Regional Floodplain Database:

Hydrologic and Hydraulic Modelling - Lower Pine River (LPR)

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Regional Floodplain Database
Hydrologic and Hydraulic Modelling

Lower Pine River (LPR) April 2013

Moreton Bay Regional Council

Emergency Management Queensland (EMQ)

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Queensland Government

Regional Floodplain Database Hydrologic and Hydraulic Modelling Lower Pine River (LPR) Final Report

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Title :	Regional Floodplain Database, Hydrologic and Hydraulic Modelling: Lower Pine River (LPR)
Author :	Anne Kolega \ Richard Sharpe
Synopsis :	Report outlining the study data, methodology and delivery of the detailed modelling of the Lower Pine River catchment, as part of Moreton Bay Regional Council's Regional Floodplain Database (Stage 3, Package 2) project.

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1 INTRODUCTION

Moreton Bay Regional Council (MBRC) is currently undertaking Stage 3 of developing the 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.

Stage 2 included the detailed hydrologic and hydraulic modelling of 5 packages, which cover 11 catchments in the MBRC LGA. Stage 3 includes the detailed hydrologic and hydraulic modelling of the two remaining catchments and the flood risk management study.

This report discusses the study data, methodology and results for Stage 3, Package 2 of the RFD, the detailed hydrologic and hydraulic modelling for the Lower Pine River catchment.

This study utilises the hydraulic model results from the Upper Pine River (UPR) and the Sideling Creek (SID) catchments (modelled as part of Stage 2), which form the upstream parts of the Pine River catchment.

1.1 Scope

The detailed models of the Lower Pine River catchment will provide MBRC with an enhanced understanding of the flood behaviour in the catchment for a large range of flood events, from the 1 year Average Recurrence Interval (ARI) event to the Probable Maximum Flood (PMF). The detailed model was developed from a pre-existing broadscale model that was developed by WorleyParsons as part of the RFD. The following primary alterations were made to convert the broadscale model to a detailed model:

- The model computational grid resolution was refined from 10m to 5m (for events smaller and up to the 100 Year ARI event);
- 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; and
- Utilisation of detailed land use delineation (developed as part of Stage 1, but not included in broadscale models).

A broad range of design flood events were simulated, as well as a number of sensitivity analyses which investigated the influence of various parameters and conditions on model results. 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 Lower Pine River

Catchment using input data that were determined and provided by MBRC or other consultants; and

- Provision of all relevant flood information obtained from the modelling, which will form the base input data for the risk management study.

1.3 General Approach

The general approach for this study is summarised as follows:

- Review existing broadscale WBNM hydrologic model and results;
- Review existing broadscale TUFLOW modelling;
- Refine the TUFLOW modelling to include additional structures and topographical information, and refine the grid size to 5m for events smaller than the 100 Year ARI event;
- Investigate the feasibility of calibrating and/or verifying the combined WBNM and TUFLOW models. There was sufficient historical information available for this task, therefore model calibration was undertaken for the January 2011 event;
- Undertake a critical storm duration assessment for the 10 year ARI event, 100 year ARI event and the PMF, based on the 10m model;
- 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 three selected critical durations;
- Assess model sensitivity to future landuse patterns, Manning's 'n', structure blockage, climate change and downstream boundary conditions;
- 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 results were mapped in this report; and
- Compilation of models and model outputs for provision to MBRC.

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

The following RFD sub-projects provide input data and/or methodologies for the Lower Pine River Stage 2 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 (WorleyParsons, 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, 2010b). A similar methodology was adopted for the Lower Pine River 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); and
- **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 (for the 5m and the 10m models) that were generated using a tool that was developed and run by WorleyParsons. The DEM resolution was 2.5m and 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);
- **Hydrography (MBCR)** – 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 or major 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;
- **Upper Pine River (UPR) Model Results** provided for the upstream boundary conditions at the North Pine Dam. This data was derived from the final UPR model Stage 2; and
- **Sidling Creek (SID) Model Results** provided for the upstream boundary conditions at Lake Kurwongbah. This data was derived from the final SID model Stage 2.

3 METHODOLOGY

3.1 Data Review

A number of data reviews were undertaken by BMT WBM. These reviews concern:

- The infrastructure data within the catchment;
- The historical flooding information of the catchment; and
- The broadscale subcatchment delineation.

The review and analysis of these data was compiled into three reports and issued to MRBC prior to completion of a draft detailed model. A summary of the data review reports is described below.

3.1.1 Infrastructure Data Assessment

This report reviewed the available infrastructure data provided by MBRC and the Department of Transport and Main Roads (DTMR) and identified any infrastructure data that needed to be collected for the detailed modelling of the Lower Pine River Catchment. Furthermore, this required data was prioritised into two categories: Priority A data (data which is critical for a high quality model) and Priority B data (all other data for which assumptions can be used and still achieve a relatively high quality model).

The key findings from this report include:

- 366 culverts and structures prioritised as category A (260 and 86 and from the broadscale model and 20 from MBRC's review);
- 27 culverts and structures prioritised as category B (10 from the broadscale model and 17 from MBRC's review);
- 8 additional locations prioritised as category A were identified by BMT WBM; and
- 8 additional locations prioritised as category B were identified by BMT WBM.

A full copy of this report is provided in Appendix A.

3.1.2 Calibration and Validation

The available information on historical flooding was provided by MBRC and reviewed as part of the model calibration feasibility report (Appendix C) along with the collection of gauge data from the Bureau of Meteorology (BoM). The feasibility of using historic flood events for calibrating the Lower Pine River model was assessed. The model feasibility report concluded that there is sufficient data available in the catchment to perform calibration and validation to historical flood events. Model validation was undertaken for the following major and most recent flood event:

- The January 2011 flood event was used for the model calibration.

A full copy of the model calibration feasibility report is provided in Appendix C.

3.1.3 Hydrography Review

The subcatchment delineation completed as part of Stage 1 was reviewed; a copy of the report letter is provided in Appendix B. The review recommended subdivisions of the subcatchment delineation for 25 subcatchments to refine the resulting flood extent. MBRC appreciated the work undertaken and considered the recommendations for use in MBRC's internal overland flow mapping project. However, MBRC adopted the original subcatchment delineation to be used for the hydrologic and hydraulic modelling.

3.2 Hydrologic Model

The existing hydrological WBNM model for the Lower Pine River catchment was reviewed and updated using relevant data, utilising the WBNM 2010 beta version. The WBNM software was nominated by MBRC as the hydrologic software package for the RDF, and was used to model the design events (utilising existing landuse), the January 2011 calibration event (using existing landuse, and historic rainfall data) and a future landuse scenario.

The subcatchment delineation and hydrology model were supplied by MBRC. Detailed hydrologic model parameters, such as adopted losses, design gauge locations and Intensity Frequency Duration (IFD) data, were based on methods adopted for the Burpengary Stage 2 Pilot Study and SKM (2010). The following methods were used for definition of design storms:

- 1 year ARI to 100 year ARI – AR&R (The Institution of Engineers Australia, 2001) was used to define rainfall depths and rainfall temporal patterns for storm events from 1 year ARI to 100 year ARI;
- 200 year ARI to 2000 year ARI – CRC Forge was used to define rainfall depths and temporal patterns were based on the temporal patterns adopted for the PMF events; and
- PMF – The Generalised Short Duration Method (GSDM) and the Revised Generalised Tropical Storm Method (GTSMR) were used, depending on the storm duration, to determine the Probable Maximum Precipitation and rainfall temporal patterns.

The flows derived from the hydrologic model were used as inflow to the hydraulic model.

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

The TUFLOW model was based on two sets of Z points provided by MBRC for two computational grid resolutions: 5m and 10m, as adopted by MBRC. These Z point layers were used to develop a 5m grid model and a 10m grid model. The 5m grid resolution model was used for events up to and including the 100 year ARI Event. The 10m model was used for events larger than and including the 100 year ARI event, the critical duration analysis and also for the sensitivity runs. The two grid resolutions were adopted due to the catchment size and the model run times; i.e. the 10 grid resolution model was used to expedite the model run times. The Lower Pine River model has extended model run times: the 5m model takes about 6 days to simulate a design event, whereas the 10m model takes about 14 hours to simulate a design event. These run times are provided as an indication, and depend on the storm magnitude, duration and computer specifications. The 5m model requires about 10.5GB of RAM and the 10m model about 2.3GB of RAM. The origin of the Z points was used to set the origin of the 2D domain, and 2D domain orientation was set to zero (or horizontal; i.e. no rotation).

The elevation information was based on 2009 ALS data that was processed using a bespoke tool (processed by WorleyParsons). Stream and road modifiers were developed and supplied to MBRC to be incorporated in the DEM tool. These terrain modifiers generate break lines to capture streams, gullies and road embankments in the Z points layer and DEM.

Figure 3-1 illustrates the Lower Pine River model layout.

3.3.3 Model Structures

The Lower Pine River catchment is, in general, moderately urbanised. The mid part of the catchment along the North Pine and South Pine Rivers is densely developed and the upper South Pine River and Cedar Creek are less developed.

The LPR catchment includes about 400 structures in total. Culvert crossings were typically represented in the model as 1D structures, with flow over these structures modelled within the 2D domain. Bridges and footbridges were represented in the 2D domain (using TUFLOW layered flow constriction features). The hydraulic structure details were either provided by MBRC in TUFLOW ready format, or in the form of engineering drawings or digital data derived from a survey.

The adopted exit and entry loss coefficients applied to the hydraulic structures were based on values reported in SKM (2012b). Structure locations are shown on Figure 3-1.

3.3.4 Landuse Mapping

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

Table 3-1 Hydraulic Model Landuse Categorisation

Landuse Type	Manning's 'n' Roughness Coefficient
Roads/Footpaths	0.015
Waterbodies	0.030
Estuarine Waterbodies	0.02
Low Grass/Grazing*	Ranging from 0.025 at 2 m depth to 0.25 a 0m depth
Crops	0.040
Medium Dense Vegetation*	Ranging from 0.075 up to a depth of 1.5m and 0.15 above 1.5m
Reeds	0.08
Dense Vegetation*	Ranging from 0.09 to 0.18 up to a depth of 1.5m and 0.18 above 1.5m
Urban Block (> 2000m^2)	0.300
Buildings	1.000
*Depth varying (linear) Manning's 'n' roughness was applied.	

Three of the landuse categories used a depth varying Manning's roughness. This allows the Manning's roughness to be adjusted depending on the depth of water flowing over a surface. For example, when there is a small depth of water over grass, the resistance is high, and thus the Manning's roughness should be high. However, as the water gets deeper, the resistance of the grass is less, thus the Manning's roughness should be low. The depth varying Manning's roughness allows this to be represented.

In highly developed blocks, larger than 2000m^2, the urban block category was used (Manning's 'n' of 0.3). For areas outside the high density residential development, an individual building layer, showing the footprint of the building was used (Manning's 'n' of 1.0).

3.3.5 Model Boundaries

The Upper Pine River catchment (UPR) and Sideling Creek catchment (SID) discharge into the Lower Pine River catchment. The UPR catchment includes Lake Samsonvale (also referred to as North Pine Dam) and the SID catchment includes the Sideling Creek Dam (Lake Kurwongbah). Therefore, the outflows from the Lake Samsonvale and Lake Kurwongbah form the major inflows to the North Pine River.

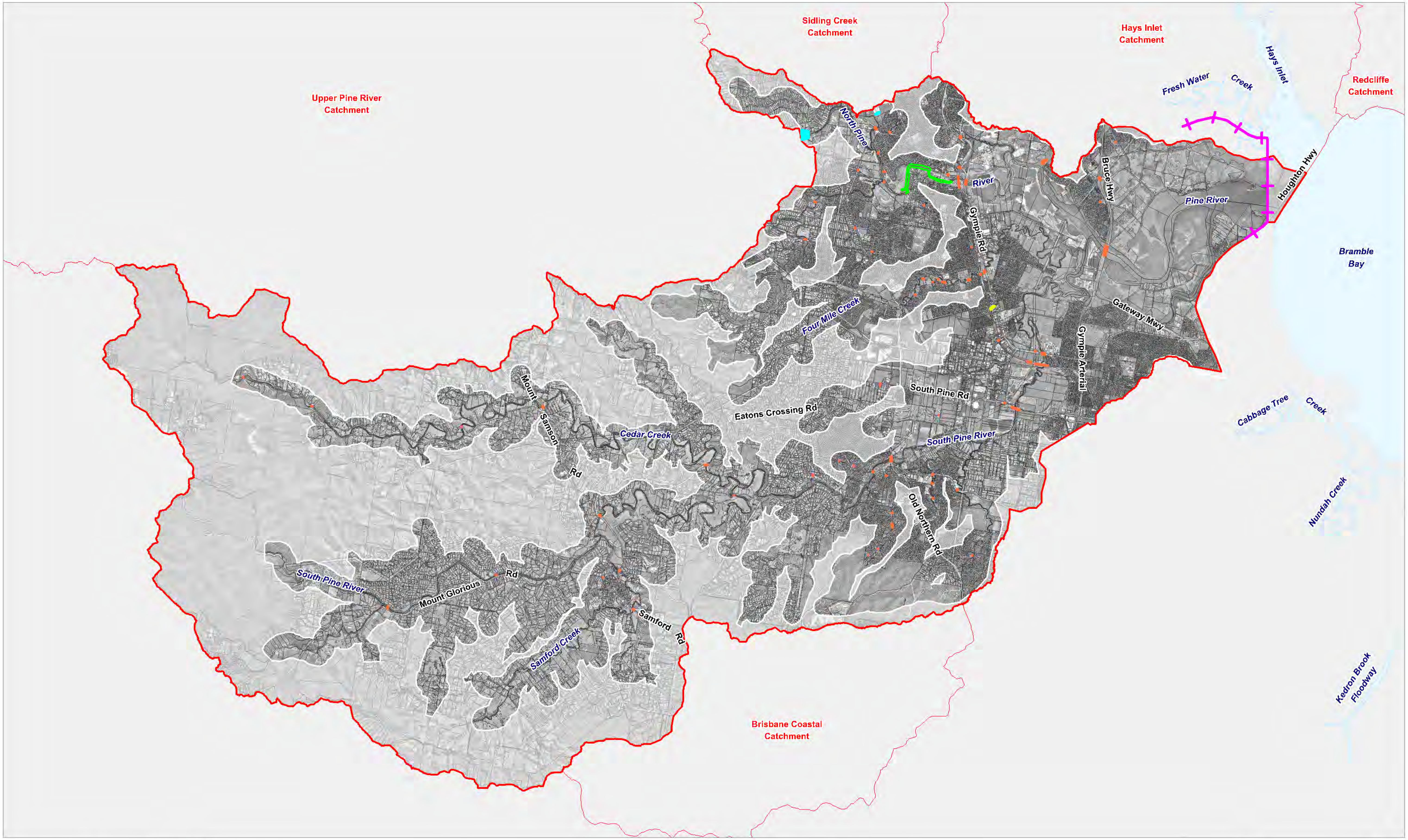
The results of the WBNM hydrologic model were used to generate runoff inflows within the LPR catchment for the hydraulic model for all design events, as discussed in Section 3.2. The inflows were applied to the 2D domain using a flow-time source boundary spread over each subcatchment. This technique applies the inflow at the lowest grid cell in a subcatchment initially and then subsequently to all wet cells in that subcatchment.

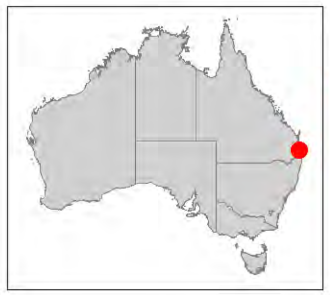
The downstream boundary conditions, joint probability and climate change scenarios were based on recommendations from the sub-project 2M report (SKM, 2012a). A static flood level was applied at the downstream boundary utilising the mean high water spring (MHWS) for all design events (see Table 3-2).

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





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Lower Pine River Catchment Boundary

Hydraulic Model Boundary

Cadastral Boundaries

Extent of Bathymetry added by BMT WBM

Downstream Boundary

Inflows (Upper Pine River and Sidling Creek Catchments)

Culvert

Bridge

Title:

TUFLOW Model Layout

Figure: **3-1**

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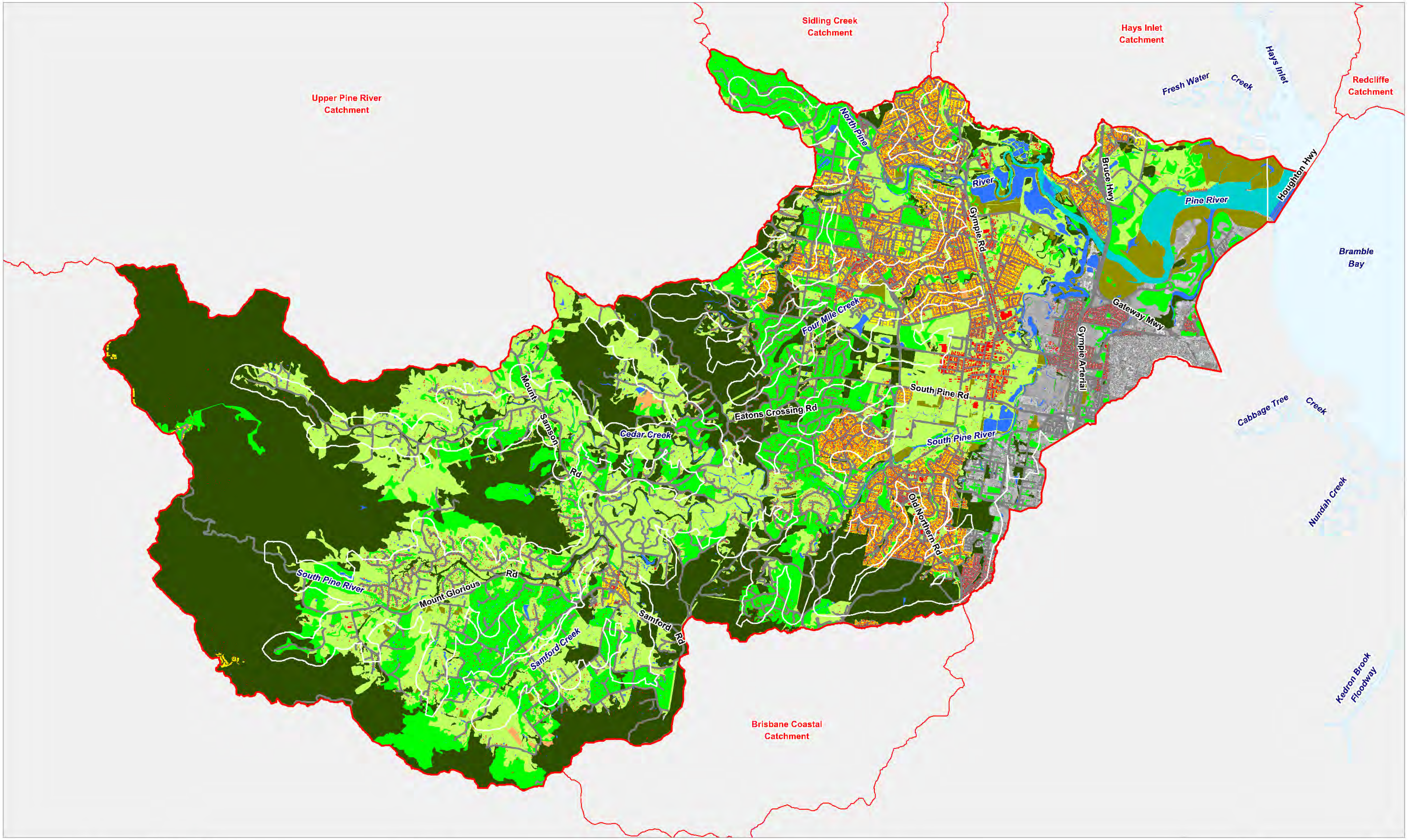

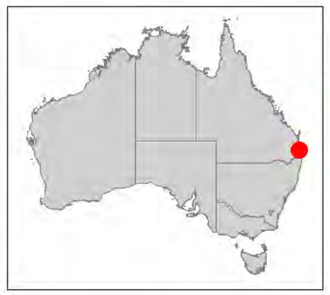

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Lower Pine River Catchment Boundary

Hydraulic Model Boundary

Landuse

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

Title:
Landuse Existing Conditions

Figure:
3-2

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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. Model calibration and/or verification were undertaken for 6 other catchments, including the UPR catchment, as part of Stage 2. Therefore, the LPR model calibration had two objectives, firstly to calibrate the model to a historic event, and also to verify the model parameters adopted during the Stage 2 model calibration of 6 catchments within MBRC's LGA.

The Lower Pine River catchment hydraulic model was calibrated against the January 2011 event. This event was chosen because it was a large event that occurred most recently, and data from a large number of rainfall and stream gauges were available. Records from 17 rainfall gauges and 9 stream gauges were used for the January 2011 flood event. The gauge level data for these gauges were obtained from MBRC and the Bureau of Meteorology's website. These recorded water levels were compared to the modelled water levels, and the model was adjusted a number of times to improve the correlation between recorded and modelled flood levels. MBRC also provided 57 flood marks with surveyed peak flood levels. Histograms were provided to demonstrate the difference between the surveyed and the recorded peak flood levels versus the number of flood marks.

A good calibration was achieved without altering the Manning's roughness parameters adopted in Stage 2 of the RFD. A new landuse type was introduced, called estuaries. This landuse type represented the Lower Pine River where the alluvium bed is relatively smooth. Details of the simulations undertaken as part of the model calibration are documented in Appendix C.

3.5 Design Flood Events

This section describes the design storm conditions that were used in the hydrodynamic modelling. Design storm events are hypothetical events that are used to estimate design flood conditions. They are based on 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 Lower Pine River model, the following methodology was adopted:

1. Hydrologic and hydraulic modelling of a range of storm durations (1hr, 3hr, 6hr, 12hr and 24hr) for the 10 year, 100 year and PMF events; 5 hours and 48 hours storm durations were also

tested for the PMF event. The 10m grid model was used for this assessment.

2. Mapping of the peak flood level results for the 'maximum envelope' of all the storm durations for the three representative events.
3. Mapping of the peak flood level results for the 'maximum envelope' of selected storm durations for the three representative 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 lead 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.

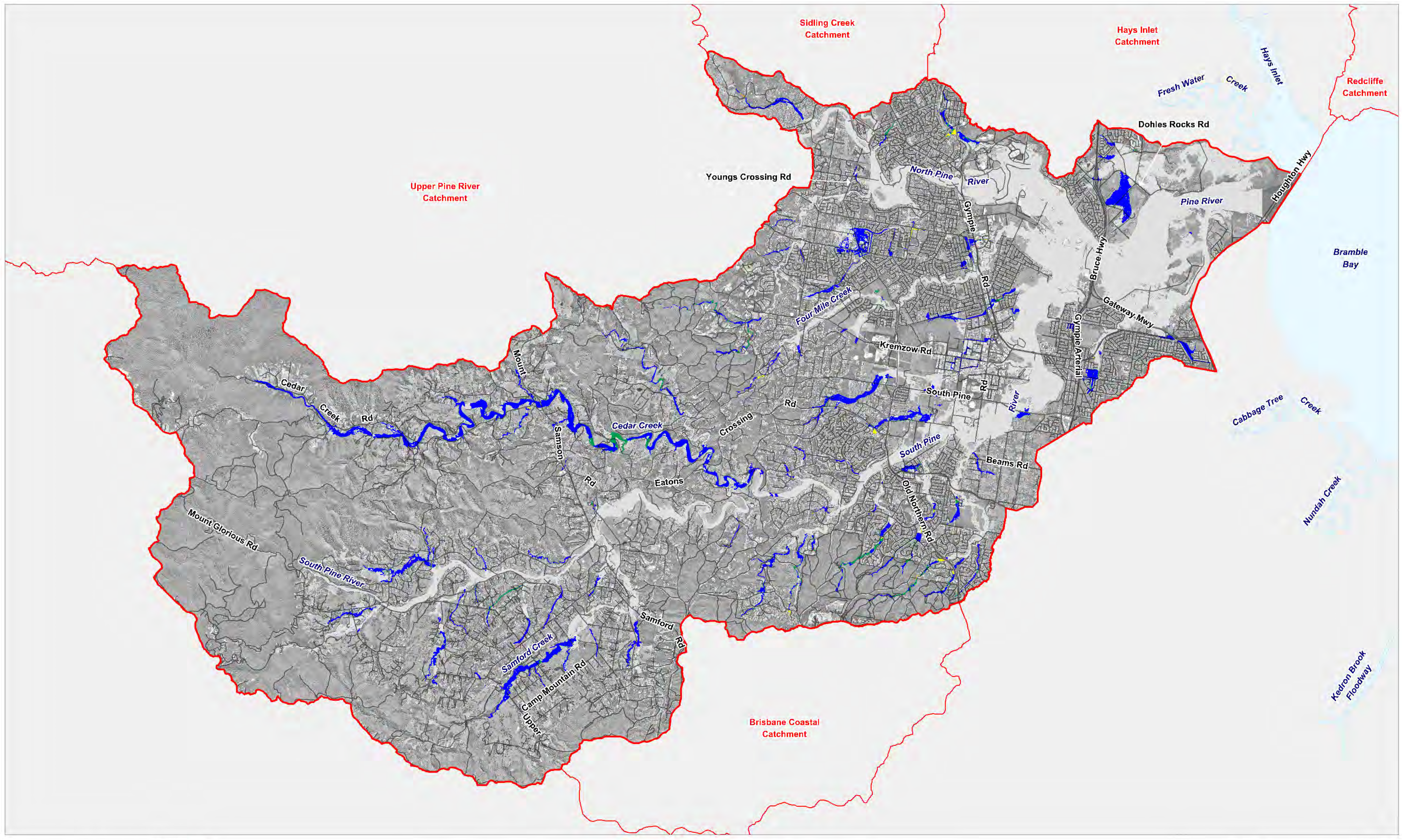
A summary of the selected critical storm durations for all events assessed is outlined in Table 3-3.

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 3-5. The figures illustrate that the selected critical durations generally capture the peak flood levels across the site in developed areas. There are some localised areas, mainly in the upper parts of the catchment, where flood levels are under predicted. For the PMF event, the area downstream of Gympie Road is also under predicted by about 0.1m

Table 3-3 Critical Storm Duration Selection

Assessment Event	Selected Critical Durations	Adopted Event
10 year ARI	3, 6 and 12 hour storms	1, 2, 5 and 10 year ARI
100 year ARI	3, 6 and 12 hour storms	20, 50 and 100 year ARI
Probable Maximum Flood	3, 5 and 24 hour storms	200, 500, 1000, 2000 year ARI and PMF

This process was undertaken in consultation with MBRC, as their knowledge on local catchment and development issues was a factor in the decision-making and selection of the critical durations.



LEGEND

Lower Pine River Catchment Boundary

Physical Road Network

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

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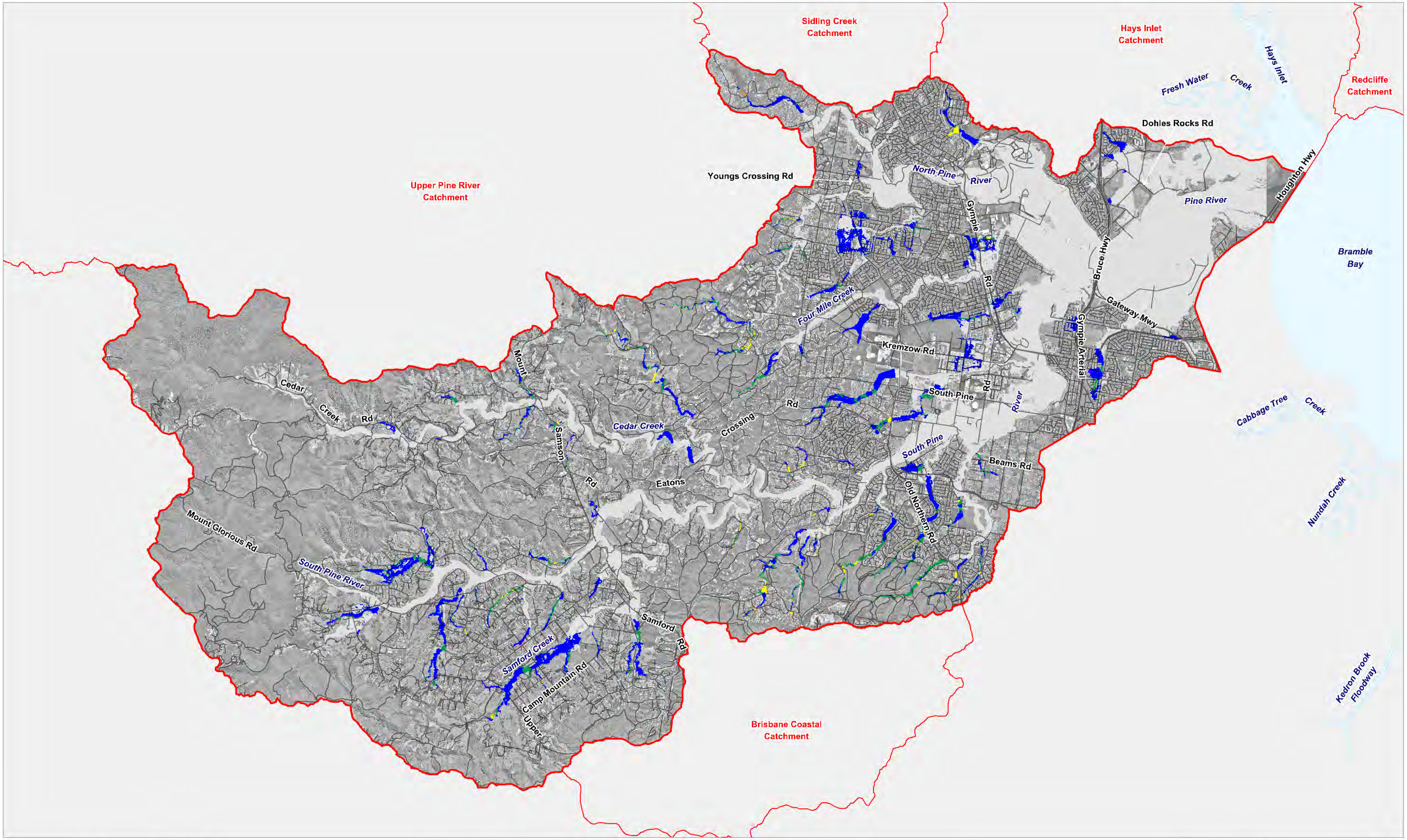

LEGEND

Lower Pine River Catchment Boundary

Physical Road Network

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**

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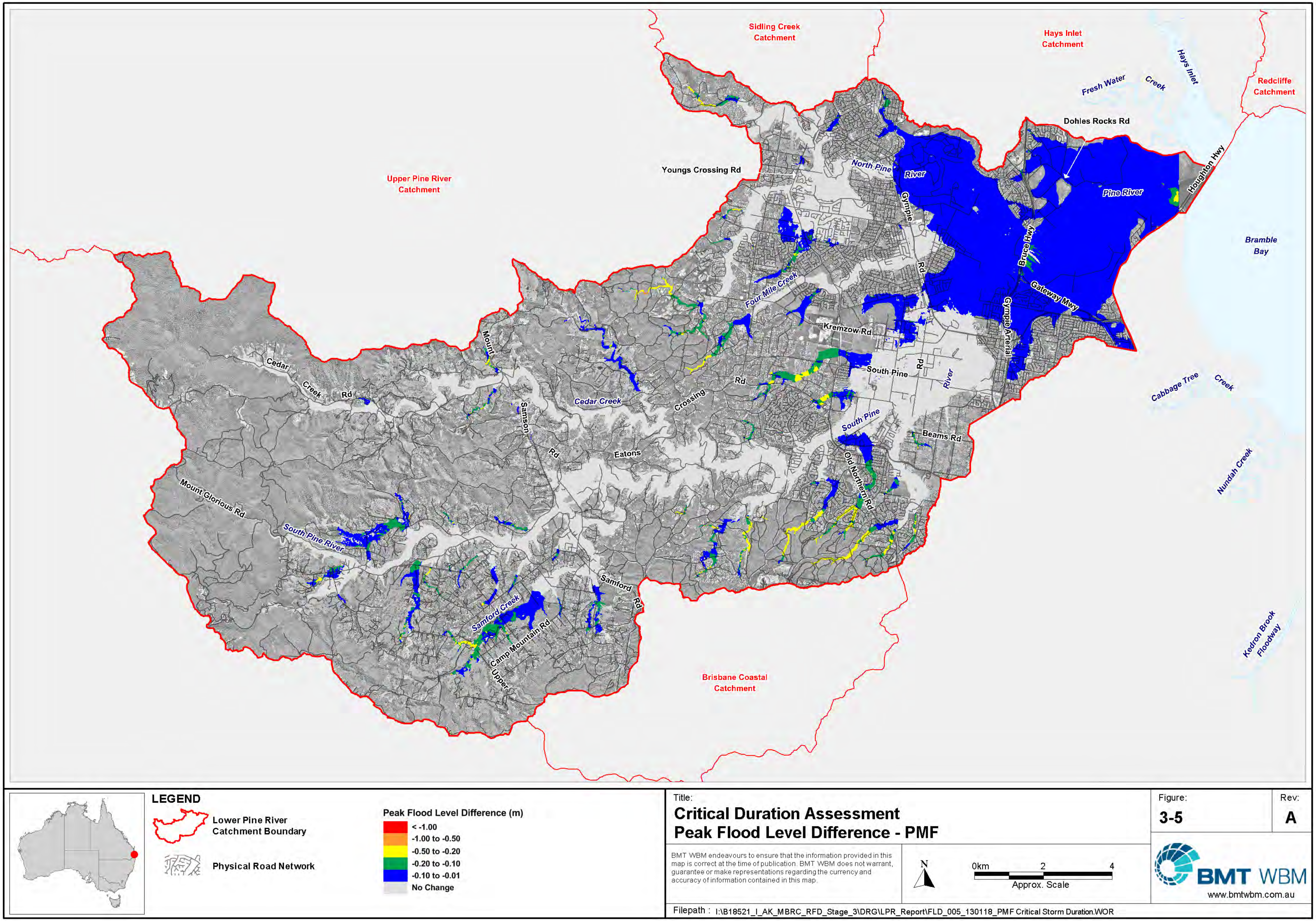

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Critical Duration Assessment
Peak Flood Level Difference - PMF

Figure: **3-5**

Rev: **A**

BMT WBM
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Filepath : I:\B18521_I_AK_MBRC_RFD_Stage_3\DRG\LPR_Report\FLD_005_130118_PMF Critical Storm Duration.WOR

3.5.2 Design Event Simulations

The Lower Pine River model was simulated for a range of ARI and storm durations and a 100 Year Embedded Design Storm (EDS). MBRC requested the use of a single EDS which synthesises a range of storm duration hyetographs into one representative design hyetograph. The EDS is useful for general investigations into changes in model parameters and catchment characteristics, as it reduces the number of model runs required (no need to run multiple storm durations).

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 Lower Pine River 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 the 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 and 3 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 2.3mAHD)
S8	Storm Tide 2	EDS rainfall with Static Storm Tide (100year current) (2.3mAHD)
S9	Storm Tide 3	Increase rainfall intensity (S4) + Increase downstream boundary (S5) + Static Storm Tide Level (100yr Greenhouse Gas +0.8m) (3.1mAHD)
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 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.

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;
- **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-009 reference point was used);
- **Storm Tide Scenario 2:** Investigated the impact of a 100 year static storm tide level (2.3mAHD) with concurrent 100 year EDS rainfall event; and

- 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 GHG) + 0.8m, resulting in a final static storm tide level of 3.1mAHD.

4 RESULTS AND OUTCOMES

4.1 Calibration and Verification

4.1.1 Overview

Calibration and verification of the modeling was undertaken for the January 2011 flood event. In total, eight simulations were undertaken as part of the calibration/verification process. Full details of each simulation can be found in the model calibration report in Appendix C.

Results from the adopted simulation are also represented in the following section.

4.1.2 January 2011 Results

Comparisons of the recorded and modelled water levels for the January 2011 flood are shown in Figure 4-1 to Figure 4-10.

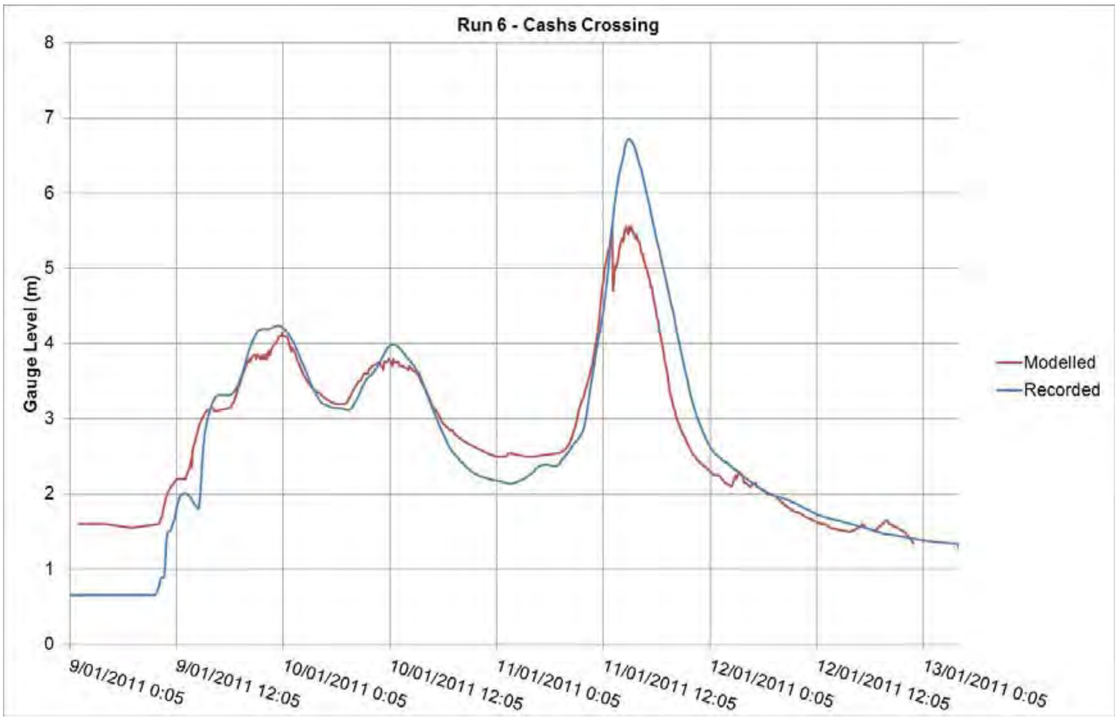

Figure 4-1 Flood Level Comparison at Cashes Crossing

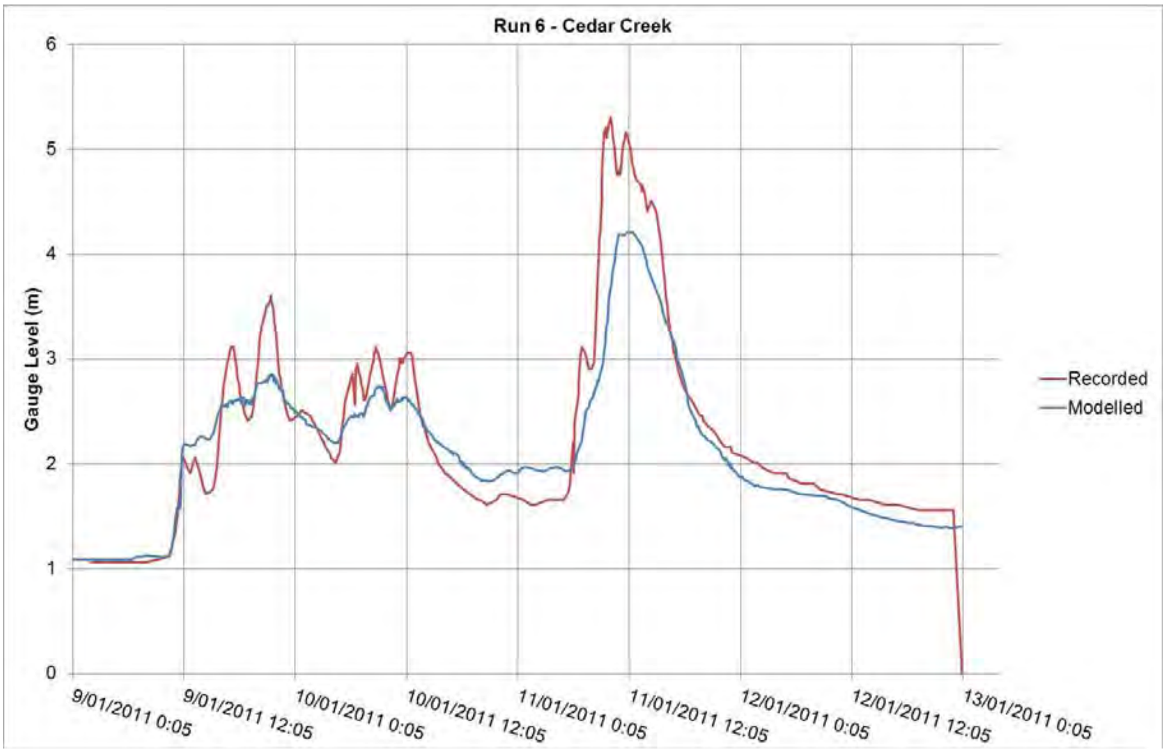

Figure 4-2 Flood Level Comparison at Cedar Creek

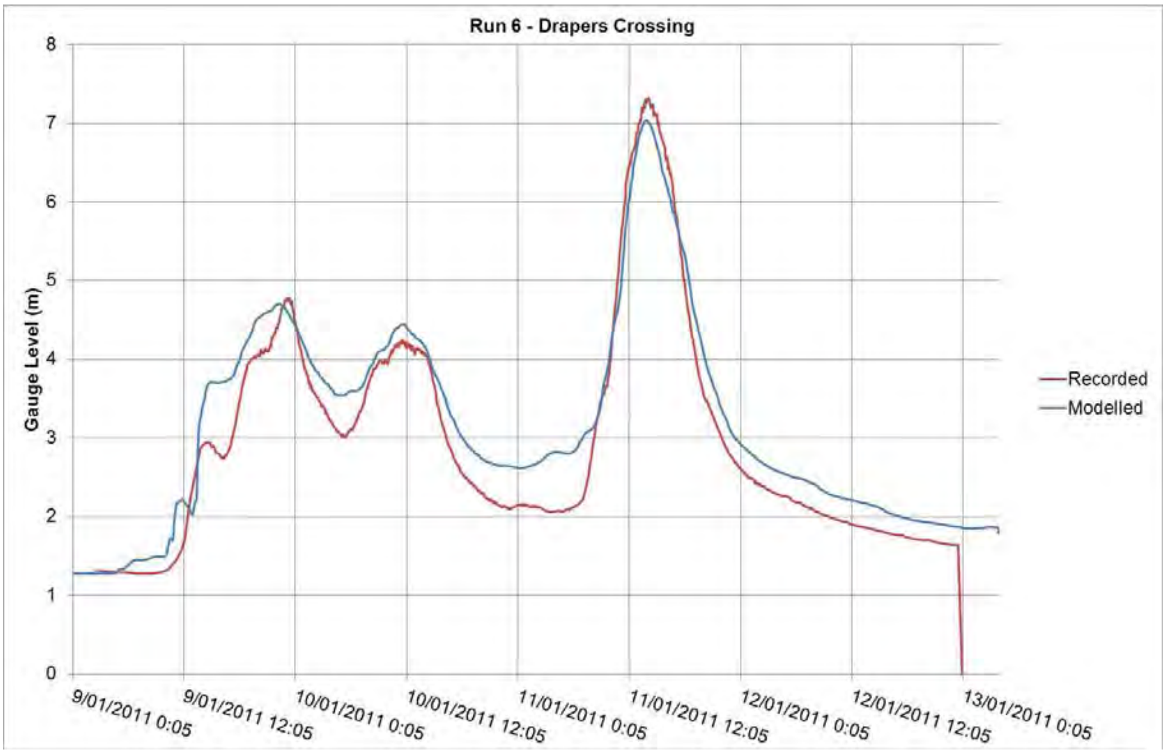

Figure 4-3 Flood Level Comparison at Drapers Crossing

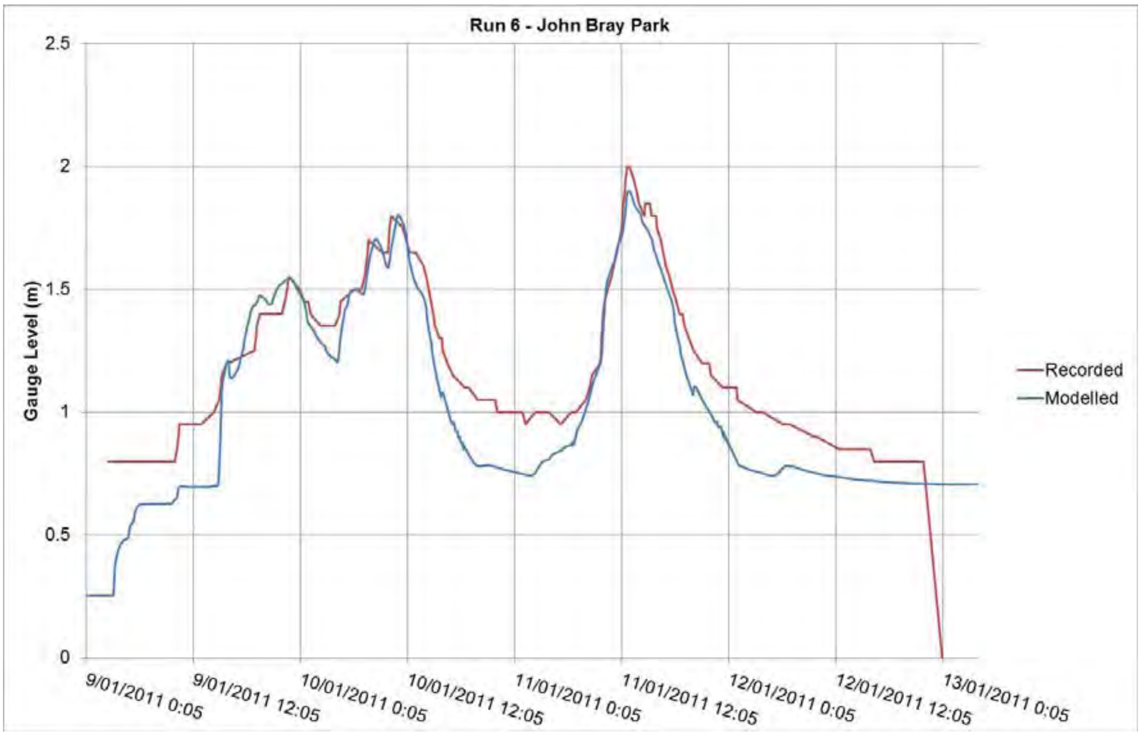

Figure 4-4 Flood Level Comparison at John Bray Park

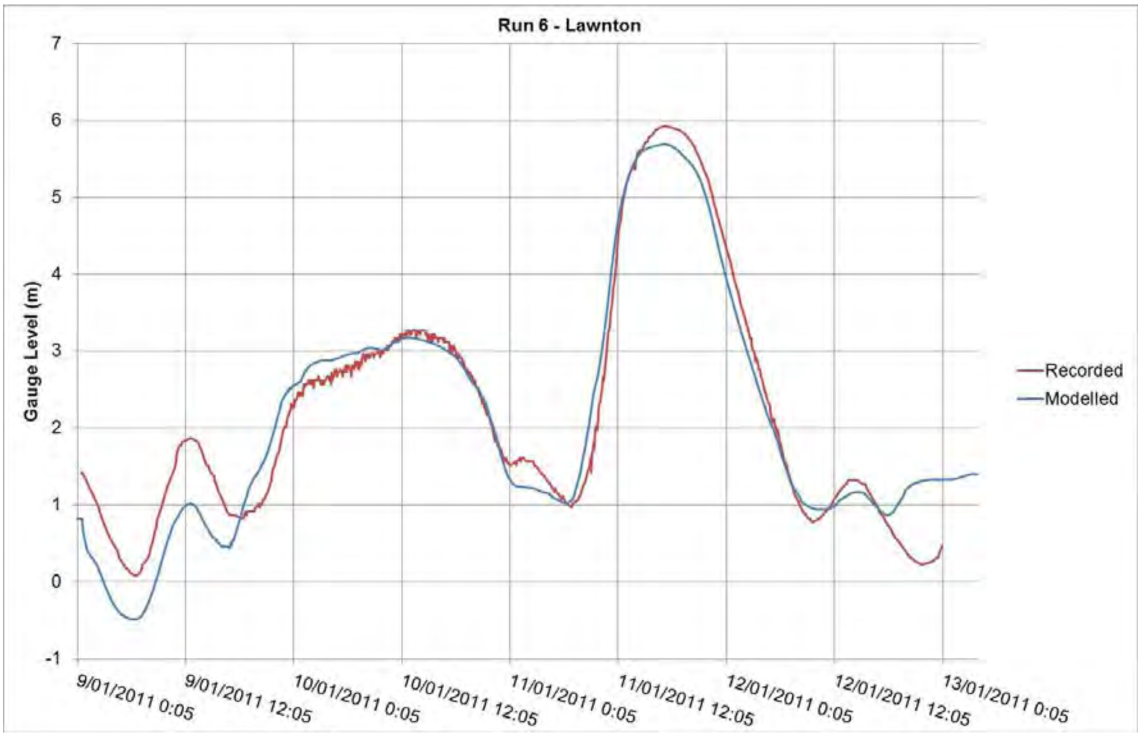

Figure 4-5 Flood Level Comparison at Lawnton

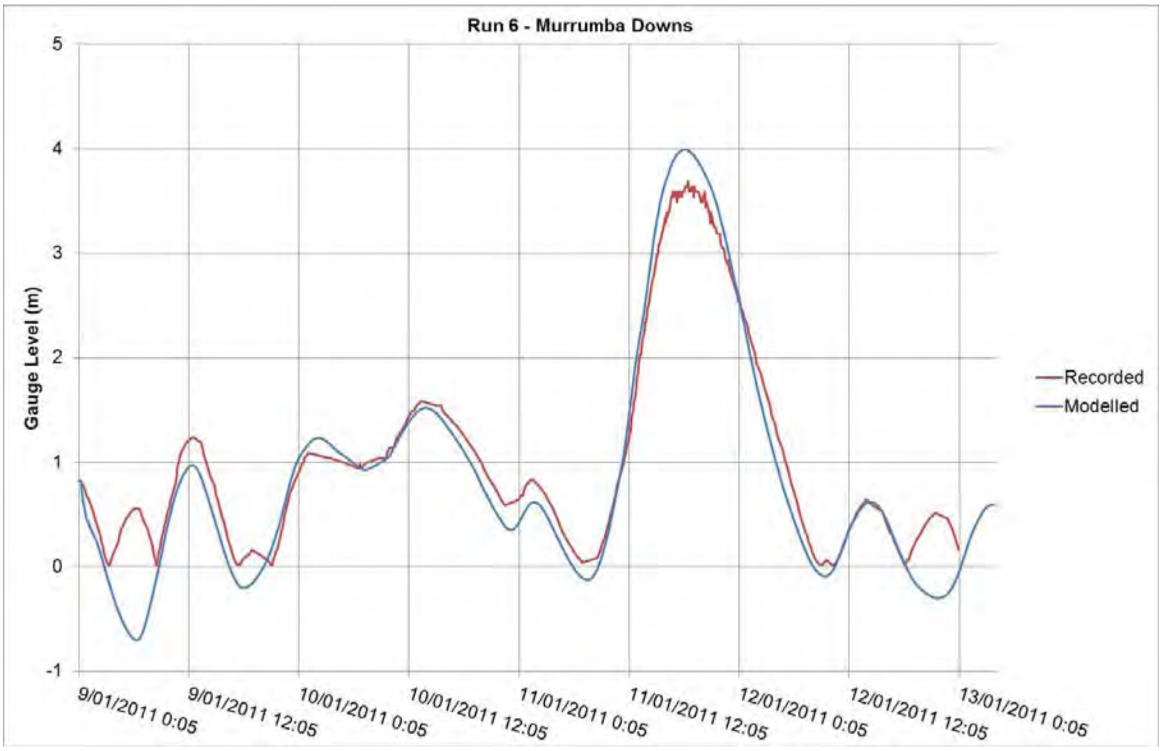

Figure 4-6 Flood Level Comparison at Murrumba Downs

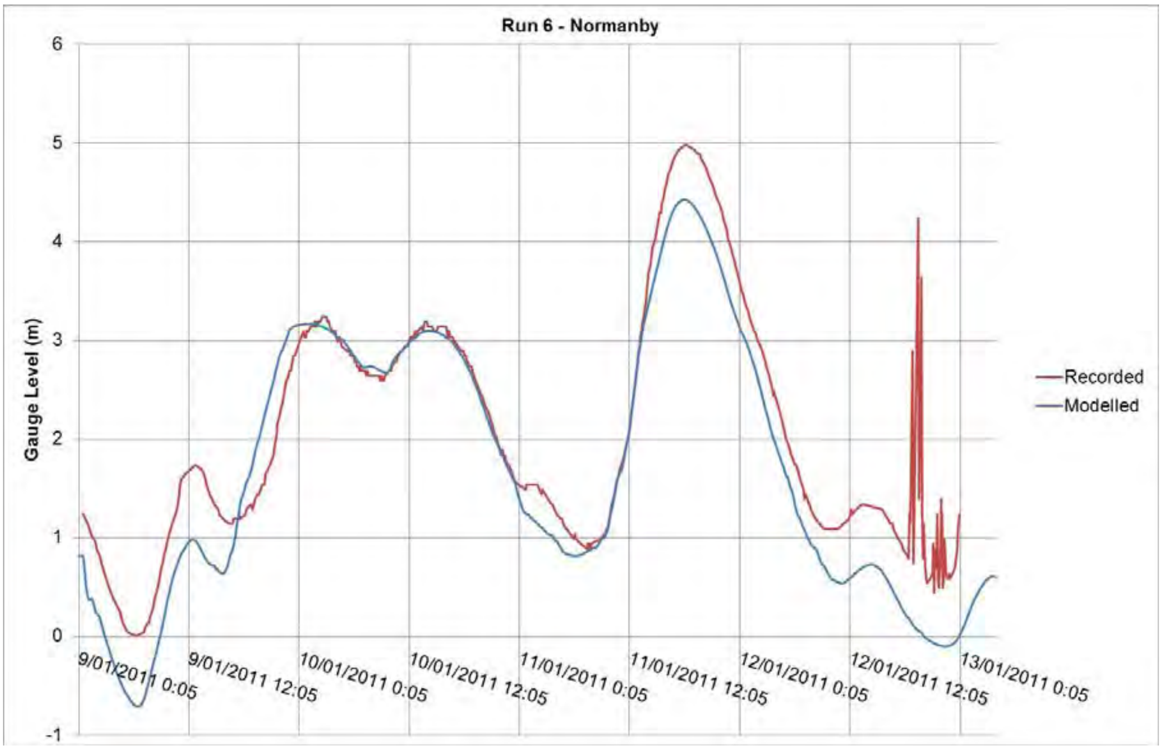

Figure 4-7 Flood Level Comparison at Normanby

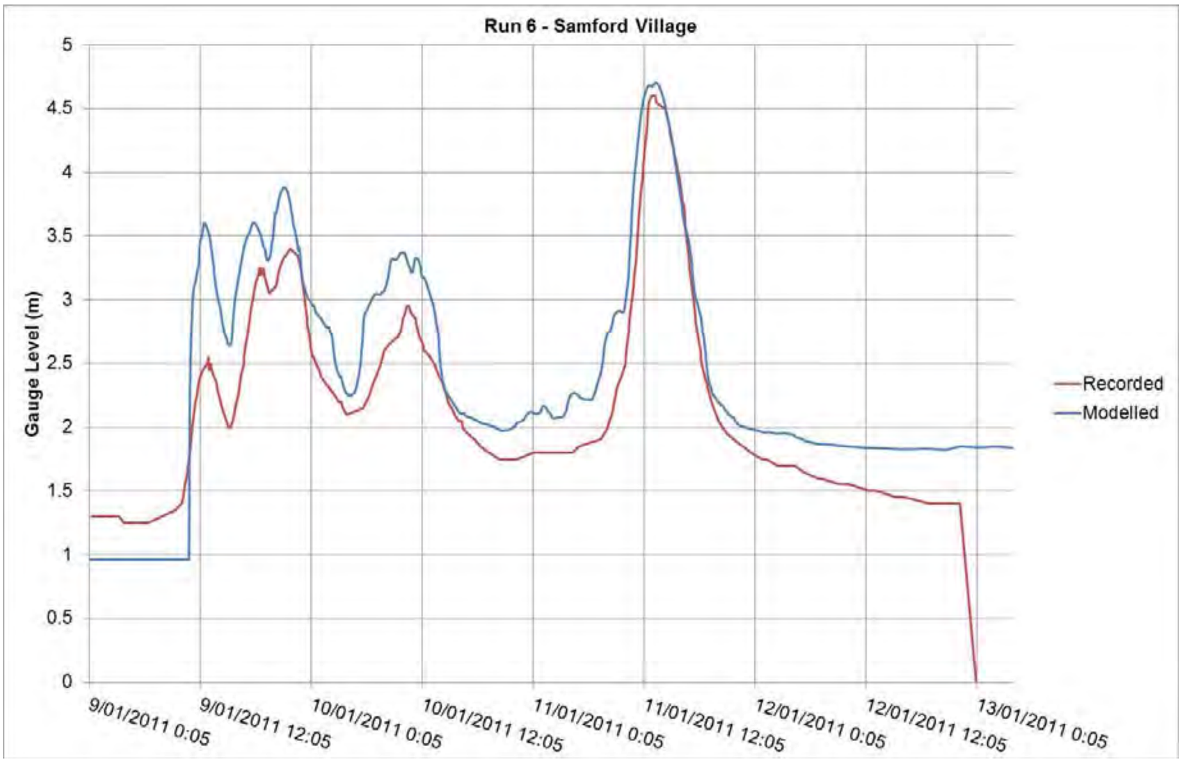

Figure 4-8 Flood Level Comparison at Samford Village

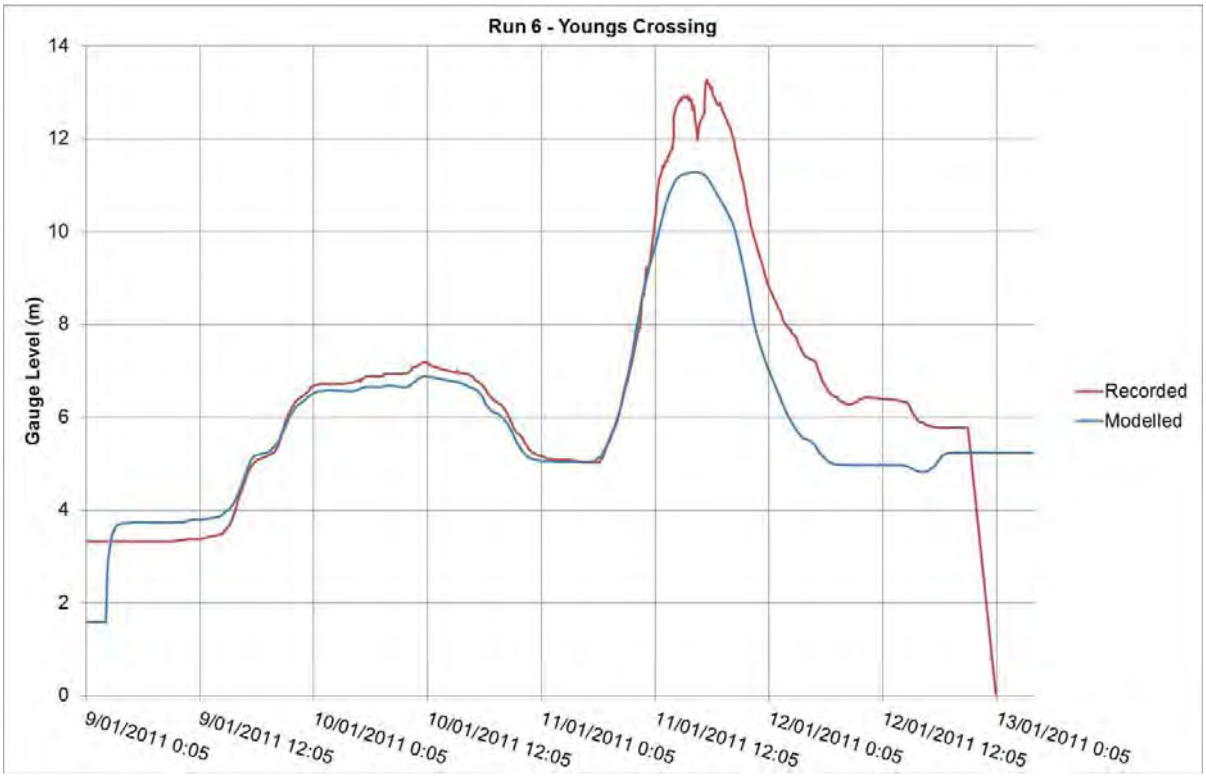

Figure 4-9 Flood Level Comparison at Youngs Crossing

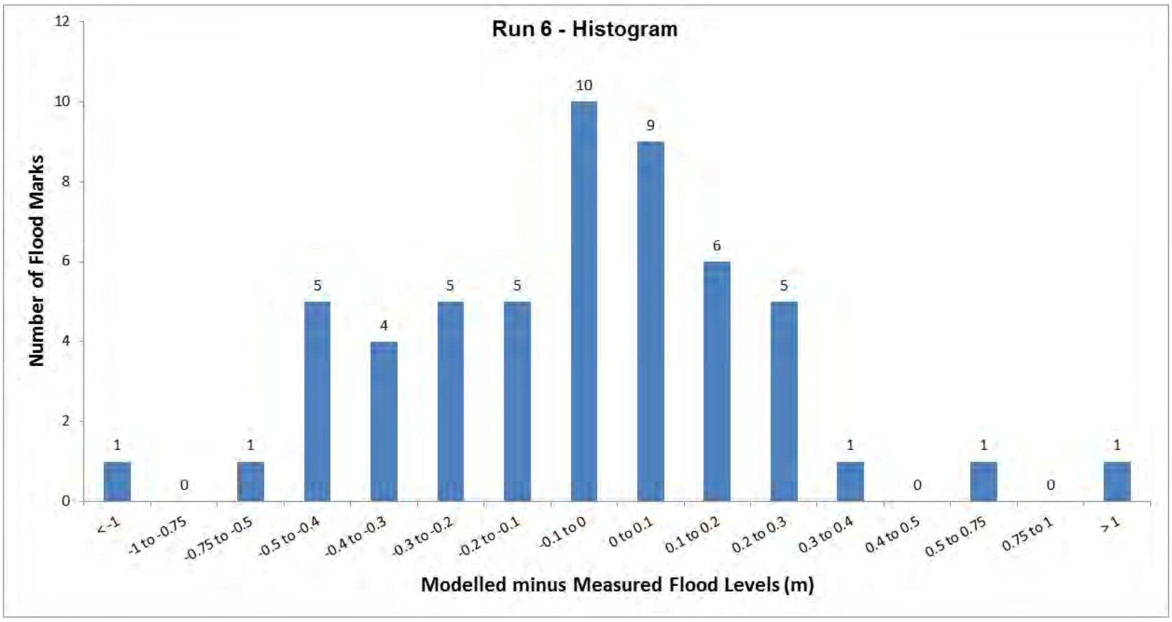

Figure 4-10 Flood Mark Histogram

4.1.3 Conclusion

The model calibration report demonstrates that reasonably good model calibration was achieved, in particular for the area between Young's Crossing and Gympie Road along North Pine River, where the majority of the flood marks were collected. The hydrograph comparison between the recorded and modelled flood levels at the river gauges indicate good timing of the peak levels and reasonable matching of the peak flood levels. The recorded and modelled peak flood levels were within 0.3m at Drapers Crossing, John Bray Park, Lawnton and Samford Village. The model was over predicting by up to 1m and 0.3m at the Cedar Creek and Murrumba Down gauges. An under prediction of the model by up to 1.1m and 0.5m occurred at the Cash's Crossing and Normanby gauges, along South Pine River.

It is known that the gauge at Youngs' Crossing malfunctioned at the peak of the flood. The under prediction at Cash's Crossing may be due to a spatial lack of rainfall data in the upper Cedar Creek catchment; i.e. the historical rainfall applied in the hydrological model in the upper Cedar Creek catchment, which has been interpolated from surrounding gauge data, may be less than what fell in reality.

Localised model adjustments may have resulted in better "fit" between the measured and modelled results. However such a course of action would be counter to Council's objective for a regionally consistent model library. Localised model adjustments may also mask underlying modelling uncertainties and input data limitations. The adopted parameter set was therefore considered on-balance to be appropriate to this model. It is also noted that this decision was reached by Council having regard to similar calibration and verification exercises in adjoining catchments. These results therefore need to be considered in the context of a regional calibration approach across multiple model domains.

4.2 Design Flood Behaviour

4.2.1 Model Results

The following data were output by the model at 30 minutes intervals as well as the peak values recorded during each simulation:

1. Flood Levels (H flag);
2. Flood Depth (D flag);
3. Flood Velocity (V flag);
4. Depth Velocity Product (Z0 flag);
5. Flood Hazard based on NSW Floodplain Development Manual (DIPNR, 2005) (Z1 flag);
6. Stream Power (SP flag); and
7. 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.

A ‘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. Flood maps are only provided for the 100 year ARI design event because the focus of this project is on digital data, rather than the provision of flood maps. A description of the digital data provided to MBRC for incorporation into their RFD is summarised in Section 4.2.2. 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. Therefore, all model input and output are being provided to MBRC at the completion of the study. The data includes all model files for the design events (for each storm duration) and sensitivity analyses.

In addition, post processing batch files were 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 acii 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. The results of the sensitivity analysis are mapped in Appendix F. A comparison of the EDS event with the 100 year design flood event with selected critical durations (3, 6 and 12 hours) is shown in Figure F1. The results indicate that peak flood levels for the EDS is up to 0.5m lower than the envelope of selected critical durations, predominantly in the downstream part of the catchment and along the North Pine River. Therefore, depending on the area of interest, for future sensitivity analyses use of the selected critical duration design events rather than the EDS event may be more appropriate.

4.3.1 Future Landuse Analysis

The Lower Pine River catchment is generally sensitive to changes in vegetation (Scenario S10) with increases in peak flood levels greater than 0.5m in the upper and middle part of the catchment, whereas the downstream part of the catchment has decreases in flood level, mostly up to 0.5m. 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.

An increase in residential development has little impact on peak flood levels across the floodplain, whereas an increase in vegetation effects the catchment significantly.

4.3.2 Hydraulic Roughness Analysis

Increasing Manning's 'n' by 20% has resulted in increases in peak flood level by up to 0.5m across most of the catchment, in particular in the upstream areas along Cedar Creek and South Pine River, along North Pine River between Young's Crossing and Gympie Road and along the Pine River, downstream of the Bruce Highway. Increases in peak flood levels larger than 0.5m are limited to the area just downstream of the North Pine Dam. This finding is consistent with the results from the model calibration, where a change in landuse significantly affected this particular location.

4.3.3 Structure Blockage Analysis

As expected, the structure blockage analysis has shown that structure blockages cause an increase in peak flood levels in the vicinity of the blocked structures, and in some areas there has been a decrease in flood levels downstream of a structure. These changes in flood level are generally limited to 0.1m, however in some places the increases are significant, being over 0.5m. The decreases are up to 0.5m.

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). Increases in peak flood levels larger than 0.5m occur in the middle parts of the North and South Pine River and in the downstream area of the catchment from approximately 2km upstream of the Bruce Highway.

The increased downstream boundary and static storm tide scenarios (100 year current) without 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 more than 0.5m for a large portion of the North Pine and Pine River catchment. Model results from this scenario also predict an increase in flood extent along the North Pine River and the Pine River.

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 F-7) rather than the difference in peak flood levels and extents. This scenario results in higher flood levels in the undeveloped area near the downstream boundary.

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

4.4 Model Limitations and Quality

Watercourses within the Lower Pine River catchment were represented in the 2D domain, for which the grid resolution is limited to either 5m or 10m. 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. The model quality report highlights areas of uncertainty and model limitations. It is recommended that this report is reviewed prior to using the model and / or results files.

5 CONCLUSION

Two TUFLOW models of the Lower Pine River catchment were developed:

i. A 5m grid resolution model for events smaller than and including the 100 year ARI event; and

ii. A 10m grid resolution model for events larger than and including the 100 year ARI event as well as the sensitivity runs and calibration.

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. The main focus of the project is delivery of the model and its outputs in digital format, therefore only a selection of results have been presented in this report. The outcomes of this work is being used in stage 3 of the RFD to analyse and assist with managing flood risk in the Lower Pine River 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 (2010b): *Design Rainfall - Burpengary Pilot Project*

APPENDIX A

APPENDIX A: INFRASTRUCTURE DATA ASSESSMENT REPORT

A part of BMT in Energy and Environment

Infrastructure Data Assessment Report
Lower Pine River Catchment
Regional Floodplain Database Stage 3

R.B18521.001.01.LPR_Infrastructure_Data_Report.doc

January 2013

Infrastructure Data Assessment Report Lower Pine River Catchment Regional Floodplain Database Stage 3

Prepared For:	Moreton Bay Regional Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Project Manager :	Anne Kolega / Richard Sharpe
Client :	Moreton Bay Regional Council
Client Contact:	Hester van Zijl / Steve Roso
Client Reference	Regional Floodplain Database Stage 3

Title :	Infrastructure Data Assessment Report for the Lower River Catchment as part of Moreton Bay Regional Council's Regional Floodplain Database Stage 3
Author :	Anne Kolega / Richard Sharpe
Synopsis :	Infrastructure Data Assessment Report including the review and prioritisation of available and required infrastructure data for the detailed modelling of the Lower Pine River catchment for Moreton Bay Regional Councils RFD Stage 3.

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1 INTRODUCTION

1.1 Background

Moreton Bay Regional Council (MBRC) is currently undertaking Stage 3 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.

Stage 3 includes the detailed hydrologic and hydraulic modelling of 2 packages, which cover the Lower Pine River (LPR) catchment and the rivers and creeks that are also part of Brisbane City Council's (BCC) Local Government Area. This *Infrastructure Data Assessment report* forms part of the hydrologic and hydraulic modelling report of the Lower Pine River catchment.

1.2 Scope

The scope of this report can be summarised in the following key points:

- Review available information provided by MBRC and the Drainage Waterways Coastal Planning Unit (DWCP); this data included information from the Department of Environment and Resource Management (DERM);
- Undertake a gap analysis based on the broadscale model results and other data provided by MBRC (i.e. local roads, state controlled roads);
- Identify infrastructure data that need to be collected for the detailed modelling;
- Prioritise the additional infrastructure data required; and
- Document methodology and required infrastructure data in an Infrastructure Data Assessment report.

1.3 Objective

The objective is to prioritise additional required data, based on the philosophy that detailed information is to be collected to develop a high quality model, with the 100 year ARI flood behaviour being of particular interest.

Priority A data involves data that is critical for a high quality model; Priority B is to include all remaining data for which assumptions, such as field inspection and desktop measurements, could be used *and* achieve a relatively high quality model.

This report has been provided to MBRC for review and further negotiation of required data considering the broader RFD objectives and potential budget constraints of the RFD.

2 AVAILABLE DATA FOR GAP ANALYSIS

The infrastructure data assessment was based on the following data being available at commencement of the study:

- Topographic data: The topography is based on LiDAR (**Li**ght **D**etection **A**nd **R**anging) data collected in 2009 and provided by Department of Environment and Resource Management (DERM);
- Hydrography dataset provided by MBRC in July 2011;
- State controlled roads and minor roads GIS layers provided by DERM in July 2011;
- As-constructed bridge plans for selected structures provided by MBRC where available;
- The structure information provided as part of the 1d_nwk_LPR and 2d_lfcsh_LPR layers from the broad-scale model developed by Worley Parsons. This structure data was based on plans, visual inspections and survey;
- The culvert survey information provided by MBRC, locating additional structures not included in the broadscale model, which have been surveyed by MBRC;
- The structure inspection information provided by MBRC, identifying additional structures, not included in the broadscale model that have been inspected by MBRC; the inspection will not be a detailed survey due to difficulties in the access, however it will provide photographs and measurements, which have proven to be helpful for modelling. MBRC has undertaken the site inspection on the 8th July 2011 and provided the collected data;
- The flood extents from the broad-scale model were utilised to locate potential structures; and
- A site visit undertaken by BMT WBM in the Lower Pine River catchment.

3 DATA CAPTURE METHODOLOGY

3.1 General Methodology

This section describes the methodology for the gap analysis and data prioritisation. All available data outlined in Section 2 were converted into GIS layers and reviewed. The roads layers were overlaid with the broadscale flood extent in the 1 in 100 year flood event to locate waterway structures. Each crossing was marked in locations where there was not already a previously modelled structure and where council had not already identified a structure as needing to be surveyed (gap analysis).

The data prioritisation was undertaken based on the following considerations and assumptions:

- Availability of accurate structure data from the broadscale model. These structures have been allocated priority A;
- Availability of additional structure data identified and already surveyed by MBRC. These have been allocated priority A;
- Culverts from the broadscale model with diameters of less than 0.6m have been allocated priority B; and
- Structures which were not included in the broadscale model but which council has identified for inspection (due to difficulty in access, not fully surveyed). These have been allocated priority B.

The outcomes of the gap analysis and prioritisation are presented in the section below.

3.2 Data Prioritisation (A and B)

3.2.1 Bridges and Culverts

The gap analysis in the Lower Pine River catchment identified the following summary of available data and structure locations for potential additional data collection:

- 270 culverts were included in the broadscale model (1d_nwk_LPR layer). Of these, 10 have a diameter of less than 0.6m and have been prioritised as category B. The remaining 260 culverts have been prioritised as category A.
- 86 structures (bridges or culverts) were included in the broadscale model (2d_lfcsh_LPR layer). Of these, as-constructed bridge plans were provided for 6 structures. These have been reviewed and compared with the structures included in the broadscale model. Updates to the modelled structures will be undertaken as part of the detailed model development, where required. These 86 structures have been prioritised as category A.
- 20 culverts (not included in the broadscale model) were identified by the MBRC as critical structures to be surveyed were reviewed and have been prioritised as category A.
- 17 structures (not included in the broadscale model) were selected by the MBRC to be inspected were reviewed. Due to their location outside the broadscale flood extent or at the flood fringe, these structures were prioritised as category B. Of these 17 structures, photos and some measurements for 13 of the structures have been provided by MBRC, 3 structures could not be found or were not accessible and for one location dimensions were provided without a

photograph. For some of these inspected structure locations, MBRC also provided structure data from their existing stormwater asset database (LPR_GIS_Stormwater_pipes.TAB).

- 16 additional structure locations were identified by BMT WBM, where no available information was available from the broadscale model and from MBRC's review, based on the road and flood extent data available (LPR_gap_analysis_003.TAB). Out of these 16 locations, 8 were categorised with priority A and the remaining 8 were categorised with priority B. Figure A-1 in the Appendix provides a summary of the available and previously selected structures to be surveying or inspected by MBRC and the additional structures identified by BMT WBM from the gap analysis.

Based on the data review and gap analysis the bridges and culverts were prioritised as follows:

- a

The data prioritisation undertaken in category A and B are illustrated in Figure A-2 in the Appendix. The associated digital data are also being provided to MBRC.

3.2.2 Channels

A number of channels were identified in the Lower Pine River catchment. The locations have been digitised and are illustrated in Figure A-1. Channel information is currently being sourced from MBRC.

3.2.3 Detention Basins and Dams

The Sideling Creek Dam (Lake Kurwongbah) and Lake Samsonvale are part of the Sideling Creek and Upper Pine River catchments, respectively. These two catchments discharge into the Lower Pine River catchment.

No other major detention basins were identified in the Lower Pine River catchment; minor basins and/or wetlands have been identified based on the DEM. One of the larger minor basins is located between Kremzow Road and Old North Road in the Four Mile Creek catchment, discharging into South Pine River.

3.2.4 Bathymetry

Bathymetry was collected by MBRC in 2005. The bathymetry survey extends from Bramble Bay to Gympie Road on the North Pine and South Pine River. Therefore, no additional bathymetry data is required.

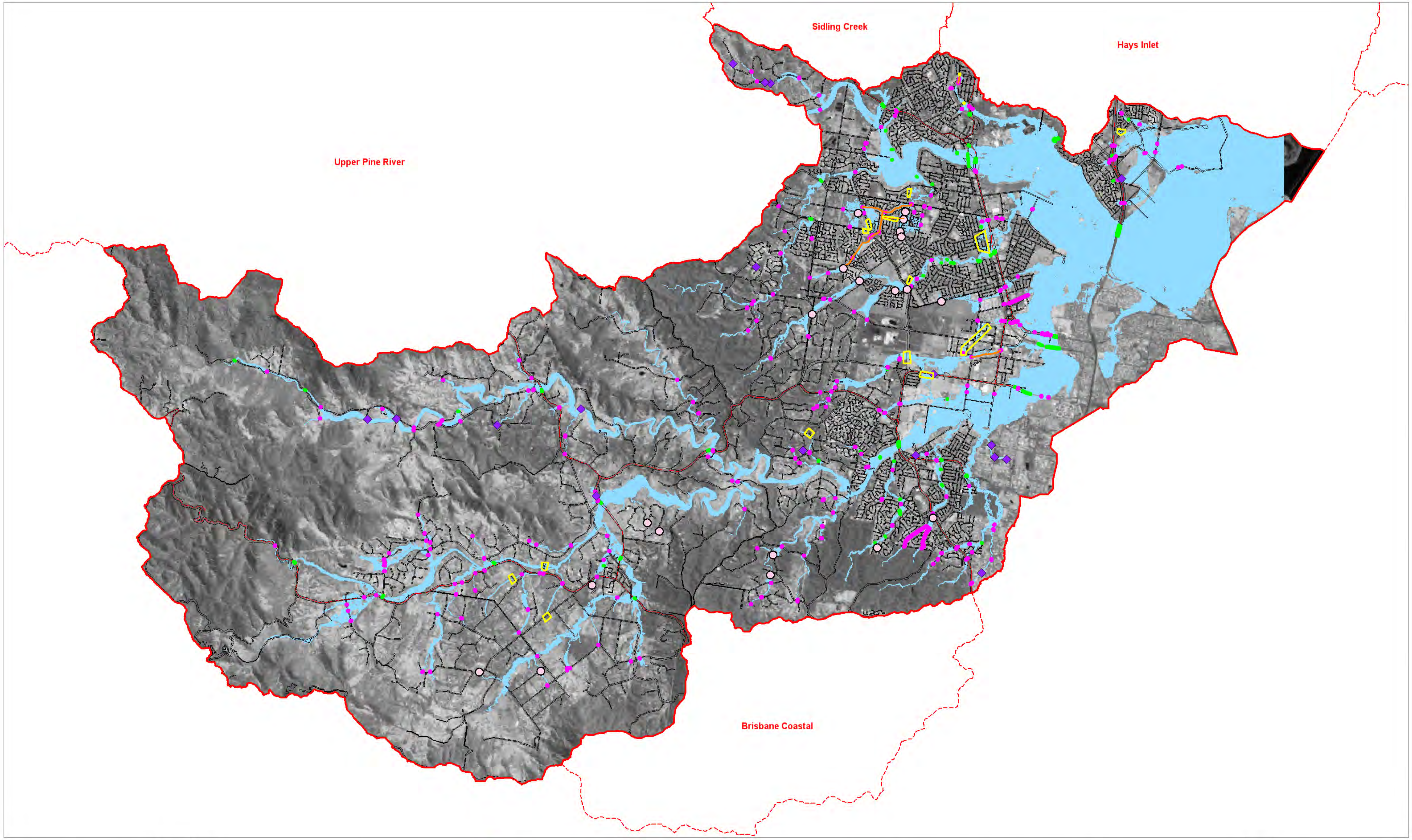
4 CONCLUSION AND RECOMMENDATION

This Infrastructure Data Assessment report has summarised available structure data as well as locations where additional structure data is required. All structures have been prioritised in two categories.

Priority A data involves data that is critical for a high quality model; priority B data includes culverts with an opening smaller than 600mm and all remaining data for which assumptions, such as field inspection and desktop measurements, could be used to achieve a relatively high quality model.

The development of the Regional Floodplain Database (RFD) will also be used for other asset data management purposes by Moreton Bay Regional Council. Therefore this is a good opportunity for MBRC to collect additional data on waterway structures.

APPENDIX A: MAPS



LEGEND

- Lower Pine River Catchment
- Road Reserves
- Structures Inspected by MBRC
- Structures Surveyed by MBRC
- Channels Identified by BMT WBM
- 1D Structures provided by MBRC
- 2D Structures provided by MBRC
- State Controlled Roads
- Minor Roads and Road Reserves
- Additional Structure Locations Identified by BMT WBM
- Flood Extent (derived from the broadscale model)

Title:
Infrastructure Data Summary - Lower Pine River

Figure: A-1

Rev: A

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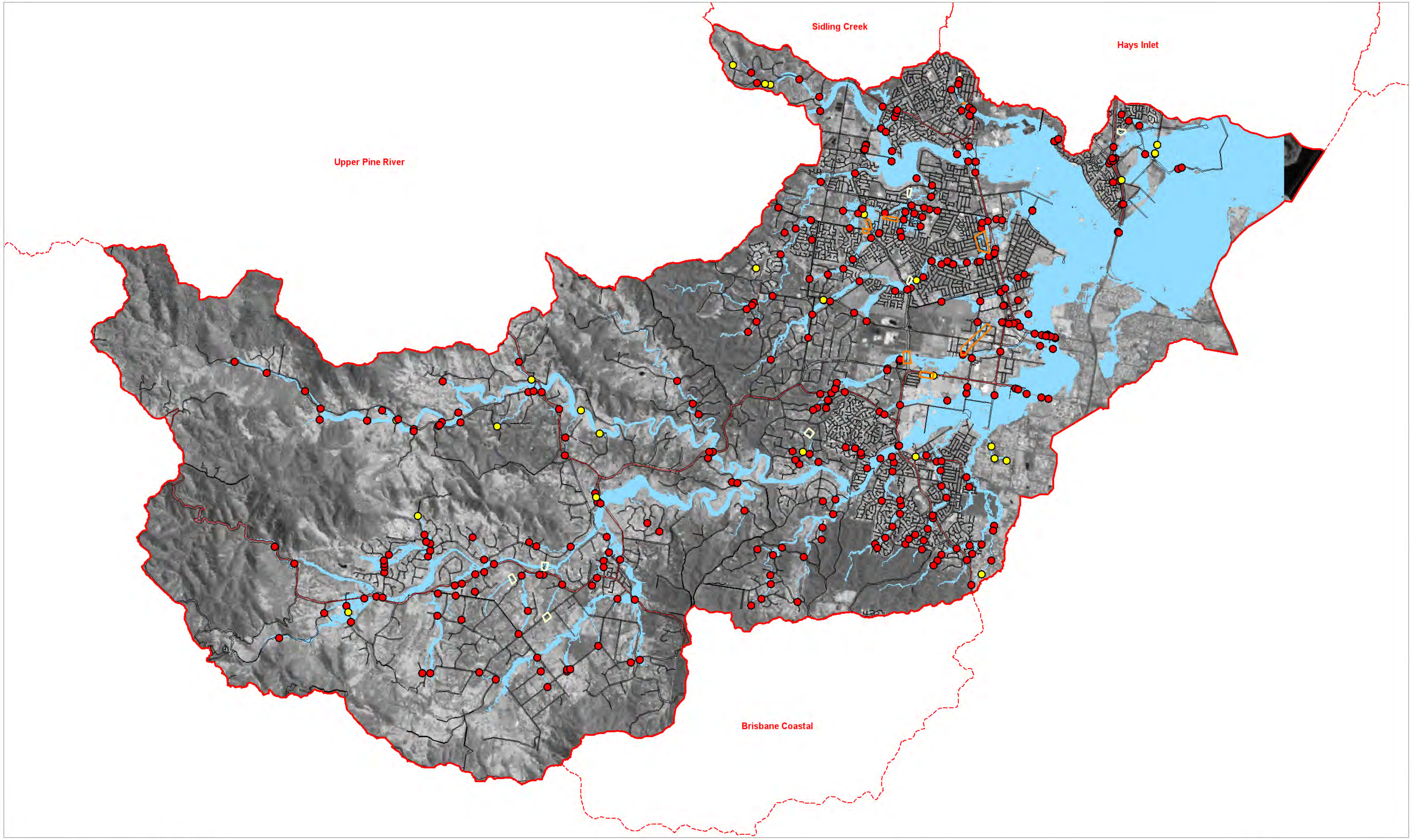
Filepath : I:\B18521_I_AK_MBRC_RFD_Stage_3\DRG\FLD_003_110803 Lower Pine Infrastructure Data.wor



LEGEND

- Lower Pine River Catchment
- Road Reserves
- Structure Priority A
- Structure Priority B
- State Controlled Roads
- Minor Roads and Road Reserves
- Additional Structures Priority A Identified by BMTWBM
- Additional Structures Priority B Identified by BMTWBM
- Flood Extent (derived from broadscale model)

Title:

Data Prioritisation Map - Lower Pine River

Figure: **A-2**

Rev: **A**

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APPENDIX B: SITE VISIT PHOTOS

Figure B- 1 Bruce Highway Bridge, Pine River

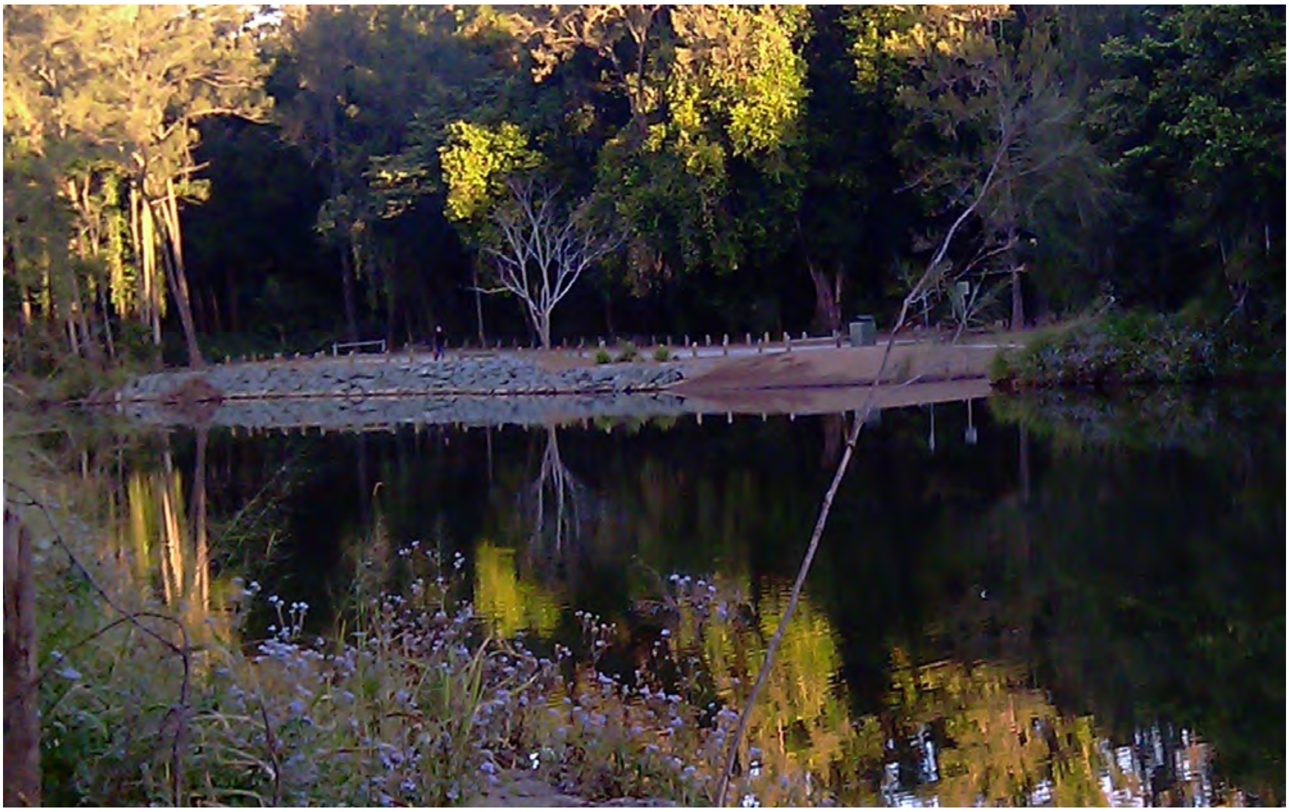

Figure B- 2 Bunya Crossing, South Pine River

Figure B- 3 Eatons Crossing Road Bridge, Cedar Creek

Figure B- 4 Cedar Creek, under Eatons Crossing Road Bridge

Figure B- 5 Eatons Crossing Road Bridge, Cedar Creek, Eastern Channel

Figure B- 6 Gympie Road Bridge, North Pine River

Figure B- 7 Gympie Road Railway Bridge, North Pine River

Figure B- 8 Youngs Crossing Road, North Pine River

Figure B- 9 Cedar Creek Road, Downstream (courtesy of MBRC)

Figure B- 10 Private Road close to Cedardell Ct, Upstream (courtesy of MBRC)

Figure B- 11 South Pine Road, Upstream (courtesy of MBRC)

Figure B- 12 Wagner Rd, Downstream (courtesy of MBRC)

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APPENDIX B

APPENDIX B: HYDROGRAPHY REVIEW REPORT

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Our Ref: AK: L.B18521.004.LPR_Hydrography_Review.doc

19 August 2011

Hester van Zijl
Waterways & Coastal Planning, Infrastructure Planning
Moreton Bay Regional Council

Attention: Hester van Zijl

Dear Hester,

RE: Hydrography Review Report for the Lower Pine River Catchment Regional Floodplain Database Stage 3

1 Background

Moreton Bay Regional Council (MBRC) is currently developing a Regional Floodplain Database (RFD). The RFD includes the development and storage of hydrologic and hydraulic models for the entire Local Government Area (LGA). These model input and output data will be included in a spatial database to store detailed information about flood behaviour across the region.

Stage 3 of the RFD includes the detailed modelling of 2 catchments, namely the Lower Pine River (LPR) catchment and the rivers and creeks that are also part of Brisbane City Council's (BCC) Local Government Area.

This *Hydrography Review Report* forms part of the modelling of the LPR catchment, RFD, Stage 3.

2 Scope

The scope of this hydrography review can be summarised by the following key points:

- Review the subcatchment delineation as part of Stage 1 (broadscale modelling);
- Identify areas that are to be refined, taking the recommendations already made by MBRC into account; and
- Propose changes and provide a report and digital data to MBRC for review.

MBRC will review the proposed changes and confirm acceptance prior to the amendment of models. This staged approach ensures that detailed Quality Assurance checks are performed and that MBRC is heavily involved in the study, which will enhance future usage of the models and data within MBRC. MBRC's review is also important to consider catchment delineation for modelling of proposed development (that MBRC is aware of to date). It also ensures consistency with MBRC's naming and identifier (ID) conventions.

3 Objective

The main objective of this task is to create a solid level of detail for future modelling within the catchment, which is consistent with MBRC's hydrography dataset and the adopted identifiers.

This task focuses on the supply of a **digital** dataset, which can be utilised and amended by MBRC.

4 Hydrography Review Data

The following data was utilised for this assessment:

- Hydrography dataset (catchment delineation, reaches and junctions) provided by MBRC in July 2011;
- The 100y flood extents from the Stage 1 broad-scale model sub-project were utilised to locate potential structures;
- Overland flow layer provided by council;
- 7 locations identified by MBRC as possible sites for additional sub-catchment breakdowns; and
- Digital Elevation Model for the catchment provided by MBRC and based on LiDAR data collected in 2009 and derived from the Department of Environment and Resource Management (DERM).

5 Methodology

The original subcatchment delineation was reviewed utilising the data outlined above. In the 7 locations where MBRC recommended a sub-catchment breakdown, this was done. In the upper catchment there are a number of rural sub-catchments with little or no development. These subcatchments were not refined as the extra detail was not considered necessary. However in several more developed sub-catchments where it was observed that significant overland flow extended further than the 100y flood extent, these were broken down further.

6 Proposed Changes

Subcatchments that were considered too coarse were subdivided, thereby refining the subcatchment delineation and the associated future model output and flood information across the Lower Pine River catchment. The proposed changes to the subcatchments are illustrated in Figure 1. Figures 1 also show the original subcatchment delineation and the flood extent from the broadscale model.

Accompanying this report, a digital dataset has been provided to MBRC on 19 August 2011

- *LPR_Hydro_Catchments_Minor_revised_002.TAB*, comprising all sub-catchments including the proposed subcatchments; and
- *LPR_Hydro_Catchments_Minor_subdivided_002.TAB* including only the catchments that we propose to change within the catchment.

The following subcatchments are proposed to be subdivided:

Sub-catchment Identifier	Catchment	Minor Basin	Subdivision Recommended by:	Number of Divisions
FMC_01_13657	Four Mile Creek	Lower Pine River	MBRC	2
TOD_01_04496	Todds Gully	Lower Pine River	MBRC	2
KFC_02_00000	Kingfisher Creek	Lower Pine River	MBRC	4
SPR_26_00000	South Pine River	Lower Pine River	MBRC	4
BER_03_00000	Bergin Creek	Lower Pine River	MBRC	4
BER_01_02235	Bergin Creek	Lower Pine River	MBRC	2
YEB_04_00317	Yebri Creek	Lower Pine River	BMT WBM	4
YEB_04_00317	Yebri Creek	Lower Pine River	BMT WBM	4
NPR_49_00829	North Pine River	Lower Pine River	BMT WBM	5
FMC_07_00872	Four Mile Creek	Lower Pine River	BMT WBM	2
OMC_01_02640	One Mile Creek	Lower Pine River	BMT WBM	2
BHC_01_07934	Bald Hills Creek	Lower Pine River	BMT WBM	2
COU_02_00000	Coulthards Creek	Lower Pine River	BMT WBM	3
SPR_01_09076	South Pine River	Lower Pine River	BMT WBM	2
FMC_02_00566	Four Mile Creek	Lower Pine River	BMT WBM	2
CON_01_07374	Conflagaration Creek	Lower Pine River	BMT WBM	2
FMC_01_16828	Four Mile Creek	Lower Pine River	BMT WBM	2
SPR_35_00000	South Pine River	Lower Pine River	BMT WBM	2
SPR_33_05420	South Pine River	Lower Pine River	BMT WBM	4
KFC_03_00298	Kingfisher Creek	Lower Pine River	BMT WBM	2
SPR_23_00000	South Pine River	Lower Pine River	BMT WBM	3
SPR_01_16606	South Pine River	Lower Pine River	BMT WBM	3
CED_13_04708	Cedar Creek	Lower Pine River	BMT WBM	2
SPR_21_00336	South Pine River	Lower Pine River	BMT WBM	2
SAM_01_04779	Samford Creek	Lower Pine River	BMT WBM	3

7 Recommendation

We recommend that MBRC reviews the proposed changes and provides feedback on the proposed changes. Based on this feedback we will adopt a final catchment breakdown and update the hydrologic model based on the agreed catchment breakdown as necessary.

8 Reference

BMT WBM (2010), Hydraulic Modelling (Broadscale) Regional Floodplain Database, Stage 1, Sub-project 1D prepared for Moreton Bay Regional Council; and

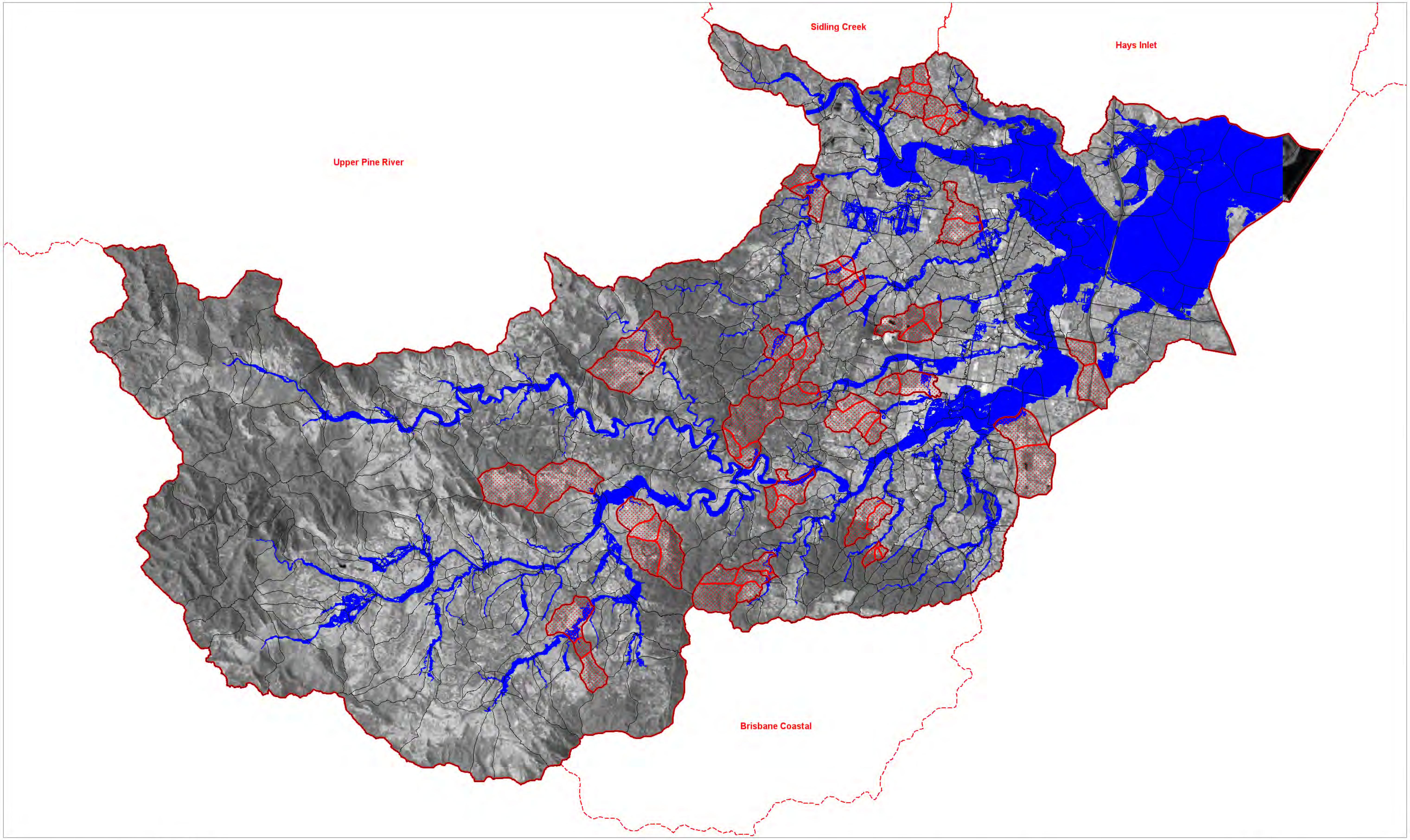
Please contact me should you wish to discuss the report.

Yours faithfully
BMT WBM Pty Ltd

Richard Sharpe
Senior Flood Engineer

Enclosed:

Figure 1: Hydrography Review and Proposed Changes Lower Pine River Catchment



LEGEND

Lower Pine River Catchment

Stage 1 Flood Extent (100 Year ARI)

Original Catchment Delineation

Proposed Catchment Delineation

Title:

Hydrography Review and Proposed Changes
Lower Pine River Catchment

Figure: **1**

Rev: **A**

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