Regional Floodplain Database:

2014 Model Maintenance Report - Byron Creek (BYR)

Moreton Bay
Regional Council

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Regional Floodplain Database 2014 Model Maintenance Report for Byron Creek (BYR)

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Prepared For:

Moreton Bay Regional Council

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Report Status

Reference	Date	Status	Author	Review
J00167D1V1	30/4/2015	DRAFT	TA	R Stewart
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J00167R1V1	23/7/2015	FINAL	TA	R Stewart RPEQ 13272

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Abbreviations

1D	One-Dimensional
2D	Two-Dimensional
AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
AHD	Australian Height Datum
AR&R	Australian Rainfall and Runoff
BoM	Bureau of Meteorology
DEM	Digital Elevation Model
DERM	Department of Environment and Resource Management (Queensland)
DTMR	Department Of Transport and Main Roads (Queensland)
EY	Exceedances per Year
GIS	Geographic Information Systems
HWMC	Hydrology and Water Management Consulting Pty Ltd
IEAust	Engineers Australia
IFD	Intensity Frequency Duration (Rainfall Intensities)
MBRC	Moreton Bay Regional Council
MDS	Moreton Bay Regional Council Design Storm
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RCP	Reinforced Concrete Pipe
RFD	Regional Floodplain Database
RCBC	Reinforced Concrete Box Culvert
SPP	State Planning Policy
TIN	Triangular Irregular Network
QUDM	Queensland Urban Drainage Manual
WBNM	Watershed Bounded Network Model (Hydrologic Modelling Software)

1 INTRODUCTION

The Byron Creek Catchment is one of fourteen 'minor basins' within the Moreton Bay Regional Council (MBRC) Local Government Area (LGA). The catchment has an approximate area of 660ha and the predominant landuse is characteristic of dense bushland.

Moreton Bay Regional Council currently has existing hydrologic and hydraulic models of all fourteen minor basins which are used to derive flood results for inclusion in their Regional Floodplain Database (RFD).

All hydrology and hydraulic models used to inform the RFD are being updated to incorporate new digital terrain data based upon aerial LiDAR which was captured in 2014 across the entire LGA. In addition to this, various other model refinements and updates have been carried out to improve the flood model predictions across the LGA.

This report has been prepared by Hydrology and Water Management Consulting (HWMC) to outline and summarise model maintenance and update features associated with RFD Maintenance (2014) for the Byron Creek minor basin.

2 2014 MODEL MAINTENANCE DETAILS

2.1 WBNM Model

Table 2-1 provides a list of all WBNM maintenance tasks outlined by MBRC at the inception of this project.

Table 2-1 WBNM Model Maintenance Tasks

Maintenance Task	Update Comments
Consolidate WBNM model files and update naming convention and folder structure	Completed
Reviewing and update minor catchment boundaries where new LiDAR indicates significant change in elevation or where major new linear infrastructure sub-divides catchments	Completed – western sub-catchments were amended as a consequence of better resolution LiDAR data. Refer Figure 2-1
Increase initial design losses to 15mm for the 1EY, 0.5EY, 20%, 10% and 5% AEP design events	Completed
Run updated WBNM models for the 1EY, 0.5EY, 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% and PMF events for at least 10 storm durations relevant to the minor basin	Complete
Run a WBNM model for the MBRC Design Storm (MDS) (1%AEP 15min in 270min 'Embedded Design Storm')	Complete
Run a WBNM model for the MDS with 20% increase in rainfall intensity	Complete
Review and compare with previous modelling results, undertake quality checking of model performance and make iterative adjustments to the model	Completed

The review of existing sub-catchment boundaries against newly collected LiDAR data demonstrated a need to amend and update various sub-catchments situated in the western extent of the minor basin. The updated minor catchments are shown in Figure 2-1 and listed below in Table 2-2.

Table 2-2 Updated Western Sub-catchments

Updated Sub-catchment ID	Updated Sub-catchment Area (Ha)
BYR_08_01079	88.7
BYR_08_00091	34.0
BYR_10_00000	32.6
BYR_08_00000	1.0
BYR_01_00000	19.8
BYR_01_00409	11.0

Existing sub-catchment fraction impervious values for Byron Creek were not altered as part of this model upgrade project. The existing landuse is predominately bushland and cleared open space and not zoned for future development.

2.2 TUFLOW Model

Table 2-3 outlines all TUFLOW model maintenance tasks required to be undertaken for the minor basin hydraulic model upgrade as outlined by MBRC. Comments are included below which outline how each task was applied to the Byron Creek minor basin.

Table 2-3 TUFLOW Model Maintenance Tasks

Model Maintenance Task	Update Comments
Consolidate TUFLOW model files as per new naming convention	Completed
Upgrade to the latest TUFLOW executable	Completed
Incorporate new LiDAR topography	Completed
Incorporate breaklines along all stream centrelines	Completed
Update Hydraulic Structures (culverts and bridges)	Not Applicable – no culverts or bridges
Make adjustments to the method of modelling trunk drainage	Not Applicable – no trunk drainage
Review the location and naming of PO lines	Completed
Review and make improvements to the TUFLOW model in hydraulic model investigation areas	Not Applicable – no investigation areas in Byron Creek Catchment
Include new bathymetry data where applicable	Not Applicable
Review spatial definition of hydraulic roughness in areas of significant flow conveyance. Incorporate updated hydraulic roughness (landuse) layers provided by Council.	Reviewed. No changes required
Review modelling of large buildings and clusters of smaller buildings	Not Applicable – no large buildings or clusters of small buildings

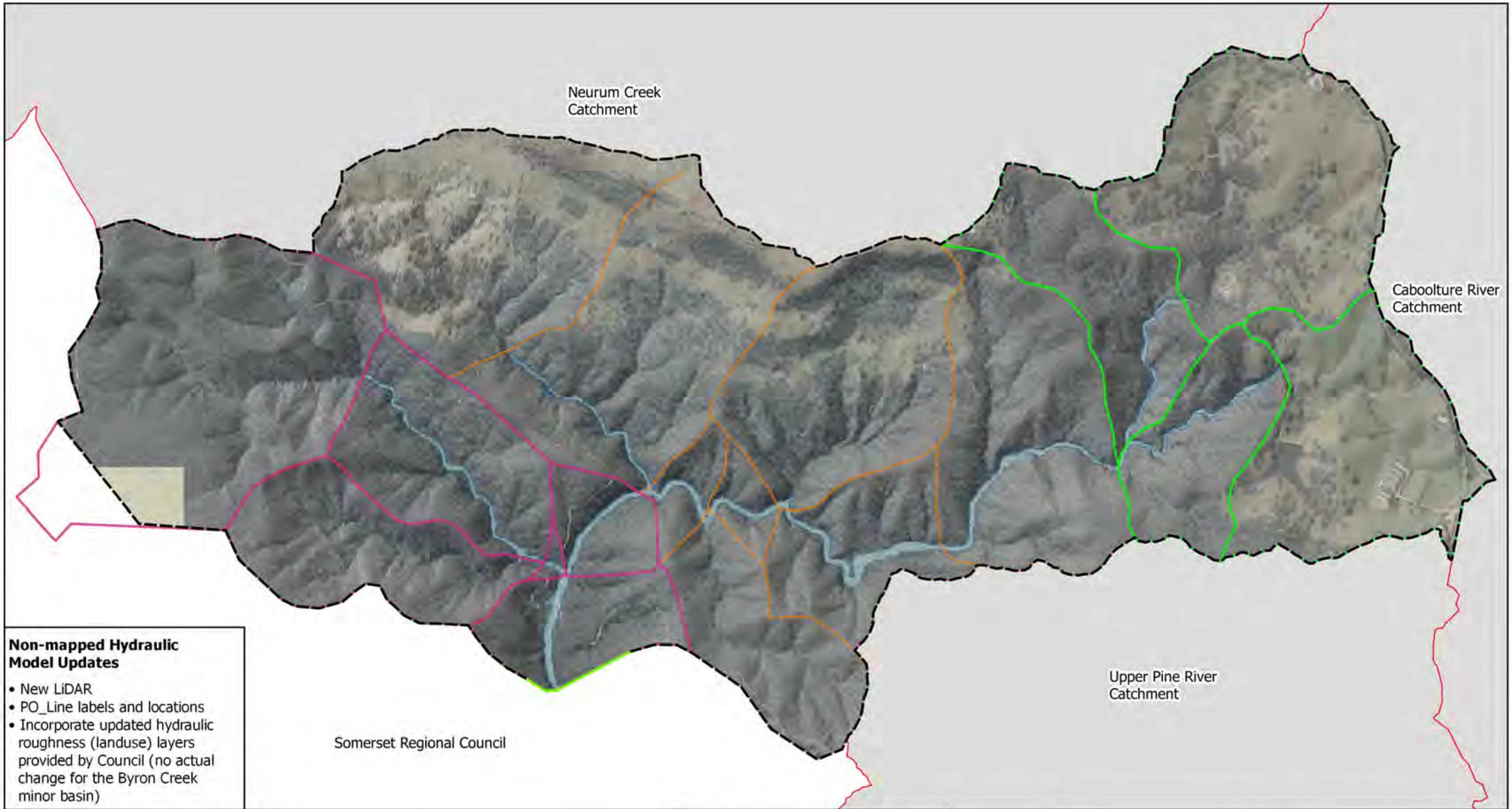
The latest TUFLOW build release (Build 2013-123-AD) has been used for the model update.

The Byron Creek ‘minor’ basin does not include any significant drainage structures or culverts. There are no significant buildings or groups of buildings within or near the flood plain. As such, all tasks relating to drainage structures and hydraulic modelling of larger structures within the flood plain were not applicable to Byron Creek.

Breaklines have been included where required to allow for a better representation of gullies in the TUFLOW model topography.

Inflow boundary polygons were upgraded as per revised WBNM sub-catchment delineation as outlined in Section 2.1. All sub-catchments were included as SA polygons and only local inflows input into the TUFLOW model. The downstream boundary location was revised further south in line with changes to western sub-catchment delineation.

Figure 2-1 provides a visual outline and list of all other relevant TUFLOW model parameters which were changed as part of the Byron Creek model upgrade.



Legend

- Updated TUFLOW outflow boundary location
- Updated hydraulic model extent
- WBNM Sub-Catchments(no changes)
- Updated WBNM Sub-Catchments boundaries
- Updated SA polygons to local inflows

Project: **RFD Maintenance 2014**

Title: **Byron Creek Maintenance Features**

Client: **Moreton Bay Regional**

Figure. 2-1

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3 MODEL SIMULATIONS

3.1 Verification

Calibration and verification against recoded rainfall and flood marks was not undertaken for the RED model because of limited historical event data.

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 a probability of occurrence, usually specified as an Average Exceedance Probability (AEP). For events less than the 20% AEP, the terminology Exceedances per Year (EY) is used.

3.2.1 River and Creek Critical Duration Assessment

A critical duration assessment was undertaken for the 1% and 0.1% AEP events, with 11 durations being analysed in each case.

Table 3-1 provides the list of 11 design durations which were chosen for hydraulic modelling for the 1% and 0.1% AEP design events.

Table 3-1 Preliminary Design Durations in TUFLOW

Durations for events less than or equal to 1% AEP (minutes)	Durations for events greater than 1% AEP (minutes)
30	30
45	45
60	60
90	90
120	120
180	150
270	180
360	240
540	300
720	360
1440	720

Figure 3-1 provides a critical duration assessment for the 1% AEP design event. The figure shows the design flood envelope generated from the (design event) duration which generates highest peak flood height at a particular location within the flood extent. The duration envelopes indicate the 60 and 90 minute design events are most critical for the 1% AEP in the Byron Creek minor basin.

Figure 3-2 provides the same analysis for the 0.1% AEP. The duration envelopes indicate the 45 and 60 minute durations are most critical.

In order to validate chosen durations prior to selection, a flood height difference plot was generated between the preliminary 11 durations flood envelope and the final adopted critical duration flood envelope. i.e. 60 and 90 minute duration for 1% AEP.

Figure 3-3 indicates no quantifiable difference in flood height between the 11 duration's envelope and the adopted critical duration's envelope for the 1% AEP.

Figure 3-4 indicates only minor differences in flood height between the 11 duration's envelope and the critical duration's envelope for the 0.1% AEP. The differences are generally less than 30mm and in most areas less than 15mm.

Table 3-2 shows the final adopted critical durations for Byron Creek minor basin.

Table 3-2 Critical Durations in TUFLOW

Critical Durations (events less than or equal 1% AEP)	Critical Durations (events greater than 1% AEP)
60 minute	45 minute
90 minute	60 minute

3.2.2 River and Creek Design Event Simulations

Design event simulations were undertaken for a range of AEP's using the critical durations determined form Section 3.2.1. Table 3-3 shows the list of design event AEP's and the applicable critical durations.

Table 3-3 Existing Case Design Event TUFLOW Simulations

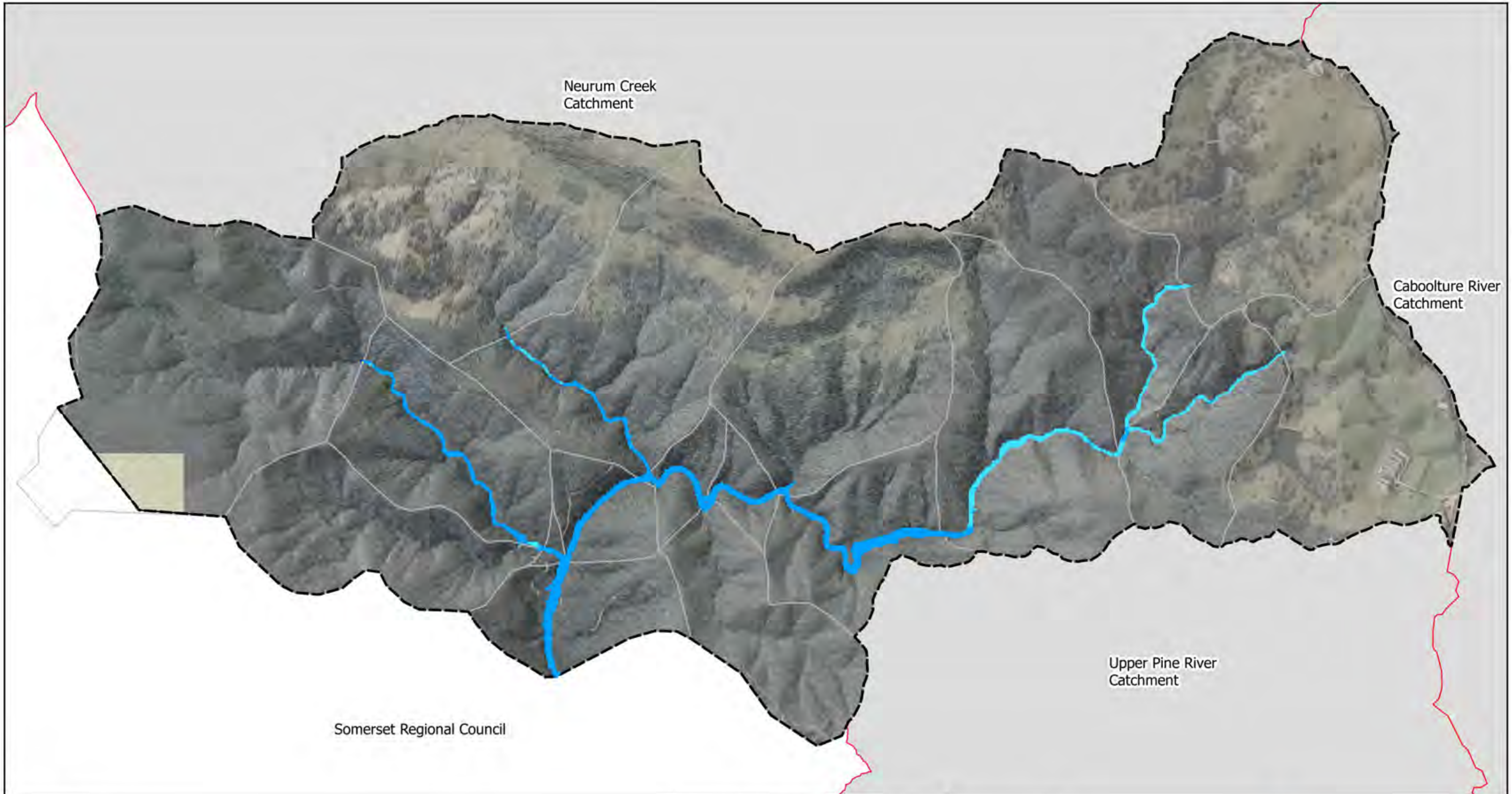
Design Event	Critical Durations
1EY, 0.5EY, 20%, 10%, 5%, 2% and 1% AEP	60 and 90 minute
0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP's and PMF	45 and 60 minute

In addition to these standard design events, Moreton Bay Regional Council have adopted an embedded design storm, termed MBRC Design Storm (MDS). 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).

The embedded design storm synthesises a range of design storm hyetographs into one representative design hyetograph. The embedded design storm is based on a 1% AEP, 270 minute design event with an embedded 'storm burst' based on the shorter 15 minute duration.

3.2.3 Storm Tide Design Event Simulations

The BYR minor basin has a model outlet elevation which is not impacted by storm tide. Consequently, storm tide simulations are not applicable to this minor basin.



Legend

1% AEP Duration Envelopes

0030	0090	0360
0045	0120	0540
0060	0180	0720
	0270	1440

BYR_002c_E_2d_code_01

BYR_002c_E_2d_SA_01

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Byron Creek Critical Duration Assessment - 1%AEP

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Figure. 3-1

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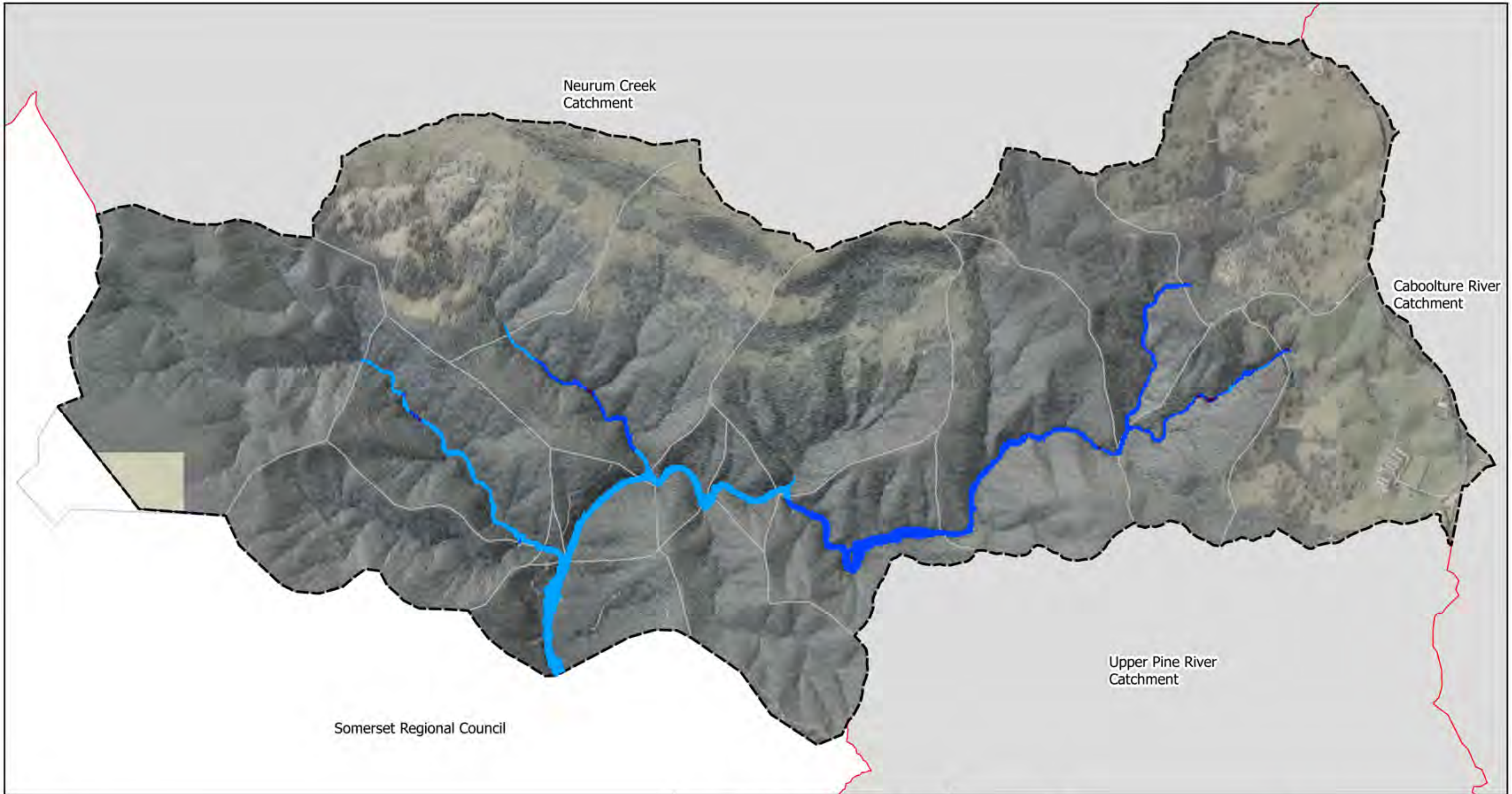

Legend

0.1% AEP Duration Envelopes

0030	0090	0240
0045	0120	0300
0060	0150	0360
	0180	0720

BYR_002c_E_2d_code_01

BYR_002c_E_2d_SA_01

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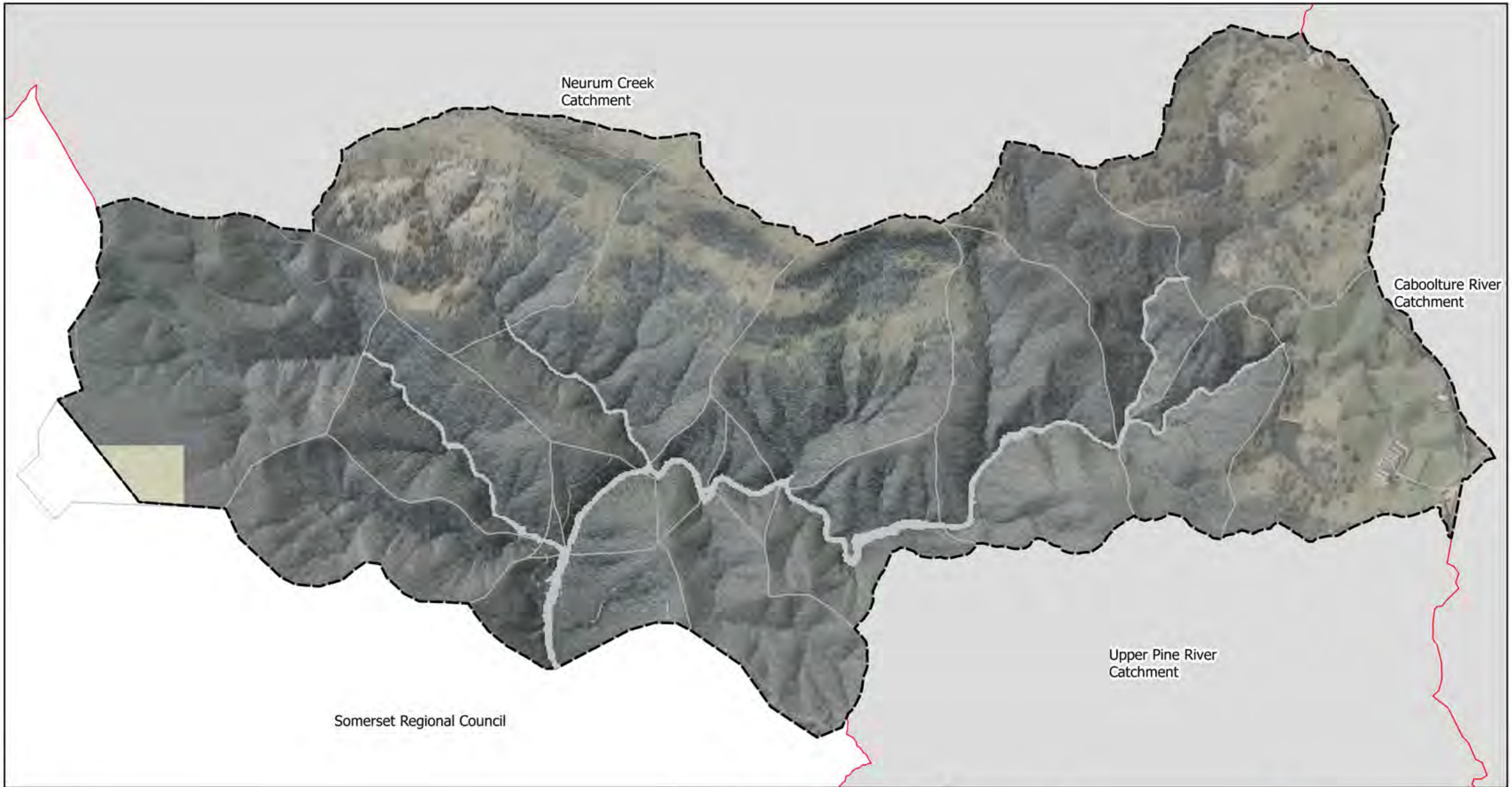

Legend

Peak Flood Level Difference (m)

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

- BYR_002c_E_2d_code_01
- BYR_002c_E_2d_SA_01

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Title:
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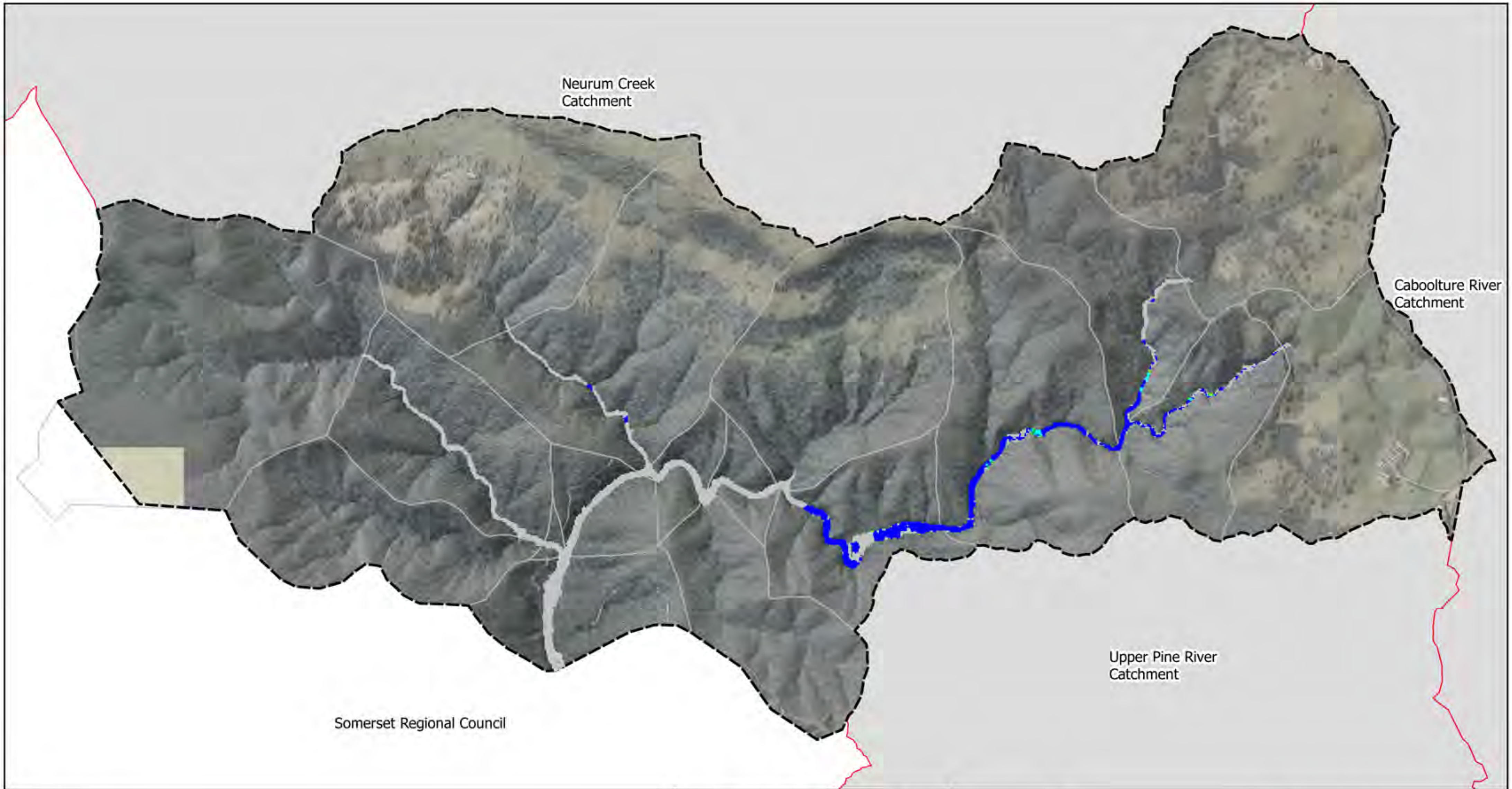

Legend

Peak Flood Level Difference (m)

- <-1.00
- -1.00 to -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- No Change
- Decrease In Inundation Extent
- BYR_002c_E_2d_code_01
- BYR_002c_E_2d_SA_01

Project: **RFD Maintenance 2014**

Title:
Byron Creek Critical Duration Assessment Peak Flood Level Difference - 0.1%AEP

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Figure. 3-4

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3.3 Sensitivity Analysis

All sensitivity testing has been undertaken using the MDS. A description of each sensitivity scenario is provide in Table 3-4 however it is noted that certain scenarios were not applicable to the BYR minor basin due to it not being influenced by ocean levels and also due to MBRC currently not having urban development planned within the minor basin.

Table 3-4 Details of Sensitivity, Climate Change and Future Scenario Runs

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

In order to check sensitivity of model results, an analysis was undertaken using the MBRC Design Storm, whereby all manning's roughness values in the 2D domain were increased by 20% in the TUFLOW model (R01). All other TUFLOW parameters were left unchanged.

3.3.2 Structure Blockage Scenario

Scenario testing of structure blockages (R02) did not apply to the Byron Creek minor basin, given that no structures are included within the catchment or model.

3.3.3 Climate Change and Downstream Boundary Conditions

The following three scenarios were modelled to test climate change impacts as a consequence of more severe and widespread rainfall.

- **R03:** Investigate the impact of an increase in rainfall intensity of 20% (as per SKM (2012a) ***Boundary Conditions, Joint Probability and Climate Change*** Report).
- **R04:** Investigate the impact of an increased downstream boundary to 0.02% AEP TWL level at the downstream boundary.
- **R05:** Investigate the impact of an increase in rainfall intensity and an increased downstream boundary. This scenario combines scenarios R03 and R04.

3.3.4 Future Landuse Analysis

The following scenario was run in order to test flood impacts on existing dwellings and infrastructure caused by an increases in vegetation roughness within the floodplain.

- **R08:** Investigate the impact of increased vegetation in the floodplain. This involved changing the ‘medium dense vegetation’ material class to a ‘high dense vegetation’ class and changing the ‘low grass/grazing’ material class to a ‘medium dense vegetation’ class.

4 MODEL RESULTS AND OUTCOMES

4.1 2014 Model Maintenance

A comparison of the updated model results has been undertaken against the existing 2012 model. The comparison has been carried out for the 1% and 5% AEP design events.

Figures 4-1 and 4-2 show the difference in peak flood heights between the existing and upgraded models for the 1% AEP and the 5% AEP events respectively. The storm durations used in creating a combined envelope for the two models and events are shown in Table 4-1.

Table 4-1 Storm duration comparison for 5% and 1% AEP design events

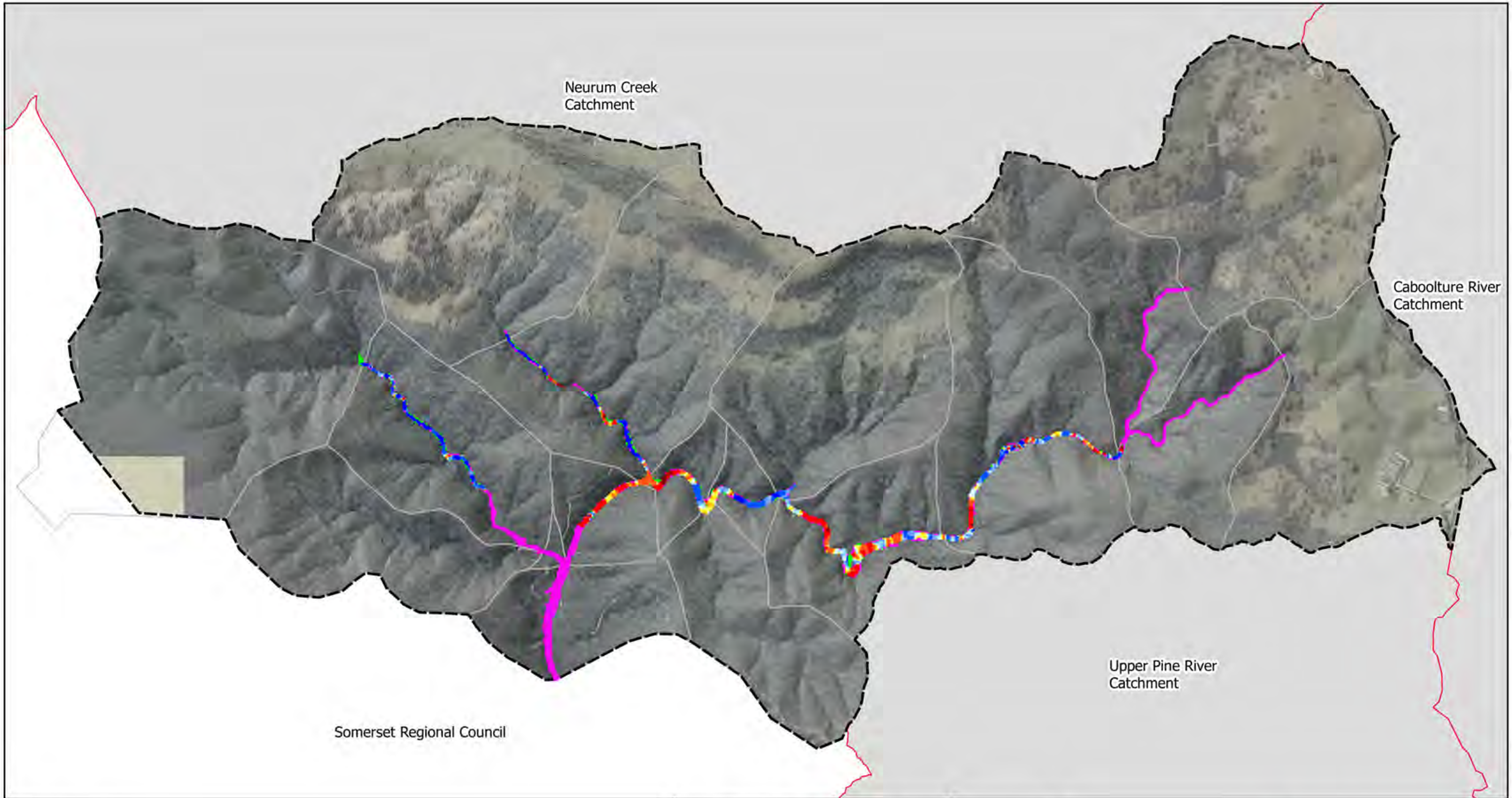
Event	Storm durations for 2012 Model	Storm durations for 2015 Maintenance Model
5% and 1% AEP	60 and 90 minute	60 and 90 minute

The flood level differences shown in Figure 4-1 (1% AEP) vary between increases and decreases along each stream reach. The range of increases and decreases vary considerably as shown in the map legend.

These differences are considered primarily a consequence of upgraded ALS data.

A considerable change in flood extent can be observed in Figures 4-1 and 4-2. The change in flood extent is symptomatic of two model changes which are outline in Section 2.2 and shown in Figure 2-1. The increase in downstream flood extent is consequential to the revised location of the model outflow boundary, while the increase in upstream flood extent is due to local inflows now being input for all upstream SA polygons.

Flood level differences in Figure 4-2 for the 5% AEP are generally as expected and follow a similar trend to differences shown for the 1% AEP (Figure 4-1). The main distinguishing feature is that flood level differences are generally all reductions. These reductions are as expected due to the increased initial rainfall loss parameter for all events up to and including the 5% AEP.



Legend

Difference in Peak Flood Levels (m)

- <-0.5
- -0.5 to -0.20
- -0.2 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- >0.50
- Increase in Inundation Extent
- Decrease in Inundation Extent
- BYR_002c_E_2d_code_01
- BYR_002c_E_2d_SA_01

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Title:

2012 BYR Model vs 2015 BYR Model Peak Flood Level Difference - 1%AEP

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Figure. 4-1

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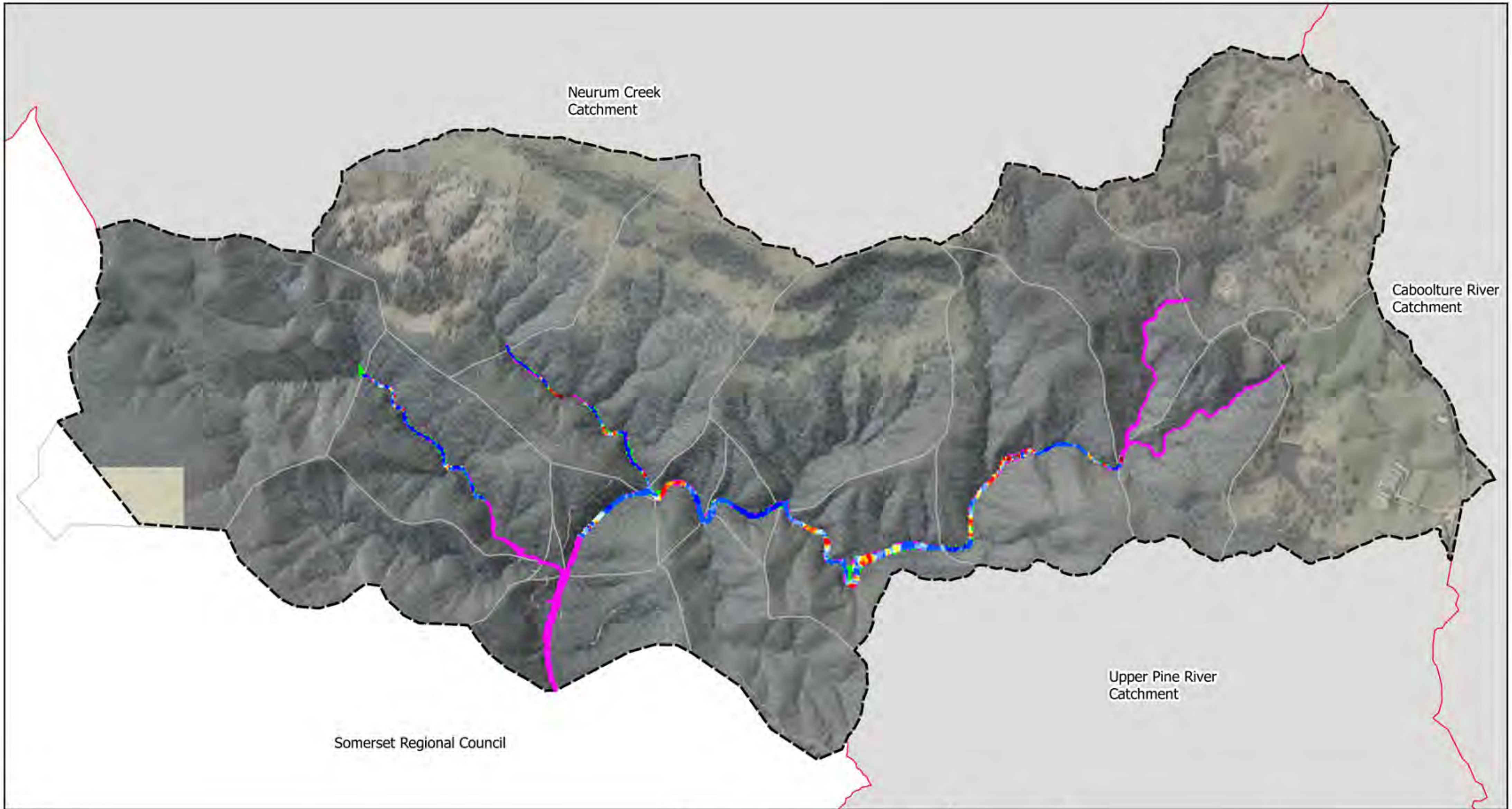

Legend

Difference in Peak Flood Levels (m)

- <-0.5
- -0.5 to -0.20
- -0.2 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- >0.50
- Decrease in Inundation Extent
- Increase in Inundation Extent
- BYR_002c_E_2d_code_01
- BYR_002c_E_2d_SA_01

Project: **RFD Maintenance 2014**

Title:

2012 BYR Model vs 2015 BYR Model Peak Flood Level Difference - 5%AEP

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Figure. 4-2

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4.2 Design Flood Behaviour

4.2.1 River and Creek

The type and format of output data from model is shown in Table 4.1. Data was output at 20 minute intervals as well as peak values recorded during each simulation:

Table 4-2 TUFLOW Data Output Type and Format

Data Output Format	Data Output Type
Flood Height (H)	WRB, XMDF, FLT
Flood Depth (D)	WRB, XMDF, FLT
Velocity (V)	WRB, XMDF, FLT
Hazard Categories (ZMBRC) (ZQRA)	XMDF, FLT
Depth Velocity Product (Z0)	XMDF, FLT
Stream Power (SP)	XMDF

A maximum grid was derived using the envelope of all critical storms durations for each event and all the TUFLOW outputs listed in Section 4-2 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.

4.2.2 Storm Tide

Storm tide modelling is not applicable to this basin.

4.3 Sensitivity Analysis Results

The MDS storm was used as a base case for the sensitivity analysis.

A comparison of the MDS event with the 1% AEP design event for selected critical durations has been undertaken. The results indicate that peak flood levels for the MDS are typically in the range of 50mm to 250mm higher than the envelope of selected critical durations.

4.3.1 Hydraulic Roughness Analysis

Increasing Manning's n by 20% has resulted in a general increase in peak flood levels across the floodplain. There is significant spatial variation in the magnitude of these impacts, with some localised areas even showing small flood level reductions due to catchment timing effects (generally in the lower reach of the modelling). Flood level differences are typically in the range of 0mm to 300mm.

4.3.2 Structure Blockage Analysis

Byron Creek catchment does not include any major drainage or significant structures.

4.3.3 Climate Change and Downstream Boundary Conditions Analysis

Climate change has a significant impact on flood levels.

Increase in rainfall intensity of 20%

Increasing rainfall by 20% has resulted in a general increase in peak flood levels across the floodplain. There is significant spatial variation in the magnitude of these impacts however they are typically in the range of 50mm to 450mm. Impacts in the steep gullies in the upper catchments are generally less than approximately 100mm.

Increase in downstream TWL to 0.02% AEP flood level

Increasing the tailwater condition to match the 0.02% AEP level has resulted in a significant increase in flood level directly adjacent to the model outflow boundary. The increase does not extent more than 160m upstream.

Increase in rainfall intensity of 20% with increased downstream TWL to 0.02% AEP flood level

The scenario is a combination of the two preceding climate change scenarios and results reflect this.

4.3.4 Future Landuse Analysis

This scenario was included to model the effects of increased roughness parameters within the floodplain. More specifically, the scenario modelled increasing Manning’s n values for low grass/grazing and medium dense vegetation. The future landuse scenario shows no change in flood level or behaviour within the MBRC area for the Byron Creek catchment. This was expected, given that the area of catchment within the floodplain has an existing landuse of dense vegetation.

4.4 Model Limitations and Quality

The Byron Creek catchment is currently an un-gauged catchment and has not been calibrated against real life flood events. As such the accuracy of these results is difficult to validate.

Parameters from adjacent (calibrated) catchments have been used as inputs into the Byron model. These parameters are considered generally reliable and fit for purpose given their geographical proximity.

Watercourses and open drains within the Byron Creek minor basin were represented in the 2D domain for which the grid resolution is 5m.

Watercourses and open drains within the BYR minor basin were represented in the 2D domain for which the grid resolution is 5m. Although various modelling techniques were used to make the representation of the watercourses and open drains as accurately as possible on a 5m grid, channel conveyance may not be adequately represented. This would have the biggest impact on smaller, more frequent events. In some instances this limitation may lead to the model over or underestimating conveyance in the watercourses. The extent of this over or underestimation will vary according to local topographic factors.

4.5 Model Specification and Run Times

The Byron Creek TUFLOW model has a relatively small 2D domain and is not demanding on computer memory (RAM). Details for the various design events are shown in Table 4.3.

Table 4-3 Model Specification and Run Time Summary

Event	Model Grid Size	Model Duration [hours]	Model Run Time [CPU hours]	Model memory (RAM) [Gb]
1EY AEP (1hr)	5m	3	0.36	1.6
10% AEP (1hr)	5m	3	0.38	1.6
1% AEP (1hr)	5m	3	0.39	1.6
0.1% AEP (45min)	5m	3	0.40	1.6
0.01% AEP (45min)	5m	3	0.36	1.6
PMF (45min)	5m	3	0.32	1.6
MDS (45min)	5m	3	0.35	1.6

5 CONCLUSIONS

Hydrology and Water Management Consulting has completed the 2014 model maintenance tasks for the WBNM and TUFLOW models of the BYR minor basin. The most significant update was the incorporation of new LiDAR data into the modelling. These model maintenance tasks are considered to have provided an overall improvement to the accuracy of the Regional Floodplain Database model predictions.

6 QUALIFICATIONS & LIMITATIONS

In preparing this report, HWMC has relied upon and assumed accurate data provided by MBRC. Unless otherwise stated in this report, HWMC has not attempted to verify the accuracy or completeness of any such information. The accuracy of this report is reliant upon the accuracy of this information.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by HWMC for use of any part of this report in any other context.

Study results should not be used for purposes other than those for which they were prepared.

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