Regional Floodplain Database:

2014 Model Maintenance Report - Mary River (MAR)

Moreton Bay Regional Council

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For further information about the copyright in this document, please contact:
Moreton Bay Regional Council
PO Box 159
CABOOLTURE QLD 4510
Email: mbrc@moretonbay.qld.gov.au
Phone: (07) 3205 0555

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Regional Floodplain Database 2014 Model Maintenance Report for Upper Mary River (MAR)

Prepared By:

Hydrology and Water Management Consulting Pty Ltd

Prepared For:

Moreton Bay Regional Council

Reference: **J00167R3V1**
Date: **June 2015**

Hydrology and Water Management Consulting Pty Ltd
PO Box 120 Coolum Beach Qld 4573
Email admin@hydrologyandwater.com.au
Web www.hydrologyandwater.com.au
ABN 25 153 466 981 ACN 153 466 981

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Report Status

Reference	Date	Status	Author	Review
J00167D3V1	18/06/2015	DRAFT	TA	R Stewart
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J00167R3V1	23/07/2015	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)
MAR	Upper Mary River
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 Upper Mary River 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 79km^2. Most upper reaches are moderately steep and heavily vegetated within the extent of floodplain. The predominant landuse in open and cleared areas is rural and open grazing as can be seen in current aerial imagery.

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 to a Regional Floodplain Database (RFD).

All hydrology and hydraulic models used to inform the RFD are currently 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 Upper Mary River (MAR) 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	Complete
Review and update minor catchment boundaries where new LiDAR indicates significant change in elevation or where major new linear infrastructure sub-divides catchments	Complete
Increase initial design rainfall losses to 15mm for the 1EY, 0.5EY, 20%, 10% and 5% year ARI events	Complete
Run updated WBNM models for the 1EY and 0.5EY. The 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP Events and also the PMF. Each of these has been run for at least 10 storm durations relevant to the minor basin to determine critical durations across 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	Complete

Existing sub-catchment fraction impervious values for MAR 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 2-2 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 Upper Mary River minor basin.

Table 2-2 TUFLOW Model Maintenance Tasks

Model Maintenance Task	Update Comments
Consolidate TUFLOW model files as per new naming convention	Complete
Upgrade to the latest TUFLOW executable	Complete
Incorporate new LiDAR topography	Complete
Incorporate breaklines along all stream centrelines	Complete
Update Hydraulic Structures (culverts and bridges)	No updates required
Make adjustments to the method of modelling trunk drainage	Not Applicable – no trunk drainage
Review the location and naming of PO lines	Complete
Review and make improvements to the TUFLOW model in hydraulic model investigation areas	Not Applicable – no investigation areas in Upper Mary River 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 and completed. No significant changes.
Review modelling of large buildings and clusters of smaller buildings	Not Applicable – no large buildings or clusters of small buildings within the floodplain.

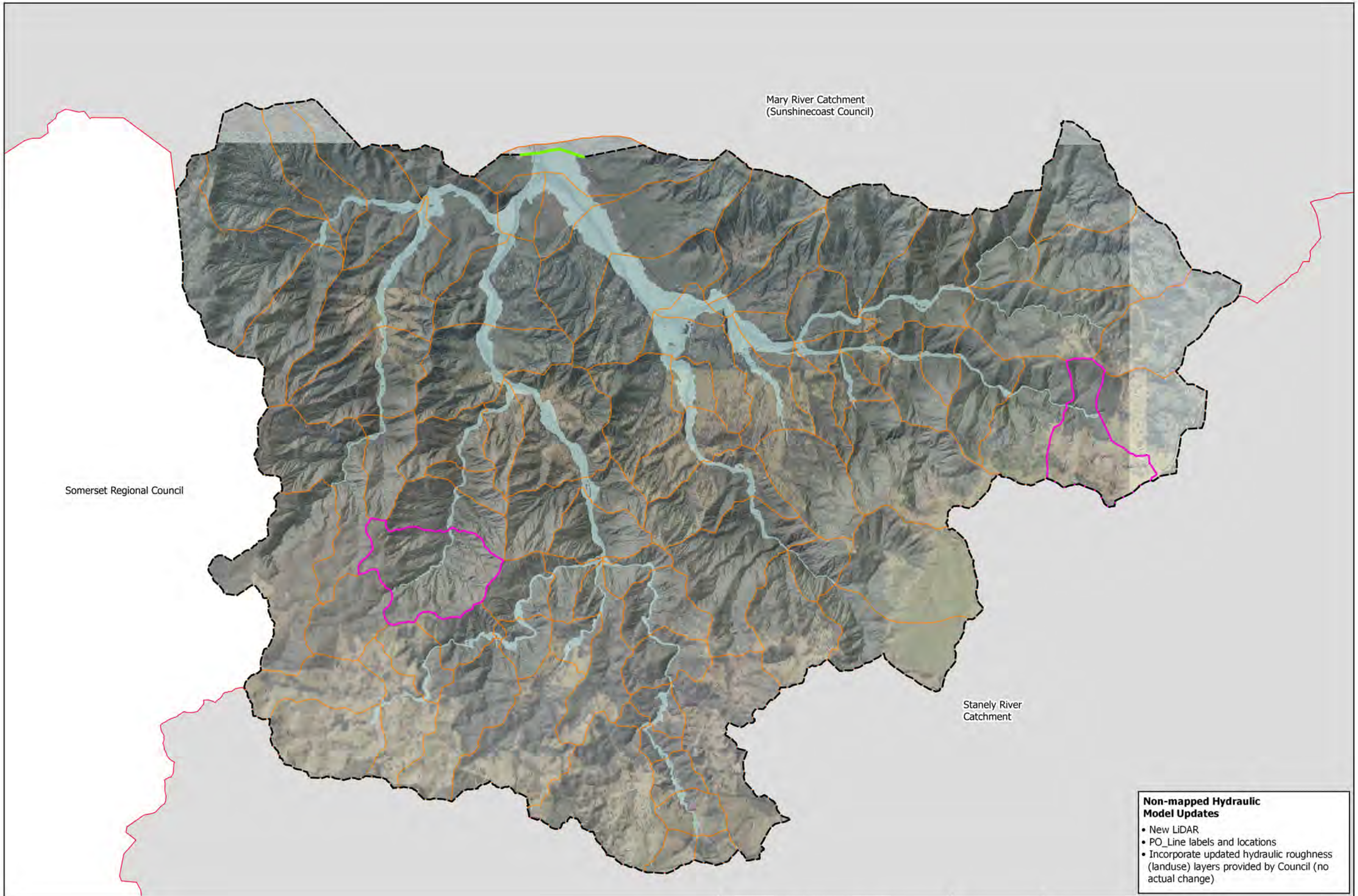
The latest TUFLOW build release (Build 2013-12-AD) has been used for the model update.

Updates have not been required within the MAR minor basin for any bridges, culverts or buildings.

Breaklines have been included where required to allow for a better representation of gullies in the TUFLOW model topography. A second breakline with the TUFLOW ‘gully’ switch activated was included and overlaid the original breakline to provide an improved connectively of the TUFLOW cells representing gullies.

All sub-catchments were included as SA polygons and only local inflows input into the TUFLOW model. In the previous modelling, some total catchment inflows where utilised and as a result, the updated flood mapping will, in some reaches, extend further upstream.

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



Non-mapped Hydraulic Model Updates

- New LiDAR
- PO_Line labels and locations
- Incorporate updated hydraulic roughness (landuse) layers provided by Council (no actual change)

Legend

- Updated TUFLOW outflow boundary location
- Updated Hydraulic Model Extent
- 2d_SA polygons changed from total to local inflows
- WBNM Sub-Catchments (no changes))

Project: **RFD Maintenance 2014**

Title:
Upper Mary River Maintenance Features

Client: **Moreton Bay Regional Council**

Figure. 2-1

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3 MODEL SIMULATIONS

3.1 Verification

Verification against recoded rainfall and flood marks was not undertaken for the MAR 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 design 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 presented the results of the critical duration assessment for the 1% AEP design event. The figure illustrates which design event durations were found to be critical across the catchment (i.e. produce the highest flood level). The results indicate that the 60, 90 and120 minute design events are most critical for the 1% AEP in the MAR minor basin.

Figure 3-2 provides the same analysis for the 0.1% AEP. The duration envelopes indicate that the 60, 90 and120 minute events are most critical.

To validate the selected durations, a flood height difference plot was generated between the 11 durations flood envelope and the chosen critical duration flood envelope.

Figure 3-3 indicates only very small differences in flood height (between 10 – 50mm) in three upstream reaches. The dominant landuse in these reaches was dense vegetation. No significant difference was observed elsewhere within the minor basin.

Figure 3-4 indicates again only minor differences (majority between 10 – 50mm) in flood height between the 11 duration's envelope and the critical duration's envelope for the 0.1% AEP.

Table 3-2 shows the final adopted critical durations for Upper Mary River minor basin.

Table 3-2 Critical Durations in TUFLOW

Critical Durations (All Design Events)
60 minute
90 minute
120 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 from Section 3.2.1. Table 3-3 shows the list of design event AEP's and the applicable critical durations.

Table 3-3 Design Event TUFLOW Simulations

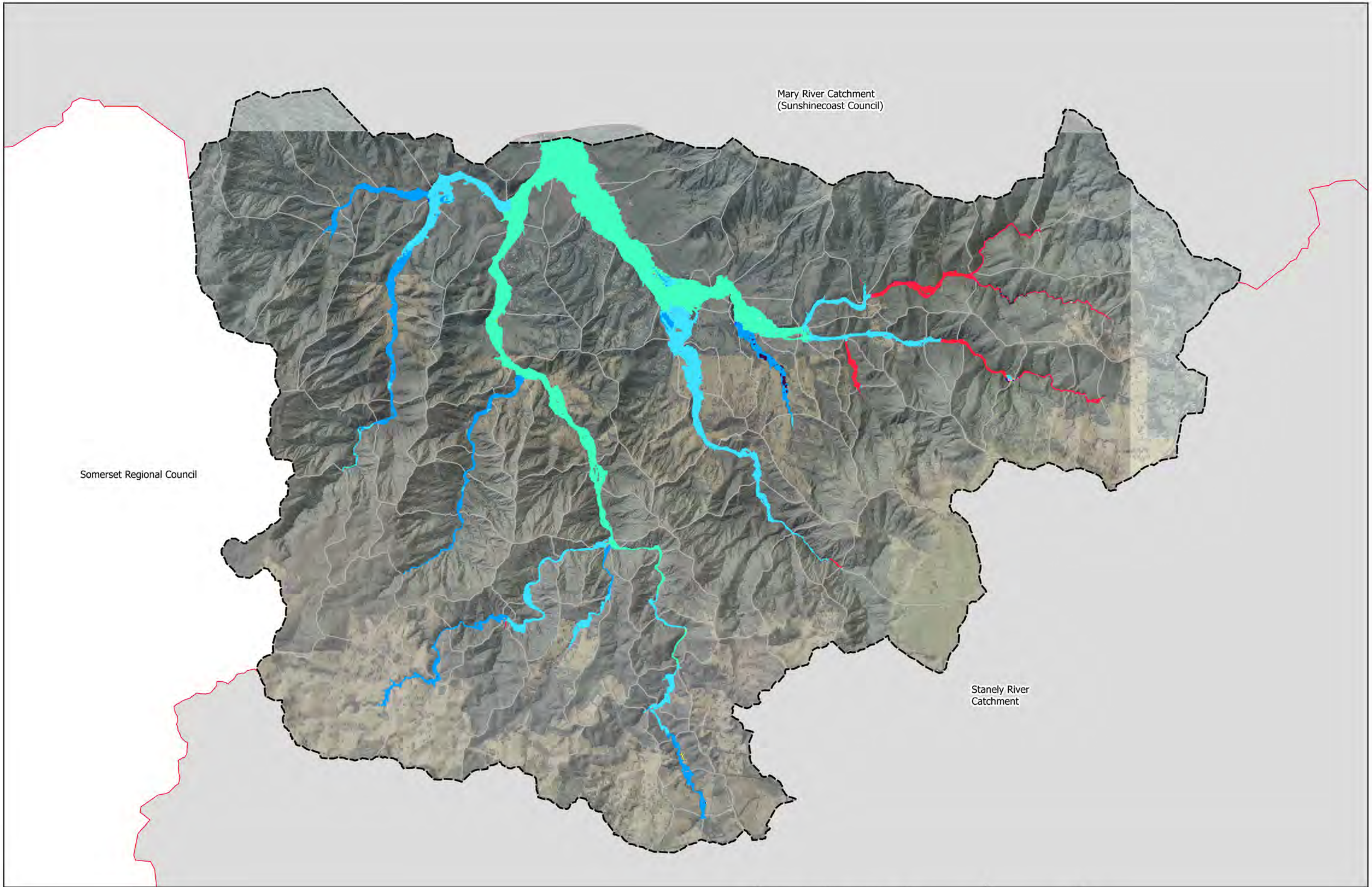
Design Event	Critical Durations
1EY, 0.5EY, 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP's and PMF	60, 90 and 120 minute

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 MAR 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

MAR_002c_E_2d_code_01

MAR_002c_E_2d_SA_01

Project: **RFD Maintenance 2014**

Title:
Upper Mary River Critical Duration Assessment - 1%AEP

Client: **Moreton Bay Regional Council**

Figure. 3-1

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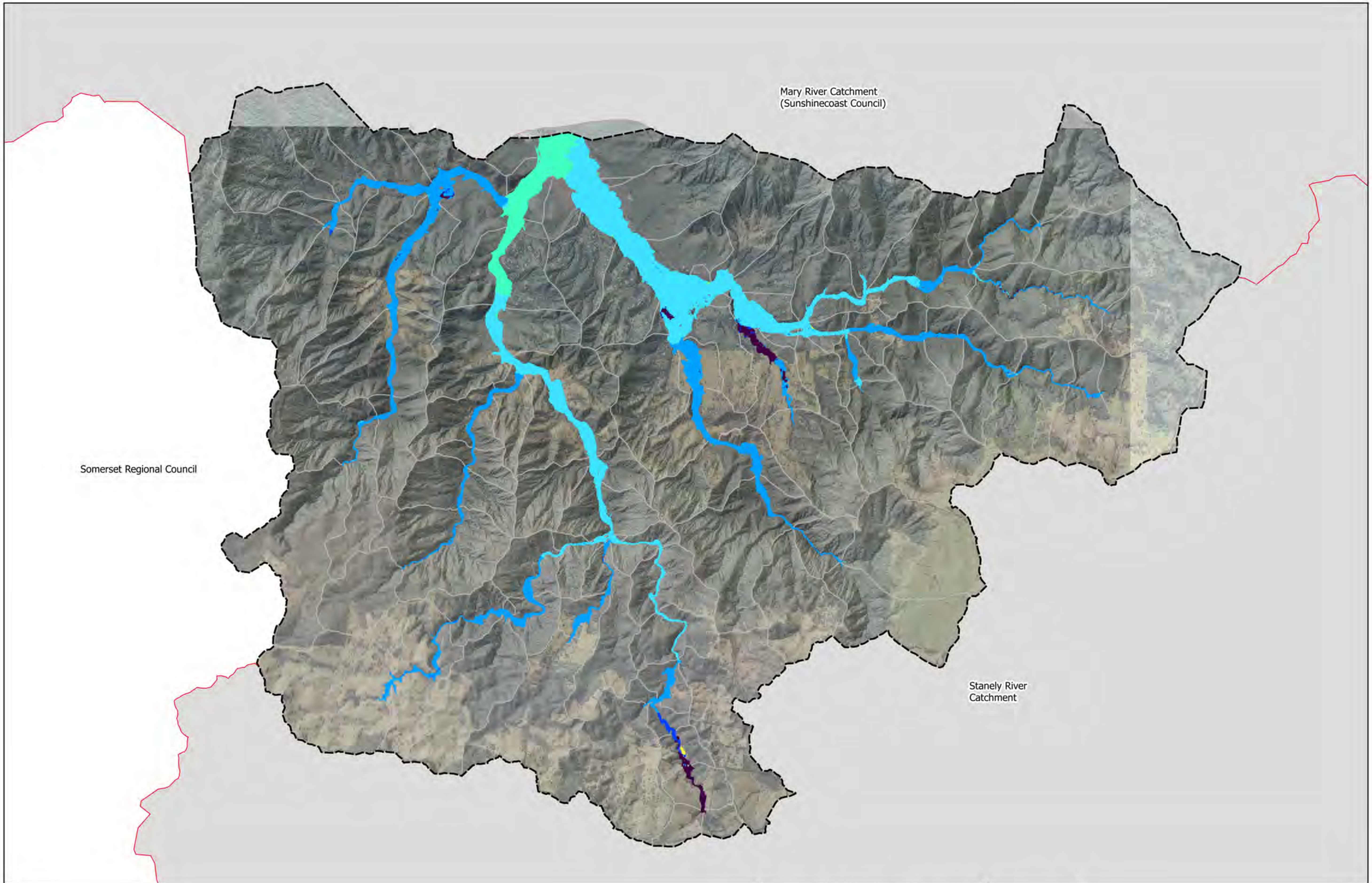

Legend

0.1% AEP Duration Envelopes

0030	0090	0240
0045	0120	0300
0060	0150	0360
	0180	0720

MAR_002c_E_2d_code_01

MAR_002c_E_2d_SA_01

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Upper Mary River Critical Duration Assessment - 0.1%AEP

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Figure. 3-2

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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
- MAR_002c_E_2d_code_01
- MAR_002c_E_2d_SA_01

Project: **RFD Maintenance 2014**

Title:
Upper Mary River Critical Duration Assessment Peak FLood Level Difference - 1%AEP

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Figure. 3-3 | Rev. A

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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
- MAR_002c_E_2d_code_01
- MAR_002c_E_2d_SA_01

Project: **RFD Maintenance 2014**

Title:
Upper Mary River Critical Duration Assessment Peak FLood Level Difference - 0.1%AEP

Client: **Moreton Bay Regional Council**

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 MAR 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

A moderate blockage scenario for culverts has been adopted for the R02 sensitivity case based upon 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.

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.
- **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.

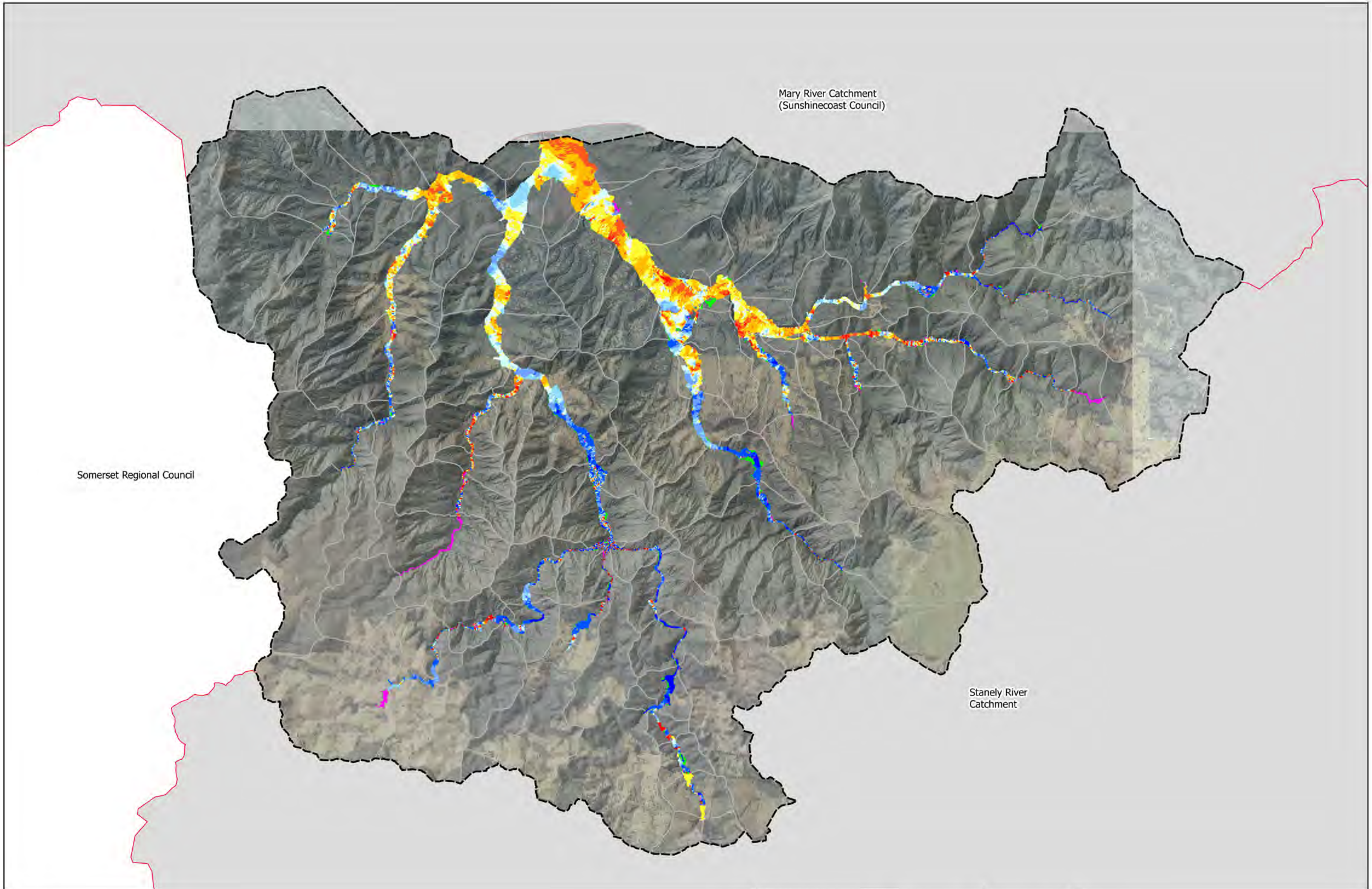
Figures 4-1 and 4-2 show the difference in peak flood heights between the existing and upgraded models for the 1% AEP and the 5% AEP events respectively. The storm durations used in creating a combined envelope for the two models and events are shown in Table 4-1.

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% AEP	60 and 120 minute	60 90 and 120 minute
1% AEP	60, 90 and 120 minute	60 90 and 120 minute

The flood level differences for the 1% AEP event, as shown on Figure 4-1, vary between increases and decreases along most stream reaches. The dominant reason for the change in flood levels is considered the upgraded ALS data set. Other factors effecting the change in flood levels are revised hydraulic roughness mapping, use of the new TUFLOW executable along with the other maintenance tasks which have been carried out.

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



Legend

Difference in Peak FLood Levels - 1% AEP

- <-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
- MAR_002c_E_2d_code_01
- MAR_002c_E_2d_SA_01

Project: **RFD Maintenance 2014**

Title:
2012 MAR Model vs 2015 MAR Model Peak Flood Level Difference - 1%AEP

Client: **Moreton Bay Regional Council**

Figure. 4-1 | Rev. A

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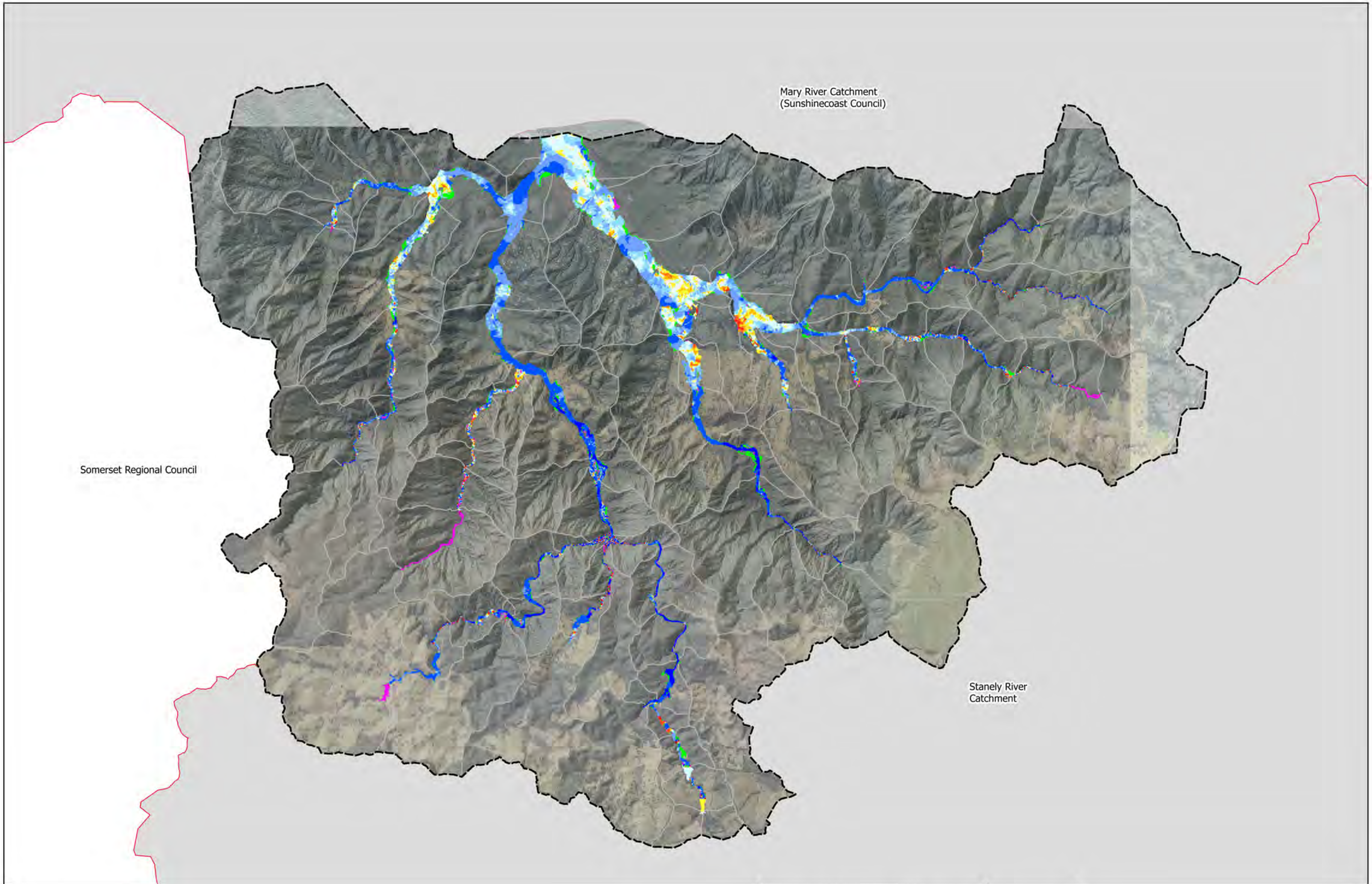

Legend

Difference in Peak FLood Levels - 5% AEP

- <-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
- MAR_002c_E_2d_code_01
- MAR_002c_E_2d_SA_01

Project: **RFD Maintenance 2014**

Title:
2012 MAR Model vs 2015 MAR Model Peak Flood Level Difference - 5%AEP

Client: **Moreton Bay Regional Council**

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 the model is shown in Table 4-2. 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 higher across the entire floodplain. In general, most flood level differences are less than 100mm across the floodplain however various reaches have larger differences which range typically between 100mm and 300mm.

4.3.1 Hydraulic Roughness Analysis

Increasing Manning's n values by 20% in the 2D domain has resulted in a general increase in peak flood levels across the floodplain. Flood level increases are generally less than 300mm and most commonly in the order of approximately 100 mm.

4.3.2 Structure Blockage Analysis

The MAR minor basin does not include any major drainage or significant structures that are within the MBRC Local Government Area.

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 400mm.

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 however the increase does not extend more than 600m upstream of the model outlet.

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

As Council currently do not have future urban development zones planned for within this minor basin, the only future landuse scenario applicable to this minor basin is for increased vegetation in the floodplain. This has been modelled by 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.

Results of this scenario show that flood level increases vary considerably across the floodplain and are typically in the range of between 0mm and 700mm. There are also some localised areas where flood levels reduce which would be due to catchment timing effects and flow attenuation through upstream vegetated areas.

4.4 Model Limitations and Quality

The MAR minor basin 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 model. These parameters are considered generally reliable and fit for purpose given their geographical proximity.

Watercourses and open drains within the MAR 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 Upper Mary River TUFLOW model has a relatively small 2D domain (for a regional scale model) and is therefore relatively un-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 [Clock hours]	Model Run Time [CPU hours]	Model memory (RAM) [Gb]
1EY (120min)	5m	4	6.328	3.5
10% AEP (120min)	5m	4	5.594	3.5
1% AEP (120min)	5m	4	7.169	3.5
0.1 AEP (120min)	5m	4	7.42	3.5
0.01% AEP (120min)	5m	4	6.356	3.5
PMF (120min)	5m	4	6.82	3.5
MDS (120min)	5m	4	4.392	3.5

5 CONCLUSIONS

Hydrology and Water Management Consulting has completed the 2014 model maintenance tasks for the WBNM and TUFLOW models of the MAR 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.

7 REFERENCES

1. Austroads, 1994, “Waterway Design”
2. BMT WBM, 2010, “TUFLOW User Manual”
3. Bureau of Meteorology, Online Rainfall IFD Data System ‘http://www.bom.gov.au/hydro/has/cdirswebx/cdirswebx.shtml’
4. Bureau of Meteorology, 2003, “Guidebook to the Estimation of Probable Maximum Precipitation: GENERALISED TROPICAL STORM METHOD”
5. Bureau of Meteorology, 2003, “The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method”
6. Engineers Australia, 1987, “Australian Rainfall and Runoff”
7. Engineers Australia, June 2012, “Australian Rainfall and Runoff Revision Project 5: Regional Flood Methods, Stage 2 Report”
8. Engineers Australia, November 2012, “Australian Rainfall and Runoff Revision Project 5: Two Dimensional Modelling in Urban And Rural Floodplains, Stage 1&2 Report”
9. Michael Boyd et al, 2012, “WBNM User Guide”
10. Michael Boyd et al, 2007, “Details of the Theory Used in WBNM”
11. Queensland Government – Natural Resources and Water, 2008, “Queensland Urban Drainage Manual , 2nd Edition” (QUDM)
12. Queensland Government, 2010, “Increasing Queensland’s resilience to inland flooding in a changing climate: Final report on the Inland Flooding Study”
13. Queensland Reconstruction Authority (QRA), September 2012, ‘Planning for Stronger, More Resilient Floodplains - Part 2 – Measures to Support Floodplain Management in Future Planning Schemes”
14. W.J. Syme, 2001, “Modelling of Bends and Hydraulic Structures in a Two-Dimensional Scheme”
15. W.J. Syme, 2011, “Modelling Structures”, ASFPM SMS Workshop USA;\
16. SKM (2010): MBRC Regional Floodplain Database Existing, Historic and Future Floodplain Land Use
17. SKM (2012a): MBRC Regional Floodplain Database Boundary Conditions, Joint Probability & Climate Change
18. SKM (2012b): MBRC Regional Floodplain Database Floodplain Parameterisation
19. Worley Parsons (2010): Regional Floodplain Database Floodplain Terrain
20. Worley Parsons (2012): Design Rainfall
21. Worley Parsons (2012): Regional Floodplain Database Hydrologic and Hydraulic Modelling Mary River (MAR)