# Regional Floodplain Database:

## 2014 Model Maintenance Report - Hays Inlet (HAY)

Moreton Bay
Regional Council

Moreton Bay Regional Council
PO Box 159
CABOOLTURE QLD 4510
Email: mbrc@moretonbay.qld.gov.au
Phone: (07) 3205 0555

*“This page left intentionally blank”*

aurecon

# Regional Floodplain Database

## 2014 Model Maintenance Report – Hays Inlet (HAY)

**Moreton Bay Regional Council**

**June 2015**

**Revision:** 2

**Reference:** 243304

Leading. Vibrant. Global.
www.aurecongroup.com

# Document control record

Document prepared by:


**Aurecon Australasia Pty Ltd**

ABN 54 005 139 873

Level 14, 32 Turbot Street
Brisbane QLD 4000

Locked Bag 331
Brisbane QLD 4001
Australia

**T** +61 7 3173 8000
**F** +61 7 3173 8001
**E** brisbane@aurecongroup.com
**W** aurecongroup.com




| **Document control** | | | | | | aurecon |
|---|---|---|---|---|---|---|
| **Report title** | | 2014 Model Maintenance Report – Hays Inlet (HAY) | | | | |
| **Document ID** | | | **Project number** | | 243304 | |
| **File path** | | MBRC_RFD_HAY_Model_Maintenance_Report_R2.docx | | | | |
| **Client** | | Moreton Bay Regional Council | **Client contact** | | | |
| **Rev** | **Date** | **Revision details/status** | **Prepared by** | **Author** | **Verifier** | **Approver** |
| 0 | June 2015 | Draft for Client Review | C Smyth | B Sexton | D Franklin | T Guest |
| 1 | June 2015 | Final | C Smyth | B Sexton | D Franklin | T Guest |
| 2 | June 2015 | Final | C Smyth | B Sexton | D Franklin | T Guest |
| | | | | | | |
| **Current revision** | | **2** | | | | |

| **Approval** | | | |
|---|---|---|---|
| Author signature | | Approver signature | |
| Name | Brian Sexton | Name | Talia Guest |
| Title | Senior Civil Engineer | Title | Associate |

# Contents

## Figures



## Tables

# 1 Introduction

Aurecon has been commissioned by Moreton Bay Regional Council (MBRC) to upgrade the Hays Inlet (HAY) hydrologic and hydraulic models as part of the Regional Floodplain Database (RFD) 2014 Maintenance project.

The key aspects of the RFD 2014 Maintenance Project updating process involved:

- Amendments to the sub-catchment parameterisation and discretisation in the WBNM hydrologic model based on latest LiDAR survey. In particular the construction of the Moreton Bay Rail Link (MBRL) required the re-discretisation of sub-catchments that are traversed by the rail alignment
- Incorporation of latest LiDAR survey within the 2D domain of the TUFLOW model
- Incorporation of latest bathymetric survey for Hays Inlet in the TUFLOW model
- Updating of TUFLOW material roughness layers in line with Councils current requirements
- Inclusion of break-lines to define channels where necessary in the TUFLOW domain
- Incorporation of the Moreton Bay Rail Link (MBRL) design and associated drainage infrastructure
- Incorporation of latest structure data within TUFLOW model pertaining to recent development areas in the TUFLOW domain
- Incorporation of underground trunk drainage within the TUFLOW 1D model domain at specific 'investigation areas'
- Generating outputs in multiple formats as per Council's requests, and using latest TUFLOW version for all simulations
- Running updated storm tide and sensitivity modelling scenarios as per Council's requirements

These updates are described in further detail in the following sections of this report.

# 2 2014 model maintenance details

## 2.1 WBNM model

The existing WBNM model was provided to Aurecon by MBRC. This was reviewed and amended in agreement with Council. The principal alterations that were made are described in the following bullet points.

- The 2014 LiDAR data was used to cross-check sub-catchment discretisation throughout the model. This led to changes in the sub-catchment discretisation in a small number of areas, most notably where development had obviously since taken place when compared against the previous LiDAR dataset
- Moreton Bay Rail Link (MBRL) is currently under construction and crosses the Hays Inlet Catchment from east to west finishing at Kippa-Ring. DEM files of the final MBRL design were provided by Council and catchments that were intersected by the rail were discretised along the rail boundary
- Aurecon also incorporated amendments as provided by Council to the fraction impervious percentages of the WBNM sub-catchments

- An initial loss of 15 mm was adopted for events up to 20% AEP. For events greater in magnitude than 20% AEP no initial loss was applied. For all events a 2.5 mm/hr continuous loss rate was applied
- Where previous modelling had not accounted for certain event magnitudes these were generated in accordance with Council and industry requirements (ie 0.02% and 0.01% AEP events)
- Quality checks against the previous WBNM modelling was carried out to ensure consistency across both model outputs, notwithstanding any differences that were owing to the aforementioned changes that were made to the model set-up/parametrisation

## 2.2 TUFLOW model

In conjunction with Council, Aurecon made a number of changes to the HAY TUFLOW model. These modifications are outlined in the following bullet points. Refer also to Figure 2-1:

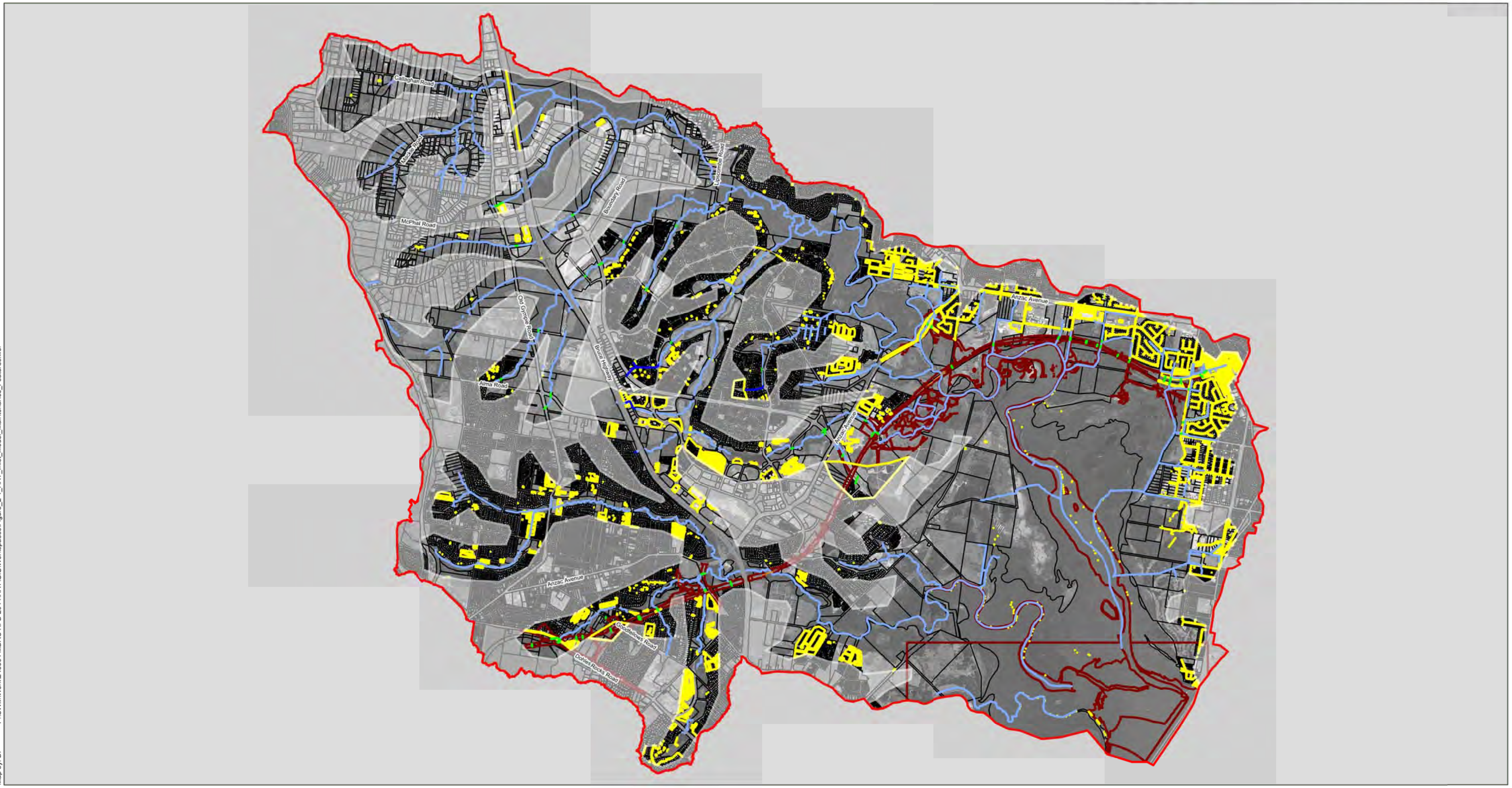
- The TUFLOW 2013-12-AD-iSP-w64 executable was used for all simulations. This TUFLOW version includes Councils hazard categories as a default output
- All TUFLOW model files were named as per Council's RFD naming convention (Run ID: 002c)
- Results were generated in multiple formats as per Council's requests – this includes XMDF, FLT and WRB outputs types. In summary the outputs coding is as follows:
  - For rivers/creeks:
    - Map Output Format == XMDF | FLT | WRB
    - WRB Map Output Data Types == h d v
    - XMDF Map Output Data Types == h v d ZMBRC Z0 ZQRA SP
    - FLT Map Output Data Types == h v d ZMBRC Z0 ZQRA
  - For storm tide:
    - Map Output Format == XMDF | FLT |
    - XMDF Map Output Data Types == h v d ZMBRC Z0 ZQRA SP Z9
    - FLT Map Output Data Types == h v d ZMBRC Z0 ZQRA Z9
- Incorporation of 2014 LiDAR survey within the 2D domain of the TUFLOW model
- Incorporation of 2014 bathymetric survey in the TUFLOW model at Hays Inlet
- Updating of TUFLOW material roughness layer in line with Councils current requirements – this includes use of the most up to date waterbody layer, and also accounts for a number of specific areas of development within the 2D domain
- Inclusion of break-lines to define channels where necessary in the TUFLOW domain – this was undertaken as per Council's standard methodology using 'z-shape' gully lines based on streamline data provided
- The received MBRL hydraulic sub-models for Freshwater Creek and Saltwater Creek were incorporated into the Hays TUFLOW model. These models included relevant ground survey, a DEM of the final rail design and hydraulic structures
- Incorporation of latest structure data within TUFLOW model pertaining to recent development areas in the TUFLOW domain. These locations were outlined in the project brief and data pertaining to each was provided by Council – this comprised design drawings, onsite survey, photographs, etc. Over the course of the project, and following Aurecon's ongoing review of the model, a small number of additional structures were also added

- Incorporation of underground trunk drainage within the TUFLOW 1D model domain at specific 'investigation areas'. These investigation areas were outlined in the project brief, of which there were eight (8) discrete locations in total. The data was typically obtained from Council's stormwater GIS layer which was also provided as part of this project. '2d SA pits' were used to control the application of the flow within the 2d domain such that it would be subsequently conveyed by the underground network, yet could still surcharge and show overland flooding where the pipe network capacity was exceeded
- A review of the modelling of buildings was also conducted to ensure the HAY model met with current industry practices
- PO lines were reviewed and amended where necessary
- Storm tide and sensitivity modelling scenarios were simulated as per Council's brief requirements

## Moreton Bay Regional Council - Regional Floodplain Database

Moreton Bay Regional Council

aurecon




Map by: DF

P:\SWM\Work\243304 MBRC RFD 2014\HAY\GIS\Workspaces\Figure_2-1_HAY_Inlet_Model_Maintenance_Features.wor

**Legend**

- Hays Inlet Catchment Boundary
- Hydraulic Model Boundary
- Cadastral Bondaries

Additional Features

- Change in Landuse Roughness
- Change in Topography/Bathymetry
- Bridge
- Open Drain/Channel
- Underground Drainage
- Additional Culvert

**Notes:**

A3 scale 1:52,500

0 2,625 m

Date: 26/06/2015 Version: 0 Job No: 243304

Projection: MGA Zone 56

Regional Floodplain Database 2014 Model Maintenance Report - Hays Inlet (HAY)

**Figure 2-1: Hydraulic Model Maintenance Features**

# 3 Model simulations

## 3.1 Verification

Verification against recorded rainfall and surveyed flood marks was not undertaken for the HAY model due to lack of 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 synthesised events used to estimate design flood conditions. They are based on a probability of occurrence, usually specified using the Average Exceedance Probability (AEP) nomenclature. For events less than the 50% AEP, the terminology Exceedances per Year (EY) is used (eg 0.5EY for the 2yr ARI event).

### 3.2.1 River and creek critical duration assessment

For the RFD 2014 Maintenance Project the Critical Duration Analysis (CDA) undertaken utilised the 1% AEP and 0.1% AEP events. Results from the CDA are shown in Figure 3-1 to Figure 3-2.

Critical durations selected from the 1% AEP event CDA were applied to all events ranging from the 1EY to the 1% AEP. Critical durations selected from the 0.1% AEP event CDA were applied to all events ranging from the 0.5% AEP to the PMF event.

The critical durations selected from the CDA is shown in Table 3-1.

Table 3-1 Critical duration assessment

| Assessment event | Durations | Selected durations | Adopted event(s) |
|---|---|---|---|
| 1% AEP | ½, 1, 1½, 2, 3, 4½, 6, 9, 12, and 24 hour storm | 1, 3 and 6 hour storm | 1EY, 0.5EY, 20%, 10%, 5%, 2% and 1% AEP |
| 0.1% AEP | ½, 1, 1½, 2, 3, 4, 5, 6, 12, and 24 hour storm | 1, 3 and 6 hour storm | 0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP and PMF |

To determine the critical storm durations, the following methodology was adopted:

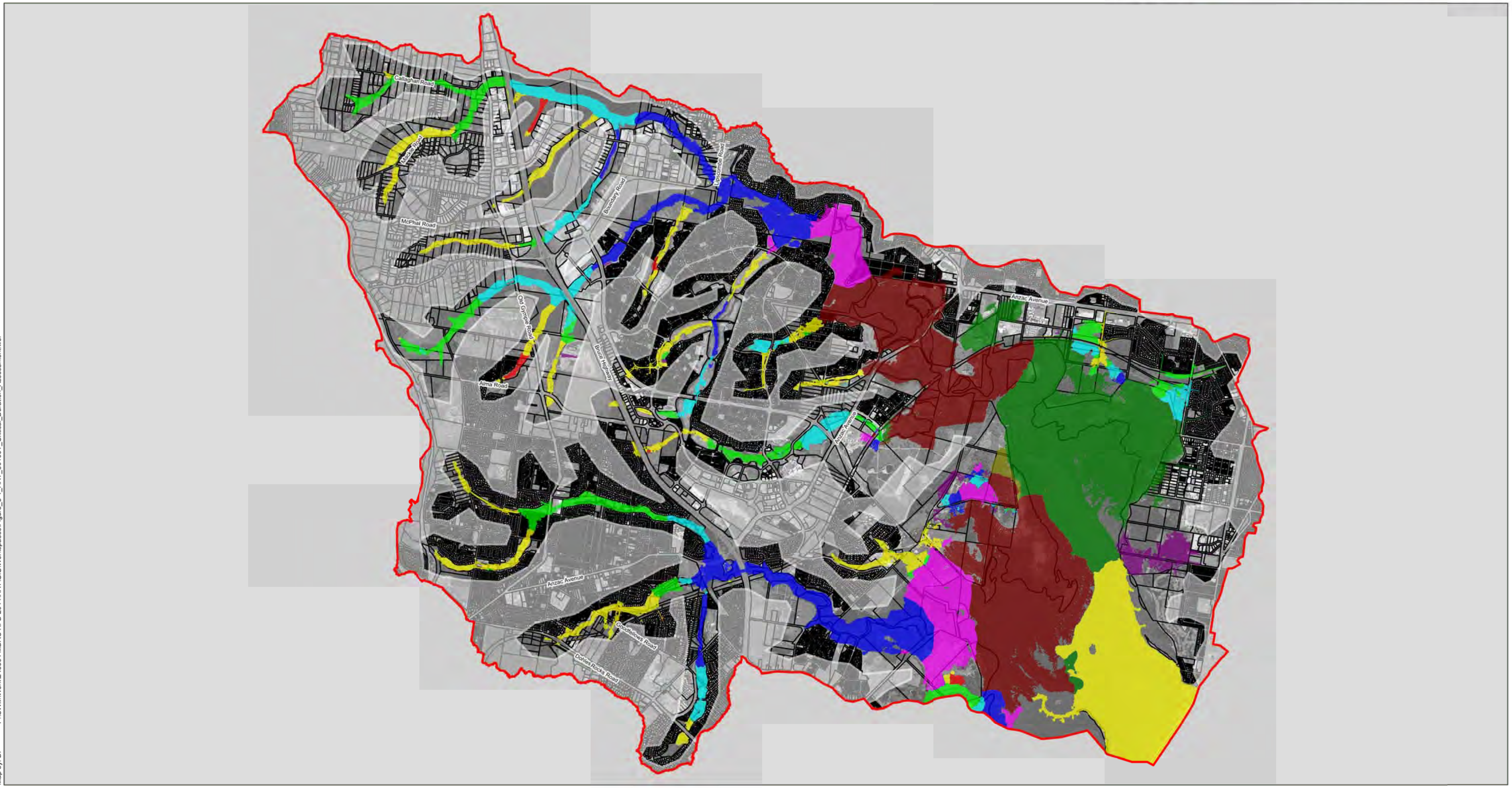
1. Hydrologic and hydraulic modelling for the range of storm durations as listed in Table 3-1
2. Mapping of the peak flood levels for the “maximum envelope” of all the storm durations
3. Mapping of the peak flood levels for the “maximum envelope” of the selected storm durations as listed in Table 3-1
4. Difference comparison between the mapped peak flood levels for the selected storm durations (iii) and the mapped peak flood levels from all storm durations (ii)
5. Selection of the critical storm durations was based on the storm durations generating the highest flood levels across the most of the minor basin area

The difference comparison for the 1% and 0.1% AEP peak flood levels determined from above methodology is shown in Figure 3-3 and Figure 3-4. These figures illustrate that the selected critical durations (see Table 3-1) generally represents the peak flood levels throughout the minor basin.

# Moreton Bay Regional Council - Regional Floodplain Database

Moreton Bay Regional Council

aurecon




Map by: DF   P:\SWM\Work\243304 MBRC RFD 2014\HAY\GIS\Workspaces\Figure_3-1_HAY_00100Y_Critical_Duration_Assessment.wor

**Legend**

Hays Inlet Catchment Boundary

Hydraulic Model Boundary

Cadastral Bondaries

Critical Durations

| | |
|---|---|
| 30 minute | 270 minute |
| 60 minute | 360 minute |
| 90 minute | 540 minute |
| 120 minute | 720 minute |
| 180 minute | 1440 minute |

**Notes:**

A3 scale 1:52,500

0 2,625 m

Date: 26/06/2015 Version: 0 Job No: 243304

Projection: MGA Zone 56

Regional Floodplain Database 2014 Model Maintenance Report - Hays Inlet (HAY)

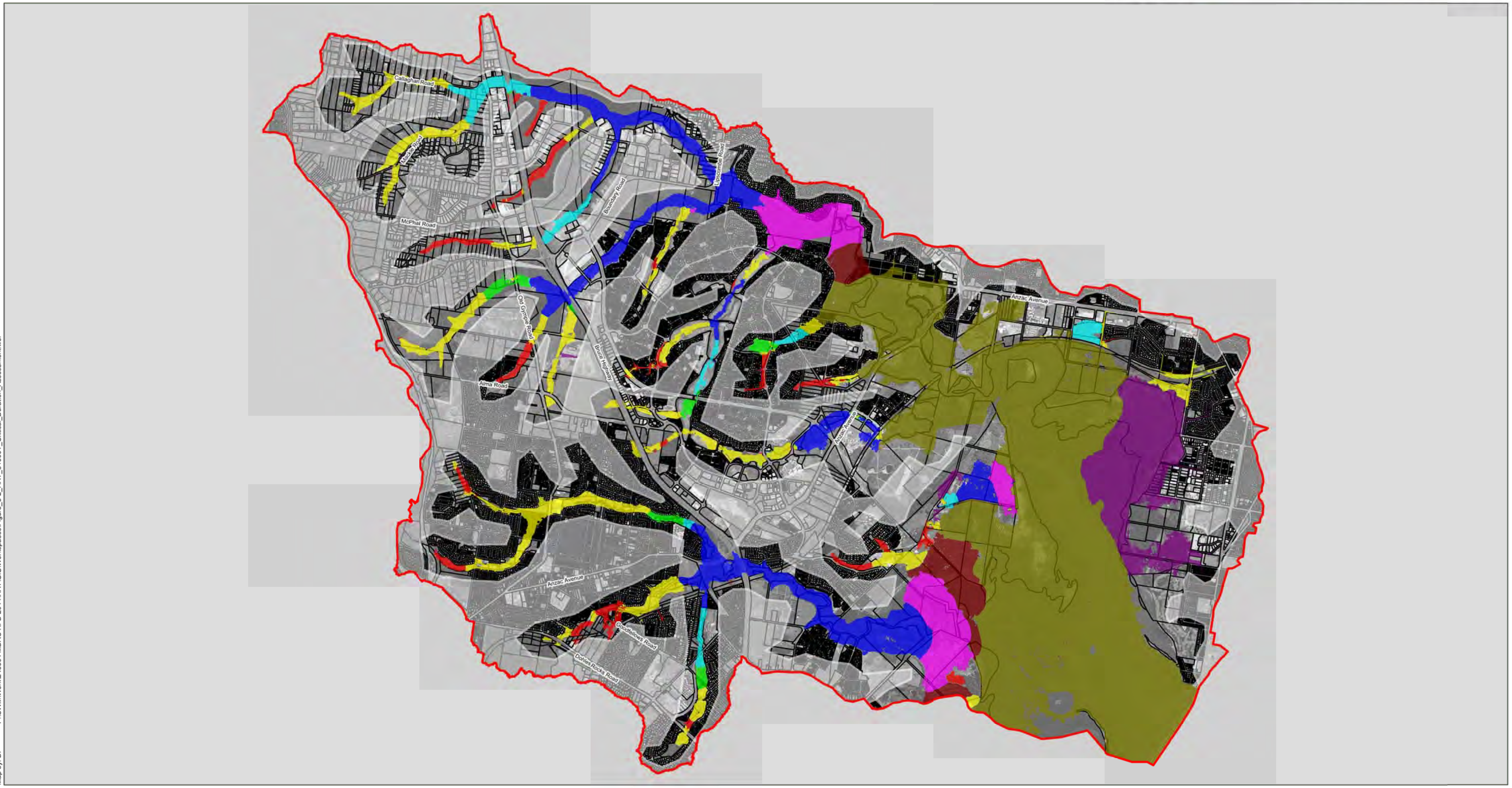
**Figure 3-1: Critical Duration Assessment - 1% AEP**

*“This page left intentionally blank”*

## Moreton Bay Regional Council - Regional Floodplain Database

Moreton Bay Regional Council

aurecon




Map by: DF P:\SWM\Work\243304 MBRC RFD 2014\HAY\GIS\Workspaces\Figure_3-2_HAY_01000Y_Critical_Duration_Assessment.wor

**Legend**

- Hays Inlet Catchment Boundary
- Hydraulic Model Boundary
- Cadastral Bondaries

**Critical Durations**

| | |
|---|---|
| 30 minute | 240 minute |
| 60 minute | 300 minute |
| 90 minute | 360 minute |
| 120 minute | 720 minute |
| 180 minute | 1440 minute |

**Notes:**

A3 scale 1:52,500

0 2,625 m

Date: 26/06/2015 Version: 0 Job No: 243304

Projection: MGA Zone 56

**Regional Floodplain Database** **2014 Model Maintenance Report - Hays Inlet (HAY)**

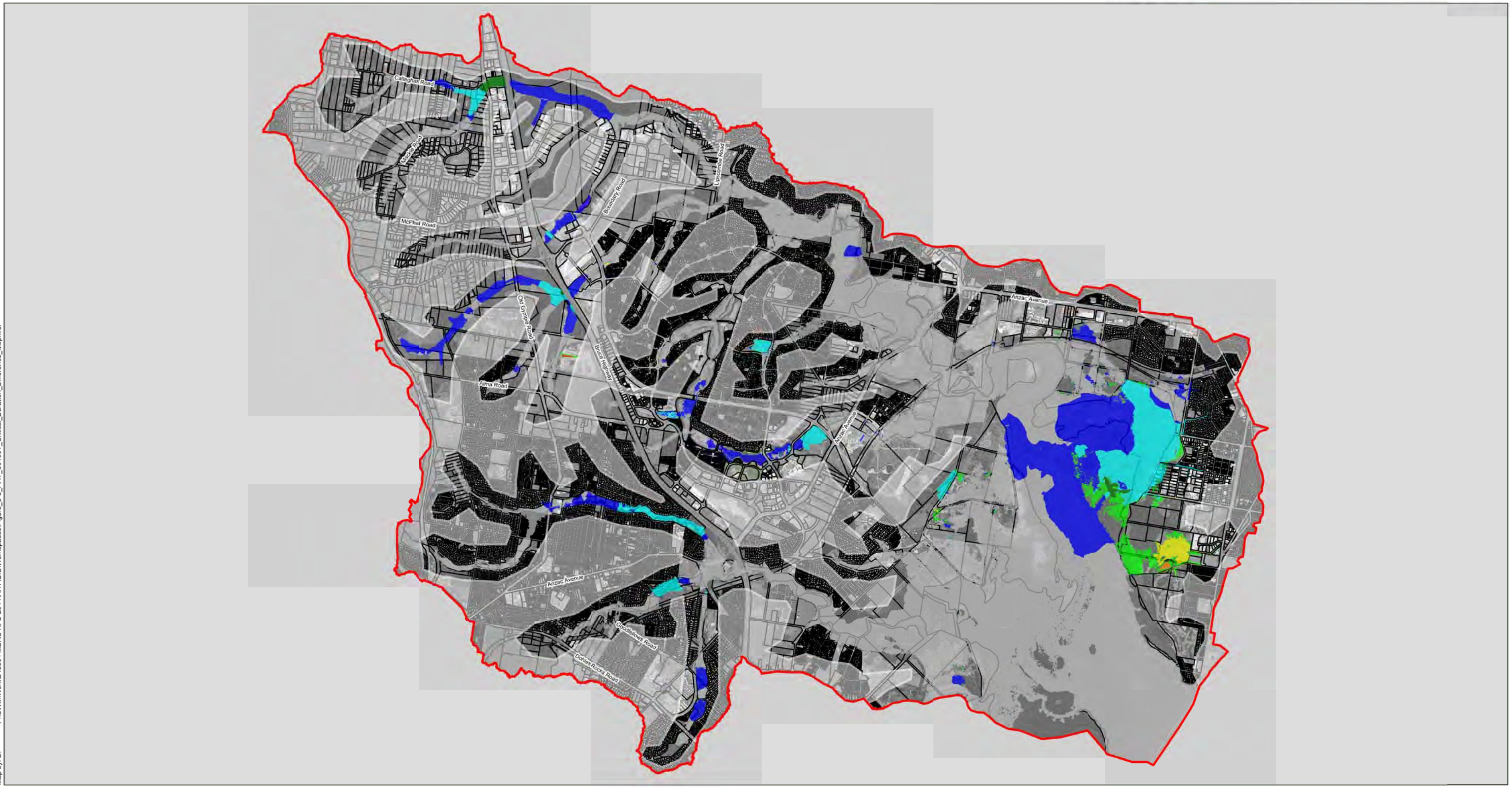
**Figure 3-2: Critical Duration Assessment - 0.1% AEP**

*"This page left intentionally blank"*

## Moreton Bay Regional Council - Regional Floodplain Database

Moreton Bay Regional Council

aurecon




Map by: DF

P:\SWM\Work\243304 MBRC RFD 2014\HAY\GIS\Workspaces\Figure_3-3_HAY_00100Y_Critical_Duration_Difference_Map.wor

**Legend**

Hays Inlet Catchment Boundary

Hydraulic Model Boundary

Cadastral Bondaries

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

Difference in Flood Extent

- Decrease in Inundation Extent
- Increase in Inundation Extent

**Notes:**

A3 scale 1:52,500

0 2,625 m

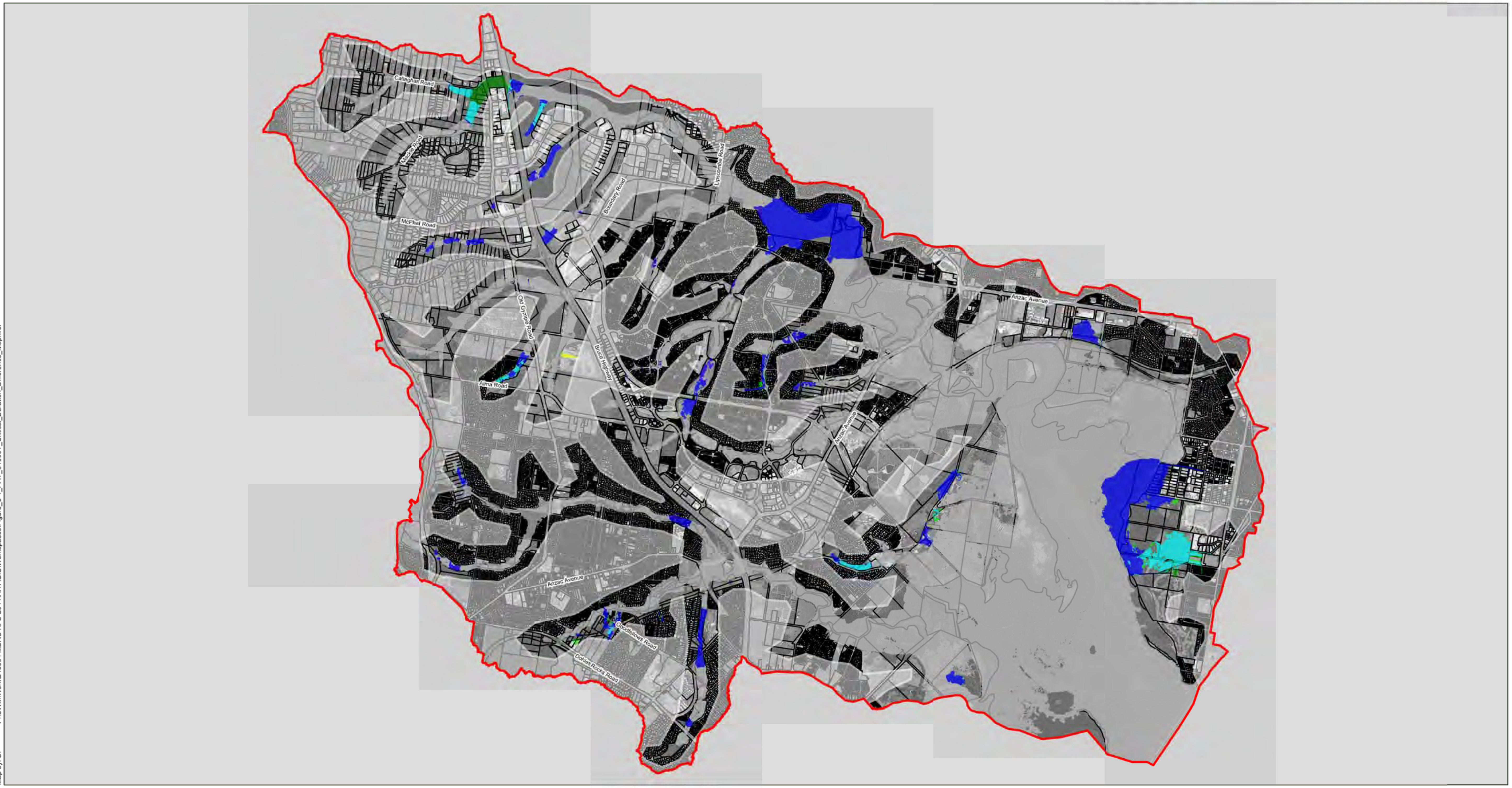
Date: 30/06/2015 Version: 1 Job No: 243304

Projection: MGA Zone 56

Regional Floodplain Database **2014 Model Maintenance Report - Hays Inlet (HAY)**

**Figure 3-3: Critical Duration Assessment**
**Peak Flood Level Difference - 1% AEP**

*"This page left intentionally blank"*




**Legend**

- Hays Inlet Catchment Boundary
- Hydraulic Model Boundary
- Cadastral Bondaries

**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

**Difference in Flood Extent**

- Decrease in Innundation Extent
- Increase in Innundation Extent

**Notes:**

A3 scale 1:52,500

0 — 2,625 m

Date: 30/06/2015 Version: 1 Job No: 243304

Projection: MGA Zone 56

Regional Floodplain Database **2014 Model Maintenance Report - Hays Inlet (HAY)**

**Figure 3-4: Critical Duration Assessment**
**Peak Flood Level Difference - 0.1% AEP**

### 3.2.2 River and creek design event simulations

The HAY model was simulated for a range of AEPs and storm durations as detailed in Section 3.2.1, as well as the MBRC Design Storm (MDS). Councils adopted design storm (ie the MDS) is a 1% AEP 15 minute event embedded within a 270 minute design storm. The MDS is useful for general investigations into changes in model parameters and catchment characteristics, as it reduces the number of model runs required (ie one run instead of multiple storm durations).

The HAY model was simulated for the following design events:

- The 1EY, 0.5EY, 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2%, 0.1%, 0.05%, 0.02%, 0.01% AEP events and the PMF event for the three selected critical durations
- The Moreton Bay Design Storm – 1% AEP 15 minute in 270 minute embedded design storm

### 3.2.3 Storm tide design event simulations

The coastal (downstream) boundary was modified for the storm tide runs to allow for accurate modelling of the inundation propagation/extents.

Note that this event utilises a dynamic (temporally varying) downstream boundary condition without any rainfall over the catchment. The downstream boundary condition was generated using MBRC's Storm Tide Hydrograph Tool as supplied by Council ('20140620 Storm Tide Hydrograph Tool.xlsx').

Only one storm tide reference point was used to develop the storm tide dynamic profile. This was MBC_004.

Table 3-2 outlines the various storm tide runs that were undertaken as part of the HAY RFD project.

**Table 3-2 Summary of storm tide events**

| ID | Description |
|---|---|
| HAY_S_002c_E_00020Y | No rainfall, dynamic Storm Tide (5% AEP current) |
| HAY _S_002c_E_00100Y | No rainfall, dynamic Storm Tide (1% AEP current) |
| HAY _S_002c_E_01000Y | No rainfall, dynamic Storm Tide (0.1% AEP current) |
| HAY _S_002c_E_10000Y | No rainfall, dynamic Storm Tide (0.01% AEP current) |
| HAY _S_002c_F_00100Y | No rainfall, dynamic Storm Tide (1% AEP future incl. Climate Change + 0.8m SLR) |

## 3.3 Sensitivity analysis

The HAY model was used to assess a total of ten (10) sensitivity simulations in order to evaluate the response of the model to changes in key parameters. Each scenario test is outlined in Table 3-3.

Note that each test was undertaken using the 1% AEP MDS storm.

Table 3-3 Sensitivity analysis summary

| ID | Scenario Test | 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 catchment development | 3.3.4 |
| R10 | Vegetated floodplain and future catchment development | 3.3.4 |

### 3.3.1 Hydraulic roughness analysis

All Manning's 'n' values in the TUFLOW models 2D domain were increased by 20%.

### 3.3.2 Structure blockage analysis

For the blockage scenario a blockage factor was only applied to all culverts in the HAY model (noting that this does not apply to underground pipe networks).

For culverts the blockage scenario was adopted from the SKM *Floodplain Parameterisation* report (2012b), and includes:

- A full blockage is applied if the culvert diagonal is less than 2.4 m
- A 15% blockage is applied if the culvert diagonal is greater than 2.4 m

### 3.3.3 Climate change and downstream boundary conditions analysis

Simulations R03 to R07 involved the testing of the models sensitivity to climate change. This involved investigation of effects associated with increased rainfall, sea-level rise and storm tide activity. The following five (5) scenarios were assessed:

- R03: Investigation of the impact of an increase in rainfall intensity of 20% (as per SKM (2012a) *Boundary Conditions, Joint Probability and Climate Change Report*)
- R04: Investigation of the impact of an increased tailwater level of 0.8 m due to predicted sea level rise
- R05: Investigation of the impact of a 20% increase in rainfall intensity and an increased tailwater level of 0.8 m due to predicted sea level rise. This test combines scenarios R03 and R04
- R06: Investigation of the impact of a 1% AEP current static storm tide level with concurrent 1% AEP MDS rainfall event
- R07: Investigation of the impact of a 20% increase in rainfall intensity and an increase in sea level rise (ie a static storm tide level (1% AEP GHG) + 0.8 m)

### 3.3.4 Future land-use analysis

Three future landuse scenarios were assessed using the 1% AEP MDS. These tests did not incorporate any changes to rainfall intensity or tailwater conditions from those assumed in the design runs. Instead they focused on altering the fraction impervious within the sub-catchment domain, as well as modifying the vegetative cover within the floodplain.

In line with anticipated future catchment development the WBNM hydrologic model was modified to reflect an increase in the fraction impervious within each subcatchment. This leads to increased run-off and higher peak discharges. These discharges were in turn incorporated into the TUFLOW model as inflow boundary conditions.

The floodplain vegetation was altered in line with the brief requirements. This was done by developing specific TUFLOW material layers to increase the roughness within the 1% AEP floodplain.

The following three (3) scenarios were assessed:

- R08: Investigation of 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
- R09: Investigation of the impact of increased residential development. The WBNM model was updated to reflect an increase in the fraction impervious within each subcatchment. The increased discharges were then incorporated into the TUFLOW model as inflow boundary conditions
- R10: Investigated the impact of increased residential development and increased vegetation in the floodplain. This test combines scenarios R08 and R09

# 4 Model results and outcomes

## 4.1 2014 model maintenance

Figure 4-1 and Figure 4-2 show the difference between the 2012 HAY model and the updated 2014 HAY model for the 5% and 1% 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 events**

| Event | Storm durations for 2012 model | Storm durations for 2014 model |
|---|---|---|
| 5% AEP | 1, 3 and 6 hour | 1, 3 and 6 hour |
| 1% AEP | 1, 3, 6, 12, 24 and 48 | ½, 1, 1½, 2, 3, 4½, 6, 9, 12, and 24 hour |

Negative values in Figure 4-1 and Figure 4-2 show where the 2014 HAY model flood levels are lower than those of the 2012 HAY model results and vice versa. These differences were investigated and satisfactorily understood. Aspects contributing to the differences included updated topography, alterations in the hydrologic model outputs that act as inflow boundary conditions to the TUFLOW model, and changes to local drainage infrastructure (eg new pipes, embankments, earthworks, etc).

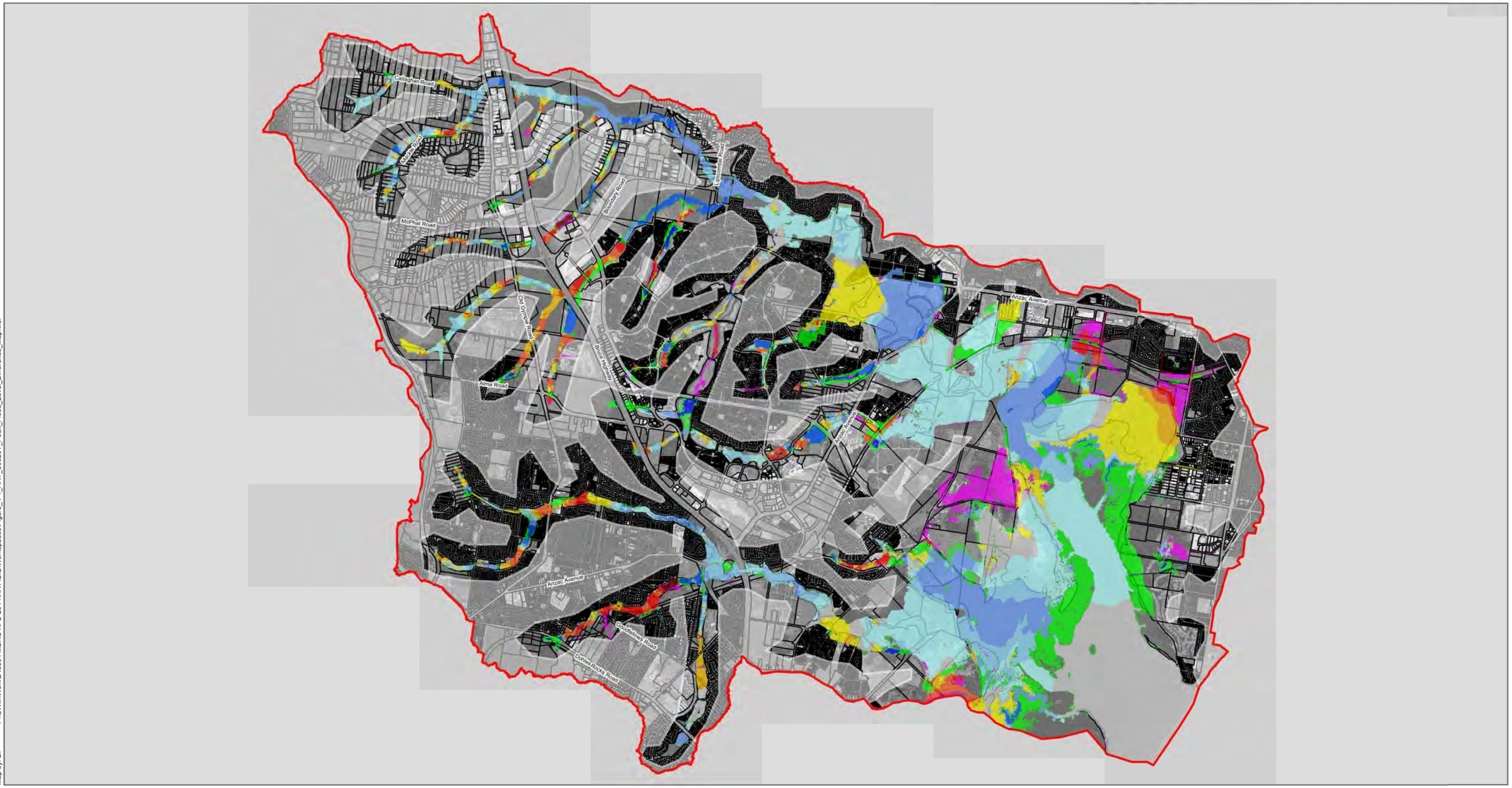
## 4.2 Verification

Verification against recorded rainfall and surveyed flood marks was not undertaken for the HAY model due to lack of historical event data.

# Moreton Bay Regional Council - Regional Floodplain Database

Moreton Bay Regional Council

aurecon




Map by: DF

P:\SWM\Work\243304 MBRC RFD 2014\HAY\GIS\Workspaces\Figure_4-1_HAY_00020Y_Peak_Flood_Level_Difference_Map.wor

**Legend**

- Hays Inlet Catchment Boundary
- Hydraulic Model Boundary
- Cadastral Bondaries

**Difference in Peak Flood Levels (m)**

- < -0.50
- -0.50 to -0.20
- -0.20 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

**Difference in Flood Extent**

- Decrease in Inundation Extent
- Increase in Inundation Extent

**Notes:**

A3 scale 1:52,500

0 — 2,625 m

Date: 26/06/2015 Version: 0 Job No: 243304

Projection: MGA Zone 56

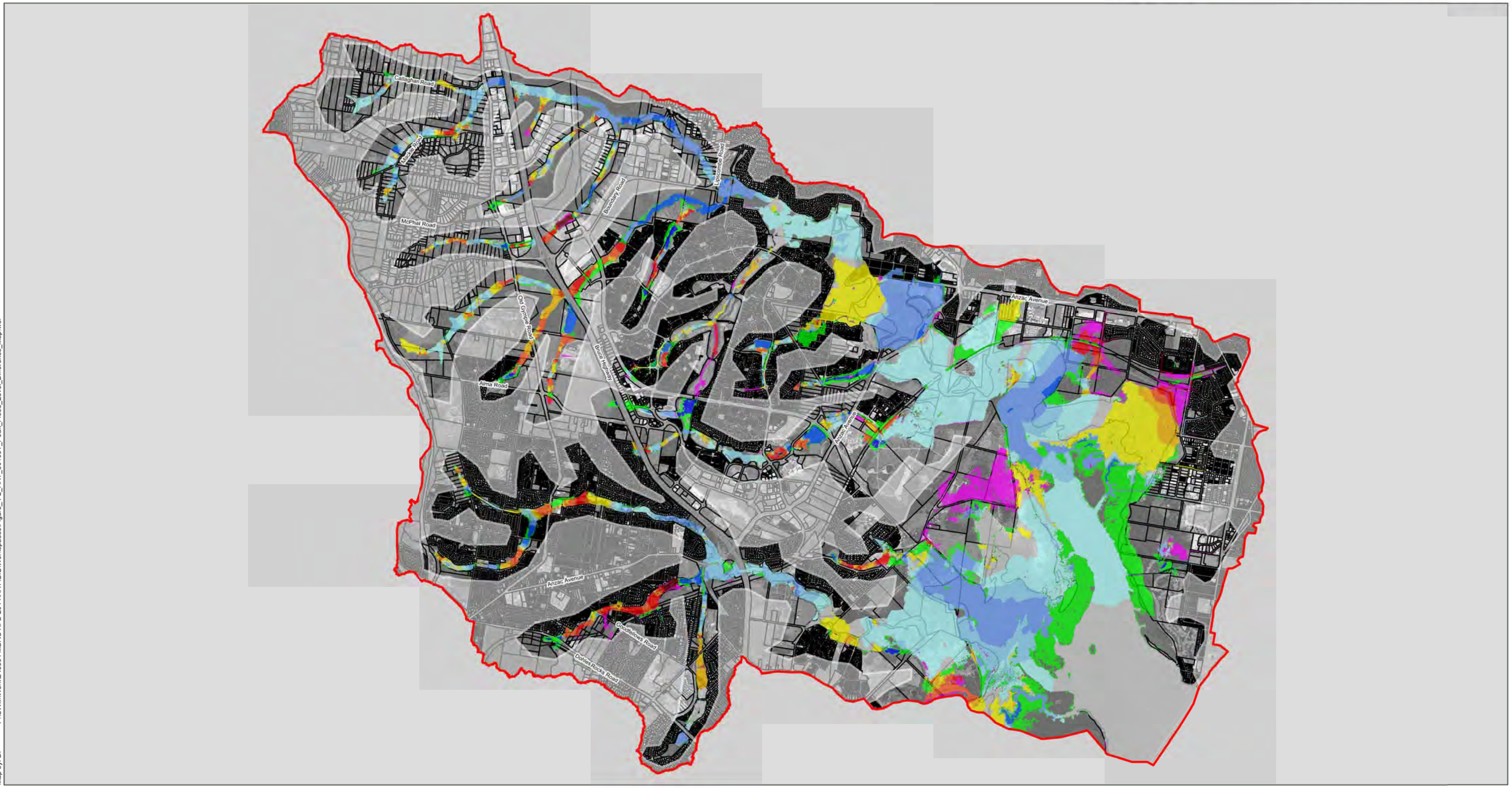
Regional Floodplain Database **2014 Model Maintenance Report - Hays Inlet (HAY)**

**Figure 4-1: 2014 HAY Model Versus 2012 HAY Model Peak Flood Level Difference - 5% AEP**

*“This page left intentionally blank”*

Moreton Bay Regional Council

aurecon




P:\SWM\Work\243304 MBRC RFD 2014\HAY\GIS\Workspaces\Figure_4-2_HAY_00100Y_Peak_Flood_Level_Difference_Map.wor

Map by: DF

**Legend**

- Hays Inlet Catchment Boundary
- Hydraulic Model Boundary
- Cadastral Bondaries

Difference in Peak Flood Levels (m)

- < -0.50
- -0.50 to -0.20
- -0.20 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

Difference in Flood Extent

- Decrease in Inundation Extent
- Increase in Inundation Extent

**Notes:**

A3 scale 1:52,500

0 2,625 m

Date: 26/06/2015 Version: 0 Job No: 243304

Projection: MGA Zone 56



**Figure 4-2: 2014 HAY Model Versus 2012 HAY Model Peak Flood Level Difference - 1% AEP**

## 4.3 Design flood behaviour

Results were generated in multiple formats as per Council's requests – this includes XMDF, FLT and WRB outputs types. The following outputs were generated both on an interval (time varying) and peak value basis:

- Flood level (h)
- Flood depth (d)
- Flow velocity (v)
- Four Hazard Classifications (ZBMRC, Z0, ZQRA, Z9)
- Stream Power (SP)

### 4.3.1 River and creek

A max-max function was used to derive the envelope of all critical storm durations (Section 3.2.1) for each event and all the TUFLOW outputs listed in Section 4.3 above. Results for the 5%, 1% and 0.1% AEP events are available on Council's website (www.moretonbay.qld.gov.au/floodcheck) as PDF suburb maps or in the Flood Explorer interactive mapping tool.

In summary the output coding for all design fluvial flooding is as follows:

- Map Output Format == XMDF | FLT | WRB
- WRB Map Output Data Types == h d v
- XMDF Map Output Data Types == h v d ZMBRC Z0 ZQRA SP
- FLT Map Output Data Types == h v d ZMBRC Z0 ZQRA

### 4.3.2 Storm tide

Outputs were generated for each storm tide event (Section 3.2.3) and all the TUFLOW outputs listed in Section 4.3 above. The outputs 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.

In summary the output coding for all storm tide flooding is as follows:

- Map Output Format == XMDF | FLT |
- XMDF Map Output Data Types == h v d ZMBRC Z0 ZQRA SP Z9
- FLT Map Output Data Types == h v d ZMBRC Z0 ZQRA Z9

## 4.4 Sensitivity analysis results

The Moreton Bay Design Storm (MDS) was used in all the sensitivity analyses, avoiding the need to run multiple durations. The results of these analyses are summarised in Sections 4.4.1 to 4.4.4.

Note also that in comparing the MDS against the 1% AEP design event (envelope of all durations) the latter was typically only marginally higher in terms of its peak flood level. Differences were generally less than 50 mm throughout the model.

### 4.4.1 Hydraulic roughness analysis

A comparison of the results showed the increase in Mannings 'n' to raise water levels by approximately 100 mm to 200 mm in the uppermost, channelised reaches of the floodplain. This leads to only minor increases in floodplain extents due to the confining effect of the topographic profile. Towards the lower, more expansive floodplain reaches the increase in flood level is minimal (typically between 10 mm and 50 mm).

### 4.4.2 Structure blockage analysis

Blockage of the structures in line with the details set out in Section 3.3.2 resulted in maximum increases in flood level of 2500 mm immediately upstream of the structure (ie at locations where the floodwater could not overtop embankments). Decreases in peak flood levels of up 1500 mm were observed downstream of a number of blocked structures. Significant increases in flood extents were experienced at certain culverts due to blockage.

### 4.4.3 Climate change and downstream boundary conditions analysis

The climate changes analyses involved testing the response of the model to changes in rainfall intensity and sea-level rise (ie increased tailwater levels) both individually and in combination.

#### Investigation of the impact of an increase in rainfall intensity of 20% (R03)

An increase in rainfall intensity resulted in flood levels being elevated by approximately 200 mm to 500 mm in the uppermost, channelised reaches of the floodplain. This leads to only minor increases in floodplain extents due to the confining effect of the topographic profile. Towards the lower, more expansive floodplain reaches the increase in flood level is minimal (typically between 10 mm and 70 mm).

#### Investigation of the impact of an increased tailwater level of 0.8 m SLR (R04)

An increase in the downstream tailwater to simulate the effects of sea level rise typically increases the flood levels in the downstream model reaches by 200 mm to 800 mm – this corresponds to an appreciable increase in the extent of flooding in the downstream floodplain reaches. The increased tailwater level does not affect the flood levels in the model reaches upstream of the MBRL alignment.

#### Investigation of increase in rainfall intensity of 20% and 0.8 m SLR (R05)

Combining the two previous scenarios, flood levels in the downstream reaches of the model (in close proximity to the downstream boundary) were observed to increase by 300 mm to 800 mm – this corresponds to an appreciable increase in the extent of flooding in the downstream floodplain reaches. The upper reaches which are beyond the influence of the tailwater did not show any significant differences when compared to the R03 results. However in the areas where the effects of both the higher tailwater and increased discharge are experienced, flood levels were observed to increase by up to 250 mm.

#### Investigation of 1% AEP current static storm tide with concurrent 1% AEP MDS rainfall event (R06)

The impact of a 1% AEP storm tide principally affects only the lower model reaches. Close to the models downstream boundary increases in flood level of up to 1400 mm are observed – this corresponds to an appreciable increase in the extent of flooding in the downstream floodplain reaches. Further upstream near the MBRL embankment where the tailwater effect is still present but reduced in magnitude, increases of 150 mm are experienced. No increases are predicted to occur 8 km upstream of the outlet model boundary on Saltwater Creek.

#### Investigation of increase in rainfall of 20% combined with a static storm tide level (1% AEP GHG) + 0.8 m sea level rise (R07)

The impact of a 1% AEP future storm tide combined with an increase in rainfall intensity and 0.8 m sea level rise has a significant impact on flood levels and extents in the catchment. This is essentially a ‘worst case’ scenario with three components being tested in combination. Close to the models downstream boundary increases in flood level of up to 2600 mm are observed – this corresponds to a large increase in the extent of flooding in the downstream floodplain reaches. Further upstream near the MBRL embankment where the tailwater effect is still present but reduced in magnitude, increases of 900 mm are experienced. The upper reaches which are beyond the influence of the tailwater did not show any significant differences when compared to the R03 results.

### 4.4.4 Future landuse analysis

**Investigation of increased vegetation in the floodplain (R08)**

The increased roughness parameters that were applied to the floodplain vegetation were observed to generate increases in flood level that were typically less than 50 mm. Some localised increases of approximately 100 mm were apparent in the most upstream reaches of the model. It is not observed to significantly increase flood extents when compared to the existing/base-case scenario.

**Investigation of increased catchment development (R09)**

Increased catchment development was observed to generate increases in flood level that were typically around 30 mm to 50 mm. Some localised increases of approximately 100 mm were apparent in certain areas. It is not observed to significantly increase flood extents when compared to the existing/base-case scenario.

**Investigation of increased vegetation in the floodplain and increased catchment development (R10)**

Testing the combination of increased vegetation and increased catchment development was observed to generate increases in flood level that were typically around 100 mm. Some localised increases of approximately 200 mm were apparent in certain areas. It is not observed to significantly increase flood extents when compared to the existing/base-case scenario.

## 4.5 Model limitations and quality

The following model limitations apply to the HAY 2014 model upgrade:

- The 5 m grid resolution within the 2D domain may not be able to accurately represent localised channels/drains that have a total width of approximately 10 m or less. Typically TUFLOW recommends that at least 3-4 grid cells be used when modelling a channel as being fully 2D
- The extent of the underground pipe network that is modelled is focused on trunk drainage infrastructure and does not contain the full network extent
- The application of inflow boundaries (SA polygons) may not fully represent the extent of localised overland flooding that can occur in each sub-catchment
- The accuracy of the various datasets provided for use in the model development cannot be verified by Aurecon. This applies to topographic data, underground network data, structural survey/dimensions, etc
- The model reflects the catchment conditions at a particular point in time. This is captured in the LiDAR survey and aerial imagery/catchment urbanisation. This is obviously subject to change due to additional catchment development, and changes in topography that may be either man-made (eg cutting/filling), or natural (eg bathymetric alterations to channel profiles following major flood events). Accordingly, periodic updates of the models are recommended to ensure they reflect any significant changes to the catchment and floodplain conditions

## 4.6 Model specification and run times

The HAY TUFLOW model has a total model domain area of approximately 57 $km^2$. Table 4-2 provides details on runtimes and memory requirements for selected design events and the MDS.

Table 4-2 Model specification and approximate run times for selected events

| Event | Model grid size | Model duration (hours) | Model run time (CPU hours) | Model memory (RAM Gb) |
|---|---|---|---|---|
| 1 EY (6 hours) | 5m | 12 | 24 | 3.1 |
| 10% AEP (6 hours) | 5m | 12 | 28 | 3.1 |
| 1% AEP (6 hours) | 5m | 12 | 32 | 3.1 |
| 0.1% AEP (6 hours) | 5m | 12 | 33 | 3.1 |
| 0.01% AEP (6 hours) | 5m | 12 | 35 | 3.1 |
| PMF (6 hours) | 5m | 12 | 38 | 3.1 |
| MDS | 5m | 12 | 36 | 3.1 |
| 1% AEP storm tide | 5m | 60 | 138 | 2.9 |
| 0.1% AEP storm tide | 5m | 60 | 110 | 2.9 |

# 5 Conclusion

The HAY hydrologic and hydraulic models have been updated successfully in line with Councils brief requirements for the RFD 2014 Maintenance Project. An assessment of the hydraulic model outputs shows the simulations to be both robust and stable across the spectrum of event magnitudes that were run. This spans from the 1EY event right through to the PMF.

The data management and modelling has been undertaken in line with Councils naming conventions and modelling approaches/techniques. Close liaison was maintained with Council personnel over the course of the project to ensure a successful outcome.

# 6 References


The Institution of Engineers Australia (1987): Australian Rainfall and Runoff

BMT WBM (2010-10-AB) TUFLOW User Manual

BMT WBM TUFLOW 2011-09 and 2012-05 Release Notes

BMT WBM TUFLOW 2013-12 Release Notes

BMT WBM (June 2012), Regional Floodplain Database Hydrologic and Hydraulic Modelling – Hays Inlet (HAY)

Queensland Government – Natural Resources and Water (2008) Queensland Urban Drainage Manual, 2nd Edition (QUDM)

SKM (2012b): MBRC Regional Floodplain Database Floodplain Parameterisation

SKM (June 2012), MBRC Regional Floodplain Database Boundary Conditions, Joint Probability & Climate Change

**Aurecon Australasia Pty Ltd**
ABN 54 005 139 873
Level 14, 32 Turbot Street
Brisbane QLD 4000
Locked Bag 331
Brisbane QLD 4001
Australia

**T** +61 7 3173 8000
**F** +61 7 3173 8001
**E** brisbane@aurecongroup.com
**W** aurecongroup.com