Regional Floodplain Database:

2014 Model Maintenance Report - Upper Pine River (UPR)

Moreton Bay Regional Council

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Regional Floodplain Database 2014 Model Maintenance Report

Upper Pine River (UPR) **June 2015**

Moreton Bay Regional Council

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Regional Floodplain Database 2014 Model Maintenance Report – Upper Pine River (UPR)

Prepared for:	Moreton Bay Regional Council
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Synopsis: This report summarises the maintenance of the Upper Pine River catchment model, undertaken in 2014 / 2015, as part of the Regional Floodplain Database for Moreton Bay Regional Council.

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Contents

List of Figures

List of Tables

1 Introduction

Worley Parsons has developed the Upper Pine River (UPR) hydrologic and hydraulic models as part of the Stage 2, Regional Floodplain Database Project (RFD) (Worley Parsons, 2012).

Since this time, 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 UPR 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 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 catchment boundaries of the existing UPR hydrologic model were reviewed against the 2014 LiDAR and the subcatchments were adjusted in three (3) locations:

- TER_10_02348 was split into three minor catchments;
- NPR_56_00000 was split into four minor catchments; and
- KOB_24_00430 was split into two minor catchments.

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.

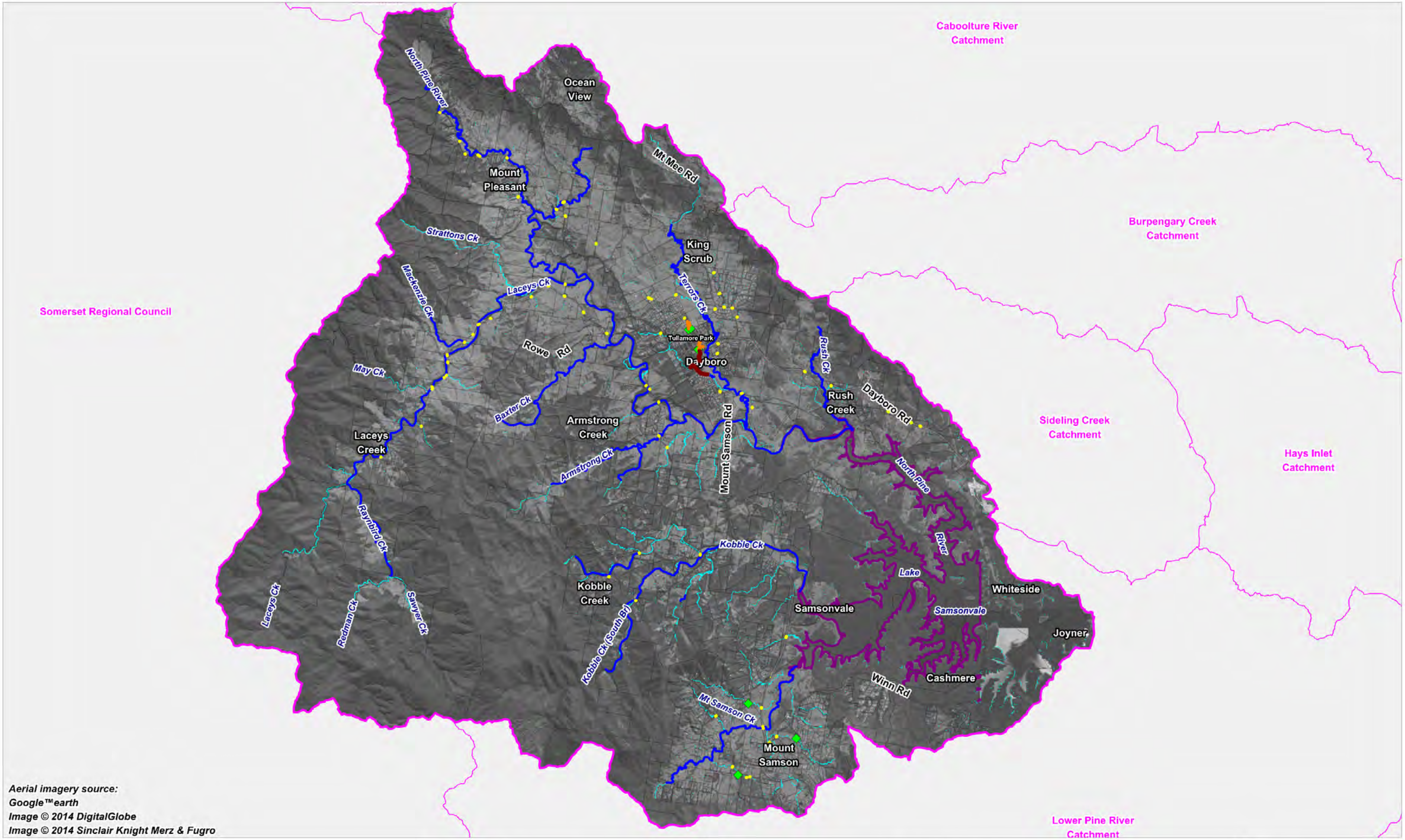
2.2 TUFLOW Model

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

- Minor modification to the code boundaries of the southern two catchments;
- 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; and
    - Elevations of Lake Samsonvale.
- Inclusion of additional culverts:
    - Previous culverts under Williams Street, in Dayboro have been upgraded to 5 x 2.4m x 1.5m box culverts;
    - Two banks of culverts along access road to Tullamore Park, Dayboro – two banks of 1 x ϕ1.2m pipes;
    - Assumed box culvert (2.1m x 0.9m) under Foggs Road, to the west of Greenmount Court, near Mount Samson; and
    - 3 x 2.1m x 2.1m box culverts under Andrew Road.
- Inclusion of trunk drainage:
    - To the west of the eastern oval within Tullamore Park, Dayboro;
    - Along Millbrook Street, Dayboro; and
    - Along Williams and Heathwood Streets, Dayboro.
- Other structures:
    - Inclusion of drain along Heathwood Street in Dayboro.

- Change in methodology of the application of hydrological flows. Where a subcatchment contains trunk drainage, the inflow (SA polygon) was 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 of 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”).
- 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 elevations of key roads crossing waterways within the modelled area.
- The downstream setup for the Lake Samsonvale has been refined as numerous instabilities were detected in the 2012 version.
- Plot output (PO) lines updated to include all locations of interest and to ensure all are located perpendicular to the general flow direction.

It should be noted that SEQ Water may temporarily lower the operational level within Lake Samsonvale. As this is a temporary measure, Council has made the decision to continue using the existing rating curve for this dam.



LEGEND

- Upper Pine River Catchment Boundary
- Cadastral Boundaries

Additional Features

- Drain
- Roads
- Streamlines
- Updated Materials
- Trunk Drainage
- Culverts
- Lake Samsonvale Elevations

Title:

Upper Pine River Model Maintenance Features

Figure: 2-1

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3 Model Simulations

3.1 Verification

The Upper Pine River hydraulic model has previously been calibrated for the January 2011 event and validated against the May 2009 event (Worley Parsons, 2012). 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 only. Council have stipulated that the January 2011 event will be used for validation for the UPR 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 Upper Pine 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; and

(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.

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, 3 and 24 hour storm	1EY, 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	2, 3 and 6 hour storm	0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.001% 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 for the 1% and 0.1% AEP events.

For the 1% AEP, it can be seen that the following durations have the widest area of influence:

- The 24 hour duration is critical along Laceys Creek and along North Pine River until upstream of Rush Creek. This is due to an artefact of the 24 hour storm, which is very similar to the 6 hour storm, being double peaked and having the 6 hour storm embedded into the 24 hour storm. The 24 hour storm was selected as one of the critical durations, as it produces highest flood levels in parts of the catchment.
- The 6 hour duration is critical along the North Pine River from around Rush Creek.
- The 2 hour duration is critical in the upper reaches of most of the creek systems.
- The 3 hour duration is critical upstream of most of the creek junctions.

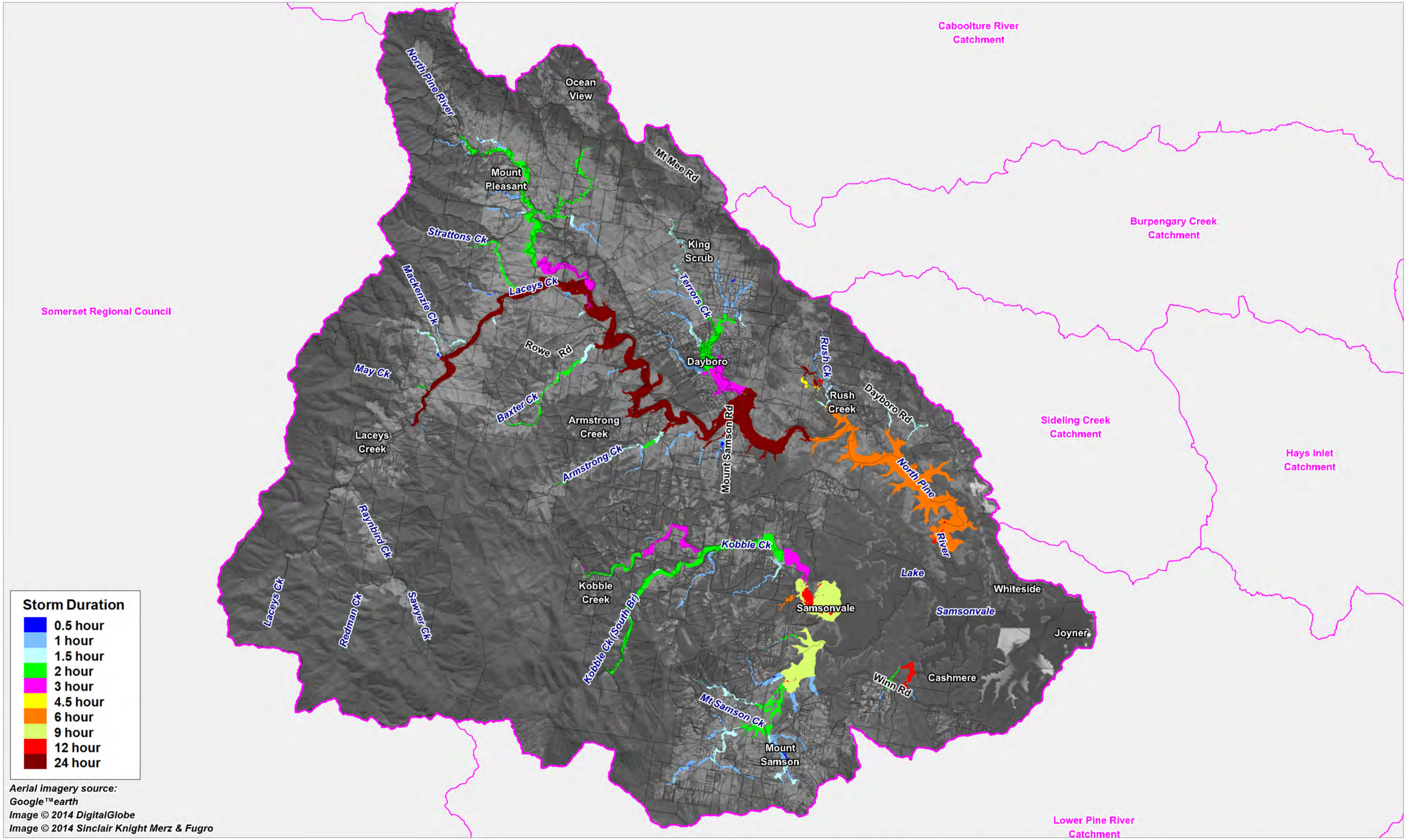
For the 0.1% AEP, it can be seen that the following durations have the widest area of influence:

- The 2 hour duration is critical in the upper reaches of most of the creek systems.
- The 3 hour duration is critical in the upper reaches of Laceys Creek, along most of Kobble Creek, and the section of North Pine River between Laceys Creek and Baxter Creek.
- The 6 hour duration is critical along North Pine River between Terrors Creek and downstream of Rush Creek.
- The 9 hour duration is critical along the North Pine River downstream of Rush Creek and upstream of Lake Samsonvale along Kobble Creek and Mount Samson 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. These figures illustrate that the selected critical durations (listed in Table 3-1) generally capture the peak flood levels across the catchment area (within ±0.01m).

For the 1% AEP, there are areas where flood levels are under predicted by up to 0.05m, noticeably along the North Pine River, downstream of Rush Creek and along Kobble Creek and Mount Samson Creek upstream of Lake Samsonvale. There are localised impacts of up to -0.1m scattered throughout the catchment, and a small area along a tributary upstream of Lake Samsonvale (near Samsonvale) of impacts up to -0.5m.

For the 0.1% AEP event, there are some areas where there is a decrease in flood levels between 0.01m and 0.1m, particularly along Laceys Creek and the lower reach of the North Pine River. There are also localised under prediction of flood levels of up to 0.2m in the upper reaches of the creek system.



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Upper Pine River Catchment Boundary

Cadastral Boundaries

Title:

Critical Duration Assessment - 1% AEP

Figure

3-1

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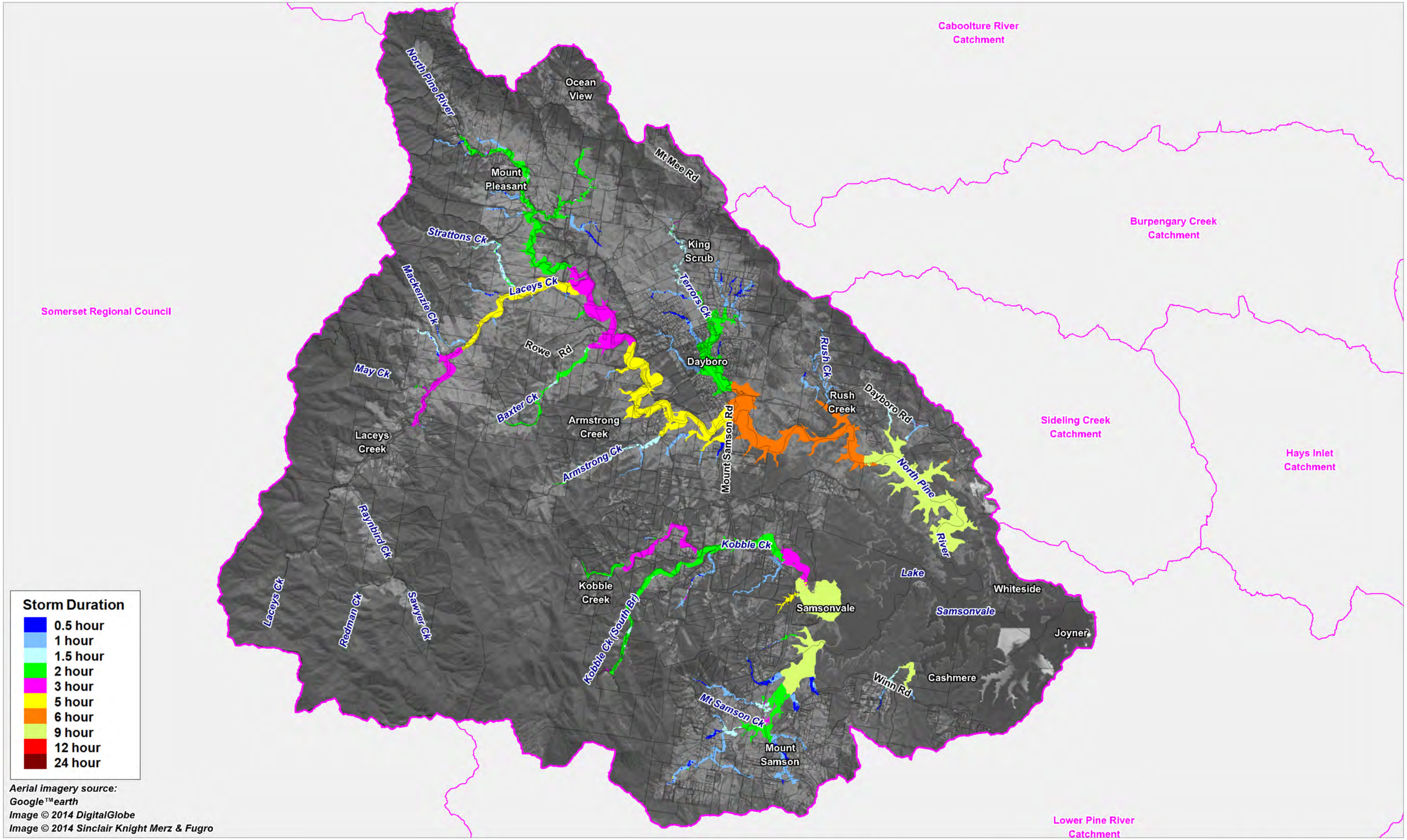

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Upper Pine River Catchment Boundary

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Title:

Critical Duration Assessment - 0.1% AEP

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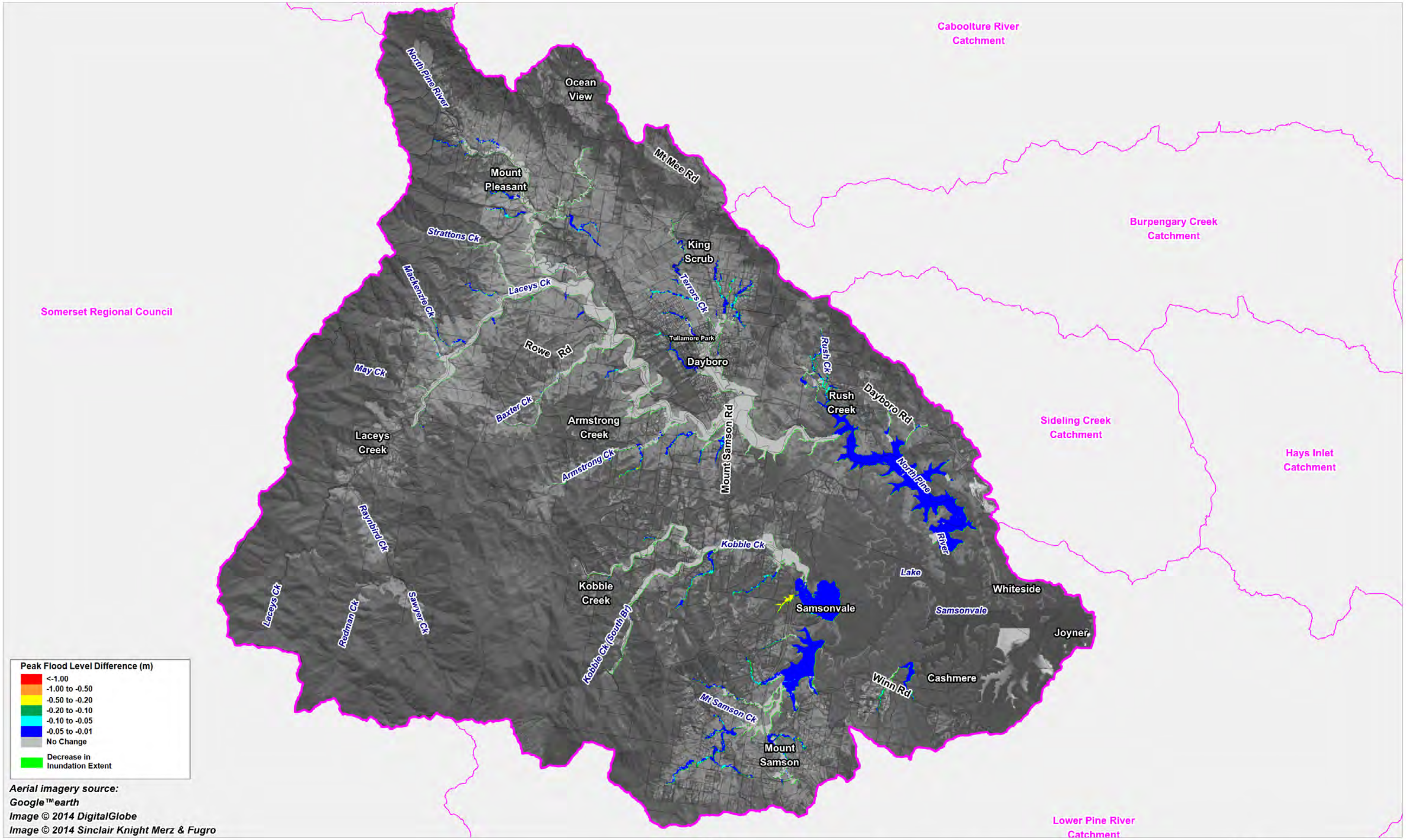

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Upper Pine River Catchment Boundary

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Title:

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

Figure 3-3

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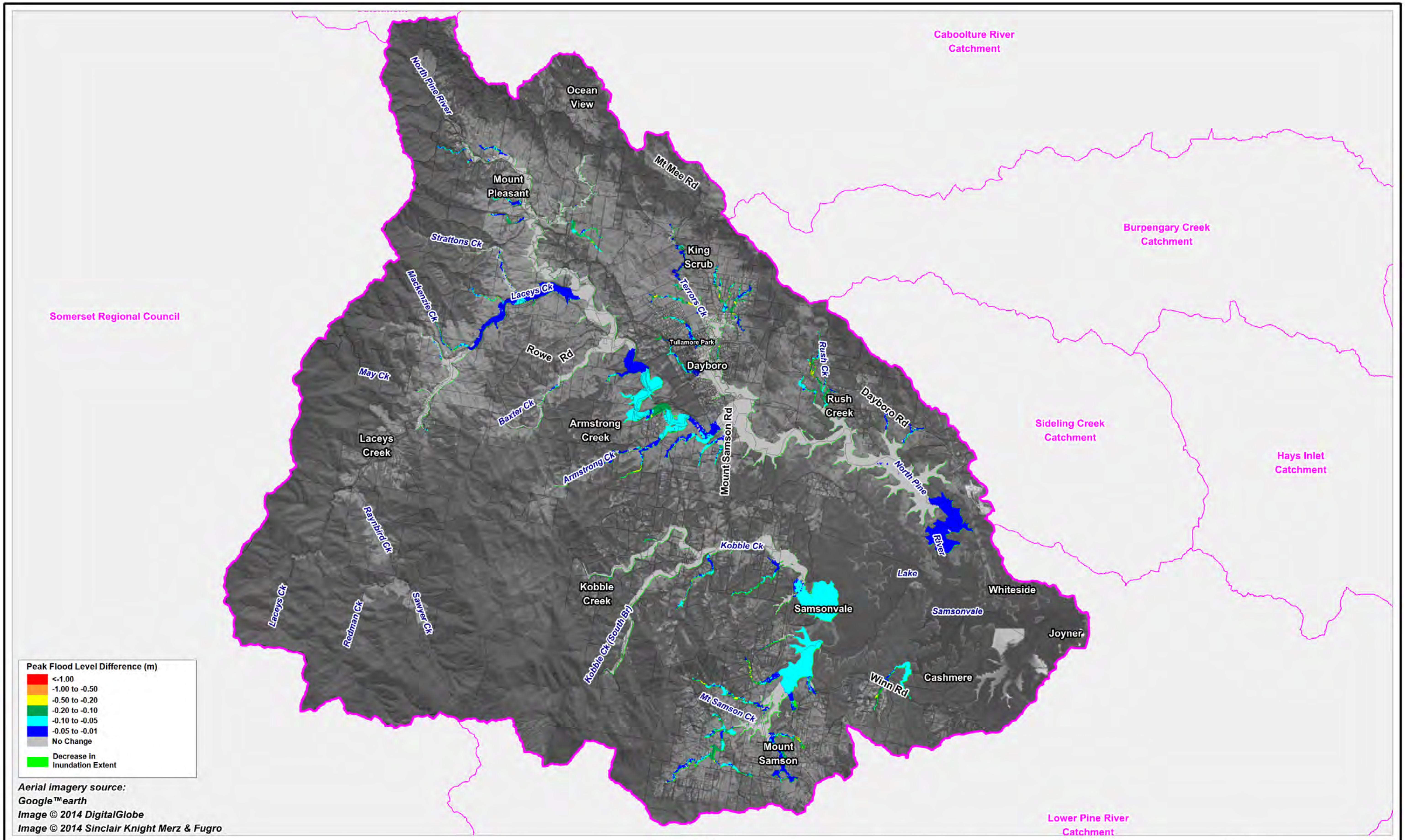

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Title:
Peak Flood Levels for critical durations minus Peak Flood Levels for all durations - 0.1% AEP

Figure **3-4** Rev: **A**

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3.2.2 River and Creek Design Event Simulations

The UPR 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).

Council advised that the 1% AEP 15 minute in 270 minute EDS was to be adopted as the MBRC Design Storm (MDS). The adopted MDS was used as the base design storm for the sensitivity analyses.

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

- The 1EY, 0.5EY, 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2%, 0.01%, 0.05%, 0.02%, 0.001% 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

Not applicable.

3.3 Sensitivity Analysis

The UPR model was simulated for six sensitivity scenarios in total. A summary of the sensitivity scenarios, the model identifier (ID), description and purpose of the four sensitivity scenarios are detailed in Table 3-2.

Table 3-2 Sensitivity Analysis Summary

ID	Description	Section
R01	Roughness	3.3.1
R02	Blockage	3.3.2
R03	Climate Change - Rainfall	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 assessment investigated the possible impact of projected increases in rainfall intensity of flooding in the catchment. A projected 20% increase in rainfall was investigated, as per *Boundary Conditions, Joint Probability and Climate Change* (SKM, 2012a).

No sensitivity testing was undertaken on the downstream boundary, as this catchment does not discharge to the ocean, therefore storm tide or sea level rise will not impact upon this catchment.

3.3.4 Future Landuse Analysis

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

- **R08:** Investigated 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:** Investigated impact of the combination 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 2012 Upper Pine River models for the 5% and 1% AEP events, respectively. Both events are based on a comparison between the 3 hour storm duration.

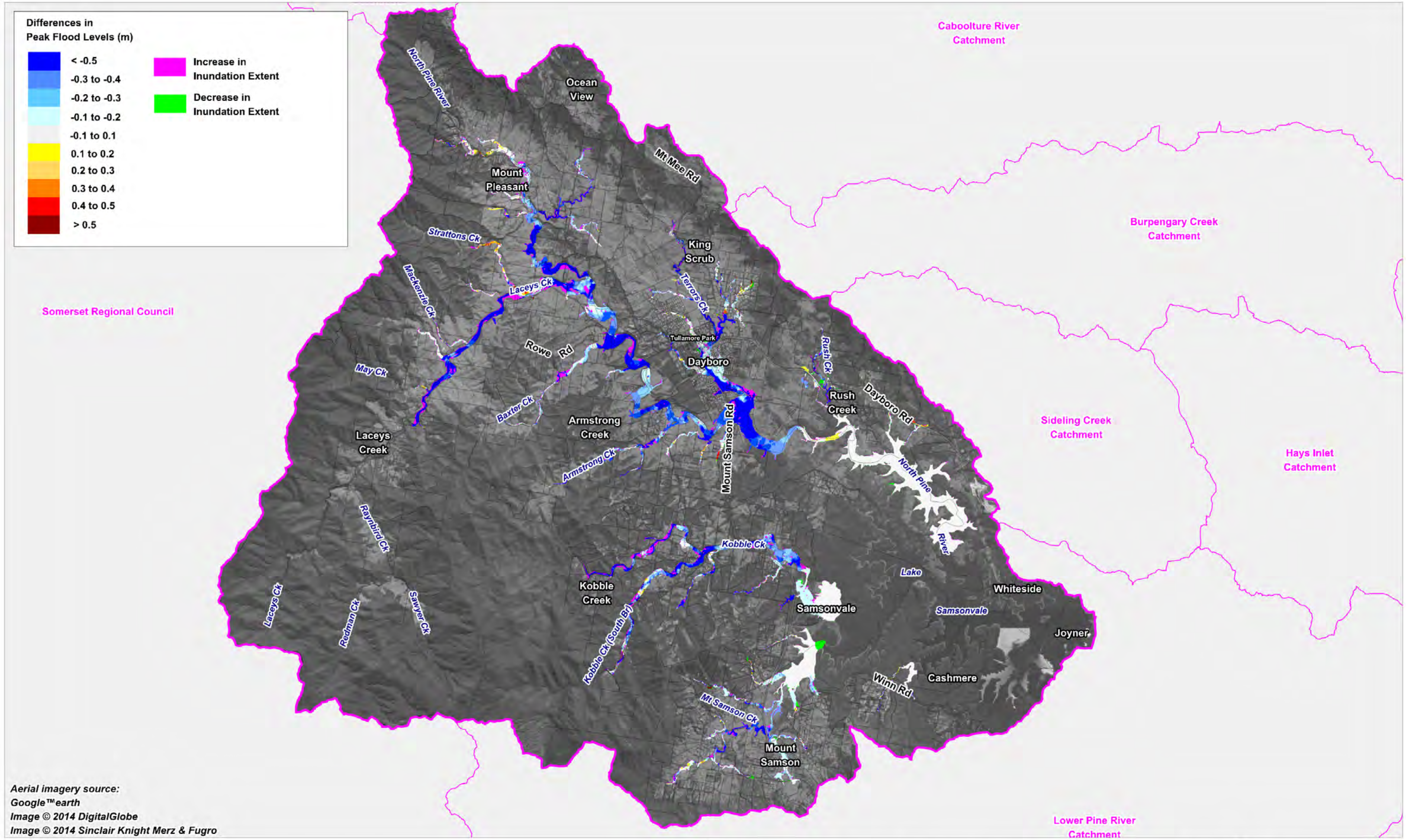
Negative values mean that the 2014 UPR model results are lower than the 2012 model results and vice versa (positive values mean that the 2014 UPR model results are higher than the 2012 model results).

Peak level differences are significant and generally in the order of 0.5m for both the 5% and the 1% AEP events. The 1% AEP event has slightly less significant differences in peak flood levels (up to -0.2m) for a large portion along North Pine River.

Peak levels in the 2014 model are generally lower than in the 2012 model in the upper parts of the model due to:

- A change in initial rainfall loss in the hydrology (5% AEP only);
- Lower elevations within creeks / streams picked up in 2014 LiDAR compared to 2009 LiDAR; and
- Breaklines along stream centrelines in the 2014 model.

In the downstream part of the model where the Lake Samsonvale is modelled in 2D, the 2014 model predicts higher peak levels than the 2012 model (around 200mm higher) for the 1% AEP event. This is because the flood wave propagates more rapidly and with a higher peak flow in the 2014 model due to wider landuse waterway corridor. Lake Samsonvale fills up more rapidly in the 2014 model resulting in higher peak flood levels, considering the representation of the dam topography is the same between the 2012 and the 2014 model.



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Upper Pine River Catchment Boundary

Cadastral Boundaries

Title:

2014 Upper Pine River Model versus 2012 Upper Pine River Model Peak Flood Level Difference - 5% AEP

Figure 4-1

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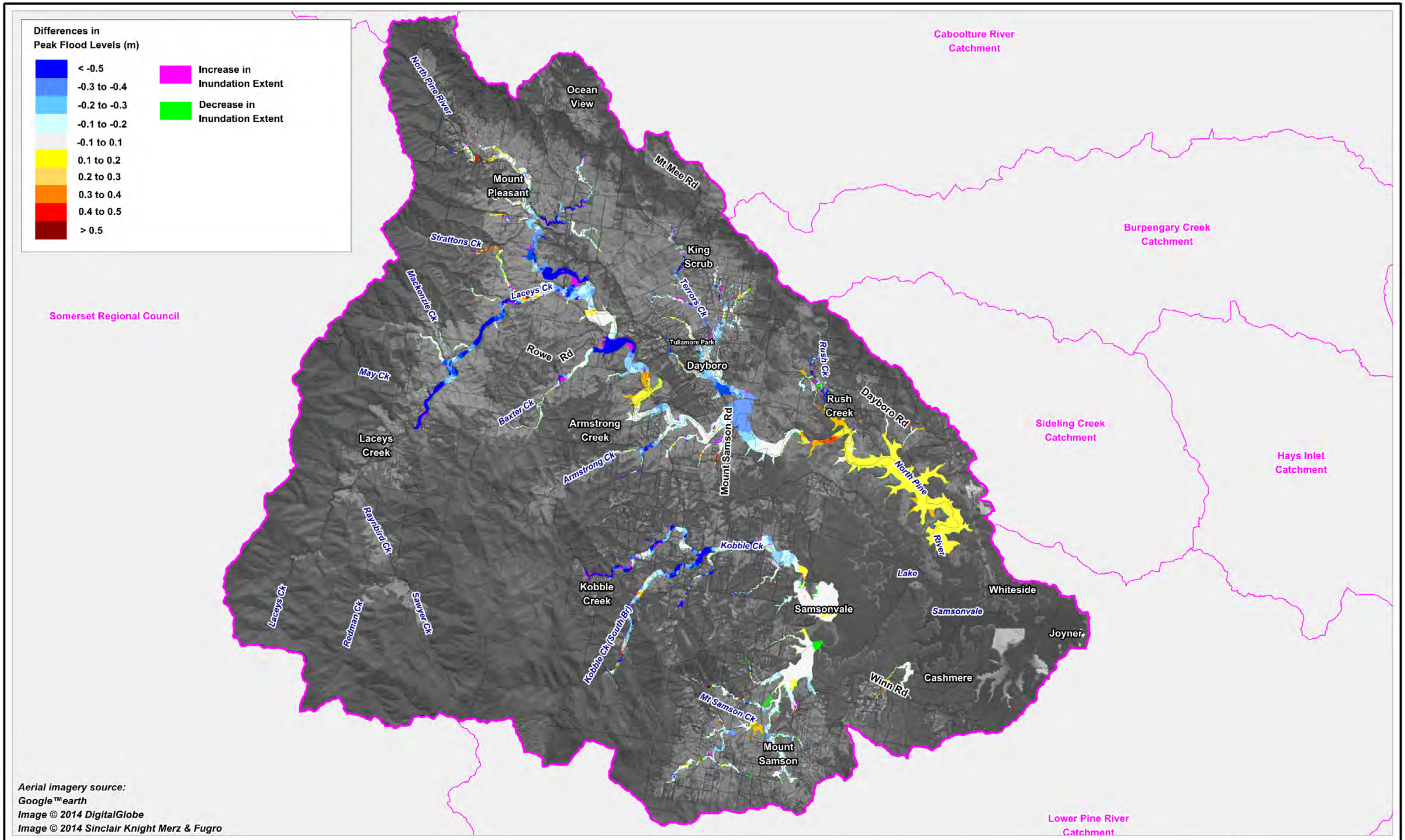

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Upper Pine River Catchment Boundary

Cadastral Boundaries

Title:
2014 Upper Pine River Model versus 2012 Upper Pine River Model Peak Flood Level Difference - 1% AEP

Figure
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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.

Figure 4-7 shows the difference in peak flood levels between the 2014 model and the 2012 model for the January 2011 event.

Typically, flood levels in the lower catchment have increased in the 2014 model:

- At the lower portions of Kobble and Mount Samson Creeks, the flood levels have increased by up to 0.3m;
- To the north of Winn Road, the flood levels have increased by up to 0.2m;
- Along North Pine River to upstream of Rush Creek, the flood levels have increased by up to 0.4m; and
- Along North Pine River between Baxter Creek and Armstrong Creek, the flood levels have increased by up to 0.3m.

In the upper reaches, the flood levels are typically lower in the 2014 model than the 2012 model:

- Decreases in levels of up to more than 0.5m along Laceys Creek, along North Pine River until the confluence with Laceys Creek and along the confluence of Baxters Creek and North Pine River;
- Decrease between 0.1m and 0.4m along Terrors Creek and along North Pine River downstream of the confluence of Terrors Creek; and
- Decreases between 0.1m and approximately 1.0m along Kobble Creek.

Hydrograph Comparison

Three river gauges recorded flood levels during the January 2011 event in the Upper Pine 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 slightly under predicts the peak flood level at North Pine Dam by only 4.5mm (100mm in the 2012 model), which is considered a very good calibration at this gauge;
- The model under predicts the peak flood level at the Baxters Creek Gauge by 0.34m (1m in the 2012 model); and
- The model under predicts the peak flood level at the Kobble Creek Gauge by 0.49m (2.5m in the 2012 model).

- The 2014 model show great improvements in peak flood levels at the Baxters Creek Gauge and the Kobble Creek Gauge, compared to the 2012 model. This improvement is likely to be due to the improved representation of the adopted hydraulic roughness parameter set and the amended breaklines along the stream centrelines.
- The under predicted flood levels at the Kobble Creek Gauge may be due to a misrepresentation of the actual rainfall due to a lack of rainfall gauges in this area.

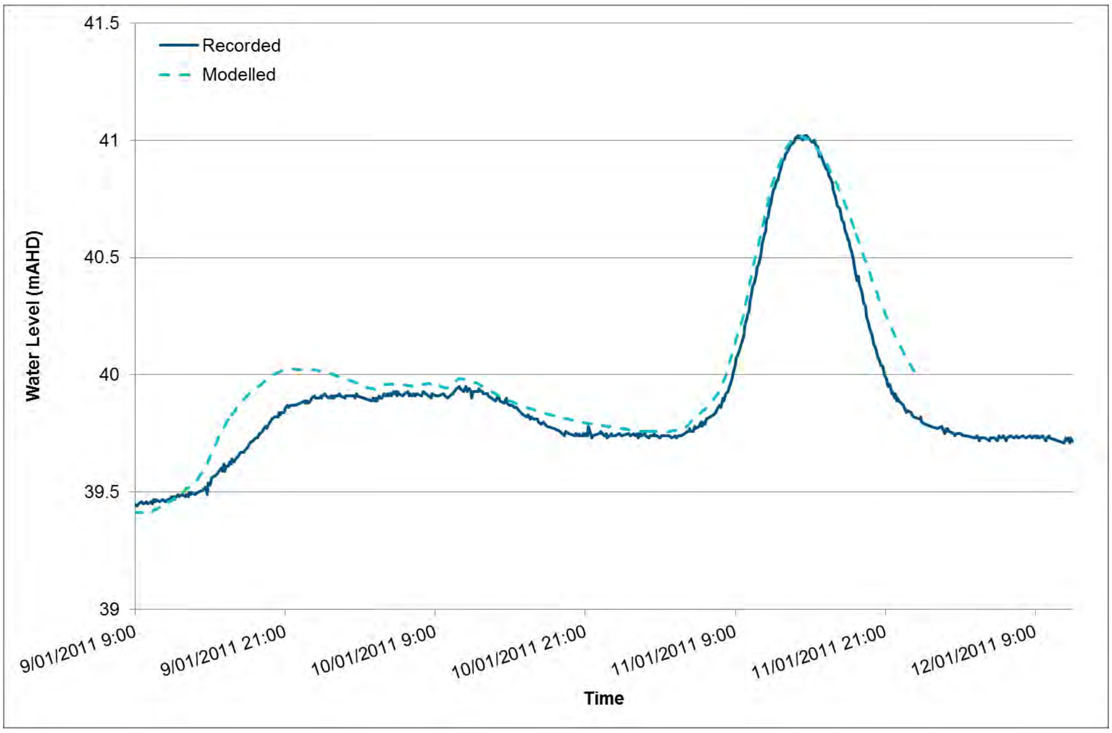


Figure 4-3 Recorded and Modelled Hydrographs at North Pine Dam - January 2011 Event

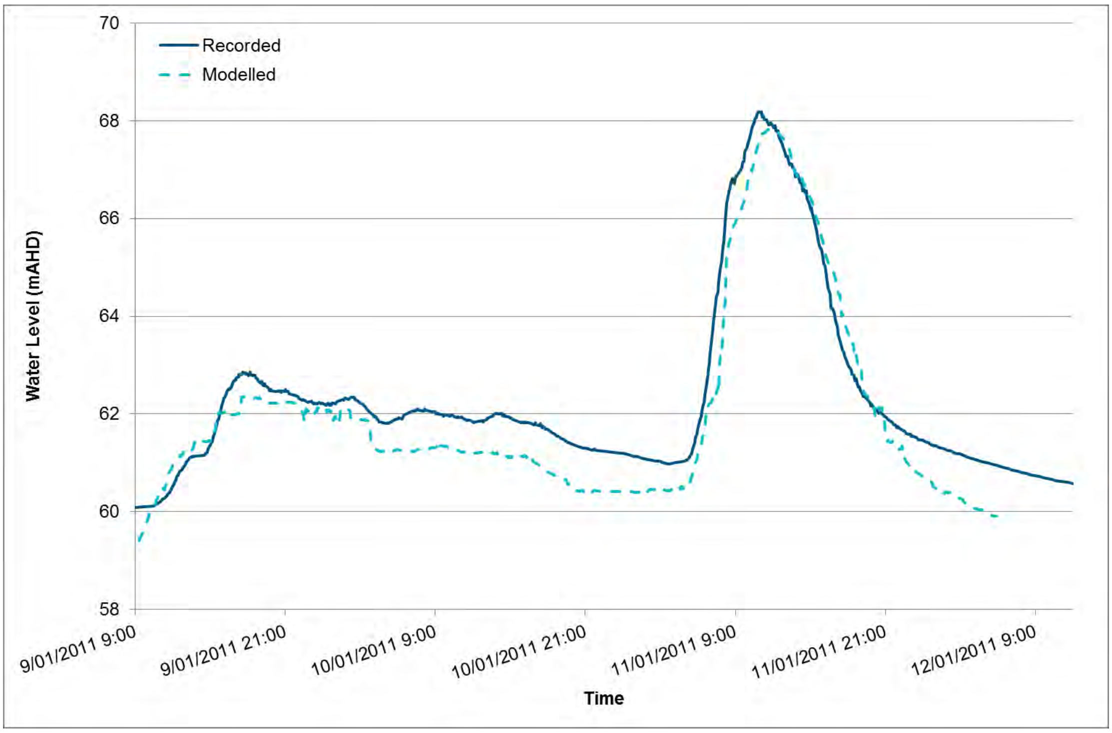


Figure 4-4 Recorded and Modelled Hydrographs at Baxters Creek Gauge – January 2011 Event

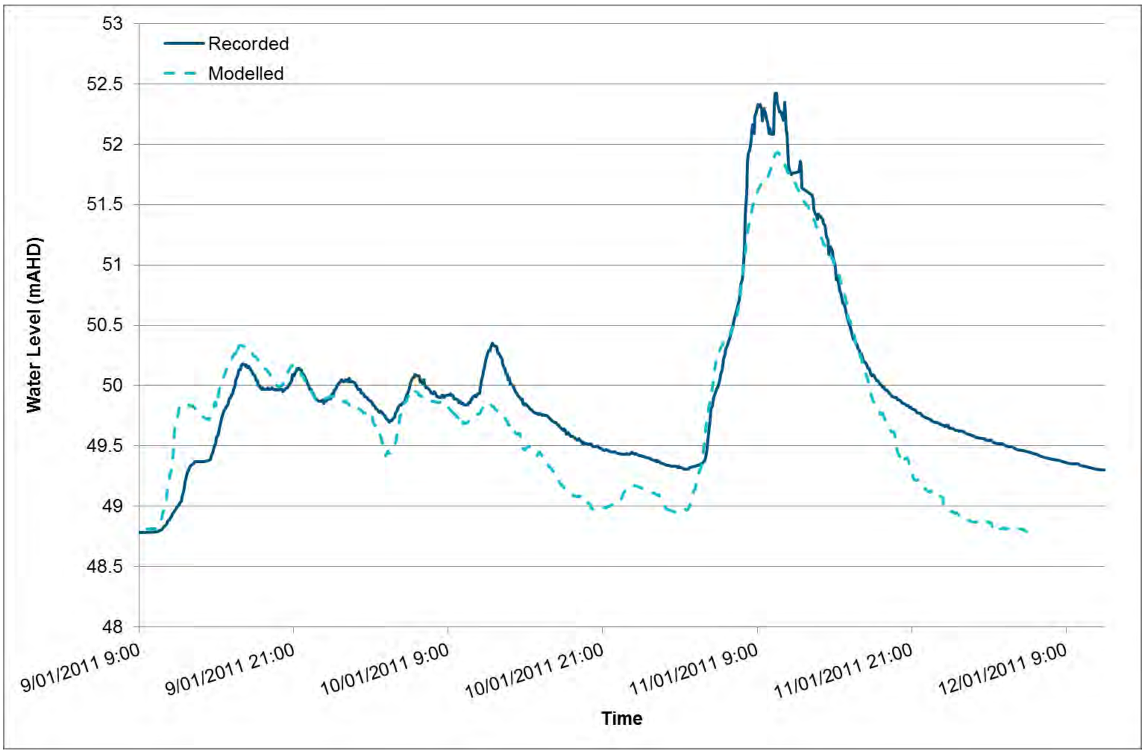


Figure 4-5 Recorded and Modelled Hydrographs at Kobble Creek Gauge - January 2011 Event

Flood Mark Comparison

Council collected 35 floodmarks for the January 2011 events in the UPR catchment, 18 of these were of high quality and the others were categorised as medium quality. Eight of these surveyed flood marks were outside of the modelled flood extent for the 2014 model (typically in the Dayboro area).

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.

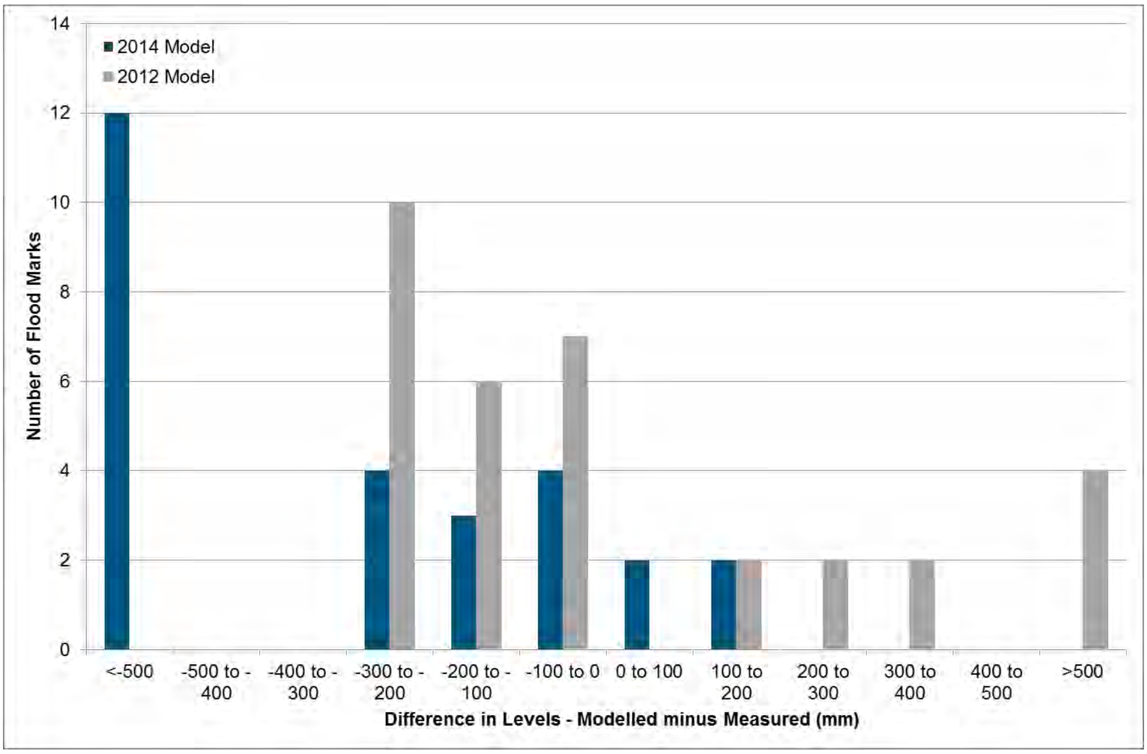
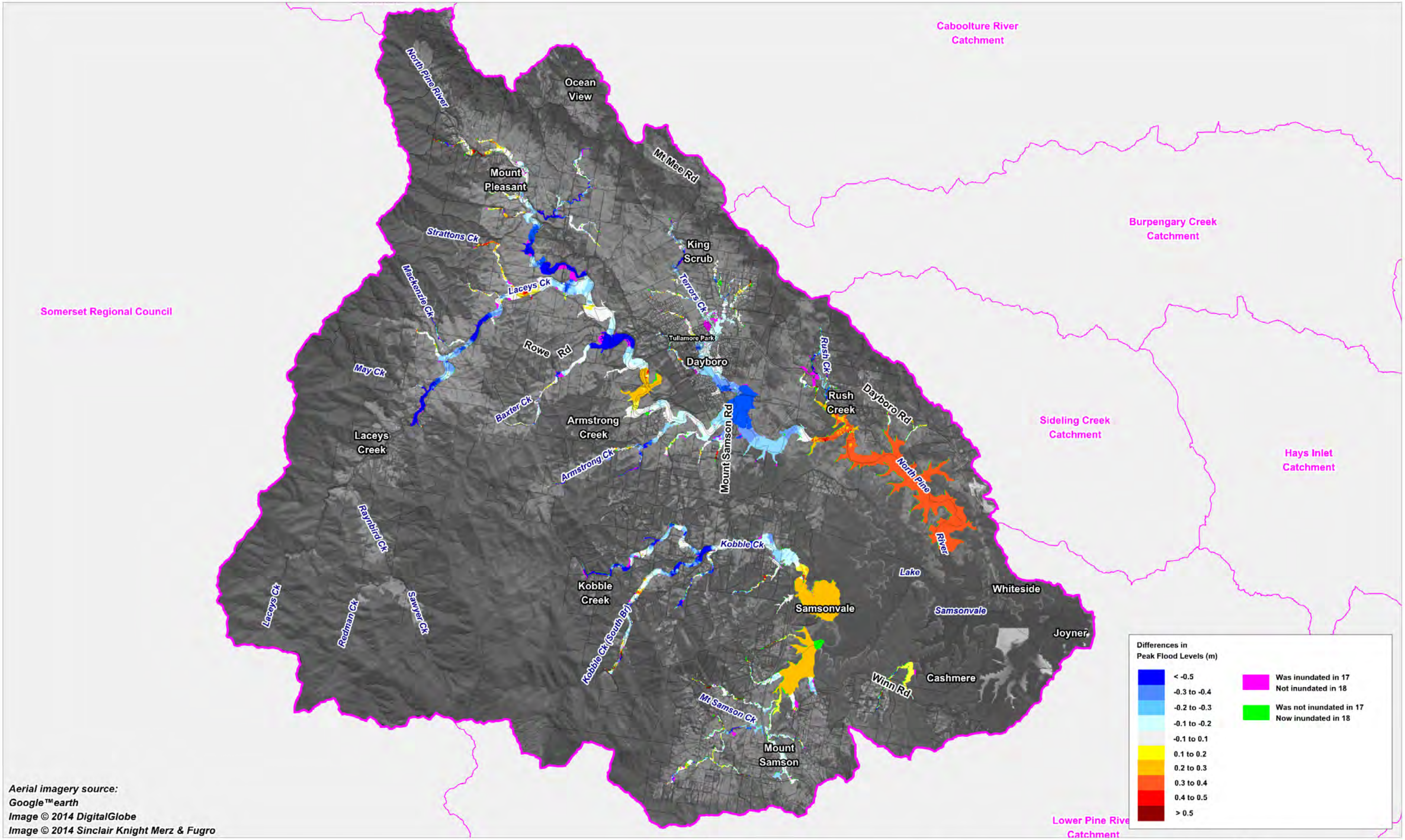


Figure 4-6 Floodmark Histogram – January 2011 Event

This histogram shows a significant portion (56%) of the flood marks are within ± 300mm, which suggests a reasonable calibration. Some flood marks differ significantly between the surveyed and the modelled level (differences greater than 500m); these flood marks are typically in the Dayboro area, and is attributed to the inclusion of the pit and pipe network.

The peak flood levels difference between the 2014 and the 2012 model for the January 2011 event is illustrated in Figure 4-7. Negative values mean that the 2014 UPR model results are lower than the 2012 model results and vice versa (positive values mean that the 2014 UPR model results are higher than the 2012 model results).



Aerial imagery source:
Google™earth
Image © 2014 DigitalGlobe
Image © 2014 Sinclair Knight Merz & Fugro

LEGEND

Upper Pine River Catchment Boundary

Cadastral Boundaries

Title:

January 2011 Event Peak Flood Level Difference
2014 Model Minus 2012 Model

Figure 4-7

Rev: A

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

N

0km 2.5 5
Approx. Scale

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www.bmtwbm.com.au

Filepath : I:\B20980_k_cmp_RFD_Maintenance\DRG\UPR\FLD_008_141111_UPR_Jan2011_Model_Comaprison.WOR

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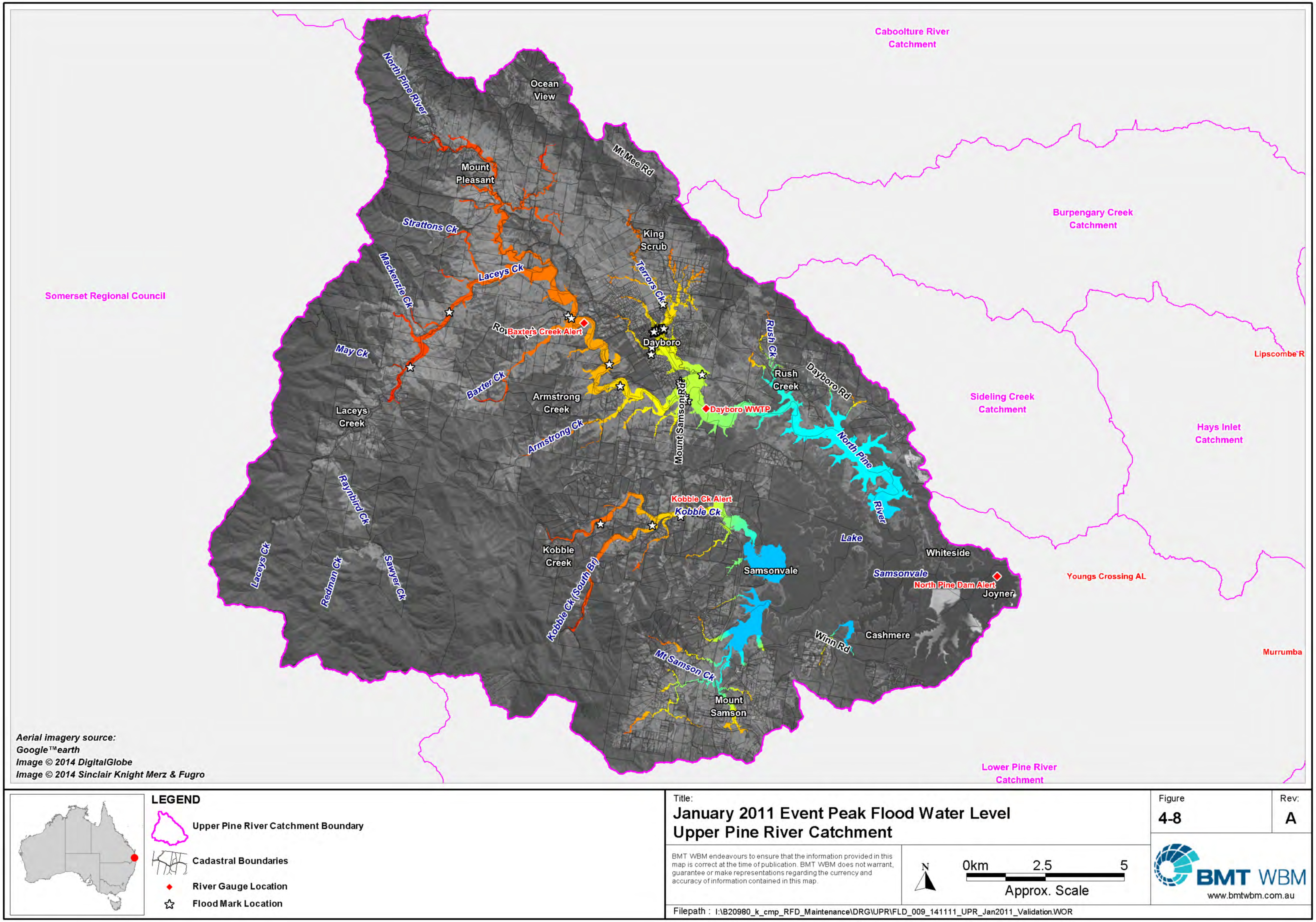

Title:
January 2011 Event Peak Flood Water Level
Upper Pine River Catchment

Figure 4-8

Rev: A

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

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www.bmtwbm.com.au

Filepath : I:\B20980_k_cmp_RFD_Maintenance\DRG\UPR\FLD_009_141111_UPR_Jan2011_Validation.WOR

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 UPR TUFLOW design event modelling include:

- North Pine River: the flood waters are fairly confined to the river until the 0.5EY AEP event:

    - In the 20% AEP event, flood waters break the banks near the confluence of Terrors Creek and North Pine River
    - In the 2% AEP event, flood waters are flowing between two tributaries for Terrors Creek.
- Kobble Creek: flood waters are fairly confined within the creek until the10% AEP event:
    - In the 0.5EY AEP event, there is some breakout flow between two tributaries in the lower catchment.
- Mount Samson Creek: flood waters are fairly confined within the waterway corridor until around the 5% AEP event.

As the outflows from the UPR model are used as inflows for the Lower Pine model, careful review of the outflows from the downstream boundary was undertaken to ensure that the flow hydrographs were smooth.

A maximum ASCII 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

Not applicable.

4.4 Sensitivity Analysis Results

The 1% AEP MDS (defined in Section 3.2.2) was used as a base case for the sensitivity analysis. 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.

A comparison of the MDS event with the 1% AEP design event (envelope of all durations) indicates that in the majority of the catchment, the MDS results in very similar peak flood levels (within 0.1m) to the envelope of the 1% AEP design event. The MDS under predicts peak flood levels by up to 0.5m in one area to then north of Dayboro Road and west of Randall Road. The MDS over predicts peak flood levels in various locations, but only in the most upstream parts of the small tributaries. The greatest over prediction (of up to 0.9m) is at the most upstream part of Rush Creek between Dayboro Road and Strong Road.

4.4.1 Hydraulic Roughness Analysis

Increasing the Manning's 'n' by 20% has resulted in an increase in flood levels of up to a maximum of approximately 0.5m. Typically, the largest impact is along North Pine River and Laceys Creek. Impacts between 0.1m and 0.3m are also seen along Kobble Creek, Mt Sampson Creek, Rush Creek and Terrors Creek.

4.4.2 Structure Blockage Analysis

Blocking the culverts on a catchment wide scale has impacts of between ±100mm. There are localised impacts surrounding some culverts;

- Culverts under Mount Pleasant Road near Henzell Road:
  - Increase in flood levels for approximately 430m upstream of the culvert between 0.1m and 0.55m
  - High area of increase in flood levels of up to 0.55m directly upstream of the culverts.
- Culverts under Laceys Creek Road, near Costelloe Road:
  - Localised increase in flood level by up to approximately 0.16m upstream of the culverts
  - Localised decrease in flood levels directly downstream of the culverts by up to 0.31m.
- Culverts under Laceys Creek Road, near MacKenzie Creek:
  - Increase in flood level between 0.1m and 0.25m for approximately 155m upstream of the culvert
  - Localised decrease in flood levels directly downstream of the culvert by approximately 0.24m.
- Culverts under Laceys Creek Road, near RP139621:
  - Increase in levels by up to 0.3m for approximately 370m upstream of the culvert.
- Culverts under Widden Place near Tareena Street:
  - An increase in flood levels by up to approximately 2.2m for approximately 90m upstream of the culvert
  - A decrease in flood levels by up to 0.38m for approximately 200m downstream of the culvert.

4.4.3 Climate Change and Downstream Boundary Conditions

R03 – Increase in rainfall intensity of 20%

A 20% increase in rainfall generally increases flood levels by:

- Between approximately 0.1m and 1m along the North Pine River and Laceys Creek;
- Between approximately 0.05m and 0.5m in the tributaries draining into North Pine River and along the tributary near Winn Road; and
- Between approximately 0.05m and 0.75m along Kobble and Mount Samson Creeks.

No sensitivity testing was undertaken on the downstream boundary, as this catchment does not discharge to the ocean, therefore storm tide or sea level rise will not impact upon this catchment.

4.4.4 Future Landuse Analysis

R08 – Increased vegetation in floodplain

Increasing the vegetation in the floodplains typically increases the levels throughout the catchment of greater than 0.5m. Areas that differ from this include:

- Along North Pine River downstream of Rush Creek – flood levels in this area are decreased by between 0.1m and 0.5m.
- Along North Pine River and Terror Creek – flood levels are typically increased by up to 0.3m.
- The downstream reaches of Kobble and Mount Samson Creeks are typically changed by ±0.1m.

R09 – Increased residential development

Increasing the residential development in the catchment typically changes the flood levels by ±0.1m. There are localised increases in levels in the following locations:

- Increases in levels between 0.1m and 0.6m to the north of the Bond / Terrors Road intersection. There is also an increase in extent in this area;
- An increase in level between 0.1m and 0.3m along Terrors Creek to the west of Bond Road and to the south of Glengariff Way;
- Increase in levels between 0.1m and 0.4m along Terrors Creek to the east of Sellin Road;
- An increase in levels of up to 0.1m to the north of Lyndhurst Road and to the east of Wattlebrae Street;
- An increase in levels of up to 0.3m to the north east of the Hay Road / Saddleback Drive intersection. There is also an increase in extent in this area; and
- An increase in levels of up to 0.1m along the creek to the west of Roderick Street.

R10 – Increased vegetation in the floodplain and increased residential development

Increasing the vegetation within the floodplain and increasing the residential development throughout the catchment typically increases the levels throughout the catchment of greater than 0.5m. The results from this scenario are very similar to the results from R08.

4.5 Model Limitations and Quality

Watercourses within the Upper Pine 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

Model run times for the design events using the 5m model are in the order of 3-4 days and the memory (RAM) requirement is significant with up to 11GB for the 5m models. Table 4-1 shows the UPR TUFLOW model has the following model run times and memory (RAM) requirements for various design events and the 1% AEP MDS. The 3 hour storm duration was chosen, as it is the longest critical storm duration modelled for all events. 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 4-1 Model Specification and Run Time Summary

Event	Grid Cell Size	Approximate Model Run Time	Model RAM/Memory
1 EY 3 hour	5m	3 days	10.72GB
10% AEP 3 hour	5m	4 days	10.72GB
1% AEP 3 hour	5m	3 days	10.72GB
0.2% AEP 3 hour	10m	0.5 days	2.69GB
0.05% AEP 3 hour	10m	0.5 days	2.69GB
1% AEP MDS	5m	5 days	10.72GB

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 Upper Pine (UPR) River catchment were reviewed and the subcatchments adjusted in three locations. 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 TUFLOW model of UPR were updated with LiDAR (elevation data collected in 2014), additional structures 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 Upper Pine River catchment.

6 References

BMT WBM, 2014, *Lower Pine River Pilot Model Improvement Study – Final Report*

SKM, 2012a, *Boundary Conditions, Joint Probability and Climate Change*

SKM, 2012b, *MBRC Regional Floodplain Database Floodplain Parameterisation*

WorleyParsons, 2012, *Regional Floodplain Database – Hydrologic and Hydraulic Modelling Report: Upper Pine River (UPR)*

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