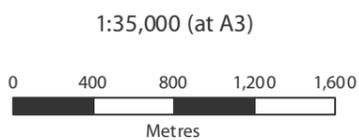
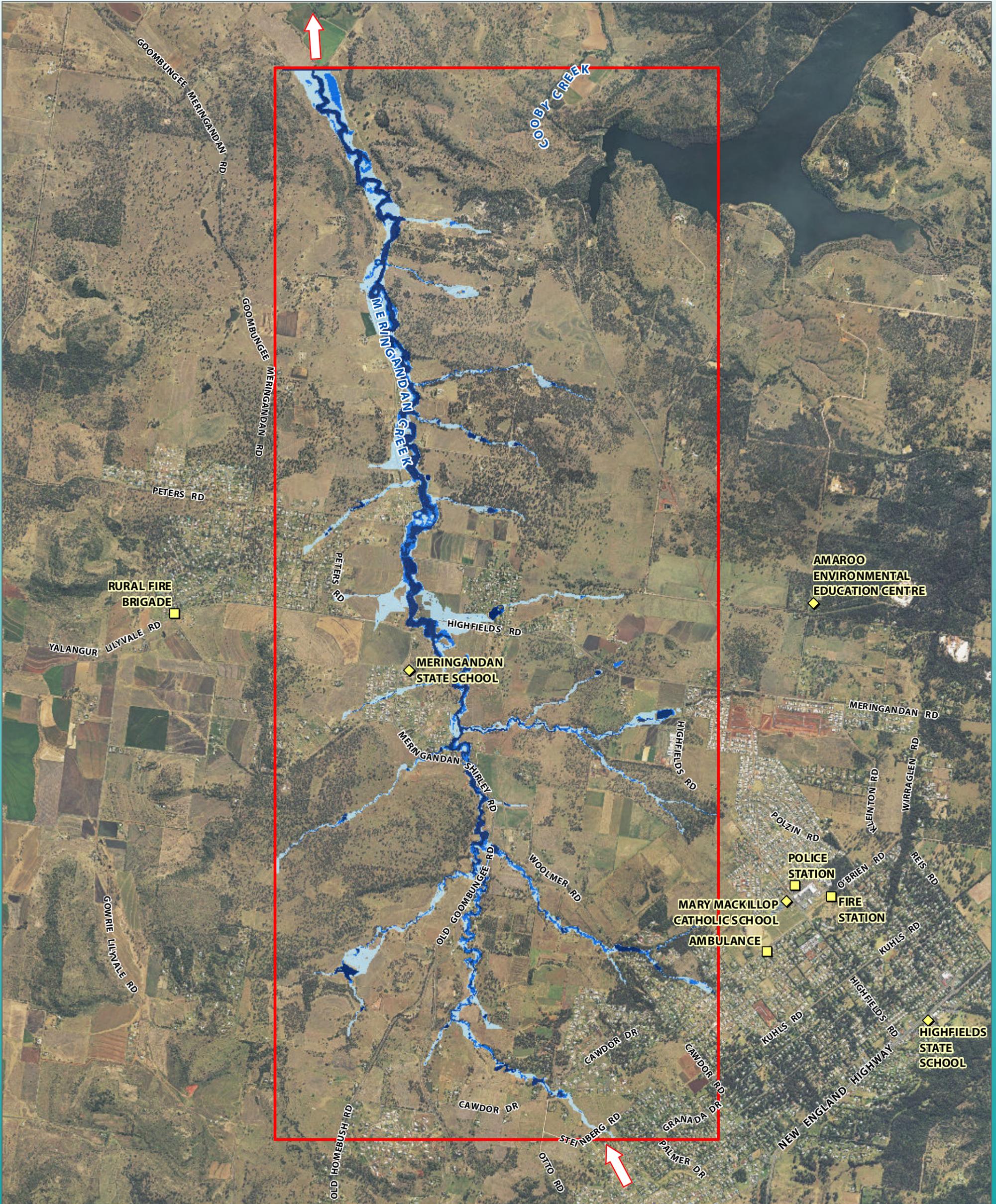
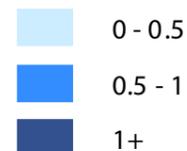


MERINGANDAN CREEK



1% AEP FLOOD DEPTH RIVERINE

Water Depth (m)



Model Extent



DirectionFlow



Emergency Services



School

Flood Studies



**TOOWOOMBA
REGION**

Rich traditions. Bold ambitions.

2D Flood Study for Meringandan Creek

September 2014 • *Endorsed on 25 February 2015*

GENERAL NOTE

These reports/documents are a base source of information that will be continually refined over time.

DISCLAIMER

While every care is taken by the Toowoomba Regional Council (TRC) to ensure the accuracy of the data used in the study and published in the report, Toowoomba Regional Council makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and disclaim all responsibility and all liability whether in contract, negligence or otherwise for all expenses, losses, damages (including indirect or consequential damage) and costs which may be incurred in any way and for any reason as a result of data being inaccurate or incomplete.

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EXECUTIVE SUMMARY

Toowoomba Regional Council is currently in the process of updating the Toowoomba Regional Council Planning Scheme. In February 2012, the State Government approved Council adopting the Toowoomba Regional Council Planning Scheme with a set of conditions to ensure the planning scheme was compliant with State Planning Policy 1/03. To meet the conditions, flood modelling of Meringandan Creek was required.

Meringandan Creek lies about ten kilometres northwest of the Toowoomba CBD. From the head waters in Highfields, Meringandan Creek flows northwest between the towns of Meringandan and Meringandan West before discharging to Cooby Creek downstream of Cooby Dam and upstream of the confluence of Gomaren Creek. Flow eventually discharges to Oakey Creek and travels through the township of Oakey.

The predominant land uses within the catchment is Rural Residential with low density residential in the upper extent of the catchment and around townships of Meringandan and Meringandan West. The Toowoomba Regional Council Planning Scheme allows for portions of the Rural and Rural Residential land to be developed in the future.

The objectives of this study were the development of a hydrological and hydraulic model for the Meringandan catchment, with the aim of assisting with the identification of critical infrastructure and emergency facilities that may be disrupted by flood events. To this end, detailed flood extent, levels, and hazard maps were prepared based on the results of the hydraulic modelling.

The outcomes of this study are:

- Development of hydrologic and hydraulic models for Meringandan Creek
- Flood mapping for design events of 20%, 10%, 5%, 2%, 1% , 0.5% and 0.2% AEP (Annual Exceedance Probability) and the Probable Maximum Precipitation Design Flood (PMP-DF);
- Analysis of the effect of future development within the catchment;
- Analysis of the effect of increased rainfall intensities due to climate change factors;
- Analysis of the sensitivity to flow and roughness variations; and
- Analysis of the impact of culvert blockage.

An XP-RAFTS hydrologic model was developed to determine flood flows. The flows from the XP-RAFTS model were applied to a MIKE FLOOD hydraulic model also developed for the study. Verification of the model was undertaken to the January 2011 flood event.

Following verification, the models were used to simulate design floods. The simulated peak flood levels and discharges for existing catchment conditions show that there is a gradual increase in water levels and discharges at all selected points from 20% AEP to PMP-DF. The maximum difference in levels between these events is 4.7 metres but most differences are generally within 2.5 -3.75 metres (refer to Table 6.3). The below Table shows the total number of buildings affected for the design events modelled. It is noted that the buildings includes carports, houses, sheds etc. and should be used as an indication of the number of houses inundated.

| Design event (AEP) | No. of structures affected |
|--------------------|----------------------------|
| 20 | 15 |
| 10 | 21 |
| 5 | 34 |
| 2 | 38 |
| 1 | 39 |
| 0.5 | 41 |
| 0.2 | 42 |
| PMP-DF | 126 |

Comparisons between the existing and future development conditions were undertaken to assess the likely impacts of the planning scheme being fully developed. The largest increase in levels for the 1% AEP event was 0.27 metres (refer to Table 6.5). The impact on the 1% AEP event was minimal due to the steep nature of the catchment. It is however expected to have proportionally increased effects on the smaller events because of varying loss model adopted.

In addition, sensitivity analysis undertaken for the following parameters for 1% AEP event:

- Inflows: These were adjusted by +/- 30% to test whether variations in flows were likely to result in significant changes in flooding.
- Roughness: These were also adjusted by +/- 30% to test whether variations in roughness were likely to result in significant changes in flooding.

The results of the sensitivity analysis indicate that the model is more sensitive to changes in flow than changes in roughness; however, the variations in flood level did not result in significant variations in flooded area due to the steep nature of the catchment. The variations in flow resulted in a difference in levels in the range of -0.40 metres through to 0.33 metres across the comparison points (refer to Table 6.6) while the difference in roughness resulted in difference in levels in the range of -0.17 metres through to 0.26 metres across the comparison points (refer to Table 6.7).

Climate Change simulations were also undertaken for 2050, 2070 and 2100 design horizons for 1%, 0.5% and 0.2% AEP events. A comparison of the maximum flood levels for the six comparison locations for 1% AEP event show increasing maximum flood levels with increasing rainfall intensity (refer to Table 6.8). The difference in levels across the comparison points for climate change is up to 0.29 metres comparing the base case to the year 2100 case for the 1% AEP event however, changes to flood behaviour and flood extent are limited.

Analysis of culvert blockage for 1% AEP event show small increase in levels. The increase are up to 0.14 metres (refer to Table 6.9) across the comparison points however; this is typically limited to those areas relatively close to structures within the floodplain.

The following recommendations are made to improve the accuracy of the modelling for future studies:

- Comprehensive collection of anecdotal evidence following future flood events;
- Installation of pluviographs and water level gauges within the catchment;
- Survey to be undertaken of all bridges, culverts and weirs within the study area;
- More detailed analysis on impacts of future urban developments; and
- Comprehensive revision of roughness maps.

1. INTRODUCTION

1.1 BACKGROUND

Toowoomba Regional Council is currently in the process of updating the Toowoomba Regional Planning Scheme. In February 2012, the State Government approved Council adopting the Toowoomba Regional Planning Scheme with a set of conditions to ensure the scheme was compliant with State Planning Policies 1/03. To meet the conditions flood studies in urban areas are required. Meringandan has been identified due to the absence of comprehensive flood modelling and the potential for flood impacts on the community and critical infrastructure both at the present time and in the future.

1.2 PROJECT OBJECTIVES

The primary objectives of this study are to develop computer based hydrologic and hydraulic models of the study area to determine and document flood levels, inundation extents, velocities, depths and hazards across the study area for historic events and design events. Other objectives include identification of critical infrastructure and emergency facilities that's safe operation may be disrupted by flood events, identification of flood events that may isolate parts of the community, preparation of detailed maps and GIS layers for inclusion in Council's database and to provide emergency planning information to input into Council's emergency planning information databases. The specific deliverables are:

- Development of hydrologic and hydraulic models for Meringandan Creek to represent flow within the floodplain;
- Preparation of maps for flood levels, flood extents, velocities, depths and hazards for design storms of 20%, 10%, 5%, 2%, 1% , 0.5% and 0.2% AEPs and Probable Maximum Precipitation Design Flood (PMP-DF); and
- Reporting the process used to develop the model and the outcomes of the study.

1.3 STUDY AREA

The Meringandan study area has a catchment of approximately 44 km² that feeds Meringandan Creek. From the headwaters of Meringandan Creek in Highfields, flow travels in a north westerly direction bisecting the townships of Meringandan and Meringandan West. Meringandan Creek eventually discharges to Cooby Creek downstream of Cooby Dam and upstream of the confluence of Cooby Creek and Gomaren Creek. Flow from Meringandan Creek eventually travels via Oakey Creek through the township of Oakey. There are about 20 minor streams contributing to flows within Meringandan Creek.

The Meringandan Creek study area extends from approximately Cawdor Drive at the upper extent of the catchment to Willis Road in the lower extent of the catchment. The study focuses on Meringandan Creek. Whilst modelled, small streams and overland flow paths were not the primary consideration for this study. See Figure 1.1.

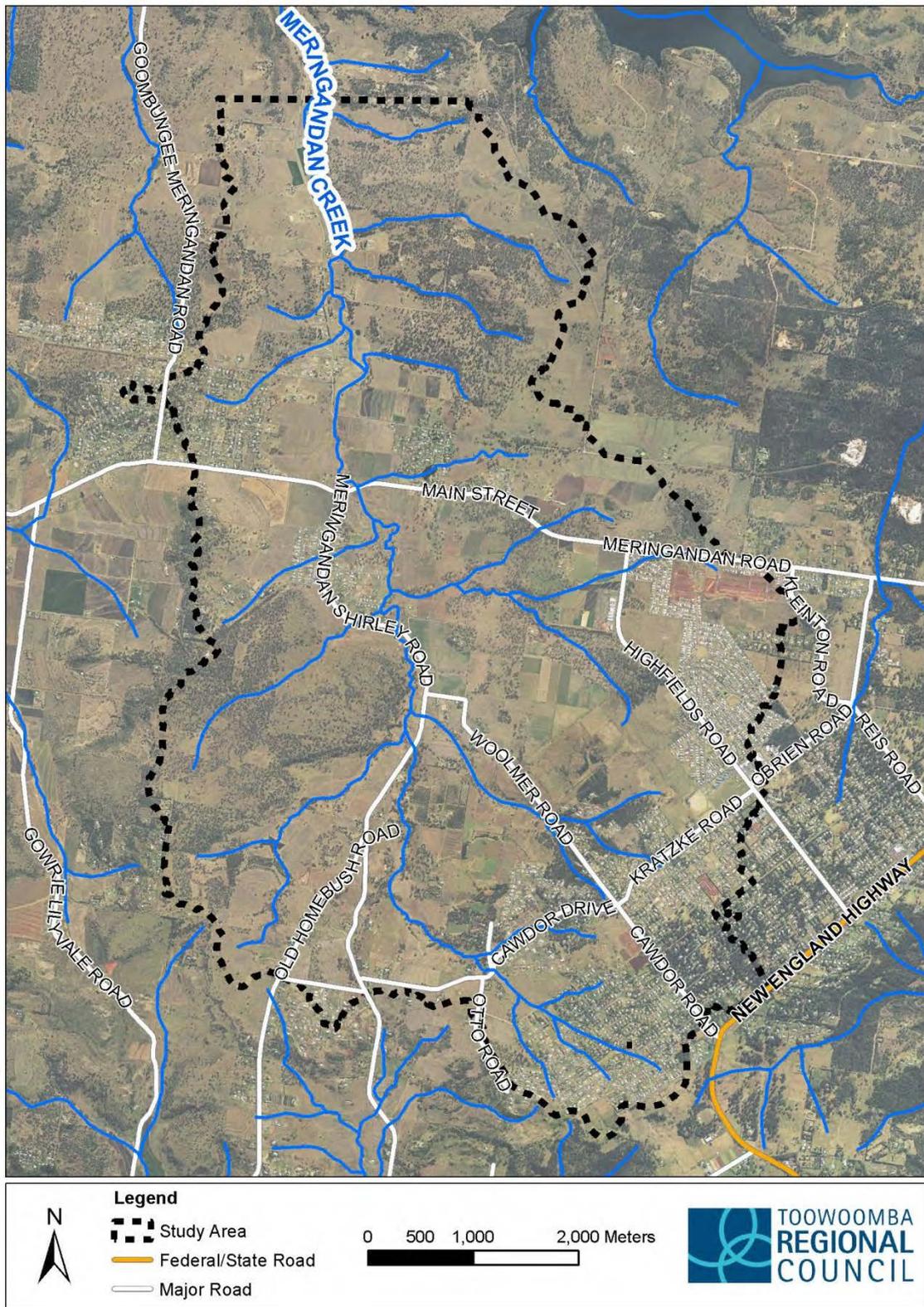


Figure 1.1 Meringandan Creek study area

The Meringandan Creek catchment comprises of primarily of rural zoning with significant portions of residential choice and low density residential predominantly situated in the upper part of the catchment (Figure 1.2). The land use within the study area is shown in Figure 1.2.

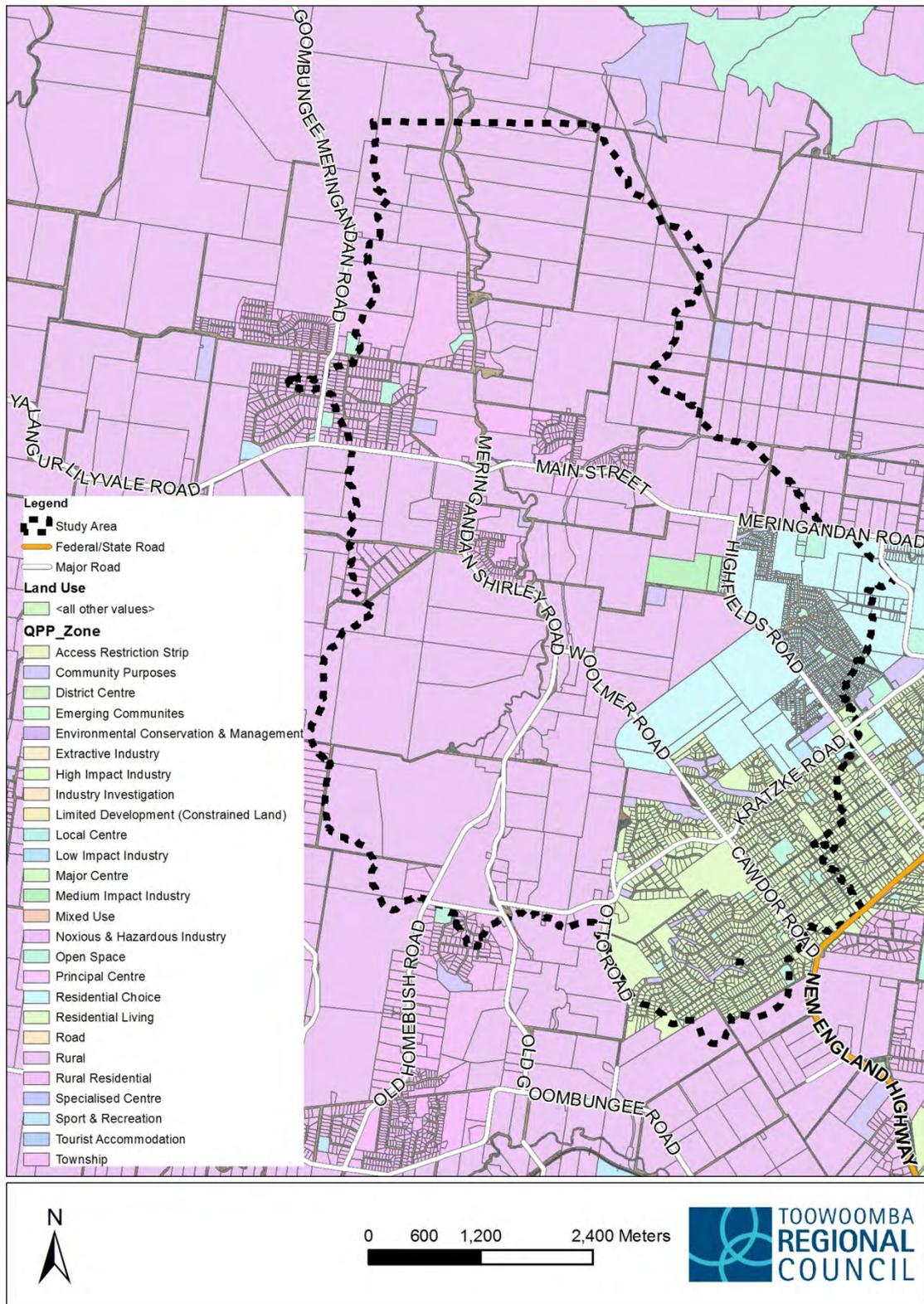


Figure 1.2 Land use within study area

1.4 LIMITATIONS

This report was prepared based on information available at the time of writing. The approach and analysis detailed within this report have been prepared by TRC specifically for use by TRC. For this

reason, any third parties are not authorised to use any contents from this report. Their use is specifically prohibited unless written approval from TRC is obtained. TRC believes the report is accurate for the intended purpose and disclaims any responsibility for any loss or damage suffered as a result of placing reliance on the information contained within this report.

Furthermore, the models detailed within this report are based on LiDAR survey. Any development or topographical change occurring within the catchment after the date that this LiDAR was flown is not included within this study.

2. AVAILABLE DATA

2.1 PREVIOUS STUDIES

No previous flood studies have been undertaken within the study area. At the time of writing, studies were also underway for the neighbouring catchment of Klein Creek and for Oakey Township for which Meringandan Creek is a tributary.

2.2 HISTORICAL RAINFALL

No pluviographs exist within the Meringandan Creek catchment.

2.3 STREAM FLOW GAUGING RECORDS

A search was undertaken for stream gauges downstream of the study area. The nearest stream flow gauge was found to be Oakey Creek at Jondaryan. As the Meringandan Creek catchment only represents a small fraction of the total catchment to Oakey Creek at Jondaryan, this gauge was not considered for calibration.

However, it should be noted that for the Oakey Township Flood Early Warning System, three water level gauges were installed along Oakey Creek in June 2014. Whilst Meringandan Creek catchment still only represents a fraction of the total contributing catchment to these gauges and rating curves have not yet been developed, these records are likely to be beneficial to future studies of Meringandan Creek catchment.

2.4 EVIDENCE OF FLOODING

Evidence of flood inundation was collected post January 2011 flood events. The post January 2011 data was limited the 15 items listed in Table 2.1 below. This consisted of eight surveyed, observed flood levels and seven anecdotal points.

The data utilised for model verification are listed in Table2.1.

Table 2-1 Evidence of flooding used for verification

| ID | Location | Data Type | Elevation (mAHD) or other detail |
|----|---------------------------|----------------------|--|
| 1 | Steinberg Rd | Anecdotal | Road washed out and fences broken. Depth 30 to 60 cm. |
| 2 | Old Goombungee Rd | Surveyed Flood Level | 514.47 (Left side of culvert) |
| 3 | Old Goombungee Rd | Surveyed Flood Level | 512.50 (Right side of culvert) |
| 4 | Meringandan Shirley Rd | Surveyed Flood Level | 503.56 (Left side of culvert) |
| 5 | Meringandan Shirley Rd | Surveyed Flood Level | 503.14 (Right side of culvert) |
| 6 | Meringandan Shirley Rd | Anecdotal | Flooding over road cut road access – depth above 60 cm |
| 7 | Goombungee Meringandan Rd | Anecdotal | Flooding over bridge – depth above 60 cm |
| 8 | Klein Rd | Surveyed Flood Level | 527.34 (Left side of culvert) |
| 9 | Klein Rd | Surveyed Flood Level | 527.25 (Right side of culvert) |
| 10 | Spies Rd | Surveyed Flood Level | 479.99 (Left side of culvert) |
| 11 | Spies Rd | Surveyed Flood Level | 478.81 (Right side of culvert) |
| 12 | Willis Rd | Anecdotal | Road scoured due to flooding – depth up to 30 cm |
| 13 | Sovereign Dr | Anecdotal | Road scoured due to flooding |
| 14 | Garrett Rd | Anecdotal | Flooding depth 30 to 60 cm. |
| 15 | Meringandan Shirley Rd | Anecdotal | Flooding over road. |

In addition, photographs were sourced showing flooding within the study area for the post December 2010 and January 2011 event.

2.5 TOPOGRAPHIC DATA

The primary topographic data available for the study was a digital elevation model (DEM) with a one metre grid developed from LiDAR. The accuracy of the LiDAR data is quoted as 94% of points within 0.15m. The DEM was developed from LiDAR flown in 2010 and is available for the whole of the study area.

2.6 GIS DATA

The following GIS layers were sourced from Toowoomba Regional Council's GIS:

- Roads: these were used in development of the hydrology model, particularly in determining the percentage of the sub-catchments that were permeable. Additionally, in some cases the roads would cross sub-catchments and change drainage patterns. Therefore the roads were used to assist in the design of the hydrological model sub-catchments;
- Building Polygons: similarly to the roads layer, the building polygons were used to determine the percentage of the catchment that is permeable;
- Planning Scheme: allowed for the identification of different land use types and delineation of road widths and channels; and
- Aerial imagery: used to assist in spatial orientation and identification of key features such as channels as well as estimate roughness in the floodplain.

2.7 STRUCTURE DATA

Limited structure data was available through Council's corporate GIS system. Subsequently a desktop inspection and field trip was undertaken to identify, measure and record the structure type, size and cover. Structures identified within the catchment are detailed in Table 5.2.

3. STUDY APPROACH

The hydrological model, developed in XP-RAFTS (XP-Software, 2009), utilises IFD curves from the Bureau of Meteorology and parameters from previous models to produce a runoff response for synthetic design floods. Outflows from the XP-RAFTS model are then input into a hydraulic model (MIKE FLOOD), which primarily utilises the DEM of the catchment to represent the floodplain.

There are no pluviographs within the Meringandan Creek catchment. However, pluviographs exist within the region at Toowoomba Airport and Cooby Dam. Data from these gauges was analysed along with data from the daily rainfall gauge network in order to complete a model validation to the January 2011 flood event.

Additionally, to determine if the model was robust to the parameter selection, sensitivity analysis was undertaken on:

- Inflows: These were varied up and down by 30% to test whether any errors from inflows from the hydrologic model were likely to cause significant changes in the flooding; and
- Roughness: This was varied up and down by 30% to test whether errors in the roughness values used were likely to cause significant changes to the flooding.

Following verification and sensitivity testing, the models have been used to undertake simulation of design storms for both existing and future development scenarios. In addition, analysis of culvert blockage and potential climate change scenarios has also been undertaken. Further details are provided in Model Results below.

4. HYDROLOGIC ANALYSIS

4.1 HYDROLOGIC MODEL DEVELOPMENT

Flood flows for the Meringandan Creek catchment were generated through development of an XP-RAFTS model. The XP-RAFTS model extends from the catchment boundary in Highfields to the downstream extent of the hydraulic model (about two kilometres downstream of the study area).

A total of 67 sub-catchments were delineated using GIS software. GIS software was also used to determine catchment length and equal area slope characteristics of each catchment. For fraction impervious values, a calculation was performed using building outline and road width GIS layers. Link lag times were determined using an average velocity of 2 m/s. The sub-catchment delineation is shown as Figure 4.1.

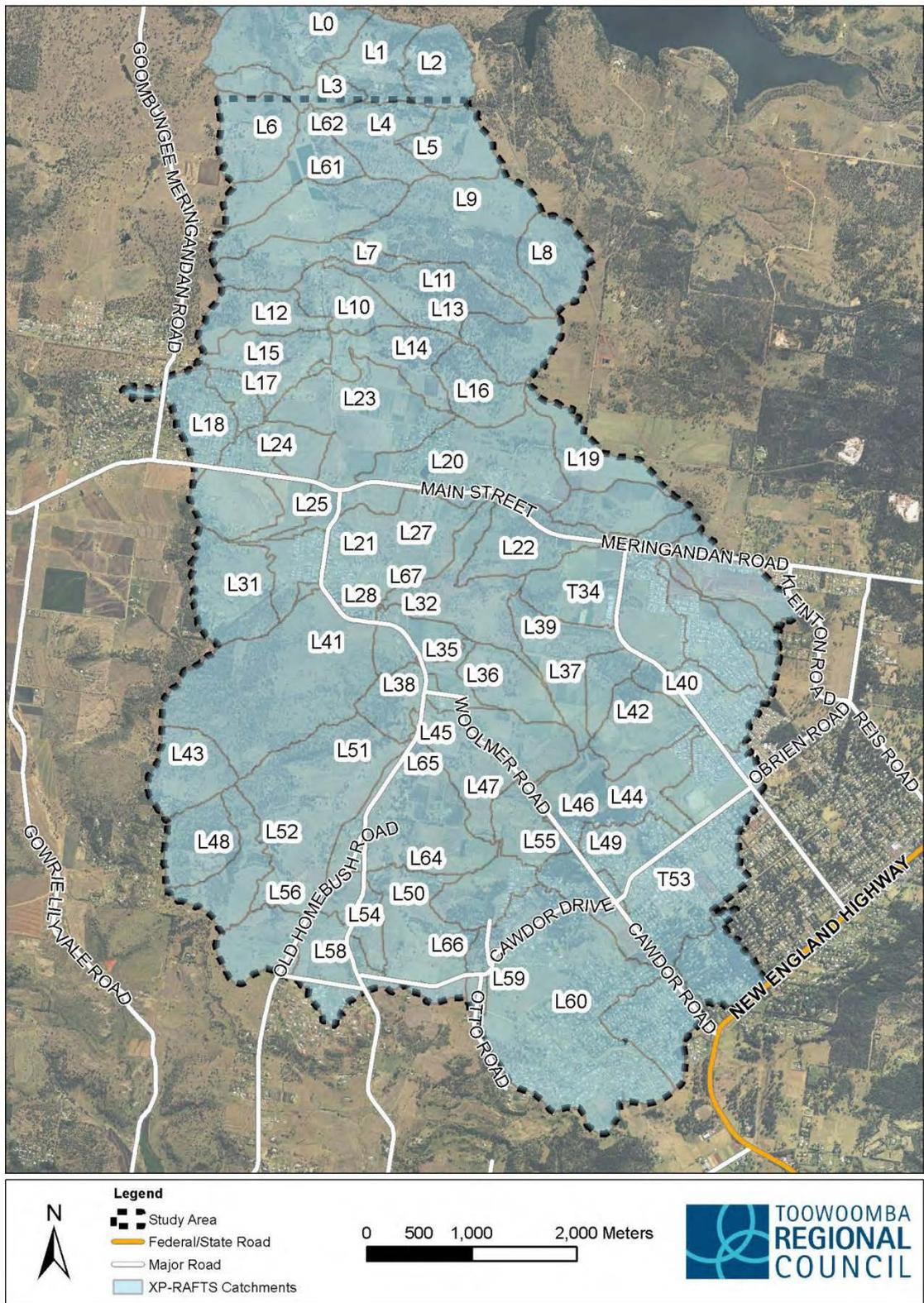


Figure 4.1 Meringandan Creek sub-catchment delineation

4.2 JANUARY 2011 VERIFICATION EVENT

The January 2011 event was the largest in recent history and is the only event with reliable information available. Even though this event has data available, the data is insufficient to have great confidence in the validated events. No information was found on other events.

The daily gauge network (Figure 4.2) was analysed to understand the rainfall distribution. Tamba daily values had been totalled for several days beyond the analysis timeframe. This meant that Tamba recorded the data from the rain event several days after the event. This data had to be verified to be able to use this in the hydrologic model. On closer inspection of surrounding gauges there was generally no rain recorded on the days immediately after the 12th of January or less than 1mm recorded. Furthermore the total value recorded at Tamba is 283.4 mm which is generally in accordance with a close gauge at Mt Kynoch which recorded 283.8 mm. It is assumed that this potential inaccuracy is acceptable.

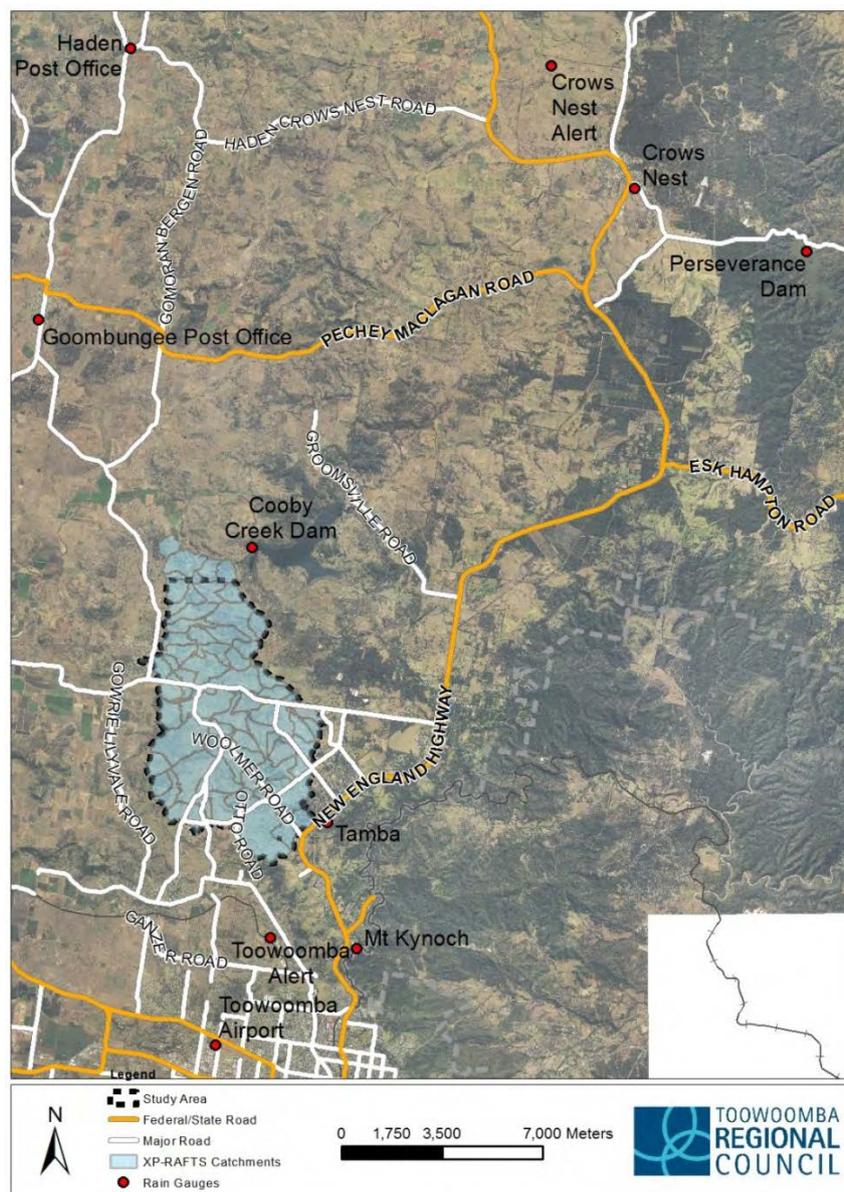


Figure 4.2 Rain gauge network

A three day period of recorded rainfall from 9am on the 9th January through to 9am of the 12th January was analysed as this covered the larger rain event. The days prior also recorded moderate rainfall and it is anticipated that this effectively primed the catchment so then no initial loss was used in the XP-Rafts model. The prior rainfall proceeded the modelled period sufficiently for the runoff to have routed through the system. Two storm events occurred in the same 24hr period from 9am on the 10th of January to 9am on the 11th of January. The upper end of the catchment had a storm in the period of 12pm – 2pm on the 10th of January. Whereas the lower end of Meringandan Creek experienced significant rain from 1am – 5:30am on the 11th of January roughly 12 hours later. This was captured between two pluviographs as shown in Figure 4.3.

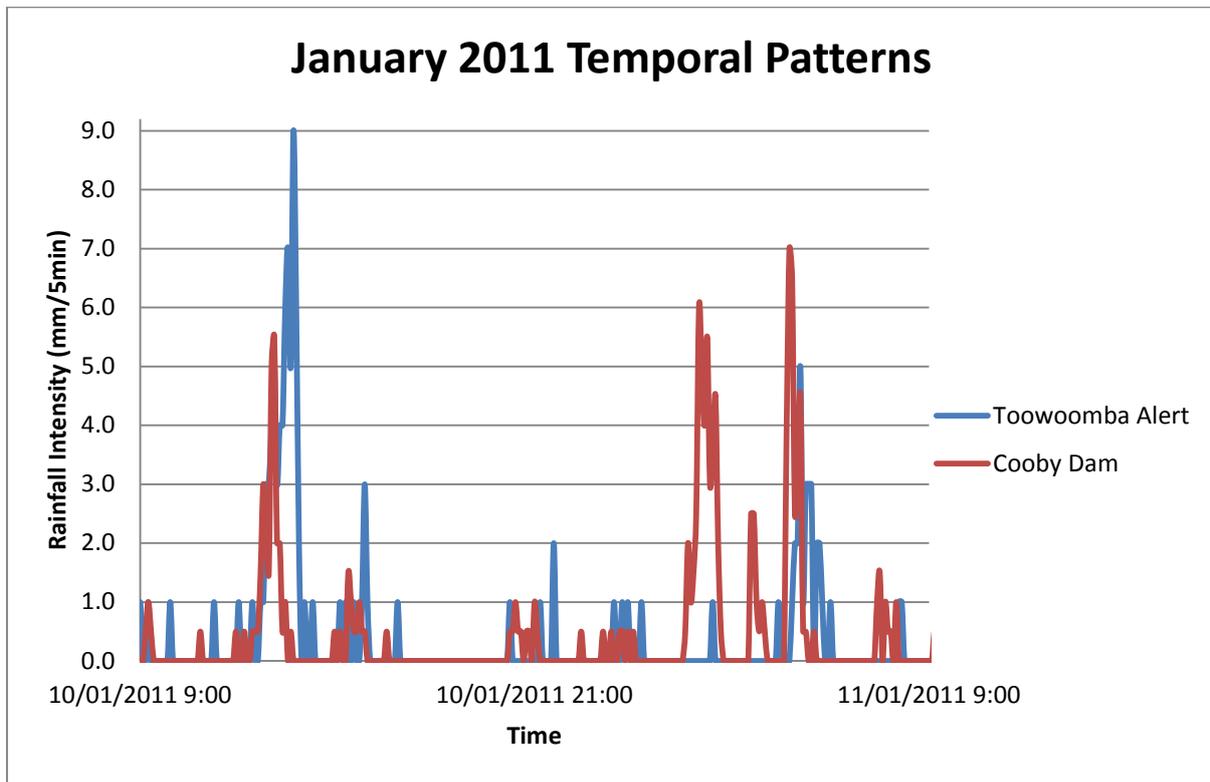


Figure 4.3 Temporal pattern comparison

The upper catchments main event began raining at approximately 1pm on the 10th of January and received 67 mm in 1.5 hrs. Another series of storms occurred in the lower catchment about 1am on the 11th of January and recorded 78.5mm in 4 hrs. This is shown in Table 4.1 and Figure 4.4 and Figure 4.5.

Table 4-1 Verification rainfall burst summaries

| Rain Gauge | Volume (mm) | Time (hrs) |
|-----------------|-------------|------------|
| Cooby Dam | 78.5 | 4 |
| Toowoomba Alert | 67 | 1.5 |

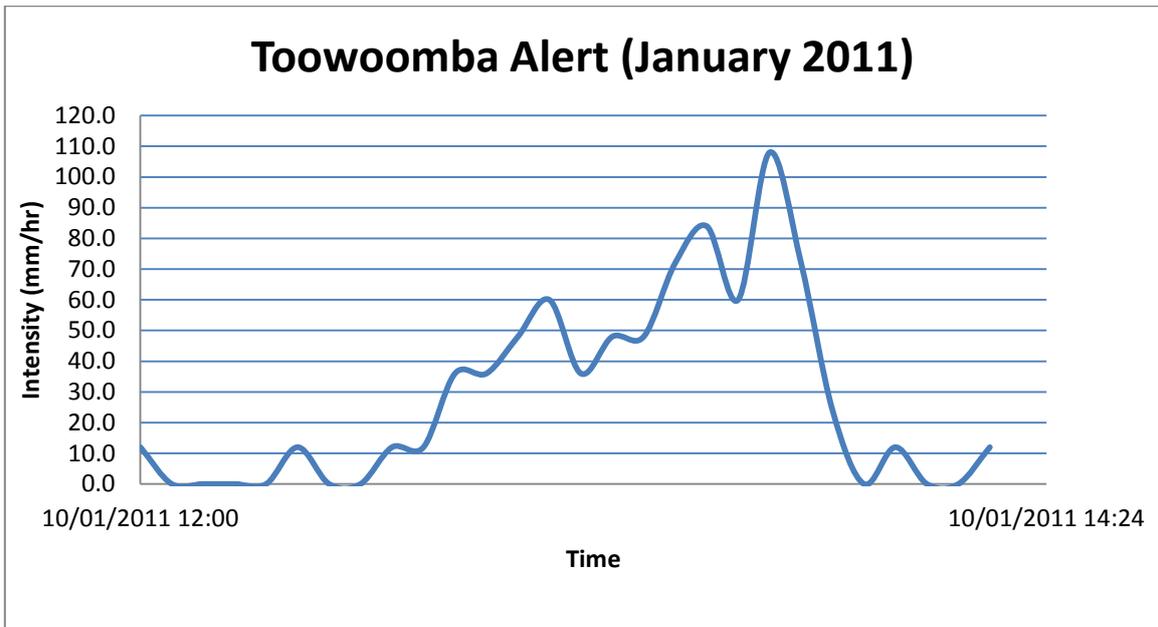


Figure 4.4 Toowoomba alert temporal pattern

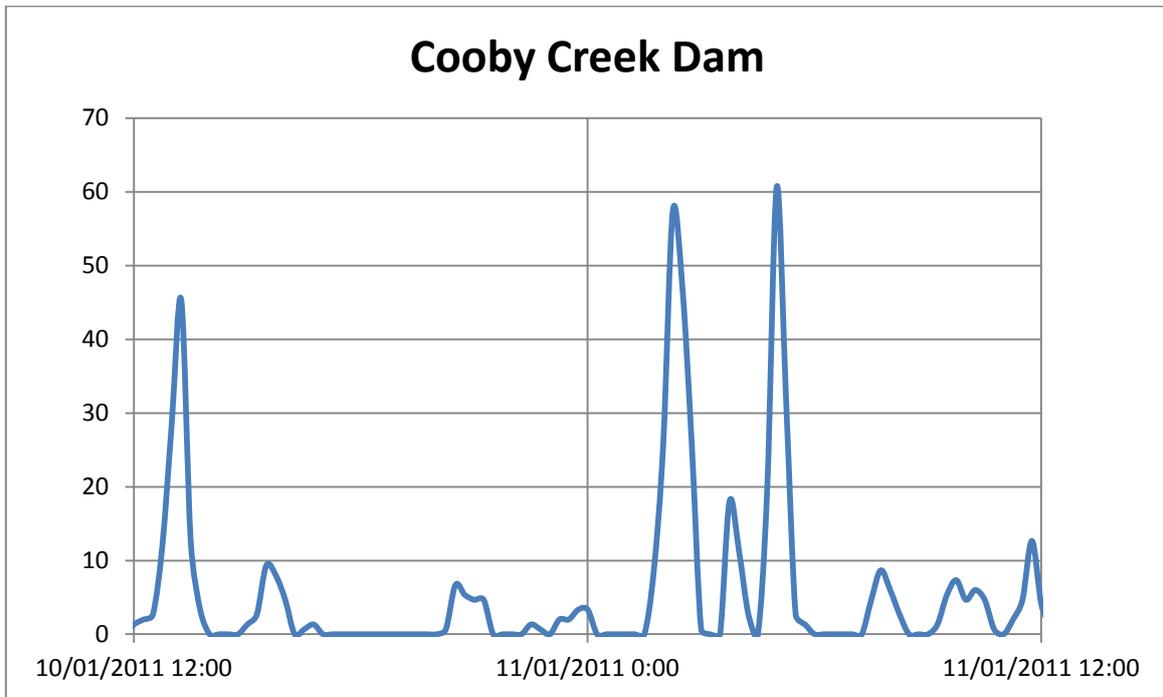


Figure 4.5 Cooby Creek dam temporal pattern

The flooding experienced in Highfields was on the 10th of January but as rain is recorded at 9am the following morning the value of the 11th reflects that rainfall. This is summarised as Table 4.2.

Table 4-2 24hr rain gauge reading to 9am (mm)

| 10/01/2011 | 11/01/2011 | 12/01/2011 | Total |
|------------|------------|------------|-------|
|------------|------------|------------|-------|

| | | | | |
|----------------------------------|-------|------------|---------|--------|
| Toowoomba Alert Pluviograph | 79 | 117 | 22 | 218 |
| Tamba 041510 | 104.6 | No Reading | 178.84* | 283.44 |
| Mt Kynoch 041096 | 104.2 | 143.2 | 36.4 | 283.8 |
| Cooby Creek Dam 041512 | 96 | 127 | 25 | 248 |
| Perseverance Dam 40480 | 136.6 | 150.2 | 25 | 311.8 |
| Haden Post Office 041042 | 94 | 126 | 20 | 240 |
| Goombungee Post Office 041037 | 96 | 100.4 | 31.6 | 228 |
| Toowoomba Airport 041529 | 83.6 | 123.4 | 26.6 | 233.6 |
| Crows Nest | - | - | - | 337 |
| Crows Nest Alert | - | - | - | 235 |

*Carried forward.

The daily gauge data was used to create an isohyetal map (Figure 4.6) which is an inverse distance weighted estimation of the rainfall that fell across the catchment in the January 2011 flooding event.

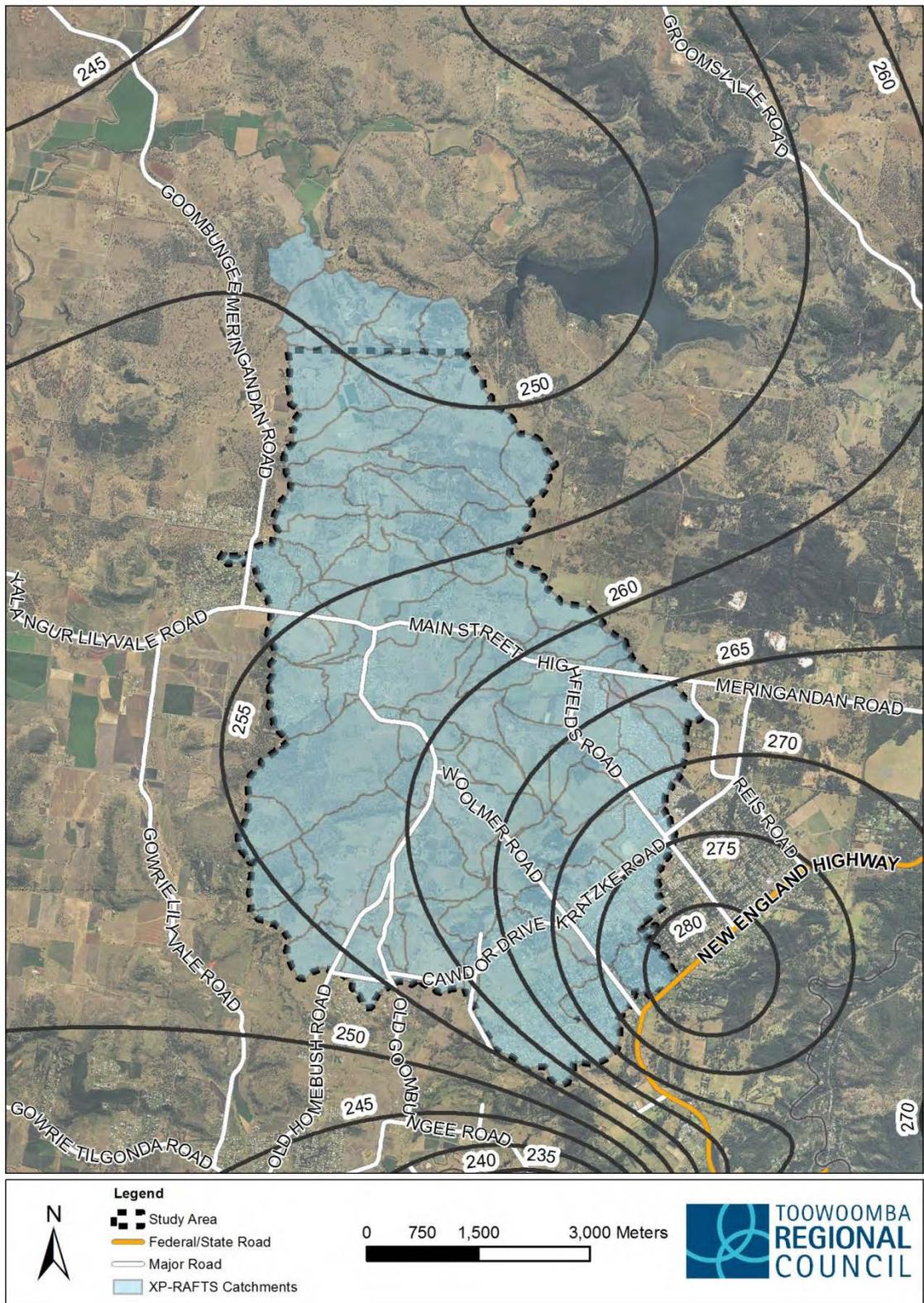


Figure 4.7 Isohyetal map allocations

4.3 JANUARY 2011 RAINFALL FREQUENCY ANALYSIS

As there is no flow gauge in Meringandan Creek, a basic frequency analysis has been done by comparing the sub-daily recorded rainfall data against the IFD design event data (Figure 4-8).

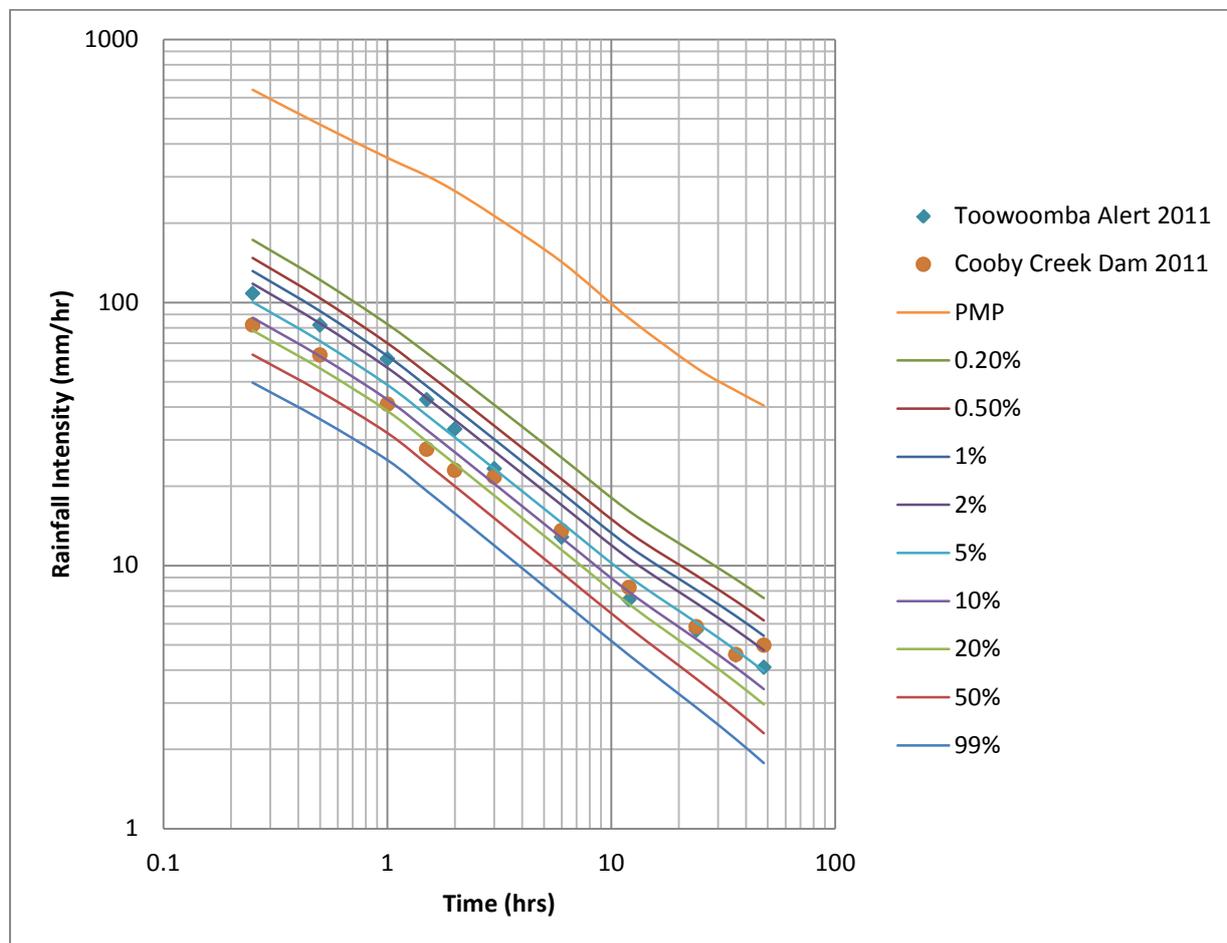


Figure 4-8 Comparison of recorded rainfall data against IFD data

The rainfall duration recorded at the Toowoomba Alert gauge was approximately 90 minutes. This gauge data can then be compared to the 90 minute design storm. Likewise the 270 minute storm could be compared to the Cooby Creek Dam rainfall gauge data.

Peak rainfall intensity and total rainfall volumes have been compared in Tables 4.3-4.6 below.

Table 4-3 Comparison of peak rainfall intensities (90 min)

| Storm Events | Peak Rainfall Intensity 90min (mm/hr) |
|-----------------|---------------------------------------|
| 50% | 24.4 |
| 20% | 29.6 |
| 10% | 32.7 |
| 5% | 37.2 |
| Toowoomba Alert | 42.7 |
| 2% | 43.3 |
| 1% | 48.1 |
| 0.5% | 53.9 |
| 0.2% | 64.2 |
| PMP | 302.9 |

Table 4-4 Comparison of 90min storm volumes (mm)

| Design Event (90min) | Total Rainfall (mm) |
|----------------------|---------------------|
| 50% | 37 |
| 20% | 44 |
| 10% | 49 |
| 5% | 56 |
| 2% | 65 |
| Toowoomba Alert | 67 |
| 1% | 72 |

Table 4-5 Comparison of peak rainfall intensities (270min)

| Storm Events | Peak Rainfall Intensity 270min (mm/hr) |
|-----------------|--|
| 50% | 12 |
| 20% | 15 |
| 10% | 16 |
| Cooby Creek Dam | 17 |
| 5% | 18 |
| 2% | 21 |
| 1% | 27 |

Table 4-6 Comparison of 270min storm volumes (mm)

| Design Event (270min) | Total Rainfall (mm) |
|-----------------------|---------------------|
| 50% | 58.5 |
| 20% | 72 |
| Cooby Creek Dam | 78.5 |
| 10% | 81 |
| 5% | 90 |
| 2% | 108 |
| 1% | 117 |

Based on the volumes of the rainfall bursts it is likely that the 10th of January 2011 event was between a 2% and 1% rainfall event closer to Highfields. The 11th of January 2011 rain event was between a 20% and 10% year rainfall event at Cooby Creek Dam.

4.4 DESIGN RAINFALL ESTIMATION

Design rainfall depths for the catchments were based on intensity frequency duration (IFD) curves for the Meringandan area following AR&R (Book Two). The rainfall intensities for the Meringandan catchment were generated from the parameters shown in Table 4-7.

Table 4-7 Design IFD parameters for Meringandan catchment

| ARI (years) | Storm Duration (hrs) | | |
|----------------|----------------------|-------|------|
| | 1 | 12 | 72 |
| 2 | 37.43 | 6.17 | 1.66 |
| 50 | 61.96 | 10.37 | 3.09 |

- Skewness = 0.33; F2 = 4.36; F50 = 16.97

Using the above parameters the design rainfall intensities for Meringandan catchment were estimated via the inbuilt facility within the XP-RAFTS hydrologic model. The PMP design rainfall depth was estimated using the latest Bureau of Meteorology PMP estimation method, via the inbuilt facility offered within the XP-RAFTS hydrologic model. Generalized Short Duration Method (GSDM) was used to calculate PMP estimates for the Meringandan catchment. The GSDM method is applicable for catchments less than 1,000 km² and storm durations less than 6 hours. Due to the relatively small size of the catchment, the critical duration of the PMP was less than 6 hours and rainfall estimates using the Generalized Tropical Storm Duration (GTSMR) method were not calculated.

The GSDM method involves calculating an initial PMP depth based on catchment area and storm duration. This initial PMP depth is then adjusted to account for site specific influences such as topography, elevation and moisture availability.

The GSDM adjustment parameters determined for the Meringandan catchment are shown in Table 4-8.

Table 4-8 GSDM adjustment parameters

| Parameter | Value |
|-----------------------------------|-------|
| Elevation Adjustment Factor (EAF) | 1 |
| Moisture Adjustment Factor (MAF) | 0.8 |

The final PMP estimates for the Meringandan catchment is summarised in Table 4-9.

Table 4-9 GSDM estimate of PMP rainfall for Meringandan catchment

| Storm duration (hours) | Depth (mm) | Intensity (mm/hr) |
|------------------------|------------|-------------------|
| 0.25 | 150 | 600 |
| 0.5 | 220 | 440 |
| 0.75 | 280 | 373.3 |
| 1 | 340 | 340 |
| 1.5 | 430 | 286.7 |
| 2 | 500 | 250 |
| 2.5 | 560 | 224 |
| 3 | 610 | 203.3 |

4.5 RAINFALL LOSSES

The simple initial loss/continuing loss model was adopted for all catchments. This method requires an estimate of the loss to simulate the initial wetting of the catchment when no runoff is generated. A constant continuing loss accounts for infiltration once the initial loss process is complete. AR&R recommends a value between 0 and 35 mm for initial loss and 2.5mm/hr for continuing loss in design storms in Queensland.

The adopted loss parameters applied to the XP-RAFTS model are summarised in Table 4-10.

Initial and continuing rainfall loss rates for impervious areas were assumed to be zero.

Table 4-10 Adopted rainfall losses for pervious areas

| ARI (years) | Initial loss (mm) | Continuing loss (mm/hr) |
|-------------|-------------------|-------------------------|
| 5 | 20 | 2.5 |
| 10 | 10 | 2.5 |
| 20 | 5 | 2.5 |
| 50 | 0 | 2.5 |
| 100 | 0 | 2.5 |
| 200 | 0 | 2.5 |
| 500 | 0 | 2.5 |
| PMP | 0 | 2.5 |

4.6 ROUGHNESS

The pervious area roughness parameters were assigned a value between 0.040 to 0.060 for the various land use classifications throughout the catchment, whereas impervious areas were assigned a value of 0.02.

4.7 CLIMATE CHANGE

The effects of climate change on rainfall intensities were considered. Rainfall intensities were calculated for up to 4 degrees of global temperature increase. A five percent increase in rainfall intensities were adopted for every change in one degree Celsius, and the hydrologic model was used to simulate two, three and four degree Celsius global temperature increases for 2050, 2070 and 2100 climate change horizons. Adopted rainfall intensities increases are shown in Table 4-11.

Table 4-11 Adopted rainfall increases as a function of temperature

| Temperature Increase (degrees Celsius) | Rainfall Intensity Increase (%) |
|--|---------------------------------|
| 2 | 10 |
| 3 | 15 |
| 4 | 20 |

5. HYDRAULIC MODELLING

A numerically coupled 1D/2D MIKE FLOOD model was developed to simulate flow across the floodplain. A MIKE FLOOD model consists of a MIKE21 model to simulate the two dimensional flow and a MIKE11 model to simulate sub-grid scale features. The development of this model is detailed in the following sections.

5.1 MIKE 21 MODEL DEVELOPMENT

A MIKE21 model was developed to simulate 2-dimensional flow across the floodplain. Each component of the model development is detailed below.

5.1.1 MODEL TOPOGRAPHY

A five-meter model DEM was developed from the one-meter DEM derived from LiDAR. The DEM was exported to ASCII format and then imported to DFS2 format for manipulation in the MIKE FLOOD software. The integrity of low lying roads were then checked against the one metre DEM to ensure that the elevations were correctly carried over from the original one metre DEM.

Following these updates, a solid wall of values equal to the land value was introduced around the outer extent of the bathymetry as per the MIKE FLOOD software manual. A single downstream boundary was then developed at the western extent of the model bathymetry. In accordance with standard practice, the boundary was developed by cutting in an artificial pool six grid cells into the model with a width equal to the maximum anticipated flood width. A fixed water level boundary is considered appropriate due to the considerable distance and fall between the study area and the boundary location. The final model topography is shown as Figure 5.1.

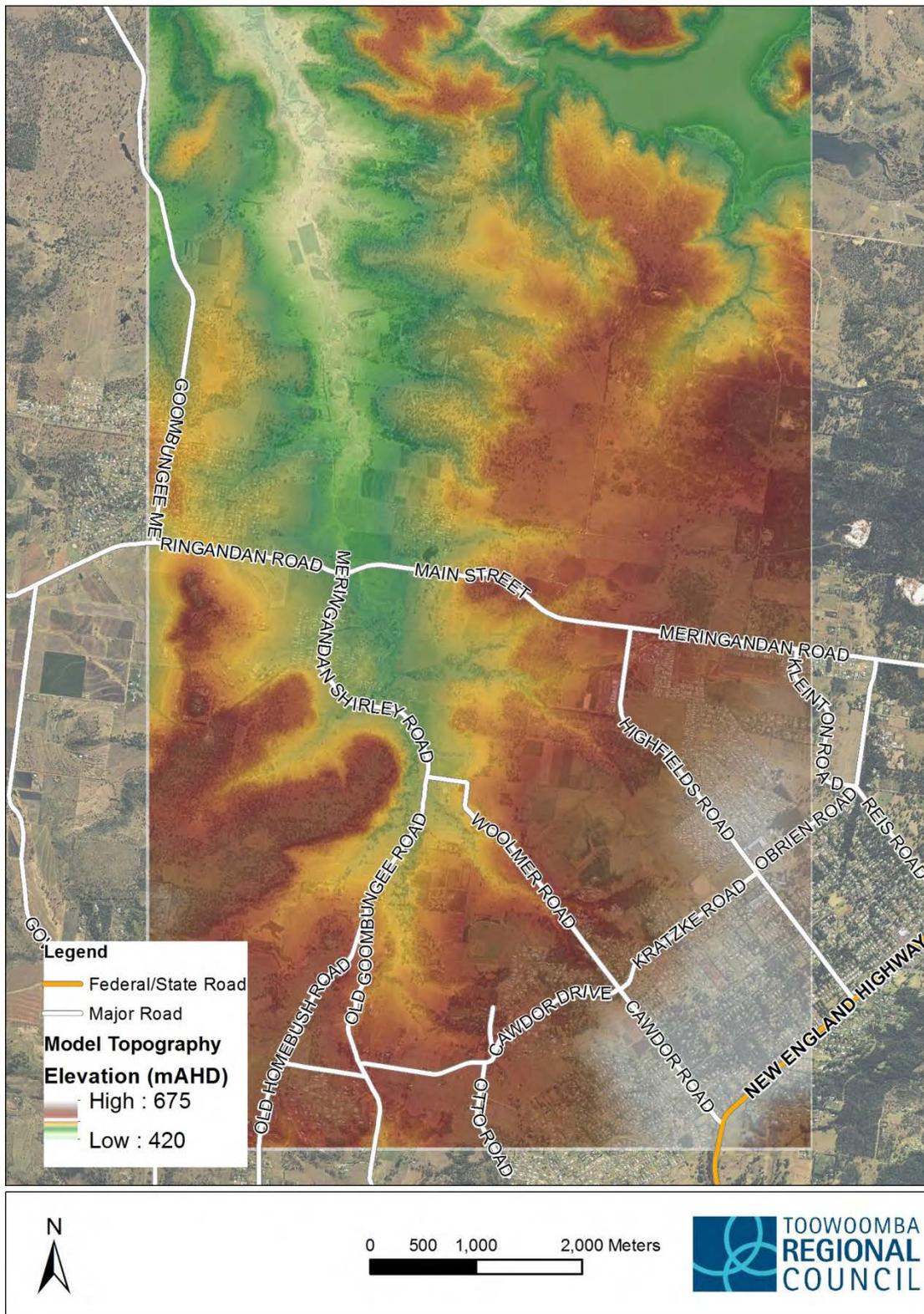


Figure 5.1 Final model topography

5.1.2 HYDRAULIC ROUGHNESS

The model roughness map was developed using the DCDB and Building Footprints of GIS layers as the primary inputs. An aerial photograph was also draped over the roughness map to enable manual edits. The Manning's M (inverse of Manning's n) values were applied as follows:

- Roads – 40 (0.025)
- Waterways - 30 (0.033)
- Developed Areas - 12 (0.083)
- Buildings – 5 (0.20)
- Floodplain – 25 (0.04)

The roughness map is shown as Figure 5.2.

5.1.3 EDDY VISCOSITY

Eddy Viscosity values were determined from the MIKE21 training manual. A value of 1.0 was assigned to the general floodplain whilst a value of 5.0 was assigned to coupled cells to promote stability.

5.1.4 DOWNSTREAM BOUNDARY CONDITION

A single fixed water level type downstream boundary condition was applied. The boundary condition was located at the downstream extent of the model domain. The water level applied was 440.31 mAHD. This is considered a sufficient distance from the study area at about two kilometres with sufficient fall to ensure that the fixed water level boundary does not impact upon the model results. The selected water level ensures that model flows can be adequately drained to minimise the potential for backwater affecting the study area.

5.1.5 INITIAL CONDITIONS

A map of initial condition values was adopted based on model bathymetry. This enabled the various farm dams within the model domain to be filled to their respective spill levels.

5.1.6 SOURCE POINTS

All flows into the model originate from 'source points'. The source point locations were determined from the location of the hydrological model sub-catchments. Each hydrological sub-catchment is loaded to an individual source point within the MIKE21 component of the model except for one sub-catchment, which is located beyond the extent of the MIKE21 model. The source point locations are shown as Figure 5.3.

The specific model grid location and co-ordinates for each sub-catchment is outlined in Table 5.1.

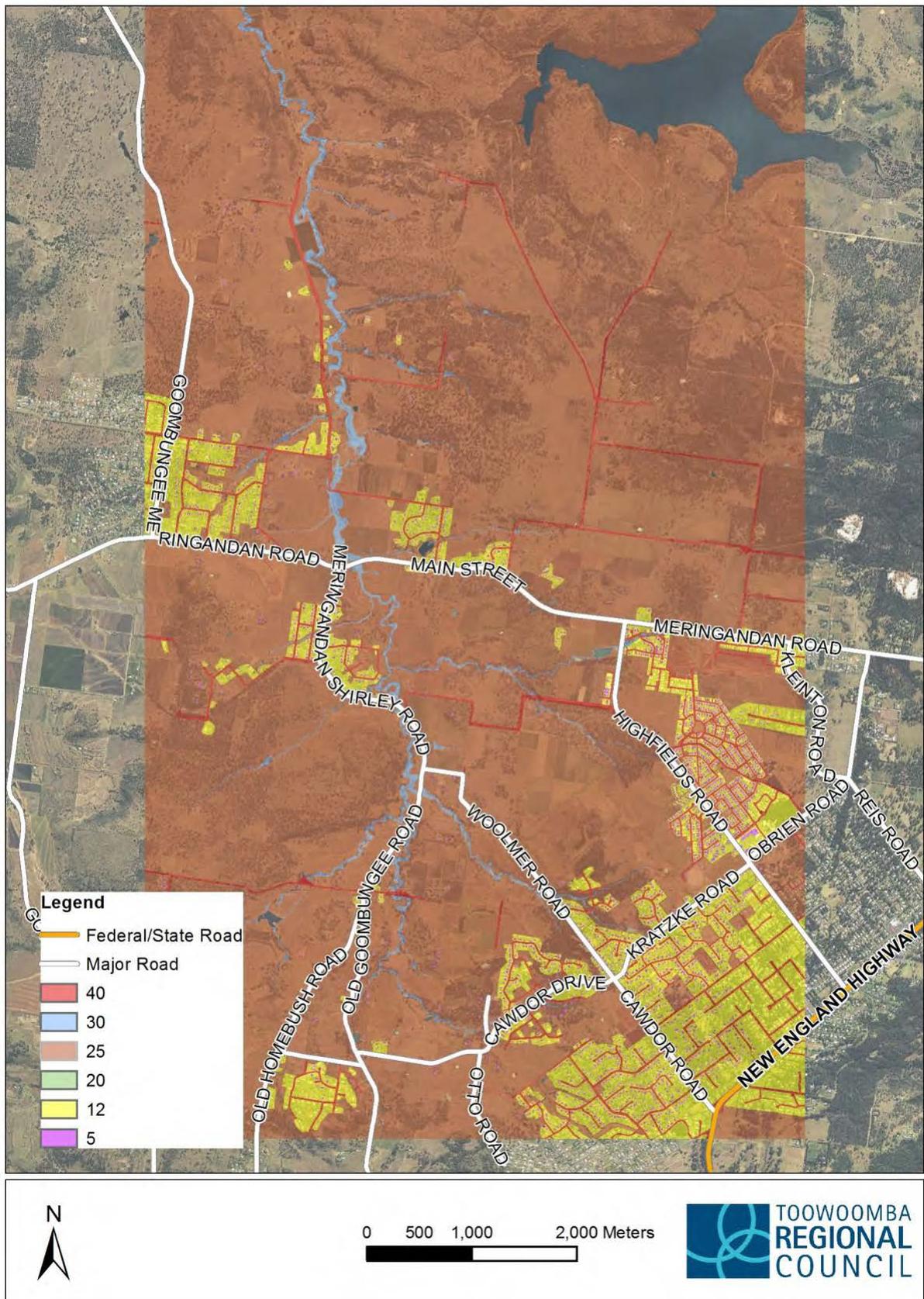


Figure 5.2 Model roughness (Manning's M)

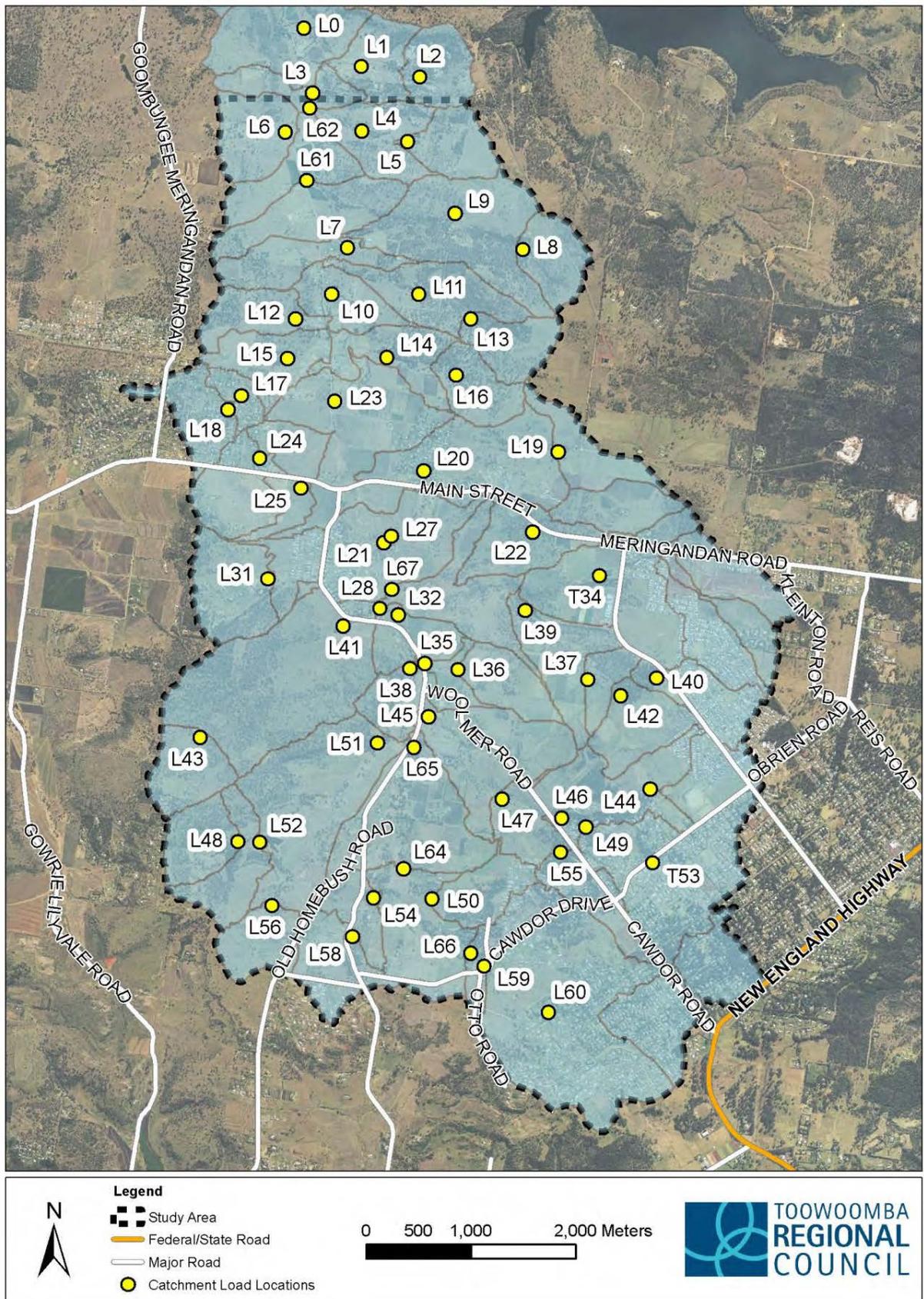


Figure 5.3 Source point locations

Table 5-1 Source points locations

| Rafts ID | J | K | Easting | Northing |
|-----------------|----------|----------|----------------|-----------------|
| L0 | 302 | 1989 | 391462.5 | 6970248 |
| L1 | 411 | 1915 | 392007.5 | 6969878 |
| L2 | 523 | 1894 | 392567.5 | 6969773 |
| L3 | 318 | 1864 | 391542.5 | 6969623 |
| L4 | 412 | 1791 | 392012.5 | 6969258 |
| L5 | 500 | 1770 | 392452.5 | 6969153 |
| L6 | 266 | 1789 | 391282.5 | 6969248 |
| L7 | 385 | 1566 | 391877.5 | 6968133 |
| L8 | 720 | 1562 | 393552.5 | 6968113 |
| L9 | 590 | 1632 | 392902.5 | 6968463 |
| L10 | 354 | 1477 | 391722.5 | 6967688 |
| L11 | 521 | 1477 | 392557.5 | 6967688 |
| L12 | 285 | 1429 | 391377.5 | 6967448 |
| L13 | 621 | 1429 | 393057.5 | 6967448 |
| L14 | 460 | 1355 | 392252.5 | 6967078 |
| L15 | 270 | 1352 | 391302.5 | 6967063 |
| L16 | 592 | 1320 | 392912.5 | 6966903 |
| L17 | 182 | 1280 | 390862.5 | 6966703 |
| L18 | 156 | 1254 | 390732.5 | 6966573 |
| L19 | 788 | 1173 | 393892.5 | 6966168 |
| L20 | 530 | 1136 | 392602.5 | 6965983 |
| L21 | 454 | 998 | 392222.5 | 6965293 |
| L22 | 739 | 1018 | 393647.5 | 6965393 |
| L23 | 361 | 1270 | 391757.5 | 6966653 |
| L24 | 217 | 1160 | 391037.5 | 6966103 |
| L25 | 295 | 1102 | 391427.5 | 6965813 |
| L27 | 468 | 1010 | 392292.5 | 6965353 |
| L28 | 447 | 871 | 392187.5 | 6964658 |
| L31 | 232 | 927 | 391112.5 | 6964938 |
| L32 | 482 | 858 | 392362.5 | 6964593 |
| T34 | 867 | 934 | 394287.5 | 6964973 |
| L35 | 532 | 765 | 392612.5 | 6964128 |
| L36 | 596 | 753 | 392932.5 | 6964068 |
| L37 | 845 | 733 | 394177.5 | 6963968 |
| L38 | 504 | 755 | 392472.5 | 6964078 |
| L39 | 725 | 866 | 393577.5 | 6964633 |
| L40 | 976 | 736 | 394832.5 | 6963983 |
| L41 | 377 | 837 | 391837.5 | 6964488 |
| L42 | 908 | 703 | 394492.5 | 6963818 |
| L43 | 103 | 622 | 390467.5 | 6963413 |
| L44 | 964 | 523 | 394772.5 | 6962918 |

| | | | | |
|------------|-----|------|----------|---------|
| L45 | 539 | 662 | 392647.5 | 6963613 |
| L46 | 795 | 467 | 393927.5 | 6962638 |
| L47 | 681 | 503 | 393357.5 | 6962818 |
| L48 | 175 | 421 | 390827.5 | 6962408 |
| L49 | 840 | 450 | 394152.5 | 6962553 |
| L50 | 547 | 311 | 392687.5 | 6961858 |
| L51 | 442 | 611 | 392162.5 | 6963358 |
| L52 | 217 | 420 | 391037.5 | 6962403 |
| T53 | 969 | 380 | 394797.5 | 6962203 |
| L54 | 435 | 313 | 392127.5 | 6961868 |
| L55 | 793 | 401 | 393917.5 | 6962308 |
| L56 | 241 | 298 | 391157.5 | 6961793 |
| L58 | 394 | 238 | 391922.5 | 6961493 |
| L59 | 646 | 181 | 393182.5 | 6961208 |
| L60 | 769 | 93 | 393797.5 | 6960768 |
| L61 | 307 | 1695 | 391487.5 | 6968778 |
| L62 | 313 | 1834 | 391517.5 | 6969473 |
| L63 | 190 | 2181 | 390902.5 | 6971208 |
| L64 | 492 | 369 | 392412.5 | 6962148 |
| L65 | 512 | 603 | 392512.5 | 6963318 |
| L66 | 621 | 206 | 393057.5 | 6961333 |
| L67 | 469 | 907 | 392297.5 | 6964838 |
| L0 | 302 | 1989 | 391462.5 | 6970248 |

5.2 MIKE 11 MODEL DEVELOPMENT

The MIKE11 component of the model was used to simulate cross drainage structures. The development of the MIKE FLOOD model is detailed below.

5.2.1 NETWORK LAYOUT AND STRUCTURES

A series of short branches were implemented into the model at the location of cross drainage structures. A total of 20 field structures were implemented into the MIKE11 model. It is noted that Meringandan Shirley Road 1 and Meringandan Shirley Road 3 consist two culvert cells each (different size) which was represented as two culverts in the MIKE11 model. Where survey data was available through Council's GIS system this data was used to implement the structures. Where survey data was not available or the data was found to be erroneous, field measurements supplemented by interrogation from Council's one metre DEM or design drawings were utilised.

Predominantly the structures were implemented as 'explicit' structures where the culvert is modelled in MIKE11 and the weir overflow is modelled in MIKE21. However, the structures at Old Meringandan Road 1 and Meringandan Shirley Road 4 were modelled as implicit structures. This was primarily due to the lack of elevation definition at these locations. The structures contained within the MIKE11 model are listed in Table 5.2 and shown geographically in Figure 5.4.

Table 5-2 Structures implemented in the MIKE11 model

| Location | Structure Type | Configuration | Data Source | Coupling Technique |
|--------------------------|----------------|--|-------------------------------------|--------------------|
| Willis Rd | Culvert | 1200 RCP | Measured (Invert taken from 1m DEM) | Explicit |
| Peters Rd | Culvert | 900 RCP | Measured (Invert taken from 1m DEM) | Explicit |
| Old Meringandan Rd 1 | Culvert | 1200 x 750 RCBC | Measured (Invert taken from 1m DEM) | Implicit |
| Old Meringandan Rd 2 | Culvert | 4 x 2400 x 1500 RCBCs | Measured (Invert taken from 1m DEM) | Explicit |
| Garrett Rd | Culvert | 4 x 1250 RCPs | Measured (Invert taken from 1m DEM) | Explicit |
| Klein Rd | Culvert | 1200 x 900 RCBC | Measured (Invert taken from 1m DEM) | Explicit |
| Curlew St | Culvert | 4 x 750 RCPs | Measured (Invert taken from 1m DEM) | Explicit |
| Corella St | Culvert | 4 x 750 RCPs | Measured (Invert taken from 1m DEM) | Explicit |
| Meringandan Shirley Rd 1 | Culvert | 2 x 1100 RCP & 1 x 1300 RCP | Measured (Invert taken from 1m DEM) | Explicit |
| Meringandan Shirley Rd 3 | Culvert | 3 x 2400 x 1800 RCBCs & 1 x 2400 x 2000 RCBC | Measured (Invert taken from 1m DEM) | Explicit |
| Meringandan Shirley Rd 4 | Culvert | 4 x 1600 RCP | Measured (Invert taken from 1m DEM) | Implicit |
| Meringandan Shirley Rd 5 | Culvert | 1250 RCP | Measured (Invert taken from 1m DEM) | Explicit |
| Old Rail | Culvert | 1500 RCP | Measured (Invert taken from 1m DEM) | Explicit |
| Old Goombungee Rd 1 | Culvert | 1600 RCP | Measured (Invert taken from 1m DEM) | Explicit |
| Old Goombungee Rd 1A | Culvert | 1600 RCP | Measured (Invert taken from 1m DEM) | Explicit |
| Woolmer Rd | Culvert | 1800 RCP | Measured (Invert taken from 1m DEM) | Explicit |
| Parkway Dr 2 | Culvert | 1800 RCP | Measured (Invert taken from 1m DEM) | Explicit |
| Parkway Dr 1 | Culvert | 2250 RCP | Measured (Invert taken from 1m DEM) | Explicit |
| Kratzke Rd | Culvert | 2000 RCP | Measured (Invert taken from 1m DEM) | Explicit |
| Cawdor Dr | Culvert | 2 x 450 RCPs | Measured (Invert taken from 1m DEM) | Explicit |

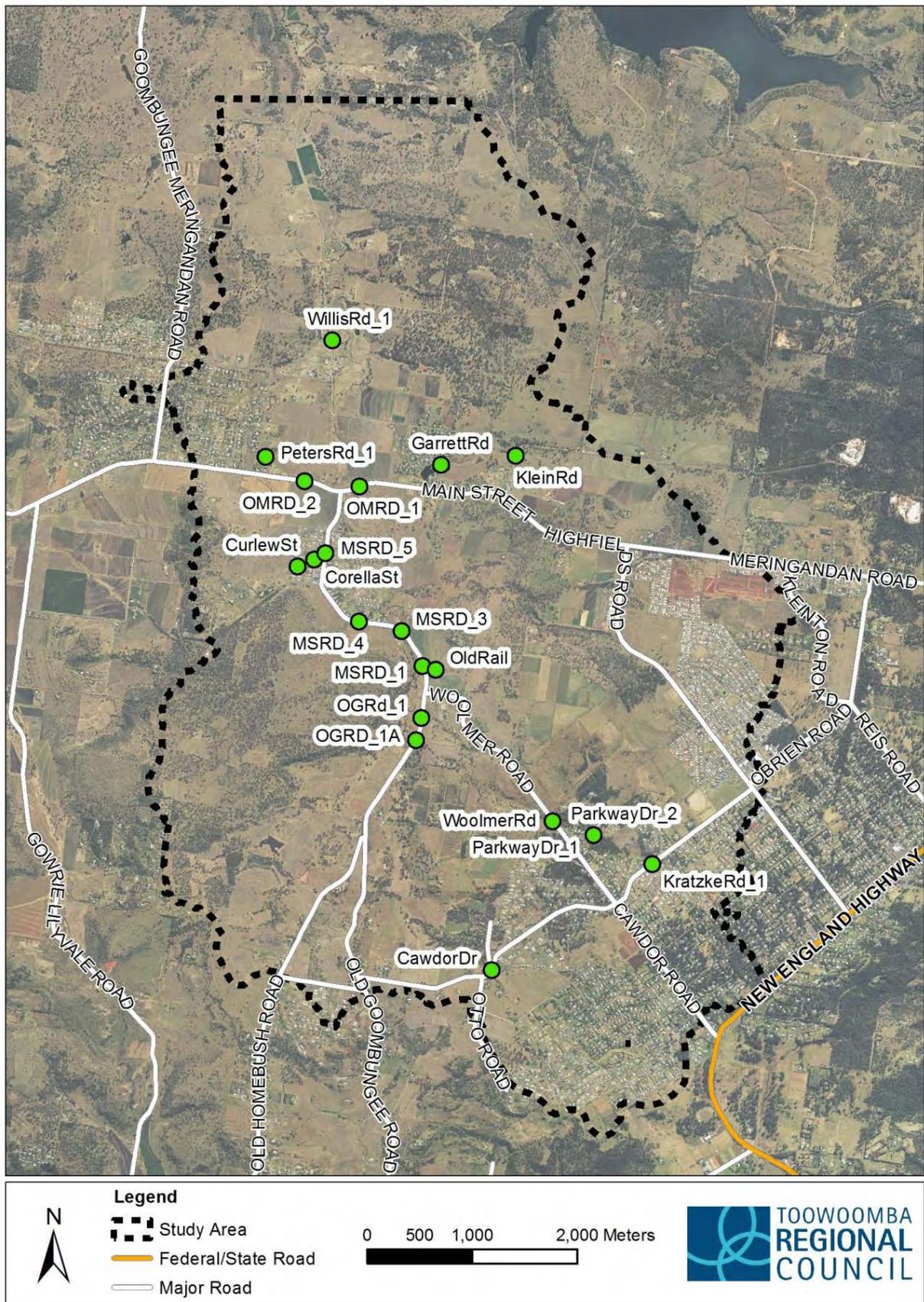


Figure 5.4 Modelled structures within Meringandan Creek study area

5.2.2 CROSS-SECTIONS

To facilitate the implementation of the structures, simple MIKE11 cross sections were implemented. In accordance with standard model development practice these were of a simple box shape and large enough to incorporate the structure. The inverts of the cross sections were set below the invert of the structures. Water level boundaries were then applied at each of end of the MIKE11 branch.

5.3 MIKE FLOOD MODEL DEVELOPMENT

The MIKE FLOOD component links the two individual models (MIKE11 & MIKE21) together. This section describes that process.

5.3.1 *STRUCTURE COUPLING*

Structures were generally coupled using the explicit technique. The number of coupled cells was determined by the size of the structure. The parameters applied at each structure were as follows:

- Momentum Factor = 1.0
- Extrapolation Factor = 0.0
- Depth Adjust = yes
- Exponential Smoothing Factor = 0.2

5.3.2 *TIME STEP AND SAVE STEP*

A fixed time step of one second was adopted to ensure a Courant number below one. A save step in the two dimensional component of once every 600 time steps was selected - equal to every ten minutes. This is considered adequate to capture the flooding behaviour within the study area whilst maintaining reasonable result file sizes.

6. MODEL RESULTS

6.1 MODEL VALIDATION

A joint calibration approach was utilised to validate the model to the January 2011 flood event. Flows derived from the XP-RAFTS model were simulated through the MIKE FLOOD model and maximum flood surface elevations from MIKE FLOOD were compared with flood debris marks recorded after flooding and anecdotal evidence.

The model was found to present a reasonable match to the surveyed flood debris levels. Seventy-five percent of the verification points were modelled within +/- 0.6 metres of the surveyed level. At one location a difference of greater than one metre was observed. It should be noted that the several significant flood events occurred over the December 2010/January 2011 period and it cannot be determined which event resulted in the surveyed flood level. Furthermore, no photos were taken of the surveyed points at the time of survey and the survey is limited to one point at each location. In addition, as no pluviographs are located within the catchment, considerable uncertainty can be attributed to the rainfall estimates applied for the validation event.

Furthermore, the model produced a good match to the anecdotal evidence collected with six out of seven locations (overtopped roads and road damage). Overtopping of Garrett Road was not replicated by the model. This may be due to blockage of the structure during the flood event (there is significant undeveloped catchment upstream of this structure). This may also be attributed to the measured (rather than surveyed) invert levels of the culverts at this location. A comparison of recorded values to modelled values at the verification points is presented as Table 6.1.

Table 6-1 Comparison at verification points

| Point ID | Location | Surveyed Elevation (mAHD) / Recorded Detail | Modelled Elevation (mAHD) / Detail | Difference (m) |
|----------|---------------------------|---|------------------------------------|----------------|
| 1 | Steinberg Rd | Road washed out and fences broken. Depth 30 to 60 cm. | Depth of 40 cm | Match |
| 2 | Old Goombungee Rd | 514.47 | 513.94 | -0.53 |
| 3 | Old Goombungee Rd | 512.50 | 513.04 | 0.54 |
| 4 | Meringandan Shirley Rd | 503.56 | 503.95 | 0.39 |
| 5 | Meringandan Shirley Rd | 503.14 | 503.86 | 0.72 |
| 6 | Meringandan Shirley Rd | Flooding over road cut road access – depth 60 cm | Depth of 41 cm | Match |
| 7 | Goombungee Meringandan Rd | Flooding over bridge – depth above 60 cm | Depth of 1.76 m | Match |
| 8 | Klein Rd | 527.34 | 527.18 | -0.16 |
| 9 | Klein Rd | 527.25 | 527.20 | -0.05 |
| 10 | Spies Rd | 479.99 | 481.09 | 1.10 |
| 11 | Spies Rd | 478.81 | 479.29 | 0.48 |
| 12 | Willis Rd | Road scoured due to flooding – depth up to 30 cm | Depth of 24 cm | Match |
| 13 | Sovereign Dr | Road scoured due to flooding | Depth of 14 cm | Match |
| 14 | Garrett Rd | Flooding depth 30 to 60 cm. | Not overtopped | No match |
| 15 | Meringandan Shirley Rd | Flooding over road. | Depth of 18 cm | Match |

The two surveyed flood elevations at Old Goombungee Road are located about 150 m apart yet the model overestimates the southern point and underestimates the northern point. Discussions with construction and maintenance crews suggested that the road damage indicated that flow was likely to have been conveyed along Old Goombungee Road from the southern flow path to the northern flow path. This behaviour is replicated by the model. (refer Figures 6.1 to 6.3)

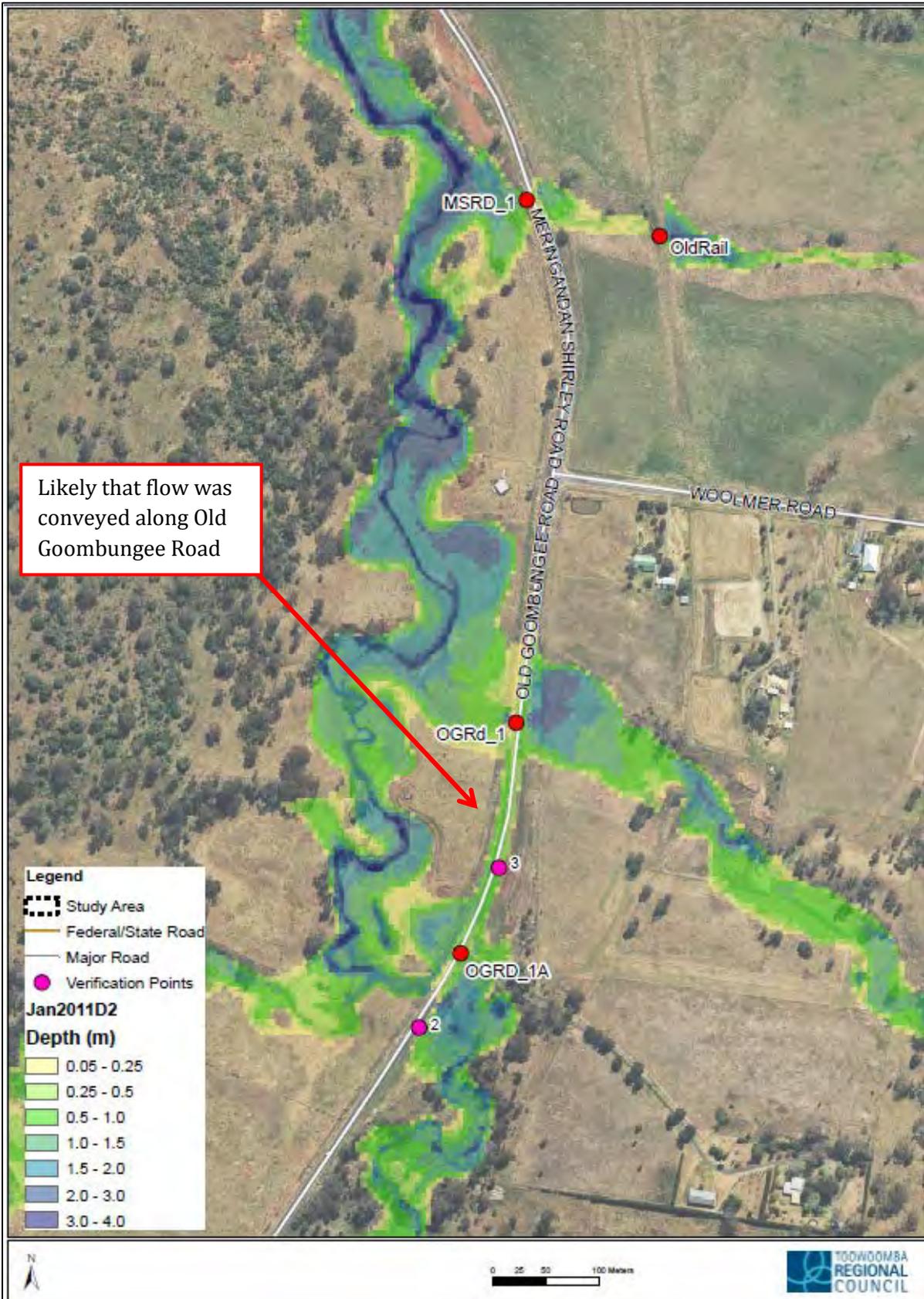


Figure 6.1 Surveyed flood points versus modelled results at Old Goombungee road



Figure 6.2 Damage to road and culverts at OGRD_1



Figure 6.3 Damage to road and culverts at OGRD_1A

Further anecdotal evidence suggests that the flood extent at Meringandan Shirley Road extended from Browns Road to the western extent of the bend on Meringandan Shirley Road. This extent is significantly wider than the extent indicated by the surveyed flood debris point (5) at this location and would indicate a higher flood level occurred than as surveyed for flood debris point 5. In addition, there is anecdotal evidence of flooding of Phipps Drive as replicated by the model. (refer Figures 6.4 and 6.5)

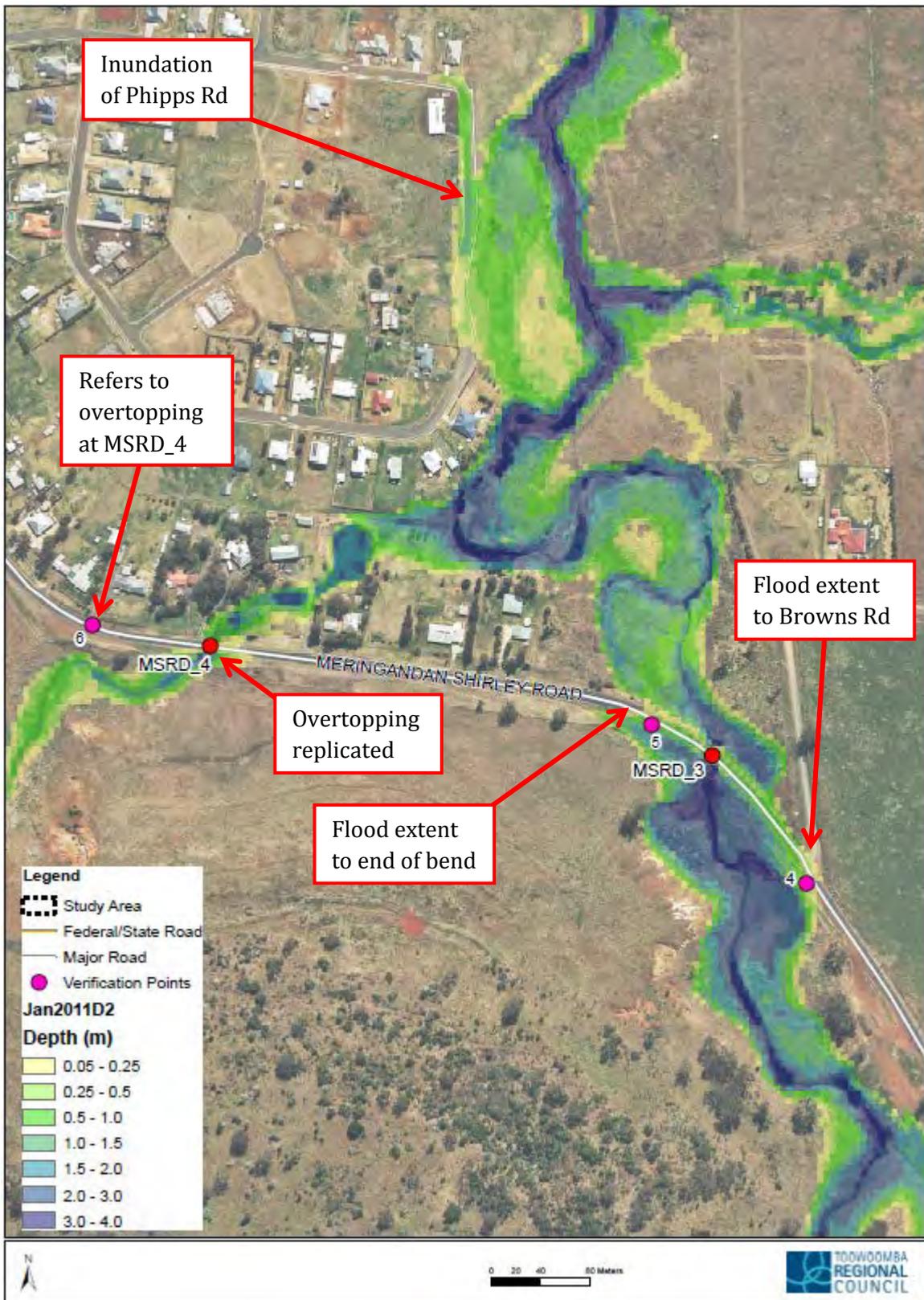


Figure 6.4 Surveyed flood points versus modelled results at Meringandan Shirley road

Max Volp Crossing on Oakey Meringandan Road was inundated on several occasions through the December 2010/January 2011 flood events. At the time of the January 2011 event, no survey was undertaken of the flood extent at this location, however anecdotal evidence suggests that upstream

of the crossing, the flood extent was such that braided channel behaviour occurred. Furthermore, downstream of the crossing, the anecdotal evidence suggests that shortcutting of the sharp bend to the north occurred but that flooding did not extend to the shed or the solar panels. (refer Figures 6.5 and 6.6)

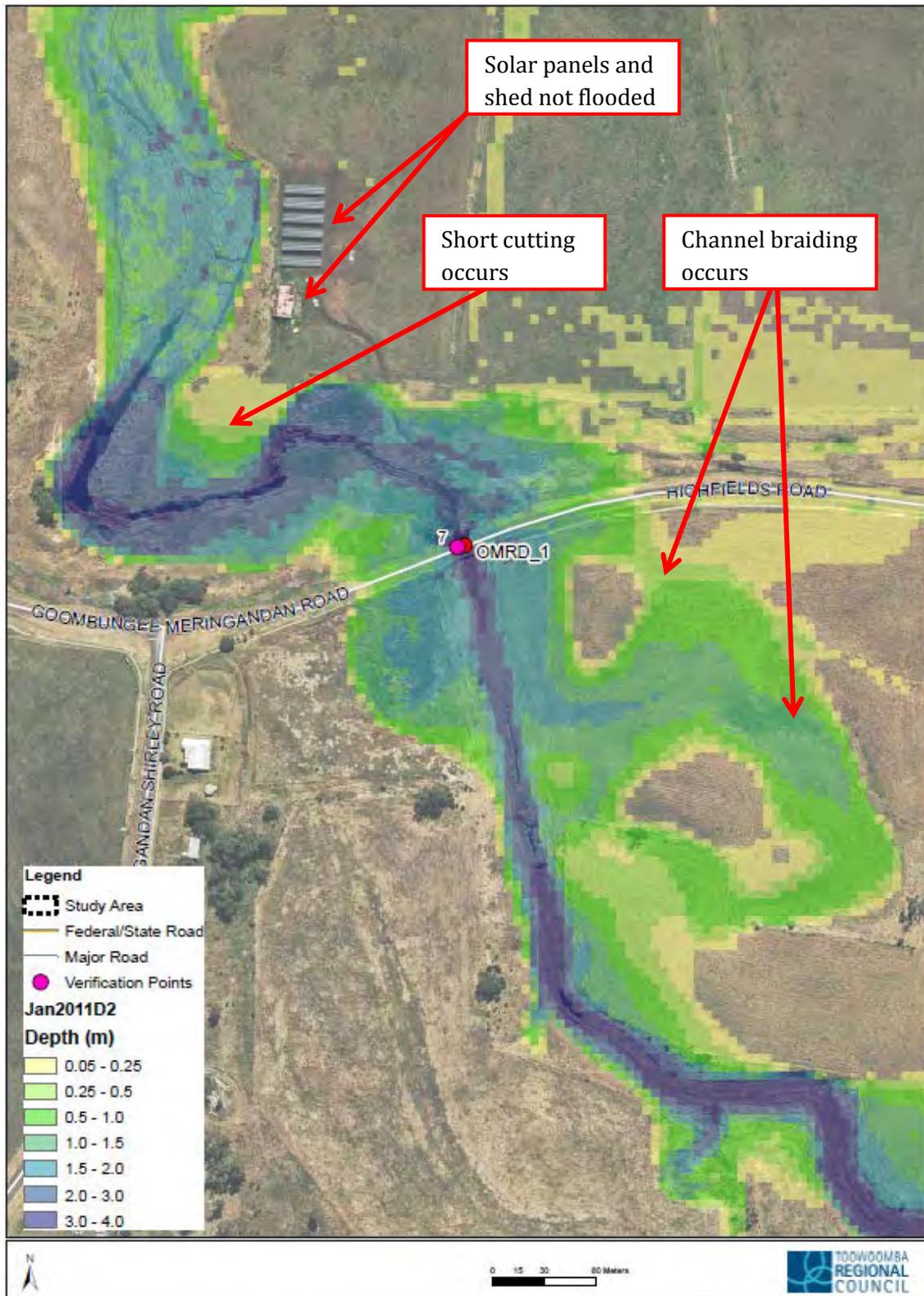


Figure 6.5 Surveyed flood points versus modelled results at Max Volp crossing



Figure 6.6 Selected photographs of Max Volp crossing

The model achieves a good match to the flood extend at Spies Road. There is however, a significant difference in modelled versus surveyed levels at this location, particularly for point 10. (refer Figure 6.7)

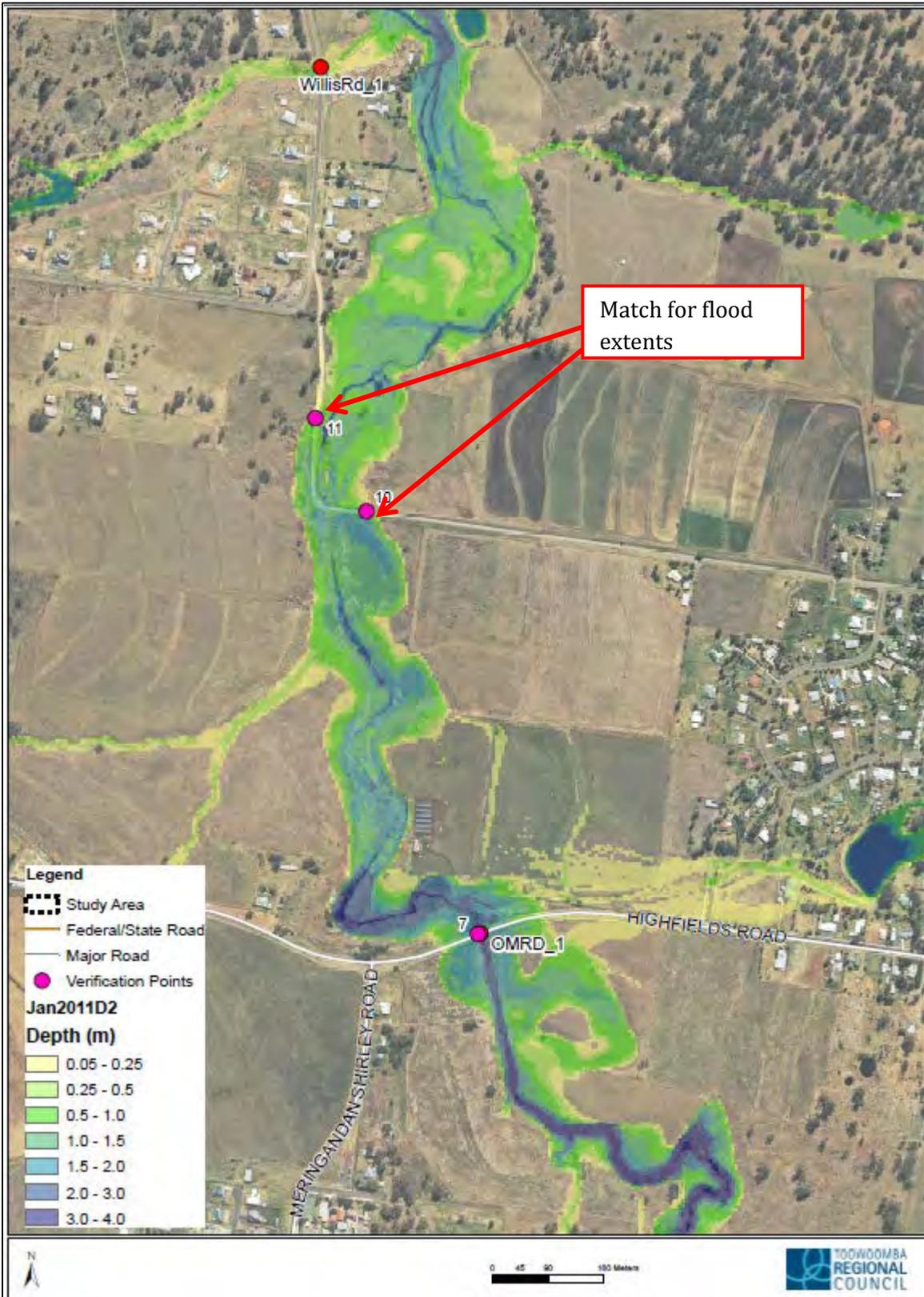


Figure 6.7 Surveyed flood points versus modelled results at Spies road

Anecdotal evidence of flood debris on the western side of Willis Road indicates that the braided channel behaviour indicated by the model at this location is correct. (refer Figure 6.8).

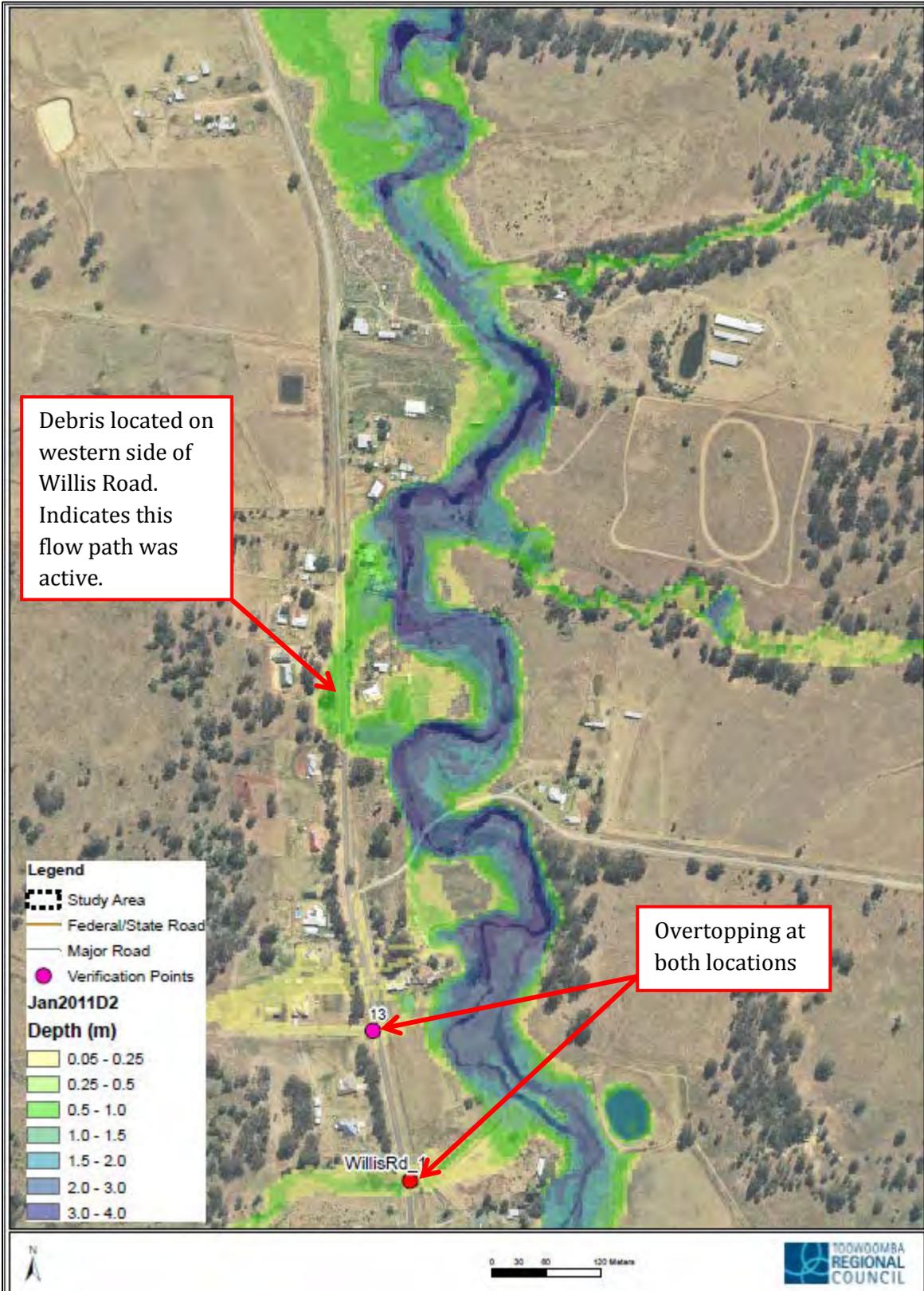


Figure 6.8 Braided flow pattern at Willis Rd.

Despite only achieving a reasonable match to surveyed debris points, the model behaviour matches the described flood behaviour for the 2011 event. It should be noted that without a Pluviograph in

the catchment, considerable uncertainty exists around the quantity and distribution of rainfall for the January 2011 event.

6.2 ASSESSMENT OF CRITICAL DURATION

Following the development of design flows, an assessment of the critical duration was undertaken. The assessment was conducted based on the 1% AEP with durations ranging from 90 minutes to 360 minutes. These events were simulated in the MIKE FLOOD model and six locations throughout the model were selected for comparison. The comparison locations are shown as Figure 6.9.

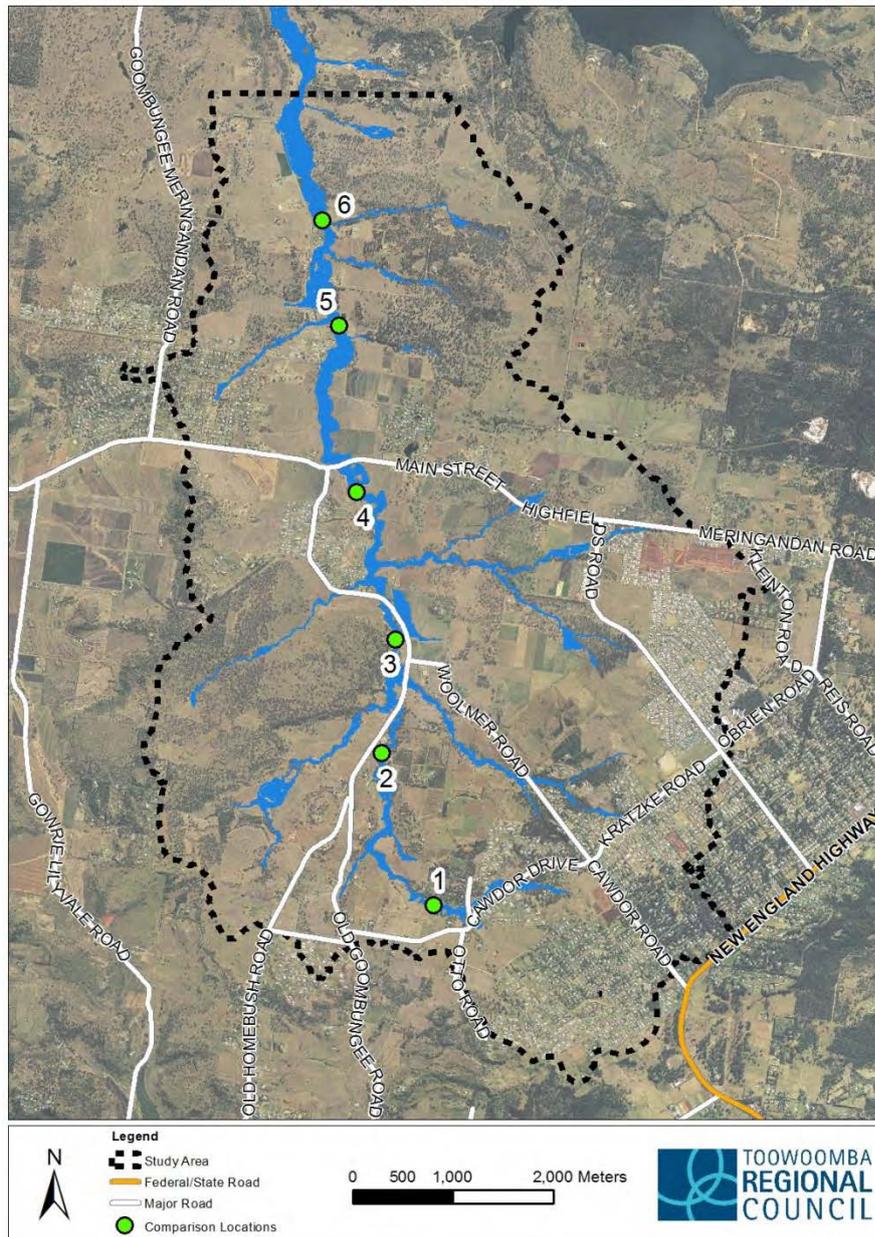


Figure 6.9 Critical duration comparison locations

The results of the comparison of maximum water level at each location are shown as Table 6.2.

Table 6-2 Maximum water level by storm duration (1% AEP)

| ID | Locations | 90 min | 120 min | 180 min | 360 min |
|----|--------------------------|--------|---------|---------|---------|
| 1 | D/S of Cawdor Drive | 554.47 | 554.48 | 554.47 | 554.45 |
| 2 | Meringandan Shirley Rd 1 | 519.62 | 519.65 | 519.63 | 519.6 |
| 3 | Meringandan Shirley Rd 2 | 505.79 | 505.93 | 505.89 | 505.75 |
| 4 | U/S of Max Volp Crossing | 488.43 | 488.6 | 488.56 | 488.43 |
| 5 | Willis Rd 1 | 473.4 | 473.51 | 473.47 | 473.33 |
| 6 | Willis Rd 2 | 465.76 | 465.88 | 465.85 | 465.74 |

The results show that for all six selected comparison locations, the 120 minute duration is critical. Based on this assessment, design simulations were carried out using the 120 minute storm duration.

6.3 DESIGN SIMULATIONS

The MIKE FLOOD hydrodynamic model was used to simulate design flows derived from the XP-RAFTS model. The simulations were undertaken for the 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2% AEPs and the Probable Maximum Precipitation design flood events. The results for maximum water level and maximum discharge for the above mentioned events are shown in Table 6.3 and Table 6.4 respectively. For comparison locations refer to Figure 6.9.

Table 6-3 Simulated maximum design flood levels (m AHD)

| ID | Location | 20% AEP | 10% AEP | 5% AEP | 2% AEP | 1% AEP | 0.5% AEP | 0.2% AEP | PMF |
|----|--------------------------|---------|---------|--------|--------|--------|----------|----------|--------|
| 1 | D/S of Cowdar Drive | 554.35 | 554.38 | 554.41 | 554.45 | 554.47 | 554.50 | 554.55 | 555.24 |
| 2 | Meringandan Shirley Rd 1 | 519.39 | 519.49 | 519.54 | 519.59 | 519.63 | 519.68 | 519.78 | 521.62 |
| 3 | Meringandan Shirley Rd 2 | 505.00 | 505.40 | 505.58 | 505.67 | 505.78 | 505.93 | 506.14 | 508.83 |
| 4 | U/S of Max Volp Crossing | 487.37 | 487.97 | 488.23 | 488.32 | 488.44 | 488.58 | 488.79 | 491.12 |
| 5 | Willis Rd 1 | 472.39 | 472.79 | 473.07 | 473.28 | 473.42 | 473.60 | 473.88 | 477.09 |
| 6 | Willis Rd 2 | 464.91 | 465.27 | 465.51 | 465.66 | 465.78 | 465.93 | 466.15 | 468.42 |

Table 6-4 Simulated maximum design discharges (m³/sec)

| ID | Location | 20% AEP | 10% AEP | 5% AEP | 2% AEP | 1% AEP | 0.5% AEP | 0.2% AEP | PMF |
|----|--------------------------|---------|---------|--------|--------|--------|----------|----------|--------|
| 1 | D/S of Cowdar Drive | 13.2 | 17.8 | 23.2 | 27.9 | 31.6 | 36.6 | 45.1 | 244.6 |
| 2 | Meringandan Shirley Rd 1 | 14.7 | 27.8 | 35.8 | 44.1 | 50.4 | 58.5 | 72.5 | 417.5 |
| 3 | Meringandan Shirley Rd 2 | 38.3 | 79.1 | 102.2 | 118.4 | 133.7 | 155.0 | 189.0 | 1068.4 |
| 4 | U/S of Max Volp Crossing | 62.1 | 121.2 | 169.1 | 205.0 | 234.5 | 273.3 | 335.5 | 1399.1 |
| 5 | Willis Rd 1 | 71.9 | 136.7 | 191.4 | 236.8 | 270.6 | 314.4 | 389.7 | 1905.0 |
| 6 | Willis Rd 2 | 80.9 | 151.4 | 213.5 | 268.0 | 306.1 | 357.8 | 441.2 | 1881.7 |

Depth, surface elevation, hazard and hydraulic category plots for the 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2% AEPs and the Probable Maximum Precipitation design flood events are provided in Appendix C. It is noted that these maps are plotted from the 2D component of the model. Flood maps for the above mentioned events are presented in Appendix C in the following order:

- Depth maps - Figure C.1 to C.8;
- Surface elevation maps - Figure C.9 to C.16;
- Hazard maps - Figure C.17 to C.24; and
- Hydraulic category maps - Figure C.25 to C.32.

ArcGIS tools were used to determine the number of properties affected by flooding. The process included converting the flood depth results (ASCIs) to polygons, and conducting a selection of the number of building footprints (a Council GIS layer) which were intersected by the flood depth polygon, within a search radius on 0 m (i.e. the building footprint had to at least touch or overlap the flooding in order to be selected). Based on this procedure, the total number of buildings affected for the 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2% AEPs and PMP-DF event was 15, 21, 34, 38, 39, 41, 42 and 126 respectively (refer to flood depth maps in Figure C.1 to C.8 of Appendix C). It is noted that the buildings includes carport, houses, sheds etc.

The MIKE FLOOD hydrodynamic model was also used to simulate the future development scenario for the design flood events. All the modelling parameters were kept similar to the existing condition except the design flows. A comparison of the results for the 1% AEP is shown as Table 6.5. The results indicate an increase in maximum flood level at some locations indicating the consideration to further mitigation works within the catchment may be necessary in the future.

Table 6-5 Comparison of simulated existing and future maximum flood levels (1% AEP)

| ID | Location | Existing Case Max Level (mAHD) | Future Case Max Level (mAHD) | Difference (m) |
|----|--------------------------|--------------------------------------|------------------------------------|-------------------|
| 1 | D/S of Cawdor Drive | 554.47 | 554.53 | 0.06 |
| 2 | Meringandan Shirley Rd 1 | 519.63 | 519.73 | 0.10 |
| 3 | Meringandan Shirley Rd 2 | 505.78 | 506.00 | 0.22 |
| 4 | U/S of Max Volp Crossing | 488.44 | 488.63 | 0.19 |
| 5 | Willis Rd 1 | 473.42 | 473.69 | 0.27 |
| 6 | Willis Rd 2 | 465.78 | 466.00 | 0.22 |

6.4 SENSITIVITY ANALYSIS

The aim of sensitivity checks is to observe the sensitivity of the catchment to large variations in flow and floodplain roughness. To examine this sensitivity, the following variations were imposed:

- +/- 30% variation in flow
- +/- 30% variation in roughness

Table 6.6 summarises the water levels obtained for the six comparison locations (refer Figure 6.9) for variation in flows whilst Table 6.7 summarises the water levels obtained for variations in floodplain roughness. Whilst the variation in maximum water levels is significant at some locations, the variation in flood extent is limited. This is expected due to the steep nature of the floodplain.

Table 6-6 Sensitivity analysis for variation in flows (1% AEP)

| ID | Location | Base Case Flood Level (mAHD) | Increased Flow Flood Level (mAHD) | Difference (m) | Decreased Flow Flood Level (mAHD) | Difference (m) |
|----|--------------------------|------------------------------------|---|-------------------|---|-------------------|
| 1 | D/S of Cawdor Drive | 554.47 | 554.53 | 0.06 | 554.41 | -0.06 |
| 2 | Meringandan Shirley Rd 1 | 519.63 | 519.73 | 0.10 | 519.53 | -0.10 |
| 3 | Meringandan Shirley Rd 2 | 505.78 | 506.05 | 0.26 | 505.50 | -0.29 |
| 4 | U/S of Max Volp Crossing | 488.44 | 488.69 | 0.25 | 488.13 | -0.31 |
| 5 | Willis Rd 1 | 473.42 | 473.76 | 0.33 | 473.03 | -0.40 |
| 6 | Willis Rd 2 | 465.78 | 466.06 | 0.28 | 465.46 | -0.32 |

Table 6-7 Sensitivity analysis for variation in roughness (1% AEP)

| ID | Location | Base Case Flood Level (mAHD) | Increased Roughness Flood Level (mAHD) | Difference (m) | Decreased Roughness Flood Level (mAHD) | Difference (m) |
|----|--------------------------|------------------------------------|--|-------------------|--|-------------------|
| 1 | D/S of Cawdor Drive | 554.47 | 554.54 | 0.07 | 554.43 | -0.04 |
| 2 | Meringandan Shirley Rd 1 | 519.63 | 519.74 | 0.11 | 519.56 | -0.07 |
| 3 | Meringandan Shirley Rd 2 | 505.78 | 506.04 | 0.26 | 505.61 | -0.17 |
| 4 | U/S of Max Volp Crossing | 488.44 | 488.67 | 0.23 | 488.30 | -0.14 |
| 5 | Willis Rd 1 | 473.42 | 473.62 | 0.20 | 473.32 | -0.11 |
| 6 | Willis Rd 2 | 465.78 | 466.00 | 0.21 | 465.66 | -0.12 |

Surface elevation map for the changed flow and changed roughness condition is provided in Figure C.33 of Appendix C.

6.5 CLIMATE CHANGE ANALYSIS

Hydrodynamic model simulations were conducted for 1%, 0.5% and 0.2% AEP events for 2050, 2070 and 2100 climate change scenarios in accordance with Section 4.7. A comparison of the maximum flood levels for the six comparison locations for 1% AEP event is presented in Table 6.8. As expected, the results show increasing maximum flood levels with increasing rainfall intensity due to climate change. The 1% AEP, 2100 horizon shows significant increases in maximum flood levels at some locations however, changes to flood behaviour and flood extent are limited.

Table 6-8 Results of climate change analysis for 1% AEP event

| Point ID | Location | Base Case (mAHD) | 2050 Case (mAHD) | Difference (m) | 2070 Case (mAHD) | Difference (m) | 2100 Case (mAHD) | Difference (m) |
|----------|--------------------------|------------------|------------------|----------------|------------------|----------------|------------------|----------------|
| 1 | D/S of Cawdor Drive | 554.47 | 554.50 | 0.03 | 554.51 | 0.04 | 554.52 | 0.05 |
| 2 | Meringandan Shirley Rd 1 | 519.63 | 519.67 | 0.04 | 519.70 | 0.07 | 519.72 | 0.09 |
| 3 | Meringandan Shirley Rd 2 | 505.78 | 505.90 | 0.12 | 505.96 | 0.18 | 506.01 | 0.23 |
| 4 | U/S of Max Volp Crossing | 488.44 | 488.54 | 0.11 | 488.61 | 0.17 | 488.66 | 0.22 |
| 5 | Willis Rd 1 | 473.42 | 473.57 | 0.15 | 473.65 | 0.23 | 473.72 | 0.29 |
| 6 | Willis Rd 2 | 465.78 | 465.90 | 0.12 | 465.96 | 0.18 | 466.01 | 0.23 |

Surface elevation maps for the 1%, 0.5% and 0.2% AEP events for climate change scenarios are provided in Figure C.34 to C.42 of Appendix C.

6.6 ASSESSMENT OF CULVERT BLOCKAGE

To analyse the potential for culvert blockage, a simulation was undertaken where each structure was assumed to have 50 percent blockage. The blockage was implemented by reducing the structure area by 50 percent whilst maintaining the invert level. The 1% AEP was selected as the event for culvert blockage analysis. Changes in maximum flood level are presented for the comparison locations in Table 6.9.

Table 6-9 Maximum flood level comparisons for blockage scenario for 1% AEP event

| ID | Location | Base Case (mAHD) | Blockage Case (mAHD) | Difference (m) |
|----|--------------------------|------------------|----------------------|----------------|
| 1 | D/S of Cawdor Drive | 554.47 | 554.48 | 0.01 |
| 2 | Meringandan Shirley Rd 1 | 519.63 | 519.65 | 0.02 |
| 3 | Meringandan Shirley Rd 2 | 505.78 | 505.91 | 0.13 |
| 4 | U/S of Max Volp Crossing | 488.44 | 488.58 | 0.14 |
| 5 | Willis Rd 1 | 473.42 | 473.50 | 0.08 |
| 6 | Willis Rd 2 | 465.78 | 465.87 | 0.08 |

The results show that the impact of culvert blockage is significant at some of the comparison locations, particularly where those are adjacent to structures. The impact dissipates at reasonably short distances from the structures. This is expected as the floodplain is relatively steep. Surface elevation map for the culvert blockage scenario is provided in Figure C.43 of Appendix C.

7. SUMMARY

The objective of this study was to develop computer based models to identify and map potential flooding along Meringandan Creek from the headwaters to Willis Road. It was not the objective of this study to develop a stormwater management plan or recommend specific upgrades to the drainage network. In order to achieve the objectives of the study, XP-RAFTS was used to generate catchment flows that were then applied to a MIKE FLOOD hydraulic model to simulate flooding.

The study produced a series of maps showing the extent of simulated flooding within the study area. Maps for 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2% AEPs and the Probable Maximum Precipitation design flood events were produced indicating the associated hazard along with depth, surface elevation and hydraulic category (refer to Figure C.1 to C.32 of Appendix C). Flood depth maps in Figure C.1 to C.8 of Appendix C indicate the total number of buildings affected due to the 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2% AEPs and PMP-DF event is 15, 21, 34, 38, 39, 41, 42 and 126 respectively. It is noted that the buildings includes carport, houses, sheds etc.

Analysis of design events for 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2% AEPs and PMP-DF shows that flooding is mostly confined to well defined channels within the floodplain. Maximum flood levels and flood extents were found to steadily increase with increasing storm size, however the flood behaviour was found to remain similar. The maximum difference in levels between these events is 4.7 metres but most differences are generally within 2.5 -3.75 metres (refer to Table 6.3).

Simulation of future development conditions indicates increases in maximum flood levels at some locations. This may require further investigation in the future. The largest increase in levels for the 1% AEP was 0.27 metres compared to the existing condition (refer to Table 6.5). The impact on the 1% AEP was minimal due to the steep nature of the catchment. It is however expected to have proportionally increased effects on the smaller events because of varying loss model adopted.

Sensitivity analysis showed that the floodplain is more susceptible to changes in flow than changes in floodplain resistance. The sensitivity analysis did not show significant changes in flood behaviour which is expected due to the steep nature of the floodplain. The variations in flow resulted in a difference in levels in the range of -0.40 metres through to 0.33 metres across the comparison points (refer to Table 6.6) while the difference in roughness resulted in difference in levels in the range of -0.17 metres through to 0.26 metres across the comparison points (refer to Table 6.7).

Climate Change simulations were also undertaken for 2050, 2070 and 2100 design horizons for 1%, 0.5% and 0.2% AEP events. A comparison of the maximum flood levels for the six comparison locations for 1% AEP event show increasing maximum flood levels with increasing rainfall intensity (refer to Table 6.8). The difference in levels across the comparison points for climate change is up to 0.29 metres comparing the base case to the year 2100 case for 1% AEP event however, changes to flood behaviour and flood extent are limited.

Analysis of culvert blockage for 1% AEP event show small increase in levels. The increase was up to 0.14 metres (refer to Table 6.9) across the comparison points however; this was typically limited to those areas relatively close to structures within the floodplain.

8. RECOMMENDATIONS

The following recommendations are made to improve the accuracy of flood modelling within the study area:

- Comprehensive collection of anecdotal evidence following future flood events;
- Survey to be undertaken of all culverts, bridges and other structures within the floodplain;
- Consideration to be given to installation of pluviographs and water level gauges within the catchment;
- Inclusion of maximum extent, depth, velocity and hazard maps for the January 2011 event across the entire study area;
- Comprehensive calibration of the hydraulic model;
- More detailed analysis on impacts of future urban developments; and
- Comprehensive revision of roughness maps.

9. REFERENCES

DHI (2012) Mike Flood User Manual, Danish Hydraulic Institute

EA, 2012, Australian Rainfall & Runoff Revision Projects 15: Dimensional Modelling in Urban and Rural floodplains, Engineers Australia

Smith, G and Wasko, C. 2012, Australian Rainfall and Runoff, Revision Project 15: Two Dimensional Simulations in Urban

Areas http://www.ncwe.org.au/arr/Website_links/ARR_WRL_UWS%202011%20v3.pdf

[Accessed, 21 January 2014]

Toowoomba Regional Planning Scheme 2012

<http://www.toowoombarc.qld.gov.au/planning-and-building/planning-scheme>

Queensland Urban Drainage Manual 3rd Edition (provisional)

[http://www.dews.qld.gov.au/_data/assets/pdf_file/0008/78128/qudm2013-](http://www.dews.qld.gov.au/_data/assets/pdf_file/0008/78128/qudm2013-provisional.pdf)

[provisional.pdf](http://www.dews.qld.gov.au/_data/assets/pdf_file/0008/78128/qudm2013-provisional.pdf) [Accessed, 22 January 2014]

XP Solutions (2009) *XP-RAFTS User Manual*

Bureau of Meteorology, Probable Maximum Precipitation, [Accessed, 17 March 2014] <http://www.bom.gov.au/water/designRainfalls/pmp>

10. APPENDICES

10.1 APPENDIX A XP-RAFTS DATA

| Sub-catchment Number | Percentage Impervious [%] | Existing Scenario Total Area [ha] | Developed Scenario Total Area [ha] | Mannings 'n' | Catchment Slope [%] |
|----------------------|---------------------------|-----------------------------------|------------------------------------|--------------|---------------------|
| 63 | 100 | 0.001 | 0.001 | 0.02 | 0.28 |
| | 0 | 46.94 | 46.94 | 0.06 | 0.28 |
| 0 | 100 | 0.967 | 1.1 | 0.02 | 0.266 |
| | 0 | 96.51 | 96.37 | 0.06 | 0.266 |
| 3 | 100 | 1.411 | 0.65 | 0.02 | 0.37 |
| | 0 | 32.73 | 33.5 | 0.06 | 0.37 |
| 1 | 100 | 0.08 | 0.001 | 0.02 | 1.97 |
| | 0 | 44.38 | 44.47 | 0.06 | 1.97 |
| 2 | 100 | 0.24 | 1.01 | 0.02 | 2.5 |
| | 0 | 45.23 | 44.47 | 0.06 | 2.5 |
| 6 | 100 | 2.77 | 1.42 | 0.02 | 0.28 |
| | 0 | 52.02 | 53.39 | 0.06 | 0.28 |
| 62 | 100 | 2.1 | 1.23 | 0.02 | 0.34 |
| | 0 | 52.15 | 53.02 | 0.06 | 0.34 |
| 4 | 100 | 0.03 | 0.001 | 0.02 | 1.17 |
| | 0 | 56.93 | 56.97 | 0.06 | 1.17 |
| 5 | 100 | 0.529 | 1.3 | 0.02 | 2.59 |
| | 0 | 43.71 | 42.94 | 0.06 | 2.59 |
| 61 | 100 | 1.03 | 1.82 | 0.02 | 2.82 |
| | 0 | 73.12 | 72.34 | 0.06 | 2.82 |
| 9 | 100 | 1.06 | 1.72 | 0.02 | 1.1 |
| | 0 | 129 | 128.38 | 0.06 | 1.1 |
| 8 | 100 | 0.39 | 1.31 | 0.02 | 2.11 |
| | 0 | 43.39 | 42.47 | 0.06 | 2.11 |
| 13 | 100 | 0.918 | 0.71 | 0.02 | 2.41 |
| | 0 | 42.6 | 42.81 | 0.06 | 2.41 |
| 11 | 100 | 2.07 | 1.93 | 0.02 | 1.42 |
| | 0 | 68.09 | 68.24 | 0.06 | 1.42 |
| 10 | 100 | 3.9 | 5.02 | 0.02 | 0.21 |
| | 0 | 39.7 | 38.6 | 0.06 | 0.21 |
| 12 | 100 | 1.55 | 3.64 | 0.02 | 1.85 |
| | 0 | 42.4 | 40.33 | 0.06 | 1.85 |
| 15 | 100 | 7.91 | 7.62 | 0.02 | 1.18 |
| | 0 | 45.39 | 45.69 | 0.06 | 1.18 |
| 17 | 100 | 5.87 | 2.98 | 0.02 | 0.97 |
| | 0 | 12.73 | 15.63 | 0.04 | 0.97 |

| Sub-catchment Number | Percentage Impervious [%] | Existing Scenario Total Area [ha] | Developed Scenario Total Area [ha] | Mannings 'n' | Catchment Slope [%] |
|----------------------|---------------------------|-----------------------------------|------------------------------------|--------------|---------------------|
| 18 | 100 | 8.76 | 8.99 | 0.02 | 2.37 |
| | 0 | 39.4 | 39.19 | 0.04 | 2.37 |
| 23 | 100 | 12.25 | 14.91 | 0.02 | 0.57 |
| | 0 | 135.6 | 132.98 | 0.06 | 0.57 |
| 16 | 100 | 0.912 | 1.07 | 0.02 | 2.3 |
| | 0 | 43.13 | 42.98 | 0.06 | 2.3 |
| 14 | 100 | 2.6 | 1.76 | 0.02 | 1.18 |
| | 0 | 51.98 | 52.87 | 0.06 | 1.18 |
| 24 | 100 | 4.25 | 4.08 | 0.02 | 2.4 |
| | 0 | 55.9 | 56.11 | 0.06 | 2.4 |
| 25 | 100 | 3.778 | 3.9 | 0.02 | 1.56 |
| | 0 | 44.86 | 44.74 | 0.06 | 1.56 |
| 20 | 100 | 10.27 | 8.83 | 0.02 | 1.24 |
| | 0 | 100.99 | 102.44 | 0.06 | 1.24 |
| 19 | 100 | 2.4 | 1.54 | 0.02 | 1.74 |
| | 0 | 42.33 | 43.2 | 0.06 | 1.74 |
| 22 | 100 | 1.29 | 0.52 | 0.02 | 1.4 |
| | 0 | 42.22 | 43 | 0.06 | 1.4 |
| 27 | 100 | 3.58 | 6.95 | 0.02 | 1.47 |
| | 0 | 59.5 | 56.18 | 0.06 | 1.47 |
| 67 | 100 | 4.27 | 2.16 | 0.02 | 1.07 |
| | 0 | 70.4 | 72.55 | 0.06 | 1.07 |
| 34 | 100 | 15.38 | 71.01 | 0.02 | 1.55 |
| | 0 | 109.85 | 54.23 | 0.06 | 1.55 |
| 21 | 100 | 8.48 | 10.14 | 0.02 | 0.3 |
| | 0 | 99.15 | 97.5 | 0.06 | 0.3 |
| 29 | 100 | 6.19 | 4.95 | 0.02 | 1.1 |
| | 0 | 25.6 | 26.86 | 0.04 | 1.1 |
| 31 | 100 | 3.84 | 9.02 | 0.02 | 2.27 |
| | 0 | 66.77 | 61.59 | 0.06 | 2.27 |
| 41 | 100 | 2.05 | 2.34 | 0.02 | 1.09 |
| | 0 | 206 | 206.68 | 0.06 | 1.09 |
| 43 | 100 | 2.28 | 1.58 | 0.02 | 2.15 |
| | 0 | 47.49 | 48.2 | 0.06 | 2.15 |
| 48 | 100 | 2.19 | 0.72 | 0.02 | 2.64 |
| | 0 | 43.9 | 45.42 | 0.06 | 2.64 |
| 51 | 100 | 3.5 | 0.94 | 0.02 | 1.7 |
| | 0 | 46.94 | 49.51 | 0.06 | 1.7 |

| Sub-catchment Number | Percentage Impervious [%] | Existing Scenario Total Area [ha] | Developed Scenario Total Area [ha] | Mannings 'n' | Catchment Slope [%] |
|----------------------|---------------------------|-----------------------------------|------------------------------------|--------------|---------------------|
| 52 | 100 | 3.92 | 3.13 | 0.02 | 0.89 |
| | 0 | 155.2 | 155.99 | 0.06 | 0.89 |
| 65 | 100 | 4.12 | 8.11 | 0.02 | 0.62 |
| | 0 | 118.87 | 114.9 | 0.06 | 0.62 |
| 45 | 100 | 2.56 | 21.83 | 0.02 | 1.15 |
| | 0 | 101.5 | 82.27 | 0.06 | 1.15 |
| 38 | 100 | 3.3 | 1.38 | 0.02 | 0.5 |
| | 0 | 35.59 | 37.52 | 0.06 | 0.5 |
| 35 | 100 | 6.15 | 1.17 | 0.02 | 1.48 |
| | 0 | 9.07 | 14.06 | 0.06 | 1.48 |
| 36 | 100 | 2.32 | 1 | 0.02 | 3.03 |
| | 0 | 41.4 | 42.76 | 0.06 | 3.03 |
| 32 | 100 | 4.62 | 2.71 | 0.02 | 0.61 |
| | 0 | 34.34 | 36.26 | 0.06 | 0.61 |
| 47 | 100 | 4.33 | 16.45 | 0.02 | 1.16 |
| | 0 | 35.05 | 22.95 | 0.06 | 1.16 |
| 50 | 100 | 5.26 | 5.15 | 0.02 | 2.07 |
| | 0 | 38.39 | 38.51 | 0.06 | 2.07 |
| 64 | 100 | 3.09 | 2.23 | 0.02 | 0.79 |
| | 0 | 83.3 | 84.18 | 0.06 | 0.79 |
| 54 | 100 | 3.23 | 3.02 | 0.02 | 1.68 |
| | 0 | 29.4 | 29.63 | 0.06 | 1.68 |
| 58 | 100 | 9.35 | 8.8 | 0.02 | 1.63 |
| | 0 | 46.9 | 47.45 | 0.06 | 1.63 |
| 56 | 100 | 5.13 | 3.89 | 0.02 | 1.51 |
| | 0 | 38.4 | 39.66 | 0.06 | 1.51 |
| 59 | 100 | 42.32 | 41.11 | 0.02 | 1.2 |
| | 0 | 207.93 | 202.26 | 0.04 | 1.2 |
| 60 | 100 | 12.98 | 11.9 | 0.02 | 3.07 |
| | 0 | 35.47 | 45.37 | 0.04 | 3.07 |
| 57 | 100 | 8.88 | 8.18 | 0.02 | 1.1 |
| | 0 | 37.47 | 38.17 | 0.04 | 1.1 |
| 53 | 100 | 24.3 | 22.55 | 0.02 | 4.89 |
| | 0 | 79.56 | 81.33 | 0.04 | 4.89 |

| Sub-catchment Number | Percentage Impervious [%] | Existing Scenario Total Area [ha] | Developed Scenario Total Area [ha] | Mannings 'n' | Catchment Slope [%] |
|----------------------|---------------------------|-----------------------------------|------------------------------------|--------------|---------------------|
| 49 | 100 | 9.77 | 7.48 | 0.02 | 2.26 |
| | 0 | 30.65 | 32.95 | 0.04 | 2.26 |
| 44 | 100 | 11.4 | 31.34 | 0.02 | 2.26 |
| | 0 | 34.32 | 14.39 | 0.04 | 2.26 |
| 46 | 100 | 10.89 | 60.63 | 0.02 | 3.94 |
| | 0 | 78.18 | 28.46 | 0.06 | 3.94 |
| 42 | 100 | 2.01 | 46.29 | 0.02 | 2.92 |
| | 0 | 52.6 | 8.43 | 0.06 | 2.92 |
| 37 | 100 | 2.14 | 5.46 | 0.02 | 2.18 |
| | 0 | 22.34 | 19.03 | 0.06 | 2.18 |
| 40 | 100 | 20.45 | 40.35 | 0.02 | 1.78 |
| | 0 | 30.8 | 10.91 | 0.04 | 1.78 |
| 26 | 100 | 17.5 | 39.89 | 0.02 | 2.99 |
| | 0 | 30.06 | 7.68 | 0.04 | 2.99 |
| 33 | 100 | 2.46 | 26.06 | 0.02 | 0.92 |
| | 0 | 29.14 | 5.55 | 0.04 | 0.92 |
| 30 | 100 | 3.64 | 27.7 | 0.02 | 2.15 |
| | 0 | 43.7 | 19.74 | 0.04 | 2.15 |
| 55 | 100 | 10.88 | 8.92 | 0.02 | 2.9 |
| | 0 | 33.69 | 35.66 | 0.04 | 2.9 |
| 66 | 100 | 9.44 | 6.82 | 0.02 | 0.88 |
| | 0 | 28.79 | 31.42 | 0.04 | 0.88 |
| 7 | 100 | 1.716 | 1.42 | 0.02 | 0.307 |
| | 0 | 49.5 | 49.81 | 0.06 | 0.307 |
| outlet | 0 | 0.001 | 0.001 | 0.025 | 0.001 |
| | 0 | 0.001 | 0.001 | 0.06 | 0.001 |
| 39 | 100 | 4.93 | 10.08 | 0.02 | 1.4 |
| | 0 | 58.47 | 53.33 | 0.06 | 1.4 |

10.2 APPENDIX B RAINFALL TEMPORAL PATTERN DATA (JANUARY 2011)

| | Toowoomba Alert | Cooby Dam Pluviograph |
|-----------------|-----------------|-----------------------|
| 9/01/2011 9:00 | 0.0 | 0.0 |
| 9/01/2011 9:05 | 0.0 | 0.0 |
| 9/01/2011 9:10 | 0.0 | 0.0 |
| 9/01/2011 9:15 | 0.0 | 0.0 |
| 9/01/2011 9:20 | 0.0 | 0.0 |
| 9/01/2011 9:25 | 0.0 | 0.0 |
| 9/01/2011 9:30 | 0.0 | 0.0 |
| 9/01/2011 9:35 | 0.0 | 0.0 |
| 9/01/2011 9:40 | 0.0 | 0.0 |
| 9/01/2011 9:45 | 0.0 | 0.0 |
| 9/01/2011 9:50 | 0.0 | 0.0 |
| 9/01/2011 9:55 | 0.0 | 0.0 |
| 9/01/2011 10:00 | 0.0 | 0.0 |
| 9/01/2011 10:05 | 0.0 | 0.0 |
| 9/01/2011 10:10 | 0.0 | 0.0 |
| 9/01/2011 10:15 | 0.0 | 0.0 |
| 9/01/2011 10:20 | 0.0 | 0.0 |
| 9/01/2011 10:25 | 0.0 | 0.0 |
| 9/01/2011 10:30 | 0.0 | 0.0 |
| 9/01/2011 10:35 | 0.0 | 0.0 |
| 9/01/2011 10:40 | 1.0 | 0.0 |
| 9/01/2011 10:45 | 0.0 | 0.0 |
| 9/01/2011 10:50 | 0.0 | 0.0 |
| 9/01/2011 10:55 | 0.0 | 0.0 |
| 9/01/2011 11:00 | 0.0 | 0.0 |
| 9/01/2011 11:05 | 0.0 | 0.5 |
| 9/01/2011 11:10 | 0.0 | 0.0 |
| 9/01/2011 11:15 | 0.0 | 0.0 |
| 9/01/2011 11:20 | 0.0 | 0.0 |
| 9/01/2011 11:25 | 0.0 | 0.0 |
| 9/01/2011 11:30 | 0.0 | 0.0 |
| 9/01/2011 11:35 | 0.0 | 0.0 |
| 9/01/2011 11:40 | 0.0 | 0.5 |
| 9/01/2011 11:45 | 0.0 | 0.5 |
| 9/01/2011 11:50 | 0.0 | 1.0 |
| 9/01/2011 11:55 | 1.0 | 0.5 |
| 9/01/2011 12:00 | 1.0 | 0.5 |
| 9/01/2011 12:05 | 1.0 | 0.0 |
| 9/01/2011 12:10 | 1.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|-----------------|--------------------|--------------------------|
| 9/01/2011 12:15 | 1.0 | 0.0 |
| 9/01/2011 12:20 | 0.0 | 1.5 |
| 9/01/2011 12:25 | 1.0 | 1.5 |
| 9/01/2011 12:30 | 0.0 | 3.0 |
| 9/01/2011 12:35 | 1.0 | 1.5 |
| 9/01/2011 12:40 | 1.0 | 1.0 |
| 9/01/2011 12:45 | 2.0 | 1.0 |
| 9/01/2011 12:50 | 3.0 | 0.5 |
| 9/01/2011 12:55 | 0.0 | 0.5 |
| 9/01/2011 13:00 | 0.0 | 0.5 |
| 9/01/2011 13:05 | 0.0 | 0.5 |
| 9/01/2011 13:10 | 0.0 | 0.5 |
| 9/01/2011 13:15 | 0.0 | 0.0 |
| 9/01/2011 13:20 | 0.0 | 0.0 |
| 9/01/2011 13:25 | 0.0 | 0.5 |
| 9/01/2011 13:30 | 1.0 | 0.0 |
| 9/01/2011 13:35 | 1.0 | 0.0 |
| 9/01/2011 13:40 | 0.0 | 1.0 |
| 9/01/2011 13:45 | 1.0 | 0.5 |
| 9/01/2011 13:50 | 0.0 | 0.5 |
| 9/01/2011 13:55 | 0.0 | 0.5 |
| 9/01/2011 14:00 | 0.0 | 1.0 |
| 9/01/2011 14:05 | 0.0 | 3.5 |
| 9/01/2011 14:10 | 1.0 | 0.5 |
| 9/01/2011 14:15 | 0.0 | 3.5 |
| 9/01/2011 14:20 | 0.0 | 1.0 |
| 9/01/2011 14:25 | 0.0 | 0.0 |
| 9/01/2011 14:30 | 1.0 | 0.0 |
| 9/01/2011 14:35 | 0.0 | 0.0 |
| 9/01/2011 14:40 | 0.0 | 0.5 |
| 9/01/2011 14:45 | 0.0 | 2.0 |
| 9/01/2011 14:50 | 0.0 | 2.0 |
| 9/01/2011 14:55 | 0.0 | 0.0 |
| 9/01/2011 15:00 | 0.0 | 0.0 |
| 9/01/2011 15:05 | 0.0 | 0.0 |
| 9/01/2011 15:10 | 0.0 | 0.5 |
| 9/01/2011 15:15 | 0.0 | 0.5 |
| 9/01/2011 15:20 | 0.0 | 0.5 |
| 9/01/2011 15:25 | 0.0 | 0.5 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|-----------------|--------------------|--------------------------|
| 9/01/2011 15:30 | 0.0 | 0.0 |
| 9/01/2011 15:35 | 0.0 | 0.5 |
| 9/01/2011 15:40 | 0.0 | 0.0 |
| 9/01/2011 15:45 | 1.0 | 0.5 |
| 9/01/2011 15:50 | 1.0 | 0.5 |
| 9/01/2011 15:55 | 0.0 | 0.5 |
| 9/01/2011 16:00 | 0.0 | 1.0 |
| 9/01/2011 16:05 | 2.0 | 1.0 |
| 9/01/2011 16:10 | 1.0 | 0.5 |
| 9/01/2011 16:15 | 3.0 | 0.0 |
| 9/01/2011 16:20 | 2.0 | 1.0 |
| 9/01/2011 16:25 | 2.0 | 2.0 |
| 9/01/2011 16:30 | 2.0 | 1.5 |
| 9/01/2011 16:35 | 2.0 | 2.5 |
| 9/01/2011 16:40 | 1.0 | 1.5 |
| 9/01/2011 16:45 | 0.0 | 1.5 |
| 9/01/2011 16:50 | 1.0 | 2.5 |
| 9/01/2011 16:55 | 0.0 | 2.0 |
| 9/01/2011 17:00 | 1.0 | 1.5 |
| 9/01/2011 17:05 | 0.0 | 2.0 |
| 9/01/2011 17:10 | 1.0 | 1.0 |
| 9/01/2011 17:15 | 0.0 | 0.5 |
| 9/01/2011 17:20 | 0.0 | 0.5 |
| 9/01/2011 17:25 | 1.0 | 0.5 |
| 9/01/2011 17:30 | 1.0 | 0.0 |
| 9/01/2011 17:35 | 1.0 | 0.5 |
| 9/01/2011 17:40 | 0.0 | 0.5 |
| 9/01/2011 17:45 | 1.0 | 0.5 |
| 9/01/2011 17:50 | 0.0 | 0.5 |
| 9/01/2011 17:55 | 1.0 | 0.0 |
| 9/01/2011 18:00 | 1.0 | 0.0 |
| 9/01/2011 18:05 | 0.0 | 0.0 |
| 9/01/2011 18:10 | 0.0 | 0.5 |
| 9/01/2011 18:15 | 0.0 | 0.0 |
| 9/01/2011 18:20 | 1.0 | 0.0 |
| 9/01/2011 18:25 | 0.0 | 0.5 |
| 9/01/2011 18:30 | 0.0 | 0.0 |
| 9/01/2011 18:35 | 0.0 | 0.5 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|-----------------|--------------------|--------------------------|
| 9/01/2011 18:40 | 1.0 | 0.0 |
| 9/01/2011 18:45 | 0.0 | 0.5 |
| 9/01/2011 18:50 | 1.0 | 0.0 |
| 9/01/2011 18:55 | 1.0 | 0.5 |
| 9/01/2011 19:00 | 1.0 | 0.5 |
| 9/01/2011 19:05 | 2.0 | 0.0 |
| 9/01/2011 19:10 | 0.0 | 0.0 |
| 9/01/2011 19:15 | 0.0 | 0.5 |
| 9/01/2011 19:20 | 0.0 | 0.0 |
| 9/01/2011 19:25 | 0.0 | 0.0 |
| 9/01/2011 19:30 | 0.0 | 0.0 |
| 9/01/2011 19:35 | 0.0 | 0.0 |
| 9/01/2011 19:40 | 0.0 | 0.5 |
| 9/01/2011 19:45 | 1.0 | 0.0 |
| 9/01/2011 19:50 | 0.0 | 0.0 |
| 9/01/2011 19:55 | 0.0 | 0.5 |
| 9/01/2011 20:00 | 0.0 | 0.0 |
| 9/01/2011 20:05 | 0.0 | 0.0 |
| 9/01/2011 20:10 | 0.0 | 1.5 |
| 9/01/2011 20:15 | 1.0 | 0.5 |
| 9/01/2011 20:20 | 0.0 | 1.0 |
| 9/01/2011 20:25 | 0.0 | 0.5 |
| 9/01/2011 20:30 | 1.0 | 0.5 |
| 9/01/2011 20:35 | 0.0 | 1.0 |
| 9/01/2011 20:40 | 1.0 | 1.0 |
| 9/01/2011 20:45 | 0.0 | 1.0 |
| 9/01/2011 20:50 | 1.0 | 0.5 |
| 9/01/2011 20:55 | 0.0 | 1.0 |
| 9/01/2011 21:00 | 1.0 | 1.0 |
| 9/01/2011 21:05 | 0.0 | 0.0 |
| 9/01/2011 21:10 | 0.0 | 0.5 |
| 9/01/2011 21:15 | 1.0 | 0.5 |
| 9/01/2011 21:20 | 2.0 | 0.0 |
| 9/01/2011 21:25 | 0.0 | 0.0 |
| 9/01/2011 21:30 | 1.0 | 0.5 |
| 9/01/2011 21:35 | 1.0 | 0.0 |
| 9/01/2011 21:40 | 1.0 | 0.0 |
| 9/01/2011 21:45 | 1.0 | 0.5 |
| 9/01/2011 21:50 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|-----------------|--------------------|--------------------------|
| 9/01/2011 21:55 | 1.0 | 0.0 |
| 9/01/2011 22:00 | 0.0 | 0.5 |
| 9/01/2011 22:05 | 0.0 | 0.0 |
| 9/01/2011 22:10 | 0.0 | 0.0 |
| 9/01/2011 22:15 | 1.0 | 0.0 |
| 9/01/2011 22:20 | 0.0 | 0.0 |
| 9/01/2011 22:25 | 0.0 | 0.0 |
| 9/01/2011 22:30 | 0.0 | 0.0 |
| 9/01/2011 22:35 | 0.0 | 0.5 |
| 9/01/2011 22:40 | 0.0 | 0.0 |
| 9/01/2011 22:45 | 0.0 | 0.5 |
| 9/01/2011 22:50 | 0.0 | 1.5 |
| 9/01/2011 22:55 | 0.0 | 1.0 |
| 9/01/2011 23:00 | 0.0 | 1.0 |
| 9/01/2011 23:05 | 0.0 | 1.0 |
| 9/01/2011 23:10 | 0.0 | 0.5 |
| 9/01/2011 23:15 | 0.0 | 1.0 |
| 9/01/2011 23:20 | 0.0 | 1.5 |
| 9/01/2011 23:25 | 0.0 | 0.5 |
| 9/01/2011 23:30 | 1.0 | 0.0 |
| 9/01/2011 23:35 | 0.0 | 0.5 |
| 9/01/2011 23:40 | 0.0 | 1.5 |
| 9/01/2011 23:45 | 0.0 | 0.5 |
| 9/01/2011 23:50 | 0.0 | 0.0 |
| 9/01/2011 23:55 | 0.0 | 0.5 |
| 10/01/2011 0:00 | 0.0 | 0.0 |
| 10/01/2011 0:05 | 0.0 | 0.0 |
| 10/01/2011 0:10 | 0.0 | 0.0 |
| 10/01/2011 0:15 | 0.0 | 0.5 |
| 10/01/2011 0:20 | 0.0 | 0.0 |
| 10/01/2011 0:25 | 0.0 | 0.0 |
| 10/01/2011 0:30 | 0.0 | 0.0 |
| 10/01/2011 0:35 | 0.0 | 0.0 |
| 10/01/2011 0:40 | 0.0 | 0.0 |
| 10/01/2011 0:45 | 0.0 | 0.0 |
| 10/01/2011 0:50 | 0.0 | 0.0 |
| 10/01/2011 0:55 | 0.0 | 0.0 |
| 10/01/2011 1:00 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|-----------------|--------------------|--------------------------|
| 10/01/2011 1:05 | 0.0 | 0.0 |
| 10/01/2011 1:10 | 0.0 | 0.0 |
| 10/01/2011 1:15 | 0.0 | 0.0 |
| 10/01/2011 1:20 | 0.0 | 0.0 |
| 10/01/2011 1:25 | 0.0 | 0.0 |
| 10/01/2011 1:30 | 0.0 | 0.0 |
| 10/01/2011 1:35 | 0.0 | 0.0 |
| 10/01/2011 1:40 | 0.0 | 0.0 |
| 10/01/2011 1:45 | 0.0 | 0.0 |
| 10/01/2011 1:50 | 0.0 | 0.0 |
| 10/01/2011 1:55 | 0.0 | 0.0 |
| 10/01/2011 2:00 | 0.0 | 0.0 |
| 10/01/2011 2:05 | 0.0 | 0.0 |
| 10/01/2011 2:10 | 0.0 | 0.0 |
| 10/01/2011 2:15 | 0.0 | 0.0 |
| 10/01/2011 2:20 | 0.0 | 0.0 |
| 10/01/2011 2:25 | 0.0 | 0.0 |
| 10/01/2011 2:30 | 0.0 | 0.0 |
| 10/01/2011 2:35 | 0.0 | 0.0 |
| 10/01/2011 2:40 | 0.0 | 0.0 |
| 10/01/2011 2:45 | 1.0 | 0.0 |
| 10/01/2011 2:50 | 0.0 | 0.0 |
| 10/01/2011 2:55 | 0.0 | 0.0 |
| 10/01/2011 3:00 | 0.0 | 0.0 |
| 10/01/2011 3:05 | 0.0 | 0.0 |
| 10/01/2011 3:10 | 0.0 | 0.0 |
| 10/01/2011 3:15 | 0.0 | 0.0 |
| 10/01/2011 3:20 | 0.0 | 0.0 |
| 10/01/2011 3:25 | 0.0 | 0.0 |
| 10/01/2011 3:30 | 0.0 | 0.0 |
| 10/01/2011 3:35 | 0.0 | 0.0 |
| 10/01/2011 3:40 | 0.0 | 0.0 |
| 10/01/2011 3:45 | 0.0 | 0.0 |
| 10/01/2011 3:50 | 0.0 | 0.0 |
| 10/01/2011 3:55 | 0.0 | 0.0 |
| 10/01/2011 4:00 | 0.0 | 0.0 |
| 10/01/2011 4:05 | 0.0 | 0.0 |
| 10/01/2011 4:10 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|-----------------|--------------------|--------------------------|
| 10/01/2011 4:15 | 0.0 | 0.0 |
| 10/01/2011 4:20 | 0.0 | 0.0 |
| 10/01/2011 4:25 | 0.0 | 0.0 |
| 10/01/2011 4:30 | 0.0 | 0.0 |
| 10/01/2011 4:35 | 0.0 | 0.5 |
| 10/01/2011 4:40 | 0.0 | 0.5 |
| 10/01/2011 4:45 | 0.0 | 0.0 |
| 10/01/2011 4:50 | 0.0 | 0.5 |
| 10/01/2011 4:55 | 0.0 | 0.0 |
| 10/01/2011 5:00 | 0.0 | 0.5 |
| 10/01/2011 5:05 | 0.0 | 0.0 |
| 10/01/2011 5:10 | 0.0 | 0.0 |
| 10/01/2011 5:15 | 0.0 | 0.5 |
| 10/01/2011 5:20 | 0.0 | 0.0 |
| 10/01/2011 5:25 | 0.0 | 0.0 |
| 10/01/2011 5:30 | 1.0 | 0.5 |
| 10/01/2011 5:35 | 0.0 | 0.0 |
| 10/01/2011 5:40 | 1.0 | 0.0 |
| 10/01/2011 5:45 | 1.0 | 0.0 |
| 10/01/2011 5:50 | 0.0 | 0.0 |
| 10/01/2011 5:55 | 0.0 | 0.5 |
| 10/01/2011 6:00 | 0.0 | 0.0 |
| 10/01/2011 6:05 | 1.0 | 0.5 |
| 10/01/2011 6:10 | 0.0 | 0.0 |
| 10/01/2011 6:15 | 0.0 | 0.5 |
| 10/01/2011 6:20 | 1.0 | 0.0 |
| 10/01/2011 6:25 | 0.0 | 0.5 |
| 10/01/2011 6:30 | 0.0 | 0.0 |
| 10/01/2011 6:35 | 0.0 | 0.0 |
| 10/01/2011 6:40 | 0.0 | 0.0 |
| 10/01/2011 6:45 | 1.0 | 0.0 |
| 10/01/2011 6:50 | 0.0 | 0.0 |
| 10/01/2011 6:55 | 0.0 | 0.0 |
| 10/01/2011 7:00 | 0.0 | 0.0 |
| 10/01/2011 7:05 | 0.0 | 0.0 |
| 10/01/2011 7:10 | 0.0 | 0.0 |
| 10/01/2011 7:15 | 0.0 | 0.0 |
| 10/01/2011 7:20 | 1.0 | 0.0 |
| 10/01/2011 7:25 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|------------------|--------------------|--------------------------|
| 10/01/2011 7:30 | 0.0 | 0.0 |
| 10/01/2011 7:35 | 0.0 | 0.0 |
| 10/01/2011 7:40 | 0.0 | 0.0 |
| 10/01/2011 7:45 | 0.0 | 0.0 |
| 10/01/2011 7:50 | 0.0 | 0.0 |
| 10/01/2011 7:55 | 0.0 | 0.0 |
| 10/01/2011 8:00 | 0.0 | 0.0 |
| 10/01/2011 8:05 | 0.0 | 0.0 |
| 10/01/2011 8:10 | 0.0 | 0.0 |
| 10/01/2011 8:15 | 0.0 | 0.0 |
| 10/01/2011 8:20 | 0.0 | 0.0 |
| 10/01/2011 8:25 | 0.0 | 0.5 |
| 10/01/2011 8:30 | 1.0 | 0.0 |
| 10/01/2011 8:35 | 0.0 | 0.5 |
| 10/01/2011 8:40 | 1.0 | 0.0 |
| 10/01/2011 8:45 | 0.0 | 0.5 |
| 10/01/2011 8:50 | 0.0 | 0.5 |
| 10/01/2011 8:55 | 0.0 | 0.0 |
| 10/01/2011 9:00 | 1.0 | 0.0 |
| 10/01/2011 9:05 | 0.0 | 0.0 |
| 10/01/2011 9:10 | 0.0 | 0.5 |
| 10/01/2011 9:15 | 1.0 | 1.0 |
| 10/01/2011 9:20 | 0.0 | 0.5 |
| 10/01/2011 9:25 | 0.0 | 0.0 |
| 10/01/2011 9:30 | 0.0 | 0.0 |
| 10/01/2011 9:35 | 0.0 | 0.0 |
| 10/01/2011 9:40 | 0.0 | 0.0 |
| 10/01/2011 9:45 | 0.0 | 0.0 |
| 10/01/2011 9:50 | 0.0 | 0.0 |
| 10/01/2011 9:55 | 1.0 | 0.0 |
| 10/01/2011 10:00 | 0.0 | 0.0 |
| 10/01/2011 10:05 | 0.0 | 0.0 |
| 10/01/2011 10:10 | 0.0 | 0.0 |
| 10/01/2011 10:15 | 0.0 | 0.0 |
| 10/01/2011 10:20 | 0.0 | 0.0 |
| 10/01/2011 10:25 | 0.0 | 0.0 |
| 10/01/2011 10:30 | 0.0 | 0.0 |
| 10/01/2011 10:35 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|------------------|--------------------|--------------------------|
| 10/01/2011 10:40 | 0.0 | 0.0 |
| 10/01/2011 10:45 | 0.0 | 0.0 |
| 10/01/2011 10:50 | 0.0 | 0.5 |
| 10/01/2011 10:55 | 0.0 | 0.0 |
| 10/01/2011 11:00 | 0.0 | 0.0 |
| 10/01/2011 11:05 | 0.0 | 0.0 |
| 10/01/2011 11:10 | 0.0 | 0.0 |
| 10/01/2011 11:15 | 1.0 | 0.0 |
| 10/01/2011 11:20 | 0.0 | 0.0 |
| 10/01/2011 11:25 | 0.0 | 0.0 |
| 10/01/2011 11:30 | 0.0 | 0.0 |
| 10/01/2011 11:35 | 0.0 | 0.0 |
| 10/01/2011 11:40 | 0.0 | 0.0 |
| 10/01/2011 11:45 | 0.0 | 0.0 |
| 10/01/2011 11:50 | 0.0 | 0.0 |
| 10/01/2011 11:55 | 0.0 | 0.5 |
| 10/01/2011 12:00 | 1.0 | 0.0 |
| 10/01/2011 12:05 | 0.0 | 0.0 |
| 10/01/2011 12:10 | 0.0 | 0.5 |
| 10/01/2011 12:15 | 0.0 | 0.0 |
| 10/01/2011 12:20 | 0.0 | 0.0 |
| 10/01/2011 12:25 | 1.0 | 0.5 |
| 10/01/2011 12:30 | 0.0 | 0.5 |
| 10/01/2011 12:35 | 0.0 | 0.5 |
| 10/01/2011 12:40 | 1.0 | 1.5 |
| 10/01/2011 12:45 | 1.0 | 3.0 |
| 10/01/2011 12:50 | 3.0 | 2.0 |
| 10/01/2011 12:55 | 3.0 | 1.5 |
| 10/01/2011 13:00 | 4.0 | 5.0 |
| 10/01/2011 13:05 | 5.0 | 5.5 |
| 10/01/2011 13:10 | 3.0 | 2.0 |
| 10/01/2011 13:15 | 4.0 | 2.0 |
| 10/01/2011 13:20 | 4.0 | 0.5 |
| 10/01/2011 13:25 | 6.0 | 1.0 |
| 10/01/2011 13:30 | 7.0 | 0.0 |
| 10/01/2011 13:35 | 5.0 | 0.5 |
| 10/01/2011 13:40 | 9.0 | 0.0 |
| 10/01/2011 13:45 | 6.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|------------------|--------------------|--------------------------|
| 10/01/2011 13:50 | 2.0 | 0.0 |
| 10/01/2011 13:55 | 0.0 | 0.0 |
| 10/01/2011 14:00 | 1.0 | 0.0 |
| 10/01/2011 14:05 | 0.0 | 0.0 |
| 10/01/2011 14:10 | 0.0 | 0.0 |
| 10/01/2011 14:15 | 1.0 | 0.0 |
| 10/01/2011 14:20 | 0.0 | 0.0 |
| 10/01/2011 14:25 | 0.0 | 0.0 |
| 10/01/2011 14:30 | 0.0 | 0.0 |
| 10/01/2011 14:35 | 0.0 | 0.0 |
| 10/01/2011 14:40 | 0.0 | 0.0 |
| 10/01/2011 14:45 | 0.0 | 0.0 |
| 10/01/2011 14:50 | 0.0 | 0.0 |
| 10/01/2011 14:55 | 0.0 | 0.5 |
| 10/01/2011 15:00 | 0.0 | 0.0 |
| 10/01/2011 15:05 | 1.0 | 0.5 |
| 10/01/2011 15:10 | 0.0 | 0.0 |
| 10/01/2011 15:15 | 1.0 | 0.0 |
| 10/01/2011 15:20 | 0.0 | 1.5 |
| 10/01/2011 15:25 | 0.0 | 1.0 |
| 10/01/2011 15:30 | 1.0 | 0.5 |
| 10/01/2011 15:35 | 0.0 | 0.5 |
| 10/01/2011 15:40 | 0.0 | 1.0 |
| 10/01/2011 15:45 | 1.0 | 0.5 |
| 10/01/2011 15:50 | 3.0 | 0.5 |
| 10/01/2011 15:55 | 1.0 | 0.0 |
| 10/01/2011 16:00 | 0.0 | 0.0 |
| 10/01/2011 16:05 | 0.0 | 0.0 |
| 10/01/2011 16:10 | 0.0 | 0.0 |
| 10/01/2011 16:15 | 0.0 | 0.0 |
| 10/01/2011 16:20 | 0.0 | 0.0 |
| 10/01/2011 16:25 | 0.0 | 0.0 |
| 10/01/2011 16:30 | 0.0 | 0.5 |
| 10/01/2011 16:35 | 0.0 | 0.0 |
| 10/01/2011 16:40 | 0.0 | 0.0 |
| 10/01/2011 16:45 | 0.0 | 0.0 |
| 10/01/2011 16:50 | 1.0 | 0.0 |
| 10/01/2011 16:55 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|------------------|--------------------|--------------------------|
| 10/01/2011 17:00 | 0.0 | 0.0 |
| 10/01/2011 17:05 | 0.0 | 0.0 |
| 10/01/2011 17:10 | 0.0 | 0.0 |
| 10/01/2011 17:15 | 0.0 | 0.0 |
| 10/01/2011 17:20 | 0.0 | 0.0 |
| 10/01/2011 17:25 | 0.0 | 0.0 |
| 10/01/2011 17:30 | 0.0 | 0.0 |
| 10/01/2011 17:35 | 0.0 | 0.0 |
| 10/01/2011 17:40 | 0.0 | 0.0 |
| 10/01/2011 17:45 | 0.0 | 0.0 |
| 10/01/2011 17:50 | 0.0 | 0.0 |
| 10/01/2011 17:55 | 0.0 | 0.0 |
| 10/01/2011 18:00 | 0.0 | 0.0 |
| 10/01/2011 18:05 | 0.0 | 0.0 |
| 10/01/2011 18:10 | 0.0 | 0.0 |
| 10/01/2011 18:15 | 0.0 | 0.0 |
| 10/01/2011 18:20 | 0.0 | 0.0 |
| 10/01/2011 18:25 | 0.0 | 0.0 |
| 10/01/2011 18:30 | 0.0 | 0.0 |
| 10/01/2011 18:35 | 0.0 | 0.0 |
| 10/01/2011 18:40 | 0.0 | 0.0 |
| 10/01/2011 18:45 | 0.0 | 0.0 |
| 10/01/2011 18:50 | 0.0 | 0.0 |
| 10/01/2011 18:55 | 0.0 | 0.0 |
| 10/01/2011 19:00 | 0.0 | 0.0 |
| 10/01/2011 19:05 | 0.0 | 0.0 |
| 10/01/2011 19:10 | 0.0 | 0.0 |
| 10/01/2011 19:15 | 0.0 | 0.0 |
| 10/01/2011 19:20 | 0.0 | 0.0 |
| 10/01/2011 19:25 | 0.0 | 0.0 |
| 10/01/2011 19:30 | 0.0 | 0.0 |
| 10/01/2011 19:35 | 0.0 | 0.0 |
| 10/01/2011 19:40 | 0.0 | 0.0 |
| 10/01/2011 19:45 | 0.0 | 0.0 |
| 10/01/2011 19:50 | 0.0 | 0.0 |
| 10/01/2011 19:55 | 0.0 | 0.0 |
| 10/01/2011 20:00 | 0.0 | 0.0 |
| 10/01/2011 20:05 | 0.0 | 0.0 |
| 10/01/2011 20:10 | 0.0 | 0.0 |
| 10/01/2011 20:15 | 1.0 | 0.5 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|------------------|--------------------|--------------------------|
| 10/01/2011 20:20 | 0.0 | 0.5 |
| 10/01/2011 20:25 | 0.0 | 1.0 |
| 10/01/2011 20:30 | 0.0 | 0.5 |
| 10/01/2011 20:35 | 0.0 | 0.5 |
| 10/01/2011 20:40 | 0.0 | 0.0 |
| 10/01/2011 20:45 | 0.0 | 0.5 |
| 10/01/2011 20:50 | 0.0 | 0.5 |
| 10/01/2011 20:55 | 0.0 | 0.0 |
| 10/01/2011 21:00 | 0.0 | 1.0 |
| 10/01/2011 21:05 | 0.0 | 0.5 |
| 10/01/2011 21:10 | 1.0 | 0.0 |
| 10/01/2011 21:15 | 0.0 | 0.0 |
| 10/01/2011 21:20 | 0.0 | 0.0 |
| 10/01/2011 21:25 | 0.0 | 0.0 |
| 10/01/2011 21:30 | 0.0 | 0.0 |
| 10/01/2011 21:35 | 2.0 | 0.0 |
| 10/01/2011 21:40 | 0.0 | 0.0 |
| 10/01/2011 21:45 | 0.0 | 0.0 |
| 10/01/2011 21:50 | 0.0 | 0.0 |
| 10/01/2011 21:55 | 0.0 | 0.0 |
| 10/01/2011 22:00 | 0.0 | 0.0 |
| 10/01/2011 22:05 | 0.0 | 0.0 |
| 10/01/2011 22:10 | 0.0 | 0.0 |
| 10/01/2011 22:15 | 0.0 | 0.0 |
| 10/01/2011 22:20 | 0.0 | 0.0 |
| 10/01/2011 22:25 | 0.0 | 0.5 |
| 10/01/2011 22:30 | 0.0 | 0.0 |
| 10/01/2011 22:35 | 0.0 | 0.0 |
| 10/01/2011 22:40 | 0.0 | 0.0 |
| 10/01/2011 22:45 | 0.0 | 0.0 |
| 10/01/2011 22:50 | 0.0 | 0.0 |
| 10/01/2011 22:55 | 0.0 | 0.0 |
| 10/01/2011 23:00 | 0.0 | 0.0 |
| 10/01/2011 23:05 | 0.0 | 0.5 |
| 10/01/2011 23:10 | 0.0 | 0.0 |
| 10/01/2011 23:15 | 0.0 | 0.0 |
| 10/01/2011 23:20 | 0.0 | 0.5 |
| 10/01/2011 23:25 | 1.0 | 0.0 |
| 10/01/2011 23:30 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|------------------|--------------------|--------------------------|
| 10/01/2011 23:35 | 0.0 | 0.5 |
| 10/01/2011 23:40 | 1.0 | 0.5 |
| 10/01/2011 23:45 | 0.0 | 0.0 |
| 10/01/2011 23:50 | 1.0 | 0.5 |
| 10/01/2011 23:55 | 0.0 | 0.0 |
| 11/01/2011 0:00 | 0.0 | 0.5 |
| 11/01/2011 0:05 | 0.0 | 0.0 |
| 11/01/2011 0:10 | 0.0 | 0.0 |
| 11/01/2011 0:15 | 1.0 | 0.0 |
| 11/01/2011 0:20 | 0.0 | 0.0 |
| 11/01/2011 0:25 | 0.0 | 0.0 |
| 11/01/2011 0:30 | 0.0 | 0.0 |
| 11/01/2011 0:35 | 0.0 | 0.0 |
| 11/01/2011 0:40 | 0.0 | 0.0 |
| 11/01/2011 0:45 | 0.0 | 0.0 |
| 11/01/2011 0:50 | 0.0 | 0.0 |
| 11/01/2011 0:55 | 0.0 | 0.0 |
| 11/01/2011 1:00 | 0.0 | 0.0 |
| 11/01/2011 1:05 | 0.0 | 0.0 |
| 11/01/2011 1:10 | 0.0 | 0.0 |
| 11/01/2011 1:15 | 0.0 | 0.0 |
| 11/01/2011 1:20 | 0.0 | 0.0 |
| 11/01/2011 1:25 | 0.0 | 0.0 |
| 11/01/2011 1:30 | 0.0 | 0.0 |
| 11/01/2011 1:35 | 0.0 | 0.5 |
| 11/01/2011 1:40 | 0.0 | 2.0 |
| 11/01/2011 1:45 | 0.0 | 1.0 |
| 11/01/2011 1:50 | 0.0 | 1.5 |
| 11/01/2011 1:55 | 0.0 | 2.5 |
| 11/01/2011 2:00 | 0.0 | 6.0 |
| 11/01/2011 2:05 | 0.0 | 5.0 |
| 11/01/2011 2:10 | 0.0 | 4.0 |
| 11/01/2011 2:15 | 0.0 | 5.5 |
| 11/01/2011 2:20 | 0.0 | 3.0 |
| 11/01/2011 2:25 | 1.0 | 3.5 |
| 11/01/2011 2:30 | 0.0 | 4.5 |
| 11/01/2011 2:35 | 0.0 | 2.0 |
| 11/01/2011 2:40 | 0.0 | 0.5 |
| 11/01/2011 2:45 | 0.0 | 0.0 |
| 11/01/2011 2:50 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|-----------------|--------------------|--------------------------|
| 11/01/2011 2:55 | 0.0 | 0.0 |
| 11/01/2011 3:00 | 0.0 | 0.0 |
| 11/01/2011 3:05 | 0.0 | 0.0 |
| 11/01/2011 3:10 | 0.0 | 0.0 |
| 11/01/2011 3:15 | 0.0 | 0.0 |
| 11/01/2011 3:20 | 0.0 | 0.0 |
| 11/01/2011 3:25 | 0.0 | 0.0 |
| 11/01/2011 3:30 | 0.0 | 0.0 |
| 11/01/2011 3:35 | 0.0 | 2.5 |
| 11/01/2011 3:40 | 0.0 | 2.5 |
| 11/01/2011 3:45 | 0.0 | 1.0 |
| 11/01/2011 3:50 | 0.0 | 0.5 |
| 11/01/2011 3:55 | 0.0 | 1.0 |
| 11/01/2011 4:00 | 0.0 | 0.5 |
| 11/01/2011 4:05 | 0.0 | 0.0 |
| 11/01/2011 4:10 | 0.0 | 0.0 |
| 11/01/2011 4:15 | 0.0 | 0.0 |
| 11/01/2011 4:20 | 0.0 | 0.0 |
| 11/01/2011 4:25 | 1.0 | 0.0 |
| 11/01/2011 4:30 | 0.0 | 0.0 |
| 11/01/2011 4:35 | 0.0 | 0.0 |
| 11/01/2011 4:40 | 0.0 | 4.0 |
| 11/01/2011 4:45 | 0.0 | 7.0 |
| 11/01/2011 4:50 | 1.0 | 6.5 |
| 11/01/2011 4:55 | 2.0 | 2.5 |
| 11/01/2011 5:00 | 2.0 | 3.0 |
| 11/01/2011 5:05 | 5.0 | 4.5 |
| 11/01/2011 5:10 | 1.0 | 0.5 |
| 11/01/2011 5:15 | 3.0 | 0.5 |
| 11/01/2011 5:20 | 3.0 | 0.0 |
| 11/01/2011 5:25 | 3.0 | 0.0 |
| 11/01/2011 5:30 | 0.0 | 0.5 |
| 11/01/2011 5:35 | 2.0 | 0.0 |
| 11/01/2011 5:40 | 2.0 | 0.0 |
| 11/01/2011 5:45 | 1.0 | 0.0 |
| 11/01/2011 5:50 | 0.0 | 0.0 |
| 11/01/2011 5:55 | 0.0 | 0.0 |
| 11/01/2011 6:00 | 1.0 | 0.0 |
| 11/01/2011 6:05 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|-----------------|--------------------|--------------------------|
| 11/01/2011 6:10 | 0.0 | 0.0 |
| 11/01/2011 6:15 | 0.0 | 0.0 |
| 11/01/2011 6:20 | 0.0 | 0.0 |
| 11/01/2011 6:25 | 0.0 | 0.0 |
| 11/01/2011 6:30 | 0.0 | 0.0 |
| 11/01/2011 6:35 | 0.0 | 0.0 |
| 11/01/2011 6:40 | 0.0 | 0.0 |
| 11/01/2011 6:45 | 0.0 | 0.0 |
| 11/01/2011 6:50 | 0.0 | 0.0 |
| 11/01/2011 6:55 | 0.0 | 0.0 |
| 11/01/2011 7:00 | 0.0 | 0.0 |
| 11/01/2011 7:05 | 0.0 | 0.0 |
| 11/01/2011 7:10 | 0.0 | 0.0 |
| 11/01/2011 7:15 | 0.0 | 0.0 |
| 11/01/2011 7:20 | 0.0 | 0.0 |
| 11/01/2011 7:25 | 0.0 | 1.0 |
| 11/01/2011 7:30 | 0.0 | 1.5 |
| 11/01/2011 7:35 | 0.0 | 0.0 |
| 11/01/2011 7:40 | 0.0 | 1.0 |
| 11/01/2011 7:45 | 0.0 | 0.5 |
| 11/01/2011 7:50 | 0.0 | 0.5 |
| 11/01/2011 7:55 | 0.0 | 0.0 |
| 11/01/2011 8:00 | 0.0 | 1.0 |
| 11/01/2011 8:05 | 1.0 | 0.0 |
| 11/01/2011 8:10 | 1.0 | 0.0 |
| 11/01/2011 8:15 | 0.0 | 0.0 |
| 11/01/2011 8:20 | 0.0 | 0.0 |
| 11/01/2011 8:25 | 0.0 | 0.0 |
| 11/01/2011 8:30 | 0.0 | 0.0 |
| 11/01/2011 8:35 | 0.0 | 0.0 |
| 11/01/2011 8:40 | 0.0 | 0.0 |
| 11/01/2011 8:45 | 0.0 | 0.0 |
| 11/01/2011 8:50 | 0.0 | 0.0 |
| 11/01/2011 8:55 | 0.0 | 0.0 |
| 11/01/2011 9:00 | 0.0 | 0.0 |
| 11/01/2011 9:05 | 0.0 | 0.0 |
| 11/01/2011 9:10 | 0.0 | 0.5 |
| 11/01/2011 9:15 | 0.0 | 0.0 |
| 11/01/2011 9:20 | 0.0 | 0.0 |
| 11/01/2011 9:25 | 0.0 | 1.0 |
| 11/01/2011 9:30 | 1.0 | 1.5 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|------------------|--------------------|--------------------------|
| 11/01/2011 9:35 | 0.0 | 0.5 |
| 11/01/2011 9:40 | 0.0 | 0.0 |
| 11/01/2011 9:45 | 0.0 | 0.0 |
| 11/01/2011 9:50 | 0.0 | 0.0 |
| 11/01/2011 9:55 | 0.0 | 1.0 |
| 11/01/2011 10:00 | 0.0 | 1.5 |
| 11/01/2011 10:05 | 0.0 | 0.0 |
| 11/01/2011 10:10 | 0.0 | 0.0 |
| 11/01/2011 10:15 | 0.0 | 0.5 |
| 11/01/2011 10:20 | 0.0 | 0.5 |
| 11/01/2011 10:25 | 0.0 | 0.5 |
| 11/01/2011 10:30 | 0.0 | 0.0 |
| 11/01/2011 10:35 | 0.0 | 0.0 |
| 11/01/2011 10:40 | 0.0 | 0.0 |
| 11/01/2011 10:45 | 0.0 | 0.0 |
| 11/01/2011 10:50 | 0.0 | 0.0 |
| 11/01/2011 10:55 | 0.0 | 0.0 |
| 11/01/2011 11:00 | 0.0 | 0.0 |
| 11/01/2011 11:05 | 0.0 | 0.5 |
| 11/01/2011 11:10 | 0.0 | 0.0 |
| 11/01/2011 11:15 | 1.0 | 0.0 |
| 11/01/2011 11:20 | 0.0 | 0.5 |
| 11/01/2011 11:25 | 0.0 | 0.0 |
| 11/01/2011 11:30 | 0.0 | 2.0 |
| 11/01/2011 11:35 | 0.0 | 1.0 |
| 11/01/2011 11:40 | 0.0 | 1.0 |
| 11/01/2011 11:45 | 0.0 | 0.5 |
| 11/01/2011 11:50 | 0.0 | 0.0 |
| 11/01/2011 11:55 | 0.0 | 0.5 |
| 11/01/2011 12:00 | 0.0 | 0.0 |
| 11/01/2011 12:05 | 1.0 | 0.0 |
| 11/01/2011 12:10 | 0.0 | 0.0 |
| 11/01/2011 12:15 | 1.0 | 0.5 |
| 11/01/2011 12:20 | 0.0 | 0.0 |
| 11/01/2011 12:25 | 1.0 | 0.0 |
| 11/01/2011 12:30 | 0.0 | 0.5 |
| 11/01/2011 12:35 | 0.0 | 0.0 |
| 11/01/2011 12:40 | 0.0 | 0.0 |
| 11/01/2011 12:45 | 0.0 | 0.0 |
| 11/01/2011 12:50 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|------------------|--------------------|--------------------------|
| 11/01/2011 12:55 | 0.0 | 0.0 |
| 11/01/2011 13:00 | 0.0 | 0.0 |
| 11/01/2011 13:05 | 0.0 | 0.0 |
| 11/01/2011 13:10 | 0.0 | 0.0 |
| 11/01/2011 13:15 | 0.0 | 0.0 |
| 11/01/2011 13:20 | 0.0 | 0.5 |
| 11/01/2011 13:25 | 0.0 | 0.0 |
| 11/01/2011 13:30 | 0.0 | 0.0 |
| 11/01/2011 13:35 | 0.0 | 0.0 |
| 11/01/2011 13:40 | 0.0 | 0.0 |
| 11/01/2011 13:45 | 2.0 | 0.0 |
| 11/01/2011 13:50 | 0.0 | 0.0 |
| 11/01/2011 13:55 | 1.0 | 0.0 |
| 11/01/2011 14:00 | 1.0 | 0.0 |
| 11/01/2011 14:05 | 1.0 | 0.0 |
| 11/01/2011 14:10 | 0.0 | 0.0 |
| 11/01/2011 14:15 | 0.0 | 0.0 |
| 11/01/2011 14:20 | 0.0 | 0.5 |
| 11/01/2011 14:25 | 1.0 | 2.0 |
| 11/01/2011 14:30 | 0.0 | 1.5 |
| 11/01/2011 14:35 | 0.0 | 0.5 |
| 11/01/2011 14:40 | 0.0 | 0.5 |
| 11/01/2011 14:45 | 0.0 | 1.0 |
| 11/01/2011 14:50 | 0.0 | 0.0 |
| 11/01/2011 14:55 | 0.0 | 0.0 |
| 11/01/2011 15:00 | 0.0 | 0.0 |
| 11/01/2011 15:05 | 0.0 | 0.0 |
| 11/01/2011 15:10 | 0.0 | 0.0 |
| 11/01/2011 15:15 | 0.0 | 0.0 |
| 11/01/2011 15:20 | 0.0 | 0.0 |
| 11/01/2011 15:25 | 0.0 | 0.0 |
| 11/01/2011 15:30 | 0.0 | 0.0 |
| 11/01/2011 15:35 | 0.0 | 0.0 |
| 11/01/2011 15:40 | 0.0 | 0.5 |
| 11/01/2011 15:45 | 0.0 | 0.0 |
| 11/01/2011 15:50 | 0.0 | 0.0 |
| 11/01/2011 15:55 | 0.0 | 0.0 |
| 11/01/2011 16:00 | 0.0 | 0.0 |
| 11/01/2011 16:05 | 1.0 | 0.5 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|------------------|--------------------|--------------------------|
| 11/01/2011 16:10 | 0.0 | 0.5 |
| 11/01/2011 16:15 | 0.0 | 0.0 |
| 11/01/2011 16:20 | 0.0 | 0.0 |
| 11/01/2011 16:25 | 0.0 | 1.0 |
| 11/01/2011 16:30 | 0.0 | 0.0 |
| 11/01/2011 16:35 | 0.0 | 0.0 |
| 11/01/2011 16:40 | 0.0 | 0.0 |
| 11/01/2011 16:45 | 1.0 | 0.5 |
| 11/01/2011 16:50 | 0.0 | 0.0 |
| 11/01/2011 16:55 | 0.0 | 0.0 |
| 11/01/2011 17:00 | 0.0 | 0.0 |
| 11/01/2011 17:05 | 1.0 | 0.0 |
| 11/01/2011 17:10 | 0.0 | 0.0 |
| 11/01/2011 17:15 | 1.0 | 0.0 |
| 11/01/2011 17:20 | 0.0 | 0.5 |
| 11/01/2011 17:25 | 0.0 | 0.0 |
| 11/01/2011 17:30 | 0.0 | 0.0 |
| 11/01/2011 17:35 | 0.0 | 0.0 |
| 11/01/2011 17:40 | 0.0 | 0.0 |
| 11/01/2011 17:45 | 1.0 | 0.0 |
| 11/01/2011 17:50 | 0.0 | 0.0 |
| 11/01/2011 17:55 | 0.0 | 0.0 |
| 11/01/2011 18:00 | 0.0 | 0.5 |
| 11/01/2011 18:05 | 0.0 | 0.0 |
| 11/01/2011 18:10 | 1.0 | 0.0 |
| 11/01/2011 18:15 | 0.0 | 0.0 |
| 11/01/2011 18:20 | 0.0 | 0.0 |
| 11/01/2011 18:25 | 0.0 | 0.0 |
| 11/01/2011 18:30 | 0.0 | 0.0 |
| 11/01/2011 18:35 | 0.0 | 0.5 |
| 11/01/2011 18:40 | 0.0 | 0.0 |
| 11/01/2011 18:45 | 0.0 | 0.0 |
| 11/01/2011 18:50 | 0.0 | 0.0 |
| 11/01/2011 18:55 | 0.0 | 0.0 |
| 11/01/2011 19:00 | 0.0 | 0.0 |
| 11/01/2011 19:05 | 0.0 | 0.0 |
| 11/01/2011 19:10 | 1.0 | 0.0 |
| 11/01/2011 19:15 | 0.0 | 0.0 |
| 11/01/2011 19:20 | 0.0 | 0.0 |
| 11/01/2011 19:25 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|------------------|--------------------|--------------------------|
| 11/01/2011 19:30 | 0.0 | 0.0 |
| 11/01/2011 19:35 | 0.0 | 0.0 |
| 11/01/2011 19:40 | 1.0 | 0.0 |
| 11/01/2011 19:45 | 0.0 | 0.0 |
| 11/01/2011 19:50 | 0.0 | 0.0 |
| 11/01/2011 19:55 | 0.0 | 0.0 |
| 11/01/2011 20:00 | 0.0 | 0.0 |
| 11/01/2011 20:05 | 0.0 | 0.0 |
| 11/01/2011 20:10 | 0.0 | 0.0 |
| 11/01/2011 20:15 | 0.0 | 0.0 |
| 11/01/2011 20:20 | 0.0 | 0.0 |
| 11/01/2011 20:25 | 0.0 | 0.0 |
| 11/01/2011 20:30 | 0.0 | 0.0 |
| 11/01/2011 20:35 | 0.0 | 0.0 |
| 11/01/2011 20:40 | 0.0 | 0.0 |
| 11/01/2011 20:45 | 0.0 | 0.0 |
| 11/01/2011 20:50 | 0.0 | 0.0 |
| 11/01/2011 20:55 | 0.0 | 0.0 |
| 11/01/2011 21:00 | 0.0 | 0.0 |
| 11/01/2011 21:05 | 0.0 | 0.0 |
| 11/01/2011 21:10 | 0.0 | 0.0 |
| 11/01/2011 21:15 | 0.0 | 0.0 |
| 11/01/2011 21:20 | 0.0 | 0.0 |
| 11/01/2011 21:25 | 0.0 | 0.0 |
| 11/01/2011 21:30 | 0.0 | 0.0 |
| 11/01/2011 21:35 | 0.0 | 0.0 |
| 11/01/2011 21:40 | 0.0 | 0.0 |
| 11/01/2011 21:45 | 0.0 | 0.0 |
| 11/01/2011 21:50 | 0.0 | 0.0 |
| 11/01/2011 21:55 | 0.0 | 0.0 |
| 11/01/2011 22:00 | 0.0 | 0.0 |
| 11/01/2011 22:05 | 0.0 | 0.0 |
| 11/01/2011 22:10 | 0.0 | 0.0 |
| 11/01/2011 22:15 | 0.0 | 0.0 |
| 11/01/2011 22:20 | 0.0 | 0.0 |
| 11/01/2011 22:25 | 0.0 | 0.0 |
| 11/01/2011 22:30 | 0.0 | 0.0 |
| 11/01/2011 22:35 | 0.0 | 0.0 |
| 11/01/2011 22:40 | 0.0 | 0.0 |
| 11/01/2011 22:45 | 0.0 | 0.0 |
| 11/01/2011 22:50 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|------------------|--------------------|--------------------------|
| 11/01/2011 22:55 | 0.0 | 0.0 |
| 11/01/2011 23:00 | 0.0 | 0.5 |
| 11/01/2011 23:05 | 0.0 | 0.0 |
| 11/01/2011 23:10 | 0.0 | 0.0 |
| 11/01/2011 23:15 | 0.0 | 0.0 |
| 11/01/2011 23:20 | 0.0 | 0.0 |
| 11/01/2011 23:25 | 0.0 | 0.0 |
| 11/01/2011 23:30 | 0.0 | 0.0 |
| 11/01/2011 23:35 | 0.0 | 0.0 |
| 11/01/2011 23:40 | 0.0 | 0.0 |
| 11/01/2011 23:45 | 0.0 | 0.0 |
| 11/01/2011 23:50 | 0.0 | 0.0 |
| 11/01/2011 23:55 | 0.0 | 0.0 |
| 12/01/2011 0:00 | 0.0 | 0.0 |
| 12/01/2011 0:05 | 0.0 | 0.0 |
| 12/01/2011 0:10 | 0.0 | 0.0 |
| 12/01/2011 0:15 | 0.0 | 0.0 |
| 12/01/2011 0:20 | 0.0 | 0.0 |
| 12/01/2011 0:25 | 0.0 | 0.0 |
| 12/01/2011 0:30 | 0.0 | 0.0 |
| 12/01/2011 0:35 | 0.0 | 0.0 |
| 12/01/2011 0:40 | 0.0 | 0.0 |
| 12/01/2011 0:45 | 0.0 | 0.0 |
| 12/01/2011 0:50 | 0.0 | 0.0 |
| 12/01/2011 0:55 | 0.0 | 0.0 |
| 12/01/2011 1:00 | 0.0 | 0.0 |
| 12/01/2011 1:05 | 0.0 | 0.0 |
| 12/01/2011 1:10 | 0.0 | 0.0 |
| 12/01/2011 1:15 | 0.0 | 0.0 |
| 12/01/2011 1:20 | 0.0 | 0.0 |
| 12/01/2011 1:25 | 0.0 | 0.0 |
| 12/01/2011 1:30 | 0.0 | 0.0 |
| 12/01/2011 1:35 | 0.0 | 0.0 |
| 12/01/2011 1:40 | 0.0 | 0.0 |
| 12/01/2011 1:45 | 0.0 | 0.0 |
| 12/01/2011 1:50 | 0.0 | 0.0 |
| 12/01/2011 1:55 | 0.0 | 0.0 |
| 12/01/2011 2:00 | 0.0 | 0.0 |
| 12/01/2011 2:05 | 0.0 | 0.0 |
| 12/01/2011 2:10 | 0.0 | 0.0 |
| 12/01/2011 2:15 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|-----------------|--------------------|--------------------------|
| 12/01/2011 2:20 | 0.0 | 0.0 |
| 12/01/2011 2:25 | 0.0 | 0.0 |
| 12/01/2011 2:30 | 0.0 | 0.0 |
| 12/01/2011 2:35 | 0.0 | 0.0 |
| 12/01/2011 2:40 | 0.0 | 0.0 |
| 12/01/2011 2:45 | 0.0 | 0.0 |
| 12/01/2011 2:50 | 0.0 | 0.0 |
| 12/01/2011 2:55 | 0.0 | 0.0 |
| 12/01/2011 3:00 | 0.0 | 0.0 |
| 12/01/2011 3:05 | 0.0 | 0.0 |
| 12/01/2011 3:10 | 0.0 | 0.0 |
| 12/01/2011 3:15 | 1.0 | 0.0 |
| 12/01/2011 3:20 | 0.0 | 0.0 |
| 12/01/2011 3:25 | 0.0 | 0.0 |
| 12/01/2011 3:30 | 0.0 | 0.0 |
| 12/01/2011 3:35 | 0.0 | 0.0 |
| 12/01/2011 3:40 | 0.0 | 0.0 |
| 12/01/2011 3:45 | 0.0 | 0.0 |
| 12/01/2011 3:50 | 0.0 | 0.0 |
| 12/01/2011 3:55 | 0.0 | 0.0 |
| 12/01/2011 4:00 | 0.0 | 0.0 |
| 12/01/2011 4:05 | 0.0 | 0.0 |
| 12/01/2011 4:10 | 0.0 | 0.0 |
| 12/01/2011 4:15 | 1.0 | 0.0 |
| 12/01/2011 4:20 | 0.0 | 0.0 |
| 12/01/2011 4:25 | 0.0 | 0.0 |
| 12/01/2011 4:30 | 0.0 | 0.0 |
| 12/01/2011 4:35 | 0.0 | 0.0 |
| 12/01/2011 4:40 | 0.0 | 0.0 |
| 12/01/2011 4:45 | 0.0 | 0.0 |
| 12/01/2011 4:50 | 1.0 | 0.0 |
| 12/01/2011 4:55 | 0.0 | 0.0 |
| 12/01/2011 5:00 | 0.0 | 0.0 |
| 12/01/2011 5:05 | 0.0 | 0.0 |
| 12/01/2011 5:10 | 0.0 | 0.0 |
| 12/01/2011 5:15 | 0.0 | 0.0 |
| 12/01/2011 5:20 | 0.0 | 0.0 |
| 12/01/2011 5:25 | 0.0 | 0.0 |
| 12/01/2011 5:30 | 0.0 | 0.0 |
| 12/01/2011 5:35 | 0.0 | 0.0 |

| | Toowoomba Alert | Cooby Dam Pluviograph |
|-----------------|--------------------|--------------------------|
| 12/01/2011 5:40 | 0.0 | 0.0 |
| 12/01/2011 5:45 | 0.0 | 0.0 |
| 12/01/2011 5:50 | 0.0 | 0.0 |
| 12/01/2011 5:55 | 0.0 | 0.0 |
| 12/01/2011 6:00 | 0.0 | 0.0 |
| 12/01/2011 6:05 | 0.0 | 0.0 |
| 12/01/2011 6:10 | 0.0 | 0.0 |
| 12/01/2011 6:15 | 0.0 | 0.0 |
| 12/01/2011 6:20 | 0.0 | 0.0 |
| 12/01/2011 6:25 | 1.0 | 0.0 |
| 12/01/2011 6:30 | 0.0 | 0.0 |
| 12/01/2011 6:35 | 0.0 | 0.0 |
| 12/01/2011 6:40 | 0.0 | 0.0 |
| 12/01/2011 6:45 | 0.0 | 0.0 |
| 12/01/2011 6:50 | 0.0 | 0.0 |
| 12/01/2011 6:55 | 0.0 | 0.0 |
| 12/01/2011 7:00 | 0.0 | 0.0 |
| 12/01/2011 7:05 | 0.0 | 0.0 |
| 12/01/2011 7:10 | 0.0 | 0.0 |
| 12/01/2011 7:15 | 0.0 | 0.0 |
| 12/01/2011 7:20 | 0.0 | 0.0 |
| 12/01/2011 7:25 | 0.0 | 0.0 |
| 12/01/2011 7:30 | 0.0 | 0.0 |
| 12/01/2011 7:35 | 0.0 | 0.0 |
| 12/01/2011 7:40 | 0.0 | 0.0 |
| 12/01/2011 7:45 | 0.0 | 0.0 |
| 12/01/2011 7:50 | 0.0 | 0.0 |
| 12/01/2011 7:55 | 0.0 | 0.0 |
| 12/01/2011 8:00 | 0.0 | 0.0 |
| 12/01/2011 8:05 | 0.0 | 0.0 |
| 12/01/2011 8:10 | 0.0 | 0.0 |
| 12/01/2011 8:15 | 0.0 | 0.0 |
| 12/01/2011 8:20 | 0.0 | 0.0 |
| 12/01/2011 8:25 | 0.0 | 0.0 |
| 12/01/2011 8:30 | 0.0 | 0.0 |
| 12/01/2011 8:35 | 0.0 | 0.0 |
| 12/01/2011 8:40 | 0.0 | 0.0 |
| 12/01/2011 8:45 | 0.0 | 0.0 |
| 12/01/2011 8:50 | 0.0 | 0.0 |
| 12/01/2011 8:55 | 0.0 | 0.0 |

10.3 APPENDIX C MAPPING

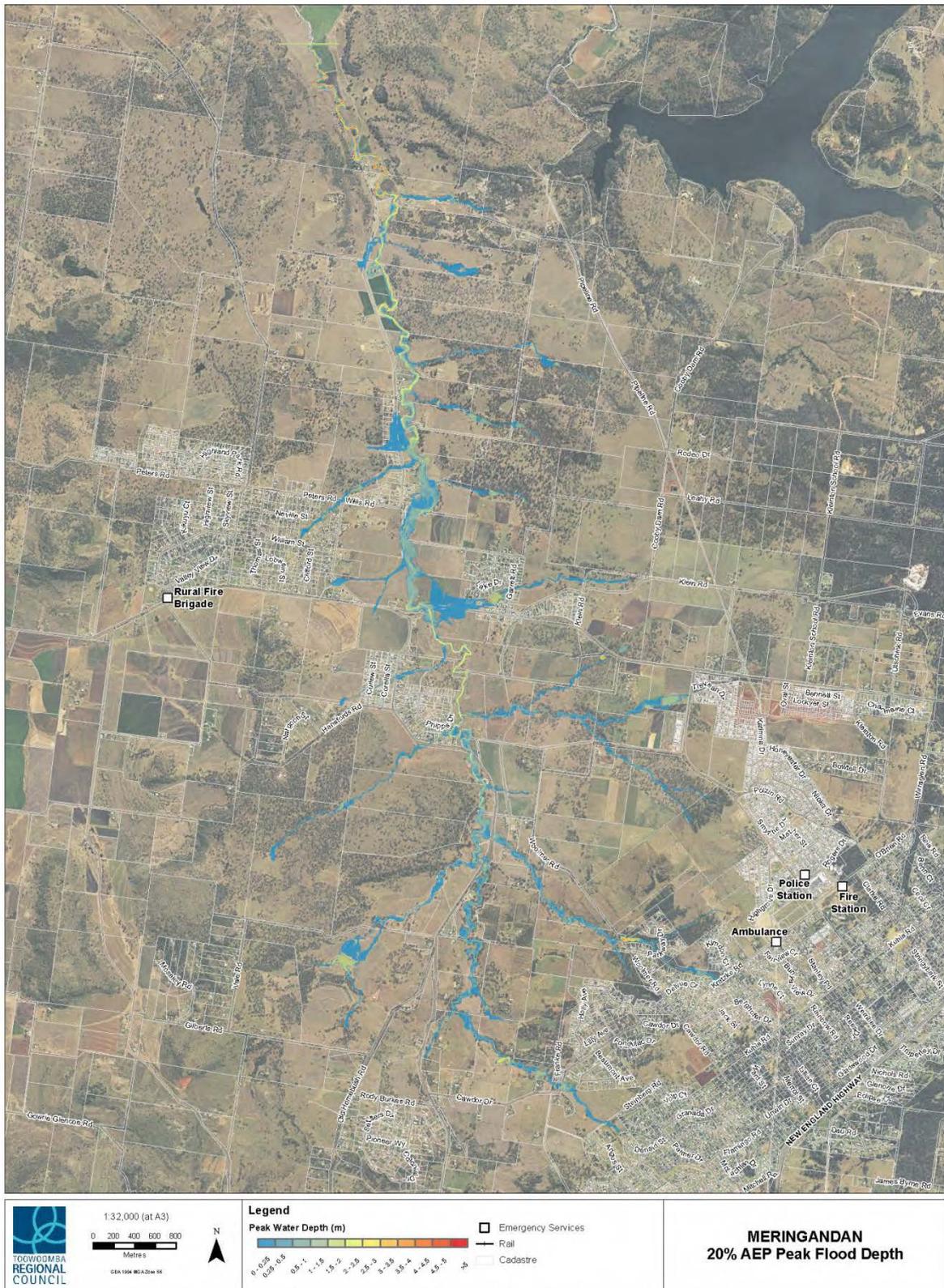
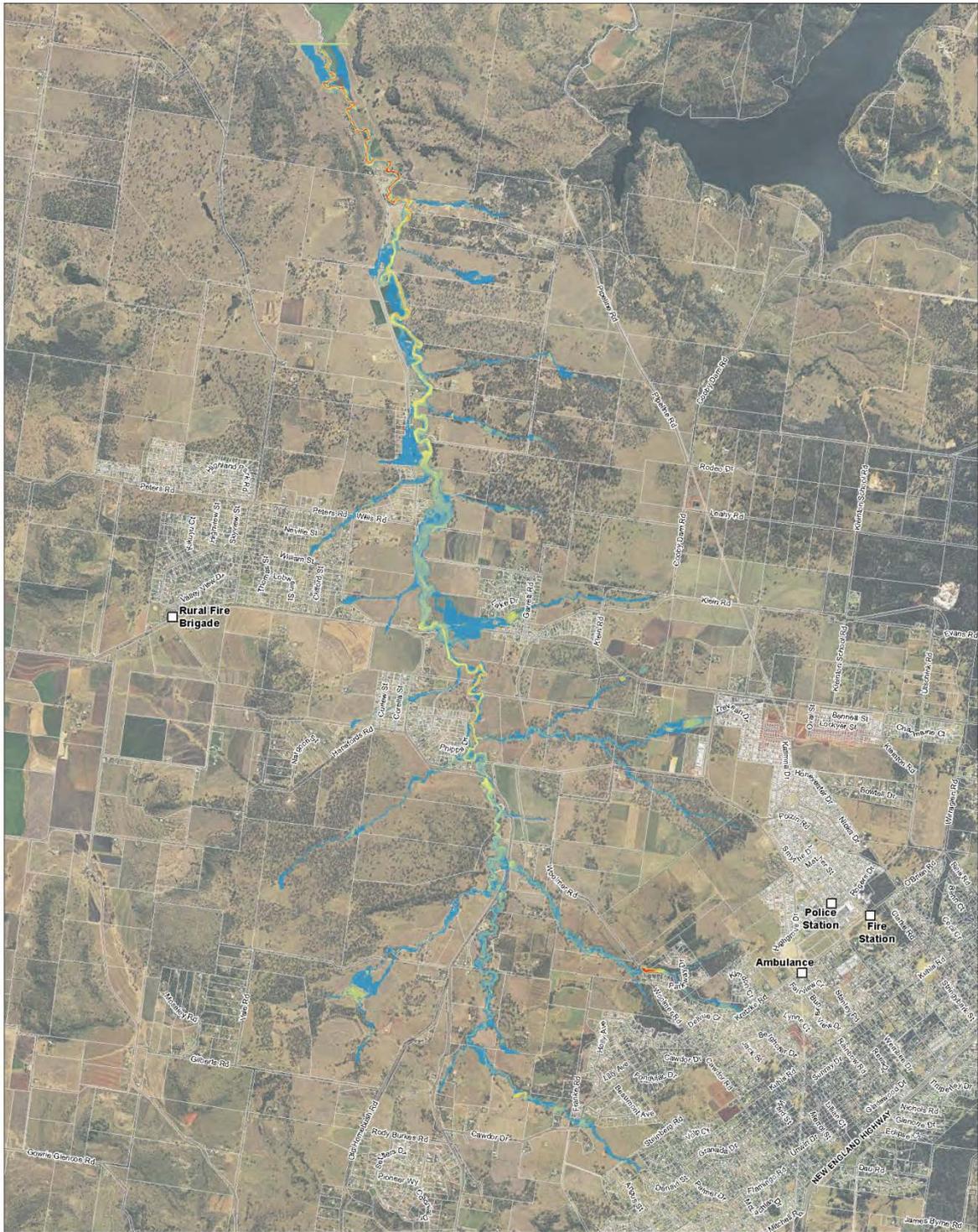
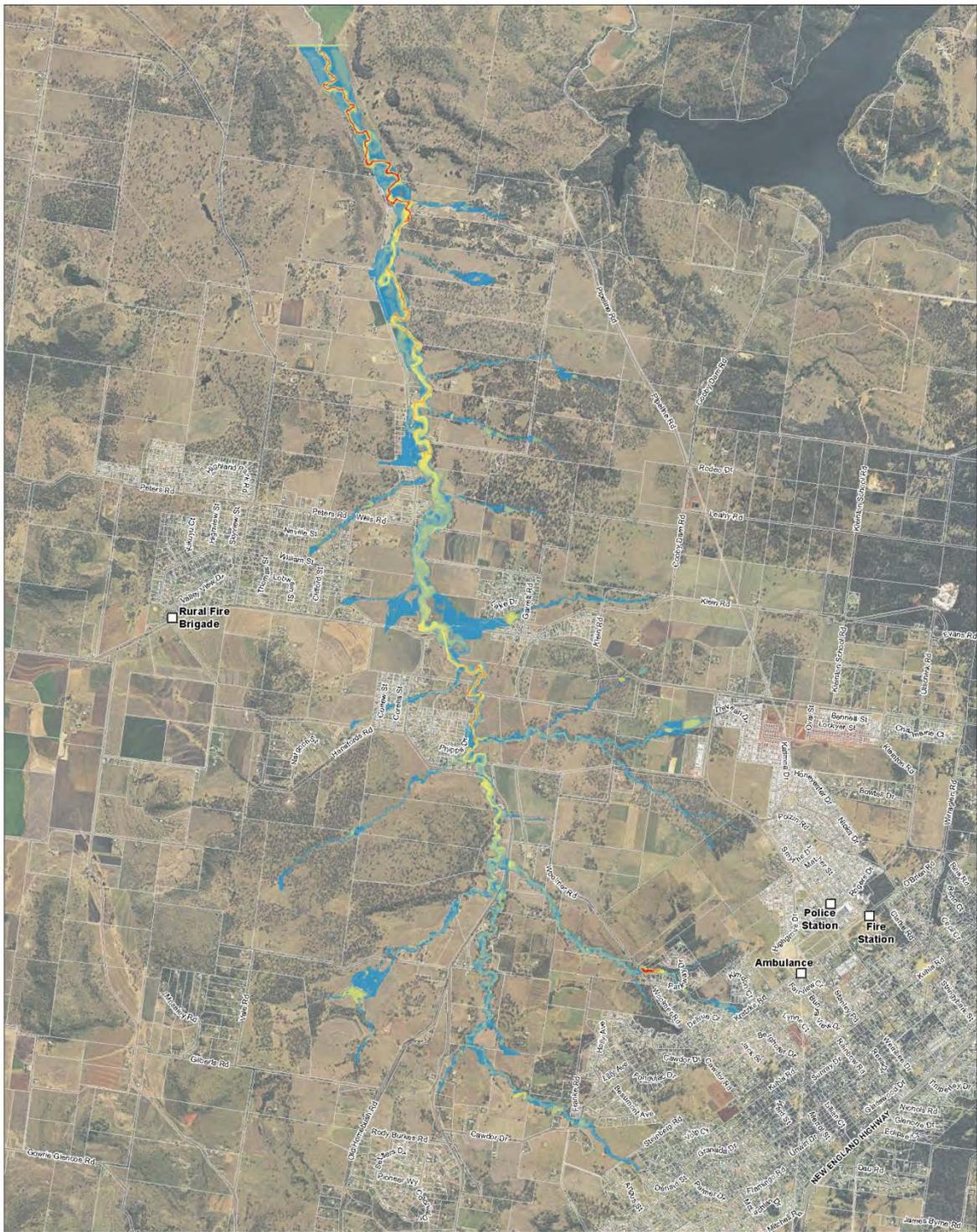


Figure C.1 Depth map for 20% AEP event for existing condition



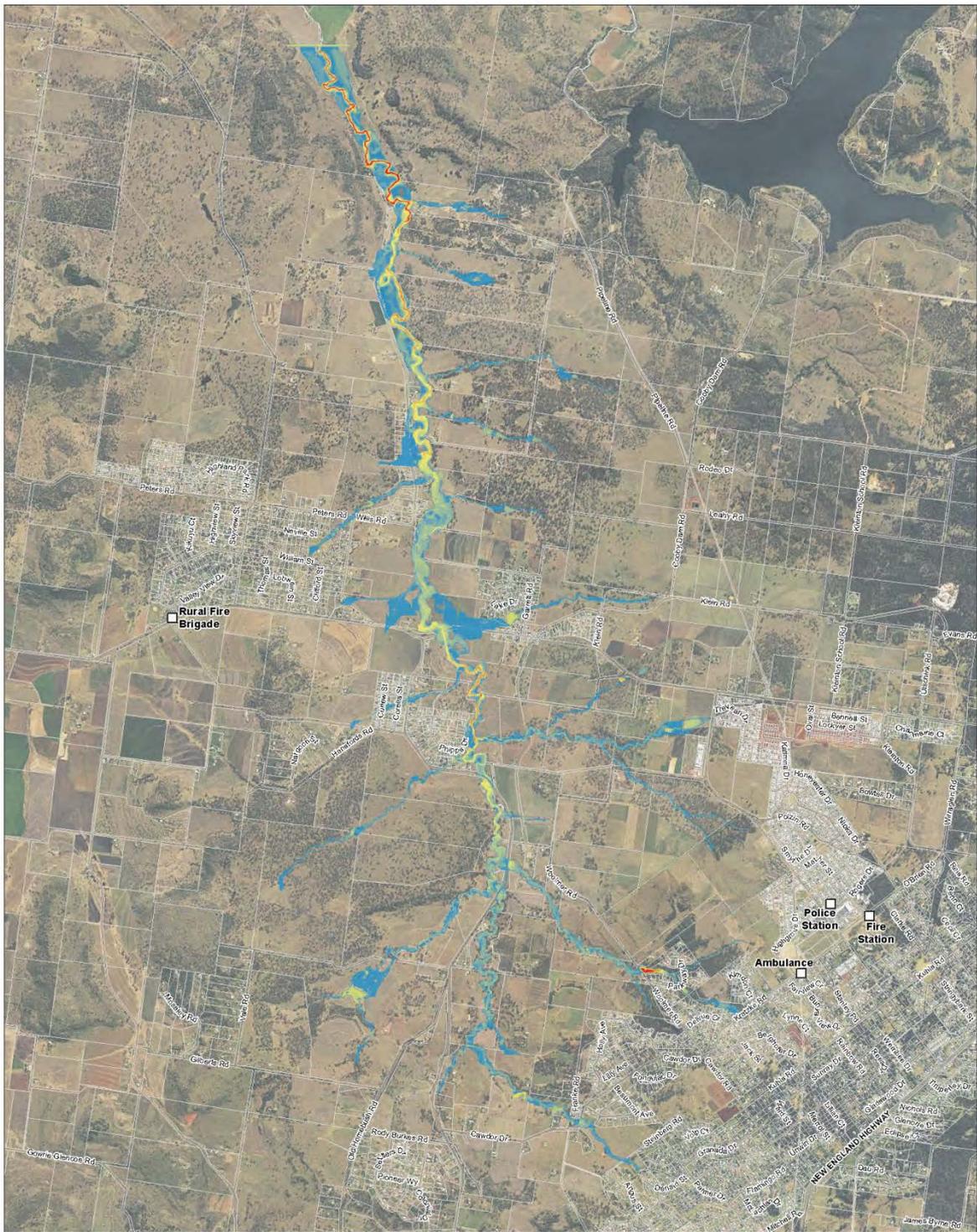
| | | | | | | | | | | | | | |
|---|--|--------|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>Legend</p> <p>Peak Water Depth (m)</p> <table border="1"> <tr> <td>0-0.25</td> <td>0.25-0.5</td> <td>0.5-1</td> <td>1-1.5</td> <td>1.5-2</td> <td>2-2.5</td> <td>2.5-3</td> <td>3-3.5</td> <td>3.5-4</td> <td>4-4.5</td> <td>4.5-5</td> </tr> </table> <p> <input type="checkbox"/> Emergency Services <input type="checkbox"/> Rail <input type="checkbox"/> Cadastre </p> | 0-0.25 | 0.25-0.5 | 0.5-1 | 1-1.5 | 1.5-2 | 2-2.5 | 2.5-3 | 3-3.5 | 3.5-4 | 4-4.5 | 4.5-5 | <p align="center">MERINGANDAN 10% AEP Peak Flood Depth</p> |
| 0-0.25 | 0.25-0.5 | 0.5-1 | 1-1.5 | 1.5-2 | 2-2.5 | 2.5-3 | 3-3.5 | 3.5-4 | 4-4.5 | 4.5-5 | | | |
| <p><small>Disclaimer: The flood information contained in this map is based on observed and marked data that was available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Tocwoodmba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in the map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information in this Plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Tocwoodmba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Tocwoodmba Regional Council. Information Communications Technology is part of the Plan Information should be reproduced without the permission of the Coordinator (S) ICT Branch, or other designated representatives of Council (11/17/2).</small></p> <p><small>U:\Projects\Spatial Services\TRC Flood Study 2014\TRC_Flood_Study_2014\Meringanda_MERFORMS\MER_10% AEP\Final AuthorDate: jpw165 12/01/2014</small></p> | | | | | | | | | | | | | |

Figure C.2 Depth map for 10% AEP event for existing condition



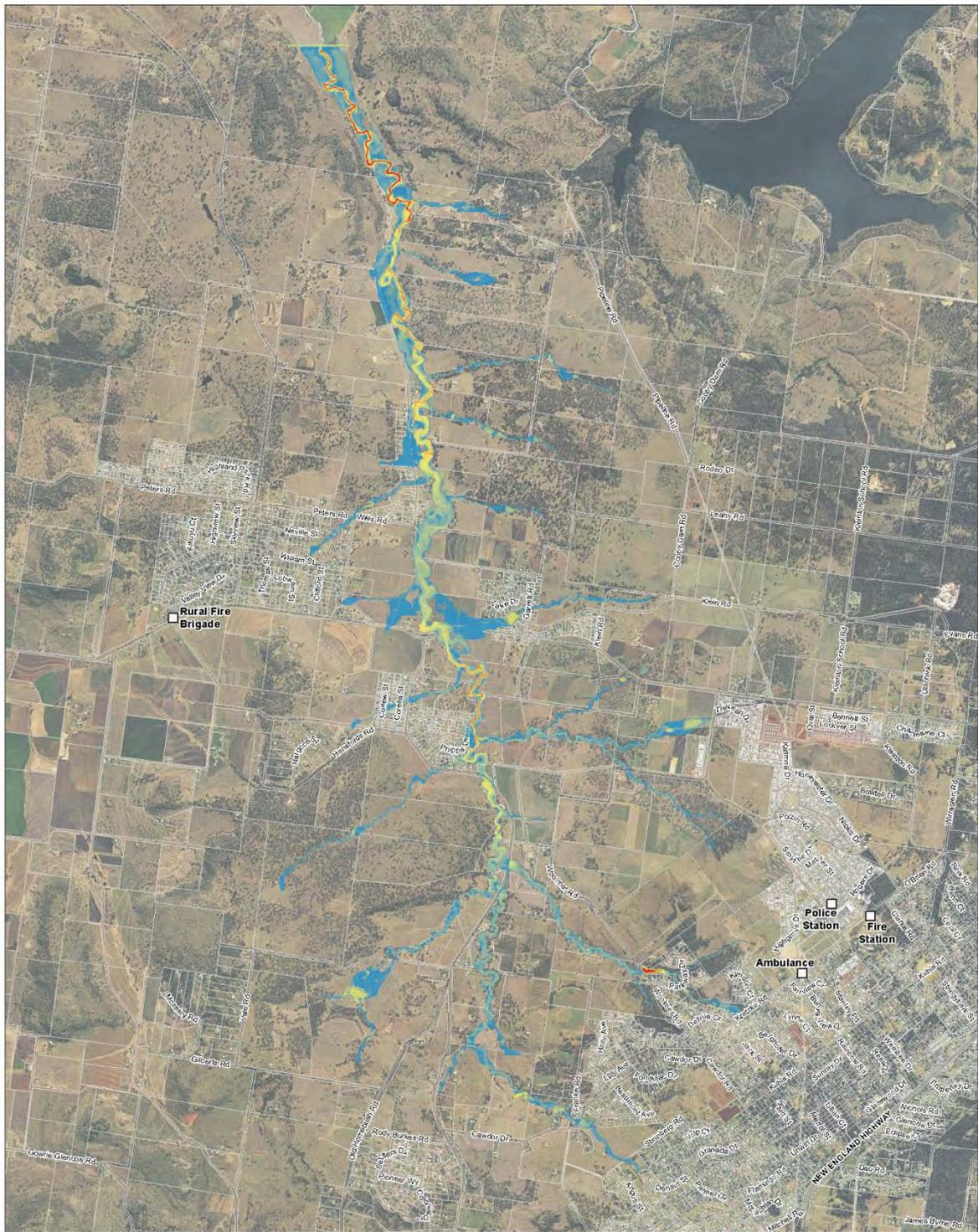
| | | | | | | | | | | | | |
|---|---|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|---|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>Legend</p> <p>Peak Water Depth (m)</p> <table border="1"> <tr> <td>0-0.25</td> <td>0.25-1</td> <td>1-1.5</td> <td>1.5-2</td> <td>2-2.5</td> <td>2.5-3</td> <td>3-3.5</td> <td>3.5-4</td> <td>4-4.5</td> <td>4.5-5</td> </tr> </table> <p> <input type="checkbox"/> Emergency Services <input type="checkbox"/> Rail <input type="checkbox"/> Cadastre </p> | 0-0.25 | 0.25-1 | 1-1.5 | 1.5-2 | 2-2.5 | 2.5-3 | 3-3.5 | 3.5-4 | 4-4.5 | 4.5-5 | <p align="center">MERINGANDAN 5% AEP Peak Flood Depth</p> |
| 0-0.25 | 0.25-1 | 1-1.5 | 1.5-2 | 2-2.5 | 2.5-3 | 3-3.5 | 3.5-4 | 4-4.5 | 4.5-5 | | | |
| <p><small>Disclaimer: The flood information contained in this map is based on observed and marked data that was available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Tocwoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information in this Plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Tocwoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Tocwoomba Regional Council. Infringement of Technology by use of the Plan Information should be reported without the permission of the Coordinator (08 137 8600) or other designated representatives of Council (11377).</small></p> <p><small>U:\Projects\Spatial Services\TRC Flood Study 2014\TRC_Flood_Study_2014\Meringandan_MERFORMS\MER_5% AEP\Map\AuthorData_purview_12.09.2014</small></p> | | | | | | | | | | | | |

Figure C.3 Depth map for 5% AEP event for existing condition



| | | | | | | | | | | | | |
|--|---|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|---|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>Legend</p> <p>Peak Water Depth (m)</p> <table border="1"> <tr> <td>0-0.25</td> <td>0.25-1</td> <td>1-1.5</td> <td>1.5-2</td> <td>2-2.5</td> <td>2.5-3</td> <td>3-3.5</td> <td>3.5-4</td> <td>4-4.5</td> <td>4.5-5</td> </tr> </table> <p> <input type="checkbox"/> Emergency Services <input type="checkbox"/> Rail <input type="checkbox"/> Cadastre </p> | 0-0.25 | 0.25-1 | 1-1.5 | 1.5-2 | 2-2.5 | 2.5-3 | 3-3.5 | 3.5-4 | 4-4.5 | 4.5-5 | <p align="center">MERINGANDAN 2% AEP Peak Flood Depth</p> |
| 0-0.25 | 0.25-1 | 1-1.5 | 1.5-2 | 2-2.5 | 2.5-3 | 3-3.5 | 3.5-4 | 4-4.5 | 4.5-5 | | | |
| <p><small>Disclaimer: The flood information contained in this map is based on observed and marked data that was available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Toowoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information in this Plan and all information referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Toowoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Toowoomba Regional Council. Infringement of Technology: No part of the Plan Information should be reproduced without the permission of the Coordinator (S) ICT Branch, or other designated representatives of Council (11/17/2).</small></p> <p><small>MapViewData\FloodData\HFRG_2014_Flood_Study\MERINGANDAN_C105\KMD\MER_DrPr_2.4\Final\AuthorDate: 24/09/2014</small></p> | | | | | | | | | | | | |

Figure C.4 Depth map for 2% AEP event for existing condition



| | | | | | | | | | | | | | |
|--|--|--------|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>Legend</p> <p>Peak Water Depth (m)</p> <table border="1"> <tr> <td>0-0.25</td> <td>0.25-0.5</td> <td>0.5-1</td> <td>1-1.5</td> <td>1.5-2</td> <td>2-2.5</td> <td>2.5-3</td> <td>3-3.5</td> <td>3.5-4</td> <td>4-4.5</td> <td>4.5-5</td> </tr> </table> <p>Emergency Services (square symbol)</p> <p>Rail (line symbol)</p> <p>Cadastre (dotted line symbol)</p> | 0-0.25 | 0.25-0.5 | 0.5-1 | 1-1.5 | 1.5-2 | 2-2.5 | 2.5-3 | 3-3.5 | 3.5-4 | 4-4.5 | 4.5-5 | <p align="center">MERINGANDAN</p> <p align="center">1% AEP Peak Flood Depth</p> |
| 0-0.25 | 0.25-0.5 | 0.5-1 | 1-1.5 | 1.5-2 | 2-2.5 | 2.5-3 | 3-3.5 | 3.5-4 | 4-4.5 | 4.5-5 | | | |
| <p><small>Disclaimer: The flood information contained in this map is based on aerial photos and maps that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Toowoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in the maps being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information in this Plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Toowoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Toowoomba Regional Council. Inquiries, Communications & Technology, the unit of the Plan Information should be reproduced without the permission of the Coordinator (S) ICT Branch, or other designated representatives of Council (11/17/2).</small></p> <p><small>MapViewData\FloodData\1014_Flood_DeptMeringandan\CMS\MODMFR_DrPr_11A\Final\AuthorDate: 24/09/2014</small></p> | | | | | | | | | | | | | |

Figure C.5 Depth map for 1% AEP event for existing condition

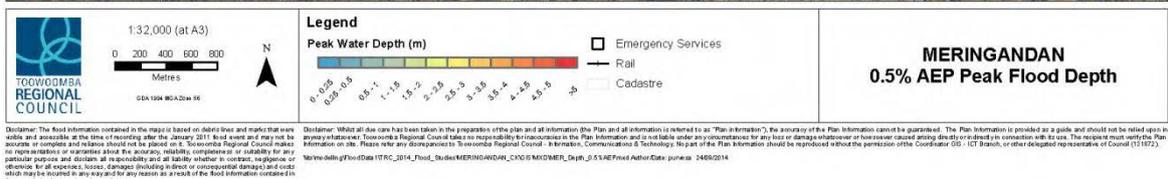
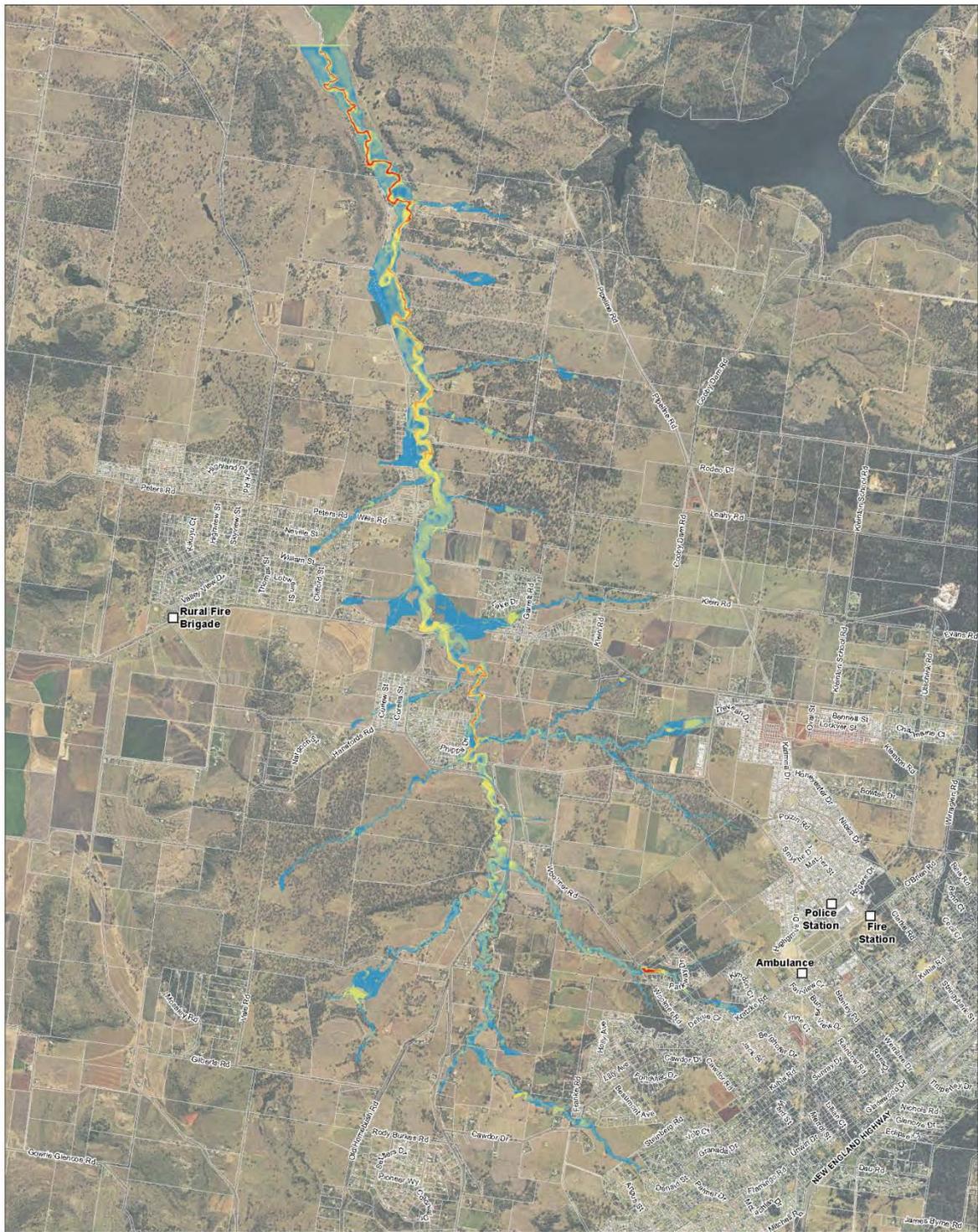
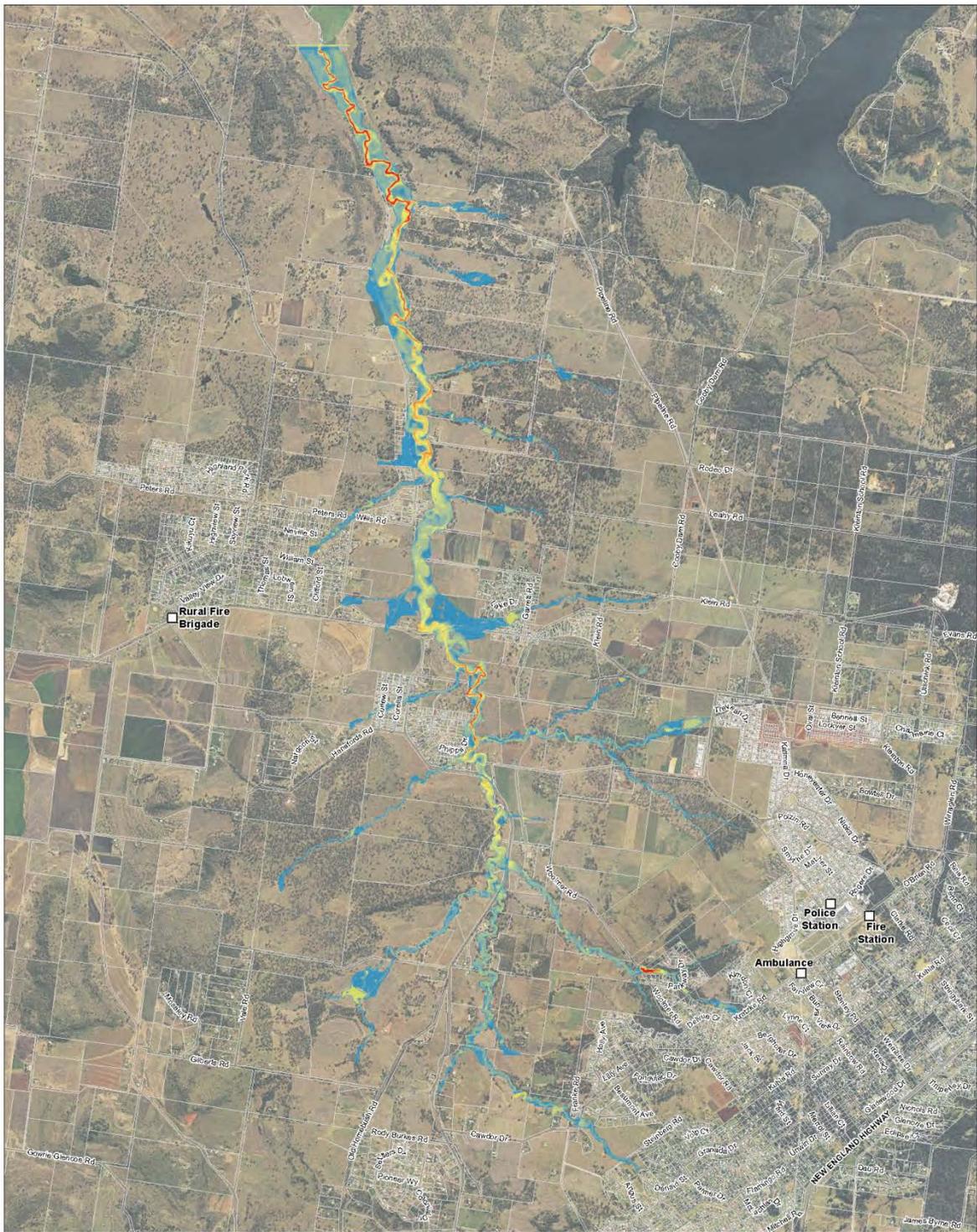


Figure C.6 Depth map for 0.5% AEP event for existing condition



| | | | | | | | | | | | | |
|--|--|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>Legend</p> <p>Peak Water Depth (m)</p> <table border="1"> <tr> <td>0-0.25</td> <td>0.5-1</td> <td>1-1.5</td> <td>1.5-2</td> <td>2-2.5</td> <td>2.5-3</td> <td>3-3.5</td> <td>3.5-4</td> <td>4-4.5</td> <td>4.5-5</td> </tr> </table> <p> <input type="checkbox"/> Emergency Services <input type="checkbox"/> Rail <input type="checkbox"/> Cadastre </p> | 0-0.25 | 0.5-1 | 1-1.5 | 1.5-2 | 2-2.5 | 2.5-3 | 3-3.5 | 3.5-4 | 4-4.5 | 4.5-5 | <p align="center">MERINGANDAN 0.2% AEP Peak Flood Depth</p> |
| 0-0.25 | 0.5-1 | 1-1.5 | 1.5-2 | 2-2.5 | 2.5-3 | 3-3.5 | 3.5-4 | 4-4.5 | 4.5-5 | | | |
| <p><small>Disclaimer: The flood information contained in this map is based on aerial photos and maps that were available and accessible at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. TocwoodMBA Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including in direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in the maps being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information in this Plan is believed to be correct, the accuracy of the Plan information cannot be guaranteed. The Plan information is provided as a guide and should not be relied upon in any way whatsoever. TocwoodMBA Regional Council takes no responsibility for inaccuracies in the Plan information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan information on site. Please refer any discrepancies to TocwoodMBA Regional Council. Infringement, Communications & Technology. No part of the Plan information should be reproduced without the permission of the Coordinator (08 137 8800), or other designated representatives of Council (111873).</small></p> <p><small>Mapfile:delly\FloodData\HFRG_2014_Flood_Study\MERINGANDAN_C10016\MODMFR_Dr\Prj_0.2%AEPEnd Author Date: 24/05/2014</small></p> | | | | | | | | | | | | |

Figure C.7 Depth map for 0.2% AEP event for existing condition

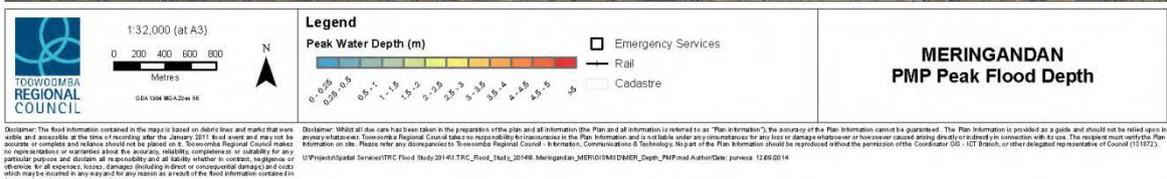
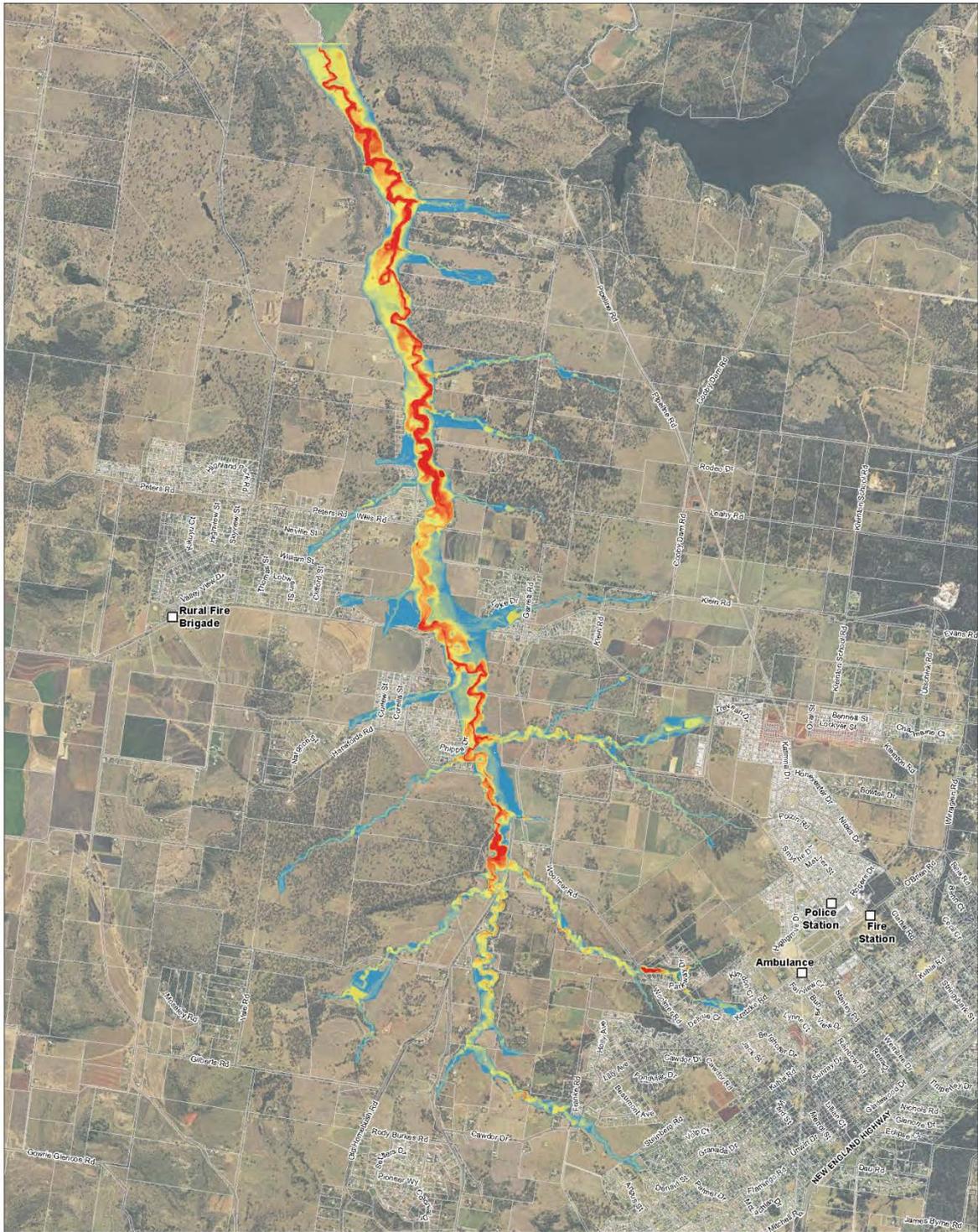
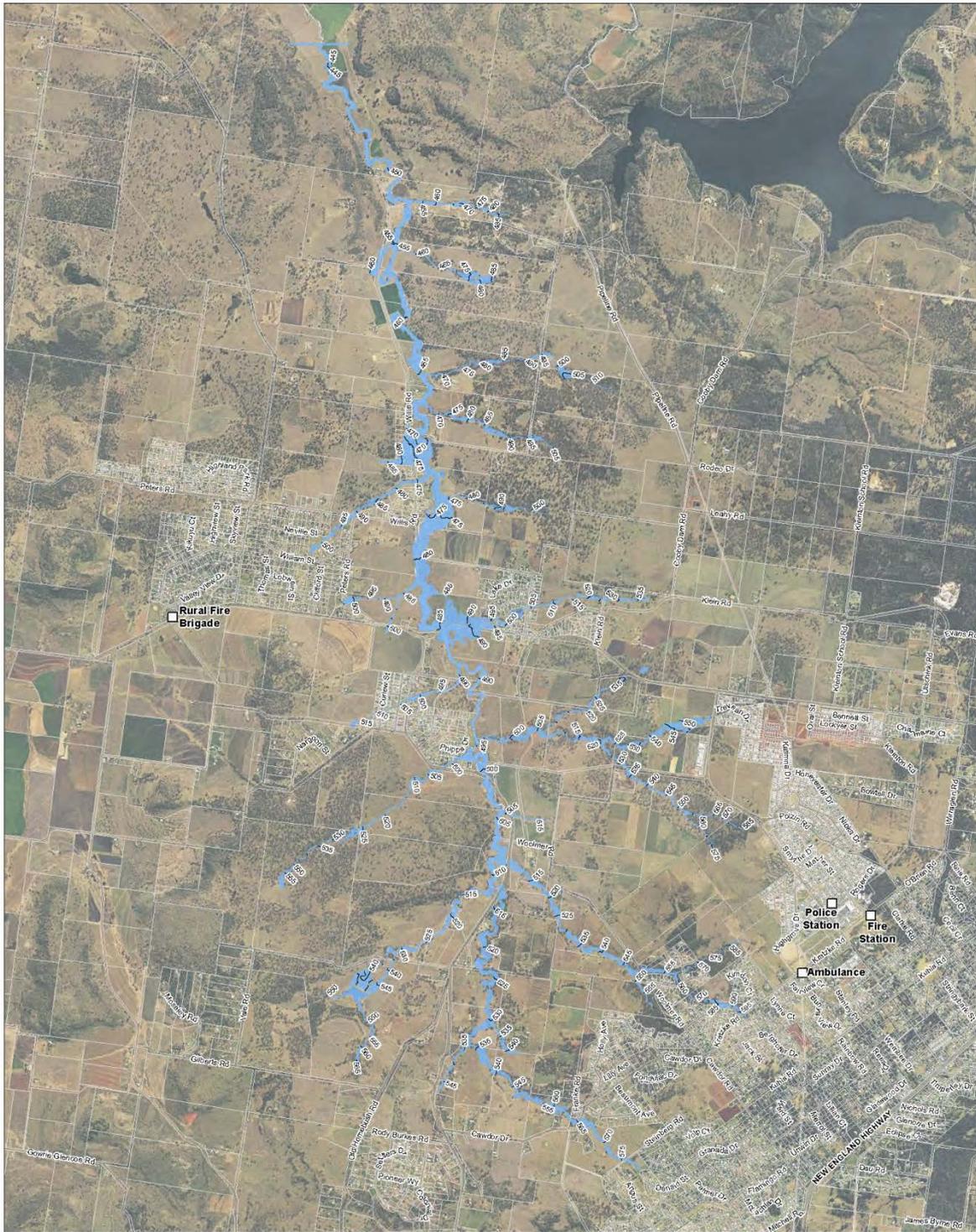


Figure C.8 Depth map for PMP-DF event for existing condition



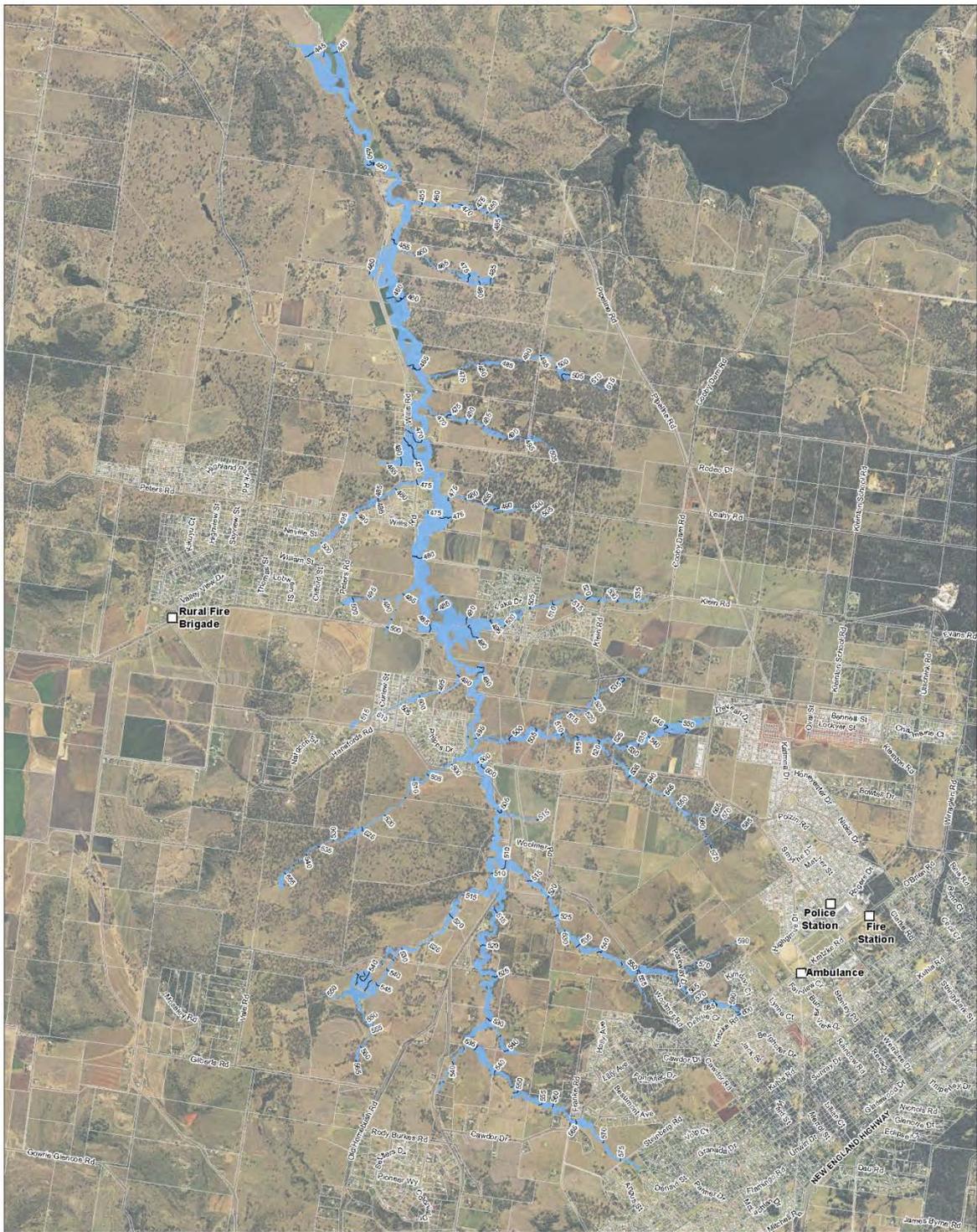
| | | |
|---|--|---|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA2006 NG</p> <p>N</p> | <p>Legend</p> <p> Inundation Extent Emergency Services</p> <p> 5 m Contours (m AHD) Rail</p> <p> Cadastre</p> | <p>MERINGANDAN 20% AEP Peak Water Surface Level 5 m Contours</p> |
|---|--|---|

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Figure C.9 Surface elevation map for 20% AEP event for existing condition



| | | |
|--|--|---|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> <p>N</p> | <p>Legend</p> <p> Inundation Extent Emergency Services</p> <p> 5-m Contours (m AHD) Rail</p> <p> Cadastre</p> | <p>MERINGANDAN 10% AEP Peak Water Surface Level 5 m Contours</p> |
| <p><small>Disclaimer: The flood information contained in this map is based on aerial data and maps that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Tocwoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise. No all expenses, losses, damages (including in direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Tocwoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Tocwoomba Regional Council's Information, Communications & Technology. No part of the Plan Information should be reproduced without the permission of the Coordinator (08 137 8800), or other designated representative of Council (11377).</small></p> <p><small>U:\Projects\Digital Services\TRC Flood Study 2014\TRC_Flood_Study_2014_Meringandan_MERFLOODMERR_Surveys\shaded_10% AEP\Final AuthorDate: 1/19/2014</small></p> | | |

Figure C.10 Surface elevation map for 10% AEP event for existing condition

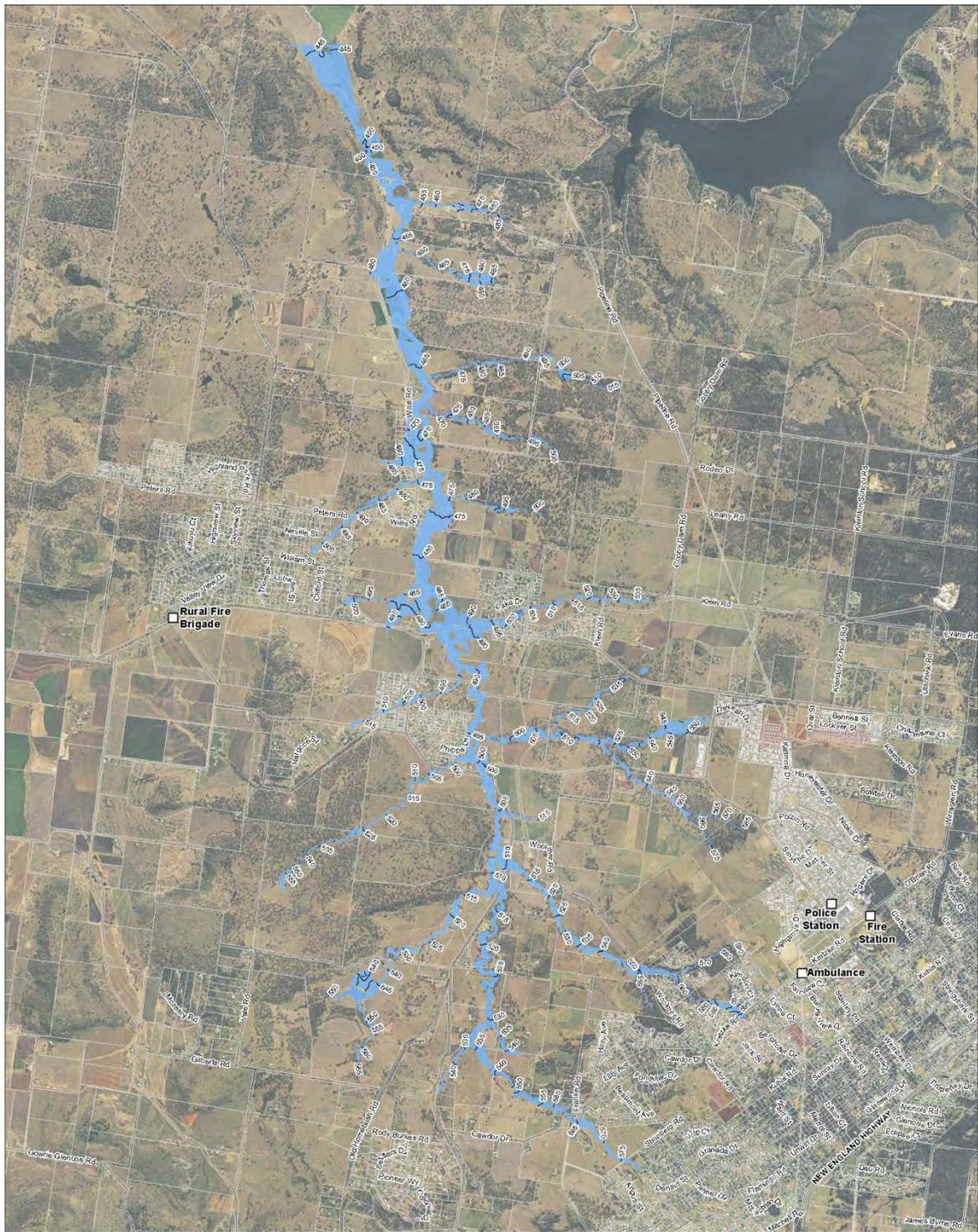
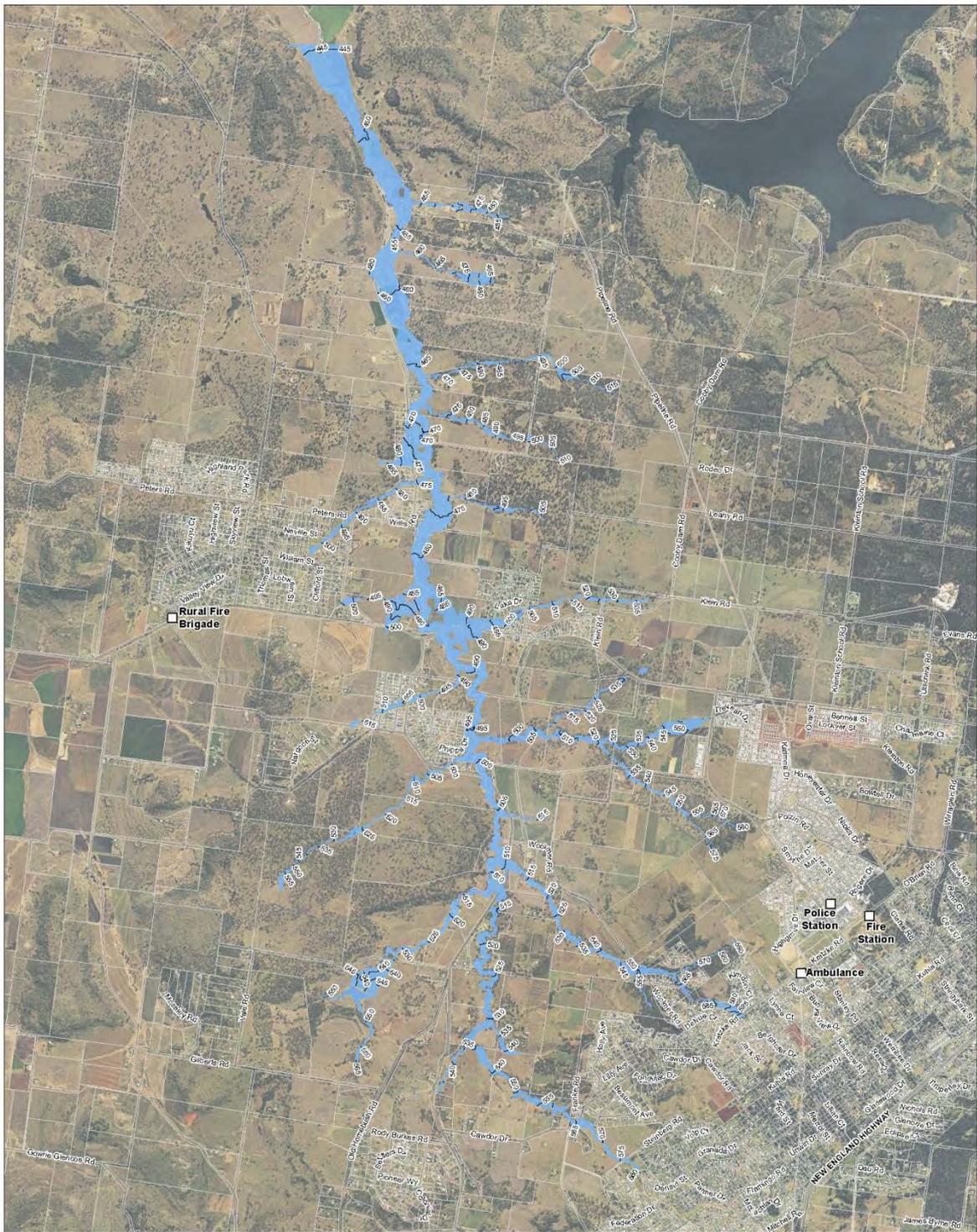


Figure C.11 Surface elevation map for 5% AEP event for existing condition



| | | | |
|---|---|--|--|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NZ</p> |  | Legend  Inundation Extent |  Emergency Services |
| | |  5 m Contours (m AHD) |  Rail |

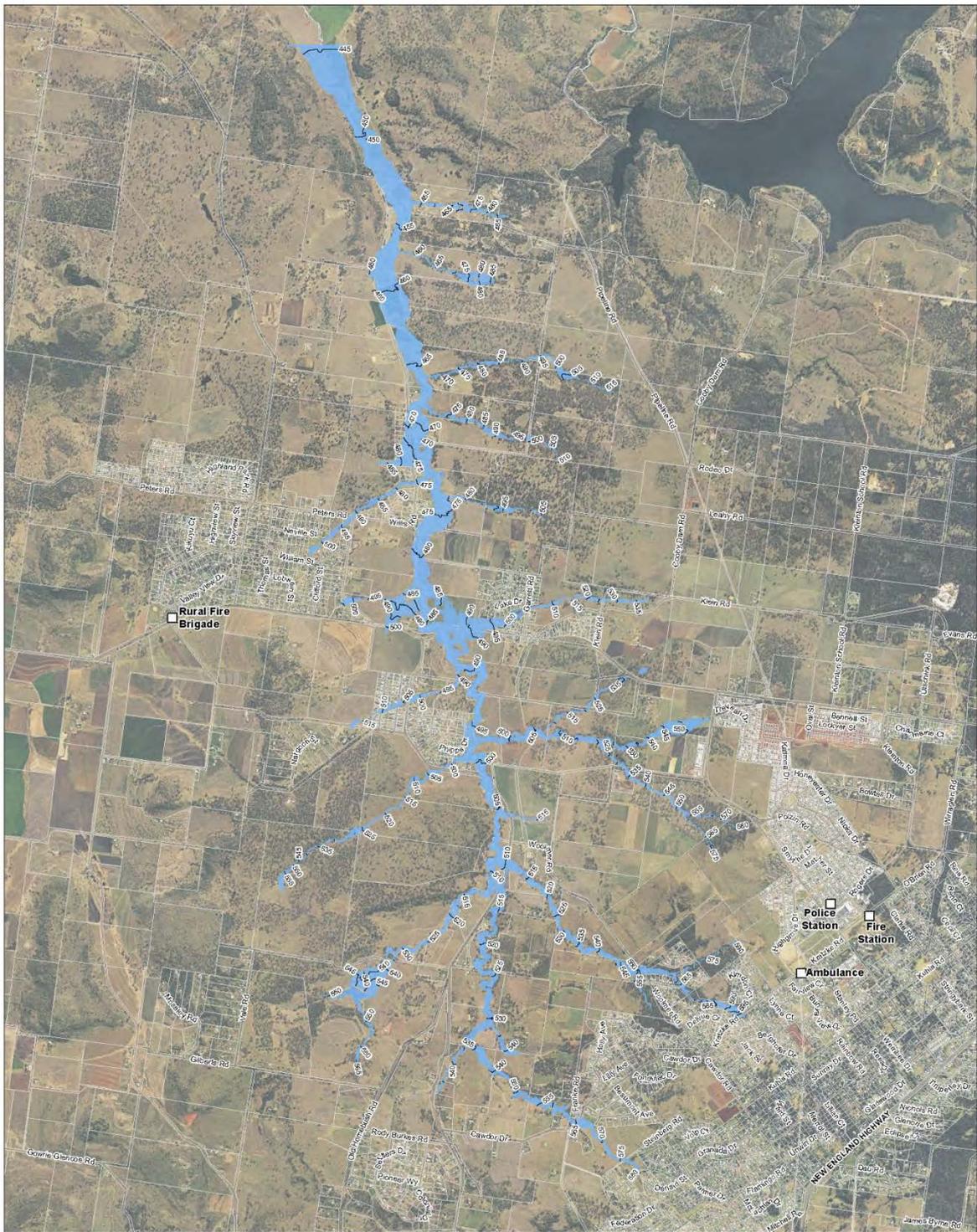
MERINGANDAN
2% AEP Peak Water Surface Level
5 m Contours

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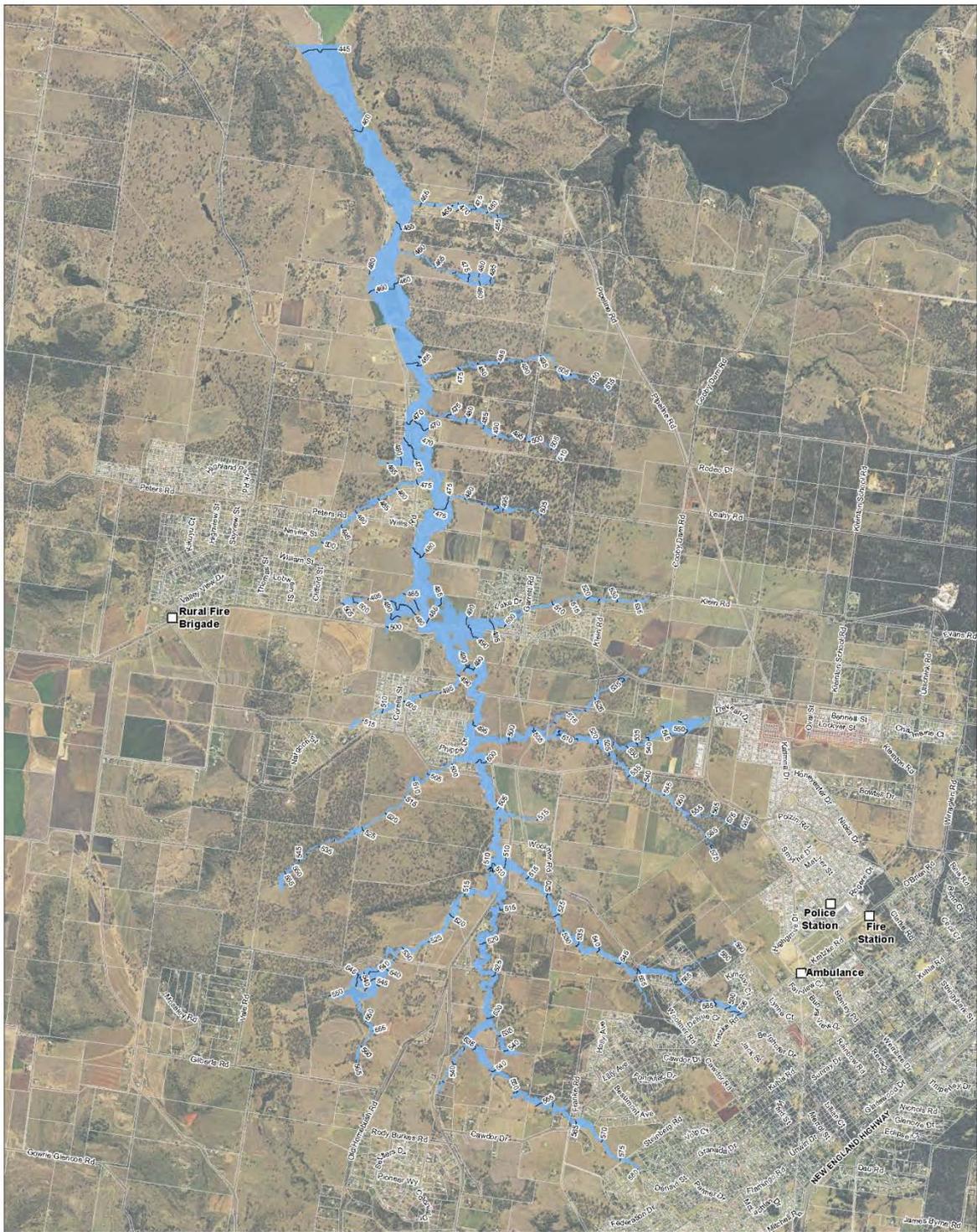
MapViewDaily\FloodData\HFRG_2014_Flood_Study\MERINGANDAN_130516\MODMER_SurfaceElevation_1\AEFinned Author Date: 24/09/2014

Figure C.12 Surface elevation map for 2% AEP event for existing condition



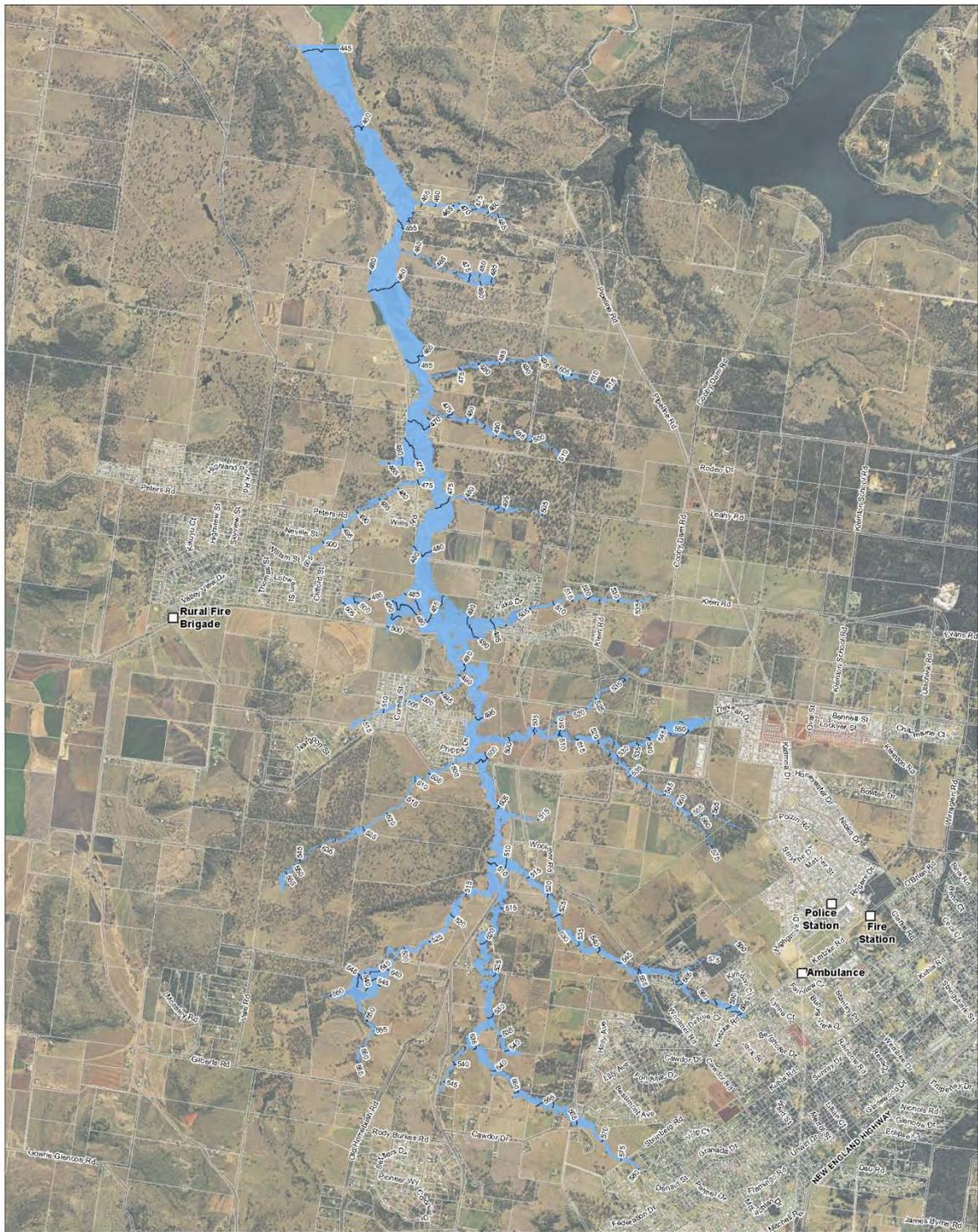
| | | |
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|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>Legend</p> <ul style="list-style-type: none"> Inundation Extent 5 m Contours (m AHD) Emergency Services Rail Cadastre | <p>MERINGANDAN 1% AEP Peak Water Surface Level 5 m Contours</p> |
| <p><small>Disclaimer: The flood information contained in this map is based on aerial photos and maps that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Tosowomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information in this Plan is information, the accuracy of the Plan information cannot be guaranteed. The Plan information is provided as a guide and should not be relied upon in any way whatsoever. Tosowomba Regional Council takes no responsibility for inaccuracies in the Plan information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan information on site. Please refer any discrepancies to Tosowomba Regional Council in Meringandan, Queensland 4702. This information should be reproduced without the permission of the Coordinator (S) - ICT Branch, or other designated representatives of Council (11/17/2).</small></p> <p><small>MapViewDaily@Flooding@TRC_2014_Flood_Study\MERINGANDAN_1%AEF\MER_SurfaceElevation_1%AEF.mxd Author Date: 24/09/2014</small></p> | | |

Figure C.13 Surface elevation map for 1% AEP event for existing condition



| | | | |
|---|----------|--|--|
| <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NZ</p> | <p>N</p> | <p>Legend</p> <p> Inundation Extent</p> <p> 5 m Contours (m AHD)</p> <p> Emergency Services</p> <p> Rail</p> <p> Cadastre</p> | <p>MERINGANDAN 0.5% AEP Peak Water Surface Level 5 m Contours</p> |
| | | <p><small>Disclaimer: The flood information contained in this map is based on a digital elevation model and maps that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Toowoomba Regional Council makes no representation or warranty about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise. No all expenses, losses, damages (including in direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information therein, the Plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Toowoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Toowoomba Regional Council in Meringandan, Queensland 4350. Technology: MapInfo 10.0. The Plan Information should be reproduced without the permission of the Coordinator (55 107) Branch, or other designated representative of Council (111872).</small></p> <p><small>MapView:delly@toowoomba.nz.govt.nz; 2014_Flood_Study\MERINGANDAN\0.5% AEP\MS\MER_MER_SurfaceElevation_0.5% AEP.mxd Author:Date: 24/05/2014</small></p> | |

Figure C.14 Surface elevation map for 0.5% AEP event for existing condition



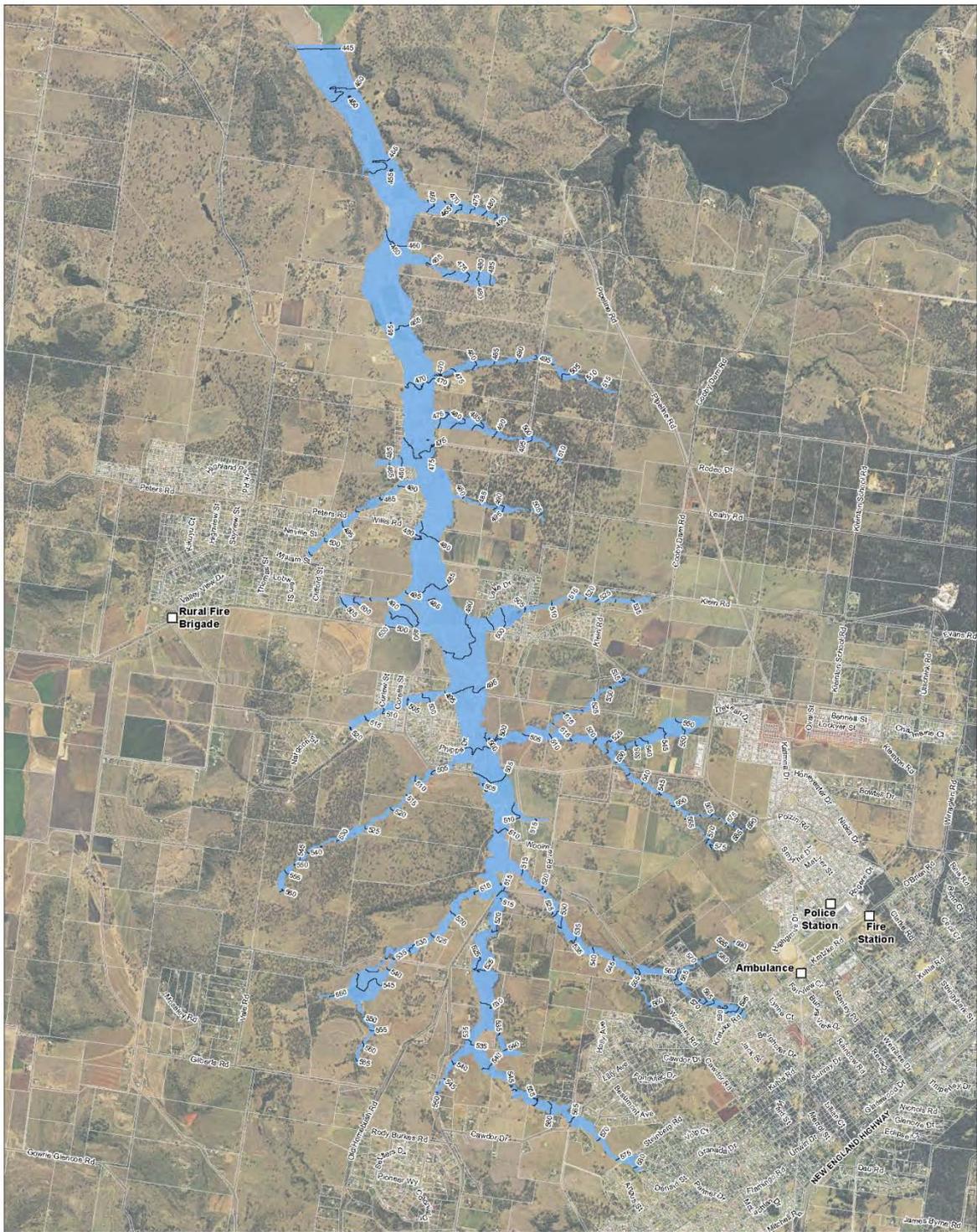
| | | |
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|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NZ</p> <p>N</p> | <p>Legend</p> <p>■ Inundation Extent Emergency Services</p> <p> 5 m Contours (m AHD) Rail</p> <p> Cadastre</p> | <p>MERINGANDAN 0.2% AEP Peak Water Surface Level 5 m Contours</p> |
|--|---|--|

Disclaimer: The flood information contained in this map is based on aerial photos and maps that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Toowoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise. No all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.

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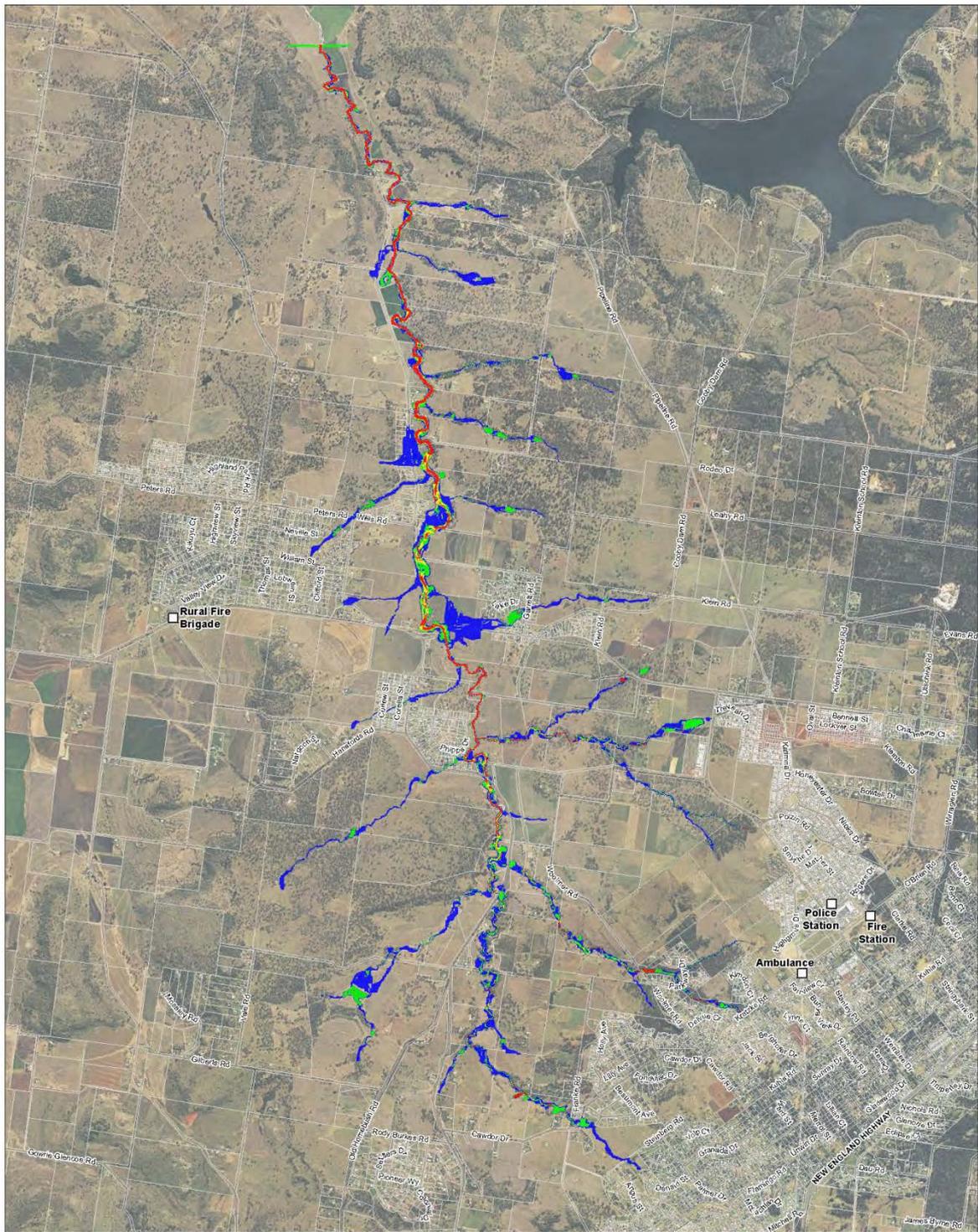
MapViewDailyFloodData_HTRC_2014_Flood_Studies\MERINGANDAN_140516\MK0MPEL_SurfaceElevation_0.2% AEP.mxd Author:Date: 24/05/2014

Figure C.15 Surface elevation map for 0.2% AEP event for existing condition



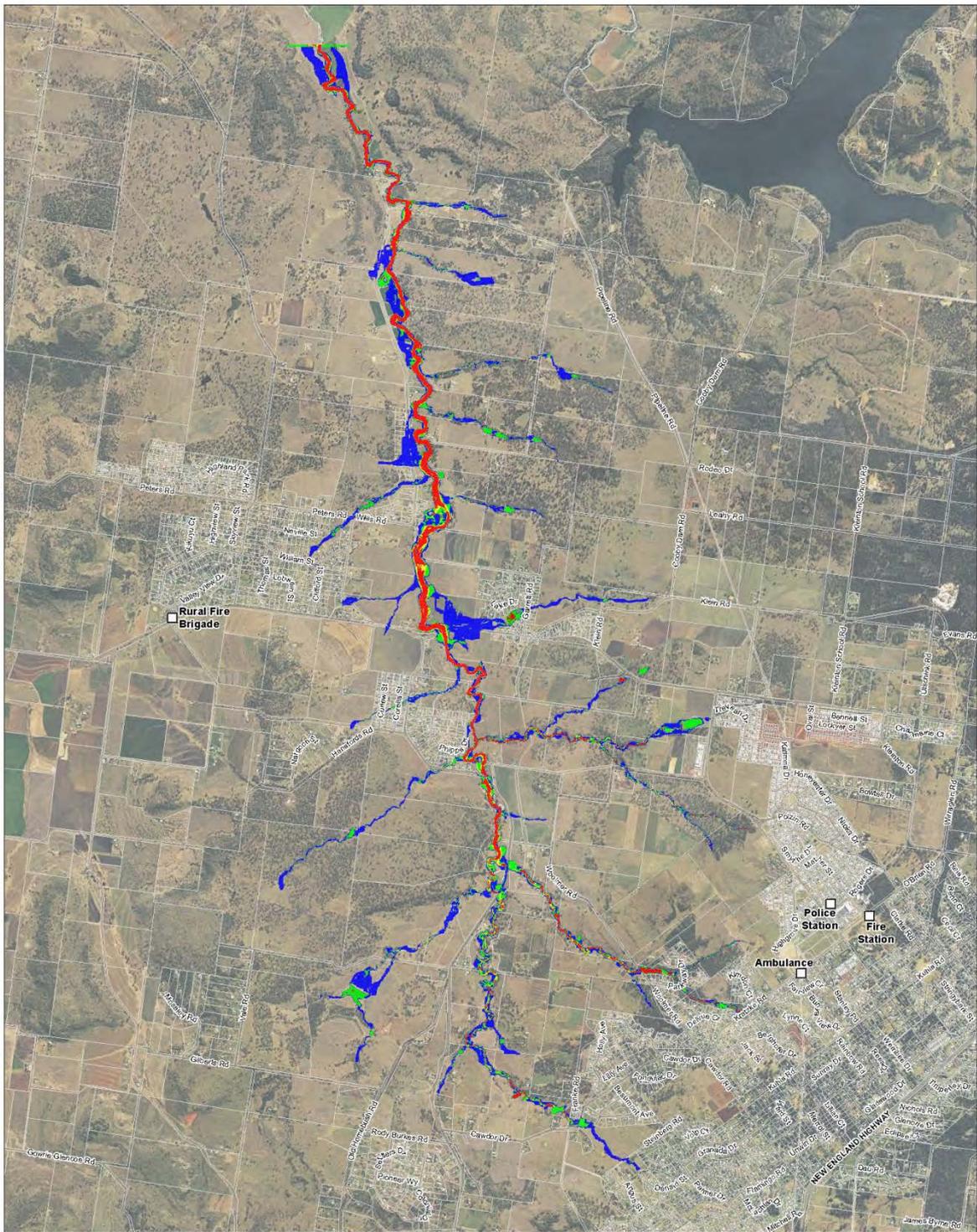
| | | |
|--|---|---|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NZ</p> <p>N</p> | <p>Legend</p> <p> Inundation Extent Emergency Services</p> <p> 5 m Contours (m AHD) Rail</p> <p> Cadastre</p> | <p>MERINGANDAN PMP Peak Water Surface Level 5 m Contours</p> |
| <p><small>Disclaimer: The flood information contained in this map is based on aerial photos and maps that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Toowoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise. No all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Toowoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Toowoomba Regional Council - Information, Communications & Technology. No part of the Plan Information should be reproduced without the permission of the Coordinator (55 107) Branch, or other designated representative of Council (111872).</small></p> <p><small>U:\Projects\GIS\GIS\Projects\TRC Flood Study 2014\TRC_Flood_Study_2014\Meringandan_MERFLOOD\MER_Flood_Study_PMP.mxd Author:Geevan 12/09/2014</small></p> | | |

Figure C.16 Surface elevation map for PMP-DF event for existing condition



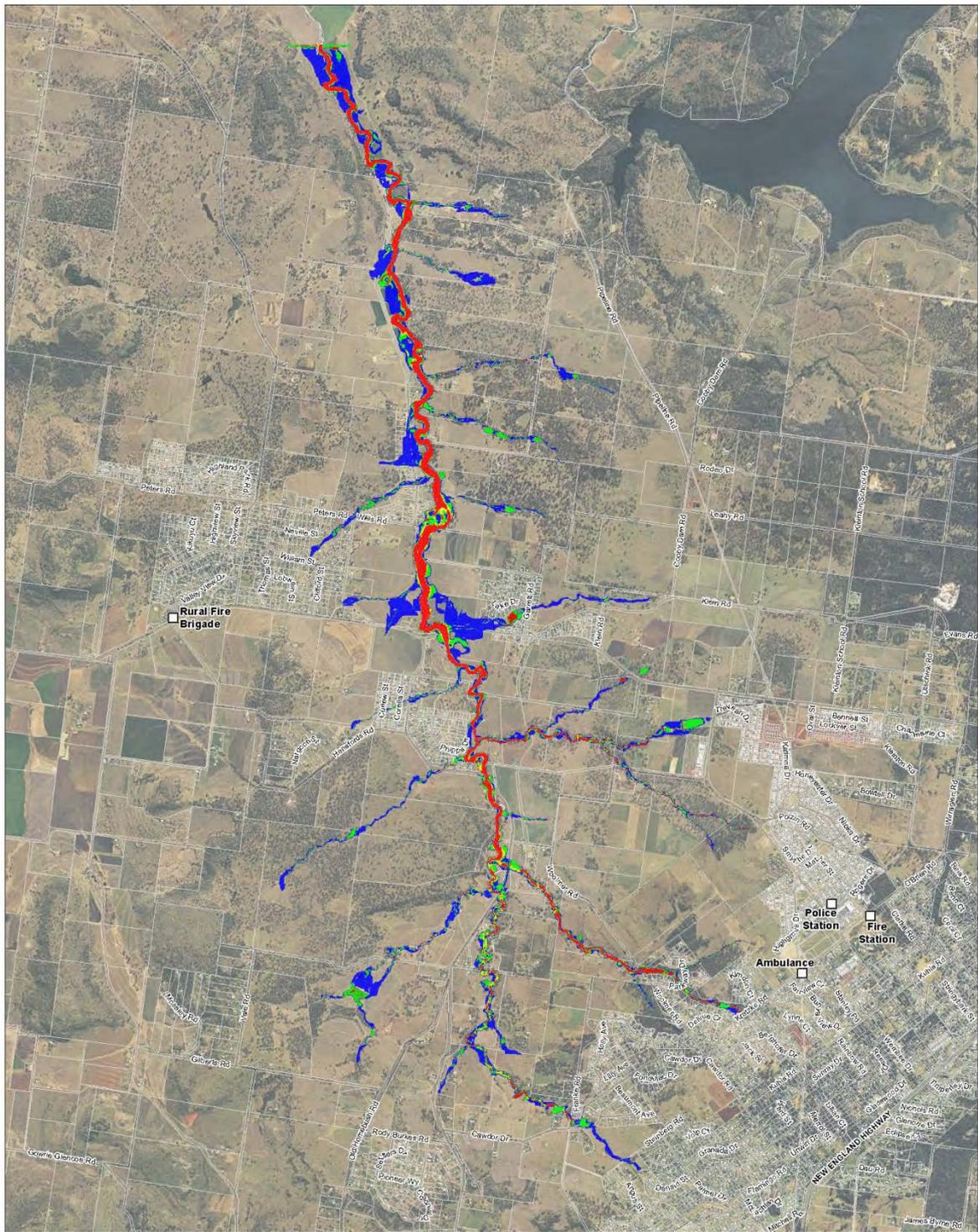
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|--|--|--|---|---|--|--|---|--|--|--|--|--|--|--|--|--|---|---|
| <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | | <p>Legend</p> <table border="0"> <tr> <td>■ Low</td> <td>■ Significant</td> <td>■ High</td> <td>■ Extreme</td> <td> Emergency Services</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td> Rail</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td> Cadastre</td> </tr> </table> | ■ Low | ■ Significant | ■ High | ■ Extreme | Emergency Services | | | | | Rail | | | | | Cadastre | <p>MERINGANDAN 20% AEP Hazard Category</p> |
| | | | ■ Low | ■ Significant | ■ High | ■ Extreme | Emergency Services | | | | | | | | | | | |
| | | | | Rail | | | | | | | | | | | | | | |
| | | | | Cadastre | | | | | | | | | | | | | | |
| <p><small>Disclaimer: The flood information contained in this map is based on digital data and maps that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Toowoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise. No all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: While all due care has been taken in the preparation of this plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Toowoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Toowoomba Regional Council - Information, Communications & Technology. No part of the Plan Information should be reproduced without the permission of the Coordinator (S) - ICT Branch, or other designated representatives of Council (11/17/21).</small></p> <p><small>U:\Projects\Digital Services\TRC Flood Study 2016\TRC Flood Study 2016\Meringandan_MERFLOOD\MER_20_1AEP.mxd Author: dms Date: 12/05/2014</small></p> | | | | | | | | | | | | | | | | | | |

Figure C.17 Hazard category map for 20% AEP event for existing condition



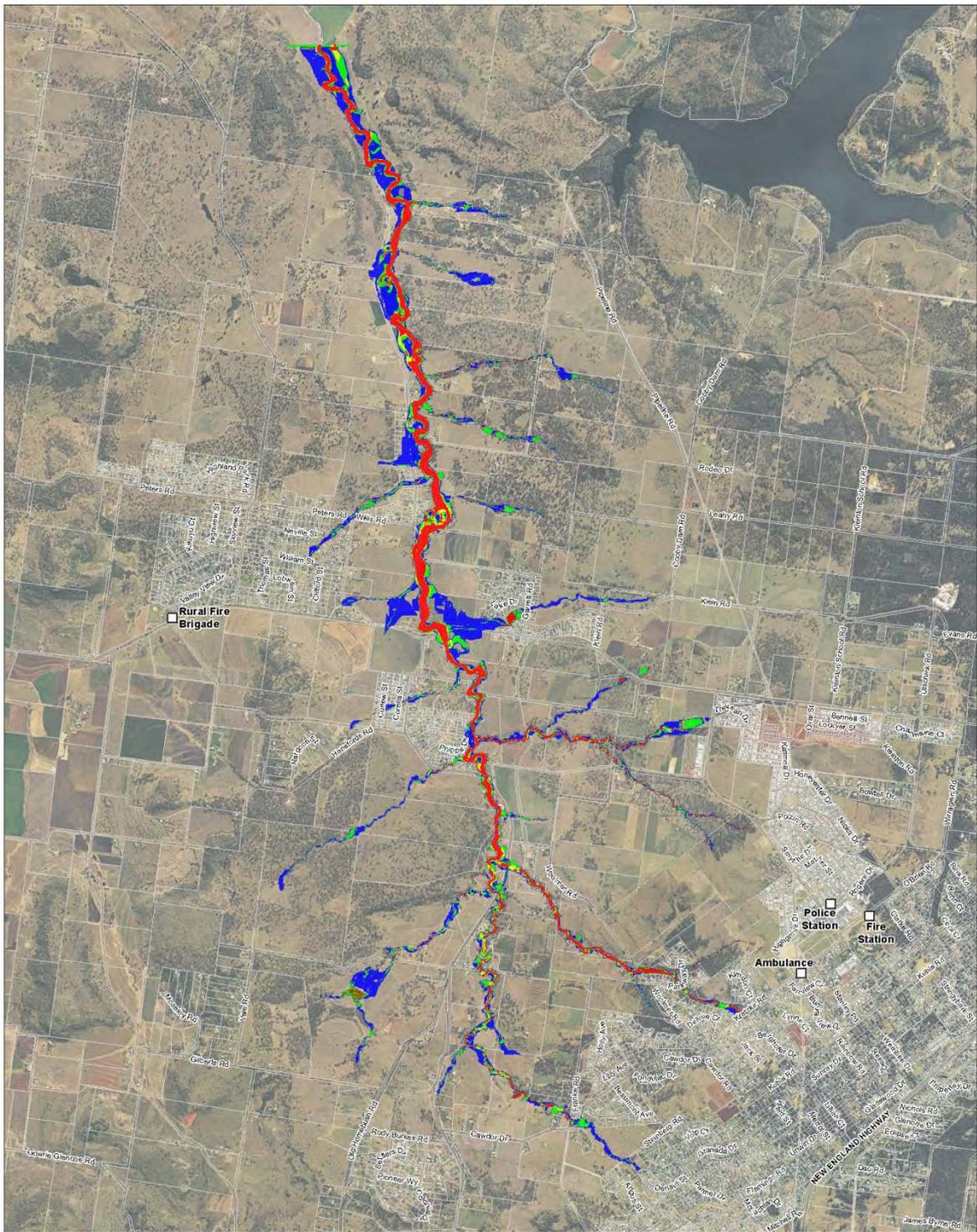
| | | | | |
|---|---|--|---|--|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> |  | <p>Legend</p> <p>Hazard Category</p> <ul style="list-style-type: none"> Low Significant High Extreme | <p> Emergency Services</p> <p> Rail</p> <p> Cadastre</p> | <p>MERINGANDAN 10% AEP Hazard Category</p> |
| | | | <p><small>Disclaimer: The flood information contained in this map is based on digital data and maps that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Togwoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise. No all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Togwoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Togwoomba Regional Council. Inquiries, Communications & Technology, 56-58 of the Plan Information should be reproduced without the permission of the Coordinator (S) - ICT Branch, or other designated representatives of Council (11/17/21).</small></p> <p><small>U:\Projects\Digital Services\TRC Flood Study 2014\TRC_Flood_Study_2014\Meringandan_MERFLOOD\MERFlood_Study_2014\AEP and Author\Date: 12/05/2014</small></p> | |

Figure C.18 Hazard category map for 10% AEP event for existing condition



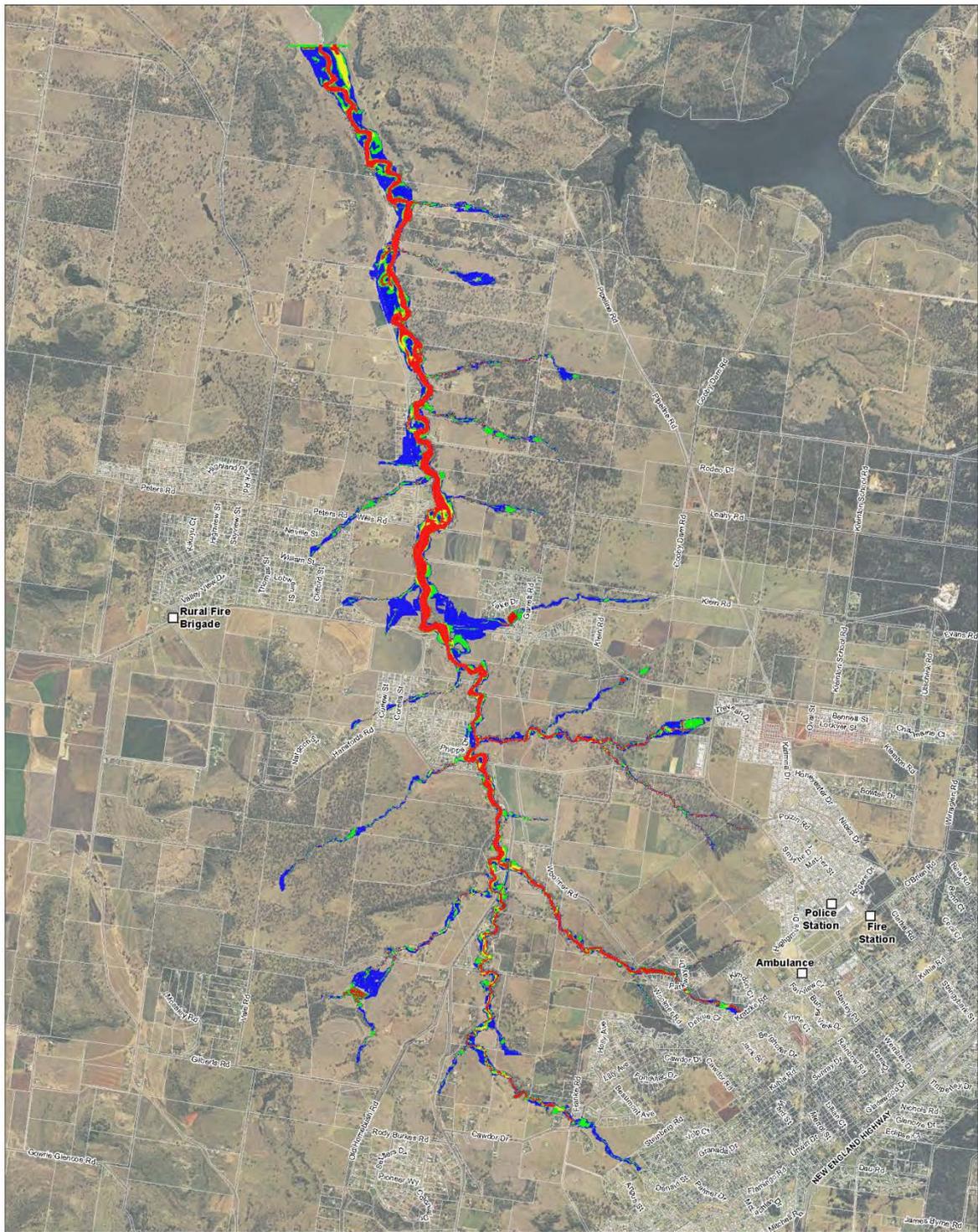
| | | | | | |
|---|--|---------------|--|---|---|
| <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | | Legend | Hazard Category Low Significant High Extreme | Emergency Services Rail Cadastre | MERINGANDAN 5% AEP Hazard Category |
| | | | <small>Disclaimer: The flood information contained in this map is based on digital data and maps that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Tocwoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise. No all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small> | | |

Figure C.19 Hazard category map for 5% AEP event for existing condition



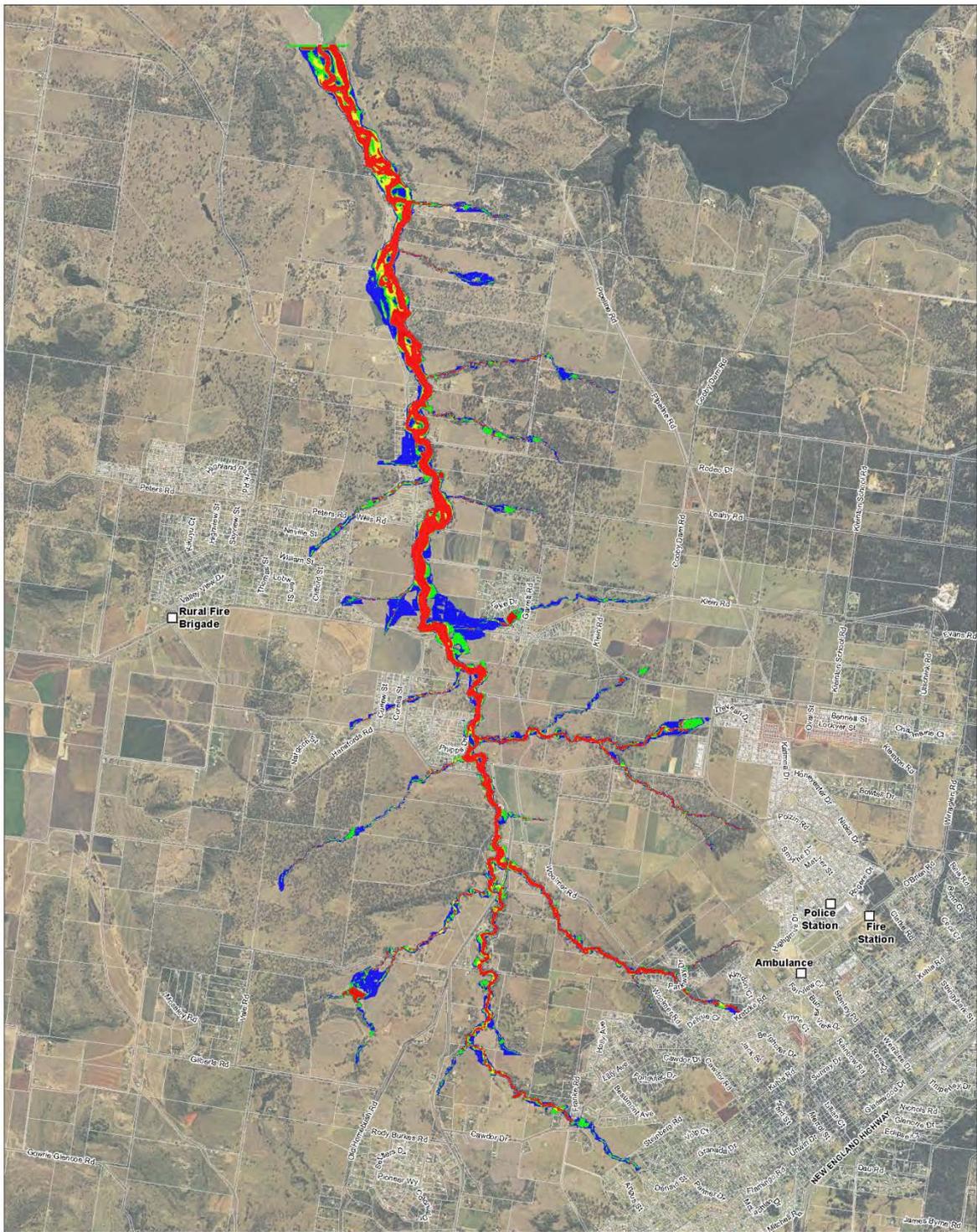
| | | | | | | | | | | | | | | | | | |
|---|--|--|--|---|--|---|--|--|--|--|--|--|--|--|--|---|---|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> <p>N</p> | <p>Legend</p> <table border="0"> <tr> <td>■ Low</td> <td>■ Significant</td> <td>■ High</td> <td>■ Extreme</td> <td> Emergency Services</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td> Rail</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td> Cadastre</td> </tr> </table> | ■ Low | ■ Significant | ■ High | ■ Extreme | Emergency Services | | | | | Rail | | | | | Cadastre | <p>MERINGANDAN 2% AEP Hazard Category</p> |
| ■ Low | ■ Significant | ■ High | ■ Extreme | Emergency Services | | | | | | | | | | | | | |
| | | | | Rail | | | | | | | | | | | | | |
| | | | | Cadastre | | | | | | | | | | | | | |
| <p><small>Disclaimer: The flood information contained in the maps is based on a dated flow and map data that was available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Tocwoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise. No all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in the maps being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of the plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Tocwoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Tocwoomba Regional Council - Information, Communications & Technology. No part of the Plan Information should be reproduced without the permission of the Coordinator (08 132 8800) or other designated representatives of Council (111872).</small></p> <p><small>Mapfile: \\p1\p1\GIS\2014_Flood_Study\MERINGANDAN_140516\MCDMFL_140516_23AEP.mxd Author: Dine parvula 24/09/2014</small></p> | | | | | | | | | | | | | | | | | |

Figure C.20 Hazard category map for 2% AEP event for existing condition



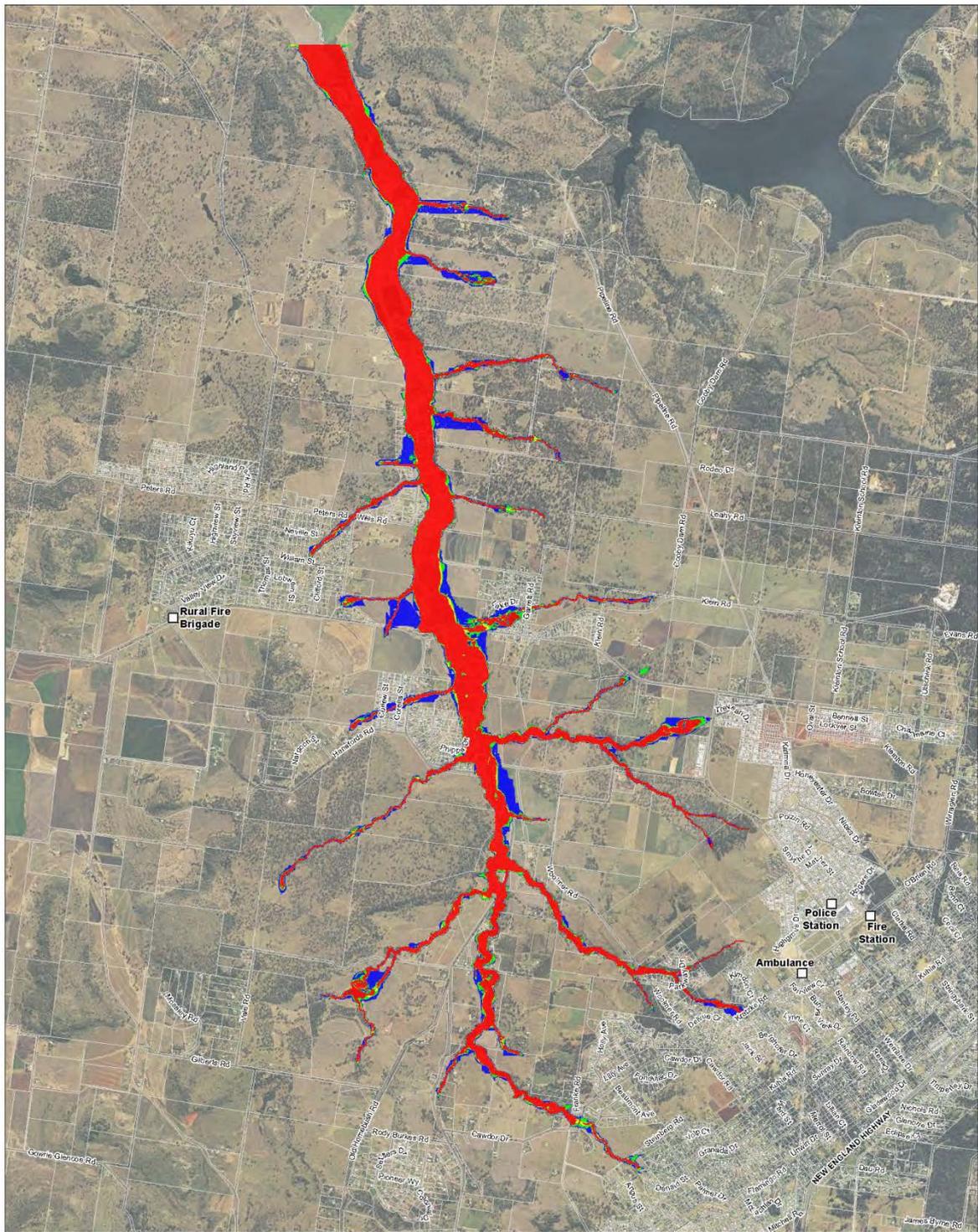
| | | | | | |
|--|--|--|---|--|---|
| | 1:32,000 (at A3) GDA 1994 MGA 2006 56 | | Legend Hazard Category Low (Blue) Significant (Green) High (Yellow) Extreme (Red) | Emergency Services Rail Cadastre | MERINGANDAN 1% AEP Hazard Category |
| | <small>Disclaimer: The flood information contained in the maps is based on dated flow and map data that was available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Toowoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility for all liability whether in contract, negligence or otherwise. No all expenses, losses, damages (including in direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in the maps being inaccurate or incomplete.</small> | | | | |

Figure C.21 Hazard category map for 1% AEP event for existing condition



| | | | | |
|---|---|--|---|---|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> |  | <p>Legend</p> <p>Hazard Category</p> <ul style="list-style-type: none"> ■ Low ■ Significant ■ High ■ Extreme | <p>Emergency Services</p> <ul style="list-style-type: none">  Rail  Cadastre | <p>MERINGANDAN 0.2% AEP Hazard Category</p> |
| | | | | |

Figure C.23 Hazard category map for 0.2% AEP event for existing condition



| | | | | |
|---|---|--|--|---|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> |  | <p>Legend</p> <p>Hazard Category</p> <ul style="list-style-type: none"> ■ Low ■ Significant ■ High ■ Extreme | <p>Emergency Services</p> <ul style="list-style-type: none">  Rail  Cadastral | <p>MERINGANDAN PMP Hazard Category</p> |
| | | | | |

Figure C.24 Hazard category map for PMP-DF event for existing condition

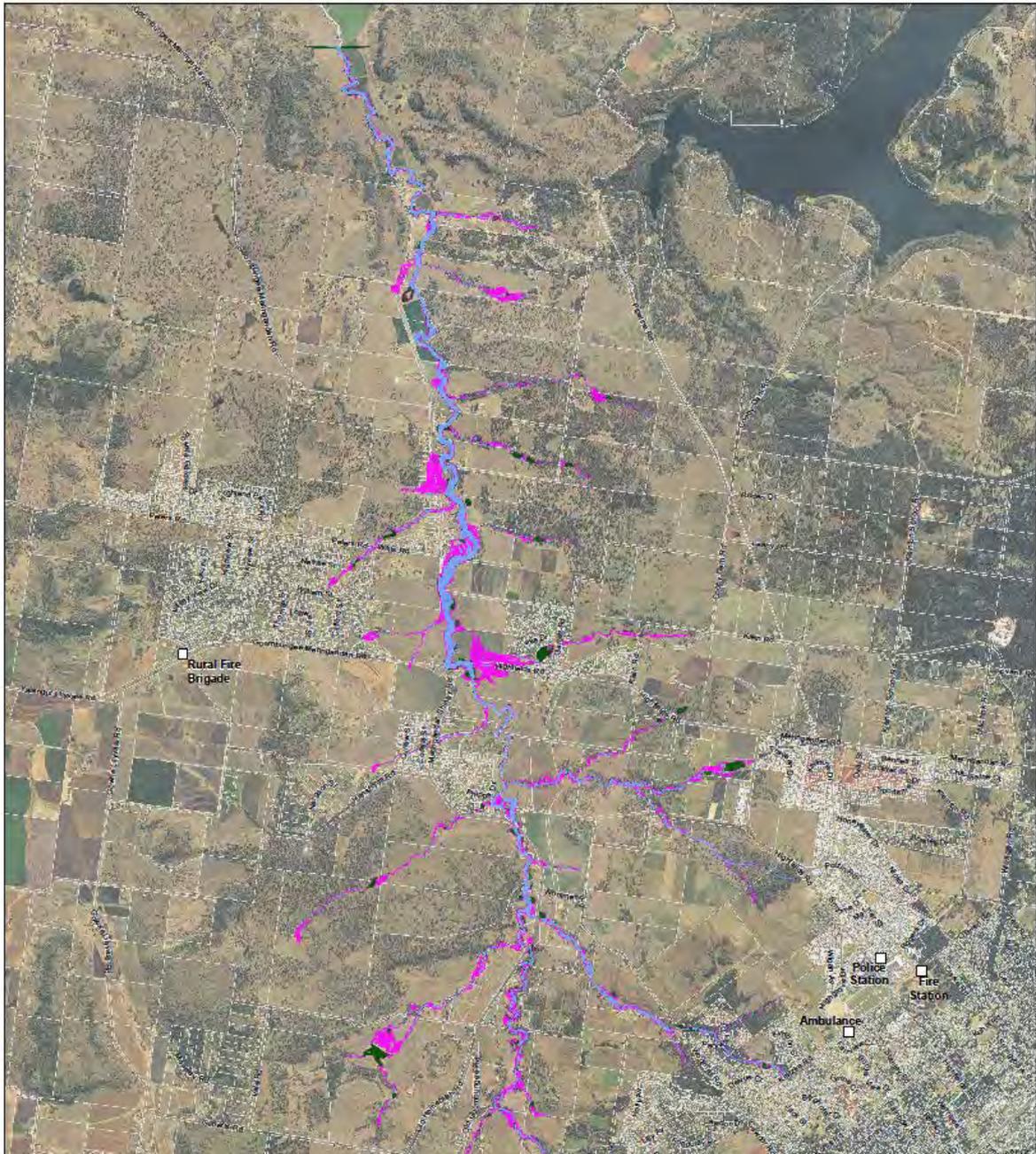


Figure C.25 Hydraulic category map for 20% AEP event for existing condition

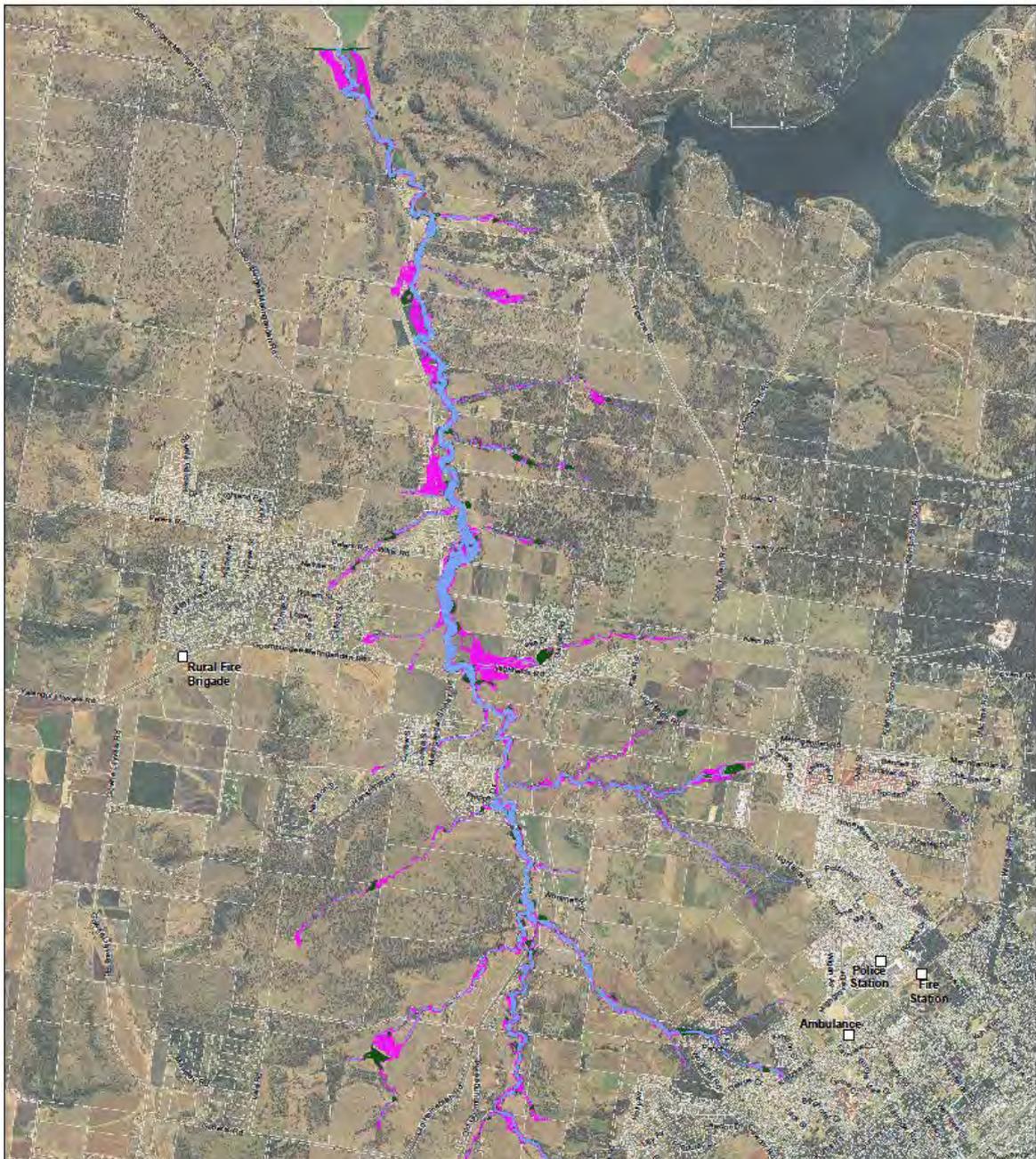


Figure C.26 Hydraulic category map for 10% AEP event for existing condition

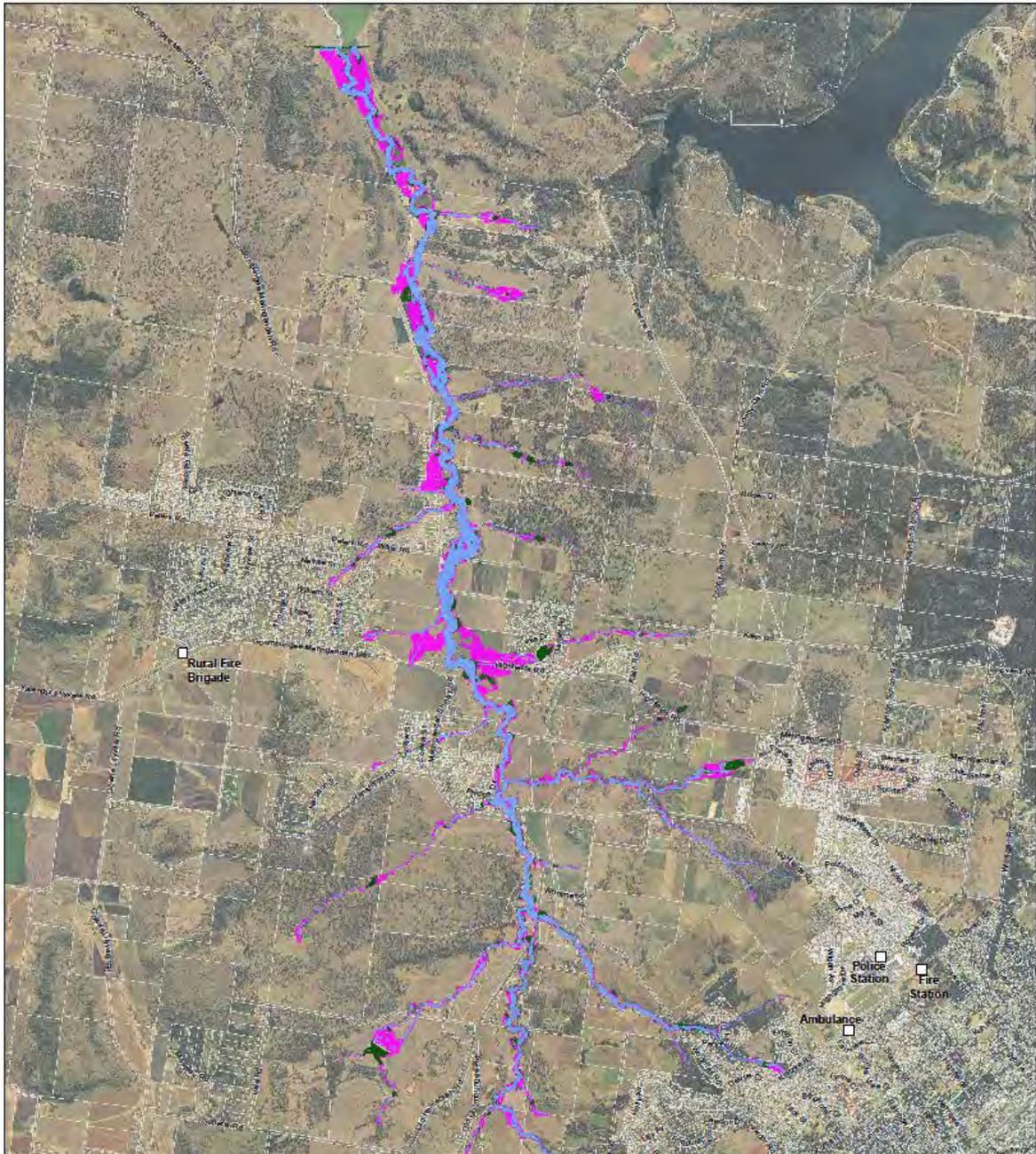


Figure C.27 Hydraulic category map for 5% AEP event for existing condition

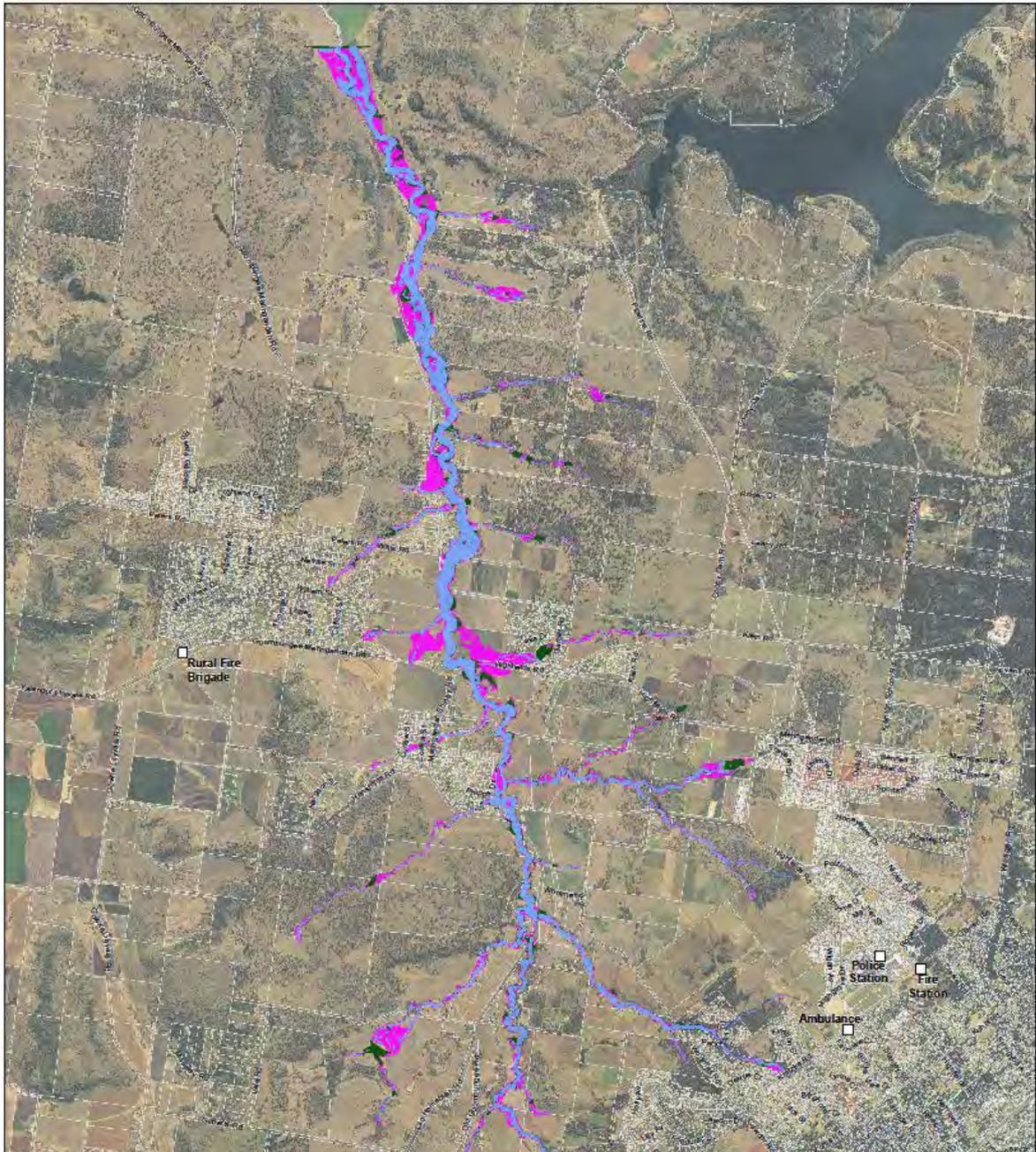


Figure C.28 Hydraulic category map for 2% AEP event for existing condition

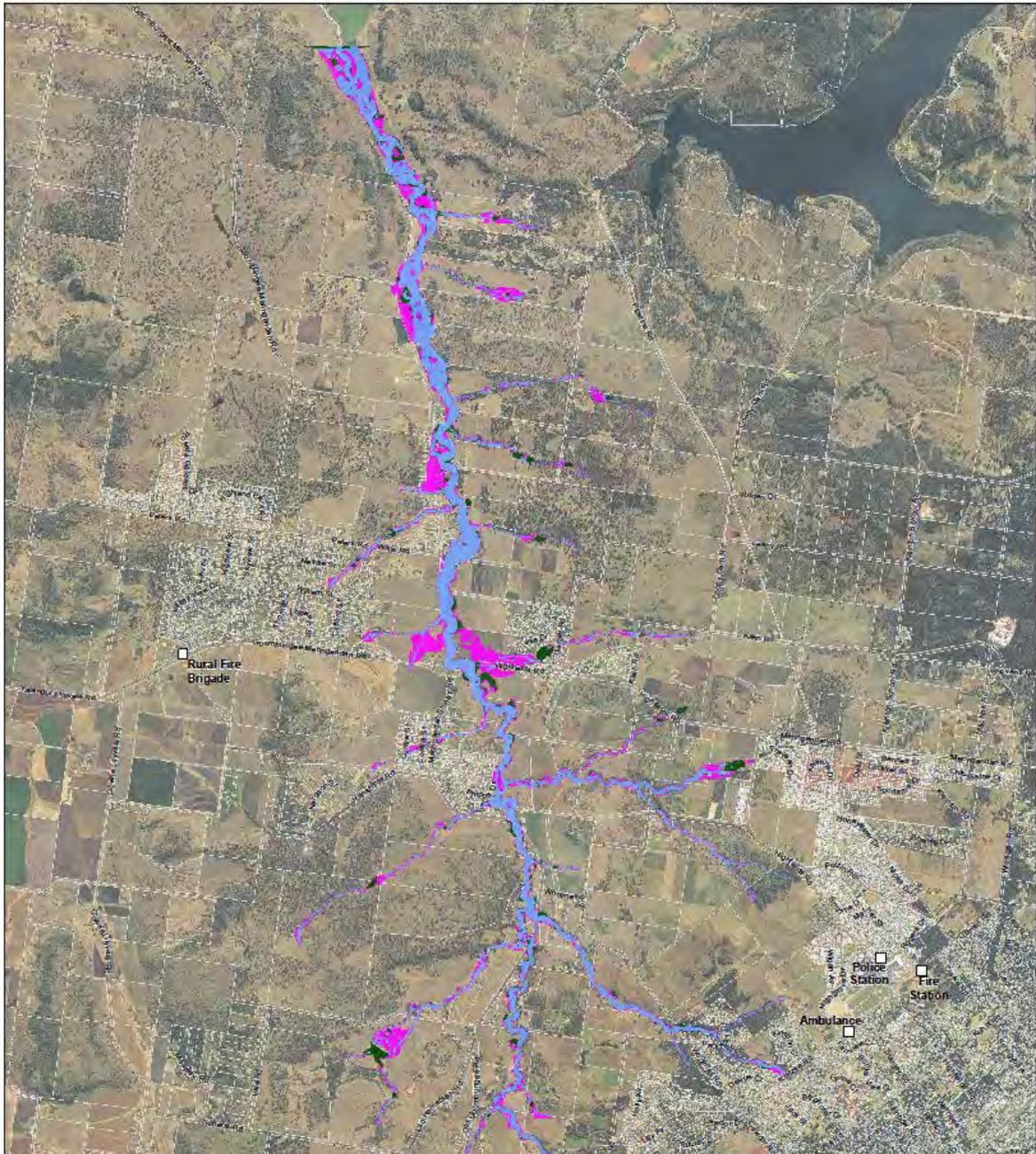


Figure C.29 Hydraulic category map for 1% AEP event for existing condition

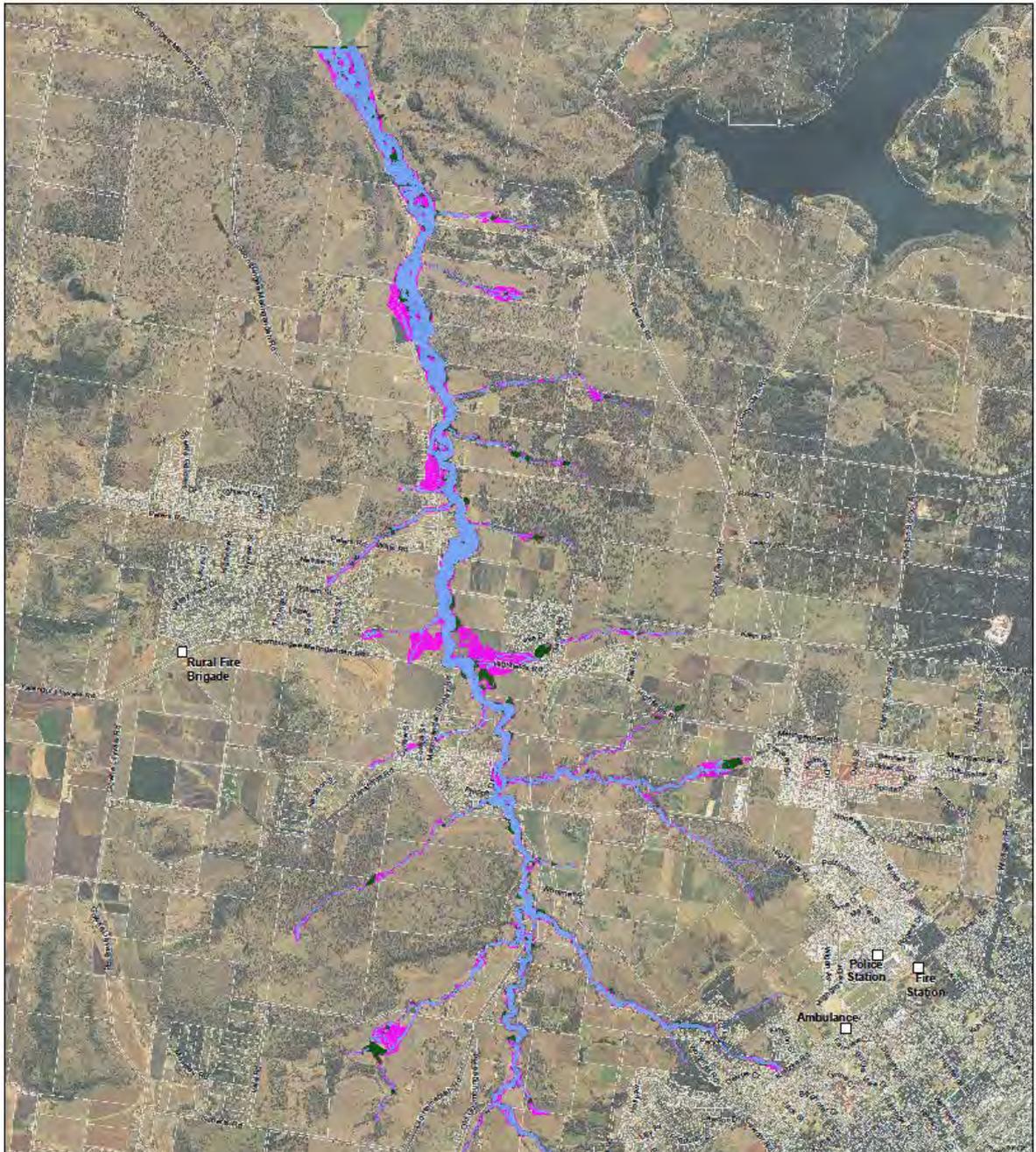


Figure C.30 Hydraulic category map for 0.5% AEP event for existing condition

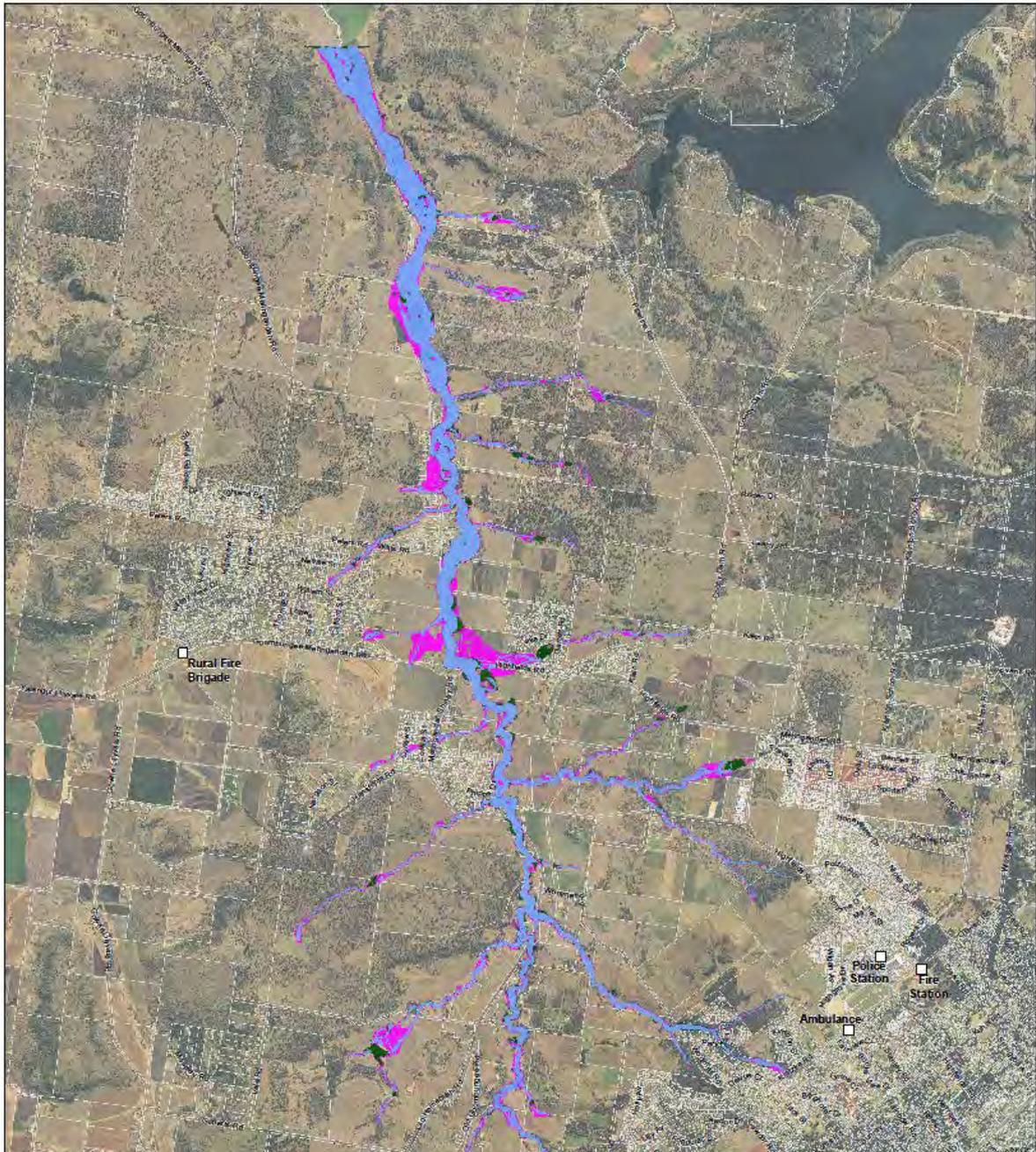


Figure C.31 Hydraulic category map for 0.2% AEP event for existing condition

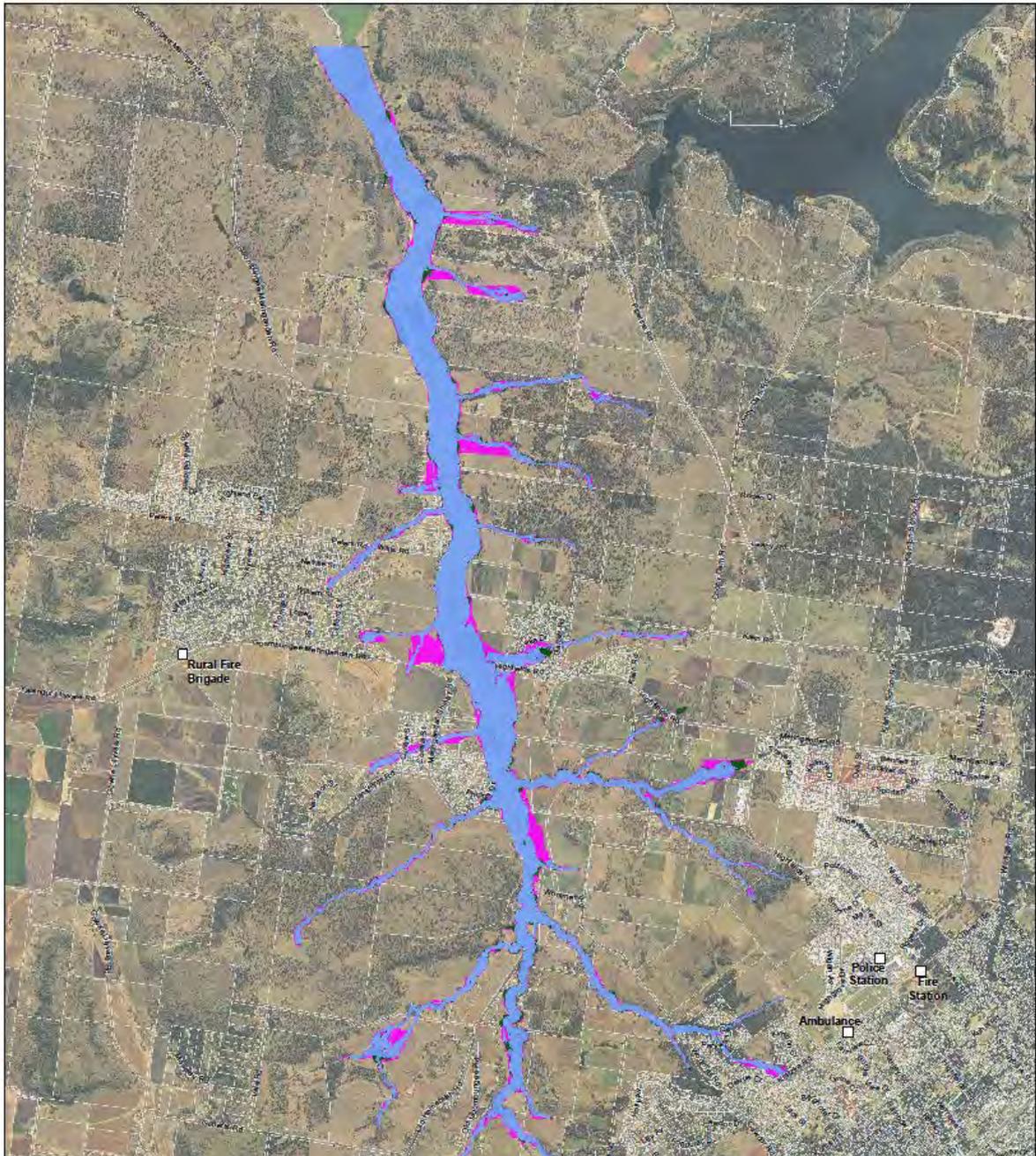


Figure C.32 Hydraulic category map for PMP-DF event for existing condition



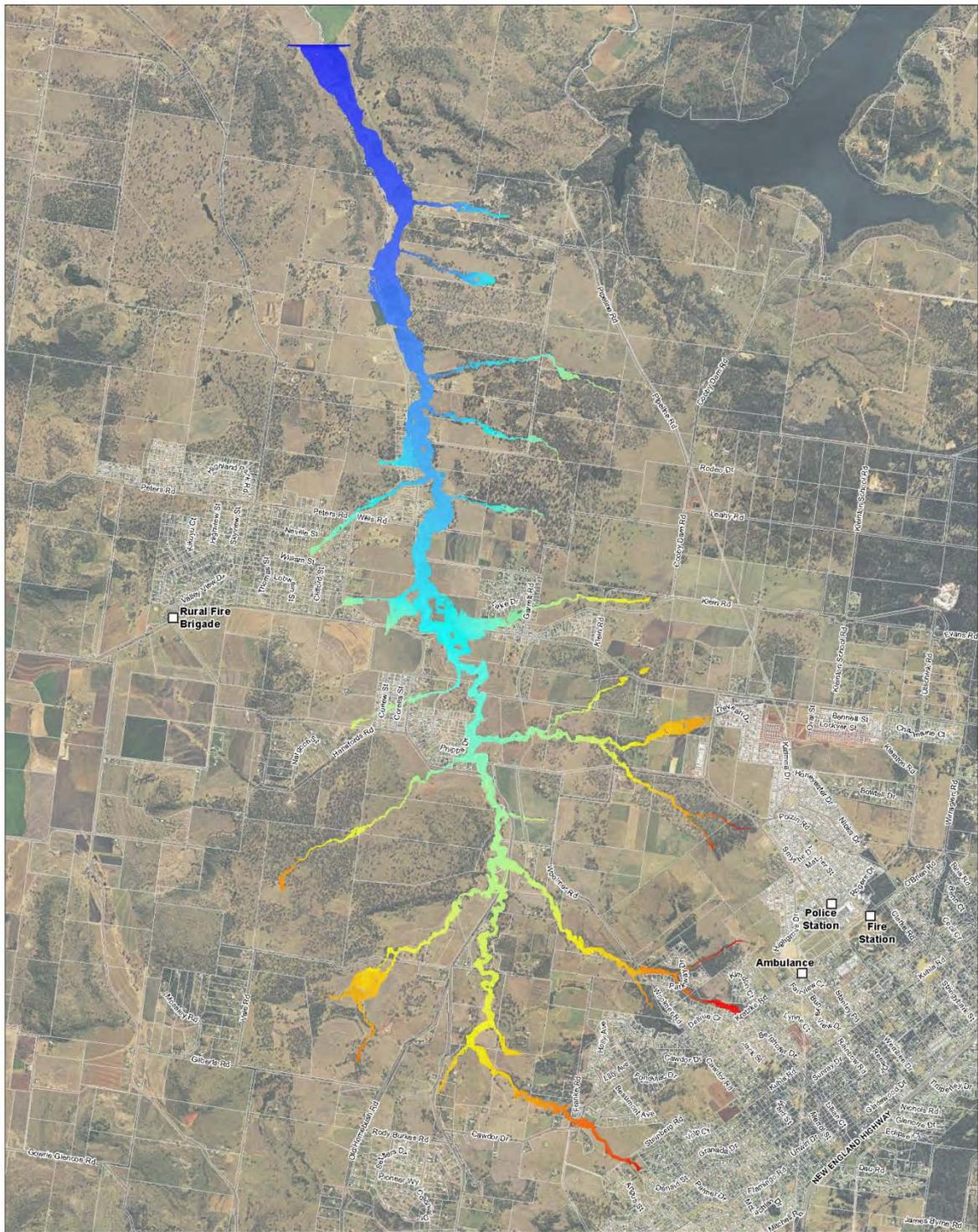
| | | | | | | |
|--|---|--|---|--|---|--|
| | 1:32,000 (at A3) GDA 1994 MGA 2006 NG | | Legend | | Emergency Services Rail Cadastral | MERINGANDAN 1% AEP Sensitivity Analysis |
| | 30% Reduction in Flow 30% Reduction in Roughness Baseline | | 30% Increase in Roughness 30% Increase in Flow | | | |

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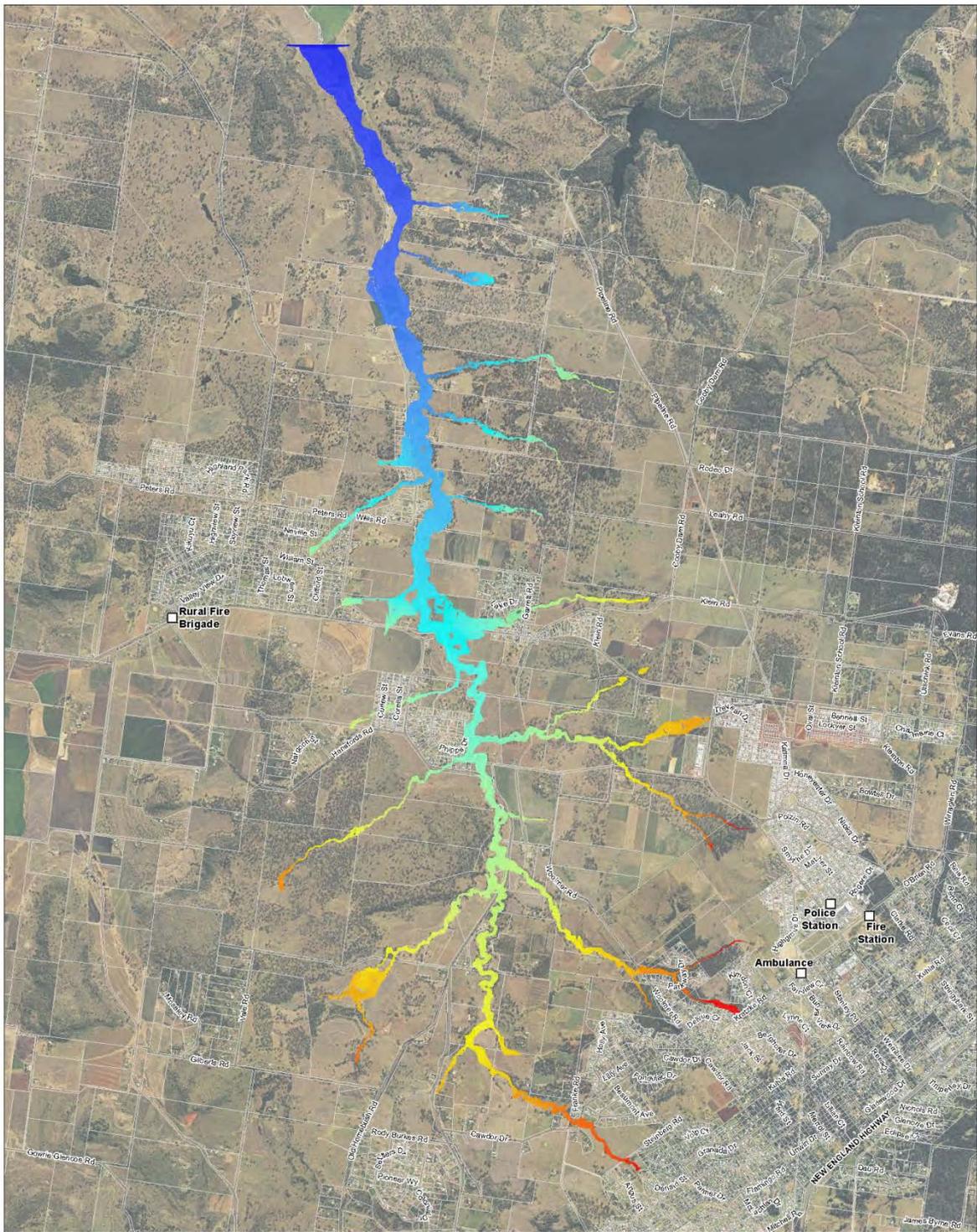
Mapfile:delly\FloodData\HFRG_2014_Flood_Sensitivity\MERINGANDAN_C1016\MODMER_Sensitivity_1% AEP.mxd Author:Gau: pures 14/05/2014

Figure C.33 Surface elevation map for sensitivity of flows and roughness for 1% AEP event of existing condition



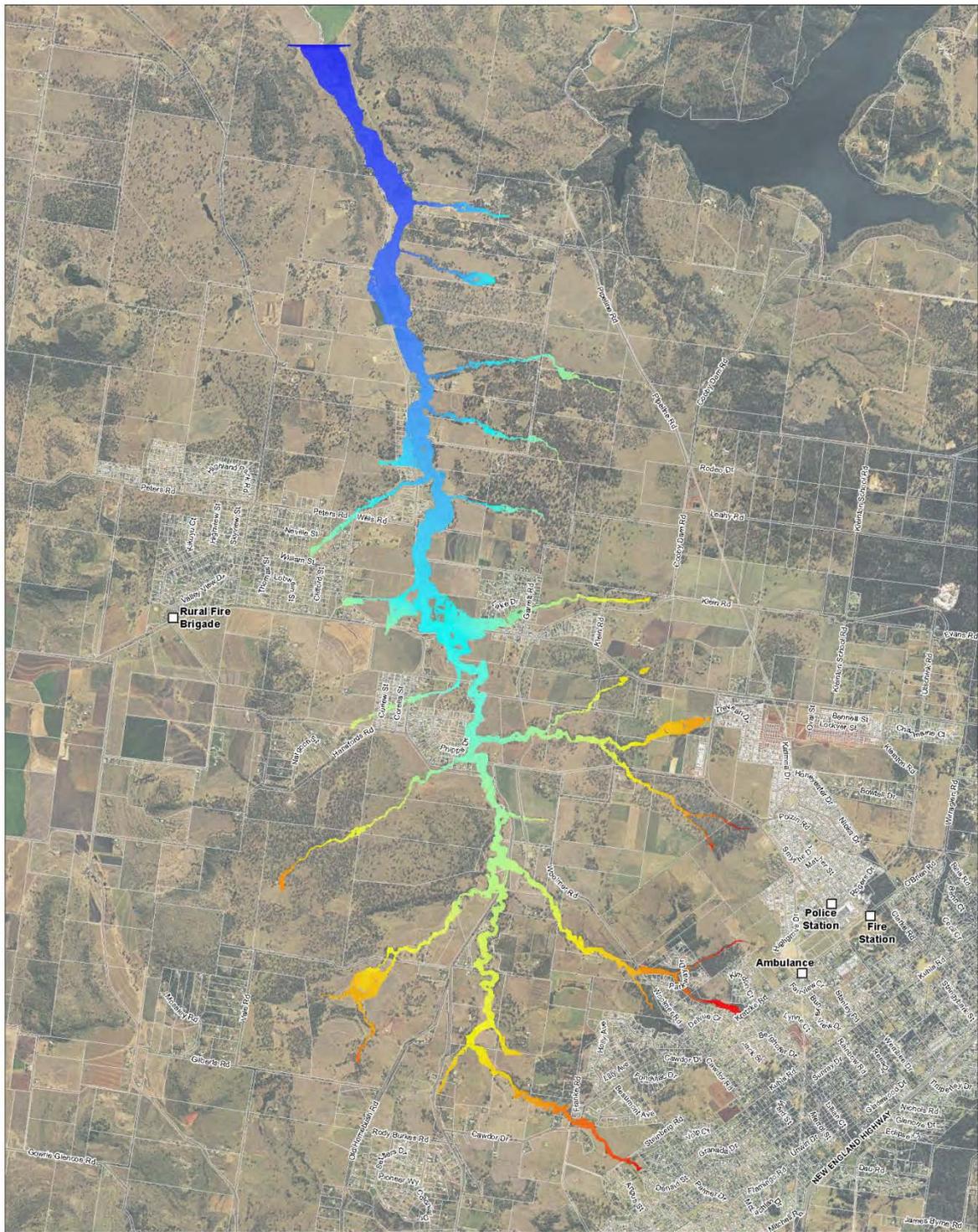
| | | |
|---|---|--|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>Legend</p> <p>Surface Elevation (m)</p> <p>High : 638</p> <p>Low : 526</p> <p>Emergency Services</p> <p>Rail</p> <p>Cadastré</p> | <p align="center">MERINGANDAN 1% AEP 2050 Climate Change Scenario Water Surface Elevation</p> |
| <p><small>Disclaimer: The flood information contained in this map is based on identified and marked that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Tocwoomba Regional Council makes no representation or warranty about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Tocwoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Tocwoomba Regional Council. Inquiries, Communications & Technology. No part of the Plan Information should be reproduced without the permission of the Coordinator (08 137 8800), or other designated representatives of Council (11377).</small></p> <p><small>MapViewData\FloodData\HTRC_2014_Flood_Studies\MERINGANDAN_C1016\MODMERF_ChrisChange_L1_AEP_2050.mxd Author:Date: june 04 24/06/2014</small></p> | | |

Figure C.34 Surface elevation map for climate change for 2050 design horizon of 1% AEP event for existing condition



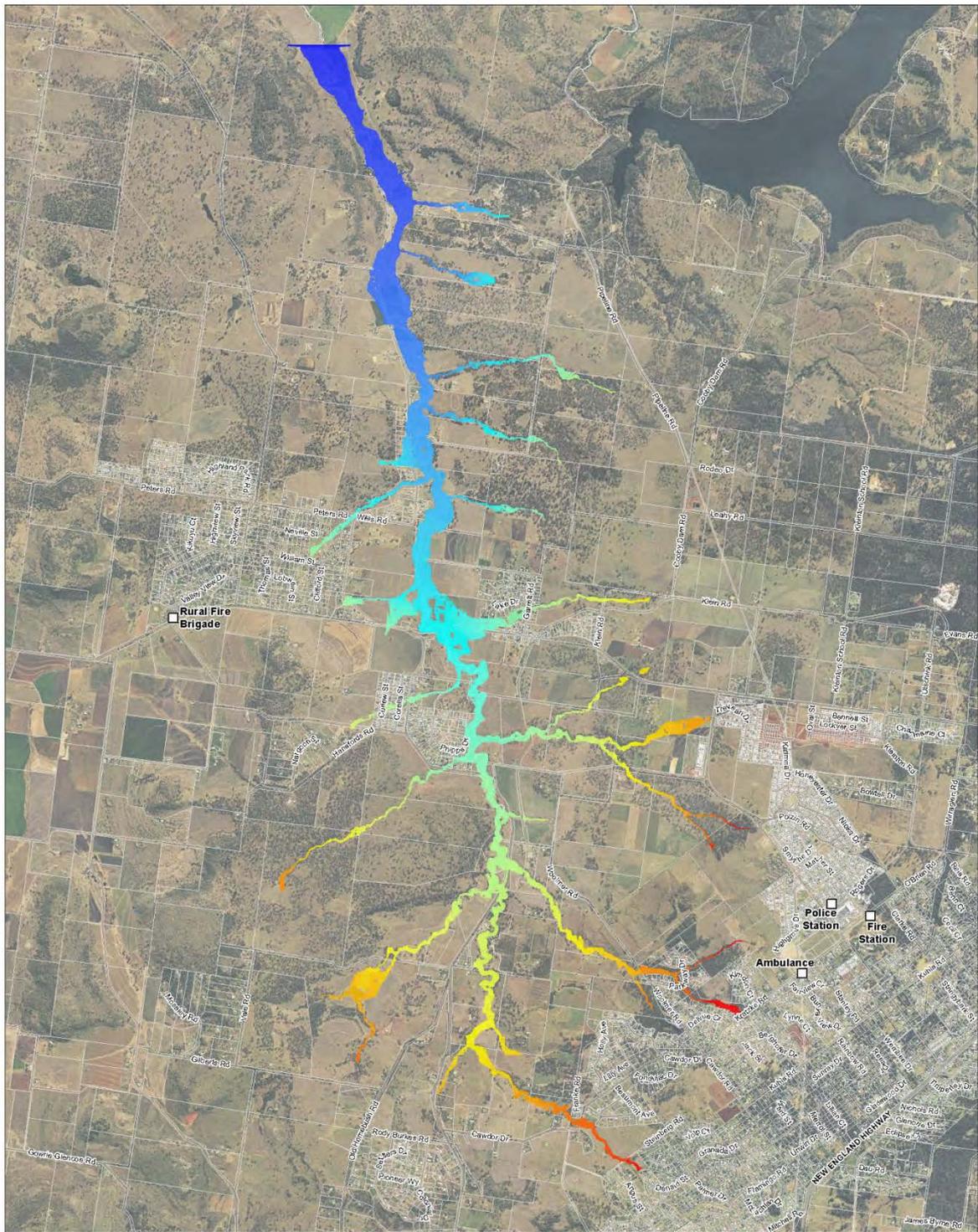
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|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>Legend</p> <p>Surface Elevation (m)  High: 638 Low: 526</p> <p> Emergency Services</p> <p> Rail</p> <p> Cadastre</p> | <p align="center">MERINGANDAN 1% AEP 2070 Climate Change Scenario Water Surface Elevation</p> |
| <p><small>Disclaimer: The flood information contained in this map is based on identified flood and marks that were available and accessible at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Toowoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability whether in contract, negligence or otherwise. No all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Toowoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Toowoomba Regional Council. Inquiries, Communications & Technology. No part of the Plan Information should be reproduced without the permission of the Coordinator (55 107 Branch), or other designated representatives of Council (111873).</small></p> <p><small>MapViewData\FloodData\HFR_2014_Flood_Studies\MERINGANDAN_C1016\MODMERF_ChrisChange_11_AEP_2070.mxd Author:Date: june 04 24/06/2014</small></p> | | |

Figure C.35 Surface elevation map for climate change for 2070 design horizon of 1% AEP event for existing condition



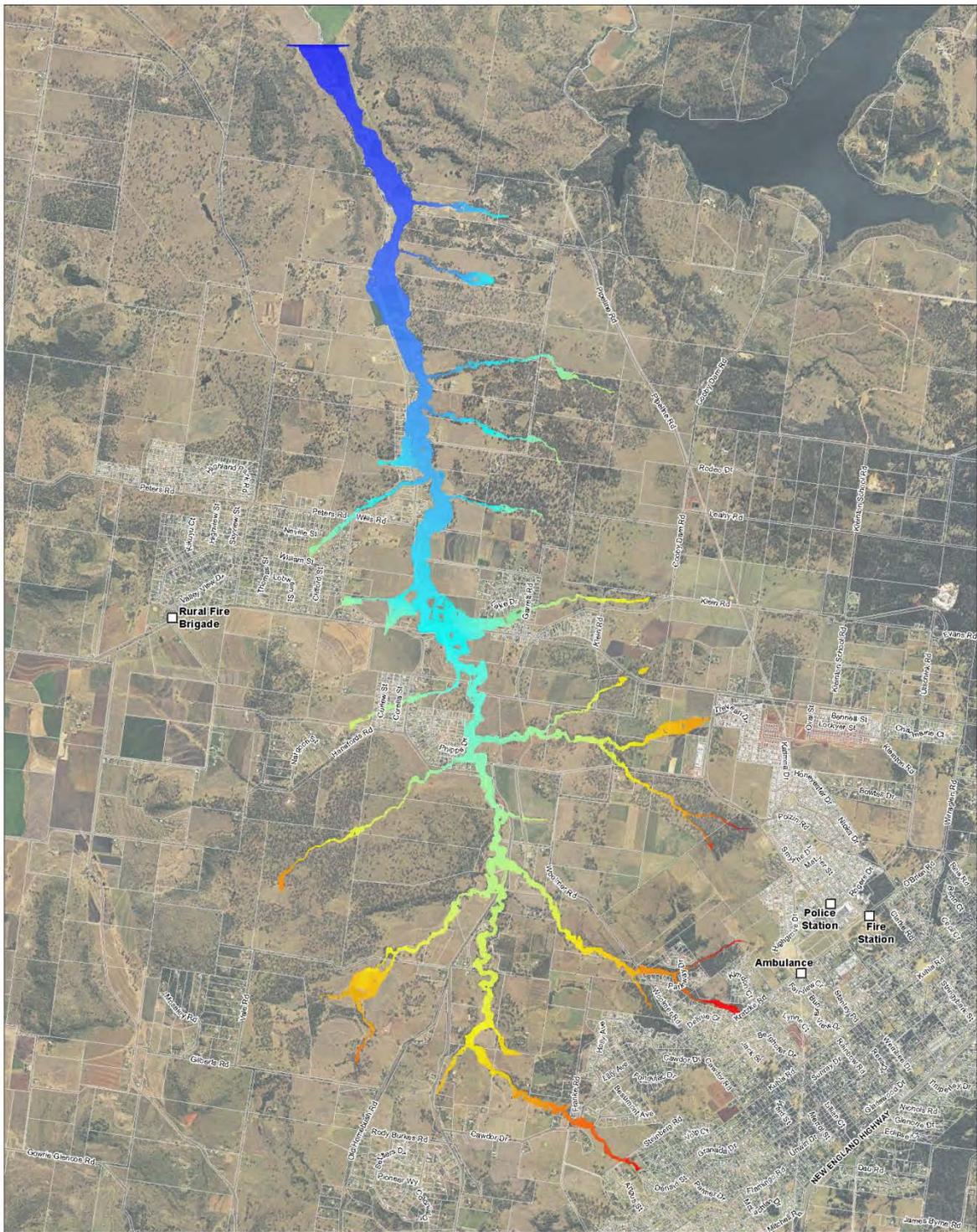
| | | |
|--|---|--|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>Legend</p> <p>Surface Elevation (m)  High: 638 Low: 526</p> <p> Emergency Services  Rail  Cadastre</p> | <p align="center">MERINGANDAN 1% AEP 2100 Climate Change Scenario Water Surface Elevation</p> |
| <p><small>Disclaimer: The flood information contained in this map is based on identified flood and marks that were available and accessible at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Toowoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Toowoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Toowoomba Regional Council. Inquiries, Communications & Technology. No part of the Plan Information should be reproduced without the permission of the Coordinator (07 137 1600), or other designated representatives of Council (111873).</small></p> <p><small>M:\new\delly\FloodData\TRC_2014_Flood_Studies\MERINGANDAN\C1016\MODMER_Chris\Change_L1_AEP_100.mxd Author:Date: june 04 2009 02:14</small></p> | | |

Figure C.36 Surface elevation map for climate change for 2100 design horizon of 1% AEP event for existing condition



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|---|--|--|---|--|
| <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | | Legend Surface Elevation (m) | Emergency Services Rail Cadastral | MERINGANDAN 0.5% AEP 2050 Climate Change Scenario Water Surface Elevation |
| | | <small>Disclaimer: The flood information contained in this map is based on identified flood marks that were visible and accessible at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Tocmoomba Regional Council makes no representation or warranty about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small> | | |

Figure C.37 Surface elevation map for climate change for 2050 design horizon of 0.5% AEP event for existing condition



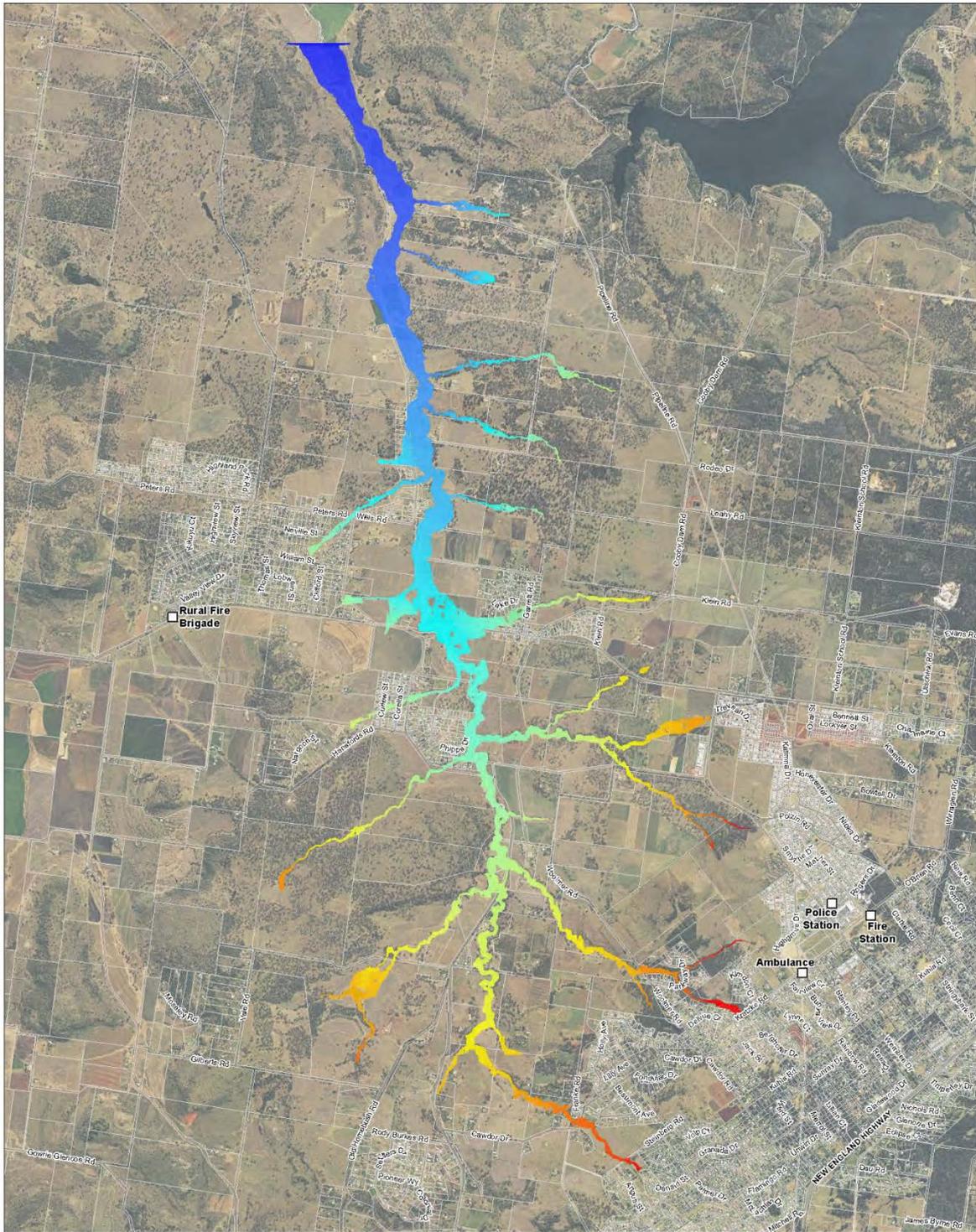
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| <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | | Legend Surface Elevation (m) | <input type="checkbox"/> Emergency Services <input type="checkbox"/> Rail <input type="checkbox"/> Cadastre |
| | | MERINGANDAN 0.5% AEP 2070 Climate Change Scenario Water Surface Elevation | |

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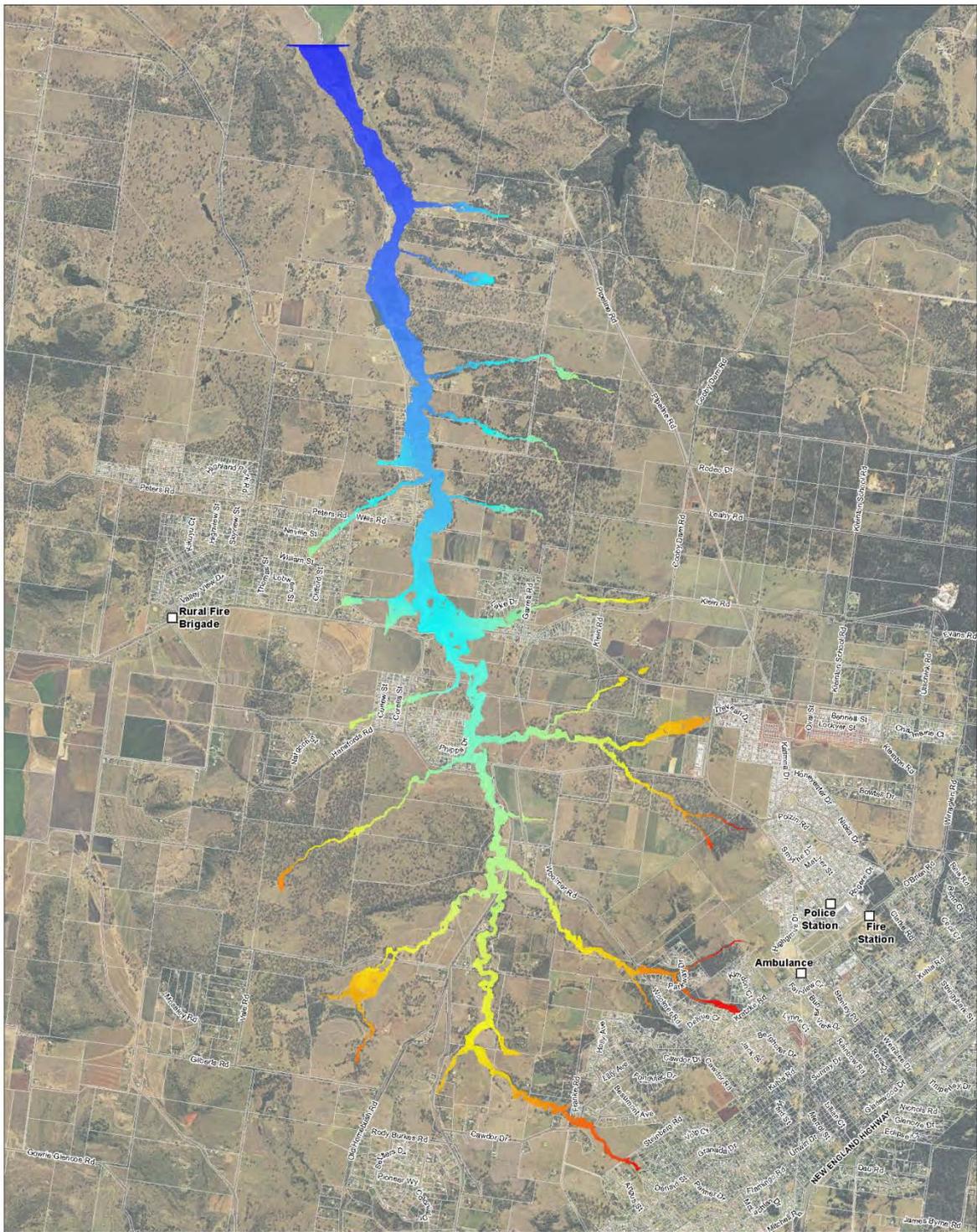
\\ntw06d01g\p\o\oas\IT\RC_2014_Flood_Study\MERINGANDAN_C10\05\MODMERF_Chris\Change_0.5%_AEP_2070.mxd Author:Date: per:aria 24/09/2014

Figure C.38 Surface elevation map for climate change for 2070 design horizon of 0.5% AEP event for existing condition



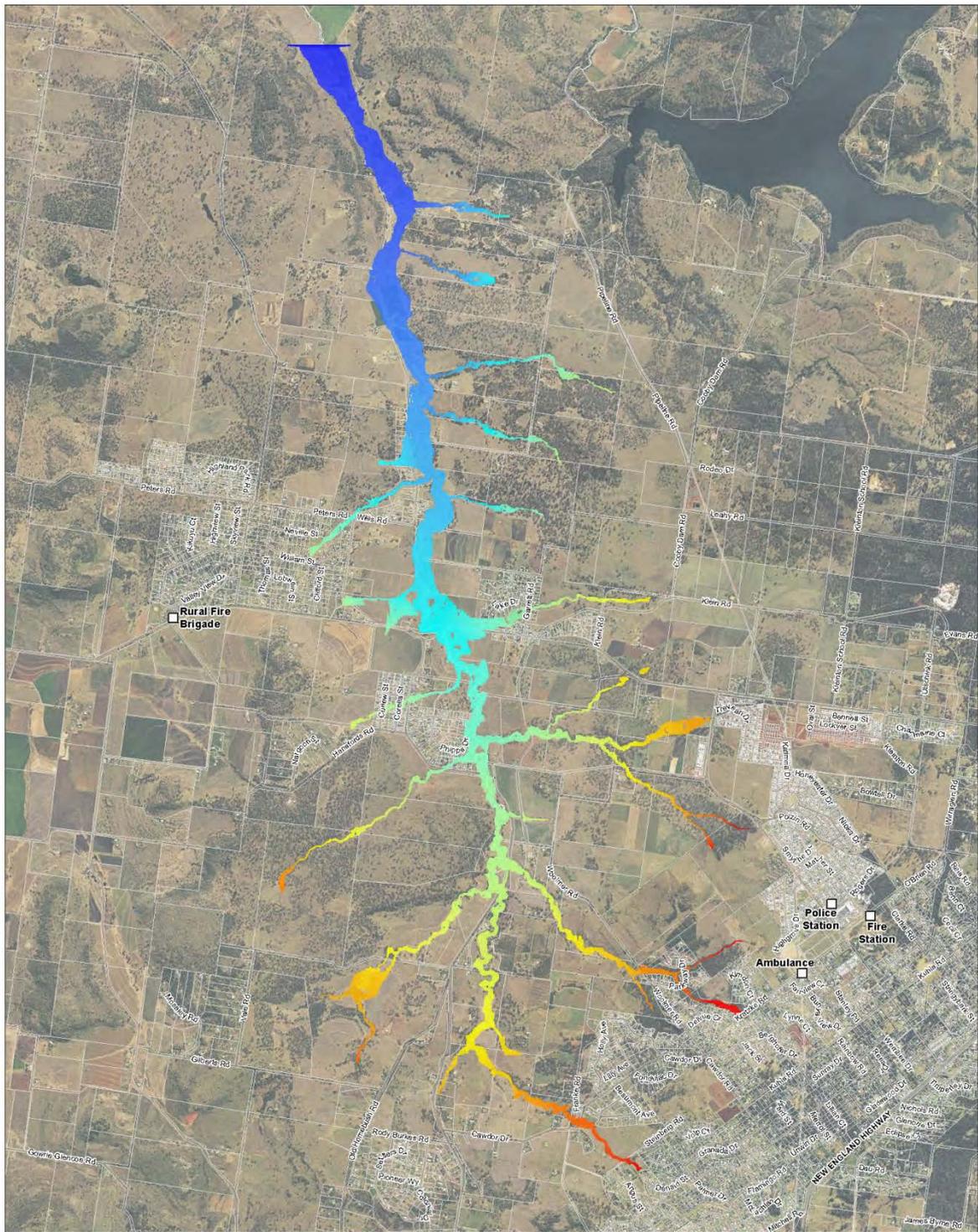
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|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> |  | Legend Surface Elevation (m)  |  Emergency Services  Rail  Cadastré | MERINGANDAN 0.5% AEP 2100 Climate Change Scenario Water Surface Elevation |
| | | <small>Disclaimer: The flood information contained in this map is based on identified and marked that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Tocmoomba Regional Council makes no representation or warranty about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small> | | |

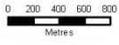
Figure C.39 Surface elevation map for climate change for 2100 design horizon of 0.5% AEP event for existing condition



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|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>Legend</p> <p>Surface Elevation (m)</p> <p>High : 638</p> <p>Low : 526</p> <p>Emergency Services</p> <p>Rail</p> <p>Cadastré</p> | <p align="center">MERINGANDAN</p> <p align="center">0.2% AEP 2050 Climate Change Scenario</p> <p align="center">Water Surface Elevation</p> |
| <p><small>Disclaimer: The flood information contained in this map is based on identified flood marks that were visible and accessible at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Toowoomba Regional Council makes no representation or warranty about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Toowoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Toowoomba Regional Council. Inquiries, Communications & Technology. No part of the Plan Information should be reproduced without the permission of the Coordinator (07 137 1600), or other designated representatives of Council (11377).</small></p> <p><small>\\nsw-ds\g\p\docs\ITRC_2014_Flood_Studies\MERINGANDAN_C14016\MK\MERF_ChrmChange_0.2%_AEP_2050.mxd Author:Date: per:ms 24/09/2014</small></p> | | |

Figure C.40 Surface elevation map for climate change for 2050 design horizon of 0.2% AEP event for existing condition

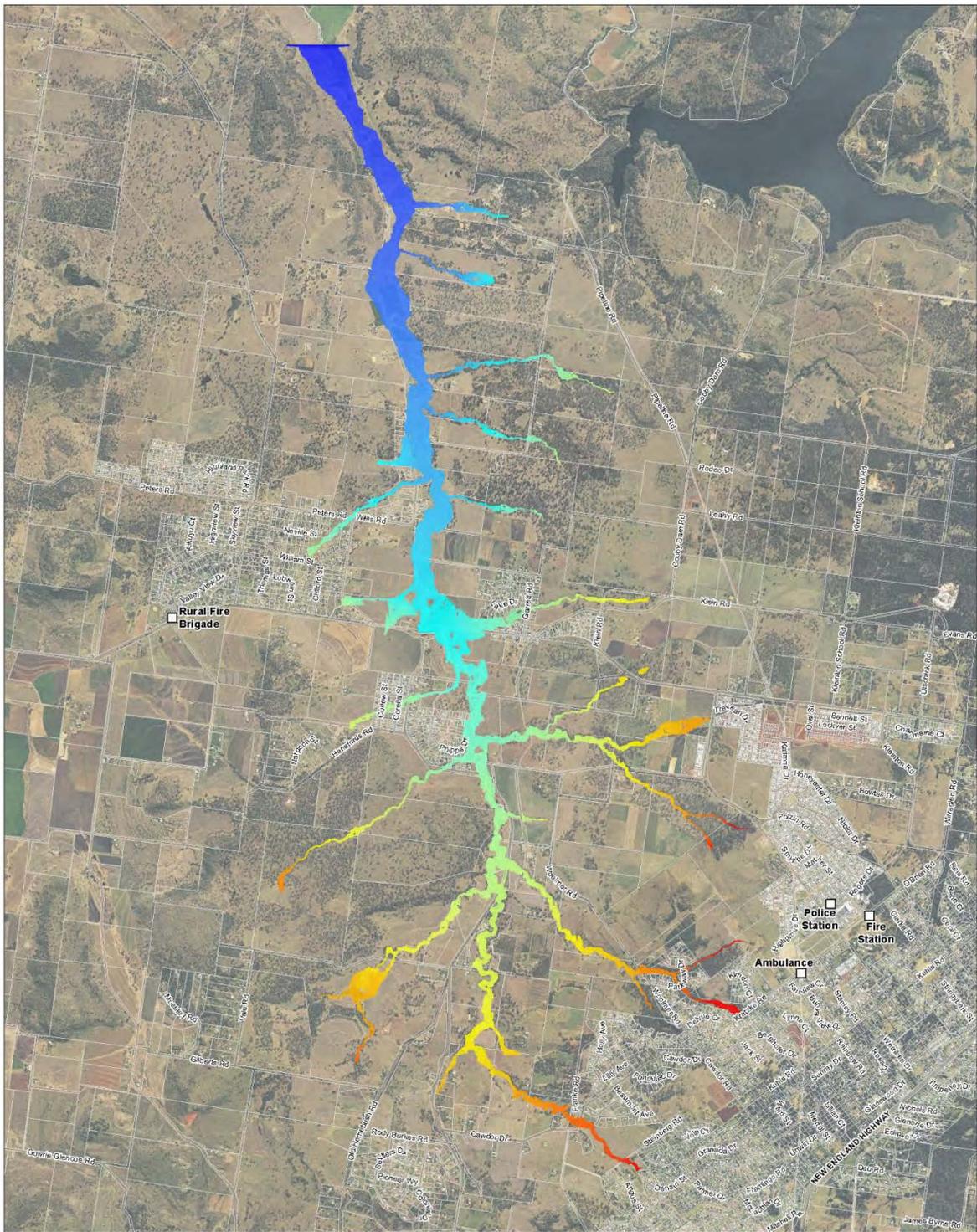


| | | | | |
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|  | 1:32,000 (at A3)  <small>GDA 1994 MGA 2006 86</small> |  | Legend Surface Elevation (m)  | <input type="checkbox"/> Emergency Services |
| |  Rail <input type="checkbox"/> Cadastre | | | |

MERINGANDAN
0.2% AEP 2070 Climate Change Scenario
Water Surface Elevation

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Figure C.41 Surface elevation map for climate change for 2070 design horizon of 0.2% AEP event for existing condition



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|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>N</p>  | <p>Legend</p> <p>Surface Elevation (m)</p>  <p>High : 638 Low : 526</p> <p>Emergency Services Rail Cadastral</p> | <p align="center">MERINGANDAN 0.2% AEP 2100 Climate Change Scenario Water Surface Elevation</p> |
| <p><small>Disclaimer: The flood information contained in this map is based on identified and marked that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Tocwoomba Regional Council makes no representation or warranty about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and liability whether in contract, negligence or otherwise. No liability for expenses, losses, damages (including direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in this map being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of this plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Tocwoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Tocwoomba Regional Council. Inquiries, Communications & Technology. No part of the Plan Information should be reproduced without the permission of the Coordinator (08 137 8800), or other designated representatives of Council (11377).</small></p> <p><small>F:\Work\Data\TRC_2014_Flood_Studies\MERINGANDAN_CPO\EMD\MER_MDP\MapChange_0.2%_AEP_2100.mxd Author:DLB Date: 24/08/2014</small></p> | | | |

Figure C.42 Surface elevation map for climate change for 2100 design horizon of 0.2% AEP event for existing condition



| | | |
|--|--|--|
|  <p>1:32,000 (at A3)</p> <p>0 200 400 600 800 Metres</p> <p>GDA 1994 MGA 2006 NG</p> | <p>Legend</p> <p>□ Baseline</p> <p>■ 50% Blockage of Structures</p> <p>□ Emergency Services</p> <p>— Rail</p> <p>□ Cadastre</p> | <p>MERINGANDAN</p> <p>1% AEP Blockage Analysis</p> |
| <p><small>Disclaimer: The flood information contained in this map is based on digital data and maps that were available at the time of recording after the January 2011 flood event and may not be accurate or complete and reliance should not be placed on it. Toowoomba Regional Council makes no representations or warranties about the accuracy, reliability, completeness or suitability for any particular purpose and disclaims all responsibility and all liability whether in contract, negligence or otherwise, for all expenses, losses, damages (including in direct or consequential damages) and costs which may be incurred in any way and for any reason as a result of the flood information contained in the maps being inaccurate or incomplete.</small></p> <p><small>Disclaimer: Whilst all due care has been taken in the preparation of the plan and all information is referred to as "Plan Information", the accuracy of the Plan Information cannot be guaranteed. The Plan Information is provided as a guide and should not be relied upon in any way whatsoever. Toowoomba Regional Council takes no responsibility for inaccuracies in the Plan Information and is not liable under any circumstances for any loss or damage whatsoever or howsoever caused arising directly or indirectly in connection with its use. The recipient must verify the Plan Information on site. Please refer any discrepancies to Toowoomba Regional Council. In Internet, Communications & Technology, the use of the Plan Information should be reproduced without the permission of the Coordinator (S) ICT Branch, or other designated representatives of Council (11/1873).</small></p> <p><small>Mapfile:///C:/Users/NTFRS_2014/Flood_Studies/MERINGANDAN_C14016/MKDWEL/Blockage_1%_AEP.mxd Author/DW/pjones 24/08/2014</small></p> | | |

Figure C.43 Surface elevation map for structure blockage of 1% AEP event for existing condition



131 872 | info@tr.qld.gov.au | www.tr.qld.gov.au
PO Box 3021 Toowoomba QLD 4350 | Toowoomba Regional Council



yoursay.toowoombaRC.qld.gov.au/flood-resilience

A safer, stronger, more resilient region

Financially, socially and
environmentally sustainable



**TOOWOOMBA
REGION**
Rich traditions. Bold ambitions.

Meringandan Flood Studies Information Sheet

WHY UNDERTAKE FLOOD STUDIES?

Following extensive flooding across the Toowoomba region, we commissioned a number of flood studies to better understand how flooding can impact our communities. These studies are now complete and available on our website.

The flood studies found that flood behaviour can be complex and vary between locations, depending on landscape, infrastructure and rainfall pattern.

SOME BASIC FLOOD TERMS

- 1 Overland flow** – short duration flooding of backyards, drainage paths, streets and rural properties caused by stormwater as it makes its way into the creek/river system;
- 2 Creek flooding** – short to medium duration flooding caused by creeks rising and breaking their banks, which can then flood nearby homes, businesses and rural properties;
- 3 River flooding** – longer duration flooding caused by significant rises in a river which can break its banks in the same way as smaller creeks.

Most of the studies undertaken or commissioned by Council relate to the first two types of flooding – overland flow and creek flooding. It's important to note that these types of flooding can occur separately or together.

KEY MESSAGES

1. Council has a legislative requirement to undertake flood management and the whole community needs to be involved.
2. Flood studies are a foundation and an essential step towards our goal of a safer, stronger, more resilient region.
3. Flood studies have been undertaken by specialist engineers and incorporate the latest data, modelling techniques and community input.
4. Community consultation enables two-way information sharing about the project to increase community awareness, enhance decision making and help achieve our goal of a safer, stronger, more resilient region.

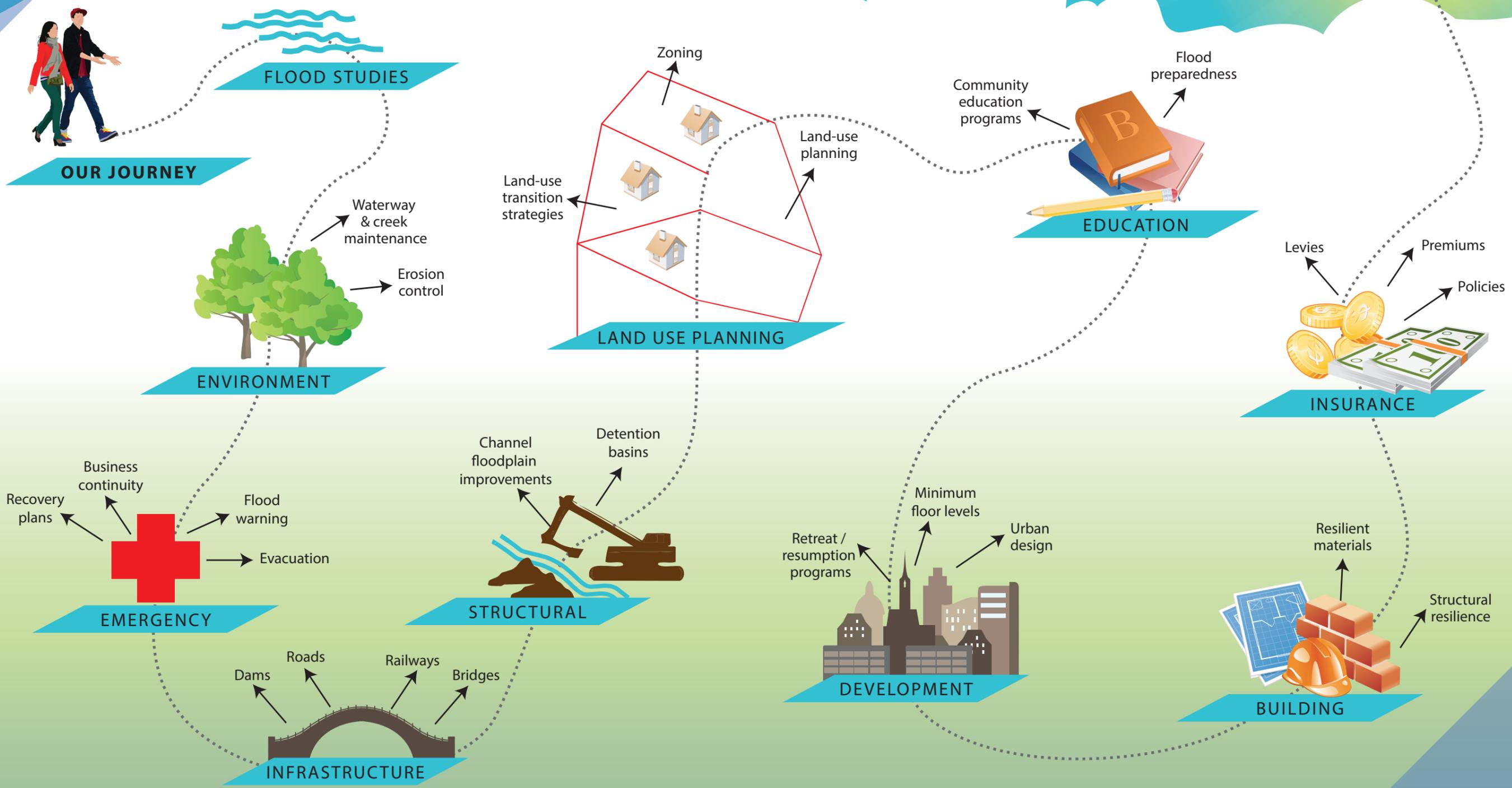
Flood + us - our journey

Steps on the path to achieving our goal

**A safer,
stronger,
more resilient
region**

Financially, socially and environmentally sustainable

OUR GOAL





Meringandan Flood Studies Information Sheet

WHAT'S MERINGANDAN'S FLOOD STORY?

A flood study and flood maps are now available for Meringandan residents. The main source of flooding for the town results from creek flooding.

From the head waters in Highfields, Meringandan Creek flows north-west between the towns of Meringandan and Meringandan West before discharging to Cooby Creek downstream of Cooby Dam and upstream of the confluence of Gomaren Creek.

The study modelled a range of flooding scenarios within the study area, from frequent small floods up to large, rare and extreme floods. The study was able to replicate observed flood levels for the events across December 2010/January 2011. Six locations within the catchment area showed roads and bridges flowing over, including Max Volp Crossing on Oakey-Meringandan Road being flooded on several occasions throughout the December 2010/January 2011 flood events.

Annual Exceedance Probability (AEP) means the chance of a flood of a given size or larger size occurring in any one year, usually expressed as a percentage.

COMMUNITY INVOLVEMENT

Improving the way we prepare for and respond to flooding as a community is very important to us. Many residents in our region contributed information to build and validate our flood knowledge during the region-wide consultation sessions and other flood studies engagement opportunities.

Community involvement with this project continues to help our region become safer, stronger and more resilient. We encourage you to access the flood study information online and stay up to date with the project by visiting the web address below.

GET INFORMED

You can access our region's current flood studies and maps by heading to <http://yoursay.toowoombarc.qld.gov.au/flood-resilience>
For more information, please contact the project team by phone, email or post.

Phone: 131 872

Email: info@tr.qld.gov.au

Post: Strategic Planning & Economic Development,
Toowoomba Regional Council, PO Box 3021, Toowoomba Q 4350.



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