Regional Floodplain Database:

2016 Model Maintenance Report - Lower Pine River (LPR)

Moreton Bay Regional Council

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Regional Floodplain Database 2016 Model Maintenance Report

Lower Pine River (LPR) **May 2016**

Moreton Bay Regional Council

Document Control Sheet

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Synopsis:	This report summarises the maintenance of the Lower Pine River catchment model, undertaken in 2016, as part of the Regional Floodplain Database for Moreton Bay Regional Council.	

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1 Introduction

BMT WBM Pty Ltd has developed the Lower Pine River (LPR) hydrologic and hydraulic models as part of the Stage 2, Regional Floodplain Database Project (RFD) (BMT WBM, 2013a).

In 2013, Moreton Bay Regional Council (Council) selected a pilot catchment within the Lower Pine River (LPR) catchment to undertake a review and further testing of various model input data. A Lower Pine River Pilot (LPRP) TUFLOW model was developed for this study using the LPR RFD 2013models (BMT WBM, 2013b). The scope of works included a review of the LPR TUFLOW model and the representation of the topography and vegetation (and associated Manning's n roughness values).

The study concluded that:

- Some unrealistic elevations were applied in some locations along waterways centrelines. This was due to tree elevation not being fully removed during the filtering process of Light Detection and Ranging (LiDAR) survey and/or coarse triangulation in areas with poor density of LiDAR point survey; and
- The waterways within the LPR RFD 2014 Maintenance model are mostly represented by high Manning's n values representing dense vegetation. However, the underlying waterway corridor may be hidden by the tree canopy in the aerial imagery. Therefore, the very thin or non-existent corridors of water applied along the main waterways may be incorrect and causing excessive attenuation in the upper catchment.

This study was used to enhance the requirements for collection of future LiDAR data.

In 2014, Council also commissioned a review and further assessment of the *Four Mile Creek Railway Bridges (*BMT WBM, 2014a and BMT WBM 2014b*).* The review was undertaken as a staged process. Stage 1 involved a desktop review and site visit. Stage 2 included:

- A comparison of the existing HEC-RAS model to the existing LPR RFD 2014 Maintenance model;
- Simulation of HEC-RAS to determine the head drop across the Four Mile Creek Railway Bridges;
- Provision of suggestions on how to improve the flood behaviour in the TUFLOW model; and
- Update the TUFLOW model to better represent the bridges and head losses.

The Stage 2 review of the Four Mile Creek Railway Bridges concluded that:

- A review of the flow through the Four Mile Creek Railway Bridges indicated that the TUFLOW model was over predicting the afflux across the bridge by as much as 0.68m. This was due to faults in the representation of the terrain in the relatively coarse TUFLOW model, as well as incorrect land use mapping across the bridge.
- Improvements in the representation of the bridge topography and land use mapping lead to a better replication of the afflux across the bridge. These changes result in a lower afflux which

better compares to a HEC-RAS model of similar construct. The updated TUFLOW model has a maximum afflux of 0.25m.

Since this time, Council has obtained additional information that could further enhance the model performance, including newly flown LiDAR elevation data and additional structure details. The hydraulic modelling software, TUFLOW, has had many advances made to it that improves modelling efficiencies.

The North Pine Dam (NPD) has had a number of changes to its flood operating procedure over the past five years. The 2016 LPR model was updated to reflect the current Operational Procedures for Flood Mitigation at North Pine Dam Nov 2014 (Revision 9). These changes affect the timing and peak flow applied to the LPR model downstream of the NPD which potentially impact the downstream peak flood levels. 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 LPR RFD 2014 Maintenance 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 January 2011 calibration event and sensitivity analysis.

This report highlights the changes to the LPR RFD 2013model and results from the LPR RFD 2016 Maintenance model for the simulated events.

2 LPR RFD 2016 Maintenance Model Details

2.1 WBNM Model

The catchment boundaries of the existing LPR hydrologic model were reviewed against the 2014 LiDAR and no changes were deemed necessary. 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 LPR RFD 2016 Maintenance model.

The following information was added and/or revised into the LPR RFD 2014 Maintenance 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; and
    - Bathymetric survey
- Inclusion of five additional developments:
    - 41 Henry Road;
    - Lot 2 White Ibis Drive, Griffin;
    - Lot 5 Silvereye Drive, Griffin;
    - Old North Road, Bray Park; and
    - Stanley Street, Warner.
- Inclusion of 124 additional culvert structures.
- Inclusion of trunk drainage, which included 376 separate pit and pipe structures.
- No additional bridges have been included in the model, although some existing bridges have been upgraded.
- 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 5m waterway materials layer along the streamlines.
- Inclusion of zlines to represent the crest elevation of key roads within the modelled area.
- 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

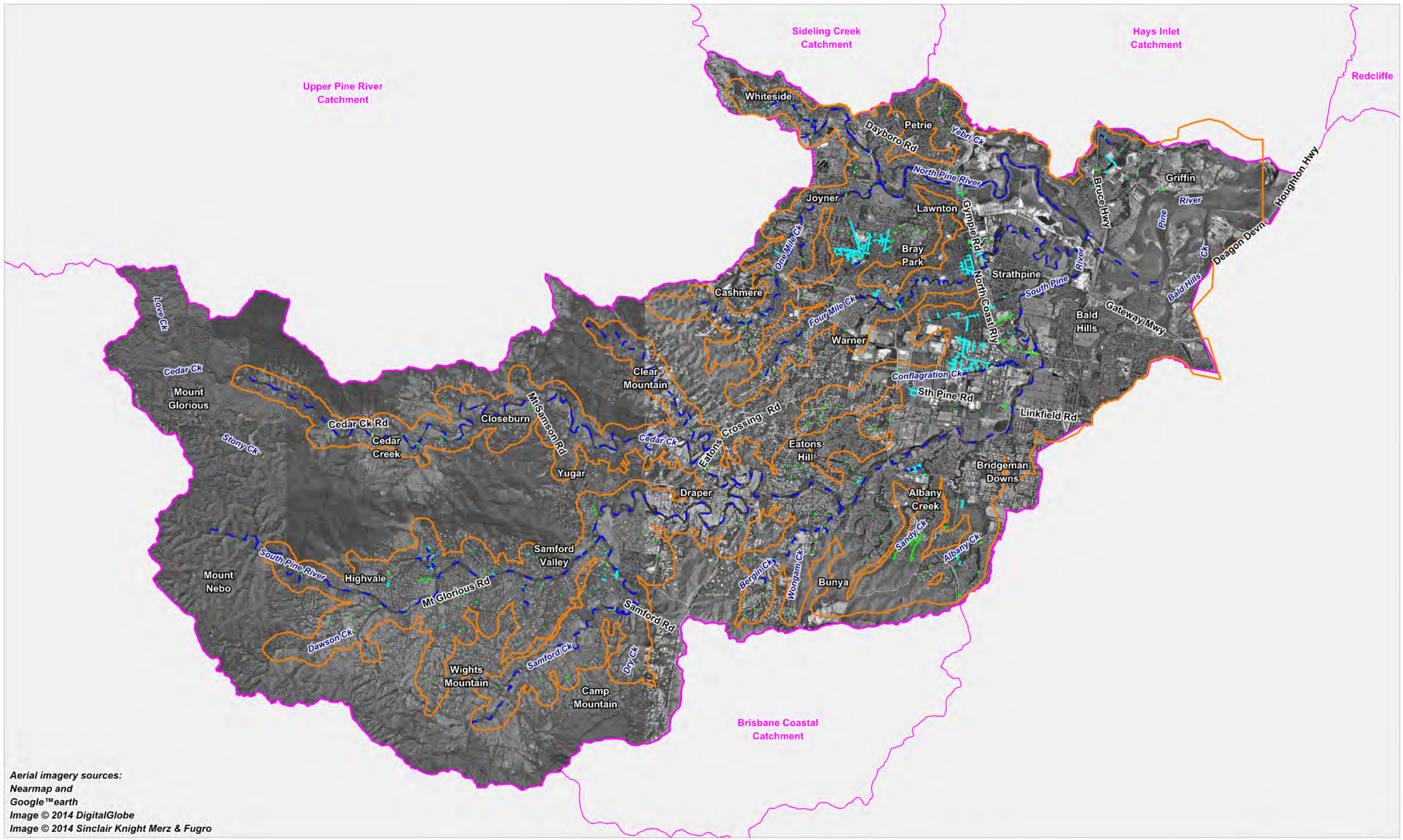
to the trunk drainage network, causing the network to reach full capacity and increase flooding in some urban areas. This was as a result of model schematisation and not an accurate reflection of actual conditions. Where the hydrological subcatchment was significantly larger than the area that the catchment 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").

- Additional plot output (PO) lines were added to include all locations of interest.

The following information was added and/or revised into the LPR RFD 2016 Maintenance model:

- DEM of the Quarry area from the 2013 LPR model (002a) located near Sweeney Reserve.
- Inclusion of the topography for Petri Station on the Moreton Bay Rail link.
- The inflow to the LPR model from the North Pine Dam used the Revision 9 North Pine Dam operating rules. These inflows were applied to the design events only; (not applicable to the storm tide events, not used for the verification events and not applied to the sensitivity analysis simulations).

On review of the model results, the changes outlined above (mainly the updated LiDAR), resulted in the model showing instabilities at the some of the more complex culverts and stormwater structures. At these structures additional nodal storage was added to improve stability along with terrain modifiers at the inlets and outlets of the culverts and trunk drainage structures.



LEGEND

Lower Pine River Catchment Boundary

Cadastral Boundaries

Additional Features

Model Extent

Roads

Streamlines

Stormwater Pipes

Culverts

Title:

LPR RFD 2016 Maintenance Model Features

Figure **2-1**

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3 Model Simulations

3.1 Verification

The Lower Pine River (LPR) hydraulic model has previously been calibrated to the January 2011 event (BMT WBM, 2013a). The changes made to the model as a result of the RFD 2014 Maintenance model maintenance, are not expected to change any of the calibration parameters. The LPR catchment also didn't experience another significant flood event since 2011 (where additional data could have been collected). Council have therefore decided to undertake a model validation only. Council have stipulated that the January 2011 event will be used for validation of the LPR RFD 2014 Maintenance 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 using the RFD 2014 LPR model. The critical duration analysis was not repeated for the 2016 model. 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 Probable Maximum Flood (PMF) events).

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

(1) Hydrologic and hydraulic modelling for a range of storm durations for the 1% AEP 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 three selected storm durations for the two representative events;

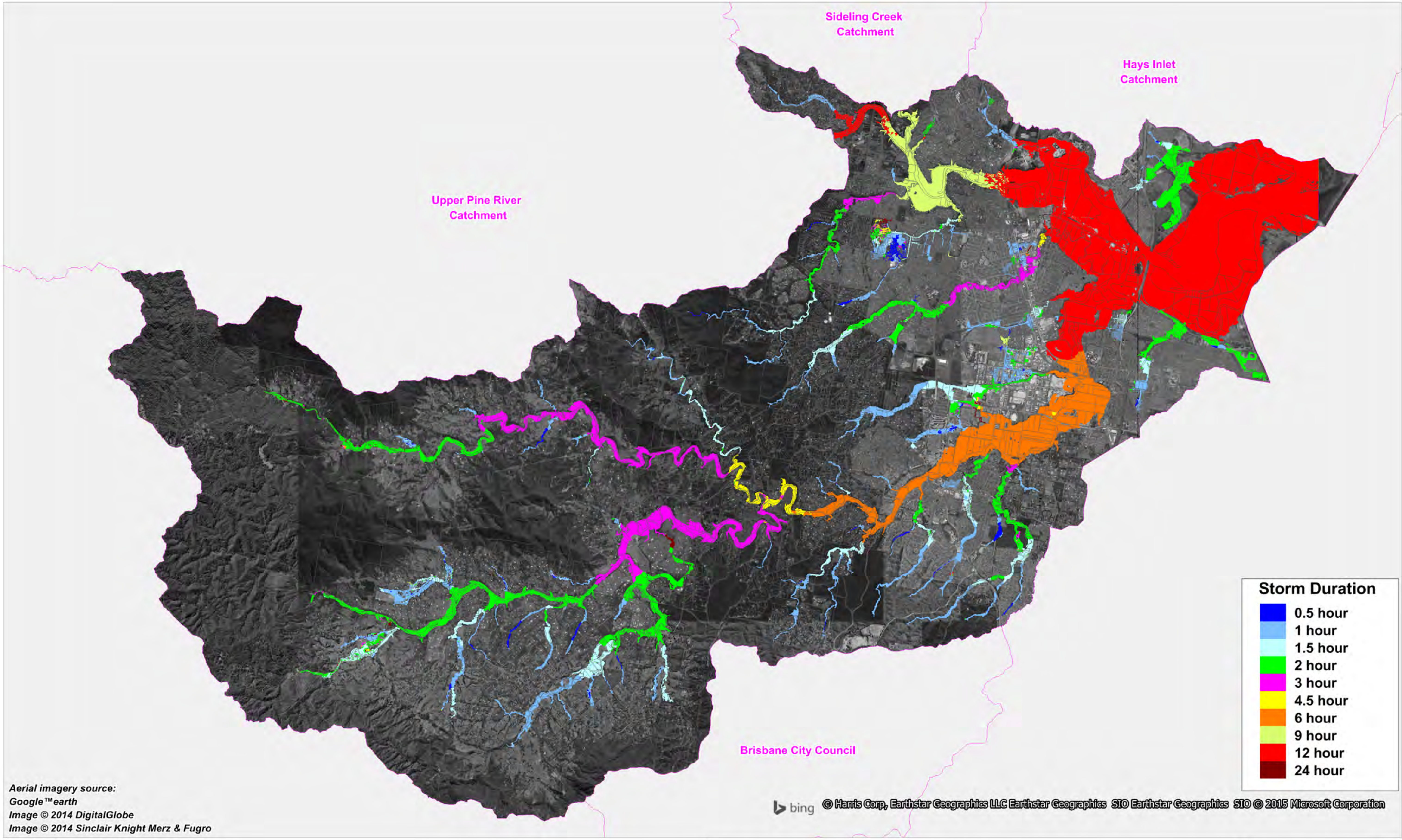
(4) Difference comparison between the mapped peak flood levels for the four selected critical durations and the results accounting for all the storm durations; and

(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, 3, 4.5, 6, 9, 12 and 24 hour storm	1, 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, 3, 5, 6, 12 and 24 hour storm	1, 3, 6, and 12 hour storm	0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP and PMF



LEGEND

Lower Pine River Catchment Boundary

Cadastral Boundaries

Title:

Critical Duration Assessment - 1% AEP

Figure 3-1

Rev: A

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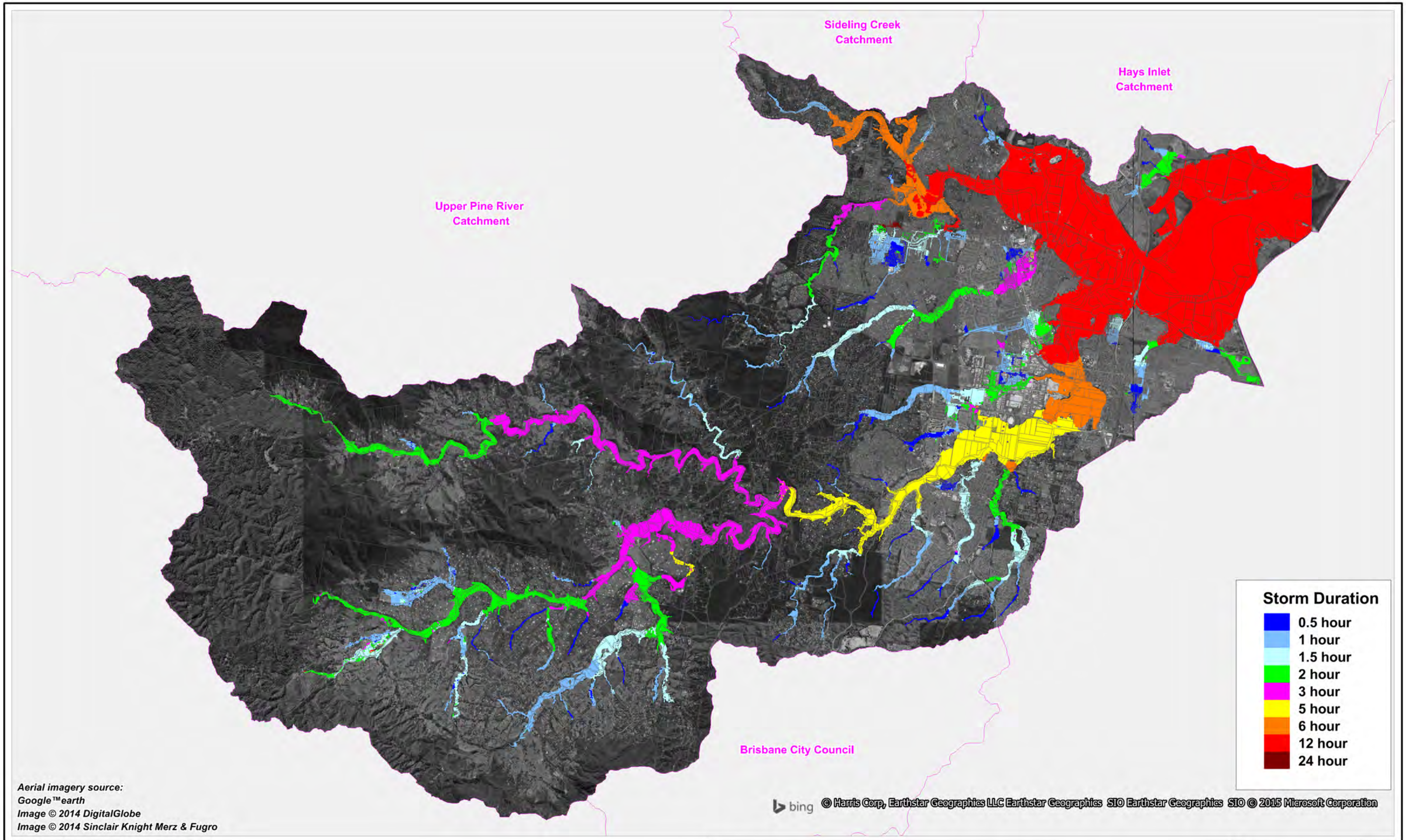

Title:
Critical Duration Assessment - 0.1% AEP

Figure 3-2

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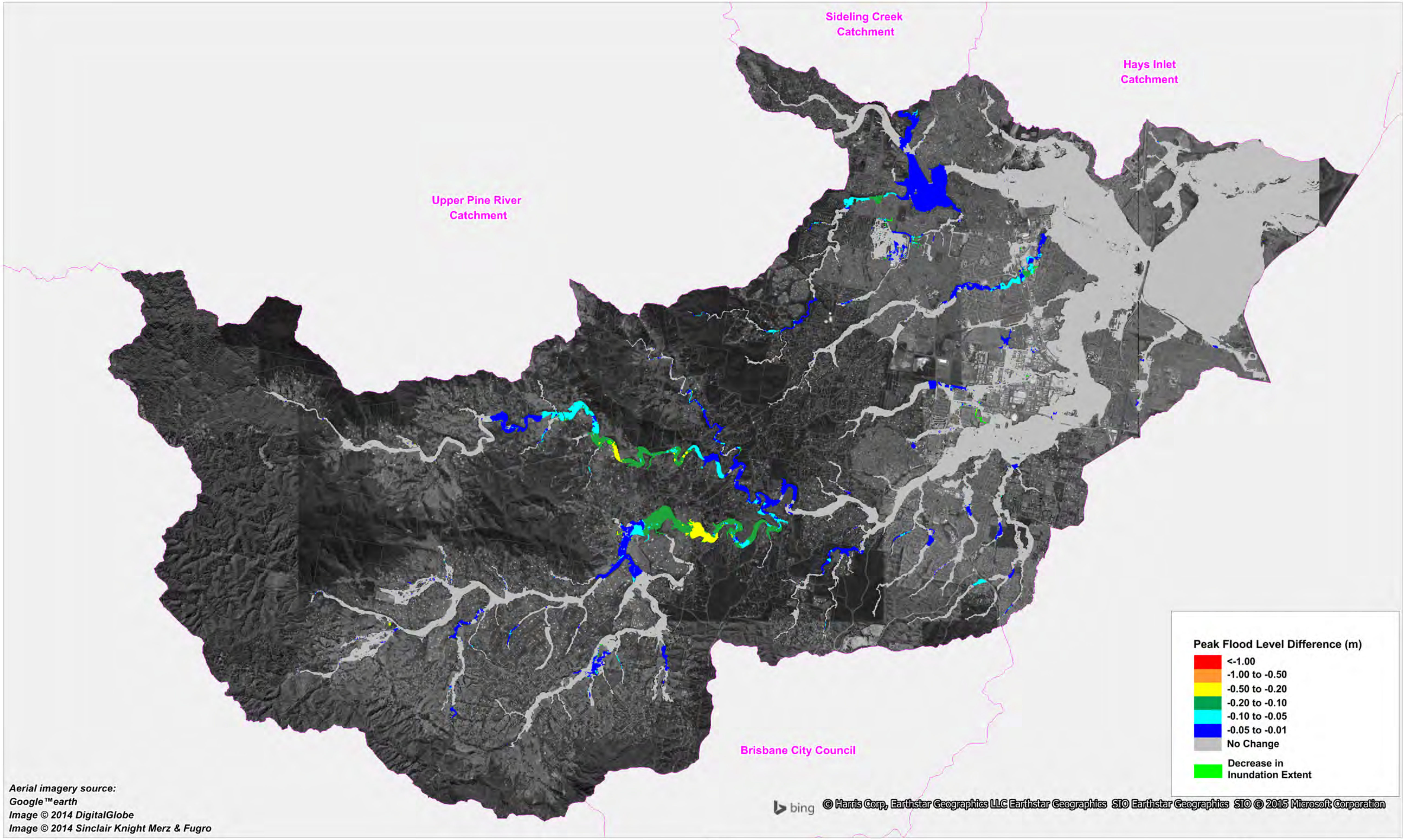

LEGEND

Lower Pine River Catchment Boundary

Cadastral Boundaries

Title:

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

Figure **3-3**

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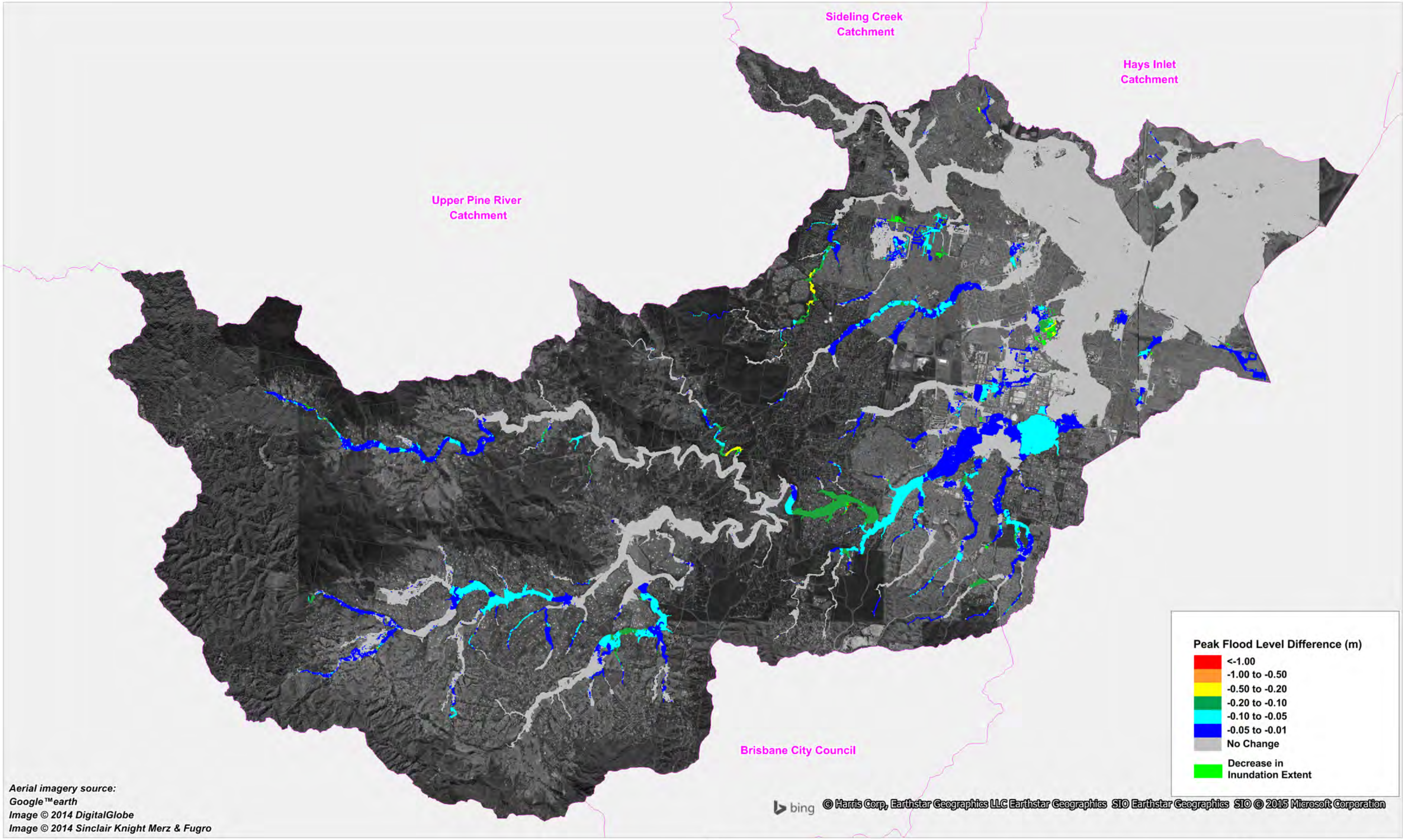

LEGEND

Lower Pine River Catchment Boundary

Cadastral Boundaries

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 LPR RFD 2014 Maintenance 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 LPR RFD 2014 Maintenance model was simulated for the following design events:

- The 1 EY, 0.5EY, 20%, 10%, 5%, 2% and 1% AEP events for the four selected critical storm durations;
- 0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP events, and the PMF event for the four 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 LPR RFD 2014 Maintenance 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 two storm tide reference points were used: MBC-005 and MBC-009.

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

Table 3-2 Storm Tide Design Events

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, resulting in instabilities. A straighter downstream boundary resulted in more stable storm tide models. The storm tide boundary was modelled with a combination of a 2d_hx, 1d_nwk_nodes, 1d_cn_nodes and 1d_bnd_nodes. This allowed for the boundary to have sloping water levels along the boundary.

3.3 Sensitivity Analysis

The LPR RFD 2014 Maintenance 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 2.3mAHD (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 2.6mAHD (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.
- **R10:** Determined the combined impact of increased vegetation in floodplains (R08) and increased residential development (R09).

4 Model Results and Outcomes

4.1 LPR RFD 2016 Maintenance Model

Figure 4-2 and Figure 4-3 shows the difference between the LPR RFD 2016 Maintenance model and LPR RFD 2013model for the 5% and 1% AEP events, respectively. Both events are based on a comparison of the 6 hour storm duration.

Negative values mean that the LPR RFD 2016 Maintenance model results are lower than the LPR RFD 2013model results and vice versa (positive values mean that the LPR RFD 2016 Maintenance model results are higher than the LPR RFD 2013results).

During the upgrade of the models it was found that, in the LPR RFD 2013model, the flows from Sideling Creek were substantially lower than they should have been. This has resulted in increased water levels in the vicinity of Sideling Creek and the junction with the Pine River. Both, the 5% AEP and 1% AEP events showed large increases in flood levels downstream of the Sideling Creek inflow due to this error in the LPR RFD 2013model. In addition, there were some substantial terrain differences in the bathymetry and the excavation pits near to the river. These terrain changes significantly altered the potential flow capacity of the Pine River.

There was a change in the operational procedures for the North Pine Dam between the development of the LPR RFD 2013model, the LPR RFD 2014 Maintenance model and LPR RFD 2016 Maintenance model. The LPR RFD 2013model used the Manual of Operational Procedures for Flood Mitigation at North Pine Dam Dec 2010 (Revision 5) and the LPR RFD 2014 Maintenance model used the Manual of Operational Procedures for Flood Mitigation at North Pine Dam Nov 2013 (Revision 8). The LPR RFD 2016 model uses the Manual of Operational Procedures for Flood Mitigation at North Pine Dam Nov 2014 (Revision 9).

Figure 4-1 presents the discharge rating curves derived from each of the Manual of Operational Procedures for Flood Mitigation at North Pine Dam (MOP FM NPD) revisions. The Manual of Operational Procedures for Flood Mitigation at North Pine Dam Nov 2013 (Revision 8) discharge ration curve compared to the Manual of Operational Procedures for Flood Mitigation at North Pine Dam Dec 2010 (Revision 5) discharge ration curve allows for greater discharges through the North Pine Dam spillway for a smaller change in storage elevation. This is likely to result in greater discharge into the North Pine River downstream of the North Pine Dam for an event of the same magnitude. The greater flow in the North Pine River is likely to result in increased peak flood levels. This is likely to contribute to the increased peak flood levels result of the North Pine River in the LPR RFD 2016 Maintenance model compared to the LPR RFD 2013 model. This change in the storage discharge relationship is also likely to affect the timing of outflow hydrograph in the 2016 model. It is likely to result in flows being discharged out of the NPD at an earlier time, which then may has an effect on the critical duration downstream of NPD.

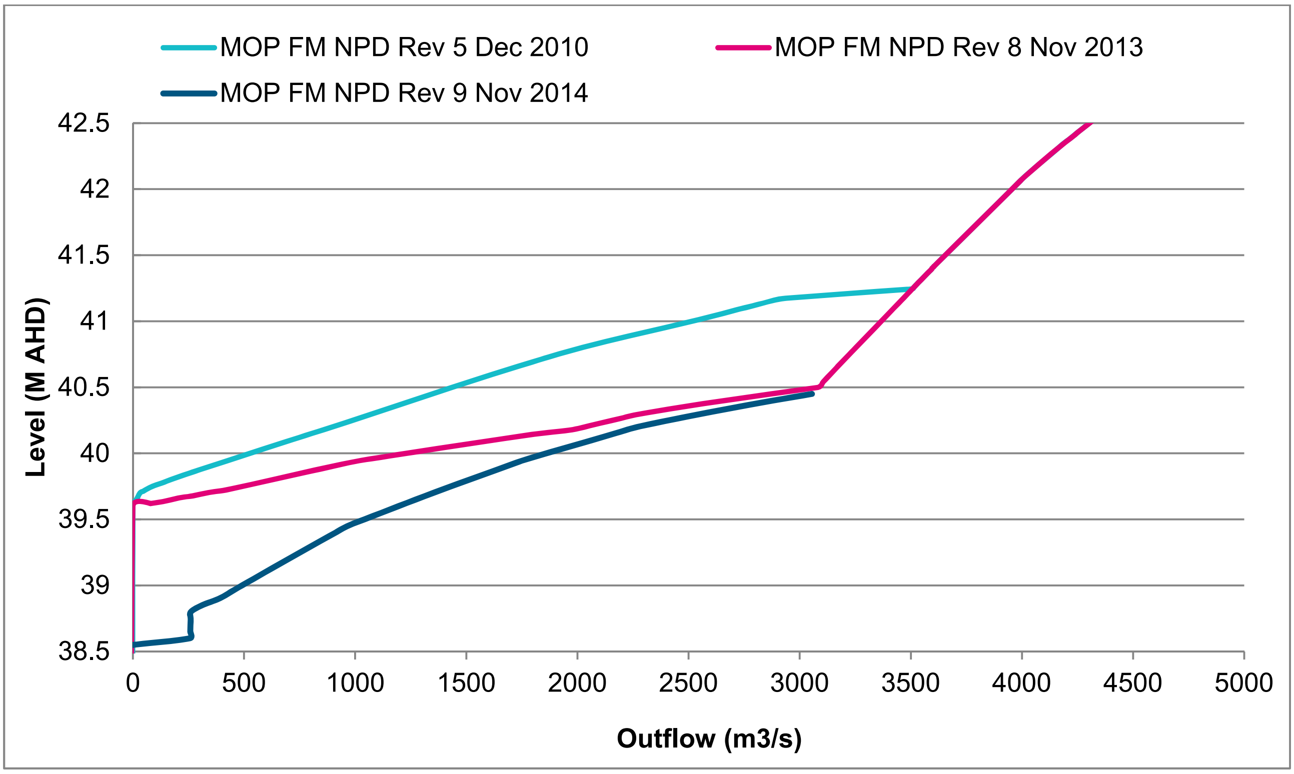

Figure 4-1 North Pine Dam Rating Curve Comparisons

In the 5% AEP event, the flood levels in the North Pine River downstream of the Bruce Highway were up to 0.36m higher in the LPR RFD 2016 Maintenance model compared to the LPR RFD 2013 model. For the reach of the North Pine River between the Bruce Highway and Nottinghill Road flood levels were between 0.10m to 0.18m higher. For the section of the North Pine River downstream of Gympie Road to approximately Bickle Road the flood levels were lower by as much as 0.25m with an isolated area showing a reduction of up to 0.9m. Upstream of Gympie Road to Youngs Crossing Road the LPR RFD 2016 showed a reduction of between 0.25 and 0.6m compared to the LPR RFD 2013 modelled results. Upstream of the Sideling Creek confluence the LPR RFD 2016 peak flood level showed decreases of between 0.50m and 1.90m.

The modelling showed reduced peak levels of 0.25m to 0.35m in Sideling Creek, from its confluence with the North Pine River, to approximately 500m upstream. The levels at the downstream end of Sideling Creek are likely to have been influenced from the lower levels in the North Pine River.

One Mile Creek showed reductions in flood level of between 0.25m and 1.50m upstream of its confluence with the North Pine River with maximum flood level reductions of approximately 1.80m. A few locations did show increases but they were isolated and near crossings where culverts and road embankments were added (Springbook Court, Cashmere).

Four Mile Creek showed increases and decreases of ±0.30m for the majority of its length. There were a few localised decreases of the order of 0.50m and one localised increase of 1.50m (upstream of Old North Road). Downstream of Walkers Road flood levels on Four Mile Creek increased by approximately 0.15m; although this is likely due to the interaction with the Pine River. Around the railway crossing and Gympie Road crossing peak flood levels showed reductions of between 0.5m and 1.0m, with the 1.0m at the railway crossing.

South Pine River showed an increase of approximately 0.13m from it confluence with North Pine River to 1500m downstream of Gympie Road. Upstream of Gympie Road to the railway crossing flood levels were approximately 0.45m higher. The DEM showed an increase in this area of between 0.2 and 0.5m, this is likely due to the increased flood levels in this area and reduced storage capacity and conveyance. A small tributary of the South Pine River that joins at this location also showed increases of between 0.40m and 0.70m. This increase on the tributary extended approximately 900m upstream of the railway crossing. From Linkfield Road to Scouts Crossing Road peak flood levels were shown to be between 0.10m and 0.25m higher. Upstream of Scouts Crossing Road flood levels were generally 0.3m to 1.00m lower with a section in the upstream of Samford Creek producing flood levels of approximately 1.0m to 1.7m lower than the LPR RFD 2013 model. A small section in Highvale, near Showgrounds Drive showed a reduction in level of approximately 3.25m lower than the LPR RFD 2013model, this could be due to the previous model have the elevation of the crossing rather than the streambed at this location.

Samford Creek was generally lower in the order of 0.10m to 0.60m; with pockets of 1.0m to 1.25m, with isolated pockets of increased levels between 0.2m and 0.45m.

Cedar Creek generally showed reductions of between 0.5m and 1.0m with a 3km section resulting in lower peak flood levels ranging from 1.5m to 2.5m lower than the 2013 model. In Closeburn, from Mount Samson Road to approximately 1.5km downstream, there was an area that indicated peak flood levels up to 1.25m higher.

In the 1% AEP event, comparison of peak flood levels showed that downstream of the Bruce Highway the Pine River showed an increase of between 0.20m and 0.45m. North Pine River upstream of the Bruce Highway to approximately it confluence with Yebri Creek the LPR RFD 2016 Maintenance model flood levels were between 0.1 and 0.35 m higher compared to the LPR RFD 2013model. Upstream of Gympie Road to approximately Turnbull Court the LPR RFD 2016 shows reduced levels between 0.10m and 0.20m. Between Turnbull Court and Inverpine Court peak flood levels are shown to increase in the LPR RDF 2016 model by approximately 0.1m to 0.2m. Upstream of the Sideling Creek confluence flood levels were between -0.05m and 0.25m of the LPR RFD 2013model flood levels until approximately 1.0km downstream of the Upper Pine inflow, where levels decrease by up to 1.25m compared to the LPR RFD 2013model flood levels.

One Mile Creek showed reductions in peak flood level of between 0.25m and 1.00m upstream of Youngs Crossing Road with maximum flood level reductions of approximately 1.40m. A few locations did show increases but they were isolated to near crossings where culverts and road embankments were added (Springbook Court, Cashmere).

Four Mile Creek generally showed increases of between 0.10m and 0.3m upstream of Kensington Way. Between Kensington Way and the railway crossing the peak flood level generally showed decreased levels of between 0.10m and 0.45m, with the railway crossing showing a decrease of 0.45m. There were a few localised decreases of the order of 0.7m and one localised increase of

1.7m (upstream of Old North Road). Downstream of Walkers Road flood levels on Four Mile Creek increased by approximately 0.40m, although this is likely due to the interaction with the Pine River.

South Pine River showed an increase of approximately 0.30m to 0.40m from its confluence with North Pine River, through to approximately 900m downstream of Gympie Road. Upstream of Gympie Road flood levels were approximately 0.0.5m to 0.25m higher until Old Northern Road. Between Old Northern Road and Mount Samson Road flood level differences between the LPR RFD 2013model and LPR RFD 2014 Maintenance model fluctuated between 0.50m lower and 0.20m higher, with the majority tending towards the lower. A small section just upstream of Bunya Road produced an increase of 0.55m. The upstream portion of the South Pine River contained a small section in Highvale near Showgrounds Drive showing a reduction in level of approximately 2.5m lower than the LPR RFD 2013model.

Samford Creek downstream of Samford Road was generally 0.20m to 0.80m lower with pockets of increased flood levels ranging from 0.05m to 0.30m. Between Samford Road and School Road flood levels increased by between 0.10m and 0.40m with a small section near Chambers Court producing levels up to 0.70m higher. The remaining upstream portion of Samford Creek was generally within the range of 0.30 higher and -0.60m lower than the LPR RFD 2013model.

Cedar Creek generally showed reduction of between 0.50m and 1.00m with small sections producing levels reduction ranging from 1.50m to 2.00m lower than the LPR RFD 2013 model. In Closeburn, from Mount Samson Road to approximately 1.4km downstream, there was an area that resulted in up to 1.6m higher peak flood levels. For 300m upstream of Mount Samson Road the peak flood levels showed an increase of approximately 0.4m with a peak increase of 0.85m at Mount Samson Road. In the area upstream of Morrison Road Closeburn for approximately 300m flood levels showed an increase of between 0.10m and 0.65m.

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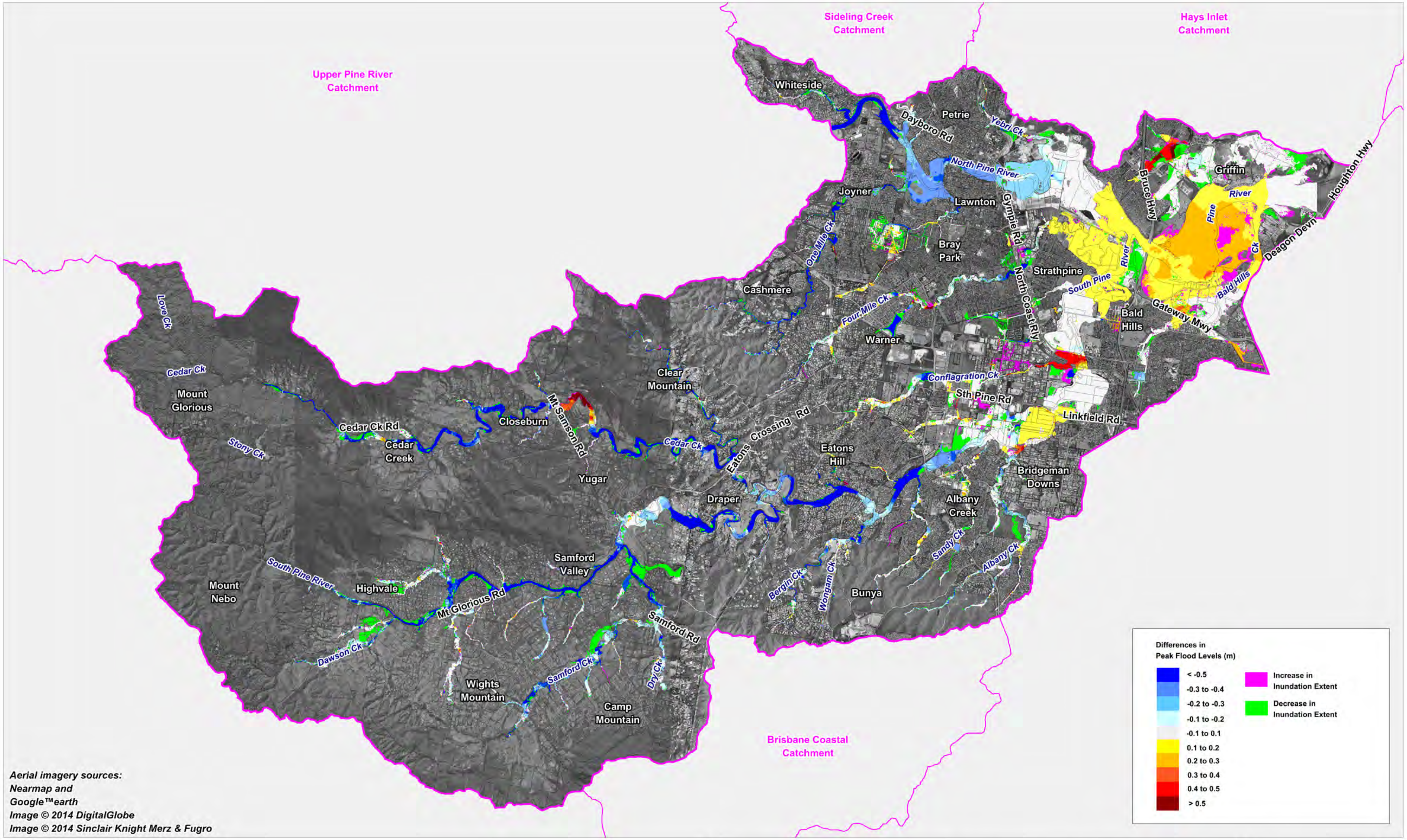

LEGEND

Lower Pine River Catchment Boundary

Cadastral Boundaries

Title:
LPR RFD 2016 Maintenance Model Versus LPR RFD 2013 Model Peak Flood Level Difference - 5% AEP

Figure **4-2**

Rev: **A**

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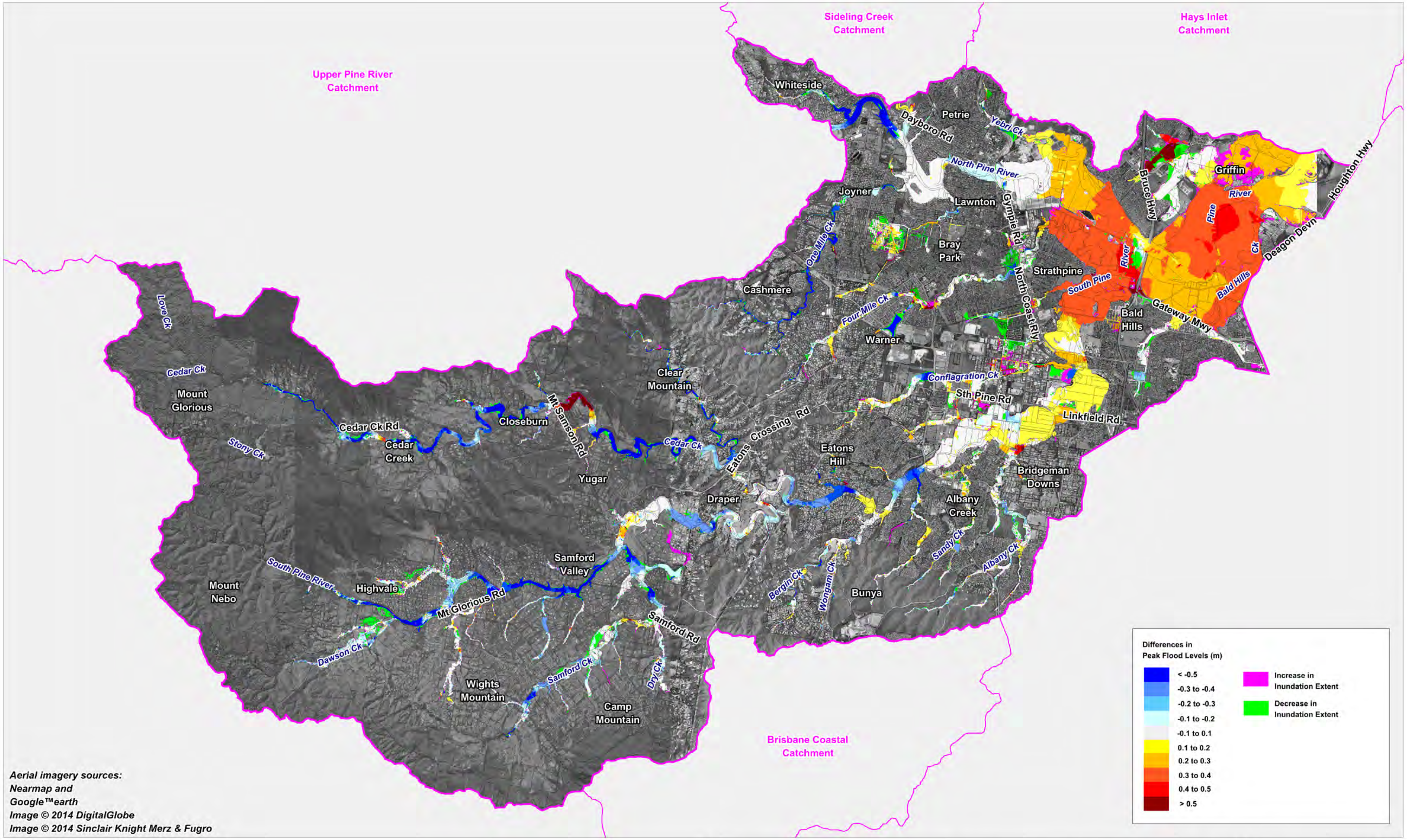

LEGEND

Lower Pine River Catchment Boundary

Cadastral Boundaries

Title:

LPR RFD 2016 Maintenance Model Versus LPR RFD 2013 Model Peak Flood Level Difference - 1% AEP

Figure 4-3

Rev: B

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4.2 Verification

Validation of the modelling was undertaken using the January 2011 event. The peak flood levels at the John Bray Park and Lawton gauges matched particularly well, within 0.1m. Considering the fluctuation in peak flood levels at the Cash's Crossing gauge, it is possible that this gauge malfunctioned at the peak of the flood event and therefore the modelled peak flood levels could be very close to the actual peak flood levels during the 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 4-14 shows the difference in peak flood levels between the LPR RFD 2014 Maintenance model and the LPR RFD 2013 model for the January 2011 event.

Results indicate that throughout the majority of the upper catchment, the flood levels between the two models tended to be lower in the LPR RFD 2014 Maintenance model compared to LPR RFD 2013 model, this is potentially due to the inclusion of streamlines that were set to ensure that there was a continuous downwards slope, the streamlines also were at least two cells wide in the 5m grid. There were areas in the upper catchment where the LPR RFD 2014 Maintenance model showed higher levels than the LPR RFD 2013 model. The mid catchment tended to show that the LPR RFD 2014 Maintenance model and LPR RFD 2013 model were in close agreement with only small patches where they differed by more than ±0.3m. The lower catchment tended to show that the LPR RFD 2014 Maintenance model showed peak flood levels that were higher than the LPR RFD 2013 model. The following key areas experience a greater difference:

- North Pine River from the North Pine Dam to 300m downstream of the Grant Street crossing showed modelled peak flood levels increased by between 0.2m and 0.75m;
- North Pine River from 600m downstream of Grant Street to 300m upstream of Youngs Crossing Road showed modelled peak flood levels decreased by between 0.2m and 0.53m;
- North Pine River from 300m upstream of Youngs Crossing Road to Gympie Road showed modelled peak flood levels increased by between 0.2m and 0.66m higher than the LPR RFD 2013 model;
- North Pine River at the Gympie Road Bridge showed peak flood levels up to 1.7m higher than the LPR RFD 2013 model;
- North Pine River from 100m downstream of Gympie Road to the Bruce Highway showed modelled peak flood levels increased by between 0.2m and 0.66m higher than the LPR RFD 2013 model;
- Pine River from downstream of the Bruce Highway showed modelled peak flood levels increased by between 0.2m and 0.75m higher than the LPR RFD 2013 model;
- South Pine River from Scouts Crossing Road to the North Coast Railway line the 2014 modelled peak flood level showed increases of between 0.2m to 0.7m; and

- South Pine River from the railway line to its confluence with the North Pine River the 2014 modelled peak flood level showed increases of between 0.2m to 0.55m.

Hydrograph Comparison

Nine river gauges recorded flood levels during the January 2011 event in the Lower 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 4-4 to Figure 4-12.

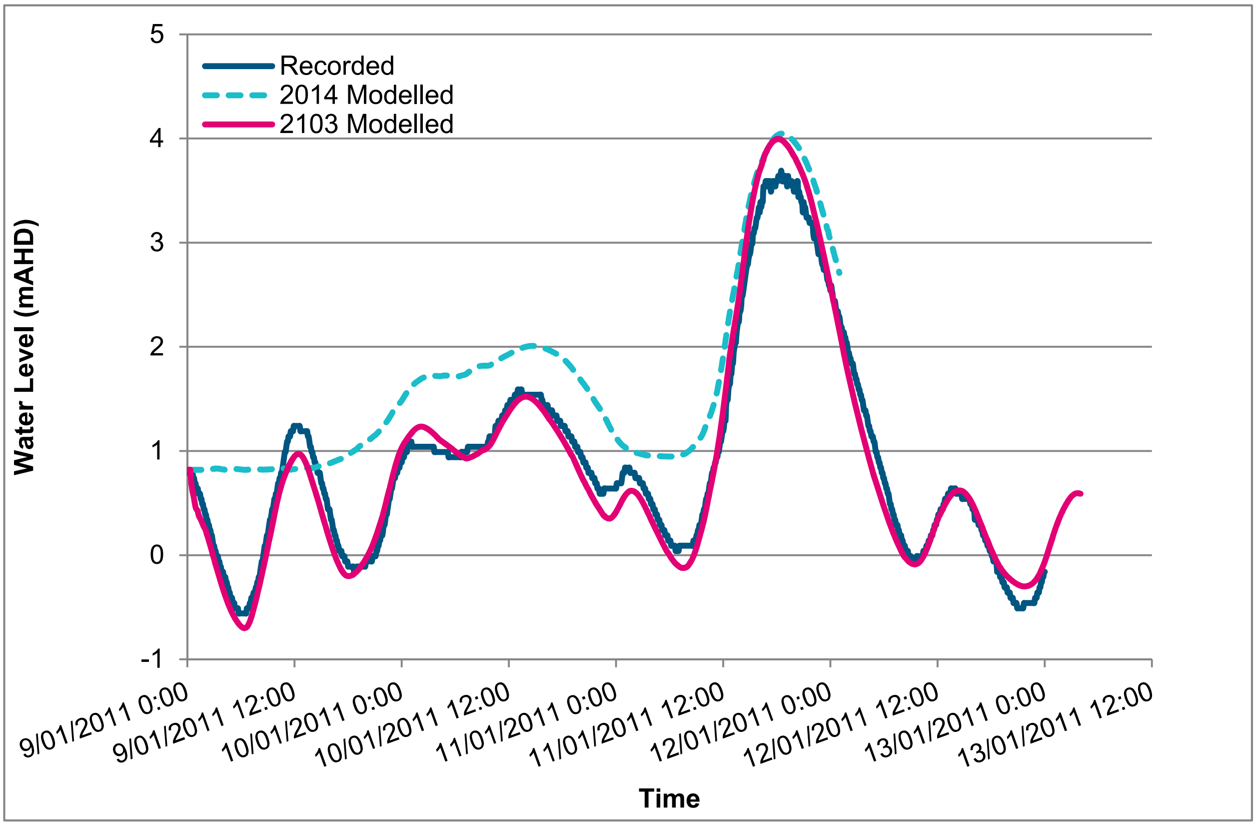

Figure 4-4 Recorded and Modelled Hydrographs at Murrumba Downs gauge – January 2011

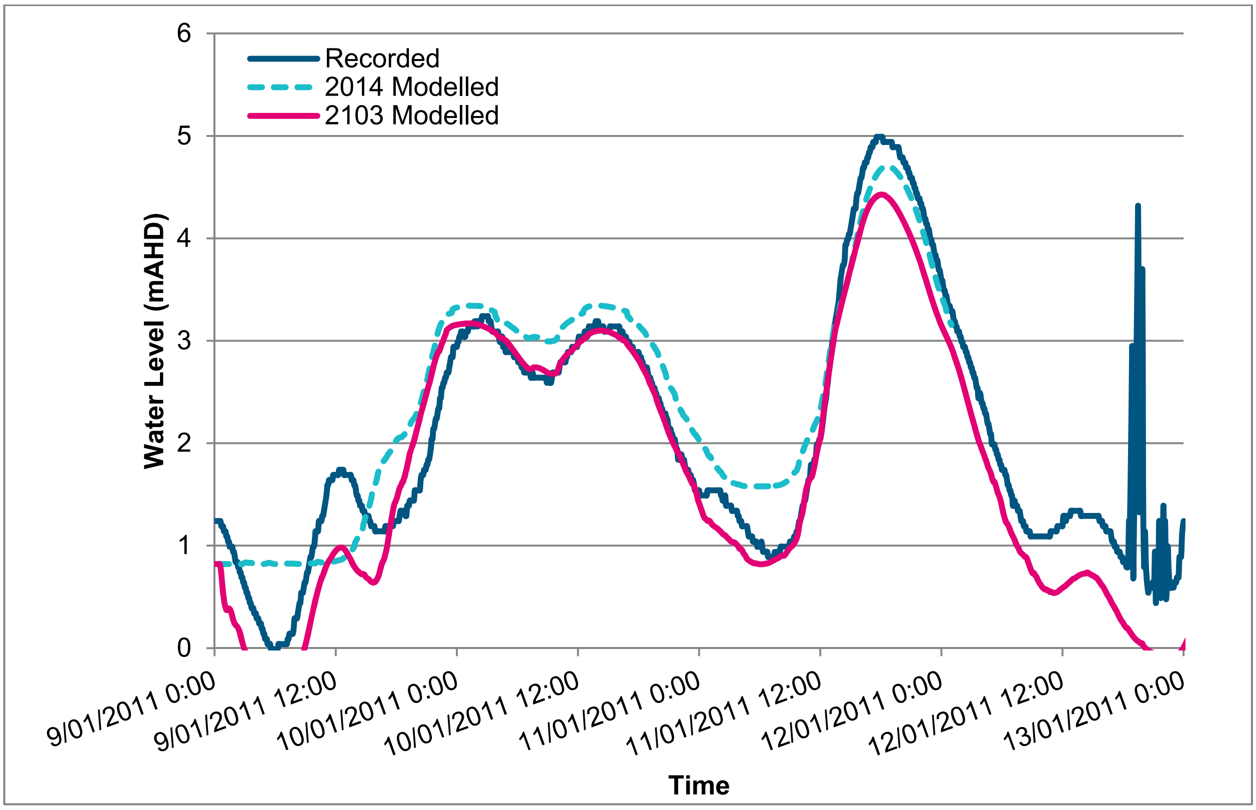

Figure 4-5 Recorded and Modelled Hydrographs at Normanby Way gauge – January 2011

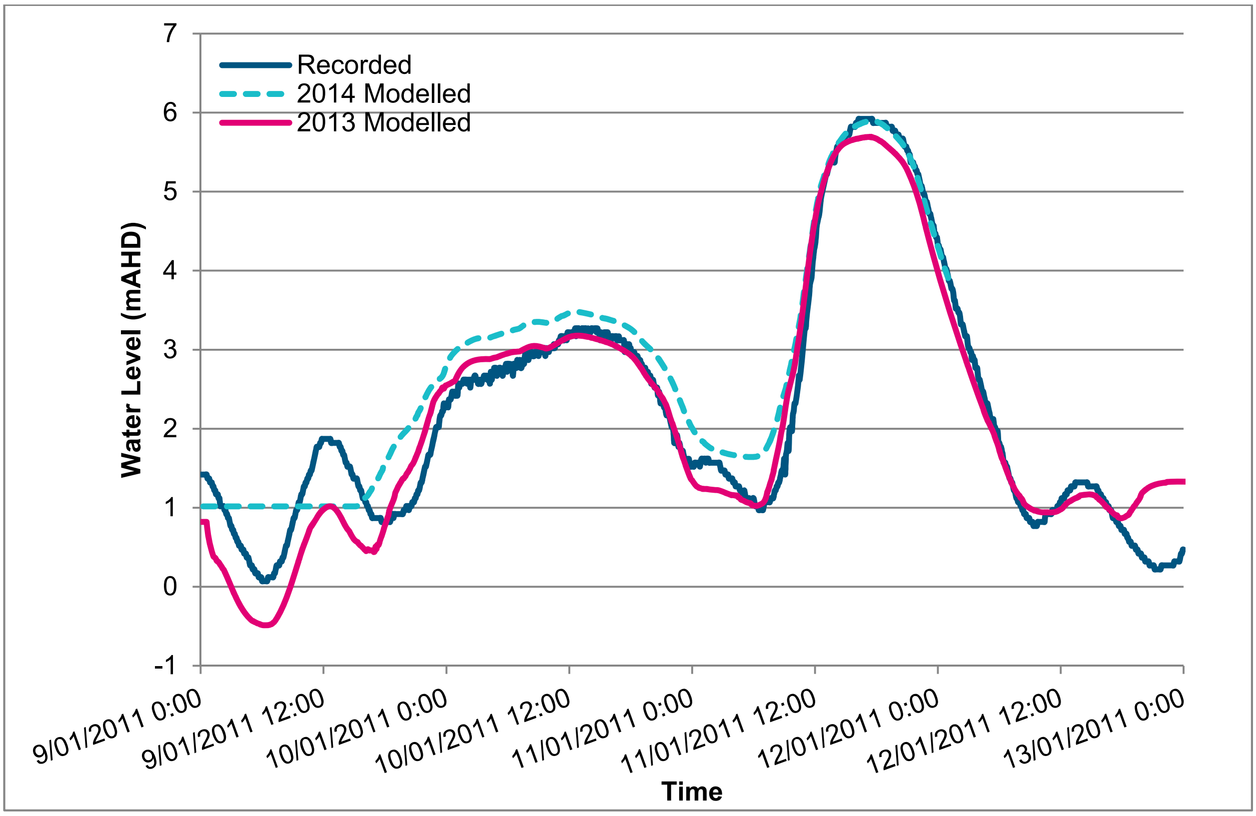

Figure 4-6 Recorded and Modelled Hydrographs at Lawton gauge – January 2011

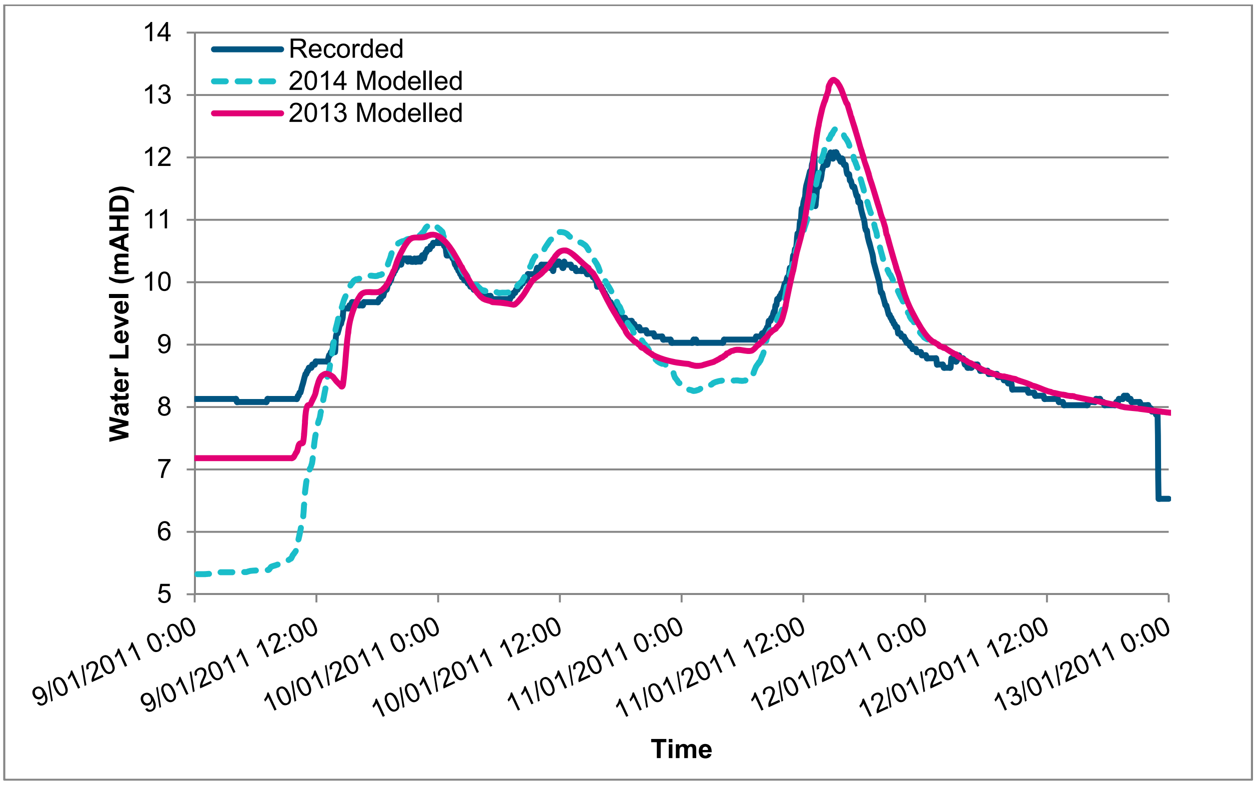

Figure 4-7 Recorded and Modelled Hydrographs at Cash's Crossing gauge – January 2011

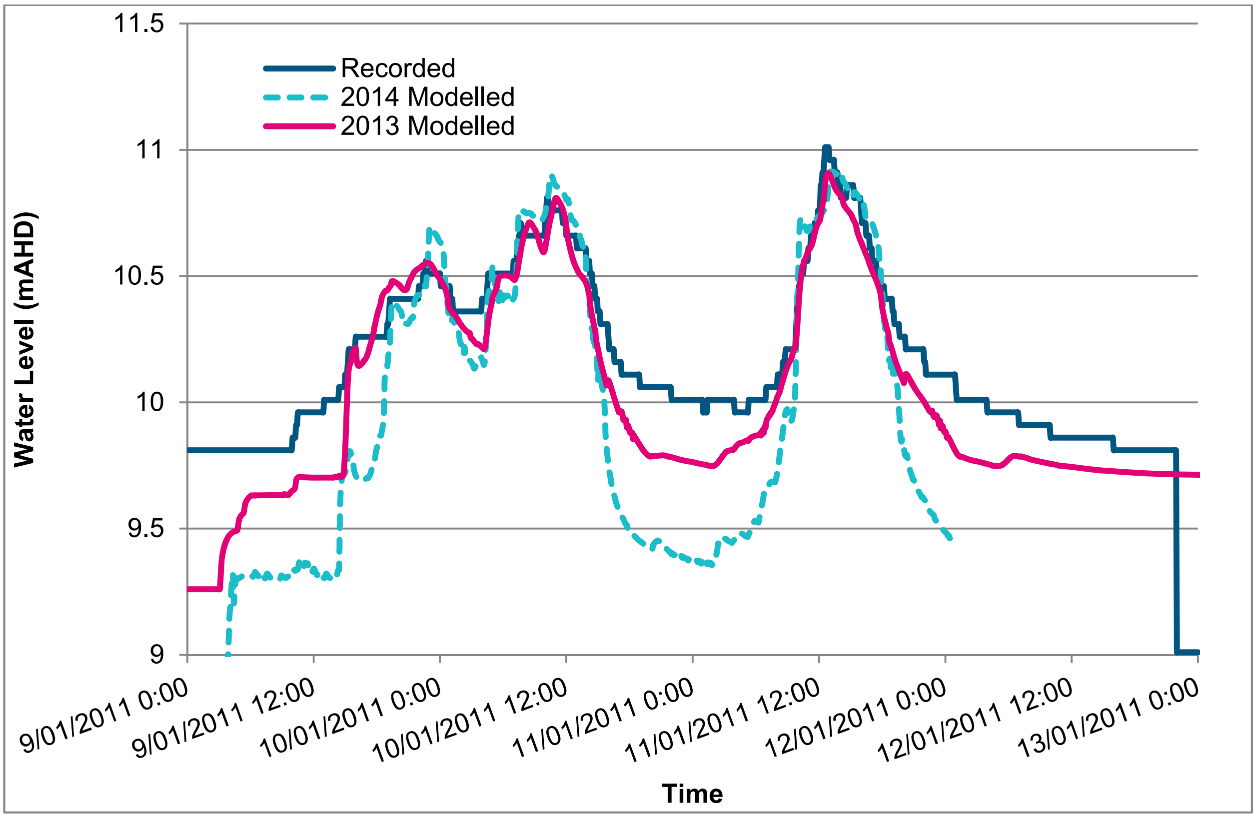

Figure 4-8 Recorded and Modelled Hydrographs at John Bray Park gauge – January 2011

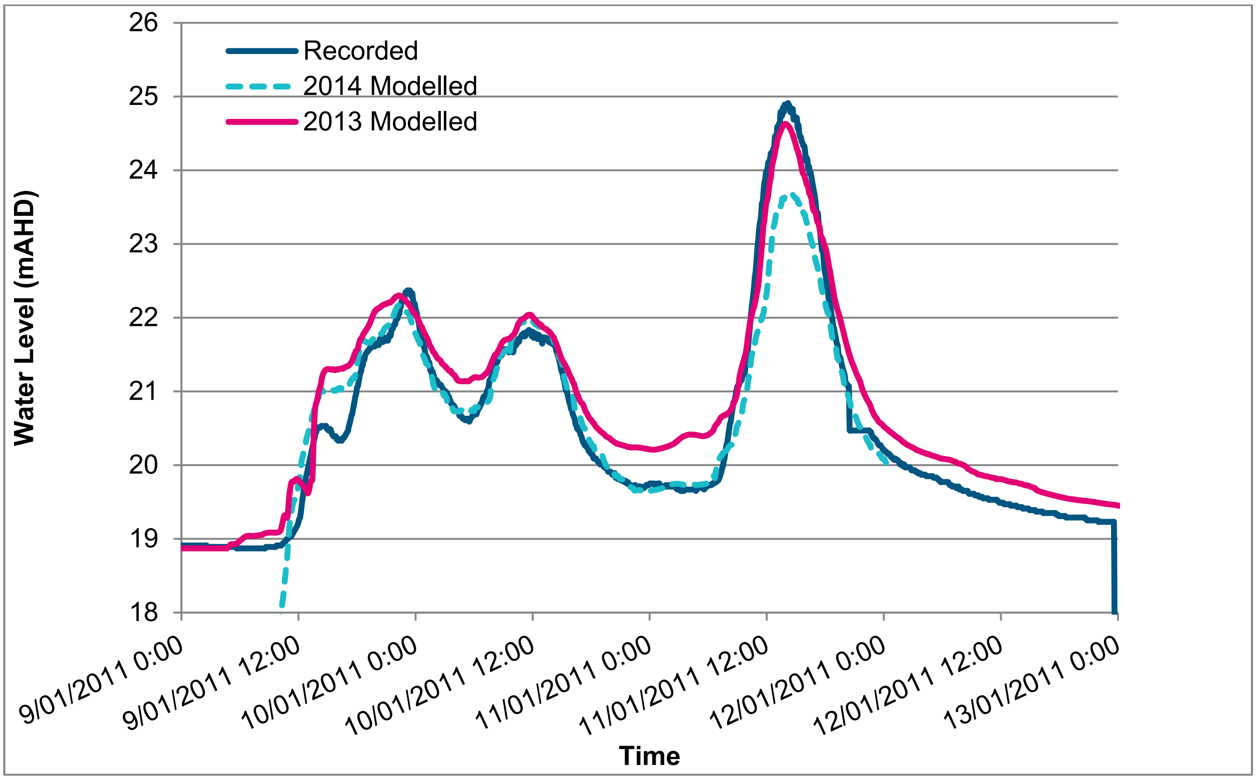

Figure 4-9 Recorded and Modelled Hydrographs at Drapers Crossing gauge – January 2011

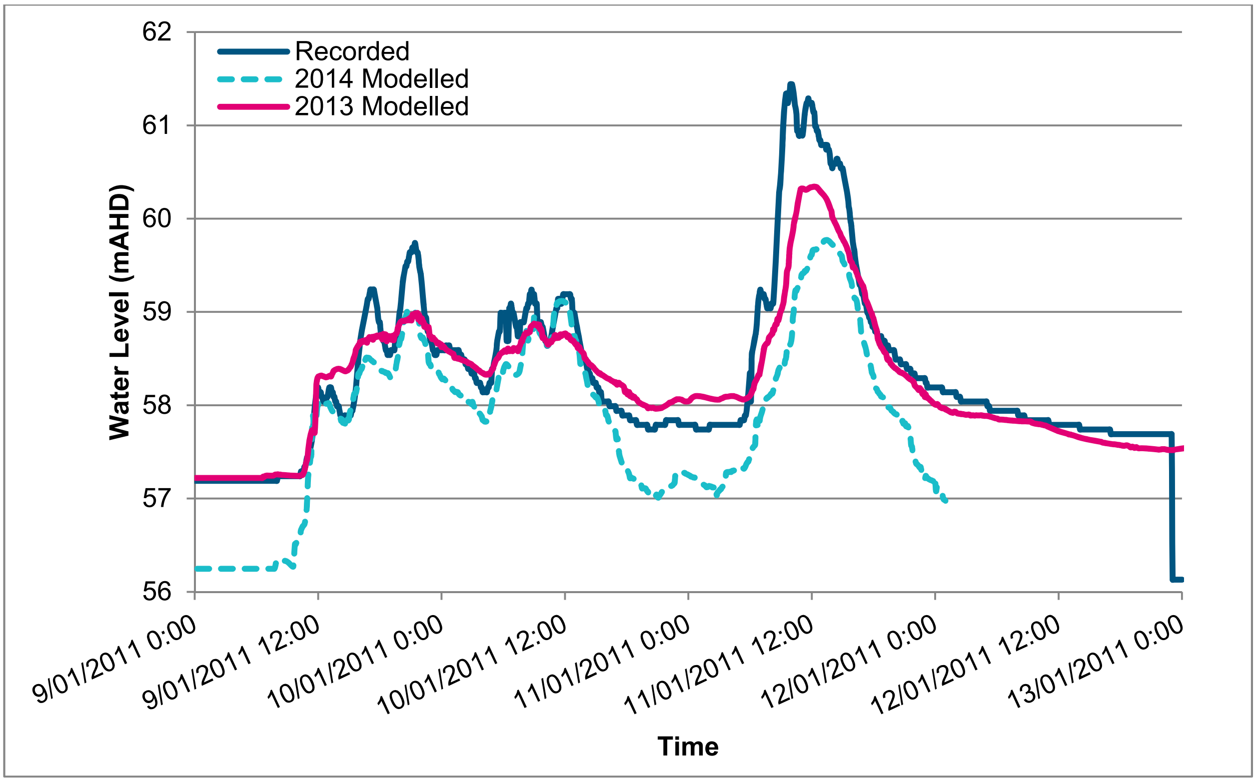

Figure 4-10 Recorded and Modelled Hydrographs at Cedar Creek Road gauge – January 2011

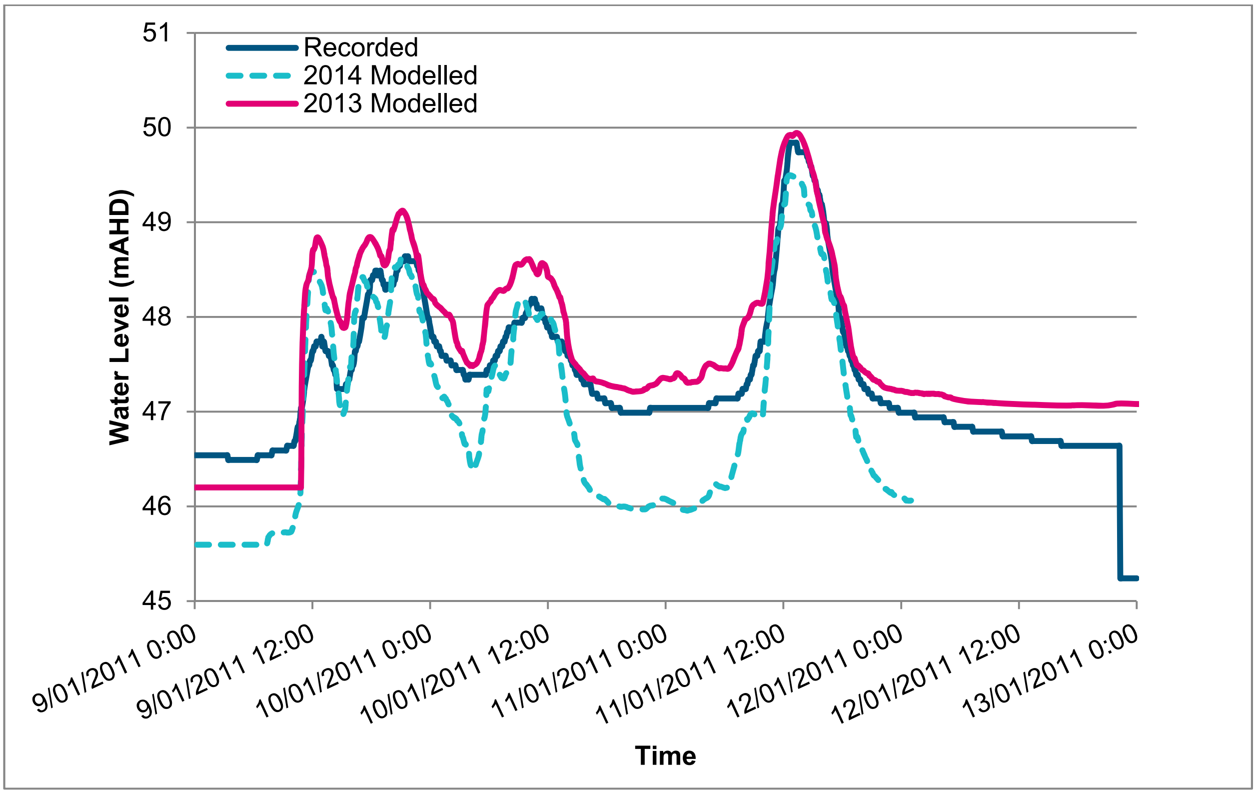

Figure 4-11 Recorded and Modelled Hydrographs at Samford Village gauge – January 2011

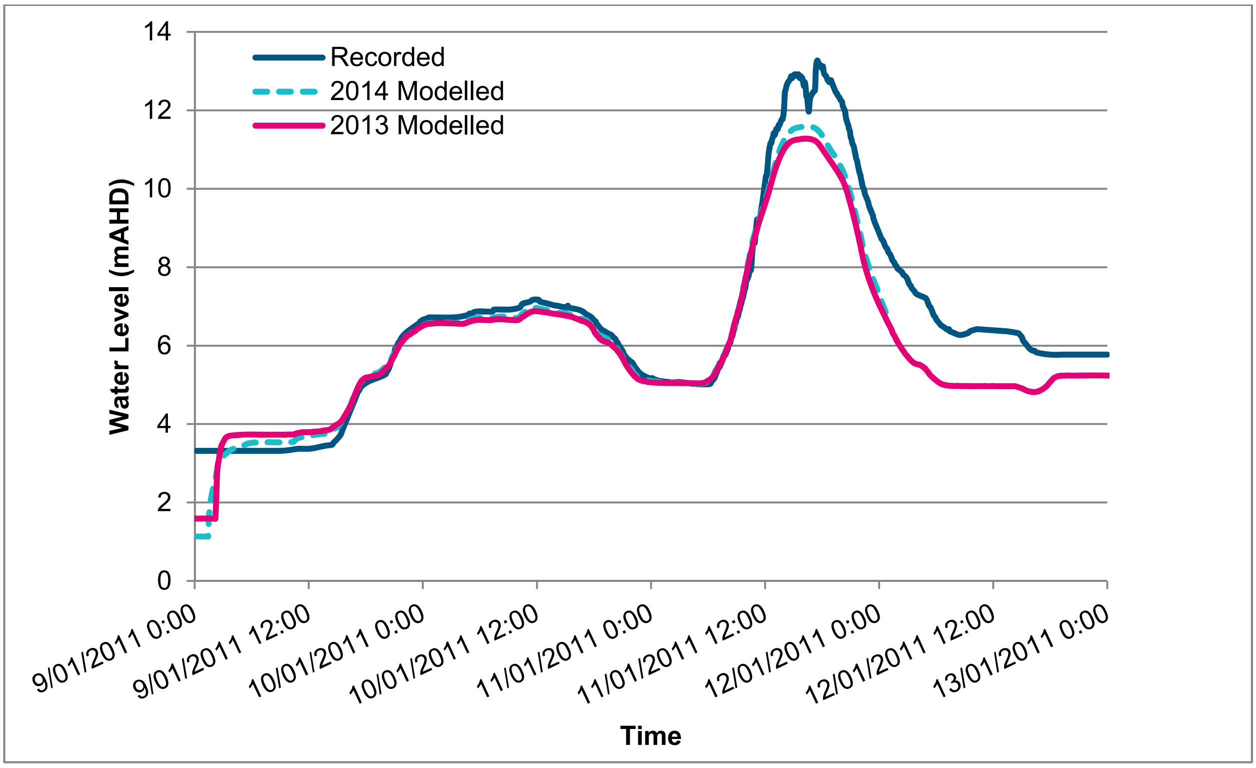

Figure 4-12 Recorded and Modelled Hydrographs at Youngs Crossing gauge – January 2011

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

- The timing (i.e. the shape of the hydrographs) at all of the gauges compares very well with the recorded hydrographs;
- The modelled peak levels of the Norman Park, Lawnton and John Bray Park are within the ±0.3m of the recorded peak level of their gauges;
- The modelled peak levels of the Murrumba Downs, Cash's Crossing and Samford Village are within the ±0.4m of the recorded peak level of their gauges; and
- The LPR RFD 2014 Maintenance model resulted in five of the nine gauges showing peak levels that were closer to the recorded peak level than the LPR RFD 2013 model.

The following key points compare the recorded and modelled peak flood levels between the LPR RFD 2014 Maintenance model and LPR RFD 2013 model:

- Peak flood levels at the Murrumba Downs gauge are not as good in the LPR RFD 2014 Maintenance model (0.36m lower than the recorded) compared LPR RFD 2013 model (0.05m lower than the recorded);
- Peak flood levels at the Normanby gauge match are out by a similar amount in the LPR RFD 2014 Maintenance model (0.29m higher than the recorded) compared to the LPR RFD 2013 model (0.28m lower than the recorded);
- Peak flood levels at the Lawnton gauge match better in the LPR RFD 2014 Maintenance model (0.03m higher than the recorded) compared to the LPR RFD 2013 model (0.20m lower than the recorded);
- Peak flood levels at the Cash's Crossing gauge match better in the LPR RFD 2014 Maintenance model (0.37m lower than the recorded) compared to the LPR RFD 2013 model (0.79m higher than the recorded);
- Peak flood levels at the John Bray Park gauge are very similar between the LPR RFD 2014 Maintenance model (0.09m lower than the recorded) and LPR RFD 2013 model (0.10m lower than the recorded);
- Peak flood levels at the Draper's Crossing gauge match not as good in the LPR RFD 2014 Maintenance model (1.22m higher than the recorded) compared to LPR RFD 2013 model (0.93m higher than the recorded);
- Peak flood levels at the Cedar Creek gauge match are not as good in the LPR RFD 2014 Maintenance model (1.67m higher than the recorded) compared to the LPR RFD 2013 model (0.57m higher than the recorded);
- Peak flood levels at the Samford Village gauge match better in the LPR RFD 2014 Maintenance model (0.34m higher than the recorded) compared to the LPR RFD 2013 model (0.45m higher than the recorded); and
- Peak flood levels at the Youngs Crossing gauge match better in the LPR RFD 2014 Maintenance model (1.68m lower than the recorded) compared to the LPR RFD 2013 model (1.99m lower than the recorded).

Flood Mark Comparison

- There were a total of 57 flood marks surveyed for the January 2011 flood event in the Lower Pine River model extent.
- 20 of the 57 flood marks were outside the modelled flood extent. Their levels were interpolated to the flood level nearest their location.
- The majority of the flood marks 59.6% were lower than that of the modelled flood level at the same location.

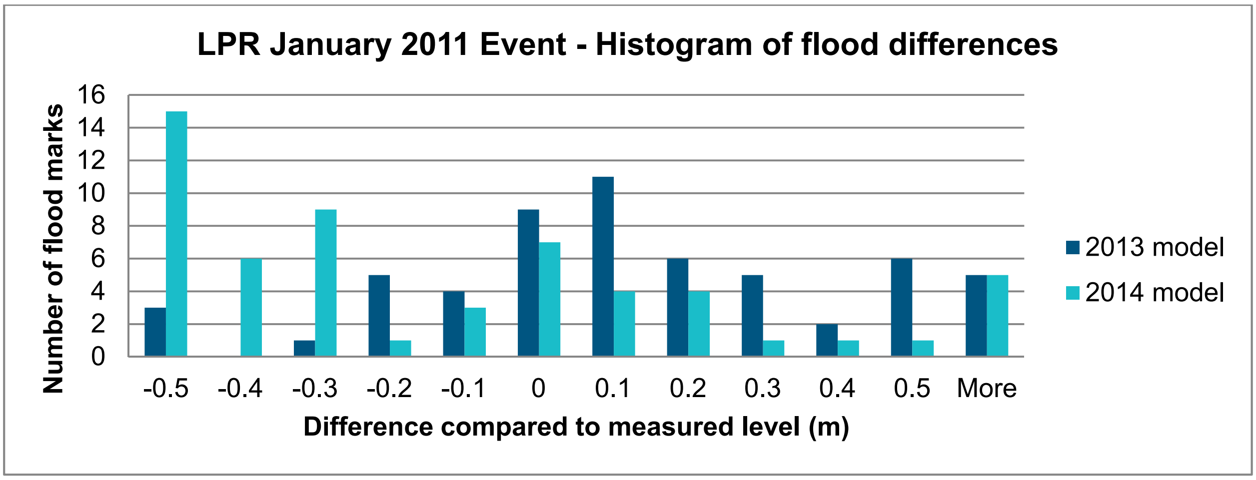

Figure 4-13 Floodmark Histogram – January 2011 Event

This histogram shows a significant portion (35%) of the flood marks are within ± 300mm and 65% of the flood marks are within ± 500mm.

The flood mark locations and the differences in surveyed and modelled peak flood levels in mm are illustrated in Figure 4-14. There is an area around the confluence of North Pine River and the One Mile Creek where the 23 measured flood levels points were consistently lower than the modelled flood levels with 21 of them >300mm lower. There are also variations between these levels by up to 1100mm, with some close points varying by approximately 300mm. The modelled results show that the peak flood level through this area was fairly constant at 11 mAHD, whereas the recorded flood levels ranged from approximately 10 mAHD through to 11.1 mAHD. Immediately downstream of this location there is the Sweeney Reserve pinch point where the modelled and the recorded levels match more closely. Just upstream of this area the modelled and the recorded levels match more closely.

Marks LPR005 (1.407mAHD) and LPR006 (1.893mAHD) near the corner of Dohles Rocks and Korman Roads, are 8m apart and have a difference in level of approximately 500mm with LPR006 matching the modelled result of approximately 1.89mAHD.

In comparison to the previous LPR 2013 flood model the flood mark calibration to the January 2011 event, the LPR RFD 2013 model calibrated better at the area around the North Pine River and One Mile Creek confluence. But for most of the rest of the flood marks the LPR RFD 2014 Maintenance model provided a closer match. The LPR RFD 2013 model had more flood marks outside the modelled flood extent.

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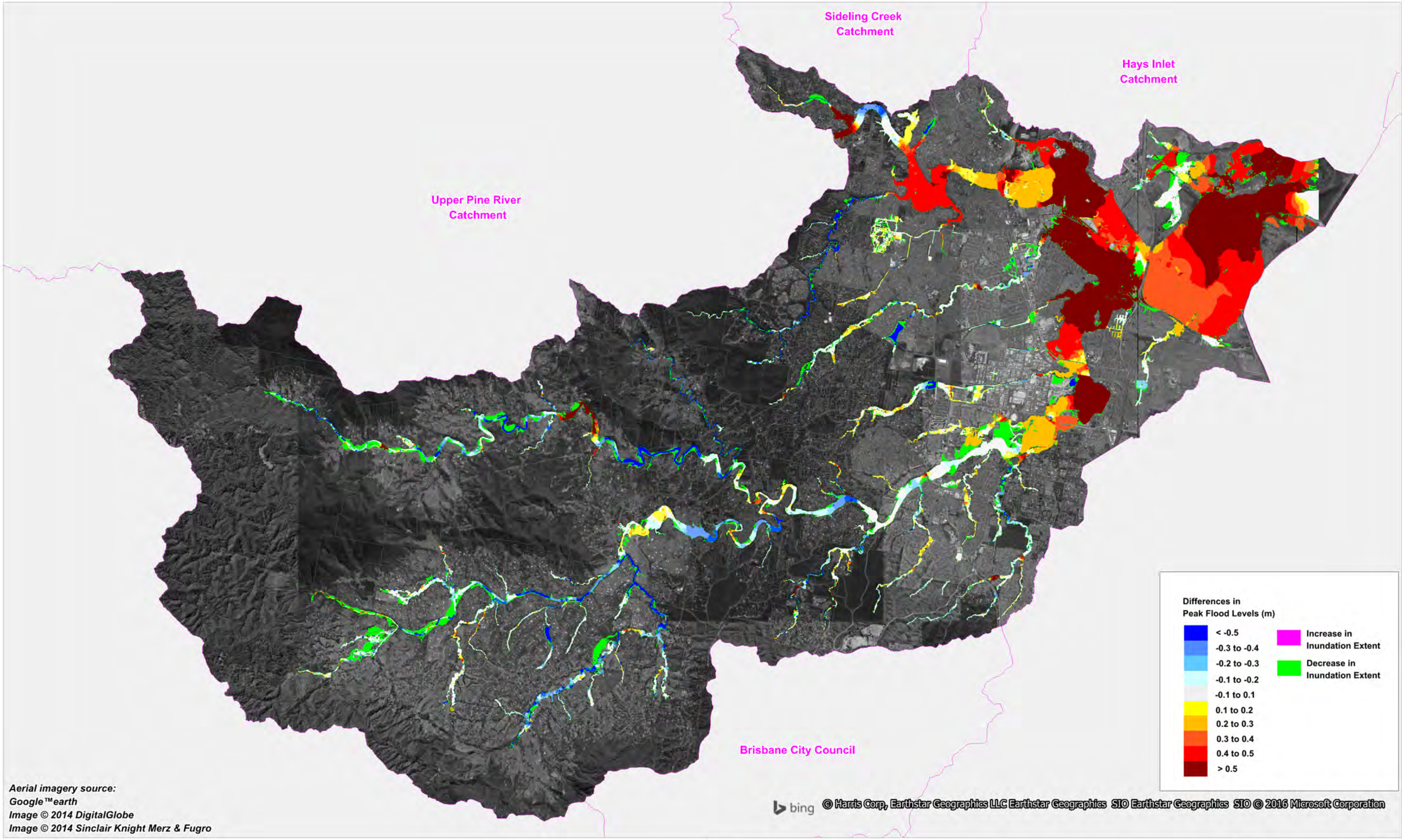

LEGEND

Lower Pine River Catchment Boundary

Cadastral Boundaries

Title:

Lower Pine River January 2011 Event Peak Flood Level Difference
LPR RFD 2014 Maintenance Model Minus LPR RFD 2013 Model

Figure **4-14**

Rev: **A**

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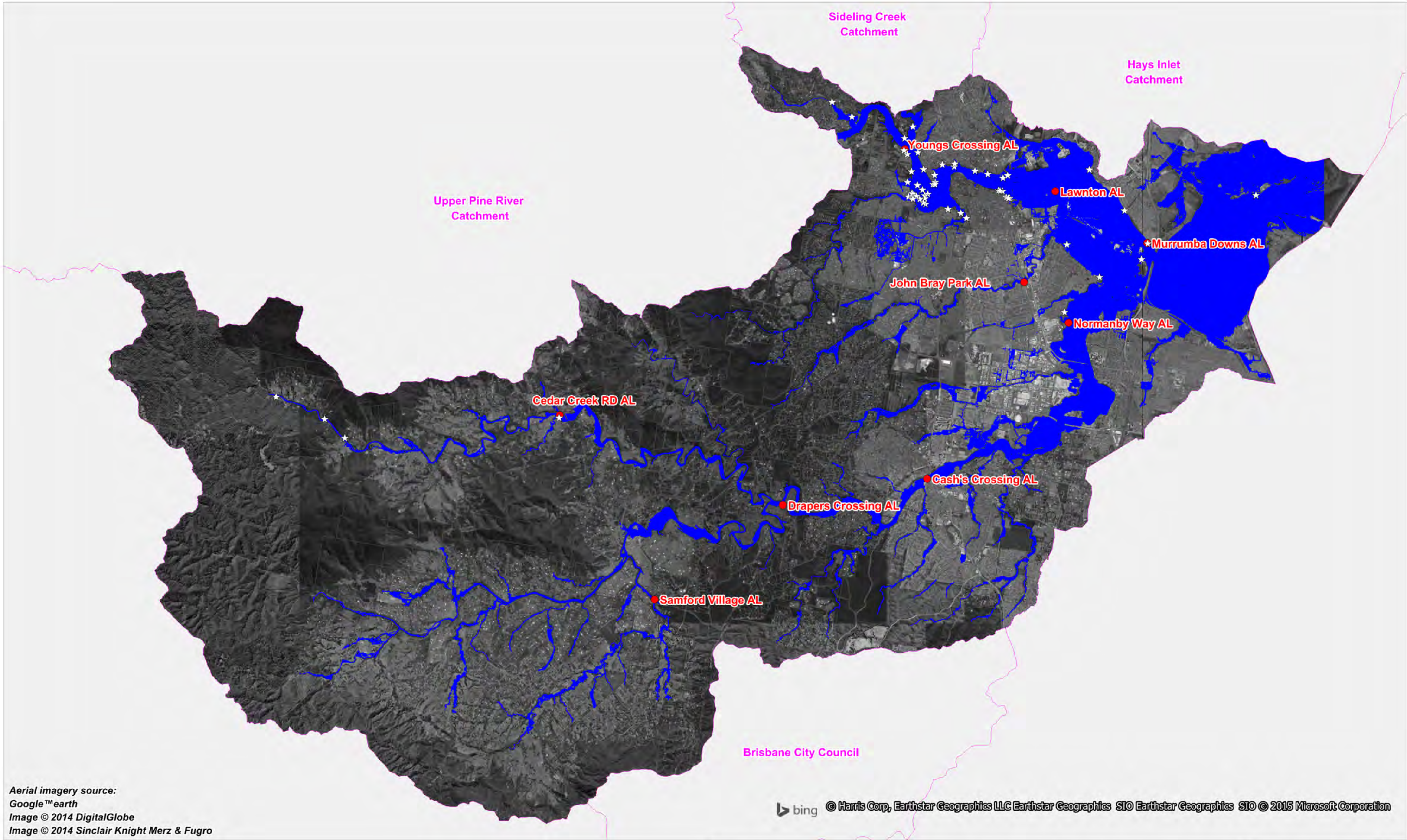

LEGEND

- Lower Pine River Catchment Boundary
- Cadastral Boundaries
- January 2011 Flood Extent
- River Alert Gauges
- ☆ Flood Marks

Title:

Lower Pine River January 2011 Event LPR RFD 2014 Maintenance Model Peak Flood Extent With Gauge Locations and Flood Marks

Figure **4-15**

Rev: **A**

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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 in this report because the focus of this project is on digital data, rather than the provision of flood maps.

4.3.1 River and Creek

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

- In the upper catchment flooding is mainly confined to the channels;

- The North Pine River break its banks near Gympie Road and engages the floodplain from this point downstream;
- Four Mile Creek is controlled by the flow that is able to pass through the North Coast Railway line. This impacts numerous properties north of the creek in events larger than the 2% AEP;
- In Bray Park near Samsonvale and Youngs Crossing Roads the model showed sheet flow rather than channelized flow, until it passes Dundee Street in all events modelled including the 1EY;
- Near the South Pine substation there is a breakout that diverts flood waters around the substation onto South Pine Road. This breakout connects other flow paths and results in additional sheet flow. This breakout occurs in all events modelled including the 1EY;
- The model indicates that there is likely to be sheet flow (breakouts from the channelized flow) through the industrial/commercial area off Kremzow Road in events 20% AEP and larger; and
- The model indicates Dohles Rocks Road becomes inundated in events larger than the 10% AEP and in the 1% it is likely that properties become inundated.

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 3.2.2 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 LPR TUFLOW storm tide modelling.

Table 4-1 Storm Tide Flood Behaviour Descriptions

Event	Flood Behaviour
1% AEP	The area east of the Bruce Highway located between the Gateway Motorway, Deagon Deviation, Henry Road and Elizabeth Road are all affected by this event. Properties on Dohles Rocks Road across from the North Pine River are inundated by flood waters. No other residential or commercial properties are affected.
5% AEP	Similar to the 1% AEP event with less properties affected along Dohles Rocks Road.
0.1% AEP	Similar to the 1% AEP event. Bells Pocket Road overtopped at Four Mile Creek Increased extent around Dohles Rocks and Elizabeth Road.
0.01% AEP	Similar to the 0.1% AEP event. Increased extent around Wagner Road, Griffin. Some properties on Holmes, Claudette and Sunnybrook streets, Brighton inundated. A property on Wagner Road is potentially inundated.
Future 1% AEP	Similar to the 0.01% AEP event. Development on Oriole Street, as well as Wagner and Junction roads, Griffin potentially isolated.

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 a lower peak flood levels to the envelope of the 1% AEP design event.

- The North Pine River showed levels that were up to 0.9m lower for a distance of approximately 1km downstream of North Pine Dam.
- From Byrnes Road North downs stream to Gympie Road the MDS event was between 0.25m to 0.65m lower than the 1% AEP design event.
- Gympie Road to the Bruce Highway the difference was between 0.15m to 0.25m.
- Downstream of the Bruce Highway the difference decreased from 150mm at the Bruce Highway to about 100mm at the downstream boundary.
- The model results for the South Pine River showed that more of the river had similar results, however the MDS resulted in lower level upstream of structures.
- Between the North Coast Railway line and Linkfield Road the MDS event resulted in levels that were between 0.45m and 0.8m lower than the 1% AEP design event.
- From Linkfield Road to Scouts Crossing Road the difference is 0.45m at Linkfield Road and for 100m upstream and then 0.3m through to Scouts Crossing Road where the two models then

have similar results. Upstream of South Pine Road the MDS event again resulted in lower levels (0.9m at the crossing) with levels approximately 0.3m to 0.5m lower for the 2km upstream of the crossing.

- Upstream of Bunya Crossing Road the difference between the modelled results for the MDS event and the 1% AEP design event was mostly between no change and 0.3m lower for the MDS event.

4.4.1 Hydraulic Roughness Analysis

Increasing the Manning's 'n' by 20% has resulted in an increase in peak flood levels of between 0.1m and 0.2m throughout the majority of the catchment. The following areas showed increases in peak flood levels greater than 0.2m:

- The North Pine River showed peak flood levels that were between 0.5m and 0.65m higher for a distance of approximately 1km downstream of North Pine Dam;
- From Byrnes Road North downstream to Houghton Street showed an increase of between 0.3m to 0.4m higher than the base MDS event;
- 500m upstream and downstream of the Bruce Highway Bridge over the Pine River the peak flood level increase was up to 0.25m;
- A section of the South Pine River between the Bunya Road crossing and Cash's Crossing showed increased peak flood levels of between 0.25m and 0.55m; and
- The South Pine River upstream of Cannington Court, Samford Village to Showgrounds Drive showed peak flood level increases of between 0.2m and 0.4m.

4.4.2 Structure Blockage Analysis

Blocking the culverts on a catchment wide scale has impacts of ±0.1m. There are localised impacts surrounding some culverts, with increases immediately upstream of the culverts of up to 1.4m. Most of the locations that were impacted were upper catchment small tributary crossings over relatively incised channels. Areas that showed impacts greater than ±0.1m included:

- A tributary on Showgrounds Drive with peak flood level increases of up to 0.55m;
- A tributary upstream of Davison Road, Camp Mountain resulted in a peak flood level increase of up to 1.0m;
- A tributary upstream of Upper Camp Mountain Road, Camp Mountain with a peak flood level increase of up to 1.4m;
- A tributary upstream of Mount Glorious Road, Camp Mountain indicated a peak flood level increase of up to 1.8m;
- A tributary upstream of Brunswick Place, Camp Mountain showed a peak flood level increase of up to 1.4m;
- Two tributary upstream of Camp Mountain Road, Camp Mountain showed peak flood level increases of up to 0.4m;

- Three tributaries upstream of Old Northern Road showed peak flood level increases up to 2.0m; with the downstream channel indicating decreases of up to 0.4m for a distance of approximately 3.5km;
- Some residential properties on Explorer Drive, Albany Creek had increases of up to 0.6m;
- Two tributaries upstream of Albany Forest Drive, Albany Creek showed increases of up to 1.5m for the smaller tributary and 0.4m for the larger tributary;
- Two tributaries upstream of Hidden Valley Drive, Eatons Hill showed increases of up to 1.4m and 2.6m;with the downstream channel having the (2.6m increase) and the upstream channel showing a decrease of up to 0.7m;
- The drainage channel near Avalon Court, Strathpine showed increased peak flood levels up to 0.4m before it crosses the railway line and then up to 1.0m between the railway line and Gympie Road. After Gympie Road the peak flood levels in the channel decreased by up to 0.5m until approximately Harvey Street;
- The drainage channel near Bradley Place Strathpine showed modelled peak flood levels with increases up to 0.6m;
- A number of the drainage channels in Bray Park showed model peak flood levels with increases up to 0.9m higher on the upstream side of crossings and decreases of up to 0.3m on the downstream side of the crossings; and
- Yebri Creek upstream of Anzac Avenue, Petri indicated peak flood levels up to 0.56m lower.

4.4.3 Climate Change and Downstream Boundary Conditions

R03 – Increase in rainfall intensity by 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 area near the downstream boundary showing no change. Areas that showed significant peak flood level increases include:

- North Pine River from the North Pine Dam to Houghton Street indicated peak flood levels increases by between 0.6m and 1.1m;
- North Pine River from Houghton Street to 1.2km downstream of Gympie Road had peak flood levels increased by between 0.4m and 0.5m;
- North Pine River from 1.2km downstream of Gympie Road to the Bruce Highway resulted in peak flood level increases by between 0.5m and 0.65m;
- Downstream of the Bruce Highway for approximately 3.3km showed modelled peak flood levels increased by approximately 0.35m; from this point they decreased to the downstream boundary;
- South Pine River from its confluence with the North Pine River to the Gympie Road showed peak flood levels increased by between 0.5m and 0.65m;
- South Pine River from the Gympie Road to Old Northern Road had modelled peak flood levels increased by between 0.25m and 0.45m;

- South Pine River upstream of Old Northern Road to Mount Samson Road indicated peak flood levels increased by between 0.6m and 1.4m;
- South Pine River upstream of Mount Samson Road resulted in peak flood level increases by between 0.2m and 0.8m;
- Samford Creek showed peak flood levels increased by between 0.2m and 0.5m with one of its tributaries showing that peak flood levels increased up to 0.7m;
- Cedar Creek upstream of its confluence with the South Pine River to Mount Samson Road indicated peak flood levels increased by between 0.6m and 1.2m;
- Cedar Creek upstream of Mount Samson Road showed peak flood levels increased by between 0.3m and 0.6m;
- One Mile Creek from its confluence with the North Pine River to Gordons Crossing Road showed peak flood levels increased by between 0.4m and 0.8m; and
- One Mile Creek upstream of Gordons Crossing Road showed peak flood levels increased by between 0.3m and 0.6m.

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 proposed sea level rise. As expected, results can be summarised as follows:

- Peak flood levels increased up to 0.8m near the downstream boundary;
- All peak flood level increases were reduce to less than 0.1m at the Bruce Highway; and
- There was a small area at the end of Johnstone Road, Brendale where peak flood levels increased by 0.2m.

R05- Increase in rainfall intensity by 20% 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 0.6m. Areas where the increased flood levels was greater than 0.6m included the following:

- North Pine River from the North Pine Dam to Washbrook Crescent with peak flood level increases by between 0.6m and 1.2m;
- North Pine River from approximately 2000m upstream of the Bruce Highway to approximately 500m upstream of the Bruce Highway resulted in peak flood level increases by between 0.6m and 0.7m;
- South Pine River from its confluence with the North Pine River to approximately 700m downstream of Gympie Road showed peak flood levels increased by between 0.6m and 0.75m;
- South Pine River from South Pine Road to Bunya Road resulted in peak flood level increases by between 0.75m and 1.5m;

- South Pine River from Bunya Road to approximately 1000m downstream of Mount Samson Road showed peak flood level increases by between 0.6m and 1.5m, with most of this section increased by between 0.6m and 0.9m;
- South Pine River from Cannington Court to Greggs Road had peak flood levels increased by between 0.6m and 0.85m; and
- Cedar Creek upstream of its confluence with the South Pine River to Mount Samson Road showed peak flood levels increased by between 0.6m and 1.2m, most of this section was increased less than 0.9m.

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

Applying the 1% static 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 Gympie Road.

- Impacts upstream of the Bruce Highway to Gympie Road were between 0.1m and 0.2m and peak flood level increase at the downstream boundary was up to 1.5m.

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 to 2.8m at the downstream boundaries of the catchment. The following locations indicate peak flood level changes greater than ±0.1m:

- North Pine River from the Bruce Highway to the downstream boundary resulted in peak flood level increases of 0.9m at the Bruce Highway to 2.8m at the downstream boundary;
- North Pine River from the Bruce Highway to Gympie Road indicated peak flood level increases of between 0.6m to 1.05m;
- North Pine River from Houghton Street to Gympie Road showed peak flood level increases by between 0.35m and 0.55m;
- North Pine River from the North Pine Dam to Houghton Street resulted in peak flood level increases by between 0.6m and 1.1m;
- South Pine River from the Bruce Highway to Gympie Road had peak flood level increases of between 0.8m to 1.05m;
- South Pine River from Gympie Road to Linkfield Road resulted in peak flood level increases of between 0.25m to 0.5m;
- South Pine River from Linkfield Road to Old Northern Road had peak flood level increases of between 0.2m to 0.45m;
- South Pine River from Old Northern Road to Bunya Road resulted in peak flood level increases of between 0.8m to 1.25m;

- South Pine River from Bunya Road to Mount Samson Road indicated peak flood level increases of between 0.5m to 0.9m; and
- South Pine River upstream of Mount Samson Road resulted in peak flood level increases of between 0.3m to 0.9m, with the majority up to 0.5m.

4.4.4 Future Landuse Analysis

R08 – Increased vegetation in floodplain

Increasing the vegetation in floodplains typically changes level throughout the catchment by ±0.3m. Areas where peak flood levels differ (from ±0.3m) include:

- North Pine River from the North Pine Dam to the railway line showed peak flood levels increased by between 0.3m and 2.4m, with only the section between Byrnes Road North and Affleck Avenue having increases greater than 1.0m;
- The drainage channels between Samsonvale Road, Youngs Crossing Road and Francis Road showed peak flood levels increased by between 0.3m and 0.66m;
- One Mile Creek from its confluence with the North Pine River to Youngs Crossing Road showed peak flood levels increased by between 0.3m and 0.7m;
- One Mile Creek up to approximately 400m upstream of Gordons Crossing Road showed peak flood levels increased by between 0.3m and 0.45m;
- North Pine River from the Bruce Highway to Gympie Road resulted in peak flood level decreases of between 0.3m to 0.6m;
- South Pine River from Feuerriegel Road to Gympie Road indicated peak flood level increases of between 0.3m to 0.5m;
- South Pine River from the railway line to Greensill Road showed peak flood level increases of between 0.3m to 1.0 m;
- South Pine just upstream of South Pine Road resulted in peak flood level decreases of between 0.3m to 0.4m;
- South Pine River from Harley Court to Bunya Road indicated peak flood level increases of between 0.3m to 1.75m;
- South Pine River from Bunya Road to Cannington Court showed peak flood level increases of between 0.3m to 2.5m; most of this section showed an increase up to 1.0m;
- South Pine River through Samford Valley from Regoli Court to Stavewood Court had peak flood level increases of between 0.3m to 0.8m; and
- Bald Hills Creek from the Gateway Motorway to approximately Holmes Street the modelled peak flood level showed decreases of between 0.3m to 0.4m.

R09 – Increased residential development

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

- A tributary upstream of Davison Road, Camp Mountain showed an increase of up to 0.4m;
- A tributary upstream of Upper Camp Mountain Road, Camp Mountain resulted in an increase of up to 0.3m;
- A tributary upstream of Mount Samson Road, Closeburn indicated an increase of up to 0.4m;
- A drainage channel along Stanley Street Strathpine resulted in an increase of up to 0.5m;
- A drainage channel along Lucy Street and crosses Walter Crescent Strathpine indicated an increase of up to 0.75m;
- A tributary of Yebri Creek Petri upstream of the railway line showed an increase of up to 0.4m; and
- A tributary of North Pine River upstream of Patman Road resulted in an increase of up to 0.35m.

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 compared to R08:

- North Pine River from the Bruce Highway to Gympie Road showed peak flood level decreases of between 0.3m to 0.55m, generally the R10 peak flood levels were approximately 20mm to 50mm higher than the R08 peak flood levels in this area;
- South Pine River upstream of Mount Samson Road indicated peak flood level increases of between 0.3m to 1.05m, with the majority up to 0.5m, generally the R10 peak flood levels were approximately 20mm to 50mm higher than the R08 peak flood levels;
- South Pine River from Bunya Road to Mount Samson Road resulted in peak flood level increases of between 0.5m to 2.55m, generally the R10 peak flood levels were approximately 60mm to 80mm higher than the R08 peak flood levels;
- South Pine River from Harley Court to Bunya Road had peak flood level increases of between 0.3m to 1.8m; generally the R10 peak flood levels were approximately 60mm to 70mm higher than the R08 peak flood levels;
- South Pine River from the railway line to Greensill Road the peak flood level showed increases of between 0.3m to 1.05m; with generally the R10 peak flood levels being approximately 30mm to 40mm higher than the R08 peak flood levels;
- South Pine River from Feuerriegel Road to Gympie Road resulted in peak flood level increases of between 0.3m to 0.55m; generally the R10 peak flood levels were approximately 30mm to 40mm higher than the R08 peak flood levels; and

- Bald Hills Creek from the Gateway Motorway to approximately Craig Street indicated peak flood level decreases of approximately 0.3m; generally the R10 peak flood levels were approximately 30mm to 40mm higher than the R08 peak flood levels.

4.5 Model Limitations and Quality

Watercourses within the Lower 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

The LPR RFD 2014 and 2016 Maintenance models have significantly long model run times, in particular for the 5m resolution and very large memory (RAM) requirements. Table 4-2 shows the LPR TUFLOW model run times and memory (RAM) requirements for various design events, the 1% AEP MDS and the January 2011 event. The 12 hour storm duration was chosen, as it is the longest available duration 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 hour	5m	12 days	28.09 Gb
1% AEP 12 hour	5m	10 days	28.09 Gb
0.2% AEP 12 hour	10m	3 days	5.64 Gb
1% Storm Tide S01	5m	1 day	6.38 Gb
1% AEP MDS	5m	9 days	28.09 Gb
January 2011	10m	16 days	5.64 Gb

5 Conclusion

As part of the Regional Floodplain Database (RFD) LPR RFD 2014 Maintenance Model Project, Council updated all of the existing hydrologic and hydraulic models, due to the availability of more accurate data. LPR RFD 2016 has been subsequently updated based on the more recent changes to the North Pine Dam operations and the inclusion of the new Moreton Bay railway line and stations.

It is recommended that when future flooding events occur additional flood mark measurements be taken in the South Pine River and Cedar Creek areas as the current validation event lacks flood mark measurements in these areas. If an additional stream gauge was to be included within the LPR RFD 2016 Maintenance model extent, it would be recommended that it be placed on Cedar Creek at Eatons Crossing or at Cedar Creek Road (just upstream of the intersection with Halls Road) as it is a significant contributing catchment that is currently ungauged.

As a result, the hydrologic subcatchments within the Lower Pine River (LPR) catchment were reviewed and found to be fit-for purpose. 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 LPR were updated with LiDAR (elevation data collected in 2014), additional structures, improved representation of streams and roads, and additional bathymetry data for the Pine River. As a result of these changes, namely the 2016 LiDAR, the downstream boundary required modification to ensure that the resulting outflows were stable.

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. . All design, historic and storm tide models and model outputs have been provided in digital format. Minimal flood maps have been provided within the report, as requested by Council. The outcomes of this work will be included into Council's Flood Explorer, used in the automated provision of Council's check property reports provided to the community and used by Council to analyse and assist with managing flood risk in the Lower Pine River catchment.

6 References

BMT WBM, 2013a, *Regional Floodplain Database Hydrologic and Hydraulic Modelling Lower Pine River (LPR) Final Report*

BMT WBM, 2013b, *Lower Pine River Pilot Model Improvement Study – Final Report*

BMT WBM, 2014a, *Four Mile Creek Railway Bridges Review - Stage 1*

BMT WBM, 2014b, *Four Mile Creek Railway Bridges Review - Stage 2*

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

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

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.

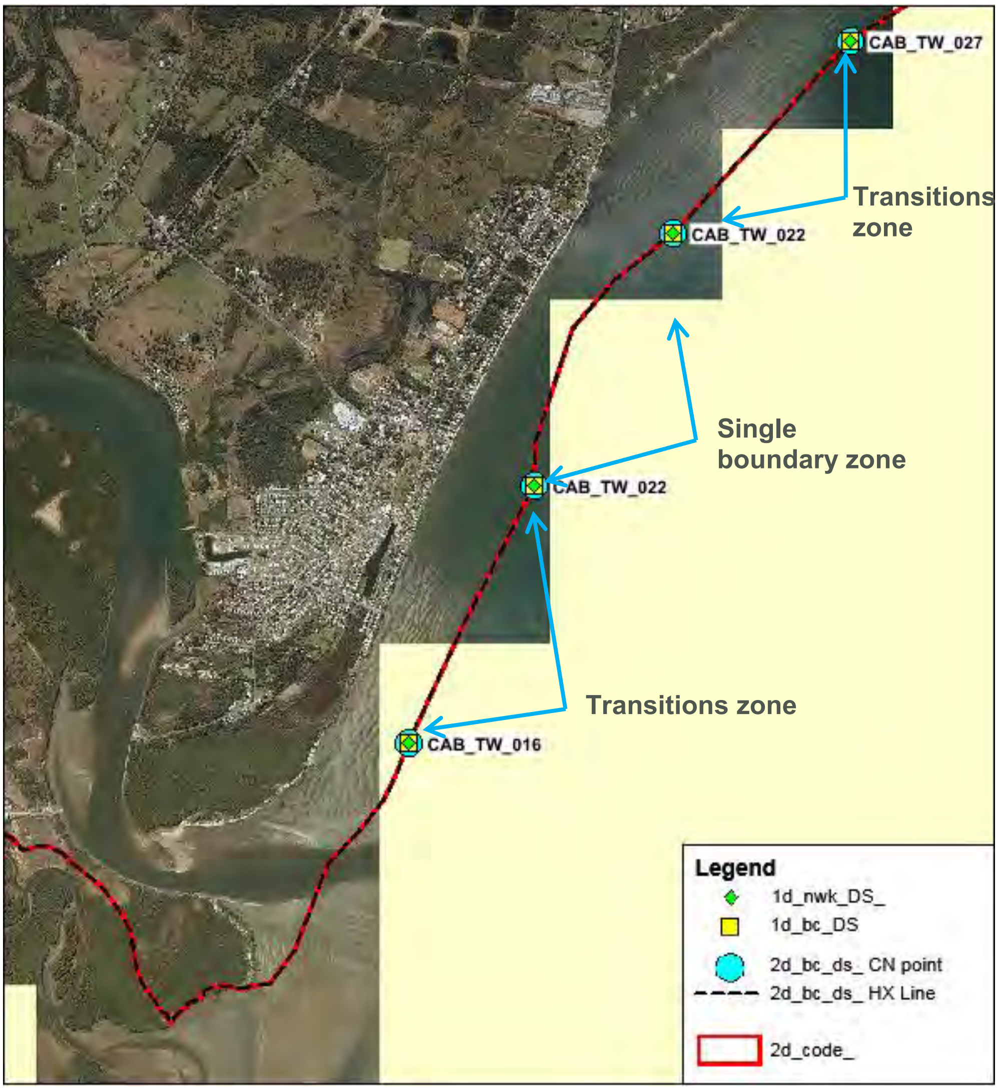
    h. DS_Invert should be set to the same value as US_Invert.

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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