0.27)	25.34 (-0.30)
Three Mile	20.78 (-0.26)	20.79 (-0.25)	20.84 (-0.20)
Ipswich	15.03 (+3.74)	15.09 (+3.80)	15.65 (+4.36)
Moggill	6.94 (-0.16)	7.38 (+0.28)	7.01 (-0.09)
Jindalee	4.01 (-0.54)	4.31 (-0.24)	3.93 (-0.62)
Port Office	1.84 (-0.16)	1.93 (-0.07)	1.89 (-0.11)
Bar	1.30 (+0.01)	1.30 (+0.01)	1.30 (+0.01)

J5 Detailed Calibration Overview (30m Grid)

The detailed calibration works builds upon the coarse calibration Phase 3 'hydrology works' detailed in Sections I1-I4. Refer to Table 33 for a description of works.

Table 33: Detailed Calibration - 1996 Hydrology Scenarios

Description of Works and Simulation Name	Hydrology Description	Comments
TCF23d	WT42D calc	First & final 1996 run for detailed calibration. Adopts Manning's n 'a' adjustments as per Table 25 (as per 1974 calibration) and utilises final DTM

Reference in Table 33 is made to TUFLOW control file (TCF) number 'd' runs consistent with Appendix I, Section I6.

J6 Detailed Calibration Results (30m Grid)

Criteria from Section I4 were also used to evaluate the detailed calibration results as follows:

1. Peak Water Level: As per section I4 a peak water level summary is provided in Table 34 (for all detailed calibration iterations).

2. Water Level hydrographs: Figure 47to Figure 62

3. 1996 Flood Inundation Extents and Spot Levels: Figure 63 to **Error! Reference source not found.** (TCF23d)

Table 34: 1996 Historical Event – Detailed Calibration Results (30m Grid) Peak Water Level Comparison (m AHD)

Location	TCF 23d
Lyons	60.52 (-3.40)
Rifle Range	57.66 (-3.18)
O'Reilly's	38.66 (-0.82)
Wivenhoe TW	35.49 (-1.56)
Lowood	33.11 (-1.88)
Savages	30.05 (-1.01)
Mt Crosby	15.05 (+0.95)
Amberley	26.55 (+1.37)
Loamside	26.55 (+0.09)
Walloon	25.28 (-0.36)
Three Mile	20.86 (-0.18)
Ipswich	15.64 (+4.35)
Moggill	7.18 (+0.08)
Jindalee	4.18 (-0.37)
Port Office	1.90 (-0.10)
Bar	1.30 (+0.01)

Appendix K Key Stakeholder Meetings

Meeting Type	Date [redacted]	Meeting Description	Attendees List
PCG	6 Jun. 2008	Project Inception	PCG and TWG (refer to Table 2 for the list of attendees)
TWG	12 Dec. 2008	Technical Review	TWG
TM	22 Jan. 2009	1974 Calibration Review	[redacted] & James Charalambous.
TM	2 Feb. 2009	1974 Calibration Review (Discuss 'RubiconFlows' spreadsheet)	John Ruffini & James Charalambous.
TM	4 Feb. 2009	1974 Calibration Review (Discuss 'RubiconFlows' spreadsheet)	Rob Ayre & James Charalambous.
TM	5 Feb. 2009	1974 Calibration Review	[redacted] & James Charalambous.
Hold Point Review 1	11 Feb. 2009	1974 Calibration Review	[redacted], Greg Roads, John Ruffini, Rob Ayre, Ken Morris, [redacted] and James Charalambous
Hold Point Review 2	18 Feb. 2009	1974 Calibration Review	[redacted], Greg Roads, John Ruffini, Rob Ayre, Ken Morris, [redacted] and James Charalambous
PCG	5 Mar. 2009	Calibration Sign-off	PCG and TWG
PCG	11 Jun. 2009	Project Deliverables and Completion	PCG and TWG

Project Control Group, Technical Working Group; TM: Technical Meeting

Appendix L Response Tools Scoping

Meeting Type	Date	Meeting Description	Attendees List
RTSM1	18 Dec 2008	Flood Response Tools	[redacted], Ken Morris, [redacted], [redacted] [redacted] and James Charalambous
RTSM2	14 Jan 2009	Flood Response Tools	[redacted] and James Charalambous
RTSM3	22 Jan 2009	Flood Response Tools	[redacted], Ken Morris, [redacted], [redacted], [redacted], [redacted] and James Charalambous
RTSM4	5 Feb. 2009	Flood Response Tools	[redacted] Ken Morris, [redacted], [redacted], [redacted], [redacted], [redacted] and James Charalambous
RTSM5	18 Feb. 2009	Flood Response Tools	[redacted], [redacted] Ken Morris, [redacted], [redacted], [redacted], [redacted], [redacted] and James Charalambous
RTSM6	26 Mar. 2009	Flood Response Tools	[redacted], [redacted], [redacted], [redacted], and James Charalambous
RTSM7	22 Apr 2009	Flood Response Tools	[redacted], [redacted], [redacted], [redacted], [redacted], [redacted], and James Charalambous
RTSM8	12 May 2009	Flood Response Tools	[redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted] and James Charalambous
RTSM9	26 May 2009	Flood Response Tools	[redacted] and James Charalambous
RTSM10	9 June 2009	Flood Response Tools	[redacted], and James Charalambous

RTSM: Response tools scoping meeting