Regional Floodplain Database:

2014 Model Maintenance Report - Stanley River (STA)

Moreton Bay Regional Council

Moreton Bay Regional Council

Regional Floodplain Database 2014 Model Maintenance Report Stanley River (STA)

June 2015

Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
V01	Draft Report	Alister Daly	Alister Daly	17/06/2015
V02	Final Report	Alister Daly	Alister Daly	23/06/2015
V03	Final Report	Alister Daly	Alister Daly	30/06/2015
V04	Final Report	Alister Daly	Alister Daly	03/07/2015

PROJECT DETAILS

Project Name	MBRC Flood Updates 2014 - STA
Client	Moreton Bay Regional Council
Client Project Manager	Hester Van Zijl
Water Technology Project Manager	Alister Daly
Report Authors	Ryan Dermek
Job Number	J3498
Report Number	R01
Document Name	1D180871.tmp

Cover Photo: **Google Satellite Image of Stanley River Minor Basin Area**

93 Boundary Street
West End QLD 4101
Telephone (07) 3105 1460
Fax (07) 3846 5144

ABN No. 60 093 377 283
ACN No. 093 377 283

TABLE OF CONTENTS

1. Introduction 1

2. 2014 Model Maintenance Details 1

2.1 WBNM Model Updates 1
2.2 TUFLOW Model Updates 2

3. Model Simulations 6

3.1 Verification 6
3.2 Design Flood Events 6

3.2.1 River & Creek Critical Duration Assessment 6

3.2.2 River & Creek Design Event Simulations 11

3.2.3 Storm Tide Design Event Simulations 11

3.3 Sensitivity Analysis 11

3.3.1 Hydraulic Roughness Analysis 11

3.3.2 Structure Blockage Scenario 12

3.3.3 Climate Change and Downstream Boundary Conditions 12

3.3.4 Future Landuse Analysis 12

4. Model Results and Outcomes 12

4.1 2014 Model Maintenance 12
4.2 Verification 16

4.2.1 Hydrograph Comparison 16

4.2.2 Flood Mark Comparison 18

4.3 Design Flood Behaviour 22

4.3.1 River & Creek 22

4.3.2 Storm Tide 22

4.4 Sensitivity Analysis Results 22

4.4.1 Hydraulic Roughness Analysis 22

4.4.2 Structure Blockage Analysis 22

4.4.3 Climate Change and Downstream Boundary Condition Analysis 23

4.4.4 Future Land use Analysis 23

4.5 Model Limitations and Quality 24
4.6 Model Specification and Run Times 25

5. Conclusion 26

6. References 27

LIST OF FIGURES

Figure 1 – STA Model Maintenance ... 4
Figure 2 – STA 1% AEP Event Critical Duration Assessment ... 7
Figure 3 – STA 0.1% AEP Event Critical Duration Assessment ... 8
Figure 4 – Change in 1% AEP Peak Water Surface Levels ... 9
Figure 5 – Change in 0.1% AEP Peak Water Surface Levels ... 10
Figure 6 – STA 1% AEP Event Water Surface Level Difference Map ... 14
Figure 7 – STA 5% AEP Event Water Surface Level Difference Map ... 15
Figure 8 – Recorded and Modelled Hydrographs at Woodford Alert Gauge ... 17
Figure 9 – Recorded and Modelled Hydrographs at Peachester Alert Gauge ... 18
Figure 10 – Floodmark Histogram, January 2011 ... 19
Figure 11 – Peak Water Surface Level and Extent Map, Verification Event, January 2011 ... 20
Figure 12 – Peak Water Surface Level Difference and Extent Map - 2014 Model vs 2012 Model, January 2011 ... 21

LIST OF TABLES

Table 1 - Updated structures applicable to STA catchment ... 2
Table 2 – Investigation Area Summary for STA Model ... 5
Table 3 – Critical Duration Assessment ... 6
Table 4 – Sensitivity Analysis Summary ... 11
Table 5 – Storm duration comparison for 5% and 1% AEP events ... 13
Table 6 – Flood Gauge Level Comparison Points – January 2011 Verification Event ... 16

LIST OF ABBREVIATIONS

AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
BoM	Bureau of Meteorology
DNRM	Department of Natural Resources and Mines
DTM	Digital Terrain Model
EY	Exceedances per Year
GIS	Geographic Information System
IFD	Intensity–Frequency–Duration
LIDAR	Laser Detection and Ranging
MBRC	Moreton Bay Regional Council
MDS	MBRC Design Storm (MDS) event (1% AEP embedded storm event)
MHWS	Mean High Water Springs
PMF	Probable Maximum Flood
RFD	Regional Floodplain Database
STA	Stanley River

“This page left intentionally blank”

1. Introduction

Moreton Bay Regional Council (MBRC) Regional Floodplain Database (RFD) is a hydrologic and hydraulic model library that interacts with spatial databases to deliver detailed flood information throughout the MBRC area. The model library includes a total of fourteen (14) coupled hydrologic and hydraulic models that cover the greater area of the MBRC.

The RFD project and associated flood model library was originally developed and prepared between 2009 and 2012. The STA models have not been updated since this time. This current project is the RFD 2014 Maintenance Project and represents the first maintenance of the STA RFD model libraries undertaken since the models were originally developed.

Water Technology Pty Ltd (WT) was commissioned by MBRC to prepare the necessary RFD Maintenance tasks and upgrades to the Stanley River (STA) minor basin areas. The report details the methodology and outcomes from the updates to both the WBNM and TUFLOW models and has been prepared in accordance with MBRC's reporting template.

Figures in this report also display flooding in the Nuerum Creek (NEU) catchment. This catchment was included in the hydraulic modelling of the STA basin as it is a major tributary, however, the NEU catchment is modelled independently as its own minor basin area and flood information from the STA model should not be used as representative of flooding in the NEU catchment.

2. 2014 MODEL MAINTENANCE DETAILS

The RFD maintenance tasks associated with this project included model updates to both the WBNM and TUFLOW models. The various technical work elements for the models were specifically outlined as a series of model update tasks detailed in Council's technical project brief.

2.1 WBNM Model Updates

RFD maintenance tasks associated with WBNM model updates are summarised as follows: -

1. WBNM model files were consolidated in accordance with Council's updated naming conventions and folder structure guidelines;
2. The STA model minor catchment boundaries were updated based on the new 2014 LiDAR data which was collected and provided by Council for this project. Minor catchment boundaries were revised and provided to Council for approval;
3. The rainfall loss rates in the WBNM model were revised to include a 15mm initial loss and 2.5mm/hr continuing loss for the 1 Exceedance Per Year (EY), 0.5EY, 20%, 10% and 5% Annual Exceedance Probability (AEP) events. Rainfall loss rates for all other design events were kept the same as that prepared in the original models;
4. Updated WBNM models were analysed for the 1EY, 0.5EY, 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2%, 0.1%, 0.05%, 0.02% and 0.01% AEP events, in addition with the Probable Maximum Flood (PMF) event. In each case, the WBNM models were analysed for the full range of storm durations;
5. The WBNM model was run based on the MBRC Design Storm (MDS) event (being a 1% AEP event with a 15 minute in 270 minute embedded design storm event); and
6. The results of the updated WBNM model were then compared with previous modelling results and checked, with iterative adjustments made to the model where required.

For Item 4 of the WBNM model updates (see above), a total of 10 storm durations were identified by WT for each of the 1% AEP and 0.1% AEP design flood events based on the peak flows determined from the WBNM models. These storm durations were then presented to Council for prior approval for inclusion on the critical duration assessment required in Task D1 of the project brief. Further details on the critical duration assessment are provided in Section 3.2.1. Some of the nominated storm events for the STA model were not available in the previous model library dataset and had not been assessed using the WBNM model developed for the original RFD Project. Accordingly, additional WBNM storm events were prepared and provided by Council for the purposes of the critical duration assessments under this project.

2.2 TUFLOW Model Updates

The RFD maintenance tasks associated with the TUFLOW model updates are summarised as follows: -

1. TUFLOW model files were consolidated in accordance with Council's updated naming conventions and folder structure guidelines.
2. The existing model was changed so that it could be run using the latest TUFLOW executable (i.e. TUFLOW Build 2013-12-AD).
3. The previous TUFLOW model was updated to include the new 2014 LiDAR data (which was collected and provided by Council for this project). In locations where 2014 LiDAR was not available 2009 LiDAR was used.
4. TUFLOW gully lines (used as a breakline) were prepared manually along the waterway centrelines to better represent the streamlines and to otherwise remove erroneous high points caused by dense vegetation. The breaklines were prepared based on careful selection of point elevations along each of the major waterways. The extent of the breakline prepared for the STA model is illustrated in Figure 1.
5. New or updated hydraulic structures were included in the TUFLOW model based on the structure data provided by Council. This data included GIS datasets, detailed survey as well as hardcopy structure plans, all of which were sourced and supplied by Council. For the STA model, new and updated structures included those as summarised in Table 1. These culverts are also highlighted in Figure 1.

Table 1 - Updated structures applicable to STA catchment

Structure ID	Road Name	Suburb	Structure Type
MBC_23_0046	Scotts Lane	Woodford	Culvert
MBC_23_0000	Scotts Lane	Woodford	Culvert
STA_52_00930	Kilcoy-Beerwah Road	Stanmore	Culverts
STA_54_00548	Kilcoy-Beerwah Road	Stanmore	Culverts
162354_4A	Kilcoy-Beerwah Road	Stanmore	Culverts
162354_4D	Kilcoy-Beerwah Road	Stanmore	Culverts
162354_4H	Kilcoy-Beerwah Road	Stanmore	Culverts
162354_4E	Kilcoy-Beerwah Road	Stanmore	Culverts
n/a	Durunder Street	Woodford	Foot Bridge

A review of the STA model layered flow constriction data for bridge structures identified that a Form Loss Coefficient (FLC) = 0 had been applied to all bridge structures. A zero FLC value effectively ignores any energy losses associated with the bridge deck. The recommended value in TUFLOW is specified as FLC=1.56 (WBM BMT, 2010). The FLC value applied in the STA model was raised for discussion with Council during the course of this project. Council subsequently advised that they will not be making any changes to the layer flow constriction modelling approach and parameters as part of the RFD 2014 maintenance project. Accordingly, WT have adopted the same FLC=0 in the current model updates.

6. The TUFLOW model has included adjustments to the method of modelling trunk drainage to direct inflows to pits as per Council's technical instructions. This includes the default TUFLOW manhole loss approach option of "ENGELHUND". WT identified with Council that this method does not necessarily allow for all pit losses to be attributed to pipe connections and may underestimate losses in the trunk drainage given that only specific trunk drainage is being included in the model. Council has since advised that the default option is to be used to be consistent with previous models and methodologies applied.
7. PO lines including locations and naming conventions have been reviewed and revised accordingly to match with the project conventions set by Council. This included adding significantly more PO lines in the model to aid Council in the extraction of hydraulic model results at various locations throughout the STA model domain.
8. A review of the model investigation areas identified by council (Figure 1) was undertaken using the updated TUFLOW model. These areas were reviewed in terms of model structure and improvements added as appropriate to provide a more representative assessment of localised flooding in the area. A detailed description of the issues identified for each of the investigation areas along with the changes made to the model are presented in Figure 1 and are shown in Table 2.
9. Spatial definition of hydraulic roughness was reviewed in areas of significant flow conveyance and updated to reflect and be consistent with the changed landuse as provided by Council. Key areas where modified land use resulted in model roughness changes is displayed in Figure 1.
10. The method for modelling large buildings and large clusters of smaller buildings in the floodplain was considered and adjusted where necessary. In accordance with Council's instructions provided during the project, modelling of buildings within the floodplain was undertaken using either an urban block layer (where the majority of flow passed through an area of urban landuse) in addition with modelling specific building footprints themselves.
11. Revised flows from the updated WBNM model maintenance tasks were incorporated in the updated TUFLOW models. Initial test runs of the TUFLOW model were undertaken for the 5% and 1% AEP events based on a 2 hour single storm duration for the STA model and using the 5m grid model. Initial results from the TUFLOW model were reviewed and adjustments made as necessary.

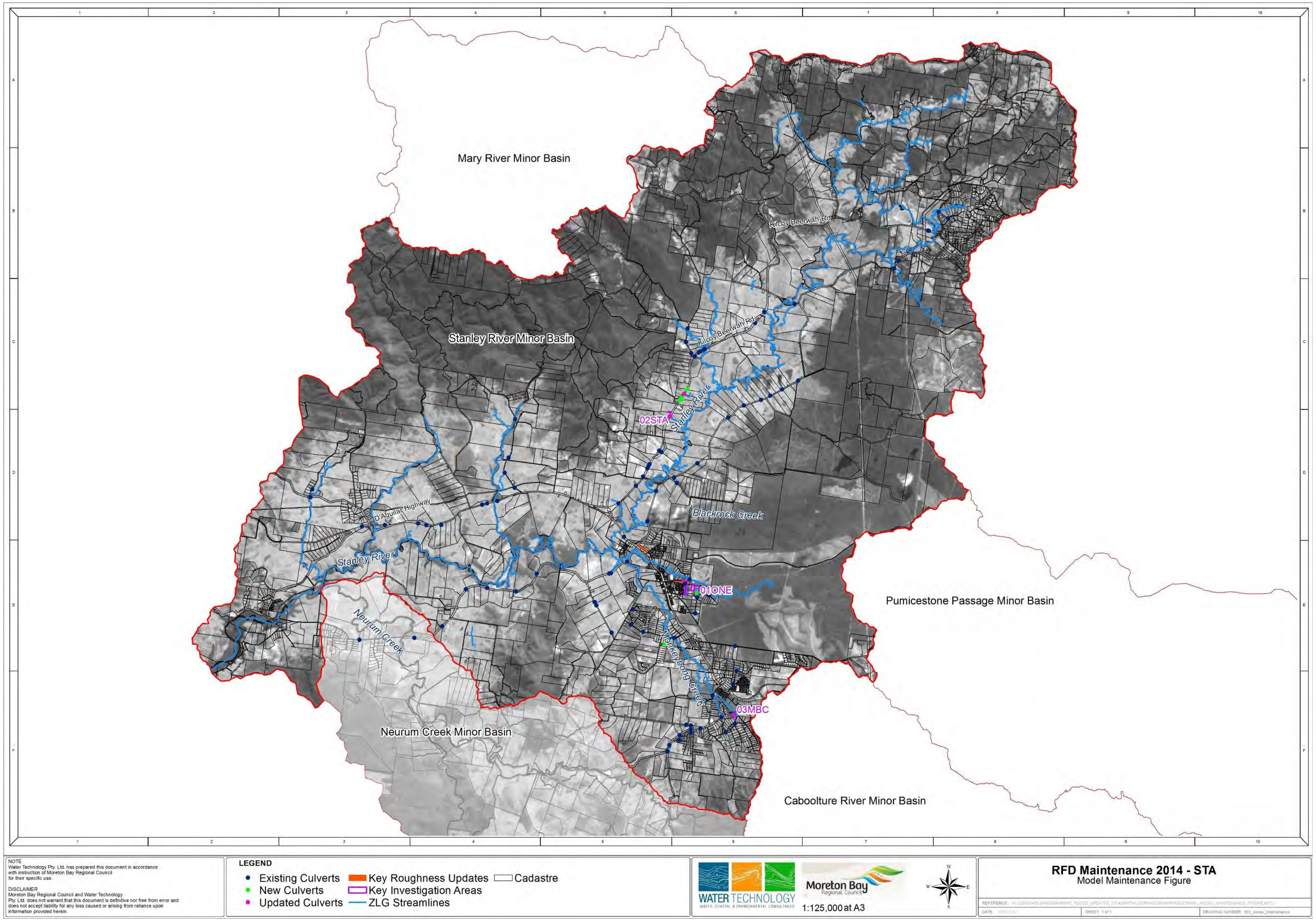

Figure 1 – STA Model Maintenance

Table 2 – Investigation Area Summary for STA Model

<table>
<tr><th>Minor Basin</th><th>Study Area ID</th><th>Major Catchment</th><th>No. of Properties Impacted</th><th>Study Area Name</th><th>Possible Investigation Actions</th></tr>
<tr><td>STA</td><td>02STA</td><td>STA</td><td>1</td><td>Kilcoy-Beerwah Road - Stanmore</td><td>include missing culverts
review landuse layers</td></tr>
<tr><td colspan="6">Culverts Added to Model
• STA_54_00548 (2*1200 RCP)
• 162354_4A (1x 1050 RCP) – From 162354B.jpg (supplied)
• 162354_4D (1x 900 RCP) – From 162354B.jpg (supplied)
• 162354_4H (3x 1200 RCP) – From 162354B.jpg (supplied)

Culverts Updated in Model
• STA_52_00930 (6x 1500x1200 RCBC) – updated from previously modelled 1x 1000x1000 RCBC
• 162354_4E (5x 1500 RCP) – updated from previously modelled 1x 1000x1000 RCBC (Previously labelled Missing05)

Other Updates
• Updated to 2014 Lidar
• Reviewed and adjusted local boundary locations
• STA_52_00930 – only applying flow upstream of road
• TUFLOW gully line added to improve model drainage downstream of Road
Z flag removed from sx connections z-shape directly adjusting topography</td></tr>
<tr><td>Comments</td><td colspan="5">Significantly greater conveyance under road should reduce impact on upstream side as a result of backwater ponding.</td></tr>
<tr><td>STA</td><td>01ONE</td><td>ONE</td><td>12</td><td>George Street - Woodford</td><td>Check if creek is accurately defined in model
review landuse layers</td></tr>
<tr><td colspan="6">• Updated to 2014 Lidar
• TUFLOW gully line added to better model creek drainage
• Reviewed and adjusted local boundary locations
  ○ ONE_35_00278 – reduced size to apply water at sub-catchment outlet
  ○ ONE_35_00000 – reduced size to apply water below impacted properties
  ○ ONE_01_02934 – reduced size to apply water below impacted properties
  ○ ONE_33_00000 – reduced size to apply water below impacted properties
  ○ ONE_33_00575 – only applying water behind road
• Removed ‘z’ flag from sx connections at culvert under George Street
• Added TUFLOW gully line internal property drain and culvert STA_1ONE_01Z flag removed from sx connections z-shape directly adjusting topography</td></tr>
<tr><td>Comments</td><td colspan="5">Application of revised inflow polygons for local boundaries and inclusion of TUFLOW gully line to better reflect conveyance should greater improve flood level estimates. Further checks to be undertaken following preliminary runs and results.</td></tr>
<tr><td>STA</td><td>03MBC</td><td>MBC</td><td>2</td><td>Delaneys Creek School Road - Delaneys Creek</td><td>Check if creek is accurately defined in model
review landuse layers</td></tr>
<tr><td colspan="6">• Updated to 2014 Lidar
• TUFLOW gully line added to model drainage at rear of property
• Reviewed and adjusted local boundary locations
  ○ MBC_04_03495 – only apply flow behind road
  ○ MBC_04_02474 – not apply flow directly on to property sx connections z-shape directly adjusting topography</td></tr>
<tr><td>Comments</td><td colspan="5">Application of revised inflow polygons for local boundaries and inclusion of TUFLOW gully line to better reflect conveyance should greater improve flood level estimates. Further checks to be undertaken following preliminary runs and results.</td></tr>
</table>

3. MODEL SIMULATIONS

3.1 Verification

The STA model was verified using the January 2011 event. Model verification was undertaken using a 10m grid model. Model verification results are discussed separately in Section 4.2.

3.2 Design Flood Events

3.2.1 River & Creek Critical Duration Assessment

The 10 selected storm duration events approved by Council as discussed previously in Section 2.1 have been used to undertake a critical duration assessment for the updated TUFLOW models. Table 3 summarises the 10 storm durations selected by Council for the STA model.

To determine the critical storm durations, the TUFLOW models have been analysed using a 10m grid to model the 10 separate storm durations for each of the 1% and 0.1% AEP design events. From this, the critical duration storms were able to be determined throughout the STA model domain. A critical storm duration map for the 1% and 0.1% AEP events was prepared and submitted to Council for the selection of the 3 critical storm durations for each event, and are shown in Figure 2 and Figure 3.

Although there are a number of critical durations represented throughout the STA model domain, council selected three critical design event storms, as shown in Table 3.

To determine the critical storm durations, the difference between mapped peak flood level for the selected storm durations and mapped peak flood level for the all storm durations was considered. These differences are displayed in Figure 4 and Figure 5, and show that the selected critical durations represent the maximum peak flood level throughout most of the model domain.

Table 3 – Critical Duration Assessment

Design Event	Tested Storm Durations (min)	Selected Durations (min)	Adopted Events
1% AEP	30, 60, 90, 120, 180, 270, 360, 540, 720 and 1440	180, 720 and 1440	1EY, 0.5EY, 20%, 10%, 5%, 2%, 1% AEP
0.1% AEP	30, 45, 60, 90, 120, 180, 240, 300, 360 and 720	120, 180 and 720	0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP and PMF

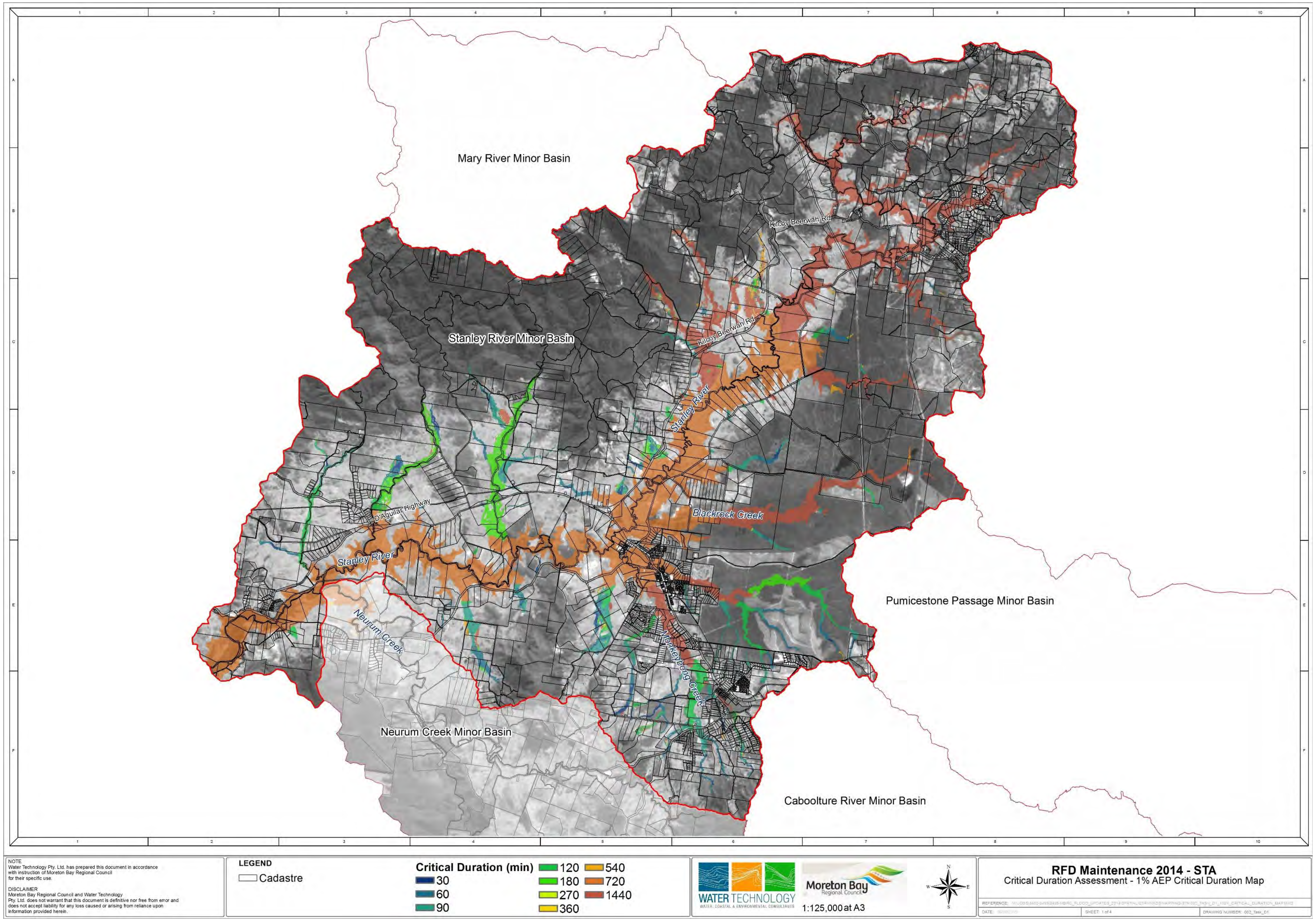

Figure 2 – STA 1% AEP Event Critical Duration Assessment

"This page left intentionally blank"

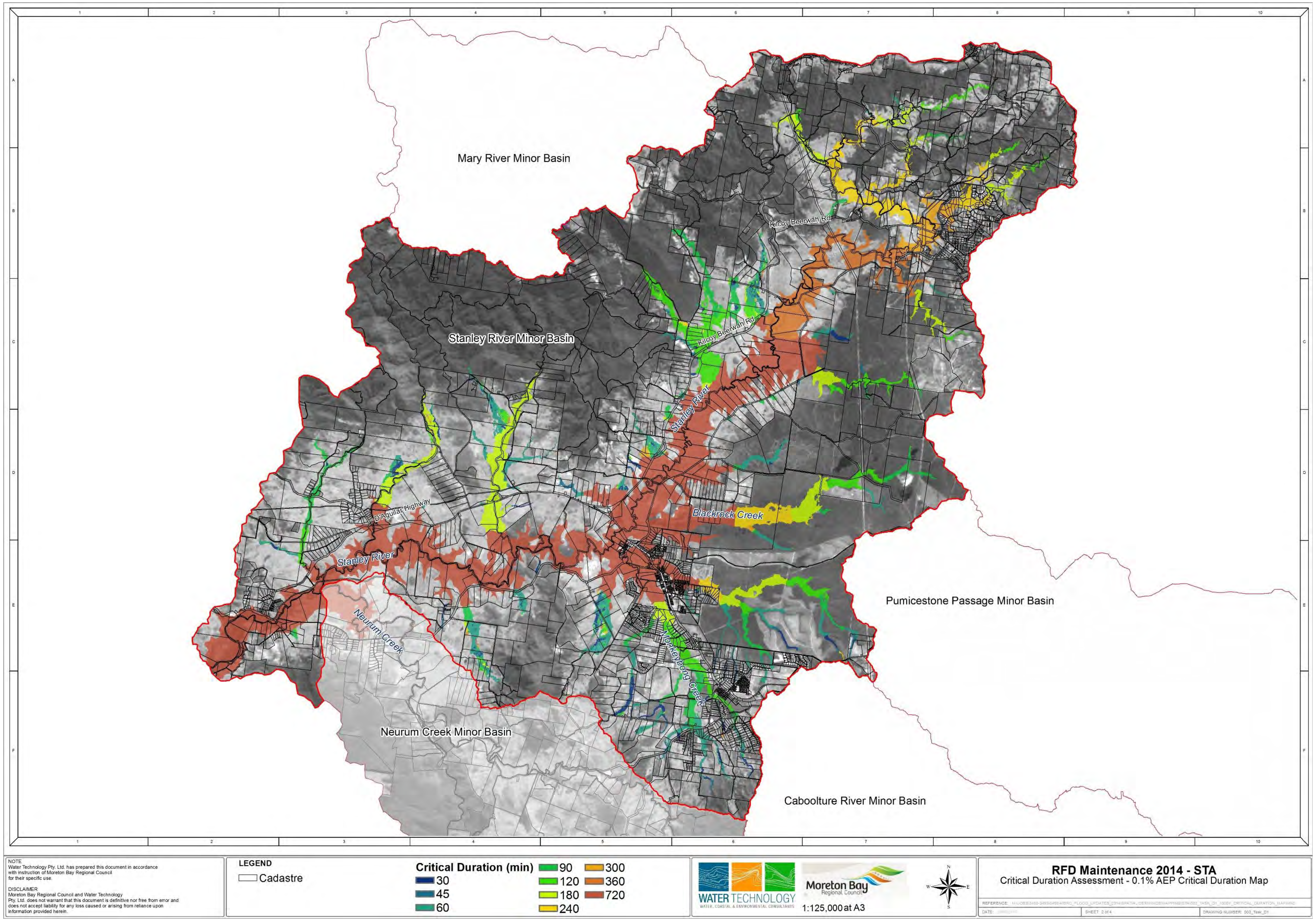

Figure 3 – STA 0.1% AEP Event Critical Duration Assessment

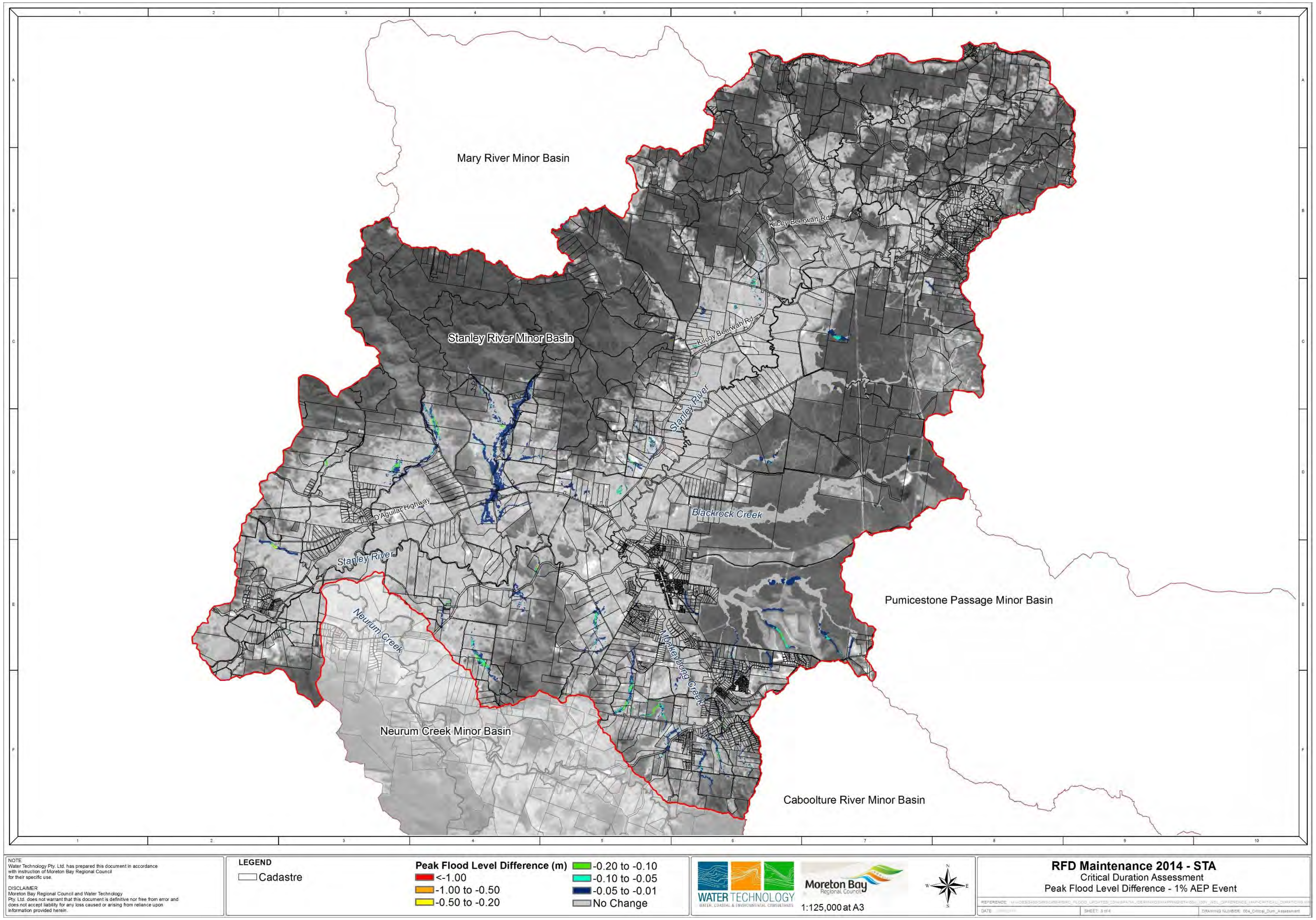

Figure 4 – Change in 1% AEP Peak Water Surface Levels

“This page left intentionally blank”

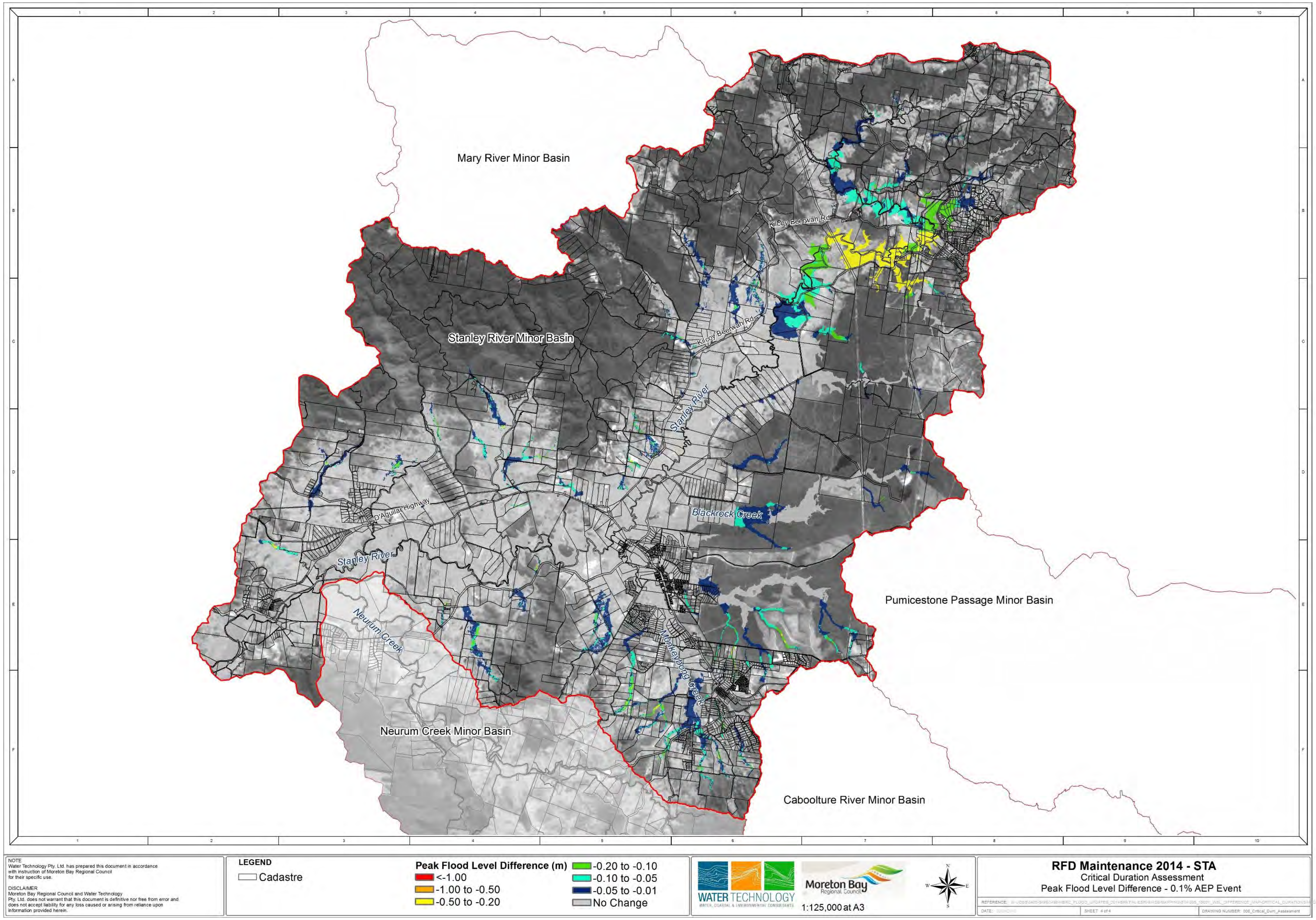

Figure 5 – Change in 0.1% AEP Peak Water Surface Levels

3.2.2 River & Creek Design Event Simulations

The updated STA TUFLOW models were analysed for the 1EY, 0.5EY, 20%, 10%, 5%, 2%, 0.5%, 0.2%, 0.05%, 0.02%, 0.01% AEP events, in addition to the PMF event. The model simulations have been undertaken based on the following storm durations: -

- 180, 720 and 1440 minute storms for the 1EY to 1% AEP events; and
- 120, 180 and 720 minute storms for the 0.5% AEP event through to the PMF event.

A 5 m grid model has been used for the 1EY to the 1% AEP event as well as the 0.1% AEP event. While a 10 m grid has been used for the 0.5% AEP event through to the PMF event.

In addition to the above design simulations, the updated TUFLOW model has also been used to run the MBRC Design Storm (MDS) event (i.e. a 1% AEP event with a 15 minute in 270 minute 'Embedded Design Storm'). The analysis of the 1% AEP MDS event has also been undertaken based on a 5 m grid model.

All results relating to the design event simulations have been provided to Council in a digital format and include post processed result files for all events analysed. There was no requirement to provide any GIS mapping for any of the design event simulations as part of the project technical specification.

3.2.3 Storm Tide Design Event Simulations

There was no requirement to undertake any storm tide modelling for the STA model as part of project technical specification.

3.3 Sensitivity Analysis

A range of sensitivity, climate change and future landuse scenario simulations were undertaken using the updated STA TUFLOW model. The specific scenarios analysed as part of this project are outlined separately below. In all cases, the updated TUFLOW 5 m grid model prepared for STA was applied based on the MDS event. The sensitivity scenarios are detailed in Table 4.

Table 4 – 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 – Increased Tailwater Level	3.3.3
R05	Climate Change – Rainfall and Increased Tailwater Level	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 following hydraulic roughness sensitivity assessment has been undertaken as part of this study:

- R01 – Increased Manning's "n" roughness by 20%.

All Manning's 'n' values in the model were increased by 20%.

3.3.2 Structure Blockage Scenario

The following structure blockage sensitivity assessment has been undertaken as part of this study:-

- R02 – Inclusion of structure blockage (moderate blockage).

The adopted blockage parameters were outlined in the SKM report (SKM, 2012a). For the moderate blockage case, this includes: -

- Full blockage (100% blockage) for culverts and pipes with a width equal to or less than 2.4 m; and
- Partial blockage (15% blockage) blockage for culverts and pipes with a width greater than 2.4 m.

The moderate blockage case applies to the 1d culvert layers (culverts) and no blockage allowance was made to the 1d network layer (the stormwater drainage network).

3.3.3 Climate Change and Downstream Boundary Conditions

The following climate change sensitivity assessments have been undertaken as part of this study:-

- R03 – Increased rainfall by 20% in WBNM model and re-run of hydraulic model based on revised flows;
- R04 – Increased downstream tailwater boundary. For the STA model, this includes raising the tailwater boundary to be equivalent to the 0.02% AEP event; and
- R05 - A combination scenario based on cases R03 and R04.

The technical methodology relating to methodology for the climate change sensitivity testing is contained within the SKM report (SKM, 2012b).

3.3.4 Future Landuse Analysis

The following future land use change sensitivity assessments have been undertaken as part of this study:-

- R08 – Increased vegetation (i.e. medium dense vegetation types were changed to high dense vegetation and low grass/grazing vegetation types changed to medium dense vegetation);
- R09 – Increased residential development based on an update of the WBNM fraction imperviousness provided by Council; and
- R10 - A combination scenario based on cases R08 and R09.

Future fraction imperviousness for hydrologic modelling was provided by council based on future land use planning.

4. Model Results and Outcomes

4.1 2014 Model Maintenance

The results of the initial runs were provided to Council for review and approval. Results from the initial TUFLOW model runs including comparisons to previous model results are shown in Figure 6 and Figure 7 for the 1% and 5% AEP events respectively. The storm durations used in creating a combined envelope for the two models and events are shown in Table 5.

Table 5 – Storm duration comparison for 5% and 1% AEP events

Event	Storm Durations for 2012 Model	Storm Durations for 2014 Maintenance Model
5% AEP	120, 720 and 1440m	120, 720 and 1440m
1% AEP	120, 720 and 1440m	120, 720 and 1440m

Significant reductions in the extent of flooding and flood levels were achieved when compared with the 2012 RFD model. Negative values in the figures mean that the 2014 STA maintenance model results are lower than the 2012 STA model results and vice versa.

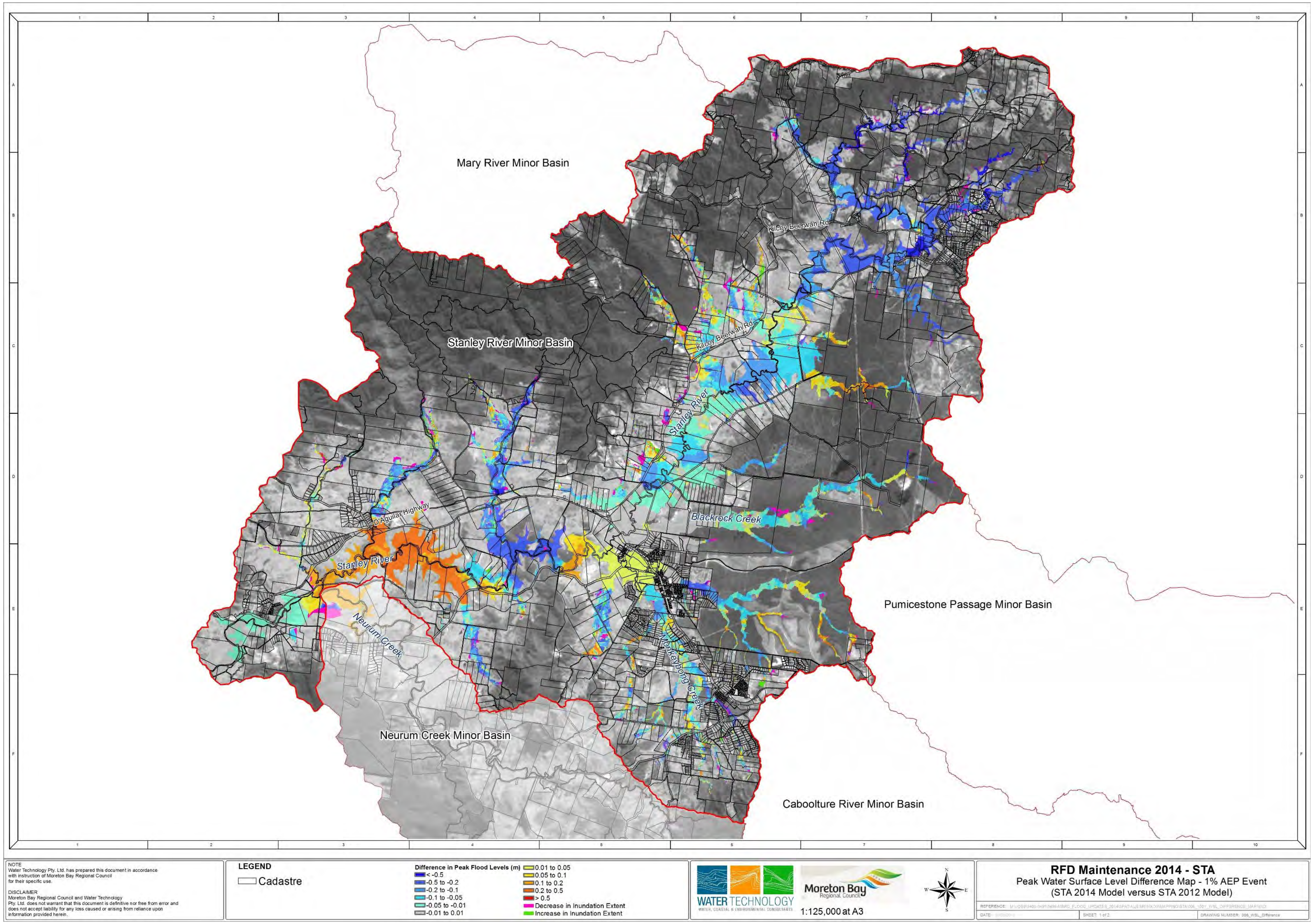

Figure 6 – STA 1% AEP Event Water Surface Level Difference Map

“This page left intentionally blank”

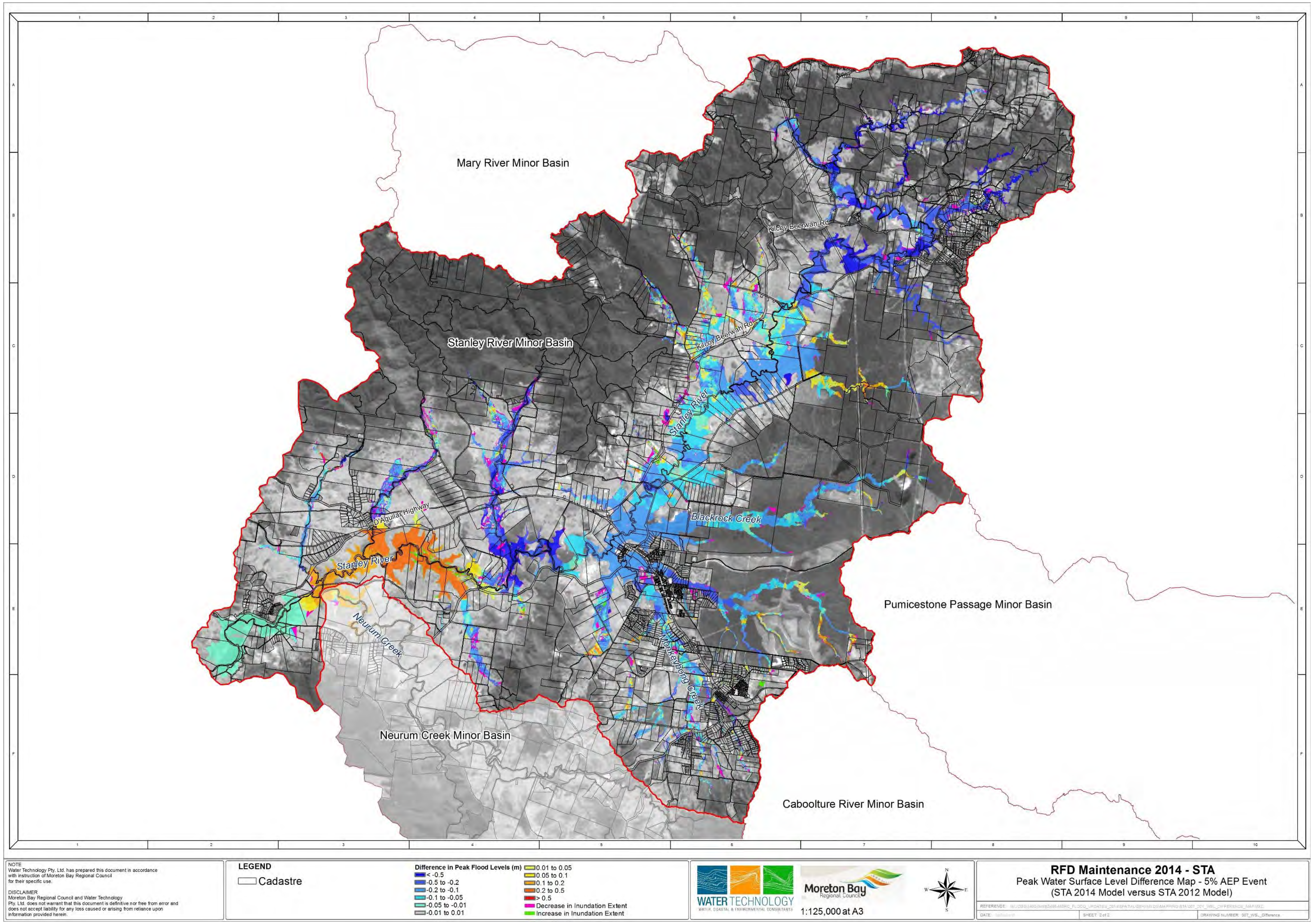

Figure 7 – STA 5% AEP Event Water Surface Level Difference Map

4.2 Verification

Verification of the STA model was undertaken for the January 2011 flood event. The previously prepared January 2011 WBNM model was used to inform inflows to the STA TUFLOW hydraulic model, with the WBNM model sub-catchments and landuse changes undertaken as detailed previously in Section 2. Historical rainfall depths as well as temporal patterns in the WBNM model remained unchanged.

Verification of the STA model to the January 2011 event was undertaken based on the comparison of predicted versus recorded historical flood levels throughout the model domain and at the Woodford and Peachester gauges. The recorded flood level points were supplied by MBRC and included approximately 80 survey marks for the January 2011 event. The survey marks additionally included existing alert monitoring gauge locations including the Woodford and Peachester alert gauges. The results of the model verification to the January 2011 event are presented in Figure 11 and Figure 12. Reductions in flood level compared to the 2012 model are visible throughout the catchment, with decreases of up to 900mm in the upper catchment, and approximately 150mm reductions through the middle catchment area on average. The lower catchment area does not experience significant water level differences. A summary of the model verification results based on gauge level comparison points are summarised in Table 6.

Table 6 – Flood Gauge Level Comparison Points – January 2011 Verification Event

Survey Mark ID	Recorded Peak Water Level (m AHD)	Modelled Peak Water Level (m AHD)	Difference (m)
STA_Woodford_Alert	116.87	115.92	-0.95
STA_Peachester_AL	135.46	134.65	-0.81

Verification of the STA model to the January 2011 event was found to provide a reasonable match to historical survey marks. The verified STA TUFLOW model was subsequently adopted for the purposes of this project.

4.2.1 Hydrograph Comparison

To demonstrate differences in flood levels between the 2012 and 2014 STA models, this section presents the hydrographs at the river gauge locations from the STA model runs for the January 2011 events.

Two river gauges recorded flood levels during the January 2011 event in the STA catchment. Hydrographs covering this event (9-12 January) are shown in Figure 8 and Figure 9 below.

A description of the graphs is provided below:

- The timing (i.e. the shape of the hydrographs) at both gauges compares very well between the recorded and the modelled flood levels throughout the event.
- The model under predicted the peak flood level at the Woodford Alert gauge by 0.97m (1.74m in the 2012 model).

- The model under predicted the peak flood level at the Peachester Alert gauge by 0.68m (0.46m).
- Whilst the peak flow at the Peachester gauge is further from the gauged level than the 2012 model, the hydrograph shape is much closer to the recorded level.
- Underestimation in the peak flows were identified by WorleyParsons (2012) as likely due to the regionally adopted parameter set, rather than considering local model adjustments.
- Improved performance in the updated model is considered likely due to the updated topography and flow conveyance provided by ZLG lines, as well as the updated model parameters in the new TUFLOW executable.
- Instabilities in the model are noted at the Peachester gauge during the verification event. This model instability is likely due to the local topography and is confined to the local area. The instability occurs at low flows in between flood peaks, so does not influence the validity of the peak flood extent and height in the region. It is also noted that this instability is visible in the 2012 model results.

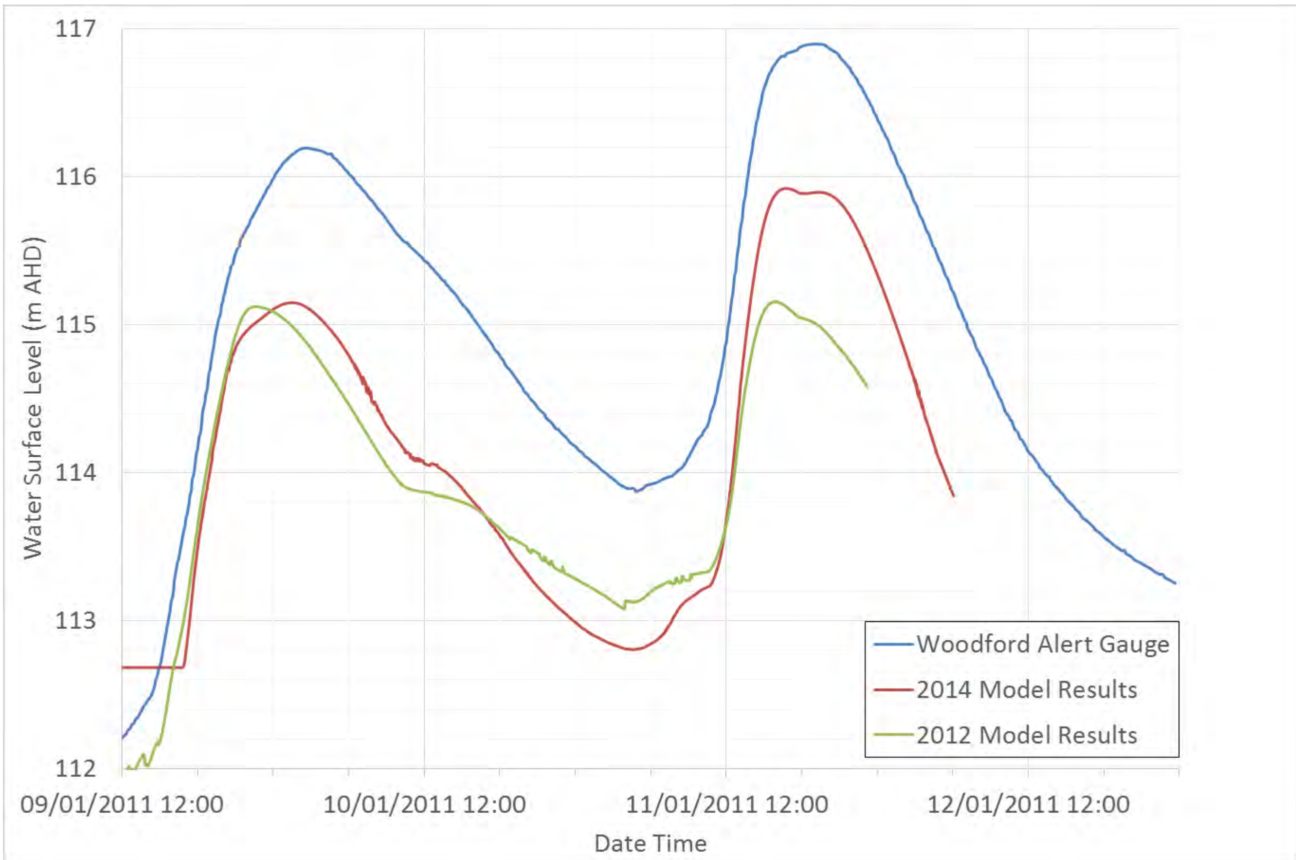

Figure 8 – Recorded and Modelled Hydrographs at Woodford Alert Gauge

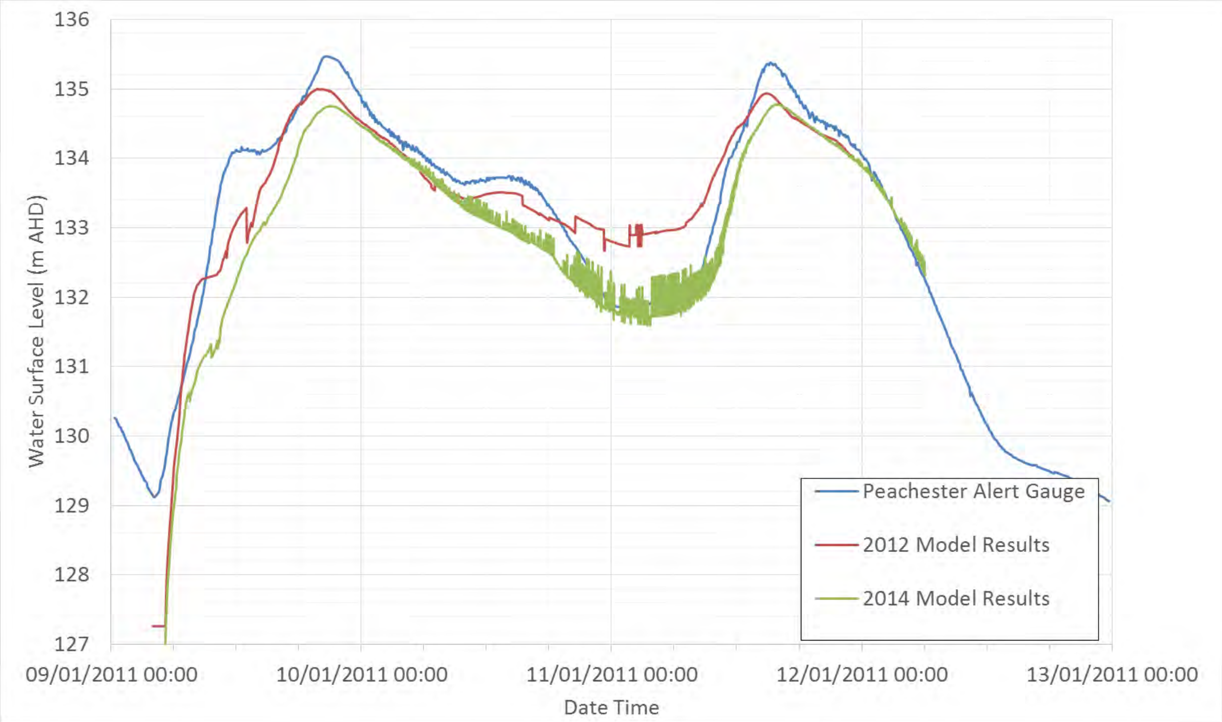

Figure 9 – Recorded and Modelled Hydrographs at Peachester Alert Gauge

4.2.2 Flood Mark Comparison

To analyse the difference in flood levels at flood marks between the 2012 and 2014 STA models a flood mark histogram was produced. This histogram shows a similar distribution of flood mark differences to the 2012 model. The histogram also shows most flood marks are lower in the model than in measured values.

Significant differences are noted at some flood marks. All floodmarks are surveyed, and are generally based on leftover debris after flooding. This type of survey can have inherent error. Previous RFD reports have also noted large differences in flood marks can be due to the base topography being different (surveyed levels versus LiDAR model topography) and council using a number of different survey team to collect the flood mark data.

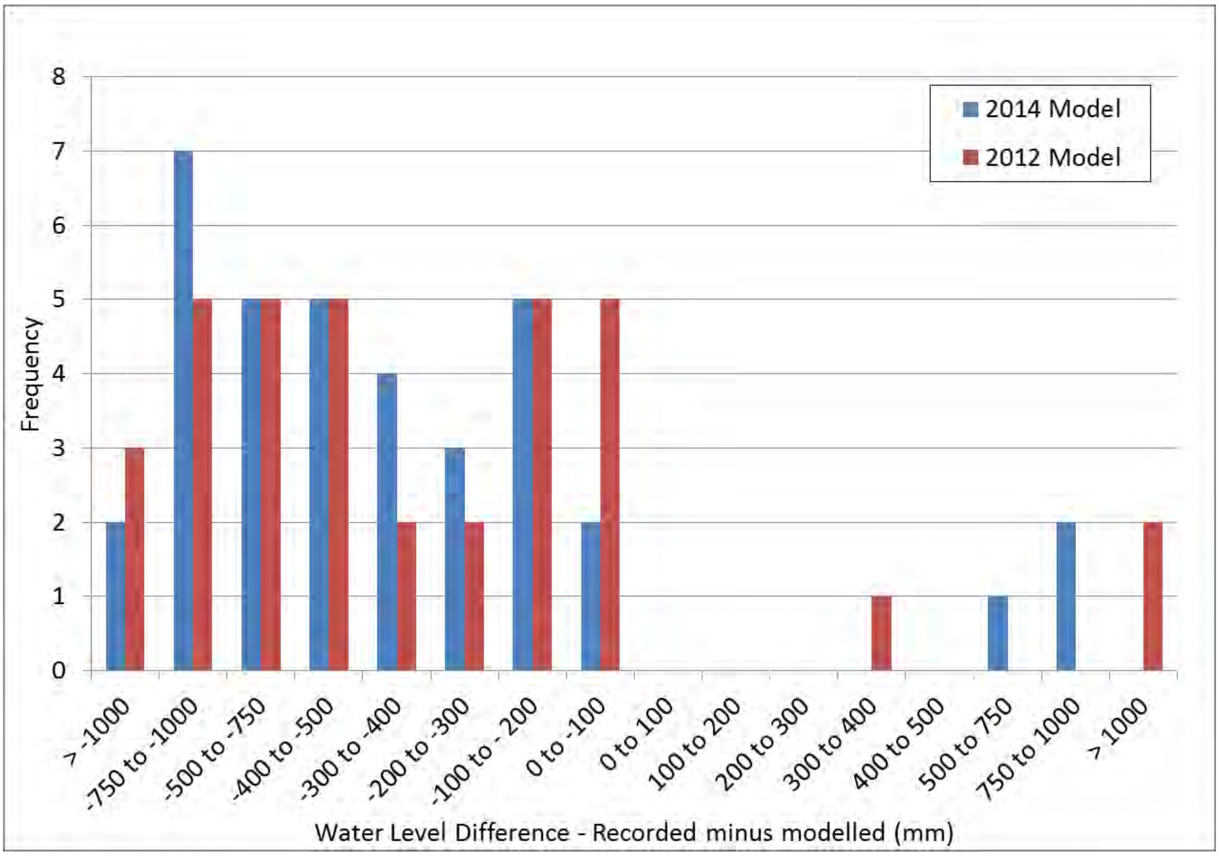

Figure 10 – Floodmark Histogram, January 2011

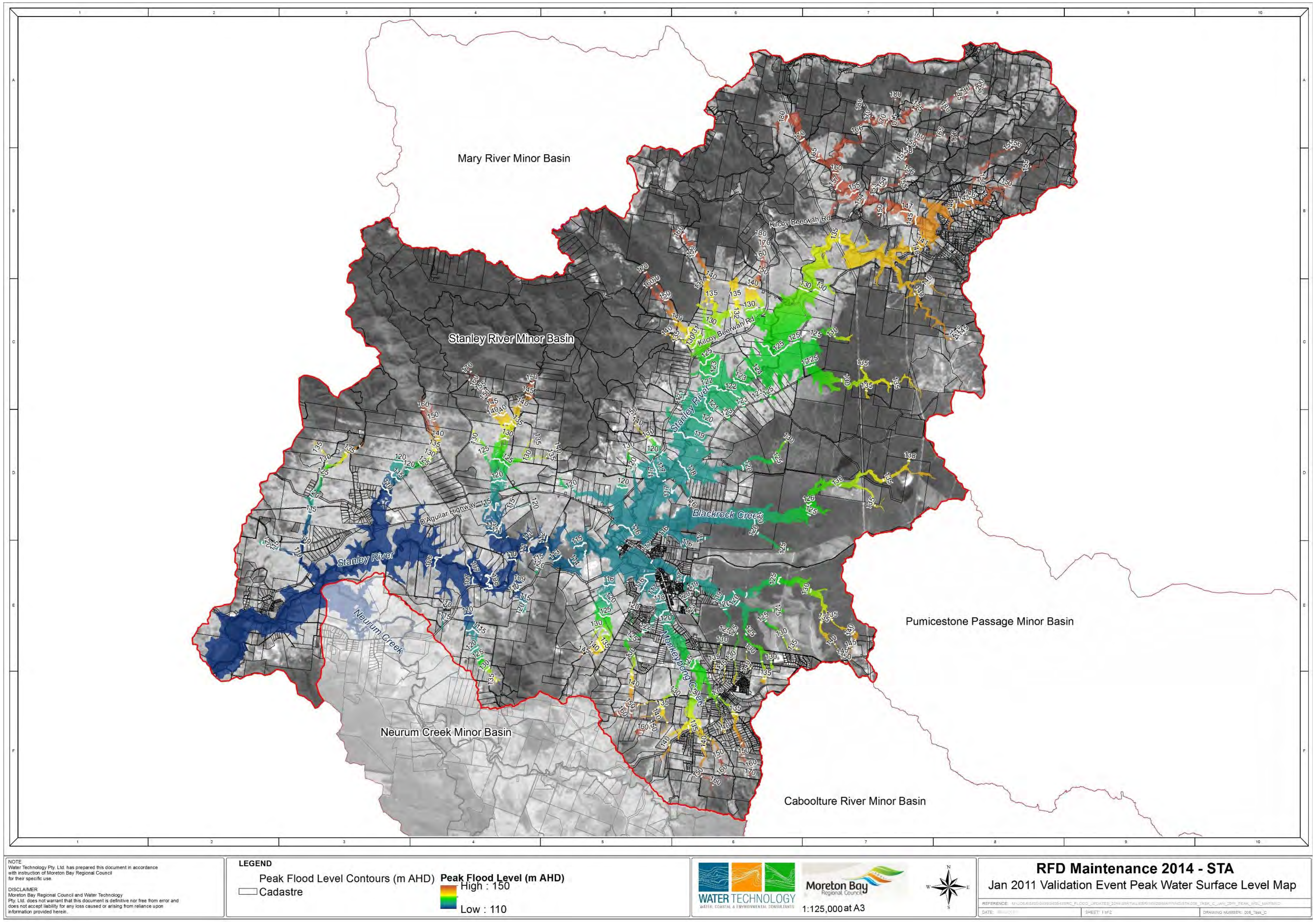

Figure 11 – Peak Water Surface Level and Extent Map, Verification Event, January 2011

“This page left intentionally blank”

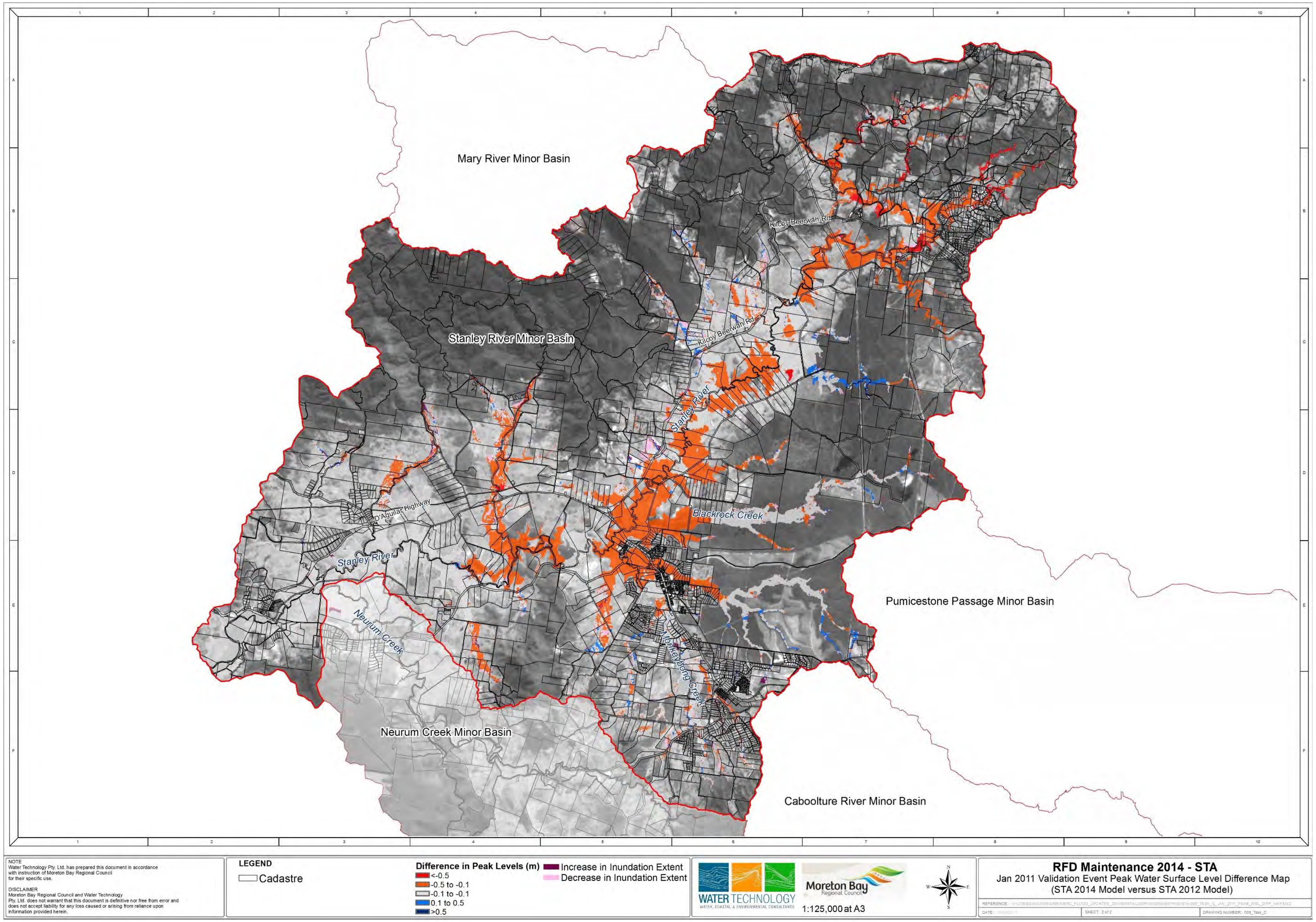

Figure 12 – Peak Water Surface Level Difference and Extent Map - 2014 Model vs 2012 Model, January 2011

4.3 Design Flood Behaviour

TUFLOW outputs (xmdf format) were provided to council for all simulations, which saved at 20 minute intervals. Peak value grids were also provided for each event and variable. The output variables include:

- Water Surface Level (H)
- Water Depth (D)
- Water Velocity (V)
- Water Depth Velocity Product (Z0)
- Hazard (ZMBRC, ZQRA)
- Stream Power (SP)

4.3.1 River & Creek

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

4.3.2 Storm Tide

There was no requirement to undertake any storm tide modelling for the STA model as part of project technical specification.

4.4 Sensitivity Analysis Results

The Moreton Bay Design Storm (MDS) was used as a base case for the sensitivity analysis. The results of the sensitivity analysis are summarised in sections 4.4.1 to 4.4.4. The MDS event generally has a lower flood peak than the 1% AEP event, on average 200mm lower along the Stanley River.

4.4.1 Hydraulic Roughness Analysis

Increasing Manning's 'n' by 20% resulted in major upstream increases in flood level of up to 1000mm in the Upper Stanley, Monkeybong and Blackrock tributaries. Flood extent was also increased, especially in the Blackrock Creek catchment. Downstream of the confluence of Blackrock Creek and the Stanley River, major reductions in flood level were noted of up to 700mm. Overall the impact of Manning's 'n' was high.

4.4.2 Structure Blockage Analysis

The structure blockage analysis shows that peak flood levels increase by more than 400 mm upstream of blocked structures and the extent of flooding also increases. Decreases in peak flood levels in the lower Stanley of approximately 10-20mm are observed.

4.4.3 Climate Change and Downstream Boundary Condition Analysis

Climate change has a significant impact on flood levels especially in the lower catchment.

Increase in Rainfall Intensity of 20%

An increase in rainfall throughout the catchment increased flood levels by between 100 -400 mm in most parts of the catchment.

Increased downstream boundary to 0.02% AEP level

An increase in downstream boundary to simulate the effects of an increased downstream water level increases flood levels in the lower Stanley River by up to 3500mm. This reflects the increase in downstream tailwater level from 103.13m AHD at 1% levels to 106.4m AHD at 0.02% levels (increase of 3270mm in tailwater level). The water level impact is confined to the lower Stanley and does not reach the confluence with Monkeybong Creek. Some small increases in flood extent are also noted in the middle and downstream areas of the catchment.

Increase in rainfall intensity and increases downstream boundary level to 0.02% AEP

Combining the above two scenarios affects the entire catchment with increases in flood levels of between 100 – 200 mm in the upper catchment, 300 – 500 mm in the middle catchment, and up to 3500 mm in the lower catchment. Some small increases in flood extent are also noted in the middle and downstream areas of the catchment.

4.4.4 Future Land use Analysis

Increasing the vegetation in the floodplain

Increasing the vegetation in the floodplain only increases flood levels in the upper Stanley River by 0 – 300 mm. The middle Stanley, near the confluence of Monkeybong Creek and Blackrock Creek, experience reductions in flood level of up to 600mm. The lower Stanley experiences increases of up to 900mm.

Increased residential development

Increased residential development has minor impacts on peak flood levels in the catchment, with isolated areas of 200-300mm of increased water level in Monkeybong Creek.

Increased vegetation in the floodplain and residential development

Combining the two scenarios above does not have an additional impact over and above the individual scenarios.

4.5 Model Limitations and Quality

The RFD maintenance tasks prepared by WT have been undertaken based on the specific project briefing and technical requirements as outlined by MBRC. The 2014 maintenance tasks prepared by WT are therefore limited in nature to undertaking:-

- Model revisions and updates in accordance with the project specifications and Council instructions; and
- Model revisions and updates performed without undertaking an extensive review or check of the overall structure and configuration of the originally developed models.

The model updates and revisions undertaken have culminated in overall model improvements compared to the models originally developed in 2012.

The following limitations apply to the updated WBNM and TUFLOW models prepared for this project:

- The same model limitations identified and discussed by Worley Parsons (WP, 2012) as part of the original development of the STA models equally apply to this study.
- The topography of the floodplain has been represented based on 2009 and 2014 LiDAR survey data provided by Council. The LiDAR data is subject to accuracy statements and these same accuracy statements will therefore equally apply to the models updated as part of this study.
- Bathymetric survey of the river or creek has not been undertaken for this study. The topography of the waterways has been defined using LiDAR data. LiDAR data is unable to pick up ground levels below the water surface, and therefore the invert of the waterways is not precisely represented.
- Watercourses have been represented in the 2D domain based on a grid resolution of 5m. A 3d breakline in the form of a TUFLOW gully line layer has also been included in the TUFLOW model to aid in channel continuity and conveyance. The representation of the watercourses in the model may lead to the model over or underestimating conveyance and indirectly affecting modelled flood levels.
- The TUFLOW model uses a fixed tailwater level which is based on a frequency relationship derived by Worley Parsons (WP, 2012). By virtue of the boundary condition applied, the model results immediately adjacent to the boundary may not be representative due to the artificial effects of the boundary condition applied at the model domain.
- Model verification has only considered one historical event. This method of verification does not replace full model calibration.
- The STA model includes a FLC=0 model parameter that has been applied to all bridge structures modelled as a layered flow constriction. A zero FLC value effectively ignores any energy losses associated with the bridge deck. The recommended value in TUFLOW is specified as FLC=1.56 (BMT WBM, 2010). Modelled flood levels in the areas of bridge structures may therefore be lower than would otherwise be the case where appropriate energy losses were applied to the bridge structures.
- The TUFLOW model includes adjustments to the method of modelling trunk drainage to direct inflows to pits and is based on a manhole loss approach option of “ENGELHUND”. This method does not necessarily allow for all pit losses to be attributed to pipe connections and may underestimate losses in the trunk drainage network given that only specific trunk drainage is being included in the model.

4.6 Model Specification and Run Times

Table 7 provides a brief summary of the STA TUFLOW model specification and run times. STA is a relatively large model, encompassing 229.4km^2 and 9,152,651 grid cells (at 5 m cell size) and has long runtimes.

Table 7– STA Model Specification and Run Times

Event	Model Grid Size	Model Run Time (hours)	2d Model Memory (RAM) [Gb]
1EY (1440m)	5m	458.9	35.1
1% AEP (1440m)	5m	420.2	35.1
0.1% AEP (720m)	10m	29.9	34.7
0.01% AEP (720m)	10m	41.7	34.7
MDS	5m	219.5	35.1

5. Conclusion

A range of WBNM and TUFLOW model updates and revisions have been prepared and documented in this report. These revisions and model updates have been prepared in accordance with the technical project specification prepared by MBRC. One of the key aspects for the model updates was the inclusion of new LiDAR data collected by Council in 2014.

Following the model updates, initial model tests have been undertaken as well as model verification tasks. The model was then used to complete a critical duration assessment which directed the design flood event assessments for the full range of events from the 1EY event through to the PMF event. Multiple storm durations as well as Council's Design Storm (MDS) Event were also assessed for the range of design events. Additionally, a number of sensitivity scenarios have also been assessed and includes future land use impacts, climate change scenarios, increased roughness, consideration of structure blockage as well as various combinations of the same.

The Regional Floodplain Database Project is focused on structuring model input and output data in a GIS database held by Council. Consequently, all model input and output data has been prepared and provided to Council in a digital format at the completion of the study. The data includes all model files for all the design events, sensitivity analysis, climate change assessment and future landuse scenarios, and includes all associated post-processing of model results as required.

The RFD Maintenance 2014 Project undertaken for the STA minor basin as documented in this report has been successful in addressing the overall objectives of the study.

It is recommended that Council continue to progressively upgrade and revise the STA models and digital data on a continual basis to maintain model performance and to ensure that the model outputs are appropriately representing the flooding behaviour of the STA floodplain. A future update should also aim to improve the STA model stability at low flows around Peachester gauge.

6. References

BMT WBM, 2009: TUFLOW Build 2009-07-AA Release Notes (http://www.tuflow.com/Downloads/Releases/TUFLOW%20Release%20Notes.2009-07-AA.001.pdf)

BMT WBM (2010), "Form loss for a 1d Bridge Channel", TUFLOW User Manual.

Sinclair Knight Merz (SKM), 2012a, "MBRC Regional Floodplain Database – Floodplain Parameterisation"

Sinclair Knight Merz (SKM), 2012b, "MBRC Regional Floodplain Database - Boundary Conditions, Joint Probability & Climate Change"

WorleyParsons, 2012 "Regional Floodplain Database - Hydrologic and Hydraulic Modelling Report: Stanley River (STA)"