Regional Floodplain Database:

Hydrologic and Hydraulic Modelling - Brisbane Coastal Creeks (BCC)

Moreton Bay Regional Council

Emergency Management Queensland (EMQ)

Australian Government
Attorney-General's Department
Emergency Management Australia

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aurecon

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1 Introduction

Moreton Bay Regional Council (MBRC) is delivering a Regional Floodplain Database (RFD) in support of their flood risk management, considering emergency response, development control, strategic landuse and infrastructure planning. The MBRC was recently formed under local government amalgamations and is responsible for Caboolture, Pine Rivers, Redcliffe and Bribie Island. The RFD project focuses on the northern sector as a key growth area for South-East Queensland.

The project is being funded by MBRC, Emergency Management Queensland (EMQ) and Emergency Management Australia (EMA) as part of the Disaster Resilience Program and will provide:

- A comprehensive and consistent description of flood behaviour across the region
- Strategies for management of any flooding problems identified
- A system/process to store and manage this information and keep it up-to-date

Stage 1 of the project was completed in July 2010 and involved a number of sub-projects. These projects delivered consistent processes and protocols for the detailed hydrologic and hydraulic model development. A key sub-project involved the development of broadscale hydrodynamic models for each minor basin to provide general understanding of flooding mechanisms and allow prioritisation of data capture.

Stage 2 (current stage) of the project involves the development of detailed hydrologic and hydraulic models for each minor basin.

Stage 3 will build on the detailed models and “add value” through assessment of flood damages and community resilience measures.

This report discusses the study data, methodology and results for the Stage 2 detailed modelling of the Brisbane Coastal Creeks (BCC) minor basin for the RFD.

This basin covers an area approximately 40 km^2 and incorporates the upper ends of the Kedron Brook and Cabbage Tree Creek catchments. Approximately 70% of the Kedron Brook catchment falls within the Brisbane City Council region. The basin is largely developed through the middle and lower reaches and includes the residential suburbs of Everton Hills, Arana Hills, Keperra, Ferny Hills, Ferny Grove and Upper Kedron.

1.1 Scope

The detailed modelling of the Brisbane Coastal Creeks minor basin will provide Council with an understanding of flood behaviour for the range of flood events between the 1 year Average Recurrence Interval (ARI) and the Probable Maximum Flood (PMF) event.

The detailed modelling converts broadscale hydrologic and hydraulic models developed as part of Stage 1 into detailed models. This conversion is done using the approaches and methodologies developed during Stage 1 and through inclusion of the latest topographic/bathymetric data and key hydraulic features, such as culverts, bridges and footbridges.

The detailed models are then used to undertake detailed catchment analysis, calibration (where possible) and flood scenario modelling. The scenario modelling includes sensitivity analysis to a range of catchment changes. The results provide detailed flood information such as levels, depths, velocities, hazard, flood extents and flood timing.

1.2 Objectives

Key objectives of this study are as follows:

- Convert the broadscale hydrologic and hydraulic models into detailed models
- Undertake detailed catchment analysis for the 1 year ARI to PMF events for current catchment conditions
- Assess a range of scenarios including climate change, land use change, vegetation change, culvert blockage and storm tide events
- Provide Council with flood mapping to be incorporated into their GIS system

1.3 General approach

The general approach for this study is summarised as follows:

- Familiarisation with background materials and models
- Review of floodplain infrastructure and bathymetric data and identification of additional data required
- Review of broadscale catchment and stream definition (hydrography) and recommendation of changes
- Review of historic flood studies, rainfall, stream gauge, flood mark and catchment data; assessment of calibration and validation feasibility; and recommendation of suitable calibration/validation events
- Review of broadscale land use and topographic data and recommendation of modifications
- Review and update of the WBNM hydrologic models for existing, historic and future scenarios
- Updating broadscale TUFLOW hydraulic models to include:
  - Boundary conditions reflective of changes in hydrography and/or downstream boundary
  - Smaller grid resolution and review of active model area
  - Existing, historic and future hydraulic landuse scenarios
  - Floodplain infrastructure and bathymetry
  - Topographic modifiers for stability and key floodplain features
- Calibration and validation of the models to a single calibration and a single validation event (if possible)
- Modelling of the 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000 and PMF design events for the existing catchment
- Assessment of the MBRC Design Storm (a 100 yr ARI 15 min in 270 min 'Embedded Design Storm')
- Undertaking sensitivity testing for:
  - Varied discharges, manning's n, tailwater and culvert blockages
  - Climate change scenarios for rainfall intensity and sea level rise
  - Storm tide without any riverine flooding
  - Future landuse

- Checking of model quality for all model runs
- Preparation of a report to describe the model establishment, methodology, limitations and input data including mapping
- Collation of GIS data and model outputs for handover to Council

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 Brisbane Coastal Creeks Stage 2 models:

- 1D – Hydrologic and Hydraulic Modelling (Broadscale), sub-project 1D developed the broadscale TUFLOW models used as the basis for the detailed modelling (BMT WBM, 2010)
- 1E – Floodplain Topography (2009 LiDAR) including 1F, 2E, 2I, sub-project 1E provided the topographic information, such as model z-pts layer and digital elevation models (DEM) utilising a DEM tool developed specifically for the RFD (WorleyParsons, 2010)
- 1G – Hydrography (MBRC), sub-project 1G supplied the subcatchment delineation including streamlines and junctions (used in the WBNM model)
- 1H – Floodplain Landuse, sub-project 1H delivered the percentage impervious raster (utilised in the hydrologic model) and the roughness Manning's 'n' values and spatial definitions (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. Based on the assessment undertaken in this sub-project, the historical flood events (May 2009 and February 1999) were selected for model calibration and/or verification
- 2B – Hydrologic and Hydraulic Modelling (Detail), sub-project 2B defined model naming conventions and model protocols to be used in the detailed modelling (BMT WBM, 2010)
- 2C – Floodplain Structures (Culverts), sub-project 2C defined the process to be used for modelling of culverts on the floodplain (Aurecon, 2010)
- 2D – Floodplain Structures (Bridges), sub-project 2D defined the process to be used for modelling of bridges on the floodplain (Aurecon, 2010)
- 2F – Floodplain Structures (Trunk Underground Drainage), sub-project 2F defined the process to be used for modelling of trunk underground drainage on the floodplain (Aurecon, 2010)
- 2G - Floodplain Structures (Basins), sub-project 2G consolidated defined the process to be used for modelling of detention basins on the floodplain (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 the February 1999 event (utilised in the hydraulic model) (SKM, 2010)
- 2K – Flood Information Historic Flooding, sub-project 2K collected flood levels for the historic May 2009 and February 1999 flood events (GHD, 2010)
- 2L – Design Rainfall and Infiltration Loss, sub-project 2L defined the rainfall parameters to be adopted in the WBNM modelling (WorleyParsons, 2010)
- 2M – Boundary Conditions, Joint Probability and Climate Risk Scenarios, sub-project 2M defined the boundary conditions and provided recommendations in regards to joint probability (ie 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, 2012)
- 2N – Floodplain Parameterisation, sub-project 2N provided recommendations for the floodplain parameters to adopt, such as a range of values for various impervious percentages for various landuse types (ie residential or rural landuse, dense vegetation), a range of values for various roughness types (ie long grass, dense vegetation) and structure losses (SKM, 2012)

2 Available data

The following list summarises the data available for the study:

- **Aerial imagery** – imagery across the entire catchment was supplied by MBRC. This included Brisbane City Council aerial imagery for the southern 60% of the Brisbane Coastal Creeks minor basin which falls in the Brisbane City Council area

- **Hydrography** – delineation of major basins, minor basins, major catchments, minor sub-catchments, reaches and junctions were provided by MBRC

- **Floodplain Landuse** – polygons for buildings, footpaths, roads, urban blocks, vegetation and waterbodies were provided by MBRC. These were developed by SKM as part of RFD Stage 1 and only covered the MBRC part of the minor basin

- **Floodplain Topography** – A 2.5 m DEM and model z-points (on a 5 m grid) were provided by Worley Parsons. The DEM Tool developed during Stage 1 was used to prepare these datasets based on LiDAR data collected in 2009 and modifiers (breaklines) developed by Aurecon

- **Woolshed Grove Development Topography** – a design surface for the Woolshed Grove development was provided by MBRC

- **Broadscale TUFLOW Model** – the broadscale Kedron Brook model was provided by MBRC. This model was developed by Cardno Lawson Treloar in 2008

- **Detailed BUR Model** – the detailed model of the Burpengary (BUR) minor basin was provided by MBRC. This model was developed by BMT WBM as part of RFD Stage 1

- **WBNM Model** – the WBNM model of the minor basin was provided by MBRC

- **Materials values** – materials values for the Stage 2 models were provided by MBRC

- **Rainfall, Stream Gauge and Historic Flood Information** – rainfall and stream gauge data was provided by MBRC. Historical flood information was also provided by MBRC

- **Floodplain Structures** – floodplain structure information was provided from a range of sources including:
  - Completed 1d_nwk and 2d_lfcsh files for QR and TMR bridges (as developed by Aurecon under a separate commission)
  - Details (plans) of a number of Council owned bridges from MBRC and Brisbane City Council
  - Existing GIS database information for some existing culverts from MBRC and Brisbane City Council
  - Detailed survey undertaken by MBRC surveyors as part of this study
  - Photos of various structures captured during site visits

- **Storm Tide Tool** – the storm tide hydrograph generator developed by Cardno Lawson Treloar as part of Council's storm tide study was provided by MBRC

- **Historical Flood Study Information** – the following historical flood study reports were provided by MBRC and Brisbane City Council
  - Kedron Brook Flood Study undertaken by Connell Wagner in 1995
  - Kedron Brook Design Events Flood Study DRAFT undertaken by Cardno Lawson Treloar in 2008
  - Kedron Brook Flood Assessment and Design and Extreme Flood Mapping undertaken by Cardno Lawson Treloar in 2008
  - Kedron Brook Flood Study undertaken by Cardno Lawson Treloar in 2009
  - Cabbage Tree Creek Flood Model Update Draft undertaken by JWP in 2006
  - Cabbage Tree Creek Extreme Event Report undertaken by JWP in 2007

- **Stage 1 Reports** – reports from the various consultants involved in Stage 1 of the RFD project were provided by MBRC

- **Example folder structure and run files** – these were provided by MBRC based on the outputs developed by BMT WBM for the RFD Stage 1

- **Mapping colour profiles** – these were developed by BMT WBM in Stage 1 of the RFD and provided by MBRC

- **Future landuse scenario** – hydrography (sub-catchments) files for the future landuse scenario were provided by MBRC

- **Impervious area raster files –** these were provided by MBRC and were developed by SKM during RFD Stage 1

3 Methodology

3.1 Data review

3.1.1 Infrastructure data assessment

At the outset of the project, the infrastructure and bathymetric data requirements for modelling of the Brisbane Coastal Creeks minor basin were assessed. This included a data gap analysis for bridges, culverts, detention basins and trunk drainage infrastructure and also for below-water bathymetric details. Infrastructure and bathymetric details were then assigned a priority (A or B) based upon their likelihood of impacting upon the model predictions.

The infrastructure was prioritised according to the significance of location and potential impacts on the hydraulic model results. Key factors which were taken into account were proximity to broadscale flood extents, surrounding land use and whether the structure was beneath a major road or a railway. The creek bathymetry was prioritised according to the size (width) of the reach, the size of the contributing catchment and proximity to urban areas.

Table 1 presents a summary of the structures and bathymetric reaches which were identified and prioritised. Within the BCC minor basin, although the creek invert levels may not be well represented in the LiDAR data, the channels themselves are well represented. The additional conveyance capacity which would be provided by accurate representation of the creek inverts is expected to be minimal; therefore it was not recommended that additional bathymetric data be captured for the BCC minor basin.

Table 1 | Infrastructure and bathymetric data

Data Item	Priority A	Priority B
Structures (culverts, bridges and trunk drains)	45	31
Bathymetric reaches	0km	0km

Following the gap analysis and the data prioritisation, a composite assessment of survey requirements was undertaken and provided to Council. A copy of the Data Infrastructure Assessment Report is included in Appendix A.

3.1.2 Calibration and validation

The feasibility of carrying out calibration and validation for the Brisbane Coastal Creek models was assessed. This was based on the availability of stream gauge, daily rainfall, pluviograph rainfall and historic flood mark data. It was determined that this data was available for four events, with stream gauges located near the downstream end of each creek. No rating curve data was available for the stream gauges; therefore this process would be limited to joint calibration of the hydrologic and hydraulic models at their downstream boundaries. Historic flood mark (Brisbane City Council Maximum Height Gauge) data was available for six locations within the Kedron Brook catchment and no historical flood mark data was available within the Cabbage Tree Creek catchment for the four events. Due to these data limitations, no calibration event was selected. The October 2010 event was selected as the validation event.

A copy of the Calibration and Validation Feasibility Report is included in Appendix C.

3.1.3 Hydrography

The hydrography provided by MBRC was reviewed to ensure the following two key objectives were supported:

- Catchments were sufficiently defined to ensure accurate representation of contributing areas at key points of interest (urbanised areas, drainage control points, areas marked for future development)
- Hydraulic model objectives were supported through appropriate flow reporting locations, noting the following:
  - The hydraulic model applies inflow distributed across the sub-catchment, effectively “filling” the sub-catchment from the lowest point
  - The hydraulic model will advise on flood immunity of major roads accessing key urban areas

A number of recommendations were made, including:

- Junctions be included at structures where no junction had previously been defined
- Sub-catchments which cover only a section of road should be modified so the inflow is not applied to the road surface in the hydraulic model, which would in turn show the road to be inundated

A copy of the Hydrography Review Report for the Brisbane Coastal Creeks minor basin is included in Appendix B.

Upon receipt of the final updated hydrography from MBRC, the sub-catchment fraction impervious values were updated using the process defined by SKM (2010) in their *Existing, Historic and Future Floodplain Land Use* report. This final hydrographic dataset was used to develop the WBNM model.

3.2 Hydrologic model

The WBNM model supplied by MBRC was adopted for use in the hydrologic modelling. The hydrologic model setup process is described in Appendix G.

Hydrologic modelling was undertaken for the following events:

- **Design events**: 1, 2, 5, 10, 20, 50 and 100 year ARI
  The 0010, 0015, 0030, 0045, 0060, 0090, 0120, 0180, 0270, 0360, 0540, 0720, 1080, 1440, 1800, 2160, 2880, 4320 minute durations were run for each event
- **Embedded design storm (EDS)**: the 0015 minute burst in a 0270 minute duration event was run for the 1, 2, 5, 10, 20, 50 and 100 year ARI events

- **Extreme events**: 200, 500, 1000 and 2000 year ARI
  The 0015, 0030, 0045, 0060, 0090, 0120, 0180, 0360 0720, 1440, 2160, 2880 and 4320 minute durations were run for each event
- **PMP event**: The 0015, 0030, 0045, 0060, 0090, 0120, 0150, 0180, 0240, 0300, 0360, 0720, 1440, 2160, 2880 and 4320 minute durations were analysed
- **Climate change event** (S4): The EDS was run with IFD rainfall intensities increased by 12%
- **Future landuse scenario** (S11): The EDS was run with percentage impervious changed to represent the future landuse scenario

The local catchment flows derived from the hydrologic model were used as inputs to the hydraulic model. No total catchment flows were used as input to the hydraulic model.

3.3 Hydraulic model

3.3.1 Model software

The following text describes the TUFLOW modelling package. This text has been copied from Section 3.2.1 of the *Hydraulic Modelling (Detail) Regional Floodplain Database Sub-Project 2B Report* (BMT WBM, 2010).

"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 a catchment. 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 5 m grid TUFLOW model was prepared in accordance with the requirements of MBRC. The model topography was developed by Worley Parsons using the DEM tool (Worley Parsons, 2010) and provided for use in this study, in both DEM and z-point format. The following information was included in the DEM tool:

- 2009 ALS data used as the base information across the entire MBRC area
- Stream breakline modifiers, as developed by Aurecon, were used to create continuous stream paths for the following stream lengths:
  - 4.1 km of Cabbage Tree Creek
  - 7.1 km of Kedron Brook

In addition to the z-points provided by the DEM tool, a number of modifiers were incorporated directly into the model, including:

- Z-points to represent the Woolshed Grove development, which was developed after the capture of the 2009 LiDAR
- Z-shapes for the road and rail embankments in a number of locations where these were not included in the 2009 ALS data
- Stability modifiers, primarily at culvert inlet and outlets

Figure 3-1 illustrates the Brisbane Coastal Creeks model layout. Additional details on the model setup are provided in Appendix D.

3.3.3 Model structures

Structures were represented using three different approaches, as recommended in the Floodplain Structures report (Aurecon, 2010):

- Culverts were modelled as 1D structures using the 1d_nwk approach
- Bridges were modelled as 2D structures using the 2d_flcsh approach

To solve stability issues, the culvert structure beneath Canvey Road in Upper Kedron was modelled using the 2D approach.

Table 2 | Number of modelled structures

Structure Type	Number of Modelled Structures
2D bridges	14
1D culverts	35
2D culverts	1

Culvert exit and entry loss coefficients were applied as per the recommendations of the SKM Floodplain Parameterisation report (2012).

3.3.4 Landuse mapping

Landuse polygons were used to define the spatially varying hydraulic roughness within the hydraulic model. In total, eleven different types of landuse were mapped and provided by SKM as part of the Floodplain Parameterisation project (2012). These polygons were reviewed and extended to cover the Brisbane City Council areas of the model. The final adopted landuse map is presented in Figure 3-2.

Manning's n roughness parameters were determined during the calibration and verification process. The adopted values are presented in Table 3.

Table 3 | Hydraulic model landuse categorisation

Landuse Type	Manning's n Roughness Coefficient
Dense vegetation	Depth varying: 0.090 – 0.180
Medium dense vegetation	Depth varying: 0.075 – 0.150
Low grass/grazing	Depth varying: 0.025 – 0.250
Reeds/swamp	0.080
Crops	0.040
Urban Blocks (> 2000 m2)	0.300
Buildings	1.000
Roads	0.015
Footpaths	0.015
Waterbodies – Creeks	0.030
Waterbodies – Rivers	0.030

3.3.5 Model boundaries

The WBNM hydrologic model results were used to provide inflows to the hydraulic model for all design, extreme, PMF and sensitivity events, as discussed in Section 3.2. 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.

Water level-discharge (QH) relationships were used as the downstream boundary conditions. Three separate conditions were used at the downstream end of Cabbage Tree Creek, the downstream end of Kedron Brook and the extreme event breakout to the south of Kedron Brook across Northmore Street. These conditions used the automatic QH relationship boundary calculation within TUFLOW and were based upon very flat slopes of 0.5%, 0.1% and 0.1% respectively.

3.4 Model calibration and validation

Calibration of the BCC models was not undertaken due to limitations with the available data. Validation of the models to the October 2010 event was carried out. The calibration and validation process which was undertaken for other minor basins provided model parameters for adoption in the BCC model validation, including:

- WBNM C value = 1.6
- Manning's n values as described in Table 3

3.5 Design flood events

This section describes the design event conditions (including design, extreme and PMF events as identified in Section 3.2) which were analysed using the hydraulic models. Design storm events are hypothetical events that are 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

A detailed assessment of the hydraulic model critical storm durations for the 10 year ARI, 100 year ARI and PMF events was undertaken using the following process:

- Hydrologic modelling of the 0010, 0015, 0030, 0045, 0060, 0090, 0120, 0180, 0270, 0360, 0540, 0720, 1080, 1440, 1800, 2160, 2880 and 4320 minute durations for the 10 and 100 year ARI events and the 0015, 0030, 0045, 0060, 0090, 0120, 0150, 0180, 0240, 0300, 0360, 0720, 1440, 2160, 2880 and 4320 minute durations for the PMP event
- Hydraulic modelling of the above events using the 5 m model for the 10 year ARI and the 10 m model for the 100 year ARI and PMF events
- Processing of the model results to create an overall peak water level envelope from all durations and a map showing the spatial extents of the critical durations
- Selection of durations (two or three) which cover the most widespread and developed areas
- Calculation of the peak water level from the selected durations
- Comparison and mapping of peak water level differences between the overall peak and the peak from the selected durations
- An iterative process covering the above three steps was undertaken to select the critical durations producing the least differences over the largest area
- The remainder of the events (ARIs) were then modelled for the selected critical durations

Table 4 presents the selected critical durations and the events to which they were applied. Figure 3-3, Figure 3-4 and Figure 3-5 show the comparisons between the overall peak water levels and the selected duration peak water levels for the 10 year ARI, 100 year ARI and PMF events respectively.

Table 4 | Critical duration selection

Assessment Event	Selected Critical Durations	Adopted Events
10 year ARI	0060, 0120, 0180	1, 2, 5, 10 and 20 year ARI
100 year ARI	0060, 0120, 0180	50 and 100 year ARI
Probable Maximum Flood	0030, 0090, 0180	200, 500, 1000, 2000 year ARI and PMF

3.5.2 Design event simulations

The Brisbane Coastal Creeks model was simulated for the return periods, grid sizes and storm durations shown in Table 5.

Table 5 | Simulated design events

Return Period (years)	Model Grid Size (m)	Modelled Durations (mins)
1, 2, 5	5	0060, 0120, 0180
10	5	0010, 0015, 0030, 0045, 0060, 0090, 0120, 0180, 0270, 0360, 0540, 0720, 1080, 1440, 1800, 2160, 2880, 4320
20, 50	5	0060, 0120, 0180
100	5	0010, 0015, 0030, 0045, 0060, 0090, 0120, 0180, 0270, 0360, 0540, 0720, 1080, 1440, 1800, 2160, 2880, 4320
200, 500, 1000, 2000	5	0030, 0090, 0180
PMF	5	0015, 0030, 0045, 0060, 0120, 0150, 0180, 0240, 0300, 0360, 0720, 1440, 2160, 2880, 4320

3.6 Sensitivity analysis

Table 6 below provides a summary of the sensitivity runs which were undertaken based on specifications by MBRC. The methodology for each of these is described further in Sections 3.6.1 to 3.6.4.

Table 6 Sensitivity runs

ID	Title	Description	Methodology Section
S1	EDS	MBRC EDS	
S2	Increase n	Increase manning's n values by 20%	3.6.2
S3	Blockage	Model blockage of culverts	3.6.3
S4	Climate Change 1	Model impact of increased rainfall	3.6.4
S5	Climate Change 2	Model impact of increased downstream boundary	3.6.4
S6	Climate Change 3	Model impact of increased rainfall (S4) and sea level (S5)	3.6.4
S7	Storm Tide 1	Model dynamic storm tide boundary – 100 year ARI storm tide event, no rainfall	N/A
S8	Storm Tide 2	Model rainfall with static storm tide boundary – 100 year ARI	N/A
S9	Storm Tide 3	Increased Rainfall (S4) + Increase in Sea level (S5) + Static ST level (100yr GHG)	N/A
S10	Future Landuse 1	Model impact of increased vegetation in floodplains	3.6.1
S11	Future Landuse 2	Model impact of increased residential development – hydrology changes only	3.6.1
S12	Future Landuse 3	Model impact of increased residential development (S11) and increased vegetation in floodplains (S12)	3.6.1

The EDS was simulated for the BCC model. The EDS is a single storm event 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. The adopted EDS event was utilised as a base case for the comparison to future landuse, sensitivity and climate change scenarios.

3.6.1 Future landuse analysis

Three future landuse scenarios were assessed:

- Increased vegetation (S10)
- Increased residential development (S11)
- A combination of the above two (S12)

For the increased vegetation case (S10), two modifications were made to the Manning's n values applied to the model. For the landuse types defined in Figure 3-2 and Table 3 the following changes were made:

- Medium Dense Vegetation was changed to Dense Vegetation
- Low Grass/Grazing was changed to Medium Dense Vegetation

For the increased residential development case (S11), the fraction impervious values in the WBNM model were increased. The sub-catchments in which development may occur were identified by MBRC and increased fraction impervious values were provided for these sub-catchments. The WBNM model was then run with these increased values for the EDS event and the resulting inflows were applied to the TUFLOW model. No changes were made to the fraction impervious values within the Brisbane City Council area.

3.6.2 Hydraulic roughness analysis

To test the sensitivity of the model to selection of landuse roughness values (S2), a scenario was run whereby Manning's n values were uniformly increased by 20%.

3.6.3 Structure blockage analysis

A blockage scenario (S3) was run to assess the effects of waterway crossings (culverts) becoming blocked during a flood event. The SKM Floodplain Parameterisation report (2012) provided recommendations for a moderate blockage scenario. The adopted blockage parameters were:

- Full blockage for culverts/pipes with width ≤ 2.4 m
- Partial (15%) blockage for culverts/pipes with width > 2.4 m

3.6.4 Climate change and downstream boundary condition analysis

Three scenarios were simulated to assess the potential impacts of climate change in accordance with the SKM Boundary Conditions, Joint Probability & Climate Change (2012) recommendations. No analysis of storm tide events was required as the model does not have an oceanic downstream boundary and the area is not impacted by storm tide events. The horizon for climate change events was selected as 2050. Details of the changes made in each of these simulations are provided below.

- Increased rainfall (S4) – the IFD parameters for the WBNM model were increased by 12%, then the increased inflows were applied to the TUFLOW model
- Increased downstream boundary (S5) – the downstream boundary was increased and the PMF level was applied as a static tailwater level. Base Case rainfall was applied
- Increased rainfall and downstream boundary (S6) – S4 and S5 were combined
- Dynamic storm tide (S7) – N/A
- Static storm tide (S8) – N/A
- Increased rainfall, sea level rise and static storm tide (S9) – N/A

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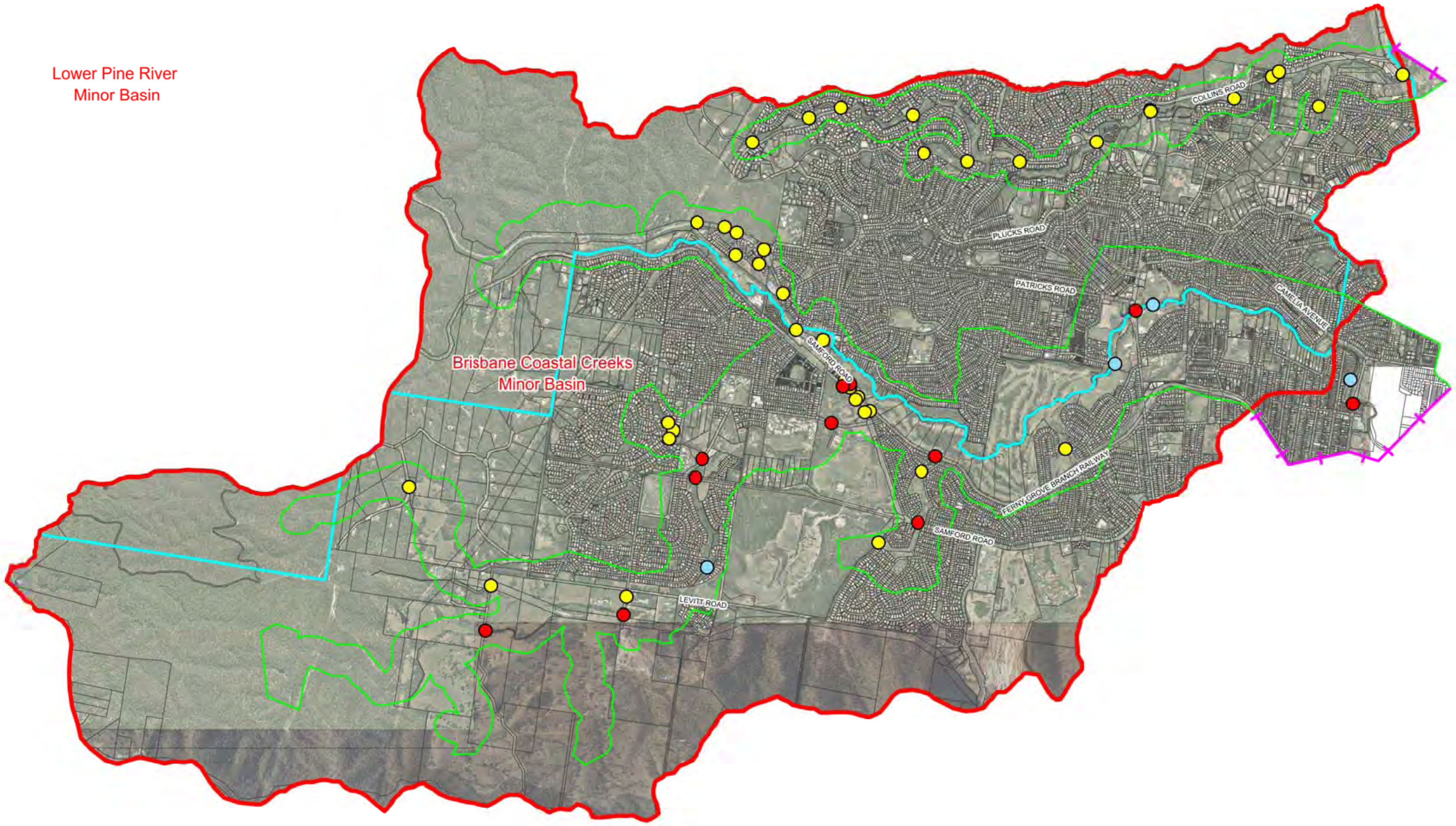

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary
- Downstream Boundary
- Hydraulic Model Boundary
- Culvert
- Bridge
- Footbridge

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

Map by: DJF P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_3-1_Hydraulic_model_layout_rev0.wor

A3 scale 1:40,000

0 1000 m 2,000 m

Date: 12/10/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure 3-1: Hydraulic Model Layout

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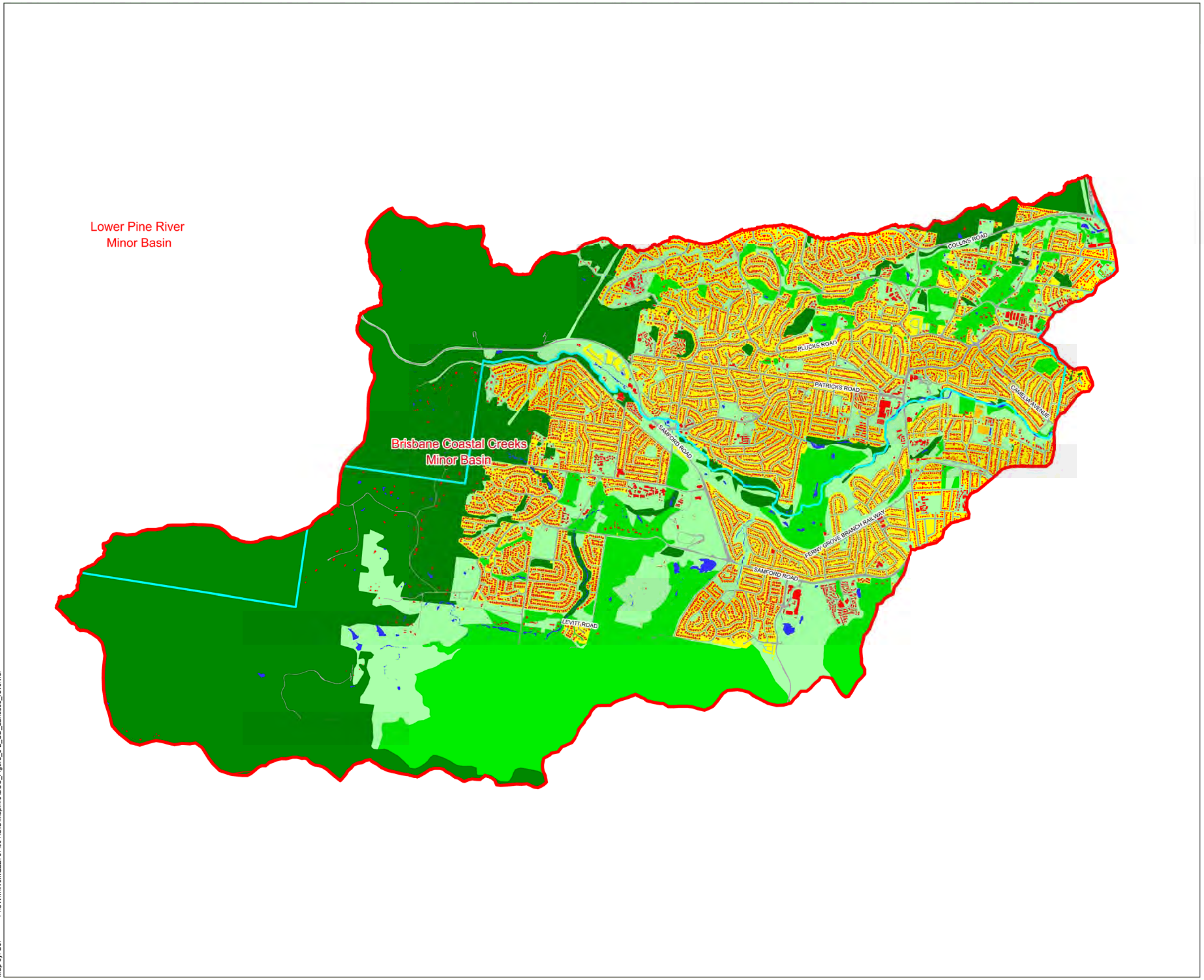

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary
- Waterbody
- Roads/Footpaths
- Buildings
- Urban Blocks
- Crops
- Dense Vegetation
- Low Grass/ Grazing
- Medium Vegetation
- Reeds

Notes:

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Map by: DJF P:\SWMIWork\222767\001\GIS\MapInfo\BCC_Figure_3-2_CD_Landuse_rev0.wor

A3 scale 1:40,000

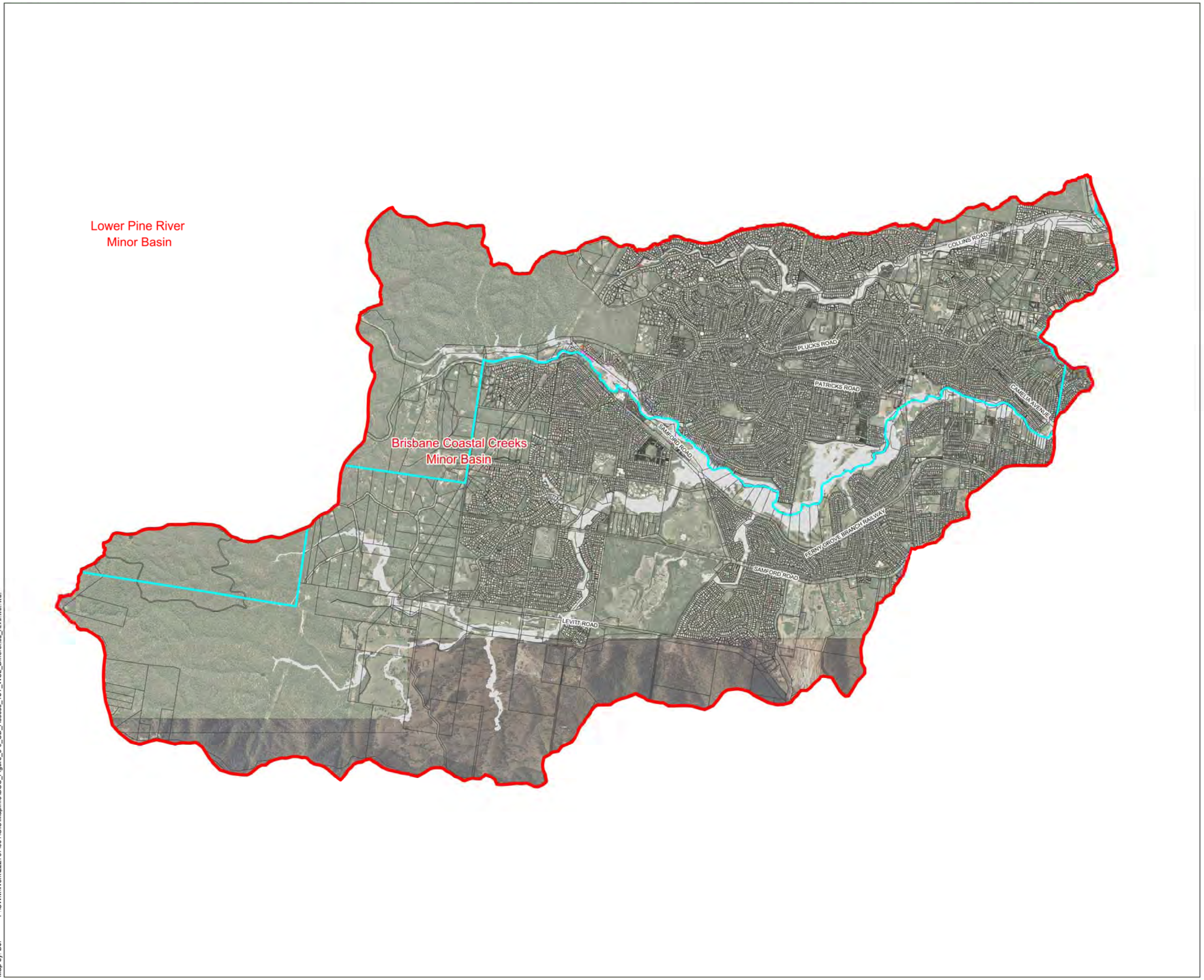
0 1000 m 2,000 m

Date: 12/10/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure 3-2: Landuse Mapping - Existing Conditions



Map by: DJF   P:\SWMI\Work\222767\001\GIS\MapInfo\BCC_Figure_3-5_CD_Assess_10Y_WSL_Difference_rev0.wor.wor

aurecon

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

A3 scale 1:40,000

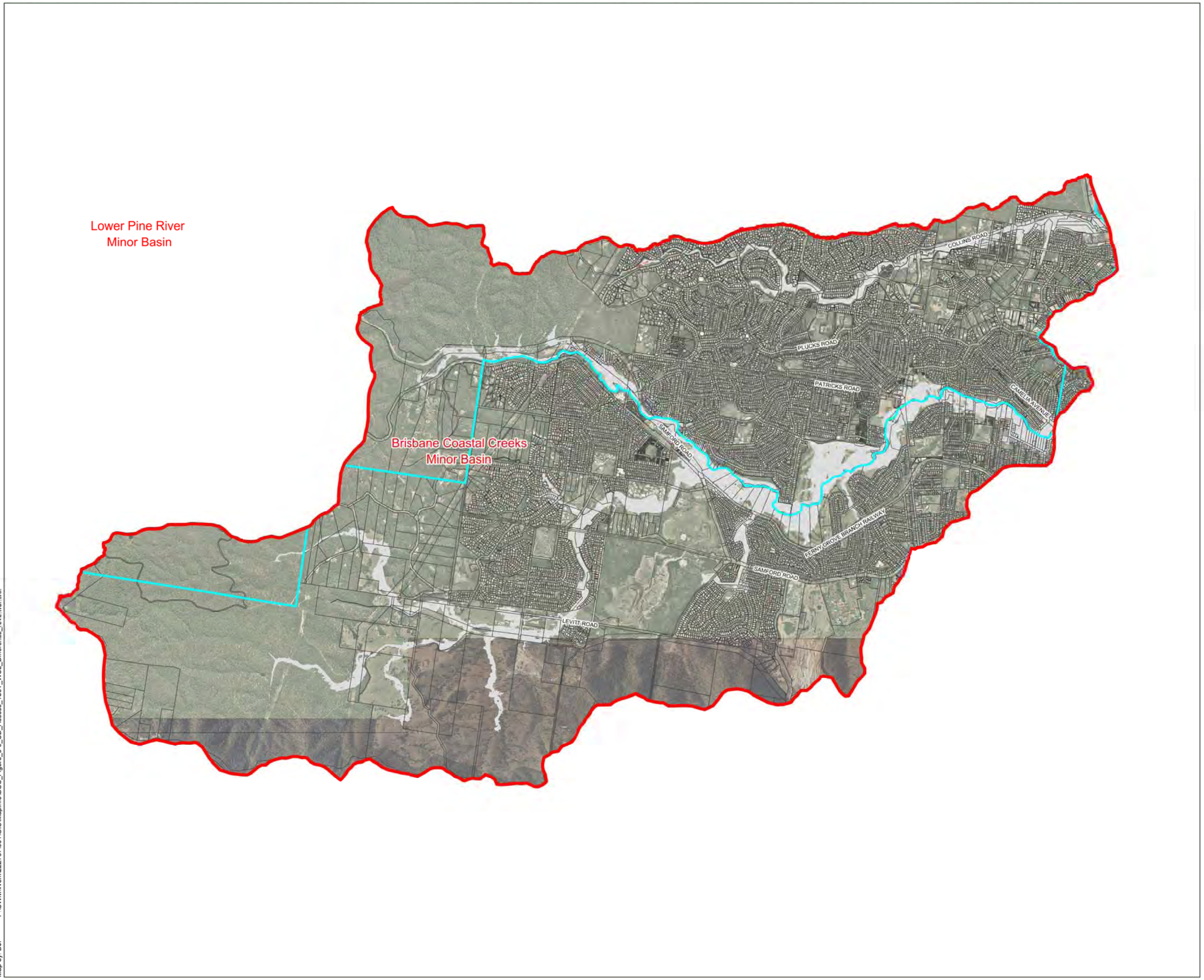
0   1000 m   2,000 m

Date: 12/10/2012   Version: 0   Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure 3-3: Critical Duration Assessment Peak Flood Difference 10 Year ARI



Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

Map by: DJF P:\SWMIWork\222767\001\GIS\MapInfo\BCC_Figure_3-5_CD_Assess_100Y_WSL_Difference_rev0.wor.wor

A3 scale 1:40,000

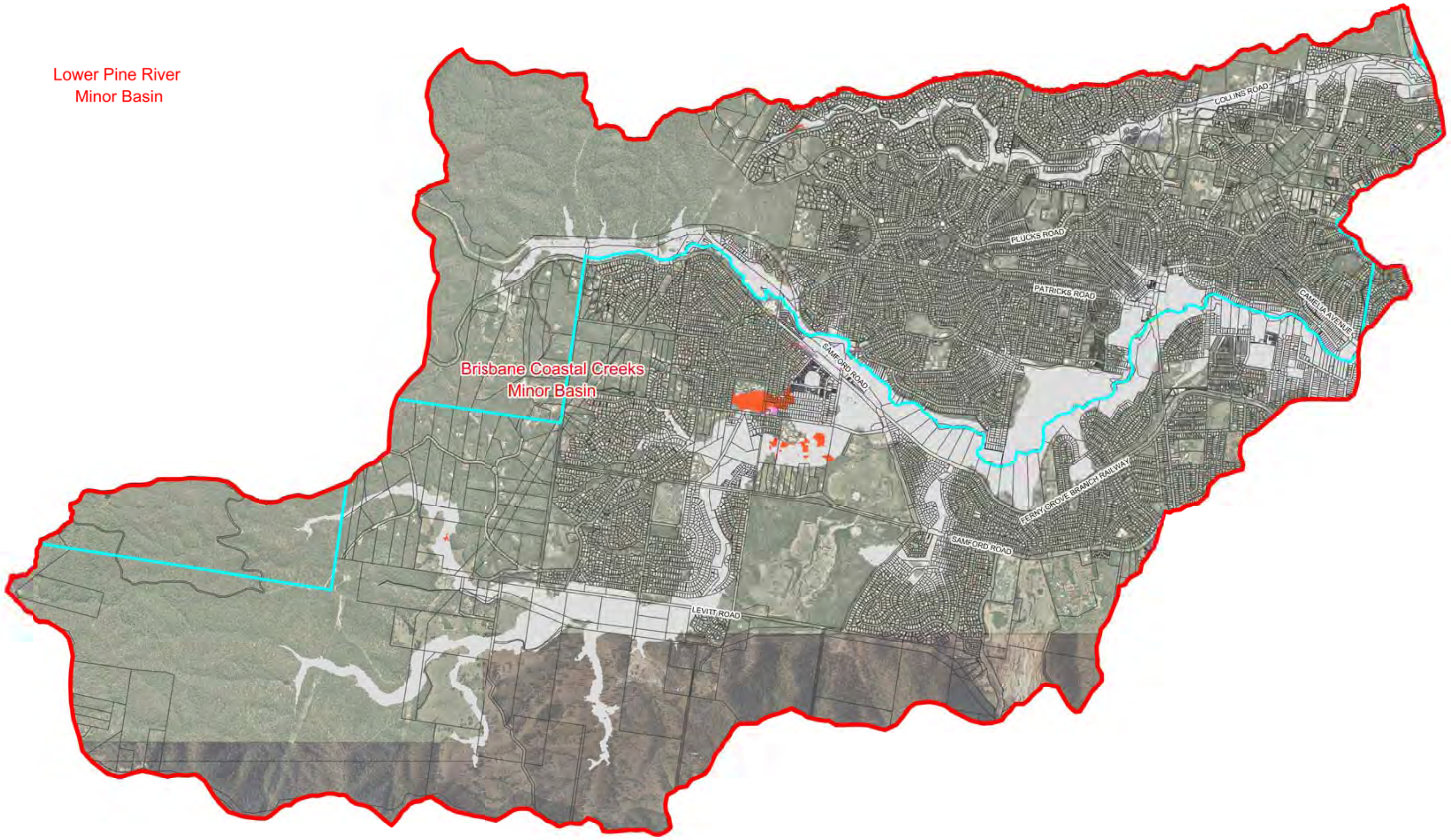
0 1000 m 2,000 m

Date: 12/10/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure 3-4: Critical Duration Assessment Peak Flood Difference 100 Year ARI



aurecon

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

Map by: DJF P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_3-5_CD_Assess_PMF_WSL_Difference_rev0.wor.wor

A3 scale 1:40,000

0 1000 m 2,000 m

Date: 12/10/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure 3-5: Critical Duration Assessment Peak Flood Difference PMF

4 Results and outcomes

4.1 Calibration and verification

The Brisbane Coastal Creeks model was verified to the October 2010 event. The peak water level comparisons for this event are presented in Table 7.This verification process showed that the model generally represents the timing and peak water levels of the October 2010 event well, with an overestimation of peak water levels in the lower reaches.

Table 7 | Comparison of modelled and recorded peak water levels

Stream gauge or maximum height gauge	Street	Recorded peak water level (m AHD)	Modelled peak water level (m AHD)	Difference (m)
Cabbage Tree Creek Stream Gauge	Old Northern Road	44.19	44.37	+0.18
Kedron Brook Stream Gauge	Osborne Road	33.30	34.18	+0.88
260	Osborne Road	32.71	33.93	+1.22
270	Dawson Parade	40.95*	41.56	+0.61
280	Pearse Street	45.21	45.48	+0.27
290	Kuringal Drive	48.59	48.51	-0.08
300	Samford Road	56.20	56.26	+0.06
310	Rangleigh Street	60.57*	61.04	+0.47

* Indicates debris-affected readings

The Brisbane Coastal Creeks model covers only one minor basin in the Moreton Bay Region. Under the direction of Council, the catchments in this region have been modelled with a uniform approach, using a standard set of modelling parameters. This holistic approach does not encourage use of minor basin or catchment specific modelling parameters. For this reason it is considered that the validation results obtained for the BCC model were within acceptable limits.

A copy of the Validation Report is included in Appendix C.

4.2 Design flood behaviour

The discussion in this section is copied from Sections 4.3.3 and 4.3.4 of BMT WBM's Hydraulic Modelling (Detail) Sub-Project 2B Report (2010). Very few changes have been made to the text from BMT WBM's report.

4.2.1 Model results

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. The flood conditions presented in these maps were derived using the envelope (maximum) of all modelled storm durations. Flood maps are only provided for the 100 year ARI design event as the focus of this project is on digital data, rather than provision of flood maps. A description of the digital data provided to Council for incorporation into their RFD is summarised in Section 4.2.2. The flood maps for 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 is being provided upon completion of the study. The data includes all model files for the 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:

- Derive the maximum envelope 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 EDS (with a 15 minute burst in a 270 minute storm duration) was simulated. The results were compared to the 100 year ARI results and are provided in Figure F1 of Appendix F. This figure shows that, the EDS model predictions are generally within ±0.1 m of the 100 year ARI results.

The 100 Year EDS was utilised for sensitivity, future landuse conditions and climate change scenarios and is therefore the Base Case for these sensitivity runs.

4.3.1 Future landuse analysis

For each of the future landuse cases, the peak flood levels were compared to those of the Base Case EDS. The results are presented in Figure F10, Figure F11 and Figure F12 in Appendix F. A summary of the model results are presented below.

- Increased vegetation (S10, Figure F10)
  - Increased vegetation density causes increases in peak water levels within the Kedron Brook catchment by up to +1.0 m near Coles Street. Upstream of this location, water levels are typically increased by +0.3 m and downstream of this location typical increases are in the order of +0.5 m. In Cabbage Tree Creek water levels are increased approximately +0.1 to +0.15 m
- Increased residential development (S11, Figure F11)
  - The impacts of increased residential development are minor as this only occurs in areas which are already developed; therefore the ultimate percentage impervious values are only slightly higher than the existing values. The most noticeable impact occurs near the intersection of Yingally and Leonarda Drives where the roadway is shown as being inundated in the increased residential development case
- A combination of the above two (S12, Figure F12)
  - Increases in peak water levels are very similar to those which occur in the increased vegetation case

4.3.2 Hydraulic roughness analysis

The increased roughness impacts are presented in Figure F2. This figure shows that increased roughness primarily impacts upon water levels along the Cedar Creek tributary to Kedron Brook. Within the MBRC area, the greatest impacts occur in the Cabbage Tree Creek catchment where water levels are increased by up to +0.25 m on the northern side of Collins Road, near Peter Street North. Within the Keperra Country Golf Club water levels are increased by up to +0.2 m.

4.3.3 Structure blockage analysis

The impacts presented in Figure F3 show that structure blockage has very little impact within Kedron Brook. The greatest impact in this catchment occurs in the small tributary which runs through the Woolshed Grove development. Water levels in this tributary increase by up to +1.0 m upstream of Samford Road.

In Cabbage Tree Creek the following impacts occur:

- Increased in peak water levels of up to +3.5 m upstream of Linkwood Drive
- Impacts of up to +0.8 m upstream of Yingally Drive
- Increases in peak water levels of +0.2 to +0.3 m upstream of View Crescent, Bunya Road, Francis Road and Bennetts Road

4.3.4 Climate change and downstream boundary condition analysis

- Increased rainfall (S4, Figure F4)
  - Increased rainfall causes an average increase in water levels of +0.2 m in Kedron Brook, with impacts of up to +0.35 m near Galoela Street
  - Peak water levels in Cabbage Tree Creek are increased by up to +0.25 m upstream of Francis Road
- Increased downstream boundary (S5, Figure F5)
  - Peak water levels in Cabbage Tree Creek are increased by +0.8 m upstream of Old Northern Road. Approximately 300m upstream of Old Northern Road peak water levels are within ±0.1 m of EDS peak water levels
- Increased rainfall and downstream boundary (S6, Figure F6)
  - The S6 results are a combination of S4 and S5 and show very similar impacts to these two scenarios. Water levels near Galeola Street are increased by up to +0.7 m
- Dynamic storm tide (S7, Figure F7)
  - N/A
- Static storm tide (S8, Figure F8)
  - N/A
- Increased rainfall, sea level rise and static storm tide (S9, Figure F9)
  - N/A

4.4 Model limitations

This section is reproduced from Section 4.7 of BMT WBM's Hydraulic Modelling (Detail) Sub-Project 2B Report (2010) and revised to be specific to the Brisbane Coastal Creeks minor basin. Given that the same approach has been used across all the Stage 2 hydraulic models, the limitations will be similar.

The topography of creeks in the non-urban areas of the Brisbane Coastal Creeks basin is defined using LiDAR data due to the absence of surveyed cross-sections or bathymetry. LiDAR is unable to pick up ground levels below the water surface, and therefore the bed levels of creeks are not represented in detail. This approach means that the flood levels, particularly for small flood events where a greater proportion of the flow is typically conveyed in bank (eg the 1 to 10 year ARI), may be overestimated. This approach has been adopted by MBRC due to budget constraints and the consideration of cost versus benefit. The use of LiDAR data in the creeks will generally be conservative (ie overestimate flood levels).

Watercourses have also been represented in the 2D domain, for which the grid resolution is limited to 5 m. In addition, for the narrower upstream reaches, a waterway landuse layer has not been incorporated. This may not allow adequate representation of the channel conveyance, particularly for the narrower upper reaches. In some instances this limitation may lead to the model over or underestimating conveyance in the watercourses.

5 Conclusions and recommendations

Hydrologic and hydraulic modelling has been undertaken to simulate the full range of design flood conditions in the Brisbane Coastal Creeks minor basin, from the 1 year ARI event to the Probable Maximum Flood. This modelling was undertaken using the standards and approaches developed during Stage 1 of the Regional Floodplain Database project.

Assessment of a range of scenarios including climate change, land use change, vegetation change and culvert blockage was also undertaken.

A comprehensive set of GIS results has been prepared for incorporation into Council's GIS systems. This includes peak water surface levels, depths, velocities, stream power and hazard. Mapping of the 100 year ARI results has also been prepared.

We recommend that the outcomes of the Model Quality Report in Appendix D should be taken into account when using the models and/or their results.

6 References

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

BMT WBM (July 2010), *Hydraulic Modelling (Broadscale) Regional Floodplain Database Stage 1 Sub-Project 1D*

BMT WBM (December 2010), *Hydraulic Modelling (Detail) Regional Floodplain Database Sub-Project 2B Report*

Bureau of Meteorology (June 2003), *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*

Bureau of Meteorology (November 2003), *Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method*

Cardno Lawson Treloar (June 2008), *Kedron Brook Design Events Flood Study DRAFT*

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Sinclair Knight Merz (June 2012), *MBRC Regional Floodplain Database Boundary Conditions, Joint Probability & Climate Change*

Sinclair Knight Merz (August 2010): *MBRC Regional Floodplain Database Existing, Historic and Future Floodplain Land Use*

Worley Parsons (September 2010), *Regional Floodplain Database Floodplain Terrain*

WorleyParsons (June 2010), *Regional Floodplain Database Design Rainfall - Burpengary Pilot Project (Draft)*

Appendices

Appendix A
Infrastructure Data Assessment Report

Appendix A
Infrastructure Data Assessment Report

aurecon

Project No. 222767
Project: Regional Floodplain Database Stage 3 Detailed Modelling: Package 1
BCC Minor Basin Data Infrastructure Assessment Report

Prepared for:
Moreton Bay Regional Council
PO Box 159
Caboolture QLD 4510

Report ref: 222767-001
4 August 2011

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Moreton Bay Regional Council

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Regional Floodplain Database Stage 3 Detailed Modelling: Package 1

Date | 4 August 2011
Reference | 222767-001
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Contents

1 Introduction

1.1 Study objective

Moreton Bay Regional Council (MBRC) is delivering a Regional Floodplain Database (RFD) in support of their flood risk management, considering emergency response, development control, strategic landuse and infrastructure planning. MBRC was recently formed under local government amalgamations and is responsible for Caboolture, Pine Rivers, Redcliffe and Bribie Island. The RFD project focuses on the northern sector as a key growth area for South-east Queensland.

The project is being funded by MBRC, Emergency Management Queensland (EMQ) and Emergency Management Australia (EMA) as part of the Natural Disaster Resilience Program and will provide:

- A comprehensive and consistent description of flood behaviour across the region
- Strategies for management of any flooding identified problems
- A system/process to store and manage this information and keep it up-to-date

Stage 1 of the project was completed in July 2010 and involved a number of sub-projects. These projects delivered consistent processes and protocols for the detailed hydrologic and hydraulic model development. A key sub-project involved the development of broadscale hydrodynamic models for each minor basin to provide general understanding of flooding mechanisms and allow prioritisation of data capture.

Stage 2 of the project involves the development of detailed hydrologic and hydraulic models for each minor basin.

Stage 3 (current stage) includes development of a further two detailed models. Stage 3 will then build on the detailed models and "add value" through assessment of flood damages and community resilience measures

1.2 Objective of Data Assessment Report

This report details the data infrastructure assessment and gap analysis for Package 1, Brisbane Coastal Creeks (as shown in Figure 1). This basin is largely urbanised, with only the upper reaches remaining forested. Flows are generally contained within the creek corridor or adjacent low lying land, with very little floodplain evident in this minor basin.

The structures within this basin are generally located in close proximity to urban areas and therefore they have the potential to impact upon flooding of these areas.

This report assesses the infrastructure and bathymetric data requirements for modelling of the Brisbane Coastal Creeks minor basin. It documents the results of the data gap analysis carried out for drainage infrastructure including bridges, culverts, detention basins and trunk drainage and also for below-water bathymetric details. The infrastructure has been prioritised according to the significance of location and potential impacts to the hydraulic model results. Following the gap analysis and the data prioritisation, a composite assessment of survey requirements has been undertaken.

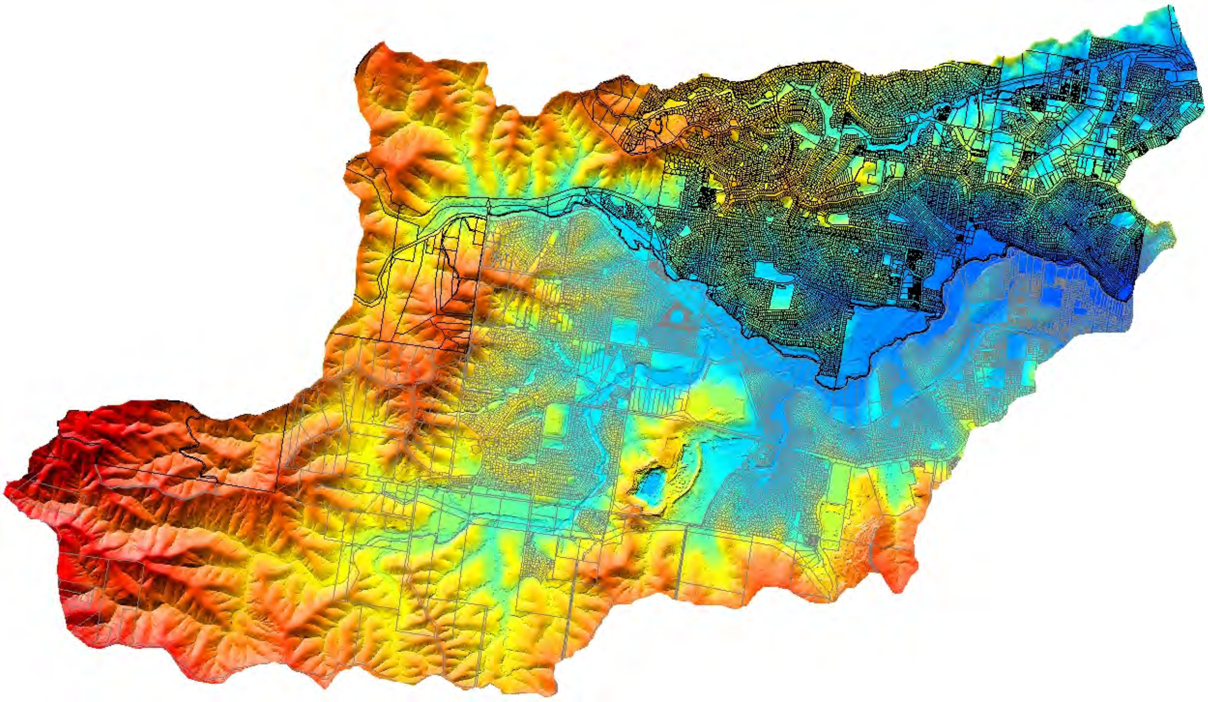

Figure 1 | BCC Minor Basin

2 Methodology

2.1 Data availability

Available data which was assessed includes:

- GIS file identifying locations of QR and TMR structure data to be provided "Stage3_QR_TMR_Structure_Locations"
- GIS file identifying locations of structures being surveyed by Council "Culvert_Survey"
- GIS file identifying structures inspected by Council "Structure_inspection"
- Microsoft PowerPoint file showing photos from structure inspection "20110714 Culvert Photo Album - BCC.ppt"
- GIS file of structures identified by as not having junctions in the existing hydrography layer "Structure_No_Junctions"
- GIS file of available stormwater data for Moreton Bay region (provided for Stage 2) "Storm_Water_Arcs" and "Storm_Water_Node"
- GIS file of available stormwater data for Brisbane City region "bm081657_sw_pipe"
- TUFLOW 2d_lfcsh_KED and 1d_nwk_KED GIS files, as modelled previously
- Structure drawings provided by Council
- BCC basin DEM
- BCC basin aerial images
- Brisbane City and Moreton Bay Region cadastral data

This data was reviewed to identify the locations of critical structures within the minor basin. These are presented in the Sections 3.1 to 3.5. Not all structures within the basin have been identified; however all structures on major waterways and the larger tributaries have been included.

2.2 Gap analysis

A gap analysis was undertaken to review the available data for each crossing and identify any data gaps, based on the critical data requirements presented in Sections 2.2.1 to 2.2.3. The available data is presented in Sections 3.1 to 3.5, as well as data gaps and the proposed capture methods to be employed in addressing these gaps. It is understood that Council does not wish to obtain further survey and the proposed capture methods have taken this into account. The site visit for this minor basin is yet to be undertaken; therefore it is possible that the required information can be captured during this site visit.

The DEM was also reviewed to assess how well the channels are represented.

2.2.1 Bridges

The critical information required for the hydraulic modelling of bridges includes:

- Deck surface/obvert levels and thickness
- Pier locations, dimensions, orientation to flow and pile arrangements
- Handrail location, height and extent
- Cross-section of the channel beneath the bridge

2.2.2 Culverts

The critical information required for the hydraulic modelling of culverts includes:

- Culvert shape
- Dimensions and number of barrels
- Culvert invert levels

2.2.3 Trunk drains

The trunk drainage data standard specifies that trunk drainage refers to “extended underground drainage systems which have a large open channel or stream feeding into them (ie stormwater pipe networks which are intended to convey flows from a major storm event)”.

The critical information required for the hydraulic modelling of trunk drainage includes:

- Pipe location, shape, dimensions, invert levels, length and number of barrels
- Stormwater pit/junction locations, type, dimensions and invert levels

2.2.4 Assumptions

A number of assumptions were made during the gap analysis:

- Complete TUFLOW ready datasets will be provided for the QR and TMR structures identified in “Stage3_QR_TMR_Structure_Locations”
- All required data will be provided for structures identified in Council’s “Culvert_Survey”
- No additional data will be provided for Council’s “Structure_inspection” structures – modelling of these structures is to be based upon the details provided in “20110714 Culvert Photo Album - BCC.ppt”

2.3 Prioritisation methodology

The structure data was prioritised into categories “A” and “B”, with Priority A structures being those required for the hydraulic modelling and Priority B structures being of less importance for the accurate modelling of the minor basin.

Prioritisation was based on the following criteria:

- Broadscale model flood extents – Structures within or nearby the 100 year ARI broadscale model flood extents were identified as Priority A structures. Conversely structures outside of these extents were considered to be less important and were identified as Priority B
- Previous modelling – Structures included in the previous modelling of this minor basin were generally identified as Priority A structures
- Structures identified in Council’s “Structure_inspection” – Generally these structures were categorised as Priority A
- Location of structure with Brisbane City area – Structures within the Brisbane City region are considered less important than those in the Moreton Bay region. Only key structures on the larger stream reaches within the Brisbane City region are identified as Priority A

3 Available data and gap analysis

3.1 Identified structures

All identified structures are shown in Figure 2. Blue dots represent Priority A structures and green dots represent Priority B structures. The GIS file “BCC_Hydraulic_Structures” provided with this report includes the details of the structures identified in Figure 2.

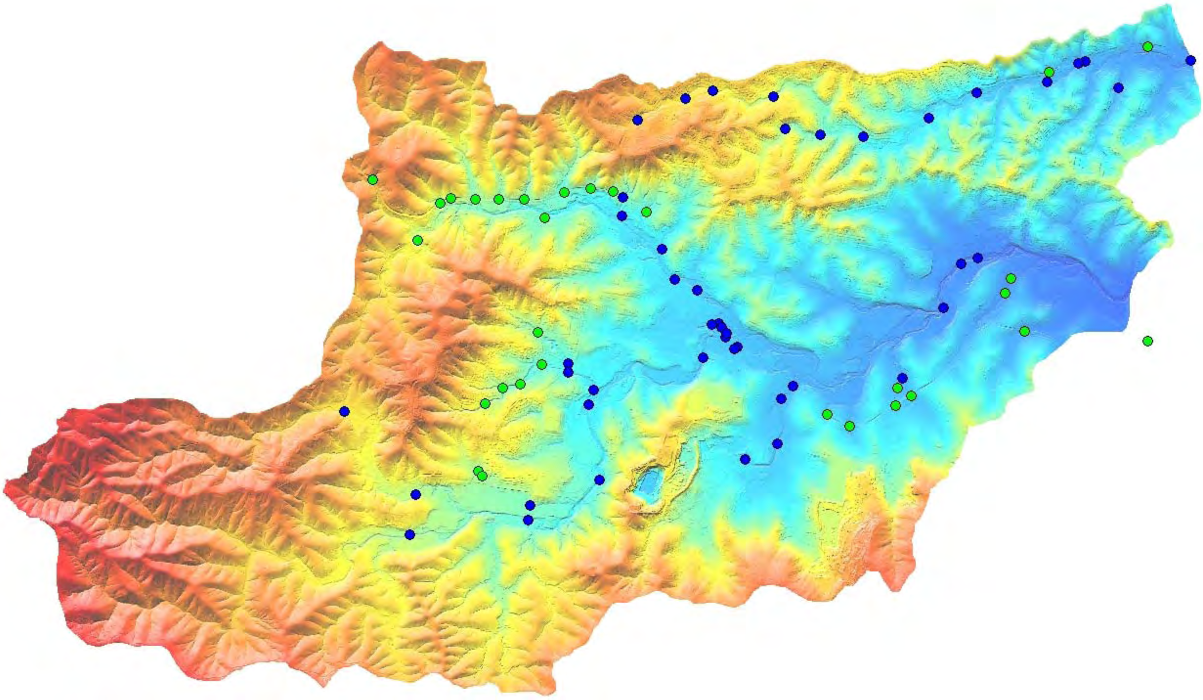

Figure 2 | BCC minor basin structures

3.2 Bridges

Table 1 shows all the bridges identified within the BCC minor basin, the available data for these bridges and the adopted structure priority.

Table 1 Identified bridges and available bridge data

Waterway ID	Crossing Name	Available Data	Priority
KED_01_01913	Dawson Parade	2d_lfcsh_KED, Drawings	A
KED_01_01913	Pedestrian (Jane St)	2d_lfcsh_KED, Drawings	A
KED_01_06019	Gordon Road	2d_lfcsh_KED	A
KED_04_00000	Samford Road	Stage3_QR_TMR_Structure_Locations	A
KED_04_00000	Tramway Street		A
KED_04_00000	Ferny Grove Rail Line	Stage3_QR_TMR_Structure_Locations	A
KED_04_02038	Upper Kedron Road		A
KED_04_02038	Pedestrian		A
KED_04_03281	Canvey Road	Structure_inspection	A
KED_10_00000	Hogart Road	Structure_inspection	A
KED_16_00000	Ross Road	Structure_inspection	A
KED_28_00000	Samford Road	Stage3_QR_TMR_Structure_Locations	A
KED_28_00000	Ferny Grove Rail Line	Stage3_QR_TMR_Structure_Locations	A
Beyond DS Bnd	Osborne Road	2d_lfcsh_KED	B
Not on reach	Ferny Grove Rail Line		B

Of the Priority A structures, there are three bridges for which no data exists and one bridge for which data only exists in the 2d_lfcsh file from the previous modelling. The following approach is proposed for these structures:

- Bridges will be located based upon the aerial photographs
- Bridge deck levels will be assumed based upon the LiDAR data to either side of the structure
- Deck thickness can be assessed during a site visit
- Pier details can be assessed during a site visit
- Handrail details can be assessed during a site visit
- The bridge can be modelled using the existing surface levels in the LiDAR data, with no cross-section data specified

3.3 Culverts

Table 2 shows all the culverts identified within the BCC minor basin and the available data for these culverts.

Table 2 Identified culverts and available culvert data

Waterway ID	Crossing Name	Available Data	Priority
CTC_01_00000	Old Northern Road	Stage3_QR_TMR_Structure_Locations	A
CTC_01_01288	Collins Road		A
CTC_01_01385	Collins Road	1d_nwk_KED	A
CTC_01_01813	John Street		A
CTC_01_02688	Francis Road	Culvert Survey, 2d_lfcsh_KED, Drawings	A
CTC_01_03455	Bunya Road	1d_nwk_KED	A
CTC_01_04319	View Crescent	1d_nwk_KED	A
CTC_01_05671	Woodhill Road	2d_lfcsh_KED, Drawings	A
CTC_01_06388	Linkwood Drive	2d_lfcsh_KED, Drawings	A
CTC_01_06685	Woodtop Court	Culvert Survey, 2d_lfcsh_KED, Drawings	A
CTC_01_07207	Ridgewood Court	Structure_inspection	A
CTC_02_00075	Yingally Drive	1d_nwk_KED	A
CTC_02_00461	Woodhill Road	1d_nwk_KED	A
CTC_04_00304	Bennetts Road	1d_nwk_KED	A
KED_01_00975	Pedestrian	bm081657_sw_culvert	A
KED_01_06294	Samford Road	1d_nwk_KED	A
KED_04_00000	Samford Road	bm081657_sw_culvert	A
KED_04_00000	Ferny Grove Rail Line	Stage3_QR_TMR_Structure_Locations	A
KED_04_00000	Samford Road	Stage3_QR_TMR_Structure_Locations	A
KED_04_00000	Samford Road	Stage3_QR_TMR_Structure_Locations	A
KED_04_00000	Ferny Grove Rail Line	Stage3_QR_TMR_Structure_Locations	A
KED_04_05168	Millwood Place	Structure_inspection	A
KED_08_00000	Canvey Road	Structure_inspection	A
KED_09_00000	Woolshed Street	Structure_inspection	A
KED_09_00227	Samford Road	Stage3_QR_TMR_Structure_Locations	A
KED_10_00000	McAlroy Road	Structure_inspection	A
KED_11_00059	Samford Road	Stage3_QR_TMR_Structure_Locations	A
KED_12_00000	Selkirk Crescent	Structure_inspection	A
KED_14_00000	Ross Road	Structure_inspection	A
KED_28_00000	Avington Street	bm081657_sw_culvert	A
KED_28_01009	Glengarry Road	Structure_inspection	A
KED_32_00000	Duggan Street	Structure_inspection	A

Waterway ID	Crossing Name	Available Data	Priority
Not on reach	Ferny Grove Rail Line		B
Not on reach	Samford Road	Stage3_QR_TMR_Structure_Locations	B
KED_03_00076	Samford Road	Stage3_QR_TMR_Structure_Locations	B
KED_05_00166	Samford Road	Stage3_QR_TMR_Structure_Locations	B
KED_01_08231	Samford Road	Stage3_QR_TMR_Structure_Locations	B
KED_01_08231	Samford Road	Stage3_QR_TMR_Structure_Locations	B
KED_05_00166	Samford Road	Structure_inspection	B
KED_07_00155	Samford Road	Structure_inspection	B
KED_01_07110	Samford Road	Stage3_QR_TMR_Structure_Locations	B
KED_08_00000	Cedar Creek Road	bm081657_sw_culvert	B
Not on reach	Ferny Grove Rail Line	bm081657_sw_culvert	B
KED_10_00404	Selkirk Crescent	bm081657_sw_culvert	B
KED_34_00000	House	bm081657_sw_culvert	B
Not on reach	Lanita Road	bm081657_sw_culvert	B
KED_01_09303	Lanita Road	Structure_inspection	B
KED_34_00000	Woking Street		B
KED_32_00000	Ferny Grove Rail Line		B
KED_32_00000	Ferny Grove Rail Line		B
Not on reach	Ferny Grove Rail Line		B
KED_08_00000			B
KED_10_00404	Selkirk Crescent		B
KED_10_00404	Selkirk Crescent		B
KED_10_00404	Selkirk Crescent		B
KED_12_00000	McGinn Road		B
Not on reach	Samford Road		B
Not on reach	Samford Road		B
CTC_01_01385	Collins Road	1d_nwk_KED	B
Not on reach	Collins Road	1d_nwk_KED	B
KED_32_00000			B

Of the Priority A structures, there are two without any existing data. The following approach is proposed for these structures:

- Culverts will be located based upon the aerial photographs
- Culvert dimensions will be measured during a site visit
- Culvert invert levels will be assumed based upon a measured depth from the road crest to the culvert obvert

3.4 Trunk underground drainage

No trunk underground drainage systems have been identified as being critical for the hydraulic modelling.

3.5 Detention basins

No detention basins have been identified as being critical for the hydraulic modelling.

3.6 Terrain

LiDAR data has been provided by Moreton Bay Regional Council and Brisbane City Council. In addition to the LiDAR data, to accurately model waterways, bathymetric information is generally required for significant perennial reaches. Within the BCC minor basin, whilst it is possible that the creek invert levels are not well represented in the LiDAR data, the creek channels themselves are well represented. The additional conveyance capacity which would be provided by accurate representation of the creek inverts is expected to be minimal; therefore it is not recommended that additional bathymetric data be captured for the BCC minor basin.

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Appendix B
Hydrography Review Report

Appendix B
Hydrography Review Report

aurecon

Project No. 222767

Project: Regional Floodplain Database Stage 3 Detailed Modelling: Package 1

BCC Minor Basin Hydrography Review Report

Prepared for:
Moreton Bay Regional Council
PO Box 159
Caboolture QLD 4510

Report ref: 222767-001
3 August 2011

Moreton Bay Regional Council

Document Control Record

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Author Signature		Approver Signature	
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Regional Floodplain Database Stage 3 Detailed Modelling: Package 1

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Reference | 222767-001
Revision | 1

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Contents

1 Introduction

1.1 Study objective

Moreton Bay Regional Council (MBRC) is delivering a Regional Floodplain Database (RFD) in support of their flood risk management, considering emergency response, development control, strategic landuse and infrastructure planning. MBRC was recently formed under local government amalgamations and is responsible for Caboolture, Pine Rivers, Redcliffe and Bribie Island. The RFD project focuses on the northern sector as a key growth area for South-east Queensland.

The project is being funded by MBRC, Emergency Management Queensland (EMQ) and Emergency Management Australia (EMA) as part of the Natural Disaster Resilience Program and will provide:

- A comprehensive and consistent description of flood behaviour across the region
- Strategies for management of any flooding identified problems
- A system/process to store and manage this information and keep it up-to-date

Stage 1 of the project was completed in July 2010 and involved a number of sub-projects. These projects delivered consistent processes and protocols for the detailed hydrologic and hydraulic model development. A key sub-project involved the development of broadscale hydrodynamic models for each minor basin to provide general understanding of flooding mechanisms and allow prioritisation of data capture.

Stage 2 of the project involves the development of detailed hydrologic and hydraulic models for each minor basin and is currently underway.

Stage 3 includes development of a further two detailed models (currently underway). Stage 3 will then build on the detailed models and “add value” through assessment of flood damages and community resilience measures.

1.2 Objective of Hydrography Review Report

This report details the hydrography review for Package 1 of Stage 3, covering the Brisbane Coastal Creeks (BCC) minor basin.

The term ‘hydrography’ describes the sub-catchment delineation, stream reach lines and junction locations and will form the basis of the hydrological model. The hydrography is required to support the following key objectives:

- Sufficiently define catchments to ensure accurate definition of contributing areas at key points of interest (urbanised areas, drainage control points, areas marked for future development)

- Support the hydraulic model objectives through appropriate flow reporting locations, noting the following:
  - The hydraulic model will apply inflow distributed across the sub-catchment, effectively "filling" the sub-catchment from the lowest point
  - The hydraulic model will advise on flood immunity of major roads accessing key urban areas

MBRC have provided initial sub-catchment boundaries, stream reaches and junctions (as shown in Figure 1). A review of the hydrography has been undertaken for each minor basin to ensure compliance with the above objectives

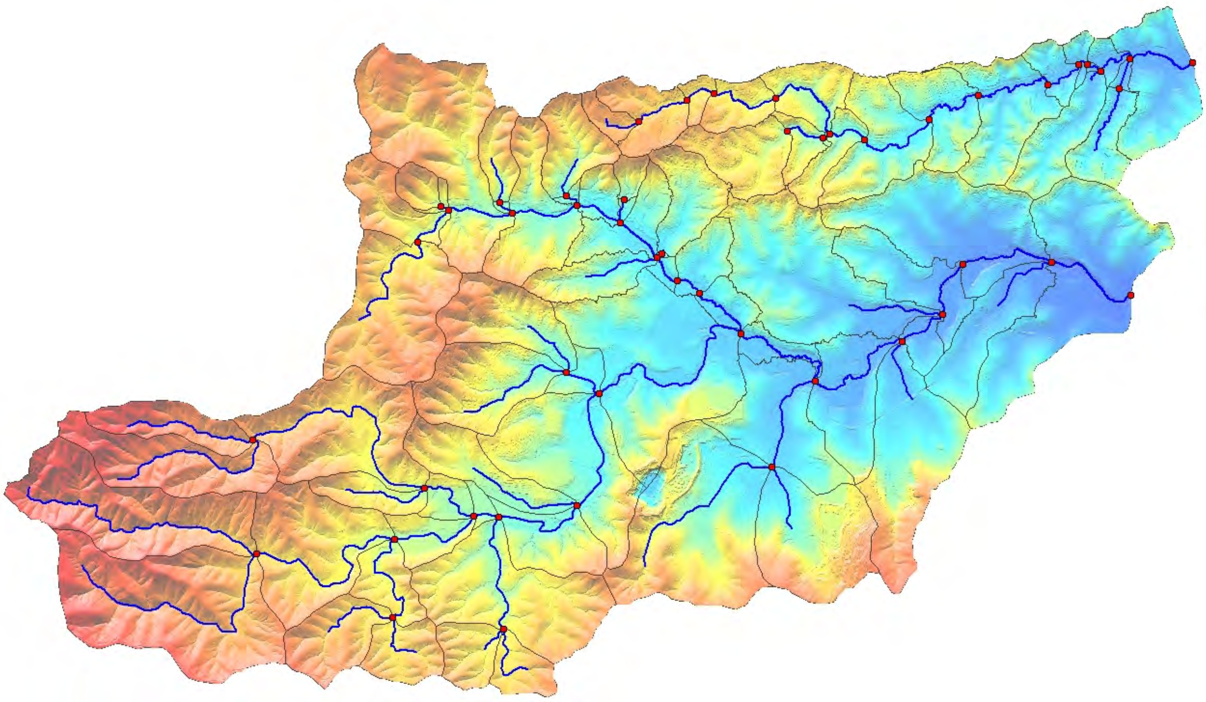

Figure 1 | BCC Minor basin hydrography

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2 Hydrography review

2.1 Minor basin appreciation

The Brisbane Coastal Creeks minor basin covers the upper ends of the Cabbage Tree Creek and Kedron Brook catchments. The northern portion of this minor basin lies within the Moreton Bay Region and the southern portion lies within the Brisbane City region, with the upper reaches of Kedron Brook running along the region divide.

This basin is largely urbanised, with only the upper reaches remaining forested. Flows are generally contained within the creek corridor or adjacent low lying land, with very little floodplain evident in this minor basin.

Comparison of the aerial photography, the 2006 Pine Rivers Planning Scheme and the 2000 City Plan for Brisbane show that, with the exception of one parcel of land in Upper Kedron, significant development is not proposed in any part of this minor basin.

Key areas of interest are those within the Moreton Bay Regional area, immediately adjacent to the creek corridors.

2.2 Stream connectivity

A review of the sub-catchment and reach network was undertaken with reference to the study objectives outlined in Section 1.2. At the downstream end of branch KED_04_05168 the reach location and connectivity does not appear to be consistent with the topographic data as shown in Figure 2. The pink line in Figure 2 shows a more appropriate location for this reach and its connection point. This pink line is included in the attached file “Proposed reach change”.

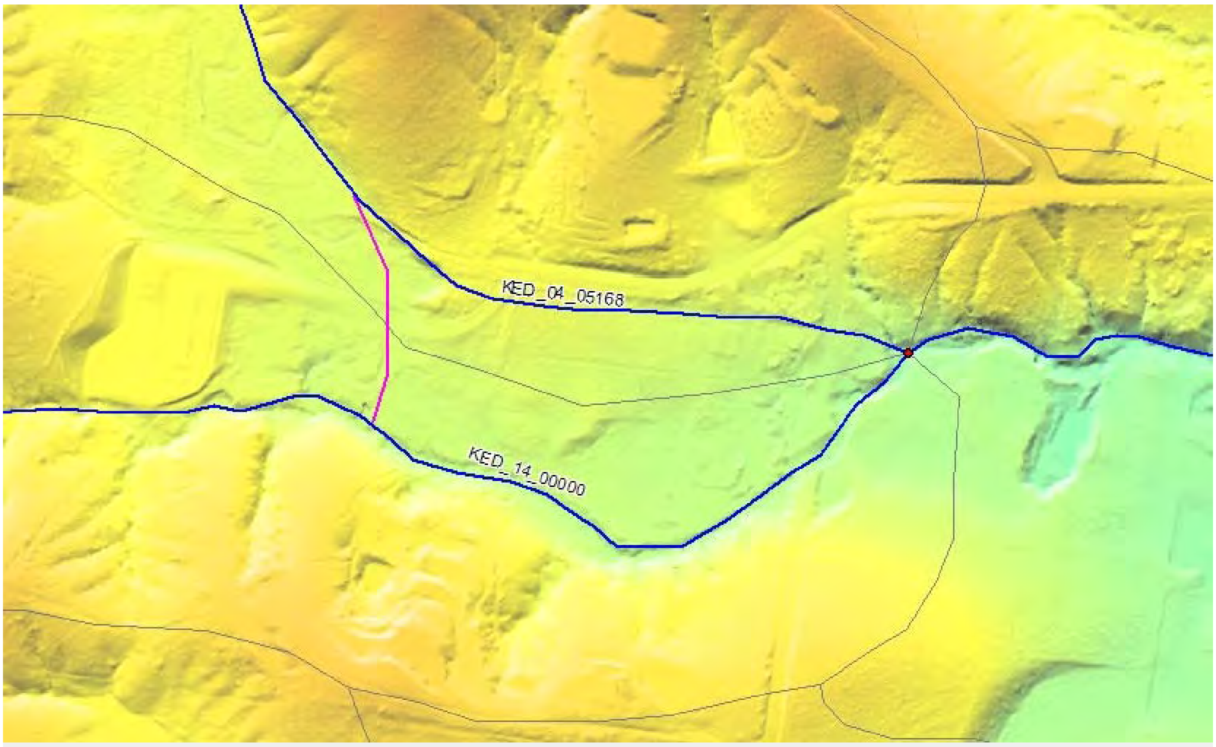

Figure 2 | Connectivity issue

2.3 Inclusion of floodplain structures

A review has been undertaken of the structures within the BCC minor basin and this is presented in the Data Infrastructure Assessment Report. Table 1 below includes a list of the structures which have been identified as “Priority A” for which no junction currently exists in the hydrography. New junctions will be required at these structure locations to ensure the contributing upstream catchment is correct. Note that this table does not include structures for which there are no reaches in the hydrography but for which it is intended to include the structures in the hydraulic modelling (eg on Samford Road and the Ferny Grove Rail line to the south-east of the Ferny Grove Railway Station). The locations of the junctions identified in Table 1 are included in the attached file “Junctions required”.

Table 1| Structures for which no junction exists in the hydrography

WW_ID	Crossing Name	Description
KED_01_00975	Pedestrian	Culvert
KED_01_01913	Pedestrian (Jane St)	Bridge
KED_04_00000	Samford Road	Bridge
KED_04_00000	Ferny Grove Rail Line	Bridge
KED_04_00000	Tramway Street	Bridge
KED_04_02038	Upper Kedron Road	Bridge
KED_04_02038	Pedestrian	Bridge
KED_04_03281	Canvey Road	Bridge
KED_04_05168	Millwood Place	Culvert
KED_08_00000	Canvey Road	Culvert

WW_ID	Crossing Name	Description
KED_09_00000	Woolshed Street	Culvert
KED_10_00000	Hogart Road	Bridge
KED_10_00000	McAlroy Road	Culvert
KED_14_00000	Ross Road	Culvert
KED_16_00000	Ross Road	Bridge
KED_28_00000	Samford Road	Bridge
KED_28_00000	Ferny Grove Rail Line	Bridge
KED_28_00000	Avington Street	Culvert
KED_28_01009	Glengarry Road	Culvert
KED_32_00000	Duggan Street	Culvert

2.4 Existing resolution/detail

Given the objectives of the RFD, the resolution of the defined hydrography is generally considered to be appropriate. The level of detail provided is sufficient to model the flood characteristics of the main Cabbage Tree Creek and Kedron Brook branches. There are a number of tributaries to these main branches which are not defined in the hydrography; however these branches would be considered local drainage networks and are beyond the scope of the RFD. An example of these tributaries is provided in Figure 3.

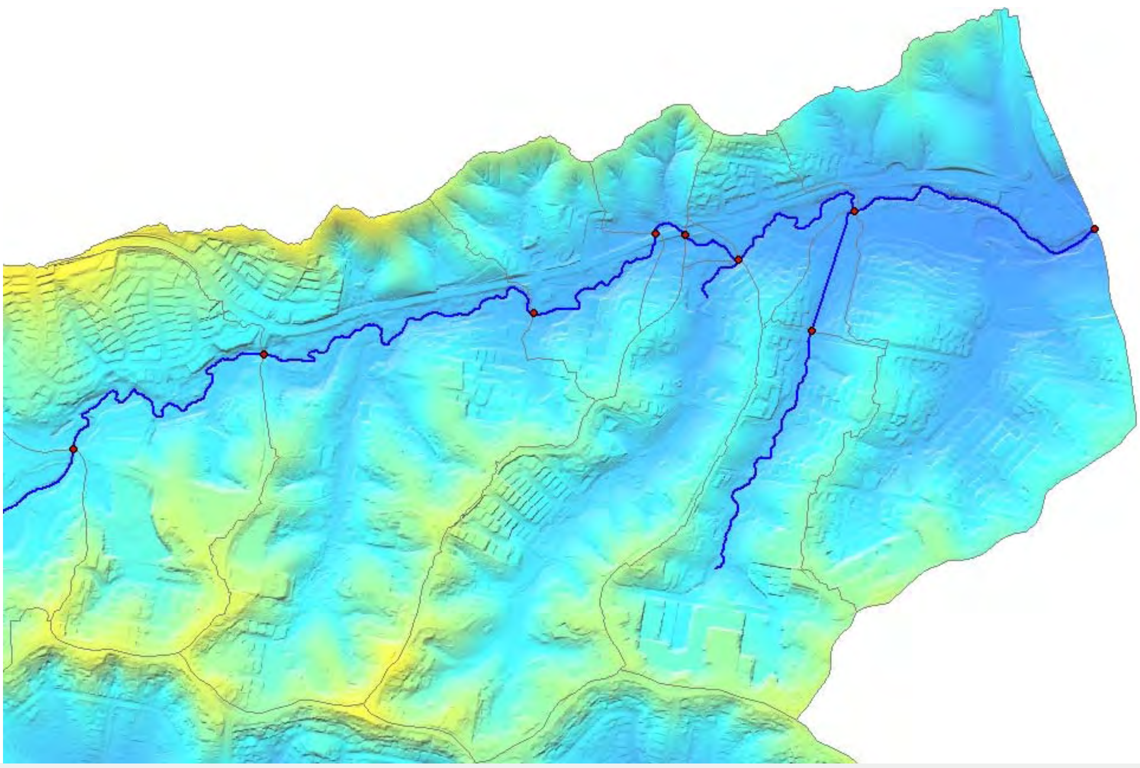

Figure 3 | Hydrography resolution example

One of the primary issues to be considered is the application of the inflow hydrographs using 2d_sa tables within the hydraulic model. If the 2d_sa table is defined to match the sub-catchment boundary, the inflow will be applied to the lowest point within the sub-catchment, with the following impacts:

- For a given sub-catchment, the flow will likely be applied at the junction and from there routed downstream within the creek/channel. Where a sub-catchment has its lowest point downstream of a structure, flows may be applied downstream of the structure. Where a sub-catchment has its primary area of interest in the upper reaches, the local inflows will bypass this area
- For the upper-most sub-catchments, there will be no flow routed through them from upstream sub-catchments. Where they are not urbanised or not of concern, the hydrography need not be modified

Similar to the approach that has been adopted with the PUM and BRI minor basins, it is proposed to modify a number of the 2d_sa boundaries in the hydraulic model to ensure that catchment inflows are being applied upstream of structures.

2.5 Future development

In the case of large areas of land being proposed for development, it would be recommended that sub-catchment delineation align with future development to allow the hydrologic and hydraulic models to be easily updated for “future land use” scenarios. However, based on a review of the 2006 Pine Rivers Planning Scheme and the 2000 City Plan for Brisbane it is anticipated land use changes will only occur within the Upper Kedron area and these will no significantly affect the existing hydrography definition.

3 Recommendations

Based on the issues discussed in the previous section, the hydrography changes in the following sections (3.1 to 3.3) are recommended.

3.1 Stream connectivity

It is recommended that the location of the downstream end of branch KED_04_05168 be modified as shown in Figure 2 to better match the flowpath shown in the topography.

3.2 Inclusion of floodplain structures

It is recommended that a junction should be included at each of the floodplain structures in Table 1 to ensure that the volume of flow calculated at each structure is accurate and to ensure consistency with the hydrography approach adopted for the detailed modelling.

3.3 Resolution/detail

The following recommendations are made with regard to the level of hydrographic detail provided:

- If a sub-catchment has its primary area of interest in the upper reaches, consideration should be given to further dividing the sub-catchment or alternatively, applying more than one 2d_sa table over the region (where flow would be distributed according to area)
- Where an upper-most sub-catchment is of interest, either the hydrography may be modified, or the 2d_sa table modified within the hydraulic model to ensure flow is routed through it

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Appendix C
Calibration and Validation Report(s)

Appendix C
Calibration and Validation Report(s)

Project: Regional Floodplain Database Stage 3 Detailed Modelling: Package 1

BCC Calibration and Validation Feasibility Report

Prepared for: Moreton Bay Regional Council

Project: 222767-001

22 September 2011

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Contents

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1.2 Objective of calibration and validation feasibility report

This report details the calibration and validation feasibility analysis for the Brisbane Coastal Creeks (BCC) minor basin. This minor basin covers the upper ends of the Cabbage Tree Creek and Kedron Brook catchments. The northern portion of this minor basin lies within the Moreton Bay Region and the southern portion lies within the Brisbane City region, with the upper reaches of Kedron Brook running along the region divide.

This basin is largely urbanised, with only the upper reaches remaining forested. Flows are generally contained within the creek corridor or adjacent low lying land, with very little floodplain evident in this minor basin within the Moreton Bay region. Representation of the creek channel capacity and the structures will be important to the accurate modelling of this catchment.

This report assesses the feasibility of carrying out calibration and validation for the hydrological and hydraulic modelling of the BCC minor basin based on the current and prospective availability of data.

2. Available data

2.1 Stream gauge data

Stream gauge data (recorded water level with respect to time) is essential to calibrating a hydrologic model. Recorded water levels are converted to discharges using derived rating curves and compared with hydrologic model predictions. Stream gauge data is also useful in calibrating a hydraulic model through comparisons of recorded and predicted water levels with time at the gauge location. Two stream gauges are located close to the downstream boundary of the BCC minor basin. The available data at these locations is presented in Table 1, Figure 1 and Figure 2. This data was sourced from Brisbane City Council for the period of record up to 31 December 2010. No rating curves are available for these gauges.

Table 1 Stream Gauge Stations

Gauge Name	Gauge Owner/Data Source	Operational Start Date	Operational Finish Date
Collins Rd (Old Northern Rd)	Brisbane City Council	27/6/94	Still operational Data sourced up to 31/12/2010
Osborne Rd	Brisbane City Council	9/3/94	Still operational Data sourced up to 31/12/2010

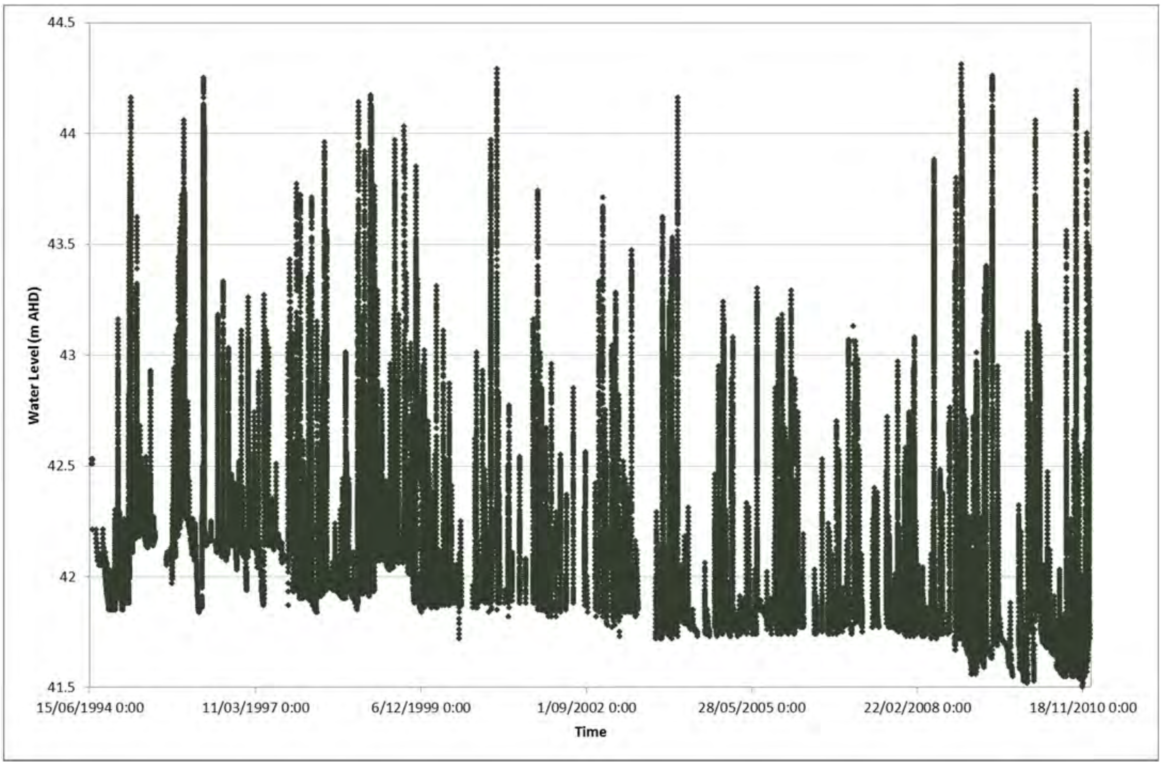


Figure 1 Recorded Water Levels in Cabbage Tree Creek at Collins Road (Old Northern Road)

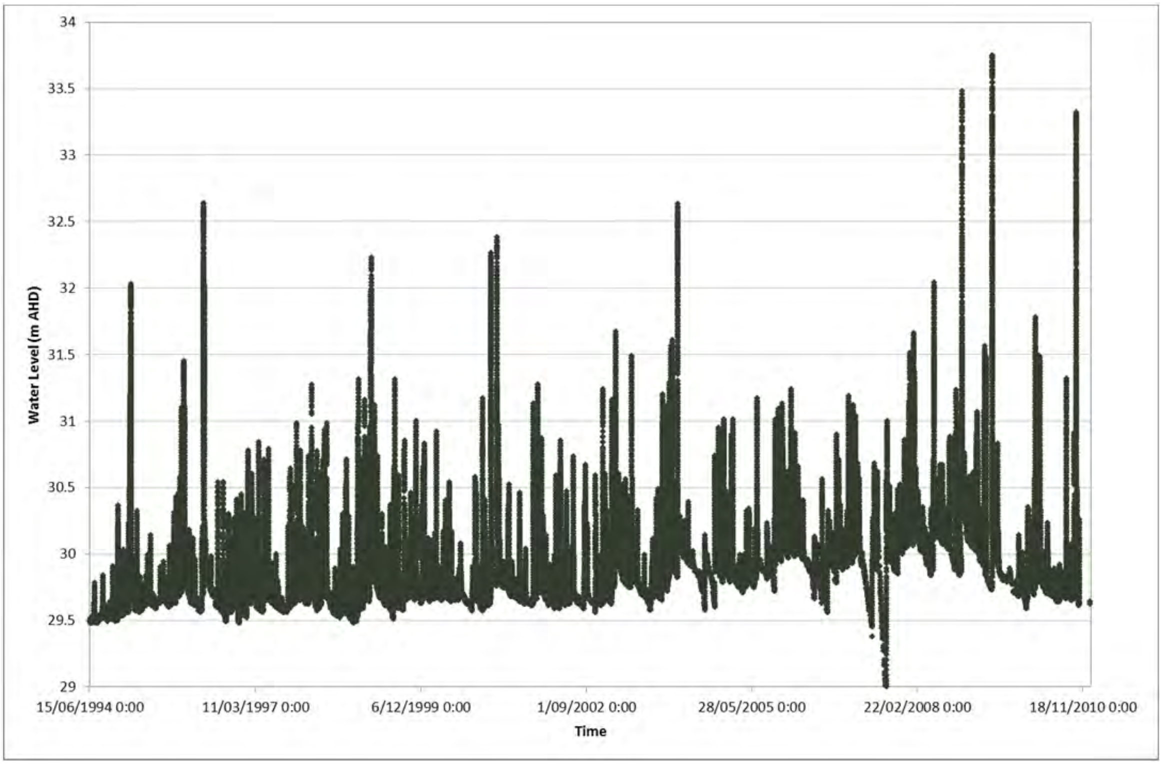


Figure 2 Recorded Water Levels in Kedron Brook at Osborne Road

Figure 1 shows that recorded water levels in Cabbage Tree Creek at Osborne Road have ranged between 41.5 and 44.3m AHD over the period of record. Water levels have exceeded 44.0m thirteen times and have exceeded 44.25m four times, with the peak recorded level occurring on 16 November 2008.

Figure 2 shows that, in the Kedron Brook catchment, the three largest events have occurred recently, with the recorded levels ranging between 29.0m and 33.75m AHD. The peak recorded level of 33.75m AHD occurred on 20 May 2009.

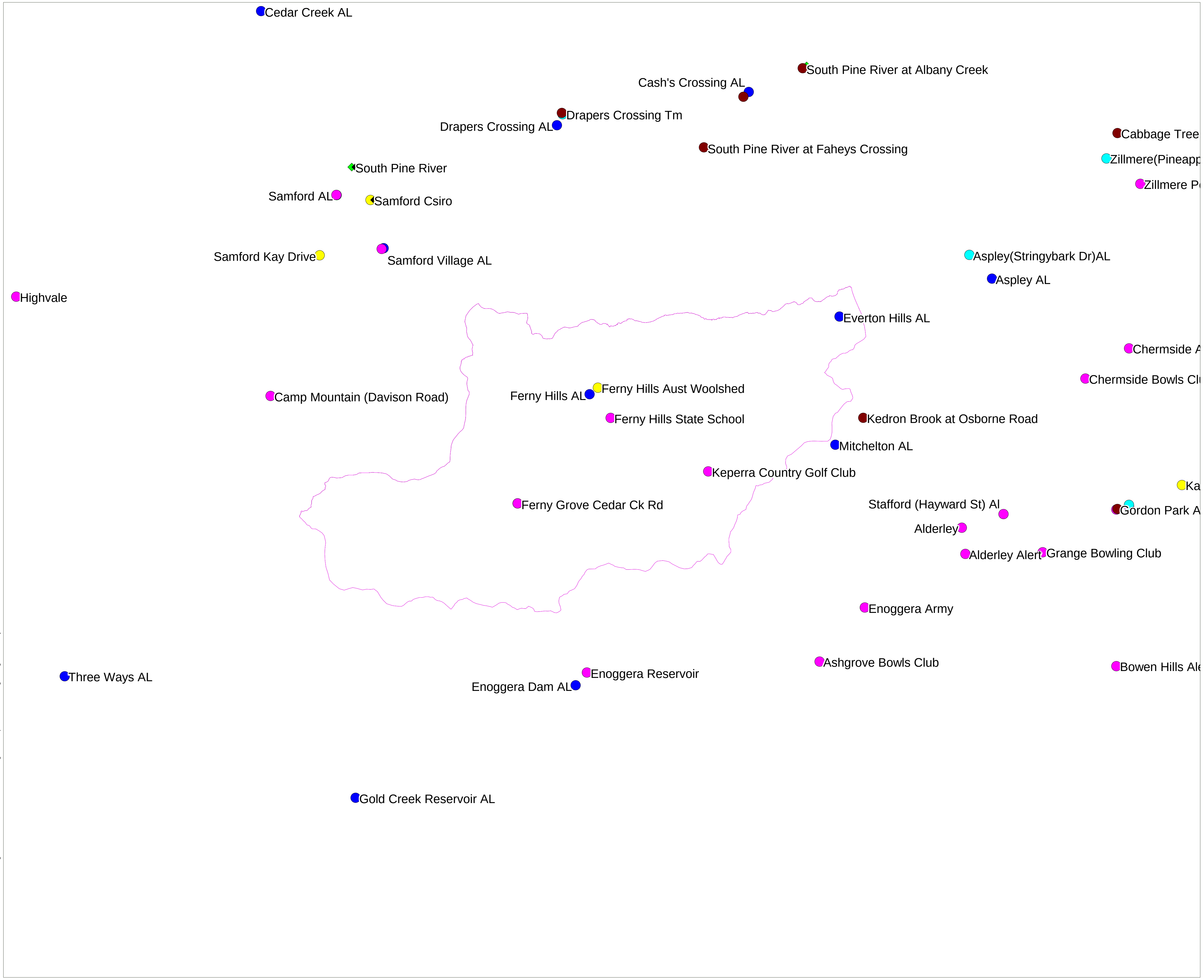
2.2 Rainfall data

Rainfall data is used to provide input to a hydrologic model regarding the amount, spatial variation and timing of rainfall during a storm event.

Rainfall station locations have been sourced from Moreton Bay Regional Council (MBRC) and the Bureau of Meteorology's (BoM) Water Resources Station Catalogue (WRSC). The gauge locations obtained from these sources are shown in Figure 3 and Figure 4 respectively. There are two types of rainfall stations:

- Alert station (or pluviometer) – rainfall is recorded in short duration intervals (as short as 6 minutes) providing rainfall patterns through the duration of a rainfall event
- Daily station – total rainfall during the course of a day is recorded (9am to 9am)

The alert stations and daily stations within the zone of influence have been provided in Table 2 and Table 3 respectively. The rainfall data has not yet been sourced for these stations.



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Legend

Gauge Types

- Battery
- Rainfall Alert
- Rainfall Daily
- Rainfall non-alert (pluviometer)
- Water Level
- Water Level Non-Alert

- WQ Event Monitoring Program

Notes:

Date: 22/09/2011 Version: 0

0 3750 (m)

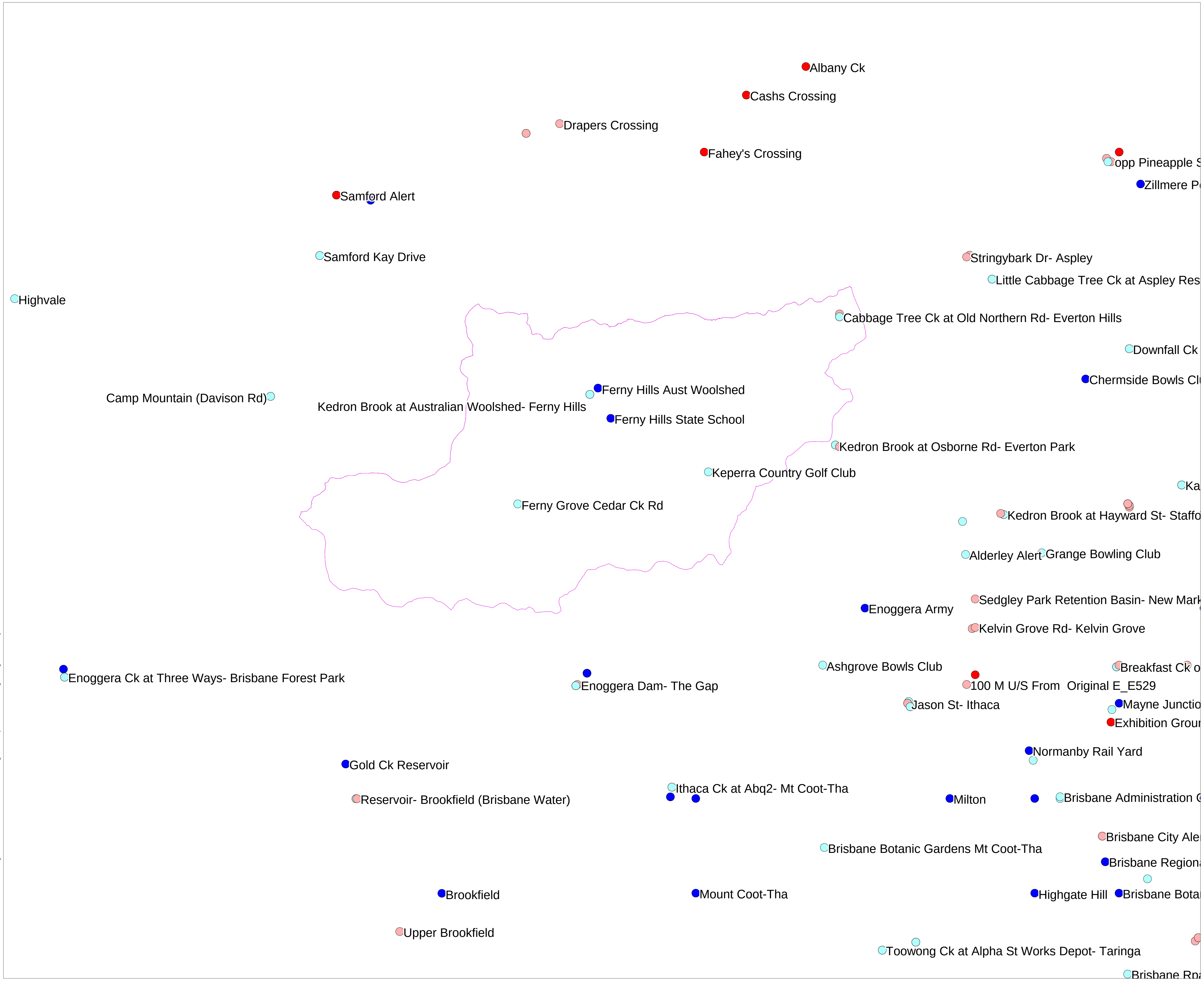
Scale 1:7 500 (m) (@ A3 size)

Projection: MGA Zone 56

RFD Stage 3 Detailed Modelling

Brisbane Coastal Creeks

Figure 1: MBRC Gauge Data Locations



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Water Resources Station Catalogue

- River Station - Operational
- River Station - Closed
- Rainfall Station - Operational
- Rainfall Station - Closed

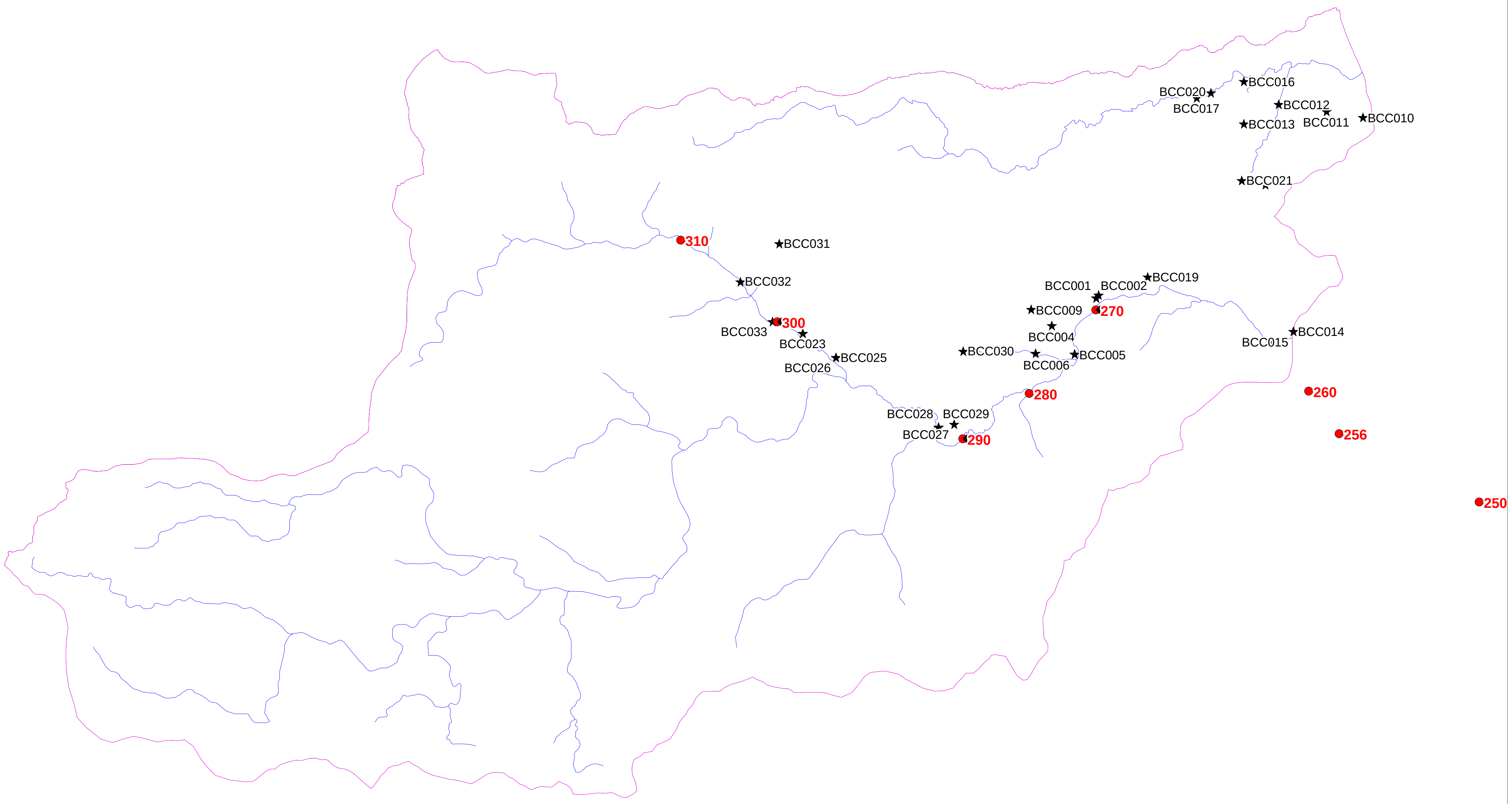
Notes:

Date: 22/09/2011 Version: 0

RFD Stage 3 Detailed Modelling

Brisbane Coastal Creeks

Figure 2: WRSC Gauge Data Locations



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Legend

● Maximum Height Gauge Location

★ Historic Flood Mark Location

Notes:

Date: 22/09/2011 Version: 0

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Scale 1:4 000 (m) (@ A3 size)

Projection: MGA Zone 56

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RFD Stage 3 Detailed Modelling

Brisbane Coastal Creeks

Figure 3: Historic Flood Mark Locations

Table 2 Alert/Pluviograph Stations

Gauge Name	Gauge Owner/ Data Source	Operational Start Date	Operational Finish Date
Samford	SEQWC/BoM	April 1995	Still operational
Samford Village	MBRC	Unknown	Unknown
Ferny Hills (Kedron Brook at Australian Woolshed)	BCC	June 1994	March 2009
Ferny Hills (Upper Kedron Recreational Reserve)	BCC	October 2009	Still operational
Everton Hills (Cabbage Tree Creek at Old Northern Road)	BCC	May 1994	Still operational
Mitchelton (Kedron Brook at Osborne Road)	BCC	March 1994	Still operational
Enoggera Dam (Enoggera Creek at Enoggera Dam)	BCC	May 1994	Still operational

Table 3 Daily Rainfall Stations

Gauge Name	Gauge Owner/Data Source	Operational Start Date	Operational Finish Date
Camp Mountain (Davison Road)	BoM	1926	Still operational
Ferny Grove Cedar Creek Road	BoM	February 1982	Still operational
Ferny Hills State School	BoM	April 1964	December 1973
Keperra Country Golf Club	BoM	September 1972	Still operational
Enoggera Reservoir	BoM	1870	November 1996

Table 2 and Table 3 show that daily rainfall records are available from 1870 onwards and pluviograph records are available since 1994 onwards.

2.3 Historic flood marks

Historical flood marks are an important part of calibrating a hydraulic model as they provide information regarding the variation in water levels across a floodplain. Table 4 presents the historic flood mark data which is available from MBRC and Table 5 presents the historic flood mark data which is available from Brisbane City Council. The data in both these tables is sorted by the date that the mark was recorded. Figure 5 shows the locations of these flood marks within the BCC minor basin.

Table 4 MBRC Historical Flood Marks

Mark ID	Street	Suburb	Date	Recorded Level
BCC004	Grove Avenue	Arana Hills	1967	44.81
BCC005	Jane Street	Arana Hills	1967	43.63
BCC008	Jane Street	Arana Hills	1967	44.67
BCC009	Leslie Street	Arana Hills	1967	48.81
BCC010	Bennetts Road	Everton Hills	1967	55.81
BCC011	Bennetts Road	Everton Hills	1967	46.42

Mark ID	Street	Suburb	Date	Recorded Level
BCC012	Bennetts Road	Everton Hills	1967	47.98
BCC013	Bunya Road	Everton Hills	1967	51.95
BCC016	Elizabeth Street	Everton Hills	1967	48.31
BCC017	John Street	Everton Hills	1967	50.43
BCC020	Peter Street	Everton Hills	1967	49.20
BCC021	Timms Road	Everton Hills	1967	59.61
BCC022	Timms Road	Everton Hills	1967	59.94
BCC023	Ferny Way	Ferny Hills	1967	55.74
BCC025	Illuta Avenue	Ferny Hills	1967	52.83
BCC033	Samford Road	Ferny Hills	1967	55.93
BCC003	Dawson Parade	Arana Hills	1970	41.56
BCC006	Jane Street	Arana Hills	1970	43.54
BCC014	Camelia Avenue	Everton Hills	1970	34.88
BCC028	Kuringal Drive	Ferny Hills	1970	48.68
BCC001	Dawson Parade	Arana Hills	1972	41.77
BCC015	Camelia Avenue	Everton Hills	1972	35.21
BCC002	Dawson Parade	Arana Hills	1974	42.60
BCC007	Jane Street	Arana Hills	1974	42.90
BCC018	Oleria Street	Everton Hills	1974	37.47
BCC019	Oleria Street West	Everton Hills	1974	41.01
BCC024	Ferny Way	Ferny Hills	1974	56.21
BCC026	Illuta Avenue	Ferny Hills	1974	51.14
BCC027	Kuringal Drive	Ferny Hills	1974	50.40
BCC029	Kuringal Drive	Ferny Hills	1974	50.78
BCC030	Kylie Avenue	Ferny Hills	1974	47.42
BCC031	Palall Crescent	Ferny Hills	1974	65.29
BCC032	Samford Road	Ferny Hills	1974	57.22

Table 5 Brisbane City Council Historical Flood Marks

Maximum Height Gauge	Street	Suburb	Date	Recorded Level
290	Kuringal Drive	Ferny Hills	05-May-80	47.30
300	Samford Rd	Ferny Grove	05-May-80	55.87
290	Kuringal Drive	Ferny Hills	03-Nov-81	47.33
290	Kuringal Drive	Ferny Hills	20-Jan-82	46.78
290	Kuringal Drive	Ferny Hills	08-Apr-84	47.55
270	Dawson Parade	Keperra	04-Apr-88	40.22

Maximum Height Gauge	Street	Suburb	Date	Recorded Level
290	Kuringal Drive	Ferny Hills	04-Apr-88	47.40
300	Samford Rd	Ferny Grove	04-Apr-88	55.68
270	Dawson Parade	Keperra	21-Feb-92	40.80
300	Samford Rd	Ferny Grove	21-Feb-92	55.85
310	Rangleigh Street	Ferny Grove	17-Mar-92	59.90
270	Dawson Parade	Keperra	19-Jan-94	40.98
290	Kuringal Drive	Ferny Hills	19-Jan-94	47.39
300	Samford Rd	Ferny Grove	19-Jan-94	55.67
270	Dawson Parade	Keperra	03-May-96	40.27
290	Kuringal Drive	Ferny Hills	03-May-96	47.55
300	Samford Rd	Ferny Grove	03-May-96	55.77
310	Rangleigh Street	Ferny Grove	03-May-96	59.90
290	Kuringal Drive	Ferny Hills	09-Mar-01	47.12
290	Kuringal Drive	Ferny Hills	05-Mar-04	47.59
280	Pearse Street	Keperra	20-Nov-08	45.32
290	Kuringal Drive	Ferny Hills	20-Nov-08	48.27
300	Samford Rd	Ferny Grove	20-Nov-08	56.04
270	Dawson Parade	Keperra	20-May-09	40.60*
280	Pearse Street	Keperra	20-May-09	45.46
290	Kuringal Drive	Ferny Hills	20-May-09	48.33
300	Samford Rd	Ferny Grove	20-May-09	55.80
310	Rangleigh Street	Ferny Grove	20-May-09	59.57*
270	Dawson Parade	Keperra	11-Oct-10	40.95*
280	Pearse Street	Keperra	11-Oct-10	45.21
290	Kuringal Drive	Ferny Hills	11-Oct-10	48.59
300	Samford Rd	Ferny Grove	11-Oct-10	56.20
310	Rangleigh Street	Ferny Grove	11-Oct-10	60.57*

** Indicates debris-affected readings*

Table 4 shows that the historical flood marks available from MBRC all occurred prior to 1975. Table 5 shows that Brisbane City Council has five maximum height gauge locations along Kedron Brook and records for these gauges are available between 1980 and 2010.

3. Flood events

3.1 Possible events for calibration/validation

The data presented in Section 2 shows that coinciding stream gauge, rainfall and maximum height gauge records are available in the Kedron Brook catchment from 1994 onwards. There are four events in which data was recorded at more than one maximum height gauge. These events occurred in May 1996, November 2008, May 2009 and October 2011. These events are therefore the best possible events for calibration and/or validation in this catchment.

In the Cabbage Tree Creek catchment, flood marks are only available for events prior to installation of the Collins Road stream gauge.

Figure 6 below presents the time series data for the four Kedron Brook events. These have been overlain to show how the event characteristics (timing, volume etc) compare. The May 1996 event has the greatest volume, the longest duration and the smallest peak of the four events. The November 2008 event had a small initial peak, then a short duration second peak. The May 2009 event had the highest peak of the four events.

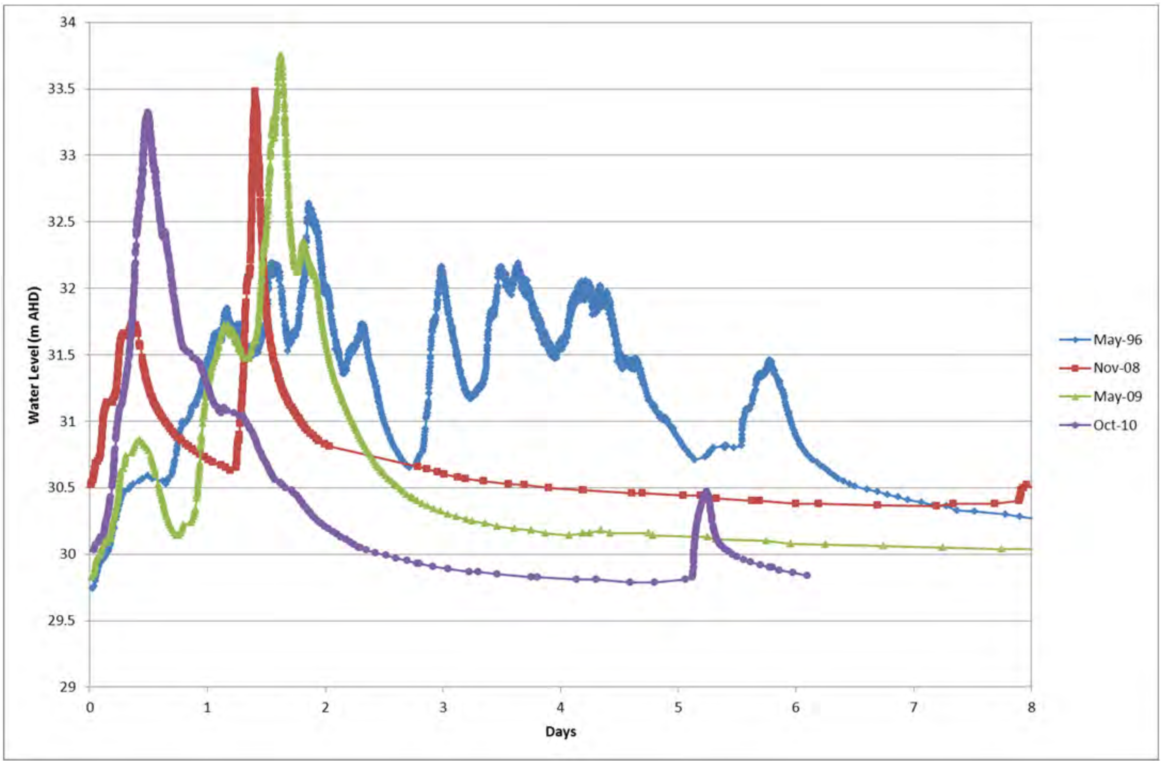

Figure 6 Recorded Water Levels in Kedron Brook at Osborne Road

Figure 7 shows the recorded water levels in the Cabbage Tree Creek for the same four events. These events all had a peak discharge of similar magnitude; however the 1996 event carried a much great volume of water and was a multi-peak event, similar to the same event in the Kedron Brook catchment.

Figure 8 shows a longitudinal profile of the recorded maximum height gauge levels along Kedron Brook. The readings for MHG 310 and MHG 270 were debris-affected for the May 2009 and October 2010 events.

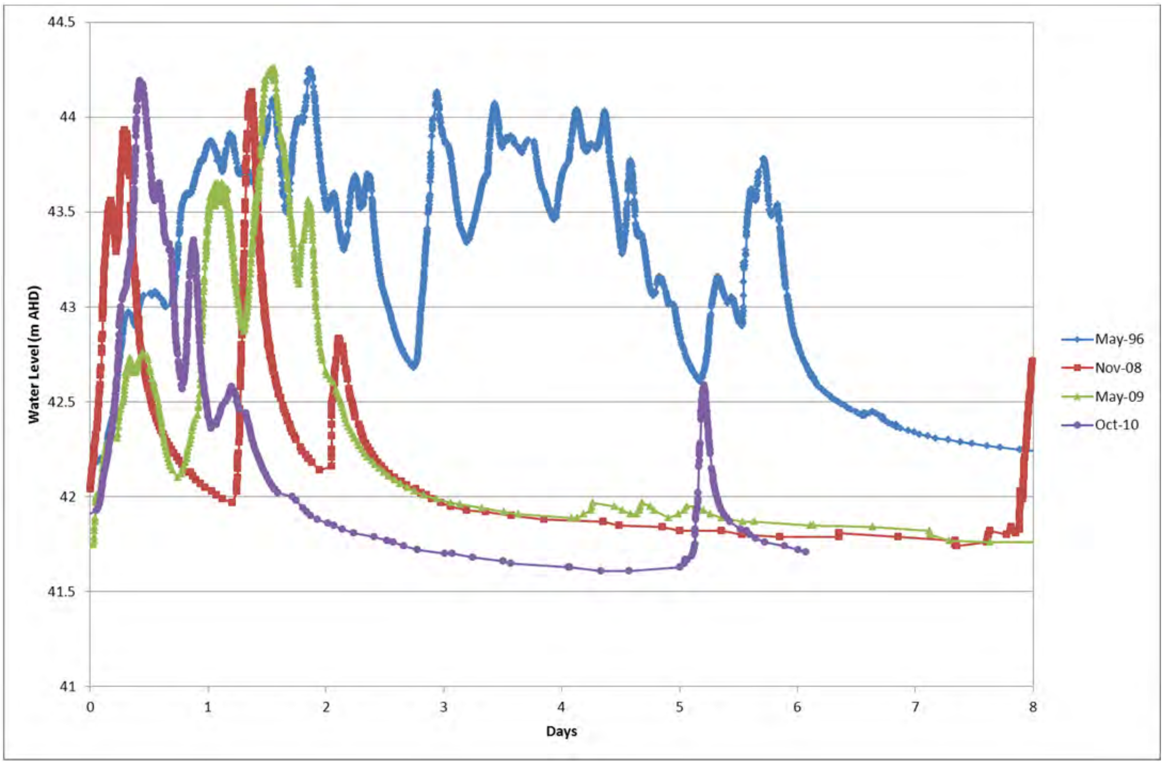

Figure 7 Recorded Water Levels in Cabbage Tree Creek at Collins Road (Old Northern Road)

Figure 8 shows that the May 1996 event is generally the smallest event. The other three events produced similar levels throughout the central part of the catchment. At MHG 270 and MHG 310, the May 1996 level is the only available level which is not debris-affected.

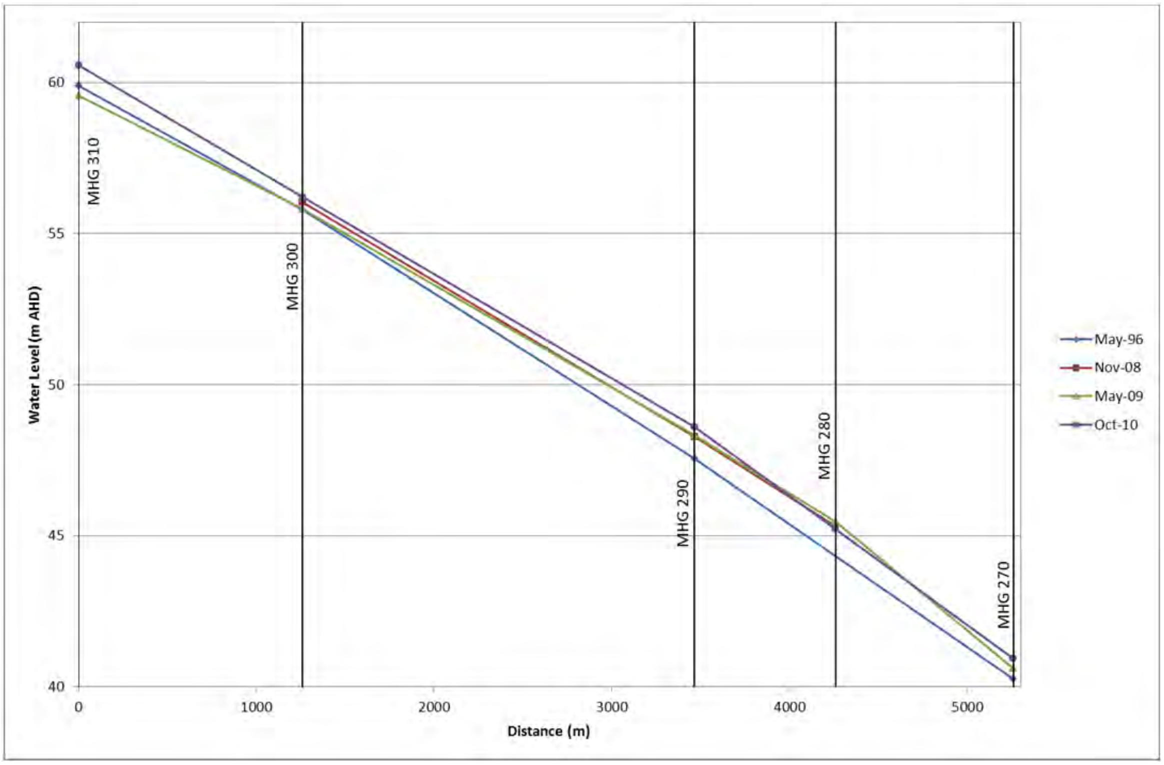

Figure 8 Recorded Peak Water Levels in Kedron Brook

3.2 Feasibility of calibration/validation

In order to achieve a good calibration it is desirable to have rainfall (pluviograph), stream gauge and recorded flood levels throughout a catchment.

For the Cabbage Tree Creek catchment:

- Rainfall data from the Ferny Hills and Everton Hills pluviograph stations is available from June 1994 onwards
- Stream gauge data for the Collins Road (Old Northern Road) stream gauge at the downstream boundary of the catchment is available from June 1994 onwards
- No recorded historical flood levels are available within the timeframes that rainfall and stream gauge data are available

For the Kedron Brook catchment:

- Rainfall (pluviograph) data is available from June 1994 onwards
- Stream gauge data for the Osborne Road stream gauge (approximately 600m downstream of the model area) is available from March 1994 onwards
- Recorded flood levels are available at 5 locations for the May 1996 event. Reliable (ie not debris-affected) recorded flood levels are available at three locations for the November 2008, May 2009 and October 2010 events

The lack of rating curves for these gauges would make stand-alone calibration of the hydrologic model impossible. With the available data, it would be possible to undertake a joint calibration of the hydrologic and hydraulic models at their downstream boundaries (if the downstream boundary of the Kedron Brook reach is moved to Osborne Road). It would also be possible to calibrate the predicted peak water levels in Kedron Brook to a few locations (maximum 5).

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Project: Regional Floodplain Database Stage 3 Detailed Modelling: Package 1: Brisbane Coastal Creeks (BCC)

Validation Report

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1. Introduction

1.1 Study objective

Moreton Bay Regional Council (MBRC) is delivering a Regional Floodplain Database (RFD) in support of their flood risk management, considering emergency response, development control, strategic land use and infrastructure planning. MBRC is responsible for the areas of Caboolture, Pine Rivers, Redcliffe and Bribie Island. The RFD project focuses on the northern sector of the Council area as a key growth area for South-east Queensland.

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- Strategies for management of any identified flooding problems
- A system/process to store and manage this information and keep it up-to-date

Stage 1 of the project was completed in July 2010 and involved a number of sub-projects. These projects delivered consistent processes and protocols for the detailed hydrologic and hydraulic model development. A key sub-project involved the development of broadscale hydrodynamic models for each minor basin to provide general understanding of flooding mechanisms and allow prioritisation of data capture.

Stage 2 of the project involves the development of detailed hydrologic and hydraulic models for each minor basin and is currently nearing completion.

Stage 3 includes development of a further two detailed models (currently underway). Stage 3 will then build on the detailed models and “add value” through assessment of flood damages and community resilience measures.

1.2 Validation report objective

This report details the validation of the Brisbane Coastal Creeks (BCC) minor basin TUFLOW model. This minor basin covers the upper ends of the Cabbage Tree Creek and Kedron Brook catchments. The northern portion of this minor basin lies within the Moreton Bay Region and the southern portion lies within the Brisbane City region, with the upper reaches of Kedron Brook running along the region divide.

This basin is largely urbanised, with only the upper reaches remaining forested. Flows are generally contained within the creek corridor or adjacent low lying land, with very little floodplain evident in this minor basin within the Moreton Bay region.

Aurecon’s Calibration and Validation Feasibility Report indicated that a standalone calibration of the hydrologic model would not be possible with the available data. Therefore, in conjunction with MBRC, it was decided to perform a joint validation exercise for the hydrologic and hydraulic models to a single historical event. MBRC determined that the BCC TUFLOW model should be validated to the October 2010 event.

2. Available data – October 2010 event

2.1 Rainfall data

Rainfall data is used to provide input to a hydrologic model regarding the quantity, spatial variation and timing of rainfall during a storm event. To represent the rainfall during the October 2010 event, rainfall records from four gauges were used. Rainfall records from alert station (or pluviometer gauges) were used. For these stations rainfall is recorded in short duration intervals (as short as 6 minutes) providing rainfall patterns throughout the duration of a rainfall event.

The four gauges used are listed in Table 1 and their locations can be seen in Figure A1. Data for all four gauges was sourced from Brisbane City Council and this data provides an adequate representation of rainfall across the catchment.

Table 1 | Alert/pluviograph stations

Gauge name	Gauge owner/ data source	Station number
Ferny Hills (Upper Kedron Recreational Reserve)	BCC	1545
Everton Hills (Cabbage Tree Creek at Old Northern Road)	BCC	1572
Mitchelton (Kedron Brook at Osborne Road)	BCC	1539
Enoggera Dam (Enoggera Creek at Enoggera Dam)	BCC	1533

The recorded cumulative rainfall depths in millimetres (mm) for these four gauges can be seen in Figure 1. This figure shows that there is limited rainfall preceding the rainfall event on 10 October 2012. On 10 October at around 8 pm there was a dramatic increase in the intensity of the rainfall which continued until approximately 12 pm on 11 October. During this period cumulative rain depths increased from 62 mm to 290 mm at the Upper Kedron Recreational Reserve gauge which is in near centre of the catchment area.

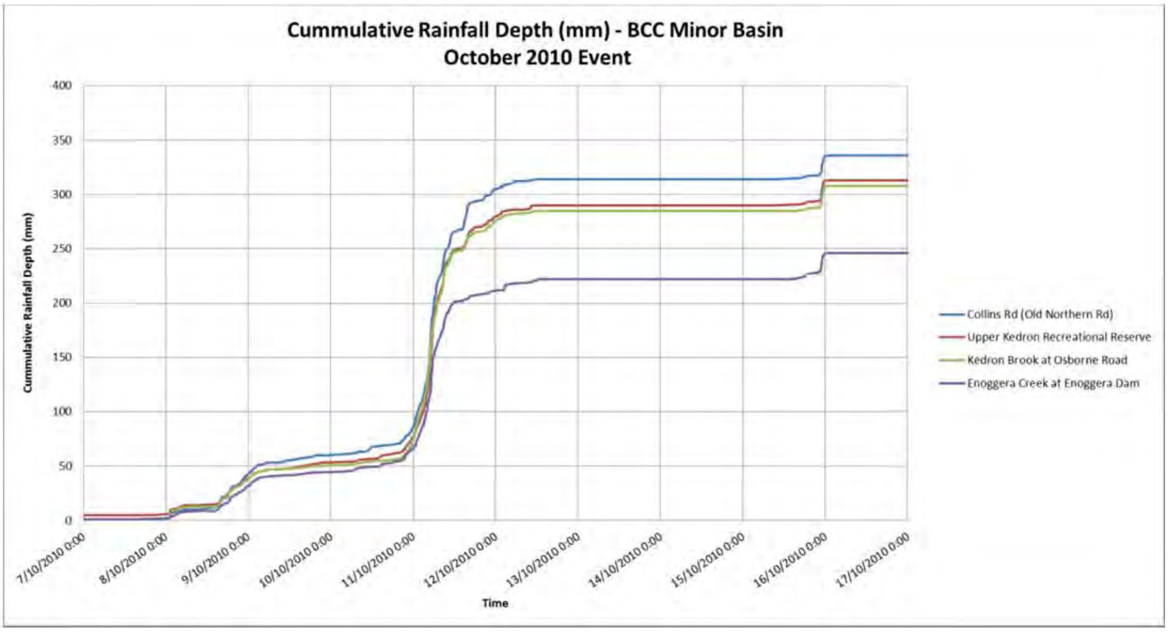

Figure 1 | Cumulative rainfall depths (mm) BCC minor basin October 2010 event

2.2 Stream gauge data

Stream gauge data (recorded water level with respect to time) can be used to calibrate a hydraulic model through comparisons of recorded and predicted water levels over time at the gauge location. Two stream gauges are located close to the downstream boundary of the BCC minor basin. The available data at these locations is presented in Table 2. This data was sourced from Brisbane City Council and no rating curves are available for these gauges.

Table 2 | Stream gauge stations

Gauge name	Gauge owner/data source	Operational start date	Operational finish date
Collins Road (Old Northern Road)	Brisbane City Council	27 June 1994	Still operational Data sourced up to 31 December 2010
Osborne Road	Brisbane City Council	9 May 1994	Still operational Data sourced up to 31 December 2010

2.3 Maximum height gauges

Spatial matching of peak water levels is an important part of calibrating a hydraulic model as this provides information regarding the variation in water levels across a floodplain. Brisbane City Council maintains a network of maximum height gauges across its regional area and six maximum height gauges are located in the upper Kedron Brook catchment. Table 3 presents the maximum height gauge data which is available from Brisbane City Council. Figure A1 displays the locations of these flood marks within the BCC minor basin.

Table 3 | Brisbane City Council historical flood marks

Maximum height gauge No.	Street	Suburb	October 2010 event recorded level (m AHD)
260	Osborne Road	Keperra	32.71
270	Dawson Parade	Keperra	40.95*
280	Pearse Street	Keperra	45.21
290	Kuringal Drive	Ferny Hills	48.59
300	Samford Road	Ferny Grove	56.20
310	Rangleigh Street	Ferny Grove	60.57*

* Indicates debris-affected readings

3. Modelling

3.1 Hydrologic model

To represent the rainfall in the hydrologic model, the rainfall records were discretised into five minute intervals. The base WBNM model as provided by MBRC was used in this assessment, with three additional sub-catchments added at the downstream end of Kedron Brook. These were added so the hydrologic and hydraulic model extents would match. The hydrologic model was run for the 48 hours from 8 pm on 8 October 2010 to 8 pm on 12 October 2010.

3.2 Hydraulic model

The BCC TUFLOW model for the validation modelling is consistent with the TUFLOW model set up for the design event assessment. The only modification was the addition of three SA inflows to represent the additional downstream Kedron Brook sub-catchments added into the hydrologic model. No other parameters were changed. The development of the hydraulic model will be outlined in the Modelling Quality Report.

4. Results

4.1 Hydrograph comparison at the river gauge locations

Figure 2 and Figure 3 present a comparison of recorded and modelled water levels at the Osborne Road gauge on Kedron Brook and the Collins Road (Old Northern Road) gauge on Cabbage Tree Creek. These figures show that the timing at both gauges compares very well between the recorded and modelled flood event. The model overestimates the peak water level by approximately 850 mm at the Osborne Road Gauge and 200 mm at the Collins Road Gauge.

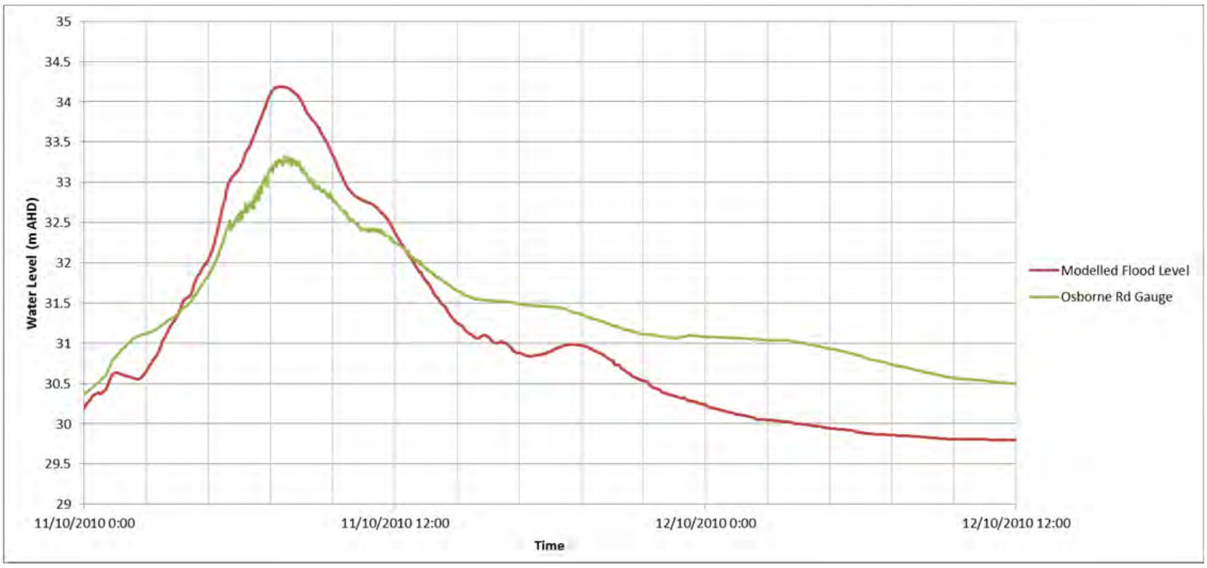

Figure 2 | Recorded and modelled hydrograph at Osborne Road gauge

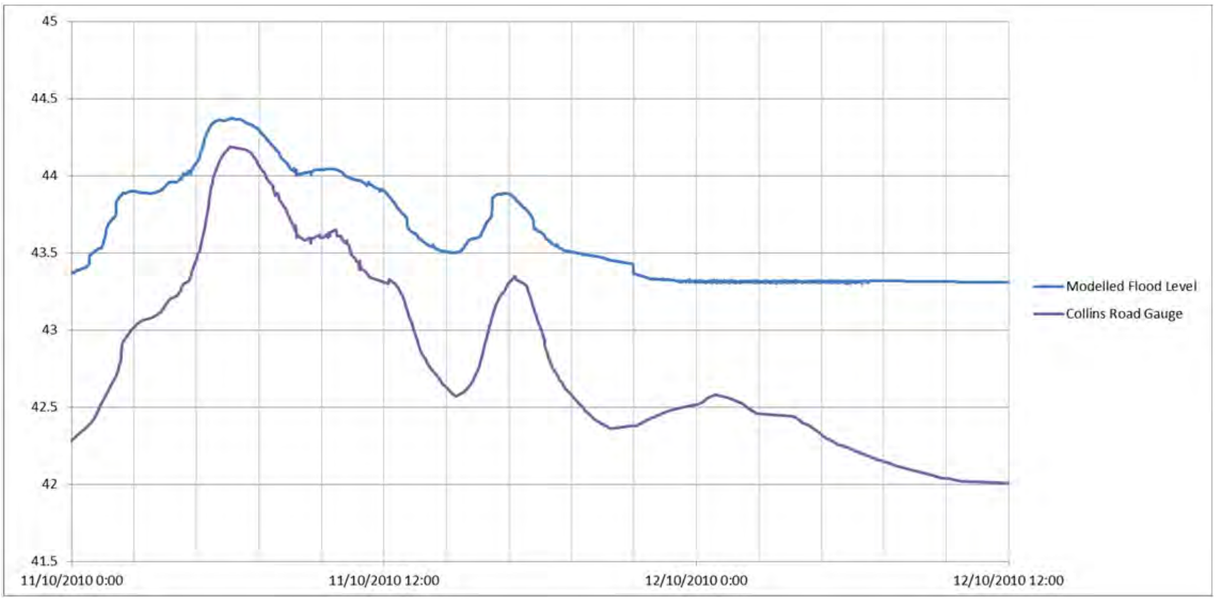

Figure 3 | Recorded and modelled hydrograph at Old Northern Road gauge

4.2 Maximum height gauges

Table 4 shows the recorded and modelled peak water levels at the six maximum gauges along Kedron Brook. Generally the model compares relatively well with the gauges and the flood extent of the event can be seen in Figure A2. Gauge 310 which is located on an upper reach of Kedron Brook shows a difference of approximately 500 mm which is most likely attributed to the fact that flood waters in this area are generally confined to a narrow channel. No bathymetric data has been included for this channel; therefore it is possible that the conveyance capacity in this reach of the creek is being underestimated in the model. The model at gauges 300, 290 and 280 are within 300 mm of the recorded levels. At Gauge 270 and 260 the model over predicts the flood levels. There appears to be a general trend for increasing overestimation of peak water levels towards the lower end of the model. Floodwaters in the lower reaches are also confined to the channel and as outlined previously, the conveyance capacity in these areas may be underestimated by the model.

Table 4 | Model results compared to maximum height gauges

Maximum height gauge	Street	Recorded peak water level (m AHD)	Modelled peak water level (m AHD)	Difference (m)
260	Osborne Road	32.71	33.93	+1.22
270	Dawson Parade	40.95*	41.56	+0.61
280	Pearse Street	45.21	45.48	+0.27
290	Kuringal Drive	48.59	48.51	-0.08
300	Samford Road	56.20	56.26	+0.06
310	Rangleigh Street	60.57*	61.04	+0.47

* Indicates debris-affected readings

Figure 4 presents a longitudinal plot of the recorded peak water levels against the modelled flood levels. This plot confirms that the model is predicting the recorded water levels relatively well, with the over estimation of peak water levels at the downstream end of the model.

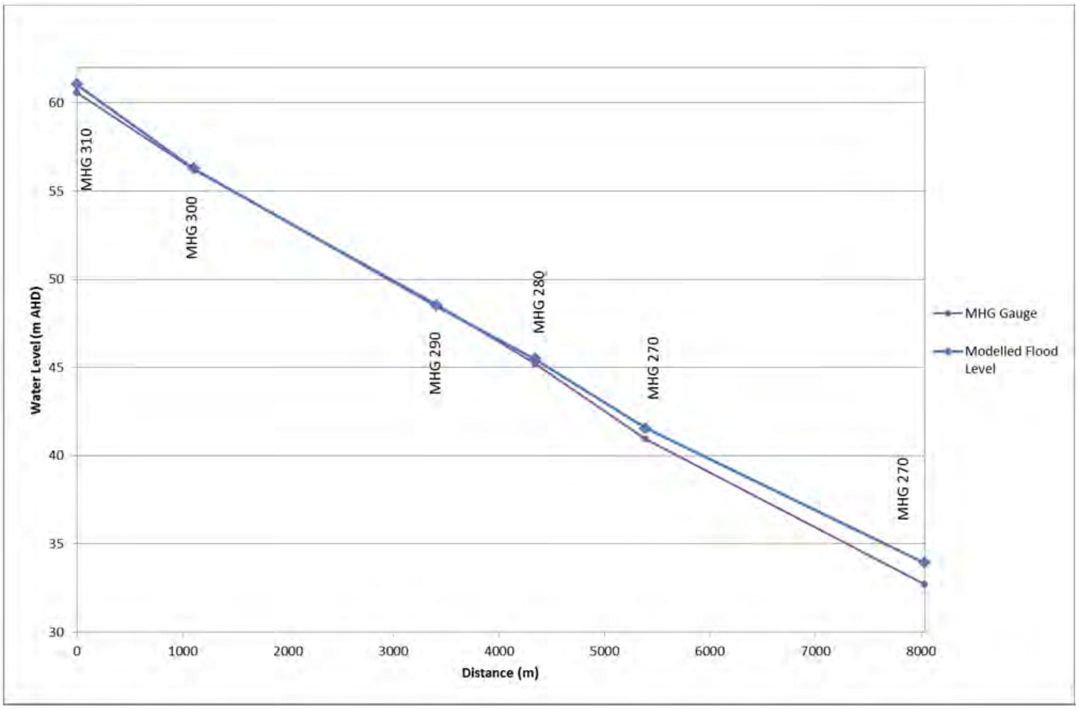

Figure 4 | Comparison of maximum height gauge and modelled peak water levels

The difference in recorded flood levels and the modelled flood levels are presented in Figure 5 below. The model is over predicting water levels.

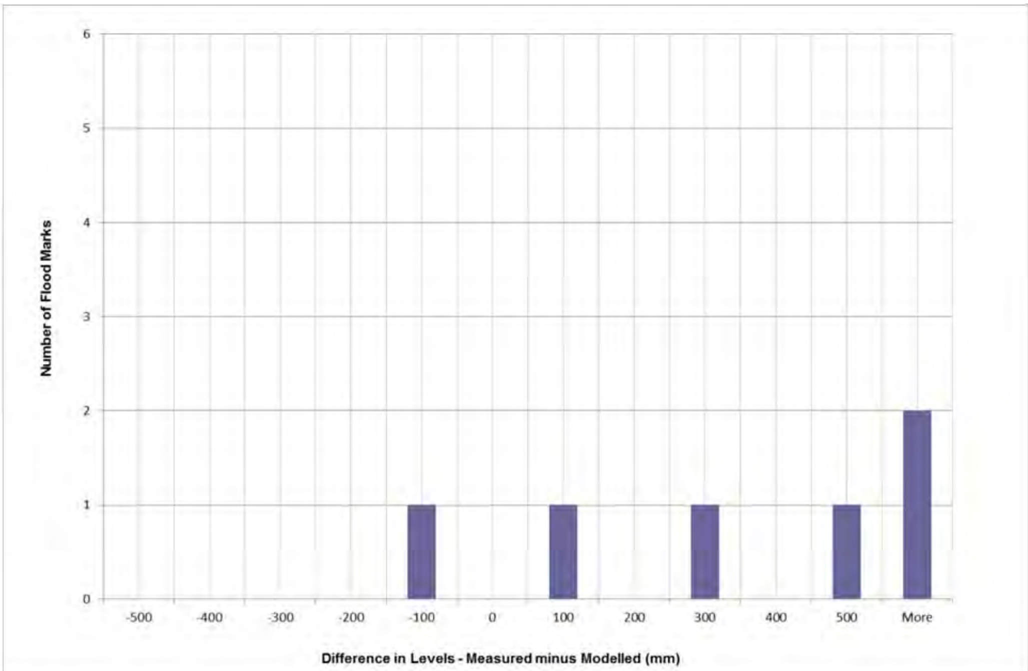

Figure 5 | Height gauge histogram

5. Discussion

The Brisbane Coastal Creeks model generally represents the timing and peak water levels of the October 2010 event well with an overestimation of peak water levels in the lower reaches. The Brisbane Coastal Creeks model covers only one minor basin in the Moreton Bay Region. Under the direction of Council, the catchments in this region have been modelled with a uniform approach, using a standard set of modelling parameters. This holistic approach does not encourage use of minor basin or catchment specific modelling parameters. For this reason it is considered that the validation results obtained for the BCC model are within acceptable limits.

Appendices

Appendix A
Additional figures

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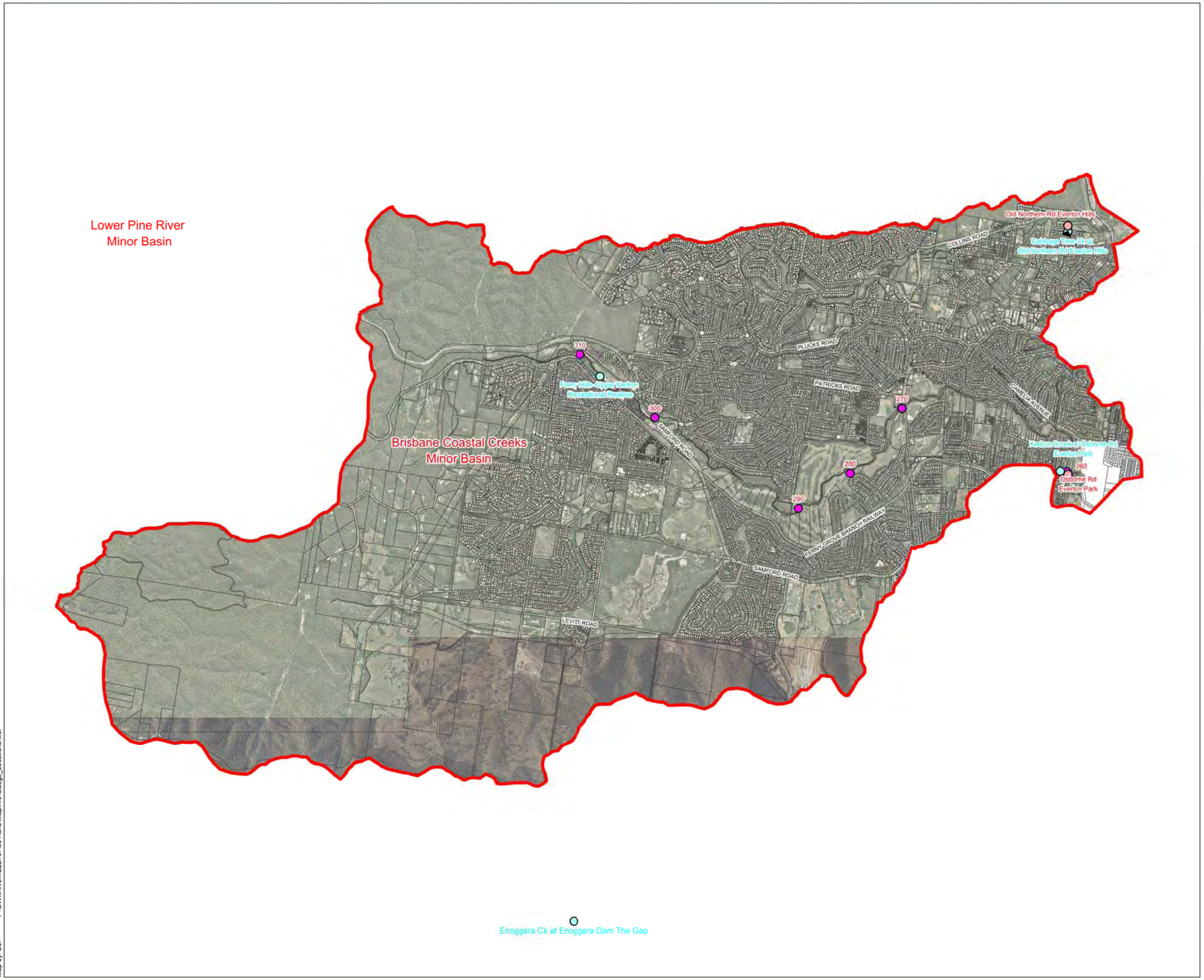


Map by: DJF   P:\SWM\Work\222767\001\GIS\MapInfo\Gauge_Locations.wor

Legend

- Cadastre
- Minor Basin Boundaries
- River Station
- Maximum Height Gauge
- Rainfall Station

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

A3 scale 1:40,000

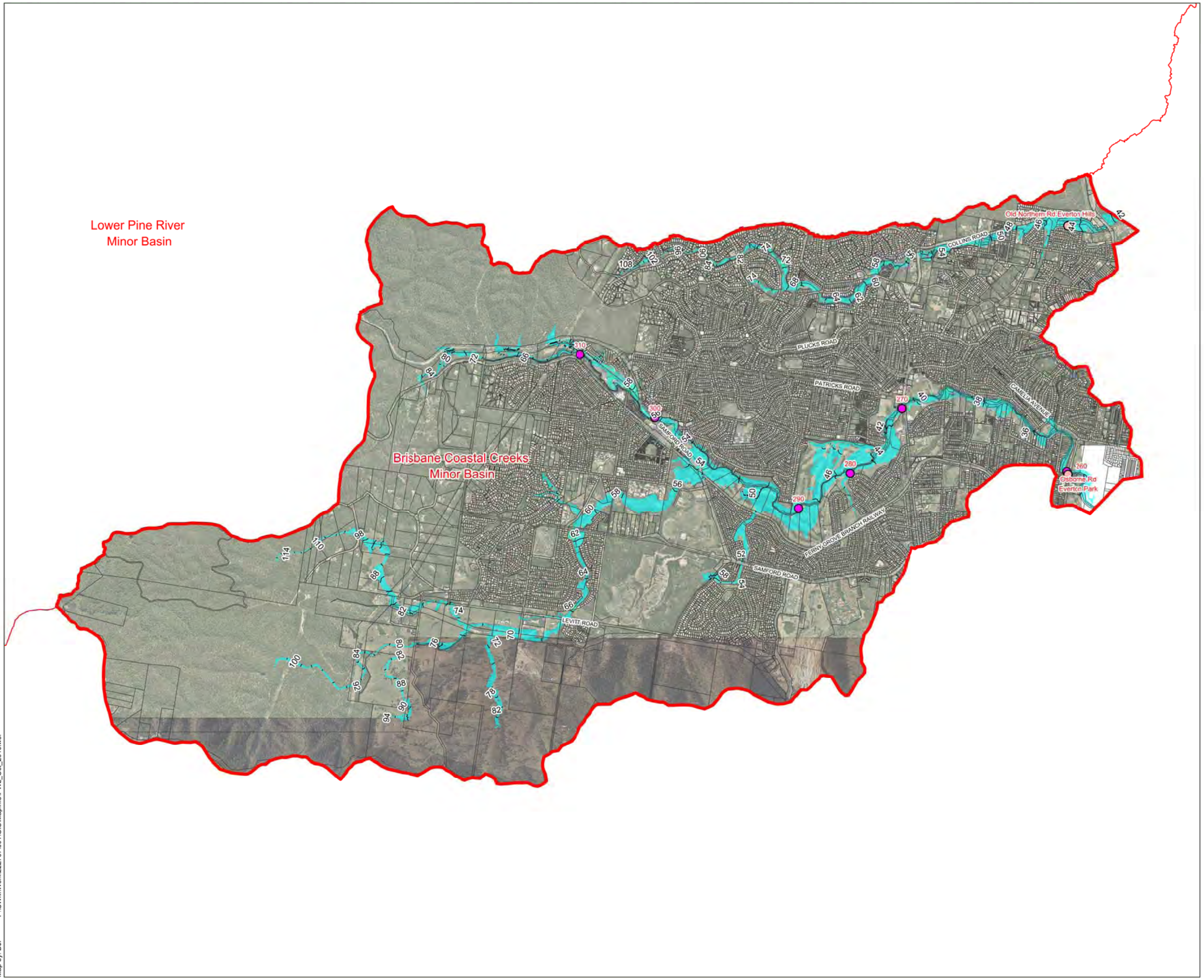
0   1000 m   2,000 m

Date: 30/07/2012   Version: 0   Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure A1: Gauge Locations



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Legend

- Cadastre
- Minor Basin Boundaries
- River Station
- Maximum Height Gauge
- Contour Lines (m AHD)
- Flood Extent

Notes:

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A3 scale 1:40,000

0 1000 m 2,000 m

Date: 30/07/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure A2: October 2010 Event Peak Flood Extent

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Appendix D
Modelling Quality Report

Appendix D
Modelling Quality Report

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Project: Regional Floodplain Database

Model Quality Report
Brisbane Coastal Creeks (BCC)

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Prepared for: Moreton Bay Regional Council

Revision: 1

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Approval			
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Title	Associate	Title	Unit Leader, Water Services

Regional Floodplain Database

Date | 09 October 2012
Reference | 222767
Revision | 1

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Contents

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1.2 Objective of model quality report

This report describes the model setup process adopted for the detailed 5 m grid TUFLOW model of the Brisbane Coastal Creeks (BCC) minor basin. It also describes the model quality and model issues for the hydrologic and hydraulic models.

2 TUFLOW model setup process

2.1 Code boundary

The code boundary was modified as per the following:

- The code boundary was extended downstream past Osborne Road and Old Northern Road to prevent model results at the stream gauge locations from being affected the downstream boundary conditions
- The code boundary was widened wherever flows were being constrained by the code boundary

In Figure 1 below, the red line shows the adopted code boundary and the blue line shows the broadscale model code boundary.

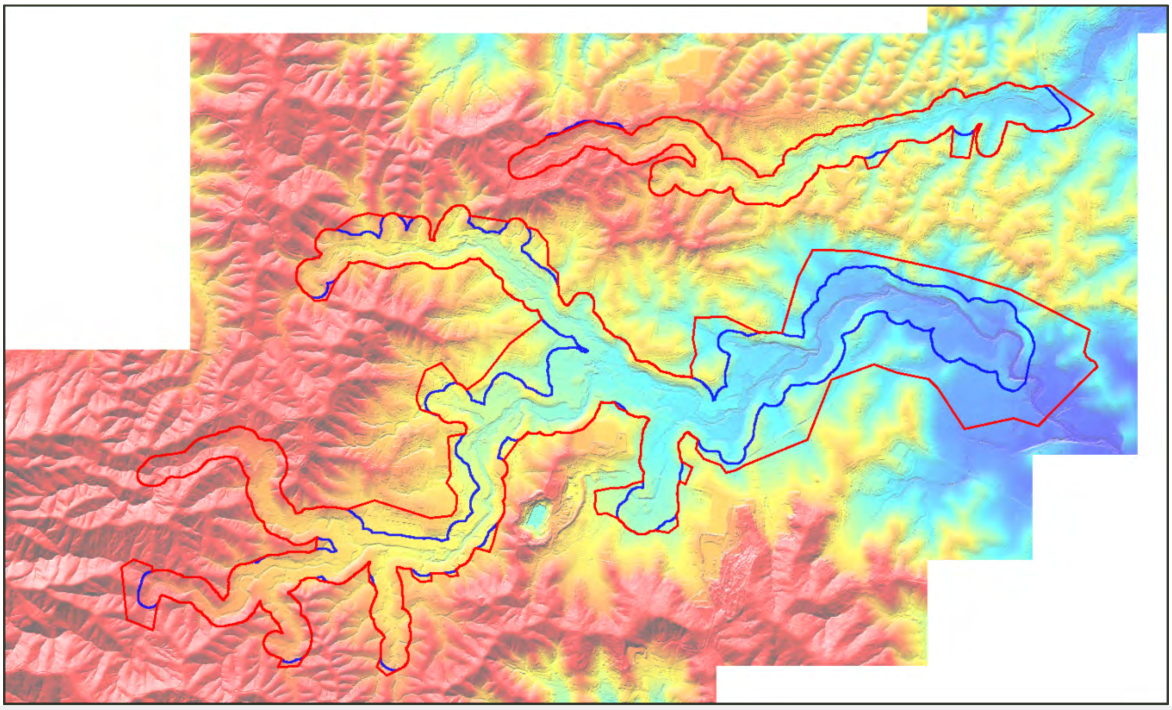


Figure 1 | Code boundary

2.2 Inflows and SA boundaries

SA boundaries were adopted based upon the final hydrography minor catchments layer provided to Aurecon on 24 February 2011. The following changes were made to this layer:

- At structures the SA boundaries were modified so they crossed the top of the structure and inflows were then applied upstream of the structure

Figure 2 below shows an example of how the SA boundaries were modified at structures. The black line represents the adopted SA boundary and the grey line represents the minor catchment definition. In this image, flow is from the left of the page towards the right of the page.

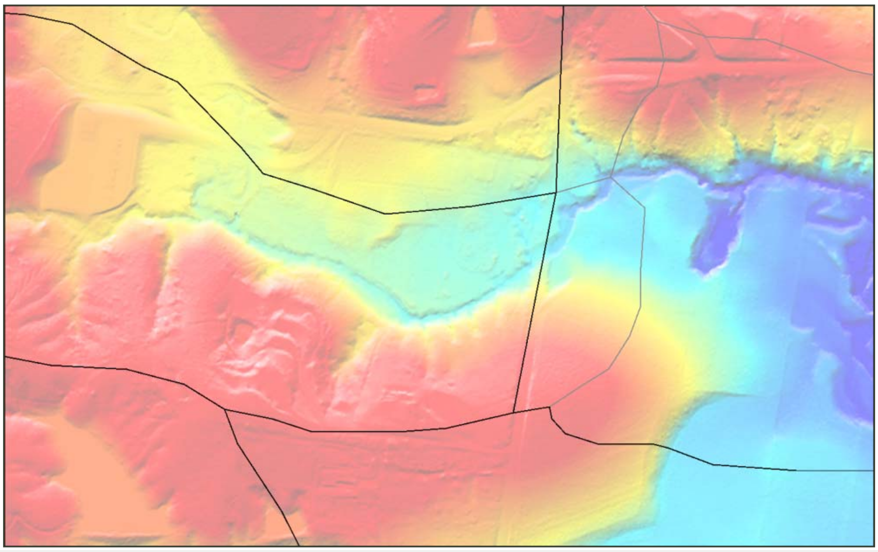


Figure 2 | SA Boundaries

2.2.1 Downstream boundaries

The locations of the downstream boundaries were modified to match the code boundary. Water level-discharge boundaries were applied at these two locations as well as a third location at the extreme event breakout.

The following slopes were adopted:

- 0.5% at Cabbage Tree Creek
- 0.1% at Kedron Brook
- 0.1% at the additional boundary for extreme events

2.2.2 Survey, topography and Zpoints

The Zpoints provided by WorleyParsons were used as the base Zpoints for the model. The following changes were made to the Zpoints:

- In locations where the lowest point within a SA boundary was a culvert inlet, a Zc upstream of the culvert was lowered such that this would become the initial location for SA inflow application
- Where required for model stability, Zlines and Zshapes have been used to lower the cells in the vicinity of culvert inlets and outlets

- The Woolshed Grove Development occurred after the LiDAR was captured in 2009. Design information for this development was provided by MBRC and used to update the Zpoints in this area

2.3 Materials

Materials files provided by MBRC at the outset of the project were reviewed and extended to cover the entire model area, including the Brisbane City Council regional area.

The Manning's n values associated with the materials files were also updated. The new values were those adopted during the model calibration process undertaken for a number of the other catchments within the MBRC region.

2.4 Structures

Hydraulic structures, including bridges, footbridges and culverts, were incorporated into the model. Appendix A presents details of all modelled structures and all other structures identified in the Data Assessment Report. Comments regarding specific structures are included in this table.

3 Quality assessment process

3.1 Hydrologic model quality

The hydrologic model quality was reviewed using the following process:

- For the 100yr 1hr and EDS runs, the peak outflow volumes and discharges and the time of peak discharge were mapped across the catchment. A visual inspection of these values was undertaken to ensure that peaks were sensible as flows moved through the system
- For the 100yr 1hr and EDS runs, a graphical review of the hydrographs throughout the system was undertaken to check that timing and volume was sensible as flows moved through the system
- It was assumed that if the 100yr 1hr and EDS runs were sensible, then the model would perform adequately for the remainder of the runs

3.2 Hydraulic model quality

The model quality was assessed using the following process:

- Review of model log to determine:
  - Whether the run was completed or unstable
  - Number of negative depths in the run
  - Whether final and peak cumulative mass error values were less than 1%
- Review of culvert discharges to determine:
  - Whether culverts were stable during the peak of the run
  - Extent of instabilities in low flows
  - Whether run duration was long enough to capture the peak at all structures
- Review of water levels to determine:
  - Whether instabilities were evident (ie whether any “blow ups” existed)
  - Whether the water surface gradients were sensible throughout the system
- Where required, modifications to the models were made to reduce instabilities and the above process was repeated
  - For the culverts, it was not possible to get all culverts stable for all runs, therefore the focus was upon obtaining stability in the peak of the critical events

4 Quality assessment results

4.1 Hydrologic model quality

The hydrologic model was found to be performing well. The following Error! Reference source not found. and Error! Reference source not found. show examples of the model hydrographs within the Cabbage Tree Creek part of the model. These figures show that:

- Between branch KED_04_04260 and KED_04_00000 there is a significant change in shape and volume which is expected as a result of the side tributary inflows
- As expected, discharges in KED_01_03019 are approximately equal to the addition of discharges from branches KED_04_00000 and KED_01_06019, with a slight change in timing resulting from routing along the reach
- Between branches KED_01_03019 and KED_01_00000, the hydrograph shape stays the same, with the timing extended and the volume only slightly increased. This is the expected model response as there are no large tributaries entering the system between these two locations

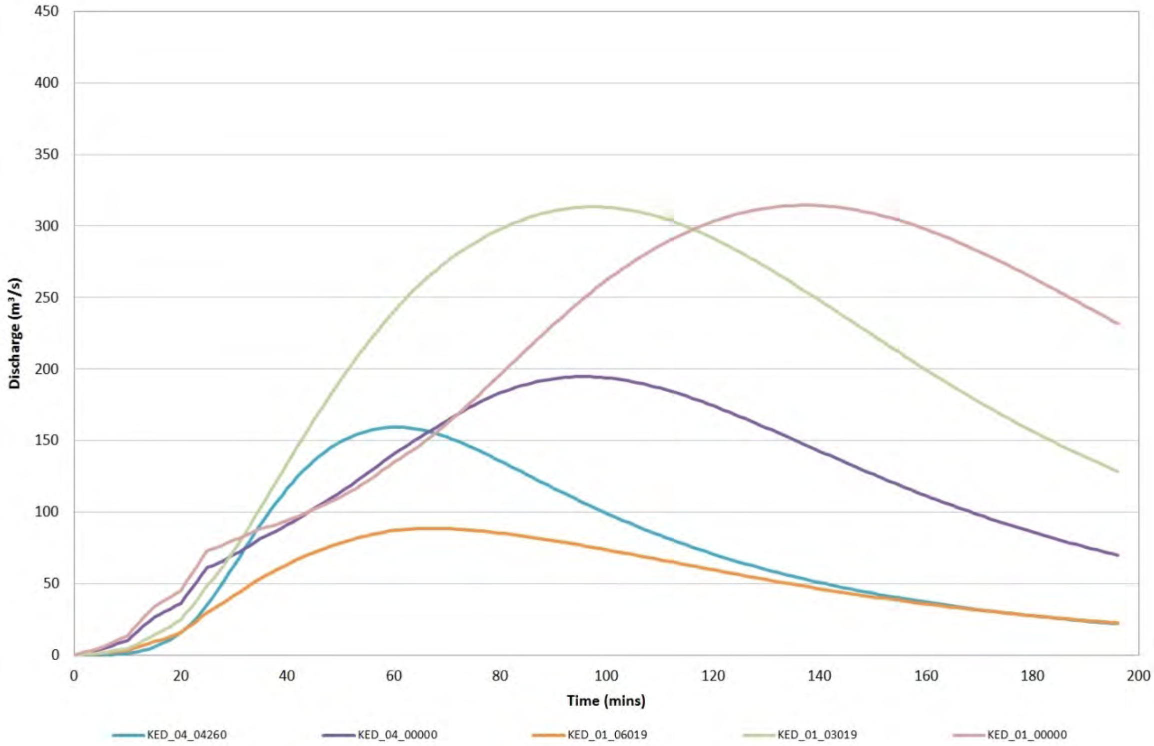


Figure 3 | WBNM 0060m Event Discharges – Kedron Brook

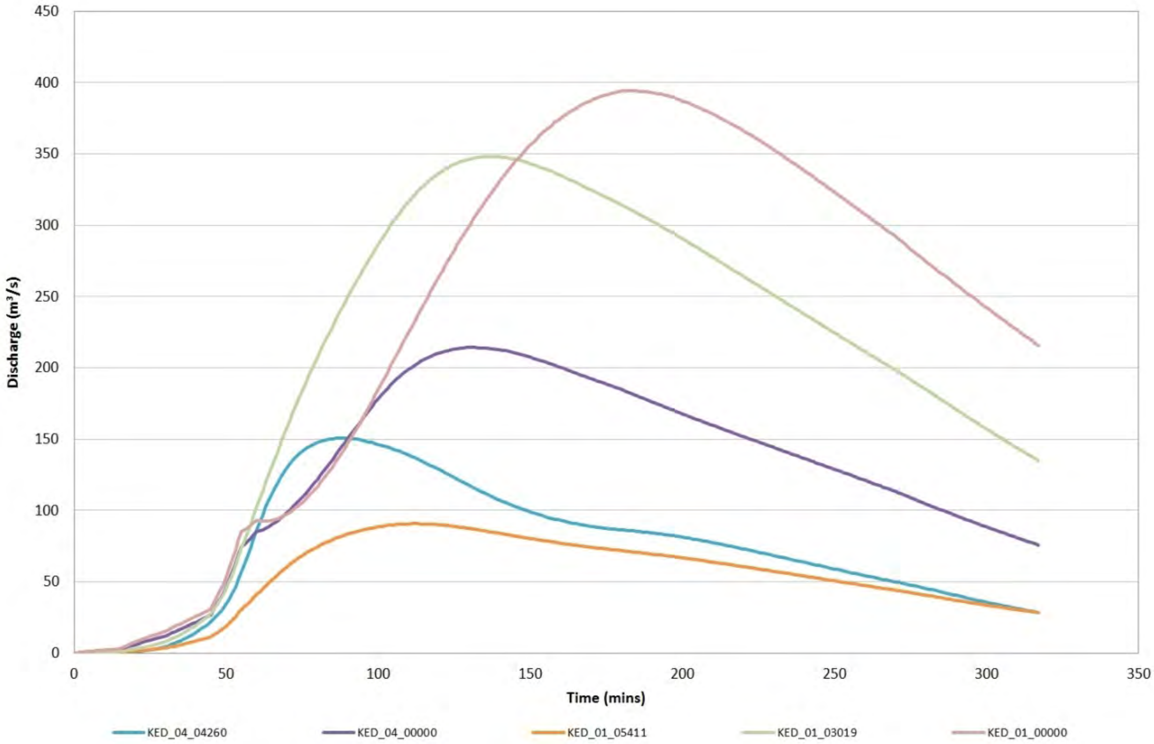


Figure 4 | WBNM EDS Event Discharges – Kedron Brook

A similar process to that described in this report for Cabbage Tree Creek was undertaken across the entire model area and for more frequent locations within each creek. No significant issues were found with model consistency, therefore the WBNM models were considered to be performing well.

4.2 Hydraulic model quality

As discussed below, there are a number of issues with the overall model quality; however there are no specific locations of concern within the model.

4.2.1 Overall stability

The parameters which were used to assess the overall stability results are provided in the table in Appendix B. These results show that:

- No 1D negative depths occur in any of the runs
- Typically there are less than 20 2D negative depths occurring, with a few exceptions in the larger events where up to 120 negative depths occur. There is one sensitivity run with nearly 30,000 2D negative depths which nearly all occur downstream of culvert CTC_02_00075.
- Volume error is within ±1.5%
- Final cumulative mass error is within ±1.5%
- Peak cumulative mass error is high in the initial startup period within the model then reduces and is within ±1.6%

Acceptable mass errors are in the order of ±1.0% and the results obtained for most runs are within or close to this range, indicating that the model is generally performing well. The exception to this is the PMF events in which mass errors of up to ±1.6% are obtained. Whilst these are outside normal acceptable ranges, it was not considered critical that the models be rerun to fix this issue for the extreme event.

4.2.2 Structure data

Many of the Brisbane City Council structures and a number of the MBRC structures within this model are represented using data measured on site. In these cases, the invert levels and/or bridge elevations are based upon reference to the LiDAR data. In comparison to surveyed data, the reliability of this approach is low. It is not expected that representing these structures accurately would significantly impact upon the results; however if a specific area of interest is in close proximity to one or more of these structures consideration should be given to obtaining better information for them.

4.2.3 Structure stability

Stability of model structures was problematic and many configurations of inlet/outlet boundaries and topography were tested. The adopted configuration proved to be the most stable. There are a number of culverts in which stability was not able to be achieved for all runs and for the entire duration of the run. Through this process, the single most unstable 1D structure was converted to a 2D structure to improve stability.

The culvert discharge results for the EDS run are presented in Appendix C. A summary of the culvert results is as follows:

- Stability is generally increased with increased discharge, ie stability issues tend to occur with low flows
- There are a number of culverts which are unstable in low flow conditions but which perform stably throughout the peak of the event
- Generally the culvert discharge and velocity instabilities have very little impact upon water levels both upstream and downstream of the culvert

5 Conclusions

The Brisbane Coastal Creeks detailed modelling has upgraded the broadscale model to a 5 m grid detailed model. This model upgrade has followed the general model setup of the Burpengary Creek (BUR) detailed model.

Changes to the model include:

- Revision of boundary conditions and their locations
- Inclusion of new Zpoints and some minor modifications to these
- Inclusion of materials layers and some minor modifications to these
- Inclusion of structures and associated boundary conditions

The model quality has been assessed through review of the model results for both the hydrologic and hydraulic model. Key findings of the quality assessment are:

- The hydrologic model is performing well
- The hydraulic model is generally performing well, with the following issues being of note
  - Model errors in a number of the PMF events are slightly outside the acceptable norm
  - A number of structures are modelled based upon measurements made on site and referenced to the LiDAR data elevations, the accuracy of these structures could be improved with additional survey but should not significantly affect the model results
  - Structure stability – the stability of the structures has been problematic and whilst stability has been significantly improved, minor instabilities are still occurring at some structures, particularly in low flow conditions

Appendices

Appendix A
Modelled Structures

Structure ID	Waterway ID	Structure Type	Crossing Name	Priority*	Is Structure Modelled?	Data Availability/Source and Comments
KED_01_01913	KED_01_01913	Bridge	Dawson Parade	A	Yes	Brisbane City Council plans
KED_01_01913	KED_01_01913	Bridge	Pedestrian (Jane St)	A	Yes	Brisbane City Council plans
KED_04_00000	KED_04_00000	Bridge	Samford Road	A	Yes	TMR plans
KED_04_00000	KED_04_00000	Bridge	Tramway Street	A	Yes	Site visit and culvert inspection
KED_04_00000	KED_04_00000	Bridge	Ferny Grove Rail Line	A	Yes	QR plans
KED_04_02038	KED_04_02038	Bridge	Upper Kedron Road	A	Yes	Site visit and culvert inspection
KED_04_02038	KED_04_02038	Bridge	Pedestrian	A	Yes	Site visit and culvert inspection
KED_04_03281	KED_04_03281	Bridge	Canvey Road	A	Yes	Site visit and culvert inspection
KED_10_00000	KED_10_00000	Bridge	Hogart Road	A	Yes	Site visit and culvert inspection
KED_16_00000	KED_16_00000	Bridge	Ross Road	A	Yes	Site visit and culvert inspection
KED_28_00000	KED_28_00000	Bridge	Samford Road	A	Yes	TMR plans
KED_28_00000	KED_28_00000	Bridge	Ferny Grove Rail Line	A	Yes	QR plans
KED_99_00515	KED_99_00515	Bridge	Osborne Road	B	Yes	Brisbane City Council plans
KED_99_00786	KED_99_00786	Bridge	Ferny Grove Rail Line	B	Yes	MBRC plans
CTC_01_00000	CTC_01_00000	Culvert	Old Northern Road	A	Yes	TMR plans
CTC_01_01288	CTC_01_01288	Culvert	Collins Road	A	Yes	Site visit and culvert inspection, Irregular culvert
CTC_01_01385	CTC_01_01385	Culvert	Collins Road	A	Yes	Site visit and culvert inspection
CTC_01_01813	CTC_01_01813	Culvert	John Street	A	Yes	Site visit and culvert inspection
CTC_01_02688	CTC_01_02688	Culvert	Francis Road	A	Yes	MBRC RTK GPS
CTC_01_03455	CTC_01_03455	Culvert	Bunya Road	A	Yes	Site visit and culvert inspection

Structure ID	Waterway ID	Structure Type	Crossing Name	Priority*	Is Structure Modelled?	Data Availability/Source and Comments
CTC_01_04319	CTC_01_04319	Culvert	View Crescent	A	Yes	Site visit and culvert inspection
CTC_01_05671	CTC_01_05671	Culvert	Woodhill Road	A	Yes	Site visit and culvert inspection, Irregular culvert
CTC_01_06388	CTC_01_06388	Culvert	Linkwood Drive	A	Yes	Site visit and culvert inspection
CTC_01_06685	CTC_01_06685	Culvert	Woodtop Court	A	Yes	MBRC RTK GPS
CTC_01_07207	CTC_01_07207	Culvert	Ridgewood Court	A	Yes	Site visit and culvert inspection
CTC_02_00075	CTC_02_00075	Culvert	Yingally Drive	A	Yes	Site visit and culvert inspection
CTC_02_00461	CTC_02_00461	Culvert	Woodhill Road	A	Yes	Site visit and culvert inspection
CTC_04_00304	CTC_04_00304	Culvert	Bennetts Road	A	Yes	Site visit and culvert inspection
KED_01_00975	KED_01_00975	Culvert	Pedestrian	A	Yes	Site visit and culvert inspection
KED_01_06019	KED_01_06019	Culvert	Samford Road	A	Yes	Site visit and culvert inspection
KED_01_06294	KED_01_06294	Culvert	Samford Road	A	Yes	TMR plans
KED_01_06294	KED_01_06294	Culvert	Samford Road	A	Yes	Site visit and culvert inspection
	KED_01_07110	Culvert	Samford Road	B	No	
	KED_01_08231	Culvert	Samford Road	B	No	
	KED_01_09303	Culvert	Lanita Road	B	No	
	KED_03_00076	Culvert	Samford Road	B	No	
KED_04_00000	KED_04_00000	Culvert	Samford Road	A	Yes	TMR plans
KED_04_00000	KED_04_00000	Culvert	Samford Road	A	Yes	TMR plans
KED_04_00000	KED_04_00000	Culvert	Samford Road	A	Yes	TMR plans
KED_04_00000	KED_04_00000	Culvert	Samford Road	A	Yes	Site visit and culvert inspection

Structure ID	Waterway ID	Structure Type	Crossing Name	Priority*	Is Structure Modelled?	Data Availability/Source and Comments
KED_04_00000	KED_04_00000	Culvert	Ferny Grove Rail Line	A	Yes	QR plans
KED_04_00000	KED_04_00000	Culvert	Ferny Grove Rail Line	A	Yes	QR plans
KED_04_05168	KED_04_05168	Culvert	Millwood Place	A	Yes	Site visit and culvert inspection
	KED_05_00166	Culvert	Samford Road	B	No	
	KED_07_00155	Culvert	Samford Road	B	No	
KED_08_00000	KED_08_00000	Culvert	Canvey Road	A	Yes	Site visit and culvert inspection
	KED_08_00000	Culvert	Cedar Creek Road	B	No	
KED_09_00000	KED_09_00000	Culvert	Woolshed Street	A	Yes	Site visit and culvert inspection
KED_09_00227	KED_09_00227	Culvert	Samford Road	A	Yes	Site visit and culvert inspection
KED_10_00000	KED_10_00000	Culvert	McAlroy Road	A	Yes	Site visit and culvert inspection
	KED_10_00404	Culvert	Selkirk Crescent	B	No	
KED_11_00059	KED_11_00059	Culvert	Samford Road	A	Yes	TMR plans
KED_12_00000	KED_12_00000	Culvert	Selkirk Crescent	A	Yes	Site visit and culvert inspection
	KED_12_00000	Culvert	McGinn Road	B	No	
KED_14_00000	KED_14_00000	Culvert	Ross Road	A	Yes	Site visit and culvert inspection
KED_28_00000	KED_28_00000	Culvert	Avington Street	A	Yes	Site visit and culvert inspection
KED_28_01009	KED_28_01009	Culvert	Glengarry Road	A	Yes	Site visit and culvert inspection
KED_32_00000	KED_32_00000	Culvert	Duggan Street	A	Yes	Site visit and culvert inspection

** As identified in the Data Assessment Report*

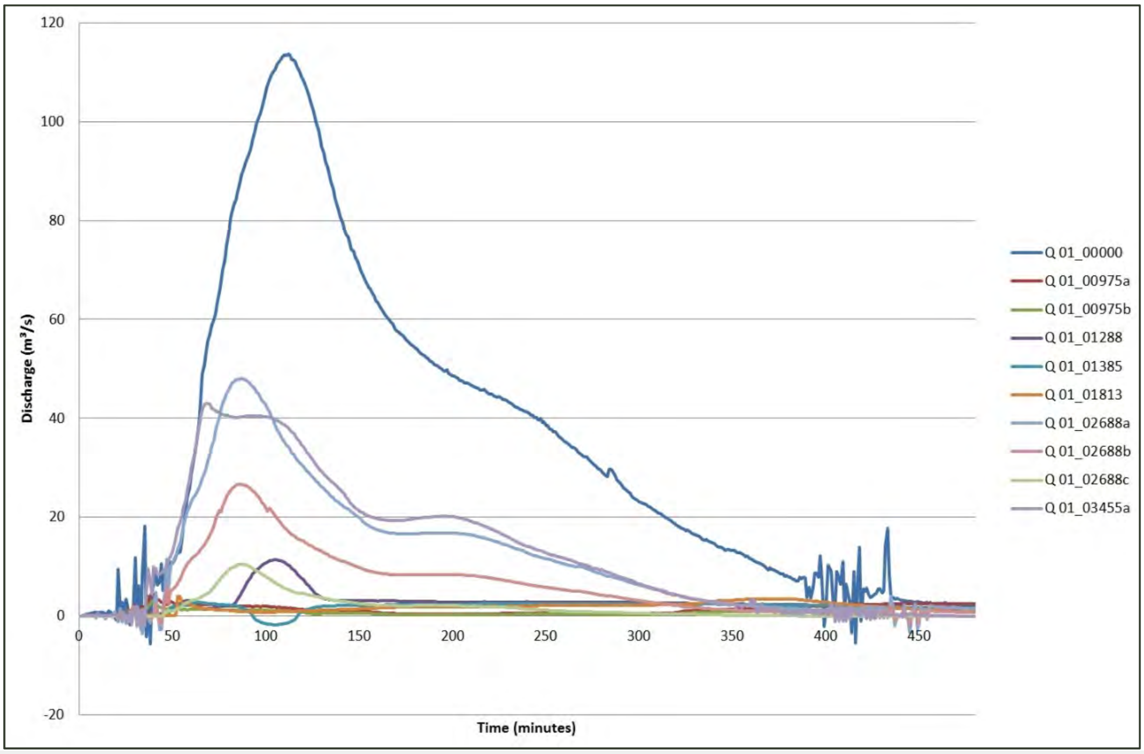
Appendix B
Overall Stability Results

Simulation	Total 1D Negative Depths	Total 2D Negative Depths	WARNINGs prior to simulation	WARNINGs during simulation	Volume Error (m3)	Final Cumulative ME	Peak Cumulative ME when Qi+Qo > 5%
00001Y_0060m	0	0	14	0	19865 or 0.9%	0.89%	0.89% at 6.00h
00001Y_0120m	0	1	14	1	25993 or 0.9%	0.92%	0.92% at 6.00h
00001Y_0180m	0	1	14	1	31279 or 0.9%	0.94%	0.94% at 8.00h
00002Y_0060m	0	0	14	0	26720 or 0.9%	0.88%	0.88% at 6.00h
00002Y_0120m	0	5	14	5	31466 or 0.8%	0.82%	0.82% at 6.00h
00002Y_0180m	0	0	14	0	35855 or 0.8%	0.80%	0.79% at 7.74h
00005Y_0060m	0	1	14	1	36631 or 0.9%	0.87%	0.87% at 5.88h
00005Y_0120m	0	4	14	4	50733 or 1.0%	0.95%	0.95% at 5.97h
00005Y_0180m	0	1	14	1	59318 or 1.0%	0.96%	0.95% at 7.47h
00010Y_0010m	0	0	14	0	12697 or 0.7%	0.75%	0.71% at 5.24h
00010Y_0015m	0	0	14	0	19013 or 0.8%	0.85%	0.81% at 5.15h
00010Y_0030m	0	2	14	2	28095 or 0.8%	0.82%	0.79% at 5.31h
00010Y_0045m	0	1	14	1	37240 or 0.9%	0.87%	0.86% at 5.70h
00010Y_0060m	0	12	14	12	46567 or 0.9%	0.94%	0.94% at 5.74h
00010Y_0090m	0	3	14	3	58220 or 1.0%	1.02%	1.02% at 5.86h
00010Y_0120m	0	1	14	1	70025 or 1.1%	1.12%	1.12% at 6.00h
00010Y_0180m	0	10	14	10	81791 or 1.1%	1.12%	1.11% at 7.22h
00010Y_0270m	0	1	14	1	85547 or 1.1%	1.06%	1.06% at 8.00h
00010Y_0360m	0	3	14	3	92172 or 1.0%	1.03%	1.02% at 9.79h
00010Y_0540m	0	15	14	15	79874 or 0.8%	0.81%	0.79% at 11.80h
00010Y_0720m	0	11	14	11	91991 or 0.9%	0.87%	0.85% at 11.53h
00010Y_1080m	0	8	14	8	178950 or 0.9%	0.85%	0.87% at 7.94h
00010Y_1440m	0	0	14	0	202106 or 0.9%	0.88%	0.94% at 9.66h
00010Y_1800m	0	1	14	1	249537 or 1.0%	1.02%	1.11% at 16.10h
00010Y_2160m	0	11	14	11	128153 or 0.9%	0.87%	0.95% at 12.06h
00010Y_2880m	0	5	14	5	143356 or 0.9%	0.94%	0.95% at 45.45h
00010Y_4320m	0	11	14	11	133785 or 0.8%	0.80%	0.94% at 9.83h
00020Y_0060m	0	3	14	3	67283 or 1.1%	1.14%	1.13% at 5.60h
00020Y_0120m	0	17	14	17	79852 or 1.1%	1.07%	1.07% at 6.00h
00020Y_0180m	0	5	14	5	93229 or 1.1%	1.07%	1.06% at 7.23h
00050Y_0060m	0	35	14	35	70662 or 1.0%	0.97%	0.97% at 5.68h
00050Y_0120m	0	10	14	10	82083 or 0.9%	0.90%	0.90% at 6.00h
00020Y_0180m	0	3	14	3	97615 or 0.9%	0.92%	0.91% at 7.29h

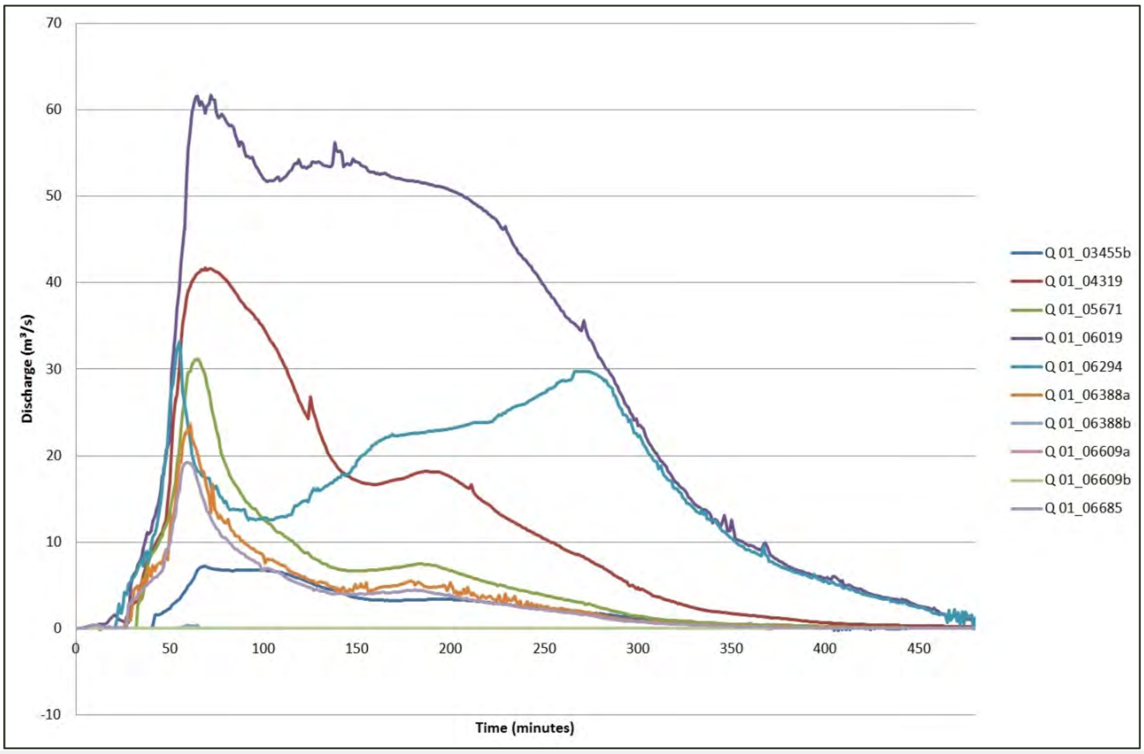
Simulation	Total 1D Negative Depths	Total 2D Negative Depths	WARNINGs prior to simulation	WARNINGs during simulation	Volume Error (m3)	Final Cumulative ME	Peak Cumulative ME when Qi+Qo > 5%
00100Y_0010m	0	6	14	6	24517 or 0.9%	0.86%	0.82% at 4.78h
00100Y_0015m	0	16	14	16	29592 or 0.8%	0.79%	0.76% at 4.91h
00100Y_0030m	0	11	14	11	59991 or 1.1%	1.05%	1.04% at 5.20h
00100Y_0045m	0	45	14	45	69764 or 1.0%	0.98%	0.97% at 5.35h
00100Y_0060m	0	20	14	20	73954 or 0.9%	0.89%	0.88% at 5.46h
00100Y_0090m	0	10	14	10	81386 or 0.9%	0.85%	0.85% at 5.85h
00100Y_0120m	0	17	14	17	83870 or 0.8%	0.80%	0.80% at 6.00h
00100Y_0180m	0	13	14	13	98983 or 0.8%	0.82%	0.81% at 7.28h
00100Y_0270m	0	16	14	16	118269 or 0.9%	0.87%	0.87% at 8.00h
00100Y_0360m	0	5	14	5	137991 or 0.9%	0.92%	0.92% at 9.83h
00100Y_0540m	0	6	14	6	187463 or 1.1%	1.12%	1.11% at 11.79h
00100Y_0720m	0	6	14	6	179253 or 1.0%	0.99%	0.97% at 14.27h
00100Y_1080m	0	8	14	8	178950 or 0.9%	0.85%	0.87% at 7.94h
00100Y_1440m	0	0	14	0	202106 or 0.9%	0.88%	0.94% at 9.66h
00100Y_1800m	0	1	14	1	249537 or 1.0%	1.02%	1.11% at 16.10h
00100Y_2160m	0	15	14	15	257369 or 1.0%	0.99%	1.03% at 10.32h
00100Y_2880m	0	9	14	9	258163 or 0.9%	0.93%	1.04% at 11.15h
00100Y_4320m	0	6	14	6	24517 or 0.9%	0.86%	0.82% at 4.78h
00200Y_0030m	0	57	14	57	67438 or 1.0%	1.03%	1.01% at 5.01h
00200Y_0090m	0	10	14	10	84921 or 0.7%	0.67%	0.67% at 5.87h
00200Y_0180m	0	7	14	7	106156 or 0.8%	0.75%	0.75% at 7.34h
00500Y_0030m	0	32	14	32	71124 or 0.9%	0.92%	0.90% at 4.98h
00500Y_0090m	0	118	14	118	164346 or 1.1%	1.09%	1.09% at 5.71h
00500Y_0180m	0	34	14	34	196163 or 1.2%	1.17%	1.16% at 7.15h
01000Y_0030m	0	0	14	0	38900 or 0.5%	0.45%	0.42% at 4.81h
01000Y_0090m	0	0	14	0	34924 or 0.2%	0.21%	0.20% at 5.63h
01000Y_0180m	0	3	14	3	43341 or 0.2%	0.23%	0.22% at 7.05h
02000Y_0030m	0	1	14	1	39566 or 0.4%	0.41%	0.37% at 4.77h
02000Y_0090m	0	2	14	2	37920 or 0.2%	0.21%	0.19% at 5.56h
02000Y_0180m	0	1	14	1	42663 or 0.2%	0.21%	0.19% at 7.01h
PMF_0015m	0	41	14	41	33822 or 0.2%	0.21%	0.15% at 4.19h
PMF_0030m	0	29	14	29	59983 or 0.3%	0.27%	0.22% at 4.43h
PMF_0045m	0	44	14	44	154610 or 0.4%	0.44%	0.44% at 6.00h

Simulation	Total 1D Negative Depths	Total 2D Negative Depths	WARNINGs prior to simulation	WARNINGs during simulation	Volume Error (m3)	Final Cumulative ME	Peak Cumulative ME when Qi+Qo > 5%
PMF_0060m	0	71	14	74	175423 or 0.4%	0.43%	0.43% at 6.00h
PMF_0090m	0	84	14	84	504018 or 0.9%	0.94%	0.94% at 3.07h
PMF_0120m	0	120	14	120	842354 or 1.3%	1.31%	1.41% at 3.48h
PMF_0150m	0	109	14	109	1029291 or 1.4%	1.36%	1.47% at 3.80h
PMF_0180m	0	47	14	47	1213716 or 1.4%	1.44%	1.56% at 4.15h
PMF_0240m	0	18	14	18	1377364 or 1.5%	1.47%	1.60% at 4.74h
PMF_0300m	0	5	14	5	1553738 or 1.5%	1.49%	1.64% at 5.27h
PMF_0360m	0	5	14	5	1403291 or 1.3%	1.31%	1.47% at 5.60h
PMF_0720m_ GSDM	0	29	14	29	521290 or 0.5%	0.46%	0.46% at 17.00h
PMF_1440m	0	1	14	1	203543 or 0.2%	0.22%	0.22% at 4.50h
PMF_2160m	0	0	14	0	312159 or 0.3%	0.28%	0.37% at 20.06h
PMF_2880m	0	6	14	6	358267 or 0.3%	0.27%	0.37% at 16.80h
PMF_4320m	0	5	14	5	476832 or 0.3%	0.29%	0.28% at 72.79h
00100Y_EDS	0	9	14	9	110471 or 0.8%	0.81%	0.81% at 7.77h
00100Y_EDS_S2	0	29174	14	29174	64069 or 0.5%	0.47%	0.47% at 8.00h
00100Y_EDS_S3	0	180	14	180	139796 or 1.0%	1.03%	1.03% at 7.85h
00100Y_EDS_S4	0	11	14	11	122289 or 0.8%	0.80%	0.79% at 7.88h
00100Y_EDS_S5	0	13	14	13	60417 or 0.4%	0.42%	0.48% at 0.00h
00100Y_EDS_S6	0	10	14	10	65504 or 0.4%	0.40%	0.48% at 0.00h
00100Y_EDS_S7							
00100Y_EDS_S8							
00100Y_EDS_S9							
00100Y_EDS_ S10	0	34	14	34	59971 or 0.4%	0.45%	0.45% at 8.00h
00100Y_EDS_ S11	0	8	14	8	110844 or 0.8%	0.81%	0.81% at 7.75h
00100Y_EDS_ S12	0	31	14	31	60235 or 0.4%	0.45%	0.45% at 8.00h

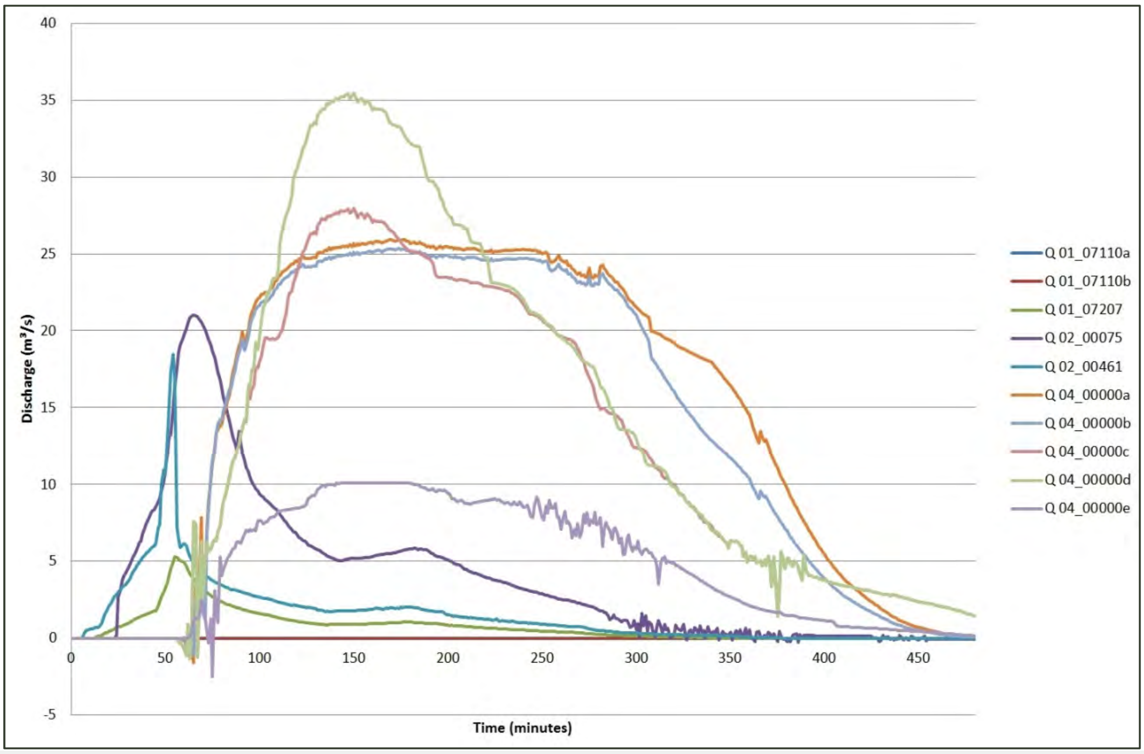
Appendix C
EDS Culvert Discharge Graphs



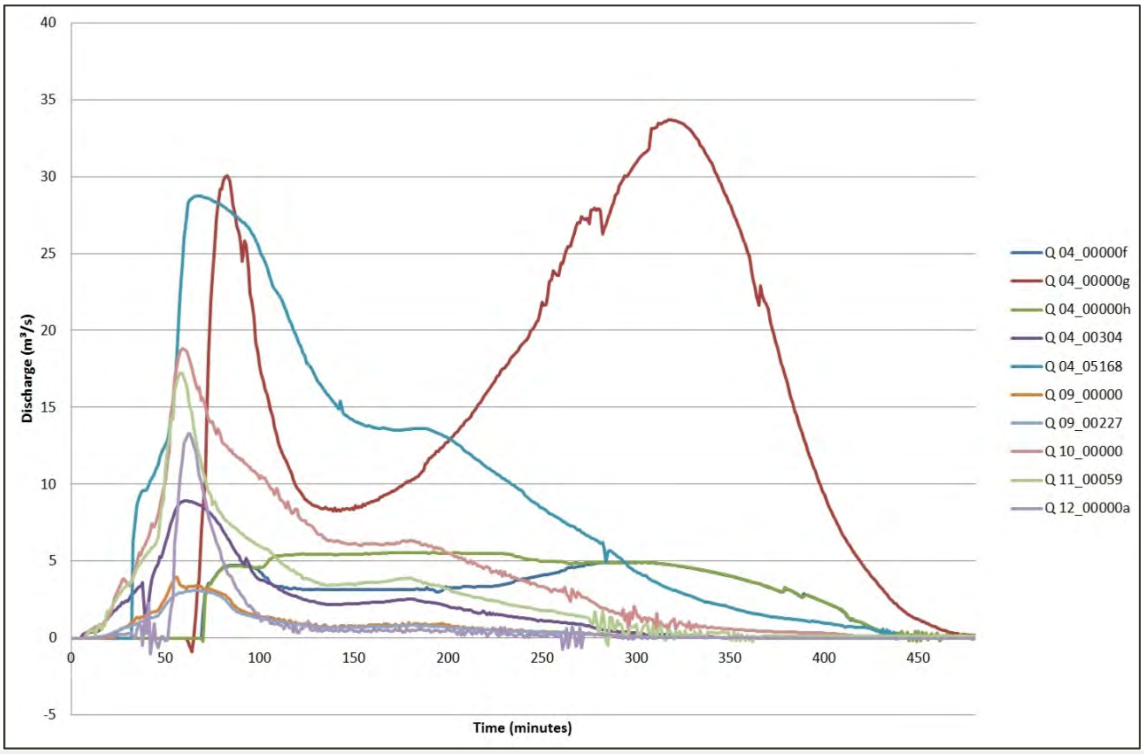
BCC Culvert Discharge Results - Chart 1



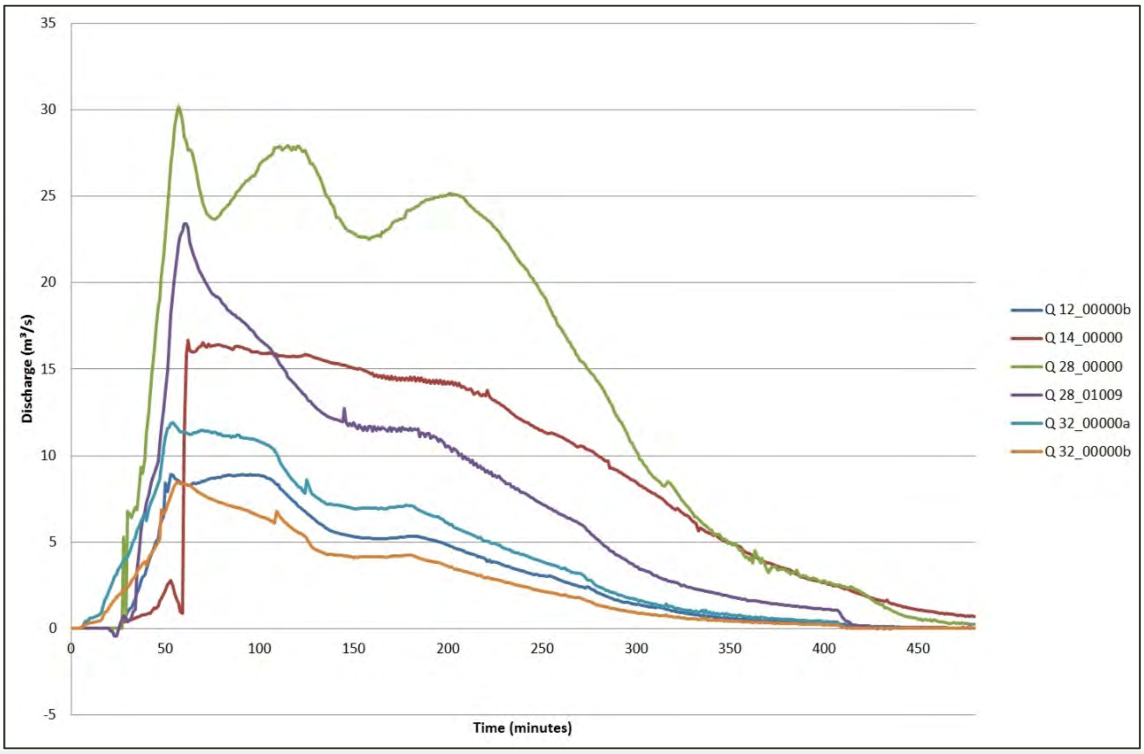
BCC Culvert Discharge Results – Chart 2



BCC Culvert Discharge Results – Chart 3



BCC Culvert Discharge Results – Chart 4



BCC Culvert Discharge Results – Chart 5

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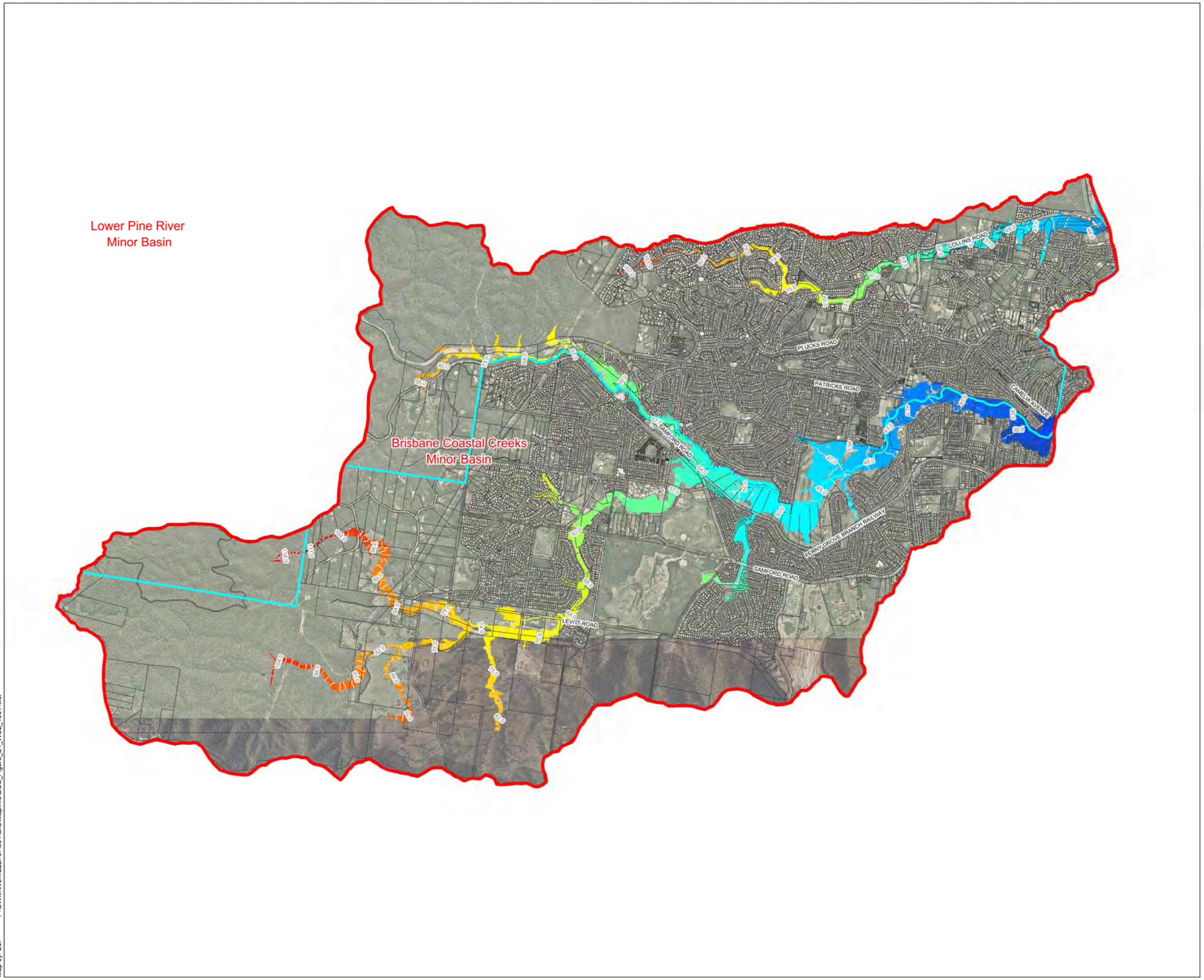
Appendix E
Flood Maps – 100 Year ARI

Appendix E
Flood Maps – 100 Year ARI



aurecon

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary
- Contour Line (m AHD)

100 Year ARI Peak Flood level (m AHD)

- >110.0
- 90.0
- 70.0
- 50.0
- 30.0

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

Map by: DJF P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_E1_WSL_100Y.wor

A3 scale 1:40,000

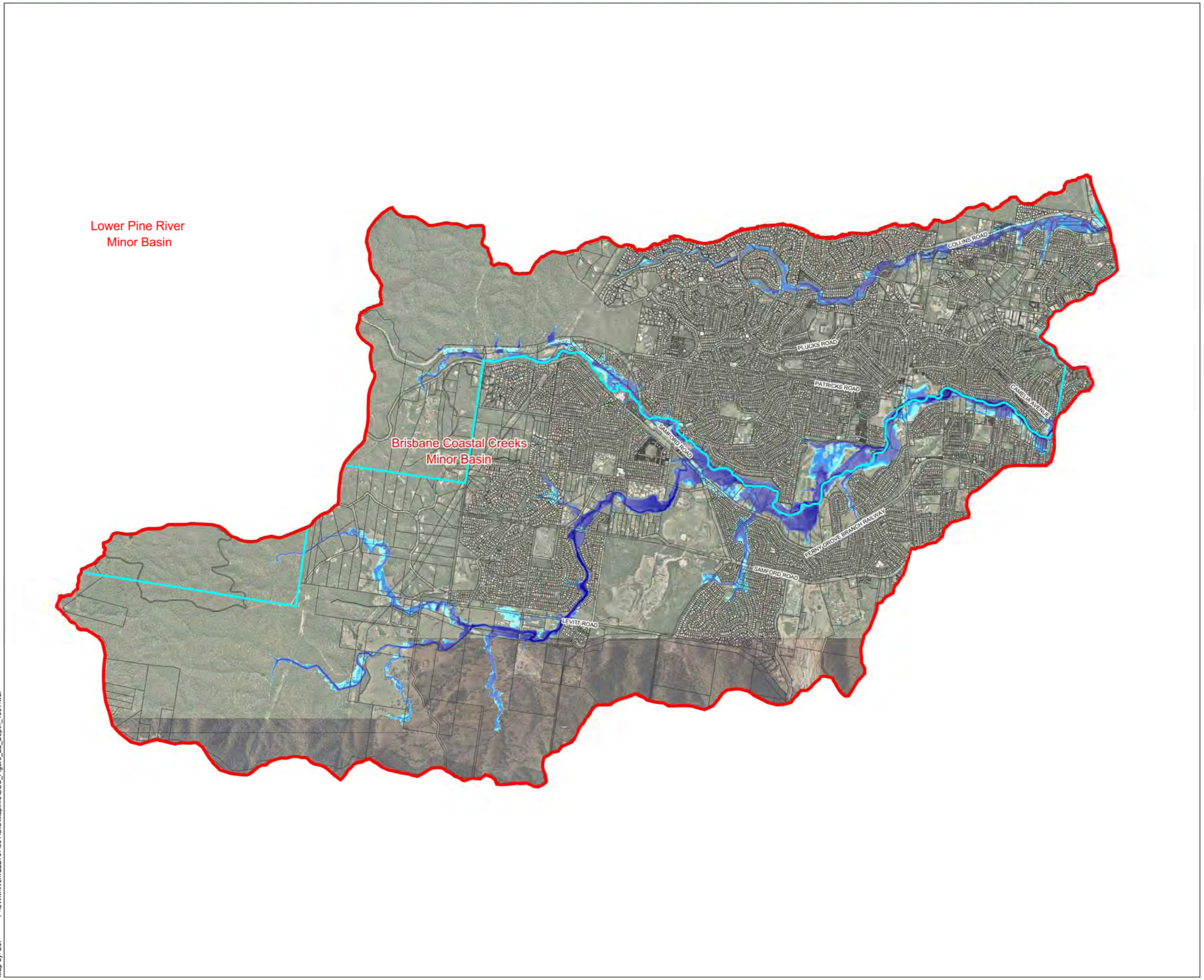
0 1000 m 2,000 m

Date: 12/10/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure E1: Peak Flood Level Map - 100 Year ARI



aurecon

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

100 Year ARI Peak Flood Depth (m)

>4.0
3.0
2.0
1.0
0.0

Notes:

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Map by: DJF P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_E2_Depth_100Y.wor

A3 scale 1:40,000

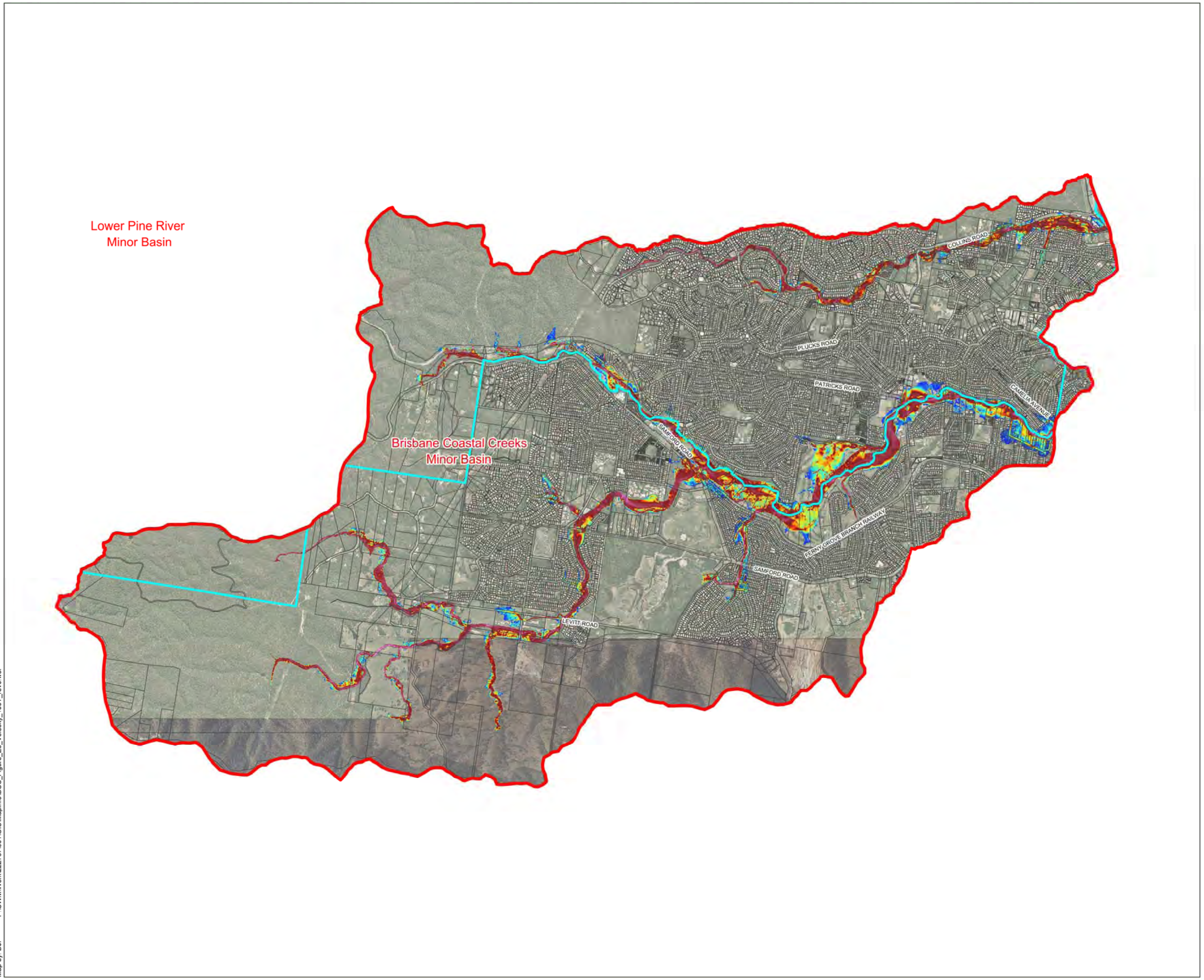
0 1000 m 2,000 m

Date: 12/10/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure E2: Peak Flood Depth Map - 100 Year ARI



Map by: DJF   P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_E3_Velocity_100Y_rev0.wor

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

100 Year ARI Peak Flood Velocity (m/s)

>6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

Notes:

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A3 scale 1:40,000

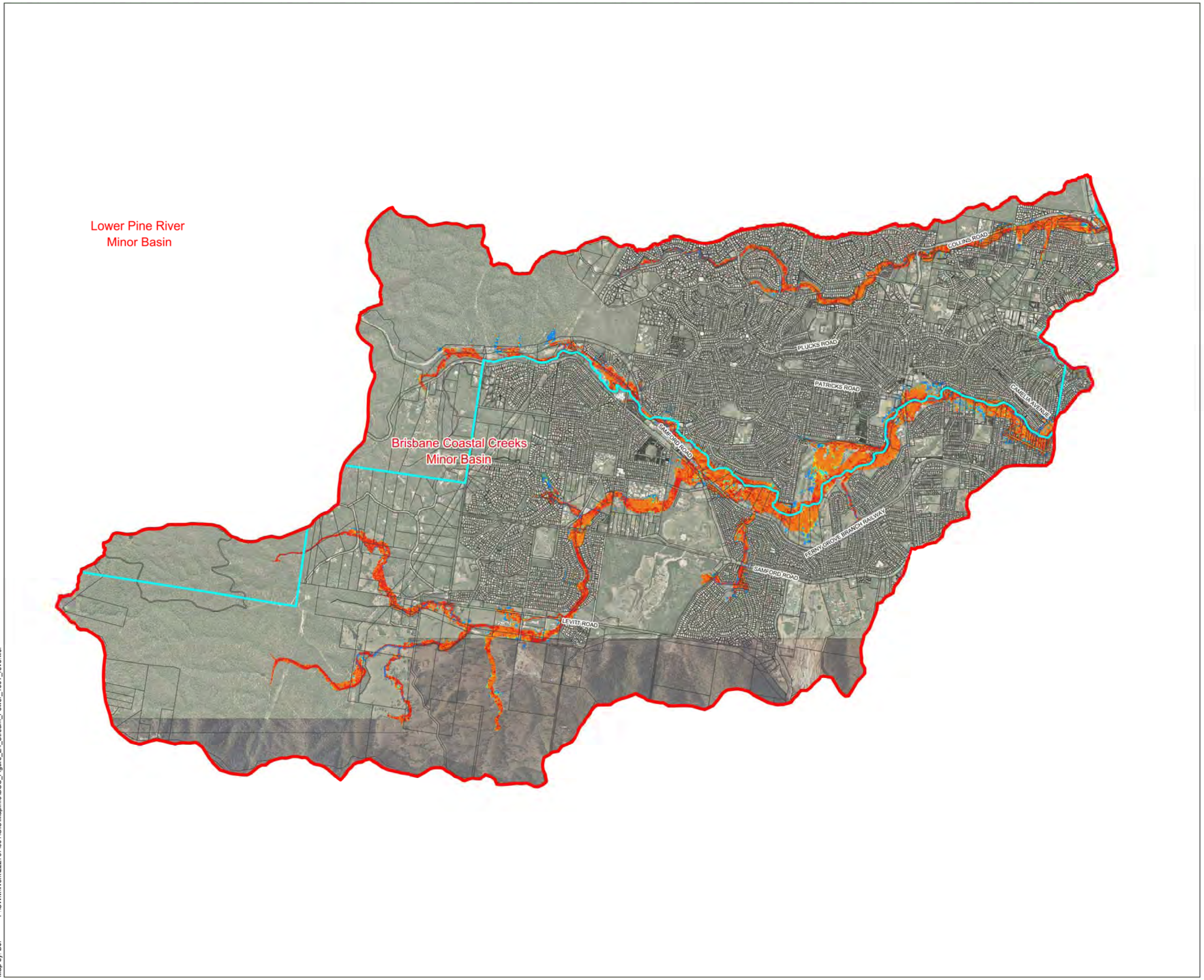
0   1000 m   2,000 m

Date: 12/10/2012   Version: 0   Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure E3: Peak Flood Velocity Map - 100 Year ARI



Map by: DJF   P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_E4_Stream_Power_100Y_rev0.wor

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

100 Year ARI Peak Stream Power

>500
10
5
3
0

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

A3 scale 1:40,000

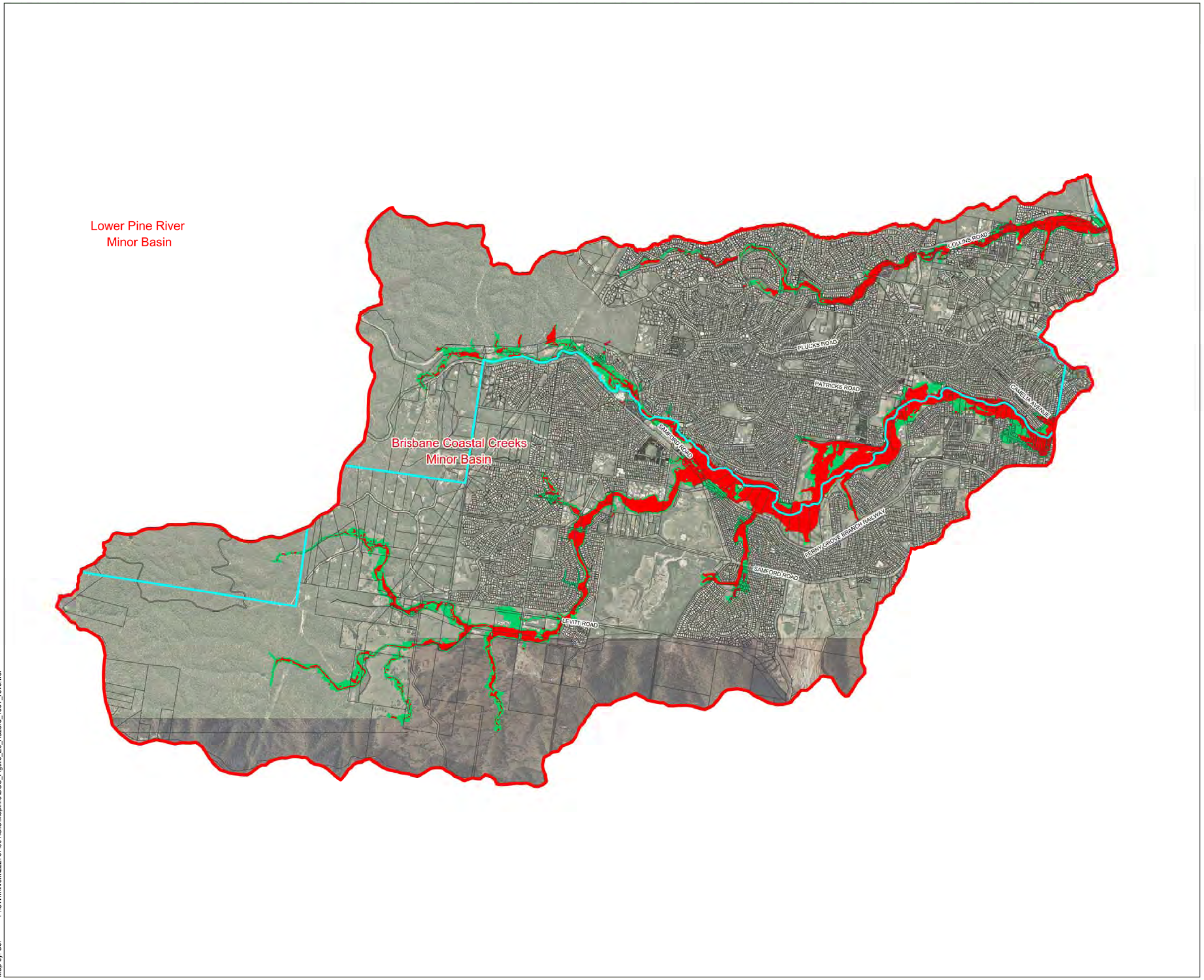
0   1000 m   2,000 m

Date: 12/10/2012   Version: 0   Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure E4: Stream Power Map - 100 Year ARI



aurecon

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

New South Wales Floodplain Development Manual Flood Hazard Category
100 Year ARI Event

- Low Hazard
- High Hazard

Notes:

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Map by: DJF P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_E5_Hazard_100Y_rev0.wor

A3 scale 1:40,000

0 1000 m 2,000 m

Date: 12/10/2012 Version: 0 Job No: 222767

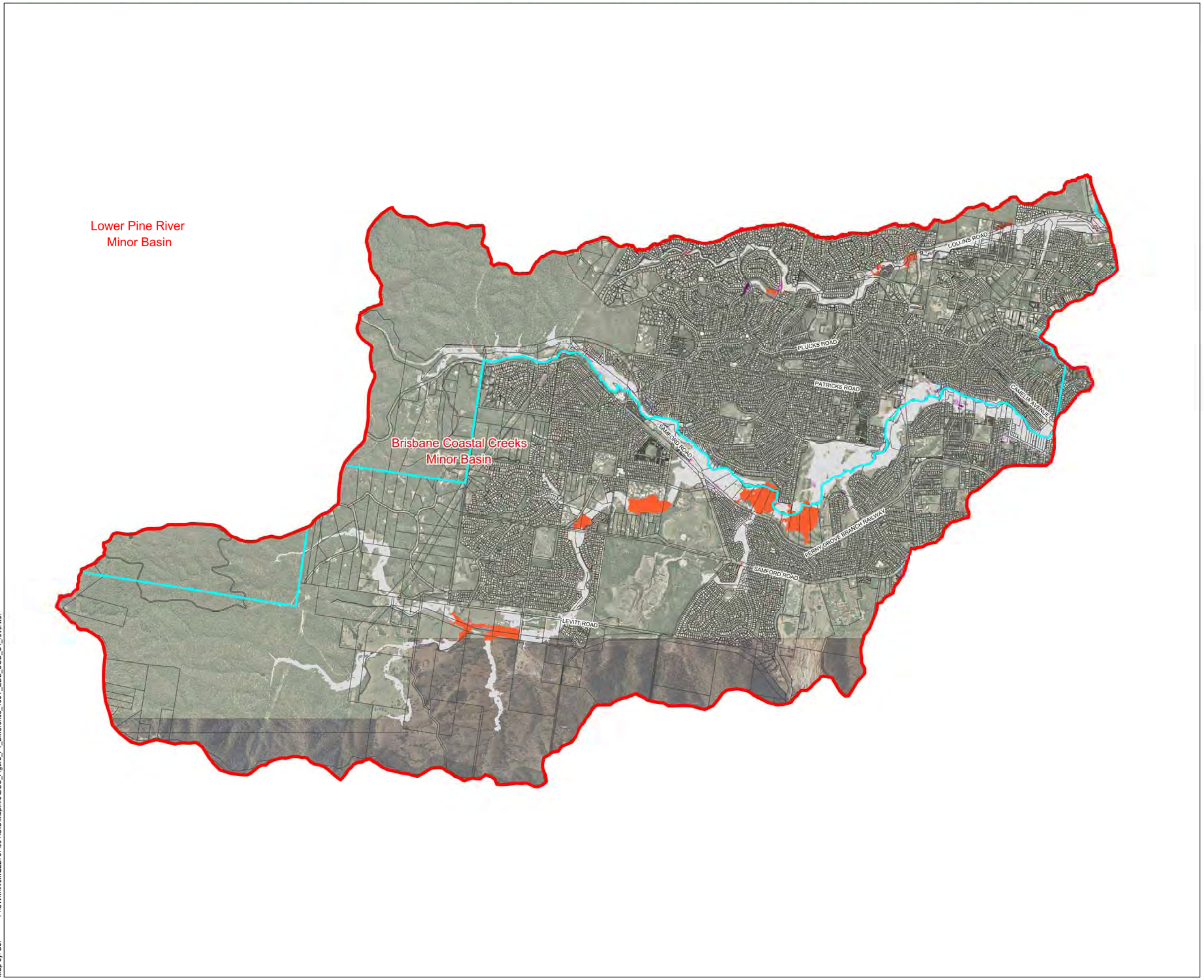
Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure E5: Peak Flood Hazard Map - 100 Year ARI

Appendix F
Model Sensitivity Analysis Maps

Appendix F
Model Sensitivity Analysis Maps



Map by: DJF   P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_F1_Difference_100Y_EDS_SCD_S1_rev0.wor

aurecon

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

This figure shows selected critical durations peak water level minus EDS peak water level

A3 scale 1:40,000

0   1000 m   2,000 m

Date: 12/10/2012   Version: 0   Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure F1: Peak Flood Level Difference between EDS and Selected Critical Storm Durations - 100 Year ARI (S1)

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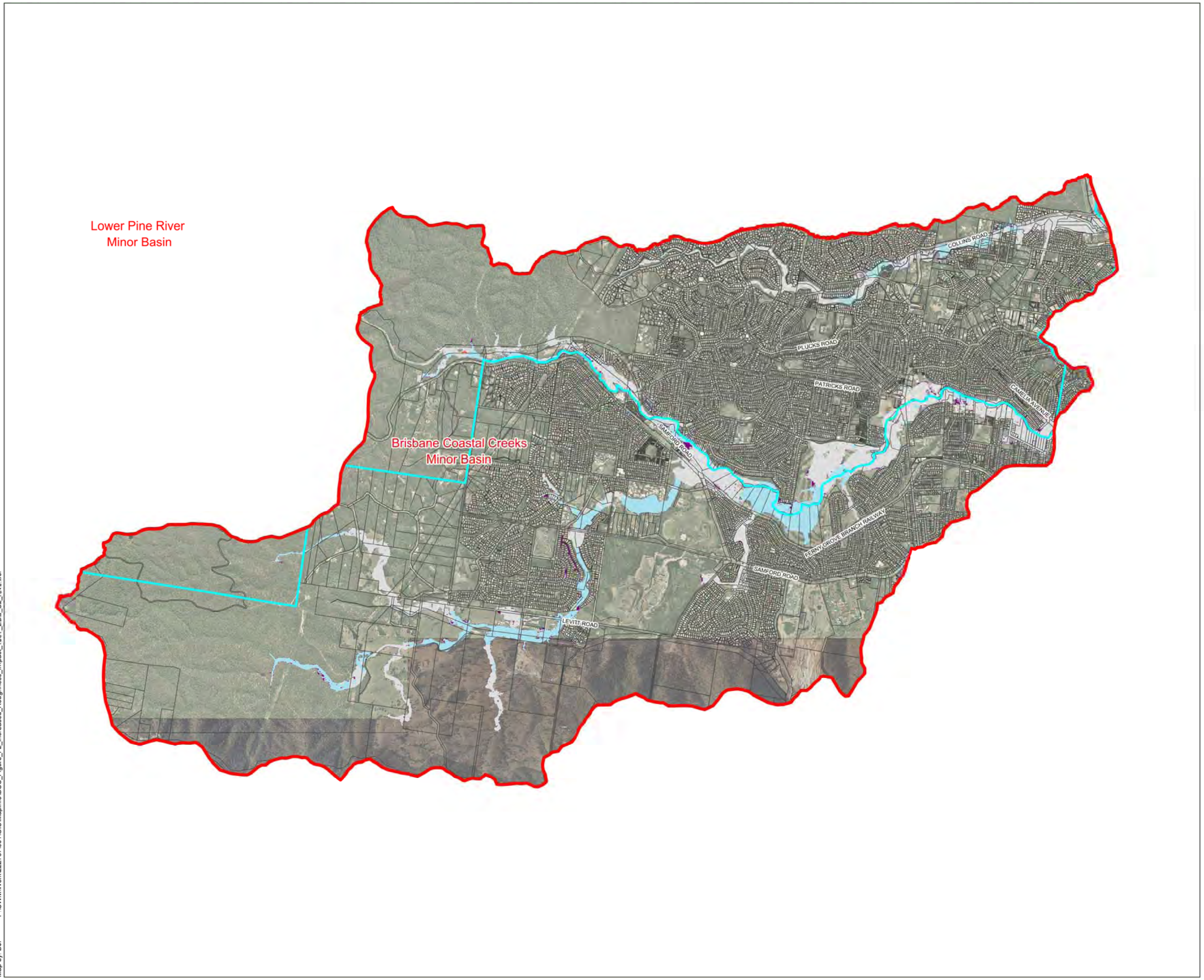


Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

This figure shows increase in roughness peak water level minus EDS peak water level

Map by: DJF   P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_F2_Increased_Roughness_Impact_100Y_EDS_S2_rev0.wor

A3 scale 1:40,000

0   1000 m   2,000 m

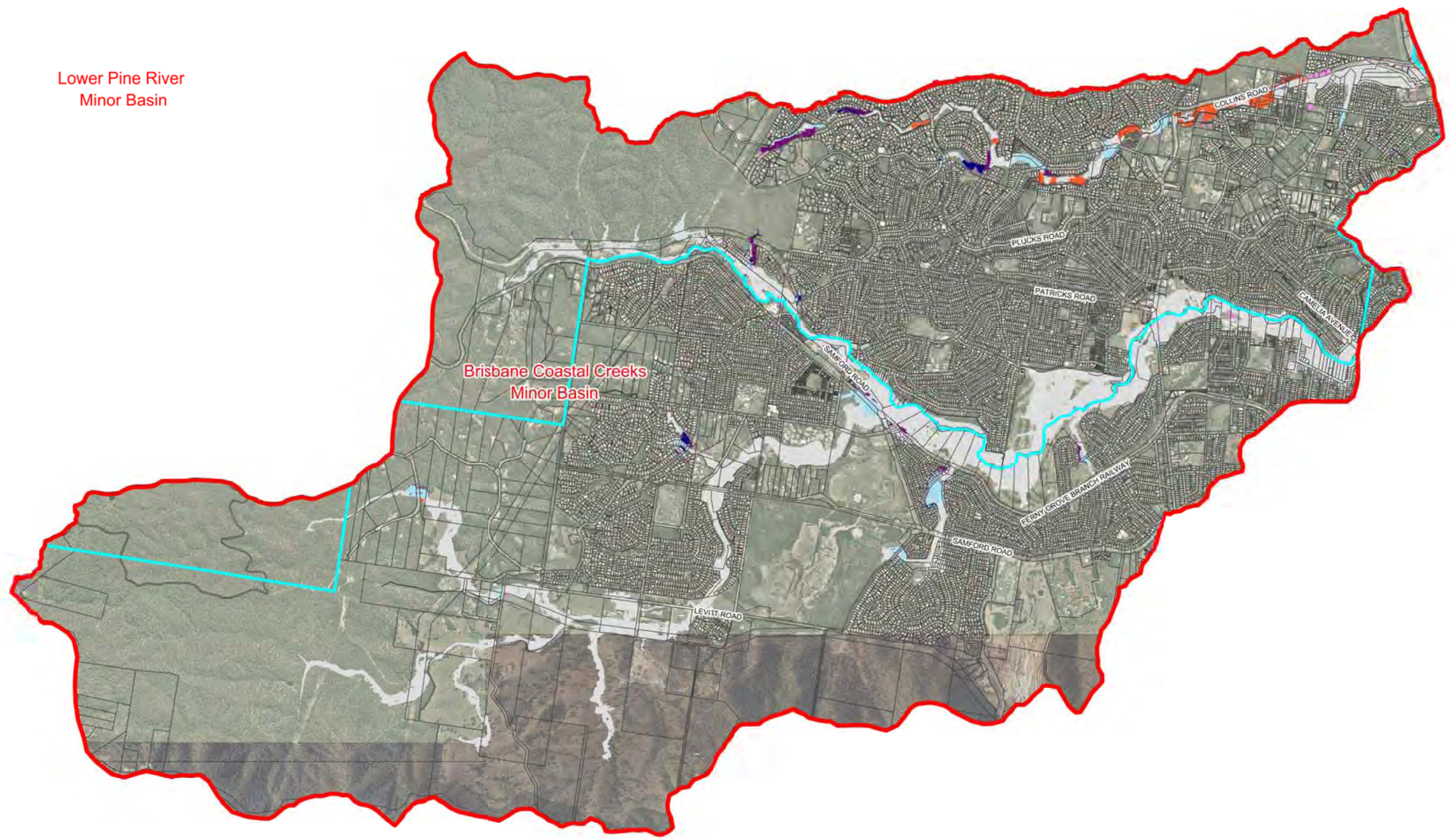
Date: 12/10/2012   Version: 0   Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure F2: Increase in Roughness Flood Level Impact 100 Year ARI (S2)

aurecon



Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

This figure shows structure blockage peak water level minus EDS peak water level

Map by: DJF   P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_F3_Culvert_Blockage_100Y_EDS_S3_rev0.wor

A3 scale 1:40,000

0   1000 m   2,000 m

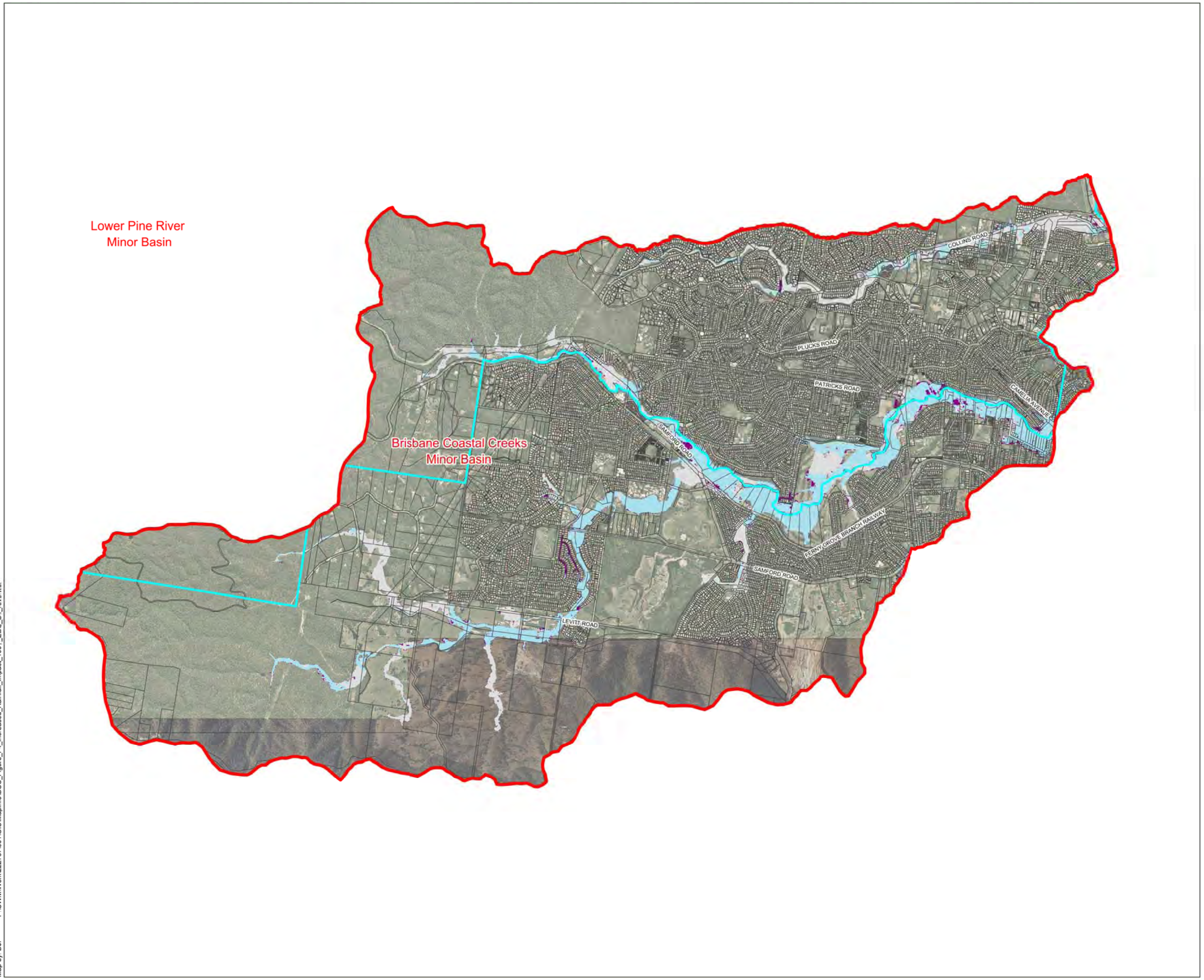
Date: 12/10/2012   Version: 0   Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure F3: Structure Blockage Flood Level Impact 100 Year EDS (S3)

aurecon



Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

This figure shows increase in rainfall peak water level minus EDS peak water level

Map by: DJF P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_F4_Increased_Rainfall_Impact_100Y_EDS_S4_rev0.wor

A3 scale 1:40,000

0 1000 m 2,000 m

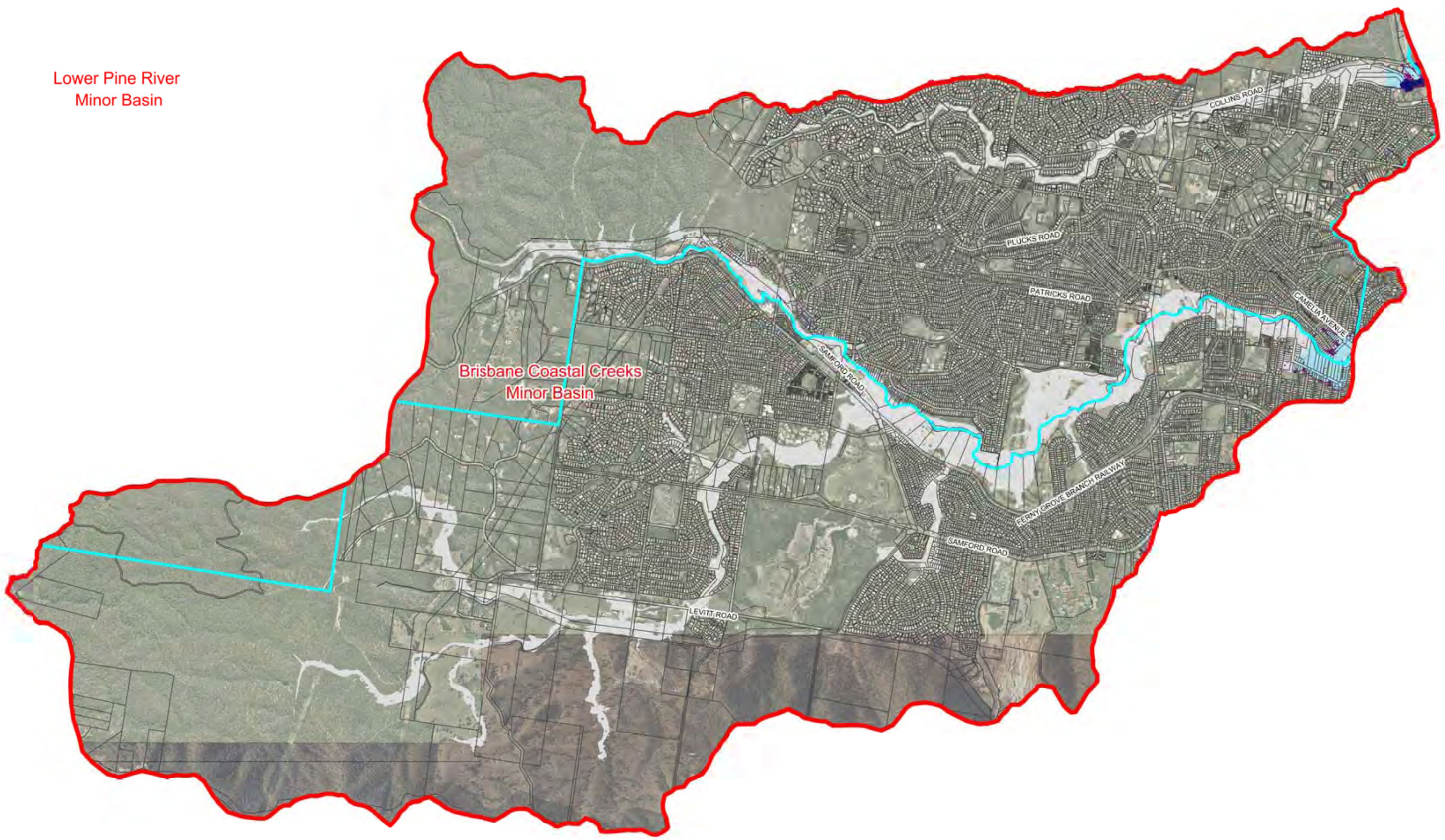
Date: 12/10/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure F4: Increase in Rainfall Flood Level Impact 100 Year EDS (S4)

aurecon



Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

This figure shows increase in downstream boundary peak water level minus EDS peak water level

Map by: DJF

P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_F5_Dif_Increased_DS_BC_100Y_EDS_S5_rev0.wor

A3 scale 1:40,000

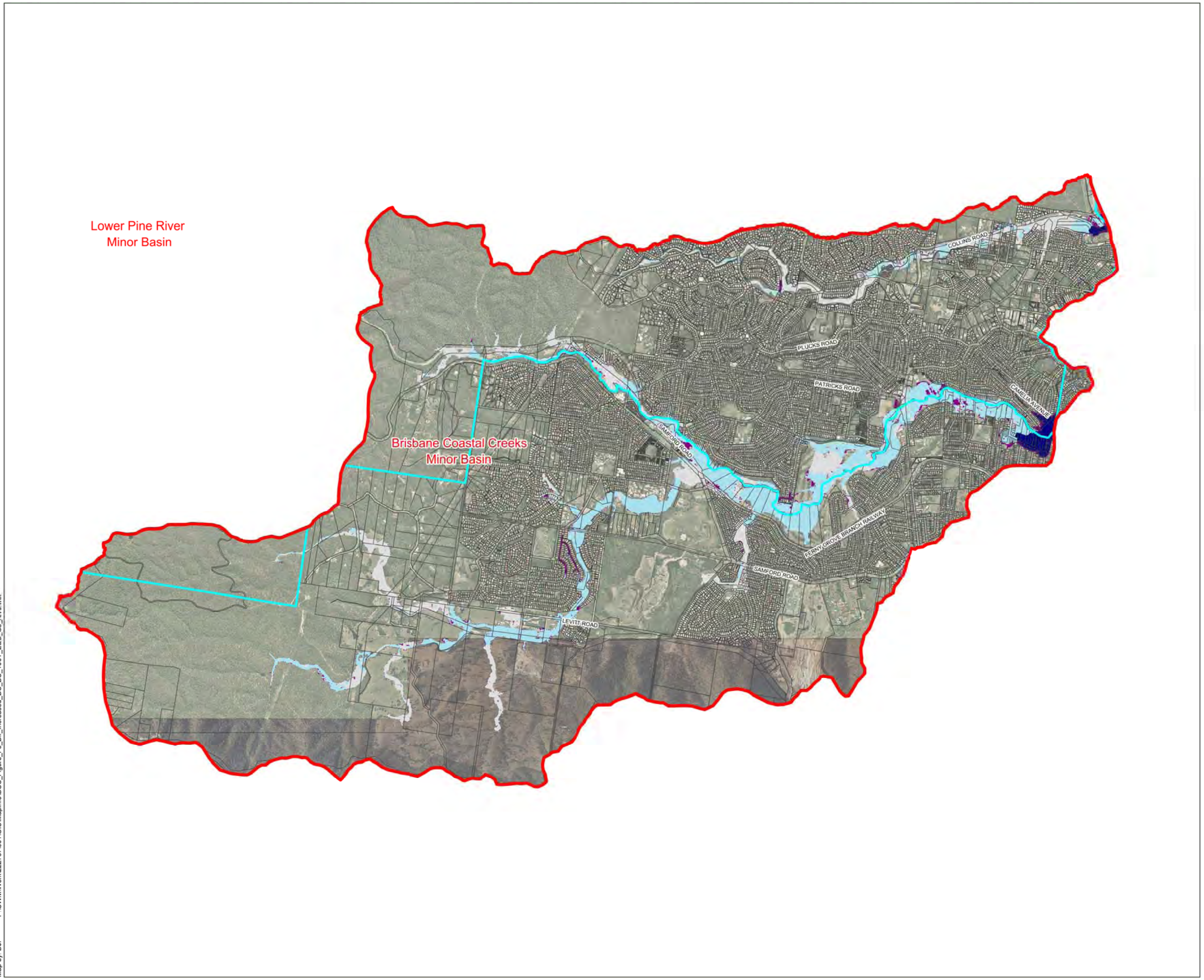
0 1000 m 2,000 m

Date: 12/10/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure F5: Increase in Downstream Boundary Flood Level Impact 100 Year EDS (S5)



aurecon

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

This figure shows increase in rainfall & downstream boundary peak water level minus EDS peak water level

Map by: DJF P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_F6_Dif_Increased_DS_BC_100Y_EDS_S6_rev0.wor

A3 scale 1:40,000

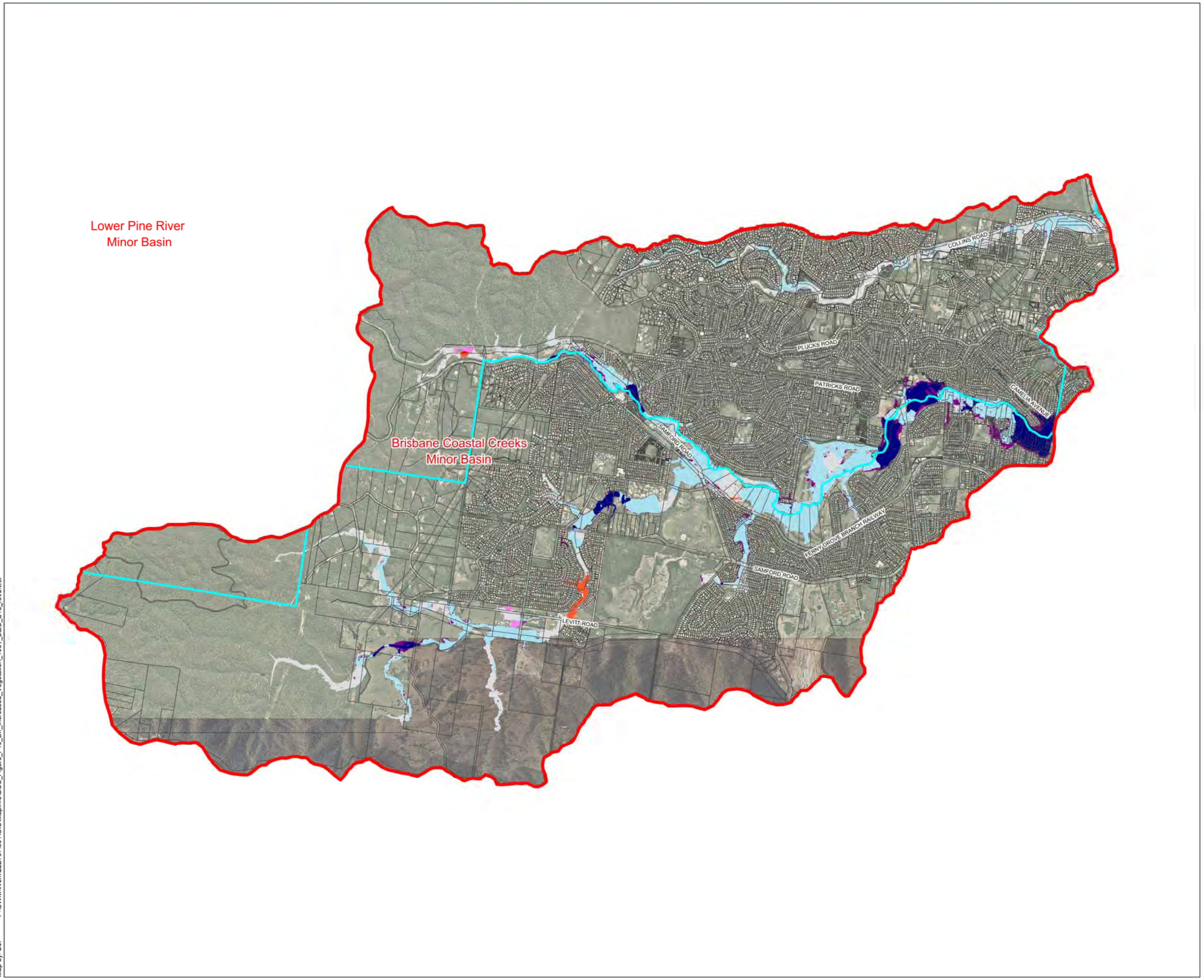
0 1000 m 2,000 m

Date: 12/10/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure F6: Increase in Rainfall & Downstream Boundary Flood Level Impact 100 Year EDS (S6)



aurecon

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

This figure shows increase in vegetation peak water level minus EDS peak water level

Map by: DJF   P:\SWM\Work\222767\001\GIS\MapInfo\BCC_Figure_F10_Dif_Increased_Vegetation_100Y_EDS_S10_rev0.wor

A3 scale 1:40,000

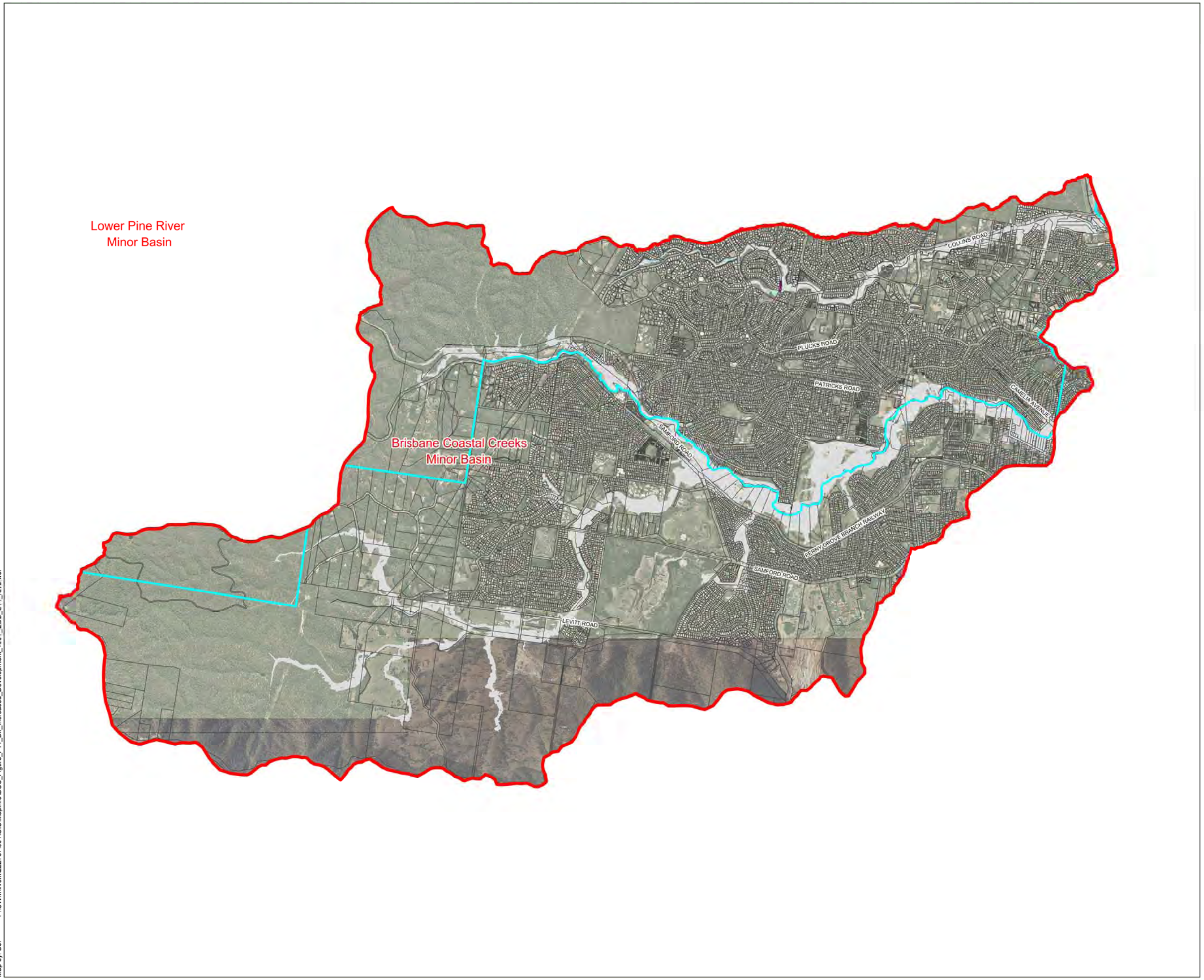
0   1000 m   2,000 m

Date: 12/10/2012   Version: 0   Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure F10: Increase in Vegetation Flood Level Impact 100 Year EDS (S10)



aurecon

Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

This figure shows increase in residential development peak water level minus EDS peak water level

Map by: DJF P:\SWMI\Work\222767\001\GIS\MapInfo\BCC_Figure_F11_Dif_Increased_Development_100Y_EDS_S11_rev0.wor

A3 scale 1:40,000

0 1000 m 2,000 m

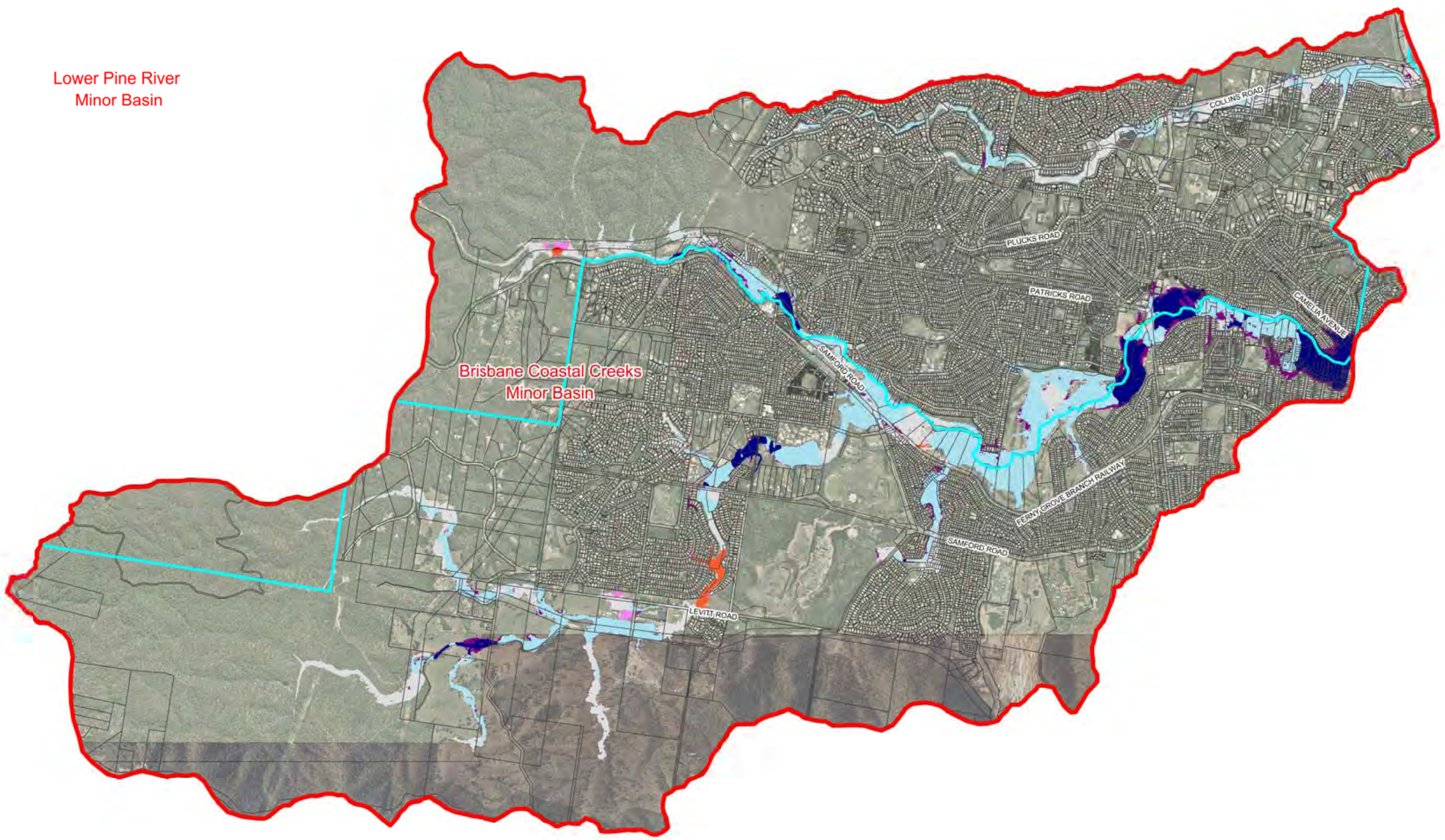
Date: 12/10/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure F11: Increase in Residential Development Flood Level Impact 100 Year EDS (S11)

aurecon



Legend

- Cadastre
- Minor Basin Boundaries
- MBRC/BCC Boundary

Peak Flood Level Difference (m)

- < -0.50
- -0.50 to -0.10
- -0.10 to 0.10
- 0.10 to 0.50
- >0.5
- Was Dry Now Wet
- Was Wet Now Dry

Notes:

This figure is based on information provided to Aurecon by Moreton Bay Regional Council (MBRC) and other parties. Although the provider of the information has not warranted the accuracy of the data and has waived liability in respect of its use, Aurecon's study was undertaken strictly on the basis that the information that has been provided is accurate, complete and adequate. Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that MBRC may suffer resulting from any conclusions based on information provided to Aurecon, except to the extent that Aurecon expressly indicates in the associated report that it has verified the information to its satisfaction.

This figure shows increase in vegetation and residential development peak water level minus EDS peak water level

Map by: DJF

P:\SWMIWork\222767\001\GIS\MapInfo\BCC_Figure_F11_Dif_Increased_Development_100Y_EDS_S12_rev0.wor

A3 scale 1:40,000

0 1000 m 2,000 m

Date: 12/10/2012 Version: 0 Job No: 222767

Projection: MGA Zone 56

RFD Detailed Modelling (BCC)

Figure F12: Increase in Vegetation and Residential Development Flood Level Impact 100 Year EDS (S12)

Appendix G
Hydrologic Modelling Details

Appendix G
Hydrologic Modelling Details

A separate report for hydrologic model establishment was not created as part of the study; therefore this section has been included to describe the process undertaken in the hydrologic modelling.

Available data

The following data was made available for the hydrologic modelling:

- Base WBNM model supplied by MBRC. This model was supplied with notes that C-value = 1.6; ARF = 1.0 and IFD file location in all runfiles will need to be amended
- Design rain gauge locations were also supplied
- Guidance on how climate change modelling is to be undertaken ie IFD coefficients to be increased by 12% (as per email correspondence from Hester van Zijl on 10 April 2012)
- Future development impervious values as supplied by Hester van Zijl on 2 May 2012
- Guidance for rainfall data setup was provided in the Worley Parsons (2010) *Database Design Rainfall – Burpengary Pilot Project (Draft)* report

Methodology

Model version

WBNM version 2010_000 was used to undertake the analyses.

The TUFLOW convert_to_ts1 utility (v 2009-10-AB) was used to convert the results to TUFLOW format.

Design event modelling

A separate .wbn file was created for each duration for each event (ARI). This was done in order to create separate output files for each event, which could then be used as input to the TUFLOW hydraulic model.

Two (2) design event rain gauge locations were adopted for the BCC minor basin as per the IFD data supplied.

The model results were then converted to .ts1 files for input to TUFLOW. Zero flow values were added to the end of each hydrograph. This was done for all WBNM model results, including the extreme events, PMP events and climate change events. Only the .loc files were used as input to the TUFLOW models.

Extreme event modelling

CRC-Forge was used to provide rainfall intensities. These were calculated for each of the five rainfall gauge locations adopted for the design events. For the 0045, 0090 and 0120 minute durations, no values are provided by CRC-Forge, therefore these were linearly interpolated between the 0030, 0060 and 0180 intensities.

PMP temporal patterns were applied to the extreme events. For the 0015, 0030, 0045, 0060, 0090, 0120, 0180 and 0360 minute events the temporal pattern for the Generalised Short Duration Method (GSDM) (BoM, 2003) was adopted. For the 1440, 2160, 2880 and 4320 minute events the temporal patterns from the coastal_avm_100 storms were adopted (as per the Generalised Tropical Storm Method (GTSMR), BoM 2003).

For the 0720 minute duration, both the GSDM and GTSMR temporal patterns were analysed. For the GTSMR, the times applying to the 1440 minute duration pattern were halved to create a 0720 minute pattern.

PMP event modelling

For the PMP event, a single storm was used across the entire model extents. The temporal patterns used for the extreme events were also used for the PMP events.

The methods set out in the GSDM (BoM, 2003) were used to provide rainfall intensities for the 0015, 0030, 0045, 0060, 0120, 0150, 0180, 0240, 0300 and 0360 minute events. The GTSMR methods (BoM, 2003) were used to provide intensities for the 1440, 2160, 2880 and 4320 minute events. For the 0720 minute event, a line of best fit was applied between the short and long duration intensities and the rainfall intensity was calculated to provide the best R^2 value to this line.

Key parameters used in the PMP analysis are provided in Table G1.

Table G1 | Adopted PMP Parameters

Parameter/Method	Value
GSDM – initial depths	Rough surface for area = 1km2
GSDM – EAF	1 as topography is below 1500m AHD
GSDM – MAF	0.85 (as per design events)
GTSMR – initial depths	Coastal summer values for area = $1km^2$
GTSMR – TAF	1.227 – median value from region inspection
GTSMR – DAF	0.979 – median value from region inspection
GTSMR – EPW	87.088 – median value from region inspection

Climate change event analysis

For the climate change scenario (S4), the IFD data adopted for the design events was increased by 12%. No other changes were made to the EDS model setup.

Future landuse scenario analysis

For the future landuse scenario (S11), the revised fraction impervious values provided by MBRC were incorporated into the .wbn file. No other changes were made to the model setup.

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