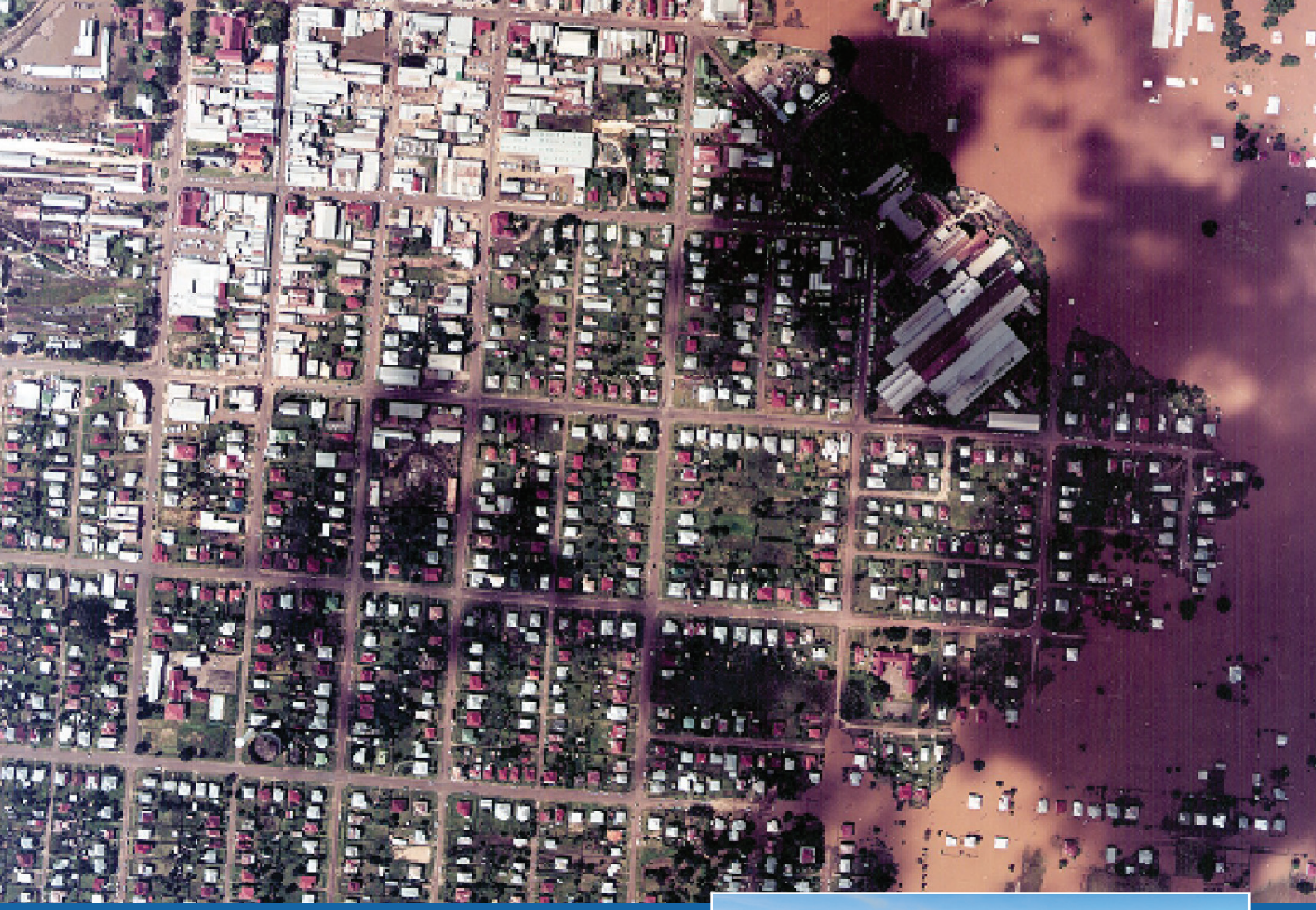




Fraser Coast Regional Council

Mary River Flood Study
Final Report

GHD Pty Ltd

December 2011

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Executive Summary

GHD was commissioned by Fraser Coast Regional Council (FCRC) to determine peak flood levels in the vicinity of Maryborough City due to regional flooding from the Mary River system. One of the primary aims of the study is to provide a degree of certainty to both Council and developers with respect to future development requirements and to provide a set of results that can be incorporated within Council's planning scheme. The study expands on GHD's 2005 Flood Study for Maryborough City Council.

The city of Maryborough has been affected by flooding on several occasions during the last 140 years, with major floods occurring in 1890, 1893, 1955, and 1974. Other more moderate flood events occurred in 1898, 1968, 1992, 1999 and 2011.

Historically the 1893 flood has been used by FCRC for planning purposes, as the highest known flood event.

A range of data has been collected for the project, including aerial photographs, reports, recorded flood levels, anecdotal flooding information, digital data and topographic information. In addition, the study area was inspected prior to the commencement of modelling and discussions were held with Council officers.

Hydrologic investigations (in this case the prediction of river flows) were undertaken using the Bureau of Meteorology's (BoM's) URBS model. The URBS model was calibrated by the BoM and subsequently verified for independent flood events by GHD.

Flood level estimation has been undertaken using the two-dimensional MIKEFLOOD and TUFLOW hydraulic models, with calibration to the March 1955 flood and verification to the January 1999 event.

Design flood events were simulated using the calibrated 2D hydraulic models. Design event simulation was undertaken for the 50 and 100 year ARI design event with a view to expand the study to include simulation of more frequent design events. The impact of climate change on the 100 year ARI design event was also assessed by testing the impact of increased (+10%) rainfall intensities and sea level rise (H.A.T.+0.8m).

A set of flood inundation maps indicating flood extent, levels, depths, velocities and hazard have been prepared for each of the design event scenarios assessed.

A comparison of the 1893 historical flood extent against the 100 year ARI design event scenario has also been provided.

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Acknowledgements

The completion of this study was made possible through the combined efforts of Fraser Coast Regional Council, the project team and Terry Malone (ex Bureau of Meteorology).

Abbreviations

2D	Two - Dimensional
AEP	Annual Exceedence Probability
AHD	Australian Height Datum
AMTD	Adopted Middle Thread Distance (distance from mouth of river)
ARF	Areal Reduction Factor
ARI	Average Recurrence Interval
BoM	Bureau of Meteorology
CRC	Cooperative Research Centre
CRCCH	Cooperative Research Centre for Catchment Hydrology
DTM	Digital Terrain Model
DNRM	Department of Natural Resources & Mines
FCRC	Fraser Coast Regional Council
TUFLOW	2D hydraulic model used for this project
HAT	Highest Astronomical Tide
IFD	Intensity Frequency Duration
LHS	Left hand side (when looking downstream)
MHWN	Mean High Water Neap
MHWS	Mean High Water Springs
MSL	Mean Sea Level
RHS	Right hand side (when looking downstream)
WRC	Water Resources Commission (now DERM)

1. Introduction

1.1 Project Aim

GHD was commissioned by Fraser Coast Regional Council to determine flood levels in the vicinity of Maryborough. The objectives of the study are as follows:

- Develop a calibrated hydrologic model of the Mary River catchment;
- Determine hydrographs (flow rates) for the 50 and 100 year ARI design events using the calibrated hydrologic model;
- Develop a calibrated two-dimensional hydraulic model that can be used for prediction of flood levels across the Mary River floodplain;
- Estimate 50 and 100 year ARI design event flood levels using the calibrated hydraulic model;
- Establish hydrologic and hydraulic models capable of predicting flow rates and flood levels for additional design flood scenarios (e.g. 10, 20, 200, 500 year ARI design flood events);
- Provide flood inundation maps for areas subject to inundation;
- Provide a set of results that can be incorporated into Council's Planning Scheme.

1.2 Methodology

The methodology of the project consisted of the following tasks:

- Collection of available data;
- Review of background information including existing flood studies;
- Inspection of the study area;
- Review of BoM's existing hydrologic model of the Mary River catchment;
- Modification of BoM's existing hydrologic model;
- Estimation of design rainfall parameters;
- Hydrologic modelling of design flood events;
- Development and calibration of a 1D/2D hydraulic model of the Mary River;
- Calibration and verification of hydraulic model to historic flood events;
- Hydraulic (2D) modelling of design floods events;
- Flood inundation mapping (flood depth, velocity and hazard); and
- Preparation of a technical report.

1.3 Study Area

The extent of the study area is defined in Figure 1-1.

320,000 340,000 360,000 380,000 400,000 420,000 440,000 460,000 480,000 500,000 520,000 540,000 560,000 580,000 600,000

7,260,000 7,240,000 7,220,000 7,200,000 7,180,000 7,160,000 7,140,000 7,120,000 7,100,000

CHILDERS

MARYBOROUGH

MUNDUBBERA

GYMPIE

1:750,000 @A3

0 15 30

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Locality
- Major Road
- Mary River
- Model Extent (5m Cell Size)
- Model Extent (20m Cell Size)

Local Government Area

- Fraser Coast Regional Council
- Other LGA

GHD CLIENTS|PEOPLE|PERFORMANCE

Fraser Coast Regional Council

Mary River Flood Study

Study Area

Job Number	41-23825
Revision	0
Date	07 Dec 2011

Figure 1-1

G:\41\23825\GIS\Maps\Deliverable\4123825_001_rev_0.mxd

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1.4 Catchment Description

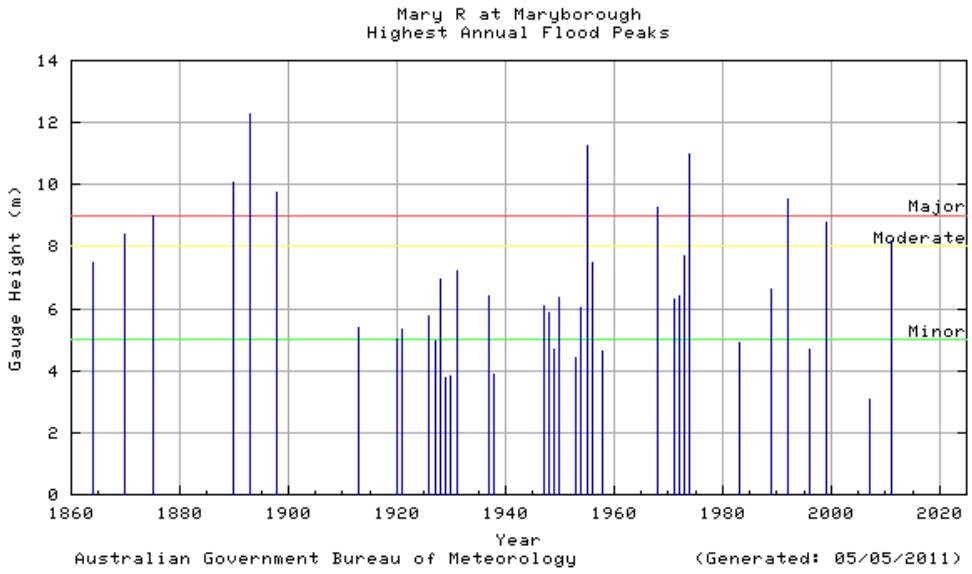
The Mary River catchment is located in the south-eastern coastal area of Queensland and covers an area of over 7000 square kilometres. The headwaters of the Mary River are located in the high rainfall areas surrounding Maleny. Average annual rainfalls in the catchment range from 2000mm in the upper portion of the catchment to approximately 1200mm near Maryborough.

1.5 History

The city of Maryborough has been affected by flooding on a number of occasions during the last 140 years, with major floods occurring in 1890, 1893, 1955, and 1974. Other (moderate) flood events occurred in 1898, 1968, 1992, 1999 and 2011.

Figure 1-2 has been extracted from the BoM website and illustrates the time of occurrence of the highest flood peaks.

Figure 1-2 Highest Peak Floods at Maryborough



Note: Gauge zero = -1.39m AHD.

Historically, the 1893 flood has been used for planning purposes as the highest flood on record. Since 1893, a number of changes to Maryborough and the Mary River have occurred. Those with the theoretical potential to exert an impact on flood levels include:

- Construction of the Barrage in 1976;
- Siltation within the river;
- Road construction; and
- Development adjacent to the river.

2. Data Collection

2.1 Project Data

Various data utilised in this project are listed below and described in the following sub-sections:

- Aerial photographs;
- Digital bathymetric survey data;
- Topographic survey data;
- Cadastral data;
- Hydrologic data;
- Historical flood level data;
- Anecdotal flood records;
- Tidal data.

2.2 Aerial Photographs

Aerial photographs for the Maryborough region were obtained for three different years, namely, 1978, 1983 and 2000. These photos provided information on the level of development and vegetation patterns that existed at the time of photography.

2.3 Bathymetric Data Sets

The following bathymetric data sets were obtained for the Mary River and used in the development of the hydraulic model:

- Bathymetric survey provided by FCRC (unknown survey date);
- Bathymetric survey of the lower river reaches from Marine Safety Queensland (survey dated 26th and 27th February 2004);
- Bathymetric survey obtained by Byrne Brothers (survey dated 24th September 2006);
- Bathymetric survey obtained by EPA;
- Bathymetric survey undertaken by Cullen & Couper Pty Ltd (local surveyors in Hervey Bay engaged by Northern Energy Corporation);
- DHI CMap data set.

The location and extent of bathymetric data sources is provided in Figure 5-2.

2.4 Digital Topographic Information

The following digital information was collected:

- Maryborough City Digital Cadastral Database (DCDB);
- Lidar data from DERM and FCRC (flown July, 2009);
- 1:25,000 contour and spot height information sourced from DERM;
- 1:250,000 contour and spot height information sourced from DERM.

2.5 Hydraulic Structures

The details and dimensions of the Lamington, Granville and Henry Palmer Bridges were obtained from the Assets and Operations Division of the Department of Transport and Main Roads Bundaberg Office.

2.6 Hydrologic Data

Hydrologic data has been obtained from the following sources:

Bureau of Meteorology (BoM)

- Mary River URBS hydrological model;
- Catchment map;
- Rainfall and evaporation data;
- Gauge records;
- Rating Curves.

Department of Natural Resources (now DERM)

- Gauge height and discharge data from several gauging stations within the catchment;
- Cross-sections at the gauging stations.

2.7 Historical Flood Data

Council provided the following data relating to historical flood levels:

- A drawing showing the estimated extent of inundation for the 1893 flood event;
- Flood level records for the 1955 flood event including spot maximum flood levels at various locations within Maryborough;
- Newspaper articles;
- Aerial photographs taken during flood events.

This data is provided in Appendices E to F.

2.8 Tidal Data

Tidal and storm surge data for the Mary River was obtained from:

- Queensland Transport (tidal division);
- Maryborough City Council.

Key tidal elevations at Maryborough and near the river mouth (Bingham) are shown in Table 2-1.

Table 2-1 Key Tidal Elevations

	Maryborough		Bingham	
Tidal Planes	**Level Datum (m LAT)**	**Level Datum (m AHD)**	**Level Datum (m LAT)**	**Level Datum (m AHD)**
AHD	1.40	0.00	2.17	0.00
MHWN	2.51	1.11	3.06	0.89
MHWS	3.20	1.80	3.84	1.67
HAT	4.00	2.60	4.87	2.70

2.9 Inspection of Study Area

Inspection of the Mary River and floodplain was undertaken in February 2004, October 2010 and February 2011. During these visits, the following activities were undertaken:

- Inception meetings with Wayne Sweeny, John Griffiths and Paul Orr;
- Inspection of the floodplain to identify potential flowpaths and flood hazard areas;
- Inspection of city areas prone to inundation;
- Review of available aerial photographs to clarify some topographic features;
- Collection of photographs of various features that are related to flooding (e.g. waterways, structures, flood affected properties, flood marks, etc).

3. Development of Hydrologic Model

3.1 Introduction

The BoM developed a rainfall URBS flood forecasting model for the Mary River in 1997. The model was originally linked to a real time data collection system used for flood forecasting purposes and built on earlier work that developed a flood routing model.

3.2 Model Development

The BoM divided the Mary River catchment into two separate catchments and developed a separate URBS model for each. These were the Upper Mary River and the Lower Mary River model.

Table 3-1 provides a summary of the total catchment area covered by each of the models. Figure 3-1 illustrates the catchment area covered by each of the models.

Table 3-1 Mary River URBS Model Catchment Areas

Model	Catchment Area (km^2)	Number of sub-catchments
Upper Mary River	3020	35
Lower Mary River	6005	54
Total	9025	89

Model results are obtained by first running the Upper Mary River model followed by the Lower Mary River model. The output hydrograph from the Upper Model is used as an inflow to the Lower Mary River Model. Resultant hydrographs are then plotted for specified locations.

3.3 Model Calibration

The BoM calibrated the Mary River URBS-CM model to the 1955, 1976, 1992 and 1999 flood events. A comparison of the predicted and recorded discharge and stage hydrographs is provided for the 1955 event in Appendix B for various locations including Gympie, Miva, the Barrage and Maryborough.

A listing of the calibrated model parameters is given in Table 3-2.

Table 3-2 Calibrated URBS Model Parameters

Model Parameter	Upper Model	Lower Model
Channel lag (α)	0.20	0.30
Catchment lag (β)	2.50	2.50
Catchment non linearity (m)	0.80	0.80
Muskingham non linearity exponent (η)	1.00	1.00
Muskingham translation (x)	0.00	0.00
Initial Loss (mm)	0.00	0.00
Continuing Loss (mm/hr)	2.00	2.00

3.4 Review of BoM Model

The BoM Mary River URBS model was reviewed by GHD to ensure that the supplied model produced the same results as obtained by the BoM. The 1955, 1992 and 1999 flood events were run and identical results to the BoM were obtained thus confirming the validity of the supplied models.

Source: Bureau of Meteorology (B.O.M.)

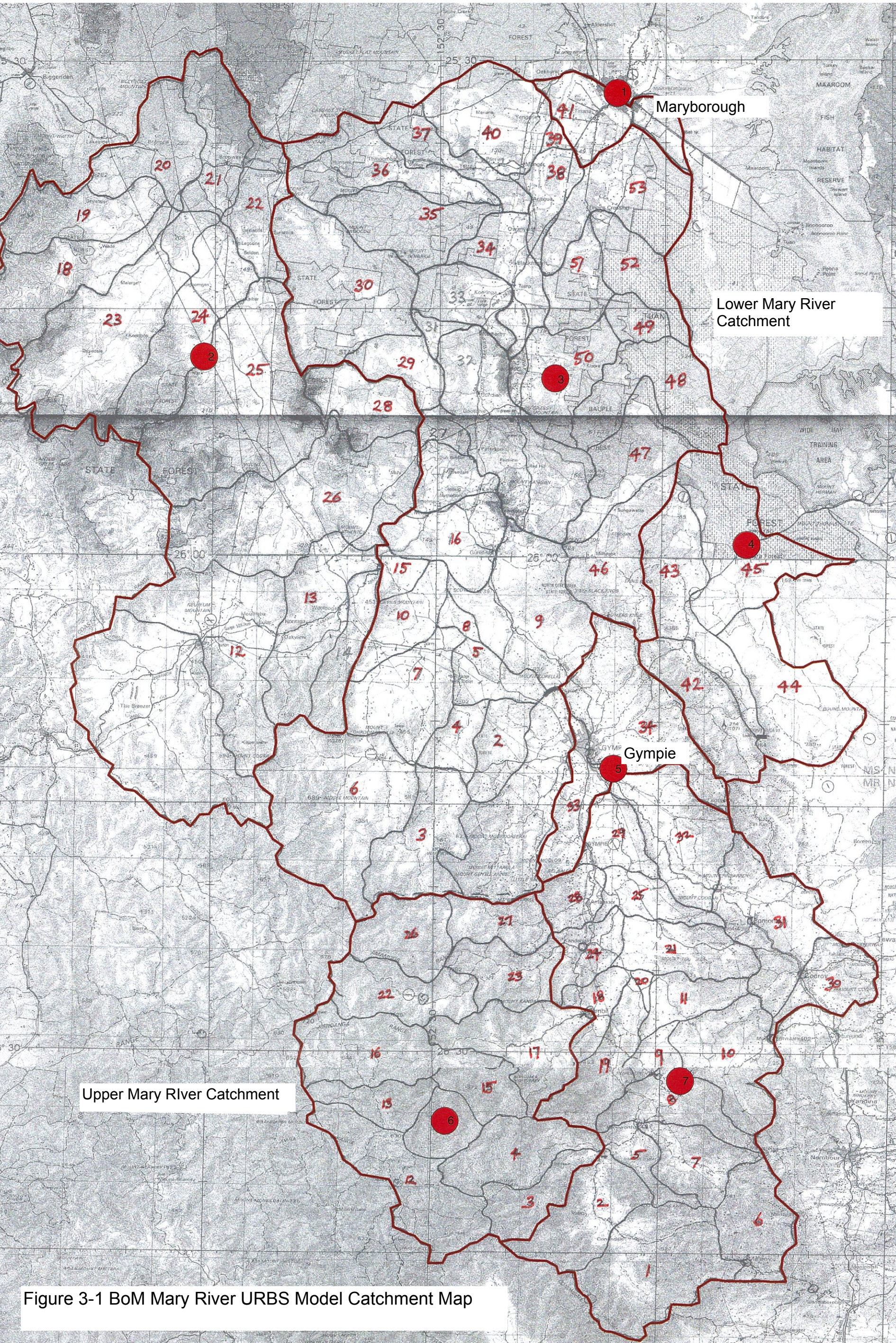


Figure 3-1 BoM Mary River URBS Model Catchment Map

4. Hydrologic Modelling of Design Events

4.1 Introduction

A design flood is a hypothetical flood that has been determined for the purpose of floodplain management and planning. Design floods are typically assigned a probability of occurrence that is specified as an Average Recurrence Interval (ARI) or as an Annual Exceedance Probability (AEP). ARI's are expressed as a percentage whilst AEP's are expressed in years. Table 4-1 provides a description of the design floods assessed in this study.

Table 4-1 Description of Design Flood Terminology

AEP	ARI	Description
50%	2 years	The best estimate of a flood which has 1 chance in 2 of occurring in any one year. This flood is likely to occur on average once every 2 years.
20%	5 years	The best estimate of a flood which has 1 chance in 5 of occurring in any one year. This flood is likely to occur on average once every 5 years.
5%	20 years	The best estimate of a flood which has 1 chance in 20 of occurring in any one year. This flood is likely to occur on average once every 20 years.
2%	50 years	The best estimate of a flood which has 1 chance in 50 of occurring in any one year. This flood is likely to occur on average once every 50 years.
1%	100 years	The best estimate of a flood which has 1 chance in 100 of occurring in any one year. This flood is likely to occur on average once every 100 years.
0.2%	500 years	The best estimate of a flood which has 1 chance in 500 of occurring in any one year. This flood is likely to occur on average once every 500 years.
	PMF	A hypothetical extreme flood used where a high level of safety is required.

It is important to note that (for example) the 100 year ARI event occurs once **on average** in 100 years and therefore may occur more than once in a 100 year period.

4.2 Philosophy

A range of factors affects the accuracy of hydrologic predictions. These include:

- The length and quality of historic streamflow and rainfall records;
- Natural climatic variability; and
- Changes to the catchment and waterway.

With a basis in statistics, each and every event may therefore alter future predictions from that point in time.

With respect to Mary River, flood levels have been gauged (measured) at Maryborough up to a height of 10.88m AHD. Therefore, any predictions above this magnitude are determined on the basis of extrapolation, and are also subject to change of development features adjacent to the gauging stations.

Hence, the prediction of design flow has a certain level of accuracy associated with it. In the case of the Mary River, this uncertainty has the potential to affect future planning decisions, and the definition of flood affected properties.

Design flood flows can be determined through the use of a calibrated hydrologic model. This requires adopting appropriate design rainfall distributions, rainfall depths, rainfall losses and temporal patterns.

In this study, the calibrated BoM URBS-CM model has been used to simulate design flood events and to determine appropriate design flood flows. A description of the key hydrologic design parameters used in the model is provided in Sections 4.3 to 4.6.

4.3 Design Rainfall Depths

Design rainfall depths have been calculated by:

- Using the IFD method as outlined in Australian Rainfall and Runoff (IEAust, 1998); and
- Adopting CRC-FORGGE point rainfall estimates.

These are discussed below.

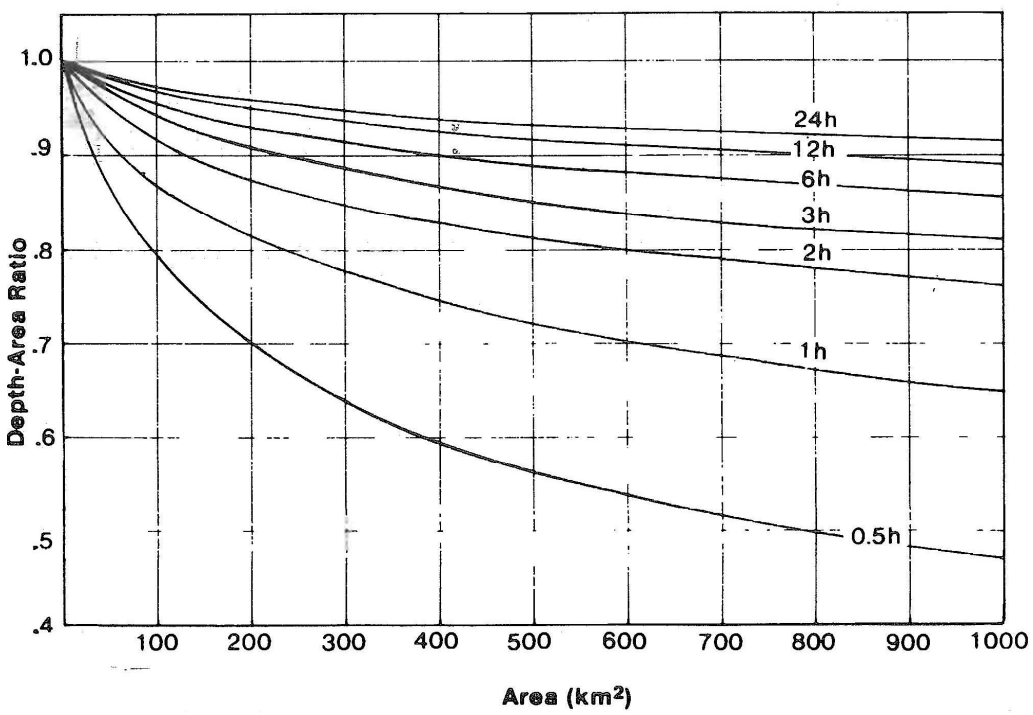
4.3.1 ARR Intensity Frequency Duration (IFD) Rainfall Estimates

In order to determine design rainfall depths across the Mary River catchment, rainfall Intensity Frequency Duration (IFD) values were calculated at the centroid of each of the 89 model sub-catchment according to the methods outlined in Australian Rainfall and Runoff (IEAust, 1998).

However, IFD derived rainfall depths are strictly applicable to a single point only. For larger areas (e.g. an individual sub-catchment) it is not realistic to assume that the same rainfall intensity will occur over the entire area, thus some reduction is usually made.

Reduced rainfall estimates are normally obtained by multiplying point rainfall estimates by an Areal Reduction Factor (ARF) (or a Depth Area Ratio) or by formula. ARF's are provided as Figure 1.6 in Book 2 of Australian Rainfall and Runoff (IEAust, 1998). Figure 1.6 is reproduced as Figure 4-1 below.

Figure 4-1 Areal Reduction Factors (Source: ARR, 1998)



As Figure 4-1 illustrates, ARF's approach unity as the duration of a storm increases and as the size of a catchment becomes smaller.

In this study, ARF's were not applied to point rainfall estimates because:

- Preliminary hydrologic investigations revealed that the critical storm duration would be greater than 24 hours;
- The average size of sub-catchments is approximately 100km^2;
- ARF's would be close to unity.

The design rainfall depths determined for each model sub-catchment are provided in Appendix C.

4.3.2 CRC-FORGE Rainfall Estimates

CRC-FORGE rainfall data is a statistical (regional) analysis of data from daily read rainfall stations. CRC-FORGE offers values for event durations from 24 hours to 120 hours (5 days), and the AEP (annual exceedance probability) range from 1 in 50 to 1 in 2000. The method has been applied to parts of Australia by the CRC for Catchment Hydrology (CRCCH), and subsequently applied in Queensland by DNRM.

CRC-FORGE method uses the concept of an expanding region focussed at the site of interest. Design rainfall estimates for frequent events (e.g. 1 in 50 AEP) are based on pooled data from a few gauges around the focal point, while design rainfall estimates

at the AEP limit of extrapolation are based on pooled rainfall data from up to several hundred gauges. Before the data from different sites can be pooled, maximum annual rainfalls from each site need to be standardised by an “index variable”.

Therefore, in the AEP range 1 in 50 to 1 in 100, CRC-FORGE method represents an alternative analysis based on more up-to-date daily rainfall data for individual stations when compared with ARR (IEAust, 1998). For these reasons, the Queensland partners of CRCCH have rejected the CRCCH recommendation to base the CRC-FORGE output on the existing ARR data for AEP 1 in 50. Instead, the Queensland protocol is to base rainfalls on CRC-FORGE, and provide for short durations and frequent events by applying factors derived from ARR in a similar manner to that adopted in Book VI (DNRM, 2002).

In order to test the sensitivity of the model to the applied rainfall depths, the hydrologic model was also run with 50 and 100 year ARI CRC-FORGE rainfall depths applied to each sub-catchment. The 50 and 100 year ARI CRC-FORGE rainfall depths are presented in Appendix C.

4.4 Design Rainfall Losses

Table 4-2 indicates the initial and continuing losses adopted for design runs. These values fall within the ranges identified in Australian Rainfall and Runoff (IEAust, 1998).

Table 4-2 Design Rainfall Losses

ARI (years)	Loss Case 1		Loss Case 2	
	Initial Loss (mm)	Continuing Loss (mm/hr)	Initial Loss (mm)	Continuing Loss (mm/hr)
50 year	0	2	12	2
100 year	0	2	10	2

4.5 Design Temporal Patterns

The hydrologic model was run for design storm durations of 12, 18, 24, 36, 48, 72 and 96 hrs. The design temporal patterns corresponding to each of these durations were extracted from Australian Rainfall and Runoff (IEAust, 1998). The 96 hour temporal pattern was generated by modification of the 72 hour temporal pattern.

The sensitivity of the model to the adopted design storm temporal pattern was tested by:

- Modifying the 1955 temporal pattern used in BoM's hydrologic model (recorded at Sommerset Dam) to fit each design storm duration; and
- Running the hydrologic model for all design events with the modified 1955 temporal patterns.

4.6 Design Flow Estimates

Hydrographs have been determined throughout the Mary River catchment using the calibrated hydrologic model for each of the design events for the scenarios listed in Table 4-3.

Table 4-3 Design Event Scenarios

Scenario No.	Rainfall Source	Loss Case	Initial Loss (mm)	Continuing Loss (mm)	Temporal Pattern Source
Scenario 1	ARR (IFD)	1	0	2	ARR
Scenario 2	ARR (IFD)	2	10	2	ARR
Scenario 3	ARR (IFD)	2	10	2	1955 Event
Scenario 4[#]	CRC-FORGE	1	0	2	ARR

Notes: # 50 and 100 year ARI event only.

The peak flow rates estimated to occur at the Maryborough Gauge in the city of Maryborough for each of the scenarios described above are presented in Table 4-4 to Table 4-7.

Results indicate that maximum peak flows at Maryborough result from Scenario 1 and Scenario 3 for design storms of 72 hours duration. Furthermore, the flow rates predicted from the hydrologic model for these Scenarios most closely match the peak flows determined from flood frequency analysis of the Maryborough Gauge data (refer Section 8). Consequently, hydrographs resulting from Scenarios 1 and 3 have been applied as inflow hydrographs at the upstream boundary of the hydraulic model to estimate design event flood levels for these cases.

Because of their relatively smaller catchment size, the critical storm durations for Saltwater Creek and Tinana Creek were less than 72 hours. As such, hydrographs for smaller duration storms were also extracted from the hydrologic models and applied as boundary conditions in the hydraulic model.

Table 4-4 Peak Flow Estimates at Maryborough - Scenario 1

ARI	Peak Design Flows (m^3/s)				
	24 hour	**36 hour**	**48 hour**	**72 hour**	**96 hour**
50 year	8104	8677	9006	9907	7878
100 year	9409	10166	10650	11912	9668

Table 4-5 Peak Flow Estimates at Maryborough - Scenario 2

ARI	Peak Design Flows (m^3/s)				
	24 hour	**36 hour**	**48 hour**	**72 hour**	**96 hour**
50 year	7742	8365	8707	9582	7625
100 year	9112	9908	10397	11644	9459

Table 4-6 Peak Flow Estimates at Maryborough - Scenario 3

ARI	Peak Design Flows (m^3/s)				
	24 hour	**36 hour**	**48 hour**	**72 hour**	**96 hour**
50 year	8371	9546	10279	10966	9775
100 year	9725	11141	12067	13009	11829

Table 4-7 Peak Flow Estimates at Maryborough - Scenario 4

ARI	Peak Design Flows (m^3/s)				
	24 hour	**36 hour**	**48 hour**	**72 hour**	**96 hour**
50 year	5458	-	8264	8653	7535
100 year	8801	-	9797	10466	9192

4.7 Climate Change Assessment

The impact of climate change on the 100 year ARI design event flood has been assessed in accordance with the methodology provided in the following Queensland Government report:

Increasing Queensland's resilience to inland flooding in a changing climate: Final Scientific Advisory Group (SAG) report—Derivation of a rainfall intensity figure to inform an effective interim policy approach to managing inland flooding risks in a changing climate (Queensland Government, Department of Environment and Resource Management, Department of Infrastructure and Planning & Local Government Association of Queensland, 2010)

The SAG report recommends that for the 100 year ARI design event, rainfall intensities for all durations should be increased by 5% per degree of global temperature increase when assessing the impact of climate change. The report indicates global temperature increases of approximately 2 degrees by 2050 and 4 degrees by 2100 which corresponds to rainfall intensity increases of 10% and 20% respectively.

Therefore, in order to assess the impact of climate change on design event flood flows, the Scenario 1 hydrologic model was run for the 100 year ARI 72 hour design event for the following climate change scenarios:

- 10% increase in rainfall intensity (corresponding to the 2050 climate change scenario); and
- 20% increase in rainfall intensity (corresponding to the 2100 climate change scenario).

The change in flow rates predicted at the Maryborough Gauge are provided in

Table 4-8 for these two climate change scenarios.

Table 4-8 100 year ARI Climate Change Peak Flow Estimates at Maryborough

Rainfall	Peak Flow Rate (m^3/s)	% Change in Peak Flow
Base Case*	11,912	0%
+10% Rainfall Intensity	13,243	+11%
+20% Rainfall Intensity	14,760	+24%

Note: The Base Case = Scenario 1 as described in Table 4-3.

5. Development of 2D Hydraulic Model

5.1 Methodology

In the Mary River Flood Study (GHD, 2005), flooding along the Mary River and adjacent floodplain was modelled using a calibrated 2D hydraulic model. The model was developed using the Delft Flooding System Delft-FLS (Delft, 2001).

As part of this study, completely new 1D/2D hydraulic models of the Mary River floodplain were developed using the TUFLOW hydraulic modelling platform. The revised hydraulic models were built using more recent aerial survey data and recently obtained bathymetric data.

A TUFLOW hydraulic model with a cell size of 20m was constructed to simulate flooding over a study area that extended from the Barrage downstream to the river mouth whilst a "nested" model with a cell size of 5m was built to provide a greater level of resolution around the city of Maryborough. Boundary conditions consisted of tide levels at the downstream extent of the hydraulic model and inflow hydrographs derived from the URBS hydrological model described in Sections 3 and 4.

The calibration of the TUFLOW hydraulic model was undertaken against recorded 1955 flood levels. Model calibration was achieved by adjusting floodplain and river roughness coefficients to within realistic limits. The model calibration was verified against the 1999 flood event. The 50 and 100 year ARI design events were then simulated using the calibrated hydraulic model to estimate design event flood levels and velocities.

The performance of the TUFLOW model was validated by development of an independent 2D MIKE21 hydraulic model. The MIKE21 model was built using the same set of model inputs that were used to construct the TUFLOW model.

5.2 TUFLOW Overview

Hydraulic modelling has been undertaken with the TUFLOW software package. TUFLOW is a hydraulic modelling package developed by WBM-BMT that integrates one-dimensional and two-dimensional schematisations into a single, dynamically coupled hydraulic modelling system that is capable of unsteady flow calculations.

An essential component of TUFLOW is the generation of digital elevation model (DEM) files that represent the terrain and roughness of the modelled region.

Boundary Conditions are specified in the model at selected locations. The range of boundary condition types includes water levels, discharges, velocities and stage-discharge relationships.

TUFLOW computes velocity and water depth at every nodal point in a model grid for each time step and produces a corresponding output file. The specification of "monitoring stations" and "cross sections" can also be used to obtain a time history of water depth, velocity and discharge at desired locations.

5.3 Model Extent

A TUFLOW hydraulic model with a cell size of 20m was constructed to simulate flooding over a study area that extended from the Barrage downstream to the river mouth whilst a model with a cell size of 5m was built to provide a greater level of resolution around the city of Maryborough. The extent of the 5m and 20m grid cell TULFOW models are provided in Figure 5-1. Results from the 20m grid cell model were used to inform the boundary conditions of the 5m model.

5.4 Digital Elevation Model (DEM)

Digital elevation models were generated for the 5m and 20m cell size hydraulic models using the digital data described in Sections 2.3 and 2.4. The data sources used to create the model DEM are provided in Figure 5-2.

The DEM's were created using 12D, ARC GIS and MapInfo software. A significant amount of time and effort was taken to create the river bathymetry to ensure that the channel was represented as accurately as possible in both the 5m and 20m cell size models.

5.5 Floodplain and River Roughness Coefficients

Manning's roughness coefficients were determined through a field inspection of the river and floodplain. In addition, recent aerial photographs were used for further assessment and comparison of the assigned roughness values.

Manning' roughness coefficients were adjusted within practical limits as part of the preliminary calibration process. The calibrated roughness values were then used in simulating the design events.

Roughness coefficients ranged from 0.025 in the river and 0.05 to 0.12 on the floodplain. The spatial distribution of roughness coefficients adopted in the hydraulic models is provided in Figure 5-3.

5.6 Boundary Conditions

The upstream boundary conditions applied to the hydraulic models included discharge hydrographs for Mary River, Tinana Creek and Saltwater Creek.

Hydrographs were extracted from the calibrated URBS-CM model at locations including the Barrage and downstream of Teddington (refer Figure 5-1). Hydrographs for Saltwater Creek were derived from an existing Council model (XP-Rafts) of Saltwater Creek.

The relative timing of catchment flows from the Mary River, Tinana Creek and Saltwater Creek has been taken into account by application of the fully dynamic flow hydrographs (as predicted by the hydrologic models) to the hydraulic model.

The boundary conditions applied at the downstream end of the river system for the 20m cell size hydraulic model are described in Table 5-1.

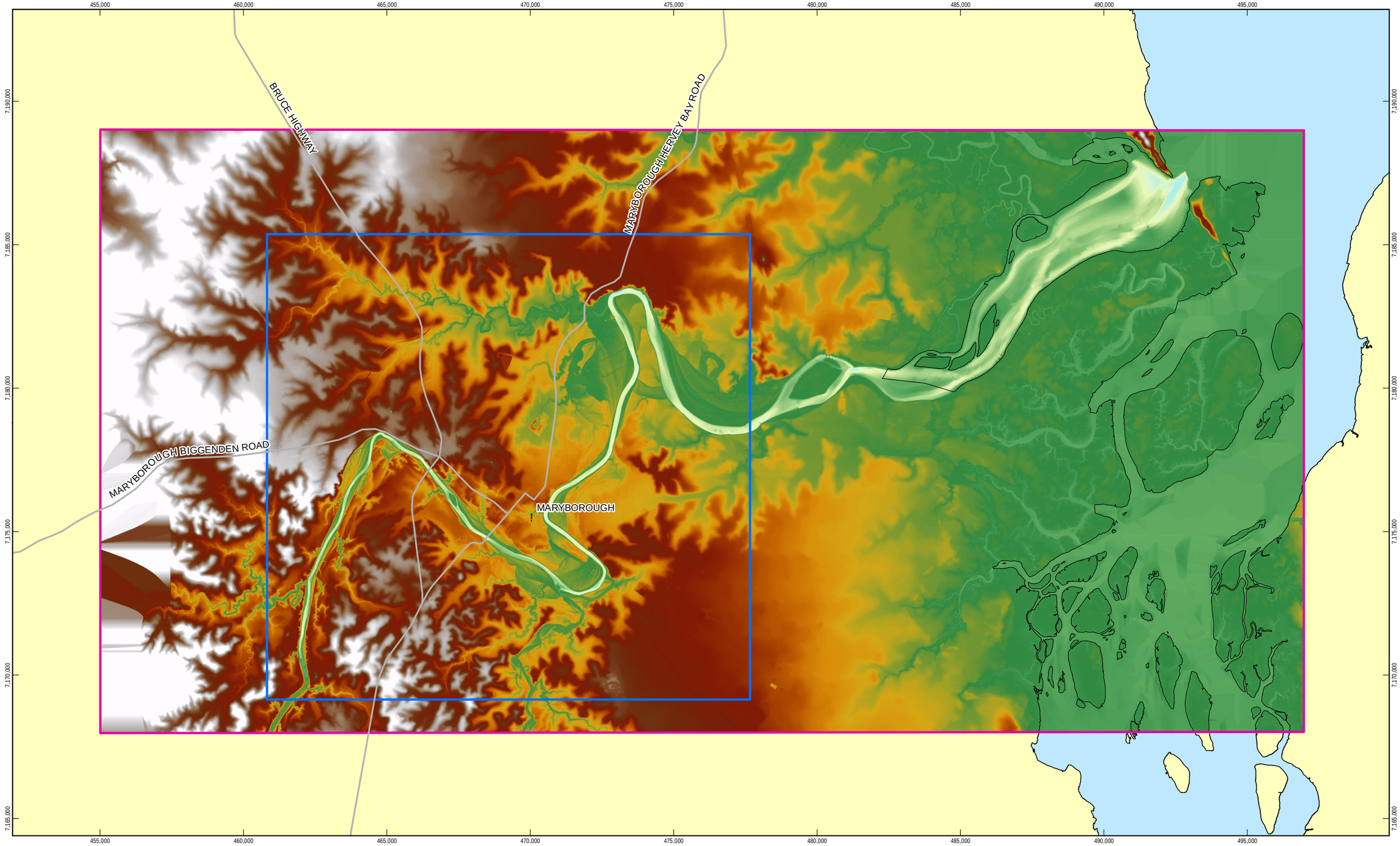
Table 5-1 Regional Hydraulic Model Tailwater Conditions

Event	Tailwater Level	Tailwater Comment
1955	1.0 m AHD	Nominal Sea Level at River Heads
50yr ARI	1.0 m AHD	Nominal Sea Level at River Heads
100yr ARI	1.0 m AHD	Nominal Sea Level at River Heads
100yr ARI	2.7 m AHD	Highest Astronomical Tide (H.A.T.)
100yr ARI + 10%RI	2.7 m AHD	Highest Astronomical Tide (H.A.T.)
100yr ARI + 10%RI	3.5 m AHD	H.A.T. + Sea Level Rise of 800mm

Note: +10%RI = 10% Increase in Rainfall Intensity Climate Change Scenario.

It is noted that for the “nested” hydraulic models with 5m cell size, dynamic tailwater levels were obtained at the downstream boundary by extracting a time series of flood levels from the 20m cell size hydraulic models at this location.

A sensitivity analysis of the adopted tailwater level was undertaken and is described in Section 7.5



1:120,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- ! Locality
- Major Road
- *5m Cell Size Model Extent*
- 20m Cell Size Model Extent
- Fraser Coast Regional Council

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Mary River Flood Study

Job Number	41-23825
Revision	0
Date	07 Dec 2011

2D Hydraulic Model Extent

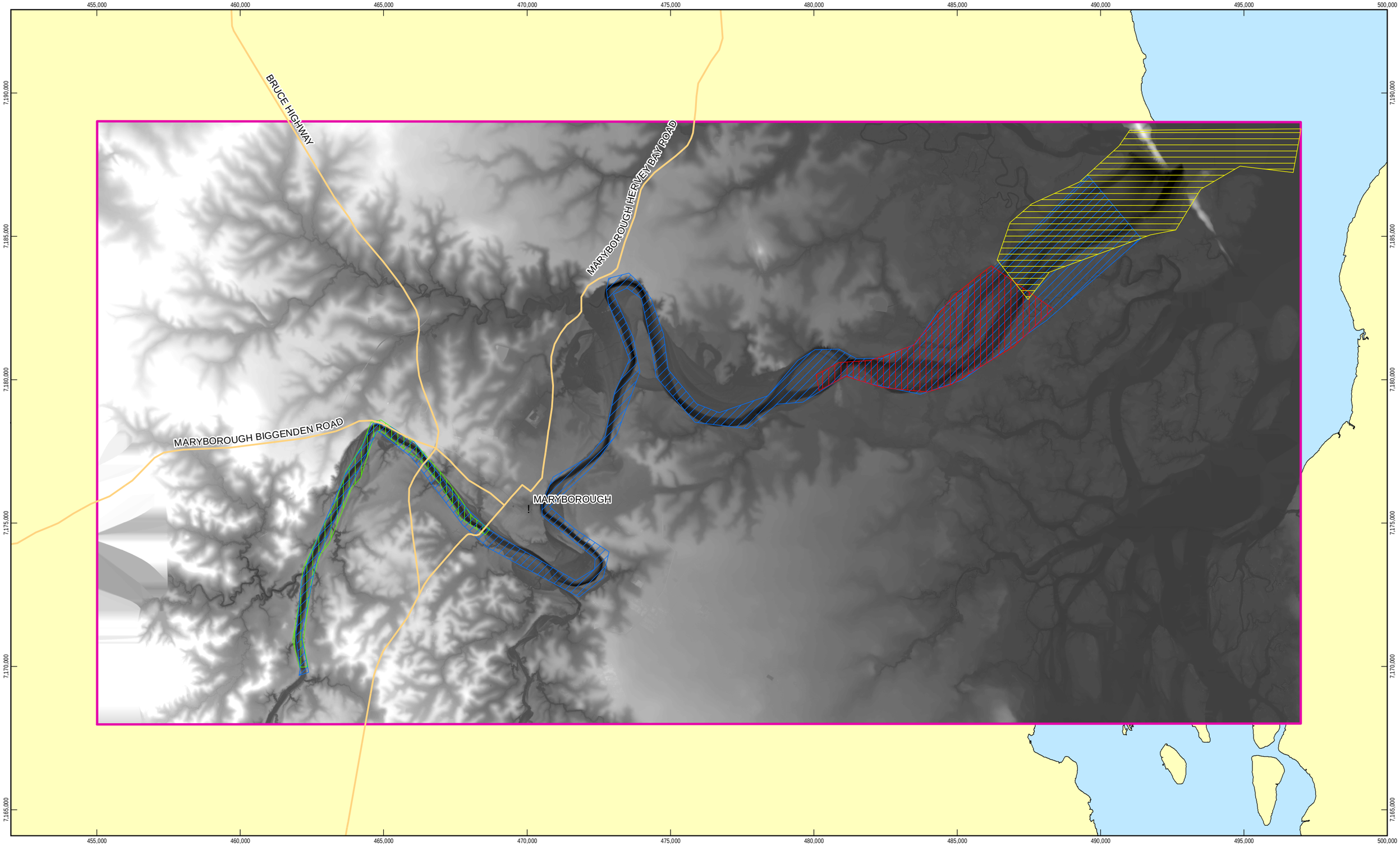
Figure 5-1

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Data source: Data Custodian, Data Set Name/Title, Version/Date.

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1:120,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

! Locality

Major Road

Survey Data Source

Marine Safety Queensland

Byrne Brothers

Cullen & Couper Pty Ltd

DHI CMap

Aerial Survey

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DEM Data Sources

Figure 5-2

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Data source: GA - Locality/2007, Roads/2007; ASGC - State Boundary/2009

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460,000 462,000 464,000 466,000 468,000 470,000 472,000 474,000 476,000 478,000

7,184,000 7,182,000 7,180,000 7,178,000 7,176,000 7,174,000

MARYBOROUGH

1:50,000 (at A3)

0 1 2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Locality
- Major Road

Hydraulic Roughness (Manning's 'n')

- 0.0265
- 0.1
- 0.02
- 0.045
- 0.06
- 0.08
- 0.1

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Floodplain Roughness Map

Figure 5-3

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model/2011

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6. 2D Hydraulic Model Calibration

6.1 Calibration Methodology

Calibration of the hydraulic model was undertaken by adopting the following procedure:

- Review of available historical flood data;
- Selection of appropriate calibration events based on the availability of good quality recorded flood level information;
- Undertake calibration of the TULFOW model by adopting appropriate model parameters (e.g. hydraulic roughness);
- Present calibration results to Council for review;
- Complete calibration of model based on Council's review;

6.2 Selection of Calibration Events

There are a number of flood events that were considered for calibration purposes. A list of flood events exceeding 7.0m AHD (at the Maryborough gauge) is provided in Table 6-1.

Table 6-1 Potential Calibration Flood Events

Event	Flood Level (gauge height*)
1893 Feb 5	12.27
1898 Jan 12	9.71
1931 Feb 07	7.22
1955 Mar 29	11.25
1956 Mar 13	7.49
1968 Jan 12	9.25
1973 July 10	7.72
1974 Jan 29	10.95
1991 Feb 24	9.50

Note: * Gauge heights are 1.39m higher than AHD.

The selection of calibration events is largely governed by:

- The availability of good quality recorded flood level information;
- The availability of reliable anecdotal evidence;
- The availability and quality of hydrologic data such as rainfall and stream gauge records.

The main sources of flood information for the Maryborough region were the Bureau of Meteorology and Maryborough City Council.

The BoM operates a gauge in Maryborough (Gauge No. 040443). The location of this gauge is shown in Figure 5-1. The BoM is also responsible for the operation of several other gauges at upstream locations including the Barrage (59.3 km AMTD, Mary River) and Teddington (15.9km AMTD, Tinana Ck)

Fraser Coast Regional Council have a reasonable record of spot flood level data for both the river and floodplain for the 1955 event (refer Appendix D). Council have only a limited collection of anecdotal flood information for other flood events.

It was decided that the March 1955 flood event would be used for hydraulic model calibration because it had the most comprehensive availability of flood level records and because of the relatively large magnitude of the event.

6.3 March 1955 Flood Event Calibration

A good calibration to the March 1955 event was achieved as shown in Figure 6-1 and Figure 6-2. Figure 6-1 illustrates that there is close agreement between the modelled and recorded peak flood levels at most locations on the floodplain. Figure 6-2 shows that there is a close agreement between the calibrated hydrologic and hydraulic models in terms of the model predicting the 1955 hydrograph at Maryborough.

It is noted that some relatively larger discrepancies exist between modelled and "recorded" 1955 flood levels at some locations along the river and particularly upstream of Henry Palmer Bridge. FCRC have indicated that the 1955 flood levels within the river and upstream of Henry Palmer Bridge have been estimated by interpolation and extrapolation of flood levels recorded on the floodplain. The difference between these modelled and "recorded" 1955 flood levels is likely to be a direct result of these estimation methods.

Differences between the recorded and modelled March 1955 flood levels at all locations could also be attributed to a number of other factors. These include:

- Lack of detailed topographic information (e.g. aerial survey) during 1955;
- Lack of detailed bathymetric survey for 1955;
- Errors in topographic and bathymetric data;
- Problems in quantifying the extent of morphological change that has occurred over time;
- State of vegetation (simulated through the use of roughness factors) at the time of the flood;
- Errors in land usage assumption and consequently in estimating corresponding roughness coefficients;
- Errors in the magnitude and timing of recorded flood levels;

- Differences between the recorded and modelled rating curves could be due to uncertainties associated with the conversion of gauged flood levels to discharges at high flows given that high flood flows tend to break the river banks and become dispersed on the floodplain.

6.4 2D Hydraulic Model Calibration Parameters

Calibration of the hydraulic model was mostly achieved by adjustment of the Manning's 'n' value to within reasonable limits. The Manning's 'n' value is a measure of the hydraulic 'roughness' or resistance to flow associated with land forms such as vegetation, buildings and other structures.

The Manning's 'n' values that provided the best calibration to the 1955 flood event are provided in Table 6-2.

Table 6-2 Adopted Manning's 'n' Values

Location	Manning's 'n'
Urban Areas	0.10
Dense Vegetation	0.12
Rural Residential	0.05
Crop	0.05
Pastures	0.045
Water Bodies	0.025-0.030

The spatial distribution of the Manning's 'n' values have been previously presented in Figure 5-2.

6.5 2D Hydraulic Model Validation

In light of the available data, a good calibration to the March 1955 flood event has been achieved. The calibration has also been verified by simulation of the January 1999 historical flood event. The calibrated hydraulic model was able to reproduce 1999 event historical flood levels to an acceptable level of accuracy.

The performance of the TUFLOW model was also validated by development of an independent 2D MIKE21 hydraulic model. The MIKE21 model was built using the same set of model inputs that were used to construct the TUFLOW model and produced a similar set of results to the TULFOW model.

Given that the hydraulic models were able to estimate historical flood levels with an acceptable level of accuracy and were verified with an independent hydraulic model, the calibrated TUFLOW models are deemed a suitable tool for estimation of design event flood levels, extents, velocities and hazard.

Note: This map illustrates the difference between modelled and recorded flood levels for the 1955 historical flood event.

457,000 460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000

7,182,000 7,179,000 7,176,000 7,173,000 7,170,000

0.71 0.21 0.15 -0.16 -0.28 0.86 -0.14 -0.37 -0.29 -0.07 -0.04 0.65 0.58 -0.12 -0.01 0.06 -0.07 -0.05 0.62 0.55 0.48 0.48 0.57 0.76 -0.33 -0.32 -0.29 -0.25 -0.22 -0.29 -0.42 0.09 0 -0.29 -0.29 -0.17 -0.17 0.57 0.44 0.32 0.28 0.26 -0.55 -0.12 -0.41 -0.05 -0.09 -0.12 -0.15 -0.12 -0.2 0.25 0.29 -0.29 0.1 0.1

1:65,000 (at A3)

0 1.5 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Flood Level Difference

1955 Modelled - Recorded (m)

- -0.5 to -0.2
- -0.2 to 0.2
- 0.2 to 0.4
- 0.4 to 0.5
- All Other

Flood Level (m AHD)

- 1.00 - 2
- 2.01 - 3
- 3.01 - 4
- 4.01 - 5
- 5.01 - 6
- 6.01 - 7
- 7.01 - 8
- 8.01 - 9
- 9.01 - 10
- 10.01 - 11
- 11.01 - 12
- 12.01 - 13
- 13.01 - 14
- 14.01 - 15
- 15.01 - 16
- 16.01 - 17

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1955 Flood Calibration Map (City Focus)

Figure 6-1

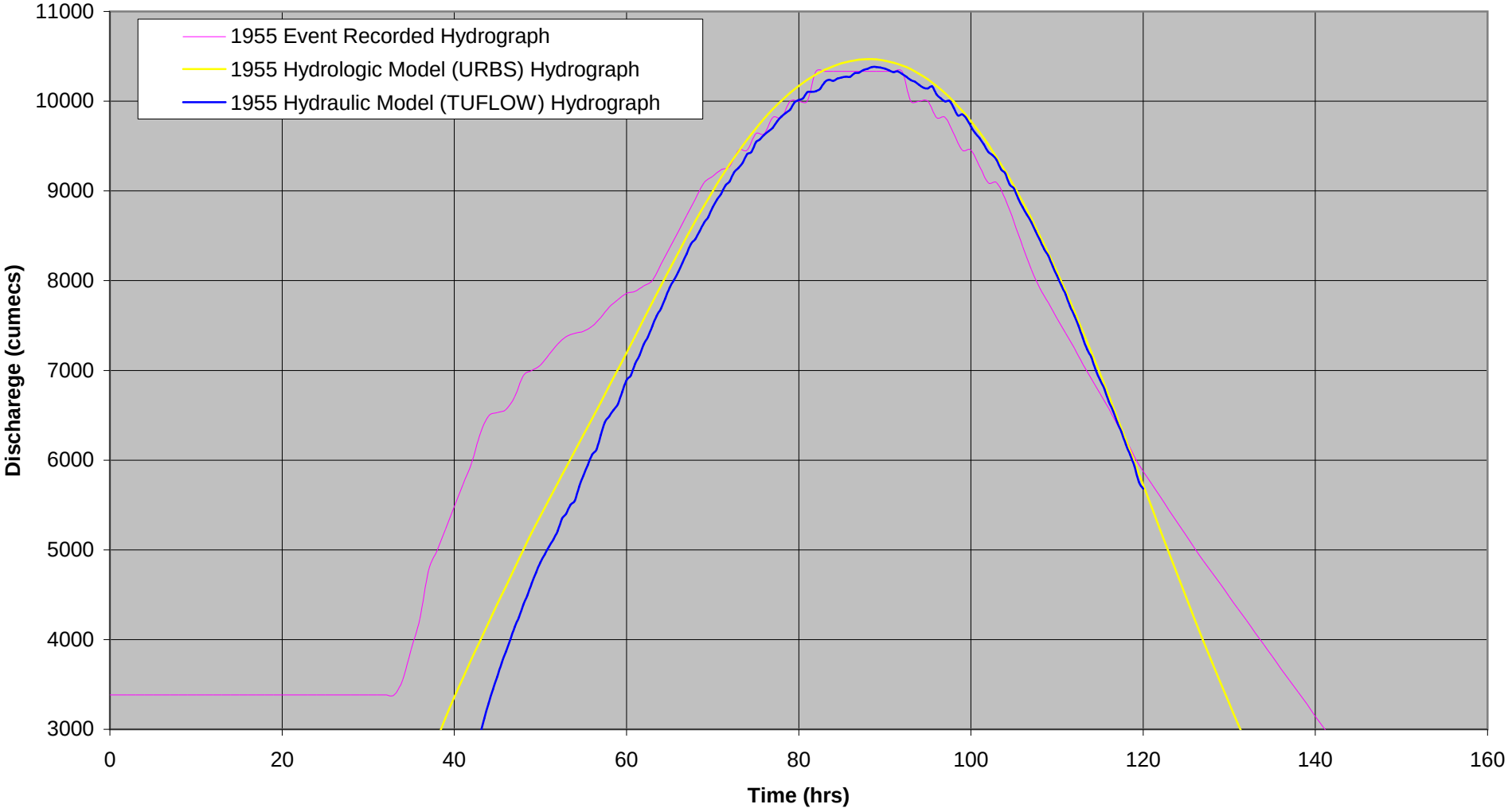
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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model/2011

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Figure 6.2 Calibrated Model Hydrographs (Maryborough)



7. Hydraulic Modelling of Design Events

7.1 Design Event Boundary Conditions

The 2D hydraulic model has been used to determine flood levels, flood depths and velocities for the 50 and 100 year ARI design events.

The upstream boundary conditions applied to the hydraulic model included discharge hydrographs for Mary River, Tinana Creek and Saltwater Creek. These hydrographs were extracted from:

- The calibrated BoM URBS-CM model at locations including the Barrage and downstream of Teddington (refer Figure 5-1); and
- Councils model of Saltwater Creek.

Given that the Susan River discharges into the Mary River near the river mouth, flood discharges from the Susan River catchment have not been applied as inflow boundary conditions in the hydraulic model.

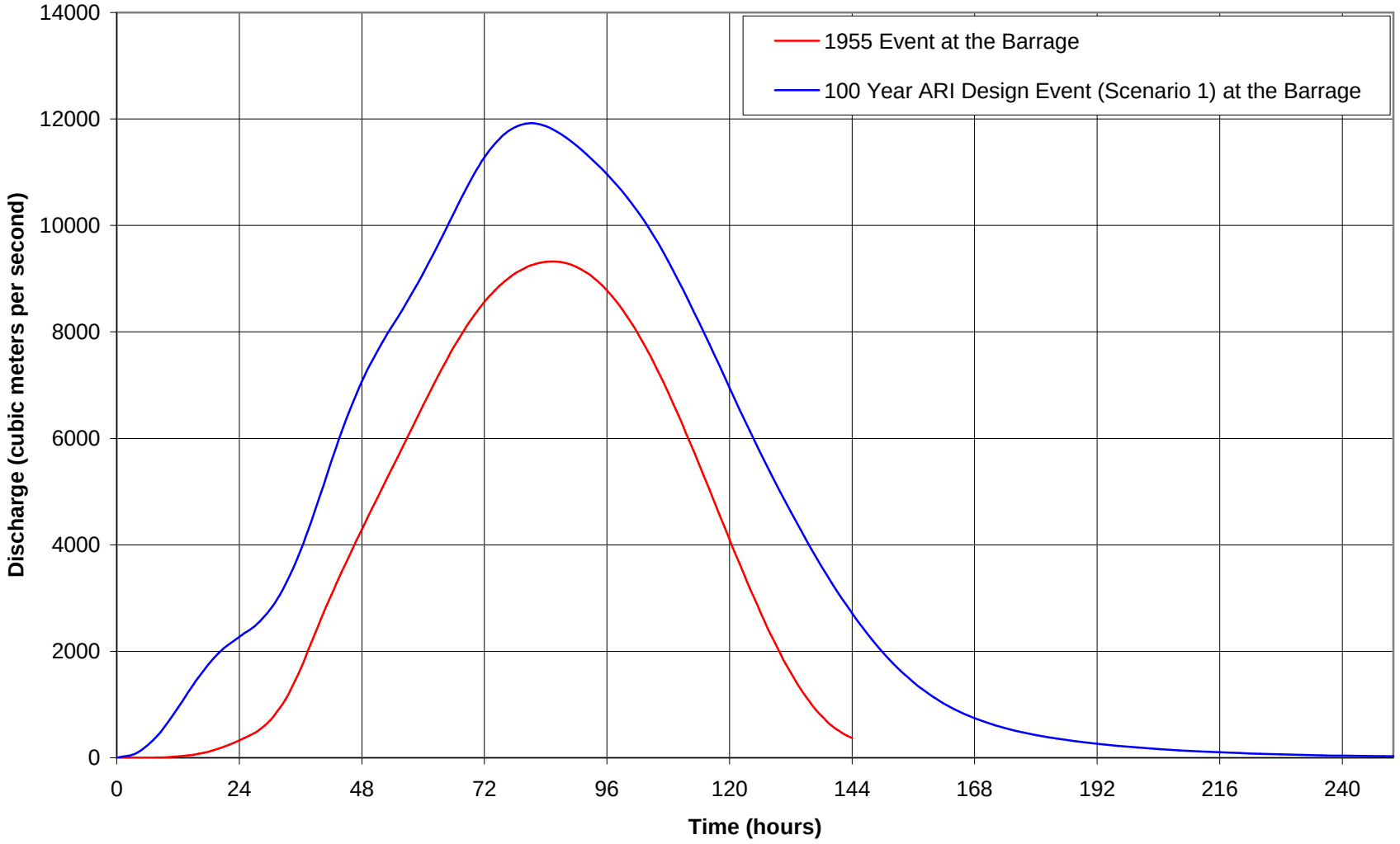
Table 7-1 lists the peak discharges of the hydrographs applied at the upstream boundaries of the model. Hydrographs for the 1955 flood event and the 100 year ARI design event (at the Barrage) are plotted in Figure 7-1.

Table 7-1 Applied Upstream Boundary Condition Peak Discharges

Event	Peak Discharge at The Barrage (m^3/s)	Peak Discharge downstream of Teddington (m^3/s)
1999 Flood	6,063	419
1992 Flood	7,046	405
1974 Flood	8,395	706
1955 Flood	9,324	1,166
50 year ARI Design	9,647	1,341
100 year ARI Design (Scenario 1)	10,521	1,455
100 year ARI Design (+10% Rainfall Intensity)	11,675	1,611

The downstream boundary conditions used in each of the design events are discussed in Section 5.6.

Figure 7.1 100 Year ARI Hydrographs (Mary River at the Barrage)



7.2 2D Hydraulic Model Results

Results from the hydraulic model are presented in this section for the March 1955 flood event and the 50 and 100 year ARI design events.

7.2.1 Flood Maps

The spatial distribution of peak flood levels, flood depths and flood velocities for both the 1955 historical event and design flood events are presented in Figures A1 to A17 in Appendix A. Flood hazard maps are also provided for the 50 and 100 year ARI design events. An index of these figures is provided in Table 7-2.

An analysis of peak flood level results indicates that the 72hour design event is the critical storm event that produces the highest flood levels in the study area. It is important to note that a "Peak" level refers to the maximum level experienced at a discrete point in the model domain and that peak levels may not occur at every location at the same point in time. Peak level maps therefore represent an envelope of maxima.

Table 7-2 Index of Flood Inundation Maps for Maryborough City

Figure No.	Flood Event	Map Centre	Map Type
A1	1955 Event	Regional Maryborough	Flood Level
A2	1955 Event	Maryborough City	Flood Level
A3	50yr ARI Design Event	Regional Maryborough	Flood Level
A4	50yr ARI Design Event	Regional Maryborough	Flood Depth
A5	50yr ARI Design Event	Regional Maryborough	Flood Velocity
A6	50yr ARI Design Event	Regional Maryborough	Flood Hazard
A7	100yr ARI Design Event	Regional Maryborough	Flood Level
A8	100yr ARI Design Event	Maryborough City	Flood Level
A9	100yr ARI Design Event	Maryborough City	Flood Depth
A10	100yr ARI Design Event	Maryborough City	Flood Velocity
A11	100yr ARI Design Event	Maryborough City	Flood Hazard
A12	100yr ARI Design Event Climate Change Scenario	Regional Maryborough	Flood Level
A13	100yr ARI Design Event Climate Change Scenario	Maryborough City	Flood Level
A14	100yr ARI Design Event Climate Change Scenario	Maryborough City	Flood Depth
A15	100yr ARI Design Event Climate Change Scenario	Maryborough City	Flood Velocity
A16	100yr ARI Design Event Climate Change Scenario	Maryborough City	Flood Hazard
A17	100yr ARI Design Event Climate Change Scenario	Maryborough City	Level Change
A18	1893 vs 100yr ARI Design Event	Maryborough City	Flood Extent

Figure No.	Flood Event	Map Centre	Map Type
A19	1893 vs 100yr ARI Design Event Climate Change Scenario	Maryborough City	Flood Extent
A20	50yr ARI Design Event	Maryborough City	Flood Levels on Cadastral Map
A21	100yr ARI Design Event	Maryborough City	Flood Levels on Cadastral Map
A22	100yr ARI Design Event Climate Change Scenario	Maryborough City	Flood Levels on Cadastral Map

7.2.2 Flood Profiles

Flood profiles for each of the design flood events are provided in Figure 7-2. Flood levels at key locations are summarised in Table 7-3 below.

Table 7-3 Predicted Flood Levels

Location	Mary River Flood Level (m AHD)			
	1955 Event	50 year ARI	100 year ARI	100 Year ARI (Climate Change)
Bruce Highway	11.52	11.81	12.27	12.91
Ferry Street	11.23	11.60	11.92	12.54
Tiger Street	9.97	10.43	10.73	11.36
Churchill St	9.44	9.97	10.28	10.94

7.2.3 Tailwater Sensitivity Analysis

The sensitivity of the 100 year ARI design event flood profile to adopted downstream tailwater conditions was tested by applying the following tailwater levels in the hydraulic model:

- 1.00m AHD (Nominal tailwater condition);
- 2.70m AHD (Highest Astronomical Tide); and
- 3.50m AHD (Highest Astronomical Tide + 800mm)

Flood profiles illustrating the result of this analysis are provided in Figure 7-3 for the 100 year ARI design event.

Results indicate that changes in the tailwater condition applied at the Mary River Mouth have a negligible impact on predicted flood levels upstream of the river bend located at Dundathu settlement (Chainage 30km AMTD).

7.2.4 Climate Change

The impact of climate change has been assessed in the hydraulic model by:

- Adopting the 2050 climate change scenario flow rates which are approximately 10% higher than existing conditions (refer Section 4.7), together with:
- Adopting a sea level rise of 0.8m above the Highest Astronomical Tide.

The increase in flood levels expected from this climate change scenario is provided in Figure A17. Results from the hydraulic model indicate that for this scenario, the 100 year ARI design event flood levels are predicted to increase by approximately 600mm in the vicinity of the City of Maryborough.

Figure 7.2 River Flood Profiles

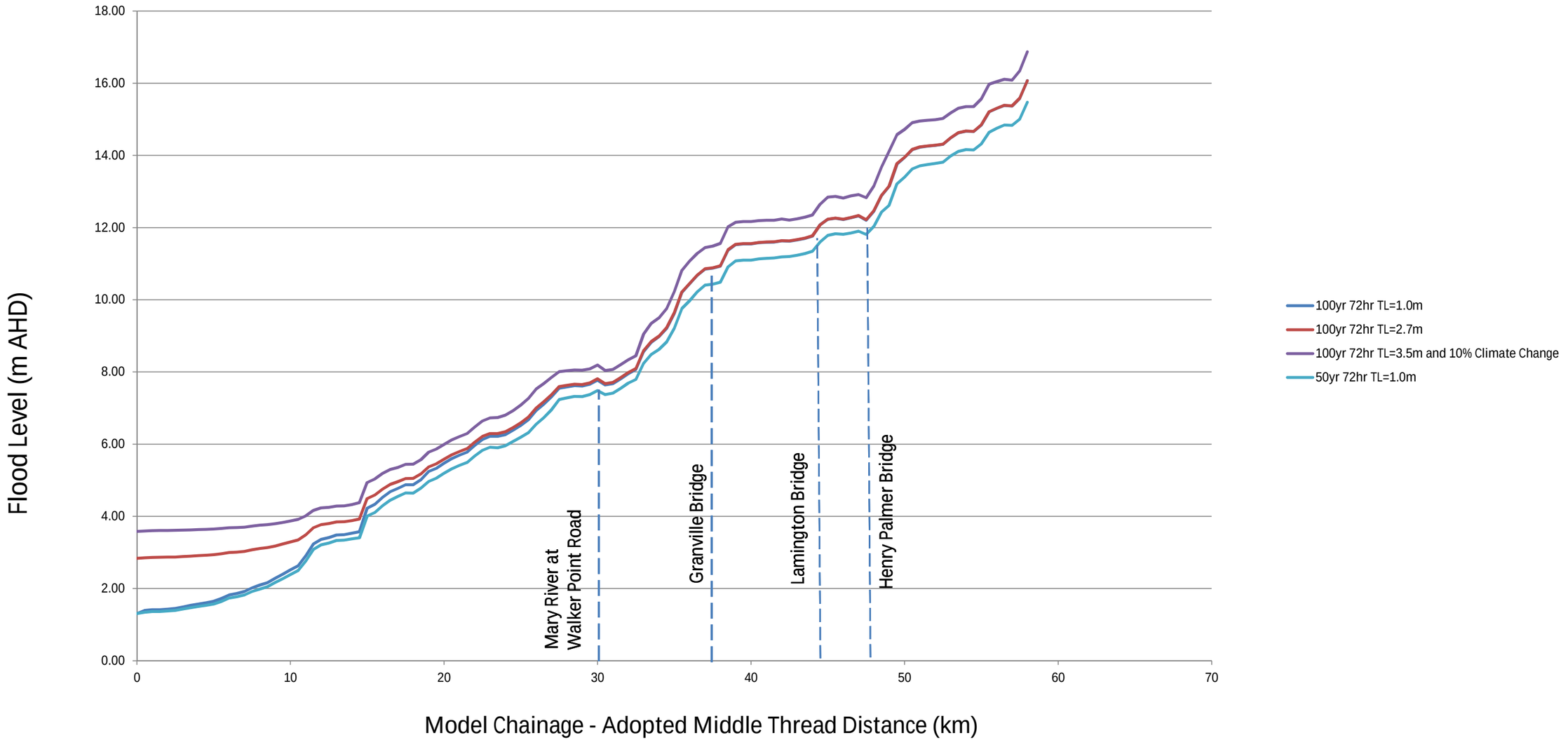
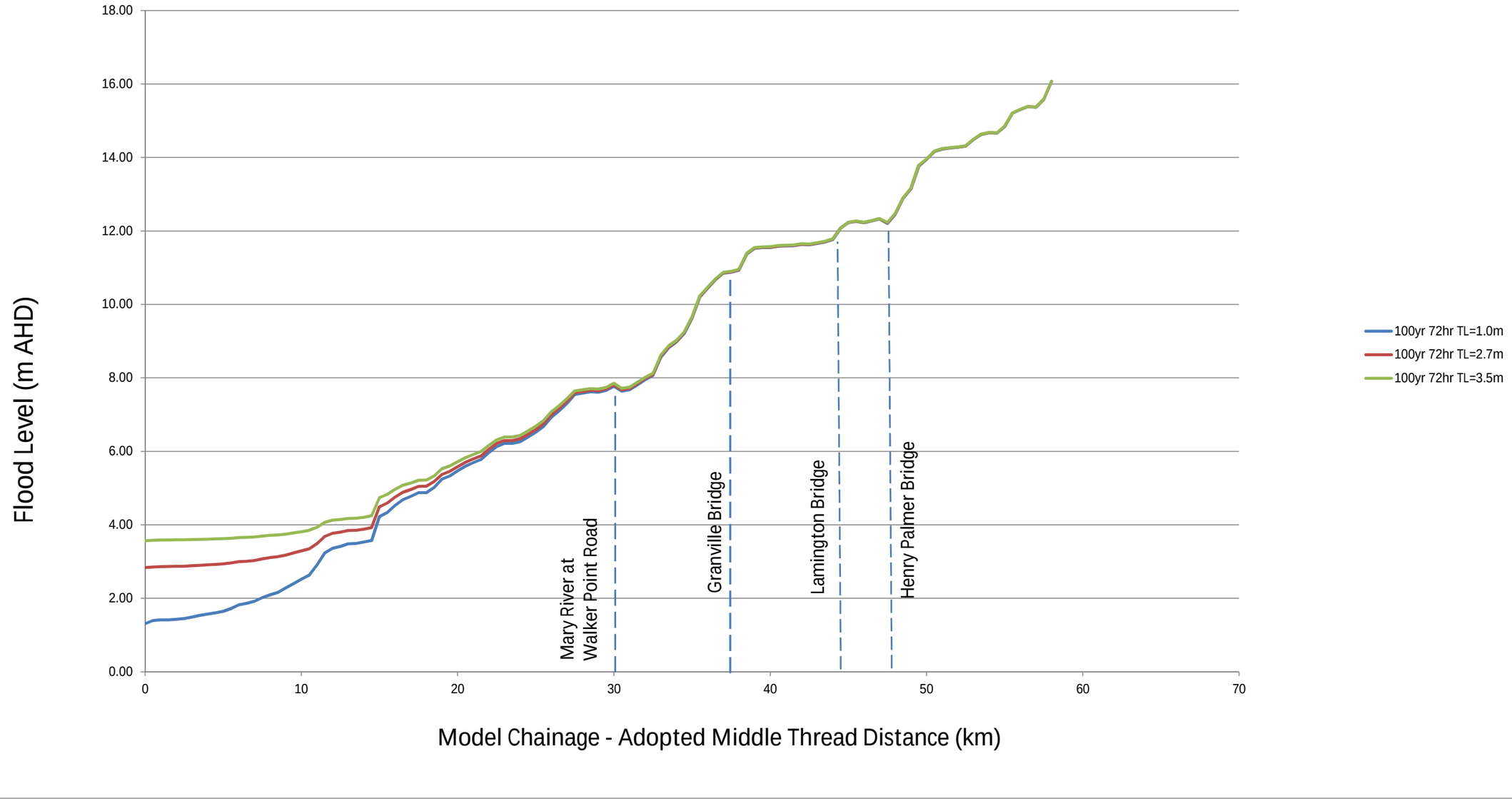


Figure 7.3 Tailwater Sensitivity Analysis



7.3 Comparison of Results to Previous Studies

A comparison of the results of this study to the results of the 2005 study is discussed below for the 1955 historical event and the 100 year ARI design event.

1955 Calibration Event

The level of calibration achieved for the 1955 historical event is considered to be good in both the 2005 and 2011 hydraulic models.

The flood levels predicted by the 2011 hydraulic model for the 1955 event are slightly lower than those predicted by the 2005 hydraulic model. However, the level of calibration achieved in the 2011 hydraulic model is considered to be better than that achieved in the 2005 hydraulic model. A better level of calibration was able to be achieved in the 2011 hydraulic as the model is based on:

- More recent and more accurate ALS data;
- A more detailed grid resolution (5m cell size);
- A more comprehensive and accurate bathymetric data set;
- A more accurate representation of floodplain land use; and
- A model domain that extends to the river mouth - providing more certainty with regard to adopted tailwater conditions.

100 year ARI design event

In both the 2005 and 2011 flood models, flow hydrographs for the Mary River have been derived for the 100 year ARI design event using:

- Industry standard ARR temporal patterns; and
- The temporal pattern for the 1955 historical flood event (sensitivity analysis).

The flood levels estimated for each of these cases using the 2005 and 2011 hydraulic models are generally similar with differences in flood level caused by differences in the level of model calibration, floodplain topography and bathymetric representation.

In both the 2005 and 2011 hydraulic models, the 100 year ARI flood levels estimated for the 1955 temporal pattern scenario are up to 500mm higher (in the city reach) than for the case where the standard ARR temporal pattern is used. This is because the flood volume generated by the 1955 temporal pattern is greater than the flood volume generated from the ARR temporal pattern, and the peak flow rate is approximately 10% larger.

The 100 year ARI peak flood level maps provided in the 2005 Report are based on the results from the 1955 temporal pattern scenario. The 100 year ARI peak flood level maps provided in this study are based on the standard ARR temporal patterns in accordance with Councils requirements.

As a result of differences in model calibration and adopted temporal patterns, the flood levels shown on the 100 year ARI peak flood level maps in this study are lower than the flood levels shown on the flood maps provided in the 2005 report.

7.4 Comparison of 1893 Flood Extent to 100 year ARI Design Flood Extents

The 1893 flood event is the largest flood on record and caused widespread flooding and damage to the city of Maryborough.

A comparison of the recorded flood levels and estimated flood extent for the 1893 flood to the flood levels and flood extent estimated for the 100 year ARI design event (without climate change) is provided in Figure A18.

A comparison of the recorded flood levels and estimated flood extent for the 1893 flood to the flood levels and flood extent estimated for the 100 year ARI design event (with climate change) is provided in Figure A19.

Figure A18 indicates that throughout the city area, the flood levels estimated for the 100 year ARI design event scenario (without climate change) are generally lower than the flood levels recorded for the 1893 historical flood event. However, upstream of the Bruce highway crossing of the Mary River the flood levels for the 100 year ARI design event scenario are generally higher than the flood levels recorded for the 1893 historical flood event.

Figure A19 indicates that throughout the city area and upstream of the Bruce Highway crossing, the flood levels estimated for the 100 year ARI design event scenario (with climate change) are generally higher than the flood levels recorded for the 1893 historical flood event.

It is noted that:

- The 1893 flood extent was provided to GHD and may have been generated from an older ground survey than that used to determine the 100 year ARI design flood extents estimated in this study. This may cause some discrepancies to occur at the flood fringe when comparing 1893 flood extents to the 100 year ARI design flood extents for a given flood level.
- Upstream of the Bruce highway crossing of the Mary River, the flood levels for the 100 year ARI design event scenario (without climate change) are generally higher than the flood levels recorded for the 1893 historical flood event. This is different to what occurs downstream of the crossing where the flood levels estimated for the 100 year ARI design event scenario are generally lower than the flood levels recorded for the 1893 historical flood event. This difference is likely to be due to the method of extrapolation and interpolation used by Council to create the 1893 flood profile upstream of the highway crossing.

7.5 Flood Hazard

Flood Hazard is a flood parameter that is often used to determine the level of risk to both life and structures associated with a particular flooding condition.

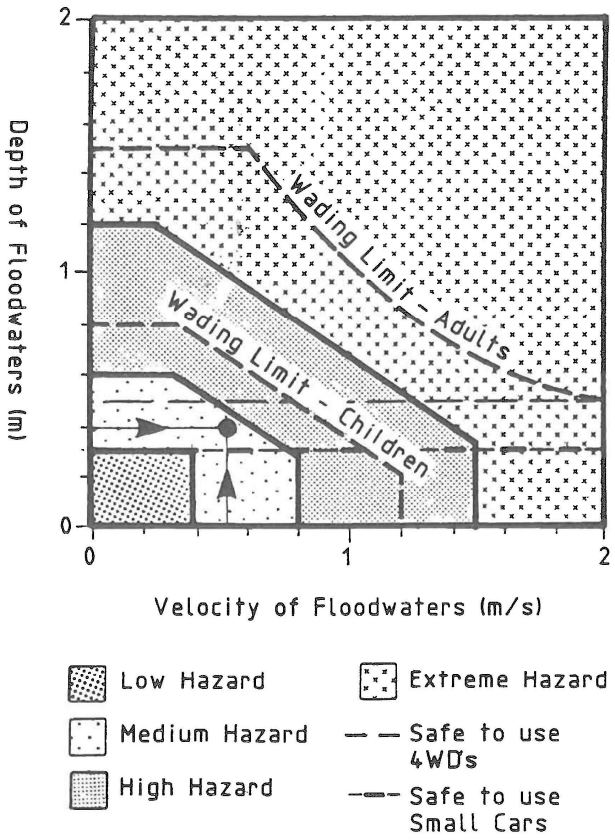
Flood hazard is often determined by considering both flood depths and flood velocities. High flood depths or velocities create a hazardous situation whilst low flood depths or low velocities create only a small amount of risk.

CSIRO's Flood Plain Management in Australia – Best Practice Principles and Guidelines (2000) defines the following four flood hazard categories:

- **Low -** there are no significant evacuation problems. If necessary, children and elderly people could wade to safety with little difficulty; maximum flood depths and velocities along evacuation routes are low; evacuation distances are short. Evacuation is possible by a sedan-type motor vehicle, even a small vehicle. There is ample time for flood forecasting, flood warning and evacuation; evacuation routes remain trafficable for at least twice as long as the time required for evacuation.
- **Medium -** Fit adults can wade to safety, but children and the elderly may have difficulty; evacuation routes are longer; maximum flood depths and velocities are greater. Evacuation by sedan-type vehicles is possible in the early stages of flooding, after which 4WD vehicles or trucks are required. Evacuation routes remain trafficable for at least 1.5 times as long as the necessary evacuation time.
- **High -** Fit adults have difficulty in wading to safety; wading evacuation routes are longer again; maximum flood depths and velocities are greater (up to 1.0 m and 1.5 m/s respectively). Motor vehicle evacuation is possible only by 4WD vehicles or trucks and only in the early stages of flooding. Boats or helicopters may be required. Evacuation routes remain trafficable only up to the minimum evacuation time.
- **Extreme -** boats or helicopters are required for evacuation; wading is not an option because of the rate of rise and depth and velocity of floodwaters. Maximum flood depths and velocities are over 1.0 m and over 1.5 m/s respectively.

Figure J1 in the Guidelines (CSIRO, 2000) is commonly used to determine the hazard categorisation of flood prone land. This figure is reproduced as Figure 7-4.

Figure 7-4 CSIRO Flood Hazard Categories



For the purposes of this study, flood hazard maps (refer Figures A6, A11 and A17) have been prepared for the 50 and 100 year ARI event using the hazard categories described above**.**

Reference to Figure A11 indicates that a high to extreme flood hazard exists across a large portion of Maryborough for the 100 year ARI design event. This is due to the large flood depths and high velocities predicted for this event

7.5.1 BoM Flood Classifications

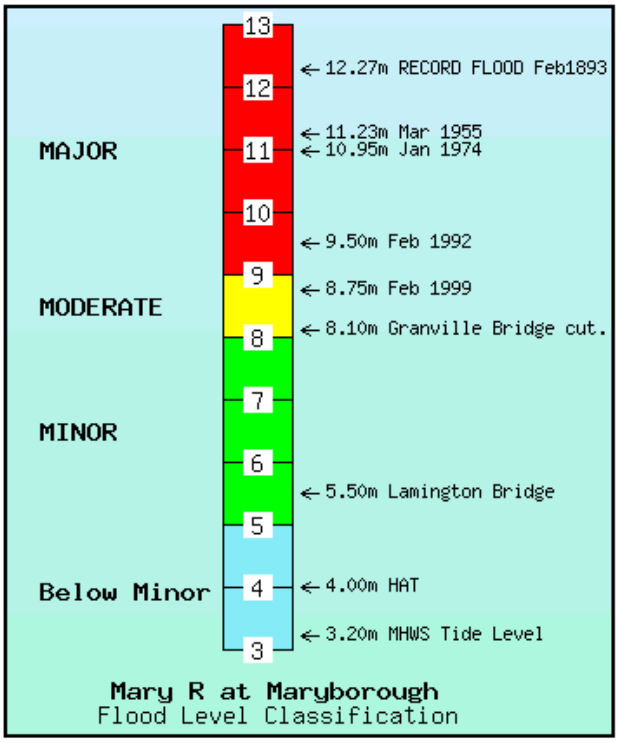
It is noted that the BoM have also developed their own system of flood risk classification. The following information has been extracted from the BoM website and is applicable to their gauge in Maryborough:

At each flood warning river height station, the severity of flooding is described as minor, moderate or major according to the effects caused in the local area or in nearby downstream areas. Terms used in Flood Warnings are based on the following definitions.

Major Flooding : This causes inundation of large areas, isolating towns and cities. Major disruptions occur to road and rail links. Evacuation of many houses and business premises may be required. In rural areas widespread flooding of farmland is likely.

Moderate Flooding : This causes the inundation of low lying areas requiring the removal of stock and/or the evacuation of some houses. Main traffic bridges may be closed by floodwaters.

Minor Flooding : This causes inconvenience such as closing of minor roads and the submergence of low level bridges and makes the removal of pumps located adjacent to the river necessary.



The BoM website also provides the following assessment of flooding potential:

Major flooding requires a large scale rainfall situation over the Mary River catchment. The following can be used as a rough guide to the likelihood of flooding in the catchment:

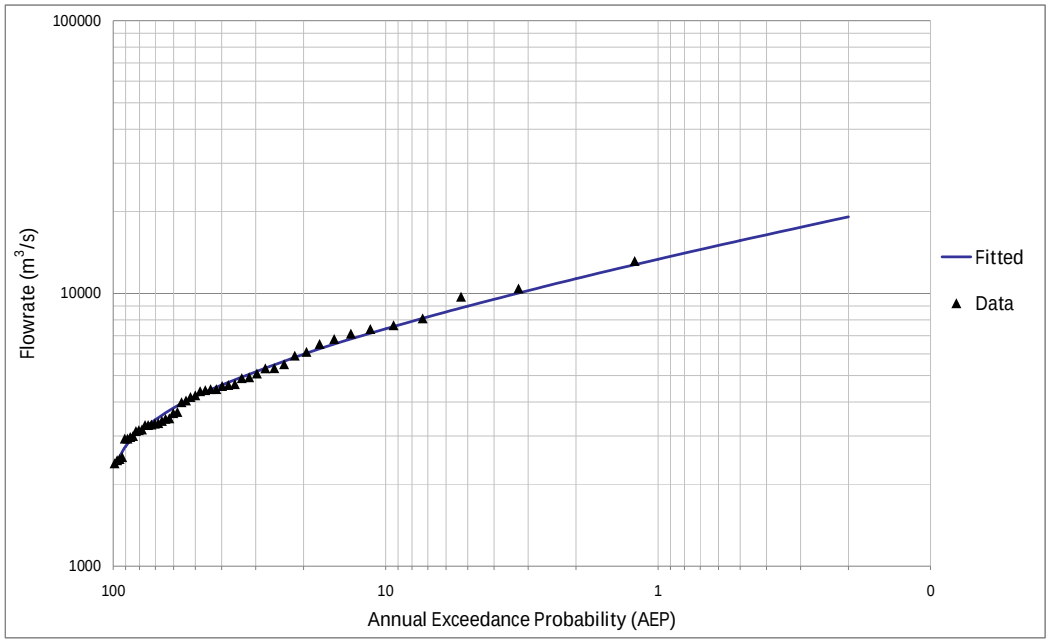
- *Average catchment rainfalls of in excess of 200mm in 48 hours may cause significant moderate to major flooding and traffic disabilities to develop, particularly in the middle to lower reaches between Kenilworth and Gympie, and extending downstream to Maryborough.*
- *Average catchment rainfalls of in excess of 300mm in 48 hours may cause significant major flooding and traffic disabilities to develop, particularly in the middle to lower reaches between Kenilworth and Gympie and extending downstream to Maryborough.*

8. Flood Frequency Analysis

A flood frequency analysis was undertaken to assess the AEP of historical flood flows. Peak flood levels were obtained from the BoM gauge at Maryborough (Gauge No. 040443). Recorded flood levels were then converted to peak flows using a rating curve that was developed from the results of the 2D hydraulic model.

A flood frequency analysis was undertaken on the historical peak flows. The resulting flood frequency plot is reproduced as Figure 8-1 below.

Figure 8-1 Flood Frequency Analysis – Maryborough



Results from the flood frequency analysis were compared with the design event peak flows obtained from the hydrologic model. Table 8-1 provides a summary of flow rates derived from the flood frequency analysis and those derived from hydrologic modelling.

Table 8-1 Flood Frequency and Design Flow Estimates

ARI	Design Scenario 1*	Design Scenario 2*	Design Scenario 3*	Design Scenario 4*	Flood Frequency Analysis#
2 year	3,048	2,490	3,095	-	4,187
5 year	4,856	4,348	5,161	-	5,985
10 year	6,457	6,024	6,819	-	7,415
20 year	7,785	7,399	8,401	-	8,982
50 year	9,907	9,581	10,953	8,652	11,325
100 year	11,912	11,644	13,009	10,466	13,350

Notes: * Refer Table 4.2 for scenario description, # Values derived from Log Normal Curve Fit.

Reference to Table 8-1 indicates that the flows predicted from the hydrologic model in Scenarios 1 and 3 most closely match the peak flows determined from the flood frequency analysis. Hence, the hydrographs obtained from the hydrologic model for these scenarios were applied as inflow boundary conditions in the 2D Hydraulic model.

9. Conclusions

A hydrologic model of the Mary River catchment was developed and calibrated to a number of historical flood events including the 1955, 1974 and 1999 events. The calibrated hydrologic model was used to estimate flowrate hydrographs for the 50 and 100 year ARI design events.

In order to estimate flood extents and flood levels, two-dimensional hydraulic models have been developed for the Mary River and the adjacent floodplain surrounding Maryborough. The models have been calibrated to the March 1955 flood event and verified against the January 1999 flood event. The calibrated hydraulic model has been used to simulate the behaviour of the 50 and 100 year ARI design flood events.

Hydrologic and hydraulic modelling has also been undertaken to assess the impact of climate change on the 100 year ARI design event. The climate change assessment was undertaken by increasing rainfall intensities by 10% and applying a tailwater level of 3.7m AHD which is equivalent to the Highest Astronomical Tide plus 0.8m of sea level rise.

Based on the results of the hydraulic models, a series of flood inundation maps have been prepared for the 50 and 100 year ARI design events to illustrate:

- Peak flood levels (m AHD);
- Peak flood depths (m);
- Peak depth-averaged flood velocity (m/s); and
- Flood Hazard.

Results from the study indicate the City of Maryborough will be subject to flooding during a 50 and 100 year ARI design event.

During the 50 and 100 year ARI design events, parts of Maryborough are expected to experience high to extreme flood hazard. This is due to the large flood depths and high velocities predicted for this event.

Results from a climate change impact assessment indicate that for the 100 year ARI design event, flood levels are predicted to be up to 600mm higher in the vicinity of Maryborough City.

It is recommended that Council consider the results of this study when making future planning decisions and developing emergency response plans.

10. References

Delft Hydraulics (2001) Delft-FLS, two-dimensional hydrodynamic modelling software and user's manual, Version 2.55.

Carroll, D.G.(2002) URBS-CM A Catchment Management and Flood Forecasting Rainfall Runoff Routing Model, Version 3.9, Brisbane, Queensland, Australia.

CSIRO (2000), Flood Plain Management in Australia – Best Practice Principles and Guidelines.

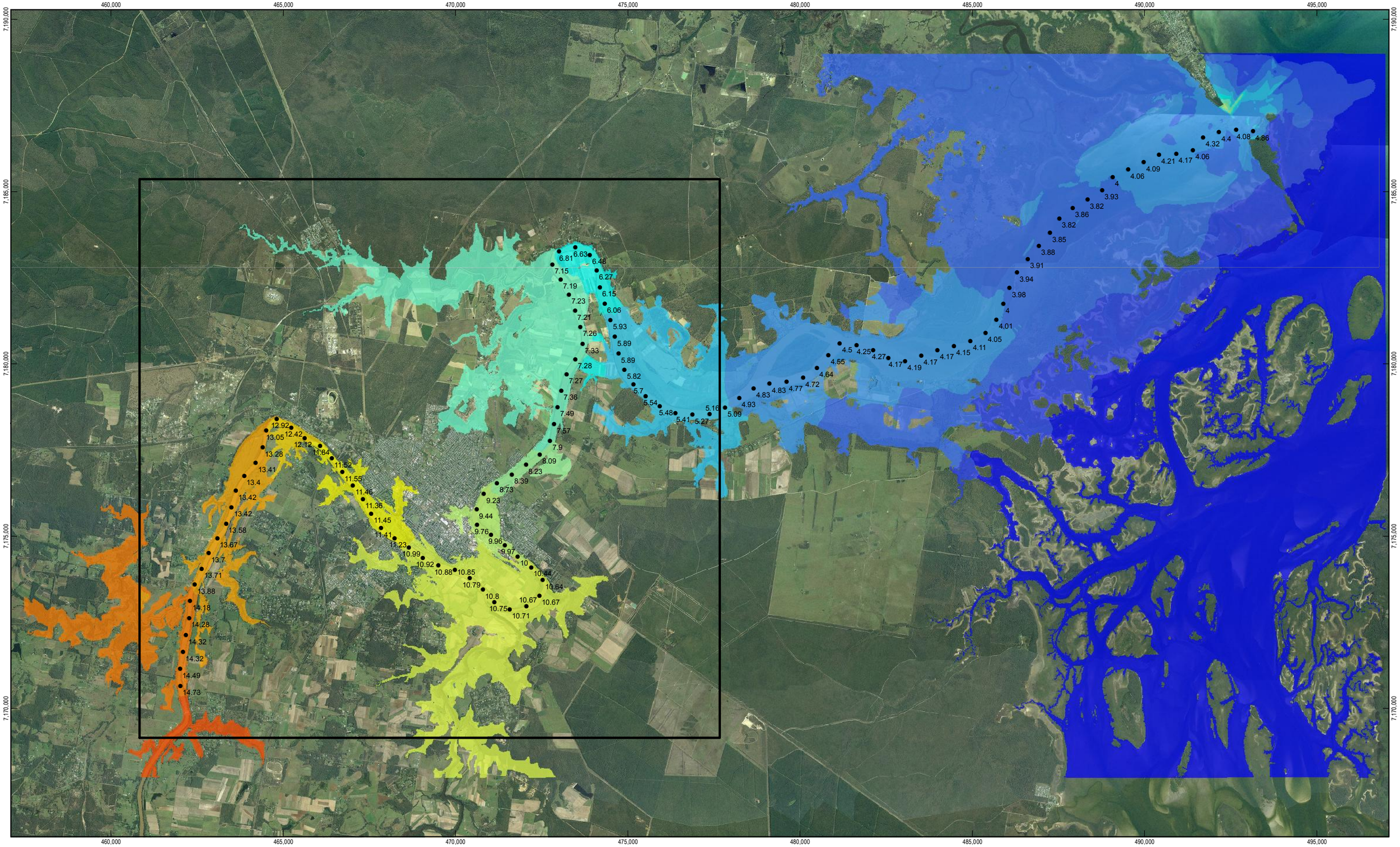
GHD (2005), Mary River Flood Study

Institution of Engineers Australia (1998) Australian Rainfall & Runoff, A guide to Flood Estimation.

Queensland Government, Department of Environment and Resource Management, Department of Infrastructure and Planning & Local Government Association of Queensland (2010). Increasing Queensland's resilience to inland flooding in a changing climate: Final Scientific Advisory Group (SAG) report - Derivation of a rainfall intensity figure to inform an effective interim policy approach to managing inland flooding risks in a changing climate.

Appendix A

Flood Maps



1:100,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Flood Level (m AHD)

Flood Level (m AHD)

- 1.00 - 2
- 2.01 - 3
- 3.01 - 4
- 4.01 - 5
- 5.01 - 6
- 6.01 - 7
- 7.01 - 8
- 8.01 - 9
- 9.01 - 10
- 10.01 - 11
- 11.01 - 12
- 12.01 - 13
- 13.01 - 14
- 14.01 - 15
- 15.01 - 16
- 16.01 - 17
- Refer to Figure A2

GHD
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Fraser Coast Regional Council
Mary River Flood Study

1955 Event
Flood Level

Job Number	41-23825
Revision	A
Date	02 Dec 2011

Figure A1

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Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

457,000 460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000

7,182,000 7,179,000 7,176,000 7,173,000 7,170,000

0.71 0.21 0.15 -0.16 -0.28 0.86 -0.14 -0.37 -0.29 -0.07 -0.04 0.65 0.58 -0.12 -0.01 -0.05 0.06 -0.07 0.62 0.55 0.48 0.48 0.57 0.76 -0.33 -0.32 -0.29 -0.25 -0.29 -0.42 -0.22 0 0.09 -0.17 -0.17 0.57 0.44 0.32 0.28 0.26 -0.55 -0.12 -0.41 -0.05 -0.09 -0.12 -0.15 -0.12 -0.2 0.25 0.29 -0.29 0.1 0.1

457,000 460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000

1:65,000 (at A3)

0 1.5 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Flood Level Difference
1955 Modelled - Recorded (m)
-0.5 to -0.2
-0.2 to 0.2
0.2 to 0.4
0.4 to 0.5
All Other

Flood Level (m AHD)
1.00 - 2
2.01 - 3
3.01 - 4
4.01 - 5
5.01 - 6
6.01 - 7
7.01 - 8
8.01 - 9
9.01 - 10
10.01 - 11
11.01 - 12
12.01 - 13
13.01 - 14
14.01 - 15
15.01 - 16
16.01 - 17

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Fraser Coast REGIONAL COUNCIL

Fraser Coast Regional Council
Mary River Flood Study

1955 Event
Flood Level
(City Focus)

Job Number	41-23825
Revision	A
Date	02 Dec 2011

Figure A2

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Mode Resultsl/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

460,000 465,000 470,000 475,000 480,000 485,000 490,000 495,000

7,190,000 7,185,000 7,180,000 7,175,000 7,170,000

Tailwater Level = 1.0m AHD

1:100,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Flood Level (m AHD)

Flood Level (m AHD)

- 1.00 - 2
- 2.01 - 3
- 3.01 - 4
- 4.01 - 5
- 5.01 - 6
- 6.01 - 7
- 7.01 - 8
- 8.01 - 9
- 9.01 - 10
- 10.01 - 11
- 11.01 - 12
- 12.01 - 13
- 13.01 - 14
- 14.01 - 15
- 15.01 - 16
- 16.01 - 17

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Fraser Coast Regional Council
Mary River Flood Study

Job Number 41-23825
Revision A
Date 02 Dec 2011

50 year ARI Design Event Flood Level

Figure A3

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model Results/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

460,000 465,000 470,000 475,000 480,000 485,000 490,000 495,000

7,185,000 7,180,000 7,175,000 7,170,000

20.23 16.69 18.87 18.33 18.66 20.03 19.33 17.4 17.89 18.62 17 19 8.54 19.95 16.36 19.92 17.47 20.76 19.75 20.25 17.14 19.23 14.34 19.74 14.69 14.91 21.29 16.61 20.08 15.71 20.51 13.13 21.48 19.43 19.78 17.78 18.28 15.93 14.88 19.58 17.71 15.34 15.58 12.52 11.5 12.39 10.79 13.12 11.43 17.87 11.14 16.32 10.88 15.2 10.55 14.75 13.44 14.47 14.09 14.51 12.63 15 10.42 16.1 11.46 16.06 11.9 15.16 12.28 15.97 13.92 16.29 8.99 16.22 8.57 19.7 11.1 20.79 8.92 19.16 8.68 19.04 8.3 16.61 14.52 16.33 10.43 18.14 7.49 4.68 4.6 4.62 6.52 7.01 4.77 5.75 0.8 0.69 0.9 1.79 2.7 3.49 3.45 4.2 6.34 7.12 5.67 6.04 5.82 5.48 4.92 5.51 6.13 5.64 9.65 9.94

Tailwater Level = 1.0m AHD

1:100,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Flood Depth (m AHD)

Flood Depth (m AHD)

25 20 15 10 5 0

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Fraser Coast Regional Council
Mary River Flood Study

Job Number	41-23825
Revision	0
Date	09 Dec 2011

50 year ARI Design Event Flood Depth

Figure A4

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model Results/2011

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460,000 465,000 470,000 475,000 480,000 485,000 490,000 495,000

7,190,000 7,185,000 7,180,000 7,175,000 7,170,000

Tailwater Level = 1.0m AHD

1:100,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Flood Velocity (m/s)

Flood Velocity (m/s)

0 - 0.5
0.51 - 1
1.01 - 1.5
1.51 - 2
2.01 - 2.5
2.51 - 3
3.01 - 3.5
3.51 - 4
4.01 - 4.5
4.51 - 5

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Fraser Coast Regional Council
Mary River Flood Study

Job Number 41-23825
Revision A
Date 02 Dec 2011

50 year ARI Design Event Flood Velocity

Figure A5

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model Results/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

460,000 465,000 470,000 475,000 480,000 485,000 490,000 495,000

7,190,000 7,185,000 7,180,000 7,175,000 7,170,000

Tailwater Level = 1.0m AHD

1:100,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Flood Hazard
- Low
- Medium
- High
- Extreme

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Fraser Coast Regional Council
Mary River Flood Study

Job Number	41-23825
Revision	A
Date	02 Dec 2011

50 year ARI Design Event Flood Hazard

Figure A6

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model Results/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000 484,000 487,000 490,000 493,000 496,000

7,188,000 7,185,000 7,182,000 7,179,000 7,176,000 7,173,000 7,170,000 7,167,000

Tailwater Level = 2.7m AHD (H.A.T.)

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:100,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Flood Level (m AHD)

Flood Level (m AHD)

1.00 - 2	4.01 - 5	9.01 - 10	14.01 - 15
2.01 - 3	5.01 - 6	10.01 - 11	15.01 - 16
3.01 - 4	6.01 - 7	11.01 - 12	16.01 - 17
	7.01 - 8	12.01 - 13	
	8.01 - 9	13.01 - 14	

CLIENTS | PEOPLE | PERFORMANCE

Fraser Coast Regional Council
Mary River Flood Study

Job Number	41-23825
Revision	0
Date	09 Dec 2011

100 year ARI Design Event Flood Level

Figure A7

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Data source: DERM - Cadaster 2011; GHD - Flood Model/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

457,000 460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000

7,182,000 7,179,000 7,176,000 7,173,000 7,170,000

7.3 7.11 6.92 7.6 6.69 7.64 6.52 7.68 6.4 7.66 6.26 7.69 6.21 7.76 6.21 7.68 6.12 7.64 5.96 7.75 5.77 7.89 5.68 5.59 7.98 8.4 8.63 8.78 9 9.43 10.01 10.28 10.53 10.72 10.73 10.73 11.22 11.4 11.42 11.41 11.45 11.48 11.53 11.52 11.53 11.59 11.6 11.67 11.92 12.13 12.16 12.02 12.13 12.29 12.27 12.55 12.89 13.32 13.95 13.83 14.15 14.25 14.22 14.23 14.23 14.4 14.48 14.51 14.51 14.7 15.04 15.14 15.17 15.17 15.38 15.62

Tailwater Level = 2.7m AHD (H.A.T.)

1:65,000 (at A3)

0 1.5 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Flood Level (m AHD)

CT Flood Level (m AHD)

- 5.46 - 6
- 6.01 - 7
- 7.01 - 8
- 8.01 - 9
- 9.01 - 10
- 10.01 - 11
- 11.01 - 12
- 12.01 - 13
- 13.01 - 14
- 14.01 - 15
- 15.01 - 16
- 16.01 - 17

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Fraser Coast Regional Council
Mary River Flood Study

100 year ARI Design Event Flood Level (City Focus)

Job Number	41-23825
Revision	0
Date	07 Dec 2011

Figure A8

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model Results/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

460,000 465,000 470,000 475,000 480,000

7,180,000 7,175,000 7,170,000

21.14 19.82 17.45 18.7 19.04 20.33 19.9 17.99 18.08 19.2 17.24 19.68 8.67 20.22 16.57 20.22 17.59 21.29 20.05 20.67 17.82 19.61 14.57 20.19 15.08 21.75 14.91 20.53 17 20.61 15.83 21.95 13.41 20.18 19.61 18.39

19.55 15.39 17.93 15.69 15.95 12.9 11.89 12.71 11.04 13.26 11.43 17.98 11.48 16.93 11.17 15.57 10.83 15 13.75 14.62 14.54 14.67 12.85 15.1 10.69 16.31 16.32 15.16 16.12 16.64 16.39 20.16 21.09 19.35 19.45 18.83 18.68 18.18 15.8 17.69

Tailwater Level = 2.7m AHD (H.A.T.)

460,000 465,000 470,000 475,000 480,000

1:65,000 (at A3)

0 1.5 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Flood Depth (m AHD)

Flood Depth (m AHD)

25 20 15 10 5 0

CLIENTS | PEOPLE | PERFORMANCE

Fraser Coast Regional Council
Mary River Flood Study

100 year ARI Design Event Flood Depth (City Focus)

Job Number	41-23825
Revision	0
Date	09 Dec 2011

Figure A9

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model Results/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

457,000 460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000

7,182,000 7,179,000 7,176,000 7,173,000 7,170,000

Tailwater Level = 2.7m AHD (H.A.T.)

1:65,000 (at A3)

0 1.5 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Flood Velocity (m/s)

Flood Velocity (m/s)			
0 - 0.5	0.51 - 1	1.01 - 1.5	1.51 - 2
2.01 - 2.5	2.51 - 3	3.01 - 3.5	3.51 - 4
4.01 - 4.5	4.51 - 5		

GHD CLIENTS | PEOPLE | PERFORMANCE

Fraser Coast Regional Council
Mary River Flood Study

100 year ARI Design Event Flood Velocity (City Focus)

Job Number	41-23825
Revision	0
Date	07 Dec 2011

Figure A10

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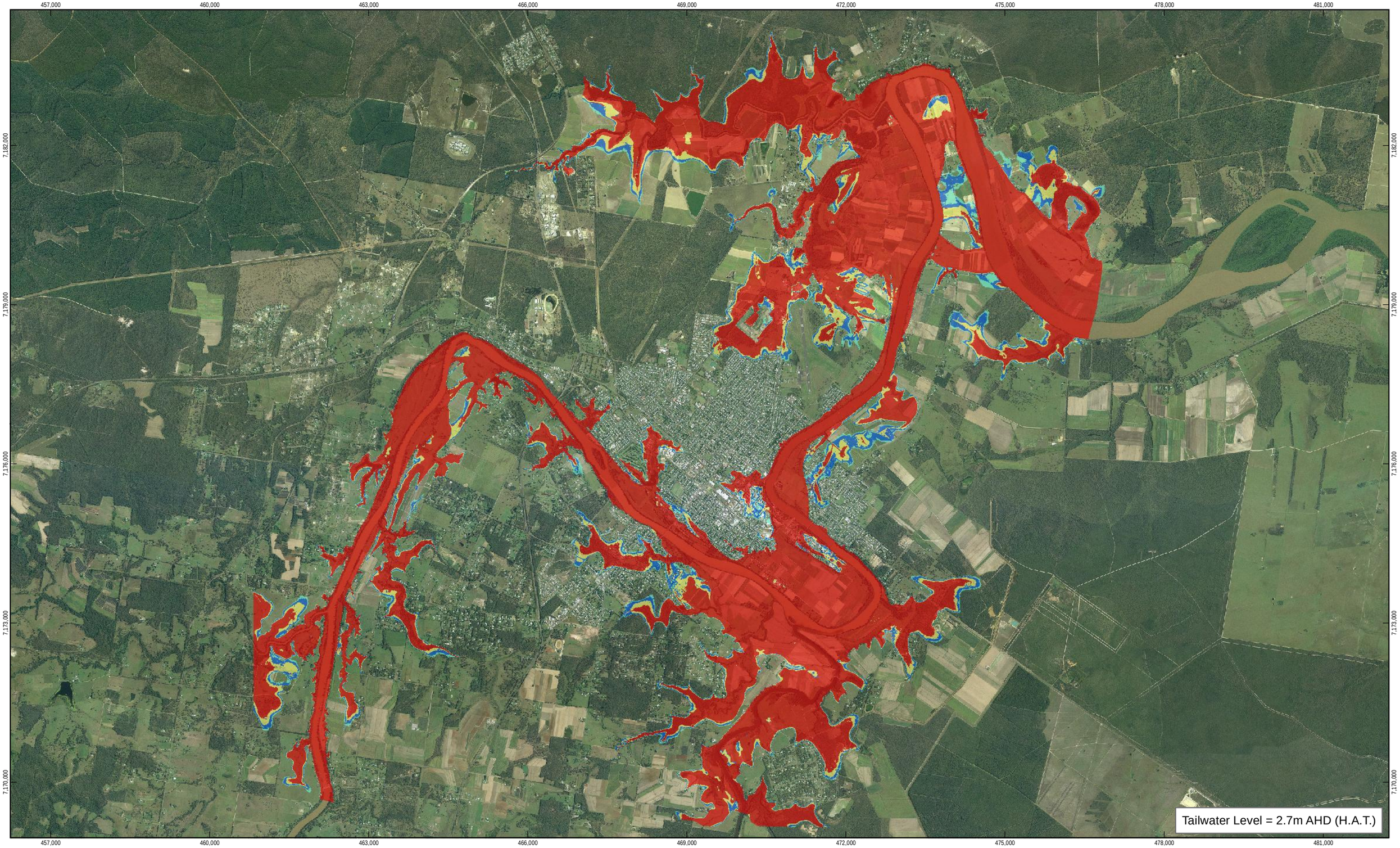
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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model Results/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

457,000 460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000

7,182,000
7,179,000
7,176,000
7,173,000
7,170,000



457,000 460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000

1:65,000 (at A3)

0 1.5 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Flood Hazard
- Low
- Medium
- High
- Extreme

CLIENTS | PEOPLE | PERFORMANCE

Fraser Coast Regional Council
Mary River Flood Study

100 year ARI Design Event Flood Hazard (City Focus)

Job Number	41-23825
Revision	0
Date	07 Dec 2011

Figure A11

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model Results/2011

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460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000 484,000 487,000 490,000 493,000 496,000

7,188,000 7,185,000 7,182,000 7,179,000 7,176,000 7,173,000 7,170,000 7,167,000

Tailwater Level = 3.5m AHD (H.A.T + 0.8m)
For the climate change scenario, rainfall intensities have been increased by 10% based on a 2 degree warming to 2050.

1:100,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Flood Level (m AHD)

Flood Level (mAHD)

1.00 - 2
2.01 - 3
3.01 - 4
4.01 - 5
5.01 - 6
6.01 - 7
7.01 - 8
8.01 - 9
9.01 - 10
10.01 - 11
11.01 - 12
12.01 - 13
13.01 - 14
14.01 - 15
15.01 - 16
16.01 - 17

CLIENTS | PEOPLE | PERFORMANCE

Fraser Coast Regional Council
Mary River Flood Study

100 year ARI Design Event Climate Change Scenario Flood Level

Job Number	41-23825
Revision	0
Date	07 Dec 2011

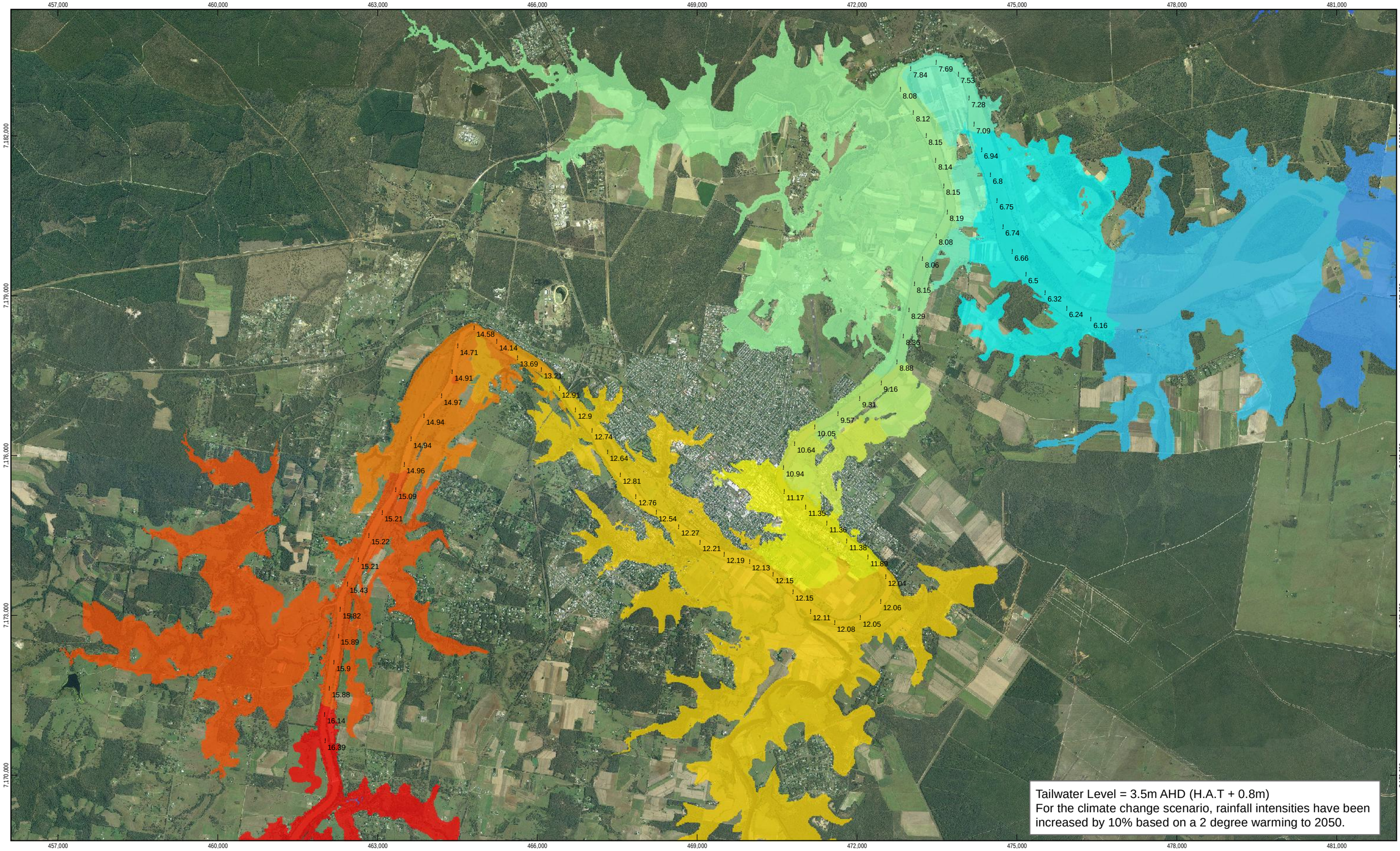
Figure A12

G:\41\23825\GIS\Maps\Deliverable\4123825_020_rev_0.mxd

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com



1:65,000 (at A3)

0 1.5 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Flood Level (m AHD)

Flood Level (m AHD)

- 1.00 - 2
- 2.01 - 3
- 3.01 - 4
- 4.01 - 5
- 5.01 - 6
- 6.01 - 7
- 7.01 - 8
- 8.01 - 9
- 9.01 - 10
- 10.01 - 11
- 11.01 - 12
- 12.01 - 13
- 13.01 - 14
- 14.01 - 15
- 15.01 - 16
- 16.01 - 17

GHD CLIENTS|PEOPLE|PERFORMANCE

Fraser Coast Regional Council

Fraser Coast REGIONAL COUNCIL

Fraser Coast Regional Council
Mary River Flood Study

100 year ARI Design Event Climate Change Scenario Flood Level - (City Focus)

Job Number	41-23825
Revision	0
Date	07 Dec 2011

Figure A13

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

460,000 465,000 470,000 475,000 480,000

7,180,000 7,175,000 7,170,000

20.19 15.94 18.52 16.19 16.57 13.36 12.5 13.19 11.58 13.75 12.03 18.5 12.03 17.29 11.69 15.97 11.36 15.43 14.28 15.03 15.01 15.04 13.38 11.19 15.49 16.78 16.86 15.71 16.72 17.29 16.99 20.73 21.73 20.02 20.1 19.48 19.31 18.83 16.46 18.33 20.38 14.04 16.43 17.7 15.55 15.67 15.17 18.41 20.66 18.25 17.29 9.32 17.79 18.68 20.42 19.71 19.44 18.32 20.7 21.92 21.07 18.7 19.87 20.38 20.96 20.94 21.98 21.43 20.25 20.91 22.47 21.3 21.41 22.61 20.9 19.14

Tailwater Level = 3.5m AHD (H.A.T +0.8m)
For the climate change scenario, rainfall intensities have been increased by 10% based on a 2 degree warming to 2050.

460,000 465,000 470,000 475,000 480,000

1:65,000 (at A3)

0 1.5 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Flood Depth (m AHD)

Flood Depth (m AHD)

25 20 15 10 5 0

CLIENTS|PEOPLE|PERFORMANCE

Fraser Coast Regional Council
Mary River Flood Study

100 year ARI Design Event Climate Change Scenario Flood Depth - (City Focus)

Job Number	41-23825
Revision	0
Date	09 Dec 2011

Figure A14

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model Results/2011

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457,000 460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000

7,182,000 7,179,000 7,176,000 7,173,000 7,170,000

4.61 4.08 3.61 2.68 3.95 2.91 3 3.89 3.29 4.48 3.52 4.38 3.26 4.72 2.55 5.18 2.3 5 2.64 5.28 3.63 3.7 5.54 3.53 5.85 5.04 4.84 5.02 4.84 4.45 4.3 4.78 3 2.87 3.37 3.56 2.55 2.45 2.25 2.68 2.64 1.77 2.86 3.44 2.56 3.62 4.14 4.45 4.18 3.47 3.86 5.06 5.61 6.3 7.15 6.56 7.05 5.97 2.99 3.89 3.47 3.13 4.16 4.07 4.48 3.87 4.29 4.46 4.7 4.52 3.99 3.72 3.67 4.21 3.86 3.39

Tailwater Level = 3.5m AHD (H.A.T +0.8m)
For the climate change scenario, rainfall intensities have been increased by 10% based on a 2 degree warming to 2050.

1:65,000 (at A3)

0 1.5 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Flood Velocity (m/s)

0 - 0.5	0.51 - 1	1.01 - 1.5	1.51 - 2
2.01 - 2.5	2.51 - 3	3.01 - 3.5	3.51 - 4
4.01 - 4.5	4.51 - 5		

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Fraser Coast Regional Council

Fraser Coast REGIONAL COUNCIL

Fraser Coast Regional Council
Mary River Flood Study

100 year ARI Design Event Climate Change Scenario Flood Velocity - (City Focus)

Job Number	41-23825
Revision	0
Date	07 Dec 2011

Figure A15

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Mode Resultsl/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

457,000 460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000

7,182,000
7,179,000
7,176,000
7,173,000
7,170,000

Tailwater Level = 3.5m AHD (H.A.T. + 0.8m)
For the climate change scenario, rainfall intensities have been increased by 10% based on a 2 degree warming to 2050.

1:65,000 (at A3)

0 1.5 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Flood Hazard
- Low
- Medium
- High
- Extreme

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Fraser Coast Regional Council
Mary River Flood Study

100 year ARI Design Event Climate Change Scenario Flood Hazard - (City Focus)

Job Number	41-23825
Revision	0
Date	07 Dec 2011

Figure A16

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model/2011

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460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000 484,000 487,000 490,000 493,000 496,000

7,188,000 7,185,000 7,182,000 7,179,000 7,176,000 7,173,000 7,170,000 7,167,000

0.74
0.71
0.49
0.58
0.38
0.44
0.41
0.77
0.58
0.61
0.71
0.61

This map illustrates the impact of increasing rainfall intensity by 10% and increasing the adopted tailwater condition from H.A.T to H.A.T+0.8m For the climate change scenario, rainfall intensities have been increased by 10% based on a 2 degree warming to 2050.

1:100,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

! Flood Level Change (m AHD)

Flood Level Change

- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

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Fraser Coast Regional Council
Mary River Flood Study

Job Number	41-23825
Revision	0
Date	07 Dec 2011

Impact of Climate Change on 100 year ARI (H.A.T Tailwater Level) Design Event

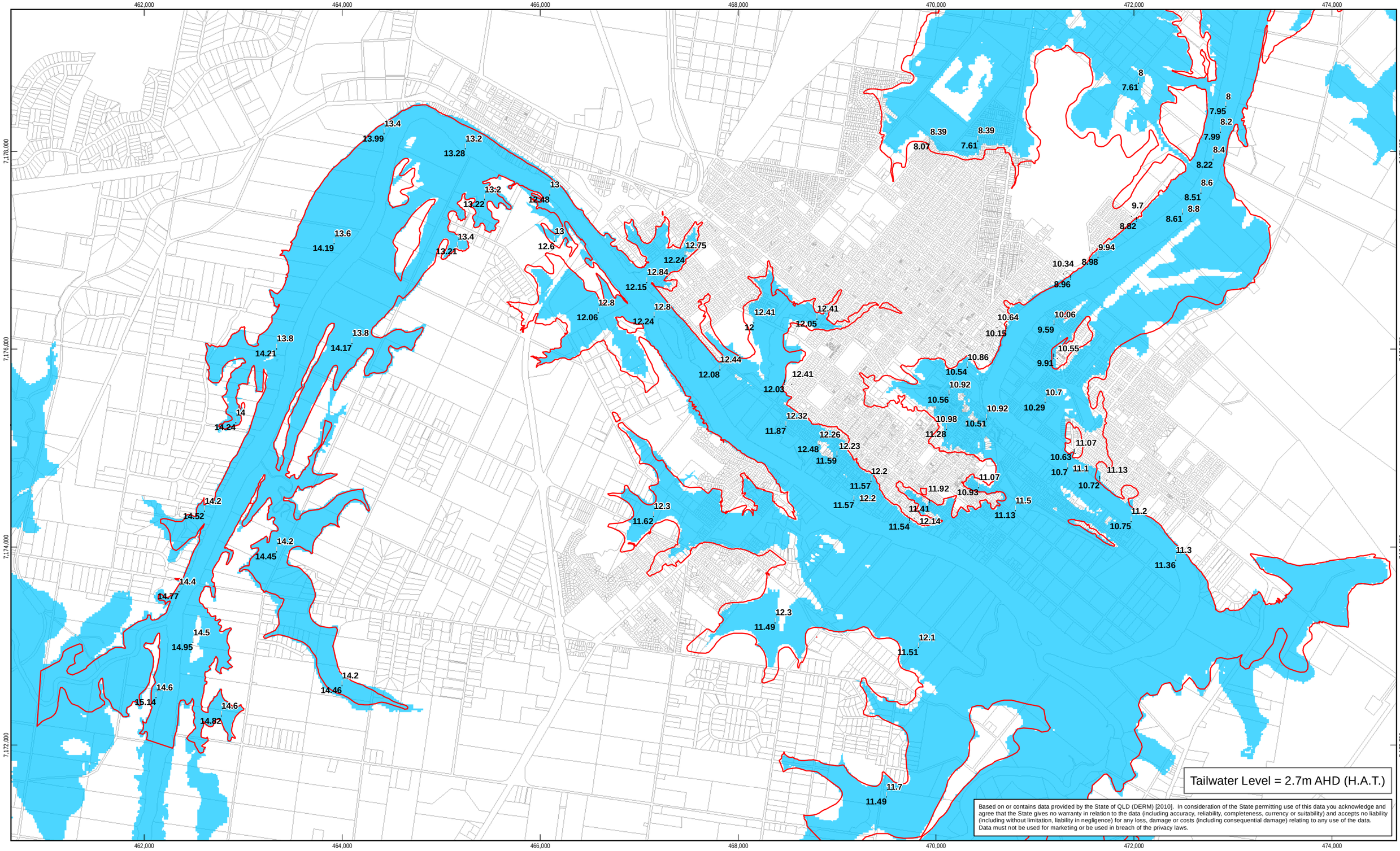
Figure A17

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Data source: Fraser Coast Regional Council - Imagery/2010; GHD - Flood Model Results/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com



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1:35,000 (at A3)

0 0.5 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

. 1893 Flood Levels (m AHD)

! 100 year ARI Flood Levels (m AHD)

1893 Flood Extent

100 year ARI Event

Cadastre Cadastre

CLIENTS | PEOPLE | PERFORMANCE

Fraser Coast Regional Council
Mary River Flood Study

1983 Flood and 100 year ARI Design Event Flood Level Differences

Job Number	41-23825
Revision	0
Date	07 Dec 2011

Figure A18

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Data source: Fraser Coast Regional Council - 1983 Flood Event/2011; DERM - Cadastre 2011; GHD - Flood Model Results/2011

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463,000 466,000 469,000 472,000

7,179,000 7,176,000 7,173,000

Tailwater Level = 3.5m AHD (H.A.T + 0.8m)
For the climate change scenario, rainfall intensities have been increased by 10% based on a 2 degree warming to 2050.

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1:35,000 (at A3)

0 0.5 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- . 1893 Flood Levels (m AHD)
- ! 100 year ARI Flood Levels (m AHD)
- 1893 Flood Extent
- Cadastre
- 100yr ARI + Climate Change Event Flood Extent

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Fraser Coast Regional Council
Mary River Flood Study

1893 Flood and 100 year ARI Design Event Climate Change Scenario Differences

Job Number	41-23825
Revision	0
Date	07 Dec 2011

Figure A19

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Data source: DERM - Cadastre/2011; Fraser Coast Regional Council - 1983 Flood Extent/2011; GHD - Flood Model Results/2011

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460,000 465,000 470,000 475,000 480,000 485,000 490,000 495,000

7,190,000 7,185,000 7,180,000 7,175,000 7,170,000

6.73 6.95 6.55 7.24 6.32 7.28 6.19 7.32 6.08 7.32 5.96 7.37 5.9 7.49 5.91 7.37 5.83 7.42 5.67 7.55 5.49 7.69 5.41 7.79 5.32 8.24 5.19 8.48 5.06 8.63 4.97 8.83 4.78 9.21 4.65 9.76 4.55 9.97 4.45 10.22 4.3 10.41 4.65 10.43 4.11 10.49 4.01 10.91 3.41 11.08 3.38 11.1 3.34 11.15 3.33 11.13 3.26 11.1 3.21 11.19 3.08 11.16 2.76 11.34 2.5 11.28 2.39 11.23 2.27 11.2 2.17 11.79 2.05 11.6 1.99 11.82 1.92 11.83 1.83 11.85 1.77 11.9 1.74 11.81 1.64 12.03 1.57 12.43 1.54 12.61 1.5 13.21 1.47 13.4 1.43 13.63 1.39 13.71 1.38 13.75 1.36 13.78 1.36 13.81 1.35 13.98 14.11 14.16 14.15 14.32 14.64 14.75 14.84 14.83 15 15.47

Tailwater Level = 1.0m AHD

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1:100,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Flood Level (m AHD)

Flood Level (m AHD)

- 1.00 - 2
- 2.01 - 3
- 3.01 - 4
- 4.01 - 5
- 5.01 - 6
- 6.01 - 7
- 7.01 - 8
- 8.01 - 9
- 9.01 - 10
- 10.01 - 11
- 11.01 - 12
- 12.01 - 13
- 13.01 - 14
- 14.01 - 15
- 15.01 - 16
- 16.01 - 17
- Cadastre

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Fraser Coast Regional Council
Mary River Flood Study

Job Number	41-23825
Revision	A
Date	02 Dec 2011

50 year ARI Design Event Flood Level

Figure A20

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Data source: DERM - cadastre/2011; GHD - Flood Model Results/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

460,000 463,000 466,000 469,000 472,000 475,000 478,000 481,000 484,000 487,000 490,000 493,000 496,000

7,188,000 7,185,000 7,182,000 7,179,000 7,176,000 7,173,000 7,170,000 7,167,000

13.83 13.32 13.95 12.89 14.15 12.55 14.25 12.27 14.22 12.29 14.23 12.13 14.23 12.02 14.4 12.16 14.48 12.13 14.51 11.92 14.51 11.67 14.7 11.6 15.04 11.59 15.14 11.53 15.17 11.52 15.17 11.53 15.38 11.48 15.62 11.45 11.42 11.41 11.4 11.22 10.73 10.73 10.72 10.53 10.28 10.01 9.43 9 8.78 8.63 8.4 7.98 7.89 7.75 7.68 7.76 7.69 7.66 7.68 7.64 7.6 7.3 7.11 6.92 6.69 6.52 6.4 6.26 6.21 6.21 6.12 5.96 5.77 5.68 5.59 5.58 5.45 5.37 5.18 5.05 5.05 4.96 4.89 4.75 4.59 4.49 3.93 3.88 3.85 3.85 3.8 3.77 3.69 3.49 3.35 3.29 3.23 3.18 3.14 3.11 3.08 3.03 3.01 3 2.96 2.94 2.92 2.91 2.9 2.89 2.88 2.87 2.87 2.86 2.85 2.84

Tailwater Level = 2.7m AHD (H.A.T.)

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:100,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Flood Level (m AHD)

Flood Level (m AHD)

- 1.00 - 2
- 2.01 - 3
- 3.01 - 4
- 4.01 - 5
- 5.01 - 6
- 6.01 - 7
- 7.01 - 8
- 8.01 - 9
- 9.01 - 10
- 10.01 - 11
- 11.01 - 12
- 12.01 - 13
- 13.01 - 14
- 14.01 - 15
- 15.01 - 16
- 16.01 - 17
- Cadastre

CLIENTS|PEOPLE|PERFORMANCE

Fraser Coast Regional Council
Mary River Flood Study

Job Number	41-23825
Revision	0
Date	09 Dec 2011

100 year ARI Design Event Flood Level

Figure A21

G:\41\23825\GIS\Maps\Deliverable\4123825_020_rev_01.mxd

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Data source: DERM - Cadaster 2011; GHD - Flood Model/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

460,000 465,000 470,000 475,000 480,000 485,000 490,000 495,000

7,190,000 7,185,000 7,180,000 7,175,000 7,170,000

14.58 14.14 14.71 13.69 14.91 13.21 14.97 12.91 14.94 12.9 14.94 12.74 14.96 12.64 15.09 12.81 15.21 12.76 15.22 12.54 15.21 12.27 15.43 12.21 15.82 12.19 15.89 12.13 15.9 12.15 15.88 16.14 16.39

7.84 7.69 7.53 8.08 7.28 8.12 7.09 8.15 6.94 8.14 6.8 8.15 6.75 8.19 6.74 8.08 6.66 8.06 6.5 8.15 6.32 8.29 6.24 8.36 6.16 8.88 5.99 9.16 5.86 9.31 5.78 9.57 5.57 10.05 5.45 10.64 5.44 10.94 5.35 11.17 5.3 11.35 5.19 11.36 5.04 11.38 4.94 11.89 4.38 12.04 4.32 12.15 4.29 12.05 4.29 12.06 4.25 12.11 4.23 12.08 4.16 4.01 3.92 3.87 3.83 3.79 3.77 3.75 3.73 3.7 3.69 3.68 3.66 3.65 3.64 3.63 3.63 3.62 3.61 3.61 3.61 3.6 3.58

Tailwater Level = 3.5m AHD (H.A.T + 0.8m)
For the climate change analysis, rainfall intensities have been increased by 10% based on a 2 degree warming to 2050.

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:100,000 (at A3)

0 2.5 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Flood Level (m AHD)

Flood Level (m AHD)

- 1.00 - 2
- 2.01 - 3
- 3.01 - 4
- 4.01 - 5
- 5.01 - 6
- 6.01 - 7
- 7.01 - 8
- 8.01 - 9
- 9.01 - 10
- 10.01 - 11
- 11.01 - 12
- 12.01 - 13
- 13.01 - 14
- 14.01 - 15
- 15.01 - 16
- 16.01 - 17
- Cadastre

CLIENTS | PEOPLE | PERFORMANCE

Fraser Coast Regional Council
Mary River Flood Study

100 year ARI Design Event Climate Change Scenario Flood Level - (City Focus)

Job Number	41-23825
Revision	0
Date	09 Dec 2011

Figure A22

G:\41\23825\GIS\Maps\Deliverable\4123825_021_rev_01.mxd

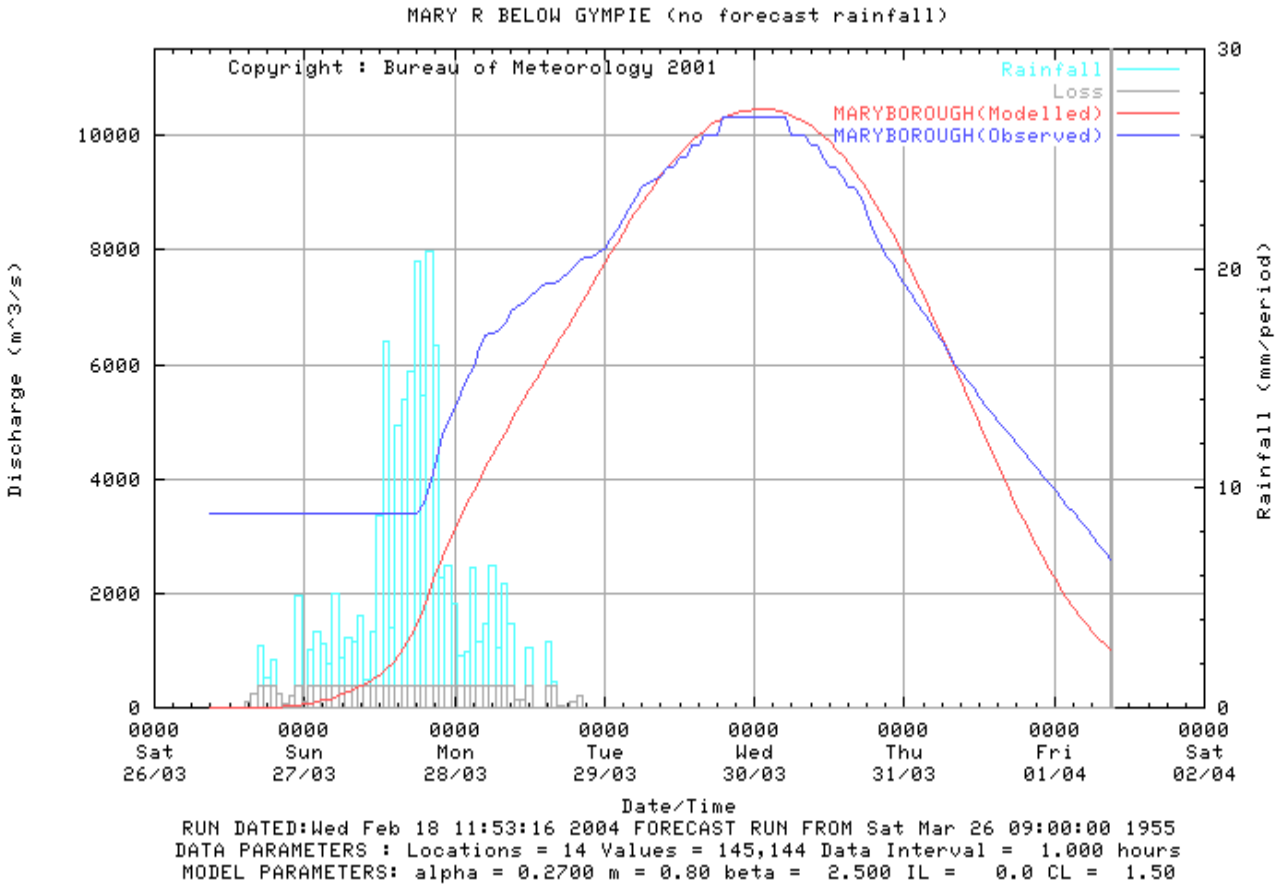
© 2011. Whilst every care has been taken to prepare this map, GHD (and DERMI) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

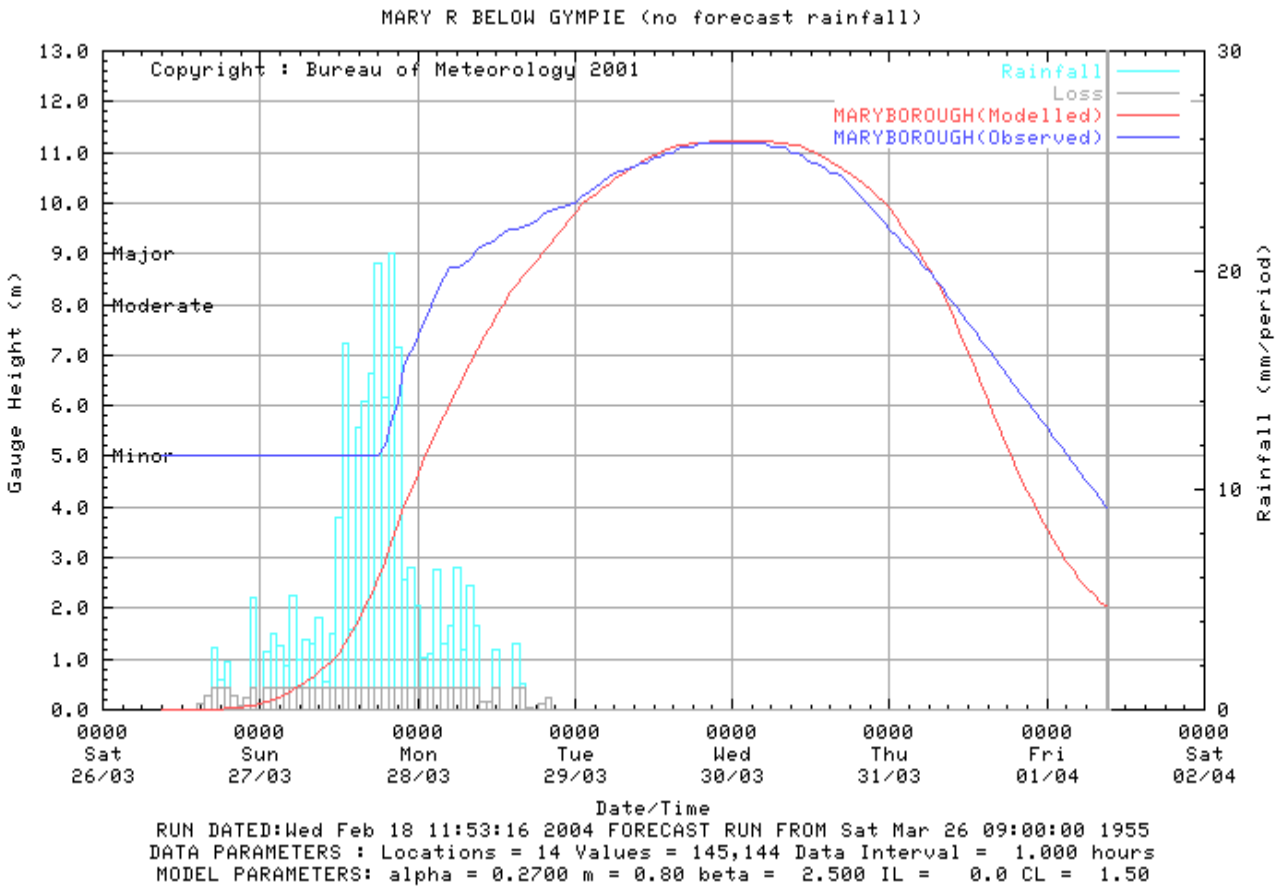
Data source: DERM - Cadastre 2011; GHD - Flood Model/2011

Level 4, 201 Charlotte St Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

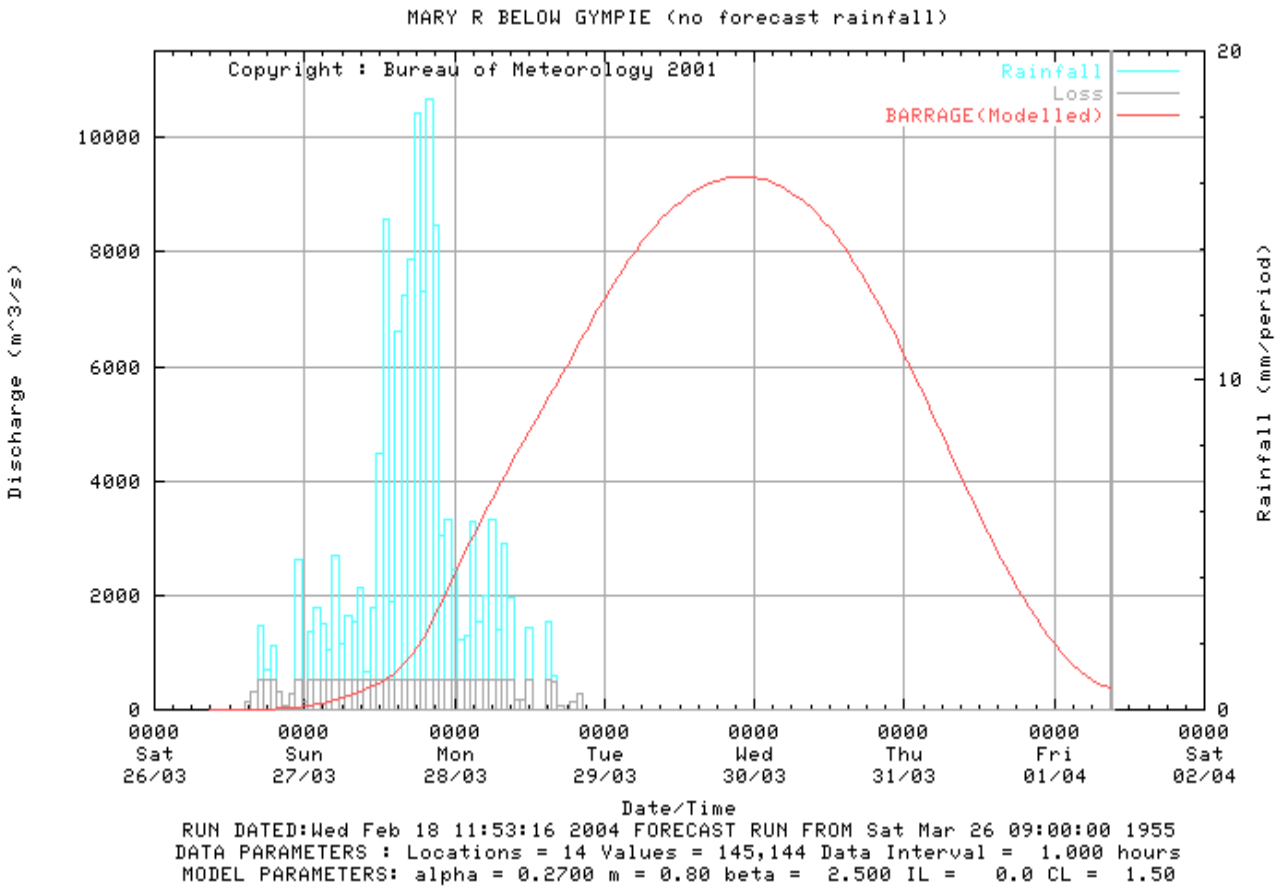
Appendix B

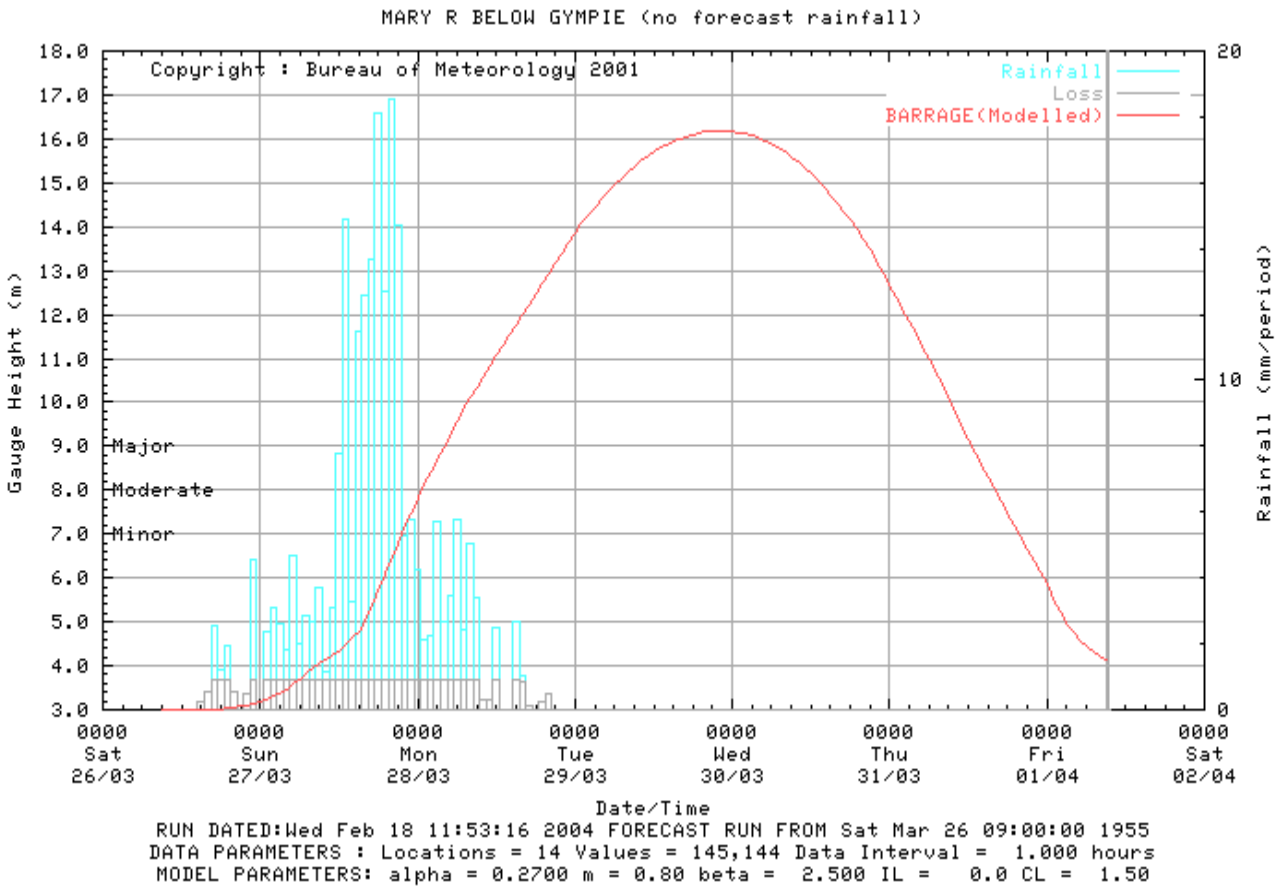
BoM URBS Model Calibration Information

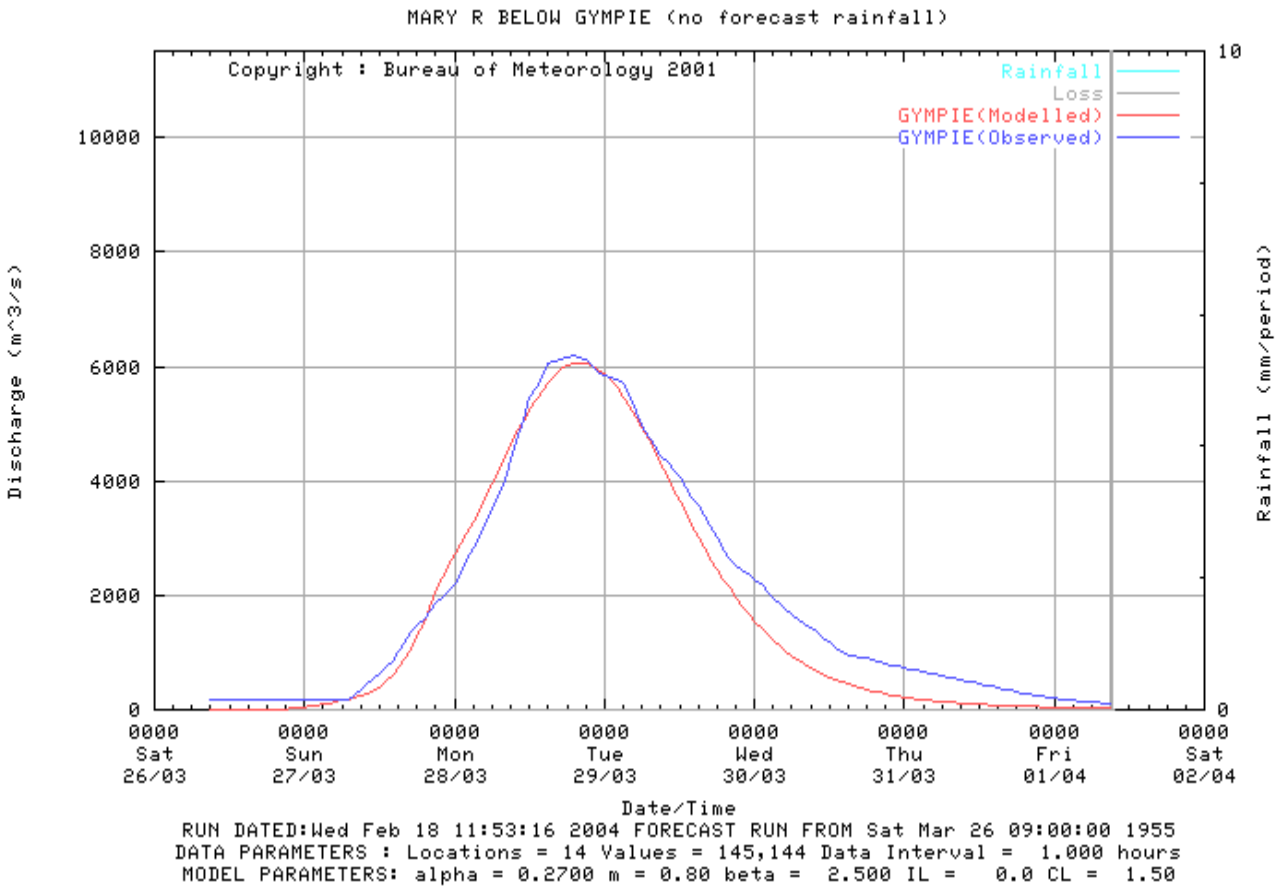

MARY R BELOW GYMPIE (no forecast rainfall)
Copyright : Bureau of Meteorology 2001
Rainfall
Loss
MARYBOROUGH(Modelled)
MARYBOROUGH(Observed)
Discharge (m^3/s)
Rainfall (mm/period)
10000
8000
6000
4000
2000
0
30
20
10
0
0000 Sat 26/03
0000 Sun 27/03
0000 Mon 28/03
0000 Tue 29/03
0000 Wed 30/03
0000 Thu 31/03
0000 Fri 01/04
0000 Sat 02/04
Date/Time
RUN DATED:Wed Feb 18 11:53:16 2004 FORECAST RUN FROM Sat Mar 26 09:00:00 1955
DATA PARAMETERS : Locations = 14 Values = 145,144 Data Interval = 1.000 hours
MODEL PARAMETERS: alpha = 0.2700 m = 0.80 beta = 2.500 IL = 0.0 CL = 1.50

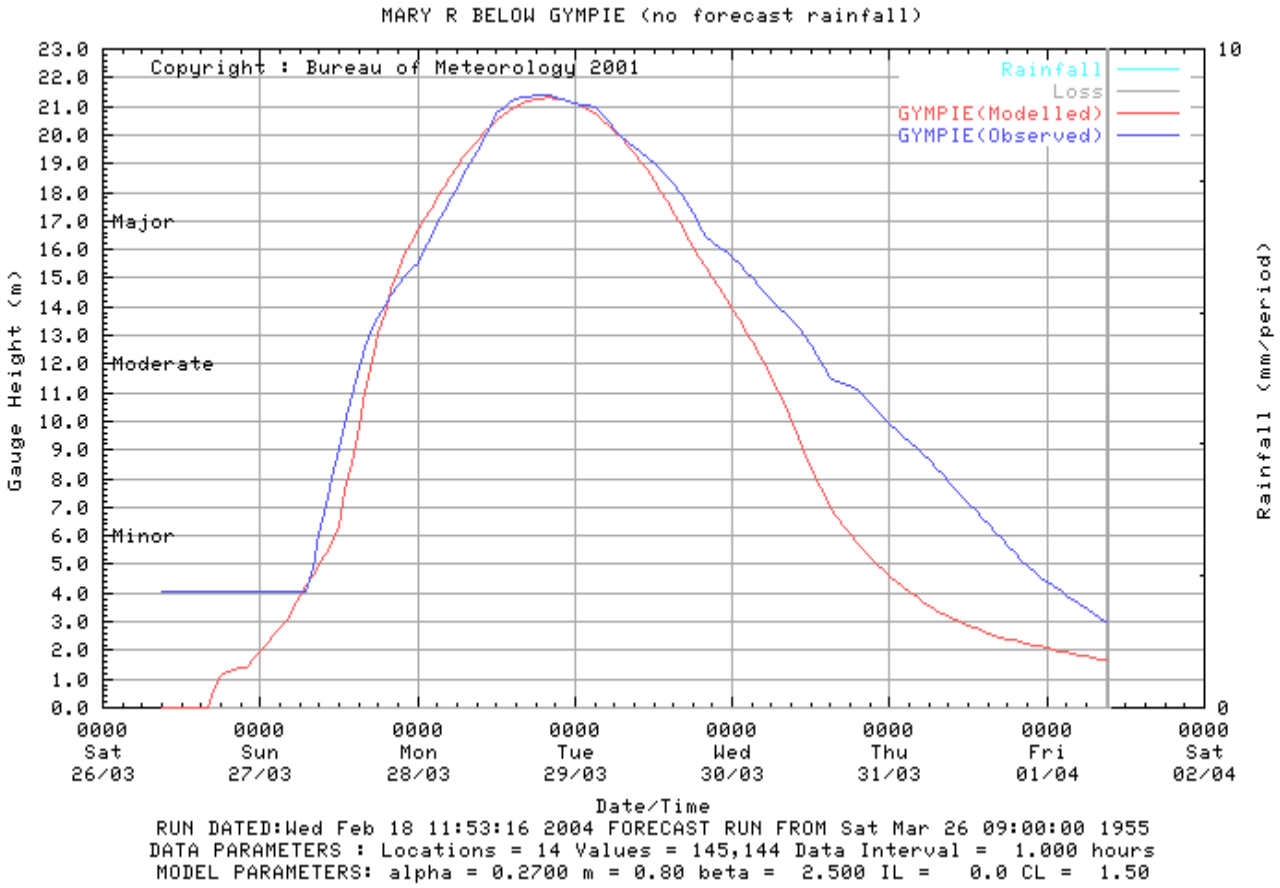


RUN DATED:Wed Feb 18 11:53:16 2004 FORECAST RUN FROM Sat Mar 26 09:00:00 1955
DATA PARAMETERS : Locations = 14 Values = 145,144 Data Interval = 1.000 hours
MODEL PARAMETERS: alpha = 0.2700 m = 0.80 beta = 2.500 IL = 0.0 CL = 1.50


MARY R BELOW GYMPIE (no forecast rainfall)
Copyright : Bureau of Meteorology 2001
Rainfall
Loss
BARRAGE(Modelled)
Discharge (m^3/s)
Rainfall (mm/period)
10000
8000
6000
4000
2000
0
20
10
0
0000 Sat 26/03
0000 Sun 27/03
0000 Mon 28/03
0000 Tue 29/03
0000 Wed 30/03
0000 Thu 31/03
0000 Fri 01/04
0000 Sat 02/04
Date/Time
RUN DATED:Wed Feb 18 11:53:16 2004 FORECAST RUN FROM Sat Mar 26 09:00:00 1955
DATA PARAMETERS : Locations = 14 Values = 145,144 Data Interval = 1.000 hours
MODEL PARAMETERS: alpha = 0.2700 m = 0.80 beta = 2.500 IL = 0.0 CL = 1.50


MARY R BELOW GYMPIE (no forecast rainfall)
Copyright : Bureau of Meteorology 2001
Rainfall
Loss
BARRAGE(Modelled)
Gauge Height (m)
Rainfall (mm/period)
Major
Moderate
Minor
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
20
10
0
0000 Sat 26/03
0000 Sun 27/03
0000 Mon 28/03
0000 Tue 29/03
0000 Wed 30/03
0000 Thu 31/03
0000 Fri 01/04
0000 Sat 02/04
Date/Time
RUN DATED:Wed Feb 18 11:53:16 2004 FORECAST RUN FROM Sat Mar 26 09:00:00 1955
DATA PARAMETERS : Locations = 14 Values = 145,144 Data Interval = 1.000 hours
MODEL PARAMETERS: alpha = 0.2700 m = 0.80 beta = 2.500 IL = 0.0 CL = 1.50


MARY R BELOW GYMPIE (no forecast rainfall)
Copyright : Bureau of Meteorology 2001
Rainfall
Loss
GYMPIE(Modelled)
GYMPIE(Observed)
Discharge (m^3/s)
Rainfall (mm/period)
10000
8000
6000
4000
2000
0
10
0
0000 Sat 26/03
0000 Sun 27/03
0000 Mon 28/03
0000 Tue 29/03
0000 Wed 30/03
0000 Thu 31/03
0000 Fri 01/04
0000 Sat 02/04
Date/Time
RUN DATED:Wed Feb 18 11:53:16 2004 FORECAST RUN FROM Sat Mar 26 09:00:00 1955
DATA PARAMETERS : Locations = 14 Values = 145,144 Data Interval = 1.000 hours
MODEL PARAMETERS: alpha = 0.2700 m = 0.80 beta = 2.500 IL = 0.0 CL = 1.50



RUN DATED:Wed Feb 18 11:53:16 2004 FORECAST RUN FROM Sat Mar 26 09:00:00 1955
DATA PARAMETERS : Locations = 14 Values = 145,144 Data Interval = 1.000 hours
MODEL PARAMETERS: alpha = 0.2700 m = 0.80 beta = 2.500 IL = 0.0 CL = 1.50

Appendix C

Design Event Rainfall Data

Upper Model Storm Duration of 72.0 hours for ARI 100 event
Design Run
Time Increment: 1.2000000
Run Duration : 432.00000
Storm Duration: 72.00000
Pluviograph.
0.00 0.00 0.00 0.00 0.00 0.11 0.25 1.12 0.54 0.86
0.24 0.05 0.22 2.01 0.11 1.06 1.37 1.15 0.81 2.06
0.89 1.27 1.17 1.64 0.52 1.37 3.44 6.58 1.45 5.08
5.56 6.05 8.01 5.62 8.20 6.50 2.34 2.54 1.87 0.93
0.99 2.53 1.19 1.53 2.54 1.08 2.22 1.51 0.14 0.15
1.09 0.00 0.00 1.18 0.46 0.05 0.00 0.11 0.22 0.00
0.00
RAIN ON SUBAREAS:
710 612 581 557 668 689 708 719 637 724
635 514 532 549 539 524 529 535 572 576
597 524 539 527 583 507 539 527 593 718
722 685 556 620 620

Loss: Variable Continuing
IL: 10.00
CL: 2.00

Lower Model Storm Duration of 72.0 hours for ARI 100 event
Design Run
Time Increment: 1.2000000
Run Duration : 432.00000
Storm Duration: 72.00000
Pluviograph.
0.00 0.00 0.00 0.00 0.00 0.11 0.25 1.12 0.54 0.86
0.24 0.05 0.22 2.01 0.11 1.06 1.37 1.15 0.81 2.06
0.89 1.27 1.17 1.64 0.52 1.37 3.44 6.58 1.45 5.08
5.56 6.05 8.01 5.62 8.20 6.50 2.34 2.54 1.87 0.93
0.99 2.53 1.19 1.53 2.54 1.08 2.22 1.51 0.14 0.15
1.09 0.00 0.00 1.18 0.46 0.05 0.00 0.11 0.22 0.00
0.00
RAIN ON SUBAREAS:
534 531 488 503 506 422 452 469 514 448
350 395 441 430 447 466 450 389 398 443
494 445 443 443 438 446 450 443 442 440
444 462 447 456 453 478 495 484 503 495
520 693 587 725 706 545 540 547 525 480
472 521 529 590

Loss: Variable Continuing
IL: 10.00
CL: 2.00

Upper Model Storm Duration of 72.0 hours for ARI 50 event
Design Run
Time Increment: 1.2000000
Run Duration : 432.00000
Storm Duration: 72.00000
Pluviograph.
0.00 0.00 0.00 0.00 0.00 0.11 0.25 1.12 0.54 0.86
0.24 0.05 0.22 2.01 0.11 1.06 1.37 1.15 0.81 2.06
0.89 1.27 1.17 1.64 0.52 1.37 3.44 6.58 1.45 5.08
5.56 6.05 8.01 5.62 8.20 6.50 2.34 2.54 1.87 0.93
0.99 2.53 1.19 1.53 2.54 1.08 2.22 1.51 0.14 0.15
1.09 0.00 0.00 1.18 0.46 0.05 0.00 0.11 0.22 0.00
0.00
RAIN ON SUBAREAS:
612 526 497 478 569 606 612 606 543 616
544 440 456 468 461 450 454 462 490 496
516 450 461 456 505 437 461 457 512 616
615 582 481 533 533

Loss: Variable Continuing
IL: 12.00
CL: 2.00

Lower Model Storm Duration of 72.0 hours for ARI 50 event
Design Run
Time Increment: 1.2000000
Run Duration : 432.00000
Storm Duration: 72.00000
Pluviograph.
0.00 0.00 0.00 0.00 0.00 0.11 0.25 1.12 0.54 0.86
0.24 0.05 0.22 2.01 0.11 1.06 1.37 1.15 0.81 2.06
0.89 1.27 1.17 1.64 0.52 1.37 3.44 6.58 1.45 5.08
5.56 6.05 8.01 5.62 8.20 6.50 2.34 2.54 1.87 0.93
0.99 2.53 1.19 1.53 2.54 1.08 2.22 1.51 0.14 0.15
1.09 0.00 0.00 1.18 0.46 0.05 0.00 0.11 0.22 0.00
0.00
RAIN ON SUBAREAS:
462 458 421 435 438 368 394 408 446 389
303 342 380 374 388 404 392 340 349 386
426 389 381 383 378 384 392 386 387 385
389 403 391 398 396 416 428 420 434 428
450 589 505 616 598 471 465 473 453 416
410 449 456 508

Loss: Variable Continuing
IL: 12.00
CL: 2.00

Upper Model Storm Duration of 72.0 hours for ARI 20 event
Design Run
Time Increment: 1.2000000
Run Duration : 432.00000
Storm Duration: 72.00000
Pluviograph.
0.00 0.00 0.00 0.00 0.00 0.11 0.25 1.12 0.54 0.86
0.24 0.05 0.22 2.01 0.11 1.06 1.37 1.15 0.81 2.06
0.89 1.27 1.17 1.64 0.52 1.37 3.44 6.58 1.45 5.08
5.56 6.05 8.01 5.62 8.20 6.50 2.34 2.54 1.87 0.93
0.99 2.53 1.19 1.53 2.54 1.08 2.22 1.51 0.14 0.15
1.09 0.00 0.00 1.18 0.46 0.05 0.00 0.11 0.22 0.00
0.00
RAIN ON SUBAREAS:
493 421 395 381 449 503 493 472 430 486
434 350 363 371 367 361 363 372 391 399
415 360 366 369 409 351 366 370 413 494
486 459 389 426 426

Loss: Variable Continuing
IL: 14.00
CL: 2.00

Lower Model Storm Duration of 72.0 hours for ARI 20 event
Design Run
Time Increment: 1.2000000
Run Duration : 432.00000
Storm Duration: 72.00000
Pluviograph.
0.00 0.00 0.00 0.00 0.00 0.11 0.25 1.12 0.54 0.86
0.24 0.05 0.22 2.01 0.11 1.06 1.37 1.15 0.81 2.06
0.89 1.27 1.17 1.64 0.52 1.37 3.44 6.58 1.45 5.08
5.56 6.05 8.01 5.62 8.20 6.50 2.34 2.54 1.87 0.93
0.99 2.53 1.19 1.53 2.54 1.08 2.22 1.51 0.14 0.15
1.09 0.00 0.00 1.18 0.46 0.05 0.00 0.11 0.22 0.00
0.00
RAIN ON SUBAREAS:
373 369 340 351 355 300 321 333 361 318
247 277 305 304 316 328 319 280 288 316
343 319 305 309 305 308 320 314 318 317
320 329 322 327 326 338 345 340 349 345
363 463 406 485 470 380 373 382 364 337
334 361 366 408

Loss: Variable Continuing
IL: 14.00
CL: 2.00

Upper Model Storm Duration of 72.0 hours for ARI 10 event
Design Run
Time Increment: 1.2000000
Run Duration : 432.00000
Storm Duration: 72.00000
Pluviograph.
0.00 0.00 0.00 0.00 0.00 0.11 0.25 1.12 0.54 0.86
0.24 0.05 0.22 2.01 0.11 1.06 1.37 1.15 0.81 2.06
0.89 1.27 1.17 1.64 0.52 1.37 3.44 6.58 1.45 5.08
5.56 6.05 8.01 5.62 8.20 6.50 2.34 2.54 1.87 0.93
0.99 2.53 1.19 1.53 2.54 1.08 2.22 1.51 0.14 0.15
1.09 0.00 0.00 1.18 0.46 0.05 0.00 0.11 0.22 0.00
0.00
RAIN ON SUBAREAS:
438 438 313 313 438 438 438 438 438 438
438 313 313 313 313 313 313 438 337 438
438 313 313 438 438 313 313 438 438 438
438 438 337 337 337

Loss: Variable Continuing
IL: 16.00
CL: 2.00

Lower Model Storm Duration of 72.0 hours for ARI 10 event
Design Run
Time Increment: 1.2000000
Run Duration : 432.00000
Storm Duration: 72.00000
Pluviograph.
0.00 0.00 0.00 0.00 0.00 0.11 0.25 1.12 0.54 0.86
0.24 0.05 0.22 2.01 0.11 1.06 1.37 1.15 0.81 2.06
0.89 1.27 1.17 1.64 0.52 1.37 3.44 6.58 1.45 5.08
5.56 6.05 8.01 5.62 8.20 6.50 2.34 2.54 1.87 0.93
0.99 2.53 1.19 1.53 2.54 1.08 2.22 1.51 0.14 0.15
1.09 0.00 0.00 1.18 0.46 0.05 0.00 0.11 0.22 0.00
0.00
RAIN ON SUBAREAS:
311 307 282 292 296 252 270 279 302 267
206 230 253 254 264 275 268 237 244 266
285 268 252 258 254 254 269 264 268 268
270 277 273 275 275 283 287 284 290 286
302 377 336 395 381 316 309 318 302 282
280 300 303 337

Loss: Variable Continuing
IL: 16.00
CL: 2.00

Upper Model Storm Duration of 72.0 hours for ARI 5 event
Design Run
Time Increment: 1.2000000
Run Duration : 432.00000
Storm Duration: 72.00000
Pluviograph.
0.00 0.00 0.00 0.00 0.00 0.11 0.25 1.12 0.54 0.86
0.24 0.05 0.22 2.01 0.11 1.06 1.37 1.15 0.81 2.06
0.89 1.27 1.17 1.64 0.52 1.37 3.44 6.58 1.45 5.08
5.56 6.05 8.01 5.62 8.20 6.50 2.34 2.54 1.87 0.93
0.99 2.53 1.19 1.53 2.54 1.08 2.22 1.51 0.14 0.15
1.09 0.00 0.00 1.18 0.46 0.05 0.00 0.11 0.22 0.00
0.00
RAIN ON SUBAREAS:
345 291 271 263 304 373 346 311 292 328
298 240 250 253 251 250 251 260 270 279
291 249 250 260 290 246 250 263 290 342
329 309 275 295 295

Loss: Variable Continuing
IL: 18.00
CL: 2.00

Lower Model Storm Duration of 72.0 hours for ARI 5 event
Design Run
Time Increment: 1.2000000
Run Duration : 432.00000
Storm Duration: 72.00000
Pluviograph.
0.00 0.00 0.00 0.00 0.00 0.11 0.25 1.12 0.54 0.86
0.24 0.05 0.22 2.01 0.11 1.06 1.37 1.15 0.81 2.06
0.89 1.27 1.17 1.64 0.52 1.37 3.44 6.58 1.45 5.08
5.56 6.05 8.01 5.62 8.20 6.50 2.34 2.54 1.87 0.93
0.99 2.53 1.19 1.53 2.54 1.08 2.22 1.51 0.14 0.15
1.09 0.00 0.00 1.18 0.46 0.05 0.00 0.11 0.22 0.00
0.00
RAIN ON SUBAREAS:
263 259 239 247 251 215 231 239 256 228
176 195 213 217 225 234 229 204 211 229
240 230 212 218 215 213 230 225 231 232
233 237 235 237 236 241 243 241 244 242
256 311 283 326 313 267 260 269 254 239
239 253 255 284

Loss: Variable Continuing
IL: 18.00
CL: 2.00

Appendix D

Historical Flood Records

hdnews,17p6,22,24,12
Lamington Bridge _
official yardstick

The Lamington Bridge is Maryborough's official flood yardstick. When the Mary River rises to 6 m, it is level with the decking of the Lamington Bridge and the city records another flood. el3 The flood after the 1992 deluge was the 21st since records were kept in 1875 and was the sixth highest on record for Maryborough. ~~el9~~ The higher floods occurred in 1974, 1955, 1898, 1893, and 1890. ~~el4~~

~~cc17p cf7,8,8.5~~ PAST FLOODS LEVELS EXCEEDING 6 m IN HEIGHT ~~el4 cc8p mv1~~ 1875 Feb 28 ~~ff~~ 8.99
1890 Mar 23 ~~ff~~ 9.83
1893 Feb 5 ~~ff~~ 12.27
1898 Jan 12 ~~ff~~ 9.71
1928 Feb 22 ~~ff~~ 6.96
1931 Feb 07 ~~ff~~ 7.22
1937 Mar 18 ~~ff~~ 6.40
1947 Mar 3 ~~ff~~ 6.10
1950 Mar 2 ~~ff~~ 6.30
1954 July 15 ~~ff~~ 6.02
1955 Mar 29 ~~ff~~ 11.25
~~rm1 cx9p~~ 1956 Mar 13 ~~ff~~ 7.49
1956 Dec 23 ~~ff~~ 7.01
1968 Jan 12 ~~ff~~ 9.25
1971 Feb 05 ~~ff~~ 6.30
1972 Feb 14 ~~ff~~ 6.43
1973 July 10 ~~ff~~ 7.72
1974 Jan 29 ~~ff~~ 10.95
1989 Apr 5 ~~ff~~ 6.65
1989 April 28 ~~ff~~ 6.55
1992 Feb 24 ~~ff~~ 9.50

1992 March 18 (cyclone Fran) 6.65
1999 February 12 8.76
Kenilworth Homestead, Justyn Rowe. ph 07 54460212

Post Office, Kennilworth: 54460247

Gympie Peaks: 1870 21m; 1893 25m; 1898 22; 1955 21m; 1974 20.57; 1989 19.6. 1992 21.4m;.

Flood Peaks, Gympie: 1870 .....21m
4/2/1893....25m
11/1/1898...22m
14/7/54.....15m
28/3/55.....21m
10/1/68.....18.6
13/2/72.....18.3
9/7/73.....19.5
1974.....20.57m
3/4/89.....19.63
23/2/92.....21.4
11/2/99....21.95

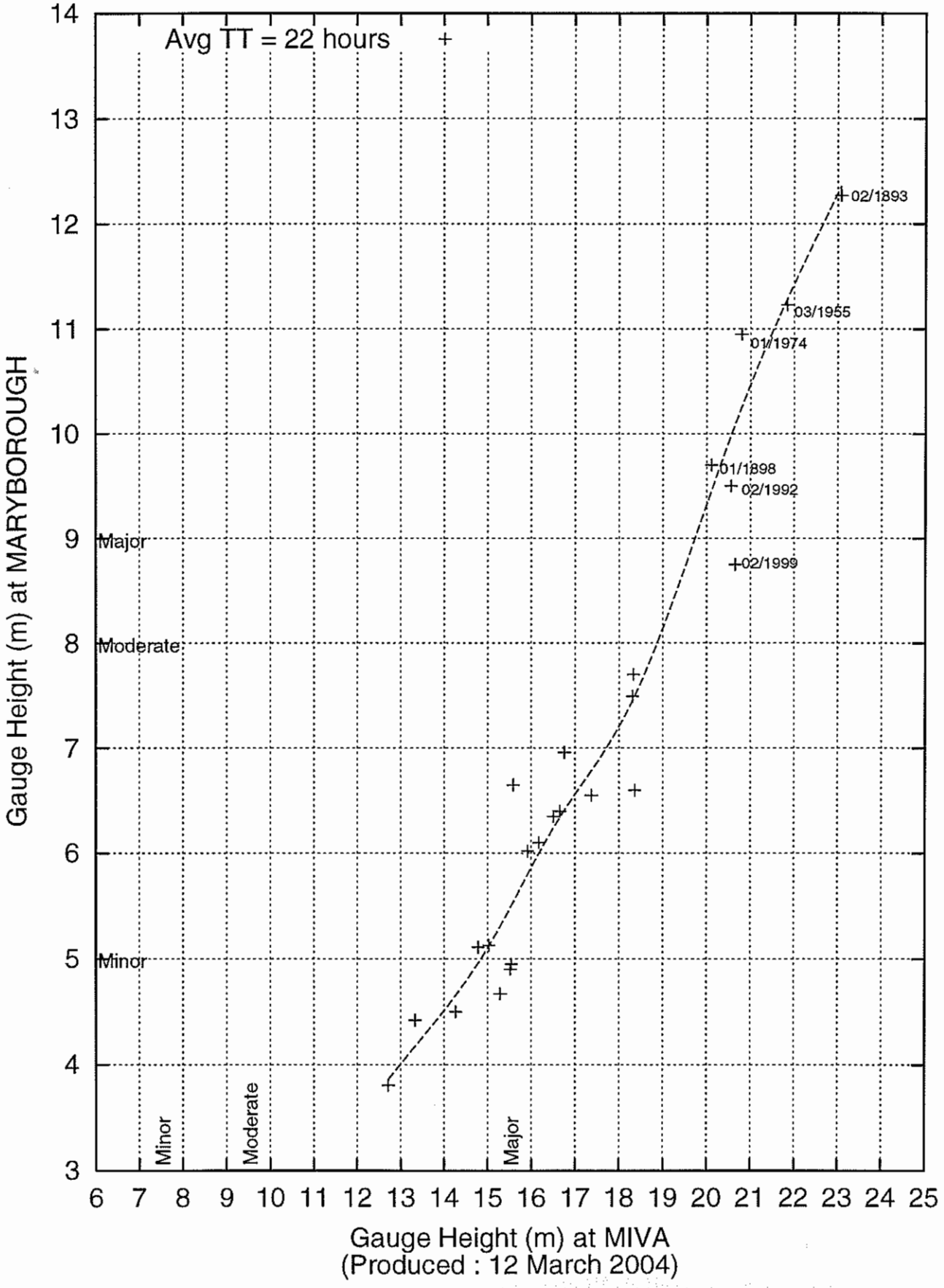
Tiaro: 1893 73ft? (22.26); 1955 68ft 1in (20.74), 1974 64ft (19.52); 1989 15.95m (73ft) .

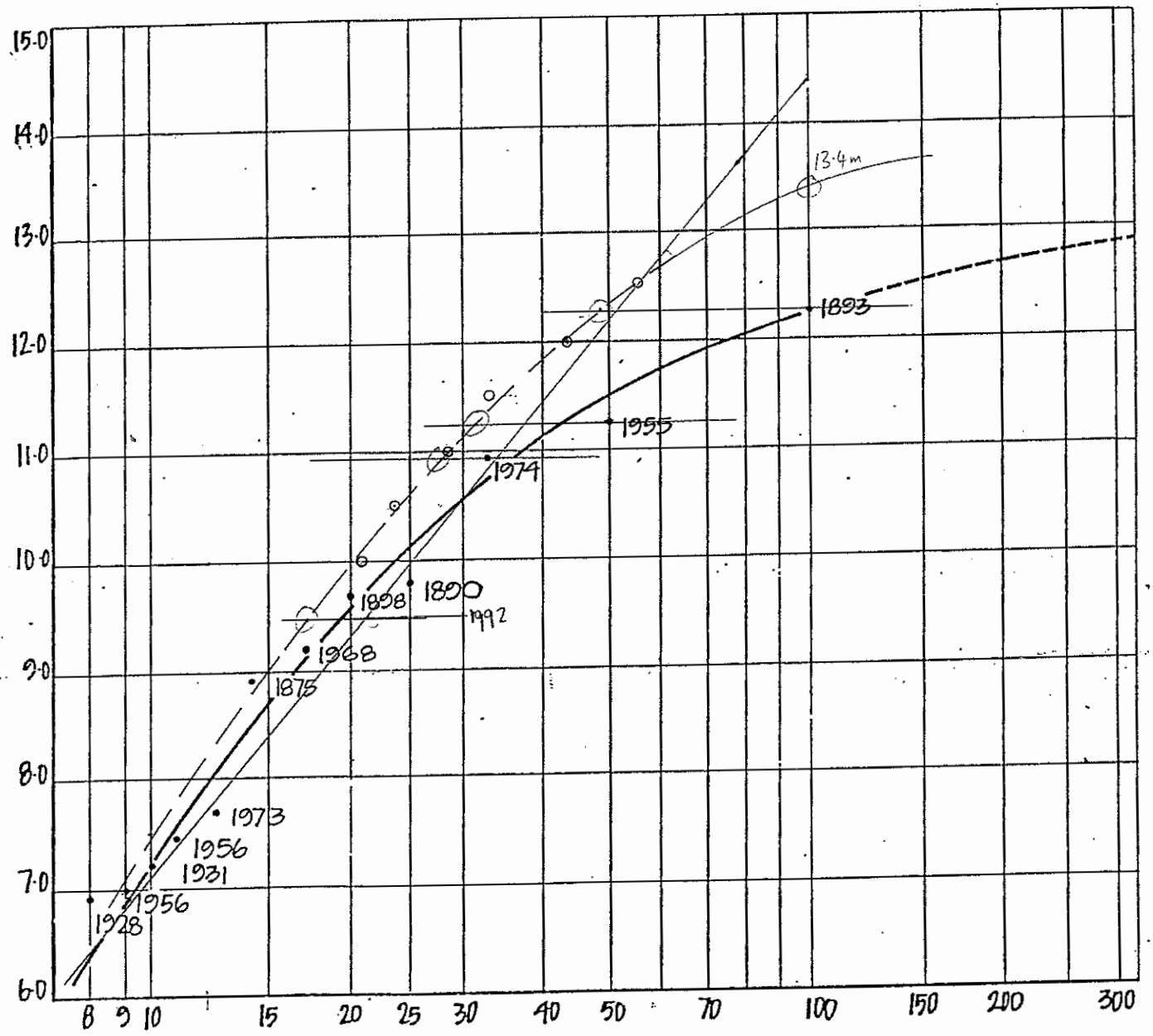
Maryborough: 1893 40ft 2in (12.2); 1955 37ft 11in (11.3m); 1974 35ft 11in (10.95m), 1989 (April 5) 6.65; 1989 (April 28) 6.55; 1992 Feb 24 9.5m.

Kent st cuts at 4.9m; Guava St and Lammy Bridge decking at 5.5m;
8.1m at Maryborough, access cuts off each side of granville bridge approaches

February 9, 1999: as at 9am 159mm for the first 9 days; wettest first 9 days February on record, February 1931, 568mm., the wettest 9 days ever were January 1893 with 672mm.
February: Maryborough average 173mm; 1971 - 988.5mm . Tiaro: February highest 629mm in 1971, average 150mm.

MIVA to MARYBOROUGH
Peak Stage Diagram





Return period · years

1 in 100 yrs = 13·4m Gauge.

1893	1 in 49
1955	1 in 31
1974	1 in 28
1992	1 in 17

Figure 7·1

MARY RIVER
MAJOR FLOODS

1875 to 1976.

IN AUG '94 11:24 WATER RESOURCES MARYBOROUGH

198000.RC

22 42422

Mr W Huxley
86/6237/2

DX 130

Your ref: VWL-s:DAM

20th August 1986

The City Administrator
Maryborough City Council
PO Box 110
MARYBOROUGH QLD 4650

Attention: Mr V. Lever-Shaw

Dear Sir

FLOOD FREQUENCIES - MARYBOROUGH FLOOD WARNING GAUGE

I refer to your correspondence of the 4th August, 1986 in which you requested data on the flood level at the Maryborough flood gauge which would result from a flood with a one (1) percent annual probability of exceedance (AEP).

The performance of frequency analyses on derived peak discharge data for the Mary River at the Maryborough gauge has indicated that a flood with a 1% AEP would have an expected peak discharge of the order of 12 000 cumecs. Reference to the rating curve derived for the Maryborough flood gauge indicates that the gauge flood level would be about 14.4 metres (13 m AHD).

Yours faithfully = 14.027 MCC at Gauge.

B/C Regional Engineer
Qld Water Resources Commission
BUNDABERG

For your information.

W N Meredith
SECRETARY

DIRECTOR WATER RESOURCES DIVISION

River Flow
8 MPH.

145

END

DISCLAIMER

THIS MAP HAS BEEN PREPARED BY MARYBOROUGH CITY COUNCIL IN AN ENDEAVOUR TO GENERALLY DEPICT THOSE PARTS OF THE CITY WHICH WOULD BE AFFECTED BY A FLOOD HAVING LEVELS EQUIVALENT TO THE GREAT FLOOD OF 1893.
THE INFORMATION USED TO PREPARE THIS MAP HAS BEEN LARGELY OBTAINED FROM THE BUREAU OF METEOROLOGY AND BY EXTRAPOLATION OF INUNDATION LEVELS RECORDED BY MARYBOROUGH CITY COUNCIL FOLLOWING VARIOUS FLOODS.
THE INFORMATION IS TO THE BEST OF MARYBOROUGH CITY COUNCILS KNOWLEDGE CORRECT.
HOWEVER MARYBOROUGH CITY COUNCIL ACCEPTS NO LIABILITY SHOULD ANY LAND HAVE BEEN EITHER INCLUDED OR EXCLUDED FROM THE FLOODED AREA DUE TO INCORRECT INFORMATION.

PAST FLOOD LEVELS EXCEEDING 7.00m IN HEIGHT

NOTE: 5.50m APPROXIMATE DECK LEVEL OF THE LAMINGTON BRIDGE

YEAR	DATE	HEIGHT	YEAR	DATE	HEIGHT
1875	Feb 28	8.99m	1956	Dec 23	7.01m
1890	Mar 23	9.83m	1968	Jan 12	9.25m
1893	Feb 5	12.27m	1973	July 10	7.70m
1898	Jan 12	9.70m	1974	Jan 29	10.95m
1931	Feb 7	7.21m	1992	Feb 23	9.50m
1955	Mar 29	11.24m	1999	Feb 11	8.75m
1956	Mar 13	7.49m			

SOURCE - Department of Science - Bureau of Meteorology (Brisbane)

PERCENTAGE PROBABILITY OF A FLOOD LEVEL BEING EQUALLED OR EXCEEDED DURING A SPECIFIED PERIOD

FLOOD LEVEL ON GAUGE (metres)	PERIOD (years)		
	1	50	100
10.0	4.8	91	99
10.5	4.2	88	98
11.0	3.5	83	97
11.5	3.0	78	95
12.0	2.3	69	90
12.5	1.9	62	85

SOURCE - Queensland Water Resources Commission

I) SHADED AREA REPRESENTS APPROXIMATE AREA OF INUNDATION EQUIVALENT TO THE 1893 FLOOD I.E. 12.27m RECORDED AT THE OFFICIAL MACALISTER STREET FLOOD GAUGE.

II) NOTE: SPECIFIC ENQUIRIES AS TO DEPTH OF FLOODING WITHIN THE SHADED AREA AND/OR THE EXTENT OF INUNDATION OVER PROPERTIES AT THE FRINGES SHOULD BE MADE AT THE ENGINEERING SERVICES DEPARTMENT OPPOSITE CITY HALL.

III) FLOOD POSTS ARE LOCATED IN THE POSITIONS INDICATED THUS ▲ REFERENCE TO THESE POSTS WILL PROVIDE AN INDICATION OF THE LIKELY INUNDATION AT VARIOUS FLOOD GAUGE LEVELS.

0 0.5 1.0 1.5km

AMMENDMENTS		
REV	DESCRIPTION	DATE

MARYBOROUGH CITY COUNCIL

OFFICIAL MARYBOROUGH CITY FLOOD MAP

SHEET	1 of 1	DATE. 29/11/01	COMPUTER REF	K:\Maps – City\F46
APPROVED	DIRECTOR OF ENGINEERING SERVICES		DRG No.	F 46 A3

LOCATION NO.	LOCATION STREETS	AHD DATUM GROUND LEVEL AT GAUGE READING OF 12.27m (1893 FLOOD)
1	QUEEN AND RUSSELL STREETS	12.843
2	GEORGE AND RUSSELL STREETS	12.753
3	QUEEN (NEPTUNE ST & LIONS DR)	12.443
4	ROCKY AND ELLENA STREETS	12.413
5	ALICE AND TANNER STREETS	12.413
6	ANN AND CHEAPSIDE STREETS	12.413
7	QUEEN AND PALLAS STREETS	12.323
8	QUEEN AND FERRY STREETS	12.263
9	QUEEN AND FORT STREETS	12.233
10	QUEEN AND LENNOX STREETS	12.203
11	SOUTH AND LENNOX STREETS	12.203
12	QUEEN AND MARCH STREETS	12.143
13	ANN AND CARLSON STREETS	11.923
14	ALBERT AND WYLAND STREETS	11.503

LOCATION NO.	LOCATION STREETS	AHD DATUM GROUND LEVEL AT GAUGE READING OF 12.27m (1893 FLOOD)
15	ALICE AND CHARLES STREETS	11.073
16	KENT AND MARCH STREETS	10.923
17	LENNOX AND WALKER STREETS	10.863
18	ADELAIDE AND KENT STREETS	10.923
19	BAZAAR AND ELLENA STREETS	10.983
20	LENNOX AND CHURCHILL STREETS	10.643
21	TREASURE AND WARATAH STREETS	10.343
22	ERROL AND IRIS STREETS	9.943
23	ERROL AND BOOKER STREETS	9.703
24	CHEAPSIDE AND ARBURY STREETS	8.393
25	VICTORY AND THURECHT STREETS	8.393
26	PULLER AND CARDIGAN STREETS	11.133
27	ODESSA AND DUNDAS STREETS	11.073
28	RAGLAN AND CAMBRIDGE STREETS	10.703
29	WOLSELEY AND STEINDL STREETS	10.553
30	BANANA AND O'BRIEN STREETS	10.063

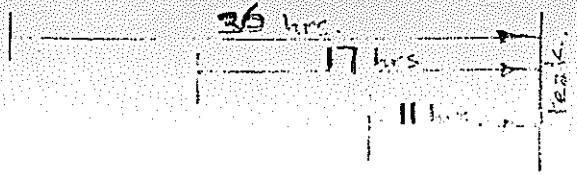
NOTE:
ALL LEVELS SHOWN ARE AHD DATUM

0 0.5 1.0 1.5km

AMENDMENTS		
REV	DESCRIPTION	DATE

MARYBOROUGH CITY COUNCIL
INTERNAL MARYBOROUGH CITY FLOOD MAP
DEFINED QUIESCENT WATER AREAS

SHEET	1 of 1	DATE. 29/11/01	COMPUTER REF	K:\Maps - City\F47
APPROVED	DIRECTOR OF ENGINEERING SERVICES		DRG No.	F 47 A3



DATE	GYMPIE Height	MIVA Height	TIARD Height	MARYBOROUGH Height	Maximum Lift above Tide*	Tide Height at MAX. Lift
23-6-83	16·75	—	—	4·85	4·20 above Tide	0·1 Low
3-12-87	8·30	—	—	3·80	2·40 above Tide	0·1 Low
7-4-88	10·50	8·70	6·30	3·20	1·6 above Tide	0·9 Low
12-4-88	10·90	9·18	6·40	3·80	1·6 above Tide	0·5 Low
6-6-88	13·00	10·95	8·20	3·25	1·3 above Tide	0·7 Low
6-7-88	12·45	11·97	10·10	3·57	1·4 above Tide	2·15 High
20-12-88	13·50	14·17	11·90	4·28	3·0 above Tide	0·20 Low
1-4-89	19·65	18·30	15·95	6·64 5-4	6·4 above Tide	0·00 Low
28-4-89	19·00	17·35	15·50	6·55 28-4	5·6 above tide	0·90 Low
23-2-92	21·50	20·45	18·60	9·48	7·8 above Tide	1·60

NOTE: Dock Level of Wharf 1·4m

* Tide is Bberg Hook level.

MARYBOROUGH CITY COUNCIL

FLOOD RECORD SHEET

MARY RIVER						TINANA CREEK		
DATE	GYMPIE	MIVA	HOME PARK	TIARO	BARRAGE	MARYBOROUGH	BAUPLE EAST	TEDDINGTON WEIR
23-06-83	16.75	-		-		4.85		
03-12-87	8.30	-		-		3.80		
07-04-88	10.50	8.70		6.30		3.20		
12-04-88	10.90	9.18		6.40		3.80		
06-06-88	13.00	10.95		8.20		3.25		
06-07-88	12.45	11.97		10.10		3.57		
20-12-88	13.50	14.17		11.90		4.28		
01-04-89	19.65	18.30		15.95		6.64		
28-04-89	19.00	17.35		15.50		6.55		
23-02-92	21.50	20.45		18.60		9.48		
18-03-92	16.10	-		-		6.65		
17-02-95	12.40	10.82	9.10	7.80	5.7	3.88	9.30	
11-02-99	21.95	20.65	20.13	18.10	12.51	8.75	12.73	11.05

 Bureau of Meteorology

PEAK FLOOD HEIGHTS

(Chronological Listing)

Station: **MARYBOROUGH**	CBM No: **040443**
Stream : **MARY RIVER**	AWRC No: **138904**
Flood Classifications: MINOR 5.0	MODERATE 8.0 MAJOR 9.0

Date	Time	Gauge Height (metres)	Site	Data Source	Data Type	Obs Site
24/02/1992	1500	9.50		LOG SHEET	MANUAL OBS	
18/03/1992	1330	6.65		LOG SHEET	MANUAL OBS	
10/01/1996	1200	4.70		OTHER	MANUAL OBS	
12/02/1999	0100	8.75		LOG SHEET	MANUAL OBS	

Note : Must be read in conjunction with Explanatory Notes.

 Bureau of Meteorology

PEAK FLOOD HEIGHTS

(Chronological Listing)

Station: **MARYBOROUGH**	CBM No: **040443**
Stream : **MARY RIVER**	AWRC No: **138904**

Flood Classifications: MINOR 5.0 MODERATE 8.0 MAJOR 9.0

GZ = -1.39 m AHD 1/9/1875

Date	Time	Gauge Height (metres)	Site	Data Source	Data Type	Obs Site
03/1864		7.48		DNRM	NOT KNOWN	
1870		8.39		DNRM	NOT KNOWN	
28/02/1875		8.99		REGISTER	NOT KNOWN	
26/01/1890		10.06		DNRM	NOT KNOWN	
05/02/1893		12.27		REGISTER	NOT KNOWN	
12/01/1898		9.70		REGISTER	NOT KNOWN	
17/01/1913		5.38		REGISTER	NOT KNOWN	
07/01/1920		5.03		REGISTER	MANUAL OBS	
06/04/1921		5.33		REGISTER	MANUAL OBS	
31/12/1921		4.88		REGISTER	MANUAL OBS	
19/12/1926		5.79		REGISTER	MANUAL OBS	
27/01/1927		4.95		REGISTER	MANUAL OBS	
22/02/1928		6.96		REGISTER	MANUAL OBS	
24/04/1928		4.93		REGISTER	MANUAL OBS	
06/04/1929		3.81		REGISTER	MANUAL OBS	
28/01/1930		3.84		REGISTER	MANUAL OBS	
30/06/1930		3.73		REGISTER	MANUAL OBS	
07/02/1931	0500	7.21		REGISTER	MANUAL OBS	
18/03/1937	0520	6.40		REGISTER	MANUAL OBS	
19/01/1938	1400	3.89		REGISTER	MANUAL OBS	
14/02/1947	0900	5.11		REGISTER	MANUAL OBS	
03/03/1947	0600	6.10		REGISTER	MANUAL OBS	
19/05/1948		5.87		REGISTER	MANUAL OBS	
25/10/1949		4.72		REGISTER	MANUAL OBS	
02/03/1950	1000	6.35		REGISTER	MANUAL OBS	
24/03/1953		4.42		REGISTER	MANUAL OBS	
13/02/1954	0800	4.50		REGISTER	MANUAL OBS	
15/07/1954	1145	6.02		REGISTER	MANUAL OBS	
29/03/1955	2300	11.23		REGISTER	MANUAL OBS	
27/05/1955	0300	4.47		REGISTER	MANUAL OBS	
11/02/1956	1030	4.88		REGISTER	MANUAL OBS	
13/03/1956	1700	7.49		REGISTER	MANUAL OBS	
30/03/1956	0130	4.42		REGISTER	MANUAL OBS	
23/12/1956	0110	7.01		REGISTER	MANUAL OBS	
12/06/1958	1950	4.67		REGISTER	MANUAL OBS	
12/01/1968	0300	9.25		REGISTER	MANUAL OBS	
05/02/1971	1100	6.30		REGISTER	MANUAL OBS	
21/02/1971	0900	5.13		REGISTER	MANUAL OBS	
14/02/1972	1300	6.40		REGISTER	MANUAL OBS	
10/07/1973	1500	7.70		REGISTER	MANUAL OBS	
29/01/1974	0700	10.95		REGISTER	MANUAL OBS	
24/06/1983	2100	4.90		REGISTER	MANUAL OBS	
05/04/1989	1000	6.60		REGISTER	MANUAL OBS	
28/04/1989	0500	6.55		REGISTER	MANUAL OBS	

Note : Must be read in conjunction with Explanatory Notes.

Appendix E

Historical Flood Related Newspaper Articles

Spirits high when Mary gets out of bed

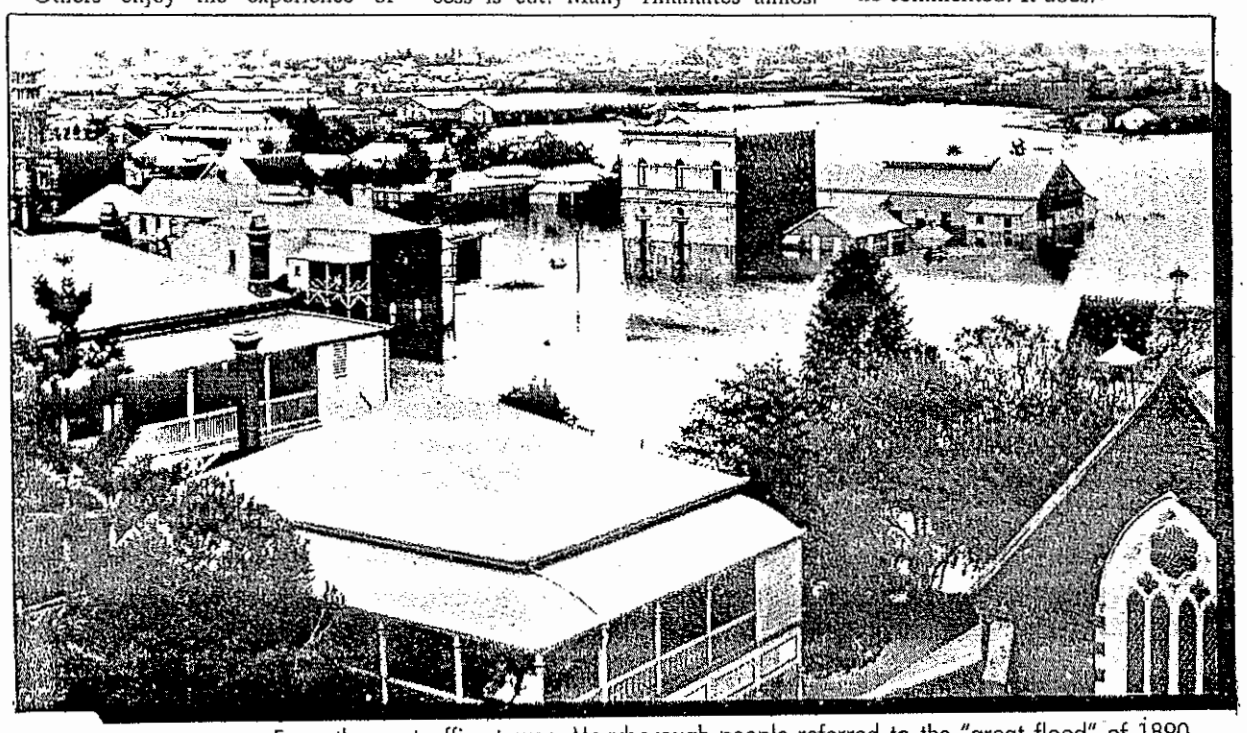
Maryborough's floods are fun for most residents. With past experience and plenty of warning of when the peak will arrive and how big it will be, they know how to handle the Mary when she surges out of bed.

Everyone pitches in to help residents and businesses move possessions from low-lying areas. As roads and bridges cut, hundreds of workers and schoolchildren have a good excuse to have a couple of days off.

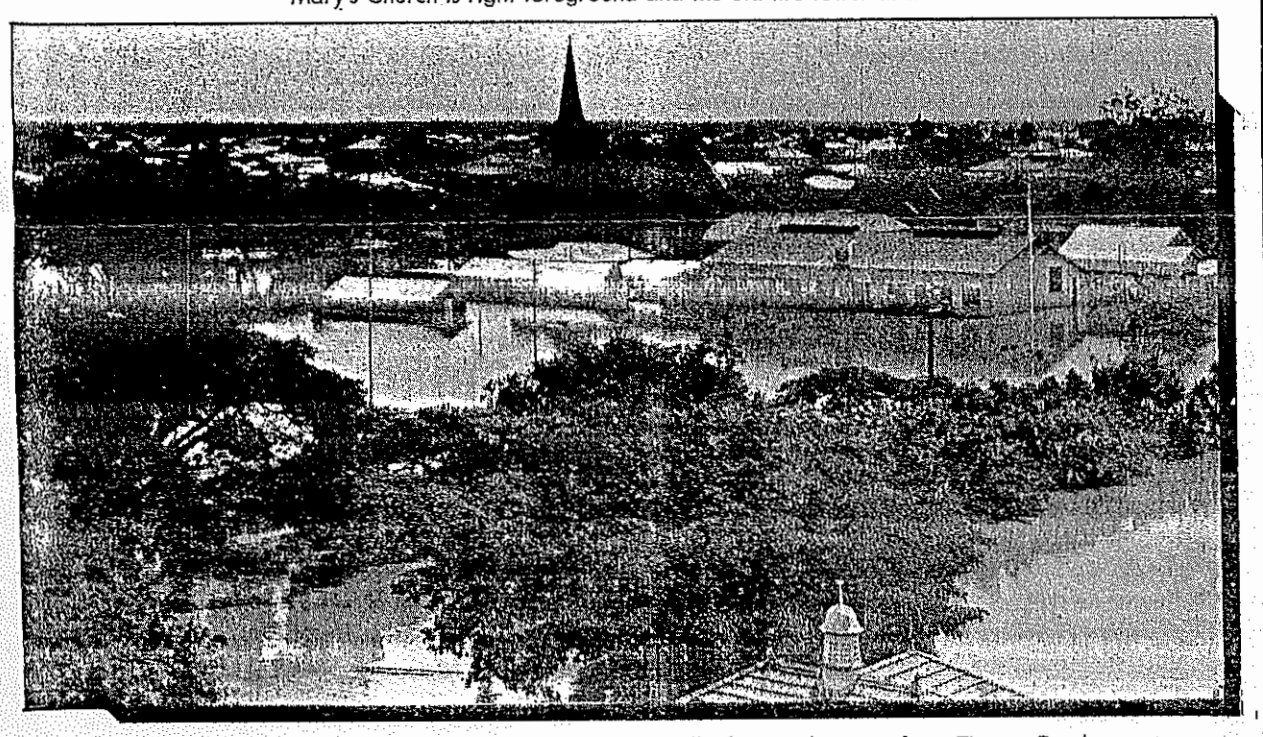
Others enjoy the experience of winding around roads or hopping in boats to get to work. Newcomers are always surprised to find Maryborough almost relishes a flood.

They liken it to a carnival atmosphere. There is a curious air in the city, tinged with excitement at the oddity of it all. Businesses continue to operate while floodwaters creep around a few metres away. Granville is isolated for two or three days but the suburb is well prepared before access is cut. Many Tinanaites almost mourn the fact that they have all-flood access now and are no longer isolated when the Lamington Bridge goes under.

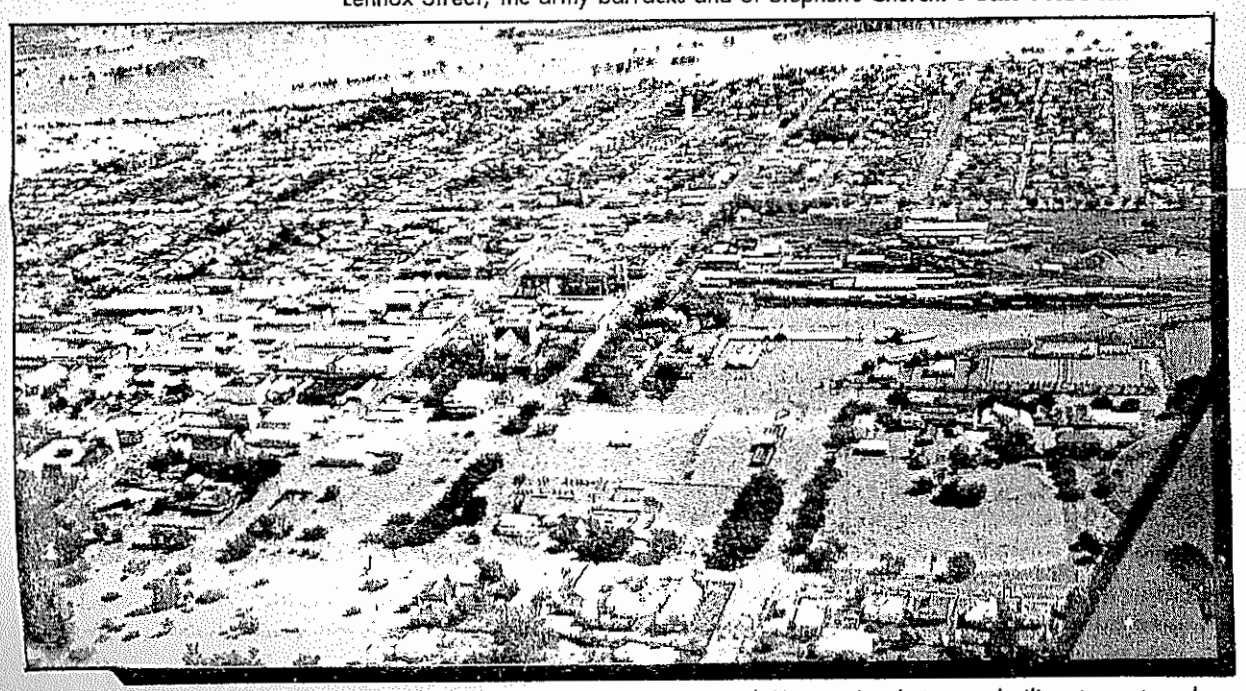
The good spirits amazed government minister Sir William Knox when he inspected the flooded city in 1974. Eighteen years later another government minister, Nev Warburton, arrived at flood time and was "amazed by the high spirits" of the city. "It says a lot about what you have here," he commented. It does..



1893 From the post office tower: Maryborough people referred to the "great flood" of 1890, never dreaming another could be worse. This one three years later was 3 m higher. St Mary's Church is right foreground and the old fire tower at the left. **Peak 12.27 m.**



1955 From the City Hall clock tower. A wall of water bursting from Tinana Creek swept over the Granville Bridge before the Mary River peak arrived from Gympie. The photo shows Lennox Street, the army barracks and St Stephen's Church. **Peak 11.30 m.**



1974 From the air: Rain falling to the west turned Munna Creek into a boiling torrent and swelled the Mary River flood coming from Gympie. Queens Park is at lower left, the City Hall is in the centre and Maryborough Bowls Club centre right. **Peak 10.95 m.**

Old tales of great flood

A hypothetical maximum flood peak for Maryborough is impossible to predict, according to the experts.

Folklore says that when the early settlers arrived they were told by Aborigines about a great flood, when the only dry land in the city area was on the hospital hill.

Development, drainage works and land clearing allows water to run away much faster today but a flood higher than 1893 is still a possiblity.

Maryborough water officer for the Queensland Water Resources Commission. Darrel Griffiths said it would depend on how much rain fell in the catchment area at a particular time.

"Take this flood, for example — if we had got another 10 inches in the catchment area before it drained away the potential is there for a much higher floods."

A spokesman for the Bureau of Meteorology said a flood the height of this year's could be expected every 17 years on average.

He said it was impossible to predict how high it was possible for a flood to reach. "You can take it only as far back as you have records. If you look around at landscapes you see strange things like boulders on top of hills and you wonder how they got there.

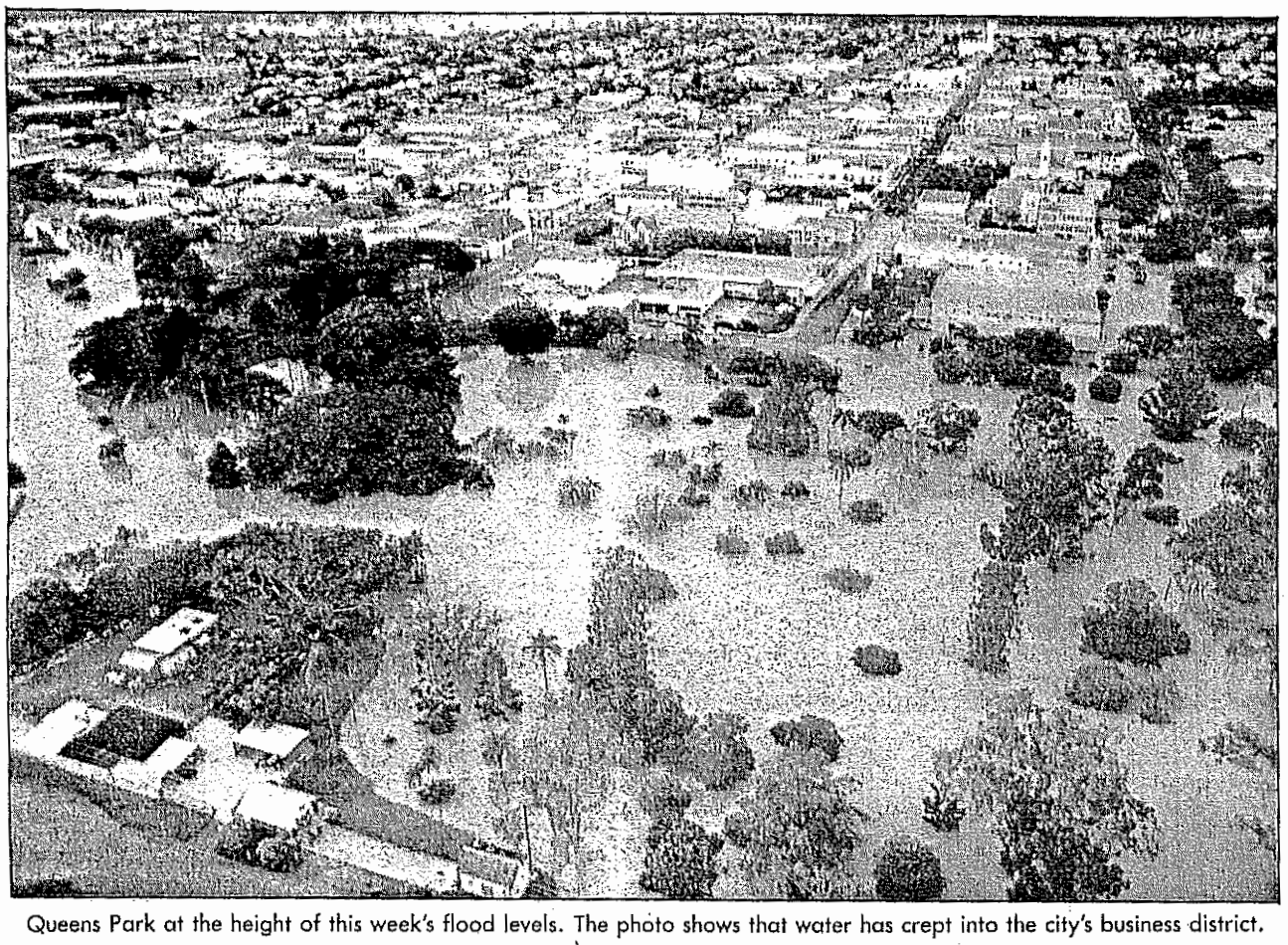
"Anything is possible."



1992 From the air: Torrential rain dumped more than 40 cm on Howard and pelted south after wreaking havoc at Pacific Haven. Three days later Maryborough had a major flood. Queens Park is in the foreground. **Peak 9.5 m.**

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Survey shows bottleneck keeps water high



Queens Park at the height of this week's flood levels. The photo shows that water has crept into the city's business district.

A bottleneck in the Mary River near Walkers Point pushes flood heights up by as much as two metres in the Maryborough city area, according to a resident's survey carried out during the disastrous 1955 flood.

Karl Phersson was one of the men involved in the survey, and maintains that by knocking out one of the embankments, Maryborough's flood problems could be eased significantly.

He said that during the 1955 floods, he and another man measured water speeds in the river. About a mile upstream of the bottleneck, water travelled about nine miles an hour. But where the river narrowed, roughly opposite the old 4MB tower on the Bay road, water raced through at more than 21 miles an hour.

Using the survey data, the men deduced that by excavating the right bank of the bottleneck water would not be held up, and levels back in Maryborough could be one and a half to two metres lower during floods.

Mr Phersson said this week that he had approached every Maryborough MP since 1955, asking them to secure funding to excavate the bank.

This week he contacted sitting member Bob Dollin who said he would look into Mr Phersson's claims.

Mr Dollin said he would check with the Water Resources department to see what studies it had done of the Mary River system.

Mr Phersson said several MPs had backed his proposal, but the Government of the day had always rejected it because of budgetary restraints.

He believes it would cost about $1 million to $1.5 million to have the job done today.

"That's value for money when you think of all the damage caused during floods, all the mess those business people in Kent Street have to clean up."

He said Maryborough would never be free of floods, but the problem could be eased rather simply be removing the bottleneck.

Maryborough looks to Gympie

The monitoring of rainfall in the Mary River catchment area gives Maryborough citizens ample warning of when a flood is heading their way.

The best gauge of the sort of flood the city can expect is Gympie. A flood peak in Gympie arrives at the city downstream about 36 hours later but what happens in Gympie is not necessarily repeated in Maryborough.

For instance, the Mary River at Gympie in the 1992 flood peak of 12.4 m was about 10 cm higher than the 1974 peak and about 5 cm lower than 1955. In Maryborough, the same flood peaked at 9.5 m, 1.4 m lower than '74 and 1.80 m lower than '55.

Many factors can come into play and vary heights as the flood peak moves from Gympie to Maryborough.

In 1974, there was heavy rainfall to the west in the Munna Creek basin. Munna Creek poured into the river and pushed levels up in Maryborough.

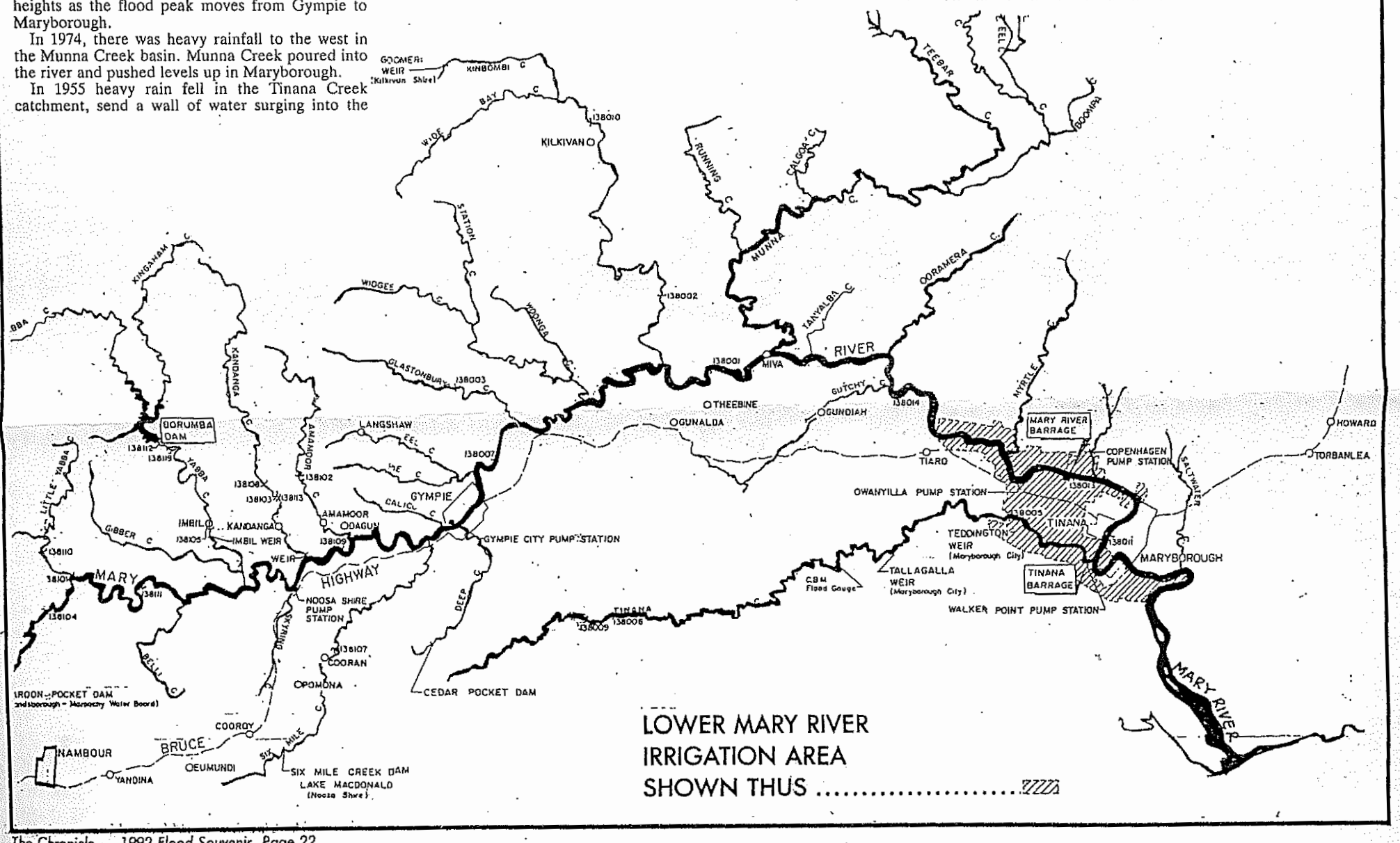
In 1955 heavy rain fell in the Tinana Creek catchment, send a wall of water surging into the Mary River. The volume of water from Tinana sent the river over the Granville Bridge before the peak arrived from Gympie.

The Bureau of Meteorology's Mary River flood warning system can give accurate predictions of what the two cities can expect and when the worst will arrive. Gympie gets between 21 to 27 hours warning of a flood while Maryborough has a couple of day's grace to prepare.

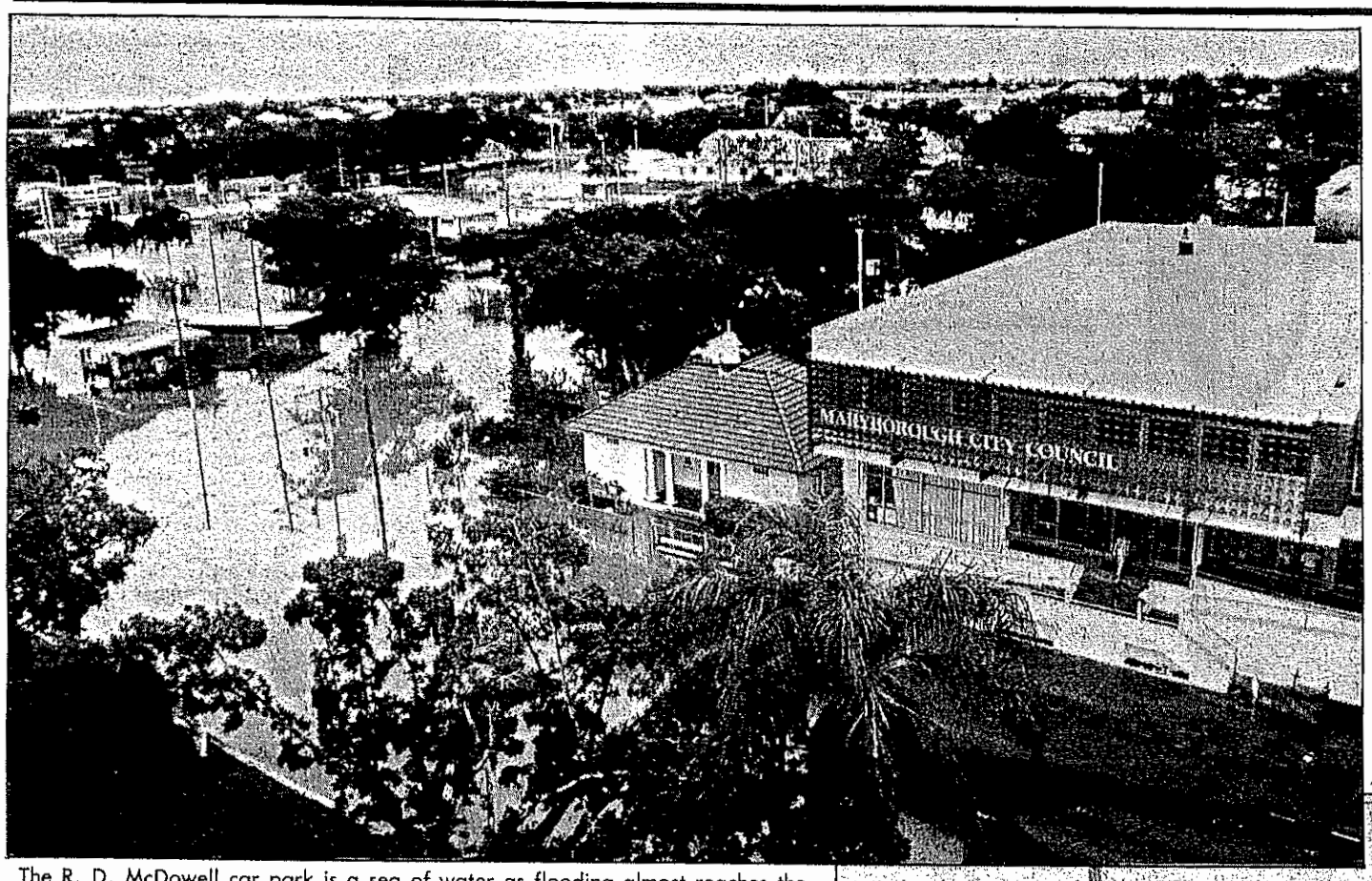
In the case of the 1992 flood, Maryborough's citizens had an idea they were in for a flood after the deluge on Thursday and Friday. They learned what size they could expect when the river peaked at Gympie on the Saturday night. The Mary did not peak in Maryborough until Monday afternoon.

High water history

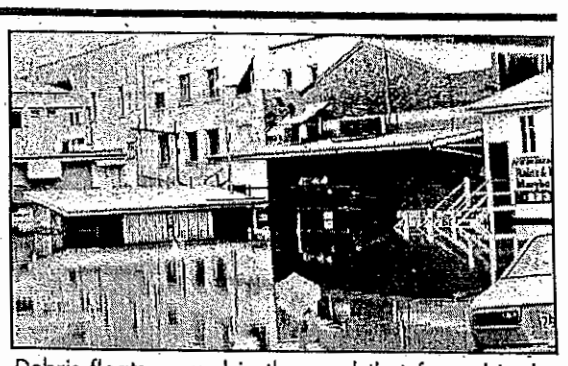
Flood hts:	1893	1955	1974	1989	1992
Gympie	25.00m	21.45m	20.50m	19.60m	21.40m
Tiaro:	22.20m	20.70m	19.50m	15.90m	18.45m
Maryb'h:	12.27m	11.30m	10.95m	6.65m	9.50m



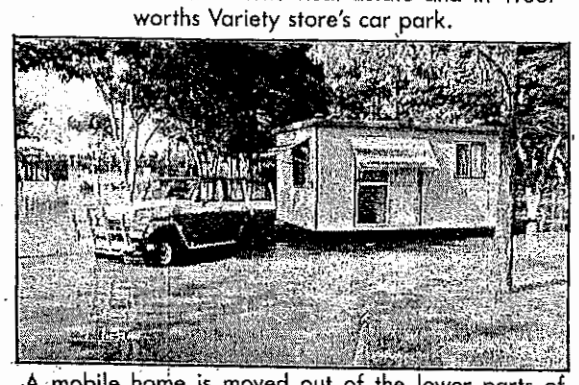
Maryborough in Flood, 1992



The R. D. McDowell car park is a sea of water as flooding almost reaches the City Hall.



Debris floats around in the pond that formed in the rear of Raine and Horne Real Estate and in Woolworths Variety store's car park.



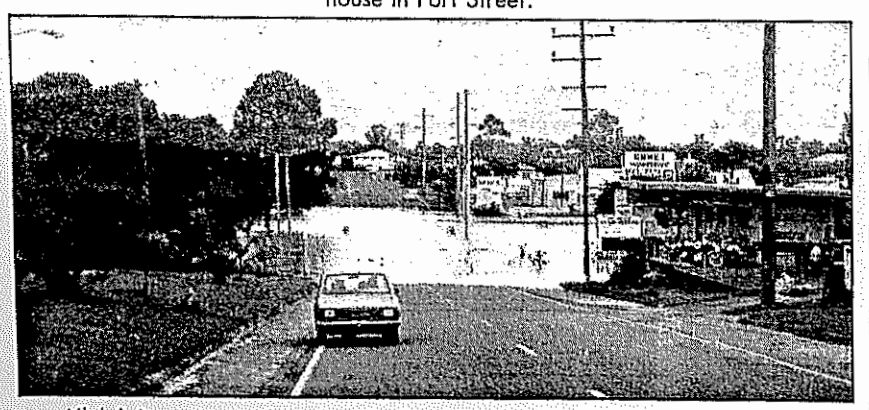
A mobile home is moved out of the lower parts of the Wallace Caravan Park as the Mary River rises.



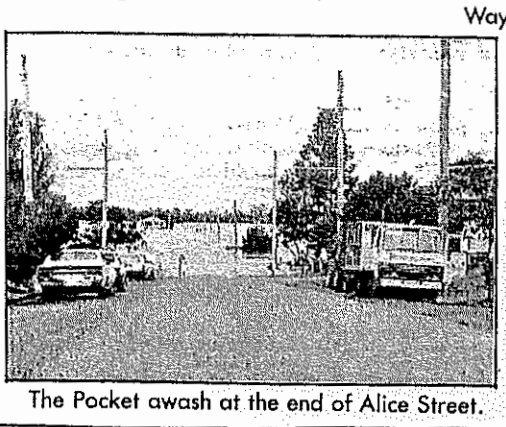
Come rain, hail or shine the mail gets through to Toni and Wayne's Hansen's house in Fort Street.



At its height the floodwaters, isolated houses in Fort Street, just past Queen Street, and inundated Toni and Wayne Hansen's home.



Ululah Lagoon could not handle the deluge and spilled over Alice Street.



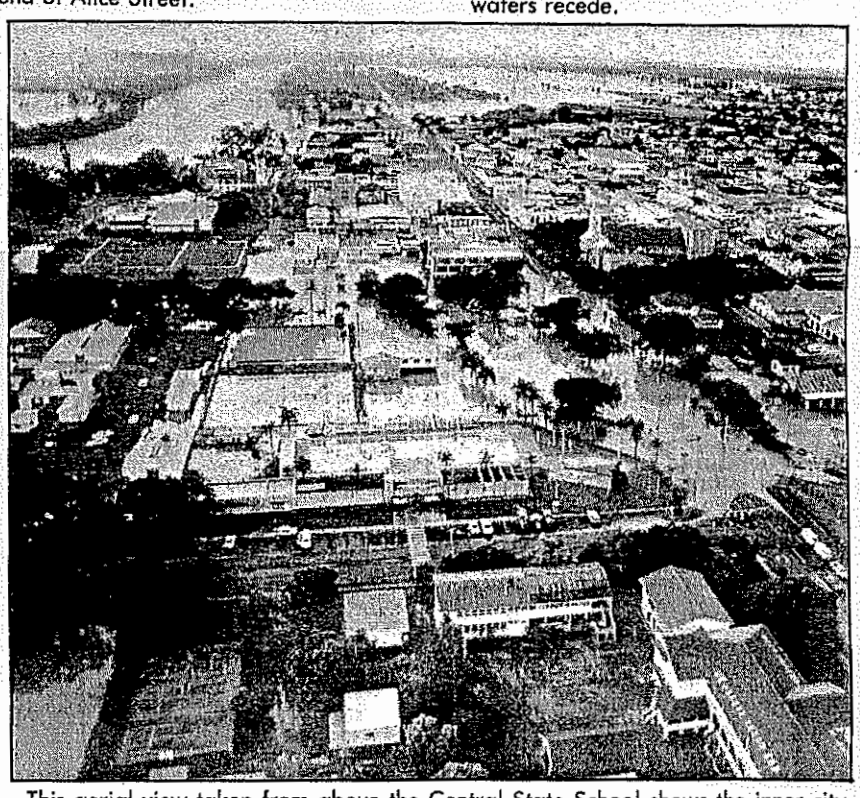
The Pocket awash at the end of Alice Street.



Bob Stien hoses the mud down Lennox Street as the floodwaters recede.

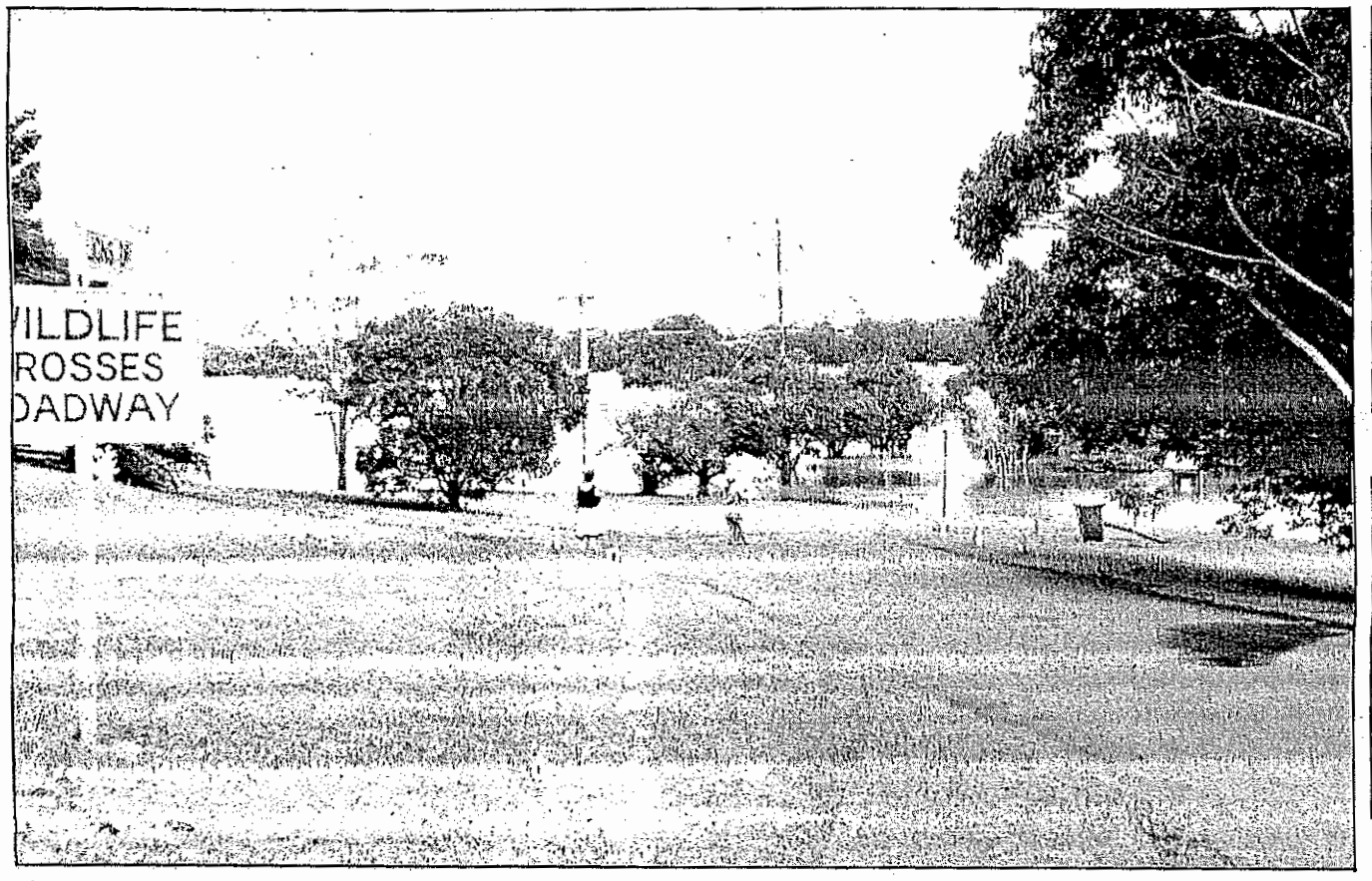


Flooding was widespread across the Pocket and lower Ann Street areas.

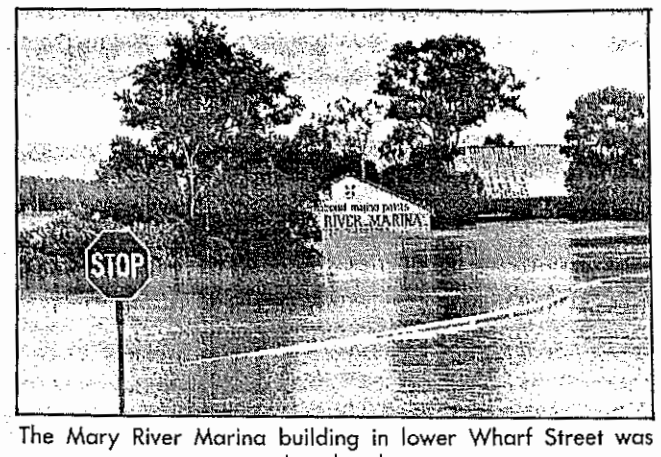


This aerial view taken from above the Central State School shows the inner city flooding.

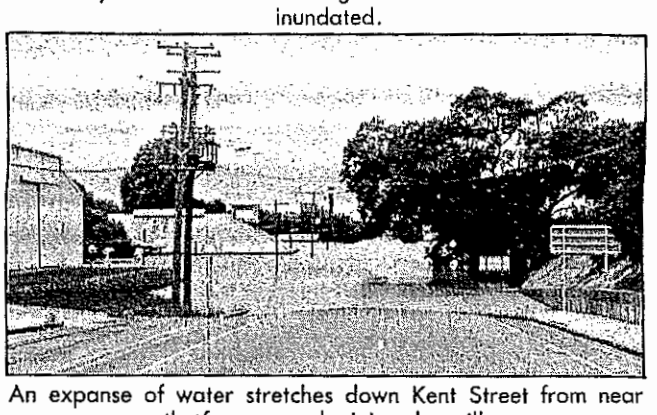
Maryborough in Flood, 1992



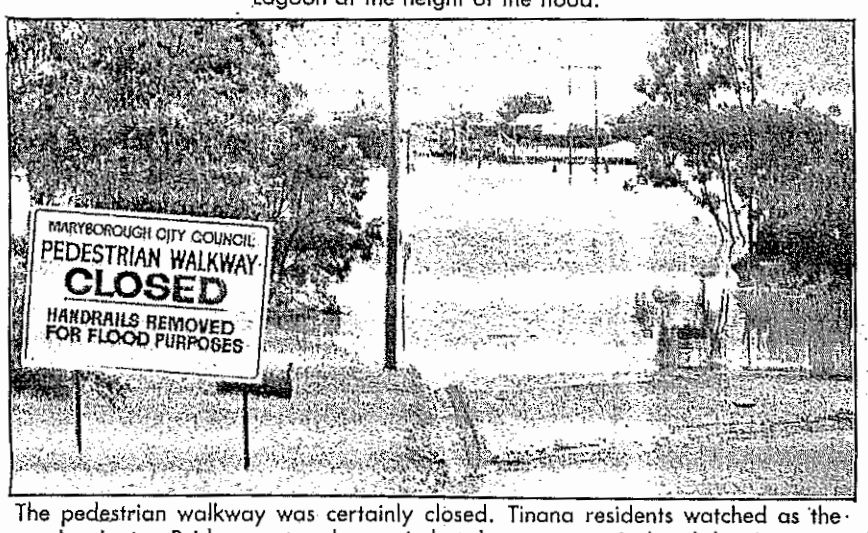
There was more than wildlife crossing the roadway in Lions Drive near Ululah Lagoon at the height of the flood.



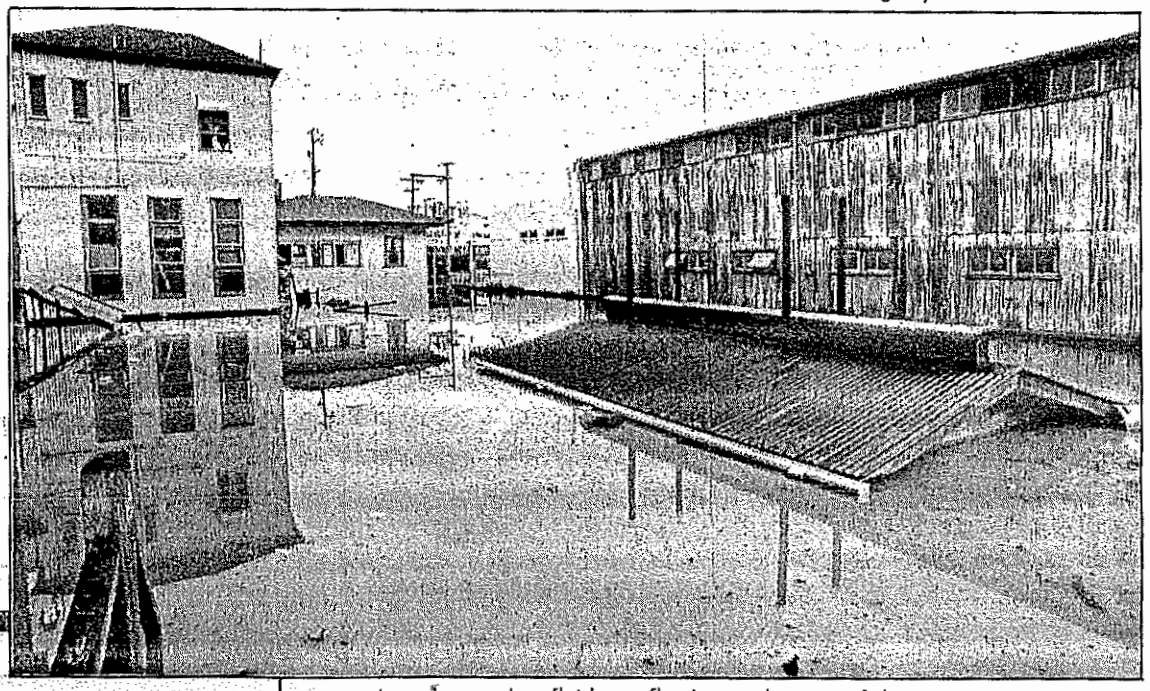
The Mary River Marina building in lower Wharf Street was inundated.



An expanse of water stretches down Kent Street from near the former sand mining dry mill.



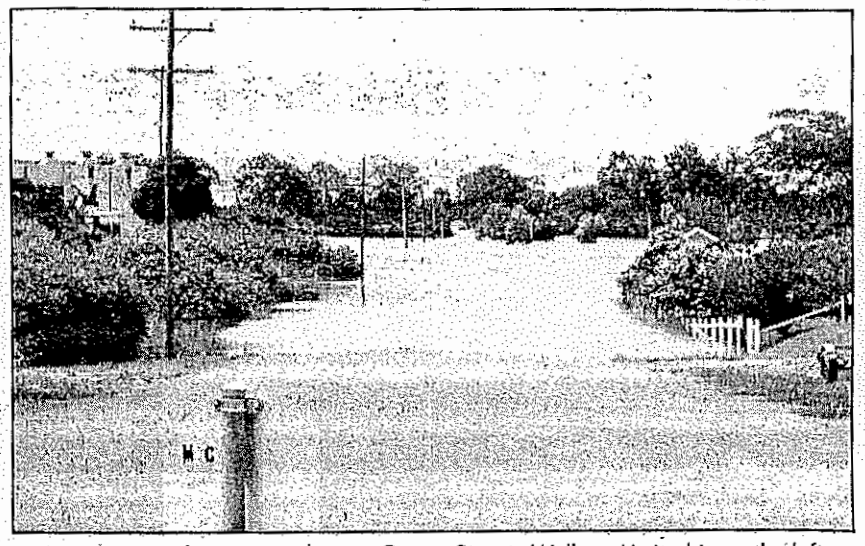
The pedestrian walkway was certainly closed. Tinana residents watched as the Lamington Bridge went under again but they were not isolated this time.



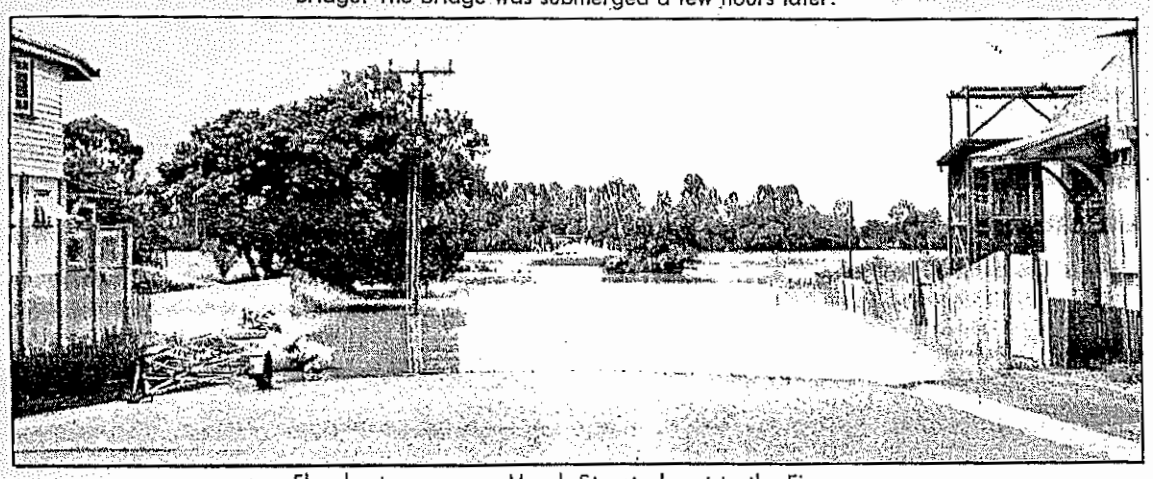
Less than amber fluid was flowing at the rear of the Queens Hotel.



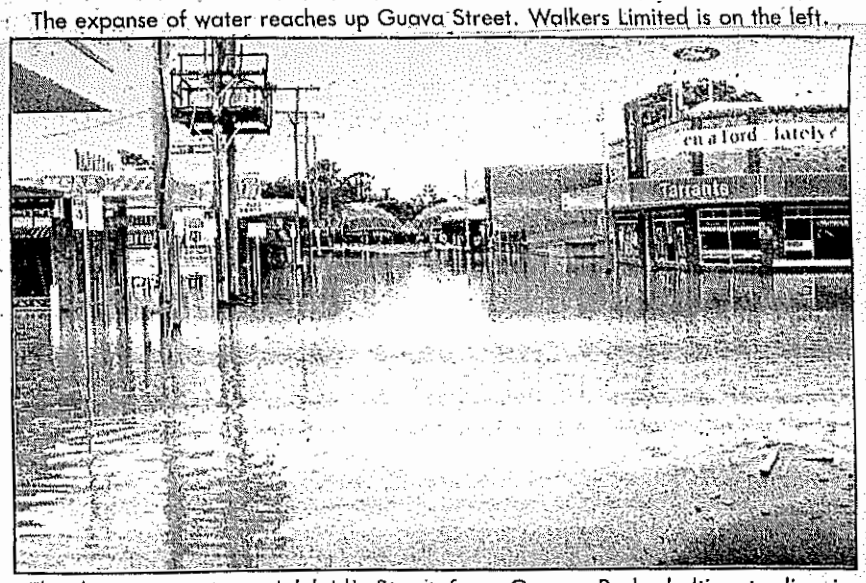
A crowd watches as an excavator tries to free up debris caught on the downstream side of the Granville Bridge. The bridge was submerged a few hours later.



The expanse of water reaches up Guava Street. Walkers Limited is on the left.



Floodwaters rose up March Street almost to the Fiveways.



Floodwaters crept up Adelaide Street from Queens Park, halting trading in several businesses.

In 1955 they rowed across for the keg

Maryborough Mayor Alan Brown remembers the times he has been ferried across the flooded Mary River to get to work in Maryborough. He recalls the time the guys rowed across to get a keg after the flood-bound revellers at the Tinana pub drank it dry.

But times are different now. What was accepted practice then is considered too dangerous today. Police and State Emergency Service workers curb actions they consider risky.

Maryborough residents have been irked by some of the flood control procedures, finding barricades keeping them out of interesting areas and streets closed off when water reaches only half the depths they have merrily ploughed through in past floods.

"I can understand that people who have normally done things for themselves feel there is some interference but I believe the emergency workers recognise that Maryborough people do know what floods are like.

"We've got a situation today where emergency services are more structured and more concerned with people's safety. The police and the SES are trained to act in emergencies and I believe they do a good job protecting people and property."

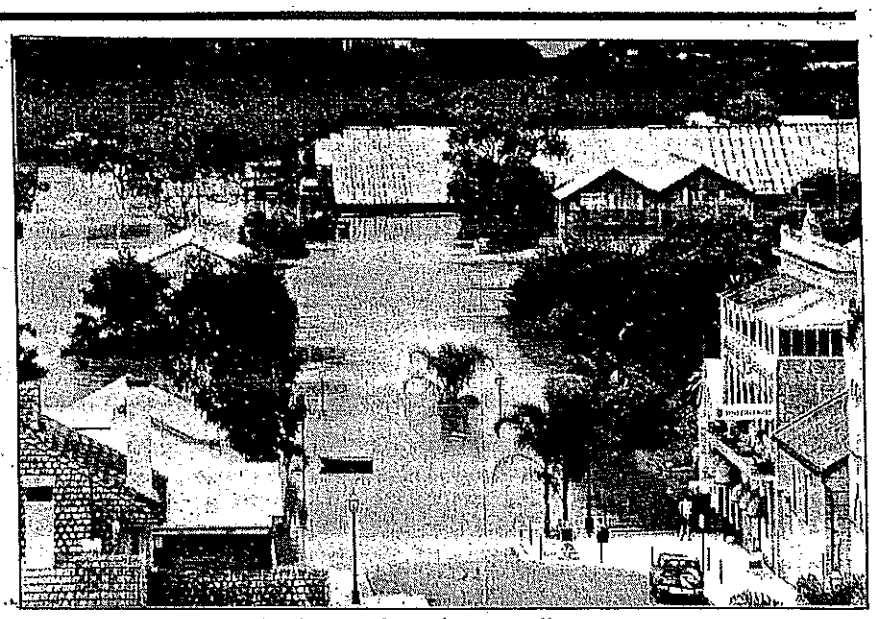
Alan, a Tinana resident, remembers the times heavy vehicles would plough across the Lamington Bridge when there was about 50cm of water flowing over the decking. The gamest drivers were cheered by crowds at either end. These days, the Lammy is closed promptly when water begins to run over the deck.

Getting to work is not considered a good enough reason to cross the main flood current anymore, as it was when Alan began work in 1947.

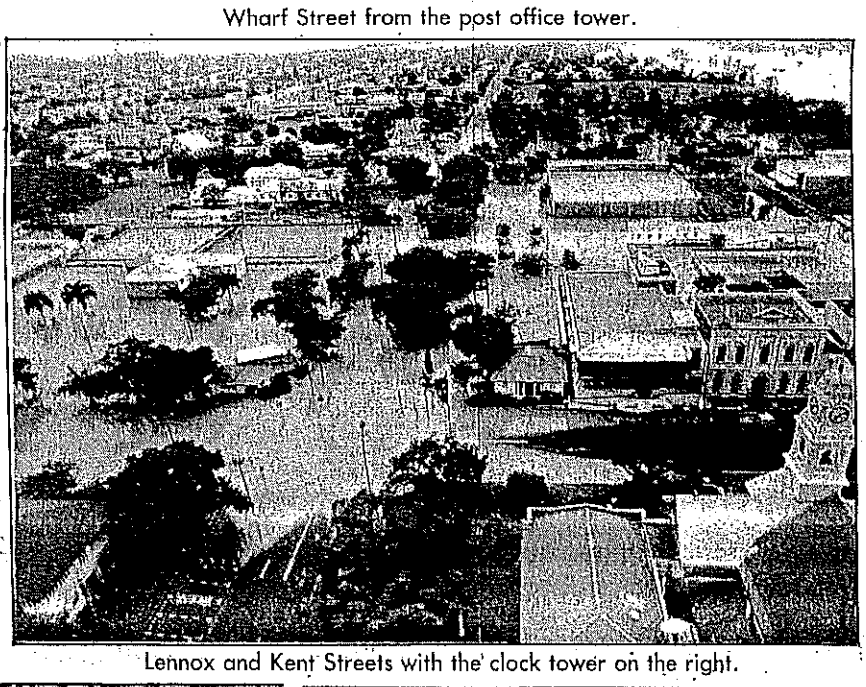
The police would also pounce on anyone emulating the act of Augie Kretner and Bevan Somerfeldt, heroes of Tinana drinkers when the suburb was cut by the 1955 flood. Tinana's stranded residents always developed a party atmosphere around the pub. When they drank it dry, Augie and Bevan launched a dinghy near the top of La Frantz Drive and rowed furiously out into the Mary. They calculated the current drift perfectly and reached the other side right at the Lamington Hotel. They hoisted a keg on board and started out for Tinana upstream at the Ululah outlet, rowing and drifting down to land on the southern approach of the Lammy Bridge.

"We are more aware of the risks today," said Alan. Too many people had died in floods elsewhere and lessons had been learnt. Police did not like to see unnecessary risks that could endanger lives, including those of emergency workers called in if things went wrong.

"Litigation has changed the way people behave as well," he said.



Wharf Street from the post office tower.



Lennox and Kent Streets with the clock tower on the right.



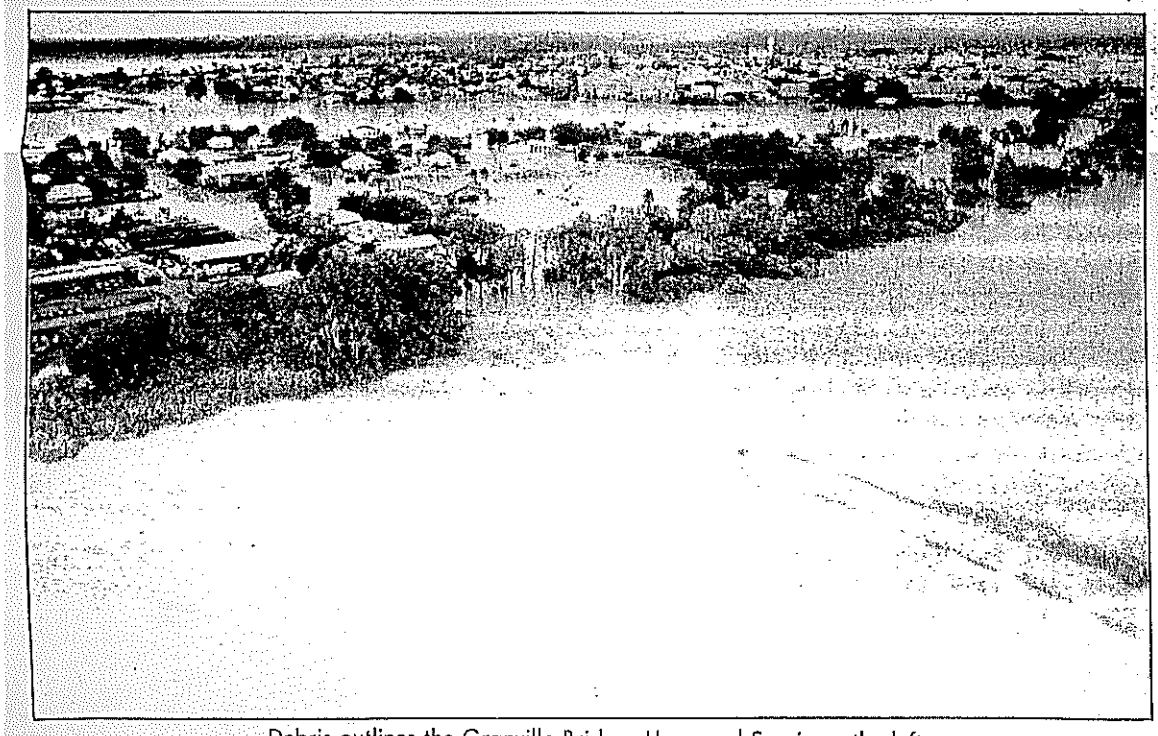
From the air above Granville, the new arm of the Mary ploughes through Lower Kent Street to rejoin the main river.



Kent Street from John Street.



The Maryborough Sailing Club in Queens Park.



Debris outlines the Granville Bridge. Hyne and Son is on the left.



Bob Stevenson begins the arduous job of sweeping mud from the Maryborough Services Bowls Club greens in Lennox Street.

Howard in Flood



Floodwaters rise up the walls of these sheds on Pacific Haven estate.



Going by boat was the only way to get around in the floodwaters that covered Pacific Haven estate.



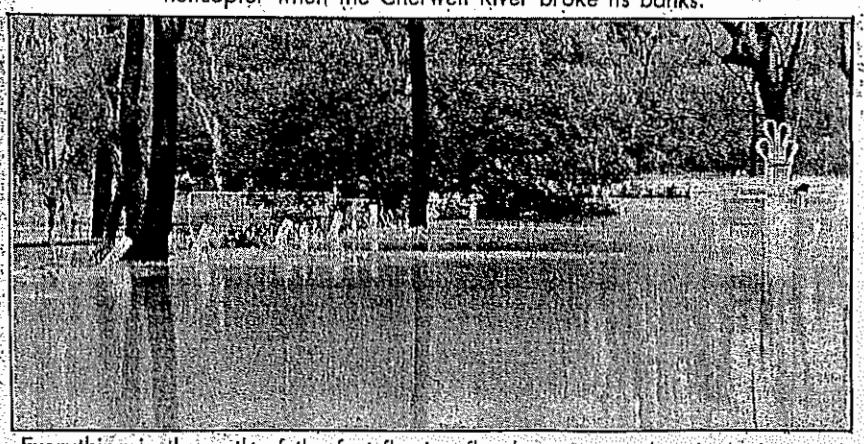
John Bell and Lorraine Woolley are thankful they are alive. They were airlifted from their water tank by a rescue crew in the Bureau of Emergency Services helicopter when the Cherwell River broke its banks.



Doug Winn of Island Close looks at the car he had bought the day before but not taken home. The station wagon was drenched by floodwaters when the deluge hit.

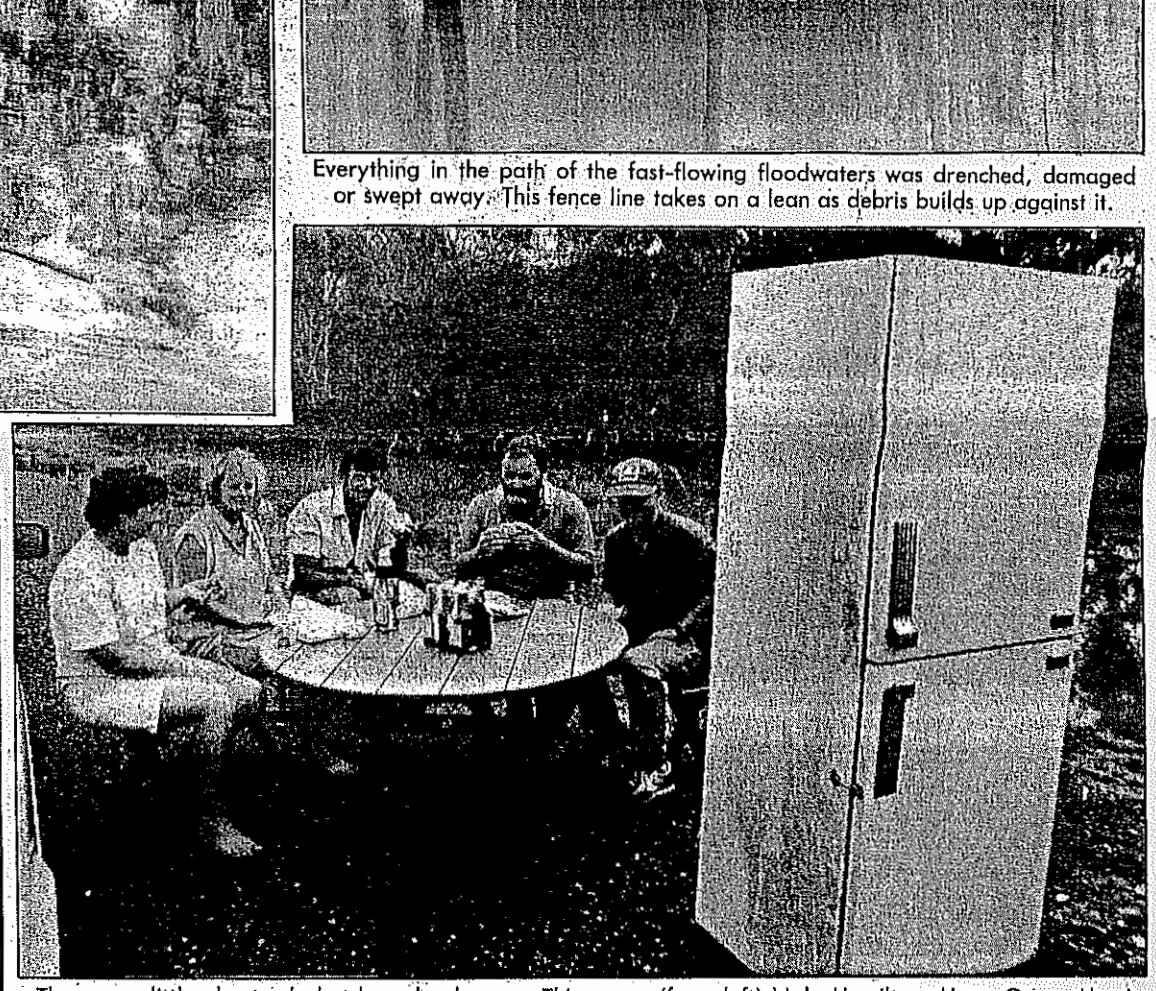


Strange sights appear in times of flood. This cobweb broom was left for its owner after being plucked from the water by a good Samaritan.



Everything in the path of the fast-flowing floodwaters was drenched, damaged or swept away. This fence line takes on a lean as debris builds up against it.

A goat lies dead after drowning in the raging torrent at Pacific Haven estate.



There was little else to do but have lunch . . . This group (from left) Nola Hamilton, Moya Owen, Morrie Hamilton, Bob Owen and son Ken sat down to eat at the table and chairs they retrieved, along with the fridge, after the items floated away from the Owens' house.



Pacific Haven resident Bob Owen walks along the road through the floodwaters.

Big dry over but rain just kept falling

It started as welcome rain on Thursday, February 20 — the drought had broken, El Nino's devastating dry cycle over.

But the rain fell heavier and heavier, and by late Thursday night people were worrying. More than 425 mm (17 inches) was dumped on the Pacific Haven area, near Howard, during the night.

The swollen Cherwell River burst its banks and quickly flooded the river plains, engulfing houses on the way.

Some people had time to move belongings to higher ground, but for most the water rose too quickly. In the darkness they struggled on to roofs or ran to neighbours to escape what was now a torrent raging through their once tranquil properties.

About 20 people spent the night huddled sodden and frightened on their roofs. Most were rescued by boat, others, including a deaf and blind 84-year-old woman were airlifted to safety later on Friday morning.

The swiftness and savageness of the flood took everyone by surprise. Roads throughout the Bundaberg and Hervey Bay areas were cut, and the rain, generated by a low sitting off Yeppoon, continued.

Gauges overflowed everywhere — perhaps it will never be known just how much rain fell in some areas.

On Friday, as police, the State Emergency Service, volunteers and the community generally rallied to help the people of Pacific Haven, Maryborough was bracing itself for problems of its own.

Heavy rain had been dumped on the city and in the Mary River catchment; already floodwaters were sweeping through Gympie.

But Maryborough people had one thing on their side — time. Time to prepare, to evacuate low-lying areas, clear out shops and houses known to go under in floods.

The city's counter disaster organisation swung into action, and residents watched as the water levels rose over the weekend.

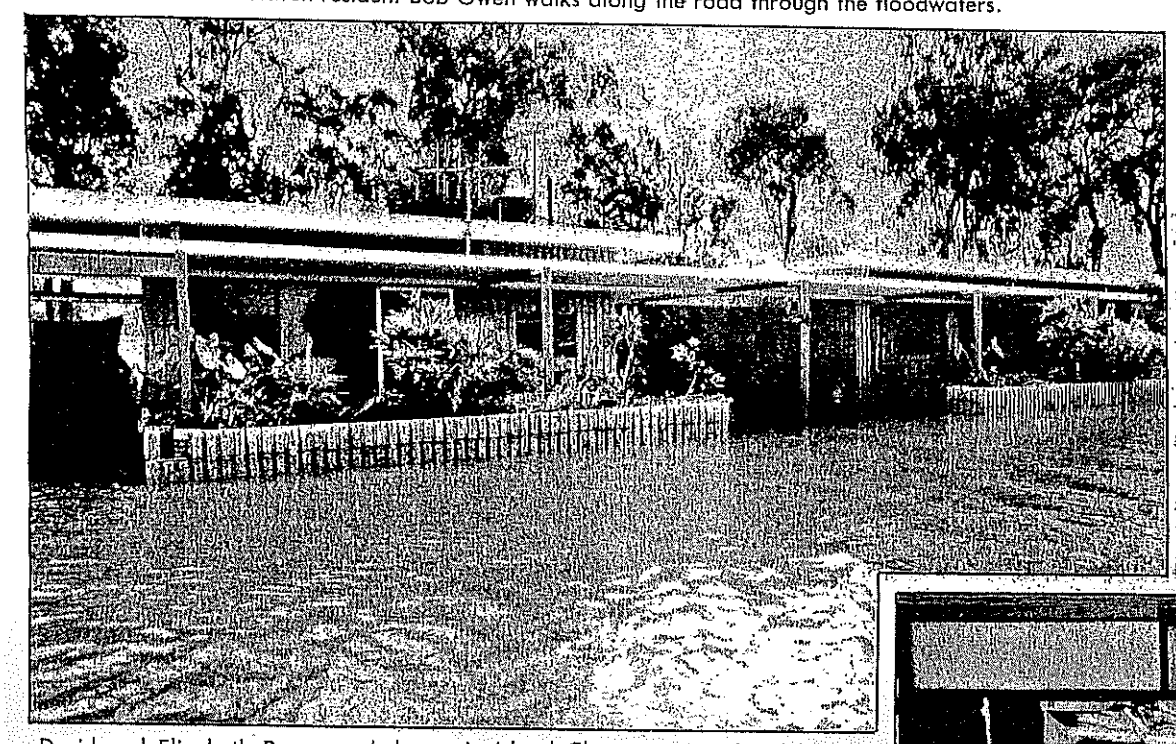
It was not until Monday afternoon that the flood peaked at 9.5 m — higher than earlier thought, but lower than the 10 m level generally regarded as the disaster mark.

The Granville, Lamington and Saltwater Creek bridges went under, shops in Kent and Adelaide streets were inundated, houses and even estates isolated.

But there were few dramas. The counter disaster plan was accurate, the State Emergency Service, police, Coast Guard Sandy Straits, and all volunteers were praised for their efforts, and for many people it was business as usual.

The massive, dirty clean-up job began in earnest as early as Monday night when water levels started to fall.

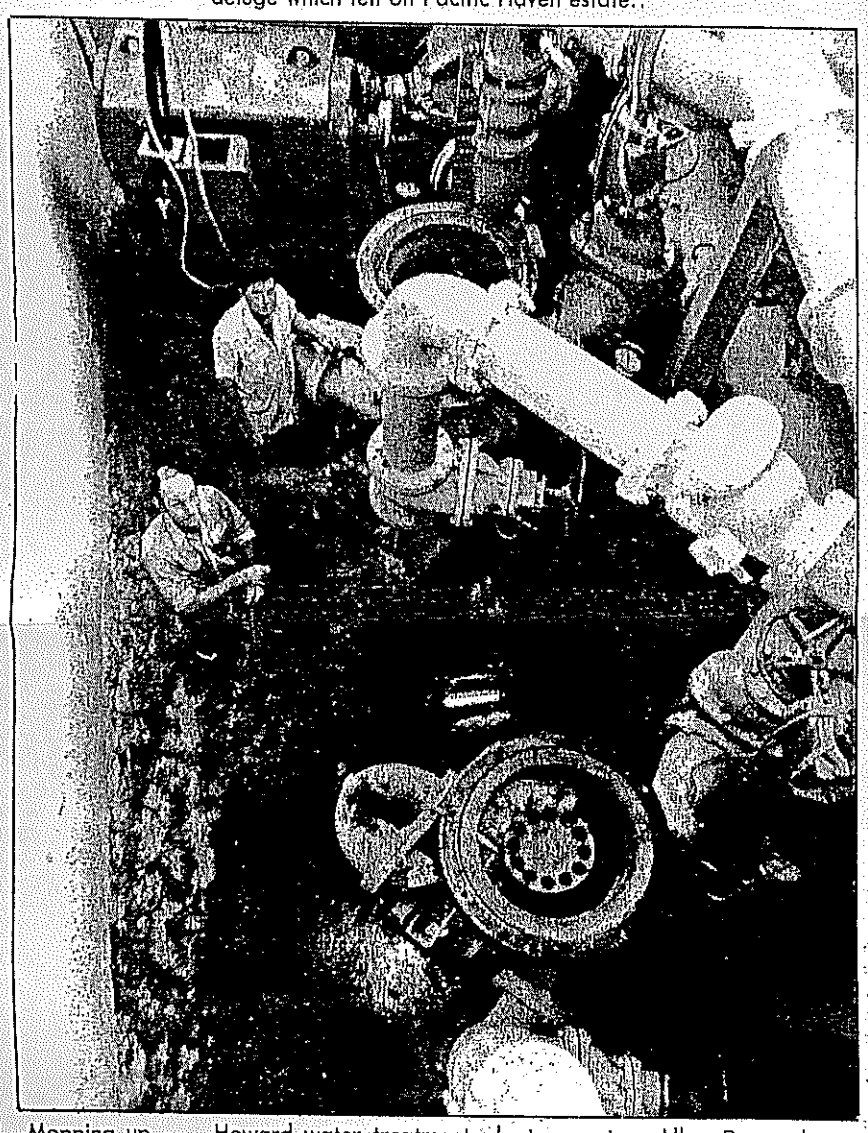
For many, the stench, the muck and the discomfort will be the worst aspect of the Deluge of '92.



David and Elizabeth Parsonage's house in Island Close was inundated by the deluge which fell on Pacific Haven estate..



A small icebox floats around on floodwaters inside the home of David and Elizabeth Parsonage, one of the hardest hit houses on the Pacific Haven estate near Howard.



Mopping up . . . Howard water treatment plant operators Allan Domaschenz (left) and Michael Moran clean up at the weekend after floodwater filled the pumping chamber.



Time for footy . . . a little rain did not stop (from left) Jason McManus, Guy Young, Adam Hand and Raymond Waddell from having fun on the Howard oval.



The Mary River spread out at the end of the Queen Street and swept across Ann, Albert and Alice Streets, forming a new arm thundering across Lower Kent Street to rejoin the main current. (Wilson Thomsen photo)

Lamington Bridge — official yardstick

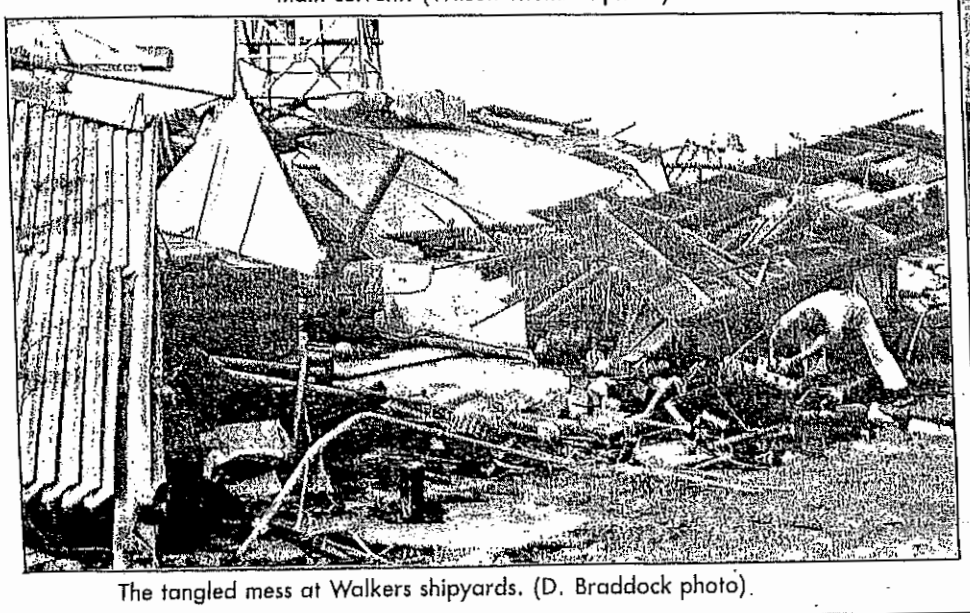
The Lamington Bridge is Maryborough's official flood yardstick. When the Mary River rises to 6 m, it is level with the decking of the Lamington Bridge and the city records another flood.

The flood after the 1992 deluge was the 21st since records were kept in 1875 and was the sixth highest on record for Maryborough.

The higher floods occurred in 1974, 1955, 1898, 1893, and 1890.

PAST FLOODS LEVELS EXCEEDING 6 m IN HEIGHT

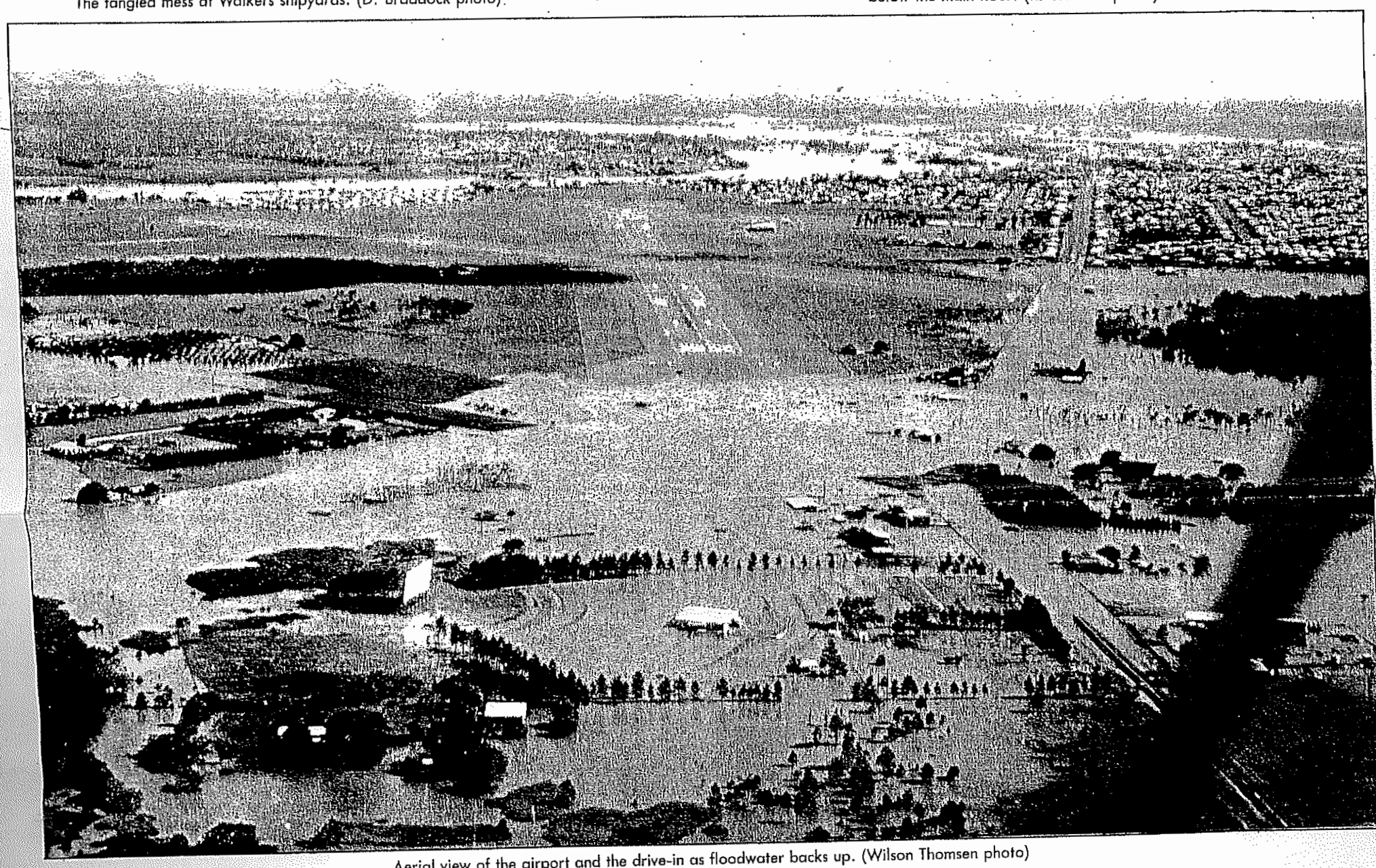
1875 Feb 28	8.99	1956 Mar 13	7.49
1890 Mar 23	9.83	1956 Dec 23	7.01
1893 Feb 5	12.27	1968 Jan 12	9.25
1898 Jan 12	9.71	1971 Feb 05	6.30
1928 Feb 22	6.96	1972 Feb 14	6.43
1931 Feb 07	7.22	1973 July 10	7.72
1937 Mar 18	6.40	1974 Jan 29	10.95
1947 Mar 3	6.10	1989 Apr 5	6.65
1950 Mar 2	6.30	1989 April 28	6.55
1954 July 15	6.02	1991 Feb 24	9.50
1955 Mar 29	11.25		



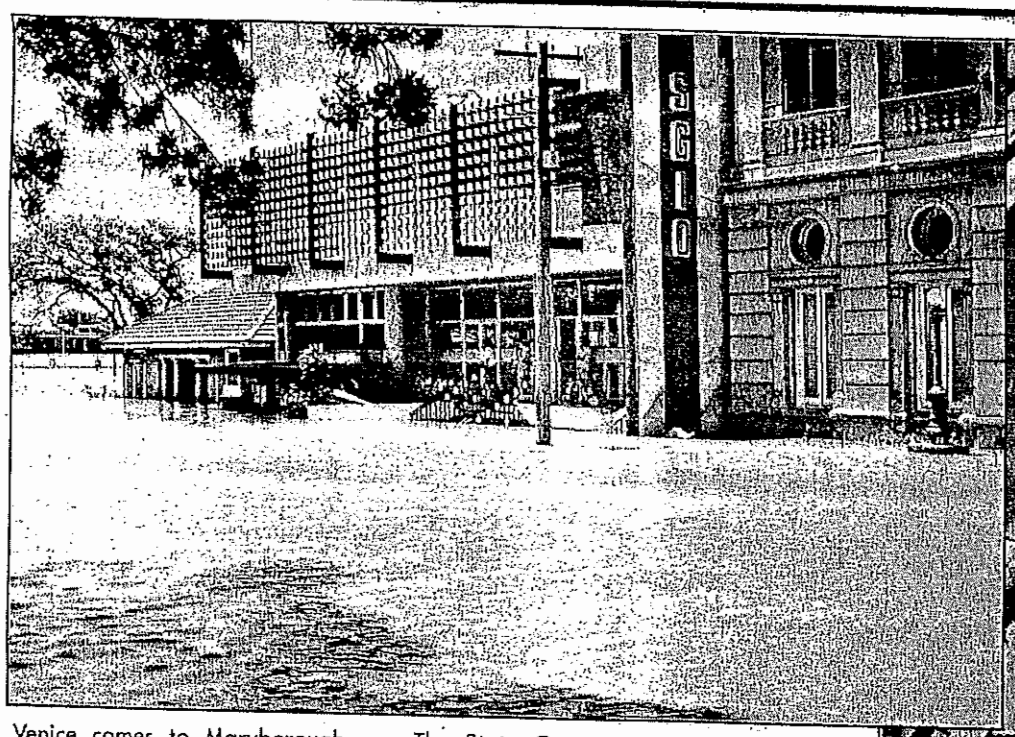
The tangled mess at Walkers shipyards. (D. Braddock photo).



Newsprint for the Chronicle come in daily while the floodwaters were up. It had been shifted to the old showgrounds before the level rose to enter the Chronicle storage shed and to hover 20 cm below the main floor. (R. Wheeler photo)



Aerial view of the airport and the drive-in as floodwater backs up. (Wilson Thomsen photo)



Venice comes to Maryborough . . . The State Government Insurance Office branch in Kent Street almost needed some flood cover when the waters rose almost to the top of the stairs in 1974. Employees had to row to work if they went.

Lamington barometer

The Lamington Bridge was purpose-built for floods after the old Maryborough Bridge washed away in the 1893 flood. It has become a significant flood barometer for Maryborough.

The pedestrian rails were designed to be taken off as a flood approaches, lessening the chance of debris being caught against the structure and pressure building up.

The word goes around Maryborough quickly when the council begins taking off the Lammy rails. It is a signal that the Mary River is reaching flood levels.

In the past, when the council workers took off the pedestrian rails it was also a signal to Tinana people that they did not have long to get home from the Maryborough City side before the Bruce Highway was cut. In the minor flood of 1989, a new bridge came into play and floodbound Tinana became the stuff of history.

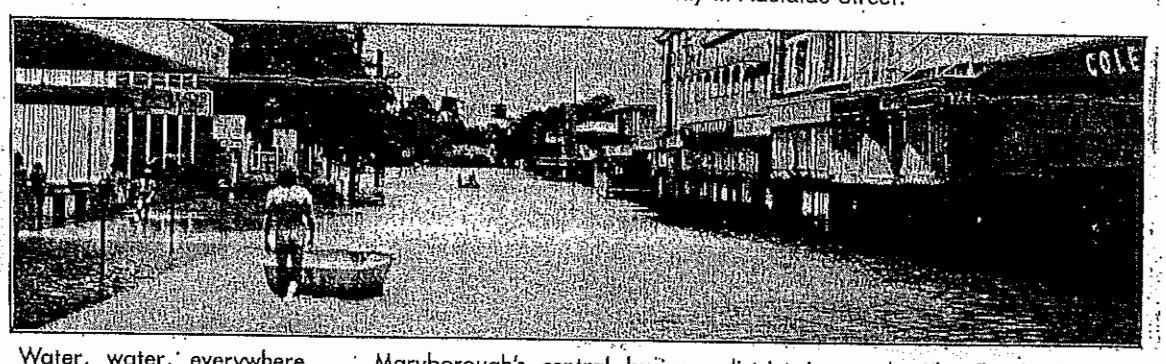
The Henry Palmer Bridge upstream has been built above flood height on the highway bypass of Maryborough. In the April, 1989, flood, the bridge was built but the approaches had not been completed. Pedestrian were allowed to use the bridge, creating the odd sight of hundreds of workers walking across the bridge to the city each morning and home again that night.

This year the Lamington Bridge going under did not have the same impact, Tinana was not cut off: vehicles merely re-routed to the new bridge, where Bruce Highway traffic continued to flow north and south, instead of jamming travellers in Maryborough and Tinana as in the past.

The passing of the era of floodbound Tinana went with a tinge of official regret. At the opening ceremony for the Henry Palmer bridge in 1990, Member for Maryborough Bob Dollin, himself a Tinanaite, noted that no longer would the isolated suburb have an impromptu fiesta when the Lammy went under.



Going with the flow . . . getting around in Maryboough's city centre could only be done in a boat. Swimming trunks were the order of the day in Adelaide Street.



Water, water, everywhere . . . Maryborough's central business district is awash. The floodwater has invaded the Services Memorial Bowls Club greens, it surrounds the old police station, is flowing along Kent Street past the City Hall and down Adelaide Street which is in the foreground.



Rising damp . . . The Chronicle building in Bazaar Street was almost cut off by rising floodwaters.



Chronicle staff Laurie Ammenhauser (left), Dave Nielsen and John James help wheel in newsprint so the presses can keep rolling during the flood. The newsprint was shifted to Woodhead and Moore in Ellena Street from the Chronicle's shed when the waters began rising.



Almost inside . . . spectators watch and wait to see if the floodwaters will rise any further and wash into the City Hall.

Granville goes it alone

Granville is now the only part of Maryborough which is isolated soon after the rails come off the Lamington Bridge.

The removal of the rails has been the signal for many years to the residents of Granville that they will be cut off from "town".

It is not the Granville Bridge which is the problem; the Mary in her own cantankerous style takes a short cut across the Pocket and over Guava and Kent Streets, just below the gas works.

The Granville Bridge, though, is the barometer of whether it is a "proper" flood. If the bridge is submerged then Granvillites feel distinctly cut off from the rest of the world. It means the other access routes are closed. There are the Cooloola Coast Road, which replaced in 1979 the slippery Tuan forest road, and the Bidwill route around through Teddington to Tinana.

Tinana now has all-flood access to Maryborough via the Henry Palmer Bridge but the eastern suburb of Granville still stays cut off in flood time.

Residents talk about the high level bridge which will carry traffic high above the murky muddy Mary from Banana to Woodstock street. They talk about it, discuss the merits and its inevitability, as they watch the floodwaters wash by every few years.

They maintain that the present bridge, opened in 1926 and widened in 1980, cannot handle the volume of traffic from the fast growing suburb, and is too easily submerged in times of flood.

They stick to that view as they watch in bright sunshine the boats ferry people and supplies to their suburb. They are thankful nowadays that as the kids ride their bicycles through huge puddles left by the rain they have heard the warnings on the radio about the rails coming off the Lamington and have rented a bunch of videos to last the duration.

They are also thankful that the local hotel is no longer Carlton controlled and has a range of beer. It was tough going during the floods of the early 1970s for tipplers of Fourex.



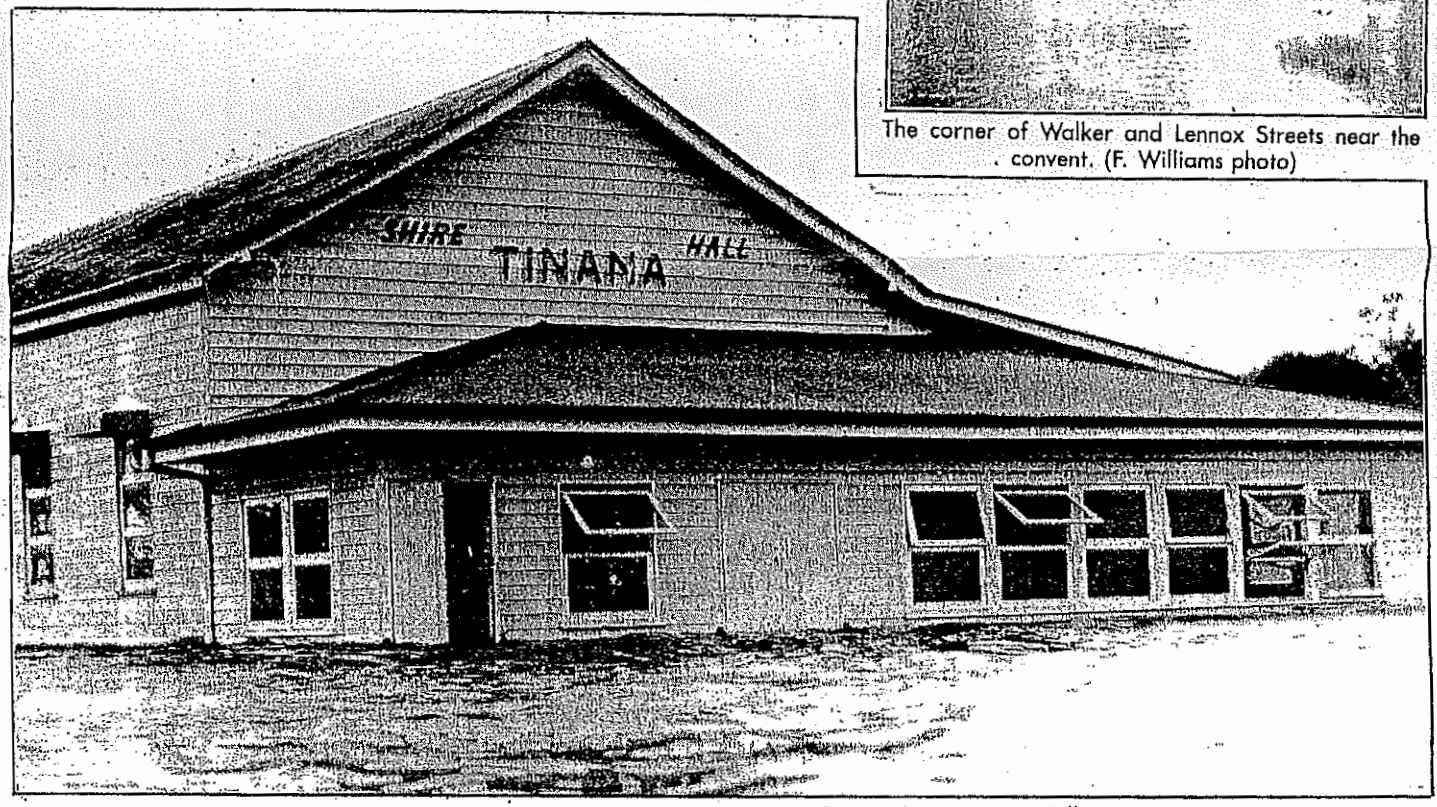
Boys fish with a bait net at the corner of Kent and John Streets. (F.Williams photo)



The corner of Walker and Lennox Streets near the convent. (F. Williams photo)



A long line of stranded travellers' cars banked up from the submerged Lamington Bridge to past the overhead rail bridge near Kent Street. On the other side, another line of north-bound vehicles waited for the water to go down and the Bruce Highway to open again. The bottleneck is now freed — highway traffic passes over the all-flood bridge on the Maryborough bypass, upstream from the Lammy. (H. Goodwin photo)



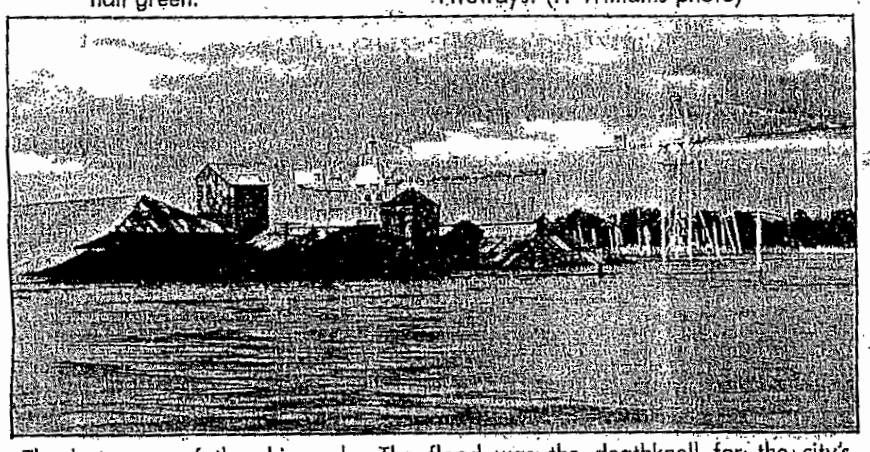
Water rose over Schultz bridge and swirled through the Tinana Hall.

'74 final straw for shipyards



The TAA arcade in Kent Street, across from the town hall green.

Looking down Lower Kent Street from the Fiveways. (F. Williams photo)



The last gasp of the shipyards. The flood was the deathknell for the city's shipbuilding industry. (M. McLucas photo)

On Monday, January 28, 1974, Maryborough was bracing itself for yet another major flood.

Flood historians were predicting an even bigger flood than that experienced in 1955, because of the rapid rate at which the river was rising — 30 cm an hour — but fortunately they were wrong.

Although the flood peak of 10.95 m was only 30 cm less than the 1955 flood, damage was to prove much less.

Lessons learned from the previous disaster, evacuation assistance from police, civil defence and service clubs, and adequate warning would all help to keep losses to a minimum.

By Wednesday, January 30, the Maryborough district looked like a giant sea of mud from the air as the swollen Mary River spread out to a width of 3.2 km.

Swifts Meatworks was under water, as were all the houses at the lower end of Ann Street. Water was through many houses in Queen Street.

Other badly affected businesses along the Mary River were Walkers Engineering and Hyne and Sons sawmills. The flood was the deathknell for Walkers' ship building operation, which had been struggling in a depressed market. The shipyards were never re-opened.

Cane farms were inundated, as was the Starline Drive-in Theatre. The Hervey Bay road was one big lake, with houses sticking out along its route.

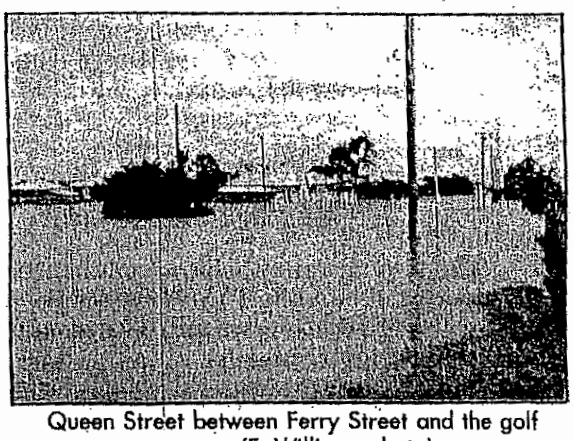
The Lamington Bridge was metres underwater, with not even a ripple betraying the existence of a bridge linking Tinana and Maryborough. Granville was cut off and water lapped at the back steps of some houses in Aubinville.

A large Mobil fuel tank was washed down the river, taking power lines with it and putting the sewage treatment works out of action.

It was not known exactly how many people were evacuated from areas. On the Sunday night 38 families had been evacuated from their homes with police help, and more families were brought out on the Monday. Many left their homes earlier without assistance.

Damage caused by the flood amounted to many hundreds of thousands of dollars.

The then Minister for Justice, Sir William Knox, who inspected flood damage in the city, said he was amazed at the "great fightback" of the Maryborough people.



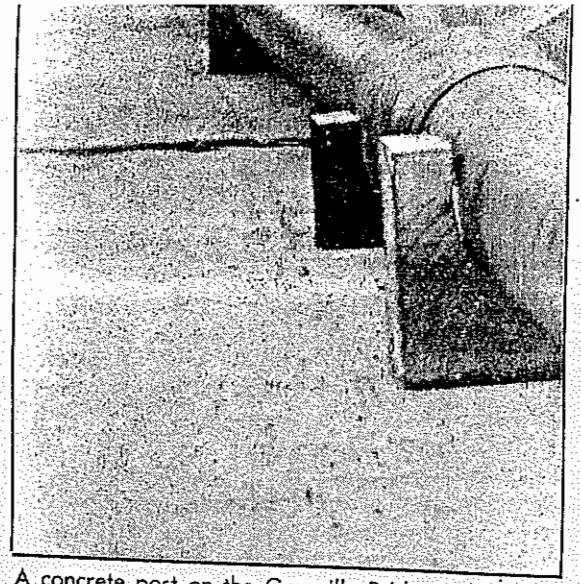
Queen Street between Ferry Street and the golf course. (F. Williams photo)



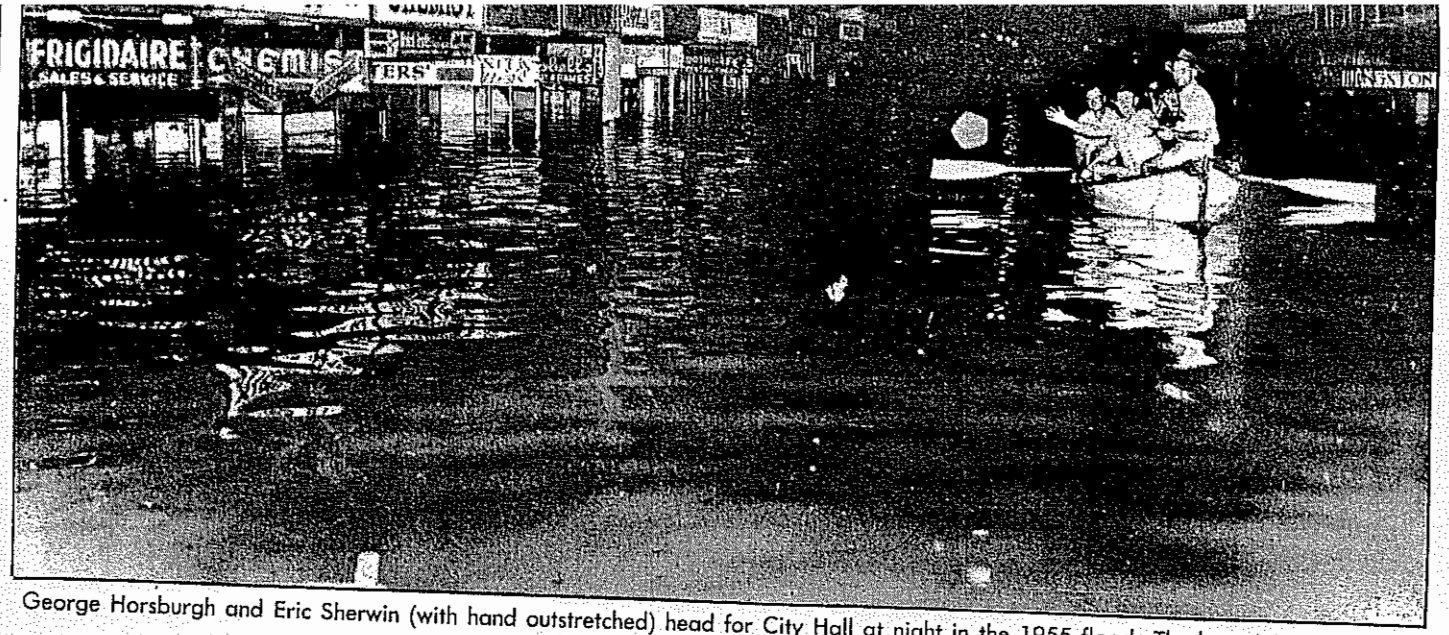
The RSL in Bazaar Street. (Kay Shaw photo)



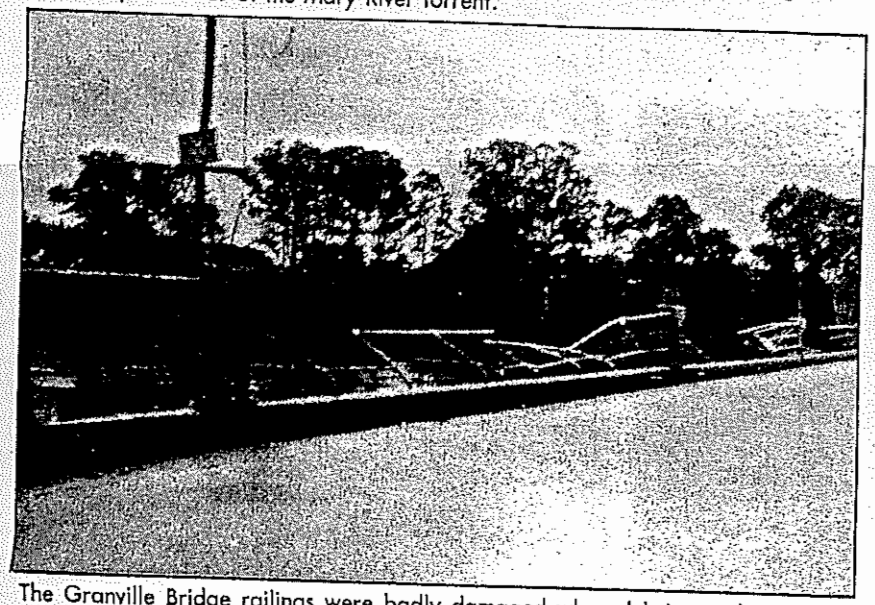
Boats tied up to parking meters in were an incongruous sight after the 1974 Australia Day floods. (Wilson Thomsen photo)



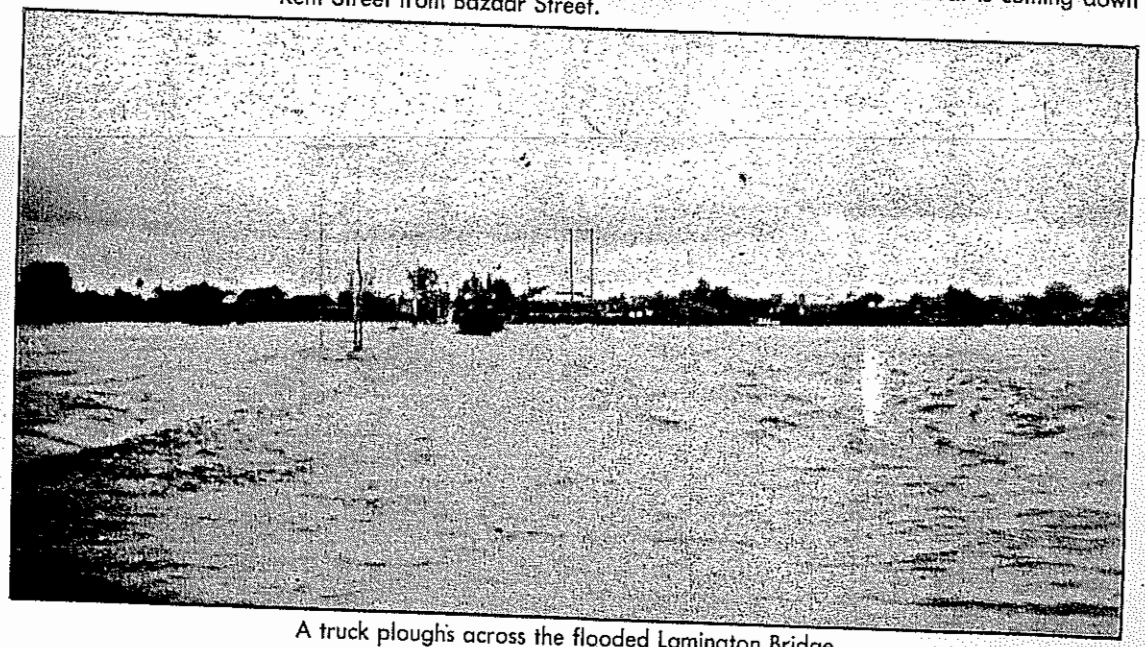
A concrete post on the Granville Bridge is left bent by the force of the Mary River torrent.



George Horsburgh and Eric Sherwin (with hand outstretched) head for City Hall at night in the 1955 flood. The boat is coming down Kent Street from Bazaar Street.



The Granville Bridge railings were badly damaged when debris caught against them in 1955 flood.



A truck ploughs across the flooded Lamington Bridge.

Insects, reptiles and fish

The waters held all manner of creatures in the 1955 flood, as the Chronicle reported at the time. Snakes and cockroaches abounded.

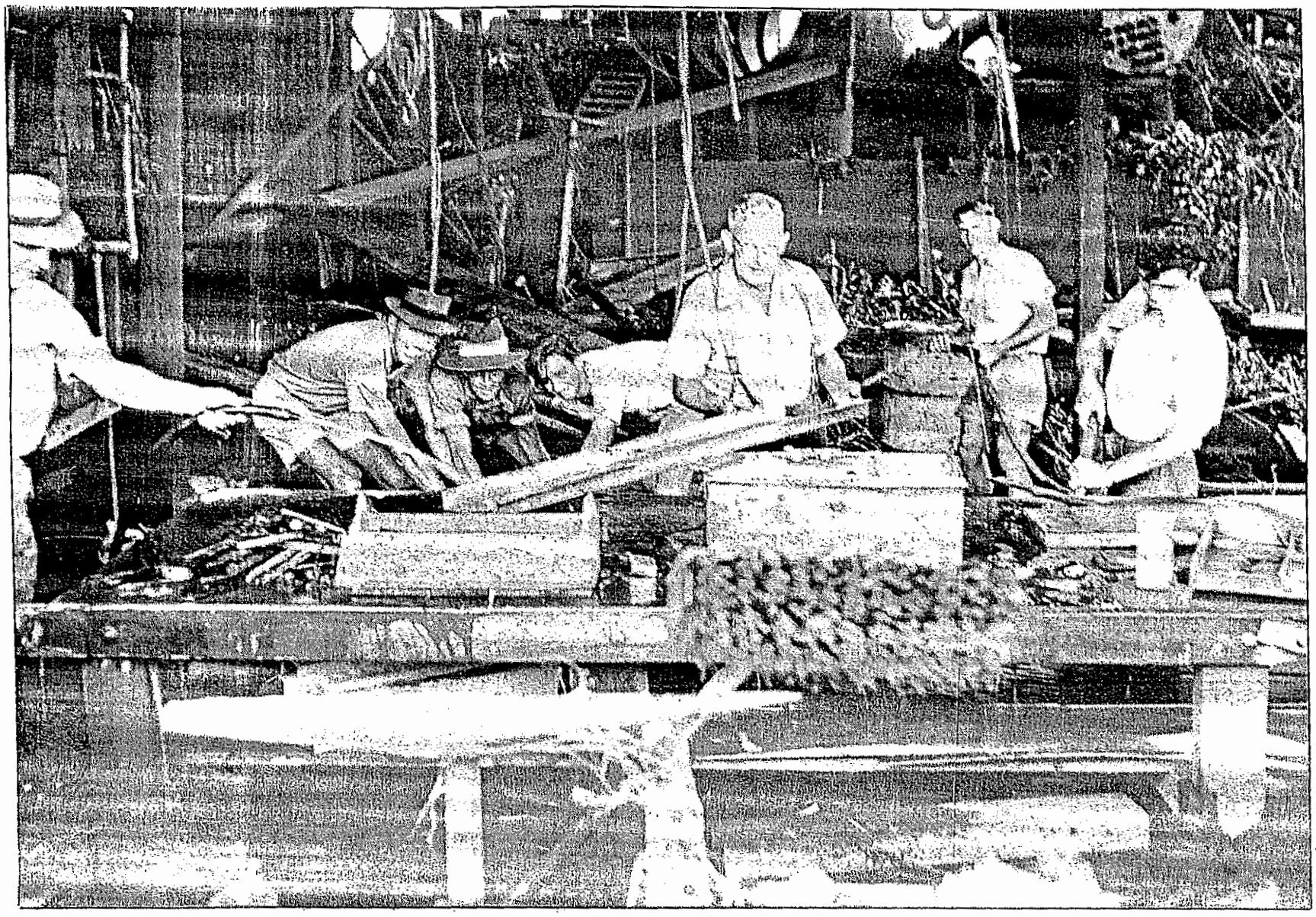
Residents at the bottom of Lennox Street grouped to clean houses, shooing out snakes. Three were killed.

A worker standing knee-deep in water felt something cold and cliny wrap around his leg. He shrieked for help but found the "reptile" was only a piece of paper.

Among the snake stories was one told by Ralph Flannigan, whose 15-year-old dog was credited with dispatching six.

Cockroaches were a curse in Maryborough. Millions of them were found crawling up to the safety of the park areas as the waters crept up. They lined fences above the flood height and flew into houses.

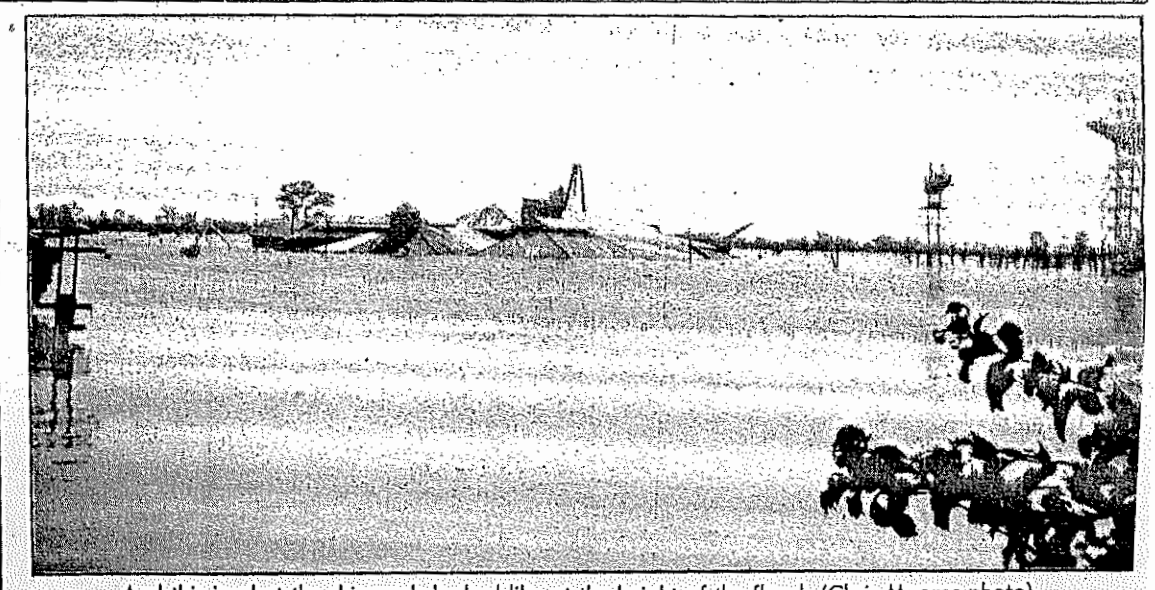
Prawns were picked up in Kent Street at the height of the flood. Mullet were frequently seen jumping out of the water and a man was seen jumping in, diving from the roof of the Queens Hotel and swimming to a roof on the other side of Kent Street.



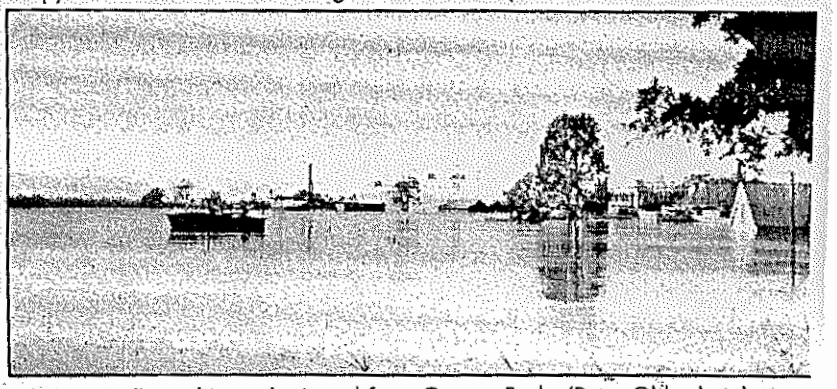
Walkers employees begin the massive clean-up after the waters receded from the shipyards. (H. and N. Gamer photo)



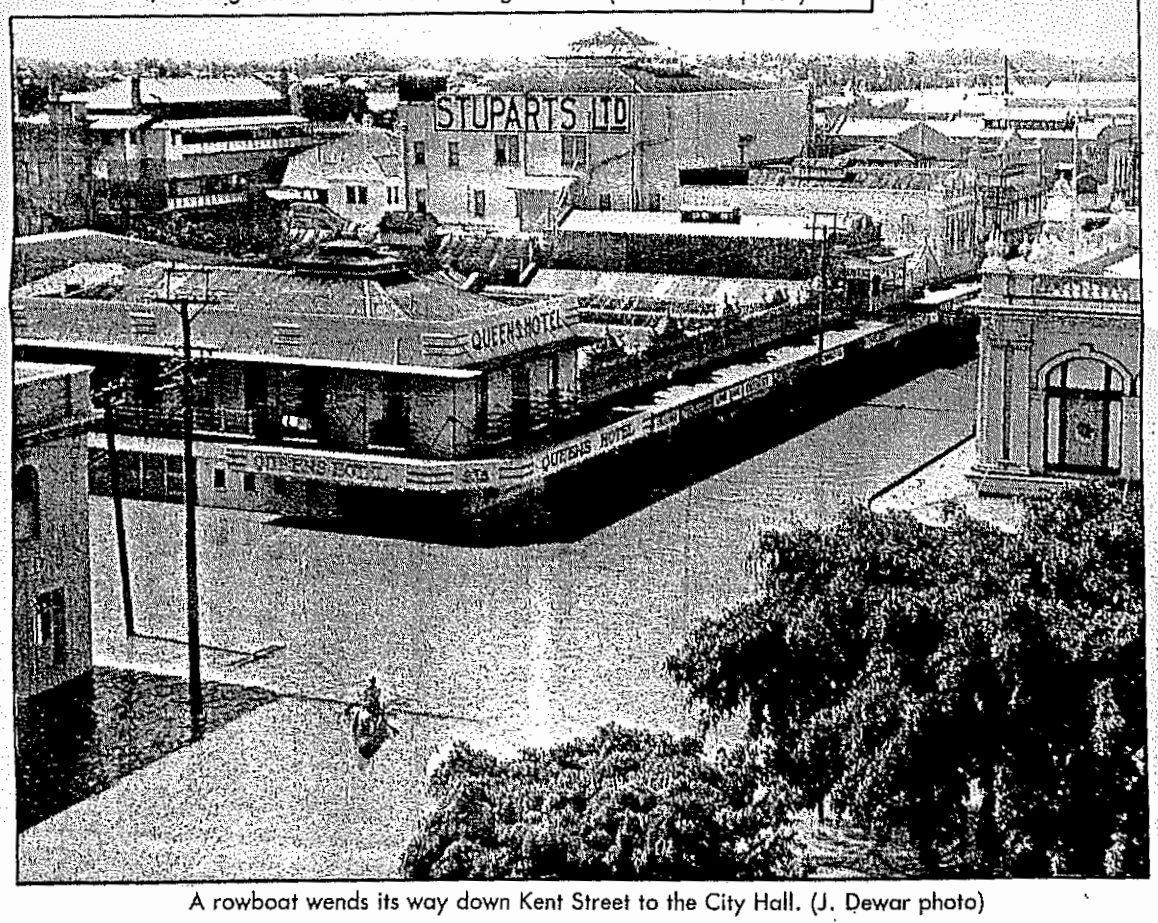
Tinana, looking towards the hall from High Street. (Alan Brown photo)



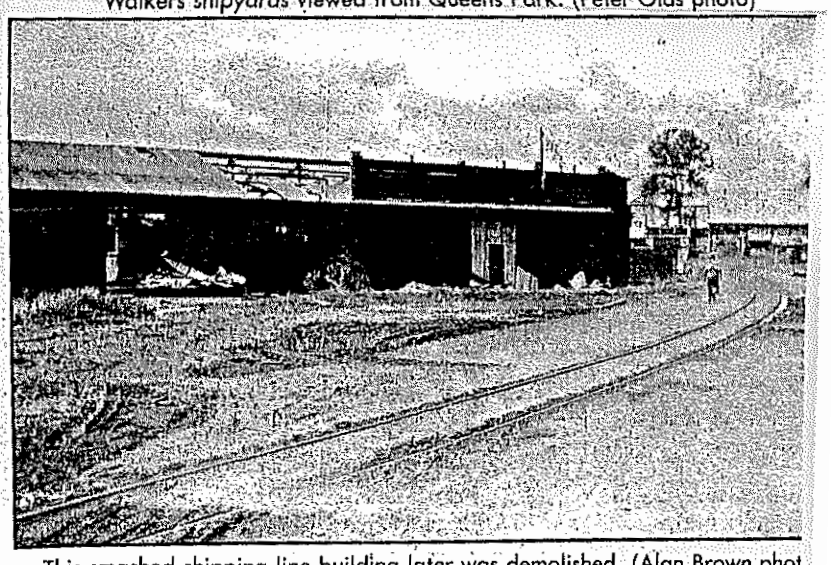
And this is what the shipyards looked like at the height of the flood. (Chris Moores photo)



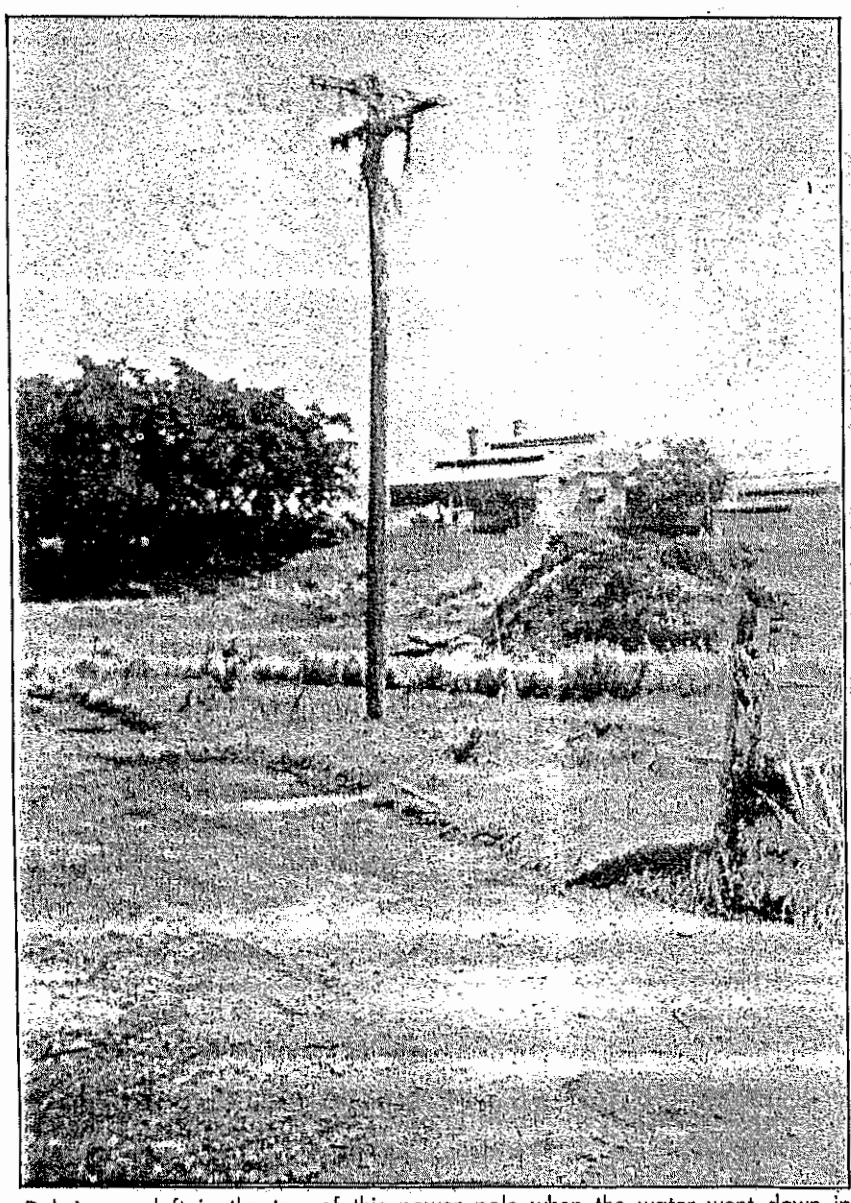
Walkers shipyards viewed from Queens Park. (Peter Olds photo)



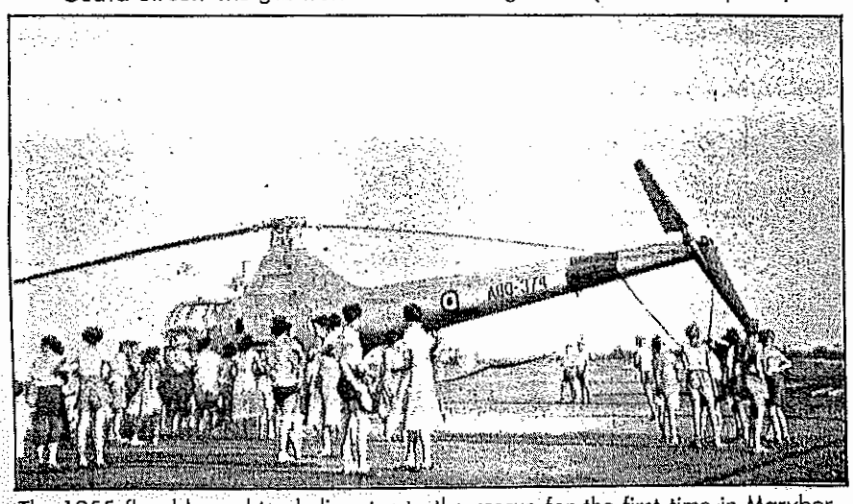
A rowboat wends its way down Kent Street to the City Hall. (J. Dewar photo)



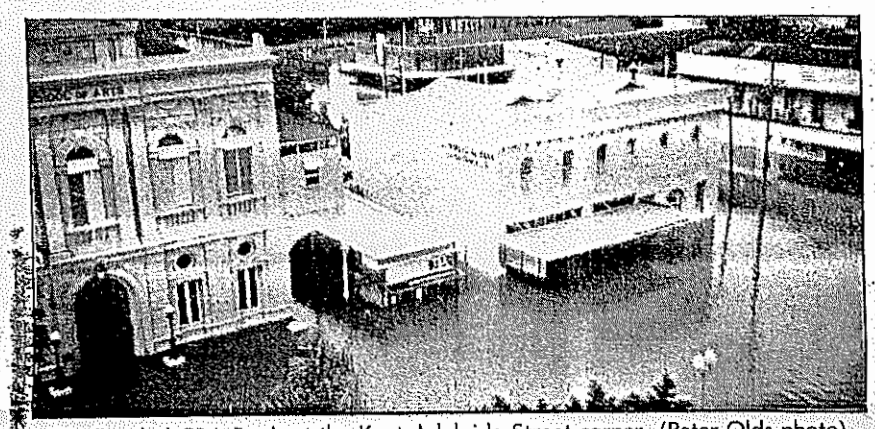
This smashed shipping line building later was demolished. (Alan Brown phot



Debris was left in the top of this power pole when the water went down in Guava Street. The gas works is in the background. (Alan Brown photo)



The 1955 flood brought a helicopter to the rescue for the first time in Maryborough (J. Dewar photo).

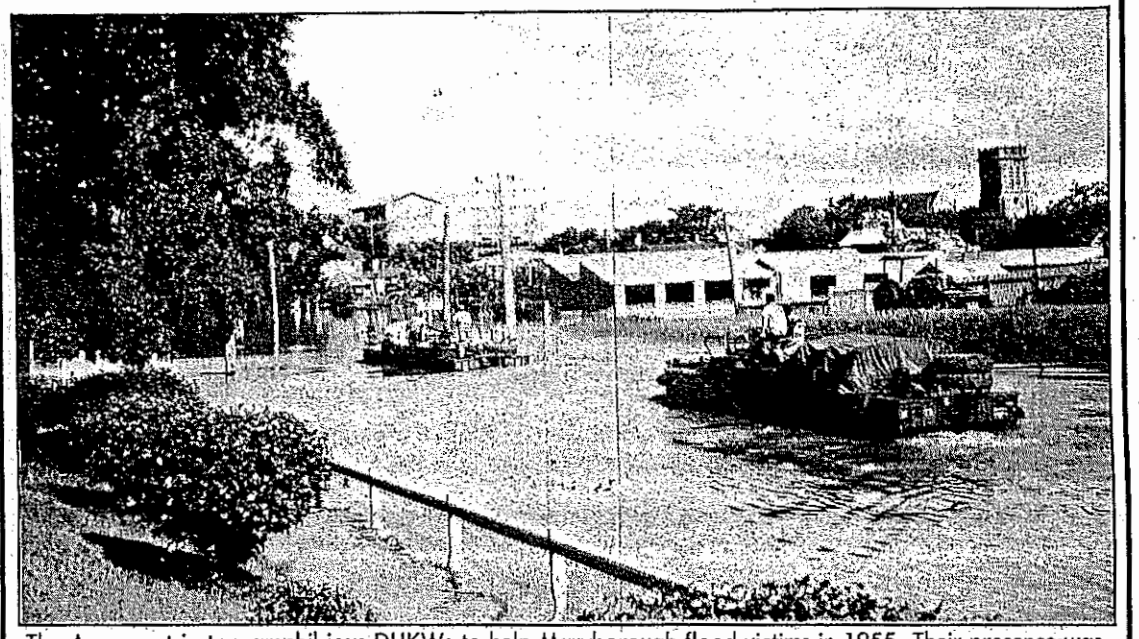


The flooded CBA Bank at the Kent-Adelaide Street corner. (Peter Olds photo)

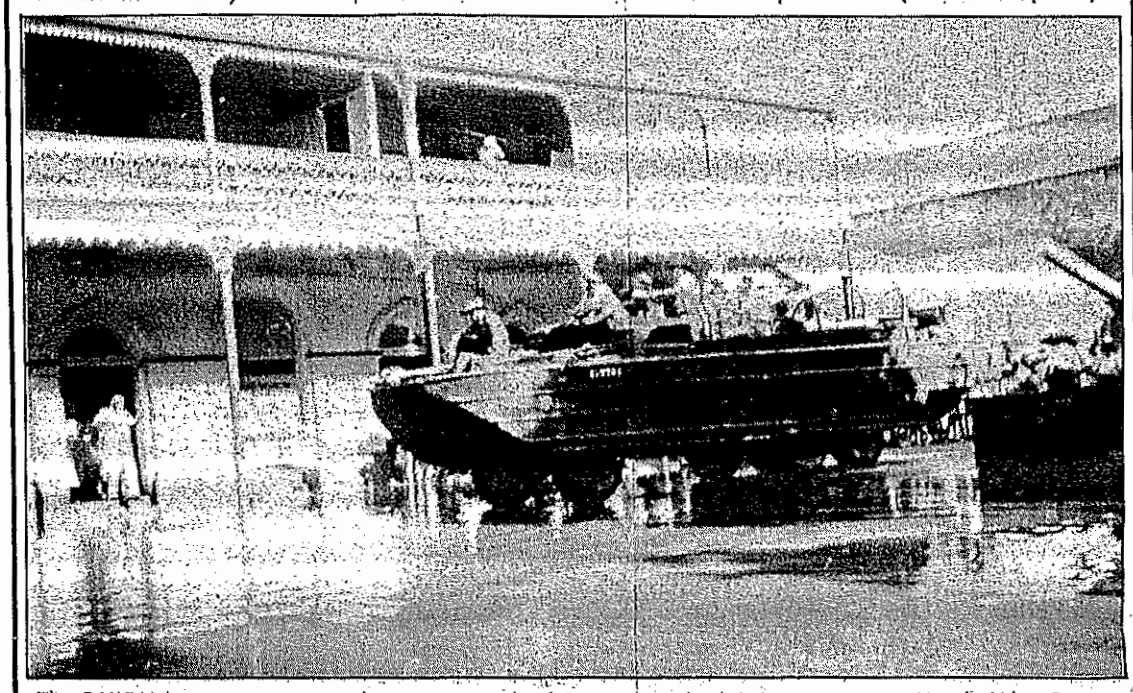


This ute was swept from under Zemeks' Mary Street house. (Alan Brown photo)

The day the Army DUKWs came to town



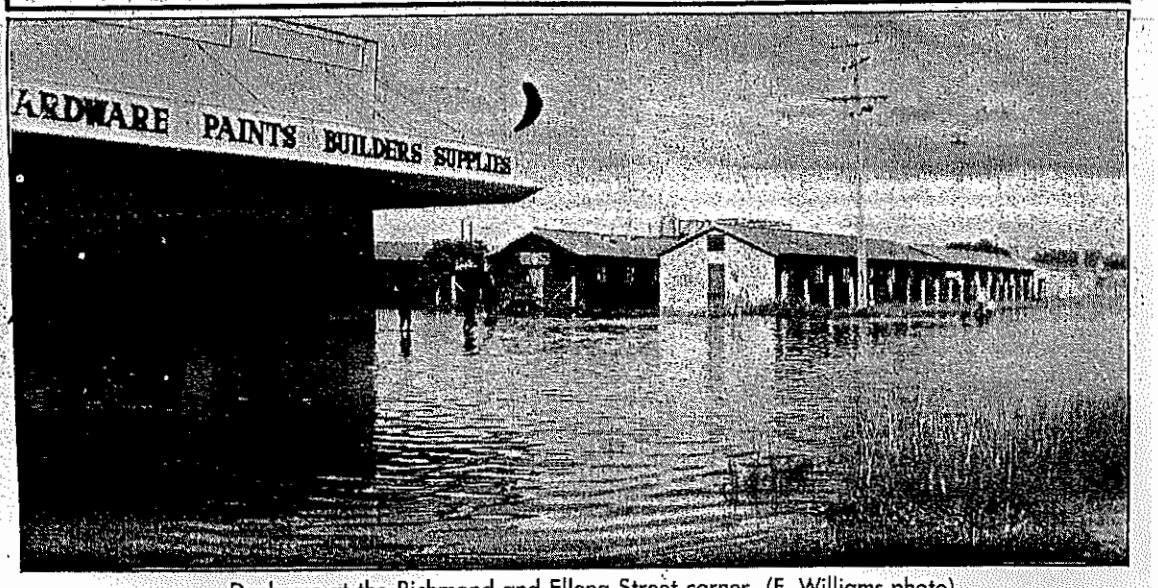
The Army sent in two amphibious DUKWs to help Maryborough flood victims in 1955. Their presence was memorable: as they motored up Kent Street the bow waves smashed shop windows. (Alan Brown photo)



The DUKWs prepare to enter the water in Wharf Street outside the Customs House Hotel. (Alan Brown photo)



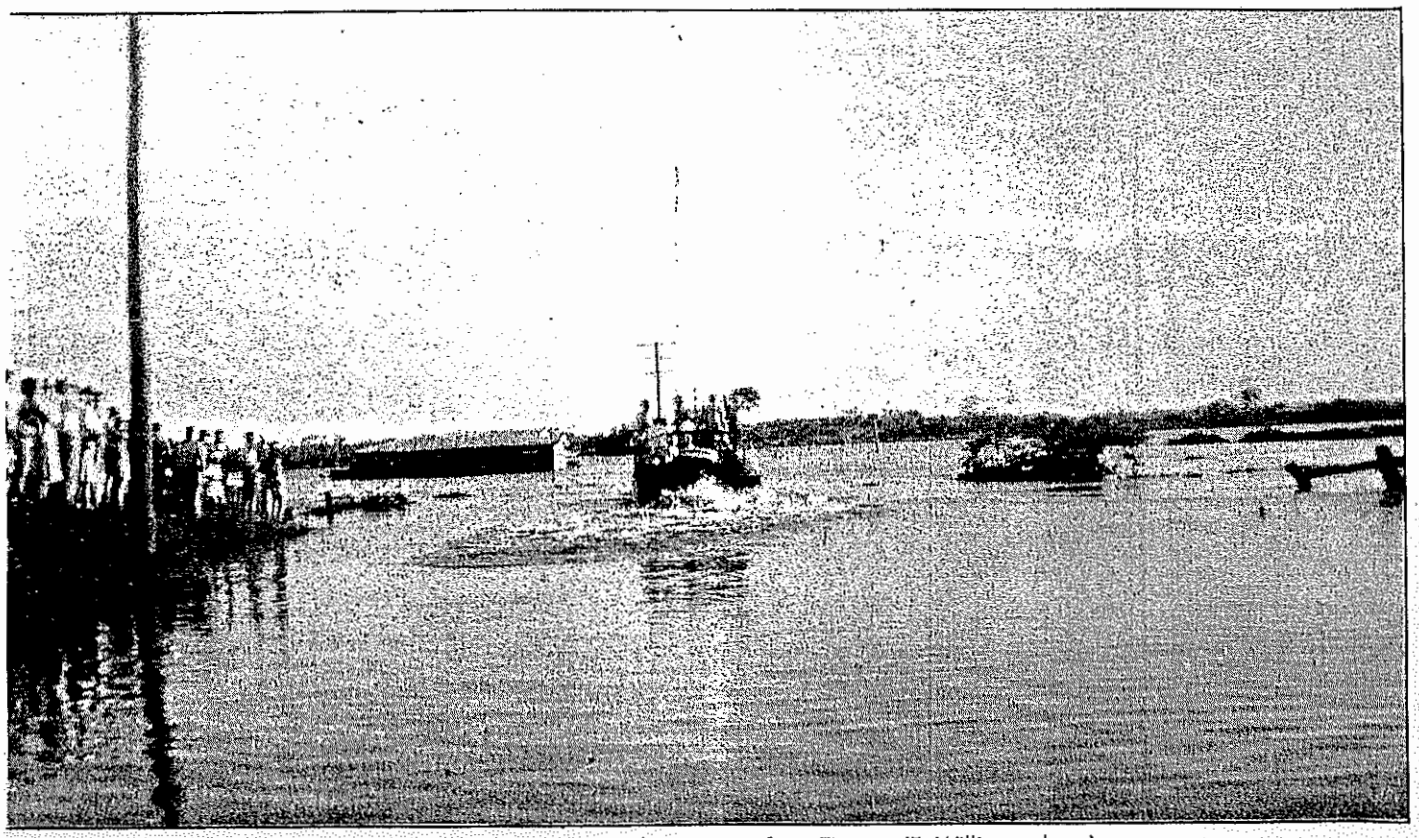
Spectators watch the DUKWs sail through Queens Park. (F. Williams photo)



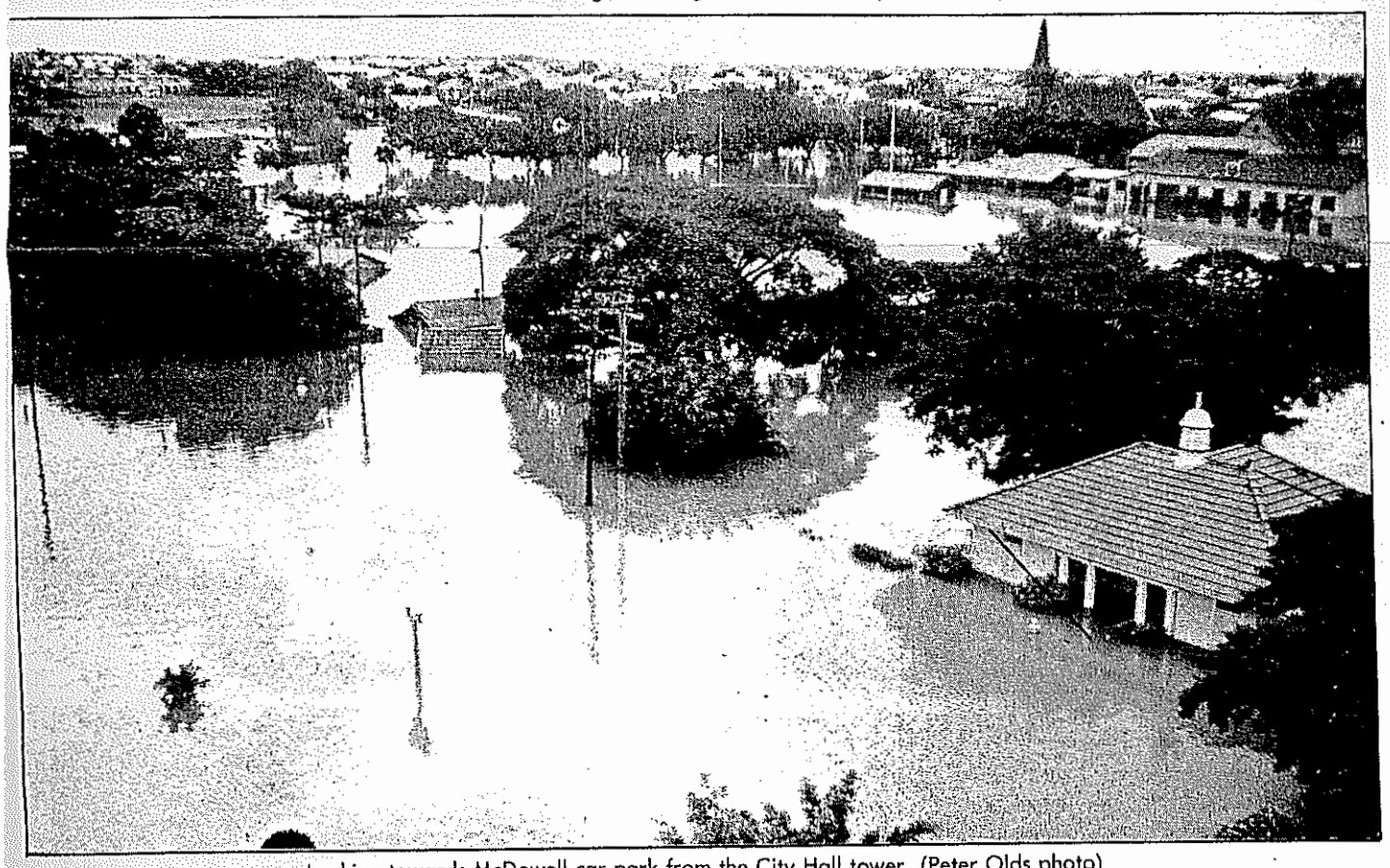
Denhams at the Richmond and Ellena Street corner. (F. Williams photo)



Spectators peer at Kent Street from the City Hall. (M. Weir photo)

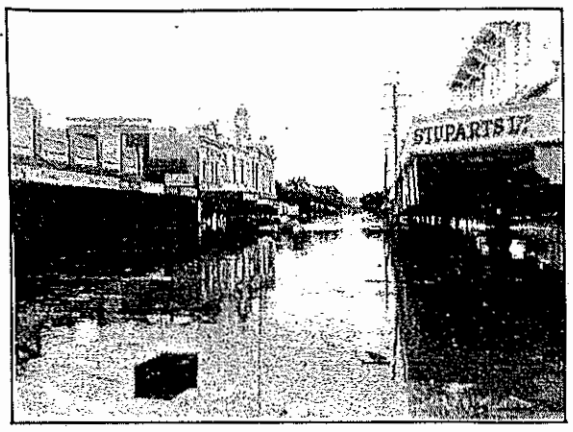


A boat comes "over" the submerged Lamington from Tinana. (F. Williams photo)



Looking towards McDowell car park from the City Hall tower. (Peter Olds photo)

Maryb'h becomes city of canals



A box floats down Kent Street from Bazaar Street. (Ron Shields photo)



The Fiveways with the river in the background. (Peter Olds photo)



Walker Street, with Queens Park on the right and Wilson Hart on the left. (J. Dewar photo)



John Street with the Central School in the background. (Peter Olds photo)



Lower Kent Street looking down from the Fiveways. (Peter Olds photo)

Maryborough in Flood, 1955



Weed in Bazaar Street, looking from Kent Street towards Alstons printing shop. (Peter Olds photo)

Flak for missions of mercy

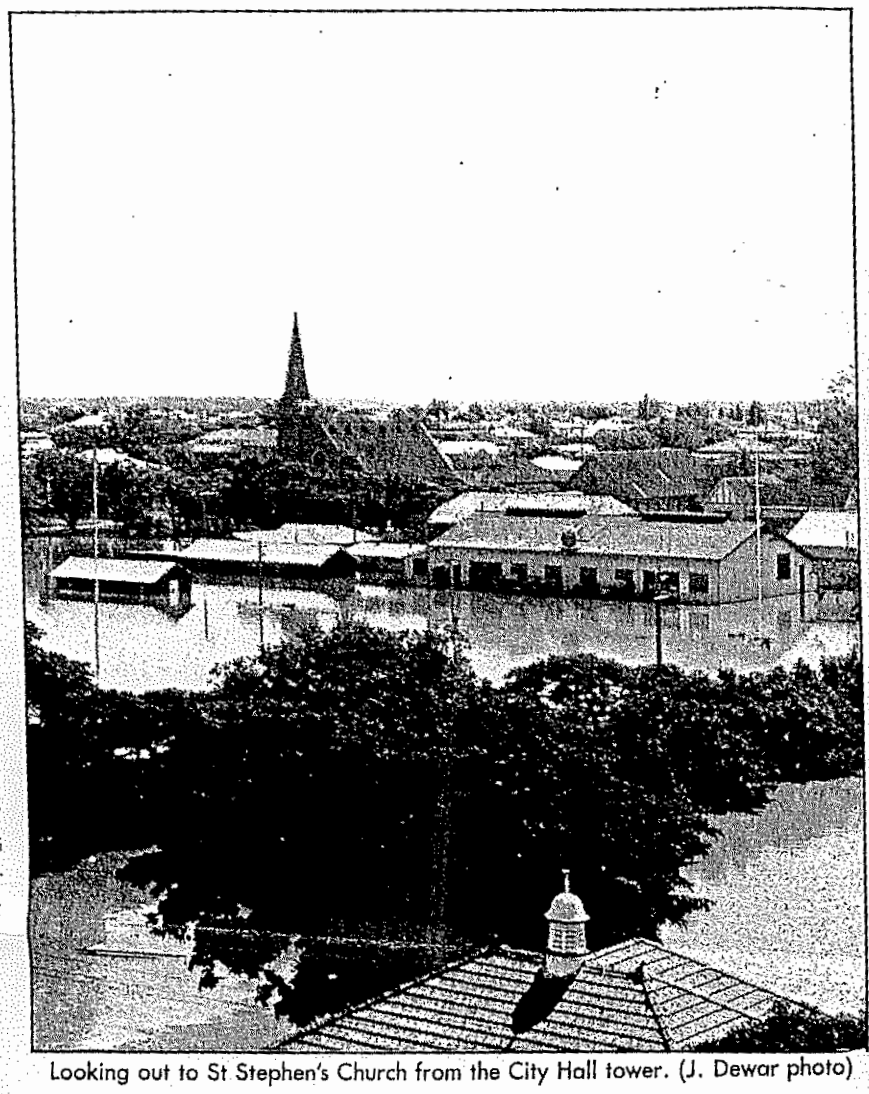
Alan Brown was worried about his father in hospital and a neighbour feared his brother had drowned in Maryborough while they were stranded in Tinana in the 1955 flood.

As water began to drop on the Lamington Bridge at dusk, the pair waded across, borrowed bikes from Joe Prickett's house behind the Lamington Hotel and set off on their separate missions.

Alan recalls returning about 8.30 pm and noticing a policeman standing by the bridge. He asked casually if it was all right to go to Tinana.

The copper replied testily "It must be." He said he knew none of the bridge had washed away because "a couple of stupid b . . . . . walked across from Tinana an hour and a half ago".

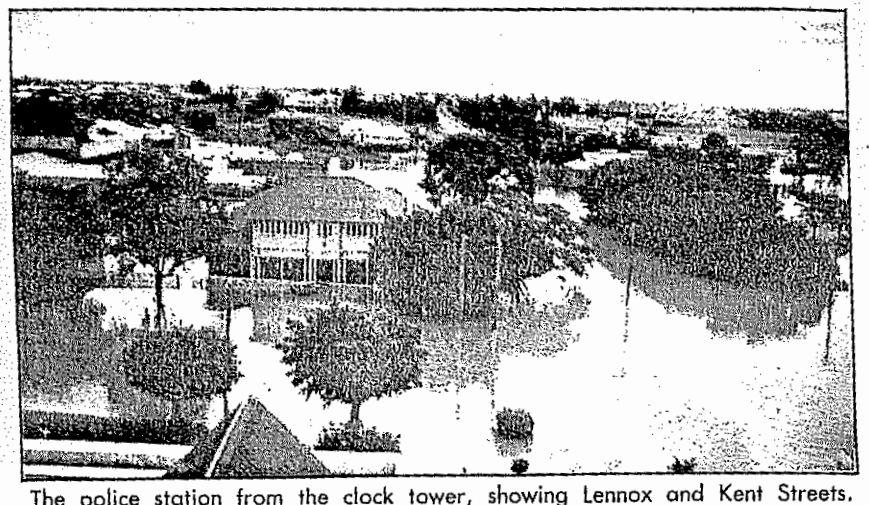
The man who is now mayor decided discretion was the better part of valour at that stage.



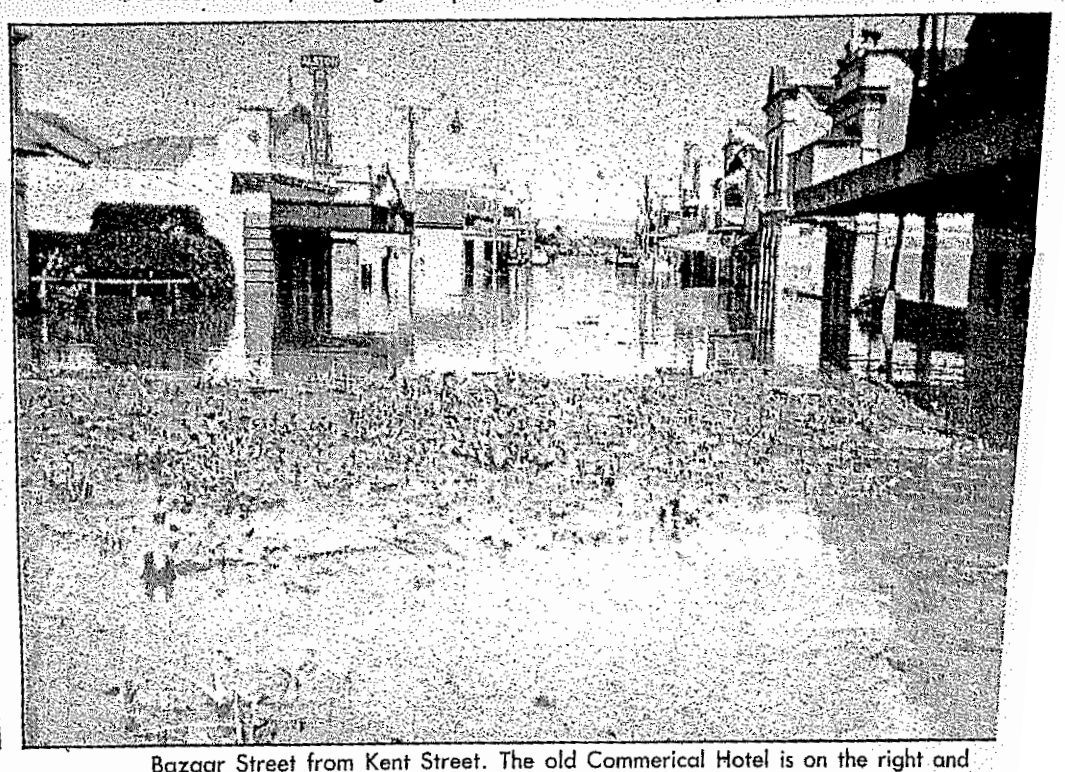
Looking out to St Stephen's Church from the City Hall tower. (J. Dewar photo)



The School of Arts, showing the top of the flooded women's public toilets. (W. M. Weir photo)



The police station from the clock tower, showing Lennox and Kent Streets. (Peter Olds photo)



Bazaar Street from Kent Street. The old Commerical Hotel is on the right and the Royal Hotel on the left. (Ron Shields photo)

'55 disaster leaves 500 homeless

The force of the biggest flood in 62 years hit Maryborough on Tuesday, March 29, 1955.

Ten homes were washed away altogether, and 500 people were left homeless. The homes washed away were in the Pocket area and close to the Lamington Bridge.

Four or five houses in Mary Street were among those swept away, one of them the home of Norma and Ron Blackburn.

"We weren't long married — only four months — and my husband and his father had taken nine months to build that house so it was quite a blow to see it washed away in a few minutes," she said.

"All I remember is watching the flood come up in the gully behind Mary Street, never thinking the flood would come up. My husband's family had lived there for many years and never had anything more than water in the house.

"We sat on one of the hills at Granville and watched it go, it broke up round about Tommy Braddock's house, at Treasure Street."

She said they were then brought over to the town side of the river in a boat and went to her parents' house in North Street.

"A lot of stuff was washed down to Island Plantation — part of our roof was found there still with the light shade attached to the beam, a wash trolley that my Dad had made and a couple of chairs, a bedspread — odds and ends that I won't part with. The fact that my Dad had made the trolley and it had been through that made it very precious."

Mrs Blackburn said they had lost everything, but the flood appeal had done tremendously well and most people who were washed away had managed to relocate. "I'll never forget the generosity, that's the only way we were able to survive. Another home was built for us with funds from flood relief, to the same design but in Dalglish Street behind the hospital, well out of the way of floods. We spent a good part of our lives there."

Mr and Mrs Blackburn now live in Brisbane, where he is an electrical engineer. The floodwaters covered Adelaide Street from Sussex Street to Boys Pty Ltd. In Kent Street the waters covered from Radio 4MB opposite the Royal Hotel to the Maryborough Bowling Club, and from the Federal Hotel to the east, was a sea of water.

Maryb'h is well prepared

Major flooding in Maryborough no longer means major disaster. It means a slick operation by practised citizens. They have plenty of warning of a coming flood, they know about how high it will be and which areas will be inundated.

First the rails come off the Lamington Bridge so debris will not be caught to build up pressure and possibly damage the bridge structure. The Lammy was "built to go under".

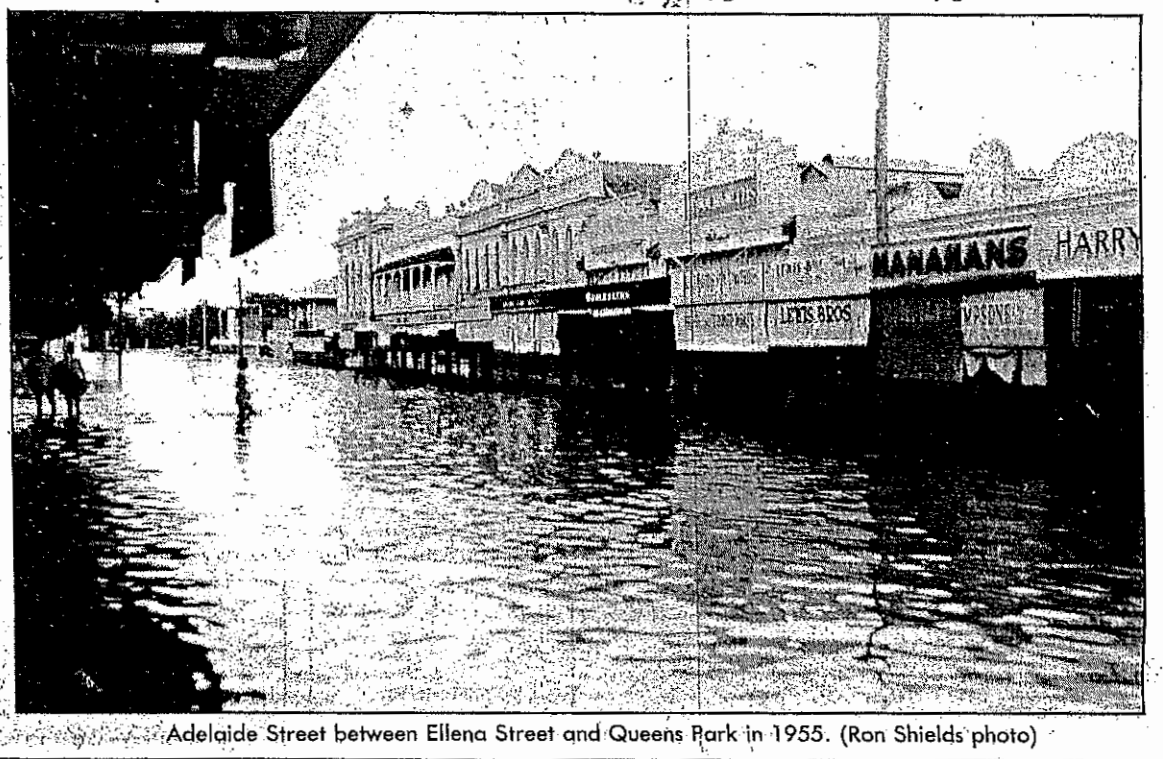
Homes in low lying areas are evacuated, depending on how high the peak is expected to be. Residents reckon on the floods of '55 and '74. Fuel depots and other industrial sites in Lower Kent Street are stripped of stock and portable gear. The workers usually have about 36 hours up their sleeves.

At Hyne and Son's sawmills in Kent Street, preparation for a flood is a clockwork operation. Shops in the inner city area are also cleared as much as possible of goods that can be damaged.

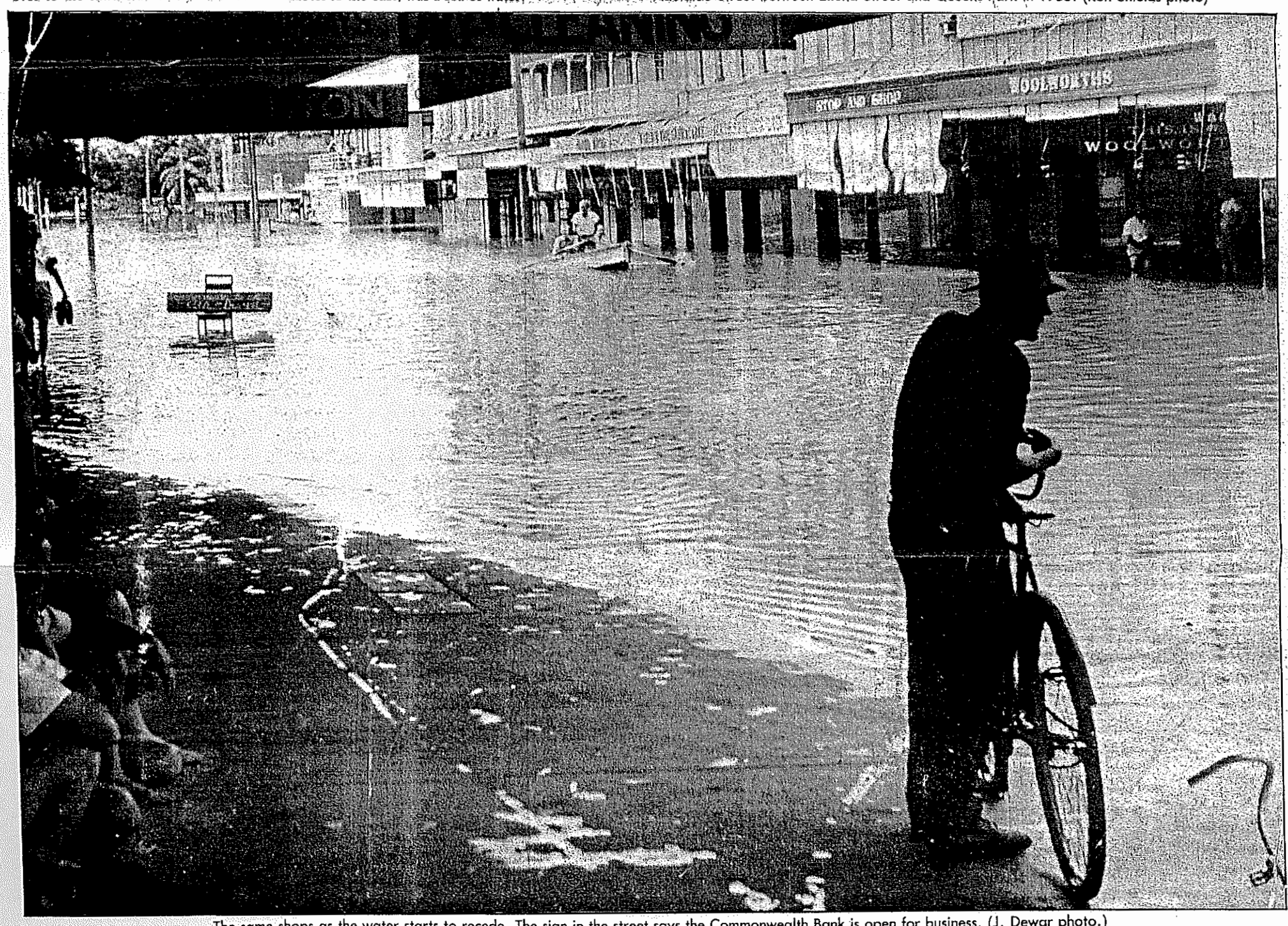
The Maryborough City Council is a master of flood control in its domain. It has kept meticulous records and its stable workforce knows what has to be done. The council knows what roads will go under when and what services are likely to be affected.

The number of houses susceptible to flooding in Maryborough has dwindled since 1955. Some were washed away then and after the 1974 flood many houses in low-lying areas were moved to higher ground or lifted on to higher stumps.

The unforeseen can happen, of course, but generally Maryborough copes capably with a flood. There is surprising little damage to life, limb or property. There's just the stinking mud to clean up when the Mary goes down.

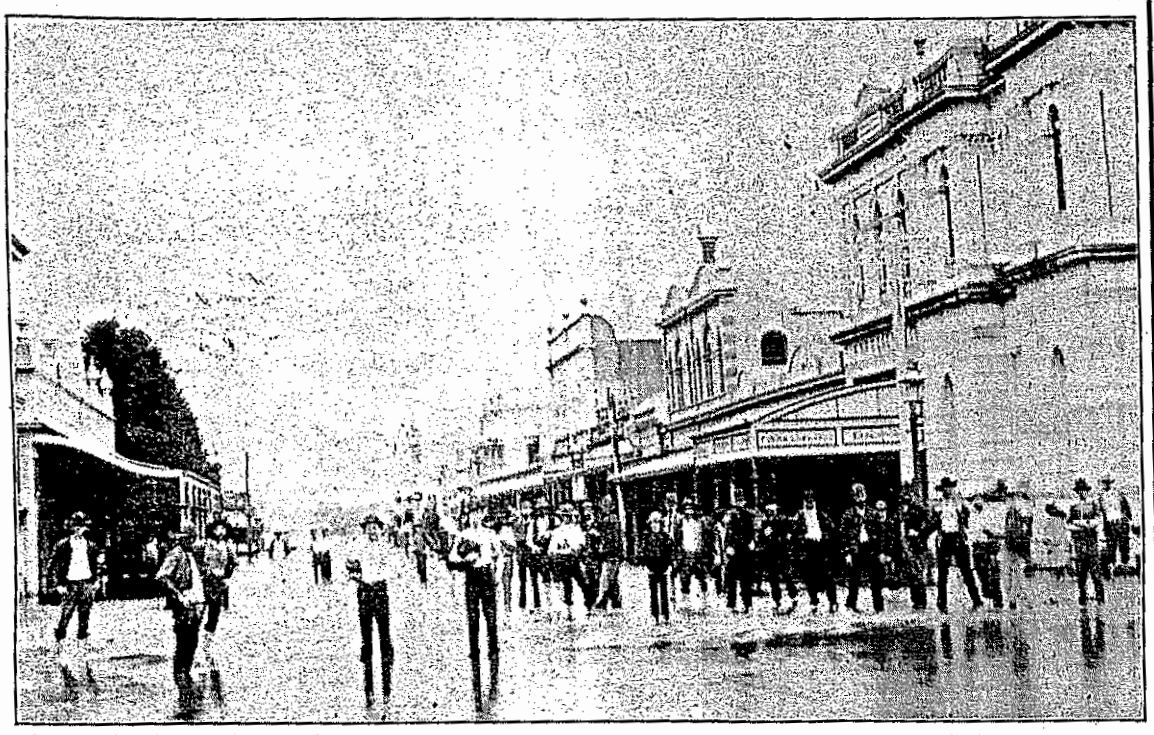


Adelaide Street between Ellena Street and Queens Park in 1955. (Ron Shields photo)

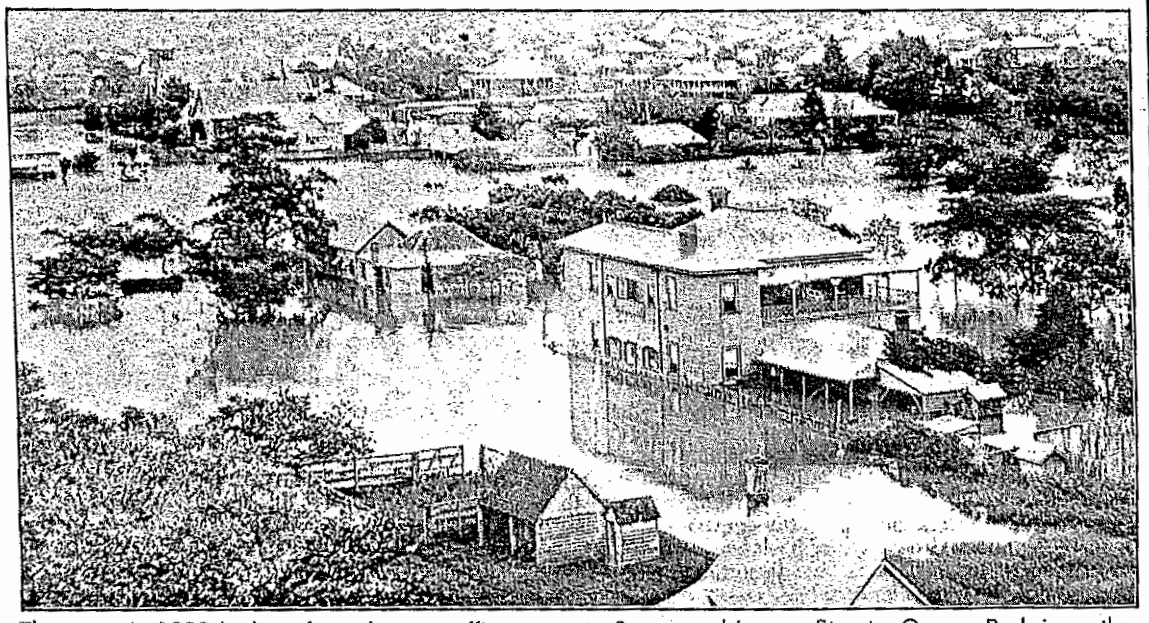


The same shops as the water starts to recede. The sign in the street says the Commonwealth Bank is open for business. (J. Dewar photo.)

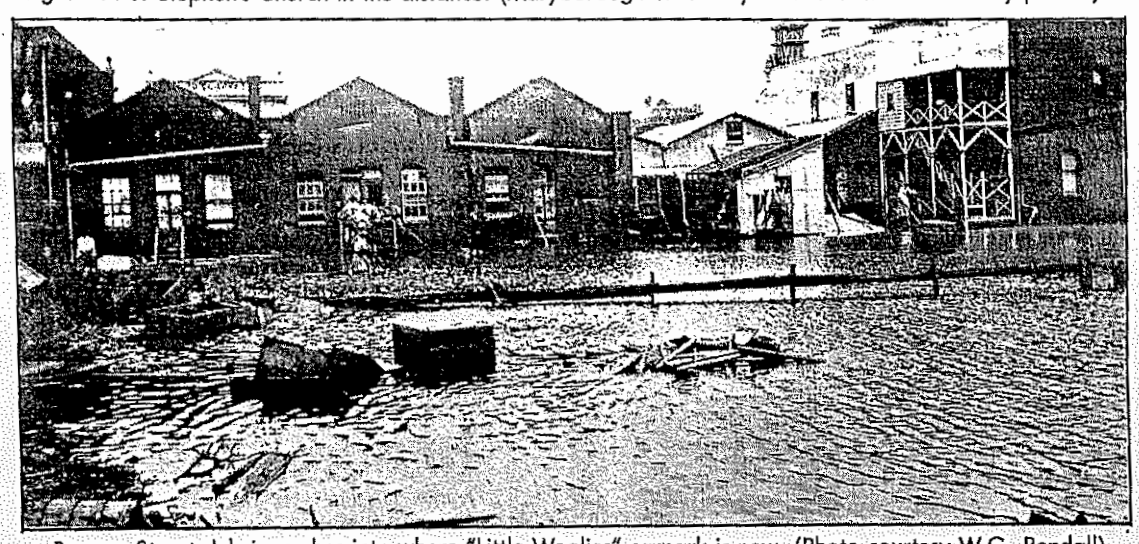
Maryborough in Flood, 1893



The '93 flood spread up to the corner of Richmond and Kent Streets, where men and youths but few women came out to gaze. (Maryborough Wide Bay-Burnett Historical Society photo.)



The scene in 1893 looking from the post office tower to Sussex and Lennox Streets. Queens Park is on the right and St Stephen's Church in the distance. (Maryborough Wide Bay-Burnett Historical Society photo.)



Bazaar Street debris washes into where "Little Woolies" carpark is now. (Photo courtesy W.G. Rendall)



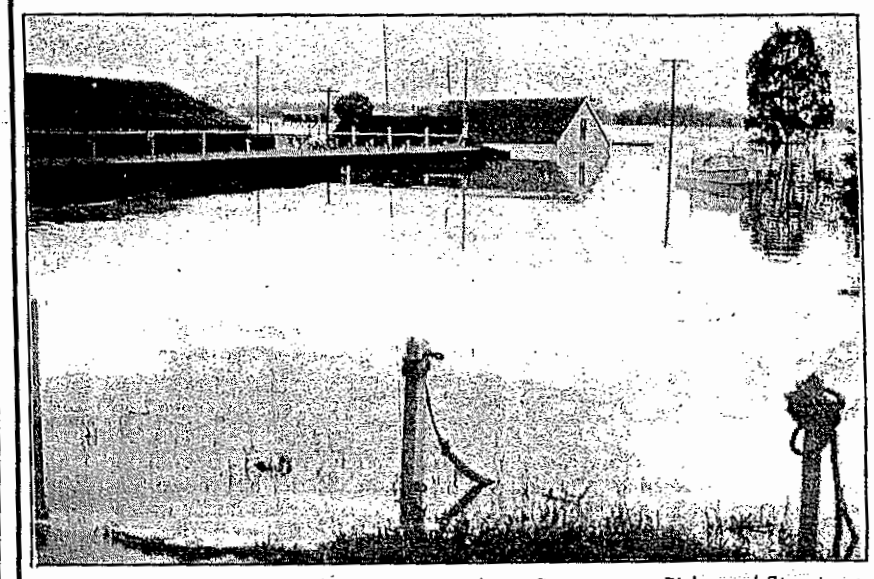
Horse-drawn vehicles move up Kent Street in the '93 flood. The old town hall is on the right, where the city council's administration building is today. (Photo courtesy W. G. Rendall.)

Maryborough in Flood,

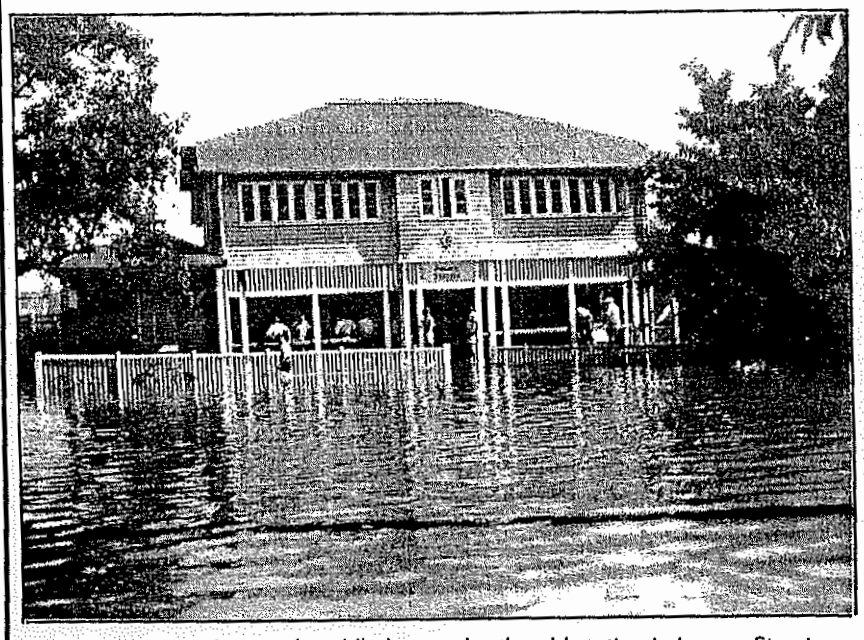
1955



Bazaar Street in 1955. The post office is in the distance. The building on the right is near where the Chronicle is today. (J. Dewar photo)



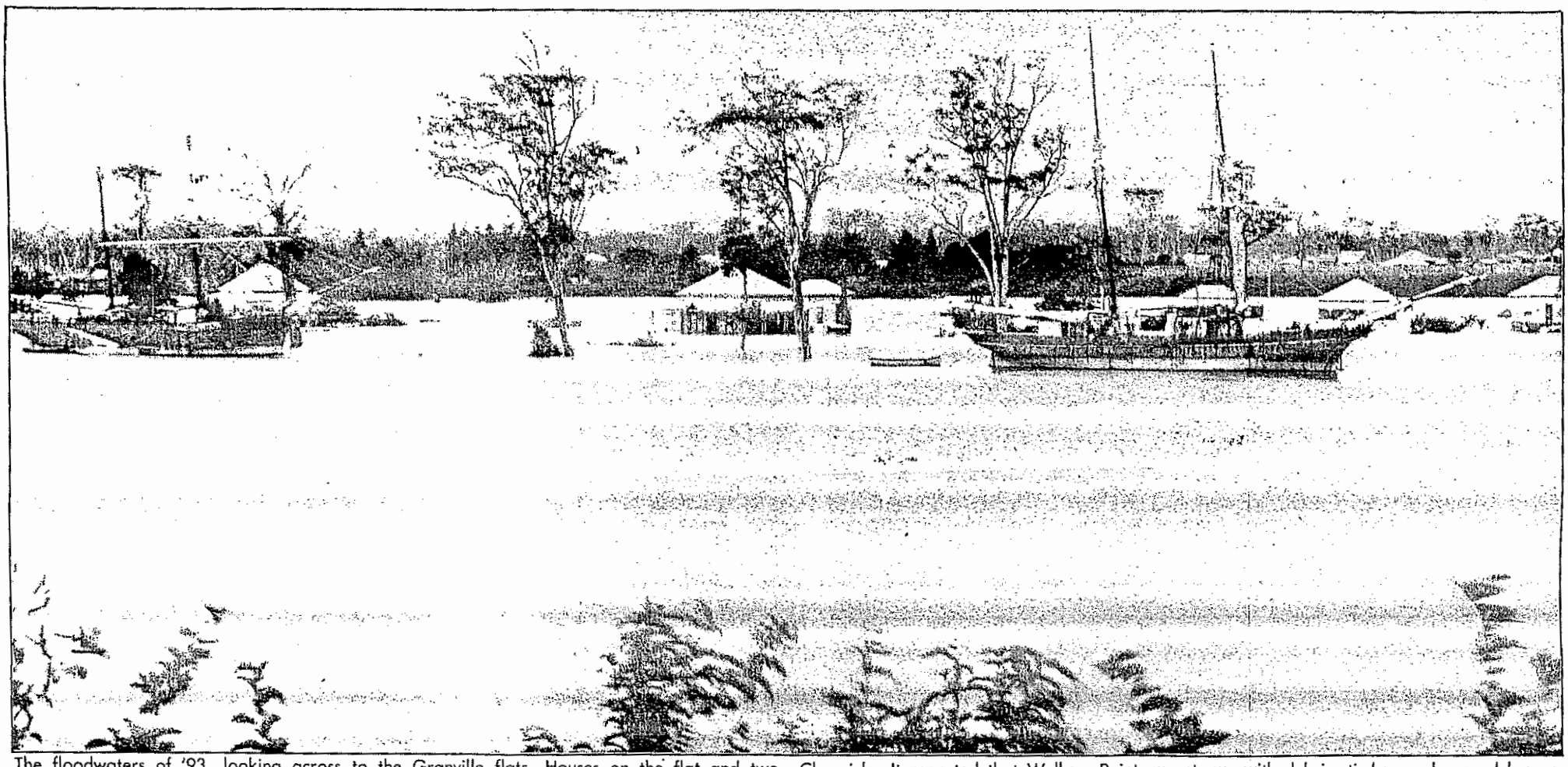
The old public baths at the top of Macalister Street, near Richmond Street. (Ron Shields photo)



Police gathered — and paddled — under the old station in Lennox Street. (Joy McIntosh photo)



The ship in the river could have sailed to the front door of these houses. (Nola Hemming photo)



The floodwaters of '93, looking across to the Granville flats. Houses on the flat and two schooners moored at Graville were swept away in the flood, which left a "remarkable state of things over in Granville, the like of which could hardly be conceived", according to the Chronicle. It reported that Walkers Point was strewn with debris, timber and several houses. Two or three houses apparently settled on the Island Plantation, quite intact. (Photo courtesy of Maryborough Wide Bay-Burnett Historical Society.)

Scenes of desolate waste

Several lives were lost and more than 130 houses washed away in the great flood of 1893, the worst in Maryborough's history.

After a week of heavy rain the river had risen 3.05 m above the level of the "great" flood of 1890. No one dreamt that a flood could be worse than that one.

In Lennox Street, the Chronicle reported, the water covered the Botanic Gardens, came up past the Rectory and stretched across to the gates of St Paul's Church. In Kent Street there was water as far as the eye could see, and the business part of town looked like Venice, there were so many boats.

Rescue workers and journalists then did not have the advantage of planes and helicopters, so full reports of the disaster had to wait until the waters receded on Thursday, February 9, revealing a desolate waste.

The floodwaters were still over the wharves, and nearly half the houses in Mary and lower Kent streets had disappeared. The body of a man named John, drowned near the Grand Hotel on Tuesday afternoon, was discovered a few yards from where he disappeared.

The raging floodwaters had scoured away every house and fence on the Granville flat, leaving the land scarred with great furrows and the bank altered in its course in many places. Two schooners moored at Granville had broken their anchors and gone down the river.

A large number of homeless people who had found a refuge on the dredge when lower Kent Street was inundated were left with only what they stood up in, as houses, furniture, and clothes had all been washed away.

It was estimated that there were more than 100 homeless families in Maryborough and 30 in Granville.

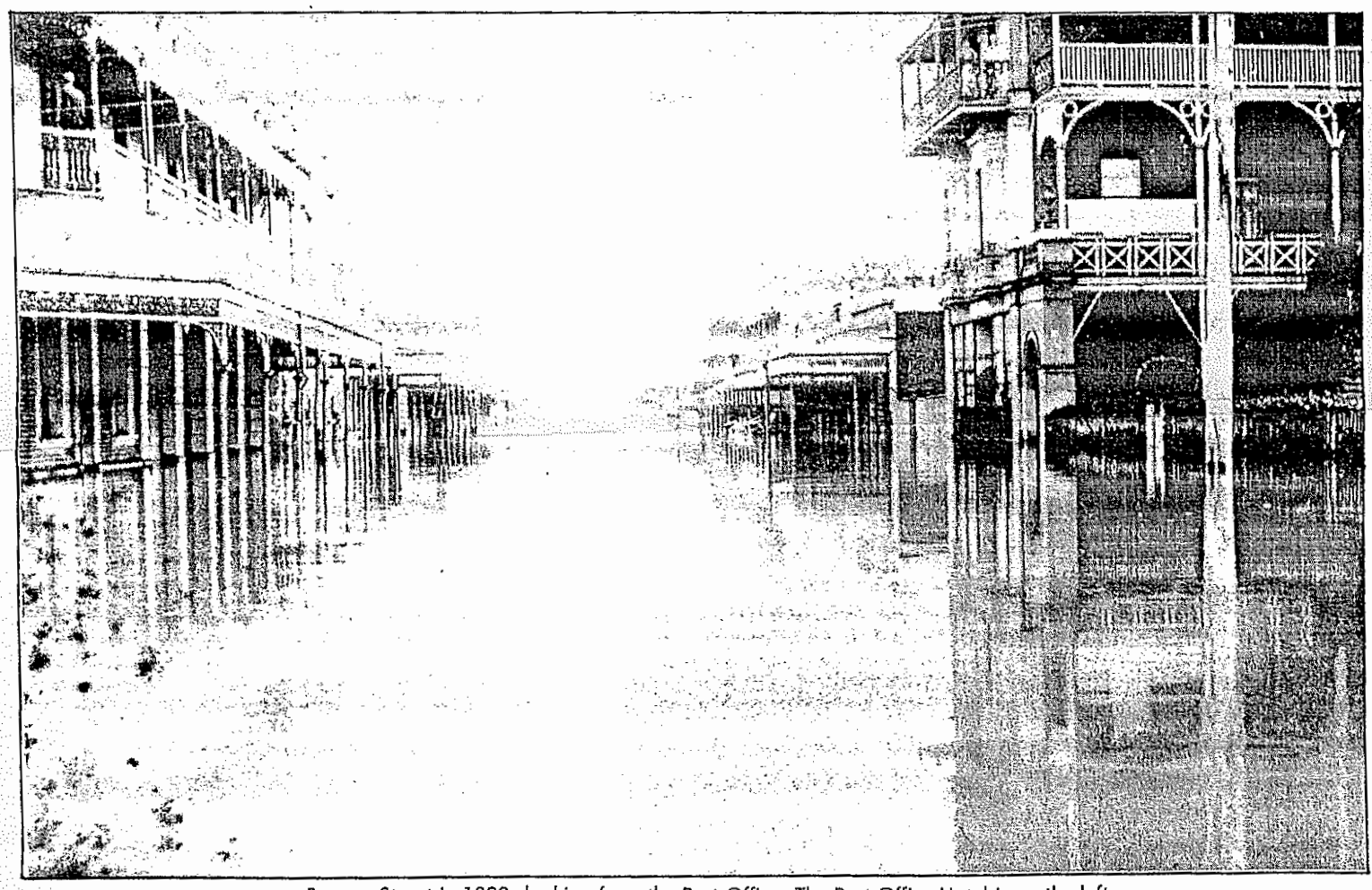
Houses, barns, horses and cattle were swept down the river for miles. Every farmer between Gympie and Maryborough with land on the banks of the Mary River suffered irreparable loss. Destruction of the Pocket, Maryborough's richest farming area, was complete, and several farmers gave up their land, disheartened by the periodic floods.

At Yengarie the water was above the railway station houses, and all the residents of the village took refuge in the school house and the hotel.

The country between Boonooroo and Granville was almost entirely under water.

A Chronicle report read: The man Wells who was on the raft in Tinana Creek with the McDonnell family reported to us yesterday that on Monday morning he swam over to McDonnell's house from the ridge to secure some casks of wine, and when there he saw the dead body of a man destitute of clothing floating in the still water about 300 yards towards the creek from the house. The body was floating face downwards, and the back of the head, part of the shoulders and lower portion of the body were visible out of the water. He looked for the body yesterday morning but it had disappeared . . . . Wells was in town for provisions and medicine for the McDonnell and Mergard families. Both McDonnell and Mrs Mergard are still suffering severely from the exposure they went through in the flood . . . .

It was reported in town yesterday that a family named Kuntz, residing at Miva, are missing. They were last seen in a boat attempting to cross the river at Miva to a place of safety.



Bazaar Street in 1893, looking from the Post Office. The Post Office Hotel is on the left.
(Photo courtesy Maryborough Wide Bay-Burnett Historical Society.)

15 hurled into Mary River as bridge breaks

About 15 men were hurled into the raging Mary River during the 1893 flood when the Maryborough Bridge was swept away on Saturday, February 4.

The men all managed to swim through the seething torrents to shore except one who was, for the time being, given up as lost. George Hogan, a log-rafter, was in the water for more than 12 hours, managing to climb out on to the bank at Granville after a desperate struggle.

In the morning light the scene was one of almost total demolition, with a gap of about 137 metres where four spans of the bridge had been carried away.

The approach to the bridge was washed away, leaving a yawning gulf many metres deep and about four metres wide.

Since the wooden bridge had been constructed in 1875 it had been predicted that the next flood would carry it away, but it had weathered each one until 1893. On the Saturday afternoon, when the water was rushing over the decking, all traffic on the bridge was suspended because of the imminent danger.

A gang of picked men was stationed along the bridge to push away with long poles the logs and debris stacking up against the bridge. Despite their efforts, the bridge was carried away with a crunching crashing noise about 7.30 pm.

As in the old days, transport between Tinana and Maryborough had to be done by ferry punt, until the Lamington Bridge was built.

The Chronicle Est.1860
Today's Fraser Coast News

Flood Souvenir

RECOMMENDED PRICE $1

THURSDAY, FEBRUARY 27, 1992

Maryborough in flood

The bountiful Mary River gave life to Maryborough almost 150 years ago. The tiny village settled by pioneers was first a shipping post for produce from the rich Wide Bay-Burnett.

The early settlers also found out the Mary was a destroyer, rising from her bed to a raging flood after heavy rain in the catchment area. Sometimes she flooded annually; sometimes she ran quietly for long drought years.

The biggest flood on record was in 1893. Major floods swept through Maryborough in 1955 and 1974, then came the long, dry years. The drought broke briefly with two moderate floods in 1989: three more parching years followed.

The Deluge of '92 brought the worst drought on record to an abrupt end. While Maryborough suffered minor damage, the region also rejoiced as the rains and river replenished the water tables.

This special limited edition of the Chronicle is a pictorial and informative record of the city's major floods. Some of the photographs from private collections are published for the first time.

1893

1992



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