Regional Floodplain Database:

Hydrologic and Hydraulic Modelling - Burpengary Creek (BUR)

Moreton Bay Regional Council
Emergency Management Queensland
Australian Government
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Regional Floodplain Database Hydrologic and Hydraulic Modelling

Burpengary Creek (BUR) November 2012

Moreton Bay Regional Council

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Burpengary Creek (BUR)
November 2012

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Title :	Regional Floodplain Database Hydrologic and Hydraulic Modelling Burpengary Creek (BUR) Update 2012 of Sub-Project 2B
Author :	Anne Kolega \ Richard Sharpe
Synopsis :	This report documents the update of the Burpengary Creek pilot study (detailed hydrologic and hydraulic modelling undertaken as part of the RFD). The update includes new development, mitigation works and amendment of model parameters to conform with RFD Stage 2 and 3.

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1 INTRODUCTION

Moreton Bay Regional Council (MBRC) is in the process of developing a Regional Floodplain Database (RFD). The RFD includes the development of coupled hydrologic and hydraulic models, for the entire local government area (LGA), that are capable of seamless interaction with a spatial database to deliver detailed information about flood behaviour across the region.

With the development of the RFD, Council has now taken a new approach that:

1. Standardises parameters and approaches for hydrologic and hydraulic modelling;
2. Standardises modelling software (hydrologic and hydraulic models); and
3. Integrates the model inputs and results into a database for ease of use within MBRC.

Stage 1 of the RFD included the broadscale modelling, whereas detailed modelling was undertaken as part of Stages 2 and 3. The Burpengary Creek catchment was chosen as the pilot study for detailed modelling. This study included model calibration and was finalised in December 2010. Stage 2 involved detailed modelling of 10 catchments within the MBRC LGA; for some of these catchments model calibration was also undertaken.

As part of Stage 2, Council decided to change some model parameters, such as the roughness for three selected landuse types, and the parameters and/or approach of the sensitivity scenarios (i.e. 20% increase in rainfall intensities rather than 12% for the climate change scenarios). Thus, for consistency in Council's LGA, the Burpengary Creek model requires an update to conform to Stages 2 and 3 of the RFD.

The focus of this report is to have a consistent report structure to the RFD Stage 2 reports. The comparison between Stage 1 and Stage 2 model results are limited to the calibration event (detailed in Appendix C).

1.1 Scope

The scope included an update of the Stage 2 Pilot model of Burpengary Creek to be consistent with modelling undertaken in other catchments, as part of Stage 2 and 3 of the RFD. The scope of works also includes recent developments in the catchment and flood mitigation works undertaken by Council in response to the January 2011 event, as follows:

- Investigate three areas, selected by Council and amend model as follows:
  - Ferny Gully area: Update and inclusion of culverts in the Ferny Gully area (under Eastern and Western Service Road near the Bruce Highway and the culvert at Pitt Road);
  - Oakey Flat Road and Piccabeen Court, Narangba: Revise TUFLOW Zpts based on survey provided by Council and include zline to represent the low point of the channel; and
  - MacDonald Drive, Narangba: Include an additional culvert at MacDonald Road, split and apply inflows upstream of the culvert.
- Amendment of obvert levels at the footbridges.
- Development at Retreat Crescent, Narangba.

- Development at Delaney Road, Burpengary.
- Bund wall and floodgate across drain near Lookout Place, Narangba.
- Overflow channel near Creekside Drive, Narangba.
- Levee near Hideaway Close, Narangba (Stage 1).
- Drainage improvements at intersections of Mathew Crescent and Rowley Road, Burpengary.
- Bund across drain at 40 Matthew Crescent, Burpengary.

The detailed model was developed from a pre-existing broad scale base model that had been originally developed by MBRC as part of the RFD. The following primary alterations were made to convert the broad scale model to a detailed model:

- The model computational grid resolution was refined from 10m to 5m.
- The latest 2009 LiDAR (**L**ight **D**etection **A**nd **R**anging) topographic data was used, incorporating terrain modifiers to enhance the capture of road embankments and stream lines in the Digital Elevation Model (DEM).
- Additional hydraulic structures were included in the model.
- Utilisation of detailed land use delineation (developed as part of Stage 1, but not included in broadscale models).

The Burpengary Creek model was calibrated to the January 2011 and validated to the two historic events of May 2009 and February 1999. As part of this update, the calibration events were re-simulated with the adopted Stage 2 roughness values. Since the historical flood events occurred before the implementation of recent mitigation works, these works were excluded from the calibration models.

The updated detailed model of Burpengary Creek will provide Council with an enhanced understanding of the flood behaviour in the catchment for a range of flood events from the 1 year Average Recurrence Interval (ARI) event to the Probable Maximum Flood (PMF) and for 12 selected sensitivity scenarios. The model results provide detailed flood information such as levels, depths, velocities, hazard, flood extents and the time at which flooding occurs.

1.2 Objectives

Key objectives of this study are as follows:

- Utilise the existing broadscale model to develop a detailed and dynamically linked two-dimensional and one-dimensional (2D/1D) hydrodynamic model of the Burpengary Creek Catchment using input data that were determined and provided by MBRC or other consultants.
- Update the Stage 1 Burpengary Creek model to a Stage 2 model and include new developments and flood mitigation works.
- Provision of all relevant flood information obtained from the modelling, which will form the base input data for Stage 3 of the RFD.

1.3 General Approach

The general approach for this study is summarised as follows:

- Update the Stage 2 Burpengary Creek Pilot model;
- Calibrate and/or verify the combined WBNM and TUFLOW models using three historic events of January 2011, May 2009 and February 1999;
- Undertake a critical storm duration assessment for the 10 year ARI event, 100 year ARI event and the PMF;
- Simulate a large range of design flood events (1, 2, 5,10, 20, 50,100, 200, 500, 1000, 2000 year ARI events and PMF events) for up to three selected critical durations;
- Assess model sensitivity to future landuse patterns, Manning's 'n', structure blockage, climate change and downstream boundary conditions;
- Compare the updated (Stage 2) model results to the Stage 1 model results;
- Provide a concise report describing the adopted methodology, study data, model results and findings. The emphasis of the RFD project is on digital data management. Therefore, only the 100 year ARI event and the sensitivity analysis were mapped in this report with results for all other events and simulations provided electronically; and
- Compilation of models and model outputs for provision to MBRC.

1.4 Related Sub-Projects (RFD Stage 1 and Stage 2 Pilot Project)

The following RFD sub-projects provide input data and/or methodologies for the updated Burpengary Creek models:

- **1D – Hydrologic and Hydraulic Modelling (Broadscale),** sub-project 1D defined model naming conventions and model protocols to be used in this sub-project (BMT WBM, 2010).
- **1E – Floodplain Topography (2009 LiDAR) including 1F, 2E, 2I,** sub-project 1E provided the topographic information, such as model Z points layer and digital elevation models (DEM). This was achieved using a bespoke DEM tool developed for the RFD (Worley Parsons, 2010a).
- **1G – Hydrography (MBRC),** sub-project 1G supplied the subcatchment delineation of the catchment including stream lines and junctions (used in the WBNM model).
- **1H – Floodplain Landuse,** sub-project 1H delivered the current percentage impervious cover (utilised in the hydrologic model) and the roughness Manning's 'n' values (utilised in the hydraulic model) (SKM, 2010).
- **1I – Rainfall and Stream Gauges Information Summary (MBRC),** sub-project 1I summarised available rainfall and stream gauge information for the study area.
- **2C – Floodplain Structures (Culverts),** sub-project 2C supplied the GIS layer of the culverts to be included in the model (Aurecon, 2010). A TUFLOW-specific MapInfo file was provided, however appropriate model linkages between the culvert data and the 2D domain had to be established.

- **2D - Floodplain Structures (Bridges),** sub-project 2D provided a GIS layer of the major bridges and foot bridges (Aurecon, 2010). A TUFLOW-specific MapInfo file was provided.
- **2F – Floodplain Structures (Trunk Underground Drainage),** sub-project 2F provided trunk underground drainage information.
- **2G - Floodplain Structures (Basins),** sub-project 2G consolidated and surveyed the existing basin information in the study area (Aurecon, 2010).
- **2I - Floodplain Structures (Channels),** sub-project 2I identified channels within the catchment (Aurecon, 2010).
- **2J – Floodplain Landuse (Historic and Future),** sub-project 2J defined the historic and future percentage impervious cover (utilised in the hydrologic model) and the roughness (Manning's 'n') values representing landuse for historical events (utilised in the hydraulic model) (SKM, 2010).
- **2K – Flood Information Historic Flooding,** sub-project 2K collected and surveyed flood levels for the historic May 2009 and February 1999 flood event (GHD, 2010).
- **2L – Design Rainfall and Infiltration Loss,** sub-project 2L developed the hydrologic models for the catchment and provided the design rainfall hydrographs for the pilot study (Burpengary Creek catchment) TUFLOW models (Worley Parsons, 2012). A similar methodology was adopted for the Caboolture catchment.
- **2M – Boundary Conditions, Joint Probability and Climate Risk Scenarios,** sub-project 2M defined the boundary conditions and provided recommendations in regards to joint probability (i.e. occurrence of storm surge in combination with river flooding events, or river flooding in combination with local tributary flooding). This project also recommended certain sea level rise and rainfall intensity values to assess Climate Risk Scenarios (SKM, 2012a).
- **2N – Floodplain Parameterisation,** sub-project 2N provided recommendations of the floodplain parameters, such as a range of values for various impervious percentages for various landuse types (i.e. residential or rural landuse, dense vegetation), a range of values for various roughness types (i.e. long grass, dense vegetation) and structure losses (SKM, 2012b).

2 AVAILABLE DATA

The following provides a list of the data available for this study:

- **Floodplain Topography** – MBRC provided a DEM and Z points that were generated using a tool developed and run by Worley Parsons. The DEM resolution was 2.5m (half the 2D computational grid resolution). The topography is based on LiDAR data collected in 2009 and provided by the Department of Environment and Resource Management (DERM). The topography for the new developments and flood mitigation works was based on drawings and/or DEMs provided by MBRC.
- **Hydrography (MBRC)** – Catchment delineation and hydrology model dataset provided by MBRC.
- **Floodplain Landuse** (Current and Future) – Polygon data for 9 different landuse categories established as part of Stage 1.
- **Floodplain Structures (Culverts and Bridges)** – As-constructed bridge plans for selected minor roads in MBRC LGA (provided by MBRC where available). Additional structure survey data, as undertaken by MBRC when no structure data was available. State controlled roads and minor road GIS layers provided by MBRC.
- **Design Rainfall** – Amendment of WBNM models, development of design simulations and provision of design rainfall hydrographs (from the 1 year ARI to the PMF).
- **Boundary Conditions, Joint Probability and Climate Risk Scenarios** – Report with recommendations for boundary conditions, joint probability and climate change scenarios.
- **Floodplain Parameterisation** information, specifically about impervious percentages for various landuse types, roughness types and structure losses.

3 METHODOLOGY

3.1 Data Review

Stage 1 of the RFD included the data compilation and review for the Stage 2 Burpengary Creek Pilot model. Council undertook and reviewed the hydrography (catchment delineation) as part of sub-project 1G.

The structure data for the Burpengary Creek Pilot study were collected as part of sub-project 2C to sub-project 2I by Aurecon. The structure data included culverts, bridges, trunk underground drainage and buildings. These sub-projects included a review of the existing data held by Council, a gap analysis, identification of additional structures to be surveyed, the preparation a survey brief, and the actual survey of additional structures. The compiled data set was then reviewed by Council and provided for inclusion in the Stage 2 Burpengary Creek Pilot model. For more information on the structure data, refer to the report Floodplain Structures Regional Floodplain Database Moreton Bay Regional Council (Aurecon, 2010).

3.2 Hydrologic Model

Sub-project 2L included the development of the hydrologic WBNM model for the Burpengary Creek catchment utilising the WBNM 2010 beta version. The WBNM software was nominated by Council as the hydrologic software package for the RFD, and was used to model the design events (utilising existing landuse), the calibration and verification events (using historic landuse) and a future landuse scenario. Detailed hydrologic model parameters, such as adopted losses, design gauge locations and Intensity Frequency Duration (IFD) data are described in *Regional Floodplain Database Design Rainfall - Burpengary Pilot Project Report* (WorleyParsons, 2012).

Model input data (i.e. landuse, catchment delineation, etc) was provided through other sub-projects outlined in Section 1.4. The flows derived from the hydrologic model were used as inflow to the hydraulic model (Section 3.3).

3.3 Hydraulic Model

3.3.1 Model Software

Because of the complex nature of floodplain flow patterns in urban and rural catchments, MBRC has adopted TUFLOW, a dynamically-linked 2D/1D hydrodynamic numerical model, to predict the flood behaviour of the catchments in their LGA. TUFLOW has the ability to:

- Accurately represent overland flow paths, including flow diversion and breakouts (2D modelling);
- Model the waterway structures of the entire catchment with a relatively high level of accuracy (1D or 2D modelling);
- Dynamically link components of the 1D models (i.e. culverts) to any point in the 2D model area; and

- Produce high quality flood map output (i.e. flood extent, flood levels, depths, velocities, hazard and stream power), which are fully compatible with Geographic Information Systems (GIS).

3.3.2 Model Geometry

A TUFLOW model was developed of the Burpengary Creek floodplain with a 5m model resolution across the entire 2D model domain as prescribed by MBRC. The origin of the DEM (using the DEM Tool) was used to set the origin in the 2D domain. Therefore, no additional data handling was required and all models are setup with a horizontal grid orientation (i.e. no rotation). This approach was selected as part of the development of the RFD and will ensure consistency of model parameters across the entire RFD study area.

A portion of the lower catchment interacts with the adjacent Caboolture River catchment. For this study however, in consultation with MBRC it was agreed that inter-catchment flow would not be simulated (and a 'glass wall' boundary was applied).

The topography for the hydraulic models was derived from the DEM tool (including the DEM modifiers) utilising the 2009 ALS data. Stream and road modifiers were used in the DEM tool to define streams and road embankments in the Z-pts layer. The DEM tool version available for this study modified the roads before the streams and therefore road embankments at stream crossings had to be defined using TUFLOW z-shapes. However, for Stage 2 studies the DEM tool has been updated so that roads are modified after the streams, negating the need to further modify the topography in TUFLOW.

The Stage 2 Pilot model geometry was used as the base. New developments and flood mitigation works were represented in the TUFLOW model as separate layers (the DEM tool was not used).

Figure 3-1 illustrates the Burpengary Creek model layout.

3.3.3 Model Structures

The floodplain and waterways were represented in the 2D domain. Culvert crossings were typically modelled as 1D elements. Uni-directional culverts (floodgates) were included in the vicinity of Mathew Crescent and near Lookout Place. Flow over structures was generally modelled within the 2D domain. Bridges and footbridges and the overflow channel near Creekside Drive were represented in the 2D domain (using TUFLOW layered flow constriction features). The hydraulic structure details were provided by Aurecon (Aurecon, 2010). The flow constriction coefficient of the bridges was reviewed and adjusted where necessary as part of this update.

The adopted exit and entry loss coefficients applied to the hydraulic structures were based on values reported in SKM (2012b).

Basin embankments and new roads (Delaney Road, Retreat Crescent and MacDonald Drive) were included in the model (the road embankment was based on data provided by MBRC) by modifying the Z-pts using TUFLOW's Z-line function. Z-lines and Z-shapes were also used to refine the topography at culvert inlets and outlets to match surveyed invert levels.

The basin to the west of Burpengary Road was represented via a flow-head source boundary which extracts flow from the basin upstream of the embankment and discharges downstream (based on a stage-discharge curve provided by Aurecon). The other two basins included a structure (1D) at the outlet of the basin.

3.3.4 Landuse Mapping

Landuse mapping was used to define the spatially varying hydraulic roughness within the hydraulic model. In total, nine different types of landuse were mapped and provided by SKM, together with associated Manning's 'n' values as presented in Figure 3-2 and Table 3-1.

The Stage 2 adopted roughness values included a depth-varying roughness approach for three of the vegetation landuse types (dense vegetation, medium dense vegetation and low grass/grazing), whereby the Manning's roughness values applied in the model are dependent on the depth of water flowing over the ground surface. At shallow depths the resistance is relatively high, and thus a higher Manning's roughness has been applied. However, at greater depths the relative resistance decreases, and a lower Manning's roughness has been applied.

Table 3-1 Hydraulic Model Landuse Categorisation

Landuse Type	Stage 2 (Updated Model) Manning's 'n' Roughness Coefficient	Stage 1 (Original Model) Manning's 'n' Roughness Coefficient
Roads/Footpaths	0.015	0.015
Waterbodies	0.030	0.030
Low Grass/Grazing*	Ranging from 0.025 at 2 m depth to 0.25 at 0m depth	0.035
Crops	0.040	0.040
Medium Dense Vegetation*	Ranging from 0.075 to 0.15 up to a depth of 1.5m and 0.15 above 1.5m	0.075
Reeds	0.08	0.08
Dense Vegetation*	Ranging from 0.09 to 0.18 up to a depth of 1.5m and 0.18 above 1.5m	0.09
Urban Block (> 2000m^2)	0.300	0.300
Buildings	1.000	1.000
*Depth varying Manning's roughness was applied.		

Footpaths were excluded from the model, as these features were typically finer than the model grid resolution. In some locations where there were sudden changes in roughness across one or a few cells (e.g. narrow roads crossing dense vegetation), roughness was locally modified to resolve associated instabilities.

In highly developed blocks larger than 2000m², the urban block category was used (Manning's 'n' of 0.3). In other areas, an individual buildings layer (building footprint) was used (Manning's 'n' of 1.0).

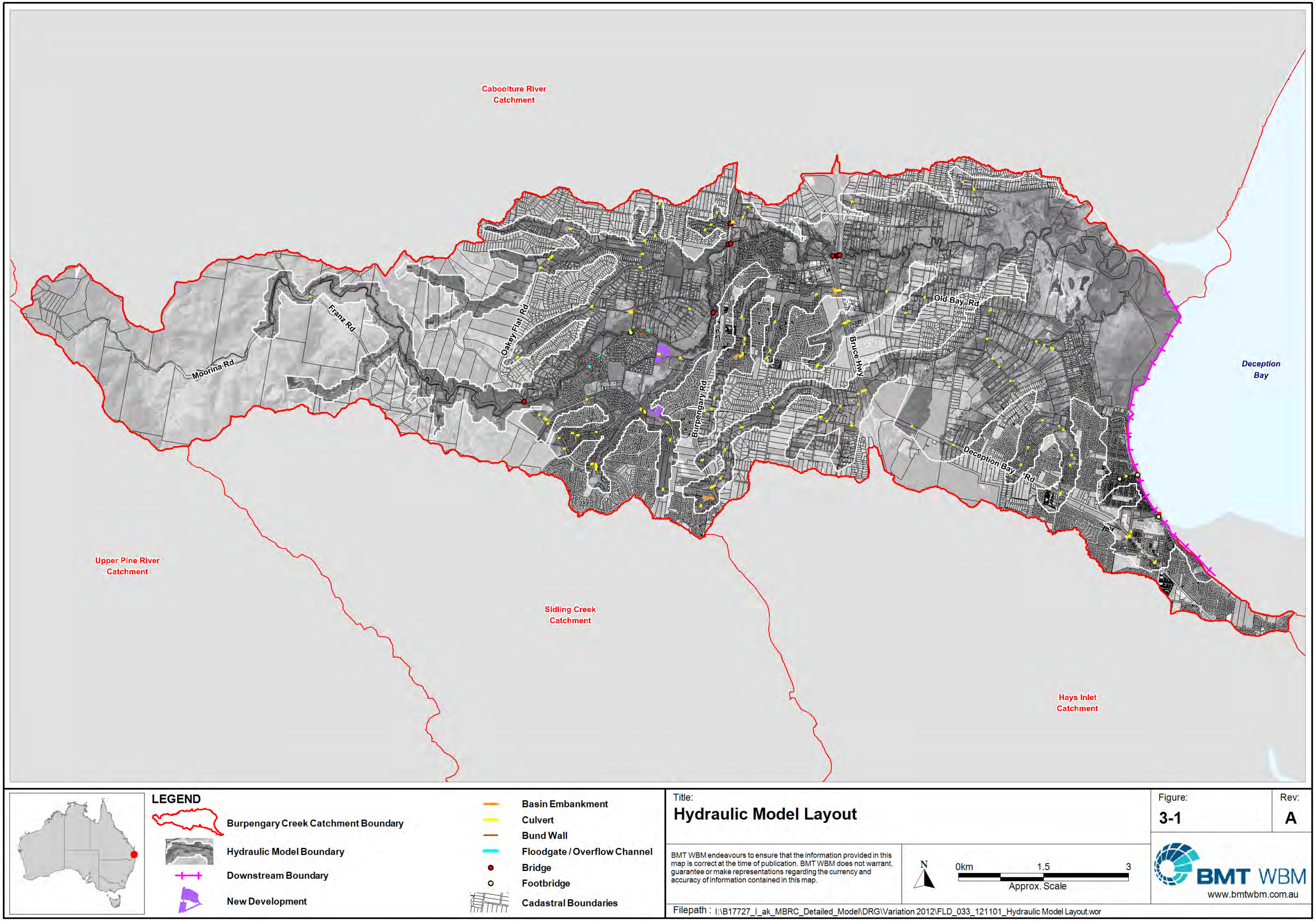
3.3.5 Model Boundaries

The results of the WBNM hydrologic model were used to generate rainfall inflows for the hydraulic model for all design events, as discussed in Section 3.1. The inflows were applied to the 2D domain using a flow-time source boundary for each subcatchment. This technique applies the inflow at the lowest grid cell in a subcatchment initially and then subsequently to all wet cells in that subcatchment.

The downstream boundary conditions, joint probability and climate change scenarios have been selected based on recommendations from the Stage 1 sub-project 2M Report (SKM, 2012a) and in consultation with Council. A static flood level has been applied at the downstream boundary utilising the mean high water spring (MHWS) for all design events (see Table 3-2). Sensitivity tests were undertaken for the downstream boundary (refer to Section 3.6).

Table 3-2 Downstream Boundary Water Level

Description	Level (mAHD)
Mean High Water Spring Tide (MHWS)	0.82



Title:
Hydraulic Model Layout

Figure: 3-1

Rev: A

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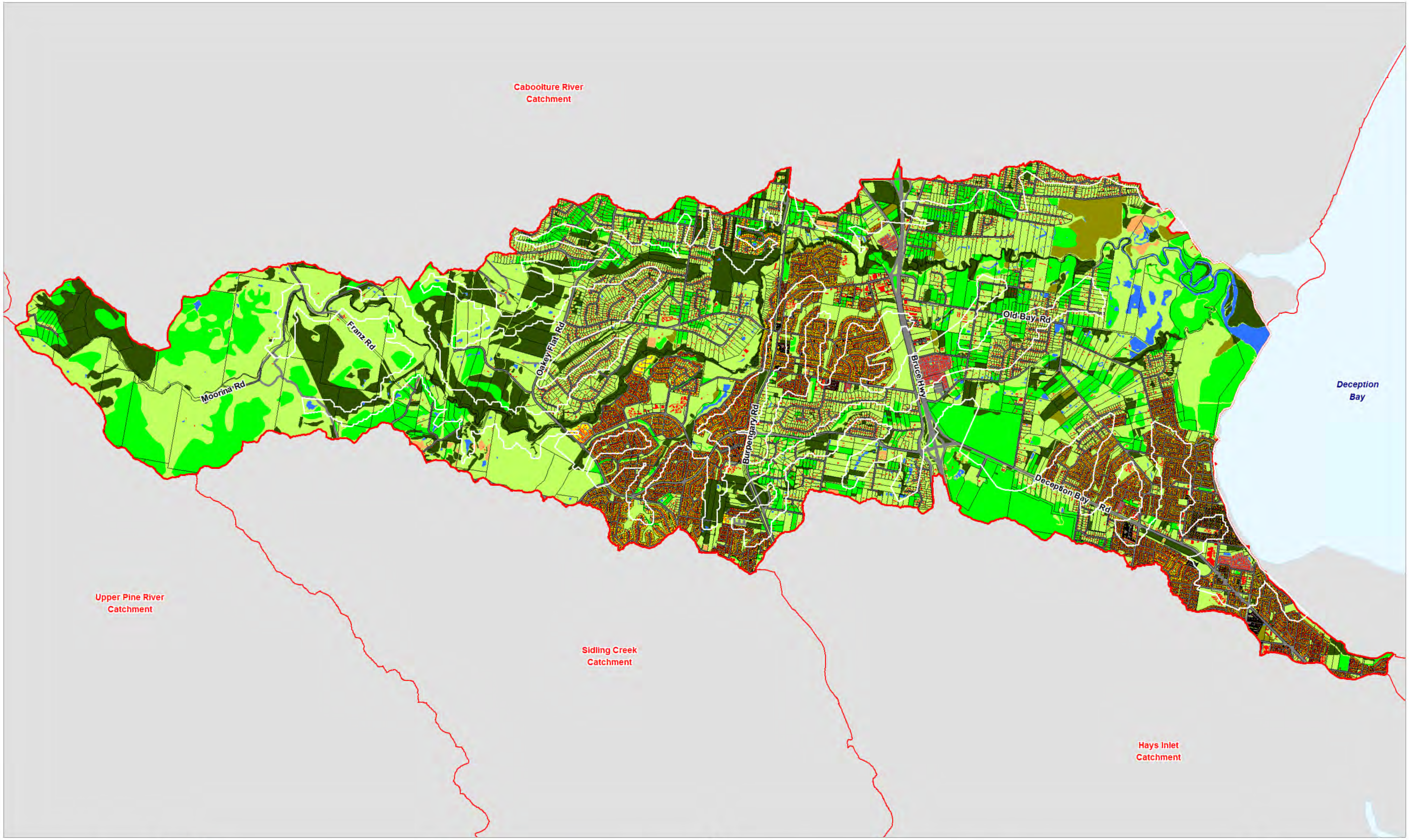

LEGEND

- Burpengary Creek Catchment Boundary
- Hydraulic Model Boundary
- Cadastral Boundaries

Landuse

- Buildings
- Urban Blocks
- Roads/Footpaths
- Waterbodies
- Crops
- Reeds
- Low Grass/Grazing
- Medium Vegetation
- Dense Vegetation

Title:

Landuse Mapping - Existing Conditions

Figure: 3-2

Rev: B

N

0km 1.5 3

Approx. Scale

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3.4 Model Calibration and Verification

Where possible, MBRC have sought to calibrate and verify the models in their LGA to historical flood events. The Burpengary Creek hydraulic model was calibrated and verified against the following three historical events:

- January 2011 (calibration event);
- May 2009 (verification event); and
- February 1999 (verification event).

These events were chosen due to the availability of rainfall and river stream gauge data and the availability of flood marks. Council provided the stream and rainfall gauge information for these historic events. A detailed flood survey was also undertaken by Council for the January 2011 event. For the May 2009 and February 1999 events, flood marks were provided by sub-project 2K (GHD, 2010). The flood marks were used for comparison with the modelled results. Recorded water levels at two river gauges were also provided for the analysis: Rowley Road Gauge and Dale Street Gauge. The Rowley Road gauge was malfunctioning for the January 2011 and February 1999 flood events.

Recorded rainfall data was used in the hydrology model to estimate runoff flows through the catchment. These flows were then routed through the TUFLOW model, with the downstream boundary adjusted to represent the predicted tidal conditions during the historical events. Delaney Road embankment and culverts were excluded from the 1999 and 2009 models; based on discussions with Council, the Delaney Road infrastructure was constructed mid to late 2009.

As part of the previous Burpengary Creek hydraulic modeling report, various calibration scenarios were investigated (BMT WBM, 2010). The original report adopted a dynamic downstream boundary, original Manning's 'n' and continuing loss of 2.5mm/hr, which was also used for the Stage 2 models. Following the calibration and verification in various other catchments as part of Stage 2 RFD, MBRC selected the final hydraulic roughness parameters in light of the calibration results across the whole region. These hydraulic roughness values are listed in Table 3-1.

The detailed model calibration and verification report is provided in Appendix C.

3.5 Design Flood Events

This section describes the design storm conditions that have been used in the hydrodynamic modelling. Design storm events are hypothetical events used to estimate design flood conditions. They are based on a probability of occurrence, usually specified as an Average Recurrence Interval (ARI).

3.5.1 Critical Storm Duration Assessment

An assessment of critical storm durations (storm duration/s that results in the highest peak flood level) was undertaken. The critical durations were selected based on the hydraulic model results, rather than the hydrological model results. This means that the selected critical durations were selected based upon the maximum flood levels rather than flows. Separate assessments were undertaken for three representative flood events;

- 10 year ARI event, to represent smaller events (1, 2, 5, 10 and 20 year ARI events);
- 100 year ARI event, to represent larger events (50 and 100 year ARI events); and
- Probable Maximum Flood (PMF), to represent extreme events (200, 500, 1000 and 2000 year ARI events and the PMF).

To determine the critical storm durations for the Burpengary Creek model, the following methodology was adopted:

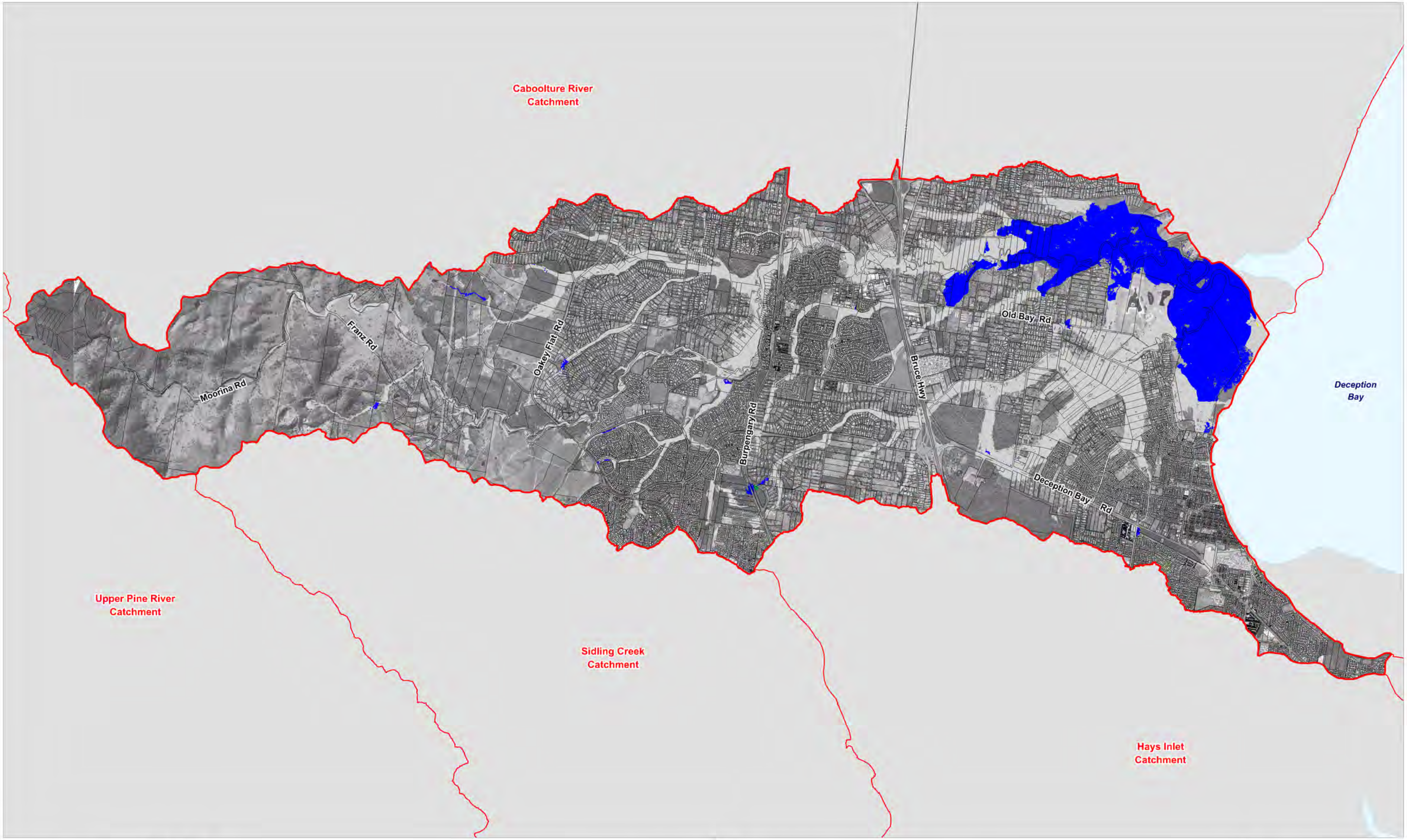
1. Hydrologic and hydraulic modelling of a range of storm durations (30min, 1hr, 3hr, 6hr and 9hr) for the 10 year 100 year ARI events and (30min, 1hr, 3hr, 5hr and 12hr) for the PMF events.
2. Mapping of the peak flood level results for the ‘maximum envelope’ of *all* the storm durations for the three dominant events.
3. Mapping of the peak flood level results for the ‘maximum envelope’ of *selected* storm durations for the three dominant events.
4. Difference comparison between the mapped peak flood levels for *selected* critical durations and the results accounting for *all* storm durations.
5. The critical duration combination resulting in the least difference compared with the mapping of the full envelope of durations was adopted. Selection of the critical durations was based on the storm durations generating the highest flood levels across the most widespread and developed areas.

The difference comparison for the 10 and 100 year ARI and the PMF peak flood levels (as described in step 4 above) is shown in Figure 3-3 to Figure 3-5The figures illustrate that the selected critical durations generally capture the peak flood levels across the site in developed areas. There are some localised and / or undeveloped areas where flood levels are under predicted by about 0.1m by the selected design storms.

Table 3-3 Critical Duration Selection

Assessment Event	Selected Critical Durations	Adopted Event
10 year ARI	1, 3 and 6 hour storm	1, 2, 5, 10 and 20 year ARI
100 year ARI	1, 3 and 6 hour storm	50 and 100 year ARI
Probable Maximum Flood	1, 3 and 5 hour storm	200, 500, 1000, 2000 year ARI and PMF

This process was undertaken in consultation with MBRC, considering local catchment and development issues in the decision-making and selection of the critical durations.



LEGEND

Burpengary Creek Catchment Boundary

Cadastral Boundaries

Peak Flood Level Difference (m)

- < -1.00
- -1.00 to -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.01
- No Change

Title:

Critical Duration Assessment
Peak Flood Level Difference – 10 Year ARI

Figure: 3-3

Rev: A

N

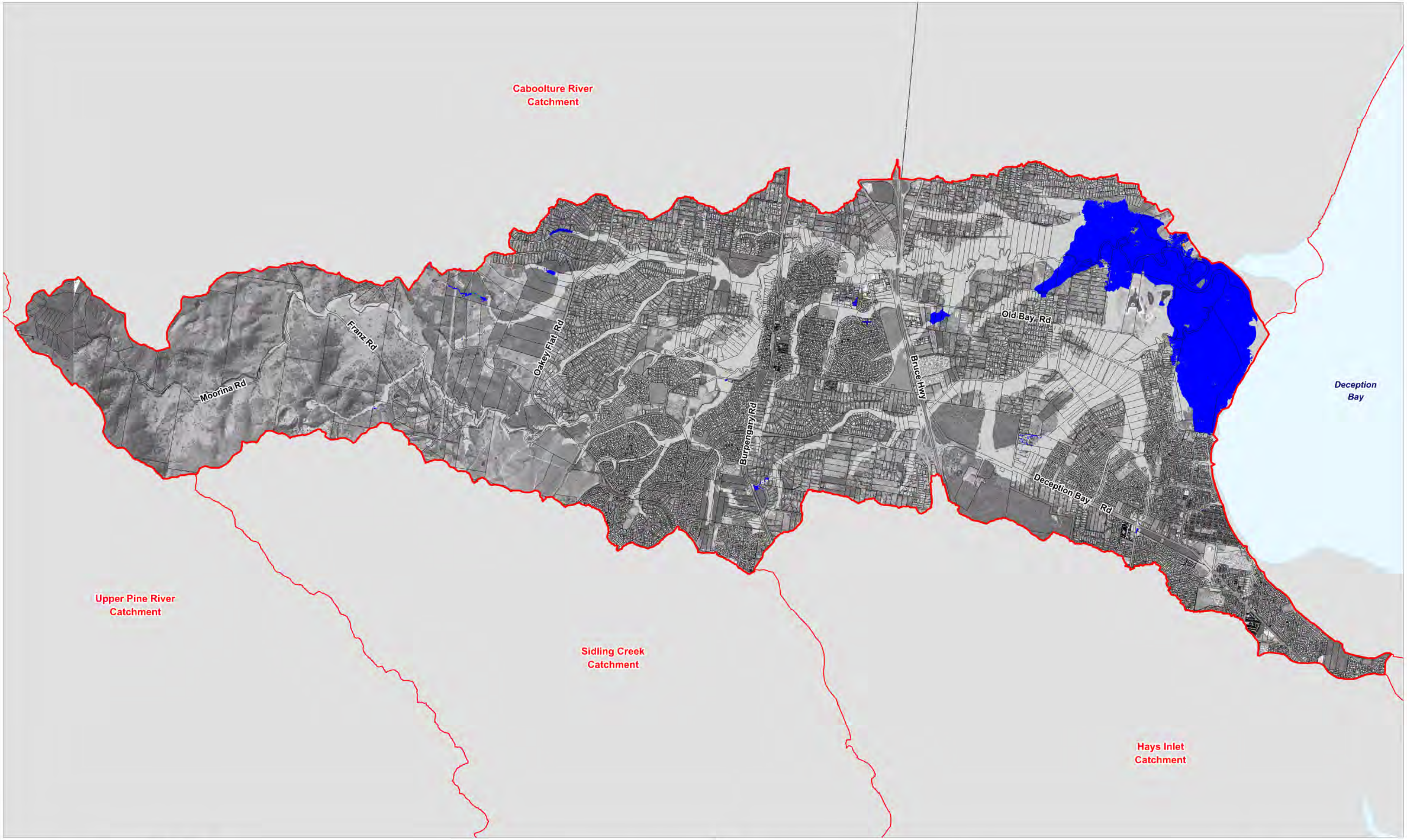
0km 1.5 3

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B17727_I_ak_MBRC_Detailed_Model\DRG\Variation 2012\FLD_030_121101_Critical Duration Assessment 10Y ARI.wor



LEGEND

Burpengary Creek Catchment Boundary

Cadastral Boundaries

Peak Flood Level Difference (m)

- < -1.00
- -1.00 to -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.01
- No Change

Title:

Critical Duration Assessment
Peak Flood Level Difference – 100 Year ARI

Figure: **3-4**

Rev: **A**

N

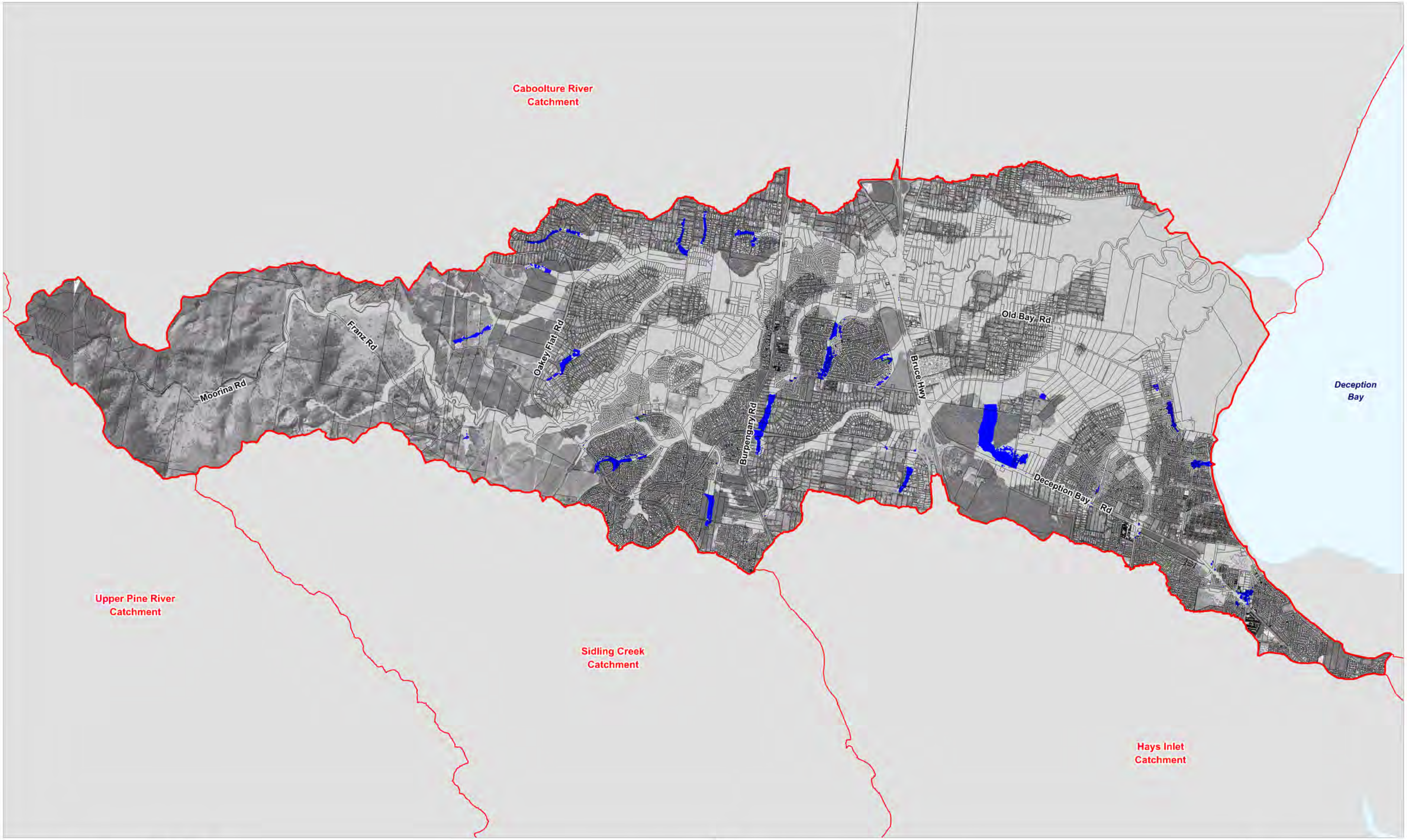
0km 1.5 3

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B17727_I_ak_MBRC_Detailed_Model\DRG\Variation 2012\FLD_031_121101_Critical Duration Assessment 100Y ARI.wor



LEGEND

Burpengary Creek Catchment Boundary

Cadastral Boundaries

Peak Flood Level Difference (m)

- < -1.00
- -1.00 to -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.01
- No Change

Title:

Critical Duration Assessment
Peak Flood Level Difference – PMF

Figure: **3-5**

Rev: **A**

N

0km 1.5 3

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : I:\B17727_I_ak_MBRC_Detailed_Model\DRG\Variation 2012\FLD_032_121101_Critical Duration Assessment PMF.wor

3.5.2 Design Event Simulations

The Burpengary Creek model was simulated for a range of Average Recurrence Intervals (ARI) and storm durations, and a 100 Year Embedded Design Storm (EDS). MBRC requested the use of a single Embedded Design Storm which approximates the flood levels and behaviour of the critical duration design events. The EDS is useful for initial investigations into changes in model parameters and catchment characteristics, as it reduces the number of model runs required.

MBRC advised that the100 year ARI 15 minute in 270 minute Embedded Design Storm was to be adopted. The adopted EDS storm was used as the base design storm for the sensitivity analyses.

In summary, the Burpengary Creek model was simulated for the following design events:

- The 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000 year ARI events and the PMF events for three selected critical storm durations; and
- The 100 year Embedded Design Storm (EDS) for a 15 minute in 270 minute envelope storm.

3.6 Sensitivity Analysis

Twelve sensitivity simulations were undertaken as part of the Stage 2 detailed modelling projects. A summary of sensitivity analysis, the model identifier (ID), title and a description of the twelve sensitivity simulations are detailed in Table 3-4.

Table 3-4 Sensitivity Analysis Summary

ID	Title	Description
S1	Embedded Design Storm (EDS)	100 Year ARI 15 burst in 270min Embedded Design Storm
S2	Increase Roughness	Increase all Manning's 'n' by 20%
S3	Blockage	Model blockage of culverts (moderate blockage)
S4	Climate Change 1	Increase rainfall intensity by 20%
S5	Climate Change 2	Increase downstream boundary to MHWS +0.8m (Sea Level Rise)
S6	Climate Change 3	Increase rainfall intensity and downstream boundary (S4 + S5)
S7	Storm Tide 1	No rainfall, dynamic Storm Tide (100year current) from Storm Tide Hydrograph Calculator (peak at 2.4mAHD)
S8	Storm Tide 2	EDS rainfall with static Storm Tide (100year current) (2.4mAHD)
S9	Storm Tide 3	Increase rainfall intensity (S4) + Increase downstream boundary (S5) + Static Storm Tide Level (100yr Greenhouse Gas +0.8m) (3.5mAHD)
S10	Future Landuse 1	Increase vegetation in floodplains
S11	Future Landuse 2	Increase residential development
S12	Future Landuse 3	Increase vegetation and residential development (S11 +S12)

3.6.1 Future Landuse Analysis

Three future landuse scenarios were assessed using future landuse data provided by MBRC. The future scenarios included changes in vegetation and / or development, but did not include a change in rainfall intensities or sea level rise due to climate change. The 100 year EDS flood event was used.

The hydrologic model utilises a 'fraction impervious' parameter which described the proportion of each subcatchment where water is not able to infiltrate, i.e. there are no rainfall losses on paved surfaces. If the fraction impervious increases, there will be more rainfall runoff and quicker concentration of flows. The fraction impervious in each subcatchment of the WBNM model was updated to reflect the future landuse scenario provided by MBRC.

Landuse is defined in the hydraulic model through the materials layer. This information covers the entire hydraulic model extent and describes landuse and the Manning's 'n' roughness values associated with each type of landuse. The materials layer was updated to reflect the future landuse scenario (change in vegetation density).

The landuse scenarios simulated included:

- **Future Landuse Scenario 1:** Investigated the impact of increased vegetation in the floodplains. This involved changing the 'medium dense vegetation' material class to a 'high dense vegetation' class and changing the 'low grass/grazing' material class to a 'medium dense vegetation' class.
- **Future Landuse Scenario 2:** Investigated the impact of an increase in residential development. The hydrology model was updated with forecast future development (provided by MBRC) to estimate future inflows for the TUFLOW model.
- **Future Landuse Scenario 3:** Investigated the impact of an increase in residential area and increased vegetation in floodplains. This scenario combines future landuse scenarios 1 and 2.

3.6.2 Hydraulic Roughness Analysis

The sensitivity of the model to landuse roughness (Manning's 'n') parameters was undertaken with the 100 year EDS design event. All Manning's 'n' values in the 2D domain were increased by 20%.

3.6.3 Structure Blockage Analysis

A blockage scenario was run to simulate the effects of waterway crossing (culverts) becoming blocked during a flood event. This is a reasonably common occurrence and is the result of debris being washed into the waterways during a flood. Recent storm event showed that blockages are generally caused by debris, or larger items, such as tree stems, wood planks, shopping trolleys or even cars. Blockages reduce the capacity for water to flow through stormwater infrastructure and force water out of the channel, often increasing overland flooding.

A moderate blockage scenario was adopted from the SKM *Floodplain Parameterisation* report (2012b), and includes:

- A full blockage is applied if the culvert diagonal is less than 2.4m; and
- A 15% blockage is applied if the culvert diagonal is greater than 2.4m.

An example of small and large culverts is shown in Image 3-1; full blockage was applied to the culvert in the left image, whereas 15% blockage was applied at the image on the right.

Image 3- 1 Photos of Small and Large Culverts with Blockage Applied

3.6.4 Climate Change and Downstream Boundary Condition Analysis

A climate change and storm tide assessment investigated the possible impact of a storm tide and projected increases in sea level rise and rainfall intensity on flooding in the catchment. In total 6 scenarios were assessed:

- **Climate Change Scenario 1:** Investigated the impact of an increase in rainfall intensity of 20% (as per SKM (2012a) *Boundary Conditions, Joint Probability and Climate Change* Report).
- **Climate Change Scenario 2:** Investigated the impact of an increased downstream boundary of 0.8m due to predicted sea level rise (downstream boundary level of 1.62mAHD).
- **Climate Change Scenario 3:** Investigated the impact of an increase in rainfall intensity and an increased downstream boundary. This scenario combines climate change scenarios 1 and 2.
- **Storm Tide Scenario 1:** Modelled a dynamic storm tide. No rainfall is applied and a dynamic storm tide (100 year current) boundary was applied (from the *Storm Tide Hydrograph Calculator* spreadsheet, developed by Cardno Lawson Treloar (2010). The MBC-014 reference point was used).
- **Storm Tide Scenario 2:** Investigated the impact of a 100 year static storm tide level (2.4mAHD) with concurrent 100 year EDS rainfall event.
- S**torm Tide Scenario 3:** Investigated the impact of an increase in rainfall and an increase in sea level rise. An increase in rainfall of 20% was applied combined with a static storm tide level (100 year Greenhouse Gas scenario) + 0.8m, resulting in a final static storm tide level of 3.5mAHD.

4 RESULTS AND OUTCOMES

4.1 Calibration and Verification

Model calibration and verification was undertaken for the following three events:

1. The January 2011 flood event;
2. The May 2009 flood event; and
3. The February 1999.

Reasonable model calibration was achieved considering the timing and peak flood levels for all three events. Whilst the Stage 2 Pilot model was under predicting flood levels across the catchment, the change in Manning's 'n' values adopted in Stage 2 of the RFD resulted in increased flood levels across the catchment. The Stage 2 model results for the January 2011 event are over predicting; whilst the Stage 2 model results for the May 2009 and February 1999 events are quite similar to recorded levels.

The detailed calibration report comparing the Stage1 and Stage 2 model calibration results is provided in Appendix C.

4.2 Design Flood Behaviour

4.2.1 Model Results

The following data were output by the model at 20 minutes intervals as well as the peak values recorded during each simulation:

- Flood Levels (H flag);
- Flood Depth (D flag);
- Flood Velocity (V flag);
- Depth Velocity Product (Z0 flag);
- Flood Hazard based on NSW Floodplain Development Manual (DIPNR, 2005) (Z1 flag);
- Stream Power (SP flag); and
- Inundation times (no flag required).

The maximum velocity was used in combination with a 'Maximum Velocity Cutoff Depth' of 0.1m. Consequently, the model result files plot the maximum velocity for depths greater than 0.1m; for depths of less than 0.1m the velocity at the peak level is recorded in TUFLOW's output file. This approach is recommended so as to exclude any high velocities that can occur as an artefact of the modelling during the wetting and drying process.

TUFLOW can provide output relevant to the timing of inundation. In particular:

- The time that a cell first experiences a depth greater than the depth(s) specified; and
- The duration of time that a cell is inundated above the depth(s) specified.

'Time Output Cutoff Depths' of 0.1m, 0.3m and 1m were selected. This selection provides further flood information in the catchment; e.g.

- Establishing when areas are inundated with shallow depths of 0.1m;
- Considering pedestrian and vehicle safety (flood depth between 0.1 and 0.3m); and
- The duration and/or time of inundation for significant flood depths of 1m and more throughout the catchment.

This information can assist in emergency planning by highlighting which areas of the catchment are inundated early in the flood event and also highlighting which regions may be isolated for long durations.

The model results were used to prepare a set of design flood maps, including inundation maps, peak flow velocity maps, hazard maps and stream power maps for the 100 year ARI flood event. The flood conditions on these maps were derived using the envelope (maximum) of all storm durations used in the critical duration analysis.

The flood maps of the 100 year ARI design storm event are presented in Appendix E.

4.2.2 Digital Data Provision

The Regional Floodplain Database is focused on structuring model input and output data in a *GIS database* held by MBRC. Therefore, all model input and output data are being provided at the completion of the study. The data includes all model files for the calibration and verification, all design events (for each duration), future scenarios, sensitivity analysis and climate change assessment.

In addition, post processing batch files have been provided. The batch files were used to:

Envelope (derive the maximum of) the critical duration runs and combine these into one file; and

Convert the envelope file into ESRI readable ascii grids (*.asc).

4.3 Sensitivity Analysis

The 100 year Embedded Design Storm (100 year ARI 15 minute in 270 minute) was used as a base case for the sensitivity analysis (S1). A comparison of the EDS event with the 100 year design flood event with selected critical durations (1, 3 and 6 hour) is shown in Figure C-1. The results indicate that peak flood levels for the EDS is generally within 0.07m compared to the envelope of selected critical durations; and only localised areas show an increase or reduction in flood extent. On this basis the 100 Year EDS was considered appropriate for the sensitivity analysis.

The results of the sensitivity analysis (Sections 4.3.1 to 4.3.1) are mapped in Appendix F.

4.3.1 Future Landuse Analysis

The Burpengary Creek catchment is generally sensitive to changes in vegetation with increases in peak flood levels of about 0.1 to 0.2m, in particular the narrow channel upstream of Oakley Flat Road, but also the centre part of the catchment between Delaney Road and O'Brien Road and the Ferny Gully area, located between O'Brien Road and Bruce Highway.

It is interesting that the increase in vegetation (Scenario 10) results in a reduction in flood levels by 0.1-0.15m in the area between Oakey Flat Road, Facer Road and Hideaway Close due to attenuation of flows in the upper catchment (upstream of Oakey Flat Road). This effect has also been assessed and presented for the Caboolture River catchment in a paper titled "*Back To Nature – Can Revegetation Of Riparian Zones Benefit Flood Risk Management"* (Sharpe, 2012).

Based on the model results, the difference in peak flood levels for the increased residential development (S11) compared to the Base Case is generally within 0.1m. There are some localised areas where the peak flood levels for the future scenario show increases ranging from approximately 0.1 to 0.3m; some of these areas have an associated increase in flood extent:

- Along Young Road;
- Upstream of Forest Ridge Drive;
- Between Oakey Flat Road and Pioneer Drive;
- Upstream of New Settlement Road; and
- In the vicinity of Pitt Road.

4.3.2 Hydraulic Roughness Analysis

A sensitivity scenario (S2) has been simulated, assessing an increase in Manning's 'n' roughness coefficients by 20% across the entire catchment.

Model results indicate that an increase in the roughness coefficients affect the Burpengary Creek upstream of Rowley Road with an increase in flood levels by 0.1-0.4m. This increase in flood levels result in an additional outbreak of Burpengary Creek and an increase in the flood extent in the vicinity of the Matthew Crescent / Rowley Road intersection. For the remaining part of the catchment, flood levels are generally within 0.1m.

4.3.3 Structure Blockage Analysis

As expected, the culvert blockage analysis has shown that culvert blockages cause an increase in peak flood levels upstream of the blocked structures, and in some areas a decrease in flood levels downstream of the structure.

Away from the blocked structures, model results indicate that the difference in peak flood levels for the blockage scenario compared to the Base Case is generally within 0.06m. Some localised areas upstream of the Bruce Highway, Hauton Road and Oakey Flat Road show an increase in flood levels of 0.1-0.4m. The largest increases in flood levels (more than 0.5m) and extent are in the following areas:

- Upstream of the Bruce Highway (and north of Pitt Road),
- Along Young Road and Forest Ridge Drive in Narangba;
- Upstream of Omara Road; and
- Between New Settlement Road and Pioneer Drive.

Reductions in peak flood levels (of about 0.1–0.3m) occur:

- Between Forest Ridge Drive and Young Road; and between Young Road and Delaney Road,
- In the vicinity of Callaghan Road, Narangba; and
- In the vicinity of Creek Road and Margaret Street, Burpengary.

4.3.4 Climate Change and Downstream Boundary Conditions Analysis

The dynamic storm tide and climate change scenarios assessed various combinations of an increase in rainfall intensity by 20% and various sea levels (static and dynamic) as described in Section 3.6.4. As expected, the highest flood levels across the catchment result from the scenarios including an increase in rainfall intensity (scenarios 4, 6 and 9). These scenarios also result in an increase in the flood extent between Rowley Road and River Oak Way and along Facer Road.

The increased downstream boundary and static storm tide scenarios (100 year current) without and increased rainfall intensity, scenarios 5 and 8, increases peak flood levels only at the most downstream part of the catchment, which is predominantly undeveloped.

The highest levels across the catchment are obtained from Scenario 9, which includes an increased rainfall, sea level rise and the Static Storm Tide Greenhouse Gas tailwater conditions. For this scenario peak flood levels increase by 0.5-2.0m between the downstream boundary and approximately Moore Road. Model results from this scenario predict a significant increase in flood extent along Uhlmann Road, and in developed areas of Deception Bay.

Scenario 7 applied the dynamic 100 year storm tide hydrograph at the downstream boundary and does not include riverine flooding (model inflows). For this scenario, peak flood levels were mapped (Figure C-7) rather than the difference of peak flood levels and extents. This scenario results in higher flood levels and extent in the undeveloped area near the downstream boundary.

It can be concluded that the catchment is sensitive to climate change and high tidal surges.

4.4 Model Limitations and Quality

Watercourses within the Burpengary Creek catchment were represented in the 2D domain, for which the grid resolution is limited to 5m. This may not allow adequate representation of the channel conveyance, particularly for smaller, more frequent flood events. In some instances this limitation may lead to the model over or underestimating conveyance in the watercourses. The extent of this over or underestimation will vary according to local topographic factors.

The model was reviewed internally and the model quality report is provided in Appendix D.

5 CONCLUSION

The Burpengary Creek hydraulic model was updated with new development, flood mitigation works and Stage 2 adopted landuse roughness values. The sensitivity scenarios (assessing various climate change, storm tide and future landuse scenarios) undertaken as part of this report are consistent with the sensitivity scenarios undertaken for all other catchments in the LGA.

The new landuse roughness values and relevant development were also applied to the three historic events. Council sought to adopt a standard set of roughness values across all catchments within the RFD. The model results for the historic events show that the flood mark histogram and the comparison of the hydrographs have significantly changed. When considering all three events it can be concluded that reasonable calibration was achieved.

The model was set up in a manner prescribed by MBRC specifically for the RFD project to ensure a consistent approach across the whole LGA and to enable the model and model outputs to be integrated into MBRC's Regional Floodplain Database. Flood maps for the 100 year ARI events have been provided with this report, together with delivery of the model and its outputs for all events in digital format. The outcomes of this work will be used in Stage 3 of the RFD to analyse and develop a plan to manage flood risk in the Burpengary Creek catchment.

6 REFERENCES

Aurecon (2010): *Floodplain Structures Regional Floodplain Database Moreton Bay Regional Council*

BMT WBM, 2010: H*ydraulic Modelling (Broadscale) Regional Floodplain Database Stage 1 Sub-project 1D*

Cardno Lawson Treloar (2010): *Moreton Bay Regional Council – Storm Tide Hydrograph Calculator*

Department of Infrastructure, Planning and Natural Resources - New South Wales (DIPNR), 2005: *Floodplain Development Manual the management of food liable land*

GHD (2010): *Moreton Bay Regional Council Regional Floodplain Database Sub-project 2K Historic Flood Information*

Sharpe (2012): *Back To Nature – Can Revegetation Of Riparian Zones Benefit Flood Risk Management?* Prepared for the Floodplain Risk Management Conference 2012

SKM (2010): *MBRC Regional Floodplain Database Existing, Historic and Future Floodplain Land Use*

SKM (2012a): *MBRC Regional Floodplain Database Boundary Conditions, Joint Probability & Climate Change*

SKM (2012b): *MBRC Regional Floodplain Database Floodplain Parameterisation*

The Institution of Engineers Australia (2001): *Australian Rainfall and Runoff*

WorleyParsons (2010a): *Regional Floodplain Database Floodplain Terrain*

WorleyParsons (2012): *Design Rainfall - Burpengary Pilot Project*

APPENDIX A

APPENDIX A:

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APPENDIX B

APPENDIX B:

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APPENDIX C

APPENDIX C

APPENDIX C: MODEL CALIBRATION REPORT

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Contract Ref: RFD Project Sub-Project 2B Detailed Modelling
Our Ref: AK: L.B17727.004.doc

26 September 2012

Steve Roso
Moreton Bay Regional Council
220 Gympie Road
Strathpine
QLD 4500

Attention: Steve Roso

Dear Steve

RE: Model Calibration Report for the Updated Burpengary Creek Model (Stage 2)

1 Introduction

As part of Stage 1 of the Regional Floodplain Database (RFD), Moreton Bay Regional Council (Council) commissioned BMT WBM to develop a detailed model of the Burpengary Creek catchment, including the combined hydrologic and hydraulic model calibration to the historic flood events in February 1999 and May 2009. In January 2011, the Burpengary Creek catchment experienced a major flood event and Council utilised this opportunity to commission BMT WBM to calibrate the Burpengary model against this event as well (refer to previous report L.B.17727.003.pdf).

During Stage 2 of the RFD, models were developed for the remaining minor basins in Council's Local Government area (LGA). Council compared the model performance for each of the minor basins against historical flood events and adopted a single set of Manning's 'n' values for the entire LGA. These Manning's 'n' values differed from those adopted for the Stage 1 Burpengary model. Thus, Council engaged us to update the Stage 1 Burpengary Creek model with the Manning's 'n' values adopted in Stage 2, as well as to include some small flood mitigation works that were recently implemented in response to the January 2011 flood.

As part of this update, the calibration events were simulated with the adopted Stage 2 roughness values. Since the historical flood events occurred before the implementation of recent mitigation works, the recent mitigation works were excluded from the calibration models.

This report outlines the results of the updated calibration analysis for the following three historic events:

- January 2011 (largest event);
- May 2009; and
- February 1999.

2 Change in Roughness

The Stage 2 adopted roughness values included a depth varying roughness approach for three of the vegetation landuse types (dense vegetation, medium dense vegetation and low grass/grazing), whereby the Manning's roughness values applied in the model are dependent on the depth of water flowing over the ground surface. Table 2-1 outlines the roughness values adopted for Stage 2 (this report) and Stage 1 (original Model).

Table 2-1: Hydraulic Model Landuse Categorisation

Landuse Type	Stage 2 (Updated Model) Manning's 'n' Roughness Coefficient	Stage 1 (Original Model) Manning's 'n' Roughness Coefficient
Roads/Footpaths	0.015	0.015
Waterbodies	0.030	0.030
Low Grass/Grazing*	Ranging from 0.025 at 2 m depth to 0.25 at 0m depth	0.035
Crops	0.040	0.040
Medium dense vegetation*	Ranging from 0.075 to 0.15 up to a depth of 1.5m and 0.15 above 1.5m	0.075
Reeds	0.08	0.08
Dense vegetation*	Ranging from 0.09 to 0.18 up to a depth of 1.5m and 0.18 above 1.5m	0.09
Urban Block (> 2000m^2)	0.300	0.300
Buildings	1.000	1.000
*Depth varying Manning's roughness was applied.		

3 Data

3.1 Rainfall

There are nine rainfall gauges located in and around the Burpengary Creek catchment, however the Rowley Road gauge (rainfall and river gauge) was malfunctioning during the event. Therefore, eight rainfall gauges were utilised in the hydrologic model. The rainfall information for the May 2009 and February 1999 events were provided by Sub-project 2K Historic Flood Information (GHD, 2010), and Council provided the rainfall information for the January 2011 flood event for these gauges.

The location of these rainfall gauges together with the location of surveyed flood marks, the flood mark reliability and the modelled flood extent for the January 2011 event is shown in Figure 1. The cumulative rainfall depth for the eight gauges surrounding the Burpengary Creek catchment is shown in Figure 2.

3.2 Flood Marks

Council collected 68 flood marks in the Burpengary Creek catchment for the January 2011 event. For the May 2009, 57 flood marks were available from Council, however three marks recorded road flooding rather than peak flood levels, thus resulting in 54 flood marks. 15 flood marks were available the February 1999 event.

3.3 River Gauges

There are two gauges in the Burpengary Creek catchment: Rowley Road gauge and Dale Street Gauge. In the January 2011 and the February 1999 events, the Rowley Road gauge was malfunctioning for the entire event or during the peak of the event, therefore only the Dale Street gauge could be used for the comparison of modelled and recorded flood levels. In the May 2009 event, both gauges were used for a hydrograph comparison.

The gauge information for the May 2009 and February 1999 events were provided by Council and Sub-project 2K Historic Flood Information (GHD, 2010).

3.4 Inflow / WBNM Model

The TUFLOW models used inflows derived from the WBNM models that were adopted in the Stage 1 report. The adopted WBNM models include a continuing loss of 2.5mm/hour and an initial loss of 0mm.

4 Model Results

4.1 Flood Mark Comparison

The peak flood level model results were compared to the recorded flood mark levels. Figure 3 shows the flood extent form the January 2011 event and the difference in flood levels between the modelled and the recorded levels in millimetre. The results were also analysed using histograms. The histograms illustrate the frequency and variance of the differences between the surveyed and modelled peak flood levels. The histograms for the original model (stage 1) and the updated model (Stage 2) for the three historic events are provided in Figures 4 to 6, respectively.

The following key points can be drawn from the flood mark comparison:

- The Stage 1 histogram shows that the model was under predicting for all three historic events; and
- Flood levels increased with the adopted Stage 2 roughness values, thus the Stage 2 histograms for all three historic events show a shift such that the model is either generally similar to the flood marks or slightly over estimating.

The histogram results are based on the modelled peak flood levels inspected at the flood marks were possible. Where the flood mark was located outside the flood extent a 5m buffer around the flood mark was utilised to inspect the modelled peak flood level. However, not all flood marks provided were within the modelled flood extent, as follows:

- January 2011: 68 flood marks provided 67 utilised in the histogram;
- May 2009 : 54 flood marks provided 48 utilised in the histogram; and
- February 1999: 15 flood marks provided 13 utilised in the histogram*

*For the February 1999 event, two flood marks were within the flood extent, but with a large difference between the recorded and modelled flood levels. These two flood marks were located near steep flood gradient and thus excluded from the analysis for Stage 1 and Stage 2 results.

4.2 Hydrograph Comparison

The recorded hydrograph at the Dale Street gauge and at the Rowley Road gauge (for the May 2009 event only) were compared against the modelled hydrographs. The hydrographs for the three historic events are presented in Figure 7 to Figure 10.

The comparison of modelled and recorded hydrographs indicates the following:

- The shape of the hydrographs between the modelled and the recorded data is similar;
- The peak flood levels occur about the same time for the modelled and the recorded hydrographs, which validates the timing; a very important calibration parameter;

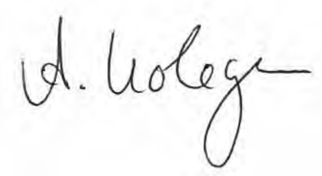
- For the January 2011 event, the modelled (Stage 2) peak flood level at Dale Street gauge is about 300mm higher than the recorded data (and Stage 1 peak flood levels were about 50mm higher than the recorded level);
- For the May 2009 event, the Stage 2 modelled peak flood level at Dale Street is about 350mm higher than the recorded peak flood level (whereas the Stage 1 results were about 150mm lower than the recorded levels);
- At Rowley Road gauge (May 2009 event) the Stage 2 modelled peak flood level is about 400mm below the recorded flood levels (whereas the Stage 1 flood level was about 1.2m below the recorded level); and
- In the February 1999 event, the Stage 2 modelled peak flood level is about 40mm below the recorded flood levels (whereas the Stage 1 flood level was about 300mm below the recorded level).

5 Conclusion

Reasonable model calibration was achieved considering the timing and peak flood levels for all three events. Whilst the Stage 1 model was under predicting flood levels across the catchment, the change in Manning's 'n' values adopted in Stage 2 of the RFD resulted in increased flood levels across the catchment. Therefore, the Stage 2 model results for the January 2011 event are over predicting, whilst the Stage 2 model results for the May 2009 and February 1999 events are quite similar to recorded levels.

Yours faithfully

BMT WBM Pty Ltd



Anne Kolega

Senior Flood Engineer

Enclosed:

Figure 1: Flood Marks, Gauge Locations and Total Rainfall Depth (4 Days) January 2011 Flood Event

Figure 2: Cumulative Rainfall (mm) – January 2011

Figure 3: Flood Level Comparison (Measured versus Modelled) January 2011 Event

Figure 4: Histogram of Flood Level Difference - January 2011 Event

Figure 5: Histogram of Flood Level Difference - May 2009 Event

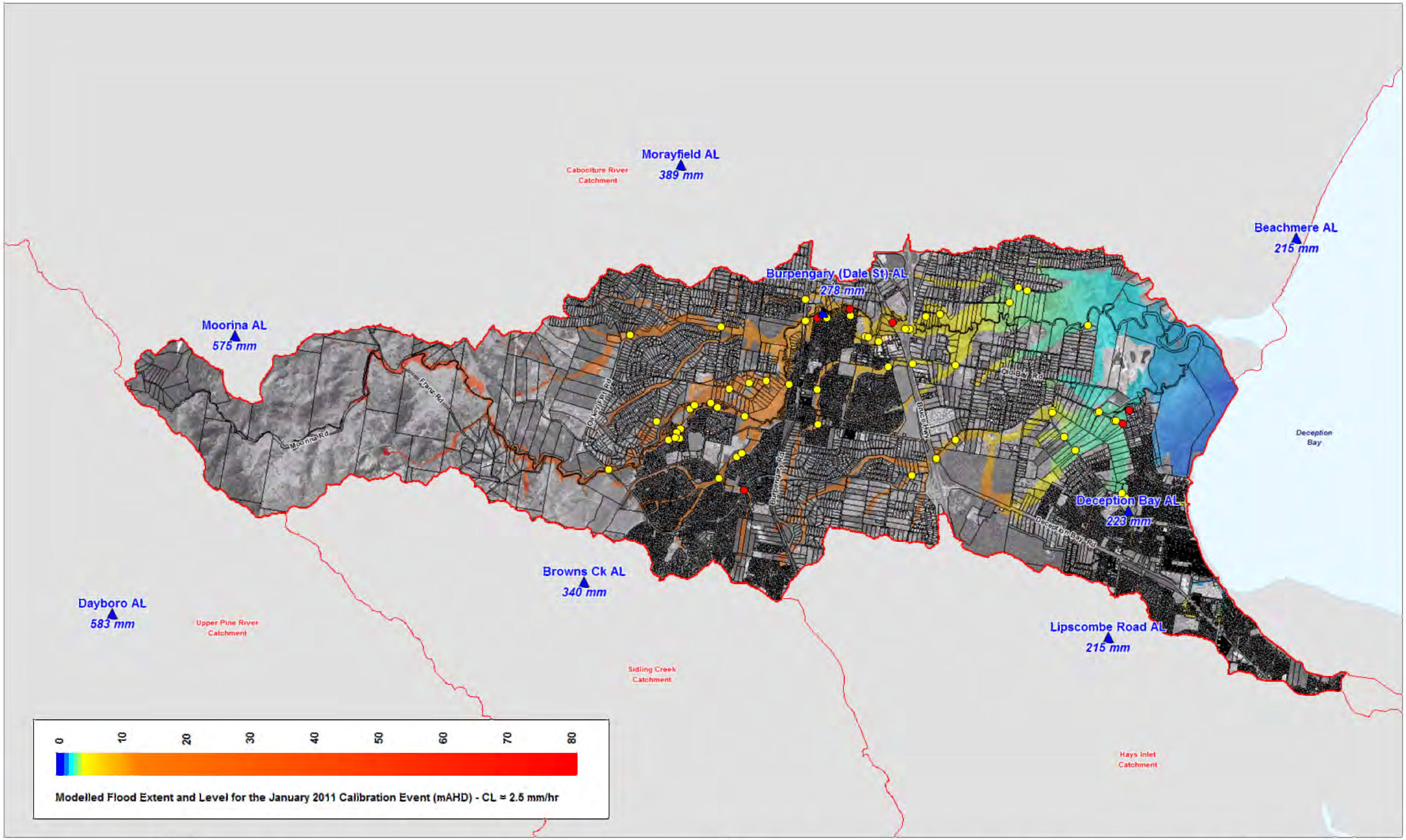
Figure 6: Histogram of Flood Level Difference – February 1999

Figure 7: Recorded and Modelled Hydrographs at Dale Street Gauge - January 2011 Event

Figure 8: Recorded and Modelled Hydrographs at Dale Street Gauge - May 2009 Event

Figure 9: Recorded and Modelled Hydrographs at Rowley Road Gauge - May 2009 Event

Figure 10: Recorded and Modelled Hydrographs at Dale Street Gauge – February 1999 Event



LEGEND

Burpengary Creek Catchment Boundary

Cadastral Boundaries

Rainfall Gauge - Station Name and Total Rainfall (4 Day Totals)

Flood Mark Reliability

High

Medium

Title:

Flood Marks, Gauges Locations and Total Rainfall (4 Days) January 2011 Flood Event

Figure: 1

Rev: C

N

0km 1.5 3

Approx. Scale

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Filepath : I:\B17727_I_ak_MBRC_Detailed_Model\DRG\Calibration_Jan11\FLD_001_120925_Jan2011_Gauges.wor

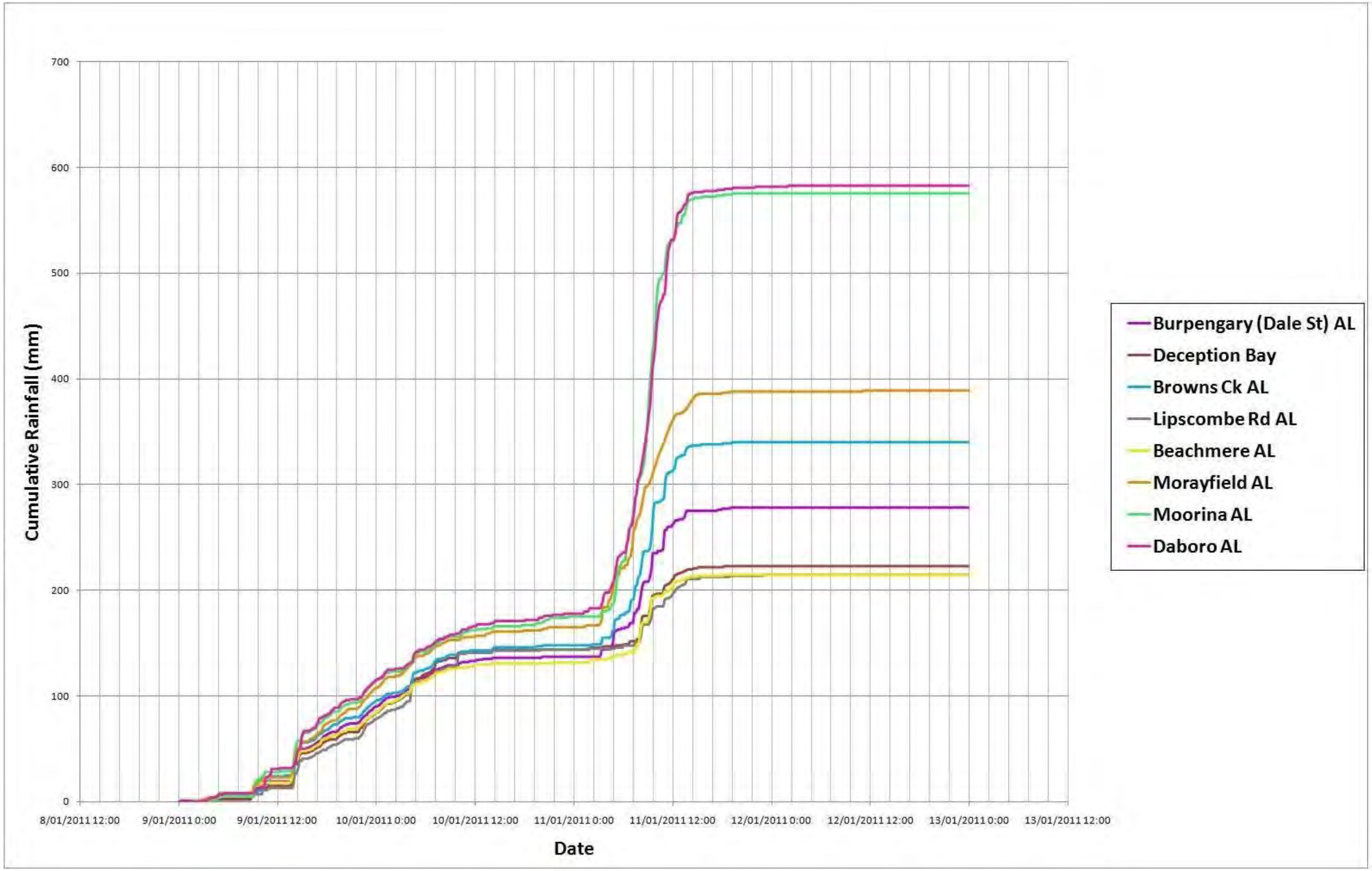
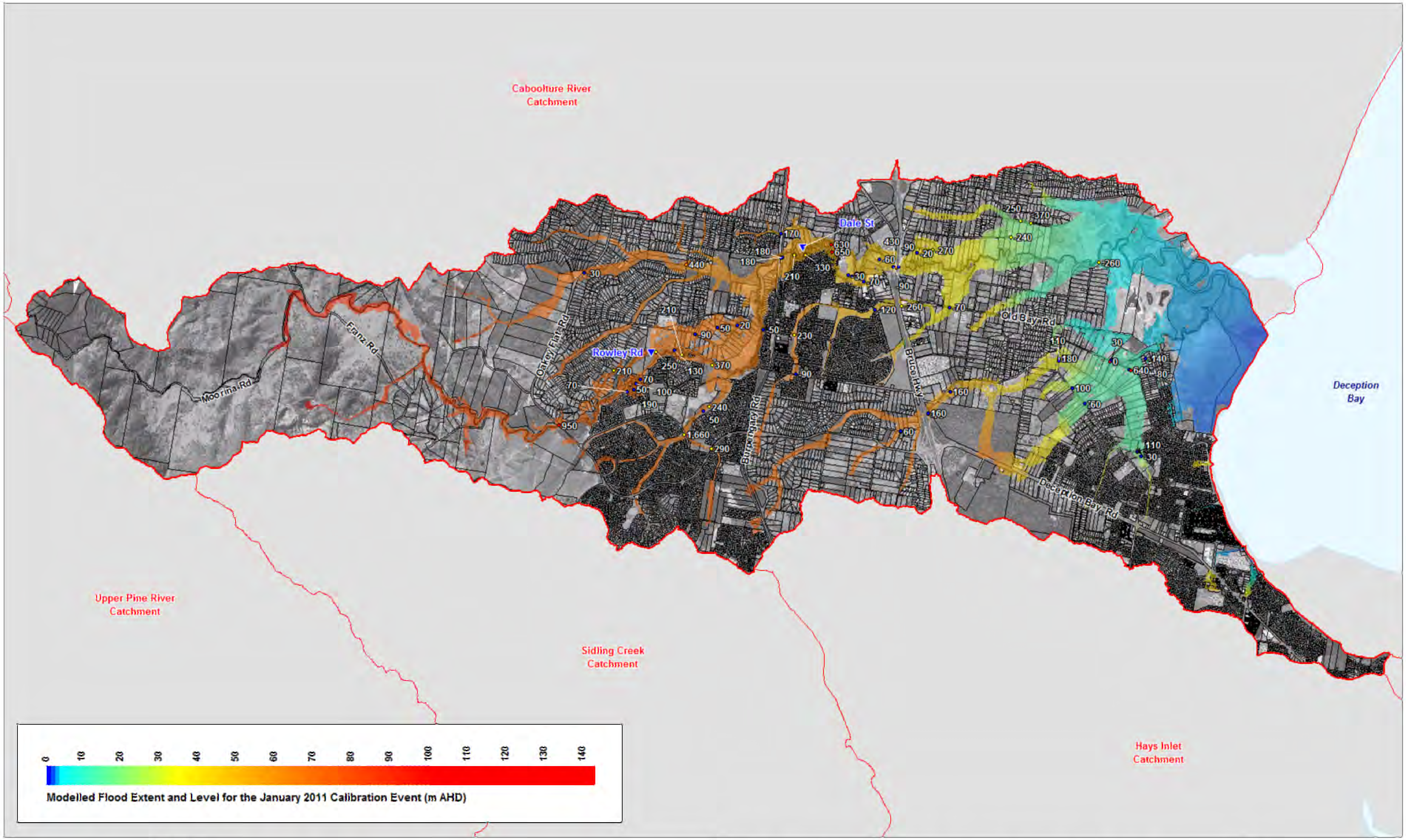


Figure 2
Cumulative Rainfall (mm) - January 2011



LEGEND

Burpengary Creek Catchment Boundary

River Stream Gauge

Cadastral Boundaries

Flood Marks
(difference between recorded and modelled level)
- model below recorded level
+ model above recorded level

- -200 to +200mm
- -400 to -200 and 200 to 400mm
- -500 to -400 and 400 to 500mm
- <-500 and > 500mm

Title:

Flood Level Comparison (Measured versus Modelled) January 2011 Event

Figure: **3**

Rev: **B**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0km 1.5 3

Approx. Scale

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Filepath : I:\B17727_I_ak_MBRC_Detailed_Model\DRG\FLD_012_120925_Jan2011_FloodMarks.wor

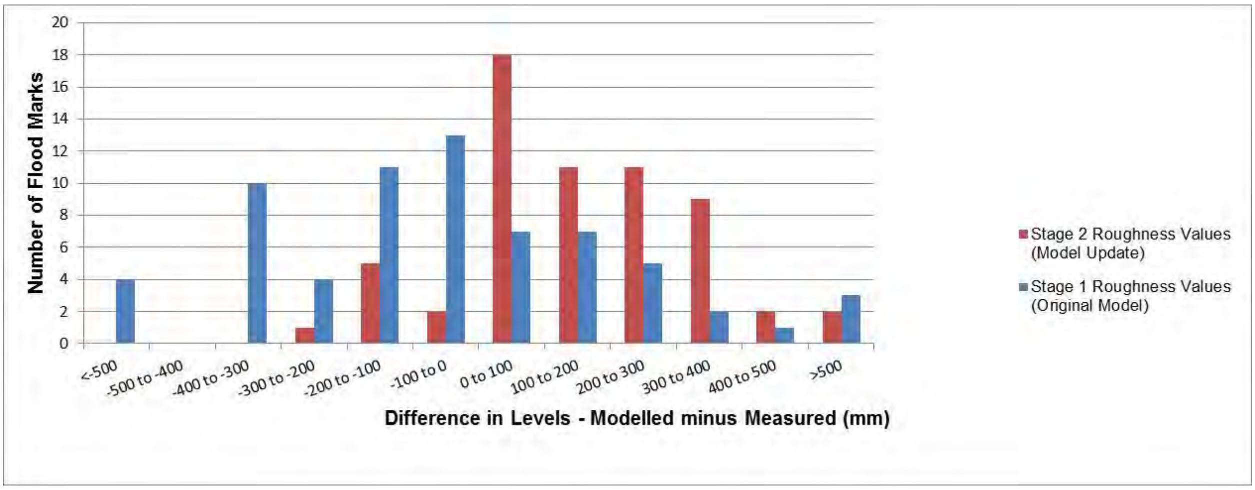

Figure 4: Histogram of Flood Level Difference - January 2011 Event

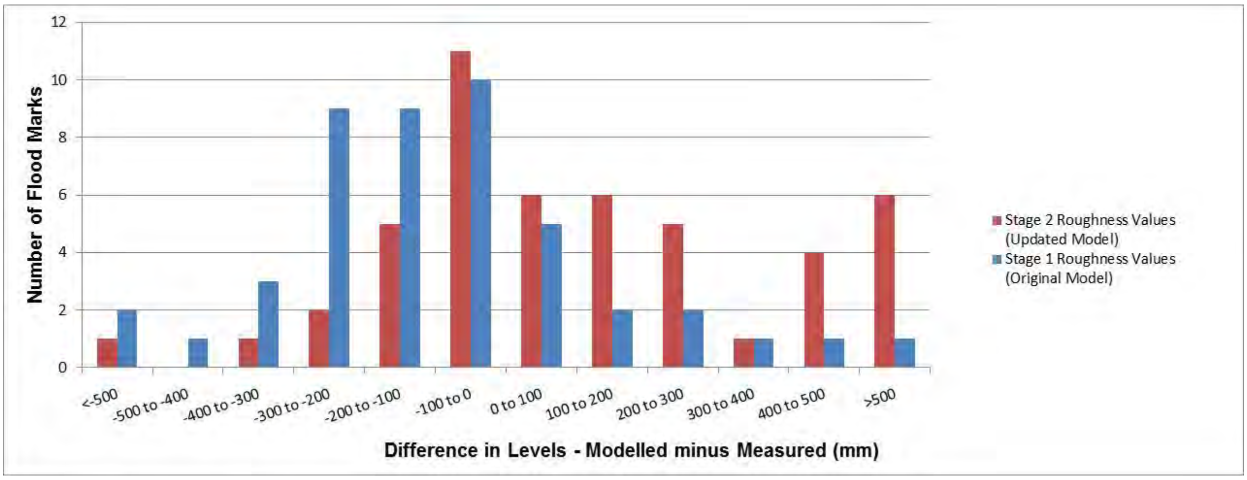

Figure 5: Histogram of Flood Level Difference - May 2009 Event

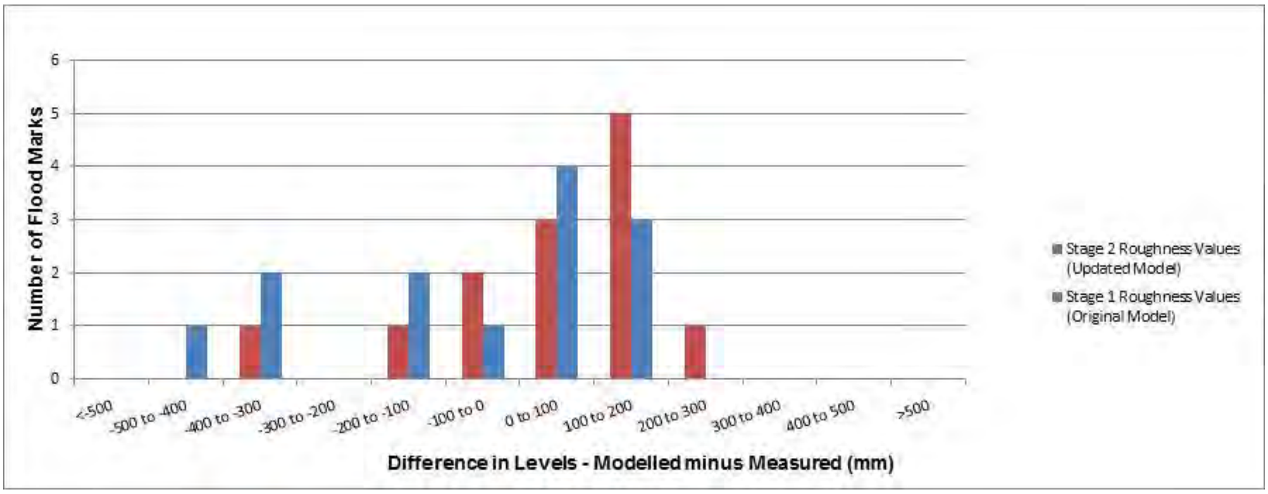

Figure 6: Histogram of Flood Level Difference - February 1999 Event

Note: A negative difference indicates that the model under predicts flood levels, and a positive difference indicates that the model over predicts flood levels.

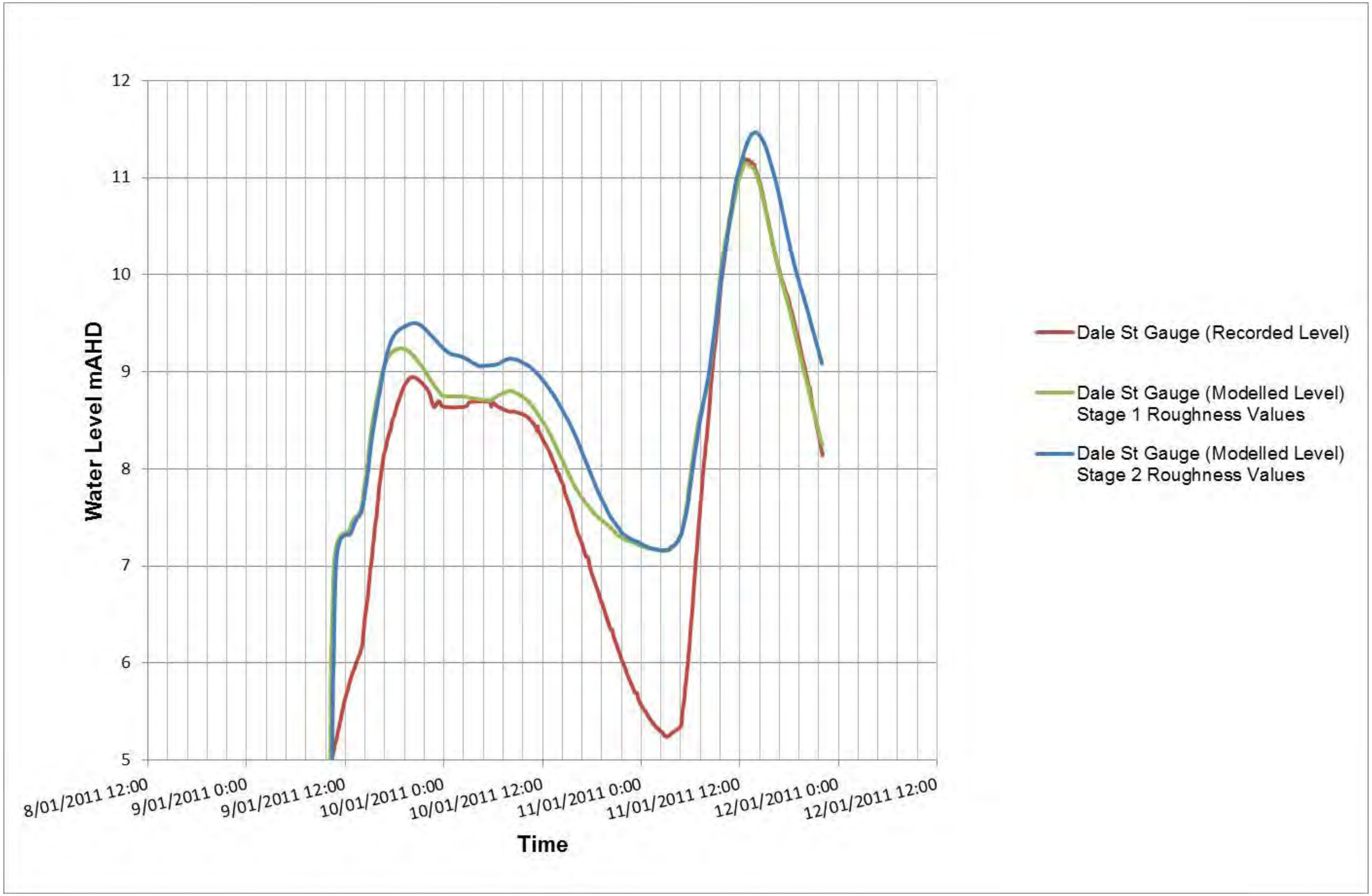

Figure 7: Recorded and Modelled Hydrographs at Dale Street Gauge - January 2011 Event

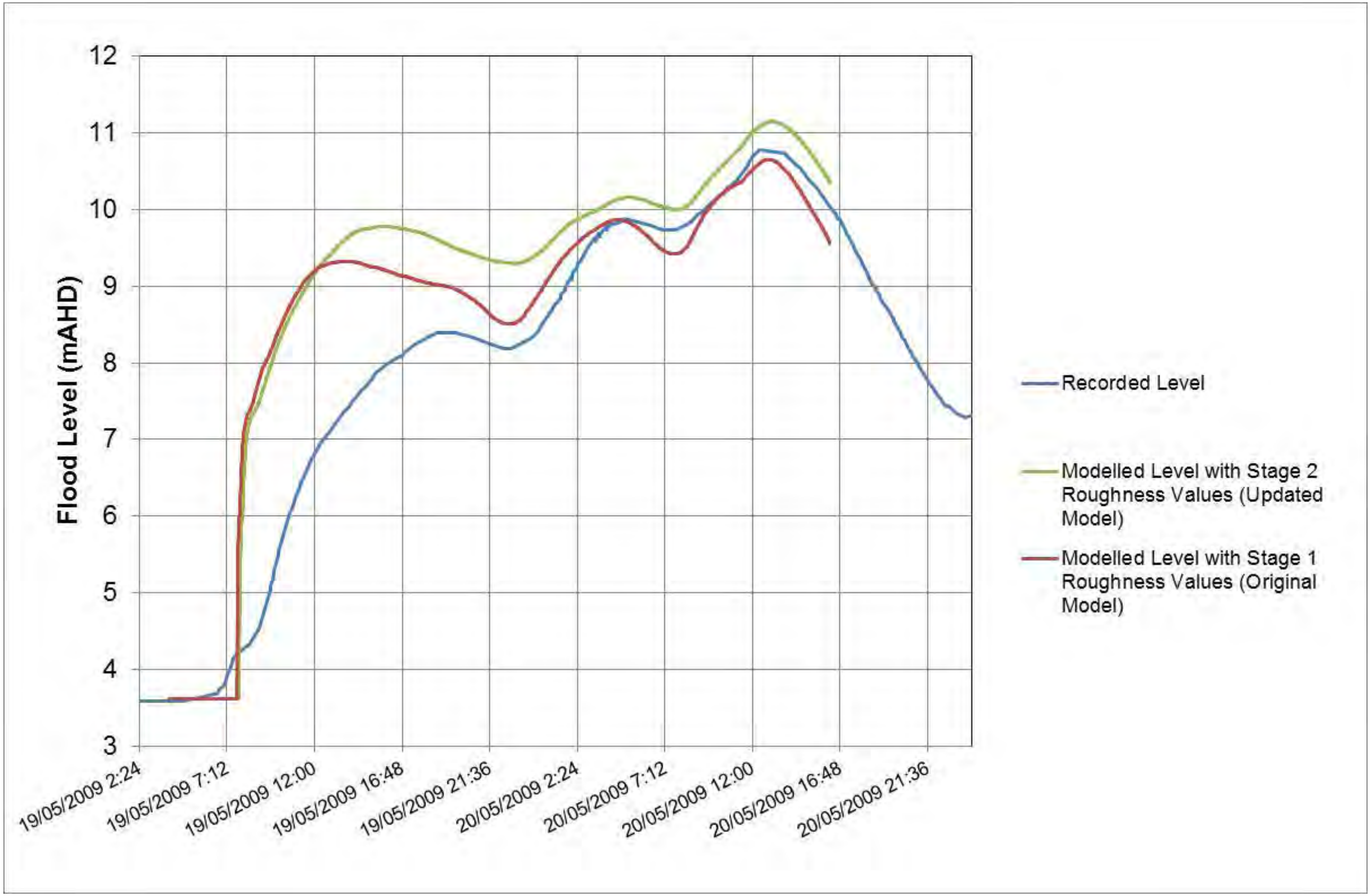

Figure 8: Recorded and Modelled Hydrographs at Dale Street Gauge – May 2009 Event

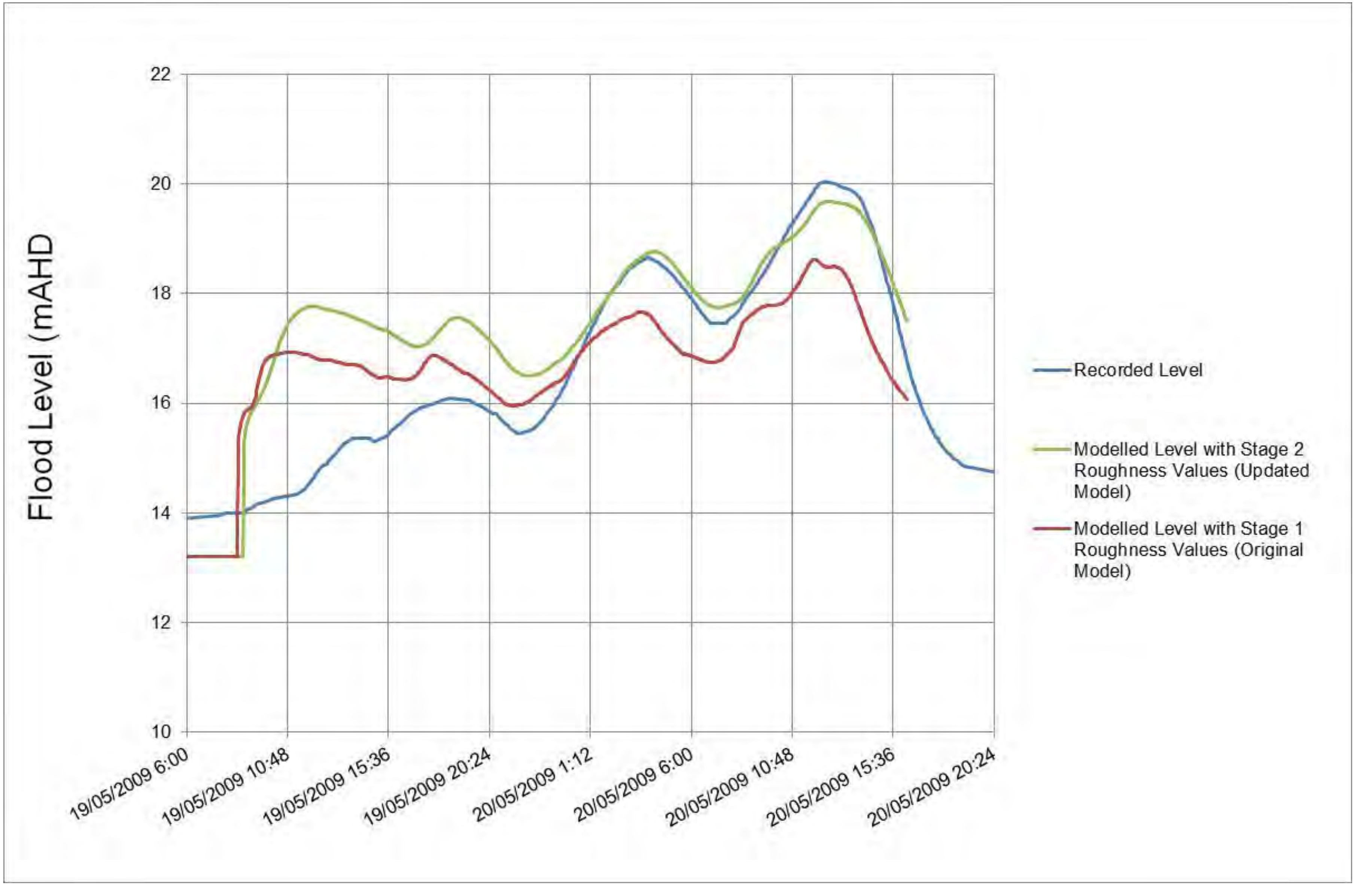

Figure 9: Recorded and Modelled Hydrographs at Rowley Road Gauge – May 2009 Event

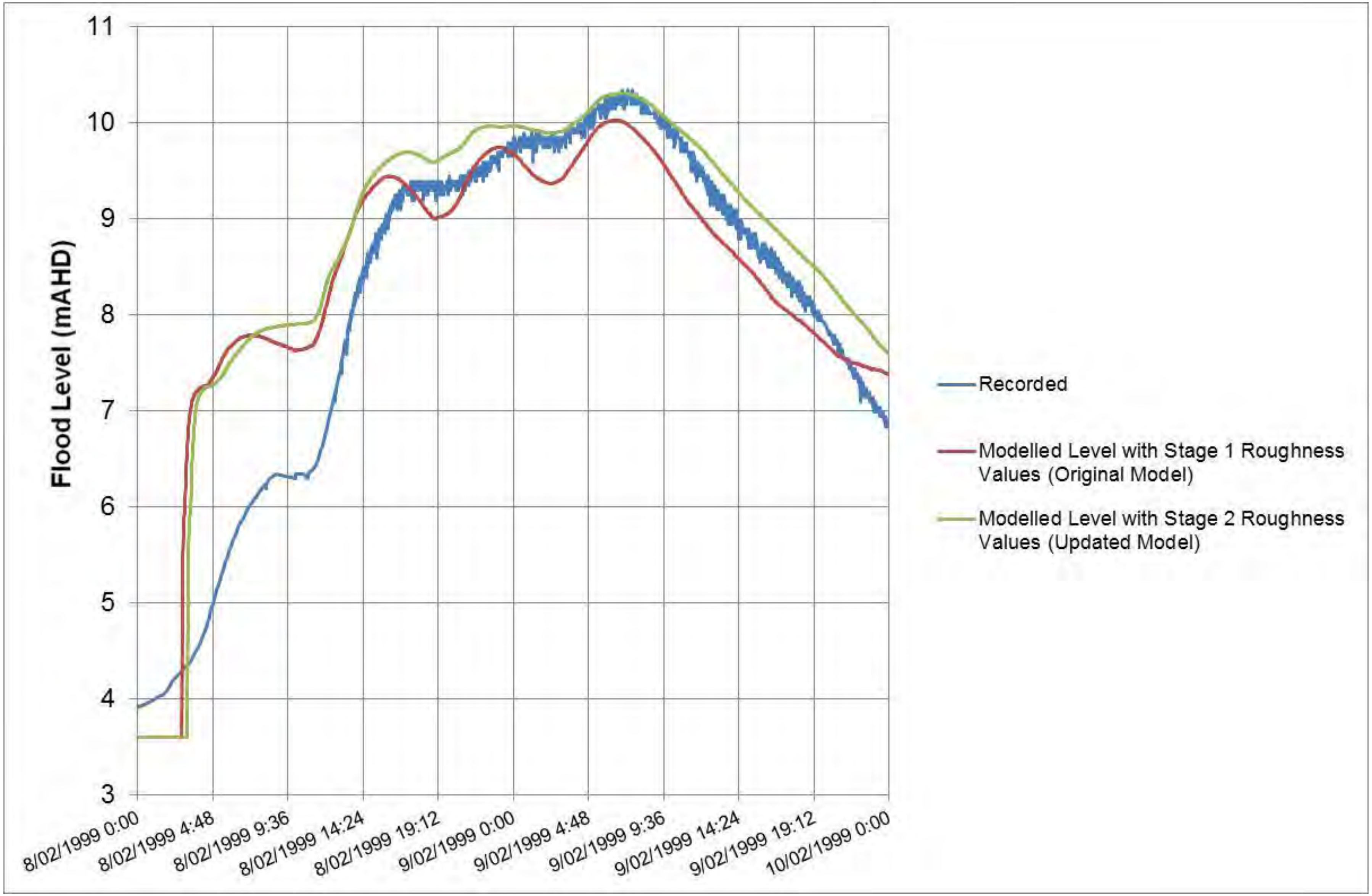

Figure 10: Recorded and Modelled Hydrographs at Dale Street Gauge – February 1999 Event