Regional Floodplain Database:

2014 Model Maintenance Report - Caboolture River (CAB)

Moreton Bay
Regional Council

“Where will our knowledge take you?”

Regional Floodplain Database 2014 Model Maintenance Report

Caboolture River (CAB) October 2015

Moreton Bay Regional Council

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Regional Floodplain Database 2014 Model Maintenance Report – Caboolture River (CAB)

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

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1 Introduction

BMT WBM has developed the Caboolture River (CAB) hydrologic and hydraulic models as part of the Stage 2, Regional Floodplain Database Project (RFD) (BMT WBM, 2012a). This model was updated in November and December 2012 by including additional structures and new development areas provided by Council (BMT WBM, 2012b). In 2013, the CAB model was further updated with additional structures and developments, along with some pilot changes to the modelling approach (BMT WBM, 2013).

In 2014, Moreton Bay Regional Council (Council) has obtained additional information that could further enhance the model performance, including newly flown Light Detection and Ranging (LiDAR) elevation data and additional structure details. The hydraulic modelling software, TUFLOW, has had many advances made to it that improves modelling efficiencies. Finally, there has been improvement to modelling techniques that will provide a better representation of flood behaviour.

Due to these reasons, Council have decided to upgrade the existing CAB model to incorporate the most recent data and improved modelling platform and techniques. The model has been re-run, incorporating these changes, for all events, including the calibration/validation events and sensitivity analysis.

This report highlights the changes and results from the 2014 model for the simulated events.

2 2014 Model Maintenance Details

2.1 WBNM Model

The WBNM minor catchments were reviewed against the 2014 LiDAR data, and the subcatchments were adjusted in two locations:

- SSC_01_03043: was split into two minor catchments. It was found that previously two flow paths were being represented by one subcatchment.
- GOD_09_00000: was split into two minor catchments. The previous layout of this area was previously highlighted as causing 'false impacts' in a sea level sensitivity scenario.

Furthermore, Council advised that the initial loss (IL) value for events up to and including the 5% AEP event be changed from 0mm to 15mm. Initial losses for events over the 5% AEP remain at 0mm.

2.2 TUFLOW Model

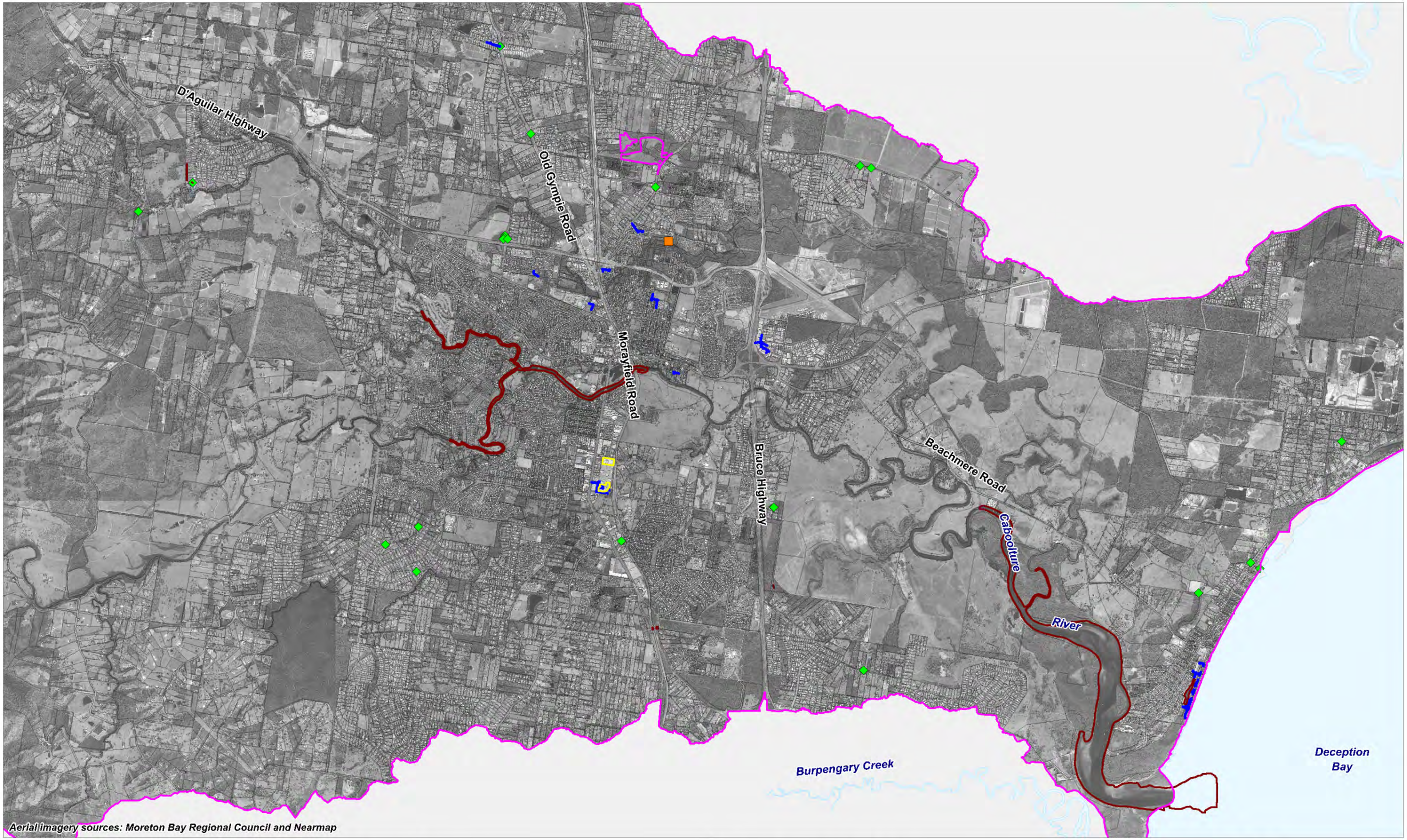
Council consolidated and provided data for the model maintenance in various formats. Figure 2-1 presents the locations of the additional data incorporated into the 2014 CAB model. In summary, the following information was incorporated into the CAB model:

- Updated topography data. This data has been read into the model as a DEM (rather than Z-points):
  - 2014 LiDAR data for the entire catchment;
  - Bathymetry data, including:
    - Caboolture River from around the North Coast Railway Line to around Sumar Lane along Caboolture River (northern branch) and to around Bishops Lane along Antibidawa Creek (southern branch); and
    - Caboolture River from the mouth to around Bloesch Road.
  - A Digital Elevation model (DEM) of a new development to the north of Pumicestone Road (Reserve Drive).
- Inclusion of additional culverts:
  - Previously, the culverts conveying flow from Yellow (Broken) Creek under Old North Road was erroneously modelled as a bridge. This bridge has been replaced with 2 x ϕ2.4m pipes.
  - Culverts under Pumicestone Road have been upgraded to 3 x 1.8m x 1.5m culverts.
  - Culverts under Bishop Road have been upgraded to 1 x 1.2m x 0.6m culvert, 1 x 0.6m x 0.45m culvert, 1 x 1.2m x 0.9m culvert and 1 x 0.9m x 0.6m culvert.
  - 3 x ϕ 0.9m pipes under Mallard Court.
  - 3 x ϕ1.2m pipes under Logrunner Drive.
  - 3 x ϕ1.5m pipes under Warbler Court.

- 4 banks of culverts under Smiths Road (2 banks of 3 x ϕ0.675m pipes, 1 bank of 4 x ϕ0.675m pipes and 1 bank of 3 x ϕ0.9m pipes).
- 2 x ϕ0.75m pipes under Lyndhurst Terrace.
- 4 x 1.2m x 0.6m culverts under Old Gympie Road, near Craigslea Drive.
- 1 x 10m x 2.7m culvert between Morayfield Road and the North Coast Railway line.
- 3 x 1.2m x 0.45 culverts under Trafalgar Square.
- 6 x ϕ0.75m pipes under Cobb Road.
- 10 x ϕ0.75m pipes from Sandy Street into the Bay.
- 1 x ϕ0.6m pipe and 1 x 1.2m x 0.75m culvert at Rogers Street Sports Field.
- 2 banks of culverts under Old Toorbul Point Road (4 x ϕ1.05m pipes and 3 x ϕ0.6m pipes).
- 4 x 0.9m x 0.6m culverts under Mynott Road.
- 5 x ϕ0.525m pipes under Payne Road.
- Where necessary, estimated inverts were updated with 2014 LiDAR information.

* Inclusion of additional trunk drainage:
  - Along Lyndhurst Terrace;
  - Between Pumicestone Road and Jensen Road;
  - Between Pumicestone Road and Bratchford Crescent;
  - To the south of the Parish Road / Abbey Road intersection;
  - Between Shell Street and Henzell Road;
  - Local drainage network within and next to Morayfield Shopping Centre;
  - Along Mary Street;
  - Along Lillee Crescent, Jubilee Street and Bradman Street;
  - Along Lear Jet Drive; and
  - Various locations along Biggs Avenue.
* Addition of other structures:
  - The Brown Street Bridge across Lagoon Creek has been included in the model from plans provided.
  - Backflow prevention structures at Eureka Court, including: 2 x ϕ0.6m uni-directional pipes and a bund.
  - The basin behind Biggs Avenue has been included as a z-shape to ensure that the bed levels are adequately captured within the model.
* An initial water level polygon has been applied to the Caboolture Weir.

- Change in methodology of the application of hydrological flows. Where a subcatchment contains trunk drainage, the inflow (SA polygon) will be changed to be read in as “Read MI SA Pits”. This directs the hydrological flows directly into the trunk drainage network.
  In some instances, it was found that the flows from large catchment were being applied directly to the trunk drainage network, causing the network to reach full capacity and increase flooding in some urban areas. This was as a result of model schematisation and not an accurate reflection of actual conditions. Where the hydrological subcatchment was significantly larger than the area that the catchment of the trunk drainage network, the SA inflows have been proportionally applied to both the trunk drainage network (“Read MI SA Pits”) and the rest of the 2D catchment not being drained by the trunk network (“Read MI SA”).
- Morayfield Shopping Centre: as discussed with Council on 5/11/2014, the Morayfield Shopping Centre has been included in the model as a layered flow constriction shape, which lowers the ground through the car-park to more accurate levels and to represent the losses associated with the piers within the car-park. Solid zlines have also been added to ensure that the solid building walls are represented in the model, ensuring an accurate representation of the flow path through this area.
- Breaklines were incorporated along all stream centrelines, as per the methodology developed as part of the Lower Pine River Pilot Study (BMT WBM, 2014).
- Waterbody material layer has been updated to include a waterway materials layer along the streamlines.
- Inclusion of zlines to represent the crest elevation of key roads within the modelled area.
- Plot output (PO) lines updated to include all locations of interest and to ensure all are located perpendicular to the general flow direction.



LEGEND

- Caboolture River Catchment Boundary
- Cadastral Boundaries

Additional Features

- New Development Areas
- Morayfield Shopping Centre
- Change in Topography/Bathymetry
- Bridge
- Culverts
- Underground Drainage

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Figure: 2-1

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3 Model Simulations

3.1 Verification

The Caboolture River hydraulic model has previously been calibrated for the January 2011 event and validated against the May 2009 event (BMT WBM, 2013). The changes made to the model as a result of the 2014 model maintenance should not impact upon the calibration parameters. Council have therefore decided to undertake a validation event only. Council have stipulated that the January 2011 event will be used for validation for the CAB model, on a 10m grid cell size.

3.2 Design Flood Events

This section describes the design storm conditions used in the hydrodynamic modelling tasks. Design storm events are hypothetical events used to estimate design flood conditions. They are based on the probability of occurrence, usually specified as an Average Exceedance Probability (AEP).

3.2.1 River and Creek Critical Duration Assessment

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

- 1% AEP event, to represent non-extreme events (1 Exceedance Year (EY) to 1% AEP events); and
- 0.1% AEP event, to represent extreme events (0.5% AEP to PMF events).

To determine the critical storm durations for the Caboolture River model, the following methodology was adopted:

(1) Hydrologic and hydraulic modelling for a range of storm durations for the 1% and 0.1% AEP events;

(2) Mapping of the peak flood level results for the ‘maximum envelope’ of all the storm durations for the two representative events;

(3) Mapping of the peak flood level results for the ‘maximum envelope’ of the selected storm durations for the two representative events;

(4) Difference comparison between the mapped peak flood levels for the selected critical durations and the results accounting for all the storm durations;

(5) Selection of the critical durations was undertaken in consultation with Council and was based on the storm durations generating the highest flood levels across the most widespread areas; and

(6) A summary of the selected critical storm durations for all events assessed is outlined in Table 3-1.

Table 3-1 Critical Storm Duration Selection

Assessment Event	Assessed Durations	Selected Critical Durations	Adopted Event
1% AEP	0.5, 1, 1.5, 2, 3, 4.5, 6, 9, 12 and 24 hour storm	2, 6 and 12 hour storm	1 EY, 0.5EY, 20%, 10%, 5%, 2% and 1% AEP
0.1% AEP	0.5, 1, 1.5, 2, 3, 5, 6, 9, 12 and 24 hour storm	5, 9 and 12 hour storm	0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP and PMF

Figure 3-1 and Figure 3-2 show which events generated the highest peak flood levels in different areas throughout the catchment. The following observations can be made:

- The 24 hour duration is critical in the Beachmere area for both events;
- For both events, the 6 hour duration is critical along parts of the Upper Caboolture River, Lagoon Creek and Wararba Creek;
- For both events, the 0.5, 1, 2 and 3 hour events are critical in the upper parts of the catchment;
- For the 1% AEP event, the 12 hour duration is critical in the lower catchment (excluding Beachmere);
- For the 0.1% AEP event, the 24 hour duration is critical in the lower Caboolture River floodplain;
- For the 0.1% AEP event, the 5 hour is critical in the middle reaches of the tributaries; and
- For the 0.1% AEP event, the 9 hour duration is critical through the township of Caboolture (along Caboolture River and Lagoon Creek).

The difference comparison for the 1% and 0.1% AEP peak flood levels (as described in step 4 above) is shown in Figure 3-3 and Figure 3-4. For the 1% AEP event, the peak flood levels through the majority of the catchment are not different between the chosen critical durations and all of the durations. The key differences include:

- Beachmere town: decreases typically around 0.2m for the 1% AEP event and between 0.05m and 0.2m in the 0.1% AEP event;
- North of Beachmere: decreases between 0.05m and 0.5m (locally, in the Quarry area, west of Mynott Road, up to approximately 1.2m) in the 1% AEP event; and a decrease between 0.05m to 0.2m (locally, in the Quarry area up to 1.0m) for the 0.1% AEP; and
- King Johns, Lagoon, Wararba and Sheep Station creeks: decreases between 0.01m and 0.2m for the 1% AEP event; and between 0.05m and 1.0m for the 0.1% AEP event.

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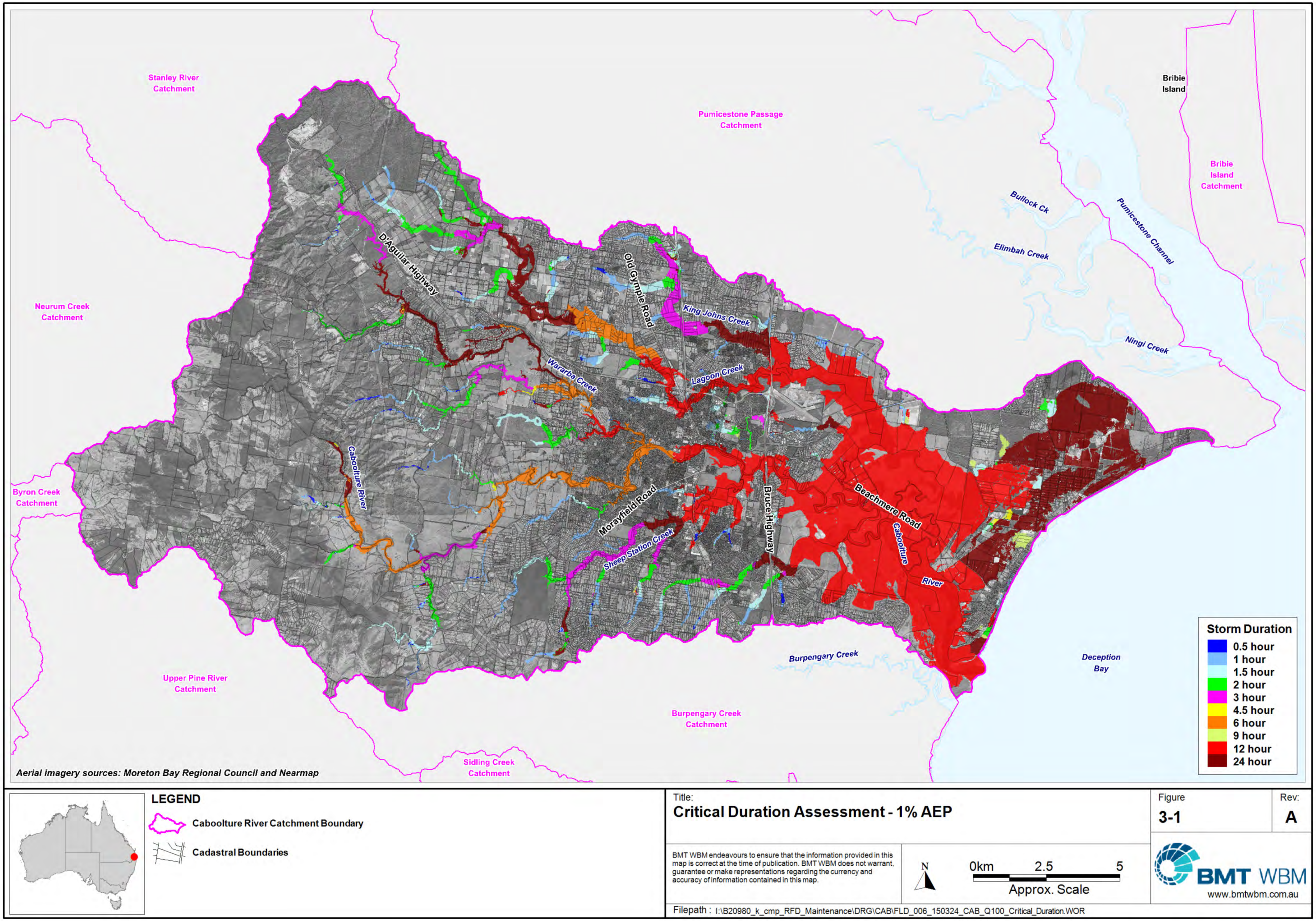
Stanley River
Catchment
Pumicestone Passage
Catchment
Bribie
Island
Bribie
Island
Catchment
Neurum Creek
Catchment
Byron Creek
Catchment
Upper Pine River
Catchment
Burpengary Creek
Catchment
Sidling Creek
Catchment
Bullock Ck
Elimbah Creek
Pumicestone Channel
Ningi Creek
Deception
Bay
Burpengary Creek
D'Aguilar Highway
Old Gympie Road
King Johns Creek
Lagoon Creek
Wararba Creek
Caboolture River
Morayfield Road
Sheep Station Creek
Bruce Highway
Beachmere Road
Caboolture
River
Storm Duration
0.5 hour
1 hour
1.5 hour
2 hour
3 hour
4.5 hour
6 hour
9 hour
12 hour
24 hour
Aerial imagery sources: Moreton Bay Regional Council and Nearmap
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Critical Duration Assessment - 1% AEP
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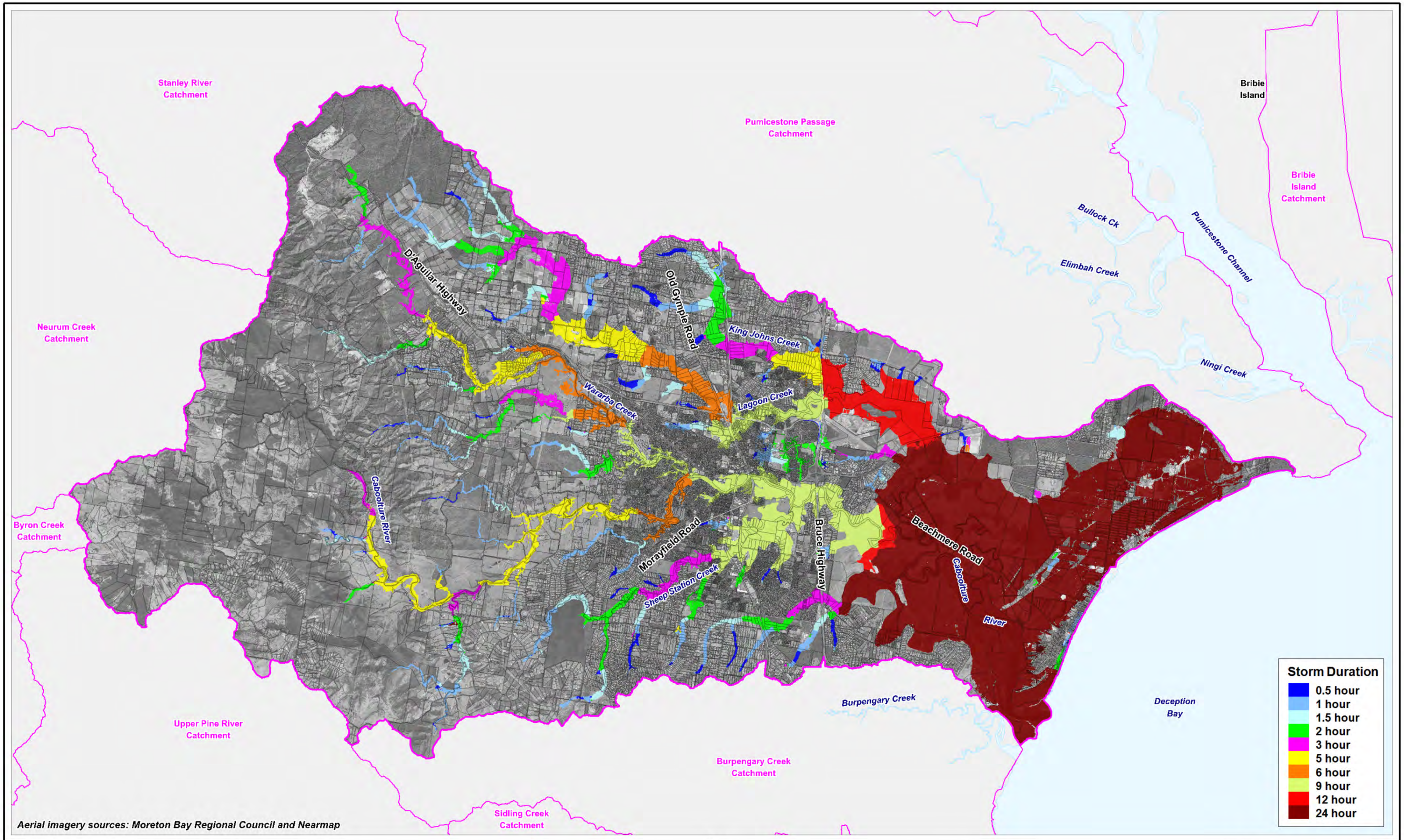

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Critical Duration Assessment - 0.1% AEP

Figure 3-2

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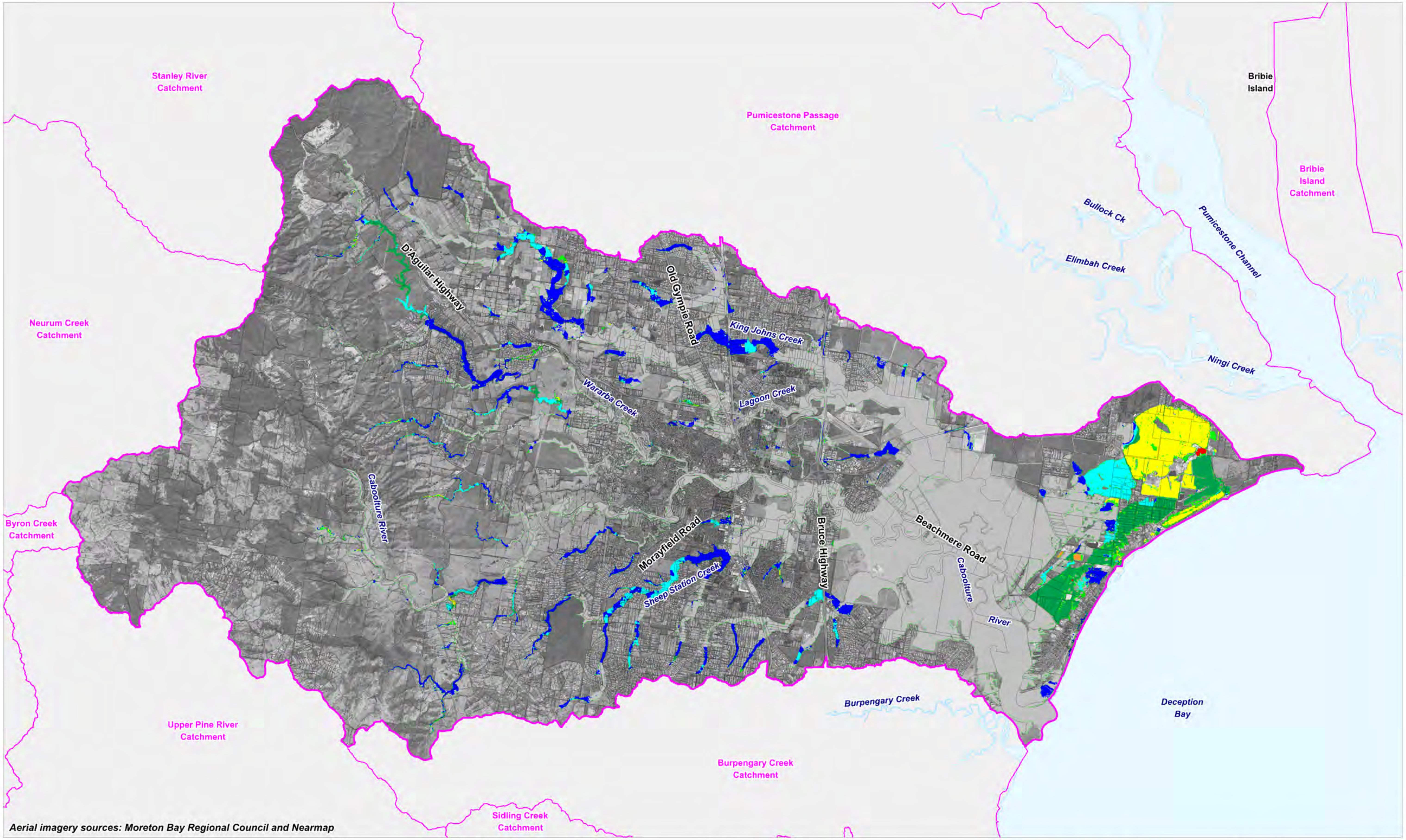

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Caboolture River Catchment Boundary

Cadastral Boundaries

Peak Flood Level Difference (m)

- <-1.00
- -1.00 to -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- No Change
- Decrease in Inundation Extent

Title:

Peak Flood Levels for critical durations minus Peak Flood Levels for all durations - 1% AEP

Figure **3-3**

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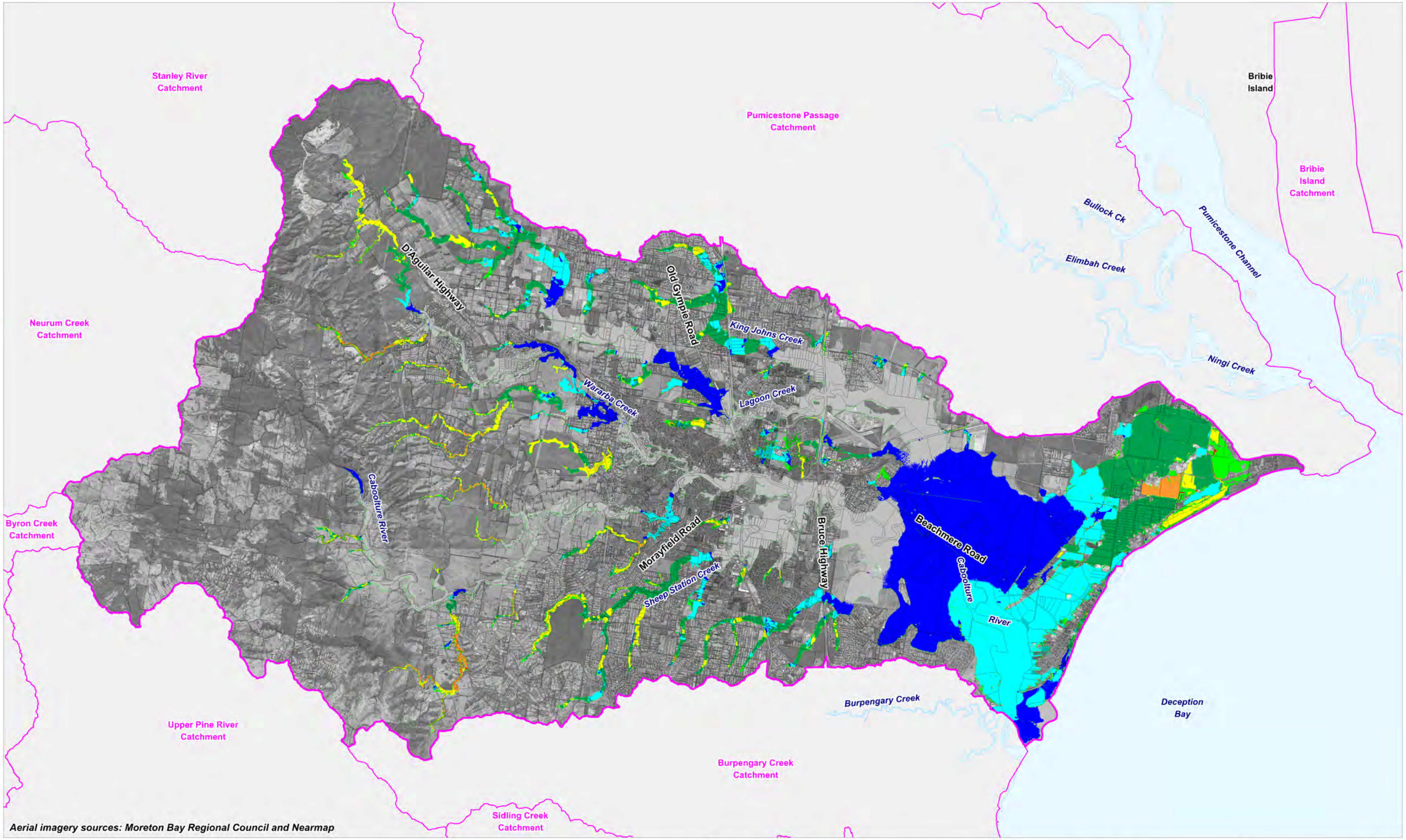

LEGEND

Caboolture River Catchment Boundary

Cadastral Boundaries

Peak Flood Level Difference (m)

- <-1.00
- -1.00 to -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- No Change

Decrease in Inundation Extent

Title:

Peak Flood Levels for critical durations minus Peak Flood Levels for all durations - 0.1% AEP

Figure **3-4**

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3.2.2 River and Creek Design Event Simulations

The CAB model was simulated for a range of AEP events and storm durations, as outlined in Section 3.2.1, as well as a Moreton Bay Design Storm (MDS). Councils adopted design storm is a 1% AEP 15 minute in 270 min embedded design storm. The MDS is useful for general investigations into changes in model parameters and catchment characteristics, as it reduces the number of model runs required (i.e. one run instead of multiple storm durations).

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

- The 1 EY, 0.5EY, 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP events, and the PMF event for the three selected critical storm durations; and
- The Moreton Bay Design Storm – 1% AEP 15 minute in 270 minute embedded design storm.

3.2.3 Storm Tide Design Event Simulations

The CAB model was simulated for a range of storm tide simulations. These simulations were based on a dynamic tide generated from the 'Storm Tide Hydrograph Tool' (Cardno Lawson Treloar, 2010). The following four storm tide reference points were used: MBC-016, MBC-022, MBC-027 and MBC-031.

Table 3-2 provides a summary of the Storm Tide design events that have been simulated.

Table 3-2 Storm Tide Design Event Simulations Summary

ID	Event	Description	Climate Change	Sea Level Rise (m)
S01	1% AEP	Current Climate	Excluded	0
S02	5% AEP	Current Climate	Excluded	0
S03	0.1% AEP	Current Climate	Excluded	0
S04	0.01% AEP	Current Climate	Excluded	0
S05	1% AEP	Future Climate	Included	0.8

The downstream boundary for the storm tide events needed to be modified, some of the major bends in the boundary needed to be smoothened. As a storm tide event has large volumes flowing into the model, the bends in the model were causing eddies to from along the boundary, causing instabilities. A straighter downstream boundary resulted in more stable storm tide models.

3.3 Sensitivity Analysis

The CAB model was simulated for ten (10) sensitivity scenarios in total. A summary of the sensitivity scenarios, the model identifier (ID), description and purpose of the ten sensitivity scenarios are detailed in Table 3-3.

Table 3-3 Sensitivity Analysis Summary

ID	Description	Section
R01	Roughness	3.3.1
R02	Blockage	3.3.2
R03	Climate Change - Rainfall	3.3.3
R04	Climate Change – Sea level rise	3.3.3
R05	Climate Change – Rainfall and Sea level rise	3.3.3
R06	Storm tide – current storm tide with current rainfall	3.3.3
R07	Storm tide – future storm tide with future rainfall and sea level rise	3.3.3
R08	Vegetated floodplain	3.3.4
R09	Future residential development	3.3.4
R10	Vegetated floodplain and future residential development	3.3.4

3.3.1 Hydraulic Roughness Analysis

The sensitivity of the model to landuse roughness (Manning's 'n') parameters was undertaken with the 1% AEP MDS event. All Manning's 'n' values within the 2D domain were increased by 20%.

3.3.2 Structure Blockage Scenario

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

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

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

It should be noted that no blockage is applied for trunk drainage infrastructure.

3.3.3 Climate Change and Downstream Boundary Conditions

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

- **R03**: Investigated the impact of an increase in rainfall intensity of 20%, as per *Boundary Conditions, Joint Probability and Climate Change* (SKM, 2012a).
- **R04**: Investigated the impact of an increased downstream boundary of MHWS + 0.8m due to predicted sea level rise.

- **R05:** Investigated the impact of an increase in rainfall intensity and an increased downstream boundary. This scenario combines R03 and R04.
- **R06:** Modelled a static storm tide to use as the reference for assessing the storm tide impacts. The downstream boundary was changed to a static storm tide level with a value of 2.5mAHD (100 year Current) with the concurrent 1% AEP EDS rainfall event.
- **R07:** Investigated the impact of an increase in sea level (R04) and a static storm tide level of 2.8mAHD (100 year GHG).

3.3.4 Future Landuse Analysis

Three future landuse scenarios were assessed to test the impact of future developments.

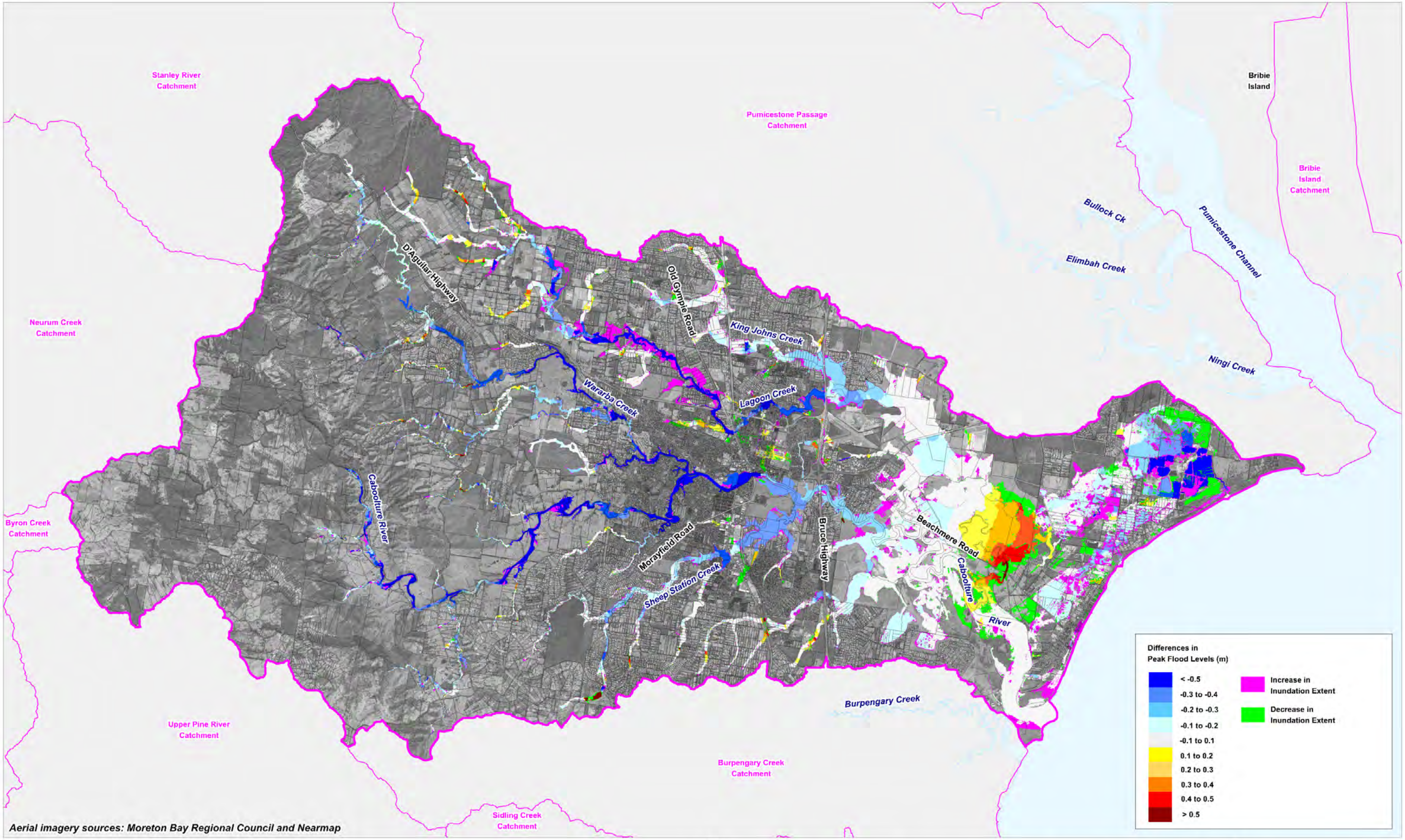
- **R08:** Assessed the impact of increased vegetation in floodplains.
  Landuse is defined in the hydraulic model through the materials layer. This information covers the entire hydraulic model extent and describes landuse and the Manning's 'n' roughness values associated with each type of landuse. The materials layer was updated to reflect the future landuse scenario (change in vegetation density). Any area with a landuse classification of Medium Dense Vegetation within the 1% AEP extent was changed to High Density Vegetation. Also, Low Grass / Grazing within the 1% AEP extent was changed to a Medium Dense Vegetation landuse classification.
- **R09:** Investigated the impact of increased residential development.
  The hydrologic model utilises a 'fraction impervious' parameter which described the proportion of each subcatchment where water is not able to infiltrate, i.e. there are no rainfall losses on paved surfaces. If the fraction impervious increases, there will be more rainfall runoff and quicker concentration of flows. The fraction impervious in each subcatchment of the WBNM model was updated to reflect the future landuse scenario provided by Council (R09).
- **R10:** Determined the impact of increased vegetation in floodplains (R08) and increased residential development (R09).

4 Model Results and Outcomes

4.1 2014 Model Maintenance

Figure 4-1 and Figure 4-2 shows the difference between the 2014 and 2013 Caboolture River models for the 5% and 1% AEP events, respectively. Both events are based on a comparison between the 3 hour storm duration.

Negative values mean that the 2014 CAB model results are lower than the 2013 model results and vice versa (positive values mean that the 2014 CAB model results are higher than the 2013 model results).



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Caboolture River Catchment Boundary

Cadastral Boundaries

Title:

2014 Caboolture River Model versus 2013 Caboolture River Model Peak Flood Level Difference - 5% AEP

Figure **4-1**

Rev: **A**

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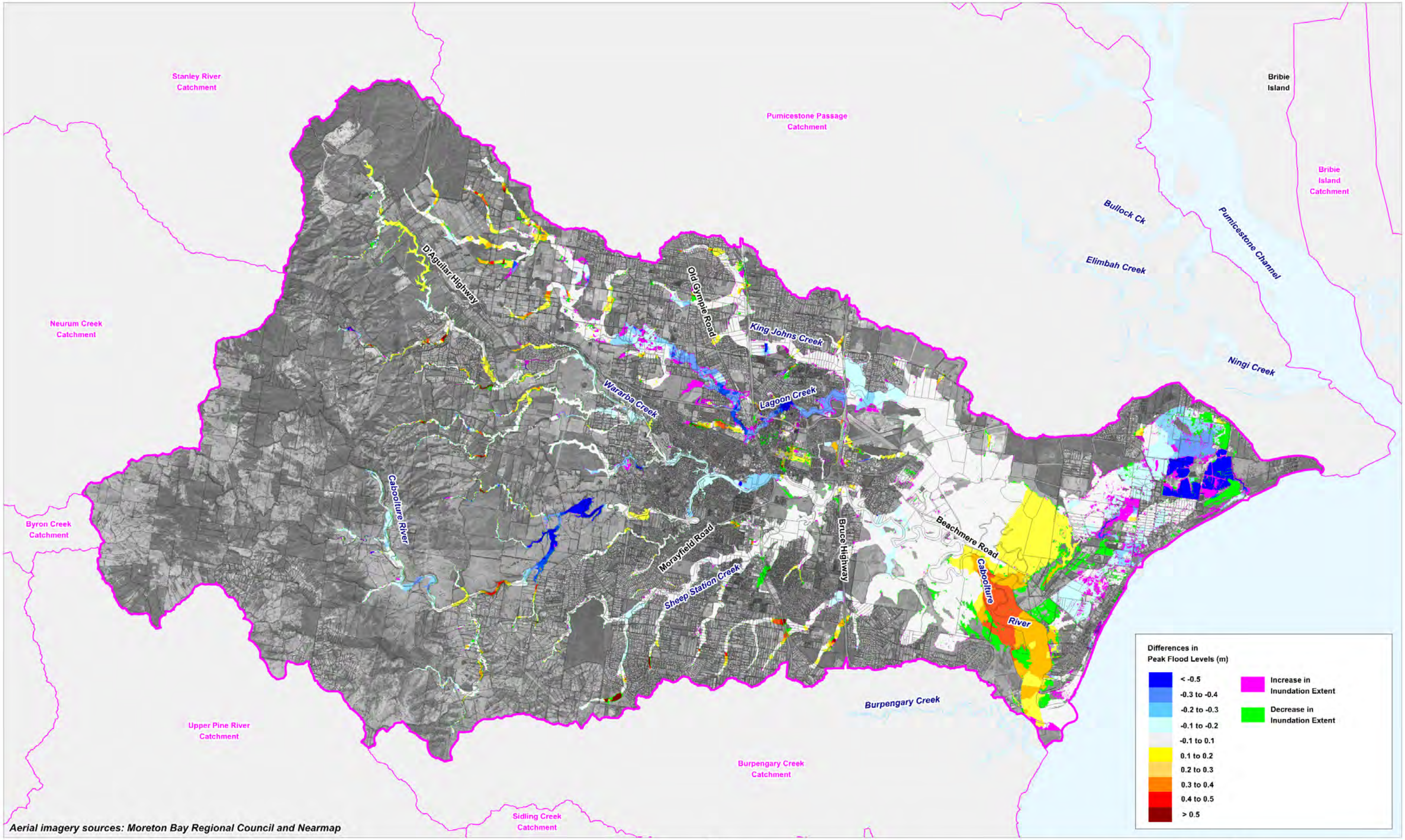

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Caboolture River Catchment Boundary

Cadastral Boundaries

Title:

2014 Caboolture River Model versus 2013 Caboolture River Model Peak Flood Level Difference - 1% AEP

Figure **4-2**

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4.2 Verification

Validation of the modelling was undertaken using the January 2011 event. Reasonable model verification was achieved considering the timing, peak flood levels and volume. This conclusion is discussed in further detail below.

Catchment Wide Comparison of Flood Levels

Figure 4-7 shows the difference in peak flood levels between the 2014 model and the 2013 model for the January 2011 event.

Results indicate that throughout the majority of the catchment, the flood levels between the two models are within ±0.1m. The following key areas experience a greater difference:

- A decrease in levels of up to 0.1m around Bentley and Peel roads in Beachmere;
- A decrease in levels between 0.2m and 0.85mto the north east of Mynott Road, Beachmere;
- A decrease in levels of up to 0.15m along and to the north of Bishop Road, Beachmere;
- A decrease in levels of up to 0.3m downstream of the Bruce Highway at the confluence of King Johns and Lagoon Creeks;
- An increase in levels of up to approximately 0.36m from Lang Street to east of the Caboolture Hospital;
- An increase in level of up to approximately 0.3m along the Caboolture River near Colburn Way, Bellmere;
- A decrease in levels of up to approximately 0.9m along the Caboolture River near Eliason Road, Bellmere; and
- In the upper reaches, the flood levels are generally higher in the 2014 model.

Hydrograph Comparison

Three (3) river gauges recorded flood levels during the January 2011 event in the Caboolture River Catchment. Hydrographs showing the recorded and modelled flood levels during the January 2011 event (covering the 4 days of the event; 9-12 January 2011) are presented in Figure 4-3 to Figure 4-5.

The following key points can be drawn from a comparison of the hydrographs:

- The timing (i.e. the shape of the hydrographs) at all three gauges compares very well between the recorded and the modelled flood levels across the entire four days of the event;
- The model over predicted the peak flood level at the Wamuran Gauge by 1.25m (1.29m in the 2013 model);
- The model under predicted the peak flood level at the Upper Caboolture Gauge by 1.71m (1.25m in the 2013 model); and
- The model under predicted the peak flood level at the Caboolture WTP gauge by 0.47m (0.5m in the 2013 model).

- There are some noticeable discrepancies between modelled and recorded peak flood levels at the three gauges. This may, in part, be due to insufficient data to enable the model to adequately capture the spatial distribution of rainfall patterns across the catchment. Inspection of radar data for the January 2011 event indicates that the location of the rain gauges (and rainfall interpolation between the gauges) ‘missed’ a zone of high rainfall in the western part of the catchment. Limitations in the model design may also have contributed to discrepancies between modelled and measured flood levels, particularly in upper parts of the catchment. For more information on the comparison between the gauge data and radar data, please refer to the previous Stage 2, RFD Project CAB report (BMT WBM, 2012a) with reference R.B18104.006.02).

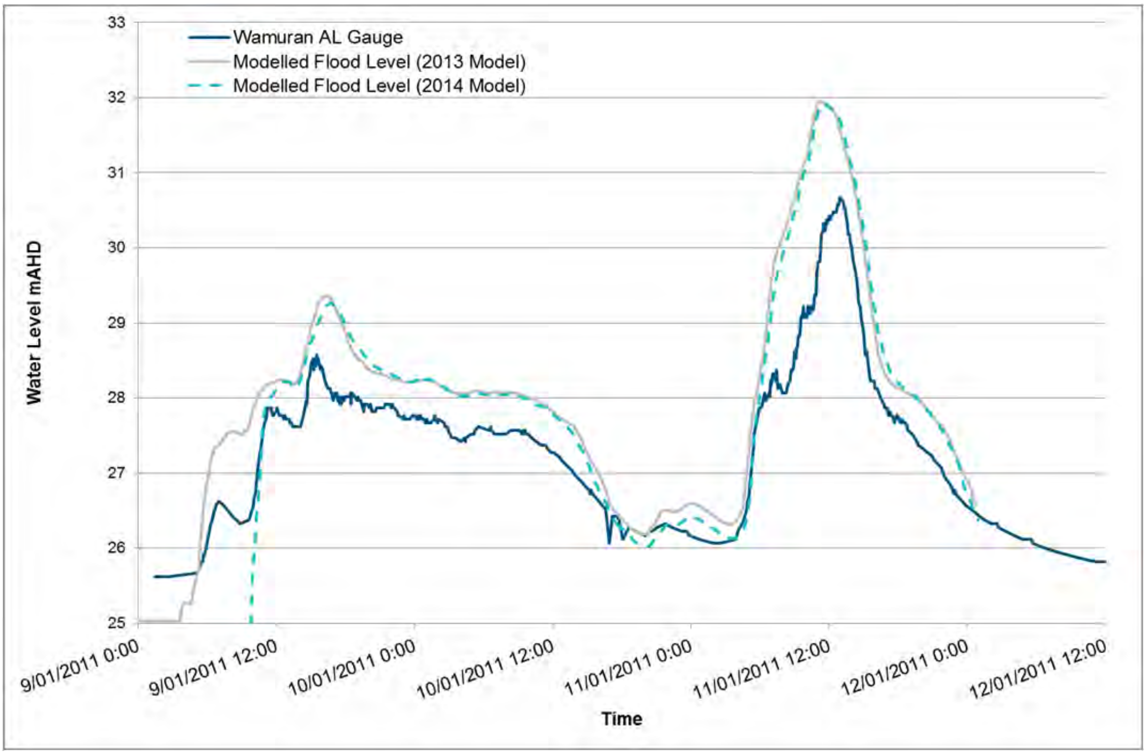


Figure 4-3 Recorded and Modelled Hydrographs at Wamuran Gauge – January 2011 Event

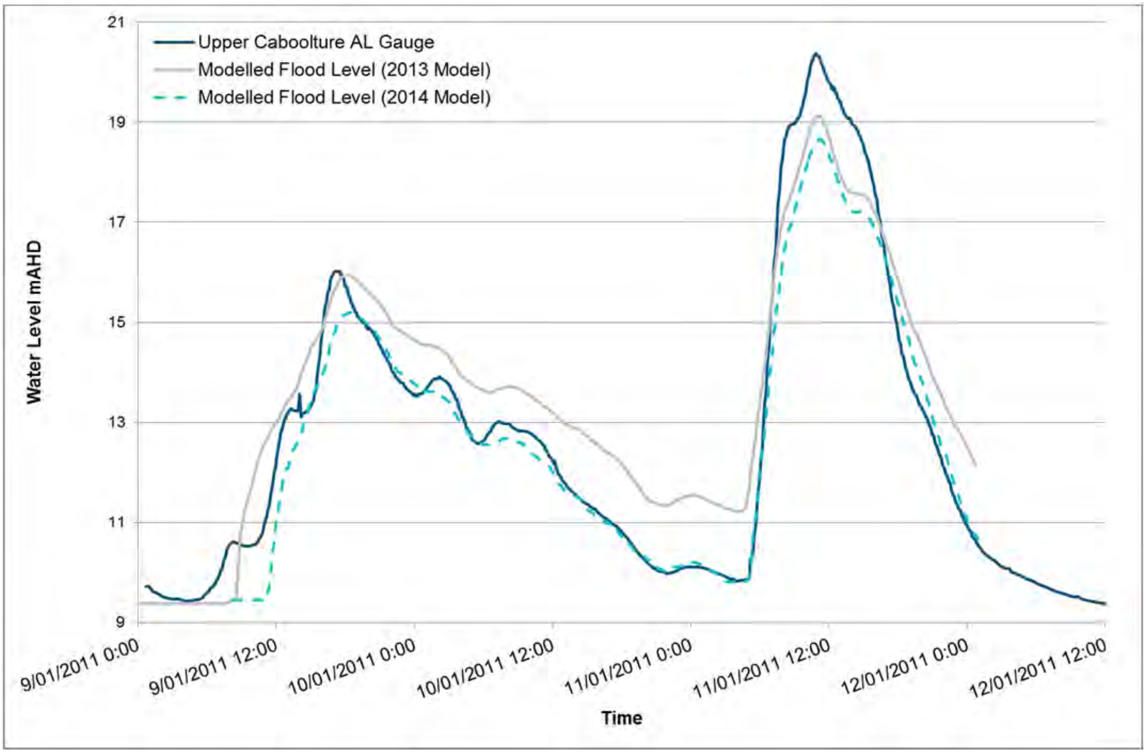


Figure 4-4 Recorded and Modelled Hydrographs at Upper Caboolture Alert Gauge – January 2011 Event

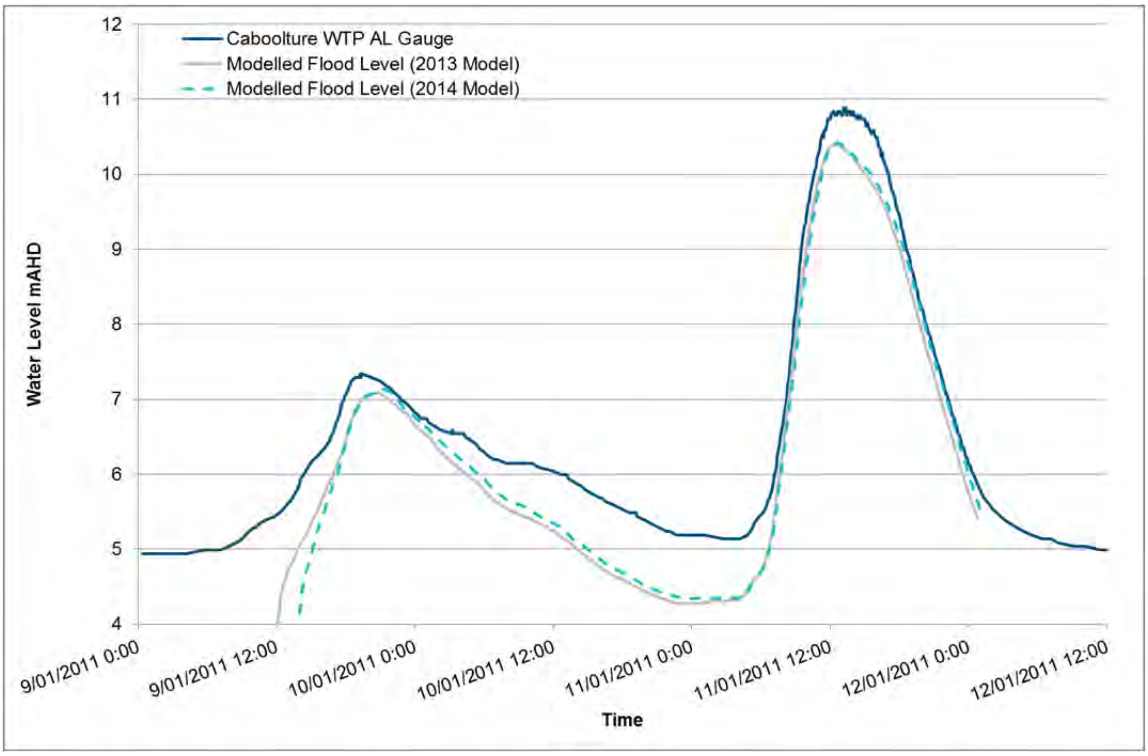


Figure 4-5 Recorded and Modelled Hydrographs at Caboolture Water Treatment Plant Gauge – January 2011 Event

Flood Mark Comparison

Council collected 89 floodmarks for the January 2011 events in the CAB catchment, 6 of these were of high quality and the others were categorised as medium quality. Two of these surveyed flood marks were outside of the modelled flood extent for both the 2014 and 2013 models.

The surveyed flood levels at the flood marks were compared to the modelled peak flood levels derived from the calibration model. The difference in flood levels versus the number of flood marks are presented as a histogram in Figure 4-6.

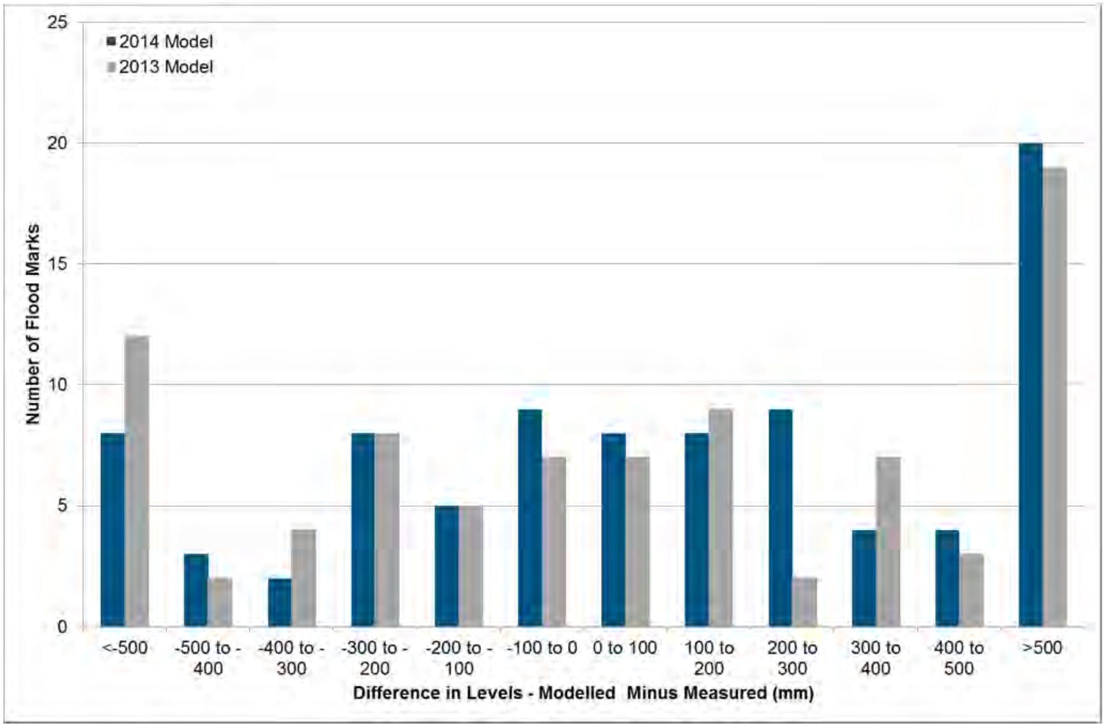
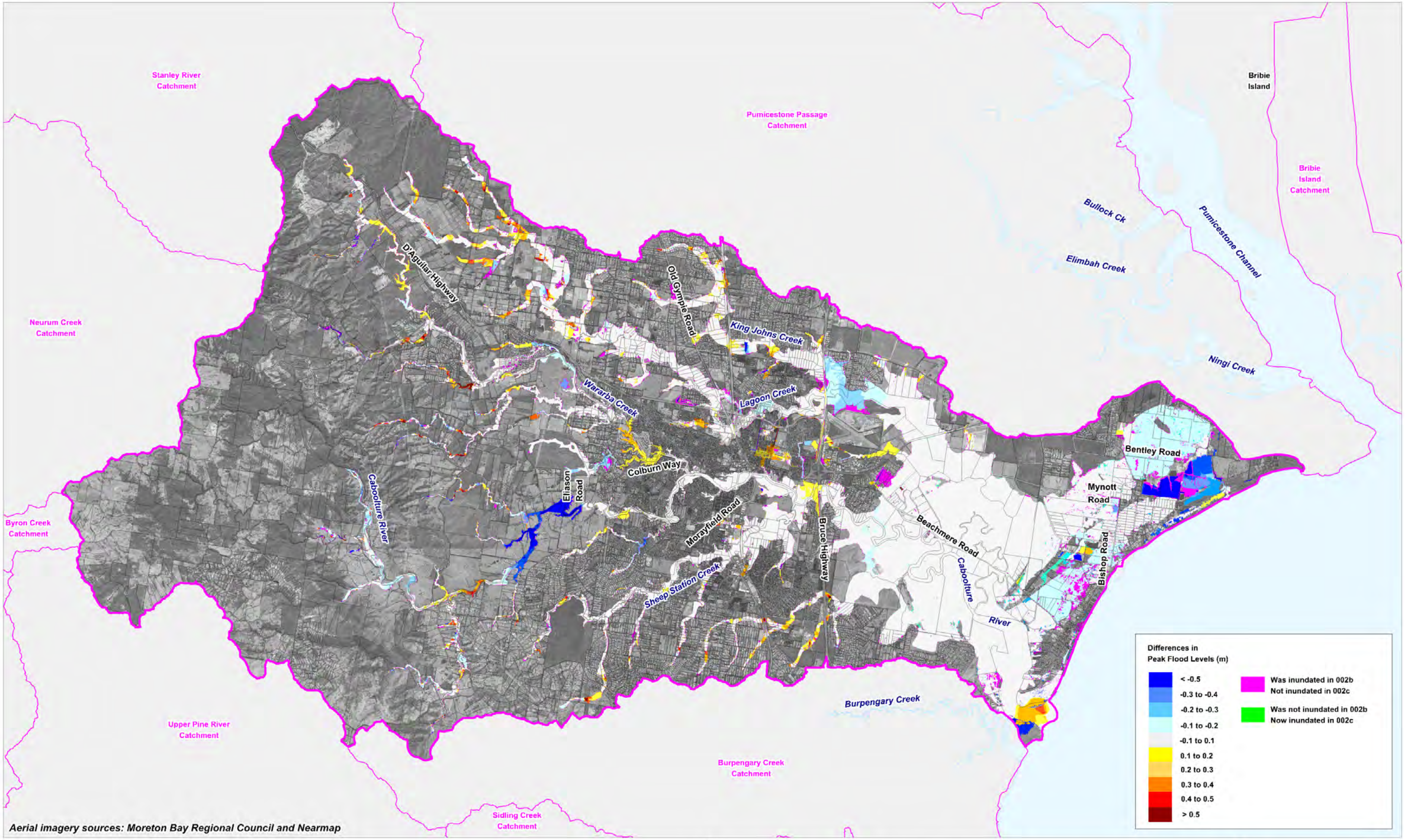


Figure 4-6 Floodmark Histogram – January 2011 Event

This histogram shows a significant portion (53%) of the flood marks are within ± 300mm, which suggests a reasonable calibration. Larger differences in flood levels generally occur in the upper reaches of Caboolture River, Warbara Creek and King Johns Creek.

Some flood marks differ significantly between the surveyed and the modelled level (greater than 500m); however it was also noted that some surveyed flood marks located close together show very different levels, which suggests that some of the flood mark levels may be inaccurate. Also, a discrepancy was found when comparing some of the surveyed flood mark levels with the ground levels used in the model (derived from LiDAR), with the flood mark level being lower than the ground level.



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Caboolture River Catchment Boundary

Cadastral Boundaries

Title:

January 2011 Event Peak Flood Level Difference 2014 Model Minus 2013 Model

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Figure 4-7

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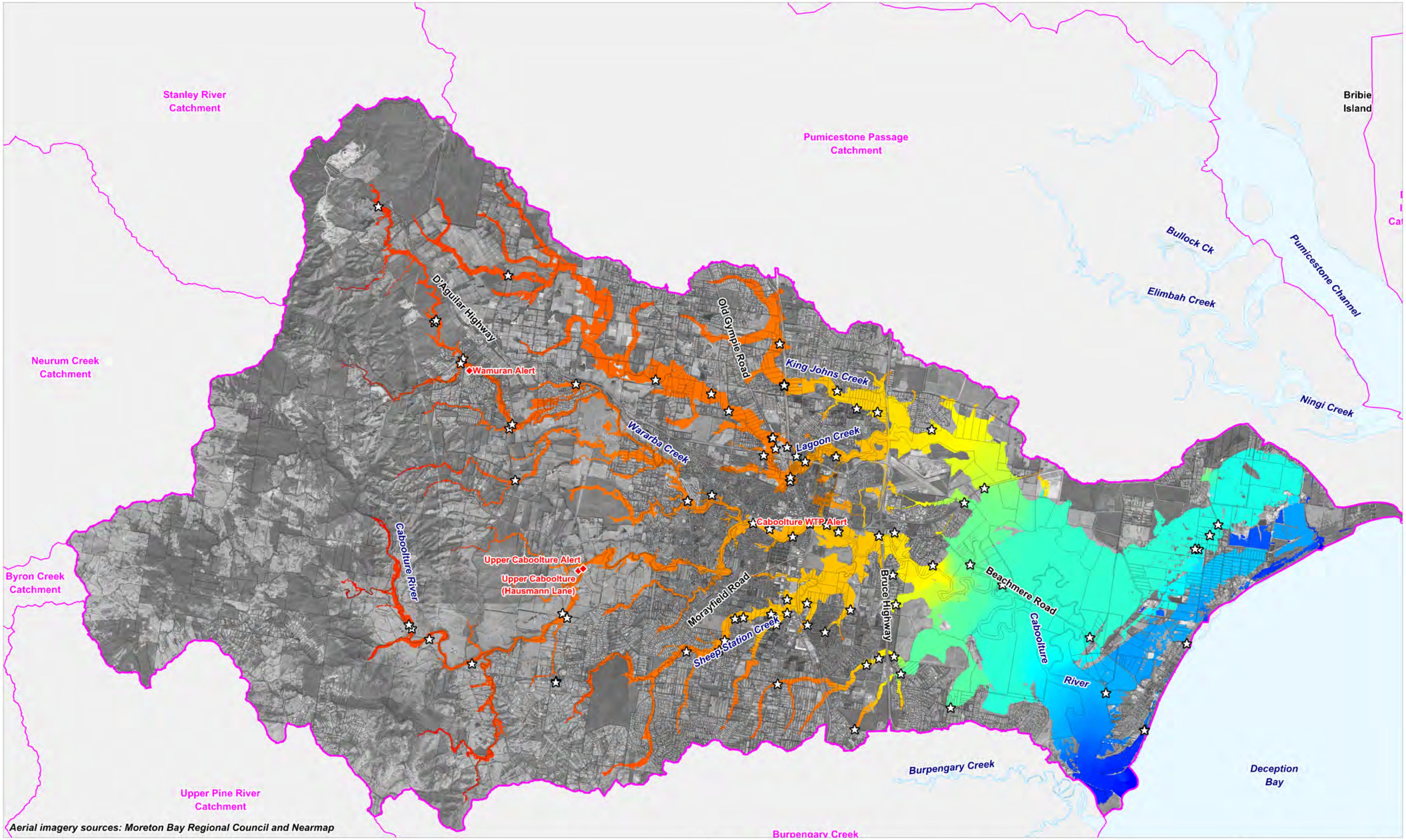

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- Caboolture River Catchment Boundary
- Cadastral Boundaries
- River Gauge Location
- Flood Mark Location

Title:

January 2011 Event Peak Flood Water Level - Caboolture River Catchment

Figure **4-8**

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4.3 Design Flood Behaviour

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

(1) Flood Levels (h flag);

(2) Flood Depth (d flag);

(3) Flood Velocity (v flag);

(4) Depth Velocity Product (Z0 flag);

(5) Hazard Categories adopted by Council (ZMBRC flag);

(6) Hazard Categories developed by the Queensland Reconstruction Authority (ZQRA flag);

(7) Steam Power (SP flag); and

(8) Inundation Times (no flag required).

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

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

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

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

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

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

Flood maps have not been provided because the focus of this project is on digital data in this report, rather than the provision of flood maps.

4.3.1 River and Creek

General patterns of flood behaviour that can be observed from the Caboolture River TUFLOW design event modelling include:

- Up to the 1% AEP event, the flood water is generally contained within the creeks in the upper reaches of the model (until around Morayfield Road).A few break outs occur on sharp bends although they are limited to rural areas.
- An exception to this is the King Johns and Lagoon Creeks which appear to break out in the 5% AEP event throughout its catchment.
- Another area where the flow isn't contained within defined flow paths is around the Caboolture Hospital where it is mainly overland flow, but becomes contained within the channel downstream of Mewett Street
- Overbank flow occurs around the floodplain area of the Caboolture River around and downstream of Morayfield Road. Flood water is held back for all of the river, creek and drainage flowpaths as they cross Morayfield Road.
- Downstream of the Bruce Highway, where many of the creeks and drainage flowpaths converge with the Caboolture River, the area becomes a single large floodplain which becomes constricted towards the downstream boundary.

A maximum grid was derived using the envelope of all critical storms (section 3.2.1) for each event and all the TUFLOW outputs listed in Section 4.3 above. Results for the 5%, 1% and 0.1% AEP events are available on Council's website (www.moretonbay.qld.gov.au/floodcheck) as PDF suburb maps or in the Flood Explorer interactive mapping tool.

4.3.2 Storm Tide

Table 4-1 discusses the general patterns of flood behaviour that can be observed from the CAB TUFLOW storm tide modelling.

Table 4-1 Storm Tide Flood Behaviour Descriptions

Event	Flood Behaviour
1% AEP	Beachmere Road acts like a levee and blocks the storm tide flood inundation extent: although it does get over topped, it limits flooding to the north of Beachmere Road. In Beachmere flooding of properties occur near the Moreton Bay shore line, i.e. on Biggs, Second and Coronation Avenue, Huntley, Kunde, Short, Main and Trevor Streets. Flooding of properties also in Beachmere but via the Caboolture River occur on Malcolm, Fiona, Whiting, Gillian, Patrick and Bryant Streets, Saint Smith and Bakers Field Roads and Timothy Esplanade. Flooding of properties to the north, north-east of the Caboolture River from Moreton Bay, along Philip, Grace, Price, Sandy, Falcon, Oak, Acorn and May Streets, Bishop and Ballay Roads, Campbell Parade, Louise and Bayside Drive and the Esplanade. Uhlmann Road water treatment plant experiences flooding.
5% AEP	The flood extent is reduced compared to the 1% AEP storm tide event. Beachmere Road has only small sections over topped, and the flood extent to the

Event	Flood Behaviour
	north is significantly reduced (compared to the 1% AEP storm tide event). No flooding to properties on Patrick, Fiona, Bryant and Short streets. No flooding to properties on Campbell Parade and Bellay Road.
0.1% AEP	The flood extent is increased compared to the 1% AEP storm tide event. Additional flooding to properties on Apollo Crescent, Solo, Intrepid, Coffey and Siska Courts, Gretel and Moatah Drives, James Road, Dorunda and Egan Avenues in Beachmere. Additional flooding to properties on Christen and Payne Drive, Mynott Road, Rodgers Street, Blaney Street and Riversleigh Road also in Beachmere.
0.01% AEP	The flood extent is increased compared to the 0.1% AEP storm tide event. Additional flooding to properties on Lalroy, Amies, Elizabeth and Rose Streets, Moreton Terrace, Karora Road and Marray Court in Beachmere.
Future 1% AEP	Flooding extent is further increased compared to the 0.01% AEP storm tide event. Additional flooding to properties on Gibson, Georgina and Sandpiper Street, Bestmann, Prichard Wallace Roads in Beachmere.

4.4 Sensitivity Analysis Results

The 1% AEP MDS (defined in Section 3.2.2) was used as a base case for the sensitivity analyses. The following sections provide a discussion of the impacts as a result of the sensitivity analyses. Maps of the impacts have not been provided as the focus of this project is on digital data, rather than the provision of flood maps.

4.4.1 Hydraulic Roughness Analysis

Increasing the roughness by 20% resulted in an increase of peak flood levels between ±0.1m throughout most of the catchment. There are some areas with greater flood level differences, as follows:

- The upper reaches of the Caboolture River upstream of Dobson Lane, Caboolture which showed the following increases to approximately:
  - 0.1m near Dobson Lane, Upper Caboolture
  - 0.2m by Litnerland Road, Rocksberg,
  - 0.3m by Hampton Road, Rocksberg,
  - 0.4m by Old North Road.
  - Upstream of Best Road, Rocksberg flood level increases fluctuate between 0.1m and 0.35m for the remainder of the modelled reach.
- The upper reaches of Wararba Creek from Richards Court through to Old North Road, Wamuran produced increases between 0.1 and 0.2m. From Forestcreek Place, Wamuran through to Campbell Pocket Road, Wamuran there were increases up to 0.12m. North of Campbells Pocket Road, Wararba Creek showed increases of between 0.1m and 0.38m.
- A farm dam west of Williams Road, Wamuran produce increases of up to 0.33m

- The lower reach of King John Creek near Beachmere Road showed decreases in peak flood levels by up to approximately 0.25m.

4.4.2 Structure Blockage Analysis

Blocking of the culverts on a catchment wide scale has impacts of between ±0.1m. There are localised impacts greater than 0.1m surrounding the following culverts with the upstream side of the culvert showing an increased peak flood level and the downstream a reduced peak flood level:

- Sumsion Road, Wamuran, increased upstream peak flood levels by up to 2.37m extending up to Rucker Road, with downstream peak flood levels reduced by up to 0.55m.
- Old North Road, Wamuran, increased upstream peak flood levels by up to 0.4m, with downstream peak flood levels reduced by up to 0.13m.
- Caboolture River Road, Moorina, produced increased peak flood levels of up to 0.2m with less than 0.1m change downstream.
- Caboolture River Road, Upper Caboolture, resulted in an increased peak flood level of up to 0.9m with less than 0.1m change downstream.
- Petersen Road, Upper Caboolture, produced an increased peak flood level of up to 0.42m extending to about Mc Loughlin Road with less than 0.1m change downstream.
- Nairn Road, Morayfield, has three locations, with culverts and increased flood levels; the largest increase in peak flood level is up to 0.42m with an increase of up to 0.15m downstream.
- Lindsay Road, Morayfield, produced an increased peak flood level of up to 0.82m with an increase of up to 0.25m downstream. This increase, downstream of the culverts, may be due to additional culverts immediately downstream for the railway line and Morayfield Road. Downstream of Morayfield Road there was a 0.21m decrease in peak flood levels.
- Buchanans Road, Morayfield, showed an increased peak flood level of up to 0.35m with less than 0.1m change downstream.
- Just south of Morayfield train station peak flood levels increased by up to 1.65m with less than 0.1m change downstream.
- North of Lower King Street along the channel system (and to the east of Caboolture Hospital) showed an increase on up to 1.2m with less than 0.1m change downstream.
- Pettigrew Street, Caboolture, produced an increased peak flood level of up to 0.58m with less than 0.1m change downstream.
- The drainage channel along Bruce Highway (near the D'Aguilar Highway intersection) showed increased peak flood levels of up to 0.9m with a decrease downstream up to 1.45m near Aerodrome Road.
- Pumicestone Road, Caboolture near Cottrill Road showed increased peak flood levels up to 0.35m with less than 0.1m change downstream.

4.4.3 Climate Change and Downstream Boundary Conditions

R03 – Increase in rainfall intensity of 20%

Increasing the intensity of the rainfall by 20% had the effect of increasing peak flood levels for the majority of the catchment with only the lower reaches (mainly east of the Bruce Highway in Beachmere and Ningi) and a few minor tributaries not recording increased peak flood levels. Areas that showed significant peak flood level increases include:

- The Caboolture River and Sheep Station Creek between the Bruce Highway and Morayfield Road showed increases of up to 0.46m with the majority of that portion of the river producing a peak flood level increase of approximately 0.35m.
- The Caboolture River upstream of Dobson Lane through to Best Road showed increases between 0.4m to 0.68m. Upstream of Best Road the levels were increased between 0.1m to 0.35m.
- Sheep Station Creek upstream of Morayfield Road produce increased peak flood levels of between 0.1m to 0.25m.
- Wararba Creek from its confluence with the Caboolture Rive through to the Caboolture Golf Club showed increased peak flood levels between 0.25m and 0.38m. From the Caboolture Golf Club through to Old North Road the peak flood levels were increased by between 0.35m and 0.5m. North of Old North Road the increased peak flood levels were between 0.2 m and 0.4m with the majority below 0.35m.
- Lagoon Creek showed increased peak flood levels of mostly between 0.1m to 0.3m, with most farm dams producing peak flood level increases of approximately 0.5m and one farm dam‘s peak flood level increased by 1.2m.
- King Johns Creek showed local increases of only up to 0.2m on the upstream side of the Bruce Highway for approximately 2km and Bribie Island Road for approximately 1.5km.

R04 - Increased downstream boundary of 0.8m due to predicted sea level rise

The majority of the catchment was unaffected by increasing the downstream boundary by 0.8m to simulate the predicted sea level rise. As expected, peak flood levels increase:

- By up to 0.8m near the downstream boundary,
- Up to 0.1m in the Caboolture River downstream of the Bruce Highway.
- In Beachmere and the area along the downstream boundary with increased flood levels ranging from 0.1 to 0.8m.

R05 - Increase in rainfall intensity and 0.8m increase in downstream boundary

A 20% increase in rainfall combined with a predicted sea level rise of 0.8m showed a corresponding increase in peak flood levels near the downstream boundary of 0.8m and extending into the catchment and upstream of the Bruce Highway. The majority of the upper catchment creeks and river showed increased peak flood levels of 0.2m to 0.4m. Areas where the increased flood levels was greater than 0.4m included the following:

- Sheep Station Creek between Morayfield Road and the Bruce Highway showed an increase of up to 0.58m.
- Caboolture River from the Bruce Highway through to McNamara Road, Rocksberg showed increased peak flood levels of between 0.55m and 1.14m with the peak increases at old North Road, Rocksberg (1.05m), between Eliason Road and Dobson Lane (1.06m) and Belleden Drive (1.14m).
- Wararba Creek showed increased peak flood levels of between 0.6 and 0.95m from its confluence with the Caboolture River upstream to Campbells Pocket Road.
- The tributary of Wararba Creek that enters north of Campbells Pocket Road showed increased peak flood levels of between 0.45m and 0.65m.
- Lagoon Creek between Beerburrum Road and the Bruce Highway showed increased peak flood levels between 0.5m and 0.65m, increased by up to 0.6m at Childs Road and increased by up to 0.55m at the D'Aguilar Highway.

R06 – 1% AEP current static storm tide with a current 1% AEP MDS rainfall event

Applying the 1% storm tide to the downstream boundary of the model with the 1% AEP MDS rainfall event had no impacts greater than ±0.1m upstream of the railway line for the Caboolture River and Sheep Station Creek and upstream of Bribie Island Road for King Johns Creek. Areas where peak flood levels are increased by more than 0.1m include:

- Beachmere and along the coast (downstream boundary) produce increased peak flood levels up to 1.68m higher than the 1% AEP MDS based model peak flood levels. The afflux decreased as the ground levels increased above the storm tide peak level.

R07- Increase in rainfall intensity (20%) combined with a static storm tide level (1% AEP GHG) + 0.8m sea level rise

This scenario investigates the impact of a 20% increase in rainfall intensity and an increased sea level (0.8m) when used together with a future static storm tide, compared to the 1% AEP MDS.

Results indicate that a large portion of the catchment is affected by increased flood levels, with peak flood level increases up to 2.8m at the downstream boundaries of the catchment. The following locations indicate peak flood level changes greater than ±0.1m:

- The influence of the increased downstream boundary extended throughout Beachmere with most of the areas experiencing increased peak flood levels in excess of 1.0m.
- The Caboolture River and Sheep Station Creek resulted in elevated peak flood levels due to the downstream boundary through to the Railway line.
- King Johns Creek has increased peak flood levels due to the downstream boundary upstream to approximately McNaught Road and Old Toorbul Point Road.
- Upstream of Morayfield Road for the Caboolture River and Sheep Station Creek and the Bruce Highway for Lagoon and King Johns Creeks peak flood level increase of between 0.1m to 0.25m.

4.4.4 Future Landuse Analysis

R08 – Increased vegetation in floodplain

Increasing the vegetation in floodplains typically changes level throughout the catchment by ±0.1m. Areas where peak flood levels are greater than ±0.1m include:

- Caboolture River produce increased peak flood levels of between 0.1m and 0.5m upstream of Belleden Drive through to Rocksberg. Further upstream there are pockets with peak flood level increases between 0.1m and 0.75m.
- Wararba Creek upstream of Campbells Pocket Road resulted in increased peak flood levels between 0.1m to 0.8m for its tributary that runs along Campbells Pocket Road to approximately Glenarba Court.
- Wararba Creek from approximately Williams Road and upstream resulted in impacts between 0.1m and 0.45m along the main channel with some of the tributaries resulting in peak differences up to 0.75m.
- Lagoon Creek showed some minor increased peak flood levels of between 0.1m and 0.2m including a small area just upstream of Brucknell Road.
- Sheep Station Creek had increased peak flood levels between 0.1m and 0.2m between Walkers Road and Buchanans Road.

R09 – Increased residential development

Increasing the residential development within the catchment typically results in impacts between ±0.1m. There are some localised increases in levels throughout the catchment with most increases less than 0.2m; the exceptions include:

- A tributary of the Caboolture River just downstream of Litnerland Road, Rocksberg has peak flood levels up to approximately 1.1m higher than the existing MDS 1% event peak flood levels.
- A tributary of Wararba Creek upstream of Alexandra Parade, Wamuran showed peak flood levels increased by between 0.1m to 1.4m with the levels increased by over 1m in the very top of the tributary.
- Lagoon Creek and one of its tributaries upstream of Ziviani Road resulted in peak flood level increases ranging from 0.1m to 0.65m.

R10 – Increased vegetation in the floodplain and increased residential development

Combining R08 and R09 produces very similar results to R08. The following areas have greater increases in peak flood levels than R08:

- A tributary of the Caboolture River just downstream of Litnerland Road, Rocksberg resulted in peak flood levels up to 1.1m higher than the existing MDS 1% event peak flood levels.
- Lagoon Creek and one of its tributaries upstream of Ziviani Road produced peak flood level increases ranging from 0.1m to 0.67m.

- A tributary of Wararba Creek upstream of Alexandra Parade, Wamuran resulted in peak flood level increases between 0.1m to 1.45m with the levels increased by over 1m in the very top of the tributary.
- A tributary of Sheep Station Creek up stream of Petersen Road has increased peak flood levels between 0.1m to 0.3m.
- A tributary of Sheep Station Creek up stream of Buchanans Road has peak flood levels that are increased by between 0.1m to 0.4m.
- Other minor tributaries in their upper reaches with peak flood level increases between 0.1m to 0.3m.

There were a few areas in this scenario resulted in reduced peak flood levels when compared to the existing 1% MDS storm. The reduced peak flood levels may be due to changes in the timing of flow hydrographs. The areas include:

- Wararba Creek downstream of Old North Road through to Greenfield Drive with peak flood levels reduced by up to 0.25m.
- Wararba Creek from Swann Road through to the confluence with the Caboolture River resulted in peak flood levels reduced by approximately 0.15m.
- Some farm dams off Lagoon Creek has reduced peak flood levels by 0.37m and 0.47m.

4.5 Model Limitations and Quality

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

4.6 Model Specification and Run Times

The CAB River TUFLOW model has large model run times and a high demand on memory (RAM). Details for various design events, the validation event and the 1% AEP MDS are shown in Table 4-2. The 12 hour storm duration was chosen, as it is the longest critical duration storm modelled. It should be noted that the model run time is partially dependent upon the machine’s specifications and the other demands on the machine’s CPU’s (e.g. other models running simultaneously).

Table 4-2 Model Specification and Run Time Summary

Event	Model Grid Size	Approximate Model Run Time	Model RAM/Memory
5% AEP 12 hr	5m	8 days	29.8 Gb
1% AEP 12 hr	5m	12 days	29.8 Gb
0.2% AEP 12 hr	10m	2 days	2.78 Gb
0.05% AEP 12 hr	10m	2 days	2.78 Gb
1% AEP MDS	5m	10 days	11.01 Gb
January 2011	10m	12 days	5.06 Gb

5 Conclusion

As part of the Regional Floodplain Database 2014 Model Maintenance Project, Council are updating all of the existing hydrologic and hydraulic models, due to the availability of more accurate data.

As a result, the hydrologic subcatchments within the Caboolture River (CAB) catchment were reviewed and two areas were modified to reflect the updated LiDAR. The initial losses within WBNM (hydrologic modelling software) for events up to and including the 5% AEP were changed from 0mm to 15mm.

The existing 5m and 10m TUFLOW models of CAB were updated with LiDAR (elevation data collected in 2014), additional bathymetry for various locations along the Caboolture River, additional structures including trunk drainage, modified topography through Morayfield Shopping Centre, and improved representation of streams and roads.

The model was set up in a manner prescribed by Council specifically for the RFD project to ensure a consistent approach across the whole Local Government Area (LGA) and to enable the model and model outputs to be integrated into Council's RFD. Minimal flood maps have been provided within the report, as requested by Council. The model and model outputs for all events have been provided in digital format. The outcomes of this work will be included into Council's Flood Explorer, used in the automated provision of Council's flood reports provided to the community and used by Council to analyse and assist with managing flood risk in the Caboolture River catchment.

6 References

BMT WBM, 2012a, *Regional Floodplain Database Hydrologic and Hydraulic Modelling Caboolture (CAB)*

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Appendix A Storm Tide Downstream Boundary Methodology

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Memorandum

From:	Eoghain O'Hanlon	To:	Hester Van Zijl
Date:	22 September 2015	CC:	
Subject:	MBRC - FRD Maintenance Storm Tide boundaries		

1 Introduction

A deviation in the chosen modelling approach for the Dynamic Storm Tide scenarios was required due to model stability issues. The originally proposed downstream (ocean) boundary setup included a number of “HT” (water surface level (Head) vs time) boundaries at the seaward extent of the 2D model domain. This method introduced unforeseen stability issues related to ‘steps’ in the water level at the boundary, particularly where multiple HT boundaries were located in close proximity.

The change in methodology introduces spatially varying water surface levels at the downstream boundary. This is achieved through the inclusion of a 2d_bc ‘HX’ boundary linked to 1d_bc elements in place of the 2d_bc ‘HT’ boundaries. This change is expanded in more detail below.

2 Methodology

The methodology of the revised downstream boundary for modelling dynamic storm tide boundaries is as follows.

1) The models code boundary is extended offshore at least 500m where possible.

2) The existing downstream 2d_bc layer is removed and a new 2d_bc polyline is digitised along the entire downstream boundary of the model. The 2d_bc line should be of type ‘HX’.

3) A new 1d_nwk points layer is then required. This layer will have points digitised at storm tide time-series extraction locations, as shown in the figure below. These points are to be snapped to the 2d_bc HX line. Each point is to be given the following attributes:

    a. Unique ID

    b. Type set to “Node”

    c. Ignore set to “F”

    d. UCS set to “T”

    e. Len_or_ANA set to 1000

    f. n_or_n_f set to 0.02

    g. US_Invert lower than the lowest elevation along the HX boundary.

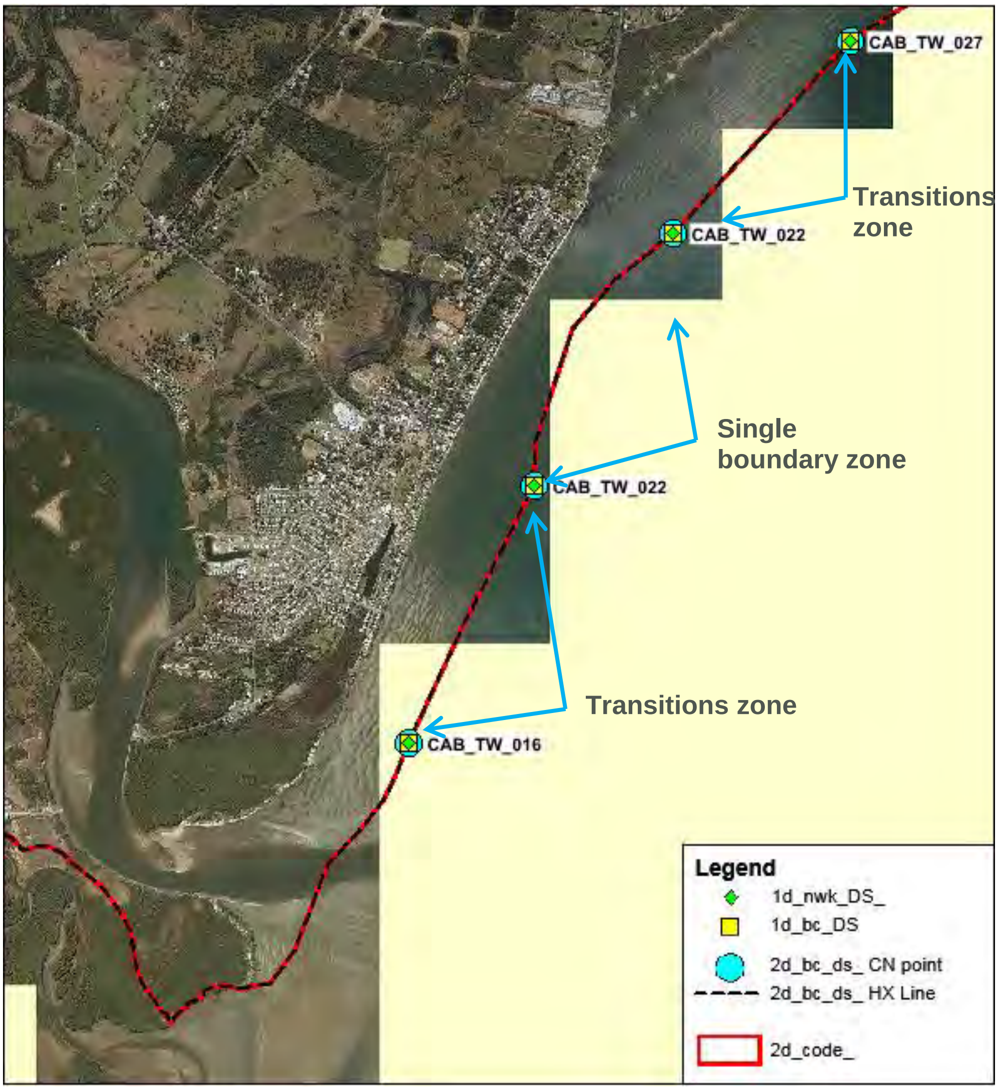
    h. DS_Invert should be set to the same value as US_Invert.

4) Using the new 2d_bc boundary layer digitise a new 2d_bc points of type ‘CN at the location of the 1d_nwk points’.

5) A 1d_bc (points) layer should be created with objects of type 'HT'. The 1d_bc points are required at the same location as the 1d_nwk nodes along the downstream boundary. The 'Name' attribute must be the storm tide boundary time-series name.

6) To apply a single water surface (i.e. not spatially varying) across a designated length of the boundary, two consecutive 1d_bc nodes are given the same 'Name' attribute. Refer to nodes CAB_TW_022 in the figure below.

7) If the DEM does not extend to the extent of the new code, it is recommended that a 2d_zsh polygon be applied to transition between the DEM and the downstream boundary.



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