bega valley shire council

Pambula River, Pambula Lake and Yowaka River Flood Study

Draft Report for Public Exhibition

Volume 1 of 2: Report Text & Appendices





Revision 2
January 2021

Catchment Simulation Solutions

Pambula River, Pambula Lake and Yowaka River Flood Study

Draft Report for Public Exhibition

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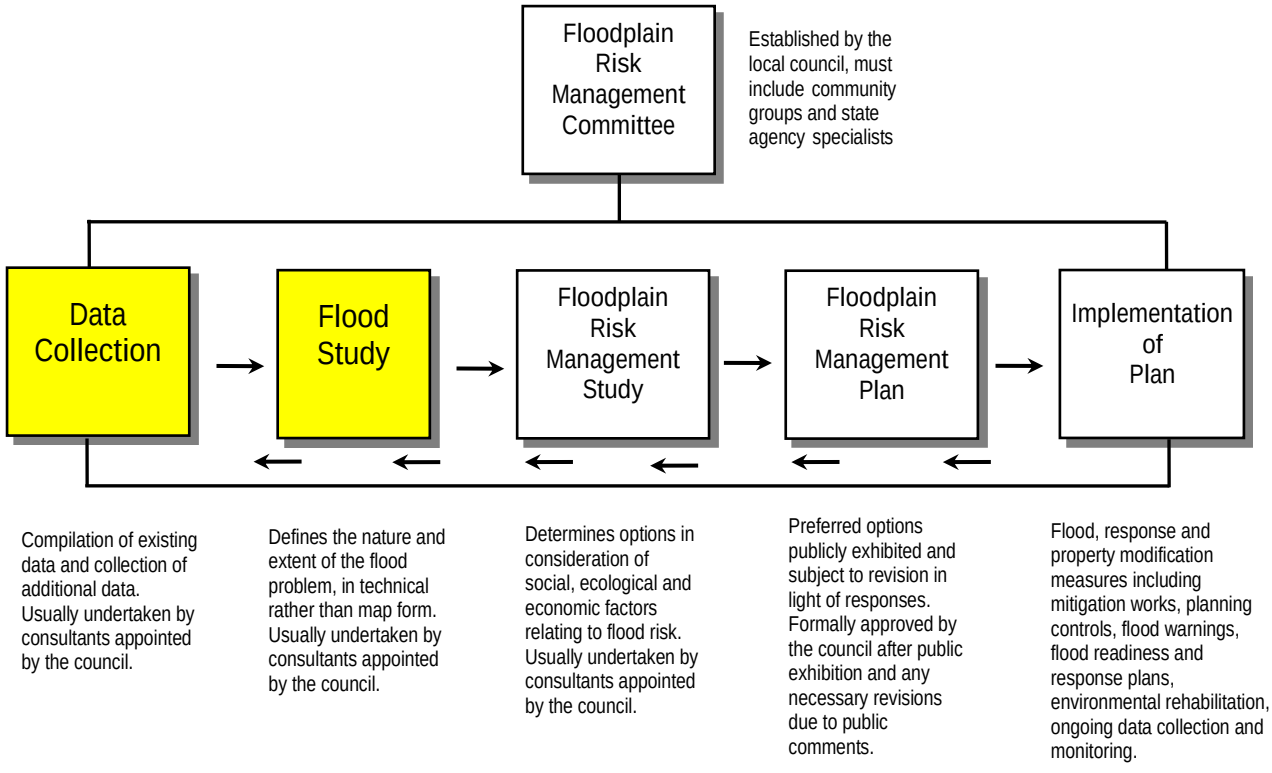
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FOREWORD

The NSW State Government's Flood Prone Land Policy is directed towards providing solutions to existing flooding problems in developed areas and ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas. The Policy is defined in the NSW Government's '*Floodplain Development Manual' (NSW Government, 2005)*.

Under the Policy, the management of flood liable land remains the responsibility of Local Government. The State Government subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist Local Government in its floodplain management responsibilities.

The Policy provides for technical and financial support by the State Government through the following stages:



The 'Pambula River, Pambula Lake and Yowaka River Flood Study' represents the first of the four stages in the process outlined above. The aim of the Flood Study is to produce information on flood discharges, levels, depths and velocities, for a range of flood events under existing topographic and development conditions. This information can then be used as a basis for identifying those areas where the greatest flood damage is likely to occur, thereby allowing a targeted assessment of where flood mitigation measures would be best implemented as part of the subsequent Floodplain Risk Management Study and Plan.

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EXECUTIVE SUMMARY

Overview

The Pambula River, Pambula Lake and Yowaka River catchment covers an area of over 300 square kilometres within the Bega Valley Council Local Government Area (LGA). The catchment extends across forested and rural areas, as well as the villages of Pambula, South Pambula, Pambula Beach, Broadwater, Greigs Flat, Nethercote and Lochiel.

During periods of heavy rainfall in the catchment there is potential for water to overtop the banks of the various creeks and rivers and inundate the adjoining floodplain, including parts of the villages identified above. Flooding has been experienced across the catchment on a number of occasions including 1970, 1971, 1973, 1978, 1983 and 1985, as well as more recent events in 2011, 2012 and 2016. The 1971 flood is considered to be the largest flood on record.

Floodwaters in the catchment can damage property and vehicles and may pose a risk to life during large floods. In addition, flooding can overtop major transportation links within the catchment including the Princes Highway, Nethercote Road, Mount Darragh Road and Back Creek Road, which can inconvenience and isolate many individuals and families.

In recognition of the potential impact that flooding may have on the local community, Bega Valley Shire Council engaged Catchment Simulation Solutions to prepare a flood study for the Pambula River, Pambula Lake and Yowaka River catchment. It documents flood behaviour across the catchment for a range of historic and design floods. This includes information on flood discharges, levels, depths and flow velocities. It also provides estimates of the variation in flood hazard and provides an assessment of the potential impacts of climate change on existing flood behaviour.

Community Consultation

A questionnaire was distributed to over 300 properties within the catchment. The questionnaire aimed to secure information on community flooding experiences, with a particular focus on information that could be used to assist in the calibration of the computer flood models that would be developed during later stages of the project. A total of 21 questionnaire responses were received.

The responses to the questionnaire showed that around 30% of the respondents had been impacted by flooding. The most common reported flood impacts were roadways being cut by floodwaters as well as flooding of paddocks.

Computer Flood Models

Flood behaviour across the catchment was defined using two computer models that were developed specifically for the study:

- A hydrologic model of the catchment was developed using the XP-RAFTS software. The hydrologic model was used to simulate the transformation of rainfall into runoff and generate discharge hydrographs at various locations across the catchment.
- A hydraulic computer model of the river system and floodplain was developed using the TUFLOW software. TUFLOW is a two-dimensional hydraulic software package that takes the discharges hydrographs produced by the hydrologic model and simulates how that flow would move and be distributed across the catchment.

The XP-RAFTS and TUFLOW models were calibrated using historic rainfall and stream flow records along with surveyed flood marks. These marks were based on photographs and reported descriptions of flood behaviour that were provided by the community. The floods that were selected for calibration include events that occurred in 1971, 1985, 2011, 2012 and 2016. The outcomes of the calibration showed that the computer models were producing reliable reproductions of each historic flood.

Design Flood Simulations

The calibrated models were used to simulate the design 10%, 5%, 2%, 1%, 0.5% and 0.2% AEP floods based upon the 2019 version of Australian Rainfall and Runoff (Geoscience Australia). The Probable Maximum Flood (PMF) was also simulated. The results of each design flood were extracted, and figures were prepared to display the results. The figures are provided in Volume 2 and include:

- Floodwater Depths and Flood Level Contours: **Figures 19** to **25**
- Floodwater Speed (including velocity vectors): **Figures 26** to **32**
- Flood Hazard: **Figures 34** to **37** (flood hazard mapping shows the potential impact that floodwaters are likely to have on people and buildings in the study area)
- Hydraulic Category: **Figures 38** to **41** (hydraulic category mapping shows areas that should preserved for the conveyance and storage of floodwaters)

Analysis of Results

The mapping shows that flooding across much of the upper catchment is typically contained near the main watercourses owing to the "incised" nature of the floodplain in these areas. More extensive inundation is predicted across parts of the lower catchment where wider floodplains combine with topographic "constrictions" combined to create a series of "bathtubs". This includes south of Pambula as well as Griegs Flat.

The catchment is traversed by several important transportation routes. The results of the flood simulations show that Nethercote Road and the Princes Highway are very susceptible to inundation and are predicted to be cut by water in events as frequent as the 10% AEP flood. These roadways would typically be cut after as little as 5 hours of rainfall and would remain cut for a minimum of 6 hours. At least H3 hazard is predicted across these roadways which demonstrates that the depth and velocity of floodwaters would be sufficient to mobilise vehicles. Therefore, one of the greatest flood risks across the catchment is associated with people potentially driving through floodwaters.

While most properties and facilities are located outside of the floodplain, some properties have a greater flood exposure. In particular, the Colonial Motor Inn and Idlewilde Motor Inn

at Pambula are predicted to be exposed to a significant hazard during the PMF and access would also be cut. It is recommended that discussions are completed with the owners of each facility to highlight the significant hazard that could occur during the PMF and encourage the preparation of a "flood safe plan" that would promote early evacuation of staff and occupants during very large Pambula River floods.

The results of additional climate change simulations indicate that should both rainfall intensity and sea level continue to increase as projected, it would produce a notable increase in flood risk across all sections of the catchment. However, the area of the catchment located east of the Princes Highway would be most significantly impacted (as this area can be impacted by both sea level rise and increases in rainfall intensity).

Flood planning category constraint mapping was also prepared (refer **Figure 61** in Volume 2) and suggests that the land use zones defined in the Bega Valley Local Environmental Plan (LEP) 2013 are broadly compatible with the flood risk. However, there are vacant parcels of land at South Pambula that are zoned for industrial and residential uses that are more significantly constrained by flooding. Therefore, care will need to be exercised if these areas are developed in the future to ensure the development is compatible with the flood hazard and floodway and flood storage areas are preserved.

1 INTRODUCTION

The Pambula River, Pambula Lake and Yowaka River catchment covers an area of over 300 square kilometres within the Bega Valley Council Local Government Area (LGA). As shown in **Figure 1**, the catchment extends across forested and rural areas, as well as the villages of Pambula, South Pambula, Pambula Beach, Broadwater, Greigs Flat, Nethercote and Lochiel.

During periods of heavy rainfall in the catchment there is potential for water to overtop the banks of the various creeks and rivers and inundate the adjoining floodplain, including parts of the villages identified above. Flooding has been experienced across the catchment on a number of occasions including 1970, 1971, 1973, 1978, 1983 and 1985, as well as more recent events in 2011, 2012 and 2016. The 1971 event is the largest flood on record.

Flooding across the catchment has the potential to result in damage to property and vehicles and may pose a risk to life during large floods. In addition, flooding can overtop major transportation links within the catchment including the Princes Highway, Nethercote Road, Mount Darragh Road and Back Creek Road, which can inconvenience and isolate many individuals and families.

Accordingly, Bega Valley Shire Council engaged Catchment Simulation Solutions to prepare a flood study for the Pambula River, Pambula Lake and Yowaka River catchment. It documents flood behaviour across the catchment for a range of historic and design floods. This includes information on flood discharges, levels, depths and flow velocities. It also provides estimates of the variation in flood hazard and provides an assessment of the potential impacts of climate change on existing flood behaviour.

The flood study comprises two volumes:

- Volume 1 (this document): contains the report text and appendices
- Volume 2: contains all figures and maps

The flood study forms the first stage in the development of a floodplain risk management plan for the Pambula River, Pambula Lake and Yowaka River catchment. This plan will, amongst other goals, aim to reduce the impact of flooding on the community and ensure that future development is compatible with the flood risk and does not create additional flooding problems.

2 CATCHMENT DESCRIPTION

The Pambula River, Pambula Lake and Yowaka River catchment is located in south-eastern New South Wales and occupies a total catchment area of 301 km^2. The catchment is fully contained within the Bega Valley Shire Council Local Government area. The extent of the catchment is shown in **Figure 1**.

The upper sections of the catchment are typically heavily forested with scattered rural residential development. However, the downstream sections of the catchment include more extensive urban development including the villages of Pambula, South Pambula, Pambula Beach, Broadwater, Greigs Flat, Nethercote and Lochiel. **Table 1** provides a summary of the different land uses across the catchment based on current land use zoning information contained within the Bega Valley Shire Council Local Environmental Plan 2013.

Table 1 Summary of Catchment Land Use based on Bega Valley Shire LEP 2013

Land Use	Area (km^2)	Percentage of Catchment
Rural	176.8	58.7%
Forest/Environmental	116.5	38.7%
Natural Waterways	3.8	1.3%
Residential	1.7	0.6%
Industrial	1.7	0.6%
Commercial/Business	0.2	0.1%
Special Activities	0.2	0.1%
Public Recreation	0.2	0.1%
TOTAL	301.1	100

The two primary watercourses in the catchment are the Pambula River and Yowaka River, which both drain into Pambula Lake near the Broadwater area. The Pambula Lake estuary, in turn, drains into the Tasman Sea near Pambula Beach via a permanently open entrance. The tidal limit extends upstream along the Pambula River to the Princes Highway and along the Yowaka River to Greigs Flat. Other major watercourses contained within the catchment include:

- Back Creek;
- Burtons Creek;
- Harts Gully; and,
- Old Hut Creek;

As shown in the digital elevation model (DEM) in **Figure 2**, the upper sections of the catchment comprise steep terrain with incised creek channels and minimal overbank/floodplain areas. However, the downstream sections of the catchment are characterised by a much broader floodplain and are commonly fringed by the villages described above.

The catchment is also traversed by several important transportation routes. This includes "local collector" roads (Back Creek Road and Nethercote Road), regional roads (Mount Darragh Road) as well as the Princes Highway which is the major transportation route between Pambula and the major adjoining towns of Eden, Merimbula and Bega. Many of watercourses within the catchment cross each of these roadways at multiple locations. As shown on the front cover of this report as well as **Plate 1** to **Plate 3**, the Princes Highway between Pambula and South Pambula is particularly susceptible to inundation which can create significant disruptions to traffic. In years gone by, inundation of the Princes Highway was considered to be a "regular, almost annual" event (George, 2012).

The focus of the current study is the lower, more developed sections of the catchment as well as areas what may be subject to development pressures in the future. Defining flood characteristics in the vicinity of each major roadway was also a key focus of the study.



Plate 1 View looking from near the top of Monaro Street at Pambula looking north (date unknown)



Plate 2 View looking north from Pambula along Princes Highway showing flooding (date unknown) (photo courtesy of Dulcie's Cottage)



Plate 3 View looking from old Princes Highway bridge crossing of Pambula River taken during the 1971 flood (Photo © The estate of A. C. ("Bubby") George)

3 PROJECT METHODOLOGY

3.1 Study Objectives

Bega Valley Shire Council outlined a range of objectives for the Pambula River, Pambula Lake and Yowaka River catchment flood study. This included:

- to review available flood-related information and historic flood data for the catchment;
- to consult with the community to gain an understanding of flooding and drainage 'trouble spots' and gather information on past floods;
- to collect additional information to define the flow carrying capacity of the various creeks, rivers, stormwater pipes, bridges and culverts;
- to develop a computer-based hydrologic flood model to simulate the transformation of rainfall into runoff
- to develop a computer based hydraulic model to simulate the movement of runoff across the catchment;
- to validate the computer models against observed information on past floods;
- to use the validated computer models to estimate flood discharges, water levels, depths and velocities for the design 10%, 5%, 2%, 1%, 0.5% and 0.2% AEP floods as well as the probable maximum flood (PMF);
- to produce maps showing predicted floodwater depths, levels and velocities for the full range of design floods;
- to produce maps showing flood hazard and flood function (i.e., hydraulic categories) for the 5%, 1% and 0.2% AEP floods and the PMF;
- to produce emergency response precinct classification and roadway inundation mapping to assist the State Emergency Service with emergency response planning;
- to quantify the potential impact of climate change on existing design flood behaviour;
- to quantify the potential impact of future development on existing flood behaviour; and
- to provide information to assist with land use planning activities.

3.2 Adopted Approach

The general approach and methodology employed to achieve the study objectives involved:

- compilation and review of available flood-related information, collection of additional data and consultation with the community (Chapter 4);
- the development of a hydrologic model to simulate the transformation of rainfall into runoff and development of a hydraulic model to simulate the movement of floodwaters across the catchment (Chapter 5);
- validation of the computer models to reproduce historic floods (Chapter 6);
- use of the computer models to estimate "design" discharges, water levels, depths, flow velocities and flood extents for the full range of design events up to and including the PMF for existing topographic and development conditions (Chapter 7);

- use of the computer model results to generate flood hazard and flood function mapping as well as flood emergency response classifications (Chapter 8);
- testing the sensitivity of the results generated by the computer model to variations in model input parameters, future development and climate change (Chapter 9); and,
- use of computer model outputs and sensitivity analysis results to provide flood planning information (Chapter 10).

4 DATA COLLECTION AND REVIEW

4.1 Overview

A range of data was made available to assist with the preparation of the Pambula River, Pambula Lake and Yowaka River catchment flood study. This included:

- Previous reports: Section 4.2
- Rainfall and stream gauge data: Section 4.3
- Survey information: Section 4.4
- GIS data: Section 4.5
- Plans: Section 4.6

A description of each dataset and a synopsis of its relevance to the study is summarised below.

Consultation with the community was also completed to source additional information on historic floods and help identify flooding trouble spots. The outcomes of the community consultation is summarised in Section 4.9.

4.2 Previous Reports

4.2.1 Floods of February 1971 on the South Coast (1976)

The 'Flood of February 1971 on the South Coast' report was published by the Water Resources Commission of NSW. It describes the processes leading up to and the consequences of significant flooding that occurred across south-eastern NSW over a 2-week period in January and February 1971. At many locations it was the largest flood on record, including the Bega River and Towamba River basins. The Pambula River and Yowaka River catchments are considered to fall within the Towamba River basin.

The report provides information on antecedent catchment conditions and storm/rainfall characteristics. This includes rainfall isohyets maps which show the following rainfall characteristics in the vicinity the Pambula River, Pambula Lake and Yowaka River catchment:

- 28 January to 3 February 1971: 5 to 7 inches of rainfall;
- 3 February to 8 February 1971: 12 to 18 inches of rainfall (with around 6 inches falling on 5 February);

It also documents stream flow observations, peak flood levels at major gauges and stream crossings, and summarises flood damages incurred. The report notes the following details for the Pambula River gauge at Lochiel:

- Peak water height = 50.5-feet (previous maximum = 14.7-feet in 1970);
- Peak discharge = 15,000 ft^3/s (previous maximum = 6,200 ft^3/s)

Although the report does not provide any specific information on flood impacts across the catchment, the rainfall and stream flow information could be used to assist in the calibration of the hydrologic and hydraulic models developed as part of the current study.

4.2.2 Bald Hills Creek Flood Study (1983)

The 'Bald Hills Creek Flood Study' was prepared in 1983 by Willing & Partners for Mr John Norton. The report was prepared to quantify flood behaviour along the lower reaches of Bald Hills Creek for the 1 in 100 year ARI flood.

Bald Hills Creek drains into Merimbula Lake and is, therefore, located outside of the Pambula River, Pambula Lake and Yowaka River catchment. In addition, flood behaviour was defined using superseded hydrologic procedures (i.e., 1977 version of Australian Rainfall and Runoff) and modelling tools. As a result, it is considered that this study affords negligible information that can be used to assist the current study.

4.2.3 Pambula River Data Assessment Study (1990)

The 'Pambula River Data Assessment Study' was prepared in 1990 on behalf of Bega Valley Shire Council. Council, at that time, were considering preparing a flood study for the Pambula and Yowaka River catchments in response to development pressure in the catchment. As a result, Council engaged the NSW Public Works Department to compile all available flood related information to facilitate the preparation of the flood study.

The data assessment study includes a summary of known historic floods including newspaper extracts dating back to 1851. It also includes a range of historic rainfall information for the 1970, 1971, 1973, 1978, 1983 and 1985 events. This includes daily totals, hourly totals (from pluviographs), rainfall mass curves and isohyet maps.

Streamflow information is also provided for the stream gauge located on the Pambula River at Lochiel. It notes that the gauge measures water levels only and the water levels are converted to an equivalent flow using a rating table/curve. The report notes that the highest recorded rating corresponded to a flow of 12,980 ML/day (i.e., 150 m^3/s), which is well below the estimated peak discharges for the majority of historic floods (e.g., the 1971 estimated peak discharge was 823 m^3/s). As a result, the flow estimates at higher stages are subject to some uncertainty.

Recorded/surveyed historic flood levels were also provided for a number of floods. This included 17 flood marks for the November 1985 flood and 11 other flood marks for a range of other floods. The location of the flood marks is shown on **Figure 3**.

The report also includes surveyed cross-sections of the Pambula River that were collected in 1985 by consulting surveyors Ryan Firth and Company. The location of each cross-section is shown in **Figure 3**.

Although the data assessment study does not document more recent floods, it provides a significant amount of historic flood information for floods that occurred in the 1970s and 1980s which can be used in calibrating the computer flood models for the current study. It also provides information that can be used to assist with the development of the hydraulic computer model (e.g., river cross-sections).

4.2.4 Bridge Over Pambula River at Pambula (2004)

The 'Bridge Over Pambula River at Pambula' was prepared to support the upgrade of the Princes Highway between Pambula and South Pambula. In particular, the study focussed on assessing the potential impacts associated with three different upgrade options reflecting a 1 in 5, 1 in 10 and 1 in 20 year ARI level of service. The report notes that the existing highway (at that time) was predicted to be overtopped in a 1 in 2 year ARI flood.

The report includes photographs showing floodwaters in the vicinity of the Princes Highway in 1990 and 1992. A selection of these photographs are provided in **Plate 4** and **Plate 5**. The report estimates the 1990 floods was a 1 in 5 year (20% AEP) flood that closed the highway at that time from Friday afternoon until noon on Saturday. The 1992 flood was estimated to be a 1 in 20 year ARI (5% AEP) flood. The depth indicator on the left side of **Plate 5** indicates a water depth across the highway of just over 0.2 metres. However, as noted in the report, this photograph may not have been taken at the peak of the flood.

Peak discharges for the Pambula River were determined based upon a flood frequency analysis that was completed at the Pambula River @ Lochiel gauge, which is situated about 3 km upstream of the Princes Highway. The discharges where subsequently factored up based on the additional catchment area located between the gauge and the highway. The adopted design discharges at the highway are summarised in **Table 2**.

Table 2 Peak Design Discharges for Pambula River at Princess Highway (2004)

Design Event	Peak Discharge (m^3/s)	
	Lochiel Gauge	Princess Hwy
5 year ARI (20% AEP)	347	410
10 year ARI (10% AEP)	451	533
20 year ARI (5% AEP)	556	657
50 year ARI (2% AEP)	731	864
100 year ARI (1% AEP)	868	1026

Flood hydraulics were defined using a 1-dimensional HEC-RAS model that was developed using the cross-sections documented in the 'Pambula River Data Assessment Study' (1990) and shown in **Figure 3**, as well as detailed ground survey that was collected in the immediate vicinity of the highway.

The HEC-RAS model was calibrated against historic flood information for the 1985 flood (also extracted from the 1990 data assessment study). The HEC-RAS model was subsequently used to simulate a range of design floods. Simulated design floods levels in the vicinity of the Princes Highway are reproduced in **Table 3**.

It is understood that the 1 in 5 year ARI highway upgrade option was ultimately adopted and implemented in 2006. Plans of the upgraded bridge and culvert crossings of the Pambula River floodplain were acquired from the RTA/RMS (now Transport for NSW) and are discussed further in Section 4.6.



Plate 4 View looking south along Princes Highway during 1990 flood (RTA, 2004)



Plate 5 View looking south along Princes Highway during 1992 flood (RTA, 2004)

Table 3 Peak Design Flood Levels for Pambula River at Princes Highway (2004)

Design Event	Peak Flood Level (mAHD)			
	Existing	Proposed 1 in 5 year road	Proposed 1 in 10 year road	Proposed 1 in 20 year road
5 year ARI (20% AEP)	3.40	3.34	-	-
10 year ARI (10% AEP)	3.50	-	3.42	-
20 year ARI (5% AEP)	3.60	-	-	3.60
100 year ARI (1% AEP)	4.30	-	-	-

Overall, the results documented in this study were found to be useful in validating the results of the hydrologic model/flood frequency analysis and hydraulic model prepared for the current study.

4.2.5 Pambula River Estuary - Data Compilation Study (2008)

The 'Pambula River Estuary – Data Compilation Study' was prepared by NGHenvironmental on behalf of Bega Valley Shire Council as the first step in the preparation of an estuary processes study (refer Section 4.2.6). Although many of the datasets collated for estuary process purposes are not required as part of a typical flood study (e.g., water quality), some information was of benefit.

Most notably, bathymetric/hydrographic survey that was collected in 2003 by the then Department of Infrastructure Planning and Natural Resources is documented. The extent of the hydrographic survey is shown in **Figure 3** and further discussion on this dataset is provided in Section 4.4.3. The study notes that no other hydrographic survey is available for the Pambula River Estuary to define historic bathymetric conditions.

The report notes that the tides within the lake exhibit a semi-diurnal pattern that is dominated by oceanic processes. It also notes that the tidal range reduces from 1.55m at the ocean entrance to 1.04m in the upper Yowaka River and 0.68m in the upper Pambula River. Accordingly, catchment runoff is going to be the more dominant flooding mechanism moving upstream.

The report includes a small section dedicated to flooding, but this mainly references the 1990 data compilation study discussed above.

Overall, most of the information contained in this report is either not relevant or can be sourced from other reports. Nevertheless, the tidal information provides an understanding of the potential interaction between tidal and catchment runoff processes which was used to assist in establishing reliable ocean level boundary conditions as part of the design flood simulations.

4.2.6 Pambula River Estuary Processes Study (2012)

The 'Pambula River Estuary Processes Study' was prepared by Cardno for Bega Valley Shire Council. It builds upon the 'Pambula River Estuary – Data Compilation Study' (2008) to describe the various natural processes that characterise the Pambula River estuary.

Like the data compilation study, much of the content of this report is not of relevance to the current flood study. However, Section 5 of the report discusses hydraulic processes. The report also provides tidal plane characteristics for the estuary as well as the ocean (as defined by an ocean tide gauge at Eden), as summarised in **Table 4**.

Table 4 Tidal Plane Characteristics (2004)

Tidal Plane	**Water Level** (mAHD)	
	Pambula River Estuary	**Ocean Level (at Eden)**
High-High Water (Solstice Spring)	0.75	0.83
Mean High Water Spring	0.42	0.43
Mean High Water	0.32	0.32
Mean Sea Level	-0.06	0.00
Mean Low Water	-0.44	-0.60
Mean Low Water Spring	-0.54	-0.71
Indian Spring Low Water	-0.78	-0.99

The study notes that, based on an analysis of historic tide information over the past 20 years, the tidal range for the estuary appears to be reducing resulting in gradual infilling of the entrance channel. It also states that significant scouring of the entrance channel only occurs during floods in excess of the 10 year ARI.

Although the study focusses on natural estuarine processes that are largely not relevant to flooding processes, the tidal information presented in this report is useful for assisting with the establishment of suitable ocean boundary conditions as part of the design flood simulations.

4.2.7 Bega Valley Shire Coastal Processes and Hazards Definition Study (2015)

The 'Bega Valley Shire Coastal Processes and Hazards Definition Study' was prepared by BMT WBM for Bega Valley Shire Council. The study was prepared to provide Council with a regional understanding of the potential hazards impacting on the coastal sections of the LGA.

The study included an assessment of potential coastal inundation extents. This assessment noted that for estuaries such as Pambula River/Pambula Lake, inundation associated with elevated ocean levels are impacted by the prevailing storm tide elevation (including the astronomical tide plus storm surge) as well as wave setup. A series of maps was subsequently prepared showing modelled inundation extent across the various estuaries for a range of planning timeframes including current/immediate, 2050 and 2100 for a range of different certainty levels (reflecting the uncertainties associated with future inundation estimates). An extract of the mapping is provided in **Plate 6** for the Pambula River estuary.

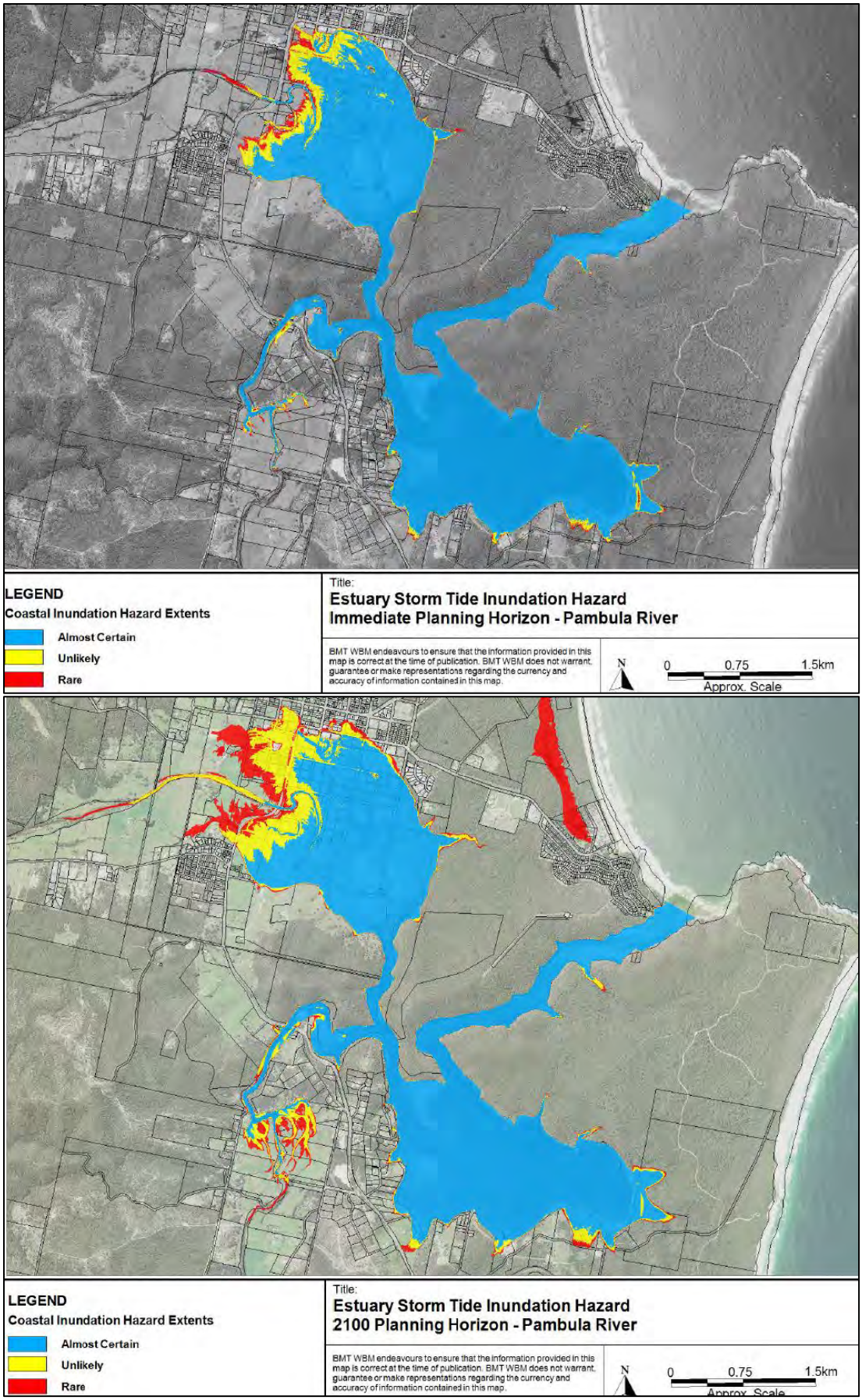


Plate 6 Coastal inundation maps for existing (top) and 2100 (bottom) timeframes (BMT, 2015)

The mapping provided in **Plate 6** shows inundation associated with elevated ocean levels extends across the Panboola wetlands and up to Bullara Street and just past the Princes Highway for existing conditions. Under 2100 conditions, coastal inundation potentially extends across Bullara Street, Monaro Street and the Princes Highway. Accordingly, elevated ocean levels have the potential to directly inundate low lying sections of the catchment even without rainfall in the catchment. Elevated ocean levels can also restrict or prevent water from draining from the catchment during heavy rainfall events, thereby exacerbating flooding. Although not considered as part of this study, this outcomes shows that the interaction between catchment runoff and coastal inundation is an important consideration of the current study, particularly when considering potential future flooding scenarios.

4.2.8 Merimbula and Back Lake Flood Study (2017)

The 'Merimbula and Back Lake Flood Study' was prepared by Cardno for Bega Valley Shire Council. The study was prepared to define the nature and extent of the existing flooding problem for the primary waterways draining the Merimbula urban area (i.e., Merimbula Lake and Back Lake and their tributaries). Due to its proximity to the current study area and the similar catchment outlet characteristics, the report contains information that can be transposed and used to assist with the current study.

As noted in the previous section, inundation can occur across the lower lying sections of the Pambula River and Yowaka River catchment as a result of elevated ocean levels only. This is also true for the Merimbula area. As a result, several "tide only" simulations were completed to assess tidal inundation extents for existing conditions as well as 2050 and 2100 sea level rise projections. Existing peak tide levels were based upon the High High Water Solstice Spring (HHWSS) level calculated at the Merimbula Wharf gauge. For each of the future sea level rise scenarios (i.e., 0.4m increase by 2050 and 0.9m increase by 2100), two simulations were completed assuming the entrance bed remained at the current elevations and another assuming the entrance bed level increased at the same rate as ocean levels.

As discussed, the interaction between catchment runoff and elevated ocean levels can have a significant impact on flood behaviour across tidally influenced areas. The potential interaction of joint catchment flooding and elevated ocean level inundation was considered based on guidance in the *'Floodplain Risk Management Guide. Modelling the Interaction of Catchment Flooding and Oceanic Inundation in Coastal Waterways' (OEH, 2015)*. This involved undertaking a range of catchment runoff and ocean level simulations and "enveloping" the results to provide a final result set for each design flood. The ocean levels summarised in **Table 5** were used as part of the design simulations. The timing of the simulations was setup such that the peak catchment outflow coincided with the peak ocean level. However, it should be noted that the hydrologic approach employed as part of this study was based on the 1987 version of Australian Rainfall & Runoff, rather than the 2019 version which reflects modern best practice (although sensitivity testing was completed using the 2016 version of Australian Rainfall & Runoff, which was in its infancy at the time this study was prepared).

Overall, this study is considered to reflect modern best practice with regard to representing the interaction between coastal and catchment flooding and a similar approach is appropriate for application as part of the current study.

Table 5 Adopted Ocean Level Boundary Conditions (Cardno, 2017)

Design Flood	**Ocean Level** (mAHD)
1% AEP	1.45
5% AEP	1.37
10% AEP	1.35
1 exceedance per year	1.25
Highest astronomical tide (HAT)	1.10

4.3 Hydrologic Data

4.3.1 Rain Gauge Data

A number of daily read and continuous (i.e., pluviometer) rainfall gauges are located within or adjacent to the Pambula River catchment. The location of each gauge is shown in **Figure 4**. Key information for each daily gauge is provided in **Table 6** and key information for each continuous rainfall gauge is summarised in **Table 7**.

The information provided in **Table 6** indicates that daily rainfall records in the vicinity of the study area are available dating back to 1890 (Wyndham Post Office gauge). However, **Table 7** shows that long term continuous rainfall records are only available from 1967 onwards and this gauge is located a significant distance south of the catchment (Green Cape Lighthouse). However, the Pambula River at Lochiel gauge is contained within the catchment and comprises continuous rainfall records extending back to 2009.

4.3.2 Stream Gauge Data

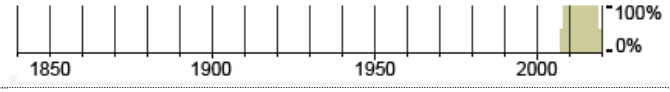
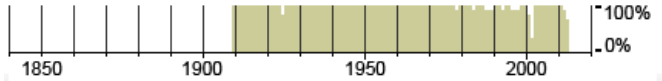
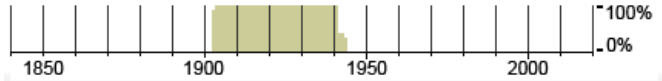
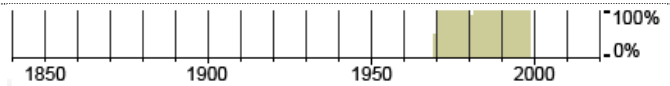
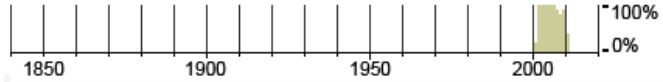
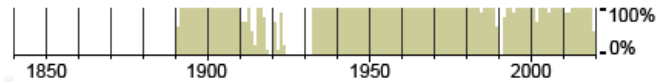
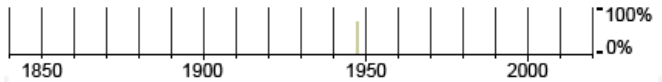
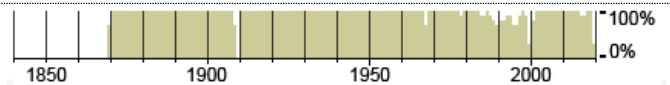
Figure 2 also shows the location of stream and water level gauges located in the vicinity of the catchment. Key information for each gauge is summarised in **Table 8**.

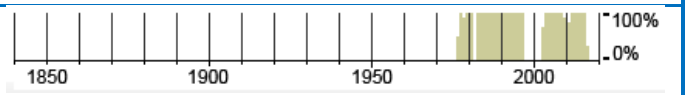
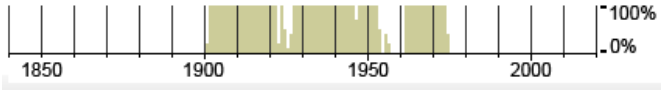
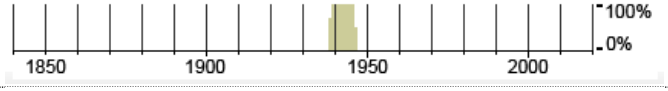
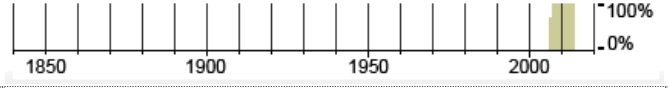
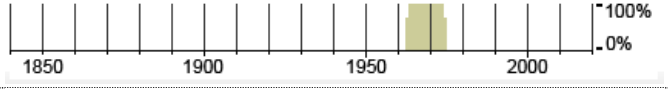
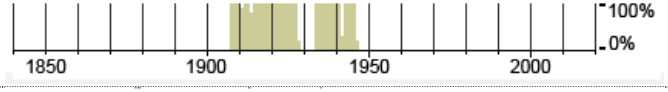
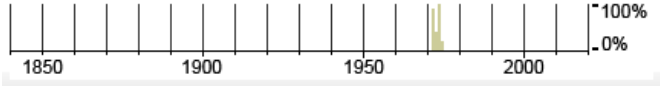
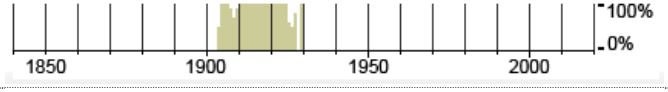
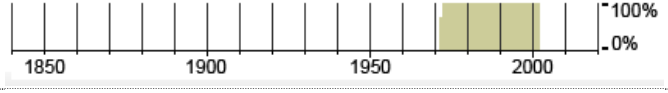
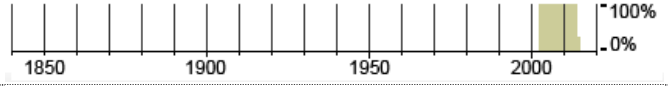
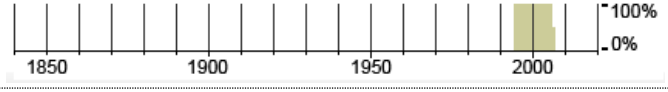
As shown in **Figure 2**, there are two stream gauge located within the catchment. This includes:

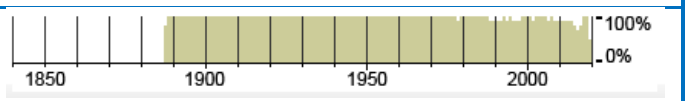
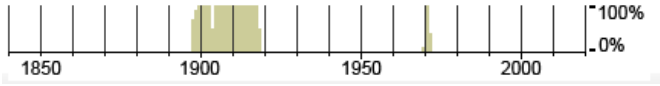
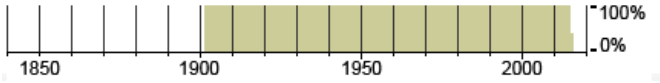
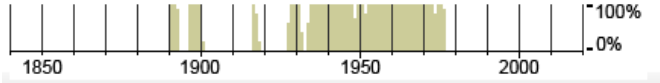
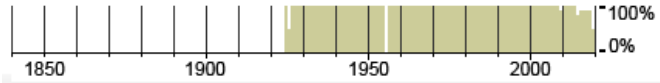
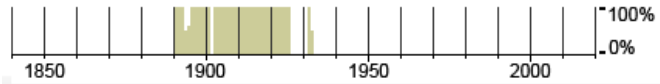
- Pambula River at Lochiel (gauge 220003): provides water levels and stream flow information (flows are estimated using water level information in conjunction with a rating curve);
- Pambula Lake (gauge 220415): provides water level information only.

As noted above, flow information for the Pambula River gauge at Lochiel is estimated using a rating curve/table. A copy of the most recent rating curve is provided in **Plate 7**. **Plate 7** also shows all "ratings" (i.e., water level and corresponding flow information collected at the gauge) that have been captured since the gauge was installed in 1966. The quality of the flow estimates is highly dependent on the quality, range of and number of ratings that have been collected. Although **Plate 7** shows considerable "scatter" of ratings at low flows, there is a considerably greater agreement at higher flows, which are of most interest for the current flood study. Unfortunately, the highest rating that has been collected corresponds to a peak gauge level of around 3 metres, which is well below the maximum recorded gauge level (6.81 metres). Accordingly, there is some uncertainty associated with flow estimates above the maximum gauging level.

Table 6 Available daily rain gauges

Gauge Number	Gauge Name	Gauge Type	Source*	Start of Records	End of Records	Distance from Centroid of Catchment (km)	Temporal Availability and Percentage of Annual Record Complete
069153	Lochiel (Carisbrook Farm)	Daily	BOM	Aug 2007	Jun 2019	1.28	
069024	Pambula Post Office	Daily	BOM	Jan 1909	Oct 2012	7.79	
069078	Nethercote	Daily	BOM	Feb 1902	Nov 1943	10.91	
069147	Merimbula Airport Aws	Daily	BOM	Feb 1998	Jul 2019	10.93	
069093	Merimbula Airport Comparison	Daily	BOM	Aug 1969	Dec 1998	10.94	
069011	Wyndham (Nyumbani)	Daily	BOM	Nov 2000	May 2010	11.75	
069066	Wyndham Post Office	Daily	BOM	Jun 1890	Jun 2019	14.22	
069109	Edrom	Daily	BOM	May 1947	Dec 1947	14.71	
069100	Dovewood	Daily	BOM	Jun 1968	Oct 1985	15.19	
069015	Eden (Marine Rescue Eden)	Daily	BOM	May 1869	Mar 2019	15.62	

Gauge Number	Gauge Name	Gauge Type	Source*	Start of Records	End of Records	Distance from Centroid of Catchment (km)	Temporal Availability and Percentage of Annual Record Complete
069073	Towamba (Nungatta St)	Daily	BOM	Jul 1976	Mar 2016	16.33	
069012	Burragate Post Office	Daily	BOM	Nov 1900	May 1974	17.1	
069009	Boyd East State Forest	Daily	BOM	May 1938	Jun 1946	17.14	
069151	Tura Beach (James Cook Court)	Daily	BOM	Apr 2006	Dec 2013	17.32	
069057	Towamba Lower	Daily	BOM	May 1962	Dec 1974	17.57	
069030	Toothdale	Daily	BOM	Feb 1907	Mar 1946	18.47	
069096	Chip Mill	Daily	BOM	Feb 1971	Feb 1974	18.84	
069083	Wolumla	Daily	BOM	Aug 1903	Dec 1929	19.39	
069110	Towamba (Rosebank)	Daily	BOM	May 1971	Dec 2001	20.69	
069069	Kanoona (Tillside)	Daily	BOM	Jan 2002	Mar 2014	22.81	
069146	Kanoona (Brindabella)	Daily	BOM	Jan 1994	Jun 2006	23.76	

Gauge Number	Gauge Name	Gauge Type	Source*	Start of Records	End of Records	Distance from Centroid of Catchment (km)	Temporal Availability and Percentage of Annual Record Complete
069013	Candelo Post Office	Daily	BOM	Apr 1887	Jun 2019	23.91	
069080	Pericoe	Daily	BOM	May 1897	Apr 1971	24.13	
069107	Kameruka (Kameruka Estate)	Daily	BOM	Jan 1901	Apr 2015	26.49	
069026	Rocky Hall Post Office	Daily	BOM	Jan 1890	Oct 1976	26.77	
069144	Black Range (Grandview Lane)	Daily	BOM	Dec 2014	Jul 2019	27	
069019	Cathcart (Mount Darragh)	Daily	BOM	Jan 1924	Jun 2019	28.02	
069152	Mount Darragh	Daily	BOM	Nov 2006	Jul 2019	28.34	
069077	Kingswood	Daily	BOM	Jan 1890	May 1932	30.82	

NOTE: * BOM = Bureau of Meteorology, SW = Sydney Water, SCA = Sydney Catchment Authority

Table 7 Available continuous rain gauges

Gauge Number	Gauge Name	Gauge Type	Source*	Start of Records	End of Records	Distance from Centroid of Catchment (km)	Timestep	Data Completeness
220003	Pambula River at Lochiel	Continuous	WaterNSW	April 2009	Aug 2019	2	Irregular	92%
069147	Merimbula Airport Aws	Pluvio	BOM	Sep 2010	Jul 2019	11	1 minute	83%
220410	Merimbula Wharf	Continuous	DPIE	Aug 1997	Sep 2001	12	15 minute	100%
069066	Wyndham Post Office	Pluvio	BOM	Jan 1993	May 2013	14	6 minute	85%
069015	Eden (Marine Rescue Eden)	Pluvio	BOM	Apr 1965	Dec 1966	16	6 minute	81%
069137	Green Cape Aws	Pluvio	BOM	Sep 2011	Jul 2019	39	1 minute	50%
069055	Green Cape Lighthouse	Pluvio	BOM	Mar 1967	May 2002	40	6 minute	57%

NOTE: * BOM = Bureau of Meteorology, DPIE = Department of Planning, Industry and Environment

Table 8 Available stream and water level gauges

Gauge Number	Gauge Name	Source*	Dataset Time Increments	Start of Records	End of Records	Located with study area?
220003	Pambula River at Lochiel	WaterNSW	Irregular	Aug 1966	Jul 2019	Yes
220415	Pambula Lake	DPIE	15 minute	Mar 1991	Aug 2019	Yes
219415	Back Lagoon	DPIE	15 minute	Feb 2009	Aug 2019	No
220410	Merimbula Wharf	DPIE	15 minute	Mar 1991	Aug 2019	No
220405	Merimbula Lake	DPIE	15 minute	May 1991	Aug 2019	No
220420	Lake Curalo	DPIE	15 minute	Jun 2007	Aug 2019	No
220470	Eden	DPIE	15 minute	Sep 1986	Aug 2019	No

NOTE: * DPIE = Department of Planning, Industry and Environment

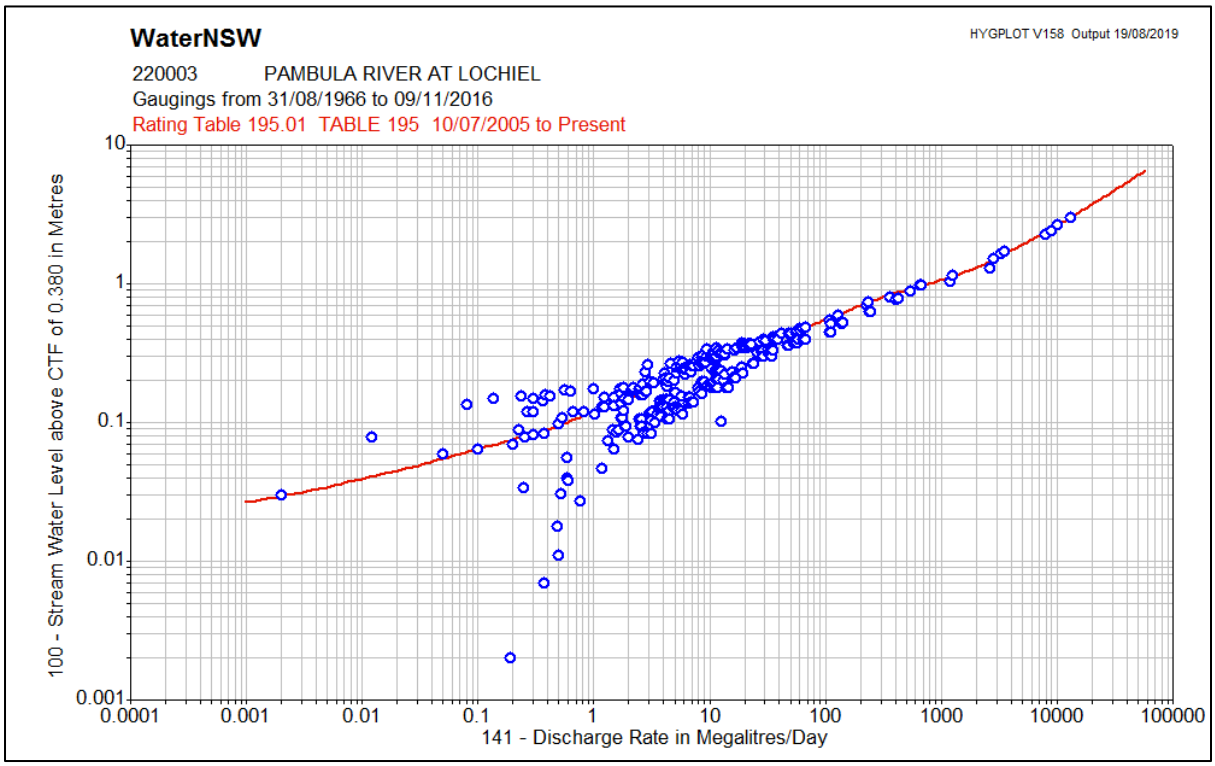


Plate 7 Rating curve (red) and recorded ratings (blue) for Pambula River at Lochiel stream gauge

4.4 Topographic and Hydrographic Information

The following topographic and hydrographic (i.e., bathymetric) datasets were provided for use in defining the variation in ground and river bed elevations across the catchment:

- 2013 Light Detection and Ranging (LiDAR) survey
- 2018 LiDAR survey
- 2003 Hydrographic Survey

Further detailed information on each topographic dataset is provided below.

4.4.1 2013 LiDAR Survey

LiDAR data was collected across part sections of the catchment in March 2013 by the NSW Government's Land and Property Information Department. The extent of the 2013 LiDAR coverage is shown in **Figure 3**. As shown in **Figure 3**, the 2013 LiDAR extends across the eastern sections of the catchment.

The LiDAR has a stated absolute horizontal accuracy of better than 0.8 metres and an absolute vertical accuracy of better than 0.3 metres and provides a minimum point density of 1.02 elevation points per square metre.

The 2013 LiDAR generally provides a good representation of the variation in ground surface elevations across the eastern parts of the catchment. However, LiDAR datasets can provide a less reliable representation of the terrain in areas of high vegetation density. This is associated with the laser ground strikes often being restricted by the vegetation canopy. Errors can also arise if non-ground elevation points (e.g., vegetation canopy, buildings) are not correctly removed from the raw dataset.

Plate 8 provides an example of the 2013 LiDAR ground points in the vicinity of Oregon and Monaro Streets at Pambula. **Plate 8** shows a high LiDAR point density across grassed and paved areas but reduced ground points in the vicinity of dense trees / vegetation. **Plate 8** also shows no ground points across buildings. Therefore, it appears that non-ground points have correctly been removed from the 2013 dataset and the resulting DEM derived from these LiDAR points will reflect the ground elevation only.

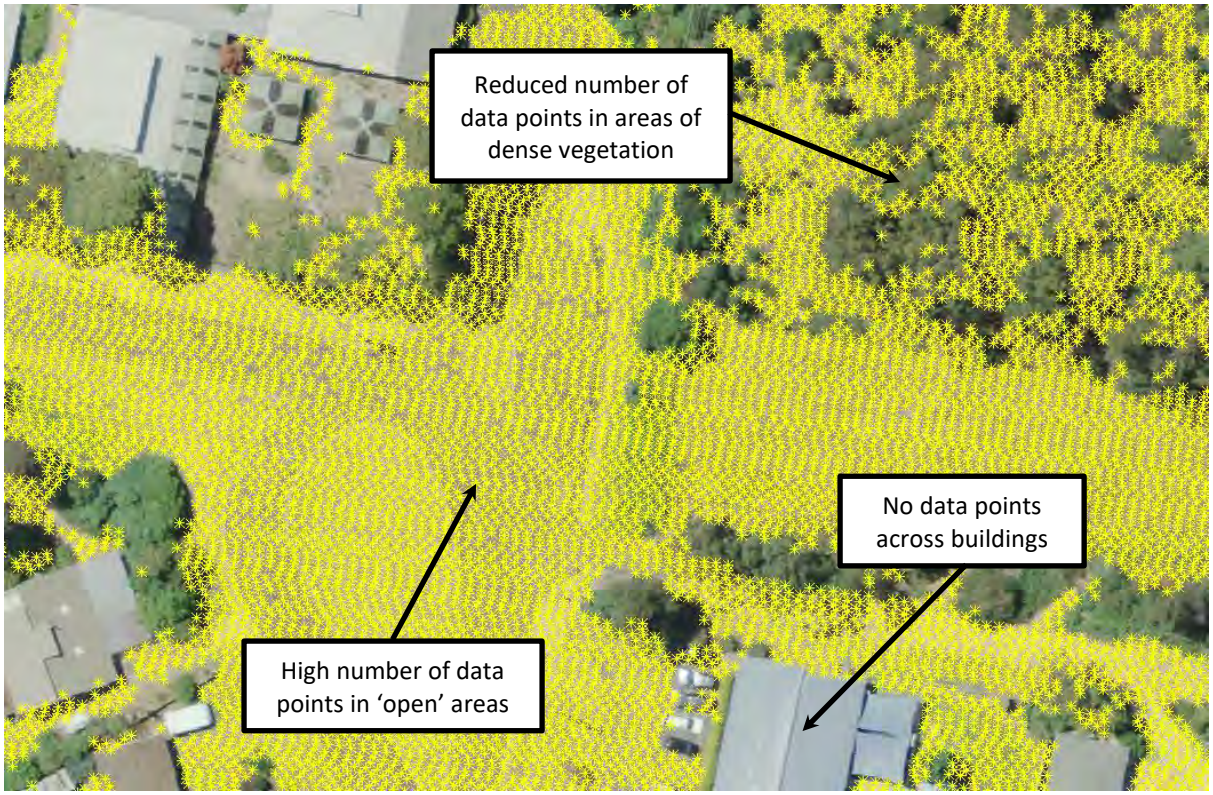


Plate 8 2013 LiDAR data points in the vicinity of Oregon and Monaro Streets

However, the LiDAR data will not pick up the details of drainage features that are obscured from aerial survey techniques, such as bridge and culvert dimensions. Although some bridge and culvert information is available from past studies and plans, there were some bridges and culverts where no detailed information was available. Therefore, survey of some bridges and culverts was also completed to ensure a reliable representation of these drainage structures were provided. Further details of the hydraulic structure survey are provided in Section 4.8.

LiDAR is also unable to penetrate water. Therefore, areas that are submerged at the time of the survey (e.g., tidal sections of the catchment) will not be represented in the terrain model. To quantify the ability for the LiDAR to reliably represent major conveyance areas which may be subject to water coverage, channel invert elevations defined in the 2013 LiDAR information were compared against channel invert information extracted from the cross-sections documented in the 'Pambula River Data Assessment Study' (1990) as well as the 2003 hydrographic survey (where available) for the Pambula River. The cross-section comparison locations are shown in **Figure 3** and the outcomes of the comparison is provided in **Table 9**. As shown in **Figure 3**, channel cross-section information from the 1990 study are available at 15 different locations along the Pambula River extending approximately 2.3 km upstream and 3.3 km downstream of the Princess Highway (cross-section 1 is the upstream most section and cross-section 15 is the downstream most section).

Table 9 Pambula River channel invert comparisons

Cross-Section ID	**Channel invert** (mAHD)		
	2013 LiDAR	**1990 Cross-Section**	**2003 Hydrosurvey**
1	3.98	4.25	N/A
2	3.08	2.95	N/A
3	2.32	2.40	N/A
4	2.08	1.90	N/A
5	1.64	1.35	N/A
6	1.61	1.35	N/A
7	1.40	1.95	N/A
Princes Highway			
8	1.04	1.00	N/A
9	0.16	-0.30	N/A
10	0.32	-0.40	-0.31
11	0.28	-0.50	-0.51
12	0.31	-1.10	-0.71
13	0.39	-2.50	-2.10
14	0.37	-2.10	-2.47
15	0.48	-4.60	-5.87

The comparison provided in **Table 9** shows that the LiDAR data is able to reproduce the 1990 cross-section inverts to within 0.3 metres at cross-sections 1 to 8. However, the LiDAR does not provide a good representation of the channel invert for cross-sections 9 to 15. Accordingly, the LiDAR information appears to provide a reasonable representation of the channel geometry across channel sections not subject to significant water coverage (i.e., non-tidal areas upstream of the Princes Highway). However, channel areas subject to significant water coverage are poorly reproduced by the LiDAR. Accordingly, it is necessary to supplement the LiDAR with river cross-section information as well as hydrographic survey across the estuarine sections of the catchment. Further information on the available hydrographic survey information is provided in Section 4.4.3 and details of the additional survey that was collected for the study is provided in Section 4.8.

4.4.2 2018 LiDAR Survey

LiDAR data was also collected across sections of the Pambula River and Yowaka River catchment in April 2018. The extent of the 2018 LiDAR coverage is provided in **Figure 3**. As shown in **Figure 3**, the 2018 LiDAR covers the western parts of the catchment and when combined with the 2013 LiDAR, it provides a complete topographic representation of the catchment. A digital elevation model (DEM) of the catchment was subsequently developed from the 2013 and 2018 LiDAR information and is shown in **Figure 2**.

The 2018 LiDAR has a stated absolute horizontal accuracy of better than 0.8 metres, an absolute vertical accuracy of better than 0.3 metres and provides a minimum point density of 0.34 elevation points per square metre. Accordingly, the 2018 LiDAR provides similar horizontal and vertical accuracy relative to the 2013 LiDAR, however, it provides less ground elevation data points per square metre. However, as the 2018 LiDAR extends across the less developed areas of the catchment that are not the focus of the current study, this is considered to be acceptable.

An example of the 2018 LiDAR ground points across a part section of the upper catchment is provided in **Plate 9**. Like the 2013 LiDAR, **Plate 9** shows that the 2018 LiDAR comprises higher point density across areas of open space and reduced density in areas of significant vegetation coverage. It also appears that non-ground points (e.g., building roof areas) have correctly being removed ensuring the resulting DEM provides ground surface elevations only.

4.4.3 2003 Hydrographic Survey

Hydrographic survey of the Pambula River estuary was collected by the former Department of Infrastructure Planning and Natural Resource in September and October 2003. The extent of the hydrographic survey is shown in **Figure 3**. The dataset reflects the only comprehensive hydrographic survey of the estuarine sections of the catchment that is available.

The hydrographic survey provides elevation points for the bed of the Pambula River, Pambula Lake and Yowaka River at typical intervals of 10 to 20 metres. The survey extends from Loala Point (located about 1 km offshore from the Pambula River entrance) upstream along the Pambula River to the southern edge of the Pamboola Wetlands and upstream along the Yowaka River to Greigs Flat.

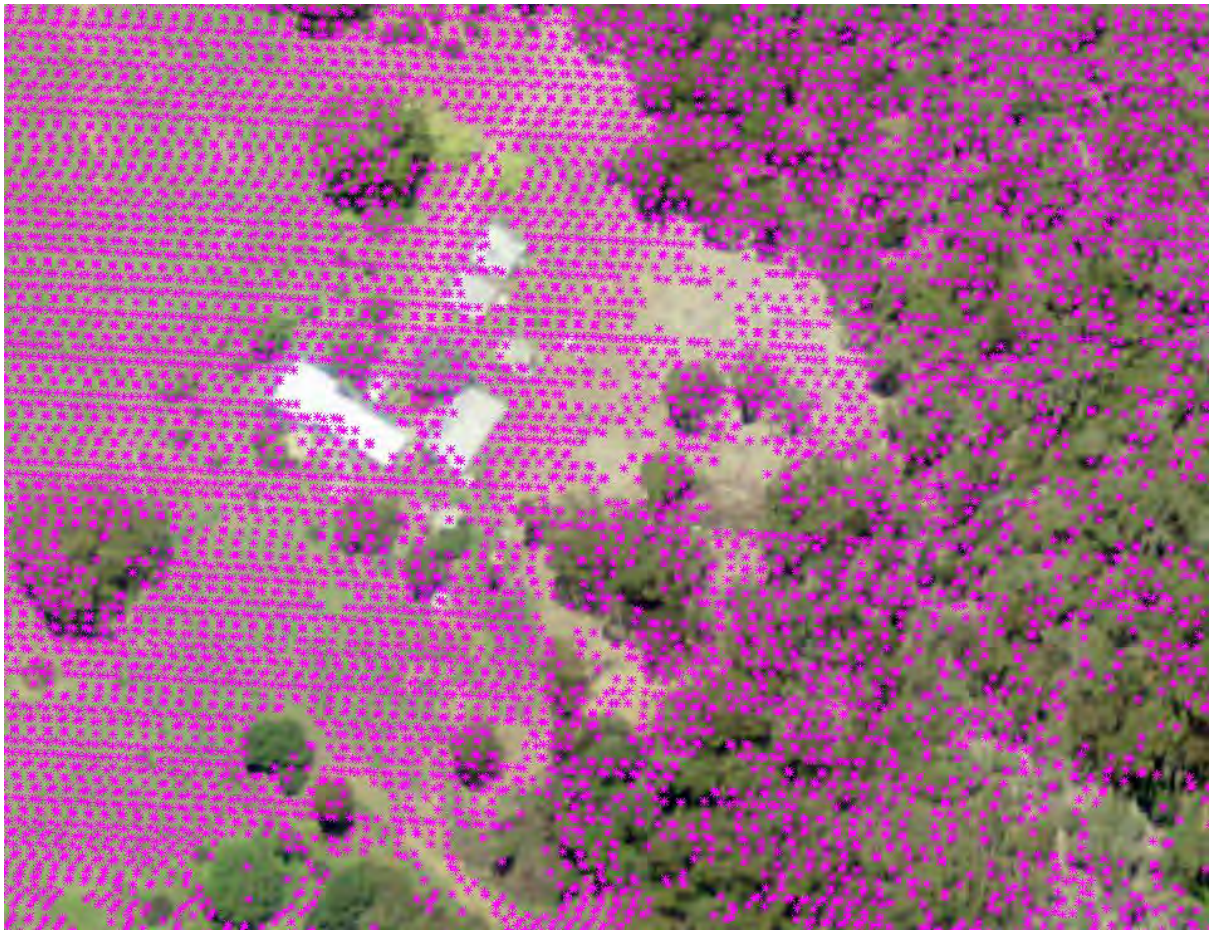


Plate 9 Example of 2018 LiDAR data points in upper catchment

This dataset is considered suitable for defining the bathymetry of the estuarine sections of the study area. However, it is noted that the natural estuarine processes have likely caused localised modification to the bathymetry since this dataset was collected. However, as a more contemporary dataset is not available, and these natural changes are likely to be small, this dataset is still considered to be the best available data for use in this flood study.

4.5 Geographic Information System (GIS) Data

A number of Geographic Information System (GIS) layers were also provided by Council to assist with the study. This included:

- Aerial Photography – provides ortho-rectified aerial imagery collected in 2018.
- Bridges – shows the location and attributes of each Council-owned bridge in the catchment (the extent of the bridges covered by this dataset is shown in **Figure 3**). The bridge attributes include bridge deck dimensions, number of spans and the lengths of each span. Overall, this layer provides sufficient detail to describe most bridges in the hydraulic model. However, it does not include non-Council owned drainage assets (e.g., structures on private property or owned by RMS). It also does not include invert elevations. However, it does include an attribute describing the height of the road above the bed of the stream which allows the inverts to be estimated from the LIDAR information.
- Drainage – shows the alignment of major watercourses in the catchment. A review of this dataset showed a low level of spatial precision with the watercourse lines often being

"offset" by >100 metres relative to the "correct" watercourse location (as defined in aerial imagery and LIDAR). As a result, this dataset was not relied upon as part of the study.

- Stormwater Pipes – Provides the location, alignment and attributes of Council owned stormwater pipes and culverts. The extent of the pipes and culverts described by this layer is shown in **Figure 3**. Due to the significant amount of information contained in this layer, a dedicated discussion is provided in the following section.
- Stormwater Pit – Provides the location and attributes of Council owned stormwater pits/inlet. The location of stormwater pits described by this layer is shown in **Figure 3**. Due to the significant amount of information contained in this layer, a dedicated discussion is provided in the following section.

In general, the GIS layers provide a suitable basis for preparing report figures as well as informing the computer flood model development. Further details on the outcomes of the review of the stormwater layers is provided below.

4.5.1 Stormwater Information

The stormwater system can play a significant role in defining flood behaviour across the "built up" sections of the catchment, particularly during more frequent events. Therefore, it was considered important to include a representation of the stormwater system in the flood model developed for the study.

As discussed, Council provided stormwater GIS layers that contain information for stormwater pits and pipes in the study area. A detailed review of these layers was completed to confirm if the available information was sufficient to include a representation of the stormwater system in the flood model.

The extent of the stormwater GIS layers is shown in **Figure 3**. The review of these GIS layers determined that there are 690 pipes and 397 pits located within the study area.

In general, the pit and pipe layers provide sufficient information to allow a representation of the stormwater system to be included in the flood model. However, some limitations were identified, including:

- 44 pipes did not include information describing the size/diameter of the pipe. However, this information could generally be estimated based upon inspection of the diameter of upstream and downstream pipes. The only exception was along Sir William McKell Drive and McPherson Circuit where none of the pipes included size information and, therefore, diameters could not be estimated. For this area, pipe diameters were measured in the field.
- Lintel lengths were generally not provided for pits with a kerb opening. A field inspection of pits across the Pambula area was completed and this determined a typical lintel length of 1.8 metres would be appropriate for application to the study area.
- Grate dimensions were typically not provided for pits that were defined as "grated inlets". A field inspection of pits across the Pambula area was completed and this determined a 0.45m by 0.9m grate was most common and would be suitable for application to the study area.

- 26 pits did not include any information describing the pit type (e.g., grate and lintel sizes). In such cases, a 1.8 metre lintel with no grate was adopted as it was the most common pit type across the urban areas.

It was noted that invert elevations are not provided in either dataset. However, the pit and pipe depths are often reported which allows the invert to be estimated by interrogating the overlying LiDAR elevation data. In instances where the pit/pipe depths were not provided, the invert elevations were estimated using the following approach:

- Invert elevation = LiDAR elevation – 0.5m cover – pipe diameter.

The suitability of the invert estimates was then confirmed by ensuring suitable "cover" was provided over the pipes at all locations (i.e., minimum of 0.5m depth of cover) and ensuring there were no adverse pipe slopes.

4.6 Engineering Plans

Council provided design and work-as-executed plans for ten drainage structures (mainly bridges) located within the catchment. The location of the drainage structures contained in the plans are shown in **Figure 3**.

The age and quality of the information contained in the plans is variable. However, they generally include information describing the size/dimensions of the structures including invert elevations and are sufficiently detailed for including a representation of these structures in the flood model.

Roads and Maritime Services (RMS) also provided plans for Princes Highway bridges and culverts. This includes bridge plans for the Pambula River and Yowaka River crossings as well as details for additional Princess Highway culverts located across the Pambula River floodplain. The location of each RMS structure is also shown in **Figure 3**.

4.7 Remote Sensing

In addition to providing elevations, the raw LiDAR also provides point descriptions (e.g., ground, buildings, trees), point intensity and multiple return information. This information can be used with aerial photography to assist with the identification of different land uses across the catchment. This, in turn, can be used to assist in defining the spatial variation in different land uses across the catchment which can inform Manning's 'n' roughness coefficients and rainfall losses in the computer flood models.

This technique of land use classification was based on research documented in a paper titled *'Using LiDAR Survey for Land Use Classification'* (C. Ryan, 2013) and was applied based upon the 2013 and 2018 LiDAR as well as the 2018 aerial imagery. The classification algorithm divided the study area into the following land use classifications:

- Buildings;
- Waterways;
- Sand;
- Trees;

- Long Grass;
- Short Grass;
- Concrete; and
- Roads.

It should be noted that perfect accuracy cannot be expected from any automated classification, particularly when the LiDAR and aerial imagery date from different periods. It was also noted that the 2018 LiDAR classifications were not as reliable as the 2013 LiDAR classifications most likely due to the reduced point density. As a result, manual updates to the remote sensing outputs were completed to ensure a reliable representation of the spatial variation in land use was provided across the catchment.

The final remote sensing output is shown in **Figure 5**.

4.8 Additional Data Collection

The various reports and datasets provided by Council afford a good description of the majority of features that will influence flood behaviour across the catchment. This includes ground surface elevations, riverbed elevations and major drainage structures such as bridges, culverts and stormwater pipes. However, it was noted that some drainage structures were not represented in the provided datasets and additional information would need to be captured to ensure these structures could be represented in the flood model. This additional information was captured through a combination of detailed ground survey (for those structures likely to have a significant impact on flood behaviour) and field measurements (for those structures less likely to significantly impact on flood behaviour).

The field measurements were collected using a Dewalt laser distance measurer. This device was used to collect details on the size of each structure (e.g., height and width), the number of spans/cells/pipes as well as the height of any overburden (i.e., height difference between the top of the structures and the road elevation). This information could then be used with the LiDAR information to estimate the invert elevations for each structure. A total of 4 structures were measured in the field and the location of each of these structures is shown in **Figure 6**.

Consulting surveyors, Veris, were engaged to undertake the detailed ground survey of hydraulic structures. A total of 5 culverts/causeways were surveyed and the location of each surveyed structure is shown on **Figure 6**.

4.9 Community Consultation

A key component of the flood study involved development of computer flood models. The computer models are typically calibrated/validated to ensure they are providing a reliable representation of flood behaviour. This is completed by using the models to replicate floods that have occurred in the past (i.e., historic floods).

Only limited historic flood information is available for the catchment. However, it was considered that the community may be able to provide additional information on past floods to assist with the computer model validation. In this regard, a community questionnaire was

prepared and was distributed to 318 properties located within the catchment. A copy of the questionnaire is included in **Appendix A**.

The questionnaire sought information from the community regarding whether they had experienced flooding, the nature of flood behaviour, if roads and houses were inundated and whether residents could identify any historic flood marks. A total of 21 questionnaire responses were received. A summary of all questionnaire responses is provided in **Appendix A**. The spatial distribution of questionnaire respondents is shown in **Figure A1**, which is also enclosed in **Appendix A**.

The responses to the questionnaire indicate that:

- The majority of respondents have lived in or around the catchment for at least 10 years.
- Nearly 30% of respondents have experienced some form of inundation or disruption as a result of flooding in the catchment. The spatial distribution of respondents that have reported past flooding problems is shown in **Figure A1** in **Appendix A** (refer red dots). The reported impacts included:
  - Inundation of front/back yards (1 respondent);
  - Traffic disruptions (3 respondents);
  - Flooded paddocks (3 respondents);
- Flooding problems were reported across the following roads:
  - Princes Highway
  - Chalkhills Road
  - Nethercote Road
  - Oaklands Road
- Some respondents believe flooding in the catchment is exacerbated by:
  - Blockage of the creek, stormwater inlets and/or drains (2 respondents)
  - Insufficient creek capacity (2 respondents)

A range of other useful observations were also provided as part of the questionnaire responses. This included:

- There are large springs located at the southern end of Pambula Lake that may interfere with flood flow calculations;
- The Princes Highway upgrade has likely increased flood levels on the western side of the highway;
- The earthworks that have been completed across the Pamboola Wetlands to create water bodies has likely restricted the available flow carrying capacity of this part of the floodplain.
- There were historic flood levels marked on the wall of the oyster bar at Pambula Lake but they have since been painted over.

A number of respondents provided information on floodwater depths and flow characteristics from past floods. Information on floods that occurred in March 2012 and June 2016 tended to be the most prolific and the information from these events is considered suitable for model calibration/validation purposes.

A limited number of photographs were also provided showing past floods. A selection of these photographs are provided in **Plate 10** to **Plate 12**.



Plate 10 Flooding across Greigs Flat (date unknown) (photo courtesy of Matt Barnes & Jack Gordon)



Plate 11 Flooding in June 2016 across rear of a Greigs Flat property



Plate 12 Floodwater extends across Princes Highway in March 2011

5 COMPUTER FLOOD MODELS

5.1 General

Computer models are the most common method of simulating flood behaviour through a particular area of interest. They can be used to predict flood characteristics such as peak discharges, flood level and flow velocity.

Two computer models were developed to simulate flood behaviour across the Pambula River, Pambula Lake & Yowaka River catchment:

- A XP-RAFTS hydrologic model was developed to simulate the transformation of rainfall into runoff across the catchment; and,
- A TUFLOW hydraulic model was developed to simulate how the runoff would be distributed/move across the study area.

The following sections describe the model development process.

5.2 XP-RAFTS Model Development

5.2.1 Subcatchment Parameterisation

The Pambula River, Pambula Lake & Yowaka River catchment was subdivided into 432 subcatchments based on the alignment of major streams, topographic divides and the location of key infrastructure (e.g., bridge and culvert crossings). The subcatchments were delineated with the assistance of the CatchmentSIM software using a 10 metre Digital Elevation Model (DEM). The subcatchment layout is presented in **Figures 7.1** to **7.7**.

Key hydrologic properties including area, impervious proportion, roughness and average vectored slope were calculated automatically for each subcatchment using CatchmentSIM in conjunction with detailed remote sensing land use information (refer Section 4.7). The spatial distribution of the different land use types is shown in **Figure 5**.

Percentage impervious and pervious 'n' roughness values were assigned to each land use (refer **Table 10**) and were used to calculate weighted average percentage impervious and pervious 'n' values for each subcatchment. The adopted subcatchment parameters are summarised in **Appendix B**.

5.2.2 Stream Routing

The sub-catchment area, roughness, slope and percentage impervious parameters that are input into the XP-RAFTS model are used by the model to estimate the transformation of rainfall excess into runoff for each subcatchment. In addition to local subcatchment runoff, most sub-catchments will also carry flow from upstream catchments along the main watercourses. The flow along the watercourses in XP-RAFTS is represented using a "link" between successive subcatchment "nodes".

Table 10 Adopted Impervious Percentage and Pervious 'n' Values for XP-RAFTS Model

Land Use Description	Pervious "n'	Impervious (%)
Buildings	0.030	100
Paved Roads	0.019	100
Gravel Roads	0.030	0
Concrete	0.016	100
Trees	0.120	0
Long Grass	0.060	0
Short Grass	0.042	0
Sand	0.030	0
Wetland/Mangroves	0.140	100
Watercourse	0.060	100

For this study, time delay lag routing was employed to represent the routing of runoff along the main watercourses into downstream subcatchments. The time delay value for each stream segment was calculated by dividing the stream length by an average stream velocity. The average stream velocity was defined using peak 1% AEP design velocity outputs from a preliminary TUFLOW model simulation. The average channel velocity from the 1% AEP flood was determined at each grid cell and then the average velocity contained within each subcatchment was calculated to enable the time delay value to be calculated. The lag values that were used to represent the routing of flows through each subcatchment are provided in **Appendix B**.

5.2.3 Rainfall Loss Model

During a typical rainfall event, not all of the rain falling on a catchment is converted to runoff. Some of the rainfall may be intercepted and stored by vegetation, some may be stored in small depressions and some may infiltrate into the underlying soils.

To account for rainfall "losses" of this nature, the hydrologic model incorporates a rainfall loss model. For this study, the "Initial-Continuing" loss model was adopted, which is recommended in 'Australian Rainfall & Runoff' (Ball et al, 2019). This loss model assumes that a specified amount of rainfall is lost during the initial saturation/wetting of the catchment (referred to as the 'Initial Loss'). Further losses are applied at a constant rate to simulate infiltration/interception once the catchment is saturated (referred to as the 'Continuing Loss Rate'). The initial and continuing losses are deducted from the total rainfall over the catchment, leaving the residual rainfall to be distributed across the catchment as runoff.

The rainfall losses that were employed in the XP-RAFTS model were adjusted as part of the model calibration process. Further details on the model calibration are provided in Chapter 6.

5.2.4 Water Storages

The catchment includes a number of water bodies (primarily farm dams). These water bodies have the potential to attenuate downstream flows from the local catchment by storing runoff.

However, the volume of storage afforded by each of the farm dams is typically small when compared to the overall catchment area. Furthermore, there is no guarantee that storage volume will be available during rainfall events (i.e., there may have been some "lead up" rainfall which filled the dams prior to the main rainfall event). As a result, water storages/farm dams were not included in the XP-RAFTS model (i.e., it was assumed that all dams were "full" at the start of the rainfall event).

5.3 TUFLOW Model Development

5.3.1 Model Extent

The extent of the TUFLOW model area is shown in **Figures 8.1** to **8.6**. The overall TUFLOW model covers a total area of 83 km^2.

The TUFLOW model extends along a 31-kilometre length of the Pambula River, a 22-kilometre length of the Yowaka River and also includes each major tributary. The model also includes Pambula Lake and extends approximately 500 metres offshore from the Pambula River entrance at Pambula Beach.

5.3.2 Grid Size and Topography

The TUFLOW software uses a grid to define the spatial variation in topography and hydraulic properties (e.g., Manning's "n" roughness) across the model area. Accordingly, the choice of grid size can have a significant impact on the performance of the model. In general, a smaller grid size will provide a more detailed and reliable representation of flood behaviour relative to a larger grid size. However, a smaller grid size will take longer to perform all of the necessary hydraulic calculations. Therefore, it is typically necessary to select a grid size that makes an appropriate compromise between the level of detail provided by the model and the associated computational time required. A grid size of 4 metres was ultimately adopted and was considered to provide a reasonable compromise between reliability and simulation time.

Elevations were assigned to the grid cells within the TUFLOW model based on the Digital Elevation Model derived from the 2013 and 2018 LiDAR information. The 2013 data covers the majority of the TUFLOW model area with the 2018 data only being used to assign elevations to the very western sections of TUFLOW model.

5.3.3 Manning's "n" Values

The TUFLOW software uses land use information to define the hydraulic (i.e., Manning's 'n') properties for each grid cell in the model. The remote sensing information described in Section 4.7 was used as the basis for defining the variation in land use across the TUFLOW model (refer **Figure 4**). This land use information, in turn, was used as the basis for assigning the variation in Manning's "n" roughness values across the model area.

Manning's "n" is an empirically derived coefficient that is used to define the resistance to flow (i.e., roughness) afforded by different material types and land uses. It is one of the key input parameters used in the development of the TUFLOW model.

The "n" values listed in **Table 11** were initially estimated based on values in literature and were then refined as part of the model calibration process. Further details of the TUFLOW model calibration are provided in Section 6.

5.3.4 River and Creek Channels

During most floods, the majority of flow is conveyed within each of the major rivers/creeks. Therefore, it is important to ensure that these watercourses are well represented in the TUFLOW model.

Table 11 Manning's "n" Roughness Values

Land Use Description	Manning's "n"
Buildings	1.000
Paved Roads	0.018
Gravel Roads	0.025
Concrete	0.013
Trees	0.080
Long Grass	0.040
Short Grass	0.030
Sand	0.024
Wetland	0.060
Lower Pambula River	0.020
Sandy watercourses	0.024
Rocky watercourses	0.035
Oyster leases	0.050

There are two primary ways to represent watercourses in the TUFLOW model; as an embedded 1-dimensional domain or as part of the 2-dimensional domain. Both options have advantages and disadvantages. A 2-dimensional creek representation was ultimately adopted as it allows a better representation of flow momentum, hydraulic losses around bends as well as the potential for localised "break outs" from the channels.

Where available, the watercourse geometry was defined using the 2003 hydrosurvey information (refer Section 4.4.3). In areas where hydrosurvey was not available, the watercourse geometry was defined using "gully lines". The elevations and widths assigned to the gully lines were informed by the following sources (in order of priority):

- Hydraulic structure ground survey
- Hydraulic structure field measurements; and
- LiDAR DEM (in areas not obstructed by vegetation).

The location of the gully lines is shown in in **Figures 8.1** to **8.6**.

The main limitation associated with a 2-dimensional representation of the watercourses is that it does not always provide a sufficiently detailed representation of the conveyance capacity of the channel. The TUFLOW User Manual (BMT, 2018) suggests a minimum of five grid cells are generally required laterally to adequately represent watercourses. A review of the TUFLOW model grid indicates that between 3 and 10 cells generally extend across the various channels, with 6 cells being most common (refer **Plate 13**). Therefore, the adopted

grid size generally appears to be adequate to represent each of the main watercourses in the flood investigation area. The 2-dimensional watercourse representation was validated against surveyed cross-sections to ensure there were no significant variations in cross-section area. An example of the cross-section comparisons are provided in **Plate 14** and **Plate 15.** This validation indicated that the 2-dimensional representation provided a channel area that was within 10% of the surveyed cross-sectional area.



Plate 13 Example of TUFLOW grid cells across Pambula River channel

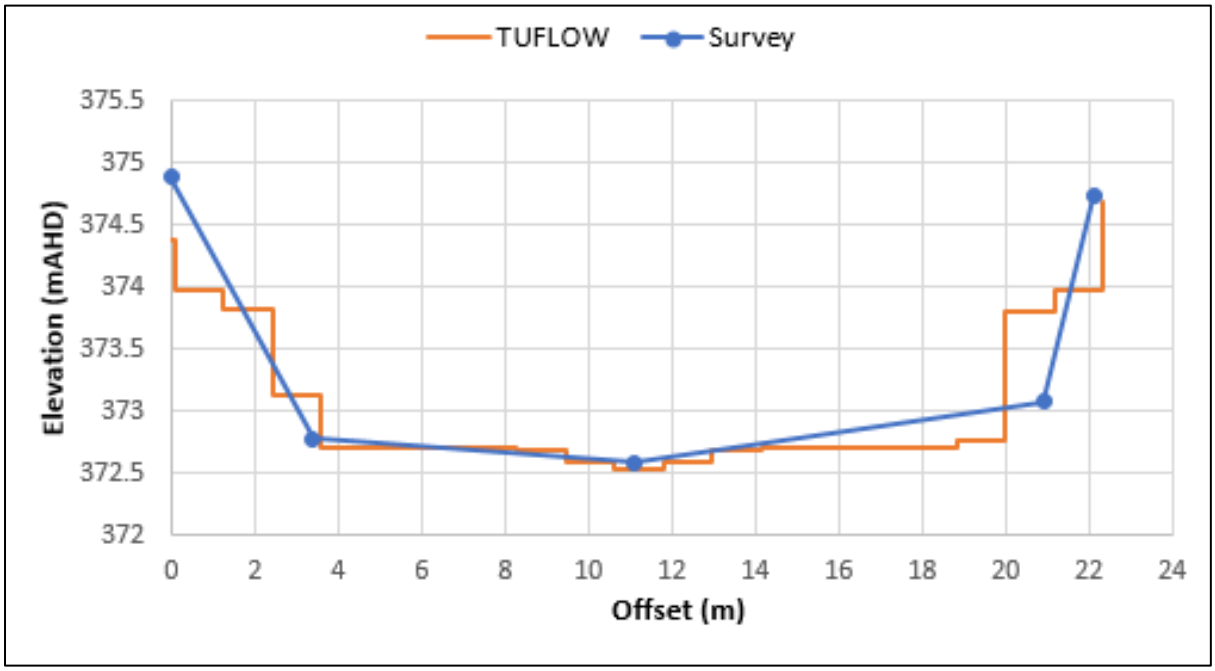


Plate 14 Example of 2-dimensional representation of Pambula River channel approximately 400 metres upstream of Princes Highway

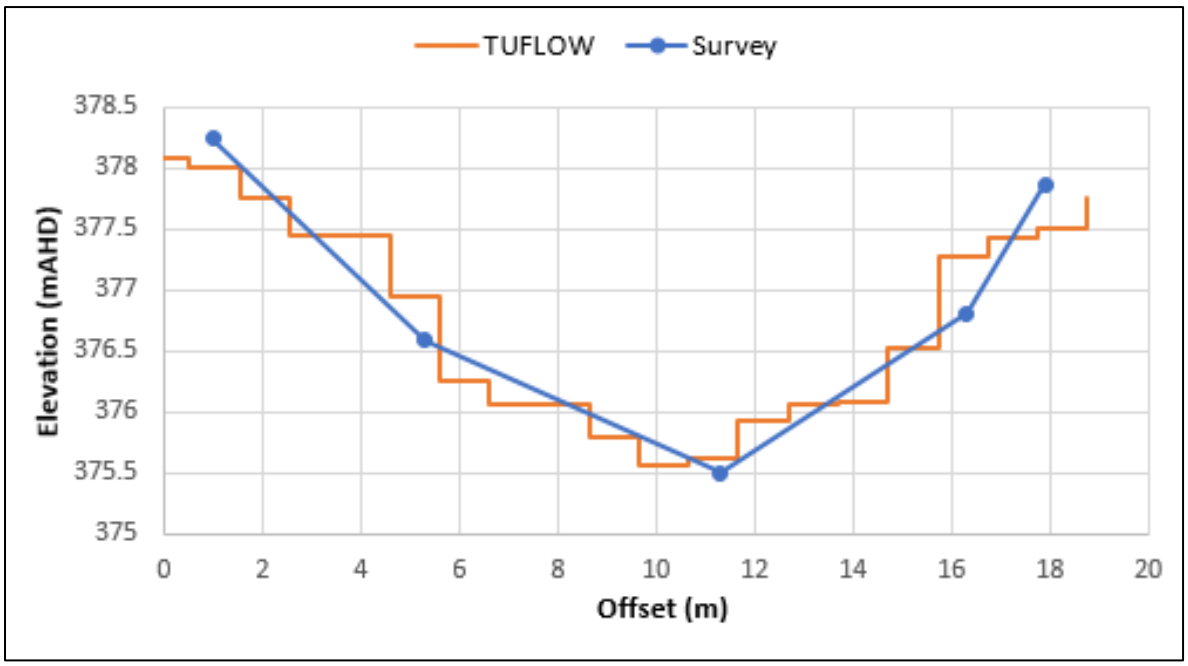


Plate 15 Example of 2-dimensional representation of Pambula River channel approximately 400 metres downstream of Princes Highway

5.3.5 Boundary Conditions

Upstream Boundary Conditions

As discussed, the XP-RAFTS model was used to simulate the transformation of rainfall into runoff and generate discharge hydrographs at discrete locations across the full extent of the catchment. The TUFLOW model extends across a part of the overall catchment. Therefore, the total flows from the upstream sections of the catchment as well as flows from the local subcatchments located within the TUFLOW model area must be accounted for. Accordingly, 'total' inflow hydrographs (i.e., hydrographs describing the total upstream contributing flow) were used to define the design inflows from those subcatchments draining into the upstream sections of the TUFLOW model. In addition, 'local' discharge hydrographs (representing flows from the local subcatchments only) were also extracted from XP-RAFTS and were used to represent inflows for those subcatchment contained within the TUFLOW model area. The local flow hydrographs were applied to the TUFLOW model at the outlet of each subcatchment. The location where local and total inflows were applied to the TUFLOW model is shown in **Figures 8.1** to **8.6**.

Downstream Boundary Conditions

Hydraulic computer models also require the adoption of a suitable downstream boundary condition in order to reliably define flood behaviour throughout the area of interest. The downstream boundary condition is typically defined as a known water surface elevation (i.e., stage). The downstream boundary of the computer model is located within the Tasman Sea. Accordingly, the water level across the downstream reaches of the model will be driven by the prevailing ocean tide levels.

Therefore, the downstream boundary condition was defined based upon a time varying water level. The time varying water level was based upon either recorded ocean heights at the Eden gauge (for historic floods) or a synthetic tide curve (for design floods). Further information on the adopted downstream boundary conditions is provided in Chapters 6 and 7.

5.3.6 Culverts and Bridges

Culverts and bridges can have a significant influence on flood behaviour, particularly if they become blocked during the course of the flood. Therefore, all major bridges and culverts within the TUFLOW model area were represented within the TUFLOW model as 1D hydraulic structures. The location of culverts and bridges that were included within the TUFLOW model is shown in **Figures 8.1** to **8.6**.

For circular and rectangular culverts, the surveyed/measured dimensions and invert elevations of the structures were included directly in the TUFLOW model. An entrance loss coefficient of 0.5 and an exit loss coefficient of 1.0 was adopted for all culverts.

The bridge deck and road surfaces above each culvert were represented as part of the 2D domain. Therefore, flow through each of the structures below the road level was represented in 1D and flow across the road surface (i.e., once the capacity of the structure is exceeded) was represented in 2D.

All bridges were represented using 2-dimensional layered flow constriction lines in TUFLOW. The use of the layered flow constriction allows separate blockage factors and energy losses to be defined for the bridge substructure, deck and hand railings. Energy losses were defined using procedures outlined in *'Hydraulics of Bridge Waterways'* (Bradley, 1978). Blockage factors were assigned as followings:

- Substructure: bridge pier width / total bridge length
- Deck: 100% blockage
- Hand /guard rails (where present): 50% blockage

Blockage

During a typical flood, sediment, vegetation and urban debris (e.g., litter, fence palings, bins) from the catchment can become mobilised leading to blockage of downstream culverts and bridges. Consequently, bridges and culverts will typically not operate at full efficiency during most floods. This can increase the severity of flooding across areas located adjacent to these structures.

In recognition of this, blockage factors were calculated for all bridges and culverts. The blockage factors were calculated based on blockage guidelines contained in 'Australian Rainfall and Runoff: A Guide to Flood Estimation' (Ball et al, 2019). The blockage calculations are summarised in **Appendix D** for each culvert and bridge located within the TUFLOW model area. The blockage factors were applied to the bridge substructure only and are in addition to the blockage afforded by the bridge piers.

5.3.7 Stormwater System

The stormwater system has the potential to convey a significant proportion of runoff across the "built up" sections of the catchment during relatively frequent rainfall events. Therefore, it was considered important to incorporate the stormwater system in the TUFLOW model to ensure the interaction between piped stormwater and overland flows was reliably represented.

The full stormwater system contained within the catchment was included within the TUFLOW model as a dynamically linked 1D network. This allowed representation of the conveyance of flows by the stormwater system below ground as well as simulation of overland flows in two dimensions once the capacity of the stormwater system is exceeded.

The properties of the stormwater system (e.g., pits types/sizes, pipe lengths/diameters) were defined based on information contained in Council's stormwater GIS asset database. As discussed in Section 4.5.1, not all required information was provided in this database, therefore, some properties of the stormwater system were estimated. The extent of the stormwater system included within the TUFLOW model is shown in **Figures 8.1** to **8.6**.

5.3.8 Water Storages

As discussed in Section 4.2.4, the catchment incorporates a number of farm dams that may attenuate downstream flows during rainfall events. However, the amount of storage volume that they afford is considered to be small relative to the overall volume of runoff during a typical rainfall event and there is no guarantee that the dams will have storage volume available during significant rainfall events. Accordingly, all dams were represented as being "full" in the TUFLOW model. This included the Panboola Wetland waterbodies.

6 COMPUTER MODEL CALIBRATION

6.1 Overview

Computer flood models are approximations of a very complex process and are generally developed using parameters that are not known with a high degree of certainty and/or are subject to natural variability. This includes catchment roughness as well as blockage of hydraulic structures. Accordingly, the model should be calibrated using rainfall, flow and flood mark information from historic floods to ensure the adopted model parameters are producing reliable estimates of flood behaviour.

Calibration is typically completed using the following process:

- Hydrologic model calibration: Recorded rainfall is first applied to the hydrologic model. Simulated flows are extracted from the hydrologic model results at locations where recorded flow hydrographs are available. Hydrologic model calibration is completed by iteratively adjusting the model parameters within reasonable bounds to achieve the best possible match between simulated and recorded flow hydrographs.
- Hydraulic model calibration: The calibrated flows from the hydrologic model are then routed through the hydraulic model. Simulated flood levels/depth are compared against surveyed flood levels from the historic flood or anecdotal reports of inundation depths. The hydraulic model parameters are adjusted until the best correlation between simulated and surveyed/reported flood levels/depths is achieved.

The following sections describe the historic floods that were selected for calibration purposes and the outcomes of the hydrologic and hydraulic model calibration.

6.2 Calibration Events

6.2.1 Available Rainfall Data

Continuous rainfall data are required to define the temporal (i.e., time-varying) distribution of rainfall in the hydrologic computer model for the nominated calibration event. There are several continuous rainfall gauges located within or adjacent to the catchment. Data for one continuous gauge dates back to 1971, however, the majority of the continuous gauges came into service between 2009 and 2011.

There are also several daily read rainfall gauges located within or adjacent to the catchment. The daily read rainfall records can be used to provide an indication of the spatial variation in rainfall during any historic event. There are several gauges with records that extend back to the late 1800s and early 1900s. When this daily data is combined with the continuous gauge data, there is sufficient information to describe the spatial and temporal variation in rainfall during any significant rainfall event that has occurred since 1971.

6.2.2 Available Stream Gauge Data

Recorded stream flow estimates are required to perform a meaningful hydrologic model calibration. Recorded stream flow data are generally obtained using gauges that record the time variation in stream water height in conjunction with a suitable rating curve/table to convert the stream heights to an equivalent discharge. Although two stream height gauges are located within the catchment, only one has a rating curve (i.e., Pambula River @ Lochiel). This gauge has records dating back to 1966. The other gauge (Pamula Lake) only comprises water level records dating from 1991 (rating curves are not typically prepared for tidal gauge as the variations in water levels introduced by the tide will lead to erroneous discharge estimates).

6.2.3 Adopted Events

The following criteria were employed to select events suitable for the purpose of model calibration and verification:

- Minimum of five significant flood events (ie., larger floods preferred over smaller floods).
- Floods after 2011 preferred as it provides the most comprehensive rainfall information.
- Events where flood marks are available are preferred so the same events can be used for both hydrologic and hydraulic model calibration.

Based on these criteria, the following events were selected for model calibration and verification:

- 1971
- 1985
- 2011
- 2012
- 2016

The historic floods were simulated in reverse chronological order as the more contemporary events (i.e., 2011, 2012 and 2016) provided a greater amount of rainfall and stream flow/level information for calibration purposes.

6.3 2016 Flood

6.3.1 XP-RAFTS Modelling

Rainfall

The 2016 flood occurred as a result of rain falling between the 4th and 7th of June. The rainfall was generated by an East Coast Low that produced significant rainfall along the coast of NSW. As shown in **Plate 16**, parts of the South Coast of NSW experienced more than 400 mm of rainfall. However, as shown in **Table 12**, the Pambula and Yowaka Rivers catchment experienced rainfall totals of between 190 and 377 mm.

Accumulated rainfall totals for each rainfall gauge that was operational during the 2016 event were used to develop a rainfall isohyet (i.e., rainfall depth contour) map for the event, which is shown in **Figure 9**.

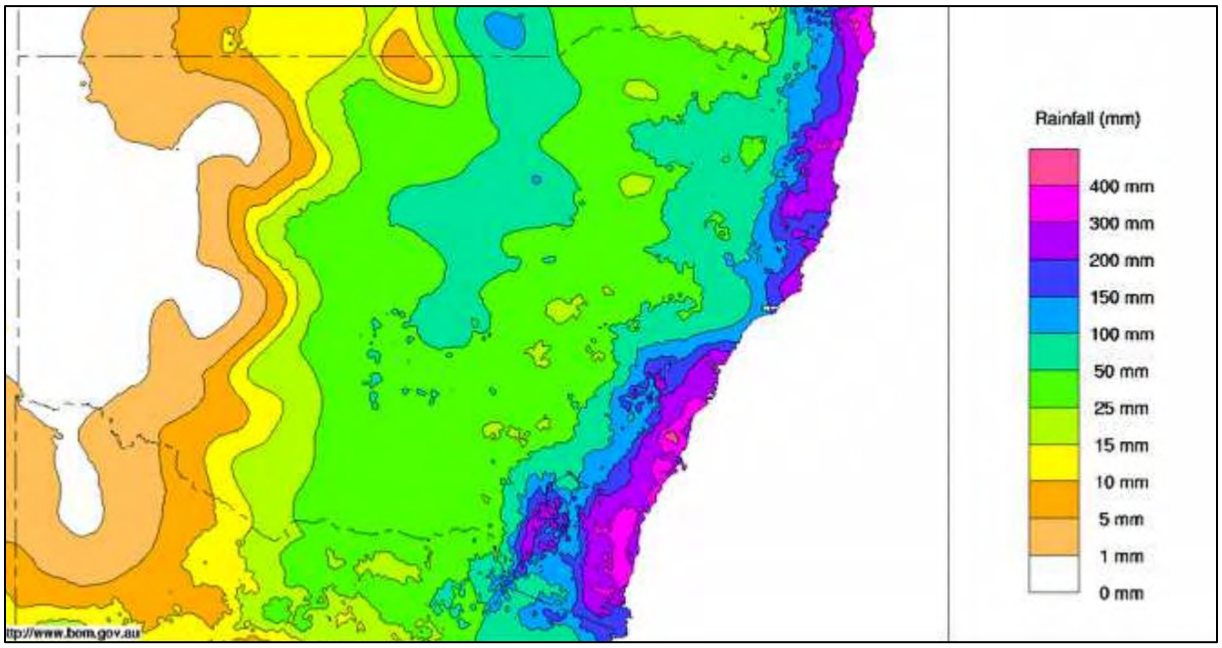


Plate 16 Four-day rainfall totals for NSW for June 2016 event (Bureau of Meteorology, 2016)

Table 12 Historic Rainfall Statistics

Event	Dates		Catchment Rainfall (mm)		
	Start	End	Minimum	Average	Maximum
2016	4th June	7th June	190	289	377
2012	1st Mar	2nd Mar	150	166	199
2011	20th Mar	25th Mar	116	230	330
1985	25th Nov	30th Nov	178	219	257
1971	4th Feb	8th Feb	295	373	475

The isohyet map and information included in **Table 12** indicates that there was some notable spatial variation in rainfall across the catchment during the 2016 event, with rainfall totals across the western sections of the catchment being approximately double of those recorded along the coast. In recognition of the variation in rainfall across the catchment during this event, the isohyets shown in **Figure 9** were used as the basis for defining spatially varying rainfall across the catchment as part of the 2016 flood simulation. This involved calculating a weighted average rainfall for each subcatchment in the XP-RAFTS model.

The temporal (i.e., time-varying) distribution of rainfall was determined based on the closest continuous rainfall gauge that provided reliable recorded rainfall information for the event. This was determined to be the Merimbula Airport gauge (Gauge #69147).

The continuous rainfall information was also analysed relative to design rainfall-intensity-duration information. This information is presented as **Figure D1** in **Appendix D** and indicates that the 2016 event produced rainfall that was around the same severity as a 20% AEP design rainfall event for some periods.

Rainfall Losses

As discussed in Section 4.2.3, the initial-continuing loss model was employed to represent rainfall losses across the catchment. The rainfall losses were initially informed based upon information downloaded from the *'Australian Rainfall and Runoff – A Guide to Flood Estimation'* (Ball et al, 2019) data hub:

- Storm initial loss: 21 mm
- Storm Continuing loss rate: 2.48 mm/hr

Initial calibration simulations with the loss rate of 2.48 mm/hr did not generate acceptable calibration results for any of the simulated floods. Therefore, the continuing loss rate was revised based upon calibrated loss rates for the adjoining Towamba River catchment as documented in the *'Eden, Twofold Bay, Towamba River Flood Study'* (Rhlem, 2019). This study employed a continuing loss rate of 1 mm/hour for pervious catchment areas.

The 1 mm/hour continuing loss rate was subsequently adjusted, as part of each calibration simulation to best reproduce the volume of runoff that was recorded at the Lochiel stream gauge. As shown in **Table 13**, a loss rate of 1.5 mm/hour was adopted for the 2016 simulation for pervious sections of the catchment. **Table 13** also shows that no rainfall losses were applied to impervious sections of the catchment (this is also consistent with the *'Eden, Twofold Bay, Towamba River Flood Study'*).

Table 13 Adopted Rainfall Losses for Calibration Simulations

Event	Initial Loss (mm)		Continuing Loss Rate (mm/hr)	
	Pervious	Impervious	Pervious	Impervious
2016	21	0	1.5	0.0
2012	21	0	1.8	0.0
2011	21	0	0.5	0.0
1985	0	0	1.0	0.0
1971	21	0	1.0	0.0

Results

The XP-RAFTS model was used to simulate rainfall-runoff behaviour for the 2016 flood based upon the rainfall and rainfall loss information presented in the preceding sections. This enabled discharge hydrographs to be generated for each subcatchment. Peak discharges for each XP-RAFTS model subcatchment for the 2016 flood are included in **Appendix E.** Peak discharges at key locations throughout the catchment are also summarised in **Table 14.**

A simulated discharge hydrograph was also extracted at the location of the Lochiel stream gauge. This simulated hydrograph is presented in the **Figure D2** in **Appendix D**. Also included on **Figure D2** is the recorded discharge hydrograph.

Figure D2 shows that the XP-RAFTS hydrograph provides a reasonable reproduction of the recorded hydrograph for the Pambula River at Lochiel gauge. More specifically, the general shape of the recorded hydrograph, the timing of the dual peaks and the magnitude of the

peak discharge (simulated = 317m^3/s versus recorded = 300m^3/s) is reproduced by the XP-RAFTS model.

Table 14 Peak Discharge at Key Locations for Historic Flood Simulations

Location		Peak Discharge (m^3/s)				
		2016	2012	2011	1985	1971
Pambula River	Lochiel Gauge	317	257	354	430	577
	Princes Hwy	361	290	383	488	652
	River entrance/Tasman Sea	847	733	836	1,167	1,600
Yowaka River	Nethercote Road bridge	147	126	171	203	275
	Princes Hwy	386	332	406	530	719

The hydrographs generated by the XP-RAFTS model were also routed through the TUFLOW model. Further discussion on the TUFLOW model simulation is provided below.

6.3.2 TUFLOW Modelling

Modifications to Reflect Historic Conditions

A review of historic aerial imagery determined that there have not been any significant changes in catchment conditions since the 2016 flood. Therefore, no modifications were completed to the TUFLOW model that was developed to reflect contemporary catchment conditions to reflect catchment conditions at the time of the 2016 flood.

Inflow Boundary Conditions

Discharge hydrographs generated by the XP-RAFTS hydrologic model were used to define inflows to the TUFLOW model.

Downstream Boundary Conditions

Hydraulic computer models also require the adoption of a suitable downstream boundary condition to reliably define flood behaviour throughout the area of interest. The downstream boundary condition is typically defined as a known water surface elevation (i.e., stage). The downstream boundary of the TUFLOW model is located within the Tasman Sea (approximately 500 metres offshore from Pambula Beach). Accordingly, the water level in this area will be governed by the prevailing ocean tide level at the time of the flood.

Although there is a water level gauge located within Pambula Lake, water levels at this location will also be influenced by catchment runoff. Therefore, this gauge was not suitable for defining ocean water levels. The next closest gauge that would not be strongly influenced by catchment runoff is located at Merimbula Wharf. Therefore, the recorded water levels at this gauge were used to define the downstream boundary conditions for the 2016 flood simulation.

Results

Calibration of the TUFLOW computer model was attempted based upon four (4) anecdotal reports of flood behaviour as well as recorded water levels at the Lochiel and Pambula Lake

gauges. In general, the anecdotal flooding reports only provided information on areas that were flooded (specific flood depths or levels were not available).

Peak floodwater depths were extracted from the results of the 2016 flood simulation and are included on **Figures 10.1** to **10.6**. A comparison between the peak flood depths generated by the TUFLOW model and the anecdotal reports of flooding for the 2016 flood is also provided in **Figures 10.1** to **10.6** as well as **Table 15**.

Table 15 Comparison between simulated floodwater depths and anecdotal flooding reports for the 2016 flood

Anecdotal Flooding Report	Simulated Floodwater Depth (m)
1 metre of water within creek	0.85
Flooding of paddock	1.52
Unknown height in Pambula River	3.03
Flooding near Harts Bridge	0.40

The time variation in simulated water levels at the Pambula River at Lochiel gauge and Pambula Lake gauge were also extracted and are provided in **Figure D3** and **D4** in **Appendix D**.

The comparison provided in **Table 15** shows that the TUFLOW model is reproducing the observations from the 2016 flood. The only depth information that was reported for this event is reproduced by the model to within 0.15 metres.

Figure D3 also shows that the simulated stage hydrograph provides a reasonable replication of the time variation in recorded stages at the Lochiel gauge. More specifically the timing and magnitude of the dual peaks is well reproduced by the TUFLOW model (both peak water levels are reproduced to within 0.1 metres).

Figure D4 also shows the TUFLOW model provides a reasonable reproduction of the recorded Pambula Lake stage hydrograph. In particular, the timing of the various ebb and flood tidal peaks is closely replicated as is the overall peak stage (1.46 mAHD recorded versus 1.41 mAHD simulated).

6.4 2012 Flood

6.4.1 XP-RAFTS Modelling

Rainfall

The 2012 flood occurred as a result of rain falling on the 1st and 2nd of March. Accumulated rainfall totals for each active rain gauge over this two-day period are presented in **Figure 11**. As shown in **Figure 11** and **Table 12**, total rainfall depths across the catchment during this event varied between 150 and 199 mm.

The isohyets shown in **Figure 11** were used as the basis for defining spatially varying rainfall across the catchment as part of the 2012 flood simulation. The temporal distribution of

rainfall was determined based on the closest continuous rainfall gauge that provided reliable recorded rainfall information for the event. This was determined to be the Lochiel gauge.

The continuous rainfall information was also analysed relative to design rainfall-intensity-duration information. This information is presented in **Figure D1** in **Appendix D** and indicates that the 2012 event produced rainfall that was between a 50% AEP and 20% AEP design rainfall event. Therefore, the 2012 event produced the lowest total rainfall depths and was the smallest event (in terms of rainfall severity) of all the events considered for calibration.

Rainfall Losses

The rainfall losses summarised in **Table 13** were applied as part of 2012 flood simulation. As shown in **Table 13**, a higher continuing loss rate of 1.8 mm/hr was required for the 2012 simulation as the 1 mm/hr loss rate generated too much runoff volume at the Lochiel stream gauge.

Results

The XP-RAFTS model was used to simulate rainfall-runoff behaviour for the 2012 flood based upon the rainfall and rainfall loss information presented in the preceding sections. This enabled discharge hydrographs to be generated for each subcatchment. Peak discharges for each XP-RAFTS model subcatchment for the 2012 flood are included in **Appendix E.** Peak discharges at key locations throughout the catchment are also summarised in **Table 14.**

A simulated discharge hydrograph was also extracted at the location of the Lochiel stream gauge. This simulated hydrograph is presented in the **Figure D5** in **Appendix D**. Also included on **Figure D5** is the recorded discharge hydrograph.

Figure D5 shows that the XP-RAFTS hydrograph provides a good reproduction of the recorded hydrograph for the Pambula River at Lochiel gauge. More specifically, the shape of the recorded hydrograph and the magnitude of the peak discharge (simulated = 256m^3/s versus recorded = 264m^3/s) is well reproduced by the XP-RAFTS model.

6.4.2 TUFLOW Modelling

Modifications to Reflect Historic Conditions

A review of historic aerial imagery determined that there have not been any significant changes in catchment conditions since the 2012 flood. Therefore, no modifications were completed to the TUFLOW model to reflect 2012 catchment conditions.

Inflow Boundary Conditions

Discharge hydrographs generated by the XP-RAFTS hydrologic model were used to define inflows to the TUFLOW model.

Downstream Boundary Conditions

The downstream boundary condition for the TUFLOW model was defined based on recorded water levels at the Merimbula Wharf gauge.

Results

Calibration of the TUFLOW computer model was attempted based upon six (6) anecdotal reports of flood behaviour/flood photographs as well as recorded water levels at the Lochiel and Pambula Lake gauges.

Peak floodwater depths were extracted from the results of the 2012 flood simulation and are included on **Figures 12.1** to **12.6**. A comparison between the peak flood depths generated by the TUFLOW model and the anecdotal reports of flooding for the 2012 flood is also provided in **Figures 12.1** to **12.6** as well as **Table 16**.

Table 16 Comparison between simulated floodwater depths and anecdotal flooding reports for the 2012 flood

Anecdotal Flooding Report	Simulated Floodwater Depth (m)
Shallow flow across Princess Highway	0.13
~1m deep at entrance to Oaklands	0.84
Water extending onto carpark of Oaklands	0.39
Flooding of paddock	1.23
Unknown height in Pambula River	2.75
Flooding near Harts Bridge	0.39

The time variation in simulated water levels at the Pambula River at Lochiel gauge and Pambula Lake gauge were also extracted and are provided in **Figure D6** and **D7** in **Appendix D**.

The comparison provided in **Table 16** shows that the TUFLOW model is reproducing the observations from the 2012 flood. The only depth information that was reported (at the entrance to Oaklands) is reproduced by the model to within 0.16 metres.

Figure D6 also shows that the simulated stage hydrograph provides a reasonable reproduction of the time variation in recorded stages at the Lochiel gauge. Although the rising limb of the simulated hydrograph occurs sooner than the recorded hydrograph, the timing and magnitude of the peak stage is well represented.

Figure D7 also shows the TUFLOW model provides a reasonable reproduction of the recorded Pambula Lake stage hydrograph. In particular, the timing and magnitude of the various ebb and flood tidal peaks is well replicated although the simulated maximum water level is 0.14 metres higher than the recorded maximum level.

6.5 2011 Flood

6.5.1 XP-RAFTS Modelling

Rainfall

The 2011 flood occurred as a result of rain falling over a 6-day period (i.e., from 20th March to 25th March). Accumulated rainfall totals for each active rainfall gauge over this two-day period are presented in **Figure 13**. As shown in **Figure 13** and **Table 12**, total rainfall depths across the catchment during this event varied between 116 and 300 mm. **Figure 13** also shows there was notable spatial variation in rainfall across the catchment during the 2011 event, with considerably more rainfall recorded across the western sections of the catchment

relative to the coast. The isohyets shown in **Figure 13** were used as the basis for defining spatially varying rainfall across the catchment as part of the 2011 flood simulation.

The temporal distribution of rainfall was determined based on the closest continuous rainfall gauge that provided reliable recorded rainfall information for the event. This was determined to be the Lochiel gauge.

The continuous rainfall information was also analysed relative to design rainfall-intensity-duration information. This information is presented in as **Figure D1** in **Appendix D** and indicates that the 2011 event produced rainfall that was roughly equivalent to the 20% AEP design rainfall event. Accordingly, the severity of rainfall during the 2011 flood was similar to the 2016 event.

Rainfall Losses

The rainfall losses summarised in **Table 13** were applied to the RAFTS model as part of 2011 flood simulation. As shown in **Table 13**, a continuing loss rate of 0.5 mm/hr was required for the 2011 simulation to reproduce the runoff volume at the Lochiel stream gauge.

Results

The XP-RAFTS model was used to simulate rainfall-runoff behaviour for the 2011 flood. Peak discharges for each XP-RAFTS model subcatchment for the 2011 flood simulation are included in **Appendix E.** Peak discharges at key locations throughout the catchment are also summarised in **Table 14.**

A simulated discharge hydrograph was also extracted at the location of the Lochiel stream gauge. This simulated hydrograph is presented in **Figure D8** in **Appendix D**. Also included on **Figure D8** is the recorded discharge hydrograph.

Figure D8 shows that the XP-RAFTS hydrograph provides a reasonable reproduction of the overall shape of the recorded hydrograph as well as the timing of the dual peaks. The XP-RAFTS model produces a slightly lower peak discharge (simulated = 368m^3/s versus recorded = 384m^3/s), however, this is still considered to be a reasonable outcome (i.e., peak discharges agree to within 5%).

6.5.2 TUFLOW Modelling

Modifications to Reflect Historic Conditions

A review of historic aerial imagery determined that there have not been any significant changes in catchment conditions since the 2011 flood. Therefore, no modifications were completed to the TUFLOW model to reflect 2011 catchment conditions.

Inflow Boundary Conditions

Discharge hydrographs generated by the XP-RAFTS hydrologic model were used to define inflows to the TUFLOW model.

Downstream Boundary Conditions

The downstream boundary condition for the TUFLOW model was defined based on recorded water levels at the Merimbula Wharf gauge during the 2011 event.

Results

Calibration of the TUFLOW computer model was attempted based upon three (3) anecdotal reports of flood behaviour as well as recorded water levels at the Lochiel and Pambula Lake gauges.

Peak floodwater depths were extracted from the results of the 2011 flood simulation and are included on **Figures 14.1** to **14.6**. A comparison between the peak flood depths generated by the TUFLOW model and the anecdotal reports of flooding for the 2011 flood is also provided in **Figures 14.1** to **14.6** as well as **Table 17.**

Table 17 Comparison between simulated floodwater depths and anecdotal flooding reports for the 2011 flood

Anecdotal Flooding Report	Simulated Floodwater Depth (m)
Water covering Nethercote Road	0.26
Unknown height Pambula River	3.32
Flooding near Harts Bridge	0.19

The time variation in simulated water levels at the Pambula River at Lochiel gauge and Pambula Lake gauge were also extracted and are provided in **Figure D9** and **D10** in **Appendix D**.

The comparison provided in **Table 17** shows that the TUFLOW model is reproducing the observations from the 2011 flood.

Figure D9 also shows that the simulated stage hydrograph provides a reasonable reproduction of the recorded stages at the Lochiel gauge. The simulated hydrograph provides a good reproduction of the timing of the dual peaks although the simulated maximum water level is about 0.2 metres lower than the recorded maximum (although the first peak level is reproduced to better than 0.05 metres).

Figure D10 also shows the TUFLOW model provides a reasonable reproduction of the recorded Pambula Lake stage hydrograph. The timing and magnitude of the various tidal peaks is generally replicated, and the maximum recorded level is reproduced to within 0.03 metres.

6.6 1985 Flood

6.6.1 XP-RAFTS Modelling

Rainfall

The 1985 flood occurred as a result of rain falling between the 25th and 30th of November. Accumulated rainfall totals for this event are presented in **Figure 15**. As shown in **Figure 15** and **Table 12**, total rainfall depths across the catchment during this event varied between 178 and 257 mm.

Figure 15 also shows there was some spatial variation in rainfall across the catchment during the 1985 event. However, the spatial variability of rainfall during this event was not nearly as significant as some of the other calibration events. Nevertheless, it was still considered important to reflect the spatially varying rainfall in the XP-RAFTS model. Therefore, the isohyets shown in **Figure 15** were used as the basis for assigning rainfall to each subcatchment as part of the 1985 flood simulation.

The temporal distribution of rainfall during the 1985 simulation was based on recorded rainfall at the closest active sub-daily rain gauge. This was determined to be the Green Cape Lighthouse rain gauge which is located over 30 km south-east of the catchment.

The continuous rainfall information for the Lochiel gauge was also analysed relative to design rainfall-intensity-duration information. This information is presented in as **Figure D1** in **Appendix D** and indicates that the 1985 event produced rainfall that was roughly equivalent to the 10% AEP design rainfall event at times.

Rainfall Losses

The rainfall losses summarised in **Table 13** were applied to the RAFTS model as part of 2011 flood simulation. As shown in **Table 13**, a lower initial rainfall loss of 0 mm was adopted as part of the 1985 simulation in order to best replicate the early stages of the recorded hydrographs at the Lochiel stream gauge. A review of antecedent rainfall records indicates that more 30 mm of rain fell in the week preceding the main rainfall event. As a result, the catchment would have already been "wet" and an initial rainfall loss of 0 mm can be justified.

Results

The XP-RAFTS model was used to simulate rainfall-runoff behaviour for the 1985 flood. Peak discharges for each XP-RAFTS model subcatchment for the 1985 flood simulation are included in **Appendix E.** Peak discharges at key locations throughout the catchment are also summarised in **Table 14.**

A simulated discharge hydrograph was also extracted at the location of the Lochiel stream gauge. This simulated hydrograph is presented in the **Figure D11** in **Appendix D**. Also included on **Figure D11** is the recorded discharge hydrograph.

Figure D11 shows that the XP-RAFTS hydrograph provides a reasonable reproduction of overall shape of the recorded hydrograph as well as the magnitude of the peak discharge (simulated = 429m^3/s versus recorded = 450m^3/s). The XP- RAFTS model hydrograph peaks slightly before the recorded hydrograph. However, this may be associated with the adopted temporal pattern at Green Cape not being fully representative of rainfall across the catchment itself.

6.6.2 TUFLOW Modelling

Modifications to Reflect Historic Conditions

A review of historic aerial imagery determined that there have been some changes across sections of the lower Pambula River catchment since the 1985 flood occurred. This includes:

- Princess Highway upgrade between Pambula and South Pambula;
- Oaklands development; and

- Filling/development south of Bullara Street (e.g., Robert Smith Homemakers centre).

As these developments have the potential to impact on flood behaviour, each of the developments was removed from the hydraulic model to better represent floodplain conditions at the time of the 1985 flood. Specific survey information from this time period was not available. Therefore, an approximation of the landform was made by incorporating "z shapes" in the TUFLOW model. The z shapes were used to remove the filling associated with each development (the additional Princes Highway culverts were also removed from the model). Although this is unlikely to exactly represent "pre-development" conditions, the size of each development relative to overall Pambula River floodplain is small. Therefore, any uncertainties should not have a significant impact on results.

Inflow Boundary Conditions

Discharge hydrographs generated by the XP-RAFTS hydrologic model were used to define inflows to the TUFLOW model.

Downstream Boundary Conditions

Unlike the 2011, 2012 and 2016 floods, no recorded water level information is available for nearby gauges to assist in defining the downstream boundary conditions for the 1985 flood. However, the 'Pambula River Data Assessment Study' (1990) includes tabulated water level versus time information from a gauge near Eden for the 1985 event. Therefore, this tabulated information was extracted and was used to define the downstream boundary in the TUFLOW model.

Results

Calibration of the TUFLOW computer model was completed based upon seventeen (17) flood marks that were surveyed following the 1985 flood. A recorded stage hydrograph was also available for the Lochiel gauge.

Peak floodwater depths were extracted from the results of the 1985 flood simulation and are included on **Figures 16.1** to **16.6**. A comparison between the peak flood levels generated by the TUFLOW model and the surveyed flood marks is also provided in **Figures 16.1** to **16.6** as well as **Table 18.**

The time variation in simulated water levels at the Pambula River at Lochiel gauge were also extracted and is provided in **Figure D12** in **Appendix D**.

The flood level comparison provided in **Table 18** shows that the TUFLOW model is providing a good reproduction of the surveyed flood mark elevations. Most flood mark elevations are reproduced to within 0.15 metres with the average absolute difference being 0.10 metres.

Figure D12 also shows that the simulated stage hydrograph provides a reasonable reproduction of the recorded stages at the Lochiel gauge. The simulated hydrograph provides a good reproduction of the peak water level at the gauge (within 0.05 metres), although the timing of the peak is slightly off. As discussed, this may be associated with the timing of the recorded rainfall at the Green Cape gauge not being fully representative of the timing of rainfall across the catchment.

Table 18 Comparison between simulated flood levels and surveyed flood marks for the 1985 flood

#	Surveyed Flood Mark (mAHD)	Simulated Flood Level (mAHD)	Difference (m)
1	3.69	3.92	0.23
2	4.39	4.27	-0.12
3	4.81	4.77	-0.04
4	4.78	4.73	-0.05
5	4.25	4.12	-0.13
6	4.20	4.25	0.05
7	2.54	2.47	-0.07
8	2.55	2.46	-0.09
9	3.57	3.44	-0.13
10	3.57	3.48	-0.09
11	2.97	3.06	0.09
12	3.69	3.78	0.09
13	3.90	3.76	-0.14
14	3.99	4.09	0.10
15	3.65	3.76	0.11
16	3.33	3.19	-0.14
17	2.45	2.52	0.07

6.7 1971 Flood

6.7.1 XP-RAFTS Modelling

Rainfall

The 1971 flood occurred as a result of significant rain falling between the 4th and 8th of February. As shown in **Figure 17** and **Table 12**, nearly 500 mm of rain fell across parts of the catchment making it the largest flood on record.

Accumulated rainfall totals for each rainfall gauge that was operational during the 1971 event were used to develop a rainfall isohyet (i.e., rainfall depth contour) map for the event, which is shown in **Figure 17**. Similar to the other calibration events, higher rainfall depths were recorded across the western parts of the catchment relative to the coastal areas.

The temporal distribution of rainfall was to be based on the closest active continuous rainfall gauge during this event. Unfortunately, the closest continuous gauge with data for the 1971 event was determined to be the Green Cape Lighthouse gauge which is located more than 30 km south of the catchment. Attempts were made to use this gauge as part of the calibration; however, the calibration outcomes were poor. A subsequent review of the 1971 rainfall records for this gauge showed inconsistencies relative to daily rainfall records for

gauges located closer to the catchment. More specifically, the Green Cape gauge recorded a total rainfall depth of only 156mm (i.e., well under half the rainfall that was experienced across most of the catchment). Secondly, as shown in **Plate 17**, the majority of rainfall recorded at the Green Cape occurred on the 6th February, while the daily gauges recorded the majority of rainfall on the 5th February. Therefore, the Green Cape gauge was not considered to be representative of the rain that fell across the catchment during the 1971 event. Unfortunately, no other active rainfall gauges were available for this event. Therefore, as a last resort, the daily rainfall information at the catchment was broken down into hourly increments and the rainfall was varied linearly based on a maximum rainfall intensity of 23.2 mm/hour at midnight on the 5th February. The adopted rainfall distribution is shown on **Figure D13** in **Appendix D**.

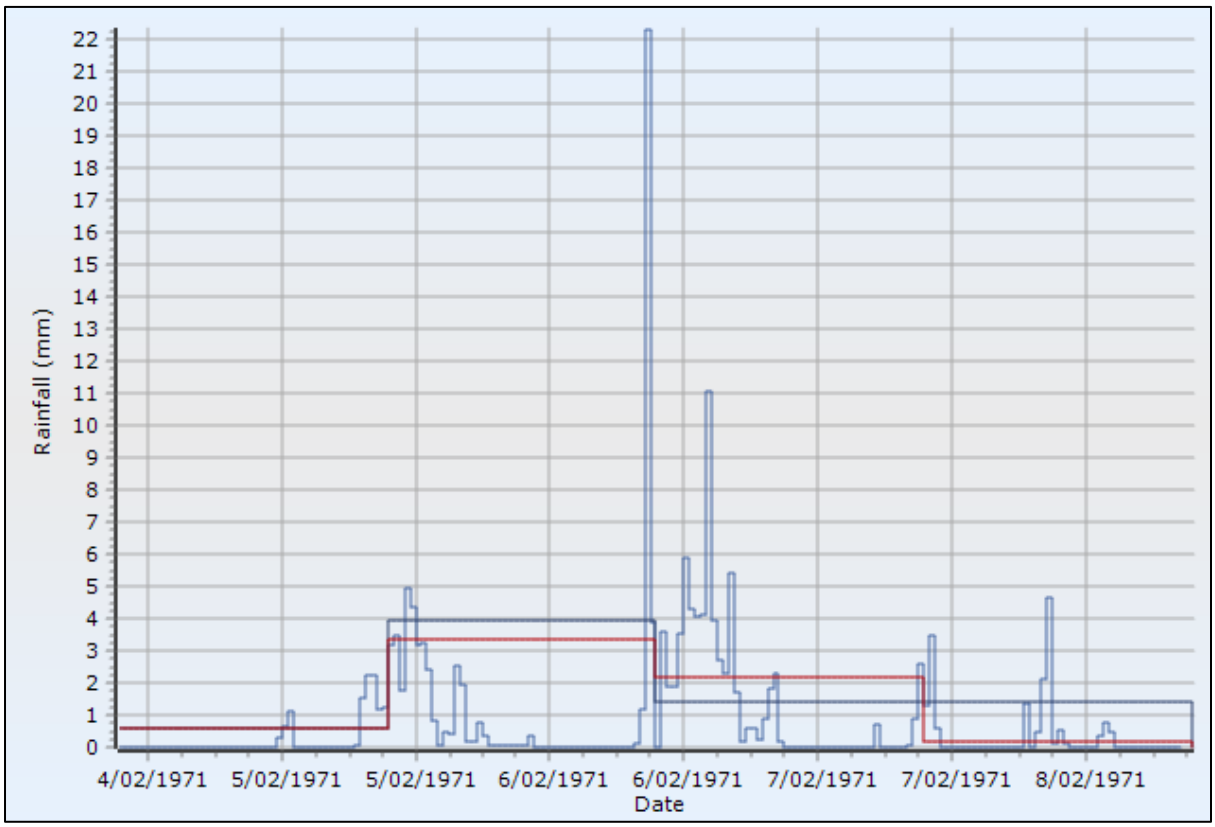


Plate 17 1971 rainfall records for Green Cape (sub-daily), Pambula Post office (daily) and Merimbula Airport (daily) gauges

Owing to the uncertainty in rainfall information, the rainfall was not varied spatially as part of the simulation. That is, a single storm was applied across the catchment based upon the average rainfall depth.

The continuous rainfall information at Green Cape was analysed relative to design rainfall-intensity-duration information. This information is presented in **Appendix D** and indicates that the 1971 approached that of a 1% AEP design rainfall event for some periods. However, as noted above, this may not be representative of what was experienced in the catchment.

Rainfall Losses

The rainfall losses summarised in **Table 13** were applied to the RAFTS model as part of 1971 flood simulation. Due to the uncertainty in rainfall, no attempt to adjust the rainfall losses was completed as part of the calibration.

Results

The XP-RAFTS model was used to simulate rainfall-runoff behaviour for the 1971 flood based upon the rainfall and rainfall loss information presented in the preceding sections. A summary of peak discharges for each XP-RAFTS model subcatchment for the 1971 flood are included in **Appendix E.**

A simulated discharge hydrograph was also extracted at the location of the Lochiel stream gauge. This simulated hydrograph is presented in the **Figure D13** in **Appendix D**. Also included on **Figure D13** is the recorded discharge hydrograph.

Figure D13 shows that simulated hydrograph provides a reasonable reproduction of the recorded hydrograph considering the uncertainty with the rainfall information.

6.7.2 TUFLOW Modelling

Modifications to Reflect Historic Conditions

The same TUFLOW modifications that were completed to reflect 1985 catchment conditions were retained for the 1971 flood simulation.

Inflow Boundary Conditions

Discharge hydrographs generated by the XP-RAFTS hydrologic model were used to define inflows to the TUFLOW model.

Downstream Boundary Conditions

Tabulated water level information for a gauge near Eden for the 1971 flood were extracted from the 'Pambula River Data Assessment Study' (1990) and was used to define the downstream boundary in the TUFLOW model.

Results

Calibration of the TUFLOW computer model was completed based upon five (5) surveyed flood marks for the 1971 flood as well as a recorded stage hydrograph for the Lochiel gauge.

Peak floodwater depths were extracted from the results of the 1971 flood simulation and are included on **Figures 18.1** to **18.6**. A comparison between the peak flood levels generated by the TUFLOW model and the surveyed flood marks is also provided in **Figures 18.1** to **18.6** as well as **Table 19.**

The time variation in simulated water levels at the Pambula River at Lochiel gauge were also extracted and is provided in **Figure D14** in **Appendix D**.

The flood level comparison provided in **Table 18** shows that the TUFLOW model is generally providing a good reproduction of the surveyed flood mark elevations. Most flood mark elevations are reproduced to within 0.2 metres with the average difference being -0.11 metres. The only major exception is at location #3, where the simulated water levels are

0.7 metres lower than the surveyed flood level. However, this surveyed level is much higher than the surrounding surveyed levels indicating it may not be reliable or may have been subject to external factors that cannot be represented in the modelling (e.g., wave action).

Table 19 Comparison between simulated flood levels and surveyed flood marks for the 1971 flood

#	Surveyed Flood Mark (mAHD)	Simulated Flood Level (mAHD)	Difference (m)
1	5.51	5.32	-0.19
2	4.08	4.09	0.01
3	4.02	3.32	-0.70
4	3.42	3.41	-0.01
5	3.00	3.35	0.35

Figure D12 also shows that the simulated stage hydrograph provides a reasonable reproduction of the recorded stages at the Lochiel gauge. The simulated hydrograph provides a good reproduction of the peak water level at the gauge (within 0.1 metres), although the timing of the peak is slightly off. As discussed, this may be associated with the timing of the recorded rainfall at the Green Cape gauge not being fully representative of the timing of rainfall across the catchment.

7 DESIGN FLOOD ESTIMATION

7.1 General

Design floods are hypothetical floods that are commonly used for planning and floodplain management investigations. Design floods are based on statistical analysis of rainfall and flood records and are typically defined by their probability of exceedance. This is often expressed as an Annual Exceedance Probability (AEP).

The AEP of a flood flow or level or depth at a particular location is the probability that the flood flow or level or depth will be equalled or exceeded in any one year. For example, a 1% AEP flood is the best estimate of a flood that has a 1% chance of being equalled or exceeded in any one year.

Design floods can also be expressed by their Average Recurrence Interval (ARI). For example, the 1% AEP flood can also be expressed as a 1 in 100 year ARI flood. That is, the 1% AEP flood will be equalled or exceeded, on average, once in 100 years.

It should be noted that there is no guarantee that a 1% AEP flood will occur once in a 100-year period. It may occur more than once, or at no time at all in the 100-year period. This is because design floods are based upon a long-term statistical average. Therefore, it is prudent to understand that the occurrence of recent large floods does not preclude the potential for another large flood to occur in the immediate future.

Design floods are typically estimated by applying design rainfall to the computer model and using the model to route the rainfall excess across the catchment to determine design flood level, depth and velocity estimates. The procedures employed in deriving design flood estimates for the Pambula River and Yowaka River catchment are outlined in the following sections.

7.2 Hydrology

Design hydrology was defined as part of the flood study based upon the 2019 revision of Australian Rainfall and Runoff (ARR2019) (Ball et al, 2019). This included a flood frequency analysis (FFA) based upon records for the Pambula River at Lochiel stream gauge as well as application of ARR2019 design storms to the calibrated XP-RAFTS model.

The following sections describe the FFA as well as the XP-RAFTS inputs and outputs.

7.2.1 Flood Frequency Analysis

A flood frequency analysis (FFA) allows peak design discharges to be estimated based on recorded information at stream gauges. This involves applying different probability distributions to find the distribution that provides the best “fit” to the historic gauge records

and then using that distribution to estimate design discharges for defined frequencies (e.g., 1% AEP discharge).

An FFA was completed as part of the current study for the Pambula River at Lochiel stream gauge. The outcomes of this assessment are presented in **Appendix F**.

Overall, it was determined that Generalised Extreme Value probability distribution provided the best "fit" to recorded data at the Lochiel gauge. As a result, the GEV discharge estimates were selected and are summarised in **Table 20**. Also included in **Table 20**, are the design discharge estimates at the Lochiel stream gauge provided by the XP-RAFTS model, which is discussed in more detailed in the following section.

Table 20 Peak Design Discharge Estimates at Lochiel Stream Gauge

AEP	Peak Flow (m^3/s)	
	FFA	XP-RAFTS ARR2019
10%	424	318
5%	513	387
2%	601	483
1%	652	552
0.5%	693	663
0.2%	735	807

7.2.2 Hydrologic Modelling

Rainfall

Point design rainfall depths were downloaded from the Bureau of Meteorology's IFD webpage. The design rainfall intensities were extracted at four locations in an attempt reflect the spatial variation in design rainfall across the catchment. The locations are shown in **Plate 6**.

A copy of the design rainfall information downloaded from the Bureau of Meteorology's IFD database is included in **Appendix G** at each location.

As part of the flood study it was also necessary to define flood characteristics for the Probable Maximum Flood (PMF). The PMF is considered to be the largest flood that could conceivably occur across a particular area.

The PMF is estimated by routing the Probable Maximum Precipitation (PMP) through the XP-RAFTS model. The PMP is defined as the greatest depth of rainfall that is meteorologically possible at a specific location.

PMP depths were derived for a range of storm durations up to and including the 6-hour event based on procedures set out in the Bureau of Meteorology's *'Generalised Short Duration Method'* (GSDM) (Bureau of Meteorology, 2003). The GSDM PMP calculations are included in **Appendix G**.



Plate 18 Locations where IFD data were extracted

Areal Reduction Factors

The design rainfall intensities presented in the preceding section are only applicable for catchment areas of up to 1 km^2. Therefore, ARR2019 includes areal reduction factors that recognise that there is unlikely to be a uniformly high rainfall intensity across all sections of large catchments.

The primary input variable to calculate the areal reduction factors is the contributing catchment area. Although the overall catchment area is 301 km^2, this area is only applicable at the catchment outlet. Across the "built up" sections of the catchment that are of primary interest for the study, the contributing catchment area is much smaller, namely:

- Lochiel - 107 km^2
- South Pambula - 119 km^2
- Pambula – 120 km^2
- Greigs Flat – 133 km^2

Based on the contributing catchment areas summarised above, a representative catchment area of 120 km^2 was adopted for the areal reduction factor calculations. The resulting reduction factors are summarised in **Table 21**. These reduction factors were applied to the point rainfall intensities described in the previous section before application of the temporal patterns described in the following section.

Table 21 Areal reduction factors

Rainfall Duration	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP	0.2% AEP
5 min	0.462	0.455	0.447	0.440	0.433	0.425
10 min	0.593	0.586	0.576	0.569	0.562	0.553
15 min	0.653	0.646	0.636	0.628	0.621	0.611
20 min	0.690	0.682	0.672	0.664	0.656	0.646
25 min	0.716	0.708	0.697	0.688	0.680	0.669
30 min	0.735	0.726	0.715	0.706	0.698	0.686
45 min	0.771	0.762	0.749	0.739	0.730	0.717
1 hour	0.793	0.782	0.768	0.758	0.747	0.733
1.50 hour	0.818	0.805	0.789	0.776	0.764	0.747
2 hours	0.832	0.818	0.799	0.785	0.771	0.752
3 hours	0.850	0.835	0.814	0.798	0.783	0.762
4.50 hours	0.875	0.862	0.844	0.831	0.818	0.801
6 hours	0.897	0.889	0.878	0.870	0.862	0.851
9 hours	0.919	0.915	0.909	0.904	0.900	0.893
12 hours	0.928	0.923	0.917	0.912	0.908	0.902
18 hours	0.961	0.960	0.960	0.959	0.959	0.958
24 hours	0.965	0.965	0.964	0.963	0.963	0.962
30 hours	0.967	0.967	0.966	0.966	0.965	0.964
36 hours	0.969	0.969	0.968	0.967	0.967	0.966
48 hours	0.972	0.971	0.970	0.970	0.969	0.969
72 hours	0.975	0.974	0.974	0.973	0.973	0.972
96 hours	0.977	0.977	0.976	0.975	0.975	0.974
120 hours	0.979	0.978	0.977	0.977	0.976	0.975
144 hours	0.980	0.979	0.978	0.978	0.977	0.977
168 hours	0.981	0.980	0.979	0.979	0.978	0.977

Rainfall Losses

As discussed, the XP-RAFTS model was developed to include the "initial-continuing loss" model to account for rainfall that is intercepted and does not contribute to runoff.

ARR2019 recommends a hierarchical approach for determining the most appropriate initial loss and continuing loss values to apply as part of design simulations. The hierarchy of

approaches recommends the adoption of calibrated rainfall loss information in preference to more generic rainfall loss information, such as that located on the ARR2019 Data Hub.

As outlined in Chapter 6, the XP-RAFTS model was calibrated against five historic rainfall events. Continuing loss rates varying between 0.5 and 1.8 mm/hour were adopted for the calibration events for pervious sections of the catchment. When a range of loss rates are used for calibration, ARR2019 recommends the adoption of an average loss rate. Therefore, the average of the calibrated continuing loss rates (i.e., 1.16 mm/hour) was adopted for the design flood simulations.

The calibration simulations utilised initial rainfall losses that varied between 0 and 21 mm. ARR2019 recommends the average calibrated initial rainfall loss (i.e., 16.8mm) is used with probability neutral loss information on the ARR2019 Data Hub site to develop "burst losses" for each AEP and storm duration. It was noted that no probability neutral rainfall losses are provided on the ARR2019 data hub for storm durations less than 1 hour. Therefore, it was assumed that the burst rainfall losses for the 1 hour storm also applied for storm durations less than 1 hour. In addition, no probability neutral losses are provided for events rarer than the 1% AEP. Therefore, the 1% AEP losses were also applied to the 0.5% and 0.2% AEP floods. The final burst losses for pervious surfaces are provided in **Table 22**. A burst/initial loss of 0 mm was adopted for the PMP simulations in line with recommendations in Chapter 4 of Book 8 of ARR2019.

Table 22 Burst Rainfall Losses for Design Storms

Duration	Burst Loss (mm)			
	10% AEP	5% AEP	2% AEP	1% AEP, 0.5% AEP & 0.2% AEP
<1 hour	9.4	9.2	8.8	5.5
1 hour	9.4	9.2	8.8	5.5
1.50 hour	9.1	8.2	7.8	4.4
2 hours	8.7	8.1	7.8	4.3
3 hours	7.8	6.8	7.7	3.7
6 hours	7.8	7.0	7.8	2.4
12 hours	9.6	8.2	9.1	3.8
18 hours	11.3	9.5	10.3	5.2
24 hours	13.8	11.3	11.3	5.4
36 hours	16.7	12.8	16.8	7.3
48 hours	19.5	19.3	18.8	8.9
72 hours	24.1	25.5	22.6	10.0

For impervious surfaces, a burst loss of 0 mm and a continuing loss rate of 0 mm/hr was adopted (as per the calibration simulations).

Temporal Patterns

ARR2019 employs 10 different temporal patterns for each AEP/storm duration to define the time variation in rainfall depth during each storm. The use of a variety of different temporal patterns is intended to reflect the natural variability of a typical rainfall event (i.e., no two storms will be the same).

The temporal patterns for the study area were downloaded from the ARR2019 data hub and were used to simulate the temporal distribution of rainfall for each design storm(a copy of the data hub download is included in **Appendix H**). In accordance with ARR2019 for catchments with an area greater than 75 km^2, the "areal" temporal patterns rather than "point" temporal patterns were selected to describe the temporal variation in rainfall. The temporal patterns for the 500 km^2 reference area were used.

For the PMP, a single temporal pattern was adopted for each PMP storm simulation in line with the approach recommended in the *'Generalised Short Duration Method'* (GSDM) (Bureau of Meteorology, 2003).

Results

The XP-RAFTS model was used to simulate rainfall runoff processes for the complete suite of design storms. The design 10%, 5%, 2%, 1% AEP, 0.5% and 0.2% storms were simulated in addition to the PMP.

As discussed, a suite of ten temporal patterns were used to represent the temporal variation in rainfall for each design flood frequency up to and including the 0.2% AEP. The peak discharges from the full suite of temporal patterns for each design event were reviewed to determine the critical storm duration for each subcatchment. The critical storm duration was defined by calculating the average discharge for each storm duration (based on all 10 temporal patterns). The duration that generated the highest average discharge was selected as the critical duration for that particular subcatchment. The resulting critical storm durations for each subcatchment are presented in **Appendix H**. The results of the hydrologic analysis indicate that the critical duration across the catchment is most commonly 12 hours. However, there are more than 10 unique critical storms for each design flood when considering all subcatchments.

Once the critical duration was determined, a representative temporal pattern was selected for that duration. The temporal pattern that generated the peak discharge immediately above the mean discharge was selected as the most representative temporal pattern for each subcatchment. The adopted temporal pattern for each subcatchment along with the peak discharge generated by the representative temporal pattern is also provided in **Appendix H**. Peak design discharges were also extracted at key locations across the catchment and are summarised in **Table 23**.

Box plots were also prepared to display the full range of results produced as part of the ARR2019 hydrologic analysis. The box plots are provided in **Appendix H** for the Princes Highway bridge crossings of the Pambula River and Yowaka River. The box plots present the following information:

Table 23 Raw XP-RAFTS Peak Design Discharges at Key Locations

Location		XP-RAFTS ID	Peak Discharge (m^3/s)						
			10%AEP	5%AEP	2%AEP	1%AEP	0.5%AEP	0.2%AEP	PMP
Pambula River	Chalk Hills Road	17.11	101	123	154	179	214	260	795
	Wolumla Peak Road	1.14	217	264	329	377	456	553	,1638
	Princes Highway	1.27	358	437	543	621	746	908	2,992
	Upstream of Yowaka River confluence	1.31	408	498	620	710	852	1037	3,375
	Downstream of Pambula Lake	1.36	836	1,023	1,277	1,479	1,776	2,164	6,453
	Ocean outlet	1.39	840	1,028	1,283	1,491	1,790	2,173	6,471
Yowaka River	Back Creek Road	114.11	124	152	190	220	264	319	954
	Nethercote Road	114.14	148	182	228	265	319	387	1,137
	Pipeclay Creek confluence	114.21	382	469	588	679	814	991	2,748
	Princes Highway	114.24	390	479	601	695	833	1,013	2,804
	Upstream of Pambula River confluence	114.25	396	487	610	705	845	1,029	2,844
Other Watercourses	Centipede Creek @ Nethercote Road	145.04	37.4	45.6	56.7	65.4	77.6	95.0	256
	Old Hut Creek @ Nethercote Road	133.11	114	139	173	201	240	291	755
	Back Creek @ Back Creek Road	49.02	3.32	4.02	5.00	5.75	6.95	8.51	43.5
	Back Creek @ Mount Darragh Road	47.05	20.9	26.1	32.4	37.0	43.7	53.7	240
	Burtons Creek @ Mount Darragh Road	_junc_43	53.6	65.4	81.5	94.1	114	138	602
	Seven Mile Creek @ Mount Darragh Road	17.08	65.2	79.3	98.8	115	136	168	528
	Chalk Hills Creek Upstream of Pambula River	1.12	102	125	155	180	214	263	733

- Median discharge for each storm duration (represented by the blue horizontal line contained within each green box)
- Average discharge for each storm duration (defined by the "✳")
- The first and third quartiles (defined by the green box), which illustrated the 25th percentile and 75th percentile discharge values
- The highest and lowest discharge value (represented by the "T" attached to the end of the green box)
- The critical storm duration is highlighted in yellow

7.3 Hydraulics

7.3.1 Boundary Conditions

Inflow Boundaries

Inflows to the TUFLOW model were defined using the critical design discharge hydrographs generated by the XP-RAFTS hydrologic model. However, as discussed in the previous section, more than ten different critical storms were identified as part of the hydrologic analysis. Although the XP-RAFTS model runs in a matter of seconds and can run a large number of storms in a relatively short amount of time, the hydraulic model takes multiple days to run a single storm. Therefore, it was not considered feasible to run all unique combinations of storm durations and temporal patterns through the hydraulic model in a timely manner.

Therefore, the assessment of critical durations and temporal patterns was restricted to the areas of primary interest to the study (i.e., the more urbanised, eastern sections of the catchment). This assessment identified three temporal patterns (6261, 6262, 6266) as being most commonly critical and, in all cases, produce peak design discharges very close to the mean discharge for each subcatchment in the main areas of interest (refer to **Plate 19** for an example of 1% AEP hydrographs). However, temporal pattern 6262 was ultimately selected for each design flood as it showed the quickest rate of rise and, therefore, would be more crucial when quantifying emergency response details such as road overtopping times.

As discussed in Section 7.2.1, a flood frequency analysis (FFA) was completed for the Pambula River at Lochiel stream gauge. **Table 20** provides a comparison between the FFA discharges and the ARR2019 discharges generated by the XP-RAFTS hydrologic model at Lochiel. This comparison shows that the ARR2019 discharges are generally lower than the FFA discharges. It was considered preferential to adopt the more robust FFA discharges which are based on statistical analysis of stream gauge records for the local catchment in preference to the ARR2019 discharges which are based on more regional information. Therefore, the design ARR2019 discharge hydrographs for temporal pattern 6262 were factored to match the calculated FFA discharges at the Lochiel gauge. The adopted adjustment factors are provided in **Table 24** and the factored peak XP-RAFTS discharges are included in **Appendix H**.

Simulations were also completed with longer storms (e.g., 18 hours) to confirm if a longer storm with more runoff volume but with a lower peak discharge may produce higher water

levels. These simulations confirmed that the 12 hour storm produced the highest water levels.

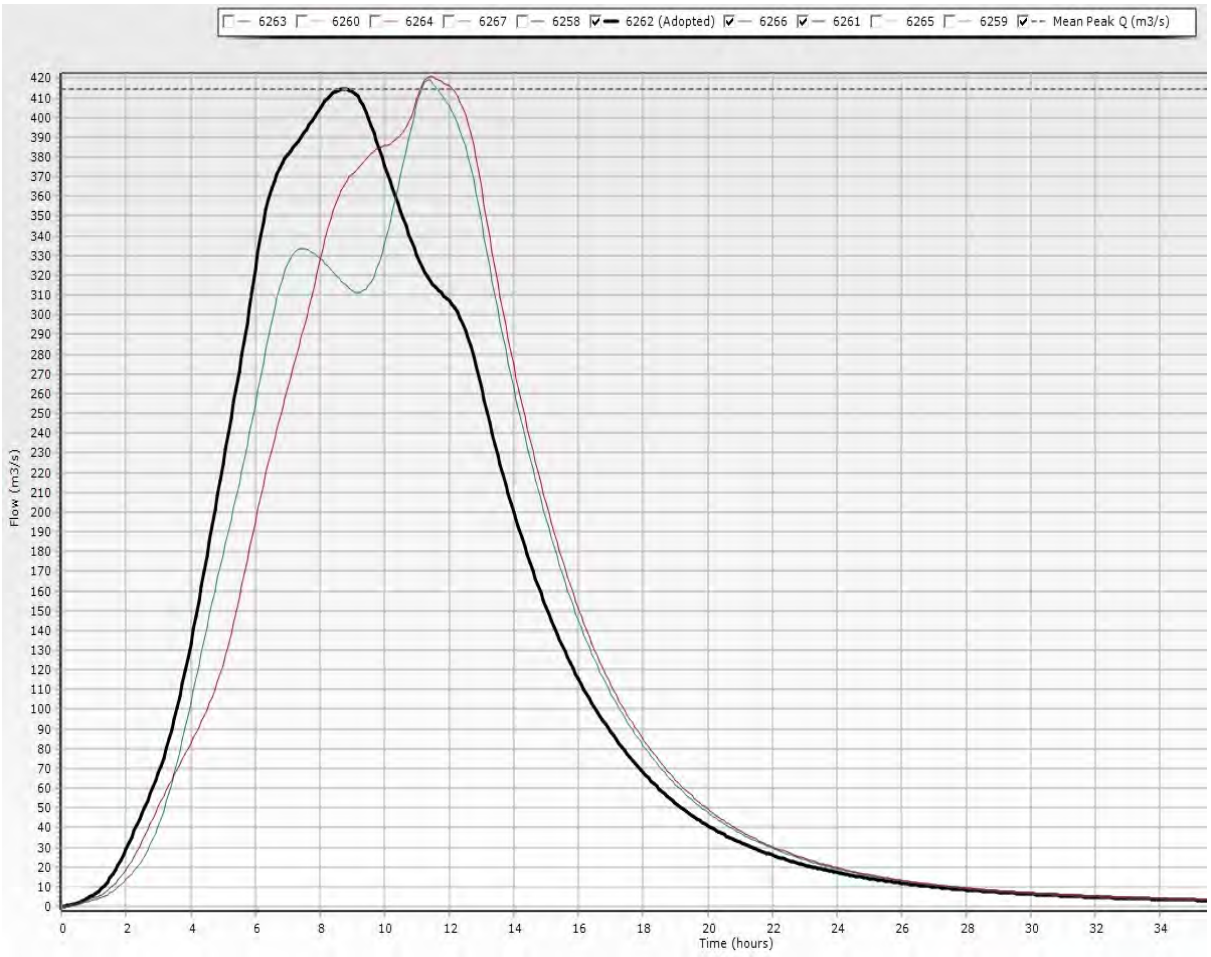


Plate 19 Sample of ARR2019 1% AEP hydrographs for the Pambula River at Princes Highway

Table 24 ARR2019 Hydrograph Adjustment Factors

AEP	Factor
10%	1.38
5%	1.36
2%	1.27
1%	1.18
0.5%	1.05
0.2%	0.92

Ocean Boundary

The Pambula River drains into the Tasman Sea near Pambula Beach. Therefore, the ocean level at the time of the flood can have an impact on flood behaviour across the lower-lying, estuarine sections of the catchment.

The ocean boundary condition was defined based on guidance provided in the *'Floodplain Risk Management Guide. Modelling the Interaction of Catchment Flooding and Oceanic Inundation in Coastal Waterways'* (Office of Environment & Heritage*, 2015).* Based on

information contained in this guideline, the combination of catchment runoff and ocean boundary conditions summarised in **Table 25** was adopted for each design simulation.

Table 25 Adopted ocean boundary conditions for design flood simulations

Design Flood Event	Catchment Flood Scenario	Ocean Level (Ocean Level at Time of Peak Catchment Outflow)
20% AEP	20% AEP	High High Water Spring (HHWS) tide (1.03 mAHD)
10% AEP	10% AEP	HHWS (1.03 mAHD)
5% AEP	5% AEP	HHWS (1.03 mAHD)
2% AEP	2% AEP	5% AEP (2.35 mAHD)
1% AEP (flood level)	1% AEP	5% AEP (2.35 mAHD)
	5% AEP	1% AEP (2.55 mAHD)
1% AEP (velocity)	1% AEP	Indian Spring Low Water (ISLW) tide (-0.82 mAHD)
0.5% AEP	0.5% AEP	1% AEP (2.55 mAHD)
0.2% AEP	0.2% AEP	1% AEP (2.55 mAHD)
PMF	PMF	1% AEP (2.55 mAHD)

NOTE: * A design flood level envelope was developed for the 1% AEP flood based upon consideration of a 1% AEP catchment runoff event with a 5% AEP ocean level plus a 5% AEP catchment runoff event with a 1% AEP ocean level. An ISLW was also included in the development of the peak 1% AEP velocity envelope.

The 'Bega Valley Shire Coastal Processes and Hazards Definition Study' (BMT WBM 2015) defines the Pambula River as having a wave-dominated, shallow open entrance which places the entrance in "group 3" (i.e., entrance type C) of the OEH guide. The peak design ocean levels for Type C entrances, as defined in the OEH guide, are also provided in **Table 25**.

A time varying ocean (i.e., tide) level was included for all design simulations. However, the peak design ocean level was arranged so that it coincided with the peak catchment outflow (the only exception was the 1% AEP ISLW simulations where a "low tide" level was adopted to maximise velocities). The adopted ocean boundary conditions are shown in **Plate 20**.

As shown in **Table 25**, each catchment runoff event was typically combined with a single ocean boundary condition to represent each design flood. The only exception is the 1% AEP event, where two additional combinations of catchment runoff and ocean level conditions were simulated to encompass an expanded range of runoff and tidal interactions given the importance of this design flood for planning purposes.

A "static" river entrance geometry was adopted for all design flood simulations. That is, the potential for scour of the river entrance during the flood was not explicitly modelled. This is a common approach, particularly in flood studies in New South Wales. Sensitivity to entrance scour can be investigated during a subsequent floodplain risk management study, if sufficient potential risk to warrant the analysis is identified.

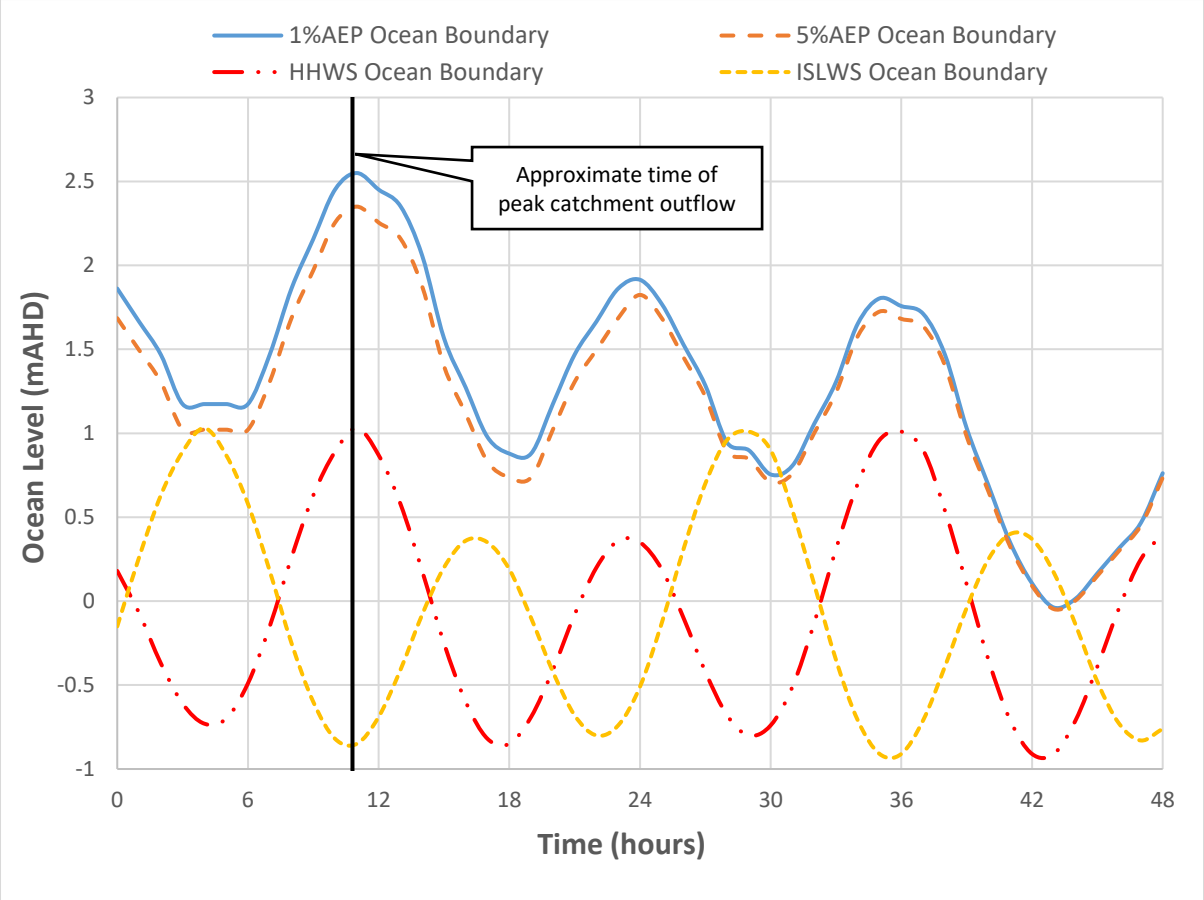


Plate 20 Adopted ocean level hydrographs for design flood simulations

7.3.2 Hydraulic Structure Blockage

'Base' blockage factors for each bridge and culvert in the catchment were estimated based upon recommendations in Chapter 6 of Book 6 of 'Australian Rainfall & Runoff' (Ball et al, 2019). This document also recommends adjusting the 'base' blockage factors up or down depending on the severity of the event (i.e., higher blockage factors during larger floods and lower blockage factors during smaller floods). A summary of the blockage scenarios that were adopted for each design flood is provided in **Appendix F** and is also summarised below:

- Low Blockage Scenario –10% AEP event
- Medium Blockage Scenario – 5%, 2%, 1% and 0.5% AEP events
- High Blockage Scenario – 0.2% AEP and PMF events

However, it was noted that application of blockage to each hydraulic structure effectively creates a number of small storages across the catchment that serve to attenuate flows and reduce water levels downstream of each structure. In recognition of the potential attenuation effects provided by the blockage factors and the understanding that structure blockage can be highly variable, each design flood was also simulated with no structure blockage. This was completed to ensure the flood risk downstream of each hydraulic structure was not underrepresented.

The impact of no blockage as well as complete blockage of culverts and bridges was assessed as part of the sensitivity analysis (refer Section 9).

7.4 Results

7.4.1 Design Flood Envelope

As discussed, a range of design storms, ocean levels and blockage scenarios were simulated for each design flood. Therefore, the results from each simulation for each design flood were interrogated and combined to form a "design flood envelope" for each design flood. It is this "design flood envelope" comprising the most critical depths, velocities and levels from a risk management perspective that forms the basis for the results documented in the following sections.

7.4.2 Presentation of Results

The results of the flood simulations were reviewed, and it was noted that several areas were only exposed to shallow water depths that would not present a significant flood hazard. Therefore, it was considered necessary for the results of the computer simulations to be "filtered" to distinguish between areas of significant inundation depth / flood hazard and those areas subject to negligible inundation. Therefore, a minimum depth threshold of 0.10 metres was adopted as the filter criteria for the study. That is, only areas where design water depths are predicted to exceed 0.1 metres are displayed in the flood mapping.

7.4.3 Peak Depths, Levels and Velocities

Results were extracted from the final design flood envelopes and were used to prepare a range of flood mapping for the 10% AEP, 5% AEP, 2% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and PMF events. This includes:

- Floodwater depths and flood level contours: **Figures 19.1** to **25.6**
- Floodwater velocities (including velocity vectors which show the direction of water movement): **Figures 26.1** to **32.6**

Peak flood levels, depths and velocities were also extracted at key locations across the catchment and are provided in **Table 26**, **Table 27** and **Table 28** respectively.

Figures 19.1 to **25.6** shows that floodwaters are typically contained in close proximity to each of the main watercourses across most of the upper catchment. Flow velocities in these areas are generally in excess of 2 m/s during each design flood. When floodwaters reach the more expansive floodplains located south of Pambula, at Greigs Flat and Pambula Lake, floodwaters slow appreciably (i.e., velocities are most commonly less than 1 m/s) and cover a more extensive areas of land. This includes number of rural properties at Greigs Flat as well as the southern fringe of Pambula.

7.5 Results Verification

The XP-RAFTS and TUFLOW models developed as part of this study were calibrated against recorded and observed flood information for five historic floods. In general, the models were found to provide a good reproduction of historic flood mark elevations. However, the outcomes of the calibration only provide evidence that the model is providing a reliable representation of flood behaviour at isolated locations (i.e., at recorded flood mark or stream gauge locations).

Table 26 Peak Design Water Levels at Key Locations

Location		Peak Water Level (mAHD)						
		10%AEP	5%AEP	2%AEP	1%AEP	0.5%AEP	0.2%AEP	PMP
Pambula River	Chalk Hills Road	81.5	81.9	82.2	82.3	82.4	82.6	86.0
	Wolumla Peak Road	62.4	62.8	63.4	63.7	63.8	64.0	69.3
	Princes Highway	3.92	3.98	4.04	4.08	4.13	4.19	7.20
	Upstream of Yowaka River confluence	1.98	2.28	3.14	3.40	3.49	3.59	6.58
	Downstream of Pambula Lake	1.61	1.85	2.79	3.03	3.09	3.16	5.04
	Ocean outlet	1.04	1.04	2.35	2.55	2.56	2.57	2.75
Yowaka River	Back Creek Road	121	121	121	122	122	122	124
	Nethercote Road	28.7	29.0	29.3	29.5	29.7	29.8	33.7
	Pipeclay Creek confluence	5.31	5.82	6.35	6.67	6.88	7.09	11.79
	Princes Highway	2.84	3.25	3.93	4.19	4.31	4.44	7.90
	Upstream of Pambula River confluence	1.97	2.27	3.15	3.41	3.50	3.60	6.62
Other Watercourses	Centipede Creek @ Nethercote Road	62.5	62.6	62.7	62.8	62.8	62.9	64.0
	Old Hut Creek @ Nethercote Road	51.3	51.6	51.9	52.1	52.2	52.3	55.0
	Back Creek @ Back Creek Road	93.7	93.9	94.1	94.2	94.3	94.3	97.0
	Back Creek @ Mount Darragh Road	16.2	16.6	17.4	17.6	17.6	17.7	20.7
	Burtons Creek @ Mount Darragh Road	26.2	26.4	26.6	26.8	26.9	26.9	29.9
	Seven Mile Creek @ Mount Darragh Road	106	106	106	106	106	106	109
	Chalk Hills Creek Upstream of Pambula River	73.3	73.8	74.2	74.4	74.6	74.8	79.2

Table 27 Peak Design Water Depths at Key Locations

Location		Peak Water Level (mAHD)						
		10%AEP	5%AEP	2%AEP	1%AEP	0.5%AEP	0.2%AEP	PMP
Pambula River	Chalk Hills Road	2.81	3.12	3.42	3.59	3.71	3.83	7.30
	Wolumla Peak Road	4.80	5.18	5.75	6.05	6.23	6.38	11.7
	Princes Highway	3.20	3.25	3.31	3.35	3.40	3.46	6.47
	Upstream of Yowaka River confluence	5.40	5.69	6.56	6.81	6.91	7.01	10.0
	Downstream of Pambula Lake	6.94	7.18	8.12	8.35	8.42	8.49	10.4
	Ocean outlet	3.10	3.11	4.42	4.62	4.62	4.63	4.81
Yowaka River	Back Creek Road	3.21	3.54	3.82	3.98	4.07	4.16	6.28
	Nethercote Road	3.01	3.30	3.61	3.81	3.95	4.10	8.03
	Pipeclay Creek confluence	5.11	5.62	6.15	6.47	6.68	6.89	11.6

	Princes Highway	3.93	4.34	5.02	5.28	5.40	5.53	8.99
	Upstream of Pambula River confluence	4.62	4.93	5.80	6.06	6.15	6.26	9.27
Other Watercourses	Centipede Creek @ Nethercote Road	3.28	3.43	3.54	3.61	3.65	3.69	4.85
	Old Hut Creek @ Nethercote Road	3.36	3.71	3.93	4.13	4.23	4.34	7.09
	Back Creek @ Back Creek Road	0.83	1.00	1.17	1.29	1.37	1.43	4.12
	Back Creek @ Mount Darragh Road	2.11	2.53	3.29	3.51	3.55	3.65	6.65
	Burtons Creek @ Mount Darragh Road	2.27	2.48	2.70	2.81	2.90	2.99	5.98
	Seven Mile Creek @ Mount Darragh Road	1.80	2.02	2.21	2.34	2.44	2.54	5.34
	Chalk Hills Creek Upstream of Pambula River	3.32	3.78	4.20	4.44	4.62	4.80	9.24

Table 28 Peak Design Flow Velocities at Key Locations

Location		Peak Water Level (mAHD)						
		10%AEP	5%AEP	2%AEP	1%AEP	0.5%AEP	0.2%AEP	PMP
Pambula River	Chalk Hills Road	2.62	2.76	2.85	2.86	2.91	2.93	3.09
	Wolumla Peak Road	3.30	3.38	3.47	3.49	3.48	3.49	3.54
	Princes Highway	2.08	2.15	2.22	2.28	2.30	2.33	2.62
	Upstream of Yowaka River confluence	1.60	1.74	1.67	2.00	1.77	1.83	2.74
	Downstream of Pambula Lake	1.63	1.80	1.73	2.05	1.86	1.94	3.11
	Ocean outlet	1.08	1.31	0.51	2.65	0.66	0.74	2.08
Yowaka River	Back Creek Road	2.19	2.30	2.42	2.48	2.55	2.61	3.93
	Nethercote Road	2.94	3.09	3.16	3.17	3.18	3.19	3.18
	Pipeclay Creek confluence	1.37	1.38	1.39	1.39	1.39	1.39	1.69
	Princes Highway	2.78	2.96	2.91	3.16	3.07	3.15	4.42
	Upstream of Pambula River confluence	2.06	2.39	2.35	2.79	2.60	2.73	4.34
Other Watercourses	Centipede Creek @ Nethercote Road	0.99	1.09	1.19	1.24	1.28	1.32	2.25
	Old Hut Creek @ Nethercote Road	2.33	2.50	2.69	2.74	2.74	2.76	2.85
	Back Creek @ Back Creek Road	0.88	0.88	0.88	0.87	0.89	0.88	0.95
	Back Creek @ Mount Darragh Road	1.20	1.25	1.25	1.28	1.27	1.26	1.33
	Burtons Creek @ Mount Darragh Road	2.74	2.93	3.04	3.12	3.15	3.16	3.73
	Seven Mile Creek @ Mount Darragh Road	3.19	3.31	3.42	3.52	3.47	3.49	4.55
	Chalk Hills Creek Upstream of Pambula River	2.42	2.51	2.58	2.62	2.66	2.70	3.38

Therefore, additional verification of the models was completed by comparing the results generated by each model against past studies as well as alternate calculation techniques. Further details on the outcomes of the model verification is presented below.

7.5.1 Comparison with Alternate Modelling Approaches

Project 5 of the Australian Rainfall & Runoff revision process included the development of a regional flood frequency estimation (RFFE) approach that enables peak design discharges to be estimated for ungauged catchments. As discussed in Section 7.2.1, a stream gauge is located within the catchment at Lochiel which enabled a flood frequency analysis to be completed. In addition, an XP-RAFTS hydrologic model was developed to simulate rainfall-runoff processes. As a result, the regional RFFE discharge estimates were not required.

Nevertheless, the RFFE can be used to assist in verifying the results produced by the XP-RAFTS model. Accordingly, peak 1% AEP discharges were established using the RFFE approach at a selection of locations across the catchment and are summarised in **Table 29**. Also included in **Table 29** are the "raw" XP-RAFTS discharges as well as the "factored" XP-RAFTS discharges at the same locations (i.e., XP-RAFTS discharges factored to match the flood frequency analysis outputs at the Lochiel stream gauge).

The RFFE approach acknowledges that there is uncertainty associated with regional approaches. Accordingly, the approach also provides confidence intervals so that an appreciation of the uncertainty in the discharge estimates developed using this approach can be gained. The confidence limits are also included in **Table 29**.

Table 29 Comparison between XP-RAFTS, FFA and Regional Flood Frequency Estimation 1% AEP discharges

Location	Peak 1% AEP Discharge (m^3/s)				
	Raw XP-RAFTS	Factored XP-RAFTS	Regional Flood Frequency Estimate		
			5% Confidence	Design Discharge	95% Confidence
Pambula River @ Lochiel Stream gauge	552	652	450	1,256	3,545
Pambula River @ Princes Highway	621	733	647	1,900	5,700
Pambula River @ Tasman Sea	1,491	1,759	778	2,228	6,450

As discussed above, the RFFE is a regional approach that does have limitations. Most notably, Chapter 3 of Book 5 of ARR2019 states that:

- The RFFE will not provide a reliable estimate when catchments incorporate a significant urban proportion, contain dams or other water storages, are affected by mining, include agricultural activity or fall outside of the shape and size characteristics of the gauged catchments used to develop the regional relationships.
- All RFFE techniques are subject to uncertainty which is likely to be greater than for at-site flood frequency analysis (such as that as documented in Section 7.2.1) or a well calibrated catchment model (such as the XP-RAFTS model documented in Section 5.2)

- The relative accuracy of the regional flood estimates is likely to be within ±50% of the true value. However, it is possible that the estimation error may exceed the true value by a factor of two or more.

With these limitations in mind, the comparison provided in **Table 29** shows that the raw and factored XP-RAFTS discharges are lower relative to the RFFE approach. However, in all cases the XP-RAFTS peak discharges fall well within the RFFE confidence limits at each location. Therefore, the XP-RAFTS model peak discharges are not unreasonable.

7.5.2 Comparison with Past Studies

There have been minimal past flooding investigations completed within the Pambula River or Yowaka River catchments. However, the 'Bridge Over Pambula River at Pambula' (2004) does include design flood discharge and flood level information for the Pambula River in the vicinity of the Princes Highway, which are reproduced in **Table 30.**

Table 30 Comparison of peak 1% AEP discharges and flood levels

Location	Discharge (m^3/s)			Flood Level (mAHD)	
	Current Study		2004 Study	Current Study	2004 Study
	Raw XP-RAFTS	Factored XP-RAFTS			
Pambula River @ Lochiel	552	652	868	21.25	N/A
Pambula River upstream of Princes Highway	621	733	1026	4.15	4.30

The comparison provided in **Table 30** shows that the current study produces peak 1% AEP discharges and flood levels that are lower than the 2004 study. However, it is noted that the 2004 study utilised a simplified hydrologic approach (involving factoring up the FFA estimates based on the contributing catchment area) that does not account for the significant floodplain storage capacity afforded in the vicinity of Pambula.

Despite the lower design discharges in the vicinity of the Princes Highway, the TUFLOW model produces a peak 1% AEP flood level that is within 0.15 metres of the 2004 study. This indicates that the design flood estimates provided by the computer models developed for the current study are reasonable.

8 IMPACTS OF FLOODING ON THE COMMUNITY

8.1 Overview

Flooding has the potential to cause significant disruption to local communities and, during very large floods, poses a risk to life and may cause damage to buildings and other infrastructure. There are also specific facilities whose occupants may be particularly susceptible to the impacts of flooding (e.g., aged care facilities).

To assist in quantifying the potential impacts that flooding may have on the communities contained within the catchment, the results of the hydraulic modelling were interrogated to prepare:

- Flood hazard mapping (Section 8.2) which quantifies the potential impacts that floodwater may have on vehicles, people and structures/buildings.
- Hydraulic category mapping (Section 8.3) which identifies areas that should be kept free of development to maintain flood function and ensure existing flooding is not increased.
- Flood emergency response categories (Section 8.4) which identifies potential emergency response requirements across the catchment including areas that may become isolated and/or require special treatment by emergency services during future floods.
- Assessment of the potential impacts that flooding may have on vulnerable and critical facilities (Section 8.5).
- Assessment of the impacts that flooding may have on major transportation routes in the catchment (Section 8.6).

8.2 Flood Hazard

Flood hazard defines the potential impact that flooding will have on vehicles, people, and property across different sections of the floodplain. More specifically, it describes the potential for floodwaters to cause damage to property or loss of life / injury (Australian Government, 2014).

For this study, the variation in flood hazard across the catchment was defined using flood hazard vulnerability curves presented in Chapter 7 of Book 6 of 'Australian Rainfall & Runoff' (Ball et al, 2019). The hazard curves are reproduced in **Plate 21** and are also described in **Table 31**.

In past flood studies in the Bega Valley Shire Council LGA (and elsewhere across NSW), hazard was defined based on categories presented in the NSW Government's 'Floodplain Development Manual' (FDM) (2005). This delineated the floodplain into two main categories: low and high. The boundary between the FDM and the new ARR2019 hazard categories do

not perfectly align but, in general, the H1 to H3 categorises fall within the low hazard category defined in the FDM and the H4-H6 categories fall with the high hazard category in the FDM.

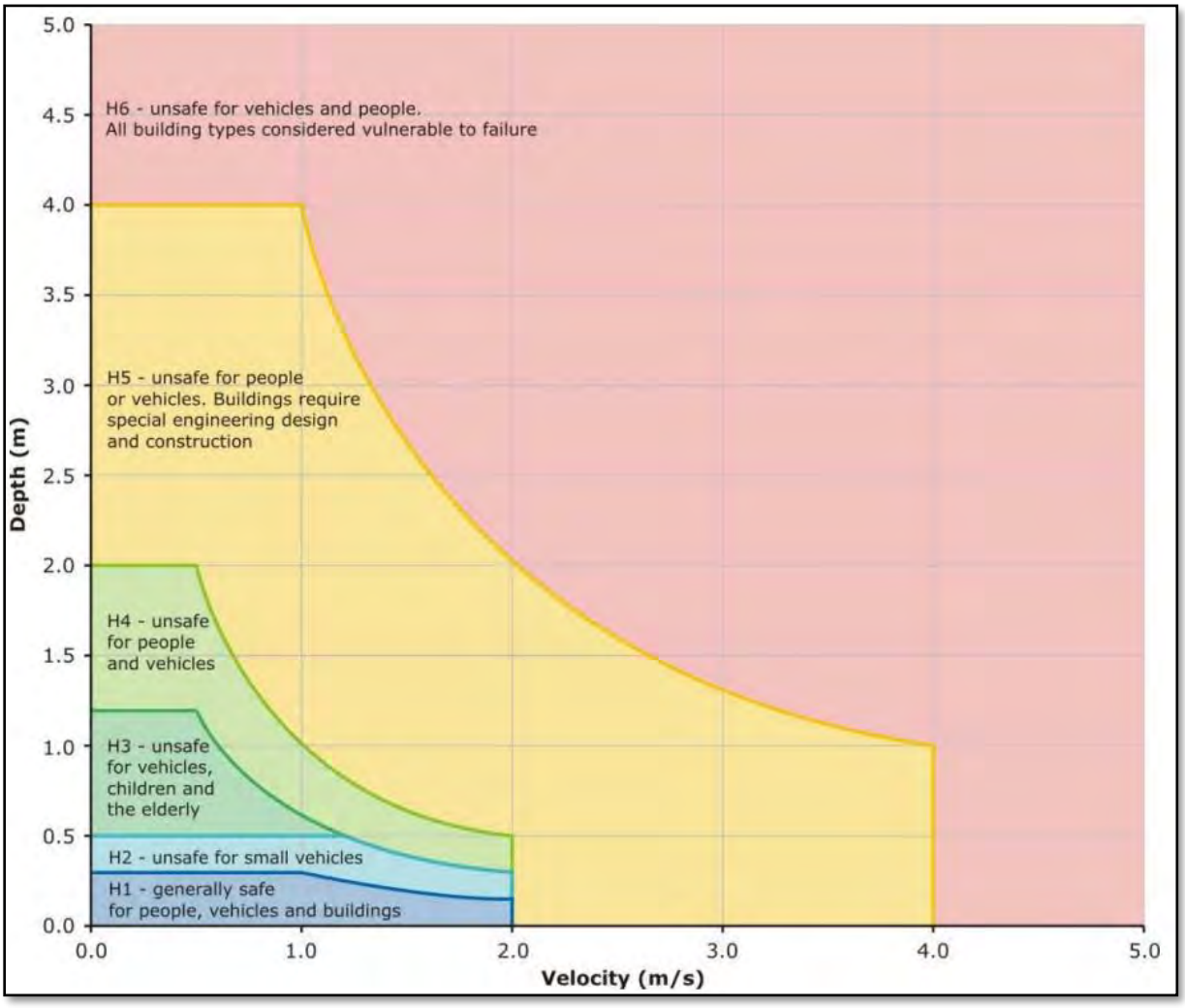


Plate 21 Flood hazard vulnerability curves (Ball et al, 2019)

Table 31 Description of Adopted Flood Hazard Categories (Ball et al, 2019)

Hazard Category	Description
H1	Relatively benign flood conditions. Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles
H3	Unsafe for vehicles, children and the elderly
H4	Unsafe for vehicles and people of all ages & levels of mobility
H5	Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

As shown in **Plate 21**, the hazard curves assess the potential vulnerability of people, cars and structures based upon the depth and velocity of floodwaters at a particular location. Therefore, peak depth, velocity and velocity-depth product outputs generated by the TUFLOW model were used to map the variation in flood hazard across the catchment based

on the hazard criteria shown in **Plate 21** for the 5% AEP, 1% AEP, 0.2% AEP floods as well as the PMF. The resulting hazard category maps are shown in **Figures 34.1** to **37.6**.

The hazard maps indicate that during the 1% AEP flood, H5 and H6 hazard conditions are common within and immediately adjacent to each of the main watercourses. Most of the expansive floodplain located south of Pambula and at Greigs Flat would be subject to at least H4 hazard in the 1% AEP flood indicating it would not be safe for people or vehicles.

During the PMF, most watercourses and floodplain areas would be subject to at least H5 hazard. This includes the Princes Highway south of Pambula. This indicates that cars and people would be exposed to a significant flood risk during large floods such as the PMF.

8.3 Hydraulic Categories

The NSW Government's *'Floodplain Development Manual'* (NSW Government, 2005) characterises flood prone areas according to the hydraulic categories presented in **Table 32.** The hydraulic categories provide an indication of the potential for development across different sections of the floodplain to impact on existing flood behaviour and highlights areas that should be retained for the conveyance and storage of floodwaters.

The *'Floodplain Development Manual'* (NSW Government, 2005) does not provide explicit quantitative criteria for defining hydraulic categories. This is because the extent of floodway, flood storage and flood fringe areas are typically specific to a particular catchment.

In line with the floodway definition provided in **Table 32**, floodways were defined, as a minimum, as all areas contained within a major watercourse (i.e., from top of bank to top of bank). Velocity, depth and velocity-depth product results were also reviewed to identify areas where the majority of floodwaters are conveyed outside of the main watercourses. Several iterations were performed, and it was determined that it would not be possible to employ the same criteria to define floodways across the major rivers and the smaller, local creeks. Therefore, separate criteria were adopted to define floodways across the major river systems and local creeks. This resulted in the additional criteria described in **Table 32**. Additional manual delineation of floodways was also completed to ensure continuity of floodways in some areas.

Likewise, a consistent set of criteria could not be established to define flood storage areas across the deeper, major waterways and the shallow and more incised local creek systems. The resulting depth criteria that was adopted to define flood storage areas is summarised in **Table 32**.

All other areas that were predicted to be flooded but were not classified as flood storage or floodway were designated as "flood fringe" areas (areas located outside of floodways where the depth of inundation was less than 0.5 metres).

The resulting hydraulic category maps for the 5% AEP, 1% AEP and 0.2% AEP floods as well as the PMF are shown in **Figures 38.1** to **41.6**.

Table 32 Qualitative and Quantitative Criteria for Hydraulic Categories

Hydraulic Category	Floodplain Development Manual Definition	Adopted Criteria
Floodway	• often aligned with obvious natural channels and drainage depressions • those areas where a significant volume of water flows during floods • they are areas that, even if only partially blocked, would have a significant impact on upstream water levels and/or would divert water from existing flowpaths resulting in the development of new flowpaths. • they are often, but not necessarily, areas with deeper flow or areas where higher velocities occur.	• Minimum top of bank to top of bank (for main stream areas) **AND** Major Rivers: • VxD >= 0.5 m^2/s AND V >= 0.3 m/s **OR** • VxD >= 0.4 m^2/s AND V >= 0.4 m/s Local Creeks: • VxD >= 0.4 m^2/s AND V >= 0.4 m/s **OR** • D >= 0.1 m AND V >= 0.8 m/s
Flood Storage	• those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood • if the capacity of a flood storage area is substantially reduced by, for example, the construction of levees or by landfill, flood levels in nearby areas may rise and the peak discharge downstream may be increased. • substantial reduction of the capacity of a flood storage area can also cause a significant redistribution of flood flows.	• If not FLOODWAY **AND** Major Rivers: • D >= 0.5 m Local Creeks: • D >= 0.2 m
Flood Fringe	• the remaining area of land affected by flooding, after floodway and flood storage areas have been defined. • development (e.g., filling) in flood fringe areas would not have any significant effect on the pattern of flood flows and/or flood levels.	• Remaining areas after FLOODWAY and FLOOD STORAGE are defined

To confirm the suitability of the hydraulic categorisation, verification simulations were completed based upon the 1% AEP flood. The verification was completed by:

- Floodway Verification: obstructions were included across part sections of floodways to confirm that the partial obstructions *"…would have a significant impact on upstream water levels and/or would divert water from existing flowpaths"*

- Flood Storage Verification: All flood storage areas were assigned a high roughness to allow water into the storage areas but prevent conveyance to confirm that these areas are indeed storage areas and not conveyance/floodway areas.
- Flood Fringe Verification: Flood fringe areas were completely filled to confirm that removal of the fringe areas would *"…not have any significant effect on the pattern of flood flows and/or flood levels"*.

The outcomes of the verification are summarised in **Appendix I** and show that the adopted criteria meet the requirements/definitions set out in the *'Floodplain Development Manual'* (2005).

The hydraulic category maps show that floodways are typically contained in close proximity to the main watercourses, particularly across the upper catchment where the channels are incised. However, more extensive floodways are predicted across the more extensive floodplains adjoining Pambula and Griegs Flat. This includes sections of the Princes Highway between Pambula and South Pambula.

As outlined in **Table 32**, flood storage areas are important for the temporary storage of floodwaters and filling these areas has the potential to adversely impact on existing flood behaviour. This was confirmed as part of the hydraulic category verification presented in **Appendix I**, which showed filling all flood storage areas would result in existing 1% AEP flood levels commonly increasing by between 0.1 and 0.2 metres. As a result, filling across the flood storage areas defined as part of this project should be discouraged.

8.4 Flood Emergency Response Precinct Classifications

In an effort to understand the potential emergency response requirements across different sections of the floodplain, Flood Emergency Response Precinct (ERP) classifications were prepared in accordance with the flow chart shown in **Plate 22** (Australian Emergency Management Institute, 2014). The ERP classifications can be used to provide an indication of areas which may be inundated and/or isolated during floods. This information, in turn, can be used to quantify the type of emergency response that may be required across different sections of the floodplain during future floods. This information can be useful in emergency response planning.

Each lot within the catchment was classified based upon the ERP flow chart for the 5% AEP, 1% AEP, and 0.2% AEP floods as well as the PMF. This was completed using the TUFLOW model results, digital elevation model and a road network GIS layer in conjunction with proprietary software that considered the following factors:

- Whether evacuation routes/roadways get "cut off" by the depth of inundation (a 0.15 m depth threshold was used to define a "cut" road).
- Whether evacuation routes continuously rise out of the floodplain.
- Whether properties become inundated.

The resulting ERP classifications for the 5% AEP, 1% AEP and 0.5% AEP floods, as well as the PMF, are provided in **Figures 42.1** to **45.6**.

Figures 42.1 to **45.6** show that the most common ERP classification is "Rising Road Egress", which indicates that evacuation routes grade up and out of the floodwaters (i.e., most people should be able to safely walk away from the floodwater to higher ground). However, there are several "flooded isolated submerged" areas (i.e., low flood islands) and "flooded isolated elevated" areas, which indicates that evacuation routes are likely to be cut during floods. Most of these areas are located on the floodplain south of Pambula and are not inhabited.

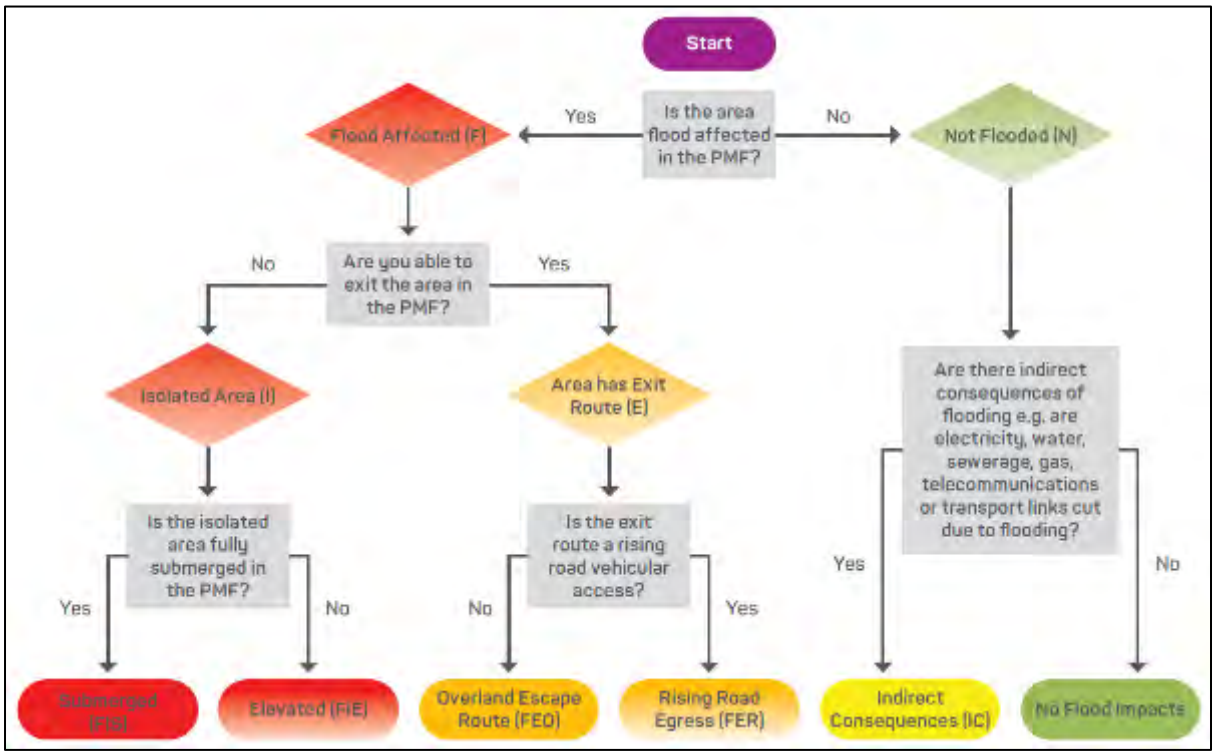


Plate 22 Flow Chart for Determining Flood Emergency Response Classifications (AEMI, 2014).

Multiple properties adjoining Nethercote Road, including those at Greigs Flat, are predicted to be isolated during floods as frequent as the 5% AEP event. Several properties located at Greigs Flat would also be considered "flooded isolated submerged" at the peak of the PMF.

8.5 Impacts on Vulnerable and Critical Facilities

The Pambula River, Pambula Lake and Yowaka River catchment is home to a range of property types and infrastructure. This includes facilities where the occupants may be particularly vulnerable during floods, such as schools and aged care homes. In addition, some facilities may play important roles for emergency response and evacuation purposes during future floods (e.g., police stations). Therefore, it is important to have an understanding of the potential vulnerability of these facilities during a range of floods.

An assessment of whether each facility is predicted to be impacted during floods was completed for the 5% AEP, 1% AEP, 0.5% AEP and PMF events. This included whether the facility was predicted to be impacted during the design flood and, if so, the flood hazard category that could be expected. An assessment of whether access to or from each facility was also completed. The outcomes of this assessment are provided in **Table 33**.

Table 33 Impact of Flooding on Vulernable and Critical Facilities

Facility		5% AEP Flood		1% AEP Flood		0.5% AEP Flood		PMF	
		Max Hazard	Vehicular Access Cut?	Max Hazard	Vehicular Access Cut?	Max Hazard	Vehicular Access Cut?	Max Hazard	Vehicular Access Cut?
Aged Care Facilities	**Imlay House** Merigan St, Pambula NSW 2549	-	-	-	-	-	-	-	-
Hospitals	**Pambula Hospital** Merimbola St, Pambula NSW 2549	-	-	-	-	-	-	-	-
Child Care facilities	**Pambula Pre-School** Dingo St, Pambula NSW 2549	*	-	*	-	*	-	*	-
	Pambula Village Pre-school 37 Toalla St, Pambula NSW 2549	-	-	-	-	-	-	-	-
	Shorebreakers Kindergarten 1-3 Monaro Street, PAMBULA NSW 2549	-	-	-	-	-	-	-	-
Schools	**Pambula Public School** 25 Oregon St, Pambula NSW 2549	-	-	-	-	-	-	-	-
	Lumen Christi Catholic College 388 Pambula Beach Rd., Pambula Beach NSW 2549	-	-	-	-	-	-	-	-
Hotels	**Idlewilde Motor Inn** 46 Bullara St, Pambula NSW 2549	-	-	-	-	-	-	H5	✓
	Colonial Motor Inn 51 Bullara St, Pambula NSW 2549	-	-	-	-	-	-	H5	✓
Caravan Parks	**Discovery Parks - Pambula Beach** 1 Pambula Beach Rd, Pambula Beach NSW 2549	H1	-	H1	-	H1	-	H1	-
	Reflections Holiday Parks Pambula 1 Toallo St, Pambula NSW 2549	-	-	-	-	-	-	-	-

*Southern section of lot is exposed to H3 hazard during 5% AEP, 1% AEP and 0.5% AEP flood event and H5 hazard for the PMF. However, building and car park remain flood free.

The information presented in **Table 33** indicates that most critical and vulnerable facilities located within the catchment are not impacted by flooding during events up to and including the PMF. The only major exception is the Discovery Park caravan park at Pambula Beach where a small section of the park is predicted to be exposed to H1 hazard conditions during each design flood. However, the H1 hazard extends predominately across open space and the H1 designation indicates that it is unlikely to pose a significant hazard to people or vehicles in the area.

It is noted that the Colonial Motor Inn and Idlewilde Motor Inn (both located near the western end of Bullara Street) is predicted to be exposed to H5 hazard during the PMF and access would also be cut. The H5 hazard classification indicates that not only would the area be unsafe for vehicles and people but there is also potential for structural damage to the buildings themselves if they have not been structurally designed withstand the forces of floodwater during the PMF. Although the PMF is a very rare flood, "sheltering in place" is unlikely to be a safe emergency response option of these facilities. It is recommended that discussions are completed with the owners of each facility to highlight the significant hazard that could occur during the PMF and encourage the preparation of a "flood safe plan" that would promote early evacuation of staff and motor inn occupants during very large Pambula River floods.

8.6 Transportation Impacts

There are several major roadways within the catchment which may be required for evacuation or emergency services access during floods. It is important to understand the impacts of flooding on these roads so that appropriate emergency response planning can occur.

An assessment of the locations where roadways are first predicted to be overtopped was completed as part of the Flood Emergency Response Precinct classifications discussed above. The roadway overtopping locations are shown as yellow dots in **Figures 42.1** to **45.6**. The numbering on the yellow dots relates to the road overtopping identifiers included in **Appendix J**. The following information is provided in **Appendix J** for each overtopping location:

- The amount of time from the initial onset of rainfall until access is cut.
- The amount of time the roadway would be cut.
- The peak flood hazard at the overtopping location.

This information is provided for the 5% AEP, 1% AEP, 0.5% AEP floods as well as the PMF.

In terms of the major transportation links that extend through the catchment, the following observations are made:

- Princes Highway is predicted to be cut during the 10% AEP flood. Inundation first commences just south of the Pambula River Bridge. Inundation of the highway would first commence around 7 hours after the initial onset of rainfall and the road would

remain cut for a minimum of 5 hours. During the 0.2% AEP flood, access would be cut for more than 7 hours.

- Nethercote Road would be cut during the 10% AEP flood between the Princes Highway and Greigs Flat. Inundation would commence about 5 hours after the initial onset of rainfall and the road would remain cut for at least 7 hours. The road is also predicted to be cut near the Yowaka River bridge crossing as well as near Ruggs Road making it one of the most susceptible major roads to inundation in the catchment. Furthermore, H5 hazard is predicted across parts of the road during floods as frequent as the 5% AEP event which also making it one of the most dangerous roads.
- Mount Darragh Road is predicted to be inundated from local catchment runoff at South Pambula during the 5% AEP flood. The flooding is "flashy" in this area. As a result, limited advanced warning time is available, but the water drains away quite quickly (i.e., in less than 2 hours during more frequent floods). During more severe floods, the road may be cut for up to 4 or 5 hours.
- Back Creek Road is predicted to be cut by floodwaters near Blairlands Road. However, inundation is only predicted during the PMF. As a result, Back Creek Road will remain trafficable during most floods in the catchment and may provide an alternate transportation route if Mount Darragh Road and/or Nethercote Road are cut by floodwaters.

9 SENSITIVITY AND CLIMATE CHANGE ASSESSMENT

9.1 Overview

Computer flood models require the adoption of several parameters that are not necessarily known with a high degree of certainty or are subject to variability. Each of these parameters can impact on the results generated by the model.

As outlined in Section 6, the computer models developed as part of the current study were calibrated using recorded rainfall, stream flow and flood mark information for historic floods. This information confirmed that the models were providing realistic descriptions of flood behaviour at locations where historic flood information was available.

Nevertheless, it is important to understand how any uncertainties and variability in model input parameters may impact on the results produced by the model. Therefore, a sensitivity analysis was undertaken to establish the sensitivity of the results generated by the computer model to changes in model input parameter values. The outcomes of the sensitivity analysis are presented in Section 9.2.

A climate change analysis was also completed to assess how increases in rainfall intensity and sea level rise may impact existing flood estimates. The outcomes of the climate change simulations are summarised in Section 9.3

9.2 Model Parameter Sensitivity

9.2.1 Initial / Storm Loss

An analysis was undertaken for the 5% AEP and 1% AEP storms to assess the sensitivity of the results generated by the TUFLOW model to variations in antecedent wetness conditions (i.e., the dryness or wetness of the catchment prior to the design storm event). A catchment that has been saturated prior to a major storm will have less capacity to absorb rainfall. Therefore, under wet antecedent conditions, there will be less "initial loss" of rainfall and consequently more runoff.

The variation in antecedent wetness conditions was represented by altering the "storm" rainfall loss in the XP-RAFTS model by ±20%. Specifically, the pervious storm losses were changed from the "design" value of 16.8mm to:

- "Wet" catchment: 13.4mm; and,
- "Dry" catchment: 20.2mm.

The modified storm losses were used with the probability neutral loss information on the ARR2019 Data Hub to develop revised "burst losses" for each AEP and storm duration (refer discussion in Section 7.2.2 for further information). The revised burst losses were

subsequently applied to the XP-RAFTS model and the updated versions of the model were used to re-simulate each of the 1% AEP and 5% AEP storms in accordance with ARR2019.

The revised discharge hydrographs were then applied to the TUFLOW model and the TUFLOW model was used to re-simulate the 5% AEP and 1% AEP floods with the modified storm losses. Peak water levels were extracted from the results of the modelling and were compared against peak flood levels for "base" design conditions. This allowed water level difference mapping to be prepared showing the magnitude of any change in water levels associated with the change in initial loss values. The difference mapping is presented in **Appendix K**.

Peak 5% AEP and 1% AEP flood level differences were also extracted from the results of the sensitivity simulations at various locations across the catchment and are presented in **Table** 34 and **Table 35**.

The difference mapping shows that changing the storms loss value will cause small, localised changes in 5% AEP and 1% AEP flood levels at isolated locations (most commonly around Greigs Flat). However, the change in levels is less than 0.03 metres at all locations. As a result, it can be concluded that the model results are relatively insensitive to changes in storm initial losses.

9.2.2 Continuing Loss Rate

An analysis was also undertaken to assess the sensitivity of the results generated by the TUFLOW model to variations in the adopted continuing loss rates. Accordingly, the continuing loss rates within the TUFLOW model were changed by ±20% from the "design" values of 1.16 mm/hr to:

- Increased Continuing Loss Rates: 1.39mm/hr.
- Decreased Continuing Loss Rates: 0.93m/hr

The modified continuing loss rates were applied to the XP-RAFTS model and were used to re-simulate each of the 1% AEP and 5% AEP storms in accordance with ARR2019. The revised discharge hydrographs were then applied to the TUFLOW model and the TUFLOW model was used to re-simulate the 5% AEP and 1% AEP floods with the modified continuing loss rates. Flood level difference mapping was prepared to quantify the impact of the changes in loss rates on peak flood levels and is provided in **Appendix K**.

Peak 5% AEP and 1% AEP flood level differences were also extracted from the results of the sensitivity simulations at various locations across the catchment and are presented in **Table** 34 and **Table 35**. A positive difference indicates that the sensitivity simulation levels are higher than the 'base case' levels while a negative difference indicates that the sensitivity levels are lower.

The results of the sensitivity analysis show that the TUFLOW model is relatively insensitive to changes in continuing loss rates. More specifically, altering the continuing loss rates is not predicted to alter 'base' design flood levels by more than 0.1 metres at most locations.

Therefore, it can be concluded that any uncertainties associated with the adopted continuing loss rates are unlikely to have a significant impact on the results generated by the TUFLOW model.

Table 34 Peak 5% AEP Sensitivity Simulation Flood Level Differences at Various Locations across the Catchment

Location		Water Level Differences (m)									
		Lower Storm Losses	Higher Storm Losses	Lower Continuing Losses	Higher Continuing Losses	Lower Manning's "n"	Higher Manning's "n"	No Blockage	Complete Blockage	ISLW Tide	ARR1987
Pambula River	Chalk Hills Road	0.01	-0.01	0.04	-0.02	-0.22	0.20	0.00	0.00	0.00	0.18
	Wolumla Peak Road	0.00	-0.01	0.05	-0.03	-0.35	0.26	-0.03	-0.12	-0.01	0.31
	Princes Highway	0.00	0.00	0.01	0.00	0.03	-0.02	-0.04	0.03	0.00	0.03
	Upstream of Yowaka River confluence	0.01	-0.01	0.05	-0.02	-0.17	0.18	0.00	0.00	-0.08	-0.21
	Downstream of Pambula Lake	0.01	-0.01	0.04	-0.01	-0.08	0.11	0.00	0.00	-0.12	-0.14
	Ocean outlet	0.02	0.01	0.04	0.00	0.12	0.00	0.00	0.01	-0.01	0.03
Yowaka River	Back Creek Road	0.01	-0.01	0.05	-0.02	-0.20	0.19	-0.08	-0.08	0.00	0.10
	Nethercote Road	0.01	-0.01	0.05	-0.02	-0.23	0.26	-0.17	-0.17	0.00	0.08
	Pipeclay Creek confluence	0.01	-0.02	0.08	-0.03	-0.33	0.32	-0.01	-0.01	0.00	-0.03
	Princes Highway	0.01	-0.01	0.06	-0.03	-0.21	0.20	-0.08	-0.08	-0.02	-0.12
	Upstream of Pambula River confluence	0.01	-0.01	0.05	-0.02	-0.17	0.18	0.00	0.00	-0.08	-0.21
Other Watercourses	Centipede Creek @ Nethercote Road	0.00	0.00	0.02	-0.01	-0.03	0.03	0.00	0.35	0.00	0.03
	Old Hut Creek @ Nethercote Road	0.00	0.00	0.03	-0.01	-0.14	0.19	-0.07	-0.07	0.00	0.07
	Back Creek @ Back Creek Road	0.00	-0.01	0.04	0.00	-0.01	0.01	0.00	2.86	0.00	0.33
	Back Creek @ Mount Darragh Road	0.03	-0.01	0.04	-0.03	-0.23	0.24	-0.01	2.02	0.01	0.31
	Burtons Creek @ Mount Darragh Road	0.00	-0.01	0.03	-0.02	-0.17	0.16	-0.08	-0.08	0.00	0.18
	Seven Mile Creek @ Mount Darragh Road	0.00	0.00	0.03	0.00	-0.17	0.15	-0.10	-0.10	0.00	0.15
	Chalk Hills Creek Upstream of Pambula River	0.01	-0.01	0.06	-0.03	-0.32	0.31	0.00	0.00	0.00	0.30

Table 35 Peak 1% AEP Sensitivity Simulation Flood Level Differences at Various Locations across the Catchment

Location		Water Level Differences (m)									
		Lower Storm Losses	Higher Storm Losses	Lower Continuing Losses	Higher Continuing Losses	Lower Manning's "n"	Higher Manning's "n"	No Blockage	Complete Blockage	ISLW Tide	ARR1987
Pambula River	Chalk Hills Road	0.00	0.00	0.03	-0.02	-0.21	0.22	0.00	0.00	0.00	0.70
	Wolumla Peak Road	0.02	0.01	0.03	-0.03	-0.34	0.30	-0.03	-0.18	0.03	1.18
	Princes Highway	0.00	0.00	0.01	0.00	0.05	0.05	-0.03	0.02	-0.01	0.10
	Upstream of Yowaka River confluence	0.00	0.00	0.02	-0.02	-0.08	0.15	0.00	0.00	-0.51	0.09
	Downstream of Pambula Lake	0.00	0.00	0.02	-0.01	0.00	0.10	0.00	0.00	-0.65	0.06
	Ocean outlet	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	-1.32	-0.20
Yowaka River	Back Creek Road	0.00	0.00	0.02	-0.03	-0.16	0.17	-0.10	-0.10	0.00	0.49
	Nethercote Road	0.00	0.00	0.03	-0.03	-0.24	0.31	-0.14	-0.14	0.00	0.58
	Pipeclay Creek confluence	0.00	-0.01	0.04	-0.05	-0.34	0.35	-0.01	-0.01	-0.02	0.65
	Princes Highway	0.00	0.00	0.03	-0.03	-0.15	0.18	-0.08	-0.08	-0.22	0.32
	Upstream of Pambula River confluence	0.00	0.00	0.02	-0.02	-0.06	0.15	0.00	0.00	-0.52	0.10
Other Watercourses	Centipede Creek @ Nethercote Road	0.00	0.00	0.01	-0.01	-0.03	0.03	0.00	0.32	0.00	0.23
	Old Hut Creek @ Nethercote Road	0.00	-0.01	0.02	-0.02	-0.17	0.24	-0.13	-0.13	0.00	0.69
	Back Creek @ Back Creek Road	0.00	0.00	0.00	-0.03	0.01	0.00	0.00	2.61	0.00	0.59
	Back Creek @ Mount Darragh Road	0.01	0.00	0.02	-0.01	-0.19	0.26	-0.02	1.10	0.02	0.99
	Burtons Creek @ Mount Darragh Road	0.00	0.00	0.02	-0.02	-0.17	0.18	-0.10	-0.10	0.00	0.60
	Seven Mile Creek @ Mount Darragh Road	0.00	0.00	0.03	-0.02	-0.19	0.19	-0.13	-0.13	0.00	0.58
	Chalk Hills Creek Upstream of Pambula River	0.00	0.00	0.03	-0.04	-0.32	0.36	0.00	0.00	0.00	1.13

9.2.3 Manning's "n"

Manning's "n" roughness coefficients are used to describe the resistance to flow afforded by different land uses and surfaces across the catchment. However, they can be subject to variability (e.g., vegetation density in the summer would typically be higher than the winter leading to higher Manning's "n" values). Therefore, additional analyses were completed to quantify the impact that any uncertainties associated with Manning's "n" roughness values may have on predicted design flood behaviour.

The TUFLOW model was updated to reflect a 20% increase and a 20% decrease in the adopted Manning's "n" values and additional 5% AEP and 1% AEP simulations were completed with the modified "n" values (no changes to hydrology were completed as part of this assessment). Peak flood levels were extracted from the results of the modelling and were used to prepare flood level difference mapping, which is presented in **Appendix K**.

Peak 5% AEP and 1% AEP flood level differences were also extracted from the results of the sensitivity simulations at various locations across the catchment and are presented in **Table** 34 and **Table 35**.

The difference mapping shows that changing the Manning's "n' values by ±20% will alter 5% AEP and 1% AEP flood level across most of the catchment. The flood level differences are most commonly contained between 0.1 and 0.2 metres. However, flood level differences of more than 0.3 metres are predicted along parts of the Pambula River and Yowaka River. The most significant changes are predicted to occur in more heavily vegetated areas where the absolute change in Manning's' "n" value is greatest.

Although reducing Manning's "n" is generally predicted to reduce flood levels across the catchment, it will also increase the speed at which floodwaters move downstream. This reduction in travel time is predicted to result in flood levels increasing in the Pambula River between the ocean entrance and Pambula Lake.

Overall, the results of the sensitivity simulations show that the model results in some areas can be quite sensitive to changes in Manning's "n" values.

9.2.4 Hydraulic Structure Blockage

As discussed in Section 6.2.3, blockage factors were applied to all bridges, culverts and stormwater inlets as part of the design flood simulations. However, as it is not known which structures will be subject to what percentage of blockage during any particular flood, additional TUFLOW simulations were completed to determine the impact that alternate blockage scenarios would have on flood behaviour. Specifically, additional simulations were undertaken with complete blockage of all stormwater inlets, bridges and culverts.

Peak flood levels were extracted from the results of the "complete blockage" and "no blockage" modelling and were compared to the "design blockage" flood level results to prepare flood level difference mapping, which is presented in **Appendix K**.

Peak 5% AEP and 1% AEP flood level differences were also extracted from the results of the sensitivity simulations at various locations across the catchment and are presented in **Table** 34 and **Table 35**.

The difference maps show that removing blockage will generate some small, localised reductions in flood levels in the vicinity of bridges and culverts. The changes are not particularly significant as many of the hydraulic structure had relatively low blockage factors applied as part of the base flood simulations. The most extensive reductions in flood levels are predicted upstream of the Princes Highway south of Pambula where the combined impact of the roadway embankment and four separate hydraulic structures is more significant.

Complete blockage will cause some more significant changes to 5% AEP and 1% AEP flood levels. Design flood levels are predicted to increase by over 2.5 metres at some locations and are driven by the significantly elevated embankments at some locations (most notable, in the steeper, upper sections of the catchment such as Back Creek Road). Blockage of the Princes Highway bridge crossing of the Yowaka River is also predicted to have a significant impact, with flood level increases extending well upstream and into the Greigs Flat area.

The results of the blockage sensitivity analysis show that the model results are sensitive to variations in blockage in the immediate vicinity of major hydraulic structures, particularly if complete blockage of structures occurs. This outcome emphasises the need to ensure key drainage infrastructure and bridges and culverts are well maintained (i.e., debris is removed on a regular basis).

9.2.5 Ocean Level

The Pambula River and Yowaka River catchment drains into the Tasman Sea which forms the downstream boundary of the hydraulic model. As discussed in Section 7.3.1, the "base" simulations adopted a design flood envelope which considered the potential interaction of both catchment runoff and elevated ocean levels. However, if the prevailing sea level at the time of a local catchment flood was different, it has the potential to impact on results across the downstream sections of the catchment.

Therefore, the enveloped flood level results for the 1% AEP flood (which included a peak 1% AEP tide level of 2.55mHAD) were compared against the 1% AEP flood level results with a ISWL tide only (i.e., a "low" tide level of -0.82 mAHD at the time of peak catchment outflow). Difference mapping was prepared to show the impact of the different tide levels on peak flood levels and the resulting mapping is presented in **Appendix K**.

Peak 5% AEP and 1% AEP flood level differences were also extracted from the results of the sensitivity simulations at various locations across the catchment and are presented in **Table** 34 and **Table 35**.

The difference mapping shows that the adopted sea level can have a significant impact on flood levels across the downstream sections of the study area. More specifically, 1% AEP flood levels are predicted to reduce by well over 0.5 metres between the ocean and the Pambula River/Yowaka River confluence and by around 0.4 metres across the floodplain south of Pambula.

It is noted that increases in 1% AEP flood levels are predicted upstream of the Princes Highway south of Pambula. This outcome is associated with the lower water levels east of the highway resulting in higher velocities and greater afflux through the Princes Highway culverts and bridge.

Therefore, the outcomes of the sensitivity simulations show that the flood level results across the lower, eastern sections of the catchment are sensitive to the adopted sea level boundary conditions. However, flood level impacts across the upstream sections of the catchment are predicted to be negligible.

9.2.6 Timing of Pambula River and Yowaka River Flows

The design flood simulations assumed that each design storm was "static" across the whole catchment. However, "real" storms often move across the catchment with respect to time. This can alter the distribution of rainfall across different parts of the catchment, which can impact on the timing of peak flows from difference parts of the catchment. Therefore, additional 1% AEP sensitivity simulation were completed by adjusting the timing of flows from the Yowaka River catchment. Two scenarios were completed (also refer **Plate 23**):

- Yowaka River flows were delayed by 40 minutes to maximise flood levels
- Yowaka River flows were delayed by 9.5 hours to minimise flood levels

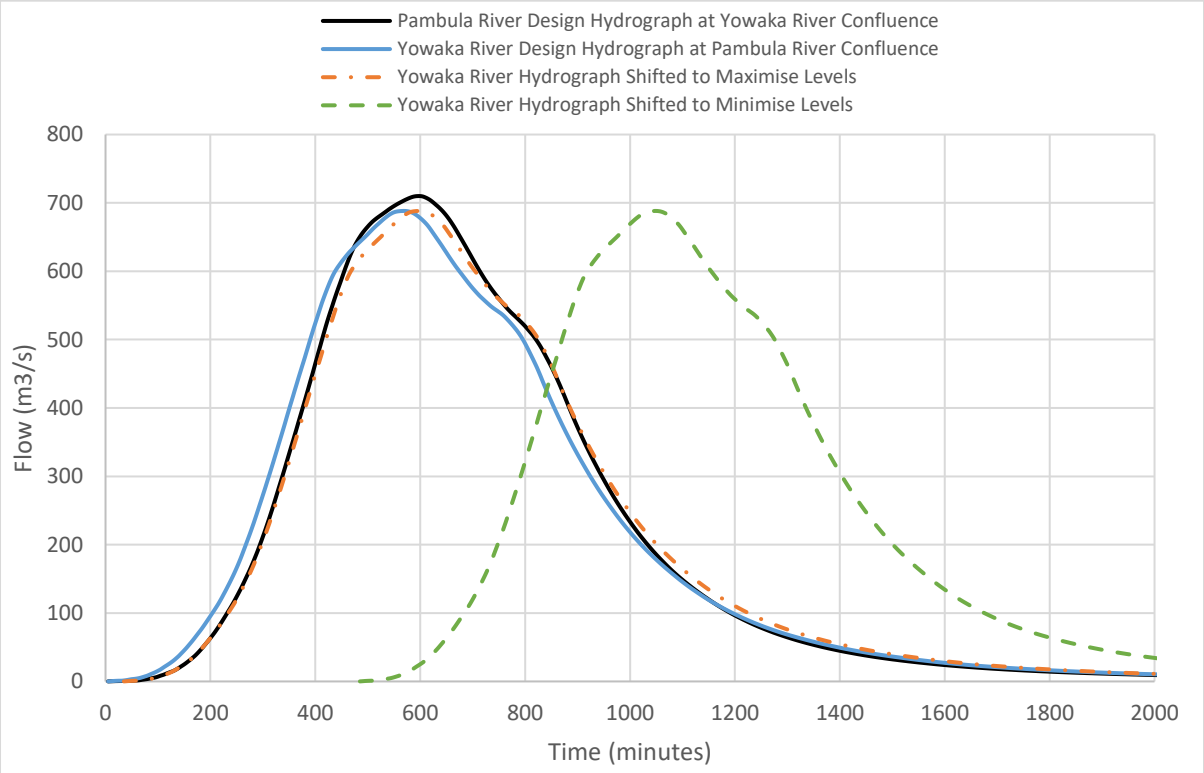


Plate 23 Hydrographs adopted to test sensitivity of timing of Yowaka River flows

The TUFLOW model was used to re-simulate the 1% AEP flood with the revised Yowaka River flows. Flood level difference mapping was prepared to quantify the impacts of the timing of flows and is presented in **Appendix K**. However, it was noted that there were negligible flood level increases in the first sensitivity simulation, therefore, the difference maps were not included. This is associated with the characteristics of the Pambula River and Yowaka River

being very similar. As a result, the time of peak catchment outflow for the "base" simulations are very similar for both catchment and there was little opportunity to better align the timing of the peak outflows (refer **Plate 23**).

However, the difference mapping shows that if the timing of the Yowaka River and Pambula River catchments was significantly offset, it does have the potential to reduce 1% AEP flood levels along the Yowaka River by more than 0.2 metres and along the Pambula River by 0.05-0.10 metres. Therefore, the flood level results along the Yowaka River and Pambula River are sensitive to the timing of flows in the Pambula River and Yowaka River.

9.2.7 Australian Rainfall & Runoff 1987

The current study was prepared based on *'Australian Rainfall and Runoff – A Guide to Flood Estimation'* (Ball et al, 2019) (ARR2019). However, most flood studies across the Bega Valley LGA over the past 30 years were prepared in accordance with the 1987 version of Australian Rainfall and Runoff (ARR1987). ARR2019 takes advantage of more thorough hydrologic procedures as well as an additional 30 years of rainfall information and should provide improved design flood estimates across the catchment. Nevertheless, it was considered important to understand how results produced based upon ARR2019 may differ from those generated using ARR1987. Therefore, an additional sensitivity assessment was completed to confirm the impact that the revised hydrologic procedures may have on design flood behaviour across the study area.

The ARR1987 design storms were first applied to the XP-RAFTS hydrologic model. Peak ARR1987 discharges were extracted for each subcatchment and are summarised in **Appendix L**. The ARR2019 discharges are also included for comparison.

The peak discharge information presented in **Appendix L** shows that ARR1987 produces higher peak design discharge estimates relative to ARR2019. The ARR1987 discharges are typically 40 to 70% higher that the ARR2019 discharges.

The ARR1987 1% AEP and 5% AEP hydrographs were applied to the TUFLOW model and the TUFLOW model was used to simulate flood behaviour with the modified hydrology. Difference mapping was prepared to show the impacts of the modified hydrology and is presented in **Appendix K**.

Peak 5% AEP and 1% AEP flood level differences were also extracted from the results of the sensitivity simulations at various locations across the catchment and are presented in **Table** 34 and **Table 35**.

The difference mapping presented in **Appendix K** also shows the ARR1987 is predicted to produce higher flood levels across most of the catchment relative to ARR2019. During the 5% AEP flood, the ARR1987 levels are typically a minimum of 0.1 metres higher than ARR2019. During the 1% AEP flood, the ARR1987 levels are typically a minimum of 0.3 metres higher than ARR2019.

It was noted that the ARR1987 flood levels are lower along the very downstream reaches of the Pambula River during each design flood. This is because the time of peak tide was arranged to coincide with the peak ARR2019 catchment outflow, not the peak ARR1987

outflow. As a result, the ARR1987 flood levels are typically lower across those sections of the catchment that are more tide-dominated.

Accordingly, there are some notable difference between flood behaviour defined under ARR1987 versus ARR2019. However, ARR2019 takes advantage of a greater amount of historic rainfall information and employs that latest available research in deriving the design flood estimates. Therefore, it is considered that the flood estimates defined under ARR2019 are reasonable and improve upon the flood estimates provided by ARR1987.

9.3 Climate Change Analysis

Climate change refers to a significant and lasting change in weather patterns arising from both natural and human induced processes. The former Office of Environment and Heritage's *'Practical Consideration of Climate Change'* states that climate change is expected to have adverse impacts on sea levels and rainfall intensities in the future.

Although there is considerable uncertainty associated with the impact that climate change may have on rainfall, it was considered important to provide an assessment of the potential impact that climate change may have on the current flood risk across the study area and the suitability of freeboard when establishing the flood planning level (refer Section 10.2.1).

The climate change assessment considered the potential impacts associated with:

- Increased sea level
- Increased rainfall intensity
- Increased rainfall intensity and increased sea level

The outcomes of the climate change simulations are provided below.

9.3.1 Increases in Sea Level

The 'NSW Coastal Planning Guideline: Adapting to Sea Level Rise' (Department of Planning, 2010) provides guidance on the expected impacts that climate change may have on sea levels. The former '*NSW Sea Level Rise Policy Statement*' (Department of Environment and Climate Change, 2009) states that ocean level increases of 0.4 metres could be expected by 2050 and a 0.9 metre increase could occur by 2100. This document has since been repealed and the NSW Government recommends that local Councils determine their own sea level rise projections based on their local conditions (NSW Department of Environment and Heritage, 2012).

The Bega Valley Shire Council has adopted a sea level rise policy (dated 2013) that is consistent with the former NSW Government's Sea Level Rise Policy. That is, a 0.4 metre increase in sea level by 2050 and a 0.9 metre increase in sea level by 2100. The sea level rise projections were incorporated as part of the following revised design flood simulations:

- Highest high-water solstice spring (HHWSS) tide with 0.4 m increase in sea level
- HHWSS tide with 0.9 m increase in sea level
- 1% AEP flood with 0.4 m increase in sea level (included full envelope of tidal and catchment runoff simulations as documented in Section 7.3.1)
- 1% AEP flood with 0.9 m increase in sea level

In addition, there is potential for sea level rise to change the tidal dynamics around the river entrance, thereby, leading to a change in erosion/deposition of bed material and an increase in river entrance bed elevations. More specifically, there is potential for the entrance bed elevation to increase proportionally with sea level rise. Therefore, each of the above sea level rise scenarios was also run with the following increases in river entrance elevations:

- 0.4 m increase in sea level = 0.4 m increase in river entrance elevation
- 0.9 m increase in sea level = 0.6 m increase in river entrance elevation

Peak floodwater depths were extracted across the tidally influenced sections of the catchment and are presented in:

- *HHWSS tide with 0.4 m increase in sea level*:
  - Existing river entrance conditions: **Figures 46.1** to **46.3**
  - River entrance elevation increase by 0.4m: **Figures 47.1** to **47.3**
- *HHWSS tide with 0.9 m increase in sea level*:
  - Existing river entrance conditions: **Figures 48.1** to **48.3**
  - River entrance elevation increase by 0.9m: **Figures 49.1** to **49.3**
- *1% AEP flood with 0.4 m increase in sea level*:
  - Existing river entrance conditions: **Figures 50.1** to **50.3**
  - River entrance elevation increase by 0.4m: **Figures 51.1** to **51.3**
- *1% AEP flood with 0.9 m increase in sea level*:
  - Existing river entrance conditions: **Figures 52.1** to **52.3**
  - River entrance elevation increase by 0.9m: **Figures 53.1** to **53.3**

In all figures, inundation extents for existing climate conditions are superimposed so that the impact of the sea level (and ocean entrance) increases can be visualised.

Flood level difference mapping was also prepared to quantify the impacts of sea level rise across the catchment on existing flood levels. The difference mapping was prepared by subtracting the peak flood levels from each climate change simulation from "existing" peak flood levels. The difference mapping is presented in **Appendix M**.

The difference mapping and floodwater depth mapping shows that increases in sea level will increase existing flood levels and extents for areas located primarily downstream/east of the Princes Highway. The magnitude of the increases is more significant during the HHWSS simulations as the sea level rise impacts are not "drowned out" by catchment runoff. Nevertheless, flood levels during the 1% AEP flood are still predicted to increase by up to 0.74 metres in Pambula Lake and up to 0.2 metres near the Princes Highway bridge crossing of the Pambula River.

Overall, the outcomes of the climate change simulations show that increases in sea level have the potential to increase the severity of flooding across the lower-lying, eastern sections of the catchment.

9.3.2 Increases in Rainfall Intensity

To gain an understanding of what impact increases in rainfall intensity may have on existing flood behaviour, the results of the 0.5% AEP and 0.2% AEP floods were compared to the results from the 1% AEP flood. The 0.5% AEP rainfall reflects a 18% increase relative to current 1% AEP rainfall intensities, while the 0.2% AEP rainfall reflects a 41% increase relative to current 1% AEP rainfall intensities.

Information provided on the ARR2019 Data Hub indicates that these rainfall increases are higher than current best estimates of rainfall intensity increases for the 2090 planning horizon based on Representative Concentration Pathway (RCP) 8.5 conditions (rainfall intensity increases for RCP8.5 and 2090 conditions are currently estimated to be 16.3%, as shown in **Plate 24**). However, it should be noted that climate change is unlikely to "stop" in 2090 so the adopted rainfall increases still provide useful information in understanding the potential impacts of climate change including what may happen beyond 2090.

	RCP 4.5	RCP6	RCP 8.5
2030	0.648 (3.2%)	0.687 (3.4%)	0.811 (4.0%)
2040	0.878 (4.4%)	0.827 (4.1%)	1.084 (5.4%)
2050	1.081 (5.4%)	1.013 (5.1%)	1.446 (7.3%)
2060	1.251 (6.3%)	1.229 (6.2%)	1.862 (9.5%)
2070	1.381 (7.0%)	1.460 (7.4%)	2.298 (11.9%)
2080	1.465 (7.4%)	1.691 (8.6%)	2.719 (14.2%)
2090	1.496 (7.6%)	1.906 (9.7%)	3.090 (16.3%)

Plate 24 Interim Climate Change Rainfall Intensity Increases (Ball et all, 2019)

Peak floodwater depths for both scenarios are presented in **Figures 54.1** to **54.6** and **Figures 55.1** to **55.6**. The 1% AEP inundation extent for current climate conditions is superimposed for comparison.

Flood level difference mapping was prepared to quantify the impacts that a 18% and 41% increase in rainfall would have on current 1% AEP flood level estimates. The difference mapping was prepared by subtracting the peak 1% AEP flood levels from the 0.5% and 0.2% AEP flood levels. The difference mapping is presented in **Appendix M**.

The difference mapping shows that rainfall increases will increase 1% AEP flood level estimates throughout the catchment, although the most notable increases are concentrated along defined watercourses. A 18% increase in rainfall is commonly predicted to increase 1% AEP flood levels by up to 0.2 metres. A 41% increase in rainfall is predicted to increase existing 1% AEP flood levels by more than 0.3 metres at many locations.

Accordingly, the outcomes of the assessment show that increases in rainfall associated with climate change have the potential to produce a notable increase in the severity of flooding across all sections of the catchment.

9.3.3 Increases in Rainfall Intensity and Increases in Sea Level

In order to gain an understanding of the combined impacts that rainfall intensity and sea level increases may have on existing flood behaviour, additional climate change simulations were completed. Four separate "combined" scenarios were considered and peak floodwater depths were extracted from the results of each combined scenario and are presented in the following figures:

- *1% AEP flood with 18% increase in rainfall intensity and 0.4 metre increase in sea level*:
  - Existing river entrance conditions: **Figures 56.1** to **56.3**
  - River entrance elevation increase by 0.4m: **Figures 57.1** to **57.3**
- *1% AEP flood with 41% increase in rainfall intensity and 0.9 metre increase in sea level:*
  - Existing river entrance conditions: **Figures 58.1** to **58.3**
  - River entrance elevation increase by 0.9m: **Figures 59.1** to **59.3**

Peak flood level difference mapping was also prepared and is presented in **Appendix M**.

The results of the simulations show that sea level rise and rainfall intensity increases will result in the 1% AEP flood level increasing throughout the catchment. In the narrow, incised, upper sections of the catchment, the flood level increases are identical to the rainfall increase only scenarios (i.e., these areas are not influenced by increases in ocean level).

However, in areas contained within the lower catchment (i.e., between the sea and roughly the Princes Highway), the combined impacts of rainfall increase, and sea level increase are more pronounced. The 0.4m increase in sea level plus 18% increase in rainfall intensity is predicted to elevate current 1% AEP flood levels by more than 0.3 metres at multiple locations while the 0.9m increase in sea level plus 41% increase in rainfall intensity is predicted to increase current 1% AEP flood level by more than 0.5 metres across large areas and by more than 0.7 metres between the Pambula River/Yowaka River confluence and the Tasman Sea.

A review of the simulation results incorporating the elevated river entrance showed no significant differences relative to the simulation results based on current river conditions. This mirrors the results documented in Section 9.3.1 and shows that the results are not sensitive to changes in the river entrance bed elevations.

Accordingly, the results of the climate change simulations indicate that should both rainfall intensity and sea level increases occur in the future, it would produce a notable increase in flood risk across all sections of the catchment. However, the area of the catchment located east of the Princes Highway would be most significantly impacted.

10 FLOOD PLANNING INFORMATION

10.1 Overview

Appropriate land use planning is one of the most effective measures available to manage the future risk as well as the ongoing/continuing flood risk. A full review of land use planning including appropriate zoning, policies and planning/building controls is typically undertaken as part of the floodplain risk management study.

Nevertheless, *'Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia'* (ADR Handbook 7) (AIDR, 2017) recommends using the best available information at any point in time to manage the flood risk. Therefore, if a flood study is available that contains relevant information (such as this one), there is no need to wait for the floodplain risk management study before this flood information is used to inform land-use planning. Accordingly, the following chapter outlines the process that was employed to develop flood planning category constraint mapping to assist in informing future land-use planning decisions.

In addition, the results of the flood study can be used to define the flood planning area (i.e., the area within which flood-related development controls apply). Defining the flood planning area will help to identify areas with a higher flood exposure/risk and, should new development or re-development occur, will help ensure appropriate controls are implemented such that the flood exposure/risk is appropriately managed.

10.2 Flood Planning Area

10.2.1 Flood Planning Level

Flood Planning Levels (FPLs) are an important tool in the management of flood risk and are derived by adding a freeboard to the "planning" flood. The FPLs can then be combined with topographic information to establish the Flood Planning Area (FPA). The FPL and FPA can then be used to assist in managing the existing and future flood risk by:

- Setting design levels for mitigation works (e.g., levees); and
- Identifying land where flood-related development controls apply to ensure that new development is undertaken in such a way as to minimise the potential for flood impacts on people and property.

Bega Valley Shire Council has defined the FPL as the level of the 1:100 ARI (i.e., 1% AEP) flood event plus 0.5 metre freeboard in the Bega Valley Shire Council Local Environmental Plan 2013.

Discussions with Council planners indicates that Council is interested in incorporating climate change into the definition of the FPL. As a result, the peak flood levels from the 1% AEP flood with 0.9 metre increase in water level were used as the basis for the FPL.

As part of the current study, Council also wished to confirm the suitability of adopting a 0.5 metre freeboard across the Pambula River, Pambula Lake and Yowaka River catchment. Freeboard is used to account for uncertainties when deriving the 1% AEP flood levels. More specifically, freeboard is used to account for the following uncertainties:

- Model parameter uncertainty (e.g., roughness, blockage of culverts/bridges, rainfall/flows); and,
- "Local" factors that can't be explicitly represented in the computer modelling (e.g., wave action or small flow paths less than the model grid size).

A discussion on each of these components is presented below.

Model Parameter Uncertainty

The potential impacts of model parameter uncertainty can be quantified by reviewing the results of the sensitivity simulations presented in Section 9. More specifically, statistical analyses were completed based upon the results of the various 1% AEP sensitivity simulations to assign "confidence limits" to the peak 1% AEP flood level estimates.

In order to reliably define confidence limits to the 1% AEP results, it would be necessary to undertake thousands (potentially tens of thousands) of simulations to reflect the numerous combinations of potential parameter estimates and provide a sufficiently large population to enable meaningful statistical analysis. Unfortunately, the long simulation times only permit a limited number of parameter scenarios to be investigated.

In instances where a sufficiently large "population" of results is not available, it is still possible to derive confidence limits using the Student's t-test (Zhang, 2013). This approach involves interrogating peak flood level estimates from all 1% AEP simulations (i.e., base and sensitivity) at each TUFLOW grid cell. This information is used to calculate a mean water level and standard deviation at each grid cell. This information can then be combined with the number of degrees of freedom (i.e., number of different 1% AEP simulations minus 1) and a "t-table" to develop 99% confidence limit estimates at each TUFLOW grid cell.

The resulting "99% Confidence Limit" grid is shown in **Plate 25**. Lighter colours indicate small confidence limits (i.e., more confidence in results) and darker colours indicate higher confidence limits (i.e., less confidence in results). It is noted that the Student's t-test assumes that the population of results is "normally" distributed with the majority of the parameters and results located in close proximity to the mean. However, the sensitivity analysis typically adopts parameter values that are at the extremes of realistic ranges. As a result, the population of water level results is unlikely to be normally distributed and the calculated confidence limits are, therefore, likely to be conservative.

The confidence interval grid provided in **Plate 25** shows that across the majority of the study area, the confidence interval is better than 0.2 metres. That is, there is 99% confidence that the "true" 1% AEP flood level is contained within ±0.2 metres of the "base" 1% AEP simulations documented in Section 7 across most of the catchment.

However, some localised areas are subject to greater uncertainty (i.e., larger confidence limits). This includes Greigs Flat as well as the very lower reaches of the Pambula River near

the river where the confidence limits approach 0.25 metres. The lower confidence near the river entrance is primarily driven by the uncertainty in ocean tide levels while the lower confidence around Greigs Flat is associated with the thick vegetation adjoining the narrow floodplain opening immediately downstream of the flat.

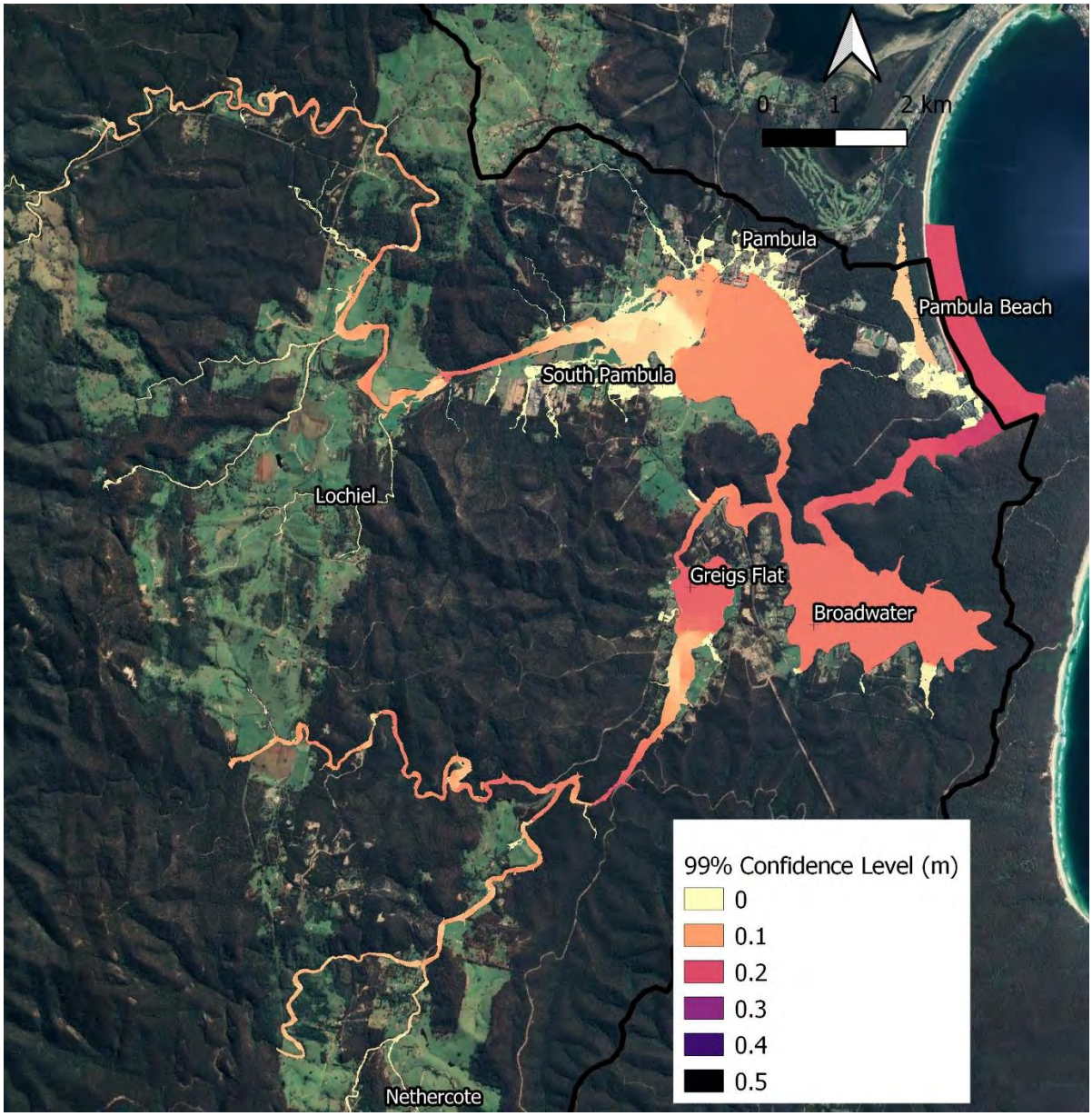


Plate 25 99% Confidence Level Grid

Therefore, modelling uncertainty is not predicted to exceed 0.25 metres at any location.

Local Factors

Unfortunately, the uncertainty associated with the remaining factors (i.e., wave action and local factors that cannot be represented in the model) cannot be as readily quantified. However, if a 0.5 metre freeboard is adopted it would provide a 0.25 metres allowance for these local factors (as outlined above, the other 0.25 metres is required to account for modelling uncertainty). A 0.25 metre allowance is considered sufficient to cater for these factors as cars/boats will most likely be travelling at low speed and generating relatively small waves (refer **Plate 26**).

Therefore, adoption of a 0.5 metre freebaord should be sufficient to account for uncertainty in the 1% AEP flood level estimates. That is, there does not appear to be suitable justification to vary the 0.5 metre freeboard defined in the LEP for this catchment.



Plate 26 Example of cars driving through flood waters and generating waves

Therefore, the 0.5 metre freeboard was added to the 1% AEP with 0.9m increase in sea level water level results to produce a Flood Planning Level (FPL) grid. The FPL grid was then extended laterally until it intersected higher ground to form the FPA. The resulting flood planning area is shown in **Figures 60.1** to **60.6**. Also included on **Figures 60.1** to **60.6** are flood planning level contours.

10.3 Flood Planning Constraint Categories

Flood planning category constraint mapping was prepared based on guidance provided in the *'Australian Disaster Resilience Guideline 7-5: Flood Information to Support Land-use Planning'* (AIDR 2017). This guideline delineates flood liable land into one of four major "constraint" categories (with several subcategories) based upon key flooding considerations such as flood hazard, flood function and emergency response. The resulting categories can serve to inform land use planning activities. The guideline notes that the categorisation is intended to support community/precinct scale decisions where flow paths and flood extents can be readily defined and was not developed to support change of land use or development at the lot/site scale.

The flood planning constraint categories (FPCC) are summarised in **Table 36**. **Table 36** also summarises how the categories are defined along with the associated planning implication/considerations. In general, a FPCC categorisation of "1" implies a more flood constrained section of land relative to FPCC category "2", and so on.

Table 36 Flood Planning Constraint Categories (AIDR, 2017)

FPCC	Sub-Category	Constraint	Implications	Consideration
1	A	Flow conveyance and storage areas in the DFE	Development or changes to topography within flow conveyance areas and flood storages areas affect flood behaviour, which will alter flow depth or velocity in other areas of the floodplain. Changes can negatively affect the existing community and other property	The majority of developments and uses have adverse impacts on flood behaviour. Consider limiting uses and development to those compatible with maintaining flood function
	B	H6 hazard in the DFE	Hazardous conditions considered unsafe for vehicles and people. All building types are considered vulnerable to structural failure	The majority of developments and uses are vulnerable to failure in this flood hazard category. Consider limiting developments and uses to those that are compatible with flood hazard H6
2	A	Flow conveyance area in events larger than the DFE	Flow conveyance areas may develop during an event larger than the DFE. People and buildings in these areas may be affected by flowing and dangerous floodwaters	Consider compatibility of developments and users with rare flood flows in this area
	B	H5 hazard in the DFE	Hazardous conditions are considered unsafe for vehicles and people, and all buildings are vulnerable to structural damage	Many uses and developments will be vulnerable to flood hazard. Consider limiting new uses to those compatible with flood hazard H5. Consider treatments such as filling (where this will not affect flood behaviour) to reduce the hazard to a level that allows standard development conditions to be applied. Alternatively, consider a requirement for special development conditions
	C	Isolated and submerged areas (low flood island or low trapped perimeter in 1%AEP event)	Area becomes isolated by floodwater or impassable terrain, with loss of evacuation route to the community evacuation location. The area will become fully submerged with no flood-free land in an extreme event, with ramifications for those who have not evacuated and are unable to be rescued	Consequences of isolation and inundation can be severe. Consider the consequences of: • evacuation difficulty or inundation of the area on the development and its users, which may include limitations on land use, or on land use that has occupants who are more vulnerable to disruption and loss • the development on emergency management planning for the existing community, including the need for additional treatments • the development on community flood recovery • disruption or loss of the development on the users and wider community
	D	Isolated but not submerged areas (high flood island or high trapped perimeter in 1%AEP event)	Area becomes isolated by floodwater or impassable terrain, with loss of an evacuation route to a community evacuation location. The area has some land elevated above the extreme flood level. Those not evacuated may be isolated with limited or no services, and will need rescue or resupply until floods recede and roads are passable	Some developments and their users may be vulnerable to disruption or loss. Consider: • the consequences of disruption or loss of the development on the users and the wider community • limiting land use, or land use that has occupants who are more vulnerable to disruption and loss • additional emergency management treatment requirements • issues associated with the level of support required during a flood, particularly for long-duration flood events • potential for loss of services
	E	H6 hazard in events rarer than the DFE	Hazardous conditions may develop in an event rarer than the DFE, which may have implications for the development and its occupants	Consider the need for additional development conditions to reduce the effect of flooding on the development and its occupants

FPCC	Sub-Category	Constraint	Implications	Consideration
3	-	Outside FPCC 2 but generally below the DFE plus freeboard	Hazardous conditions may exist creating issues for vehicles and people. Structural damage to buildings that meet building standards unlikely because of flooding	Standard land-use and development controls aimed at reducing damage and the exposure of the development to flooding in the DFE are likely to be suitable. Consider the need for additional conditions for emergency response facilities, key community infrastructure and vulnerable users
4	-	Outside of FPCC 3 but within the PMF extent	Emergency response may rely on key community facilities such as emergency hospitals, emergency management headquarters and evacuation centres operating during an event. Recovery may rely on key utility services being able to be readily re-established after an event	Consider the need for conditions for emergency response facilities, key community infrastructure and land uses with vulnerable users

The FPCC use a "Defined Flood Event" (DFE), which is analogous to the "planning flood" (i.e., 1% AEP event). It also requires consideration of flood impacts in events rarer than the DFE. The 0.2% AEP event was selected for this purpose.

The information contained in **Table 36** was used with the flood modelling outputs (most notably the flood hazard, hydraulic category and emergency response mapping) to prepare the FPCC map shown in **Figures 61.1** to **61.6**. Also included on **Figures 61.1** to **61.6** are the current land use zones to gain an appreciation of how the current zoning align with the FPCC.

The FPCC categories presented in **Figures 61.1** to **61.6** show that current land use zones are broadly compatible with the level of flood exposure. More specifically, the more highly constrained land (i.e., FPCC 1) typically coincides with areas of open space (e.g., zones E1-E5, W1), which is considered to be a compatible land use.

FPCC 1 and 2 does extend through some industrial zoned land in South Pambula. Fortunately, much of the FPCC 1 area does not include existing development. It is recommended that any future industrial development in this area is kept clear of FPCC 1 and 2 and any development falling within FPCC 3 is implemented with appropriate development controls to ensure it is compatible with the flood risk.

There are also some FPCC 1 and 2 areas that extend through residentially zoned land in Pambula. However, these areas are currently undeveloped and align with natural waterways and drainage depressions. Again, future development in these flood constrained areas should be discouraged. In general, other areas of Pambula are most commonly impacted by FPCC 3 and 4. Future development in these areas could be considered (subject to appropriate development controls). However, sensitive/vulnerable developments (e.g., aged care facilities, childcare centres) should ideally be located outside of the floodplain.

10.4 Impacts of Future Development

Although the Pambula River, Pambula Lake and Yowaka River catchment comprises small pockets of urban development (e.g., Pambula, South Pambula and Pambula Beach), the majority of the catchment comprises large areas of National Parks and state forest that comprise a negligible urban footprint. However, there are some sections of the catchment

that have the potential to be developed in the future based upon current land use zonings defined in the Bega Valley Local Environmental Plan (LEP) 2013.

This future development has the potential to alter existing flood behaviour which may impact on the existing flood risk across the catchment. Accordingly, additional computer flood simulations were completed to quantify the potential impacts that future development may have on the existing flood risk across the catchment.

Those areas that are currently undeveloped but are likely to be developed in the future (based upon current LEP zoning) were first identified. This was completed by reviewing land use zoning information relative to contemporary aerial imagery.

Bega Valley Shire Council strategic planners were also consulted to identify areas that have the potential to be rezoned in the future to promote further urban development. This consultation yielded no significant additional areas for consideration as part of the assessment.

As the future "make up" of these areas is not known, assumptions were made regarding the likely land use composition. This information was used to calculate weighted average impervious and pervious "n" values for each land use, and these were used to update the XP-RAFTS hydrologic model (refer **Table 37**). Average impervious and pervious "n" values for current/existing conditions are also provided in **Table 37** so that the magnitude of the changes for each LEP zone can be understood. The comparison shows that the adopted future impervious percentages are higher than current impervious percentages (reflecting an increase in hard surfaces and reduced potential for infiltration) while pervious "n" values are lower (reflecting a lower effective roughness and more rapid response to rainfall).

Only land that falls within the LEP zones identified in **Table 37** were updated as part of the assessment. Land falling within LEP zones not included in **Table 37** were left unchanged from the "existing" flood assessment. This includes public recreation areas as well as all National Parks and environmental conservation/management areas. Therefore, negligible future development was assumed across the upper/western catchment areas.

The most notable areas that are currently undeveloped, but the current zoning may permit future development include:

- IN1 area located north of Mount Darragh Road at South Pambula
- IN1 area located south of Pambula Beach Road and east of McPherson Cct
- R2 area located south of George Street at South Pambula

The updated impervious proportions and pervious "n" values were applied to a new "ultimate catchment development" version of the XP-RAFTS model. The updated model was used to re-simulate the 5% AEP, 1% AEP and 0.2% AEP and PMP storms under potential future catchment development conditions. Peak discharges extracted from the results of the revised hydrologic assessment are presented in **Appendix N**. Peak 5% AEP, 1% AEP and 0.2% AEP and PMF discharges for current catchment development conditions are also included in **Appendix N** for comparison.

Table 37 Adopted land use information for future development assessment

LEP Zone	Average Impervious (%)		Average Pervious "n"	
	Current	Adopted Future	Current	Adopted Future
B1 - Neighbourhood Centre	0	80	0.035	0.025
B2 - Local Centre	27	80	0.043	0.025
B4 - Mixed Use	24	80	0.052	0.025
B5 - Business Development	11	90	0.065	0.020
IN1 - General Industrial	8	90	0.055	0.020
IN2 - Light Industrial	9	80	0.068	0.025
R2 - Low Density Residential	24	40	0.051	0.035
R3 - Medium Density Residential	29	70	0.048	0.030
R5 - Large Lot Residential	14	20	0.058	0.050
RU4 - Primary Production Small Lots	2	20	0.067	0.050
SP1 - Special Activities	8	50	0.058	0.045
SP2 - Infrastructure	20	50	0.058	0.045
SP3 - Tourist	20	50	0.052	0.045

The discharge comparison indicates that future catchment development is predicted to generate very localised increases in peak design discharges at some locations (although discharges across most of the catchment are predicted to largely remain unaltered). The increases most commonly occur downstream of areas where there is potential for more significant intensification of development (i.e., Pambula and South Pambula). The most significant increase in discharges is predicted north of Mount Darragh Road at South Pambula where increases of 2 to 3 m^3/s are common during each design flood (equating to an increase of about 10% above current discharges during most design floods).

Although localised increases in local catchment runoff are predicted, only minimal changes in discharges are predicted along the main rivers (i.e., Pambula and Yowaka Rivers). Interestingly, small reductions in design discharges (i.e., typically 1-2 m^3/s) are predicted for the Pambula River near Pambula and South Pambula which appears to be associated with the more rapid rainfall response from the "developed" catchments allowing local catchment runoff to "escape" into the river and out to sea before flow from the upper catchment arrives.

To quantify the impact that the changes in design discharges are predicted to have on future flood behaviour, the hydrographs generated by the future catchment conditions XP-RAFTS model were subsequently applied to the TUFLOW model. In addition to updates to hydrology to reflect intensification of development, two different topographic scenarios were represented in the TUFLOW model to maintain flood function (ensure floodways and flood storage areas are preserved as a minimum):

- Existing topography is maintained.
- Existing topography is maintained except for 1% AEP flood fringe areas which were elevated to the flood planning level.

The updated TUFLOW model was used to re-simulate the 5% AEP, 1% AEP and 0.2% AEP floods as well as the PMF (with and without filling). Flood level difference mapping was also prepared to quantify the impact that future catchment development is predicted to have on "existing" design flood levels across the catchment. The difference mapping is presented in **Appendix N**.

The difference mapping shows future development with no topographic changes is predicted to generate small increases in flood level at localised locations across the lower sections of the catchment during floods up to and including the 1% AEP event. The most extensive changes in flood level are predicted to occur at South Pambula which is zoned for industrial and residential development. However, the flood level increases are not predicted to exceed 0.02 metres in this area. The biggest increase in flood level is predicted to be ~0.1 metres during the 5% AEP flood and occurs in the wetland area to the west of the Discovery Parks caravan park at Pambula Peak. Negligible flood level impacts are predicted during the 0.2% AEP flood and PMF.

Inclusion of filling is not predicted to change the magnitude or extent of the flood level impacts during the 5% AEP and 1% AEP floods (which helps to provide evidence that the 1% AEP flood fringe areas were suitably delineated). However, inclusion of filling is predicted to have more significant impacts during the 0.2% AEP flood and PMF at South Pambula. Flood level increases of more than 0.5 metres are predicted at some locations. Therefore, care will need to be exercised if earthworks are completed to support the development of this area in the future to ensure flood impacts are minimised during events larger than the 1% AEP flood.

Therefore, the outcomes of the assessment shows that future development may have small localised adverse impacts on flood behaviour (i.e., increases in flood discharges and levels). However, flooding across the broader catchment is not predicted to be significantly impacted. Care will need to be exercised if filling is proposed as part of any future development to ensure flood function is maintained and existing flood behaviour is not exacerbated.

11 CONCLUSION

This report documents the outcomes of investigations completed to quantify flood behaviour across the Pambula River, Pamula Lake and Yowaka River catchment. It provides information on design flood discharges, levels, depths and velocities as well as hydraulic and flood hazard categories for a range of design floods.

Flood behaviour across the catchment was defined using two computer models that were developed specifically for the study:

- A hydrologic model of the catchment was developed using the XP-RAFTS software. The hydrologic model was used to simulate the transformation of rainfall into runoff and generate discharge hydrographs at various locations across the catchment.
- A hydraulic computer model of the river system and floodplain was developed using the TUFLOW software. TUFLOW is a two-dimensional hydraulic software package that takes the discharges hydrographs produced by the hydrologic model and simulates how that flow would move and be distributed across the catchment. It can be used to produce a range of important flood information including floodwater depths and velocities.

The XP-RAFTS and TUFLOW models were calibrated using historic rainfall and stream flow records along with surveyed flood marks and reported descriptions of flood behaviour that were provided by the community. The floods that were selected for calibration include events that occurred in 1971, 1985, 2011, 2012 and 2016. The outcomes of the calibration showed that the computer models were producing reliable reproductions of each historic flood.

The calibrated models were used to simulate the design 10%, 5%, 2%, 1%, 0.5% and 0.2% AEP floods based upon the 2019 version of Australian Rainfall and Runoff (Geoscience Australia). The Probable Maximum Flood (PMF) was also simulated. The following conclusions can be drawn from the results of the investigation:

- Flooding across much of the upper catchment is mostly contained near the main watercourses owing to the “incised” nature of the floodplain in these areas. More extensive inundation is predicted across parts of the lower catchment where wider floodplains combined with major topographic “constrictions” combine to create a series of “bathtubs”. The most significant “bathtubs” are located south of Pambula as well as at Griegs Flat.
- Flooding across the catchment can occur from a variety of different storm and rainfall durations. The worst-case flooding typically occurs as a result of rainfall of at least 12 hours in duration.
- The catchment is traversed by several important transportation routes. The results of the flood simulations show that Nethercote Road and the Princes Highway are predicted to be cut by floodwaters in events as frequent as the 10% AEP flood. Blockage of major bridges and culverts can also result in more frequent overtopping of

major roadways which highlights the importance of routine maintenance on this infrastructure, particularly immediately after a flood.

- While most properties and facilities are located outside of the floodplain, some properties have a greater flood exposure. In particular, the Colonial Motor Inn and Idlewilde Motor Inn at Pambula are predicted to be exposed to a significant hazard during the PMF and access would also be cut. It is recommended that discussions are completed with the owners of each facility to highlight the significant hazard that could occur during the PMF and encourage the preparation of a "flood safe plan" that would promote early evacuation of staff and occupants during very large Pambula River floods.
- The results of additional climate change simulations indicate that should both rainfall intensity and sea level continue to increase as projected, it would produce a notable increase in flood risk across all sections of the catchment. However, the area of the catchment located east of the Princes Highway would be most significantly impacted (as this area can be impacted by both sea level rise and increases in rainfall intensity).
- Flood planning category constraint mapping prepared as part of the study suggests that the land use zones defined in the Bega Valley Local Environmental Plan (LEP) 2013 are broadly compatible with the flood risk. However, there are vacant parcels of land that at South Pambula that are zoned for industrial and residential uses that are more significantly constrained by flooding. Therefore, care will need to be exercised if these areas are developed in the future to ensure the development is compatible with the flood hazard and floodway and flood storage areas are preserved.

12 REFERENCES

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APPENDIX A
COMMUNITY CONSULTATION

Pambula River, Pambula Lake and Yowaka River Flood Study

Community Questionnaire

CONTACT DETAILS

Please provide your contact details in case we need to contact you for additional information. This information will remain confidential at all times and will not be published.

Name: _____

Street Address: _____

Lot/DP (if known)_____or Rates Assessment Number:_____

Phone No. _____

Email: _____

1) What type of property do you live in / own?

- ☐ Residential
- ☐ Commercial
- ☐ Industrial
- ☐ Vacant Land
- ☐ Other (Please specify:_____)

2) What is the occupier status of this property?

- ☐ Owner occupied
- ☐ Rental property
- ☐ Business
- ☐ Other (Please specify:_____)

3) How long have you lived /worked in the area?

(a) At your current address? _____

(b) In the catchment area? _____

4) Has your property ever been affected by flooding?

- ☐ Yes
- ☐ No (If you answered No, please go to Question 9)

5) How was your property affected by flooding?

- ☐ Roadway was cut by water
- ☐ My front/backyard was flooded
- ☐ My garage was flooded
- ☐ My house was flooded
- ☐ Other (Please specify:_____)

6) Are you interested in being part of Councils Floodplain Focus Group that will help guide this and future studies? Further information can be found here: https://www.begavalley.nsw.gov.au/cp_themes/default/page.asp?p=DOC-GKM-01-85-66

☐ Yes ☐ No

7) Can you provide additional information on these past floods?

Year of flood(s)	☐ 1971 ☐ 2011 ☐ 1985 ☐ 2012 ☐ 1989 ☐ 2016 ☐ Other (_____)	☐ 1971 ☐ 2011 ☐ 1985 ☐ 2012 ☐ 1989 ☐ 2016 ☐ Other (_____)	☐ 1971 ☐ 2011 ☐ 1985 ☐ 2012 ☐ 1989 ☐ 2016 ☐ Other (_____)
Month of flood			
Approximate time of flood			
Flood depth / height & location			
How confident are you with the height / depth of the flood?	☐ High (exact) ☐ Medium (within 10cm) ☐ Low (within 50cm)	☐ High (exact) ☐ Medium (within 10cm) ☐ Low (within 50cm)	☐ High (exact) ☐ Medium (within 10cm) ☐ Low (within 50cm)

8) Do you have any photographs or videos of these floods?

☐ Yes ☐ No

If you answered 'Yes', can you provide a copy of these photos/videos to assist with the computer flood model calibration? ☐ Yes ☐ No

Are you happy to allow your images to be used for the final report or publicity purposes by Council and its consultant? ☐ Yes ☐ No

9) If you have identified flood marks of use for the flood study and model calibration, are you happy for Council, it's consultant or sub-consultant surveyor, access to your property to capture the flood mark level?

☐ Yes ☐ No

10) Was your property damaged by the floodwaters?

☐ Yes ☐ No

If 'Yes', please provide details:

_____

_____

_____

11) Do you have any suggestions on ways of reducing the flooding problems?

_____

_____

_____

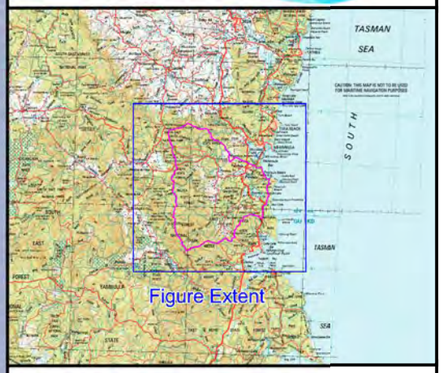
12) Do you have any other comments, suggestions or information that you think may assist the study?

_____

_____

_____

bega valley shire council



Myrtle Mountain
Tura Beach
Merimbula
Pambula River
Seven Mile Creek
Wyndham
MOUNT DARRAGH ROAD
Burtons Creek
Pambula River
Pambula
Pambula Beach
South Pambula
Back Creek
Lochiel
Pambula Lake
Pacific Ocean
Broadwater
NETHERCOTE ROAD
Yowaka River
Yowaka River
BACK CREEK ROAD
Old Hut Creek
Burragate
Nethercote
PRINCES HIGHWAY
Eden
Towamba

LEGEND

- Catchment Boundary
- Watercourse
- Major Road

Questionnaire Responses Locations
Has your property ever been affected by flooding?

- Yes
- No

Notes:
Aerial photograph: Google Satellite 2019

N
W E
S

Scale 1:100,000 (at A3)

0 2.5 5.0
Km

Figure A1:
Spatial Distribution of Questionnaire Responses

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Fig A1 Community Questionnare.wor

Community Questionnaire Responses - Pambula River, Pambula Lake, Yowaka River Flood Study

#	Property Type	Occupier Status	How long have your lived in area?		Has your property ever been affected by flooding	How was your property affected by flooding?					Are you interested in being part of Councils Floodplain Focus Group that will help guide this and future studies?	Can you provide additional information on these past floods					Photos/Videos			If you have identified flood marks of use for the flood study and model calibration, are you happy for Council, it's consultant or sub-consultant surveyor, access to your property to capture the flood mark level?	Was your property damaged by floodwaters, if yes please provide details	Do you have any suggestions on ways of reducing the flooding problems?	Do you have any other comments, suggestions or information that you think may assist the study?
			Current Address (years)	In the catchment area? (years)		Roadway was cut by water	My front/back yard was flooded	My garage was flooded	My house was flooded	Other		Year of flood(s)	Month of flood	Approximate time of flood	Flood depth/height & location	How confident are you with height/ depth of the flood?	Do you have any Photographs or Videos of these floods	If you answered "Yes" can you provide a copy of these photos/videos to assist with the computer flood model calibration?	Are you happy to allow your images to be used for the final report or publicity purposes by Council and its consultant?				
1	Other	Owner Occupied	20		Yes					Harts Ck Flats (Bridge Lake)	Yes	2011, 2012, 2016					No			Yes, only garage and garden sheds	No	Work with not against nature change view of flooding from negative to positive. Retain water in landscape vs engineering to allow the water to escape	Importance of vegetation esp. watercourses drainage line recognition of likely extreme events more frequent occurrence including fire followed by flood.
2	Residential	Owner Occupied	9	9	No						No									No	No		No
3	Vacant Land	Owner Occupied	19	48	No															Yes	No	No	No
4	Residential	Owner Occupied	19		No																		
5	Residential	Owner Occupied	5	5	No															Yes	No	We are on a streamline, more vegetation in the gully has reduced run off plus depth of flowing water.	
6	Residential	Owner Occupied	12	12	No															Yes	No		
7	Residential	Owner Occupied	15		No						No									No	No	Clean out all rivers and wetlands at Pambula	trees on wetlands they hold off water back. Flow will come up to the town as it did years ago
8	Residential	Owner Occupied	13	26	No															Yes	No		
9	Other	Owner Occupied	11	11	No															No	No		Nethercote Rd has one low spot that is subject to inundation when the Yowaka floods. This spot is about 700m from the highway immediately before the road diverges from the riverside. About twenty families are stranded when this happens. It would be simple to raise and floodproof the road whenever roadworks are next undertaken.
10	Other	Owner Occupied	8		Yes	Yes					Yes	2011, 2012, 2016	2011, March 2012, do not recall 2016, do not recall	2011, 8pm	Unknown height Pambula River		Yes	Yes	Yes		No		
11	Other	Owner Occupied	5		No															Yes	No	I think that there needs to more clean ups. I know that there hasn't been a decent flood in a long time. I'm concerned the next decent flood what the Pambula river will wash up. While the levels are low should be getting in there and giving a good tidy up of rotten trees/ dead grass/ limbs and branches etc. Give the river a bit of talk and identifying hazards now.	
12	Other	Owner Occupied	18	45	Yes					Causeway flooded and paddocks near river, fences damaged. Pump damaged	No						Yes						
13	Residential	Owner Occupied	1.5	1.5	No																		
14	Residential	Owner Occupied	21	21	No															No	No		There are more questions on the questionnaire than appear here but we have never had any flooding of any type. Even during the wettest rain events the drainage on our property is excellent.
15	Residential	Owner Occupied	11	11	Yes	Yes				Paddocks Flooded	Yes	2012, 2016, 2014	1st March 2012, 6th June 2016	2012, 3pm 2016, 10am		Medium	Yes	Yes	Yes	Yes	Yes, Fencing washed away. Lost part of hay crop ready to bale. Some areas of erosion	Not unless you can change the rainfall and tides or build a big dam	We have a fair few photos. I can upload to a Dropbox or similar if requested. Also talk to Jack Gordon who is now resident at bimbimbi as he was long time resident at Greigs Flat
16	Residential	Owner Occupied	6	6	No															No	No		
17	Residential	Owner Occupied	3.5	3.5	Yes		Yes				No	2016	Jan	Late January taking months to recede	1m	Medium	Yes	Yes	Yes	Yes	No	Drainage culvert north of causeway on Oaklands Road just past Bega street should be cleared and maintained to allow flood waters to pass through more quickly to Pambula flats.	No
18	Residential	Owner Occupied	1	1	No																		
19	Other	Owner Occupied	15	36	Yes	Yes				Land between Nethercote Rd and Yowaka River	No	1985, mid 1990s, 1989	Autumn, December	Early morning, high tide	Debris 2m, water just below Yowaka Deck	High	No			No	No	Drainage lines - gullies kept grassed minimal soil disturbance	
20	Residential	Owner Occupied	26	26	No															No	No		
21	Residential	Owner Occupied	0.5																				

APPENDIX B
XP-RAFTS MODEL INPUTS

Subcatchment ID	Area (ha)	Total Upstream Area (ha)	Slope (%)	Impervious Prop (%)	Main Stream Length (m)	Average Stream Velocity (m/s)	Lag (mins)
1.01	320.5	320.5	11.5	0.0	2759	3.9	11.9
1.02	15.4	411.8	14.2	0.0	345	4.8	1.2
1.03	17.4	570.9	8.6	0.1	509	4.3	2.0
1.04	86.8	811.9	7.6	1.9	771	3.5	3.7
1.05	71.7	1041.0	4.4	1.7	843	4.4	3.2
1.06	21.3	1062.3	4.9	5.0	741	4.8	2.6
1.07	44.5	1280.4	4.9	2.0	688	5.3	2.2
1.08	22.2	1414.7	6.4	3.1	450	4.2	1.8
1.09	40.8	1455.5	4.2	2.6	729	4.0	3.0
1.10	56.8	2458.6	3.6	3.2	1158	4.6	4.2
1.11	118.0	2935.8	6.7	3.1	1592	4.0	6.7
1.12	219.5	3385.4	2.0	2.9	3079	4.0	12.9
1.13	31.1	6955.8	1.7	6.9	715	4.9	2.4
1.14	60.5	7253.5	1.8	5.6	1851	4.6	6.7
1.15	12.1	7265.6	6.8	2.3	145	3.5	0.7
1.16	22.9	7398.3	6.4	4.9	544	5.5	1.7
1.17	209.5	7985.2	2.4	3.0	3204	6.2	8.7
1.18	76.5	8592.3	3.8	1.3	482	3.1	2.6
1.19	18.5	8732.9	1.7	13.3	544	4.9	1.8
1.20	64.1	10643.7	2.3	2.8	887	4.3	3.4
1.21	60.2	10703.9	2.2	7.0	1283	4.5	4.7
1.22	47.3	11474.9	1.9	6.4	1087	3.9	4.6
1.23	35.0	11665.9	4.1	6.0	750	4.5	2.8
1.24	3.5	11669.4	7.2	9.7	187	4.2	0.7
1.25	15.2	11726.8	0.5	11.5	948	4.6	3.5
1.26	8.8	11853.2	0.3	14.1	705	3.8	3.1
1.27	10.9	12015.5	0.0	20.2	1162	2.9	6.7
1.28	28.0	12043.5	0.2	8.9	1257	1.4	14.8
1.29	22.7	12754.6	0.2	9.7	686	1.1	10.5
1.30	4.1	12887.2	0.3	47.2	379	0.4	16.4
1.31	31.8	14023.6	0.5	42.2	990	1.2	13.4
1.32	7.5	14035.6	9.2	22.3	122	2.3	0.9
1.33	58.3	27945.7	0.0	40.5	1208	2.6	7.7
1.34	63.2	28008.9	0.6	71.9	922	0.8	19.6
1.35	32.8	29717.1	1.6	54.3	966	0.8	20.3
1.36	18.5	29781.4	1.3	77.1	1051	2.2	7.8
1.37	9.2	29825.6	1.7	86.5	555	2.4	3.9
1.38	13.1	29883.0	5.9	66.7	584	2.5	3.9
1.39	67.8	30118.7	1.6	36.6	1470	2.4	10.4
1.40	139.1	30490.7	1.8	38.0	247	1.1	3.7
2.01	75.9	75.9	11.9	0.0	2243	2.8	13.1
3.01	141.6	141.6	11.3	0.0	2678	3.3	13.3
4.01	154.3	154.3	9.2	1.3	2691	3.5	12.8
5.01	157.4	157.4	10.7	0.0	2665	3.3	13.6
6.01	173.6	173.6	5.7	1.8	3651	3.3	18.5
7.01	112.0	112.0	4.8	0.0	3324	2.7	20.8
8.01	343.6	343.6	5.1	0.0	4208	3.6	19.3
8.02	108.5	645.1	5.1	0.0	1582	3.4	7.9
8.03	0.9	646.0	11.3	0.0	69	4.3	0.3
8.04	7.9	918.9	6.5	6.4	327	3.9	1.4
8.05	27.5	946.3	3.1	5.3	985	4.4	3.7
9.01	192.9	192.9	6.9	0.0	3438	3.4	17.0
10.01	109.2	109.2	7.3	0.0	2422	3.5	11.4
10.02	1.1	265.0	14.9	0.0	66	3.2	0.3

Subcatchment ID	Area (ha)	Total Upstream Area (ha)	Slope (%)	Impervious Prop (%)	Main Stream Length (m)	Average Stream Velocity (m/s)	Lag (mins)
11.01	154.7	154.7	7.9	0.0	2343	3.8	10.3
12.01	122.9	122.9	11.0	0.6	2108	3.1	11.3
12.02	53.6	214.1	4.8	3.5	876	3.4	4.3
12.03	5.6	344.5	8.0	6.6	288	3.5	1.4
13.01	37.6	37.6	14.3	0.6	855	2.2	6.5
14.01	104.0	104.0	7.8	1.1	1929	2.7	11.9
14.02	20.7	124.8	6.5	1.3	230	2.7	1.4
15.01	14.7	14.7	18.2	0.0	611	2.1	4.8
16.01	153.8	153.8	3.7	1.5	2862	2.8	16.9
16.02	76.3	230.1	3.3	2.4	1499	3.2	7.7
17.01	223.0	223.0	6.1	0.0	3094	3.6	14.3
17.02	82.7	504.0	5.0	2.1	1012	3.7	4.6
17.03	44.6	644.7	5.2	2.8	842	3.8	3.7
17.04	33.6	941.4	7.6	2.0	406	4.5	1.5
17.05	165.0	1106.3	5.0	1.6	1071	3.6	5.0
17.06	46.9	1390.3	4.8	2.9	955	4.7	3.4
17.07	51.2	1577.3	4.6	3.3	1088	4.4	4.2
17.08	45.1	2137.1	11.4	2.7	482	5.5	1.5
17.09	48.4	2185.5	5.4	4.6	829	5.4	2.6
17.10	1.8	2363.6	4.5	15.6	150	3.3	0.8
17.11	146.2	3419.6	1.9	3.7	2242	3.9	9.6
17.12	54.3	3473.9	4.4	2.2	394	5.3	1.2
17.13	27.7	3501.6	2.2	6.0	824	4.0	3.4
18.01	198.3	198.3	6.7	1.3	2753	3.7	12.4
19.01	96.1	96.1	5.6	2.1	2822	3.2	14.7
20.01	263.1	263.1	4.6	1.5	3369	3.5	15.8
21.01	214.3	214.3	4.0	1.8	3828	3.3	19.1
21.02	22.8	237.1	7.5	2.9	533	3.5	2.5
22.01	135.8	135.8	6.8	1.1	2342	2.6	14.9
23.01	115.9	115.9	5.6	2.7	2168	2.5	14.5
23.02	110.4	376.2	5.1	3.4	1556	3.4	7.7
23.03	85.8	508.4	4.1	3.6	1351	3.1	7.2
23.04	6.3	514.7	10.2	8.5	214	4.5	0.8
24.01	149.9	149.9	7.1	1.0	2103	2.6	13.3
25.01	46.4	46.4	11.0	0.1	1309	3.5	6.3
26.01	174.3	174.3	4.2	1.5	3044	3.0	17.0
26.02	2.1	176.4	2.9	8.0	133	3.0	0.7
27.01	210.9	210.9	8.1	0.0	2569	3.5	12.3
27.02	209.4	470.7	5.1	1.7	3068	4.3	11.8
27.03	200.6	858.6	2.1	1.9	3069	4.3	12.0
28.01	37.0	37.0	15.0	1.0	1211	2.5	8.1
28.02	13.4	50.4	7.9	4.5	458	2.6	2.9
29.01	187.3	187.3	6.0	1.7	3668	3.4	17.9
30.01	51.1	51.1	6.3	0.0	1166	1.1	17.7
31.01	37.8	37.8	4.4	0.3	799	1.1	12.1
32.01	237.2	237.2	5.3	1.4	3335	3.4	16.2
33.01	109.8	109.8	4.8	1.2	1988	2.6	13.0
34.01	157.7	157.7	6.5	1.3	1941	2.6	12.4
34.02	215.3	373.0	6.2	1.8	1493	3.0	8.2
34.03	4.4	377.4	10.9	4.8	229	4.2	0.9
35.01	111.4	111.4	5.0	1.4	2055	2.7	12.9
35.02	142.5	253.8	2.7	2.1	1612	3.3	8.2
35.03	72.1	337.6	3.3	2.7	636	2.4	4.4
35.04	4.0	341.6	5.9	13.6	194	3.5	0.9

Subcatchment ID	Area (ha)	Total Upstream Area (ha)	Slope (%)	Impervious Prop (%)	Main Stream Length (m)	Average Stream Velocity (m/s)	Lag (mins)
35.05	93.9	530.5	2.6	2.2	1129	2.8	6.7
36.01	11.6	11.6	6.3	0.1	534	1.5	5.9
37.01	95.0	95.0	4.5	1.7	2139	2.4	14.8
38.01	101.4	101.4	3.6	1.9	2492	2.3	18.0
38.02	20.7	122.1	4.0	3.7	315	2.1	2.6
39.01	128.1	128.1	5.9	1.0	1708	2.9	9.9
39.02	69.4	257.8	8.9	1.7	965	3.2	5.1
39.03	37.6	371.4	4.9	3.7	1132	3.8	5.0
39.04	225.9	779.8	3.4	2.1	2673	4.8	9.2
39.05	160.7	995.2	2.2	3.7	1799	3.8	7.8
39.06	65.6	1846.8	2.8	4.0	335	2.7	2.1
40.01	60.3	60.3	17.0	1.1	1563	3.1	8.5
41.01	76.1	76.1	20.1	1.1	1698	3.1	9.2
42.01	182.5	182.5	6.1	1.5	2700	3.0	15.2
43.01	54.8	54.8	6.1	1.5	1382	2.6	9.0
44.01	192.2	192.2	8.8	1.6	2896	3.2	15.0
44.02	187.8	500.8	3.5	2.0	2216	3.6	10.3
44.03	80.3	785.9	2.8	1.7	1046	4.2	4.1
45.01	120.9	120.9	8.7	1.2	2076	2.8	12.2
46.01	204.8	204.8	4.1	1.7	3484	3.1	18.9
47.01	162.0	162.0	5.2	1.8	2802	2.8	16.9
47.02	2.5	224.8	13.8	9.6	127	3.0	0.7
47.03	17.4	242.2	5.6	3.7	223	3.1	1.2
47.04	159.8	514.3	3.4	2.5	2377	3.5	11.4
47.05	89.4	660.9	4.4	2.9	731	2.8	4.4
48.01	60.3	60.3	4.6	3.1	1723	2.0	14.3
49.01	86.2	86.2	5.5	1.7	2130	2.2	16.0
49.02	11.0	97.2	6.1	8.3	319	2.4	2.2
49.03	1.1	98.3	12.6	19.6	51	3.3	0.3
50.01	14.1	14.1	6.3	5.0	583	1.2	8.4
51.01	57.1	57.1	7.7	1.7	1490	2.7	9.1
52.01	24.3	24.3	8.5	0.0	1159	2.6	7.4
52.02	38.7	63.0	4.1	0.8	685	2.0	5.8
53.01	98.1	98.1	2.9	0.1	1420	1.9	12.2
54.01	36.2	36.2	4.3	0.6	1164	1.6	12.2
54.02	15.7	51.9	3.2	4.5	406	1.4	4.8
54.03	6.0	57.9	3.7	9.2	174	1.4	2.0
55.01	42.2	42.2	8.0	1.1	1139	2.9	6.6
56.01	57.8	57.8	10.0	1.0	1255	2.7	7.9
56.02	41.4	99.2	4.6	2.5	820	2.7	5.1
56.03	18.4	117.5	2.0	3.2	508	2.4	3.5
57.01	49.9	49.9	8.1	2.8	1384	3.0	7.6
57.02	101.6	151.5	1.7	3.9	2117	2.6	13.7
58.01	100.5	100.5	5.6	1.1	1796	2.8	10.7
58.02	46.4	146.9	4.0	2.9	632	2.5	4.3
58.03	22.9	212.6	1.3	5.6	873	2.4	6.1
58.04	20.2	354.4	1.2	6.5	224	1.3	2.8
58.05	34.6	389.5	0.3	6.9	1260	1.9	11.1
58.06	49.7	572.8	0.5	3.7	797	1.8	7.4
58.07	80.0	658.8	1.2	4.9	1133	1.5	13.0
59.01	42.8	42.8	6.3	0.8	1398	2.0	11.4
60.01	37.9	37.9	8.7	0.6	1090	2.0	9.0
60.02	10.9	48.8	4.6	6.5	498	2.0	4.2
60.03	32.8	114.6	1.5	7.0	836	1.7	8.0

Subcatchment ID	Area (ha)	Total Upstream Area (ha)	Slope (%)	Impervious Prop (%)	Main Stream Length (m)	Average Stream Velocity (m/s)	Lag (mins)
61.01	33.0	33.0	5.1	0.1	966	1.1	14.6
62.01	7.0	7.0	1.9	12.4	730	1.1	11.1
63.01	0.5	0.5	4.6	6.1	200	1.9	1.7
64.01	20.7	20.7	5.8	1.7	1071	1.1	16.2
64.02	28.1	121.7	1.1	5.9	327	1.6	3.4
65.01	11.8	11.8	3.6	7.7	900	1.1	13.6
66.01	13.9	13.9	11.0	0.6	539	1.0	8.7
66.02	41.4	57.5	3.6	2.6	649	1.6	6.9
67.01	2.2	2.2	11.3	34.9	281	1.1	4.3
68.01	3.6	3.6	14.9	21.3	291	1.1	4.4
69.01	3.5	3.5	14.4	30.0	320	1.1	4.8
69.02	2.8	6.3	7.7	21.3	167	1.1	2.4
70.01	2.7	2.7	12.9	23.6	253	1.1	3.8
71.01	2.9	2.9	14.2	31.4	347	1.1	5.3
72.01	3.4	3.4	13.9	26.2	330	1.1	5.0
73.01	2.5	2.5	13.1	13.3	253	1.1	3.8
74.01	29.6	29.6	4.4	0.1	1117	1.7	10.8
75.01	83.1	83.1	0.0	2.9	2222	1.0	37.0
75.02	13.8	96.9	0.2	2.2	474	0.5	17.0
76.01	20.6	20.6	5.1	0.2	729	1.0	11.8
76.02	11.0	31.7	0.0	3.9	500	0.5	16.6
77.01	50.5	50.5	6.3	4.7	1125	1.8	10.7
77.02	60.3	110.8	6.1	4.7	632	2.4	4.3
77.03	115.3	226.1	4.1	3.2	1064	2.7	6.5
77.04	25.5	251.6	3.7	4.9	452	2.4	3.2
77.05	16.3	267.9	1.9	11.0	511	2.3	3.7
77.06	3.7	271.5	0.7	14.7	286	1.9	2.6
77.07	7.4	547.6	0.5	12.0	241	1.0	4.0
77.08	21.8	569.4	0.2	3.8	128	1.3	1.6
77.09	3.3	574.5	0.0	16.6	142	1.1	2.2
77.10	5.5	585.7	0.2	40.2	452	1.0	7.8
77.11	7.9	672.2	0.0	7.7	535	0.6	14.8
77.12	33.7	772.6	0.2	3.2	824	0.6	21.5
77.13	18.0	992.9	0.2	3.1	737	0.3	35.5
78.01	48.8	48.8	4.6	4.7	1435	2.3	10.5
78.02	53.5	145.6	0.2	6.3	1266	1.2	18.0
79.01	30.4	30.4	6.4	0.7	971	1.1	14.7
80.01	12.9	12.9	5.6	1.9	570	1.1	8.6
81.01	31.3	31.3	5.8	2.2	1029	2.0	8.5
81.02	3.1	34.4	4.3	8.1	225	1.9	2.0
81.03	2.1	67.7	3.9	6.8	243	1.9	2.2
81.04	3.1	120.0	1.4	12.5	239	0.8	5.3
82.01	5.7	5.7	15.2	4.7	380	1.1	5.8
82.02	21.7	27.4	6.3	2.0	428	1.1	6.5
82.03	3.8	31.2	4.5	8.6	225	1.1	3.5
83.01	19.0	19.0	8.1	10.2	694	1.1	10.5
83.02	5.6	36.4	4.5	26.2	243	1.1	3.7
83.03	3.2	40.5	3.1	17.2	276	1.1	4.2
84.01	3.1	3.1	8.9	25.1	495	1.1	7.5
84.02	2.2	11.9	5.2	35.7	168	1.1	2.6
85.01	6.6	6.6	9.6	16.8	465	1.1	7.0
86.01	0.9	0.9	8.0	41.2	218	1.1	3.3
87.01	4.7	4.7	7.4	29.4	413	1.1	6.3
87.02	2.2	8.8	7.9	11.7	123	1.2	1.8

Subcatchment ID	Area (ha)	Total Upstream Area (ha)	Slope (%)	Impervious Prop (%)	Main Stream Length (m)	Average Stream Velocity (m/s)	Lag (mins)
88.01	1.9	1.9	12.2	9.1	224	1.1	3.4
89.01	3.0	3.0	2.8	17.5	355	2.3	2.6
90.01	1.9	1.9	3.6	25.3	159	1.1	2.4
91.01	5.8	5.8	1.2	35.1	424	1.1	6.4
92.01	11.8	11.8	2.7	1.9	605	0.8	12.8
92.02	34.3	49.3	2.6	4.8	581	1.1	8.6
92.03	2.6	51.9	3.6	42.3	122	1.6	1.2
92.04	10.1	72.5	1.6	25.7	312	1.3	4.1
93.01	3.1	3.1	5.6	5.1	339	1.1	5.1
94.01	3.2	3.2	8.4	28.2	492	1.1	7.5
95.01	3.9	3.9	6.3	31.3	397	1.1	6.0
96.01	1.6	1.6	8.2	35.4	193	1.1	2.9
97.01	1.8	1.8	8.5	37.0	173	1.1	2.6
98.01	6.1	6.1	3.6	14.3	585	1.1	8.9
99.01	46.5	46.5	2.7	1.4	1040	1.1	15.6
99.02	10.1	60.2	2.9	17.8	270	1.5	2.9
100.01	1.0	1.0	5.6	22.7	205	1.1	3.1
101.01	0.7	0.7	7.8	29.0	181	1.1	2.7
102.01	1.2	1.2	4.0	31.5	176	1.1	2.7
103.01	0.7	0.7	7.3	51.4	156	1.1	2.4
104.01	2.4	2.4	6.0	31.0	277	1.1	4.2
104.02	3.5	6.5	6.2	23.1	116	1.1	1.8
105.01	0.5	0.5	7.6	54.7	92	1.1	1.4
106.01	119.3	119.3	1.5	0.5	2071	1.5	22.6
106.02	8.0	169.0	0.2	7.3	149	0.6	4.2
107.01	41.7	41.7	5.2	0.4	1356	1.6	14.4
108.01	31.5	31.5	1.8	3.0	1076	1.3	13.6
108.02	1.9	33.4	0.0	7.6	287	0.6	7.6
109.01	57.4	57.4	6.5	0.0	1144	2.0	9.7
110.01	32.0	32.0	7.0	0.0	967	1.7	9.3
111.01	12.6	12.6	23.3	2.5	429	1.7	4.3
112.01	9.6	9.6	23.7	0.0	365	1.1	5.5
113.01	4.5	4.5	25.8	2.0	266	1.1	4.0
114.01	198.8	198.8	5.7	1.5	2872	3.3	14.3
114.02	9.5	294.5	10.0	5.3	371	3.9	1.6
114.03	106.4	572.4	4.0	1.8	1325	4.0	5.5
114.04	410.1	1100.2	2.0	1.9	4199	3.8	18.6
114.05	3.7	1467.7	4.2	8.4	199	3.1	1.1
114.06	93.3	3142.2	3.8	2.3	1311	5.8	3.8
114.07	8.3	3409.3	10.3	3.3	171	5.2	0.5
114.08	134.1	3701.9	2.7	2.8	1775	4.3	6.8
114.09	90.2	3792.1	3.5	2.3	906	5.1	2.9
114.10	62.0	3990.7	3.9	2.4	695	4.6	2.5
114.11	14.9	4257.1	4.9	4.8	183	4.9	0.6
114.12	60.2	4317.3	2.4	4.5	1126	4.7	4.0
114.13	297.2	4988.8	2.0	2.2	3853	5.3	12.1
114.14	160.7	5232.2	1.8	3.0	2434	4.3	9.4
114.15	25.2	5257.4	5.4	2.8	254	3.7	1.2
114.16	79.9	10961.8	4.2	2.6	663	4.5	2.5
114.17	25.1	11728.9	4.7	4.4	594	6.7	1.5
114.18	19.5	11949.2	4.7	3.3	332	5.9	0.9
114.19	109.0	12058.2	2.0	3.3	1105	5.1	3.6
114.20	14.5	12193.1	1.1	8.3	520	4.3	2.0
114.21	74.1	13269.7	0.4	6.2	1635	2.5	11.1

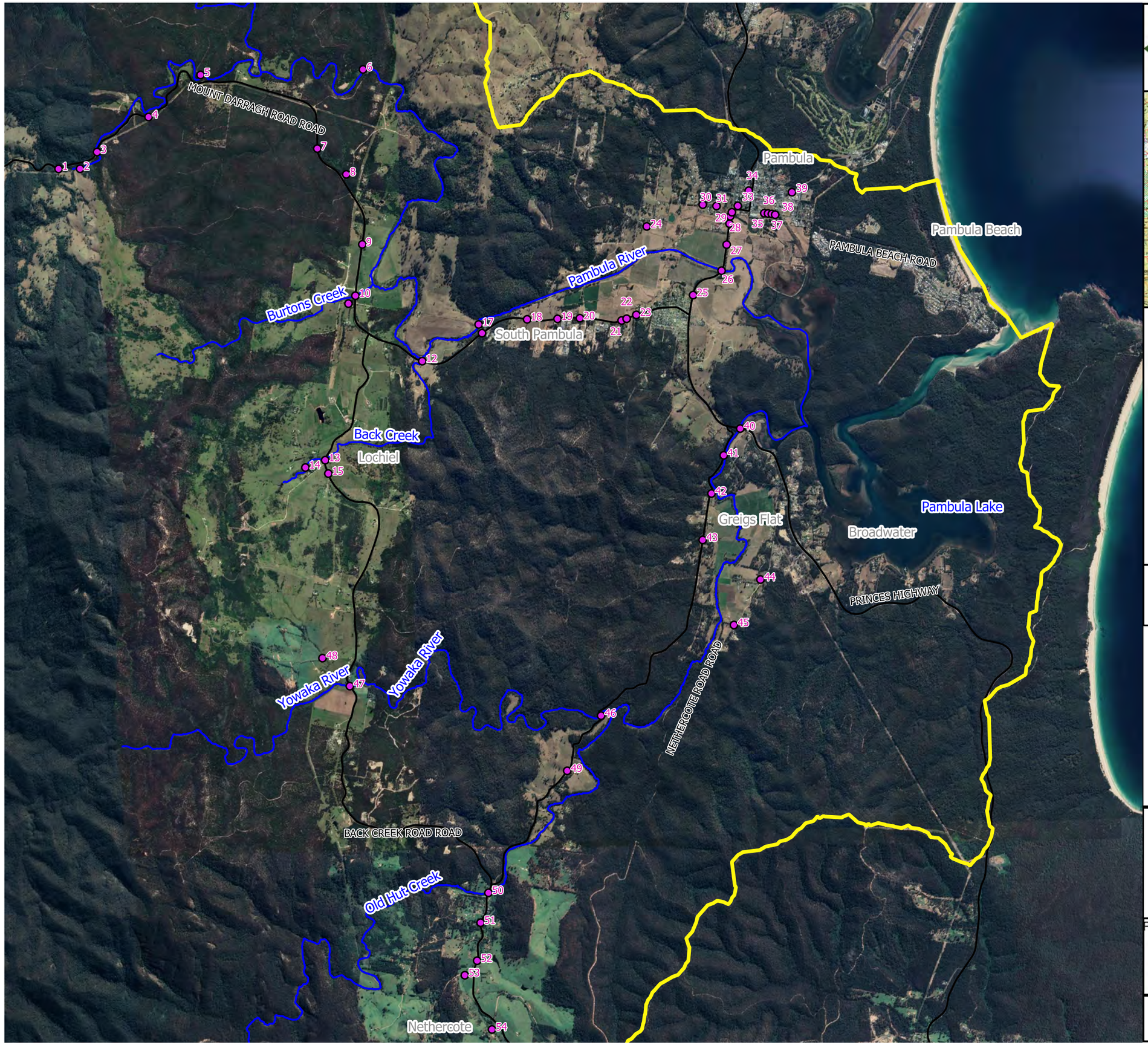
Subcatchment ID	Area (ha)	Total Upstream Area (ha)	Slope (%)	Impervious Prop (%)	Main Stream Length (m)	Average Stream Velocity (m/s)	Lag (mins)
114.22	5.8	13410.7	2.9	12.6	248	1.1	3.7
114.23	1.4	13458.0	7.4	25.5	93	2.4	0.7
114.24	49.7	13581.0	2.6	9.9	1009	3.6	4.7
114.25	59.7	13814.9	1.6	24.8	1563	3.0	8.6
115.01	86.2	86.2	6.6	0.0	2280	3.1	12.2
116.01	171.5	171.5	6.1	0.8	2703	3.4	13.1
117.01	117.7	117.7	6.4	1.4	1880	3.0	10.4
118.01	363.7	363.7	3.3	1.5	5651	3.7	25.6
119.01	350.3	350.3	6.2	1.1	4217	3.6	19.6
119.02	51.7	526.4	7.1	2.3	864	4.5	3.2
119.03	64.8	1360.1	4.3	2.8	1006	4.3	3.9
119.04	92.3	1581.3	3.1	2.9	1611	4.3	6.2
120.01	124.4	124.4	7.1	1.4	2062	3.2	10.7
121.01	168.1	168.1	10.9	1.3	2829	4.0	11.9
121.02	66.2	441.3	6.0	2.2	722	4.2	2.9
121.03	26.0	570.8	8.1	2.8	612	4.6	2.2
121.04	31.1	768.9	5.9	2.9	757	4.5	2.8
122.01	207.0	207.0	9.9	1.2	2445	3.5	11.8
123.01	103.5	103.5	9.2	1.4	2147	3.3	11.0
124.01	167.0	167.0	6.0	1.7	3203	3.4	15.9
125.01	129.0	129.0	8.6	1.3	2286	3.9	9.7
126.01	258.8	258.8	5.6	1.4	3883	3.8	16.9
127.01	158.5	158.5	7.7	1.7	2941	3.3	14.9
128.01	136.6	136.6	5.5	3.3	3039	2.9	17.4
129.01	106.8	106.8	5.6	2.1	2546	2.7	15.5
129.02	27.2	196.2	5.1	1.8	351	2.8	2.1
129.03	55.3	251.5	3.4	4.8	457	2.7	2.8
130.01	62.1	62.1	4.9	1.4	1509	1.9	13.2
131.01	43.0	43.0	13.1	0.2	1011	2.6	6.4
131.02	203.2	246.2	3.3	2.5	1785	2.5	11.8
131.03	128.1	374.3	3.2	2.8	1195	3.1	6.4
132.01	82.8	82.8	9.0	0.9	1523	2.7	9.3
133.01	248.8	248.8	11.6	0.6	3219	3.8	14.3
133.02	97.3	528.8	8.9	1.9	884	3.6	4.1
133.03	105.8	893.6	5.2	2.0	1391	4.8	4.8
133.04	30.4	1005.4	8.1	3.0	618	4.3	2.4
133.05	161.3	1269.5	5.5	2.0	1173	3.7	5.3
133.06	5.8	1275.3	17.2	0.9	38	4.2	0.2
133.07	207.5	2473.6	3.9	2.1	1414	4.0	5.9
133.08	18.6	2492.2	5.0	3.6	400	5.2	1.3
133.09	153.3	2961.1	4.3	2.6	2222	5.4	6.9
133.10	105.9	3251.5	2.9	3.1	1567	4.5	5.9
133.11	345.8	3778.3	2.1	2.0	3616	4.3	14.1
133.12	46.6	5167.9	3.5	6.1	727	4.5	2.7
133.13	225.0	5523.7	1.4	2.5	2212	4.7	7.9
133.14	36.0	5624.5	1.7	7.2	1020	4.9	3.5
134.01	182.6	182.6	11.7	1.5	2918	4.4	11.1
135.01	259.0	259.0	6.5	1.3	3093	3.3	15.8
136.01	81.4	81.4	11.4	1.6	2039	3.9	8.8
137.01	102.8	102.8	9.7	1.9	2331	3.5	11.0
138.01	484.0	484.0	4.4	1.2	3637	3.4	17.9
138.02	110.5	594.4	3.2	2.2	1768	3.9	7.5
138.03	38.2	990.7	4.7	3.2	858	4.5	3.2
139.01	175.6	175.6	6.1	1.5	2072	3.1	11.3

Subcatchment ID	Area (ha)	Total Upstream Area (ha)	Slope (%)	Impervious Prop (%)	Main Stream Length (m)	Average Stream Velocity (m/s)	Lag (mins)
139.02	168.7	358.1	3.4	1.6	1002	3.1	5.4
140.01	13.9	13.9	28.3	0.0	498	2.1	3.9
141.01	244.6	244.6	10.8	1.5	2369	3.4	11.6
141.02	43.8	288.4	7.9	1.6	617	4.2	2.5
142.01	27.2	27.2	12.8	0.0	1239	2.1	9.8
143.01	184.5	184.5	12.9	1.6	2534	4.5	9.3
144.01	181.0	181.0	8.4	1.8	3248	2.9	18.4
145.01	130.9	130.9	7.4	1.6	2528	2.9	14.7
145.02	60.7	389.8	4.5	2.2	1161	3.5	5.5
145.03	113.8	600.2	2.6	2.6	1632	3.4	7.9
145.04	7.0	1166.7	9.5	7.0	114	2.6	0.7
145.05	3.3	1170.0	8.5	9.0	143	4.8	0.5
145.06	41.2	1343.0	3.3	7.5	1042	4.4	4.0
146.01	198.2	198.2	4.4	1.7	2586	2.7	16.0
147.01	96.6	96.6	6.5	2.1	2328	2.5	15.2
148.01	287.6	287.6	3.7	3.0	3052	2.9	17.6
148.02	21.1	423.0	8.6	6.0	472	3.1	2.5
148.03	19.3	559.4	4.2	6.3	549	3.4	2.7
149.01	114.4	114.4	4.4	3.3	2489	2.4	17.1
150.01	117.1	117.1	3.5	2.6	2981	2.3	21.2
151.01	95.7	95.7	4.7	1.8	2028	2.3	14.4
152.01	36.1	36.1	7.7	3.4	1001	1.1	15.2
153.01	130.9	130.9	7.1	3.5	2453	2.8	14.8
154.01	50.4	50.4	6.5	2.5	1651	2.3	11.9
154.02	14.4	64.8	6.2	5.8	287	2.3	2.1
155.01	249.0	249.0	3.7	1.5	2716	3.0	15.1
155.02	2.8	251.8	6.8	7.1	150	2.8	0.9
155.03	18.8	397.1	6.7	1.9	240	3.1	1.3
155.04	14.3	411.4	7.8	2.2	213	2.9	1.2
155.05	49.7	636.9	1.8	4.4	1385	3.5	6.6
155.06	7.4	742.0	9.8	7.9	392	4.7	1.4
156.01	121.9	121.9	4.0	1.8	2427	2.6	15.7
156.02	4.6	126.4	6.6	5.5	175	2.2	1.3
157.01	89.7	89.7	4.8	1.7	2041	2.7	12.7
158.01	44.7	44.7	5.1	1.4	1563	2.1	12.7
159.01	41.5	41.5	6.9	1.1	1171	2.9	6.6
160.01	91.6	91.6	5.7	1.5	2068	2.8	12.4
160.02	6.1	97.7	7.3	5.4	294	2.5	1.9
161.01	200.9	200.9	4.5	1.4	3037	3.1	16.5
162.01	12.2	12.2	21.8	0.0	587	2.0	4.9
162.02	106.3	118.5	3.7	1.7	1847	2.9	10.5
162.03	1.9	120.4	2.8	14.7	202	2.2	1.5
163.01	19.3	19.3	4.4	2.2	849	1.0	13.5
163.02	42.6	61.9	4.5	2.5	578	1.6	5.9
163.03	156.5	218.5	4.0	2.2	2743	2.8	16.3
163.04	120.5	338.9	3.4	1.5	1515	3.3	7.6
163.05	168.4	810.2	2.5	1.8	1944	3.7	8.8
163.06	34.0	844.2	0.7	5.7	650	2.6	4.1
164.01	302.9	302.9	2.9	1.7	4661	2.9	26.6
165.01	139.2	139.2	2.7	1.9	2746	2.4	19.2
165.02	19.1	158.3	3.0	4.7	653	2.5	4.3
166.01	32.9	32.9	6.2	0.4	976	1.7	9.4
166.02	40.1	73.0	2.0	4.9	800	1.2	11.5
166.03	62.2	135.2	1.3	3.1	1106	1.2	14.9

Subcatchment ID	Area (ha)	Total Upstream Area (ha)	Slope (%)	Impervious Prop (%)	Main Stream Length (m)	Average Stream Velocity (m/s)	Lag (mins)
167.01	24.2	24.2	8.3	0.4	1070	1.1	16.2
167.02	21.7	45.9	3.2	3.8	223	1.7	2.2
168.01	72.8	72.8	6.8	0.2	1661	2.8	9.9
168.02	0.5	73.3	17.2	13.2	50	3.4	0.2
169.01	138.0	138.0	4.6	2.0	1758	2.2	13.1
169.02	17.4	155.4	5.4	5.2	472	2.6	3.0
170.01	18.9	18.9	8.1	11.1	589	1.1	8.9
171.01	23.3	23.3	4.3	6.6	633	1.1	9.5
172.01	13.6	13.6	7.7	5.5	541	1.1	8.2
173.01	27.2	27.2	12.6	0.0	862	2.9	5.0
173.02	179.3	244.5	5.4	3.8	1927	2.7	11.9
173.03	145.3	482.1	4.9	1.4	1422	3.7	6.4
173.04	51.0	533.1	1.5	1.7	1105	2.3	8.1
173.05	25.8	736.0	0.5	68.0	789	0.4	30.4
173.06	63.8	977.7	0.4	80.8	700	0.5	25.2
173.07	12.1	1675.4	0.0	100.0	580	0.2	42.4
174.01	20.7	20.7	16.5	0.0	686	1.7	6.7
175.01	17.3	17.3	6.7	0.0	525	1.4	6.3
176.01	14.7	14.7	15.6	0.0	708	2.4	5.0
176.02	77.7	92.4	7.1	1.8	1777	2.8	10.5
177.01	110.3	110.3	1.2	0.3	2073	0.9	36.4
178.01	57.6	57.6	3.3	0.4	1397	1.2	19.6
179.01	9.1	9.1	2.9	0.1	465	1.1	7.1
180.01	102.6	102.6	1.7	0.0	2271	1.5	25.9
180.02	9.9	112.5	1.7	51.2	267	0.4	10.2
181.01	59.0	59.0	3.8	0.0	1108	1.9	9.7
182.01	6.4	6.4	14.5	0.2	357	1.1	5.4
183.01	72.2	72.2	15.2	1.0	1418	3.1	7.7
183.02	74.2	146.3	5.5	1.9	1146	2.9	6.7
183.03	27.2	267.3	4.0	1.7	357	2.9	2.0
183.04	92.8	435.1	3.1	2.4	1003	3.2	5.3
183.05	17.7	452.7	2.6	5.8	479	2.6	3.0
183.06	63.7	685.5	0.3	88.6	1552	0.6	46.2
184.01	12.2	12.2	13.5	0.0	554	2.2	4.2
184.02	81.6	93.8	5.2	1.6	1817	2.8	10.8
185.01	14.6	14.6	23.3	0.0	743	2.2	5.7
185.02	60.4	74.9	5.7	2.0	1295	2.8	7.8
186.01	32.1	32.1	4.2	3.8	1032	1.1	15.6
187.01	42.4	42.4	5.5	1.1	1128	1.7	10.8
187.02	39.4	81.8	4.0	2.3	444	1.9	3.9
188.01	11.3	11.3	6.3	9.5	597	1.1	9.0
189.01	11.7	11.7	8.9	2.9	454	1.1	6.9
190.01	7.6	7.6	13.8	7.8	394	1.1	6.0
191.01	24.6	24.6	4.9	2.0	536	1.2	7.3
192.01	25.0	25.0	33.1	0.7	303	1.1	4.6
193.01	20.8	20.8	37.1	1.1	330	1.1	5.0
194.01	3.4	3.4	39.3	0.6	336	1.1	5.1
195.01	7.2	7.2	29.7	1.0	427	1.1	6.5
196.01	8.2	8.2	28.0	0.0	376	1.1	5.7
197.01	6.5	6.5	19.2	24.8	234	1.1	3.6
198.01	9.6	9.6	32.2	0.0	375	1.1	5.7
199.01	23.9	23.9	11.7	0.0	497	1.1	7.5
199.02	7.9	31.8	12.9	11.5	86	1.8	0.8
200.01	3.7	3.7	36.8	0.0	365	1.1	5.5

Subcatchment ID	Area (ha)	Total Upstream Area (ha)	Slope (%)	Impervious Prop (%)	Main Stream Length (m)	Average Stream Velocity (m/s)	Lag (mins)
201.01	8.9	8.9	33.5	0.0	462	1.1	7.0
202.01	122.6	122.6	2.7	0.0	2234	1.7	21.5
203.01	12.9	12.9	30.9	0.1	363	1.1	5.5
204.01	8.7	8.7	40.1	1.3	276	1.1	4.2
205.01	11.1	11.1	34.4	4.0	269	1.1	4.1
206.01	2.7	2.7	19.8	32.1	273	1.1	4.1
207.01	9.9	9.9	16.2	32.6	400	1.1	6.1
208.01	16.6	16.6	11.3	3.6	507	1.6	5.2
208.02	5.8	22.4	8.1	38.7	191	1.6	1.9
208.03	18.0	42.9	2.4	26.5	395	0.9	7.1
208.04	59.2	107.3	1.3	4.4	840	0.6	23.4
208.05	35.4	142.7	1.1	0.8	393	0.5	13.7
209.01	2.5	2.5	9.2	38.7	433	1.1	6.6
210.01	5.2	5.2	8.4	26.1	298	1.1	4.5
211.01	5.4	5.4	14.1	18.7	473	1.1	7.2
211.02	0.9	6.3	13.7	28.9	106	1.1	1.6
211.03	16.0	24.6	2.6	15.2	272	1.8	2.5
212.01	2.3	2.3	17.7	47.4	288	1.1	4.4

APPENDIX C
BLOCKAGE CALCULATIONS



bega valley shire council



LEGEND

Hydraulic Structure ID

Notes:
Aerial photograph: Google Satellite 2019

N
W E
S

Scale 1:53,000 (at A3)

0 1.0 2.0

Appendix C
Blockage Calculations

Prepared By:

Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

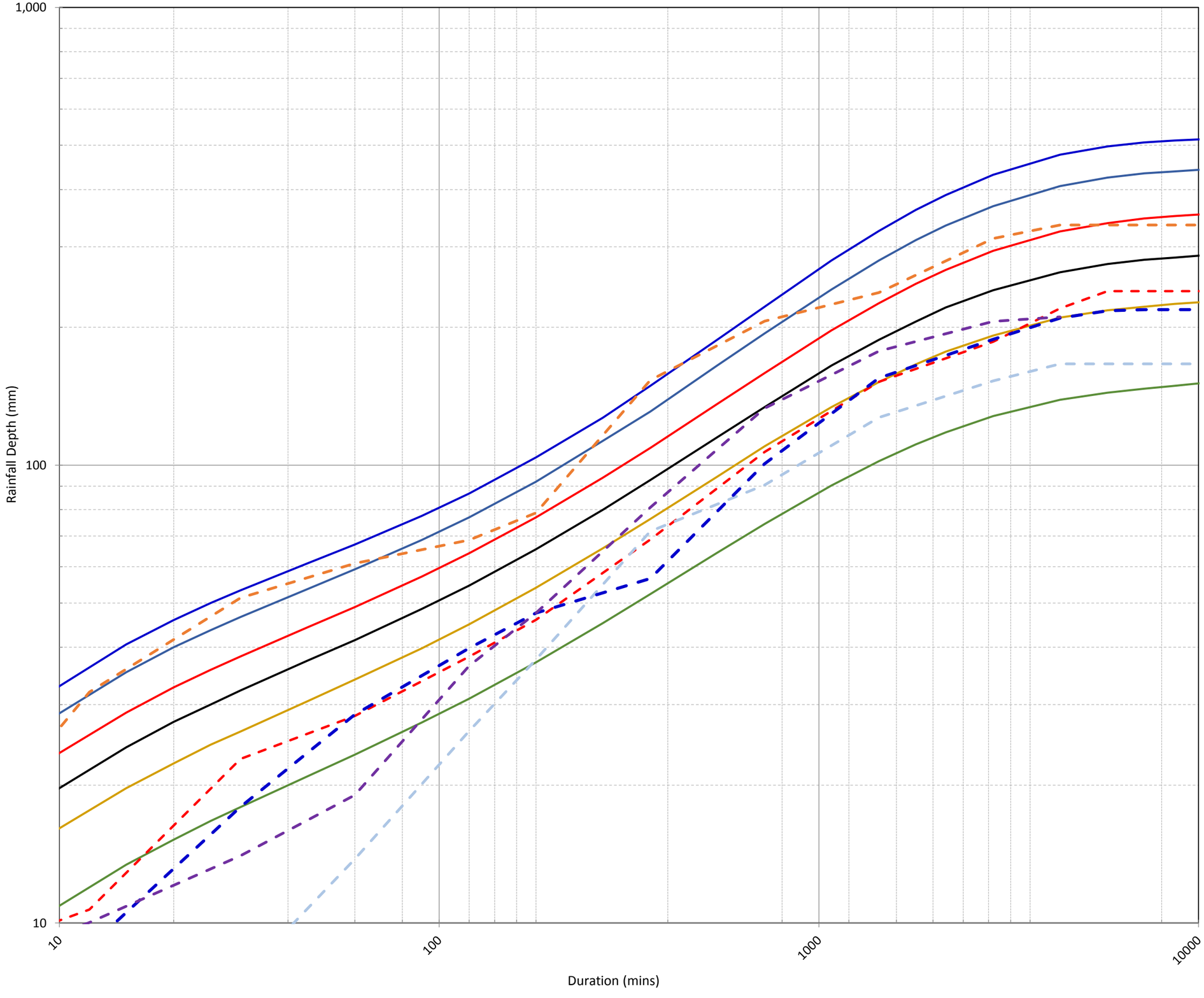
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STRUCTURE BLOCKAGE ASSESSMENT

Structure ID	Roadway	Waterway	Structure Type	Structure Type	Structure Dimensions			Land Use Across Upstream Catchment	Max. L10 (m)	Control Dimension	Main Stream Slope (%)	Debris Availability (L, M, H)	Debris Mobility (L, M, H)	Debris Transportability (L, M, H)	Debris Potential	Debris Potential at Structure	Adjustment for AEP			Design Blockage Level		
					Dia/Width /Span	Height	Cells / Spans										AEP >5%	AEP 5%-0.5%	AEP < 0.5%	AEP >5%	AEP 5%-0.5%	AEP < 0.5%
1	Mount Darragh Rd	Seven Mile Creek	C	Pipe Culvert	2.7	0	1	Dense Trees	3	W<L	0	M	M	L	**MML**	Low	Low	Low	Medium	25%	25%	50%
	Mount Darragh Rd	Seven Mile Creek	C	Pipe Culvert	2.55	0	1	Grass with Scattered Trees	0.8	W>3L	0	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	0%
2	Box Range	Pambula River	C	Pipe Culvert	0.6	0	1	Grass with Scattered Trees	0.8	W<L	0.86	L	M	L	**LML**	Low	Low	Low	Medium	25%	25%	50%
3	Mount Darragh Rd	Pambula River	B	Bridge	32.5	5	3	Dense Trees	3	W>3L	0.86	M	M	L	**MML**	Low	Low	Low	Medium	0%	0%	0%
4	Mount Darragh Rd	Pambula River	C	Pipe Culvert	1.05	0	1	Dense Trees	3	W<L	6.01	M	M	H	**MMH**	Medium	Low	Medium	High	25%	50%	100%
4	Mount Darragh Rd	Pambula River	C	Pipe Culvert	1.05	0	1	Dense Trees	3	L<W<3L	6.01	M	M	H	**MMH**	Medium	Low	Medium	High	0%	10%	20%
5	Chalkhills Road	Pambula River	R	Box Culvert	1.8	0.9	2	Grass with Scattered Trees	0.8	L<W<3L	0.57	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
6	Wolumba Peak Road	Pambula River	R	Box Culvert	3	1.8	3	Dense Trees	3	L<W<3L	0.44	M	M	H	**MMH**	Medium	Low	Medium	High	0%	10%	20%
7	Mount Darragh Rd	Unnamed Creek	R	Box Culvert	3.6	2	1	Dense Trees	3	L<W<3L	1.91	M	M	M	**MMM**	Medium	Low	Medium	High	0%	10%	20%
8	Lochview Farm Road	Unnamed Creek	R	Box Culvert	1.2	0.525	2	Grass with Scattered Trees	0.8	L<W<3L	1.4	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
9	Mount Darragh Rd	Unnamed Creek	R	Box Culvert	3.6	2.1	1	Dense Trees	3	L<W<3L	2.34	M	M	M	**MMM**	Medium	Low	Medium	High	0%	10%	20%
10	Mount Darragh Rd	Burtons Creek	B	Bridge	42.8	9	3	Grass with Scattered Trees	0.8	W>3L	0.73	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	0%
11	Robinsons Road	Unnamed Creek	C	Pipe Culvert	0.45	0	1	Grass with Medium Trees	1.25	W<L	1.24	L	M	M	**LMM**	Low	Low	Low	Medium	25%	25%	50%
12	Mount Darragh Rd	Back Creek	R	Box Culvert	3.6	3.6	3	Grass with Scattered Trees	0.8	W>3L	1.76	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	0%
	Mount Darragh Rd	Back Creek	R	Box Culvert	3.6	2.1	1	Urban	1	W>3L	1.76	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	0%
13	Back Creek Road	Back Creek	R	Box Culvert	2.1	2.1	1	Grass	0.5	W>3L	7.23	L	M	H	**LMH**	Medium	Low	Medium	High	0%	0%	10%
14	Blairlands Road	Back Creek	C	Pipe Culvert	1.2	0	2	Grass with Scattered Trees	0.8	L<W<3L	5.71	L	M	H	**LMH**	Medium	Low	Medium	High	0%	10%	20%
15	Back Creek Road	Unnamed Creek	R	Box Culvert	2.75	2.1	2	Grass	0.5	W>3L	2.57	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	0%
16	Mount Darragh Rd	Unnamed Creek	C	Pipe Culvert	1.5	0	2	Dense Trees	3	W<L	1.93	M	M	M	**MMM**	Medium	Low	Medium	High	25%	50%	100%
17	Unnamed Road	Pambula River	R	Box Culvert	1.8	0.4	2	Dense Trees	3	W<L	8.01	M	M	H	**MMH**	Medium	Low	Medium	High	25%	50%	100%
18	Mount Darragh Rd	Unnamed Creek	C	Pipe Culvert	1.05	0	3	Dense Trees	3	W<L	1.5	M	M	M	**MMM**	Medium	Low	Medium	High	25%	50%	100%
19	Mount Darragh Rd	Unnamed Creek	R	Box Culvert	3	1.2	3	Grass with Medium Trees	1.25	L<W<3L	1.14	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
20	Mount Darragh Rd	Unnamed Creek	R	Box Culvert	3.05	1.22	3	Grass with Medium Trees	1.25	L<W<3L	0.9	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
21	Mount Darragh Rd	Unnamed Creek	C	Pipe Culvert	0.6	0	4	Grass with Medium Trees	1.25	W<L	6.85	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
22	Mount Darragh Rd	Unnamed Creek	C	Pipe Culvert	0.6	0	1	Dense Trees	3	W<L	6.85	M	M	H	**MMH**	Medium	Low	Medium	High	25%	50%	100%
23	Mount Darragh Road	Unnamed Creek	C	Pipe Culvert	0.6	0	0	Dense Trees	3	W<L	0.85	M	M	L	**MML**	Low	Low	Low	Medium	25%	25%	50%
24	Oaklands Road	Unnamed Creek	C	Pipe Culvert	0.525	0	1	Grass with Medium Trees	1.25	W<L	0.09	L	M	L	**LML**	Low	Low	Low	Medium	25%	25%	50%
25	Princes Highway	Unnamed Creek	R	Box Culvert	2.1	1.2	2.1	Grass with Scattered Trees	0.8	L<W<3L	0.21	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
26	Princes Highway	Pambula River	B	Bridge	18	3.7	3	Grass with Scattered Trees	0.8	W>3L	0.06	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	0%
27	Monaro Street	Unnamed Creek	R	Box Culvert	2.1	1.2	57	Grass with Scattered Trees	0.8	L<W<3L	0.05	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
28	Monaro Street	Unnamed Creek	R	Box Culvert	2.1	1.2	24	Grass with Scattered Trees	0.8	L<W<3L	0.06	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
29	Monaro Street	Unnamed Creek	R	Box Culvert	2.1	1.2	10	Grass	0.5	W>3L	0.06	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	0%
30	Oaklands Road	Unnamed Creek	R	Box Culvert	1.8	0.6	3	Grass with Medium Trees	1.25	L<W<3L	1.05	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
31	Bega Street	Unnamed Creek	R	Box Culvert	2.1	0.9	3	Grass with Scattered Trees	0.8	L<W<3L	0.07	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
32	Monaro Street	Unnamed Creek	C	Pipe Culvert	0.9	0	1	Grass with Medium Trees	1.25	W<L	0.06	L	M	L	**LML**	Low	Low	Low	Medium	25%	25%	50%
	Monaro Street	Unnamed Creek	C	Pipe Culvert	0.9	0	1	Grass with Medium Trees	1.25	L<W<3L	0.06	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
	Monaro Street	Unnamed Creek	C	Pipe Culvert	0.9	0	1	Grass with Medium Trees	1.25	W<L	0.06	L	M	L	**LML**	Low	Low	Low	Medium	25%	25%	50%
33	Bullara Street	Unnamed Creek	R	Box Culvert	2	1	0	Urban	1	L<W<3L	3.74	L	M	H	**LMH**	Medium	Low	Medium	High	0%	10%	20%
34	Unnamed Road	Unnamed Creek	C	Pipe Culvert	1.5	0	1	Urban	1	L<W<3L	2.06	M	M	M	**MMM**	Medium	Low	Medium	High	0%	10%	20%
35	Bullara Street	Unnamed Creek	R	Box Culvert	1.8	0.6	1	Urban	1	L<W<3L	2.34	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%

Structure ID	Roadway	Waterway	Structure Type	Structure Type	Structure Dimensions			Land Use Across Upstream Catchment	Max. L10 (m)	Control Dimension	Main Stream Slope (%)	Debris Availability (L, M, H)	Debris Mobility (L, M, H)	Debris Transportability (L, M, H)	Debris Potential	Debris Potential at Structure	Adjustment for AEP			Design Blockage Level		
					Dia/Width /Span	Height	Cells / Spans										AEP >5%	AEP 5%-0.5%	AEP < 0.5%	AEP >5%	AEP 5%-0.5%	AEP < 0.5%
36	Bullara Street	Unnamed Creek	C	Pipe Culvert	0.75	0	2	Grass	0.5	L<W<3L	1.58	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
37	Bullara Street	Unnamed Creek	C	Pipe Culvert	0.75	0	1	Urban	1	W<L	1.58	L	M	M	**LMM**	Low	Low	Low	Medium	25%	25%	50%
38	Bullara Street	Unnamed Creek	C	Pipe Culvert	0.75	0	2	Urban	1	W<L	1.58	L	M	M	**LMM**	Low	Low	Low	Medium	25%	25%	50%
39	Arthur Kaine Drive	Unnamed Creek	C	Pipe Culvert	0.6	0	4	Urban	1	W<L	1.12	L	M	M	**LMM**	Low	Low	Low	Medium	25%	25%	50%
40	Princes Highway	Yowaka River	B	Bridge	33	15	2	Dense Trees	3	W>3L	0.23	M	M	L	**MML**	Low	Low	Low	Medium	0%	0%	0%
41	Nethercote Rd	Yowaka River	C	Pipe Culvert	0.45	0	3	Grass with Medium Trees	1.25	W<L	0.08	L	M	L	**LML**	Low	Low	Low	Medium	25%	25%	50%
42	Nethercote Road	Yowaka River	C	Pipe Culvert	0.6	0	1	Urban	1	W<L	16.48	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
43	Nethercote Rd	Pipeclay Creek	B	Bridge	24	3.3	2	Dense Trees	3	W>3L	1.12	M	M	M	**MMM**	Medium	Low	Medium	High	0%	0%	10%
44	Yowaka River Road	Yowaka River	C	Pipe Culvert	0.375	0	2	Dense Trees	3	W<L	6.08	M	M	H	**MMH**	Medium	Low	Medium	High	25%	50%	100%
45	Yowaka River Road	Yowaka River	C	Pipe Culvert	0.9	0	2	Grass with Medium Trees	1.25	W<L	3.22	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
	Yowaka River Road	Yowaka River	C	Pipe Culvert	1.05	0	1	Grass	0.5	L<W<3L	3.22	L	M	H	**LMH**	Medium	Low	Medium	High	0%	10%	20%
46	Nethercote Rd	Yowaka River	B	Bridge	27	2.8	3	Dense Trees	3	W>3L	0.48	M	M	L	**MML**	Low	Low	Low	Medium	0%	0%	0%
47	Back Creek Rd	Yowaka River	B	Bridge	30	4	2	Grass with Scattered Trees	0.8	W>3L	0	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	0%
48	Mine Road	Unnamed Creek	C	Pipe Culvert	0.6	0	1	Grass with Scattered Trees	0.8	W<L	1.98	L	M	M	**LMM**	Low	Low	Low	Medium	25%	25%	50%
49	Nethercote Road	Unnamed Creek	C	Pipe Culvert	0.75	0	1	Dense Trees	3	W<L	5.18	M	M	H	**MMH**	Medium	Low	Medium	High	25%	50%	100%
50	Nethercote Rd	Old Hut Creek	B	Bridge	30	8.5	2	Dense Trees	3	W>3L	0.82	M	M	L	**MML**	Low	Low	Low	Medium	0%	0%	0%
51	Nethercote Road	Unnamed Creek	C	Pipe Culvert	0.9	0	1	Dense Trees	3	W<L	0.73	M	M	L	**MML**	Low	Low	Low	Medium	25%	25%	50%
	Nethercote Road	Unnamed Creek	C	Pipe Culvert	0.9	0	0	Grass	0.5	L<W<3L	0.73	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
52	Nethercote Rd	Centipede Creek	R	Box Culvert	2.4	1.5	3	Grass with Scattered Trees	0.8	L<W<3L	0.93	L	M	L	**LML**	Low	Low	Low	Medium	0%	0%	10%
53	Ruggs Road	Centipede Creek	R	Box Culvert	2.4	1.5	3	Dense Trees	3	W<L	1.13	M	M	M	**MMM**	Medium	Low	Medium	High	25%	50%	100%
54	Fourters Road	Unnamed Creek	C	Pipe Culvert	0.375	0	2	Grass with Scattered Trees	0.8	W<L	3.58	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%

APPENDIX D
MODEL CALIBRATION RESULTS



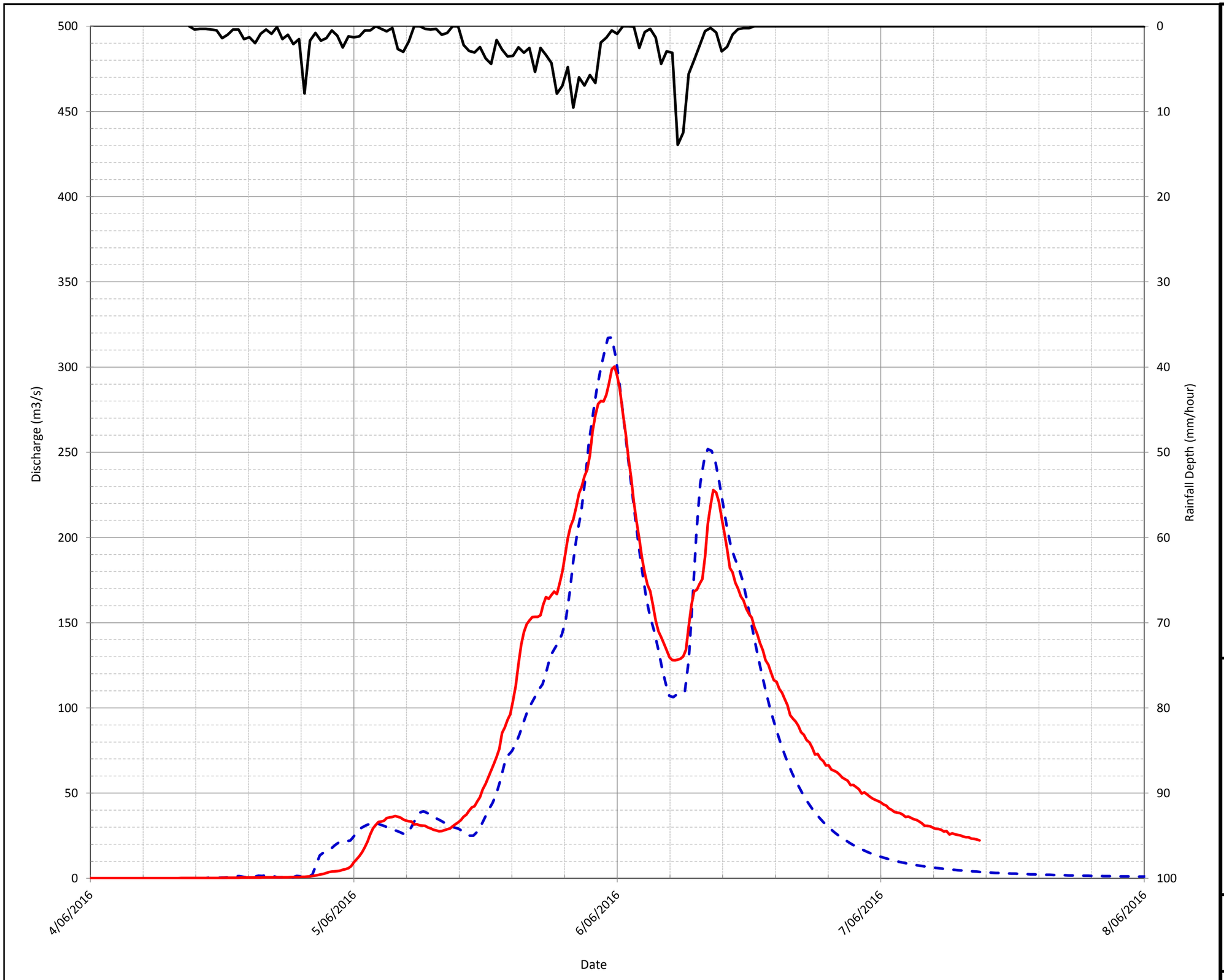
LEGEND:

- 1% AEP
- 2% AEP
- 5% AEP
- 10% AEP
- 20% AEP
- 50% AEP
- 2016 Rainfall
- 2012 Rainfall
- 2011 Rainfall
- 1985 Rainfall
- 1971 Rainfall

Figure D1:
Design Intensity - Frequency - Duration Curves
Vs
Historic Rainfall

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip Street
Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



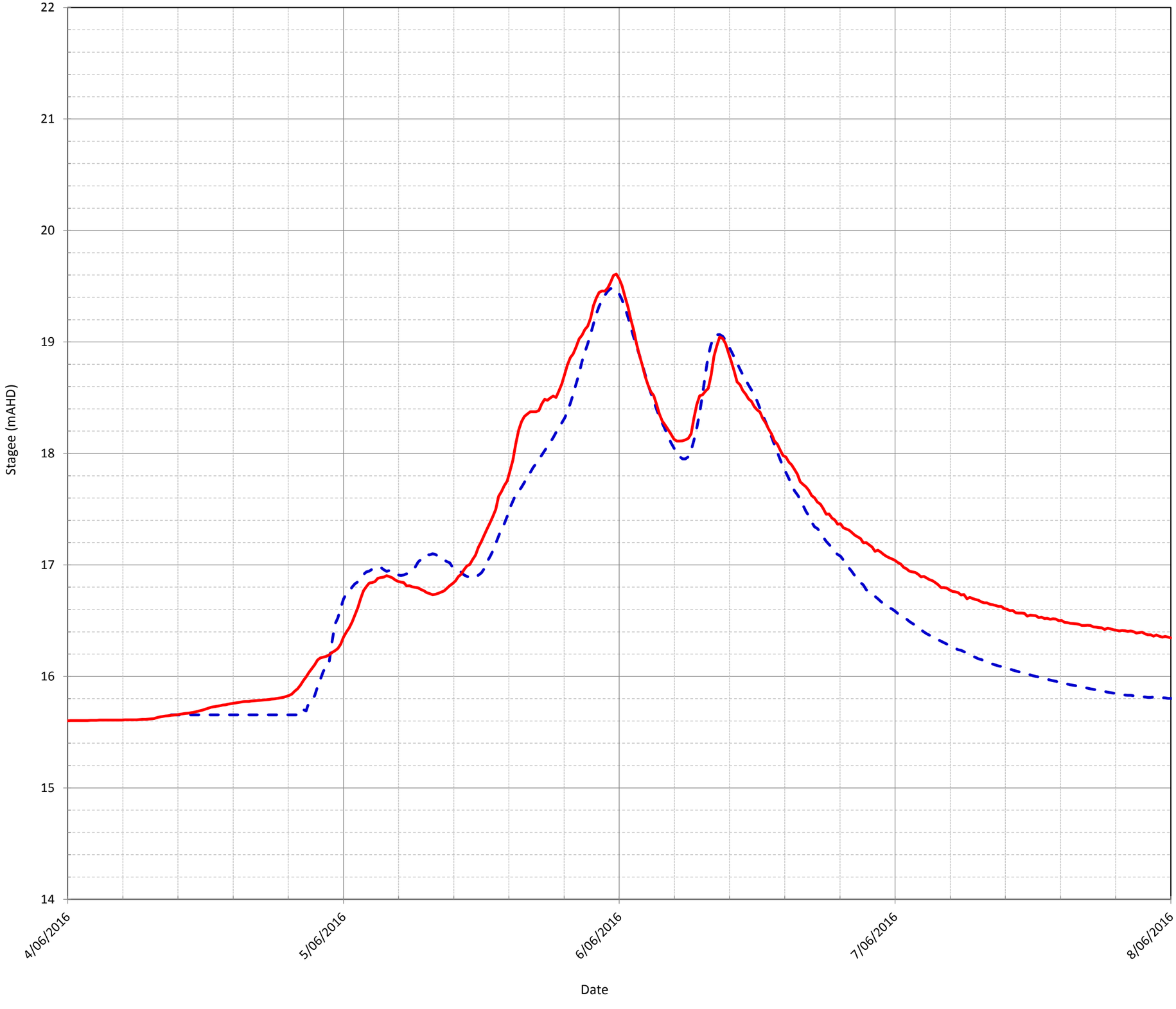
LEGEND:

- Simulated Discharge Hydrograph
- Recorded Discharge Hydrograph
- Rainfall

Figure D2: Comparison Between Simulated and Recorded Discharge Hydrographs for Pambula River @ Lochiel for 2016 Flood

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Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



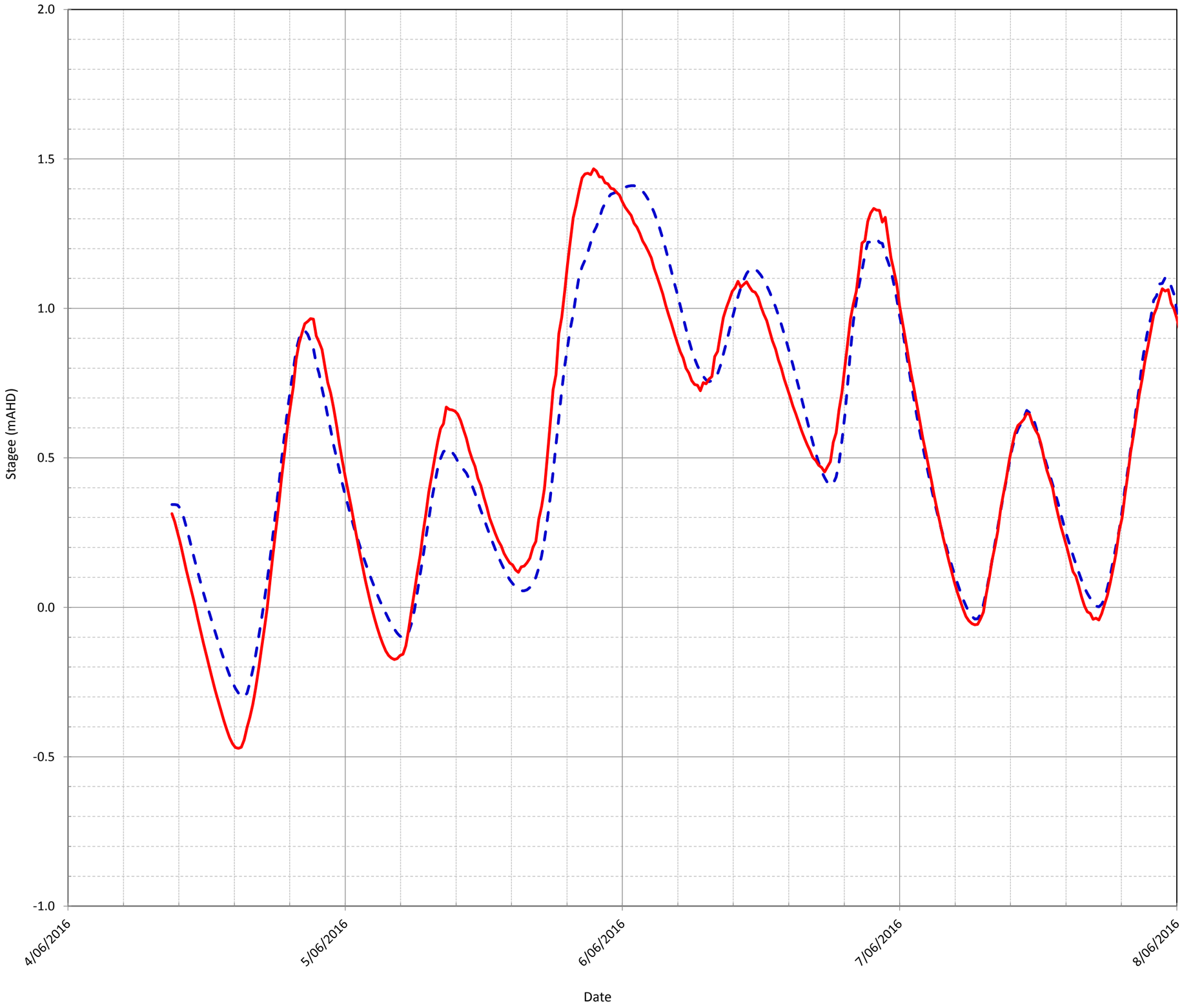
LEGEND:

- Simulated Stage Hydrograph
- Recorded Stage Hydrograph

Figure D3: Comparison Between Simulated and Recorded Stage Hydrographs for Pambula River @ Lochiel for 2016 Flood

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Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



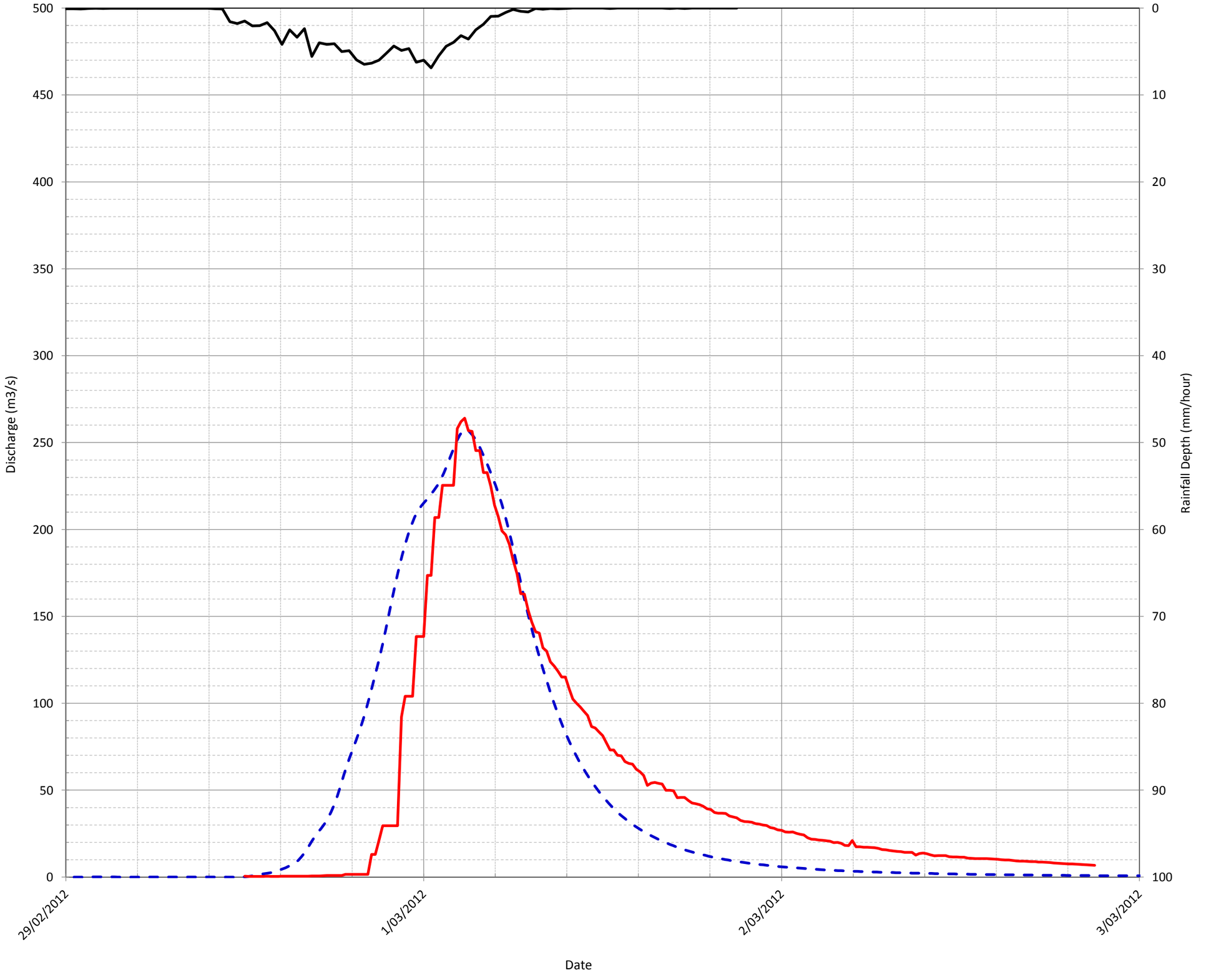
LEGEND:

- Simulated Stage Hydrograph
- Recorded Stage Hydrograph

Figure D4: Comparison Between Simulated and Recorded Stage Hydrographs for Pambula Lake for 2016 Flood

Prepared By:
Catchment Simulation Solutions
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Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



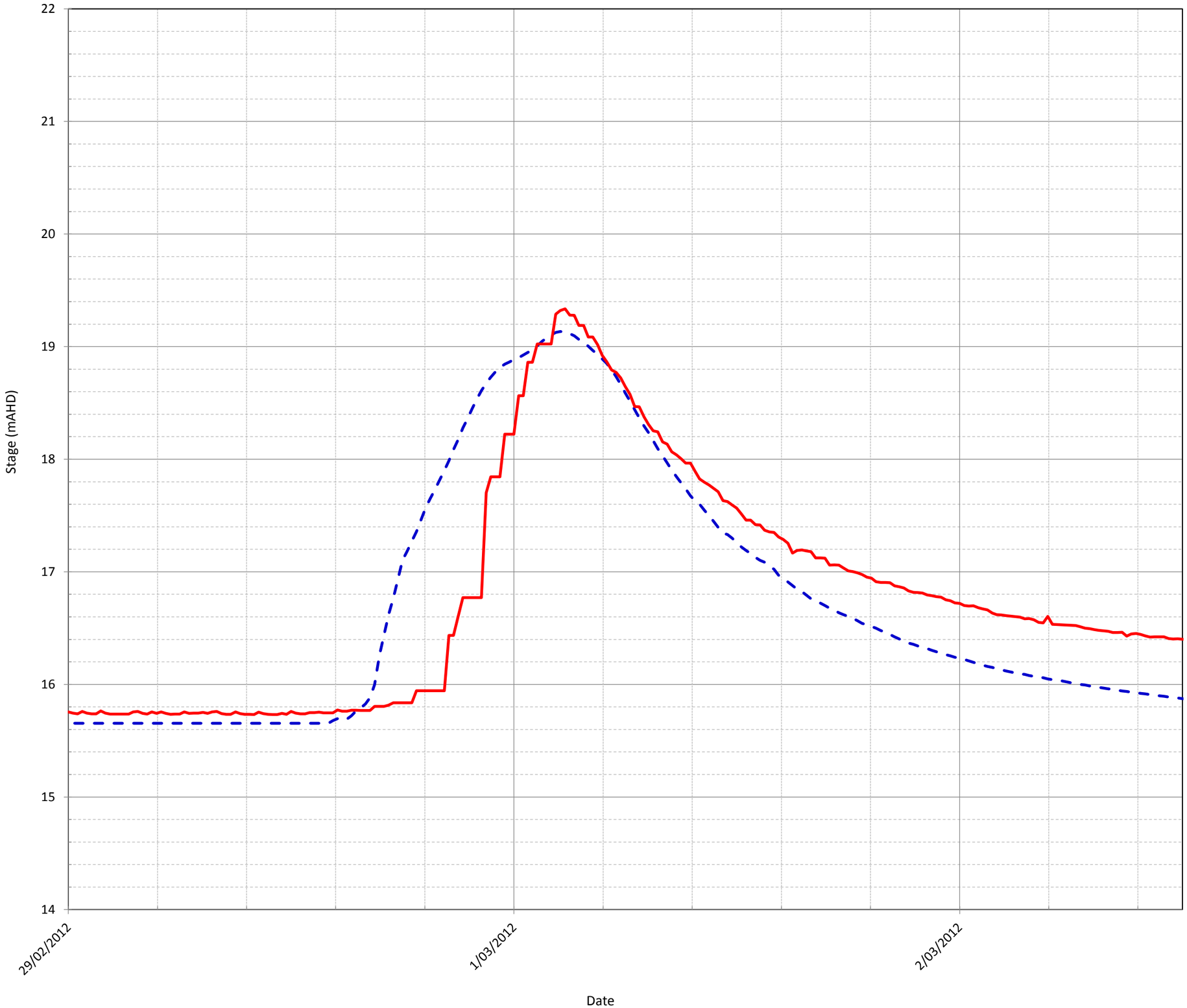
LEGEND:

- Simulated Discharge Hydrograph
- Recorded Discharge Hydrograph
- Rainfall

Figure D5: Comparison Between Simulated and Recorded Discharge Hydrographs for Pambula River @ Lochiel for 2012 Flood

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip Street
Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



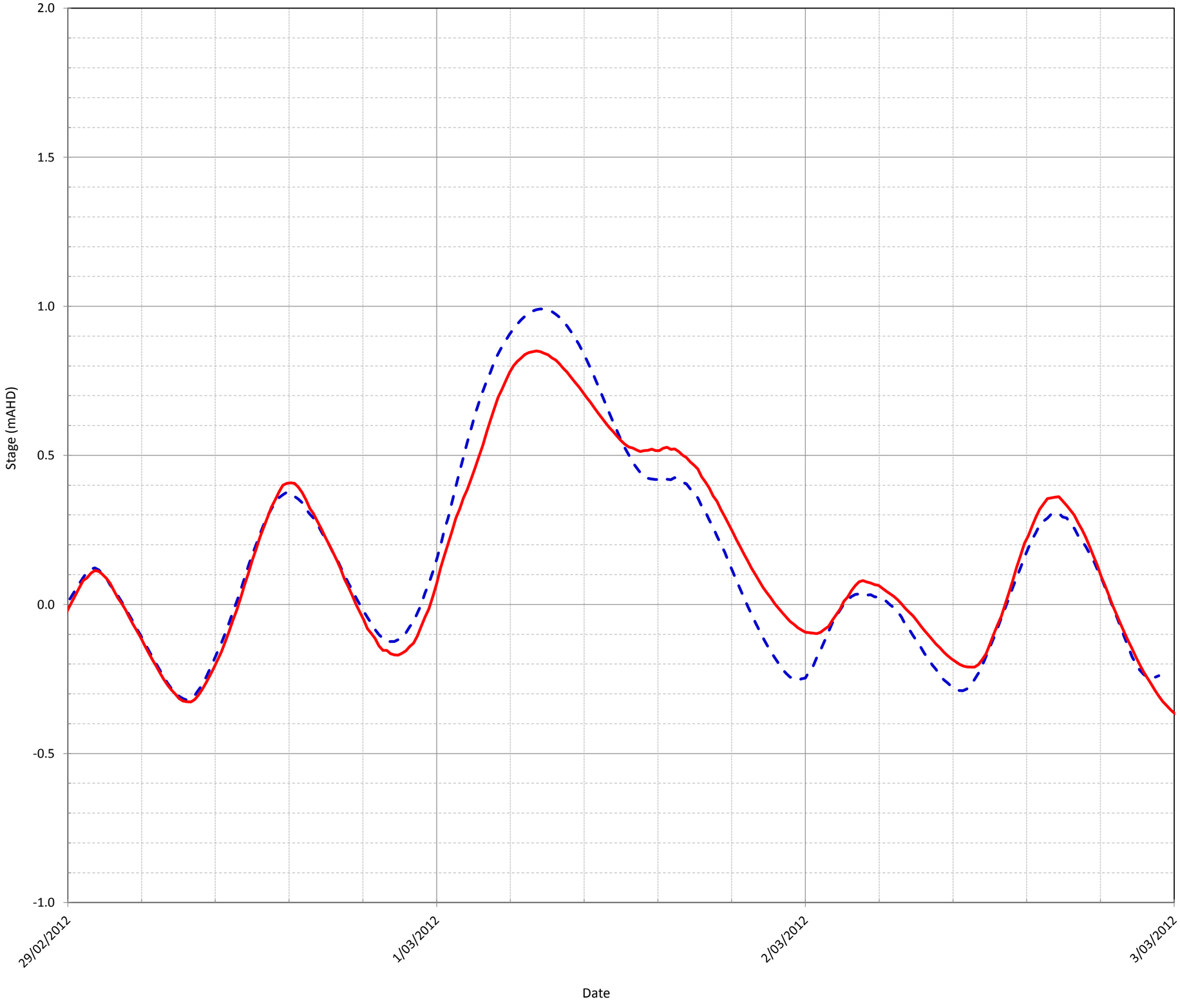
LEGEND:

- Simulated Stage Hydrograph
- Recorded Stage Hydrograph

Figure D6: Comparison Between Simulated and Recorded Stage Hydrographs for Pambula River @ Lochiel for 2012 Flood

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip Street
Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



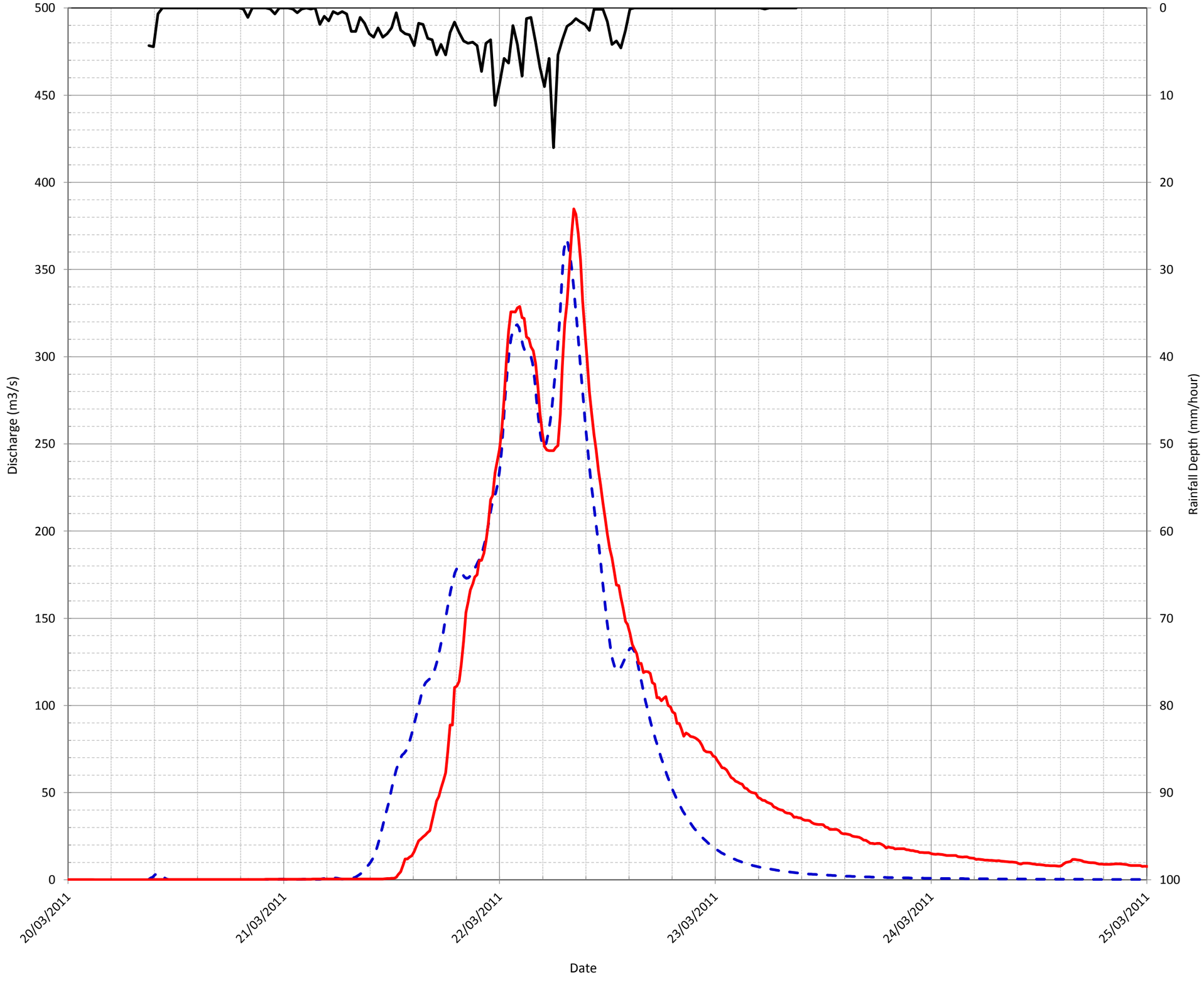
LEGEND:

- Simulated Stage Hydrograph
- Recorded Stage Hydrograph

Figure D7: Comparison Between Simulated and Recorded Stage Hydrographs for Pambula Lake for 2012 Flood

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip Street
Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



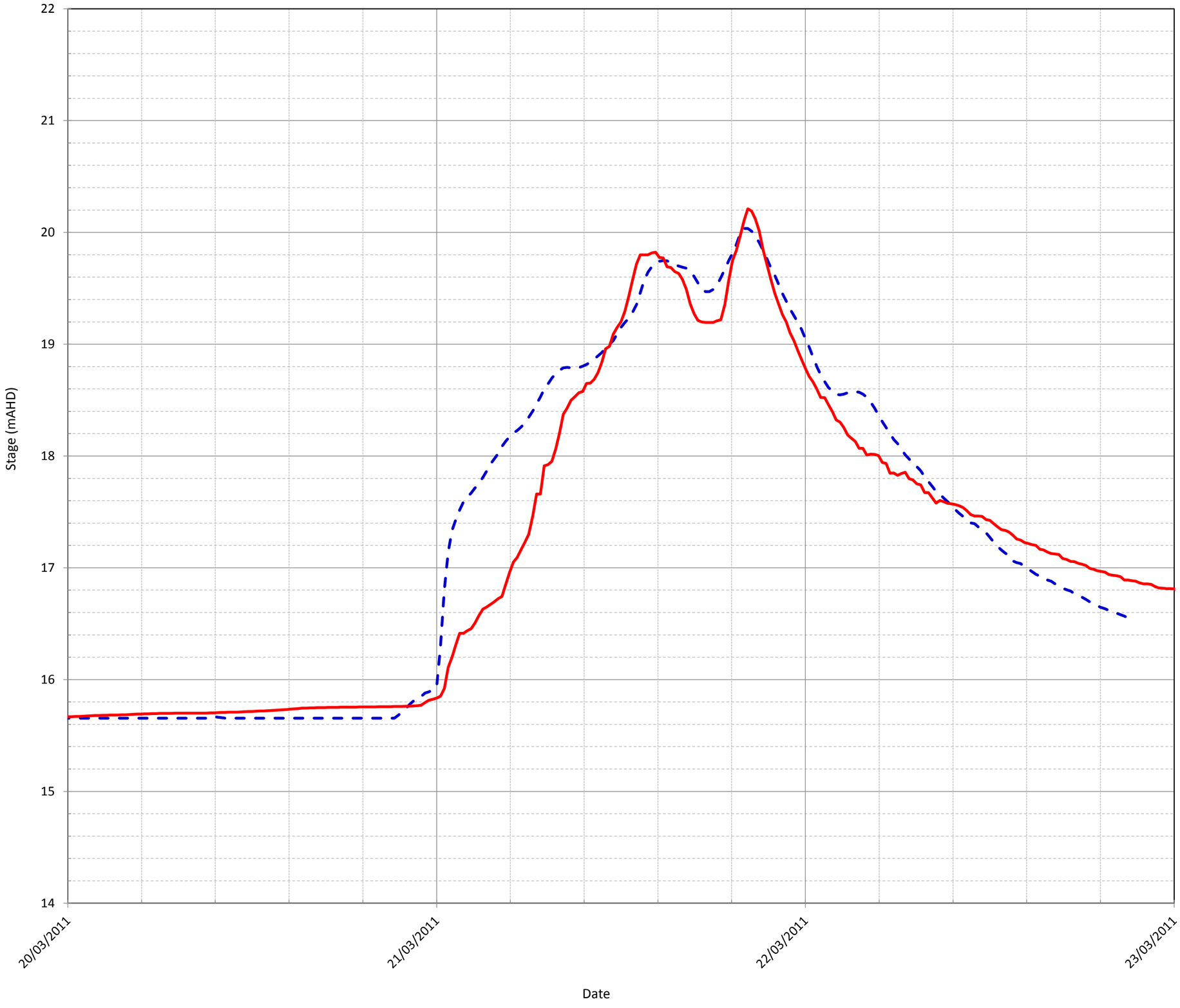
LEGEND:

- Simulated Discharge Hydrograph
- Recorded Discharge Hydrograph
- Rainfall

Figure D8: Comparison Between Simulated and Recorded Discharge Hydrographs for Pambula River @ Lochiel for 2011 Flood

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip Street
Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



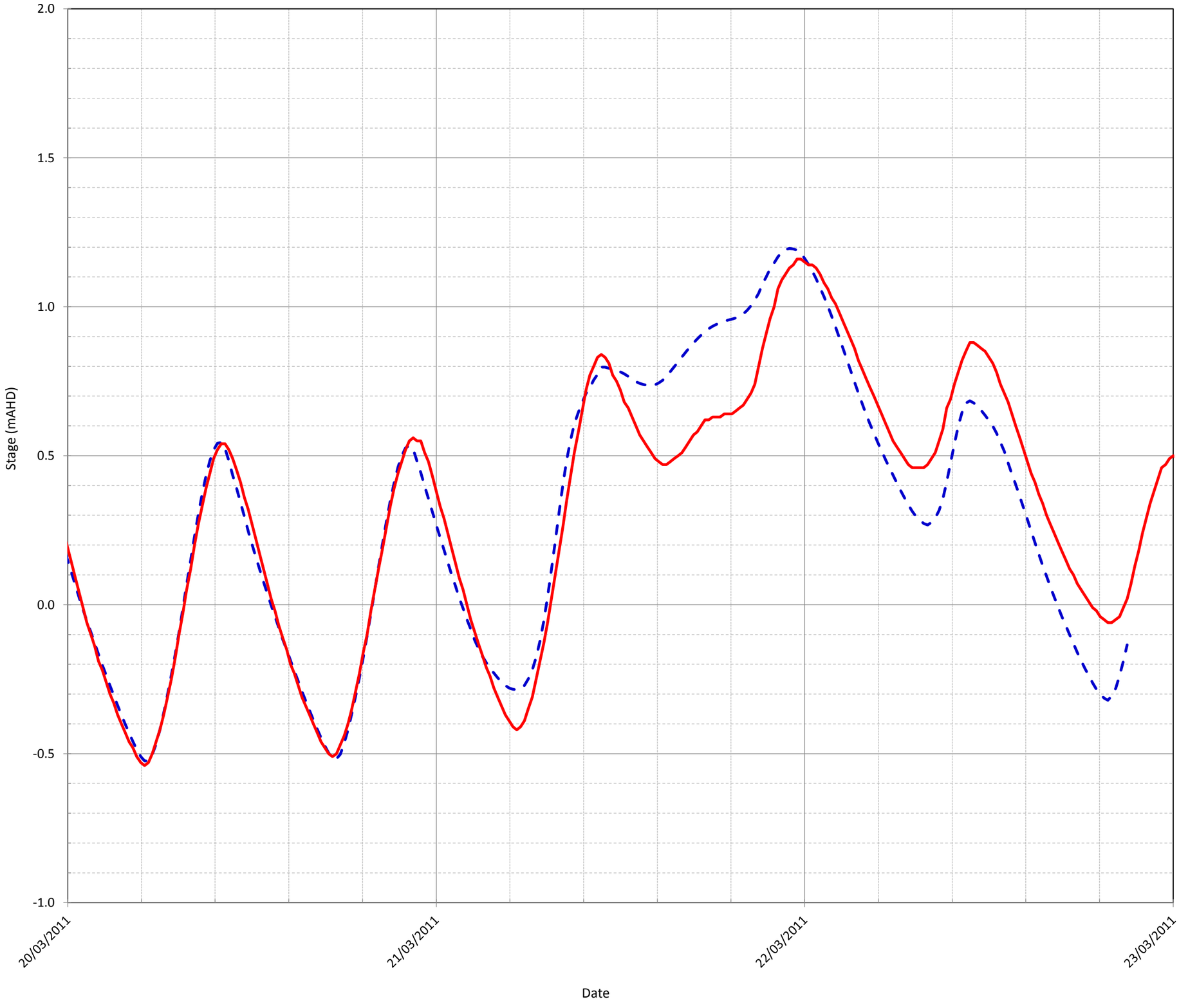
LEGEND:

- Simulated Stage Hydrograph
- Recorded Stage Hydrograph

Figure D9:
Comparison Between Simulated and Recorded Stage Hydrographs for Pambula River @ Lochiel for 2011 Flood

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip Street
Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



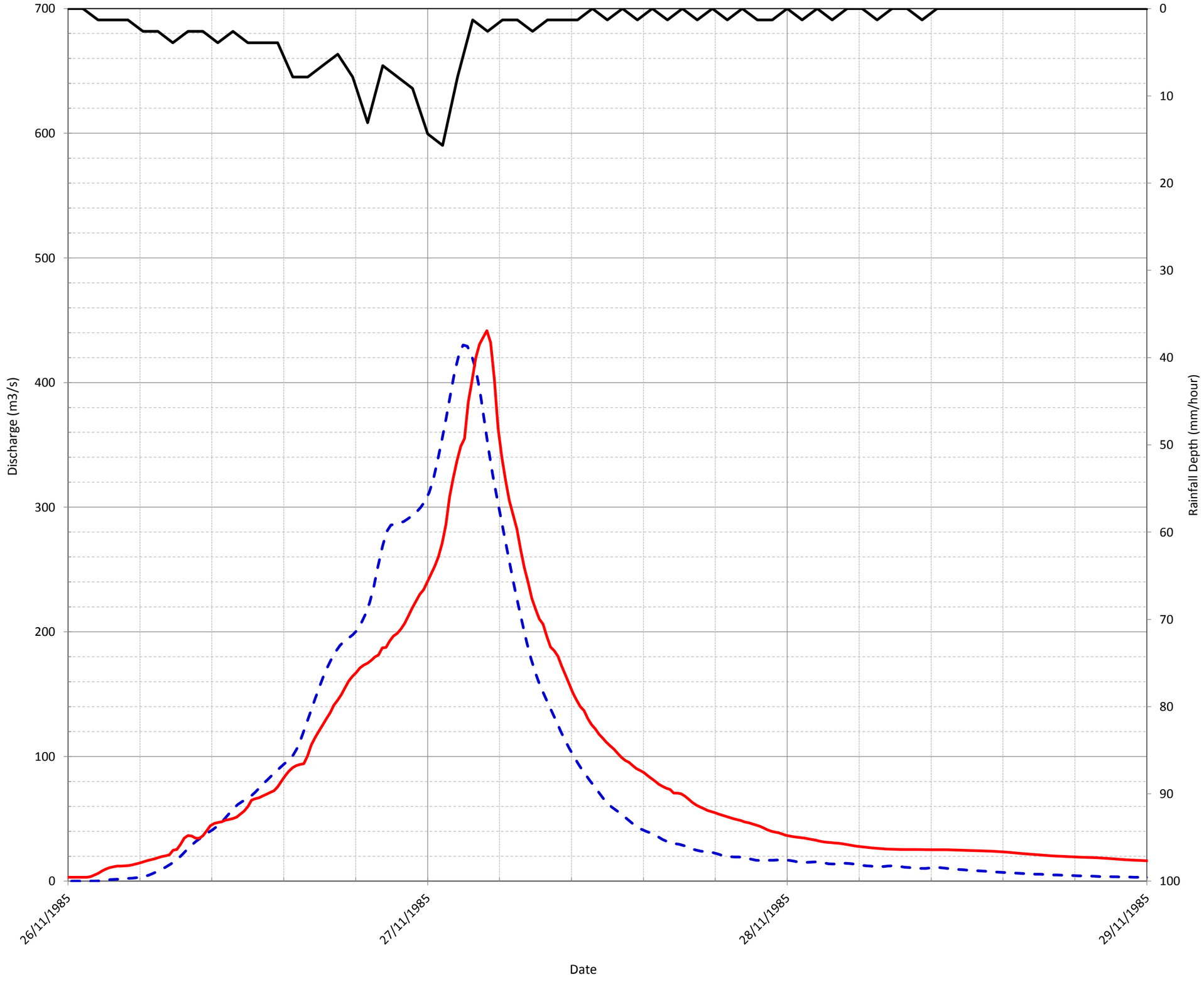
LEGEND:

- Simulated Stage Hydrograph
- Recorded Stage Hydrograph

Figure D10: Comparison Between Simulated and Recorded Stage Hydrographs for Pambula Lake for 2011 Flood

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip Street
Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



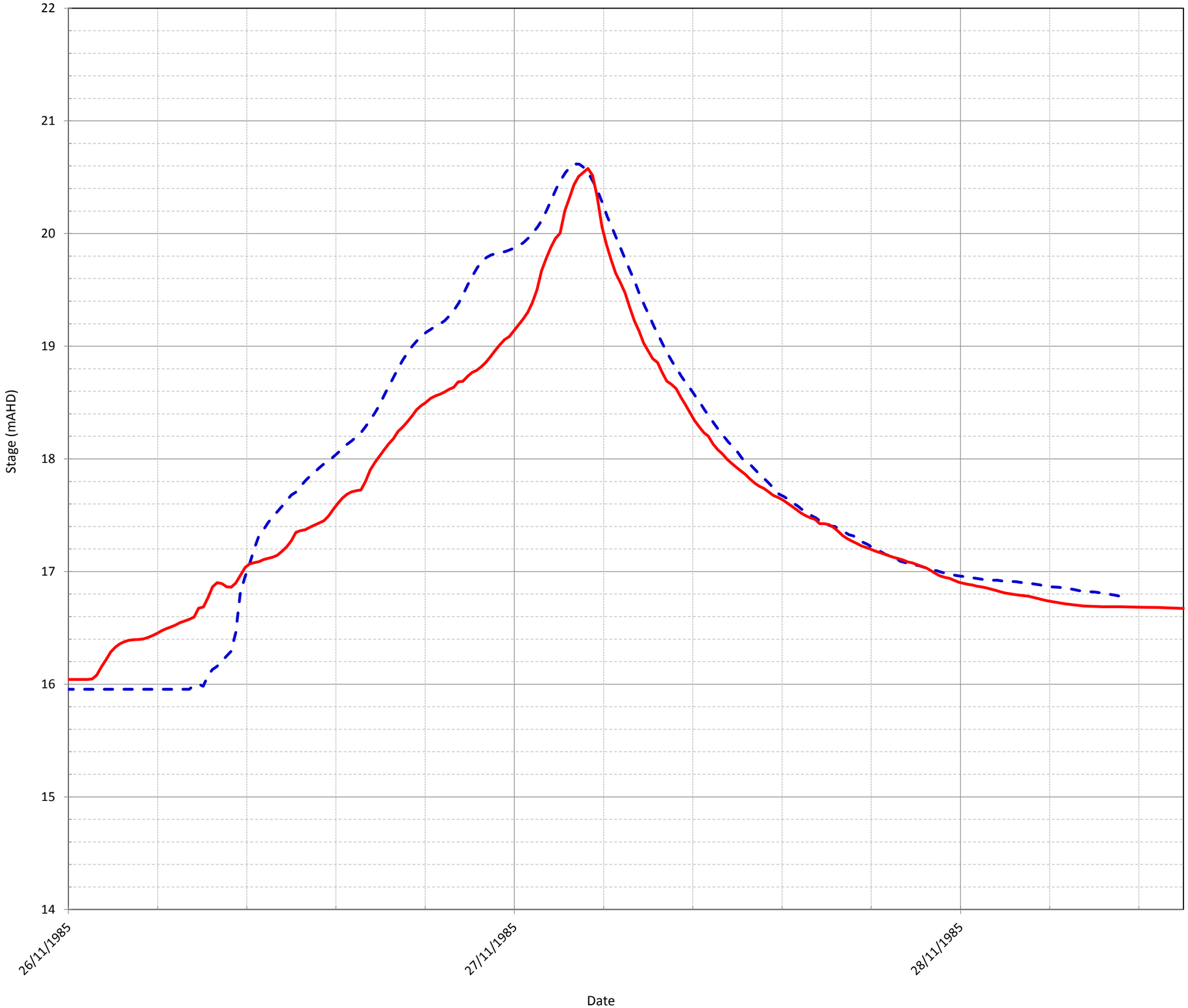
LEGEND:

- Simulated Discharge Hydrograph
- Recorded Discharge Hydrograph
- Rainfall

Figure D11: Comparison Between Simulated and Recorded Discharge Hydrographs for Pambula River @ Lochiel for 1985 Flood

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip Street
Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



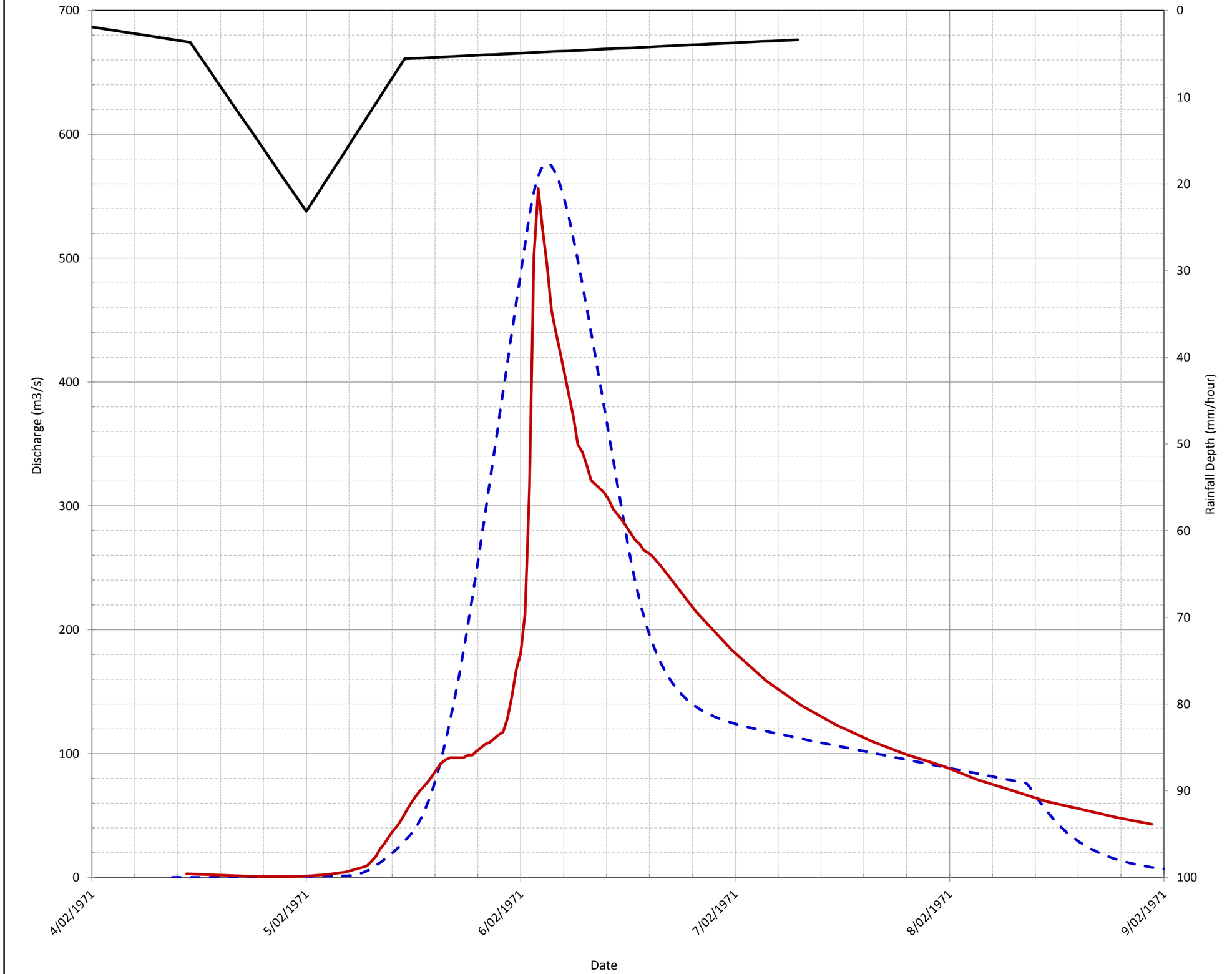
LEGEND:

- Simulated Stage Hydrograph
- Recorded Stage Hydrograph

Figure D12:
Comparison Between Simulated and Recorded Stage Hydrographs for Pambula River @ Lochiel for 1985 Flood

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip Street
Sydney, NSW, 2000

File Name: Lochiel Stage Hydrographs.xlsx



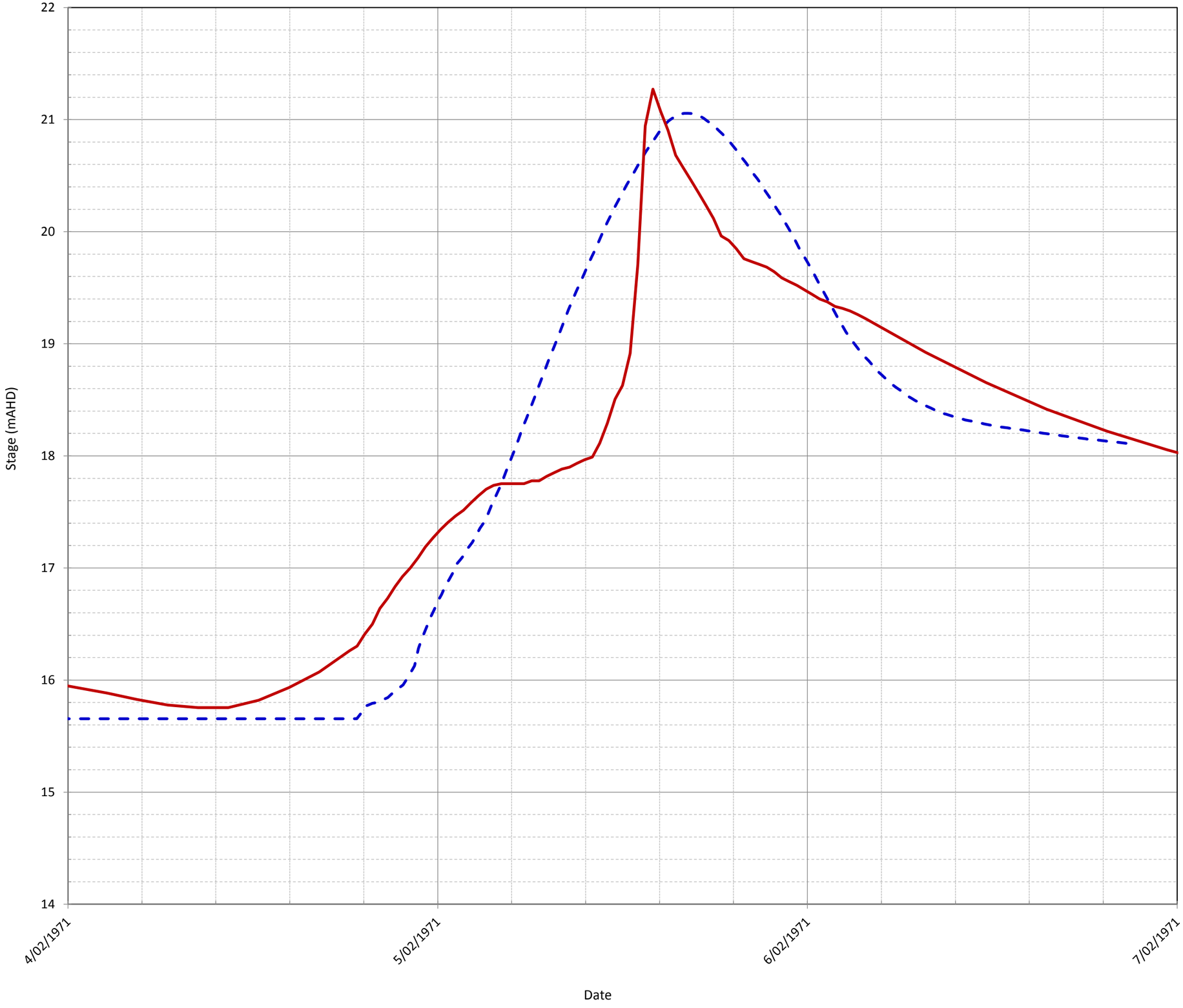
LEGEND:

- Simulated Discharge Hydrograph
- Recorded Discharge Hydrograph
- Rainfall

Figure D13:
Comparison Between Simulated and Recorded Discharge Hydrographs for Pambula River @ Lochiel for 1971 Flood

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip Street
Sydney, NSW, 2000

File Name: IFD Comparison.xlsx



LEGEND:

- Simulated Stage Hydrograph
- Recorded Stage Hydrograph

Figure D14: Comparison Between Simulated and Recorded Stage Hydrographs for Pambula River @ Lochiel for 1971 Flood

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip Street
Sydney, NSW, 2000

File Name: IFD Comparison.xlsx

APPENDIX E

XP-RAFTS OUTPUTS FOR HISTORIC FLOOD SIMULATIONS

XP-RAFTS Peak Discharges for Historic Flood Simulations

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
1.01	10.2	8.48	13.5	13.5	17.8
1.02	13.5	10.9	17.9	17.7	23.0
1.03	18.9	15.0	25.1	24.8	32.0
1.04	26.8	21.3	35.2	35.1	45.5
1.05	34.3	27.5	44.4	44.9	58.3
1.06	35.1	28.1	45.2	45.8	59.5
1.07	41.7	33.6	53.5	54.6	71.4
1.08	45.7	37.1	58.5	60.1	78.7
1.09	47.0	38.2	59.9	61.8	80.9
1.10	76.2	64.3	94.7	102	135
1.11	92.1	77.5	110	123	162
1.12	103	86.8	123	138	184
1.13	207	171	256	282	376
1.14	216	179	263	293	392
1.15	216	179	264	293	393
1.16	220	182	267	299	400
1.17	238	196	279	323	432
1.18	255	209	293	346	464
1.19	259	212	297	352	472
1.20	317	257	354	430	577
1.21	319	258	355	433	580
1.22	344	277	374	465	623
1.23	350	281	378	473	633
1.24	350	281	378	474	633
1.25	352	283	379	476	637
1.26	357	286	381	481	644
1.27	361	290	383	488	652
1.28	362	290	383	488	653
1.29	384	310	394	517	692
1.30	385	311	395	520	695
1.31	417	346	409	562	754
1.32	417	346	409	562	754
1.33	792	679	802	1095	1487
1.34	792	680	802	1096	1490
1.35	841	725	832	1159	1580
1.36	841	726	833	1160	1584
1.37	842	726	833	1161	1586
1.38	842	727	833	1162	1588
1.39	847	733	836	1167	1600
1.40	855	741	839	1177	1619
2.01	2.68	2.01	3.57	3.47	4.34
3.01	4.79	3.65	6.39	6.22	8.00

Catchment Simulation Solutions

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
4.01	5.06	3.96	6.63	6.57	8.62
5.01	5.24	4.27	6.45	6.84	8.86
6.01	5.12	4.34	6.68	6.92	9.42
7.01	3.26	2.89	4.04	4.43	6.08
8.01	9.06	8.53	11.9	12.8	18.0
8.02	18.1	16.5	22.8	25.0	34.4
8.03	18.1	16.5	22.9	25.0	34.5
8.04	26.7	24.1	32.2	36.5	49.5
8.05	27.6	24.8	33.1	37.7	51.1
9.01	5.80	5.16	7.19	7.84	10.5
10.01	3.47	3.03	3.59	4.58	6.07
10.02	8.41	7.37	9.02	11.1	14.7
11.01	4.90	4.30	5.37	6.47	8.58
12.01	4.18	3.44	4.01	5.44	6.96
12.02	7.29	5.96	7.06	9.58	12.1
12.03	11.6	9.56	11.5	15.2	19.4
13.01	1.45	1.09	1.39	1.88	2.19
14.01	3.39	2.86	3.42	4.41	5.82
14.02	4.12	3.44	4.19	5.37	7.00
15.01	0.732	0.440	0.647	0.792	0.868
16.01	4.08	3.63	5.29	5.81	8.13
16.02	6.24	5.51	7.66	8.74	12.2
17.01	6.46	5.18	9.14	8.83	12.1
17.02	15.0	12.2	20.1	20.3	27.5
17.03	19.5	15.7	25.6	26.1	35.3
17.04	27.6	22.3	37.1	37.4	50.9
17.05	32.6	26.3	43.0	44.1	59.9
17.06	40.8	32.9	54.1	55.5	75.1
17.07	47.3	37.6	60.8	63.9	85.5
17.08	65.5	51.6	82.7	88.0	117
17.09	67.1	52.8	84.4	90.1	119
17.10	72.2	57.1	90.5	97.1	129
17.11	100	80.8	128	137	184
17.12	102	82.1	130	139	187
17.13	103	82.8	131	140	188
18.01	6.07	4.94	7.89	8.14	10.9
19.01	2.98	2.36	3.84	3.91	5.30
20.01	6.94	5.77	10.1	9.81	13.8
21.01	5.73	4.80	8.14	8.12	11.3
21.02	6.56	5.39	9.21	9.27	12.5
22.01	4.62	3.41	4.79	5.98	7.68
23.01	3.70	2.85	4.91	4.87	6.44
23.02	11.9	9.29	15.3	15.6	20.8
23.03	16.4	12.7	20.5	21.5	28.3

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
23.04	16.6	12.9	20.7	21.9	28.6
24.01	4.78	3.70	6.26	6.28	8.32
25.01	1.71	1.21	2.15	2.28	2.69
26.01	4.95	4.16	6.01	6.80	9.36
26.02	5.03	4.22	6.11	6.91	9.47
27.01	6.51	5.17	8.99	8.71	11.6
27.02	14.2	11.5	19.5	19.3	25.7
27.03	23.9	19.7	32.6	33.4	45.5
28.01	1.46	0.961	2.08	1.87	2.15
28.02	1.96	1.31	2.78	2.53	2.93
29.01	5.53	4.66	7.18	7.49	10.2
30.01	1.71	1.27	1.64	2.23	2.87
31.01	1.23	0.913	1.05	1.60	2.11
32.01	6.66	5.98	6.27	9.20	12.7
33.01	3.24	2.77	2.63	4.37	5.98
34.01	4.85	4.30	3.84	6.45	8.67
34.02	12.4	10.1	8.70	16.2	20.9
34.03	12.5	10.3	8.86	16.4	21.2
35.01	3.30	2.58	3.23	4.44	6.07
35.02	6.80	5.38	6.73	9.62	13.4
35.03	9.39	7.23	8.74	13.1	17.9
35.04	9.53	7.33	8.87	13.3	18.1
35.05	15.1	11.3	13.3	20.7	28.4
36.01	0.421	0.288	0.312	0.572	0.673
37.01	2.84	2.05	2.41	3.77	5.19
38.01	2.86	2.05	2.53	3.89	5.44
38.02	3.61	2.50	3.08	4.89	6.60
39.01	3.86	3.21	4.65	5.20	7.02
39.02	8.44	6.67	9.87	11.3	14.4
39.03	12.5	9.76	14.3	16.6	20.9
39.04	24.5	20.3	26.4	33.0	42.9
39.05	31.1	24.9	31.8	41.7	54.6
39.06	57.1	44.4	57.0	76.6	101
40.01	2.34	1.65	2.68	2.98	3.50
41.01	2.93	2.13	3.18	3.77	4.42
42.01	5.71	4.99	5.83	7.57	10.1
43.01	1.89	1.34	1.60	2.43	3.10
44.01	6.31	4.97	6.42	8.26	10.8
44.02	15.8	12.1	15.9	21.1	27.6
44.03	23.9	18.1	23.7	32.2	42.8
45.01	4.22	3.06	4.19	5.49	6.90
46.01	5.62	4.35	5.76	7.87	10.9
47.01	5.36	4.74	4.67	6.97	9.09
47.02	7.53	6.57	6.44	9.77	12.6

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
47.03	8.15	7.08	7.08	10.7	13.6
47.04	16.7	14.0	14.3	22.3	28.7
47.05	21.5	17.3	17.7	28.7	36.9
48.01	2.08	1.76	1.64	2.66	3.41
49.01	2.99	2.43	2.62	3.85	4.91
49.02	3.40	2.75	3.02	4.44	5.55
49.03	3.43	2.78	3.07	4.50	5.62
50.01	0.735	0.438	0.534	0.767	0.835
51.01	2.00	1.39	1.29	2.57	3.25
52.01	0.907	0.604	0.592	1.20	1.41
52.02	2.16	1.43	1.37	2.85	3.57
53.01	3.04	1.84	1.98	4.02	5.42
54.01	1.21	0.838	0.711	1.56	2.04
54.02	1.77	1.22	1.05	2.35	2.94
54.03	1.99	1.39	1.21	2.68	3.29
55.01	1.49	0.961	0.808	1.96	2.42
56.01	2.06	1.40	1.11	2.69	3.32
56.02	3.44	2.44	1.81	4.48	5.64
56.03	4.05	2.92	2.10	5.28	6.67
57.01	1.78	1.30	0.945	2.33	2.86
57.02	4.25	3.74	2.30	5.87	7.95
58.01	3.19	2.62	2.00	4.17	5.58
58.02	4.69	3.88	2.85	6.13	8.16
58.03	6.84	5.68	3.99	8.97	11.8
58.04	11.6	9.21	6.65	15.3	19.8
58.05	12.5	10.1	7.10	16.6	21.6
58.06	18.1	15.5	9.87	24.3	31.5
58.07	20.6	18.3	11.0	27.7	36.2
59.01	1.47	1.20	0.768	1.91	2.43
60.01	1.36	0.971	0.847	1.81	2.19
60.02	1.75	1.24	1.07	2.34	2.81
60.03	3.84	2.85	2.26	5.08	6.42
61.01	1.11	0.841	0.634	1.44	1.86
62.01	0.257	0.193	0.161	0.343	0.404
63.01	0.0344	0.0160	0.0156	0.0282	0.0296
64.01	0.751	0.615	0.363	1.01	1.20
64.02	4.18	3.73	2.07	5.63	6.90
65.01	0.428	0.340	0.227	0.582	0.683
66.01	0.631	0.465	0.272	0.733	0.819
66.02	1.93	1.80	0.957	2.61	3.24
67.01	0.167	0.0865	0.0683	0.129	0.134
68.01	0.265	0.142	0.109	0.211	0.220
69.01	0.264	0.145	0.110	0.208	0.217
69.02	0.441	0.253	0.181	0.369	0.385

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
70.01	0.189	0.108	0.0748	0.156	0.164
71.01	0.213	0.123	0.0864	0.172	0.180
72.01	0.250	0.141	0.101	0.200	0.208
73.01	0.186	0.0985	0.0695	0.145	0.151
74.01	1.04	1.02	0.458	1.35	1.69
75.01	0.944	0.795	0.247	0.984	2.11
75.02	1.13	0.958	0.292	1.19	2.51
76.01	0.733	0.728	0.308	0.968	1.18
76.02	0.804	0.804	0.339	1.10	1.36
77.01	1.77	1.47	0.905	2.30	2.87
77.02	3.93	3.40	1.96	5.10	6.33
77.03	7.42	7.24	3.57	9.78	12.6
77.04	8.34	8.17	3.93	11.0	14.1
77.05	8.92	8.80	4.16	11.8	15.0
77.06	9.05	8.95	4.21	11.9	15.2
77.07	17.8	18.3	8.07	24.1	29.9
77.08	18.3	18.9	8.27	24.8	30.9
77.09	18.4	19.1	8.34	25.0	31.1
77.10	18.8	19.5	8.47	25.6	31.7
77.11	21.5	22.7	9.60	29.4	36.4
77.12	24.0	25.7	10.7	33.0	41.2
77.13	29.0	31.8	13.1	40.3	51.4
78.01	1.66	1.60	0.755	2.16	2.75
78.02	4.14	4.17	1.79	5.75	7.32
79.01	1.10	0.999	0.500	1.47	1.75
80.01	0.531	0.483	0.209	0.660	0.755
81.01	1.11	1.19	0.439	1.44	1.79
81.02	1.22	1.32	0.487	1.61	1.97
81.03	2.43	2.66	1.000	3.29	3.91
81.04	4.89	4.89	1.97	6.10	6.99
82.01	0.331	0.245	0.126	0.319	0.343
82.02	1.07	1.10	0.419	1.36	1.59
82.03	1.24	1.26	0.480	1.57	1.82
83.01	0.773	0.797	0.308	0.977	1.12
83.02	1.75	1.56	0.677	1.95	2.16
83.03	1.98	1.73	0.753	2.17	2.41
84.01	0.199	0.143	0.0737	0.178	0.187
84.02	0.706	0.527	0.284	0.675	0.715
85.01	0.356	0.287	0.152	0.366	0.392
86.01	0.0635	0.0414	0.0257	0.0505	0.0525
87.01	0.301	0.215	0.115	0.270	0.285
87.02	0.581	0.398	0.202	0.507	0.532
88.01	0.134	0.0838	0.0404	0.108	0.112
89.01	0.154	0.130	0.0558	0.165	0.180

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
90.01	0.105	0.0830	0.0414	0.106	0.113
91.01	0.275	0.253	0.124	0.303	0.340
92.01	0.400	0.450	0.160	0.526	0.668
92.02	1.60	1.90	0.656	2.11	2.74
92.03	1.70	2.02	0.727	2.25	2.89
92.04	2.48	2.93	1.21	3.35	4.09
93.01	0.160	0.132	0.0496	0.170	0.185
94.01	0.209	0.149	0.0779	0.184	0.193
95.01	0.259	0.184	0.0990	0.229	0.240
96.01	0.116	0.0775	0.0438	0.0961	0.101
97.01	0.127	0.0854	0.0487	0.106	0.111
98.01	0.284	0.260	0.114	0.322	0.359
99.01	1.36	1.71	0.593	1.85	2.52
99.02	1.87	2.29	0.881	2.56	3.28
100.01	0.0607	0.0422	0.0244	0.0556	0.0586
101.01	0.0506	0.0321	0.0201	0.0404	0.0423
102.01	0.0781	0.0561	0.0316	0.0716	0.0753
103.01	0.0542	0.0351	0.0231	0.0430	0.0447
104.01	0.165	0.107	0.0623	0.141	0.148
104.02	0.424	0.288	0.163	0.375	0.394
105.01	0.0417	0.0258	0.0172	0.0319	0.0331
106.01	2.54	3.29	1.31	3.88	5.84
106.02	4.01	4.78	1.98	5.81	8.28
107.01	1.39	1.47	0.636	1.81	2.35
108.01	0.902	1.13	0.410	1.23	1.69
108.02	0.927	1.16	0.422	1.27	1.75
109.01	1.94	1.99	0.893	2.51	3.23
110.01	1.14	1.10	0.529	1.48	1.83
111.01	0.712	0.476	0.287	0.695	0.749
112.01	0.552	0.357	0.227	0.534	0.571
113.01	0.281	0.170	0.131	0.255	0.270
114.01	5.92	4.89	7.87	8.02	10.8
114.02	9.03	7.31	11.9	12.1	16.1
114.03	17.1	14.1	22.5	23.1	31.2
114.04	28.6	23.6	38.4	40.2	55.7
114.05	37.0	30.9	50.6	52.7	74.0
114.06	88.0	73.1	112	121	165
114.07	95.6	80.1	120	132	179
114.08	104	87.6	129	143	195
114.09	107	90.0	132	147	200
114.10	113	95.6	138	155	211
114.11	122	103	147	167	225
114.12	124	105	148	170	229
114.13	141	120	165	194	262

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
114.14	147	126	171	203	275
114.15	148	127	171	204	276
114.16	314	265	351	430	581
114.17	337	285	369	460	622
114.18	343	290	373	468	634
114.19	346	293	376	472	639
114.20	350	297	378	477	647
114.21	376	323	400	517	702
114.22	381	327	403	523	710
114.23	382	328	404	525	712
114.24	386	332	406	530	719
114.25	392	338	409	539	731
115.01	2.76	2.17	3.48	3.60	4.80
116.01	5.11	4.18	6.78	6.89	9.35
117.01	3.83	3.08	4.37	5.02	6.58
118.01	8.25	7.36	12.1	12.4	18.2
119.01	9.69	8.25	12.5	13.4	18.7
119.02	15.4	12.9	18.8	20.9	28.4
119.03	42.3	34.3	51.3	56.2	74.7
119.04	49.1	40.1	58.7	65.2	86.7
120.01	3.93	3.24	4.43	5.21	6.90
121.01	5.61	4.29	6.71	7.29	9.46
121.02	14.5	11.3	17.5	18.9	24.7
121.03	18.9	14.7	22.6	24.6	32.0
121.04	25.0	19.7	30.1	32.7	42.8
122.01	6.69	5.28	8.24	8.77	11.5
123.01	3.47	2.69	4.07	4.49	5.83
124.01	4.99	4.19	6.28	6.71	9.10
125.01	4.22	3.47	4.52	5.51	7.22
126.01	7.29	6.75	8.23	10.0	13.9
127.01	5.11	4.37	5.28	6.67	8.81
128.01	4.38	3.94	4.23	5.77	7.60
129.01	3.58	3.11	3.29	4.64	6.02
129.02	6.78	5.80	6.33	8.93	11.1
129.03	8.76	7.45	8.04	11.5	14.3
130.01	2.21	1.87	2.01	2.88	3.56
131.01	1.64	1.25	1.66	2.14	2.50
131.02	6.96	6.37	7.36	9.76	13.1
131.03	10.6	9.79	10.7	14.8	20.0
132.01	2.88	2.34	2.17	3.69	4.71
133.01	8.17	5.99	9.85	10.6	13.9
133.02	17.6	13.0	20.9	22.8	29.7
133.03	28.3	21.3	34.3	37.2	49.4
133.04	32.2	24.2	38.8	42.3	55.7

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
133.05	40.5	30.9	48.2	53.3	70.2
133.06	40.7	31.1	48.5	53.6	70.5
133.07	71.8	56.5	88.4	98.1	132
133.08	72.5	57.0	89.1	98.9	133
133.09	87.3	69.2	105	119	159
133.10	96.4	76.9	114	131	175
133.11	110	88.6	128	150	202
133.12	152	125	167	207	277
133.13	161	133	175	220	295
133.14	164	136	177	224	300
134.01	6.15	4.59	7.31	8.01	10.3
135.01	7.50	5.77	9.60	10.2	14.0
136.01	2.86	2.10	3.24	3.69	4.65
137.01	3.49	2.67	3.84	4.51	5.81
138.01	11.5	9.07	16.5	17.0	24.6
138.02	14.4	11.5	20.1	21.1	30.4
138.03	25.8	20.7	33.7	36.8	51.4
139.01	5.30	4.30	6.12	7.11	9.61
139.02	10.1	8.44	12.3	14.2	19.2
140.01	0.802	0.406	0.741	0.770	0.828
141.01	7.99	6.53	8.51	10.4	13.6
141.02	9.52	7.72	10.0	12.4	16.1
142.01	1.06	0.778	1.09	1.36	1.58
143.01	6.30	5.13	6.25	8.20	10.5
144.01	5.92	4.93	5.68	7.76	10.1
145.01	4.34	3.50	4.11	5.65	7.36
145.02	11.9	10.2	11.6	15.9	21.3
145.03	18.6	15.8	17.5	24.7	32.9
145.04	35.9	30.8	32.6	48.1	63.7
145.05	36.0	30.9	32.7	48.3	63.9
145.06	42.0	35.7	37.6	56.1	73.6
146.01	5.62	5.02	5.72	7.75	10.6
147.01	3.33	2.65	2.87	4.29	5.49
148.01	8.18	7.39	7.33	11.2	15.4
148.02	12.7	11.1	11.3	17.2	22.9
148.03	17.1	14.9	15.0	23.0	30.4
149.01	3.73	3.13	3.19	4.88	6.39
150.01	3.68	3.20	3.00	4.88	6.48
151.01	3.23	2.66	2.59	4.16	5.41
152.01	1.33	1.05	1.20	1.78	2.09
153.01	4.28	3.70	3.62	5.60	7.32
154.01	1.78	1.44	1.41	2.32	2.88
154.02	2.30	1.87	1.93	3.10	3.72
155.01	6.30	5.97	5.68	9.09	12.9

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
155.02	6.39	6.05	5.78	9.23	13.1
155.03	10.9	9.98	9.49	15.3	21.0
155.04	11.4	10.4	9.91	16.0	21.7
155.05	18.4	16.5	15.3	25.3	34.1
155.06	21.8	19.5	17.9	29.7	39.9
156.01	3.68	3.30	3.02	4.95	6.68
156.02	3.84	3.44	3.17	5.19	6.93
157.01	2.74	2.46	2.14	3.61	4.92
158.01	1.48	1.26	1.09	1.93	2.51
159.01	1.44	1.18	1.05	1.87	2.36
160.01	2.89	2.58	2.17	3.77	5.08
160.02	3.11	2.76	2.35	4.08	5.43
161.01	5.54	5.33	4.38	7.73	10.7
162.01	0.682	0.391	0.428	0.675	0.728
162.02	3.44	3.29	2.65	4.77	6.39
162.03	3.51	3.35	2.70	4.86	6.49
163.01	0.807	0.614	0.692	0.997	1.13
163.02	2.19	1.86	1.90	2.94	3.55
163.03	6.56	5.97	5.46	9.02	11.9
163.04	9.87	9.05	8.00	13.6	18.3
163.05	21.1	19.6	17.1	30.2	42.0
163.06	21.9	20.4	17.7	31.4	43.8
164.01	7.09	6.65	6.08	10.5	15.3
165.01	3.53	3.44	2.79	5.14	7.25
165.02	4.18	3.98	3.22	6.01	8.29
166.01	1.16	0.988	0.725	1.50	1.88
166.02	2.43	2.19	1.49	3.15	4.10
166.03	4.15	4.01	2.54	5.52	7.40
167.01	0.898	0.729	0.544	1.19	1.40
167.02	1.69	1.40	1.02	2.26	2.66
168.01	2.43	2.12	1.36	3.13	4.09
168.02	2.45	2.13	1.37	3.16	4.12
169.01	4.30	4.19	2.25	5.72	7.62
169.02	4.94	4.77	2.58	6.59	8.61
170.01	0.793	0.650	0.429	0.979	1.11
171.01	0.834	0.744	0.495	1.10	1.34
172.01	0.594	0.462	0.303	0.710	0.797
173.01	1.06	0.820	0.754	1.36	1.58
173.02	7.80	6.98	5.67	10.5	13.5
173.03	15.2	13.9	10.9	20.4	26.6
173.04	16.5	15.3	11.8	22.3	29.2
173.05	21.4	20.2	15.2	29.1	38.9
173.06	27.5	26.8	18.9	37.5	51.3
173.07	50.0	47.0	33.8	66.9	89.9

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
174.01	0.929	0.637	0.641	1.09	1.22
175.01	0.652	0.512	0.468	0.854	1.00
176.01	0.693	0.458	0.465	0.779	0.863
176.02	3.14	2.72	2.22	4.11	5.22
177.01	2.27	2.35	1.67	3.27	5.12
178.01	1.72	1.72	1.17	2.32	3.13
179.01	0.314	0.285	0.193	0.407	0.520
180.01	2.28	2.62	1.59	3.41	5.08
180.02	2.62	2.86	1.83	3.77	5.57
181.01	1.79	1.89	1.03	2.39	3.22
182.01	0.337	0.229	0.173	0.350	0.379
183.01	2.61	2.15	1.92	3.47	4.17
183.02	5.03	4.27	3.55	6.58	8.28
183.03	8.95	7.82	6.30	11.7	15.0
183.04	14.1	12.7	9.98	18.7	24.1
183.05	14.7	13.2	10.3	19.5	25.1
183.06	22.4	20.2	14.9	29.1	38.2
184.01	0.575	0.381	0.377	0.652	0.720
184.02	3.03	2.74	2.14	4.00	5.21
185.01	0.803	0.467	0.516	0.804	0.866
185.02	2.53	2.23	1.84	3.39	4.21
186.01	1.16	0.997	0.714	1.52	1.85
187.01	1.44	1.29	0.928	1.87	2.40
187.02	2.73	2.49	1.75	3.55	4.60
188.01	0.528	0.379	0.299	0.603	0.667
189.01	0.597	0.394	0.331	0.636	0.692
190.01	0.427	0.265	0.237	0.424	0.454
191.01	0.882	0.776	0.561	1.17	1.41
192.01	1.40	0.927	0.644	1.38	1.49
193.01	1.24	0.768	0.586	1.16	1.24
194.01	0.239	0.133	0.110	0.196	0.207
195.01	0.435	0.273	0.195	0.406	0.431
196.01	0.490	0.304	0.226	0.462	0.492
197.01	0.411	0.251	0.217	0.371	0.390
198.01	0.584	0.365	0.251	0.543	0.576
199.01	0.940	0.838	0.502	1.20	1.39
199.02	1.32	1.13	0.698	1.63	1.86
200.01	0.249	0.143	0.115	0.209	0.220
201.01	0.550	0.342	0.236	0.506	0.535
202.01	3.09	3.58	1.99	4.45	6.36
203.01	0.772	0.497	0.323	0.723	0.773
204.01	0.569	0.338	0.241	0.497	0.522
205.01	0.690	0.427	0.303	0.630	0.666
206.01	0.195	0.111	0.0954	0.158	0.165

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
207.01	0.675	0.404	0.333	0.581	0.607
208.01	0.759	0.625	0.335	0.878	0.979
208.02	1.07	0.856	0.530	1.20	1.33
208.03	1.93	1.64	0.942	2.24	2.53
208.04	3.50	3.70	1.81	4.70	5.72
208.05	4.23	4.79	2.21	5.93	7.46
208.06	5.44	5.95	2.62	7.45	9.82
209.01	0.188	0.107	0.0858	0.149	0.156
210.01	0.317	0.213	0.151	0.297	0.314
211.01	0.333	0.214	0.166	0.308	0.325
211.02	0.397	0.251	0.196	0.361	0.380
211.03	1.10	0.943	0.609	1.27	1.44
212.01	0.180	0.102	0.0884	0.139	0.145
_junc_10	21.5	19.3	17.6	29.3	39.5
_junc_108	0.552	0.423	0.226	0.544	0.578
_junc_11	336	284	368	459	621
_junc_111	2.35	2.57	0.966	3.18	3.79
_junc_114	1.36	1.71	0.593	1.85	2.52
_junc_12	10.9	9.70	7.90	14.6	18.7
_junc_13	101	84.4	126	138	188
_junc_138	7.44	6.49	6.31	9.63	12.5
_junc_14	85.4	70.6	109	118	160
_junc_142	5.79	4.97	5.30	7.52	9.57
_junc_143	163	135	177	223	298
_junc_15	312	262	349	426	576
_junc_16	342	290	373	467	633
_junc_165	24.9	26.8	11.1	34.3	42.9
_junc_168	23.3	24.8	10.4	31.9	39.7
_junc_17	95.3	79.8	120	131	179
_junc_174	16.5	13.7	9.10	22.1	28.4
_junc_18	36.8	30.8	50.5	52.5	73.8
_junc_181	0.105	0.0672	0.0432	0.0834	0.0870
_junc_185	0.116	0.0775	0.0438	0.0961	0.101
_junc_186	0.336	0.234	0.127	0.290	0.304
_junc_187	1.84	2.20	0.826	2.46	3.11
_junc_19	135	115	159	185	249
_junc_193	8.06	7.01	5.69	10.6	13.5
_junc_194	11.5	10.0	8.14	15.1	19.2
_junc_199	13.5	10.5	17.4	17.9	23.5
_junc_2	156	129	170	213	285
_junc_20	111	93.8	136	153	207
_junc_204	6.16	5.09	3.61	8.04	10.6
_junc_21	122	103	146	167	225
_junc_22	349	296	378	477	646

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
_junc_228	0.577	0.352	0.285	0.500	0.525
_junc_23	354	301	382	483	655
_junc_231	144	123	167	198	267
_junc_232	18.6	15.4	15.6	24.8	31.9
_junc_233	26.4	21.6	28.0	35.4	46.0
_junc_234	347	279	376	469	628
_junc_24	21.0	17.2	26.8	28.1	37.8
_junc_25	17.0	15.5	14.1	24.1	33.4
_junc_26	14.1	11.5	18.6	19.0	25.5
_junc_263	8.48	6.55	11.2	11.1	14.8
_junc_265	8.33	6.44	11.8	11.2	14.5
_junc_27	8.68	7.06	11.4	11.6	15.6
_junc_28	382	328	404	525	712
_junc_29	380	327	403	522	709
_junc_3	14.1	12.8	12.0	19.6	26.7
_junc_30	384	330	405	528	716
_junc_31	11.6	9.86	10.2	15.2	19.2
_junc_32	390	336	408	536	727
_junc_324	352	282	378	475	636
_junc_328	414	342	408	558	746
_junc_329	23.9	23.1	17.0	32.9	44.4
_junc_33	11.2	8.76	13.0	15.0	18.8
_junc_330	49.8	46.7	33.7	66.6	89.3
_junc_331	840	724	832	1159	1579
_junc_34	18.2	14.7	20.1	24.2	31.0
_junc_35	6.04	4.84	7.32	8.18	10.5
_junc_36	341	275	372	461	617
_junc_37	12.5	10.1	17.0	17.0	22.9
_junc_38	10.5	8.03	10.6	13.8	17.6
_junc_39	382	308	394	515	689
_junc_4	13.6	11.5	16.9	18.6	25.6
_junc_40	18.0	14.6	23.9	24.2	32.8
_junc_41	11.7	9.22	6.65	15.3	19.8
_junc_42	21.5	16.5	21.6	28.9	38.4
_junc_43	55.0	43.1	55.4	73.9	97.4
_junc_44	356	286	381	481	643
_junc_45	315	256	352	427	573
_junc_46	26.4	21.4	35.7	35.9	49.0
_junc_47	361	290	383	487	652
_junc_48	259	212	296	351	471
_junc_49	13.2	13.1	5.97	17.6	22.5
_junc_5	12.3	9.57	15.0	16.1	21.0
_junc_50	39.1	31.7	52.2	53.3	72.4
_junc_51	253	208	292	343	460

Subcatchment ID	Peak Discharge (m^3/s)				
	2016	2012	2011	1985	1971
_junc_52	45.4	36.3	58.8	61.5	82.7
_junc_53	12.4	9.37	11.3	17.0	23.3
_junc_54	63.8	50.4	81.0	85.8	114
_junc_55	72.1	57.0	90.4	97.0	129
_junc_56	232	192	275	315	421
_junc_57	95.4	76.7	123	130	174
_junc_58	219	182	266	298	399
_junc_59	205	170	254	279	372
_junc_6	40.3	32.6	49.0	53.6	71.1
_junc_60	214	177	262	291	389
_junc_61	19.7	16.1	26.6	26.8	35.9
_junc_62	98.3	83.0	118	131	174
_junc_63	87.8	73.9	106	117	154
_junc_64	40.2	32.4	51.9	52.7	68.9
_junc_65	11.4	9.40	11.2	14.9	19.1
_junc_66	74.5	62.9	92.8	99.4	132
_junc_67	44.9	36.4	57.6	59.0	77.4
_junc_68	32.1	25.6	41.7	41.9	54.4
_junc_69	23.9	19.0	31.7	31.4	40.7
_junc_7	46.6	37.8	55.8	61.7	81.9
_junc_70	18.3	14.5	24.3	24.0	31.0
_junc_71	14.9	13.7	19.1	20.7	28.5
_junc_72	26.5	23.8	31.9	36.1	49.1
_junc_73	12.9	10.5	17.0	17.0	22.1
_junc_74	8.38	7.33	8.96	11.1	14.7
_junc_75	24.5	19.7	32.4	35.2	49.4
_junc_76	9.96	8.52	9.83	13.4	17.9
_junc_77	25.1	18.8	30.5	33.0	43.6
_junc_78	31.2	23.4	37.5	40.9	54.0
_junc_79	35.7	26.9	42.6	46.8	61.5
_junc_8	18.0	14.0	21.5	23.3	30.5
_junc_80	14.3	10.6	17.2	18.6	24.2
_junc_81	66.4	51.6	82.0	90.4	122
_junc_82	15.3	12.8	14.5	20.2	26.7
_junc_83	11.9	10.5	10.5	16.0	21.7
_junc_84	82.0	64.6	99.1	111	149
_junc_85	16.4	14.3	14.3	22.0	29.4
_junc_86	102	81.7	120	138	185
_junc_87	35.7	30.6	32.2	47.8	63.3
_junc_88	39.2	33.5	35.3	52.5	69.3
_junc_89	93.6	74.2	111	127	169
_junc_9	23.9	18.9	28.9	31.3	41.0
_junc_90	151	124	165	205	275
_junc_91	10.2	9.44	8.96	14.4	19.9

APPENDIX F

FLOOD FREQUENCY ANALYSIS FOR PAMBULA RIVER AT LOCHIEL GAUGE

F1 Flood Frequency Analysis

Overview

As discussed in the main report, a stream gauge is located on the Pambula River at Lochiel. The gauge provides continuous water level records dating back to 1966. When combined with the rating curve/table for the gauge, this length of record is sufficient to support a Flood Frequency Analysis (FFA).

The following sections outline the FFA that was completed for the Lochiel stream gauge. The FFA was completed in accordance with the 2019 revision of Australian Rainfall and Runoff (ARR2019) (Geoscience Australia, 2019)

Rating Curve

Stream gauges such as the one at Lochiel records flood level information only. To convert the flood level information to flows/discharges (which are required for the FFA), a rating curve is required. The WaterNSW rating curve for the gauge is provided in Figure F1. Figure F1 also shows all "ratings" (i.e., water level and corresponding flow information that was measured at the gauge) that have been captured since the gauge was installed in 1966. The ratings form the basis for the rating curve.

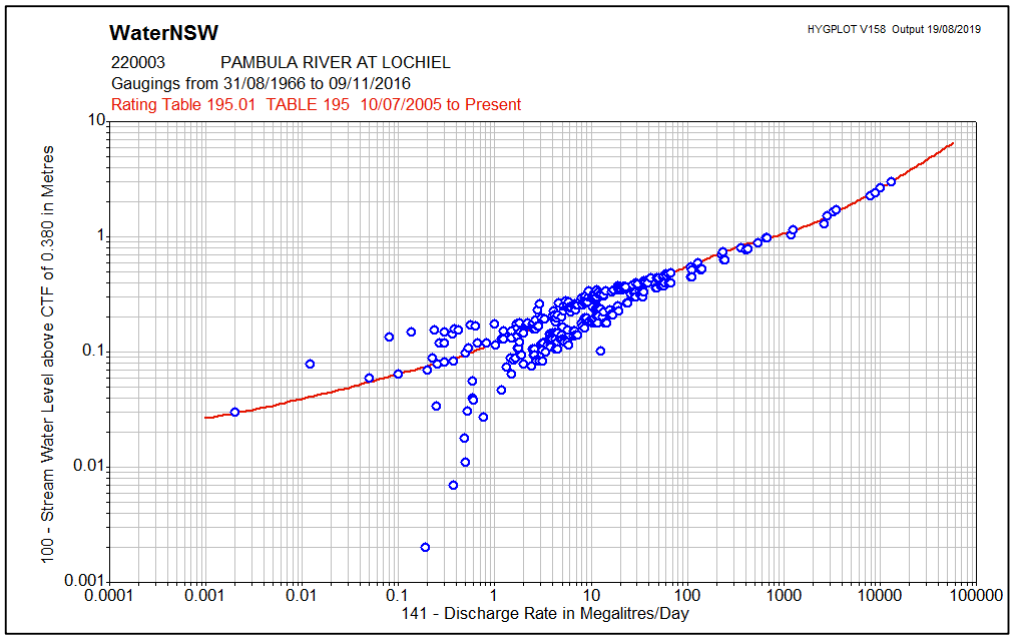


Figure F1 **Rating curve (red) and recorded ratings (blue) for Pambula River at Lochiel stream gauge**

A shown in Figure F1, there is a noticeable "scatter" of ratings around the rating curve, particularly at lower water levels. Therefore, to confirm the reliability of the WaterNSW rating curve before application as part of the FFA, a "synthetic" rating curve was prepared. This was prepared using the TUFLOW model flow and water level results at the Lochiel gauge location.

The resulting synthetic rating curve is shown in Figure F2. The existing waterNSW rating curve is also included in Figure F2.

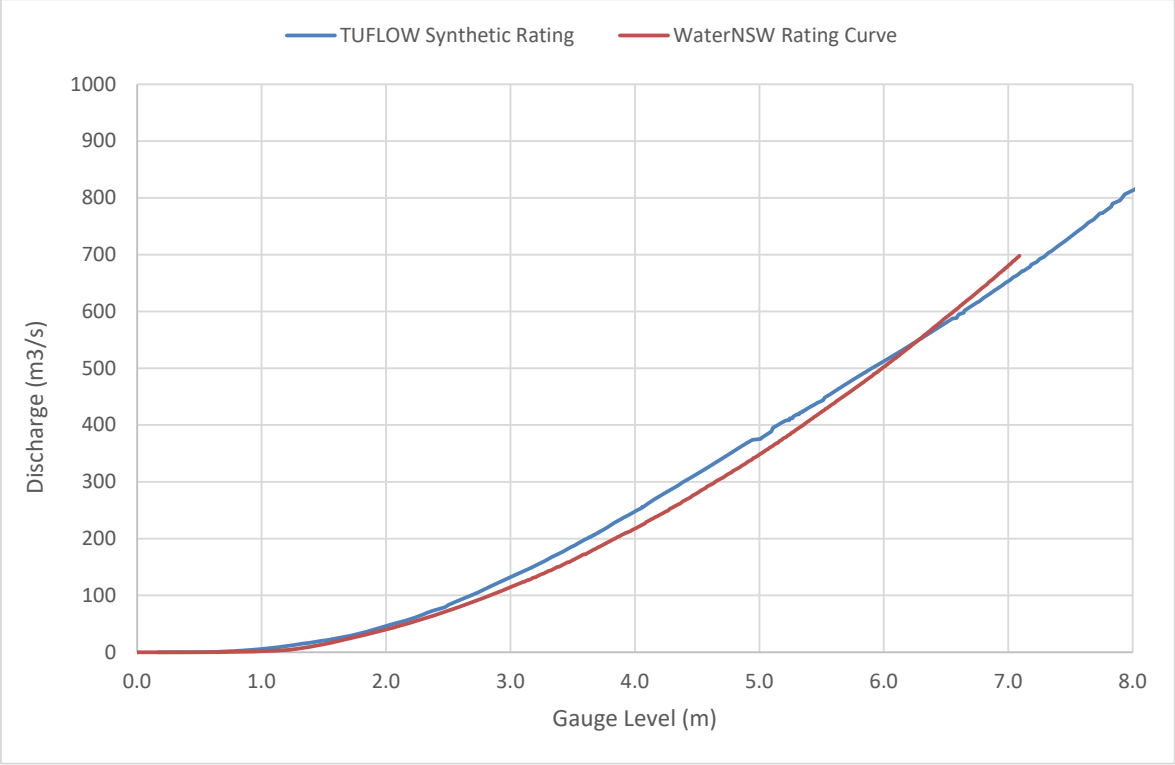


Figure F2 Comparison between WaterNSW rating curve and TUFLOW synthetic rating curve

The comparison in Figure F2 shows a good overall agreement between the two rating curves. The maximum difference in discharge between the two curves for a set gauge level is 30 m^3/s which is negligible when looking at the magnitude of the discharges under consideration as part of the current flood study (i.e., a minimum of ten times larger than the 30 m^3/s difference). As a result, it is considered that the existing WaterNSW rating curve is suitable for application as part of the FFA.

Censoring of Flows

Censoring flows (i.e., removing low flows from the analysis) is typically undertaken as part of a FFA. This is usually done to improve the fit of the observed data to the probability distribution.

As part of this study, the ARR2019 recommended Grubbs-Beck test was used to censor low flows in the peak annual series for the gauge. This removed 27 low flows that fell below approximately 86 m^3/s. The lowest uncensored flow is 109 m^3/s.

Multiple probability distributions were fitted to both the censored and non-censured flows to confirm which dataset provided the best "fit". An example of one such comparison is provided in Figure F3 for the Generalised Extreme Value (GEV) distribution.

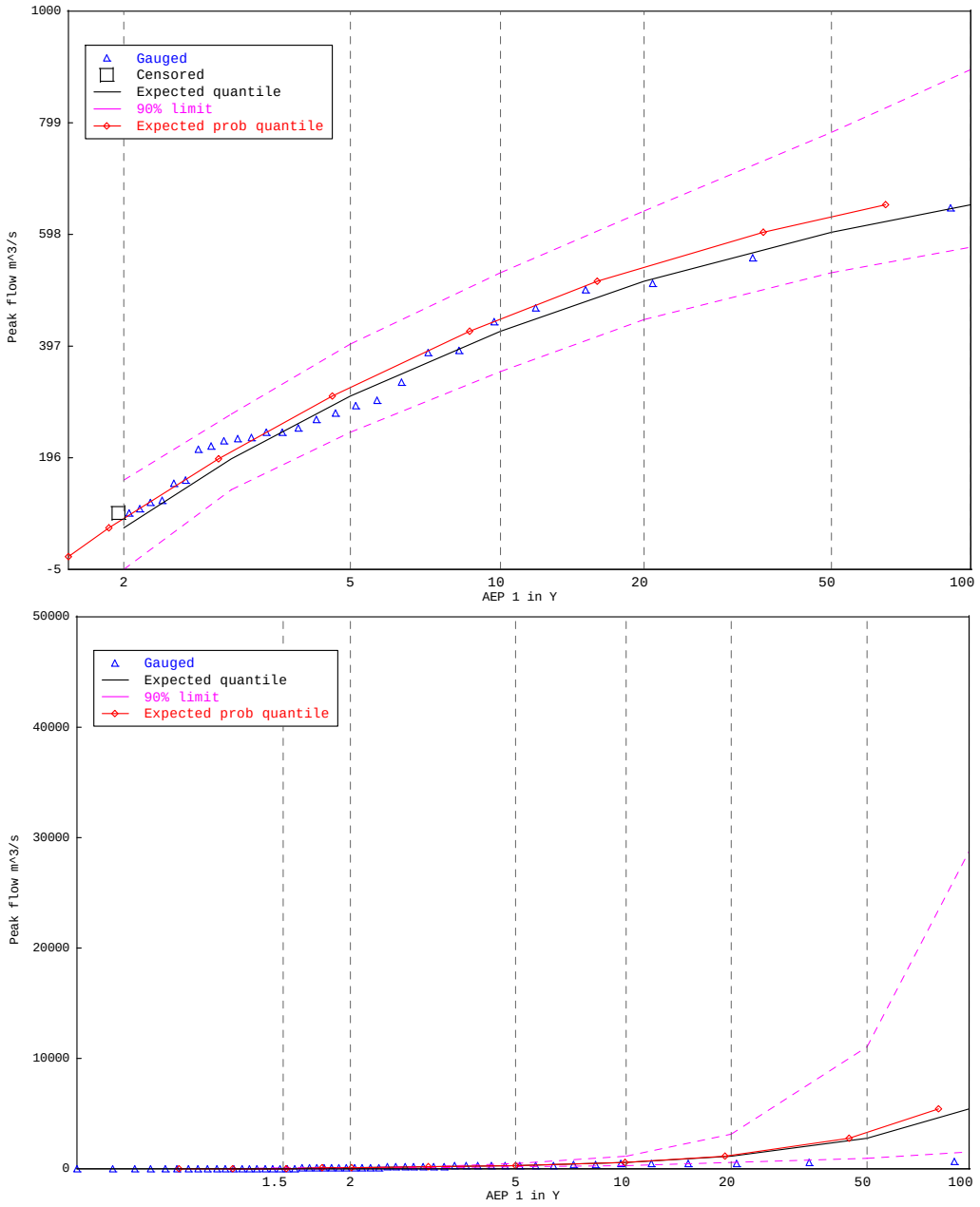


Figure F3 Comparison between censored (top) and uncensored GEV (bottom) probability distributions

Figure F3 shows that the censored flows fit the GEV distribution much better, with all plotting positions for historic floods between the 90% limits in the censored flow distribution. In the uncensored flow distribution, both the low flows and the high flows do not fit the distribution well, and the 90% limits are significantly larger than for the censored flows. As a result, the censored flows only were used for further analysis.

Probability Distribution

A range of probability distributions were tested using the FLIKE software against the recorded data to determine the distribution that provided the best fit. The probability distributions investigated included:

- Gumbel
- Log Normal
- Log Pearson Type III (LP3)
- Generalised Extreme Value (GEV)

Figure F4 to Figure F7 show the probability plots for all of these distributions based upon the censored flow series. A qualitative assessment was undertaken by observing the plotting positions against the expected peak quantile and it was found that LP3 and GEV tended to best fit the data. The Log Normal distribution produced plotting positions that fell outside the 90% limits and is not considered suitable.

Overall, the GEV appears to provide the best overall "fit" to the historic stream gauging information.

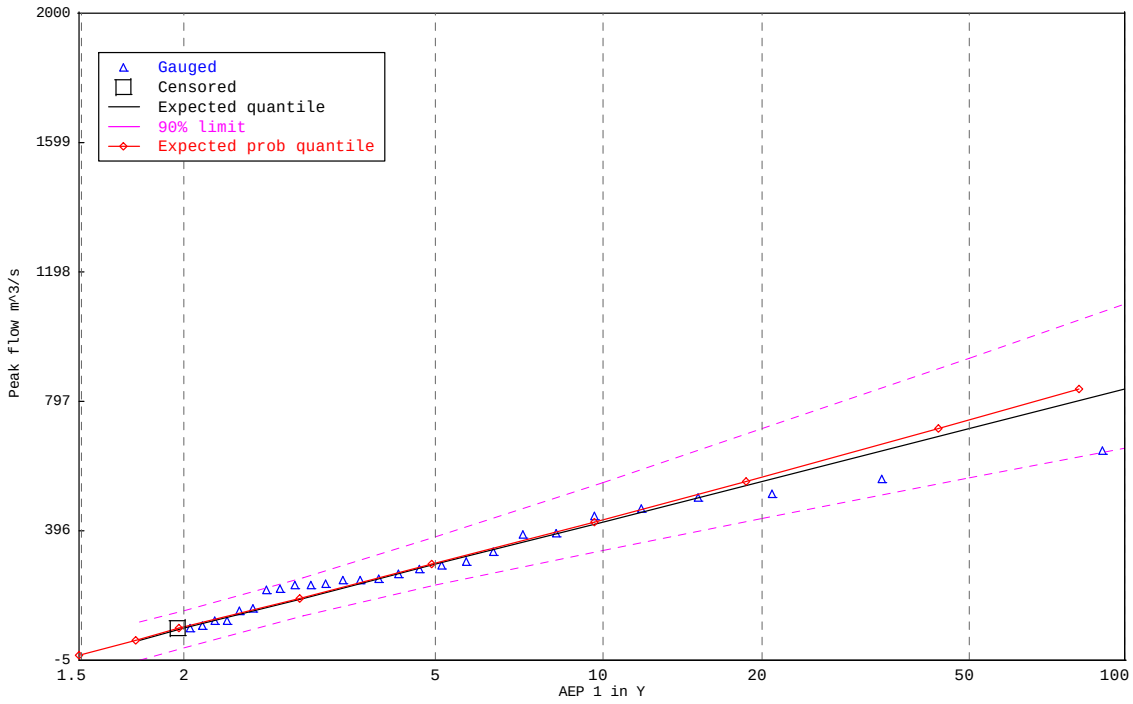


Figure F4 Gumbel Probability Plot (Censored)

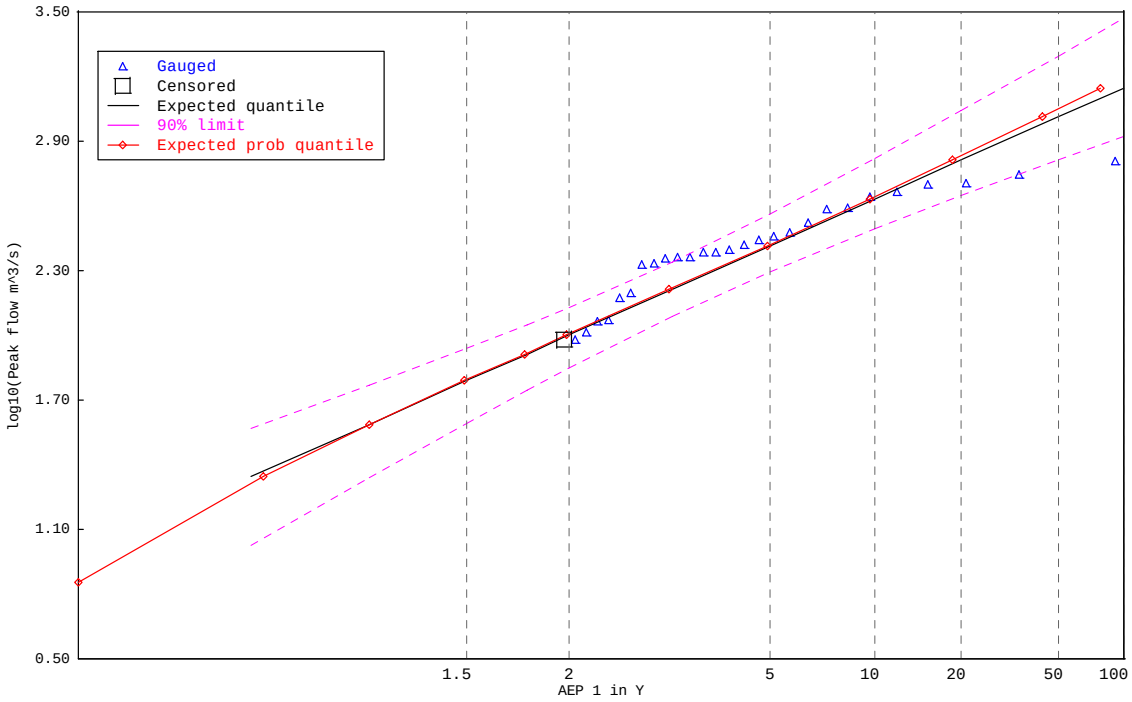


Figure F5 Log Normal Probability Plot (Censored)

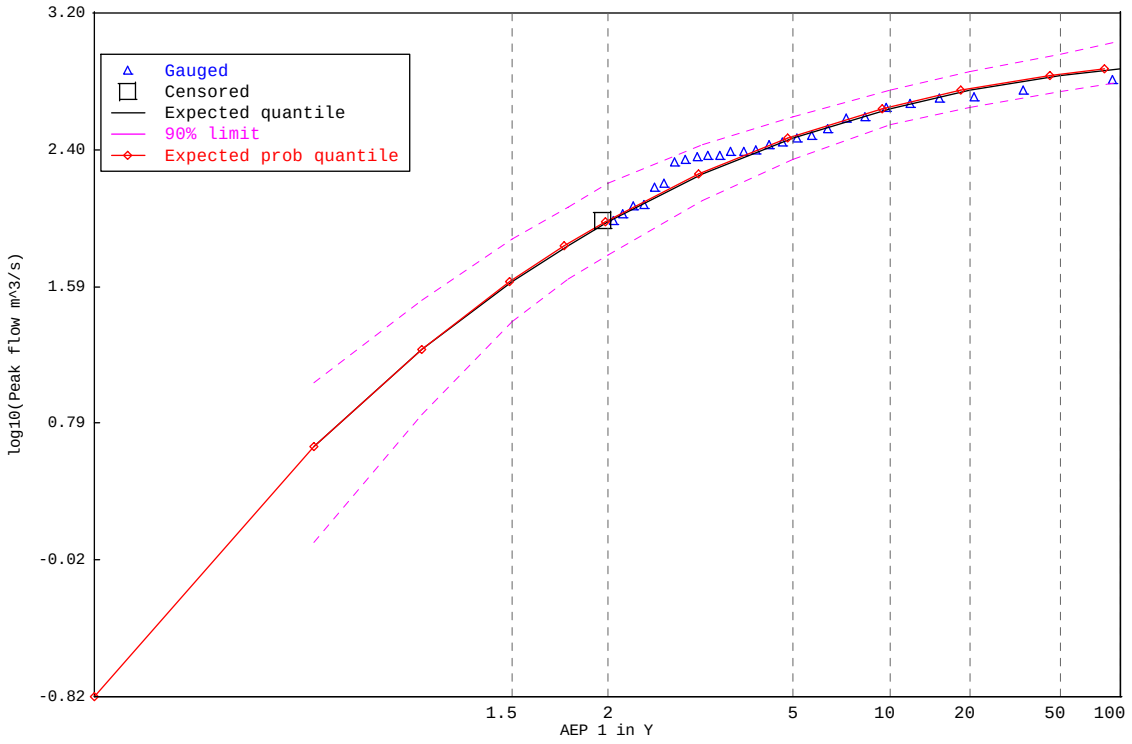


Figure F6 LP3 Probability Plot (Censored)

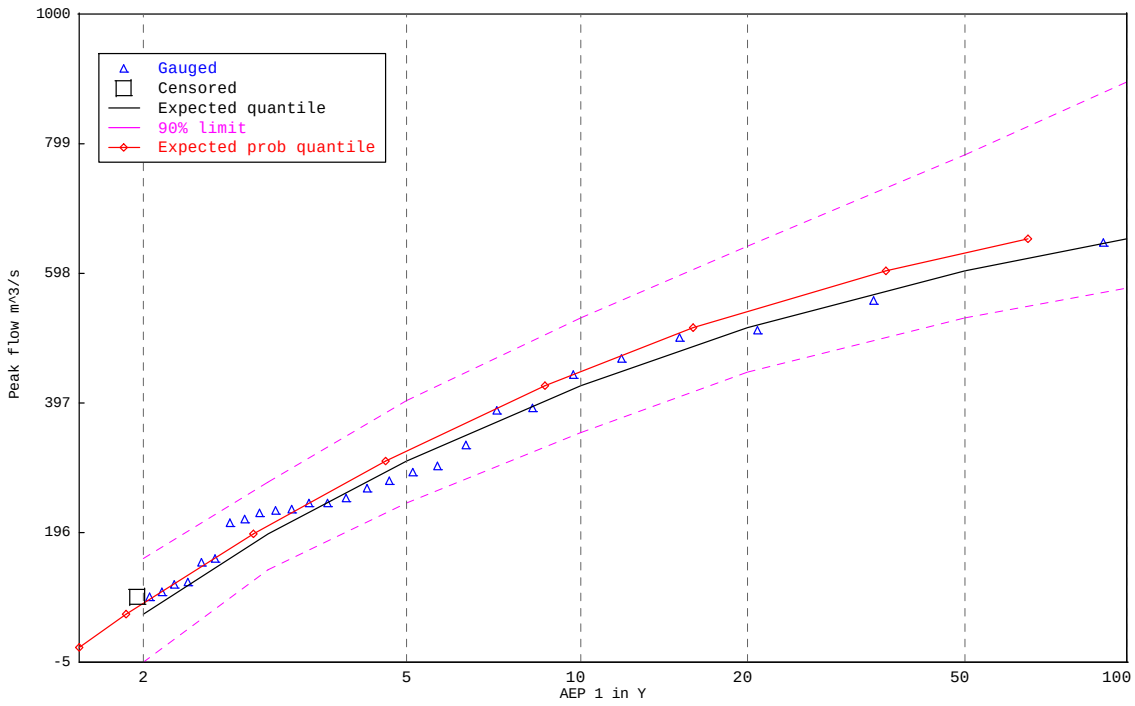


Figure F7 GEV Probability Plot (Censored)

The peak design discharge estimates provided by each probability distribution at the Lochiel gauge is summarised in Table 1. It shows that apart from the log normal distribution, there is a reasonable level of agreements between the three remaining distributions. For events rarer than the 2% AEP flood, the peak discharge estimates start to diverge although there is still a reasonable correlation between the LP3 and GEV which are considered to provide the best overall fits.

Table 1 Flood Frequency Analysis Peak Design Discharge Estimates

AEP	Peak Flow (m^3/s)			
	Gumbel	Log Normal	LP3	GEV
10%	423	429	433	424
5%	549	649	554	513
2%	712	1032	676	601
1%	834	1406	744	652
0.5%	956	1867	796	693
0.2%	1117	2631	844	735

APPENDIX G
DESIGN RAINFALL

Coastal Intensity-Frequency-Duration Data

Duration	Rainfall Depth (mm)						
	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
1 min	3.88	4.60	5.60	6.39	7.49	9.00	-
2 min	6.26	7.34	8.72	9.75	11.4	13.7	-
3 min	8.65	10.2	12.1	13.6	15.9	19.2	-
4 min	10.8	12.7	15.3	17.3	20.2	24.3	-
5 min	12.7	15.0	18.2	20.6	24.1	29.0	-
10 min	19.6	23.3	28.5	32.7	38.3	46.0	-
15 min	24.1	28.6	35.0	40.2	47.2	56.7	75.0
20 min	27.3	32.5	39.7	45.5	53.4	64.1	-
25 min	29.9	35.5	43.4	49.6	58.2	69.9	-
30 min	32.1	38.1	46.4	53.0	62.1	74.6	110
45 min	37.4	44.2	53.5	60.9	71.3	85.7	141
1 hour	41.6	49.2	59.3	67.2	78.6	94.5	173
1.5 hour	48.8	57.4	68.9	77.8	91.1	109	226
2 hour	55.1	64.7	77.5	87.3	102	123	259
3 hour	66.1	77.6	92.9	105	123	147	320
4.5 hour	80.6	94.7	114	128	151	181	-
6 hour	93.4	110	132	150	176	211	413
9 hour	115	136	165	189	221	266	-
12 hour	134	159	194	222	261	313	-
18 hour	163	194	240	277	325	390	-
24 hour	184	222	275	319	374	450	-
30 hour	201	243	303	352	415	500	-
36 hour	214	260	324	379	445	537	-
48 hour	233	284	356	416	485	586	-
72 hour	253	310	390	457	528	636	-
96 hour	263	323	406	476	549	660	-
120 hour	268	331	415	485	561	674	-
144 hour	272	336	420	491	569	683	-
168 hour	276	340	425	496	575	691	-

Central Intensity-Frequency-Duration Data

Duration	Rainfall Depth (mm)						
	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
1 min	3.90	4.62	5.63	6.43	7.55	9.07	-
2 min	6.22	7.31	8.68	9.73	11.3	13.6	-
3 min	8.62	10.1	12.1	13.6	15.9	19.1	-
4 min	10.8	12.7	15.3	17.3	20.3	24.4	-
5 min	12.7	15.1	18.2	20.7	24.2	29.1	-
10 min	19.7	23.5	28.7	32.9	38.7	46.5	-
15 min	24.2	28.8	35.3	40.6	47.6	57.2	101
20 min	27.5	32.7	40.0	45.9	53.9	64.7	-
25 min	30.0	35.7	43.6	50.0	58.6	70.4	-
30 min	32.2	38.2	46.6	53.3	62.5	75.1	148
45 min	37.4	44.2	53.6	61.0	71.5	85.9	188
1 hour	41.5	49.0	59.2	67.1	78.6	94.5	228
1.5 hour	48.5	57.1	68.6	77.5	90.7	109	294
2 hour	54.6	64.2	76.9	86.7	102	122	338
3 hour	65.5	76.9	92.0	104	122	146	412
4.5 hour	79.9	93.9	113	127	149	179	-
6 hour	92.8	109	131	149	175	210	544
9 hour	115	136	165	188	221	265	-
12 hour	134	159	194	222	262	314	-
18 hour	165	197	242	280	329	394	-
24 hour	188	226	280	325	381	458	-
30 hour	206	249	310	361	425	512	-
36 hour	221	267	334	389	458	552	-
48 hour	241	294	368	431	503	607	-
72 hour	264	324	407	477	551	663	-
96 hour	275	338	425	497	574	689	-
120 hour	281	346	434	507	586	703	-
144 hour	284	350	438	512	593	711	-
168 hour	287	353	442	515	597	717	-

Upper NW Intensity-Frequency-Duration Data

Duration	Rainfall Depth (mm)						
	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
1 min	3.93	4.67	5.70	6.52	7.65	9.18	-
2 min	6.21	7.30	8.68	9.74	11.3	13.6	-
3 min	8.62	10.2	12.2	13.7	16.0	19.2	-
4 min	10.8	12.8	15.4	17.5	20.4	24.5	-
5 min	12.8	15.2	18.4	20.9	24.5	29.4	-
10 min	20.0	23.8	29.2	33.5	39.3	47.2	-
15 min	24.5	29.2	35.9	41.3	48.5	58.2	86.0
20 min	27.8	33.1	40.6	46.7	54.8	65.7	-
25 min	30.3	36.1	44.2	50.7	59.5	71.4	-
30 min	32.5	38.7	47.2	54.0	63.4	76.1	125
45 min	37.6	44.5	54.0	61.6	72.1	86.6	159
1 hour	41.6	49.2	59.4	67.5	79.0	94.9	195
1.5 hour	48.4	57.1	68.6	77.5	90.7	109	253
2 hour	54.4	64.0	76.7	86.5	101	122	289
3 hour	65.3	76.6	91.7	103	121	145	358
4.5 hour	79.9	93.7	112	127	149	179	-
6 hour	93.1	109	131	149	175	210	462
9 hour	116	137	166	189	223	267	-
12 hour	137	162	197	225	265	318	-
18 hour	170	203	249	287	337	405	-
24 hour	196	235	291	337	395	475	-
30 hour	217	261	325	378	445	536	-
36 hour	233	283	352	411	483	583	-
48 hour	258	314	393	460	536	647	-
72 hour	285	350	439	514	594	714	-
96 hour	298	367	460	539	621	745	-
120 hour	304	375	470	550	634	761	-
144 hour	307	379	474	554	641	768	-
168 hour	309	381	476	555	643	772	-

Upper SW Intensity-Frequency-Duration Data

Duration	Rainfall Depth (mm)						
	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP	0.2% AEP	PMF
1 min	4.06	4.82	5.86	6.70	7.83	9.36	-
2 min	6.34	7.44	8.87	10.0	11.6	13.8	-
3 min	8.8	10.4	12.4	14.0	16.3	19.5	-
4 min	11.1	13.1	15.8	17.9	20.8	24.9	-
5 min	13.2	15.6	18.9	21.4	25.0	29.9	-
10 min	20.6	24.5	30.0	34.4	40.2	48.1	-
15 min	25.3	30.1	36.9	42.4	49.6	59.2	75.0
20 min	28.7	34.1	41.7	47.9	56.0	66.9	-
25 min	31.3	37.2	45.4	52.0	60.8	72.7	-
30 min	33.5	39.7	48.4	55.4	64.7	77.3	110
45 min	38.6	45.7	55.4	63.1	73.6	88.0	141
1 hour	42.7	50.4	60.8	69.1	80.6	96.4	173
1.5 hour	49.6	58.4	70.2	79.4	92.6	111	226
2 hour	55.8	65.5	78.6	88.7	104	124	259
3 hour	66.9	78.5	94.1	106	124	148	320
4.5 hour	82.1	96.3	116	131	153	182	-
6 hour	95.9	113	135	153	180	215	413
9 hour	120	142	172	195	229	274	-
12 hour	142	168	204	233	273	326	-
18 hour	177	210	258	297	348	416	-
24 hour	205	244	301	348	407	486	-
30 hour	226	271	336	390	458	550	-
36 hour	244	293	364	423	496	597	-
48 hour	269	325	405	472	549	661	-
72 hour	297	360	451	526	606	727	-
96 hour	310	377	471	550	633	757	-
120 hour	316	385	481	561	646	773	-
144 hour	319	390	486	566	654	782	-
168 hour	321	392	488	568	658	787	-

GSDM CALCULATION SHEET

LOCATION INFORMATION

Catchment Pambula & Yowaka Rivers Area 301 km^2

State New South Wales Duration Limit 6.0 hrs

Latitude 36.9669^0S Longitude 149.7995^0E

Portion of Area Considered:

Smooth, **S** = 0.00 (0.0 - 1.0) Rough, **R** = 1.00 (0.0 - 1.0)

ELEVATION ADJUSTMENT FACTOR (EAF)

Mean Elevation 202 m

Adjustment for Elevation (-0.05 per 300m above 1500m) 0.00

EAF = **1.00** (0.85 – 1.00)

MOISTURE ADJUSTMENT FACTOR (MAF)

MAF = **0.60** (0.40-1.00)

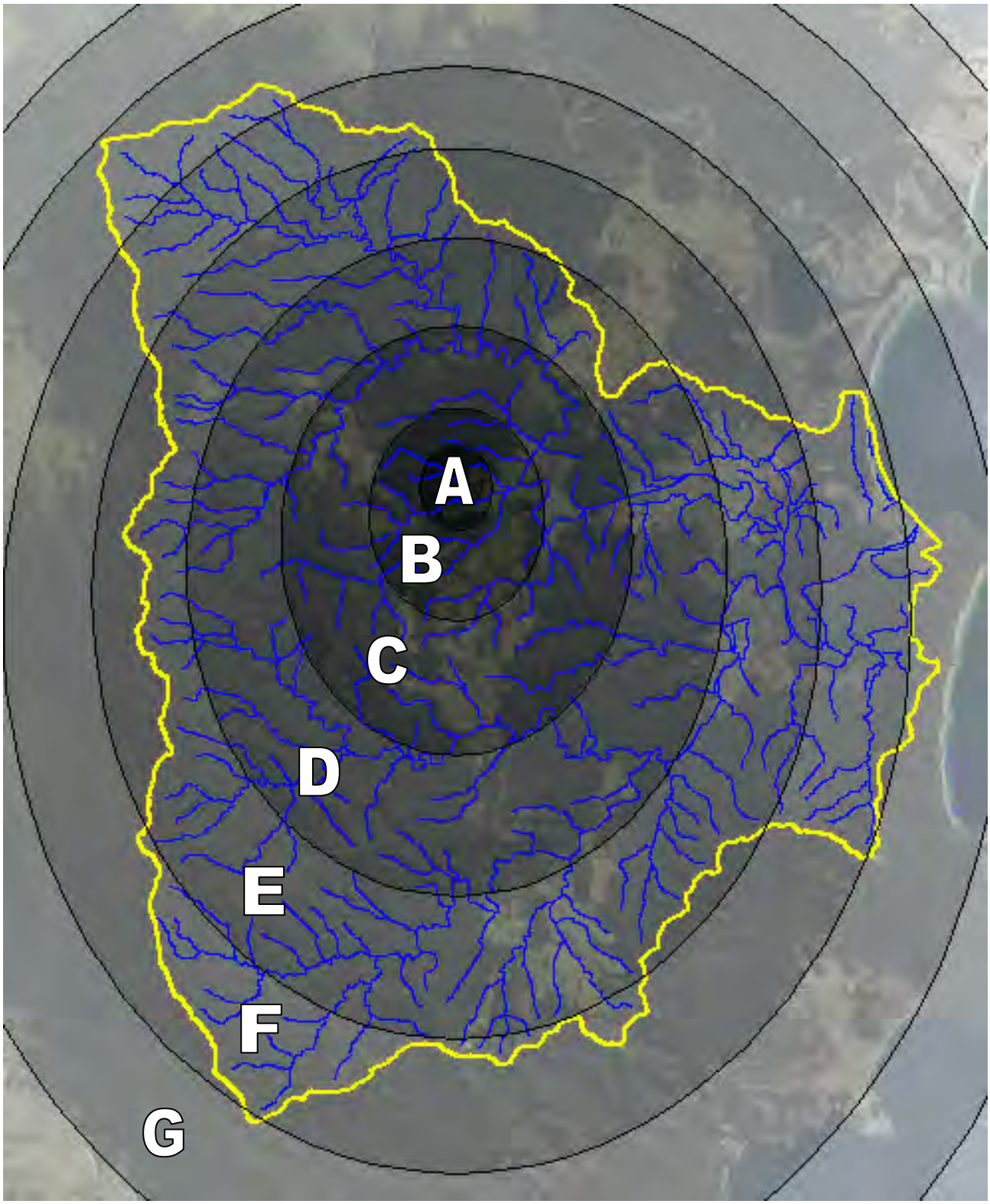
PMP VALUES (mm)

Duration (hours)	Initial Depth -Smooth (D_S)	Initial Depth -Rough (D_R)	PMP Estimate = (D_SxS + D_RxR) x MAF x EAF	Rounded PMP Estimate (nearest 10 mm)
0.25	140	140	84	80
0.50	204	204	123	120
0.75	260	260	156	160
1.00	315	315	189	190
1.50	362	412	247	250
2.00	412	473	284	280
2.50	446	539	323	320
3.00	479	584	350	350
4.00	545	660	396	400
5.00	589	709	426	430
6.00	627	756	454	450

Prepared By David. Tetley Date 07/02/2020

Checked By Chris Ryan Date 11/02/2020

GSDM SPATIAL DISTRIBUTION



GSDM SPATIAL DISTRIBUTION

DURATION = 0.25 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.58	2.58	232	139	359	359	139
B	13.36	15.94	204	122	1952	1592	119
C	48.92	64.86	177	106	6890	4938	101
D	85.30	150.16	157	94	14187	7297	86
E	96.53	246.69	145	87	21442	7255	75
F	50.51	297.20	140	84	24990	3548	70
G	7.70	304.91	140	84	25540	550	71
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 0.50 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.58	2.58	336	202	520	520	202
B	13.36	15.94	301	181	2880	2359	177
C	48.92	64.86	260	156	10122	7243	148
D	85.30	150.16	231	139	20808	10686	125
E	96.53	246.69	213	128	31458	10650	110
F	50.51	297.20	205	123	36606	5148	102
G	7.70	304.91	204	123	37396	790	103
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 0.75 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.58	2.58	425	255	658	658	255
B	13.36	15.94	383	230	3663	3005	225
C	48.92	64.86	330	198	12846	9183	188
D	85.30	150.16	293	176	26393	13547	159
E	96.53	246.69	270	162	39984	13590	141
F	50.51	297.20	261	157	46617	6633	131
G	7.70	304.91	260	156	47623	1006	131
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 1.0 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.58	2.58	493	296	764	764	296
B	13.36	15.94	449	269	4295	3532	264
C	48.92	64.86	397	238	15452	11157	228
D	85.30	150.16	356	214	32068	16616	195
E	96.53	246.69	329	198	48746	16677	173
F	50.51	297.20	317	190	56475	7729	153
G	7.70	304.91	315	189	57649	1174	152
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 1.5 Hours

Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.58	2.58	636	382	985	985	382
B	13.36	15.94	575	345	5500	4515	338
C	48.92	64.86	511	307	19889	14389	294
D	85.30	150.16	460	276	41482	21592	253
E	96.53	246.69	427	256	63271	21789	226
F	50.51	297.20	414	248	73772	10501	208
G	7.70	304.91	412	247	75367	1596	207
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 2.0 Hours

Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.58	2.58	744	447	1152	1152	447
B	13.36	15.94	672	403	6428	5276	395
C	48.92	64.86	590	354	22965	16537	338
D	85.30	150.16	529	317	47652	24687	289
E	96.53	246.69	491	294	72616	24963	259
F	50.51	297.20	475	285	84674	12059	239
G	7.70	304.91	473	284	86527	1852	241
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 2.5 Hours

Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.58	2.58	821	493	1272	1272	493
B	13.36	15.94	742	445	7097	5826	436
C	48.92	64.86	663	398	25806	18708	382
D	85.30	150.16	600	360	54048	28243	331
E	96.53	246.69	558	335	82631	28583	296
F	50.51	297.20	541	325	96444	13812	273
G	7.70	304.91	539	323	98556	2113	274
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 3.0 Hours

Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.58	2.58	901	541	1396	1396	541
B	13.36	15.94	810	486	7748	6353	476
C	48.92	64.86	717	430	27908	20160	412
D	85.30	150.16	649	389	58462	30554	358
E	96.53	246.69	604	362	89381	30918	320
F	50.51	297.20	586	351	104443	15063	298
G	7.70	304.91	584	350	106762	2319	301
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 4.0 Hours

Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.58	2.58	1030	618	1595	1595	618
B	13.36	15.94	926	556	8858	7263	544
C	48.92	64.86	811	487	31568	22710	464
D	85.30	150.16	730	438	65804	34235	401
E	96.53	246.69	683	410	101074	35270	365
F	50.51	297.20	663	398	118224	17150	340
G	7.70	304.91	660	396	120831	2607	338
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 5.0 Hours

Ellipse	Catchment Area Between Ellipse (km^2)	Catchment Area Enclosed by Ellipse (km^2)	Initial Mean Rainfall Depth (mm)	Adjusted Mean Rainfall Depth (mm)	Rainfall Volume enclosed by Ellipse ($mm.km^2$)	Rainfall Volume between Ellipses ($mm.km^2$)	Mean Rainfall Depth between ellipses (mm)
A	2.58	2.58	1135	681	1758	1758	681
B	13.36	15.94	1018	611	9738	7980	597
C	48.92	64.86	890	534	34642	24904	509
D	85.30	150.16	797	478	71793	37151	436
E	96.53	246.69	737	442	109126	37333	387
F	50.51	297.20	712	427	127012	17886	354
G	7.70	304.91	709	426	129750	2738	356
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 6.0 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.58	2.58	1200	720	1859	1859	720
B	13.36	15.94	1084	651	10369	8511	637
C	48.92	64.86	950	570	36979	26610	544
D	85.30	150.16	848	509	76387	39407	462
E	96.53	246.69	785	471	116240	39853	413
F	50.51	297.20	759	456	135393	19153	379
G	7.70	304.91	756	454	138330	2938	381
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

APPENDIX H
XP-RAFTS ARR2019 OUTPUTS

Results - ARR Data Hub
[STARTTXT]

Input Data Information
[INPUTDATA]
Latitude,-36.935000
Longitude,149.810000
[END_INPUTDATA]

River Region
[RIVREG]
Division,South East Coast (NSW)
River Number,20
River Name,Towamba River
[RIVREG_META]
Time Accessed,17 August 2020 02:01PM
Version,2016_v1
[END_RIVREG]

ARF Parameters
[LONGARF]
Zone,SE Coast
a,0.06
b,0.361
c,0.0
d,0.317
e,8.11e-05
f,0.651
g,0.0
h,0.0
i,0.0
[LONGARF_META]
Time Accessed,17 August 2020 02:01PM
Version,2016_v1
[END_LONGARF]

Storm Losses
[LOSSES]
ID,9848.0
Storm Initial Losses (mm),21.0
Storm Continuing Losses (mm/h),6.2
[LOSSES_META]
Time Accessed,17 August 2020 02:01PM
Version,2016_v1
[END_LOSSES]

Temporal Patterns
[TP]
code,SSmainland
Label,Southern Slopes (Vic/NSW)
[TP_META]
Time Accessed,17 August 2020 02:01PM
Version,2016_v2
[END_TP]

Areal Temporal Patterns
[ATP]
code,SSmainland
arealabel,Southern Slopes (Vic/NSW)
[ATP_META]
Time Accessed,17 August 2020 02:01PM
Version,2016_v2
[END_ATP]

Median Preburst Depths and Ratios
[PREBURST]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),1.6 (0.071),1.3 (0.038),1.0 (0.025),0.8 (0.016),2.0 (0.034),2.9 (0.044)
90 (1.5),3.1 (0.114),3.9 (0.099),4.4 (0.092),5.0 (0.087),4.6 (0.068),4.4 (0.057)
120 (2.0),2.9 (0.093),3.6 (0.081),4.1 (0.075),4.6 (0.071),4.4 (0.057),4.2 (0.049)
180 (3.0),4.1 (0.112),7.6 (0.142),10.0 (0.153),12.2 (0.159),8.4 (0.091),5.5 (0.053)
360 (6.0),8.4 (0.162),20.4 (0.270),28.4 (0.308),36.0 (0.333),31.2 (0.239),27.6 (0.187)
720 (12.0),7.6 (0.104),15.3 (0.142),20.4 (0.154),25.3 (0.161),25.5 (0.133),25.6 (0.117)
1080 (18.0),5.8 (0.066),13.0 (0.099),17.7 (0.110),22.2 (0.115),26.8 (0.112),30.2 (0.110)
1440 (24.0),2.5 (0.025),7.4 (0.050),10.6 (0.058),13.7 (0.062),19.0 (0.069),23.0 (0.072)
2160 (36.0),0.5 (0.005),1.5 (0.009),2.2 (0.010),2.9 (0.011),6.7 (0.021),9.5 (0.025)
2880 (48.0),0.0 (0.000),0.2 (0.001),0.3 (0.001),0.4 (0.002),2.2 (0.006),3.4 (0.008)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
[PREBURST_META]
Time Accessed,17 August 2020 02:01PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST]

10% Preburst Depths
[PREBURST10]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0

(0.000)
1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0
(0.000)
2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0
(0.000)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0
(0.000)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0
(0.000)
[PREBURST10_META]
Time Accessed,17 August 2020 02:01PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been
slightly altered. Point values remain unchanged.
[END_PREBURST10]

25% Preburst Depths
[PREBURST25]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0
(0.000)
180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0
(0.000)
360 (6.0),0.0 (0.000),1.0 (0.013),1.6 (0.018),2.3 (0.021),1.0 (0.007),0.0
(0.000)
720 (12.0),0.1 (0.001),0.7 (0.006),1.1 (0.008),1.4 (0.009),0.6 (0.003),0.0
(0.000)
1080 (18.0),0.0 (0.000),0.3 (0.002),0.4 (0.003),0.6 (0.003),1.4 (0.006),2.0
(0.007)
1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0
(0.000)
2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0
(0.000)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0
(0.000)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0
(0.000)
[PREBURST25_META]
Time Accessed,17 August 2020 02:01PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been
slightly altered. Point values remain unchanged.
[END_PREBURST25]

75% Preburst Depths
[PREBURST75]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),19.1 (0.828),25.1 (0.742),29.0 (0.703),32.8 (0.673),27.9 (0.474),24.2
(0.362)
90 (1.5),28.7 (1.055),35.8 (0.904),40.6 (0.841),45.2 (0.794),40.0 (0.585),36.1
(0.468)
120 (2.0),36.8 (1.198),46.3 (1.035),52.6 (0.967),58.7 (0.918),52.5 (0.686),47.9

(0.555)
180 (3.0),35.1 (0.953),52.3 (0.973),63.6 (0.975),74.5 (0.973),69.9 (0.762),66.4 (0.643)
360 (6.0),27.3 (0.527),57.1 (0.755),76.9 (0.835),95.9 (0.885),94.4 (0.724),93.4 (0.632)
720 (12.0),26.1 (0.357),45.6 (0.422),58.5 (0.442),70.8 (0.451),78.3 (0.409),84.0 (0.383)
1080 (18.0),16.9 (0.192),36.0 (0.275),48.6 (0.301),60.7 (0.314),65.2 (0.274),68.6 (0.250)
1440 (24.0),18.4 (0.185),25.0 (0.169),29.4 (0.160),33.6 (0.152),53.0 (0.193),67.5 (0.212)
2160 (36.0),8.9 (0.078),20.4 (0.119),28.0 (0.130),35.3 (0.135),50.8 (0.156),62.4 (0.164)
2880 (48.0),1.4 (0.011),7.8 (0.042),12.0 (0.051),16.0 (0.056),24.7 (0.069),31.2 (0.074)
4320 (72.0),0.0 (0.000),0.4 (0.002),0.7 (0.003),0.9 (0.003),3.0 (0.008),4.5 (0.010)
[PREBURST75_META]
Time Accessed,17 August 2020 02:01PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST75]

90% Preburst Depths
[PREBURST90]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),63.2 (2.736),100.8 (2.982),125.7 (3.044),149.5 (3.065),120.2 (2.042),98.2 (1.471)
90 (1.5),76.9 (2.831),108.8 (2.745),130.0 (2.691),150.2 (2.641),145.7 (2.134),142.4 (1.846)
120 (2.0),69.0 (2.247),100.2 (2.240),120.9 (2.222),140.7 (2.200),146.0 (1.906),150.0 (1.737)
180 (3.0),77.4 (2.100),118.4 (2.205),145.6 (2.232),171.7 (2.241),148.5 (1.620),131.1 (1.270)
360 (6.0),88.4 (1.709),116.5 (1.539),135.1 (1.466),152.9 (1.411),169.0 (1.295),181.0 (1.226)
720 (12.0),60.5 (0.827),90.4 (0.838),110.1 (0.832),129.1 (0.823),155.8 (0.813),175.7 (0.801)
1080 (18.0),46.7 (0.529),75.3 (0.575),94.3 (0.583),112.4 (0.582),149.2 (0.627),176.8 (0.644)
1440 (24.0),60.1 (0.605),72.1 (0.487),80.0 (0.435),87.6 (0.396),114.4 (0.417),134.5 (0.423)
2160 (36.0),37.6 (0.328),57.8 (0.337),71.1 (0.331),84.0 (0.322),110.9 (0.341),131.1 (0.345)
2880 (48.0),19.7 (0.159),34.4 (0.185),44.2 (0.189),53.5 (0.187),71.3 (0.199),84.5 (0.201)
4320 (72.0),7.7 (0.058),19.8 (0.098),27.7 (0.109),35.4 (0.113),47.8 (0.121),57.1 (0.123)
[PREBURST90_META]
Time Accessed,17 August 2020 02:01PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST90]

Interim Climate Change Factors
[CCF]
,RCP 4.5,RCP6,RCP 8.5
2030,0.648 (3.2%),0.687 (3.4%),0.811 (4.0%)
2040,0.878 (4.4%),0.827 (4.1%),1.084 (5.4%)
2050,1.081 (5.4%),1.013 (5.1%),1.446 (7.3%)
2060,1.251 (6.3%),1.229 (6.2%),1.862 (9.5%)
2070,1.381 (7.0%),1.460 (7.4%),2.298 (11.9%)
2080,1.465 (7.4%),1.691 (8.6%),2.719 (14.2%)
2090,1.496 (7.6%),1.906 (9.7%),3.090 (16.3%)

[CCF_META]
Time Accessed,17 August 2020 02:01PM
Version,2019_v1
Note,ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.
[END_CCF]

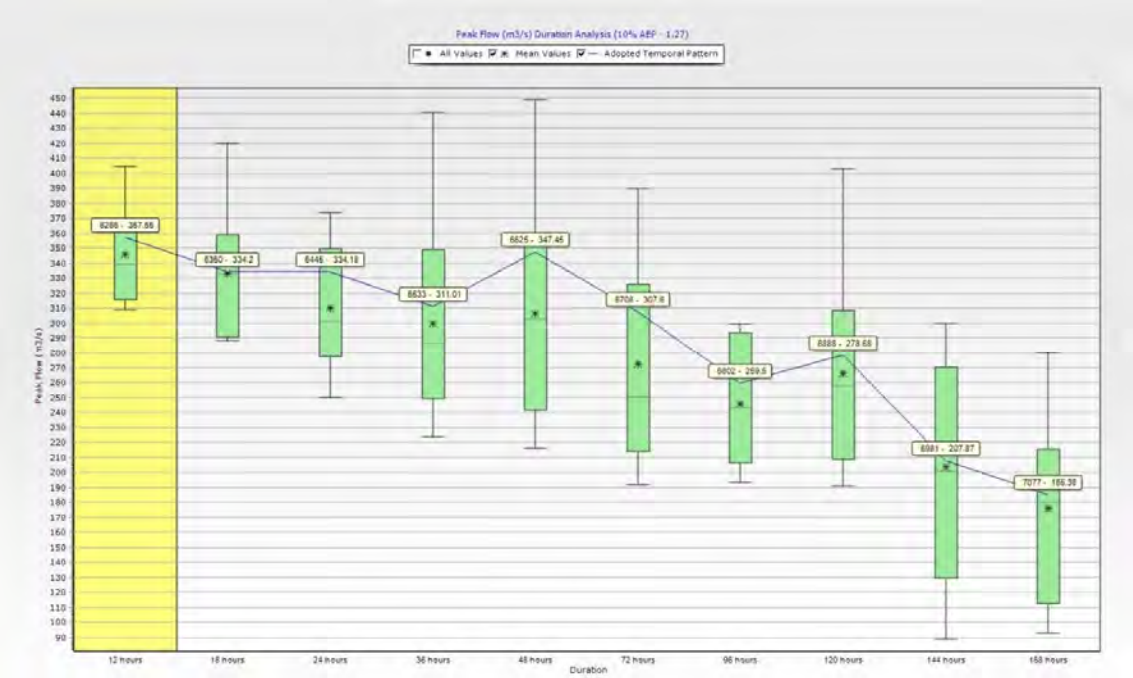
Probability Neutral Burst Initial Loss
[BURSTIL]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),11.1,8.6,8.1,7.7,7.3,4.8
90 (1.5),10.1,8.0,8.0,7.4,6.6,4.0
120 (2.0),10.0,8.1,7.7,7.0,7.0,3.9
180 (3.0),10.2,7.9,7.4,6.3,6.6,3.4
360 (6.0),10.7,6.7,6.6,6.3,7.2,2.2
720 (12.0),12.8,8.4,8.6,7.5,8.6,3.6
1080 (18.0),15.0,9.6,9.7,7.9,9.0,4.7
1440 (24.0),16.0,11.5,11.5,9.5,10.9,5.2
2160 (36.0),18.6,14.1,13.5,10.6,13.7,6.6
2880 (48.0),21.1,17.0,16.3,13.9,16.3,8.8
4320 (72.0),23.0,20.1,19.3,20.6,17.8,9.9
[BURSTIL_META]
Time Accessed,17 August 2020 02:01PM
Version,2018_v1
Note,As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.
[END_BURSTIL]Transformational Pre-burst Rainfall
[PREBURST_TRANS]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),10.1,12.6,13.1,13.5,13.9,16.4
90 (1.5),11.1,13.2,13.2,13.8,14.6,17.2
120 (2.0),11.2,13.1,13.5,14.2,14.2,17.3
180 (3.0),11.0,13.3,13.8,14.9,14.6,17.8
360 (6.0),10.5,14.5,14.6,14.9,14.0,19.0
720 (12.0),8.4,12.8,12.6,13.7,12.6,17.6
1080 (18.0),6.2,11.6,11.5,13.3,12.2,16.5

1440 (24.0),5.2,9.7,9.7,11.7,10.3,16.0
2160 (36.0),2.6,7.1,7.7,10.6,7.5,14.6
2880 (48.0),0.1,4.2,4.9,7.3,4.9,12.4
4320 (72.0),0.0,1.1,1.9,0.6,3.4,11.3
[PREBURST_TRANS_META]
The tranformational pre-burst is intended for software suppliers in the NSW area and is simply the Initial Loss - Burst Initial Loss. It is not appropriate to use these values if considering a calibrated initial loss.
[END_PREBURST_TRANS]

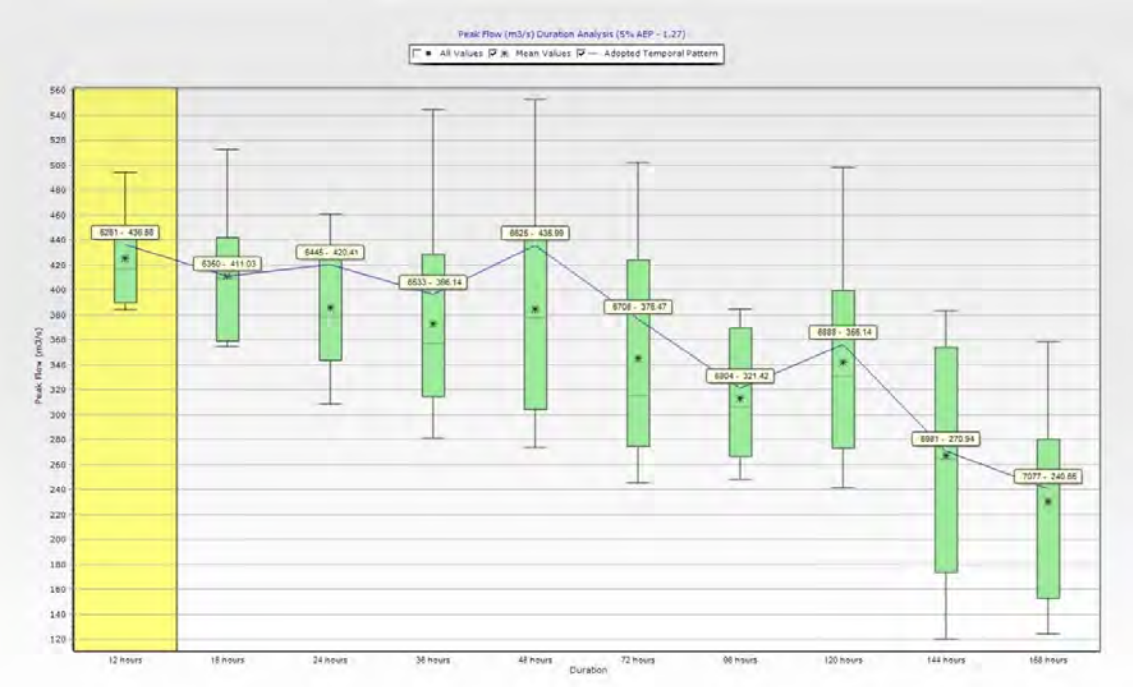
[ENDTXT]

ARR2019 Box Plots for Pambula River at Princes Highway

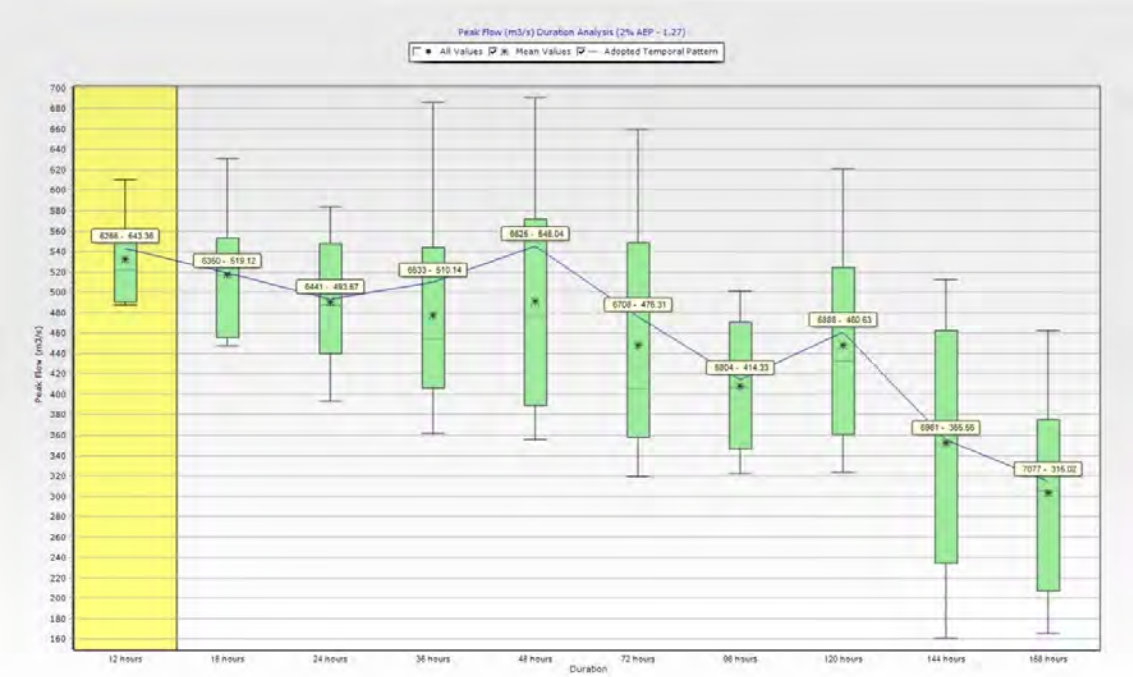
10%AEP



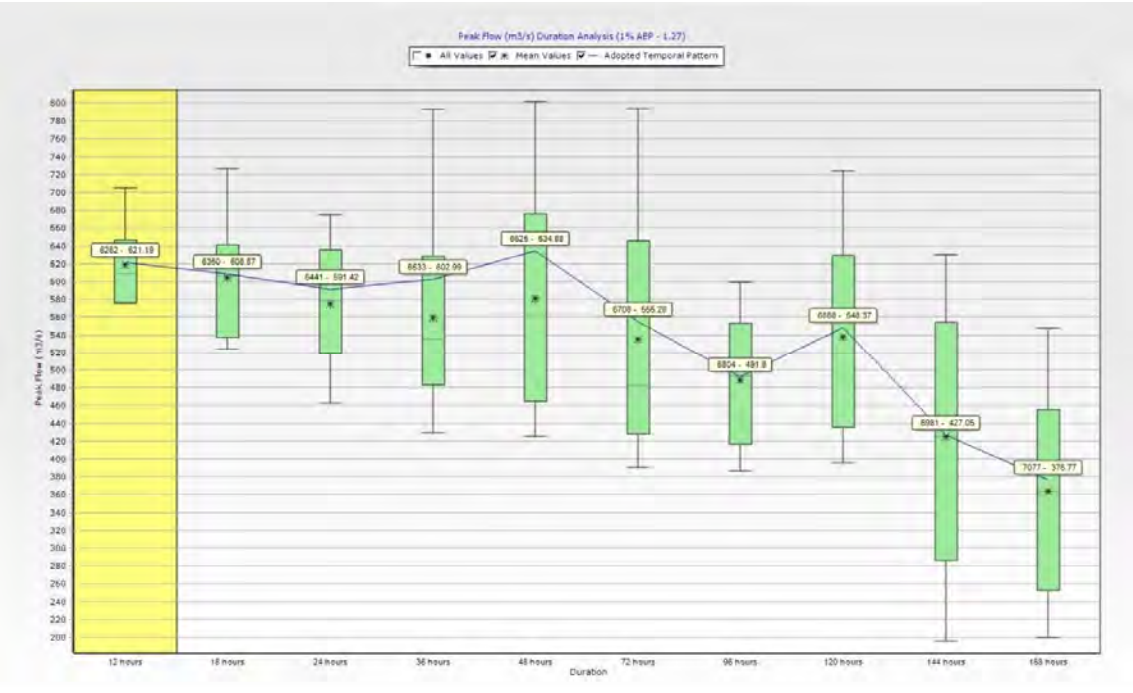
5%AEP



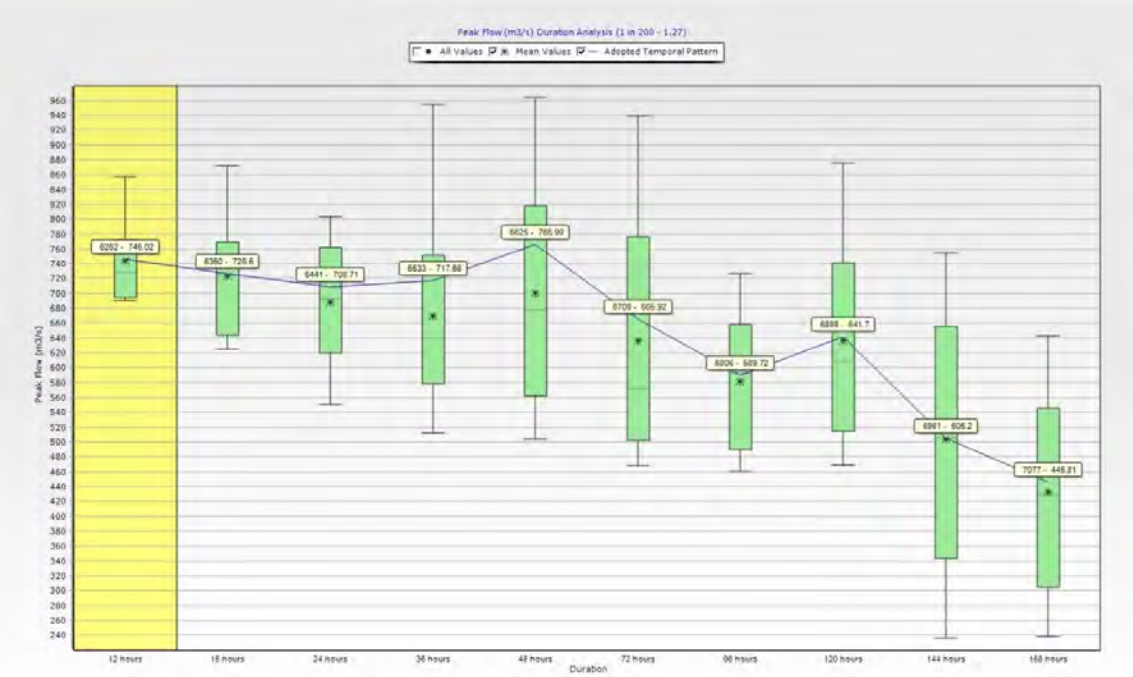
2%AEP


Peak Flow (m3/s) Duration Analysis (2% AEP - L.27)
All Values
Mean Values
Adopted Temporal Pattern
Peak Flow (m3/s)
6266 - 643.36
6360 - 519.12
6441 - 493.67
6533 - 510.14
6625 - 548.04
6708 - 476.31
6804 - 414.23
6888 - 460.63
6961 - 365.55
7077 - 316.02
12 hours
18 hours
24 hours
36 hours
48 hours
72 hours
96 hours
120 hours
144 hours
168 hours
Duration

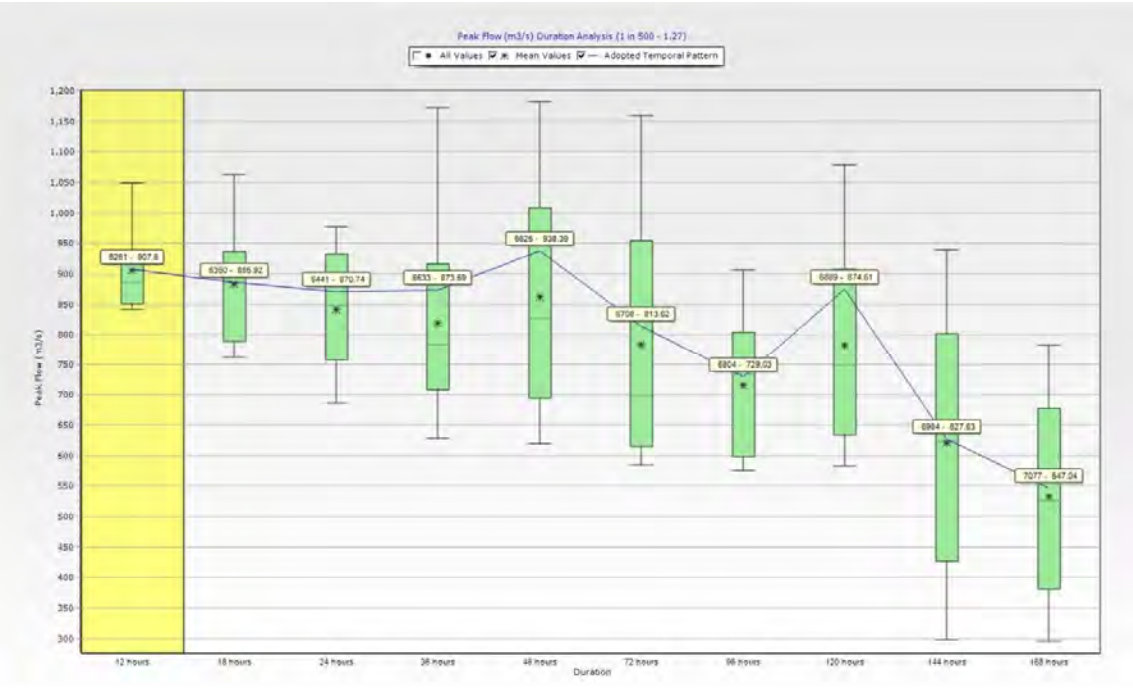
1%AEP


Peak Flow (m3/s) Duration Analysis (1% AEP - L.27)
All Values
Mean Values
Adopted Temporal Pattern
Peak Flow (m3/s)
6262 - 621.19
6360 - 608.87
6441 - 591.42
6633 - 602.99
6625 - 624.88
6709 - 555.29
6804 - 491.8
6888 - 540.37
6961 - 427.05
7077 - 376.77
12 hours
18 hours
24 hours
36 hours
48 hours
72 hours
96 hours
120 hours
144 hours
168 hours
Duration

0.5%AEP

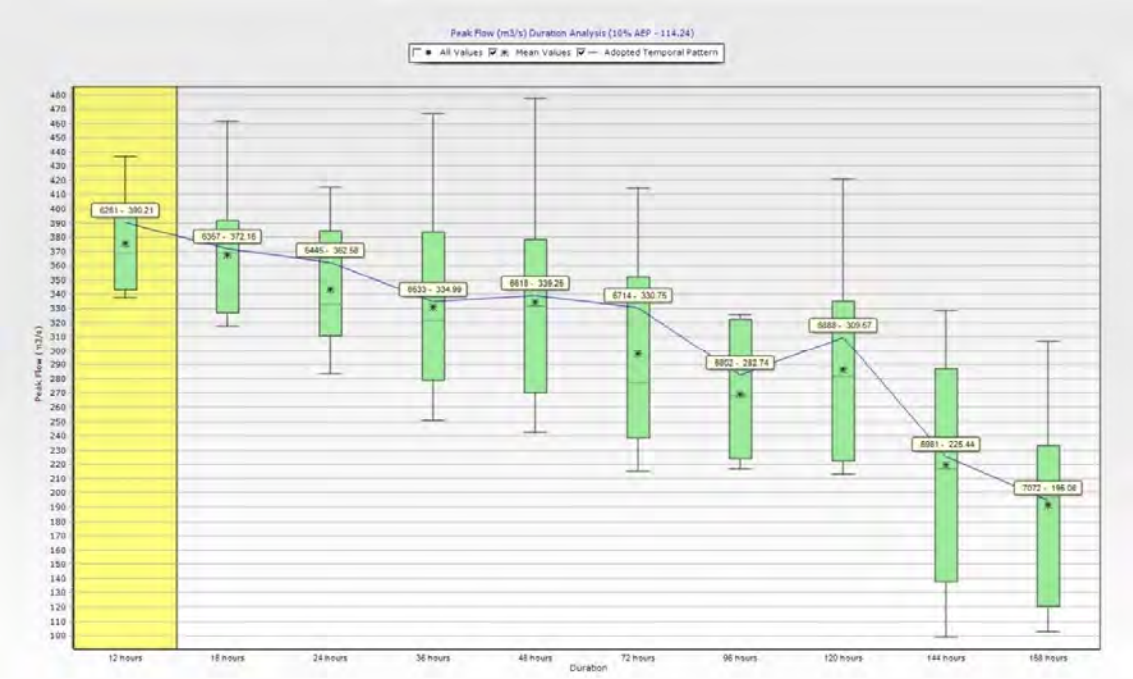

Peak Flow (m3/s) Duration Analysis (1 in 200 - 1.27)
All Values
Mean Values
Adopted Temporal Pattern
Peak Flow (m3/s)
Duration
12 hours
18 hours
24 hours
36 hours
48 hours
72 hours
96 hours
120 hours
144 hours
168 hours
6282 - 746.02
6360 - 726.6
6441 - 708.71
6633 - 717.68
6625 - 765.99
6709 - 666.92
6806 - 649.72
6888 - 641.7
6961 - 606.2
7077 - 446.81

0.2%AEP

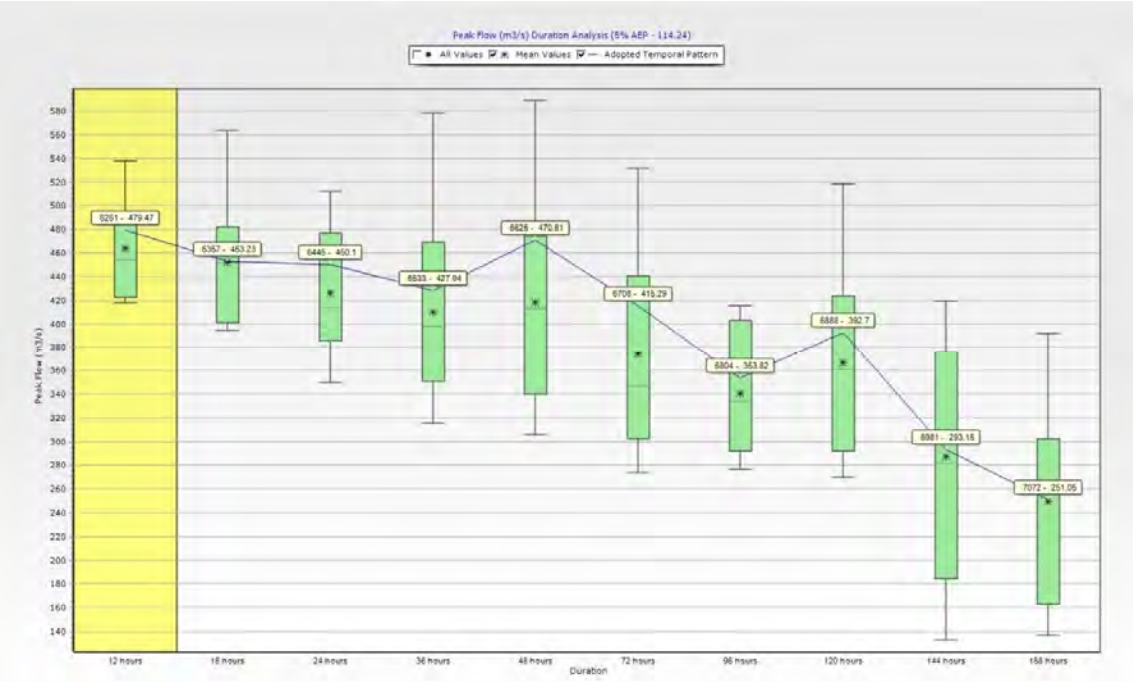

Peak Flow (m3/s) Duration Analysis (1 in 500 - 1.27)
All Values
Mean Values
Adopted Temporal Pattern
Peak Flow (m3/s)
Duration
12 hours
18 hours
24 hours
36 hours
48 hours
72 hours
96 hours
120 hours
144 hours
168 hours
8261 - 907.6
6360 - 886.92
6441 - 870.74
6633 - 873.69
6625 - 938.39
6709 - 813.62
6804 - 729.03
6889 - 874.61
6904 - 827.63
7077 - 847.04

ARR2019 Box Plots for Yowaka River at Princes Highway

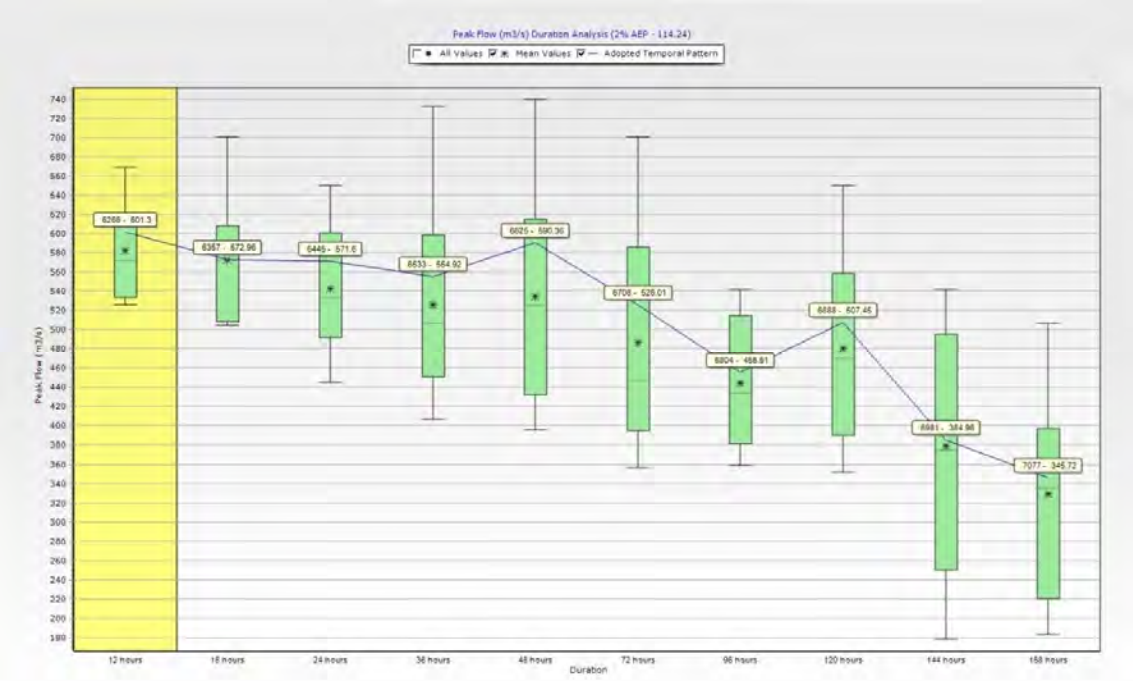
10%AEP



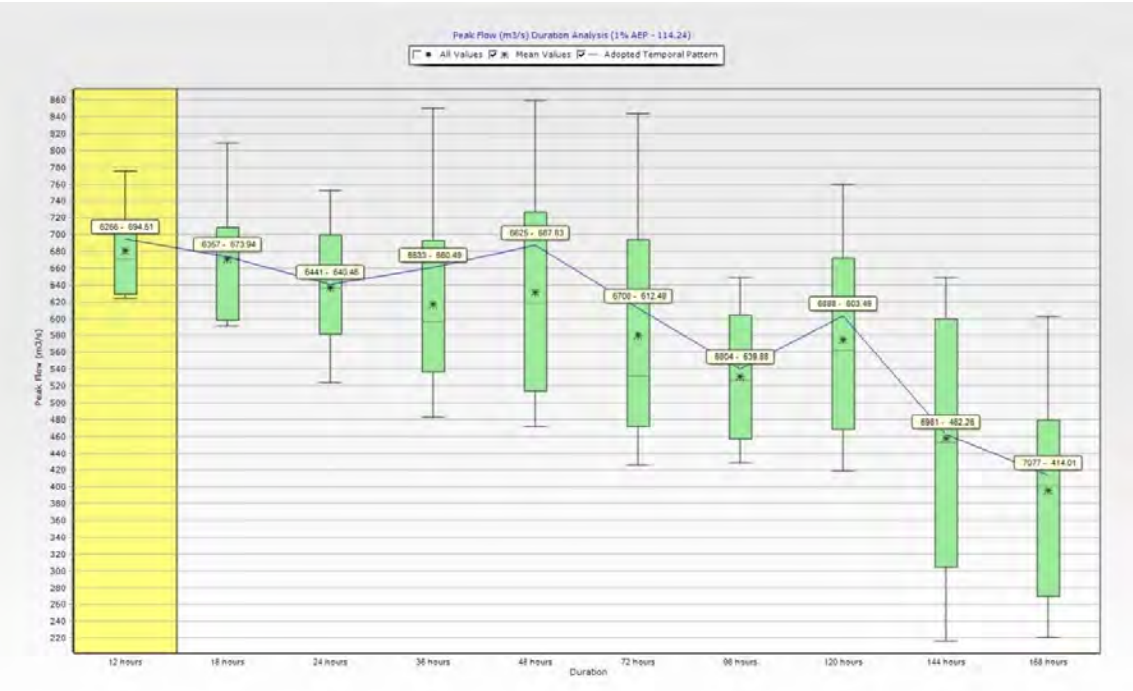
5%AEP



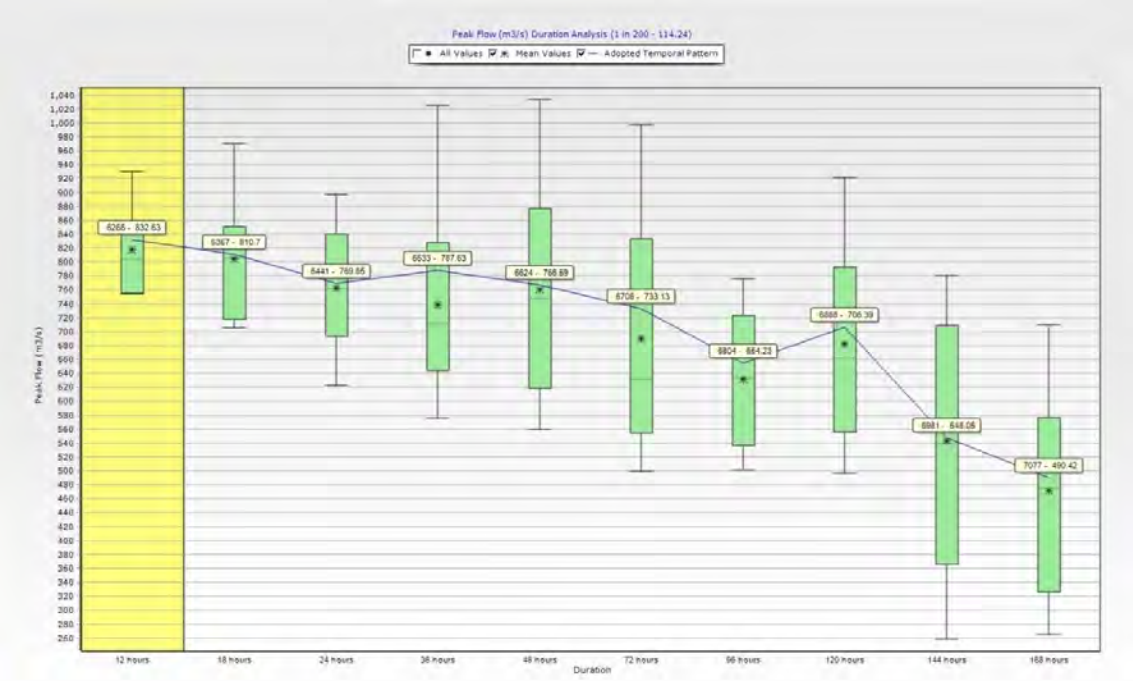
2%AEP


Peak Flow (m3/s) Duration Analysis (2% AEP - 114.24)
All Values
Mean Values
Adopted Temporal Pattern
Peak Flow (m3/s)
Duration
12 hours
18 hours
24 hours
36 hours
48 hours
72 hours
96 hours
120 hours
144 hours
168 hours
6268 - 601.3
6357 - 572.96
6445 - 571.6
6633 - 564.92
6625 - 590.36
6706 - 526.01
6804 - 468.81
6888 - 507.46
6981 - 384.98
7077 - 345.72

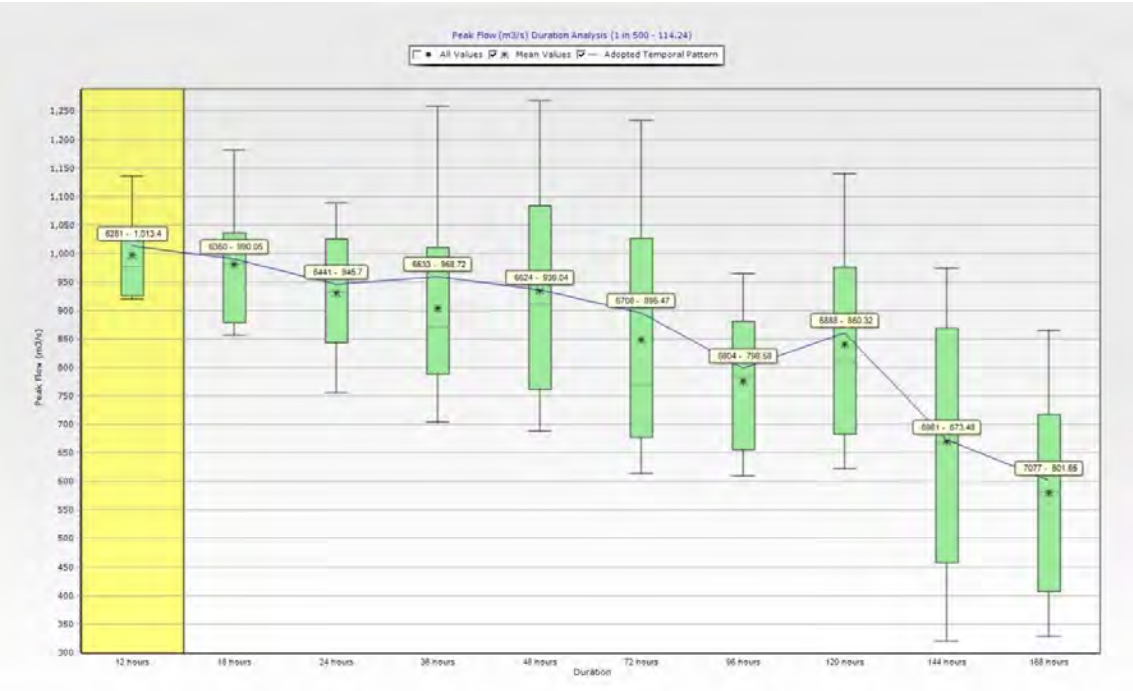
1%AEP


Peak Flow (m3/s) Duration Analysis (1% AEP - 114.24)
All Values
Mean Values
Adopted Temporal Pattern
Peak Flow (m3/s)
Duration
12 hours
18 hours
24 hours
36 hours
48 hours
72 hours
96 hours
120 hours
144 hours
168 hours
6266 - 694.51
6357 - 673.94
6441 - 640.46
6633 - 660.49
6625 - 687.63
6700 - 612.49
6804 - 539.88
6888 - 603.48
6981 - 482.28
7077 - 414.01

0.5%AEP


Peak Flow (m3/s) Duration Analysis (1 in 200 - 114.24)
All Values
Mean Values
Adopted Temporal Pattern
Peak Flow (m3/s)
Duration
12 hours
18 hours
24 hours
36 hours
48 hours
72 hours
96 hours
120 hours
144 hours
168 hours
4266 - 832.83
6367 - 810.7
6441 - 769.65
6633 - 787.63
6624 - 768.89
6708 - 733.13
6804 - 664.23
6888 - 706.39
6981 - 648.05
7077 - 490.42

0.2%AEP


Peak Flow (m3/s) Duration Analysis (1 in 500 - 114.24)
All Values
Mean Values
Adopted Temporal Pattern
Peak Flow (m3/s)
Duration
12 hours
18 hours
24 hours
36 hours
48 hours
72 hours
96 hours
120 hours
144 hours
168 hours
6281 - 1,013.4
6360 - 990.05
6441 - 945.7
6633 - 968.72
6624 - 936.04
6708 - 895.47
6804 - 798.58
6888 - 860.32
6981 - 673.48
7077 - 801.65

10% AEP XP-RAFTS Peak Flows

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
1.01	12 hours	10.2	6262	10.3	14.1
1.02	12 hours	13.4	6266	13.6	18.7
1.03	12 hours	18.7	6266	18.9	26.1
1.04	12 hours	26.5	6266	26.8	36.9
1.05	12 hours	33.9	6261	34.0	46.9
1.06	12 hours	34.6	6261	34.7	47.8
1.07	12 hours	41.1	6261	41.3	57.0
1.08	12 hours	45.1	6261	45.4	62.7
1.09	12 hours	46.3	6261	46.7	64.5
1.10	12 hours	75.1	6261	76.3	105
1.11	12 hours	90.3	6261	91.6	126
1.12	12 hours	100	6261	102	141
1.13	12 hours	203	6261	208	287
1.14	12 hours	211	6261	217	299
1.15	12 hours	212	6261	217	300
1.16	12 hours	216	6261	221	305
1.17	12 hours	232	6261	238	329
1.18	12 hours	249	6261	256	353
1.19	12 hours	253	6261	260	359
1.20	12 hours	308	6261	318	438
1.21	12 hours	309	6261	319	441
1.22	12 hours	332	6266	342	473
1.23	12 hours	337	6266	348	480
1.24	12 hours	337	6266	348	480
1.25	12 hours	339	6266	350	483
1.26	12 hours	342	6266	353	488
1.27	12 hours	346	6266	358	493
1.28	12 hours	347	6266	358	494
1.29	12 hours	366	6266	377	521
1.30	12 hours	367	6266	379	522
1.31	12 hours	395	6266	408	562
1.32	12 hours	395	6266	408	563
1.33	12 hours	775	6266	794	1095
1.34	12 hours	775	6266	794	1096
1.35	12 hours	818	6266	836	1154
1.36	12 hours	818	6266	836	1154
1.37	12 hours	819	6266	836	1154
1.38	12 hours	819	6266	837	1155
1.39	12 hours	824	6266	840	1159
1.40	12 hours	830	6266	845	1167
2.01	12 hours	2.62	6262	2.63	3.63
3.01	12 hours	4.73	6265	5.61	7.74
4.01	12 hours	5.02	6261	5.09	7.02
5.01	12 hours	5.20	6266	5.21	7.19
6.01	12 hours	5.18	6261	5.31	7.33
7.01	12 hours	3.29	6266	3.34	4.61
8.01	18 hours	9.13	6350	9.14	12.6
8.02	12 hours	18.0	6258	18.1	25.0
8.03	12 hours	18.0	6258	18.2	25.0

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
8.04	12 hours	26.5	6266	27.2	37.6
8.05	12 hours	27.4	6266	28.1	38.8
9.01	12 hours	5.85	6261	5.97	8.24
10.01	12 hours	3.48	6262	3.50	4.83
10.02	12 hours	8.43	6262	8.46	11.7
11.01	12 hours	4.92	6262	4.93	6.80
12.01	12 hours	4.12	6265	4.91	6.78
12.02	12 hours	7.15	6266	7.17	9.89
12.03	12 hours	11.4	6266	11.4	15.8
13.01	12 hours	1.38	6266	1.42	1.96
14.01	12 hours	3.37	6261	3.38	4.66
14.02	12 hours	4.08	6265	4.77	6.58
15.01	12 hours	0.580	6262	0.610	0.842
16.01	18 hours	4.14	6351	4.18	5.77
16.02	12 hours	6.27	6258	6.36	8.78
17.01	12 hours	6.52	6261	6.74	9.30
17.02	12 hours	15.2	6261	15.5	21.4
17.03	12 hours	19.5	6261	19.9	27.5
17.04	12 hours	27.5	6266	28.3	39.0
17.05	12 hours	32.5	6266	33.4	46.1
17.06	12 hours	40.4	6261	41.7	57.5
17.07	12 hours	46.3	6261	47.5	65.6
17.08	12 hours	63.9	6261	65.2	89.9
17.09	12 hours	65.4	6261	66.7	92.0
17.10	12 hours	70.5	6261	72.0	99.4
17.11	12 hours	98.6	6261	101	140
17.12	12 hours	100	6261	103	142
17.13	12 hours	101	6261	104	143
18.01	12 hours	6.12	6261	6.20	8.56
19.01	12 hours	2.99	6261	3.04	4.20
20.01	18 hours	7.03	6350	7.04	9.72
21.01	12 hours	5.79	6267	5.79	7.99
21.02	12 hours	6.49	6267	6.50	8.97
22.01	12 hours	4.55	6265	5.41	7.47
23.01	12 hours	3.71	6266	3.75	5.18
23.02	12 hours	11.8	6262	11.9	16.4
23.03	12 hours	16.2	6261	16.3	22.5
23.04	12 hours	16.4	6261	16.5	22.8
24.01	12 hours	4.79	6262	4.79	6.61
25.01	12 hours	1.68	6266	1.72	2.37
26.01	12 hours	5.01	6258	5.04	6.96
26.02	12 hours	5.08	6258	5.11	7.05
27.01	12 hours	6.56	6261	6.62	9.14
27.02	12 hours	14.1	6261	14.4	19.9
27.03	12 hours	23.5	6258	23.6	32.6
28.01	12 hours	1.36	6266	1.42	1.96
28.02	12 hours	1.85	6266	1.92	2.65
29.01	12 hours	5.60	6261	5.74	7.92
30.01	12 hours	1.69	6265	2.00	2.76
31.01	12 hours	1.22	6261	1.22	1.68

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
32.01	12 hours	6.75	6258	6.80	9.38
33.01	12 hours	3.28	6266	3.33	4.60
34.01	12 hours	4.90	6261	5.00	6.90
34.02	12 hours	12.1	6261	12.1	16.7
34.03	12 hours	12.2	6261	12.3	16.9
35.01	12 hours	3.34	6266	3.40	4.69
35.02	18 hours	6.79	6350	6.84	9.44
35.03	12 hours	9.21	6258	9.33	12.9
35.04	12 hours	9.33	6258	9.46	13.1
35.05	12 hours	14.8	6258	14.8	20.5
36.01	12 hours	0.420	6266	0.430	0.593
37.01	12 hours	2.78	6261	2.85	3.93
38.01	12 hours	2.80	6258	2.83	3.91
38.02	12 hours	3.46	6258	3.47	4.79
39.01	12 hours	3.91	6266	3.97	5.48
39.02	12 hours	8.17	6261	8.21	11.3
39.03	12 hours	11.9	6266	12.5	17.2
39.04	12 hours	23.5	6261	23.8	32.9
39.05	12 hours	29.7	6261	30.2	41.7
39.06	12 hours	54.5	6261	55.6	76.7
40.01	12 hours	2.16	6266	2.24	3.09
41.01	12 hours	2.71	6266	2.79	3.85
42.01	12 hours	5.58	6261	5.65	7.80
43.01	12 hours	1.81	6265	2.15	2.97
44.01	12 hours	6.10	6261	6.11	8.43
44.02	12 hours	15.2	6261	15.3	21.2
44.03	12 hours	23.0	6261	23.4	32.3
45.01	12 hours	4.03	6259	4.83	6.67
46.01	12 hours	5.52	6258	5.62	7.76
47.01	12 hours	5.19	6261	5.24	7.23
47.02	12 hours	7.27	6261	7.34	10.1
47.03	12 hours	7.87	6261	7.94	11.0
47.04	12 hours	16.0	6261	16.3	22.4
47.05	12 hours	20.7	6261	20.9	28.9
48.01	12 hours	1.99	6266	2.02	2.79
49.01	12 hours	2.86	6259	3.40	4.69
49.02	12 hours	3.25	6266	3.32	4.58
49.03	12 hours	3.29	6266	3.38	4.66
50.01	12 hours	0.550	6262	0.590	0.814
51.01	12 hours	1.91	6266	1.91	2.64
52.01	12 hours	0.860	6266	0.890	1.23
52.02	12 hours	2.06	6266	2.10	2.90
53.01	12 hours	2.97	6262	2.98	4.11
54.01	12 hours	1.16	6265	1.36	1.88
54.02	12 hours	1.70	6266	1.75	2.42
54.03	12 hours	1.91	6266	2.02	2.79
55.01	12 hours	1.42	6259	1.68	2.32
56.01	12 hours	1.98	6266	2.00	2.76
56.02	12 hours	3.28	6266	3.32	4.58
56.03	12 hours	3.86	6266	3.91	5.40

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
57.01	12 hours	1.70	6262	1.71	2.36
57.02	12 hours	3.92	6267	4.01	5.53
58.01	12 hours	3.11	6266	3.11	4.29
58.02	12 hours	4.55	6262	4.56	6.29
58.03	12 hours	6.59	6266	6.63	9.15
58.04	12 hours	11.1	6261	11.1	15.3
58.05	12 hours	11.9	6261	11.9	16.4
58.06	12 hours	17.2	6261	17.3	23.9
58.07	12 hours	19.6	6261	19.9	27.5
59.01	12 hours	1.41	6265	1.68	2.32
60.01	12 hours	1.31	6266	1.32	1.82
60.02	12 hours	1.68	6262	1.72	2.37
60.03	12 hours	3.62	6266	3.67	5.06
61.01	12 hours	1.07	6265	1.26	1.74
62.01	12 hours	0.250	6262	0.260	0.359
63.01	12 hours	0.020	6262	0.020	0.028
64.01	12 hours	0.730	6266	0.740	1.02
64.02	12 hours	4.01	6261	4.02	5.55
65.01	12 hours	0.420	6262	0.430	0.593
66.01	12 hours	0.520	6262	0.560	0.773
66.02	12 hours	1.87	6261	1.88	2.59
67.01	12 hours	0.100	6262	0.110	0.152
68.01	12 hours	0.170	6262	0.170	0.235
69.01	12 hours	0.170	6261	0.170	0.235
69.02	12 hours	0.290	6262	0.300	0.414
70.01	12 hours	0.120	6262	0.130	0.179
71.01	12 hours	0.140	6262	0.150	0.207
72.01	12 hours	0.160	6262	0.170	0.235
73.01	12 hours	0.110	6262	0.120	0.166
74.01	12 hours	0.990	6266	0.990	1.37
75.01	48 hours	0.770	6625	0.770	1.06
75.02	48 hours	0.920	6621	0.920	1.27
76.01	12 hours	0.700	6266	0.710	0.980
76.02	12 hours	0.750	6266	0.760	1.05
77.01	12 hours	1.70	6266	1.72	2.37
77.02	12 hours	3.74	6266	3.80	5.24
77.03	12 hours	7.09	6261	7.17	9.89
77.04	12 hours	7.93	6261	7.99	11.0
77.05	12 hours	8.45	6261	8.51	11.7
77.06	12 hours	8.57	6261	8.63	11.9
77.07	12 hours	16.7	6261	16.7	23.0
77.08	12 hours	17.0	6261	17.1	23.5
77.09	12 hours	17.1	6261	17.2	23.7
77.10	12 hours	17.4	6261	17.5	24.1
77.11	12 hours	19.9	6261	20.1	27.7
77.12	12 hours	22.2	6261	22.5	31.0
77.13	12 hours	26.6	6261	27.3	37.6
78.01	12 hours	1.59	6261	1.60	2.21
78.02	12 hours	3.74	6261	3.75	5.18
79.01	12 hours	1.07	6266	1.09	1.50

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
80.01	12 hours	0.470	6262	0.500	0.690
81.01	12 hours	1.06	6266	1.07	1.48
81.02	12 hours	1.18	6262	1.18	1.63
81.03	12 hours	2.36	6262	2.41	3.33
81.04	12 hours	4.37	6262	4.49	6.20
82.01	12 hours	0.230	6262	0.240	0.331
82.02	12 hours	0.970	6262	1.01	1.39
82.03	12 hours	1.11	6262	1.15	1.59
83.01	12 hours	0.710	6262	0.750	1.04
83.02	12 hours	1.42	6262	1.50	2.07
83.03	12 hours	1.57	6262	1.66	2.29
84.01	12 hours	0.140	6262	0.150	0.207
84.02	12 hours	0.500	6262	0.530	0.731
85.01	12 hours	0.270	6262	0.280	0.386
86.01	12 hours	0.040	6261	0.040	0.055
87.01	12 hours	0.210	6262	0.220	0.304
87.02	12 hours	0.380	6262	0.400	0.552
88.01	12 hours	0.080	6262	0.080	0.110
89.01	12 hours	0.120	6262	0.130	0.179
90.01	12 hours	0.080	6262	0.080	0.110
91.01	12 hours	0.230	6262	0.250	0.345
92.01	12 hours	0.380	6261	0.380	0.524
92.02	12 hours	1.54	6261	1.58	2.18
92.03	12 hours	1.64	6261	1.70	2.35
92.04	12 hours	2.39	6261	2.50	3.45
93.01	12 hours	0.120	6262	0.130	0.179
94.01	12 hours	0.140	6262	0.150	0.207
95.01	12 hours	0.180	6262	0.190	0.262
96.01	12 hours	0.070	6262	0.080	0.110
97.01	12 hours	0.080	6262	0.090	0.124
98.01	12 hours	0.240	6262	0.250	0.345
99.01	12 hours	1.34	6266	1.37	1.89
99.02	12 hours	1.79	6261	1.85	2.55
100.01	12 hours	0.040	6262	0.040	0.055
101.01	12 hours	0.030	6262	0.030	0.041
102.01	12 hours	0.050	6262	0.060	0.083
103.01	12 hours	0.030	6261	0.040	0.055
104.01	12 hours	0.110	6262	0.110	0.152
104.02	12 hours	0.280	6262	0.300	0.414
105.01	12 hours	0.030	6261	0.030	0.041
106.01	18 hours	2.62	6350	2.65	3.66
106.02	18 hours	3.81	6355	3.85	5.31
107.01	12 hours	1.34	6265	1.57	2.17
108.01	12 hours	0.880	6258	0.890	1.23
108.02	12 hours	0.900	6258	0.910	1.26
109.01	12 hours	1.86	6266	1.86	2.57
110.01	12 hours	1.09	6266	1.09	1.50
111.01	12 hours	0.500	6262	0.530	0.731
112.01	12 hours	0.380	6262	0.400	0.552
113.01	12 hours	0.190	6262	0.190	0.262

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
114.01	12 hours	6.00	6261	6.13	8.46
114.02	12 hours	9.15	6261	9.27	12.8
114.03	12 hours	17.7	6261	18.1	25.0
114.04	18 hours	27.8	6357	27.8	38.4
114.05	18 hours	37.1	6357	37.4	51.6
114.06	12 hours	88.8	6266	91.2	126
114.07	12 hours	96.1	6266	98.8	136
114.08	12 hours	104	6266	107	148
114.09	12 hours	107	6266	110	152
114.10	12 hours	113	6266	116	160
114.11	12 hours	121	6261	124	171
114.12	12 hours	122	6261	126	174
114.13	12 hours	138	6261	142	196
114.14	12 hours	143	6261	148	205
114.15	12 hours	144	6261	149	206
114.16	12 hours	309	6261	320	441
114.17	12 hours	330	6261	341	471
114.18	12 hours	336	6261	348	480
114.19	12 hours	338	6261	350	483
114.20	12 hours	342	6261	354	489
114.21	12 hours	368	6261	382	527
114.22	12 hours	371	6261	386	532
114.23	12 hours	373	6261	387	534
114.24	12 hours	376	6261	390	538
114.25	12 hours	382	6261	396	547
115.01	12 hours	2.88	6261	2.88	3.97
116.01	12 hours	5.39	6261	5.52	7.62
117.01	12 hours	3.71	6262	3.72	5.13
118.01	18 hours	9.35	6350	9.39	13.0
119.01	12 hours	10.2	6258	10.4	14.3
119.02	12 hours	16.0	6261	16.5	22.7
119.03	12 hours	43.7	6261	44.2	61.0
119.04	12 hours	50.6	6261	51.3	70.7
120.01	12 hours	4.13	6262	4.14	5.71
121.01	12 hours	5.80	6266	5.82	8.03
121.02	12 hours	15.0	6261	15.0	20.7
121.03	12 hours	19.5	6266	19.6	27.1
121.04	12 hours	25.8	6261	25.9	35.7
122.01	12 hours	6.97	6261	6.99	9.65
123.01	12 hours	3.58	6265	4.21	5.81
124.01	12 hours	5.28	6261	5.38	7.42
125.01	12 hours	4.39	6266	4.39	6.06
126.01	12 hours	7.16	6258	7.24	9.99
127.01	12 hours	5.32	6261	5.37	7.41
128.01	12 hours	4.28	6261	4.36	6.02
129.01	12 hours	3.45	6265	4.04	5.58
129.02	12 hours	6.49	6266	6.64	9.16
129.03	12 hours	8.36	6266	8.53	11.8
130.01	12 hours	2.12	6266	2.14	2.95
131.01	12 hours	1.63	6266	1.69	2.33

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
131.02	12 hours	6.69	6267	6.76	9.33
131.03	12 hours	10.3	6258	10.4	14.4
132.01	12 hours	2.74	6259	3.26	4.50
133.01	12 hours	8.45	6266	8.50	11.7
133.02	12 hours	18.1	6266	18.2	25.0
133.03	12 hours	29.2	6261	29.5	40.7
133.04	12 hours	33.1	6261	33.3	46.0
133.05	12 hours	41.6	6261	42.0	57.9
133.06	12 hours	41.8	6261	42.2	58.2
133.07	12 hours	73.3	6258	73.4	101
133.08	12 hours	73.9	6261	76.0	105
133.09	12 hours	88.8	6261	91.1	126
133.10	12 hours	97.8	6261	100	138
133.11	12 hours	110	6261	114	157
133.12	12 hours	153	6261	157	217
133.13	12 hours	161	6261	165	228
133.14	12 hours	163	6261	168	232
134.01	12 hours	6.34	6266	6.35	8.76
135.01	12 hours	7.95	6261	8.18	11.3
136.01	12 hours	2.91	6259	3.45	4.76
137.01	12 hours	3.59	6265	4.25	5.87
138.01	18 hours	12.9	6350	12.9	17.8
138.02	18 hours	15.9	6350	15.9	22.0
138.03	18 hours	27.3	6350	27.5	38.0
139.01	12 hours	5.60	6261	5.69	7.85
139.02	12 hours	10.6	6258	10.7	14.8
140.01	12 hours	0.600	6262	0.620	0.856
141.01	12 hours	8.28	6261	8.33	11.5
141.02	12 hours	9.82	6261	9.84	13.6
142.01	12 hours	1.05	6266	1.10	1.52
143.01	12 hours	6.47	6266	6.47	8.93
144.01	12 hours	6.15	6261	6.16	8.50
145.01	12 hours	4.50	6261	4.51	6.22
145.02	12 hours	12.4	6261	12.6	17.4
145.03	12 hours	19.1	6261	19.5	26.9
145.04	12 hours	36.7	6261	37.4	51.6
145.05	12 hours	36.8	6261	37.5	51.8
145.06	12 hours	42.2	6261	43.0	59.4
146.01	12 hours	5.95	6258	5.97	8.24
147.01	12 hours	3.41	6265	4.05	5.59
148.01	12 hours	8.63	6258	8.66	12.0
148.02	12 hours	13.2	6261	13.5	18.6
148.03	12 hours	17.4	6261	17.8	24.6
149.01	12 hours	3.88	6266	3.92	5.41
150.01	12 hours	3.60	6266	3.66	5.05
151.01	12 hours	3.11	6265	3.65	5.04
152.01	12 hours	1.28	6266	1.32	1.82
153.01	12 hours	4.16	6266	4.22	5.82
154.01	12 hours	1.70	6266	1.70	2.35
154.02	12 hours	2.24	6262	2.24	3.09

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
155.01	18 hours	6.18	6351	6.26	8.64
155.02	18 hours	6.26	6351	6.35	8.76
155.03	12 hours	10.5	6267	10.5	14.5
155.04	12 hours	10.9	6267	11.0	15.2
155.05	12 hours	17.5	6258	17.7	24.4
155.06	12 hours	20.8	6258	20.8	28.7
156.01	12 hours	3.62	6261	3.67	5.06
156.02	12 hours	3.77	6261	3.83	5.29
157.01	12 hours	2.68	6261	2.72	3.75
158.01	12 hours	1.42	6261	1.42	1.96
159.01	12 hours	1.37	6259	1.64	2.26
160.01	12 hours	2.82	6262	2.82	3.89
160.02	12 hours	3.02	6261	3.04	4.20
161.01	12 hours	5.44	6258	5.53	7.63
162.01	12 hours	0.490	6262	0.510	0.704
162.02	12 hours	3.34	6258	3.36	4.64
162.03	12 hours	3.40	6258	3.42	4.72
163.01	12 hours	0.710	6262	0.740	1.02
163.02	12 hours	2.11	6262	2.11	2.91
163.03	12 hours	6.29	6261	6.45	8.90
163.04	12 hours	9.52	6266	9.84	13.6
163.05	18 hours	20.3	6350	20.4	28.2
163.06	18 hours	21.1	6350	21.2	29.3
164.01	18 hours	7.29	6350	7.31	10.1
165.01	18 hours	3.47	6351	3.50	4.83
165.02	12 hours	4.00	6267	4.06	5.60
166.01	12 hours	1.10	6259	1.30	1.79
166.02	12 hours	2.33	6266	2.33	3.22
166.03	12 hours	3.97	6261	4.05	5.59
167.01	12 hours	0.850	6266	0.880	1.21
167.02	12 hours	1.62	6266	1.66	2.29
168.01	12 hours	2.34	6265	2.75	3.80
168.02	12 hours	2.36	6266	2.36	3.26
169.01	12 hours	4.22	6261	4.29	5.92
169.02	12 hours	4.79	6261	4.88	6.73
170.01	12 hours	0.710	6262	0.750	1.04
171.01	12 hours	0.800	6266	0.830	1.15
172.01	12 hours	0.510	6262	0.550	0.759
173.01	12 hours	0.980	6266	1.02	1.41
173.02	12 hours	7.44	6261	7.52	10.4
173.03	12 hours	14.6	6261	14.7	20.3
173.04	12 hours	15.8	6261	16.1	22.1
173.05	12 hours	20.0	6261	20.6	28.5
173.06	12 hours	25.7	6261	26.8	37.0
173.07	12 hours	46.9	6261	48.5	66.9
174.01	12 hours	0.770	6262	0.810	1.12
175.01	12 hours	0.620	6266	0.640	0.883
176.01	12 hours	0.560	6262	0.590	0.814
176.02	12 hours	3.01	6266	3.08	4.25
177.01	18 hours	2.20	6350	2.24	3.09

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
178.01	12 hours	1.69	6261	1.73	2.39
179.01	12 hours	0.300	6265	0.360	0.497
180.01	18 hours	2.33	6350	2.34	3.23
180.02	18 hours	2.59	6357	2.59	3.57
181.01	12 hours	1.75	6261	1.78	2.46
182.01	12 hours	0.250	6262	0.260	0.359
183.01	12 hours	2.53	6266	2.56	3.53
183.02	12 hours	4.79	6266	4.90	6.76
183.03	12 hours	8.57	6266	8.80	12.1
183.04	12 hours	13.5	6261	13.5	18.6
183.05	12 hours	14.1	6261	14.1	19.4
183.06	12 hours	21.3	6261	21.4	29.6
184.01	12 hours	0.460	6262	0.490	0.676
184.02	12 hours	2.92	6261	2.93	4.04
185.01	12 hours	0.580	6262	0.610	0.842
185.02	12 hours	2.44	6266	2.60	3.59
186.01	12 hours	1.11	6262	1.13	1.56
187.01	12 hours	1.38	6265	1.64	2.26
187.02	12 hours	2.62	6265	3.08	4.25
188.01	12 hours	0.430	6262	0.460	0.635
189.01	12 hours	0.450	6262	0.480	0.662
190.01	12 hours	0.310	6262	0.320	0.442
191.01	12 hours	0.840	6266	0.860	1.19
192.01	12 hours	1.00	6262	1.04	1.44
193.01	12 hours	0.850	6262	0.880	1.21
194.01	12 hours	0.150	6262	0.160	0.221
195.01	12 hours	0.300	6262	0.300	0.414
196.01	12 hours	0.330	6262	0.350	0.483
197.01	12 hours	0.280	6262	0.290	0.400
198.01	12 hours	0.400	6262	0.410	0.566
199.01	12 hours	0.860	6266	0.900	1.24
199.02	12 hours	1.17	6262	1.21	1.67
200.01	12 hours	0.160	6262	0.160	0.221
201.01	12 hours	0.370	6262	0.380	0.524
202.01	18 hours	3.02	6351	3.03	4.18
203.01	12 hours	0.530	6262	0.550	0.759
204.01	12 hours	0.360	6262	0.370	0.511
205.01	12 hours	0.470	6262	0.490	0.676
206.01	12 hours	0.120	6262	0.130	0.179
207.01	12 hours	0.440	6262	0.470	0.649
208.01	12 hours	0.630	6262	0.660	0.911
208.02	12 hours	0.880	6262	0.940	1.30
208.03	12 hours	1.66	6262	1.74	2.40
208.04	12 hours	3.04	6261	3.21	4.43
208.05	12 hours	3.79	6258	3.82	5.27
208.06	18 hours	4.54	6350	4.62	6.38
209.01	12 hours	0.120	6262	0.120	0.166
210.01	12 hours	0.220	6262	0.240	0.331
211.01	12 hours	0.230	6262	0.240	0.331
211.02	12 hours	0.270	6262	0.280	0.386

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
211.03	12 hours	0.940	6262	0.980	1.35
212.01	12 hours	0.110	6261	0.110	0.152
_junc_10	12 hours	20.5	6258	20.6	28.4
_junc_108	12 hours	0.410	6262	0.430	0.593
_junc_11	12 hours	329	6261	341	470
_junc_111	12 hours	2.29	6262	2.33	3.22
_junc_114	12 hours	1.34	6266	1.37	1.89
_junc_12	12 hours	10.4	6261	10.5	14.4
_junc_13	12 hours	101	6266	104	144
_junc_138	12 hours	7.18	6261	7.23	9.98
_junc_14	12 hours	86.0	6266	88.3	122
_junc_142	12 hours	5.55	6266	5.56	7.67
_junc_143	12 hours	162	6261	167	231
_junc_15	12 hours	307	6261	317	438
_junc_16	12 hours	335	6261	347	479
_junc_165	12 hours	23.0	6261	23.4	32.3
_junc_168	12 hours	21.6	6261	21.8	30.1
_junc_17	12 hours	95.9	6266	98.5	136
_junc_174	12 hours	15.8	6261	15.8	21.8
_junc_18	18 hours	37.0	6357	37.3	51.4
_junc_181	12 hours	0.070	6261	0.070	0.097
_junc_185	12 hours	0.070	6262	0.080	0.110
_junc_186	12 hours	0.220	6262	0.240	0.331
_junc_187	12 hours	1.78	6261	1.87	2.58
_junc_19	12 hours	132	6261	137	189
_junc_193	12 hours	7.70	6266	7.93	10.9
_junc_194	12 hours	11.0	6266	11.4	15.7
_junc_199	12 hours	13.4	6261	13.6	18.7
_junc_2	12 hours	157	6261	161	222
_junc_20	12 hours	111	6266	114	157
_junc_204	12 hours	5.94	6266	5.95	8.21
_junc_21	12 hours	120	6261	124	171
_junc_22	12 hours	341	6261	354	488
_junc_228	12 hours	0.380	6262	0.400	0.552
_junc_23	12 hours	346	6261	358	495
_junc_231	12 hours	140	6261	145	200
_junc_232	12 hours	17.9	6261	18.1	25.0
_junc_233	12 hours	25.3	6261	25.6	35.3
_junc_234	12 hours	335	6266	345	476
_junc_24	12 hours	21.4	6261	21.7	30.0
_junc_25	18 hours	16.2	6350	16.4	22.6
_junc_26	12 hours	14.6	6261	14.8	20.4
_junc_263	12 hours	8.49	6262	8.50	11.7
_junc_265	12 hours	8.28	6261	8.32	11.5
_junc_27	12 hours	8.84	6261	8.97	12.4
_junc_28	12 hours	373	6261	387	534
_junc_29	12 hours	371	6261	386	532
_junc_3	12 hours	13.6	6258	13.8	19.0
_junc_30	12 hours	375	6261	389	537
_junc_31	12 hours	11.2	6261	11.2	15.4

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_32	12 hours	380	6261	395	544
_junc_324	12 hours	339	6266	349	482
_junc_328	12 hours	392	6266	405	559
_junc_329	12 hours	22.3	6261	23.2	32.0
_junc_33	12 hours	10.8	6266	11.3	15.6
_junc_330	12 hours	46.6	6261	48.1	66.4
_junc_331	12 hours	817	6266	836	1153
_junc_34	12 hours	17.5	6261	17.5	24.2
_junc_35	12 hours	5.91	6261	5.97	8.24
_junc_36	12 hours	329	6266	339	468
_junc_37	12 hours	12.6	6261	12.9	17.8
_junc_38	12 hours	10.1	6266	10.2	14.0
_junc_39	12 hours	365	6266	376	519
_junc_4	12 hours	14.3	6258	14.3	19.7
_junc_40	12 hours	18.1	6261	18.5	25.5
_junc_41	12 hours	11.1	6261	11.1	15.3
_junc_42	12 hours	20.6	6261	21.0	28.9
_junc_43	12 hours	52.6	6261	53.6	73.9
_junc_44	12 hours	342	6266	353	487
_junc_45	12 hours	306	6261	316	435
_junc_46	12 hours	26.4	6266	27.1	37.5
_junc_47	12 hours	346	6266	357	493
_junc_48	12 hours	252	6261	260	358
_junc_49	12 hours	12.3	6261	12.4	17.1
_junc_5	12 hours	12.8	6266	12.9	17.8
_junc_50	12 hours	38.9	6266	40.2	55.5
_junc_51	12 hours	247	6261	254	350
_junc_52	12 hours	44.7	6261	45.9	63.4
_junc_53	12 hours	12.1	6258	12.2	16.8
_junc_54	12 hours	62.5	6261	63.7	87.9
_junc_55	12 hours	70.4	6261	71.9	99.3
_junc_56	12 hours	227	6261	233	321
_junc_57	12 hours	93.9	6261	96.4	133
_junc_58	12 hours	215	6261	220	304
_junc_59	12 hours	201	6261	206	284
_junc_6	12 hours	41.6	6261	42.1	58.1
_junc_60	12 hours	210	6261	215	297
_junc_61	12 hours	19.7	6261	20.2	27.8
_junc_62	12 hours	96.3	6261	98.0	135
_junc_63	12 hours	86.2	6261	87.4	121
_junc_64	12 hours	39.7	6261	39.9	55.1
_junc_65	12 hours	11.2	6265	13.3	18.4
_junc_66	12 hours	73.4	6261	74.5	103
_junc_67	12 hours	44.3	6261	44.7	61.7
_junc_68	12 hours	31.7	6266	31.9	44.1
_junc_69	12 hours	23.7	6261	23.7	32.7
_junc_7	12 hours	48.0	6261	48.6	67.0
_junc_70	12 hours	18.1	6266	18.3	25.2
_junc_71	12 hours	14.8	6258	15.0	20.7
_junc_72	12 hours	26.3	6266	26.9	37.2

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_73	12 hours	12.8	6266	12.9	17.8
_junc_74	12 hours	8.40	6262	8.42	11.6
_junc_75	18 hours	26.2	6350	26.3	36.3
_junc_76	12 hours	10.4	6261	10.5	14.5
_junc_77	12 hours	25.9	6261	26.1	36.0
_junc_78	12 hours	32.1	6261	32.3	44.5
_junc_79	12 hours	36.7	6261	36.8	50.8
_junc_8	12 hours	18.6	6266	18.7	25.7
_junc_80	12 hours	14.8	6266	14.8	20.5
_junc_81	12 hours	67.7	6261	69.4	95.8
_junc_82	12 hours	15.7	6261	15.9	22.0
_junc_83	12 hours	12.5	6261	12.7	17.6
_junc_84	12 hours	83.5	6261	85.5	118
_junc_85	12 hours	16.8	6261	17.1	23.7
_junc_86	12 hours	104	6261	106	147
_junc_87	12 hours	36.5	6261	37.2	51.3
_junc_88	12 hours	39.8	6261	40.5	55.9
_junc_89	12 hours	94.9	6261	97.2	134
_junc_9	12 hours	24.7	6261	24.8	34.2
_junc_90	12 hours	152	6261	156	215
_junc_91	12 hours	9.87	6267	9.93	13.7

5% AEP XP-RAFTS Peak Flows

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
1.01	12 hours	12.4	6262	12.5	16.9
1.02	12 hours	16.2	6266	16.4	22.3
1.03	12 hours	22.6	6266	22.9	31.1
1.04	12 hours	32.1	6266	32.3	43.9
1.05	12 hours	41.1	6266	41.2	56.0
1.06	12 hours	41.9	6266	42.1	57.2
1.07	12 hours	49.8	6266	50.1	68.2
1.08	12 hours	54.7	6266	55.1	75.0
1.09	12 hours	56.3	6266	56.6	77.0
1.10	12 hours	91.7	6261	92.5	126
1.11	12 hours	110	6261	111	151
1.12	12 hours	123	6261	125	169
1.13	12 hours	249	6261	254	345
1.14	12 hours	259	6261	264	359
1.15	12 hours	260	6261	265	360
1.16	12 hours	264	6261	270	367
1.17	12 hours	285	6261	291	396
1.18	12 hours	305	6261	313	425
1.19	12 hours	310	6261	318	432
1.20	12 hours	378	6261	387	527
1.21	12 hours	380	6261	390	530
1.22	12 hours	408	6261	418	568
1.23	12 hours	414	6261	425	578
1.24	12 hours	415	6261	425	578
1.25	12 hours	416	6261	427	581
1.26	12 hours	421	6261	432	587
1.27	12 hours	425	6261	437	594
1.28	12 hours	426	6261	437	594
1.29	12 hours	449	6266	461	627
1.30	12 hours	451	6266	463	629
1.31	12 hours	486	6266	498	677
1.32	12 hours	486	6266	498	677
1.33	12 hours	953	6266	971	1321
1.34	12 hours	954	6266	972	1322
1.35	12 hours	1006	6266	1023	1391
1.36	12 hours	1007	6266	1023	1392
1.37	12 hours	1008	6266	1024	1392
1.38	12 hours	1009	6266	1024	1393
1.39	12 hours	1014	6266	1028	1398
1.40	12 hours	1022	6266	1034	1407
2.01	12 hours	3.15	6262	3.22	4.38
3.01	12 hours	5.71	6259	6.76	9.19
4.01	12 hours	6.08	6266	6.11	8.31
5.01	12 hours	6.28	6259	7.46	10.1
6.01	12 hours	6.34	6261	6.44	8.76
7.01	12 hours	4.06	6266	4.13	5.62
8.01	18 hours	11.3	6350	11.3	15.4
8.02	12 hours	22.3	6266	22.9	31.1
8.03	12 hours	22.3	6266	22.9	31.2

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
8.04	12 hours	32.6	6261	33.3	45.3
8.05	12 hours	33.6	6261	34.3	46.7
9.01	12 hours	7.16	6262	7.16	9.74
10.01	12 hours	4.24	6262	4.25	5.78
10.02	12 hours	10.3	6262	10.3	14.0
11.01	12 hours	5.96	6261	5.97	8.12
12.01	12 hours	4.99	6259	5.90	8.02
12.02	12 hours	8.66	6266	8.78	11.9
12.03	12 hours	13.8	6266	13.9	19.0
13.01	12 hours	1.66	6262	1.74	2.37
14.01	12 hours	4.10	6262	4.10	5.58
14.02	12 hours	4.96	6265	5.86	7.97
15.01	12 hours	0.690	6262	0.730	0.993
16.01	12 hours	5.17	6258	5.23	7.11
16.02	12 hours	7.81	6258	7.84	10.7
17.01	12 hours	8.04	6261	8.21	11.2
17.02	12 hours	18.6	6262	18.6	25.3
17.03	12 hours	23.9	6262	23.9	32.5
17.04	12 hours	33.8	6261	34.4	46.8
17.05	12 hours	39.8	6261	40.6	55.2
17.06	12 hours	49.7	6261	50.7	69.0
17.07	12 hours	56.8	6261	57.8	78.6
17.08	12 hours	78.3	6261	79.3	108
17.09	12 hours	80.1	6261	81.2	110
17.10	12 hours	86.3	6261	87.6	119
17.11	12 hours	121	6261	123	168
17.12	12 hours	123	6261	125	171
17.13	12 hours	124	6261	127	172
18.01	12 hours	7.49	6262	7.49	10.2
19.01	12 hours	3.65	6262	3.66	4.98
20.01	12 hours	8.71	6258	8.84	12.0
21.01	12 hours	7.20	6258	7.29	9.91
21.02	12 hours	8.07	6258	8.15	11.1
22.01	12 hours	5.50	6259	6.52	8.87
23.01	12 hours	4.52	6266	4.57	6.22
23.02	12 hours	14.4	6262	14.5	19.7
23.03	12 hours	19.6	6261	19.7	26.8
23.04	12 hours	19.9	6261	20.0	27.2
24.01	12 hours	5.81	6261	5.81	7.90
25.01	12 hours	2.03	6266	2.11	2.87
26.01	12 hours	6.17	6261	6.34	8.62
26.02	12 hours	6.26	6261	6.42	8.73
27.01	12 hours	8.01	6262	8.04	10.9
27.02	12 hours	17.3	6261	17.6	23.9
27.03	12 hours	29.1	6261	30.0	40.7
28.01	12 hours	1.64	6262	1.73	2.35
28.02	12 hours	2.23	6266	2.35	3.20
29.01	12 hours	6.86	6261	6.96	9.47
30.01	12 hours	2.05	6266	2.05	2.79
31.01	12 hours	1.48	6265	1.73	2.35

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
32.01	12 hours	8.35	6261	8.60	11.7
33.01	12 hours	4.03	6261	4.09	5.56
34.01	12 hours	5.96	6262	5.97	8.12
34.02	12 hours	14.7	6266	14.9	20.3
34.03	12 hours	14.9	6266	15.2	20.6
35.01	12 hours	4.11	6261	4.17	5.67
35.02	12 hours	8.46	6258	8.52	11.6
35.03	12 hours	11.5	6258	11.5	15.6
35.04	12 hours	11.6	6258	11.6	15.8
35.05	12 hours	18.3	6266	18.7	25.5
36.01	12 hours	0.510	6266	0.530	0.721
37.01	12 hours	3.42	6266	3.47	4.72
38.01	12 hours	3.47	6266	3.56	4.84
38.02	12 hours	4.26	6261	4.35	5.92
39.01	12 hours	4.80	6262	4.82	6.56
39.02	12 hours	9.97	6266	10.3	14.1
39.03	12 hours	14.5	6266	15.2	20.6
39.04	12 hours	28.9	6261	29.0	39.5
39.05	12 hours	36.5	6261	36.9	50.2
39.06	12 hours	67.1	6261	67.8	92.2
40.01	12 hours	2.60	6266	2.70	3.67
41.01	12 hours	3.27	6266	3.40	4.62
42.01	12 hours	6.84	6261	6.88	9.36
43.01	12 hours	2.19	6266	2.19	2.98
44.01	12 hours	7.44	6266	7.50	10.2
44.02	12 hours	18.6	6261	18.7	25.4
44.03	12 hours	28.2	6261	28.6	38.9
45.01	12 hours	4.90	6262	4.94	6.72
46.01	12 hours	6.88	6258	6.91	9.40
47.01	12 hours	6.30	6266	6.34	8.62
47.02	12 hours	8.81	6266	8.93	12.1
47.03	12 hours	9.54	6266	9.84	13.4
47.04	12 hours	19.6	6261	19.6	26.7
47.05	12 hours	25.3	6266	26.1	35.5
48.01	12 hours	2.40	6266	2.42	3.29
49.01	12 hours	3.46	6259	4.09	5.56
49.02	12 hours	3.94	6266	4.02	5.47
49.03	12 hours	3.99	6266	4.09	5.56
50.01	12 hours	0.660	6262	0.700	0.952
51.01	12 hours	2.30	6266	2.31	3.14
52.01	12 hours	1.04	6266	1.09	1.48
52.02	12 hours	2.50	6266	2.56	3.48
53.01	12 hours	3.64	6262	3.67	4.99
54.01	12 hours	1.41	6265	1.67	2.27
54.02	12 hours	2.06	6266	2.12	2.88
54.03	12 hours	2.32	6266	2.45	3.33
55.01	12 hours	1.73	6262	1.76	2.39
56.01	12 hours	2.39	6266	2.40	3.26
56.02	12 hours	3.98	6266	4.00	5.44
56.03	12 hours	4.68	6266	4.70	6.39

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
57.01	12 hours	2.07	6266	2.12	2.88
57.02	12 hours	4.84	6267	4.92	6.69
58.01	12 hours	3.80	6262	3.81	5.18
58.02	12 hours	5.56	6262	5.57	7.58
58.03	12 hours	8.05	6266	8.07	11.0
58.04	12 hours	13.5	6266	13.6	18.4
58.05	12 hours	14.5	6261	14.5	19.8
58.06	12 hours	21.0	6261	21.1	28.7
58.07	12 hours	24.0	6261	24.2	33.0
59.01	12 hours	1.71	6259	2.03	2.76
60.01	12 hours	1.59	6266	1.61	2.19
60.02	12 hours	2.04	6266	2.05	2.79
60.03	12 hours	4.41	6266	4.48	6.09
61.01	12 hours	1.30	6259	1.54	2.09
62.01	12 hours	0.300	6262	0.320	0.435
63.01	12 hours	0.030	6262	0.030	0.041
64.01	12 hours	0.880	6266	0.910	1.24
64.02	12 hours	4.89	6266	5.20	7.07
65.01	12 hours	0.510	6262	0.540	0.734
66.01	12 hours	0.630	6262	0.660	0.898
66.02	12 hours	2.27	6261	2.27	3.09
67.01	12 hours	0.120	6262	0.130	0.177
68.01	12 hours	0.200	6262	0.210	0.286
69.01	12 hours	0.200	6261	0.200	0.272
69.02	12 hours	0.340	6262	0.360	0.490
70.01	12 hours	0.150	6262	0.160	0.218
71.01	12 hours	0.160	6261	0.160	0.218
72.01	12 hours	0.190	6262	0.200	0.272
73.01	12 hours	0.140	6262	0.150	0.204
74.01	12 hours	1.20	6262	1.21	1.65
75.01	48 hours	1.06	6621	1.07	1.46
75.02	36 hours	1.25	6536	1.27	1.73
76.01	12 hours	0.850	6266	0.860	1.17
76.02	12 hours	0.910	6262	0.920	1.25
77.01	12 hours	2.06	6262	2.06	2.80
77.02	12 hours	4.54	6266	4.60	6.26
77.03	12 hours	8.65	6261	8.70	11.8
77.04	12 hours	9.67	6261	9.69	13.2
77.05	12 hours	10.3	6261	10.3	14.0
77.06	12 hours	10.5	6261	10.5	14.2
77.07	12 hours	20.3	6266	21.4	29.2
77.08	12 hours	20.8	6266	22.0	29.9
77.09	12 hours	20.9	6266	22.1	30.1
77.10	12 hours	21.3	6261	21.3	28.9
77.11	12 hours	24.3	6261	24.4	33.1
77.12	12 hours	27.2	6261	27.4	37.2
77.13	12 hours	32.8	6261	33.4	45.4
78.01	12 hours	1.94	6261	1.94	2.64
78.02	12 hours	4.59	6261	4.59	6.24
79.01	12 hours	1.29	6266	1.32	1.80

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
80.01	12 hours	0.570	6262	0.600	0.816
81.01	12 hours	1.28	6266	1.29	1.75
81.02	12 hours	1.42	6266	1.45	1.97
81.03	12 hours	2.86	6262	2.96	4.03
81.04	12 hours	5.28	6262	5.48	7.45
82.01	12 hours	0.280	6262	0.290	0.394
82.02	12 hours	1.18	6262	1.23	1.67
82.03	12 hours	1.35	6262	1.41	1.92
83.01	12 hours	0.850	6262	0.900	1.22
83.02	12 hours	1.70	6262	1.80	2.45
83.03	12 hours	1.89	6262	1.99	2.71
84.01	12 hours	0.160	6262	0.170	0.231
84.02	12 hours	0.600	6262	0.630	0.857
85.01	12 hours	0.320	6262	0.340	0.462
86.01	12 hours	0.050	6261	0.050	0.068
87.01	12 hours	0.250	6262	0.260	0.354
87.02	12 hours	0.460	6262	0.490	0.666
88.01	12 hours	0.100	6262	0.100	0.136
89.01	12 hours	0.150	6262	0.160	0.218
90.01	12 hours	0.090	6262	0.100	0.136
91.01	12 hours	0.280	6262	0.300	0.408
92.01	12 hours	0.470	6266	0.480	0.653
92.02	12 hours	1.88	6261	1.90	2.58
92.03	12 hours	2.00	6261	2.04	2.77
92.04	12 hours	2.91	6261	3.01	4.09
93.01	12 hours	0.150	6262	0.150	0.204
94.01	12 hours	0.170	6262	0.180	0.245
95.01	12 hours	0.210	6262	0.220	0.299
96.01	12 hours	0.090	6262	0.090	0.122
97.01	12 hours	0.100	6262	0.100	0.136
98.01	12 hours	0.280	6262	0.300	0.408
99.01	12 hours	1.66	6261	1.68	2.28
99.02	12 hours	2.21	6261	2.27	3.09
100.01	12 hours	0.050	6262	0.050	0.068
101.01	12 hours	0.040	6262	0.040	0.054
102.01	12 hours	0.060	6262	0.070	0.095
103.01	12 hours	0.040	6261	0.040	0.054
104.01	12 hours	0.130	6262	0.140	0.190
104.02	12 hours	0.340	6262	0.360	0.490
105.01	12 hours	0.030	6261	0.030	0.041
106.01	18 hours	3.30	6350	3.31	4.50
106.02	18 hours	4.76	6355	4.81	6.54
107.01	12 hours	1.63	6265	1.93	2.62
108.01	12 hours	1.09	6261	1.12	1.52
108.02	12 hours	1.12	6261	1.15	1.56
109.01	12 hours	2.26	6259	2.66	3.62
110.01	12 hours	1.31	6262	1.35	1.84
111.01	12 hours	0.610	6262	0.630	0.857
112.01	12 hours	0.470	6262	0.490	0.666
113.01	12 hours	0.230	6262	0.230	0.313

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
114.01	12 hours	7.35	6261	7.45	10.1
114.02	12 hours	11.2	6261	11.3	15.4
114.03	12 hours	21.7	6261	21.9	29.8
114.04	18 hours	34.4	6355	34.9	47.5
114.05	18 hours	45.9	6357	46.1	62.6
114.06	12 hours	109	6261	112	152
114.07	12 hours	118	6261	121	165
114.08	12 hours	128	6261	132	179
114.09	12 hours	132	6261	135	183
114.10	12 hours	139	6261	142	193
114.11	12 hours	148	6261	152	206
114.12	12 hours	150	6261	154	209
114.13	12 hours	170	6261	174	237
114.14	12 hours	177	6261	182	248
114.15	12 hours	178	6261	183	249
114.16	12 hours	381	6261	391	532
114.17	12 hours	406	6261	418	569
114.18	12 hours	413	6261	426	579
114.19	12 hours	416	6261	429	584
114.20	12 hours	421	6261	434	590
114.21	12 hours	453	6261	469	637
114.22	12 hours	458	6261	474	644
114.23	12 hours	460	6261	475	646
114.24	12 hours	464	6261	479	652
114.25	12 hours	471	6261	487	662
115.01	12 hours	3.49	6262	3.50	4.76
116.01	12 hours	6.59	6261	6.66	9.06
117.01	12 hours	4.54	6261	4.55	6.19
118.01	18 hours	11.6	6350	11.6	15.8
119.01	12 hours	12.7	6266	13.1	17.8
119.02	12 hours	19.7	6261	20.1	27.3
119.03	12 hours	53.3	6261	53.8	73.1
119.04	12 hours	61.7	6261	62.3	84.8
120.01	12 hours	5.04	6261	5.10	6.94
121.01	12 hours	7.01	6259	8.32	11.3
121.02	12 hours	18.2	6266	18.2	24.8
121.03	12 hours	23.6	6266	23.6	32.2
121.04	12 hours	31.3	6266	31.5	42.9
122.01	12 hours	8.47	6266	8.51	11.6
123.01	12 hours	4.33	6265	5.15	7.00
124.01	12 hours	6.45	6261	6.52	8.87
125.01	12 hours	5.33	6266	5.34	7.26
126.01	12 hours	8.90	6261	9.18	12.5
127.01	12 hours	6.45	6266	6.51	8.85
128.01	12 hours	5.23	6261	5.33	7.25
129.01	12 hours	4.20	6265	4.97	6.76
129.02	12 hours	7.87	6266	8.04	10.9
129.03	12 hours	10.1	6266	10.3	14.1
130.01	12 hours	2.56	6266	2.57	3.50
131.01	12 hours	1.98	6262	2.08	2.83

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
131.02	12 hours	8.32	6258	8.45	11.5
131.03	12 hours	12.8	6258	12.8	17.4
132.01	12 hours	3.32	6259	3.92	5.33
133.01	12 hours	10.2	6265	12.1	16.4
133.02	12 hours	21.9	6265	26.0	35.4
133.03	12 hours	35.6	6261	35.7	48.5
133.04	12 hours	40.3	6266	40.6	55.3
133.05	12 hours	50.6	6261	50.7	68.9
133.06	12 hours	50.9	6261	50.9	69.2
133.07	12 hours	90.1	6261	92.0	125
133.08	12 hours	90.9	6261	92.7	126
133.09	12 hours	109	6261	111	151
133.10	12 hours	120	6261	122	166
133.11	12 hours	135	6261	139	188
133.12	12 hours	188	6261	191	260
133.13	12 hours	197	6261	202	275
133.14	12 hours	201	6261	206	280
134.01	12 hours	7.67	6266	7.68	10.4
135.01	12 hours	9.74	6261	9.94	13.5
136.01	12 hours	3.51	6262	3.56	4.84
137.01	12 hours	4.34	6265	5.17	7.03
138.01	18 hours	15.9	6351	16.0	21.8
138.02	18 hours	19.6	6351	19.8	26.9
138.03	18 hours	33.4	6350	33.7	45.9
139.01	12 hours	6.84	6261	6.90	9.38
139.02	12 hours	13.1	6261	13.5	18.3
140.01	12 hours	0.710	6262	0.740	1.01
141.01	12 hours	10.0	6266	10.0	13.6
141.02	12 hours	11.9	6266	11.9	16.2
142.01	12 hours	1.26	6262	1.32	1.80
143.01	12 hours	7.81	6266	7.85	10.7
144.01	12 hours	7.46	6266	7.52	10.2
145.01	12 hours	5.46	6266	5.46	7.43
145.02	12 hours	15.1	6261	15.3	20.8
145.03	12 hours	23.4	6261	23.7	32.2
145.04	12 hours	44.9	6261	45.6	62.0
145.05	12 hours	45.0	6261	45.7	62.2
145.06	12 hours	51.7	6261	52.4	71.2
146.01	12 hours	7.35	6261	7.52	10.2
147.01	12 hours	4.11	6259	4.89	6.65
148.01	12 hours	10.6	6261	10.9	14.8
148.02	12 hours	16.1	6261	16.5	22.4
148.03	12 hours	21.3	6261	21.7	29.6
149.01	12 hours	4.72	6261	4.76	6.47
150.01	12 hours	4.42	6262	4.42	6.01
151.01	12 hours	3.77	6265	4.47	6.08
152.01	12 hours	1.55	6266	1.61	2.19
153.01	12 hours	5.08	6261	5.15	7.00
154.01	12 hours	2.07	6262	2.10	2.86
154.02	12 hours	2.73	6262	2.78	3.78

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
155.01	12 hours	7.75	6267	7.81	10.6
155.02	12 hours	7.84	6267	7.92	10.8
155.03	12 hours	13.1	6258	13.3	18.0
155.04	12 hours	13.7	6258	13.8	18.8
155.05	12 hours	21.8	6261	22.3	30.3
155.06	12 hours	25.7	6261	26.1	35.5
156.01	12 hours	4.47	6262	4.47	6.08
156.02	12 hours	4.65	6261	4.72	6.42
157.01	12 hours	3.28	6262	3.29	4.47
158.01	12 hours	1.74	6265	2.05	2.79
159.01	12 hours	1.66	6259	1.98	2.69
160.01	12 hours	3.44	6262	3.45	4.69
160.02	12 hours	3.69	6261	3.71	5.05
161.01	12 hours	6.77	6258	6.79	9.23
162.01	12 hours	0.590	6262	0.610	0.830
162.02	12 hours	4.13	6261	4.23	5.75
162.03	12 hours	4.20	6261	4.30	5.85
163.01	12 hours	0.860	6262	0.900	1.22
163.02	12 hours	2.56	6262	2.61	3.55
163.03	12 hours	7.79	6261	7.92	10.8
163.04	12 hours	11.8	6261	12.1	16.5
163.05	12 hours	25.3	6267	25.3	34.4
163.06	12 hours	26.3	6258	26.7	36.4
164.01	18 hours	9.12	6350	9.13	12.4
165.01	12 hours	4.35	6267	4.36	5.93
165.02	12 hours	5.04	6267	5.04	6.85
166.01	12 hours	1.33	6262	1.35	1.84
166.02	12 hours	2.83	6265	3.35	4.56
166.03	12 hours	4.90	6261	4.94	6.72
167.01	12 hours	1.04	6266	1.08	1.47
167.02	12 hours	1.97	6266	2.04	2.77
168.01	12 hours	2.84	6262	2.84	3.86
168.02	12 hours	2.86	6265	3.37	4.58
169.01	12 hours	5.18	6262	5.18	7.04
169.02	12 hours	5.88	6261	5.96	8.11
170.01	12 hours	0.860	6262	0.910	1.24
171.01	12 hours	0.970	6262	0.980	1.33
172.01	12 hours	0.620	6262	0.650	0.884
173.01	12 hours	1.18	6262	1.24	1.69
173.02	12 hours	9.11	6266	9.55	13.0
173.03	12 hours	17.9	6261	17.9	24.4
173.04	12 hours	19.4	6261	19.6	26.6
173.05	12 hours	24.7	6261	25.3	34.4
173.06	12 hours	31.8	6261	32.9	44.8
173.07	12 hours	57.6	6261	59.0	80.3
174.01	12 hours	0.940	6262	0.990	1.35
175.01	12 hours	0.740	6266	0.770	1.05
176.01	12 hours	0.670	6262	0.700	0.952
176.02	12 hours	3.65	6266	3.70	5.03
177.01	18 hours	2.77	6357	2.78	3.78

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
178.01	12 hours	2.08	6261	2.11	2.87
179.01	12 hours	0.360	6259	0.430	0.585
180.01	18 hours	2.90	6350	2.91	3.96
180.02	18 hours	3.22	6357	3.23	4.39
181.01	12 hours	2.15	6262	2.15	2.92
182.01	12 hours	0.300	6262	0.310	0.422
183.01	12 hours	3.05	6266	3.10	4.22
183.02	12 hours	5.80	6266	5.89	8.01
183.03	12 hours	10.4	6266	10.6	14.4
183.04	12 hours	16.4	6266	16.9	23.0
183.05	12 hours	17.1	6266	17.6	23.9
183.06	12 hours	25.9	6266	26.3	35.7
184.01	12 hours	0.560	6262	0.590	0.802
184.02	12 hours	3.55	6266	3.64	4.95
185.01	12 hours	0.690	6262	0.730	0.993
185.02	12 hours	2.96	6266	3.13	4.26
186.01	12 hours	1.34	6266	1.37	1.86
187.01	12 hours	1.68	6259	2.01	2.73
187.02	12 hours	3.19	6265	3.78	5.14
188.01	12 hours	0.530	6262	0.570	0.775
189.01	12 hours	0.550	6262	0.580	0.789
190.01	12 hours	0.370	6262	0.390	0.530
191.01	12 hours	1.03	6266	1.05	1.43
192.01	12 hours	1.20	6262	1.25	1.70
193.01	12 hours	1.02	6262	1.06	1.44
194.01	12 hours	0.180	6262	0.190	0.258
195.01	12 hours	0.360	6262	0.370	0.503
196.01	12 hours	0.410	6262	0.420	0.571
197.01	12 hours	0.340	6262	0.350	0.476
198.01	12 hours	0.480	6262	0.500	0.680
199.01	12 hours	1.04	6262	1.09	1.48
199.02	12 hours	1.41	6262	1.48	2.01
200.01	12 hours	0.190	6262	0.200	0.272
201.01	12 hours	0.450	6262	0.460	0.626
202.01	12 hours	3.78	6258	3.84	5.22
203.01	12 hours	0.630	6262	0.660	0.898
204.01	12 hours	0.440	6262	0.460	0.626
205.01	12 hours	0.560	6262	0.580	0.789
206.01	12 hours	0.150	6261	0.150	0.204
207.01	12 hours	0.530	6262	0.560	0.762
208.01	12 hours	0.760	6262	0.790	1.07
208.02	12 hours	1.06	6262	1.12	1.52
208.03	12 hours	2.00	6262	2.11	2.87
208.04	12 hours	3.75	6261	3.95	5.37
208.05	12 hours	4.72	6258	4.73	6.43
208.06	18 hours	5.68	6350	5.75	7.82
209.01	12 hours	0.140	6262	0.150	0.204
210.01	12 hours	0.270	6262	0.280	0.381
211.01	12 hours	0.280	6262	0.290	0.394
211.02	12 hours	0.320	6262	0.330	0.449

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
211.03	12 hours	1.14	6262	1.19	1.62
212.01	12 hours	0.130	6261	0.140	0.190
_junc_10	12 hours	25.4	6261	25.9	35.2
_junc_108	12 hours	0.490	6262	0.510	0.694
_junc_11	12 hours	405	6261	417	567
_junc_111	12 hours	2.77	6262	2.86	3.89
_junc_114	12 hours	1.66	6261	1.68	2.28
_junc_12	12 hours	12.7	6266	13.3	18.0
_junc_13	12 hours	124	6261	127	173
_junc_138	12 hours	8.70	6266	8.76	11.9
_junc_14	12 hours	106	6261	108	147
_junc_142	12 hours	6.73	6259	7.99	10.9
_junc_143	12 hours	200	6261	204	278
_junc_15	12 hours	378	6261	388	528
_junc_16	12 hours	413	6261	425	578
_junc_165	12 hours	28.2	6261	28.5	38.8
_junc_168	12 hours	26.4	6261	26.6	36.1
_junc_17	12 hours	118	6261	121	164
_junc_174	12 hours	19.3	6266	19.6	26.6
_junc_18	18 hours	45.8	6357	45.9	62.5
_junc_181	12 hours	0.080	6261	0.080	0.109
_junc_185	12 hours	0.090	6262	0.090	0.122
_junc_186	12 hours	0.270	6262	0.280	0.381
_junc_187	12 hours	2.17	6261	2.25	3.06
_junc_19	12 hours	163	6261	167	227
_junc_193	12 hours	9.34	6266	9.54	13.0
_junc_194	12 hours	13.4	6266	13.7	18.7
_junc_199	12 hours	16.3	6261	16.4	22.3
_junc_2	12 hours	192	6261	196	267
_junc_20	12 hours	136	6261	140	190
_junc_204	12 hours	7.25	6261	7.26	9.87
_junc_21	12 hours	148	6261	151	206
_junc_22	12 hours	420	6261	433	589
_junc_228	12 hours	0.450	6262	0.470	0.639
_junc_23	12 hours	426	6261	439	597
_junc_231	12 hours	173	6261	177	241
_junc_232	12 hours	21.8	6261	21.9	29.7
_junc_233	12 hours	31.0	6261	31.1	42.3
_junc_234	12 hours	411	6261	422	573
_junc_24	12 hours	26.2	6261	26.5	36.0
_junc_25	12 hours	20.3	6267	20.3	27.6
_junc_26	12 hours	17.8	6261	18.0	24.4
_junc_263	12 hours	10.3	6261	10.4	14.1
_junc_265	12 hours	10.1	6261	10.1	13.8
_junc_27	12 hours	10.8	6262	10.8	14.7
_junc_28	12 hours	460	6261	475	646
_junc_29	12 hours	458	6261	473	644
_junc_3	12 hours	16.9	6258	17.0	23.1
_junc_30	12 hours	462	6261	478	650
_junc_31	12 hours	13.5	6266	13.9	18.9

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_32	12 hours	469	6261	485	660
_junc_324	12 hours	416	6261	426	580
_junc_328	12 hours	482	6266	495	673
_junc_329	12 hours	27.6	6261	28.4	38.6
_junc_33	12 hours	13.1	6266	13.7	18.7
_junc_330	12 hours	57.3	6261	58.7	79.8
_junc_331	12 hours	1006	6266	1023	1391
_junc_34	12 hours	21.3	6266	22.0	29.9
_junc_35	12 hours	7.23	6261	7.27	9.89
_junc_36	12 hours	404	6261	414	563
_junc_37	12 hours	15.5	6261	15.7	21.4
_junc_38	12 hours	12.3	6266	12.4	16.8
_junc_39	12 hours	448	6266	460	625
_junc_4	12 hours	17.7	6261	18.0	24.5
_junc_40	12 hours	22.2	6262	22.2	30.2
_junc_41	12 hours	13.5	6266	13.6	18.5
_junc_42	12 hours	25.3	6261	25.6	34.9
_junc_43	12 hours	64.7	6261	65.4	88.9
_junc_44	12 hours	421	6261	431	586
_junc_45	12 hours	376	6261	385	524
_junc_46	12 hours	32.5	6261	33.2	45.1
_junc_47	12 hours	425	6261	436	593
_junc_48	12 hours	309	6261	317	431
_junc_49	12 hours	15.0	6261	15.1	20.5
_junc_5	12 hours	15.5	6266	15.5	21.1
_junc_50	12 hours	47.9	6261	49.0	66.6
_junc_51	12 hours	303	6261	310	421
_junc_52	12 hours	54.9	6261	55.9	76.0
_junc_53	12 hours	15.0	6266	15.4	21.0
_junc_54	12 hours	76.5	6261	77.6	105
_junc_55	12 hours	86.3	6261	87.6	119
_junc_56	12 hours	278	6261	284	386
_junc_57	12 hours	115	6261	117	160
_junc_58	12 hours	264	6261	269	366
_junc_59	12 hours	247	6261	251	341
_junc_6	12 hours	50.8	6261	51.2	69.7
_junc_60	12 hours	257	6261	262	357
_junc_61	12 hours	24.1	6261	24.5	33.3
_junc_62	12 hours	118	6261	119	162
_junc_63	12 hours	105	6261	106	144
_junc_64	12 hours	48.1	6266	48.4	65.9
_junc_65	12 hours	13.6	6266	13.7	18.6
_junc_66	12 hours	89.7	6261	90.4	123
_junc_67	12 hours	53.8	6266	54.2	73.7
_junc_68	12 hours	38.4	6266	38.5	52.4
_junc_69	12 hours	28.7	6266	28.9	39.3
_junc_7	12 hours	58.5	6261	59.0	80.3
_junc_70	12 hours	21.9	6266	22.1	30.0
_junc_71	12 hours	18.3	6258	18.4	25.0
_junc_72	12 hours	32.3	6261	33.0	44.9

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_73	12 hours	15.6	6266	15.6	21.2
_junc_74	12 hours	10.2	6262	10.2	13.9
_junc_75	18 hours	32.1	6350	32.3	43.9
_junc_76	12 hours	12.7	6261	12.9	17.5
_junc_77	12 hours	31.5	6261	31.5	42.9
_junc_78	12 hours	39.0	6261	39.0	53.0
_junc_79	12 hours	44.6	6266	44.9	61.0
_junc_8	12 hours	22.5	6265	26.5	36.1
_junc_80	12 hours	17.9	6265	21.2	28.8
_junc_81	12 hours	83.1	6261	84.6	115
_junc_82	12 hours	19.2	6261	19.3	26.3
_junc_83	12 hours	15.3	6261	15.6	21.2
_junc_84	12 hours	102	6261	104	142
_junc_85	12 hours	20.5	6261	21.0	28.5
_junc_86	12 hours	127	6261	129	176
_junc_87	12 hours	44.6	6261	45.3	61.6
_junc_88	12 hours	48.7	6261	49.4	67.2
_junc_89	12 hours	116	6261	118	161
_junc_9	12 hours	30.0	6266	30.2	41.1
_junc_90	12 hours	186	6261	190	258
_junc_91	12 hours	12.4	6258	12.6	17.1

2% AEP XP-RAFTS Peak Flows

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
1.01	12 hours	15.4	6262	15.5	19.6
1.02	12 hours	20.1	6266	20.2	25.7
1.03	12 hours	28.0	6266	28.2	35.9
1.04	12 hours	39.8	6266	39.9	50.6
1.05	12 hours	50.9	6266	50.9	64.6
1.06	12 hours	51.9	6266	51.9	66.0
1.07	12 hours	61.8	6266	62.0	78.7
1.08	12 hours	67.9	6266	68.2	86.7
1.09	12 hours	69.8	6266	70.2	89.1
1.10	12 hours	114	6261	115	146
1.11	12 hours	137	6261	138	175
1.12	12 hours	153	6261	155	197
1.13	12 hours	312	6261	316	402
1.14	12 hours	324	6261	329	418
1.15	12 hours	325	6261	330	419
1.16	12 hours	331	6261	336	427
1.17	12 hours	356	6261	363	461
1.18	12 hours	382	6261	390	495
1.19	12 hours	388	6261	396	503
1.20	12 hours	473	6261	483	613
1.21	12 hours	476	6261	486	617
1.22	12 hours	510	6261	520	661
1.23	12 hours	519	6266	529	672
1.24	12 hours	519	6266	529	672
1.25	12 hours	521	6266	531	675
1.26	12 hours	526	6266	537	682
1.27	12 hours	532	6266	543	690
1.28	12 hours	533	6266	544	691
1.29	12 hours	562	6266	574	728
1.30	12 hours	564	6266	575	731
1.31	12 hours	608	6266	620	787
1.32	12 hours	609	6266	620	787
1.33	12 hours	1196	6266	1211	1538
1.34	12 hours	1197	6266	1212	1539
1.35	12 hours	1263	6266	1276	1621
1.36	12 hours	1264	6266	1277	1622
1.37	12 hours	1265	6266	1277	1622
1.38	12 hours	1266	6266	1278	1623
1.39	12 hours	1272	6266	1283	1629
1.40	12 hours	1282	6266	1291	1640
2.01	12 hours	3.90	6262	4.04	5.13
3.01	12 hours	7.04	6259	8.16	10.4
4.01	12 hours	7.53	6266	7.54	9.58
5.01	12 hours	7.77	6266	7.78	9.88
6.01	12 hours	7.93	6262	7.96	10.1
7.01	12 hours	5.10	6262	5.13	6.52
8.01	18 hours	14.3	6350	14.4	18.3
8.02	12 hours	28.0	6266	28.7	36.5
8.03	12 hours	28.1	6266	28.8	36.5

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
8.04	12 hours	40.8	6261	41.6	52.8
8.05	12 hours	42.1	6261	42.9	54.4
9.01	12 hours	8.93	6262	8.98	11.4
10.01	12 hours	5.27	6262	5.28	6.71
10.02	12 hours	12.7	6262	12.7	16.2
11.01	12 hours	7.41	6262	7.42	9.42
12.01	12 hours	6.15	6262	6.19	7.86
12.02	12 hours	10.7	6262	10.7	13.6
12.03	12 hours	17.1	6266	17.3	21.9
13.01	12 hours	2.05	6262	2.17	2.76
14.01	12 hours	5.09	6266	5.09	6.46
14.02	12 hours	6.15	6266	6.18	7.85
15.01	12 hours	0.850	6262	0.900	1.14
16.01	12 hours	6.53	6258	6.55	8.32
16.02	12 hours	9.83	6266	10.1	12.8
17.01	12 hours	10.0	6262	10.1	12.8
17.02	12 hours	23.1	6262	23.3	29.5
17.03	12 hours	29.8	6262	29.9	38.0
17.04	12 hours	42.2	6261	42.8	54.4
17.05	12 hours	49.8	6262	49.8	63.2
17.06	12 hours	62.1	6261	63.1	80.1
17.07	12 hours	71.0	6261	72.0	91.5
17.08	12 hours	97.7	6261	98.8	125
17.09	12 hours	100.0	6261	101	128
17.10	12 hours	108	6261	109	139
17.11	12 hours	152	6261	154	196
17.12	12 hours	154	6261	157	199
17.13	12 hours	155	6261	158	201
18.01	12 hours	9.30	6262	9.34	11.9
19.01	12 hours	4.55	6262	4.56	5.79
20.01	12 hours	11.0	6258	11.1	14.1
21.01	12 hours	9.10	6258	9.12	11.6
21.02	12 hours	10.2	6258	10.2	12.9
22.01	12 hours	6.78	6262	6.80	8.64
23.01	12 hours	5.60	6261	5.63	7.15
23.02	12 hours	17.9	6262	18.0	22.9
23.03	12 hours	24.4	6266	24.6	31.3
23.04	12 hours	24.7	6266	25.0	31.8
24.01	12 hours	7.21	6262	7.21	9.16
25.01	12 hours	2.49	6266	2.59	3.29
26.01	12 hours	7.76	6261	7.91	10.0
26.02	12 hours	7.86	6261	8.02	10.2
27.01	12 hours	9.93	6266	9.95	12.6
27.02	12 hours	21.6	6261	21.8	27.7
27.03	12 hours	36.5	6261	37.5	47.6
28.01	12 hours	2.03	6262	2.15	2.73
28.02	12 hours	2.76	6262	2.91	3.70
29.01	12 hours	8.58	6262	8.61	10.9
30.01	12 hours	2.51	6262	2.52	3.20
31.01	12 hours	1.84	6262	1.84	2.34

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
32.01	12 hours	10.5	6261	10.7	13.6
33.01	12 hours	5.06	6262	5.09	6.46
34.01	12 hours	7.42	6262	7.44	9.45
34.02	12 hours	18.2	6266	18.3	23.3
34.03	12 hours	18.4	6266	18.7	23.7
35.01	12 hours	5.14	6262	5.17	6.57
35.02	12 hours	10.7	6258	10.8	13.7
35.03	12 hours	14.5	6261	14.9	18.9
35.04	12 hours	14.7	6261	15.1	19.2
35.05	12 hours	23.1	6261	23.6	30.0
36.01	12 hours	0.630	6266	0.650	0.826
37.01	12 hours	4.30	6262	4.33	5.50
38.01	12 hours	4.41	6261	4.50	5.72
38.02	12 hours	5.39	6261	5.51	7.00
39.01	12 hours	5.97	6262	6.01	7.63
39.02	12 hours	12.4	6266	12.8	16.2
39.03	12 hours	18.1	6266	18.8	23.9
39.04	12 hours	36.0	6261	36.1	45.8
39.05	12 hours	45.6	6261	45.8	58.2
39.06	12 hours	84.0	6261	84.5	107
40.01	12 hours	3.21	6266	3.36	4.27
41.01	12 hours	4.06	6266	4.28	5.44
42.01	12 hours	8.53	6262	8.54	10.8
43.01	12 hours	2.69	6262	2.71	3.44
44.01	12 hours	9.24	6259	10.8	13.7
44.02	12 hours	23.2	6261	23.3	29.6
44.03	12 hours	35.4	6261	35.8	45.5
45.01	12 hours	6.08	6262	6.26	7.95
46.01	12 hours	8.72	6261	8.98	11.4
47.01	12 hours	7.84	6266	7.87	9.99
47.02	12 hours	10.9	6266	11.0	14.0
47.03	12 hours	11.8	6266	12.2	15.5
47.04	12 hours	24.4	6261	24.4	31.0
47.05	12 hours	31.5	6266	32.4	41.1
48.01	12 hours	2.96	6259	3.43	4.36
49.01	12 hours	4.29	6262	4.36	5.54
49.02	12 hours	4.90	6262	5.00	6.35
49.03	12 hours	4.97	6262	5.06	6.43
50.01	12 hours	0.820	6262	0.860	1.09
51.01	12 hours	2.84	6262	2.90	3.68
52.01	12 hours	1.29	6266	1.35	1.71
52.02	12 hours	3.11	6262	3.13	3.98
53.01	12 hours	4.56	6266	4.58	5.82
54.01	12 hours	1.75	6259	2.05	2.60
54.02	12 hours	2.56	6266	2.64	3.35
54.03	12 hours	2.89	6266	3.05	3.87
55.01	12 hours	2.15	6266	2.16	2.74
56.01	12 hours	2.95	6266	2.96	3.76
56.02	12 hours	4.93	6266	4.96	6.30
56.03	12 hours	5.80	6266	5.82	7.39

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
57.01	12 hours	2.55	6266	2.58	3.28
57.02	12 hours	6.11	6267	6.19	7.86
58.01	12 hours	4.75	6266	4.75	6.03
58.02	12 hours	6.94	6266	6.95	8.83
58.03	12 hours	10.1	6261	10.1	12.8
58.04	12 hours	16.8	6266	17.0	21.6
58.05	12 hours	18.1	6261	18.1	23.0
58.06	12 hours	26.3	6261	26.4	33.5
58.07	12 hours	30.0	6261	30.3	38.4
59.01	12 hours	2.12	6262	2.15	2.73
60.01	12 hours	1.97	6266	2.04	2.59
60.02	12 hours	2.54	6266	2.61	3.31
60.03	12 hours	5.48	6266	5.63	7.15
61.01	12 hours	1.61	6259	1.88	2.39
62.01	12 hours	0.380	6262	0.400	0.508
63.01	12 hours	0.030	6262	0.030	0.038
64.01	12 hours	1.09	6266	1.13	1.44
64.02	12 hours	6.09	6266	6.46	8.20
65.01	12 hours	0.630	6262	0.660	0.838
66.01	12 hours	0.780	6262	0.820	1.04
66.02	12 hours	2.83	6266	3.03	3.85
67.01	12 hours	0.150	6261	0.150	0.191
68.01	12 hours	0.240	6262	0.260	0.330
69.01	12 hours	0.240	6261	0.250	0.318
69.02	12 hours	0.410	6262	0.440	0.559
70.01	12 hours	0.180	6262	0.190	0.241
71.01	12 hours	0.200	6261	0.200	0.254
72.01	12 hours	0.230	6261	0.230	0.292
73.01	12 hours	0.170	6261	0.170	0.216
74.01	12 hours	1.48	6262	1.53	1.94
75.01	48 hours	1.46	6621	1.49	1.89
75.02	48 hours	1.72	6618	1.75	2.22
76.01	12 hours	1.06	6266	1.07	1.36
76.02	12 hours	1.14	6262	1.16	1.47
77.01	12 hours	2.54	6266	2.58	3.28
77.02	12 hours	5.60	6266	5.65	7.18
77.03	12 hours	10.8	6266	11.0	14.0
77.04	12 hours	12.0	6266	12.3	15.7
77.05	12 hours	12.8	6266	13.1	16.7
77.06	12 hours	13.0	6266	13.3	16.9
77.07	12 hours	25.3	6266	26.7	33.9
77.08	12 hours	25.8	6266	27.4	34.8
77.09	12 hours	26.0	6266	27.6	35.1
77.10	12 hours	26.5	6266	28.1	35.6
77.11	12 hours	30.3	6266	32.0	40.6
77.12	12 hours	33.9	6261	34.0	43.1
77.13	12 hours	41.1	6261	41.7	53.0
78.01	12 hours	2.39	6266	2.44	3.10
78.02	12 hours	5.74	6266	6.10	7.75
79.01	12 hours	1.59	6266	1.65	2.10

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
80.01	12 hours	0.700	6262	0.740	0.940
81.01	12 hours	1.59	6266	1.60	2.03
81.02	12 hours	1.76	6266	1.80	2.29
81.03	12 hours	3.54	6262	3.70	4.70
81.04	12 hours	6.51	6262	6.84	8.69
82.01	12 hours	0.340	6262	0.360	0.457
82.02	12 hours	1.46	6262	1.53	1.94
82.03	12 hours	1.67	6262	1.76	2.24
83.01	12 hours	1.06	6259	1.13	1.44
83.02	12 hours	2.09	6262	2.23	2.83
83.03	12 hours	2.32	6262	2.47	3.14
84.01	12 hours	0.200	6262	0.210	0.267
84.02	12 hours	0.730	6262	0.770	0.978
85.01	12 hours	0.400	6262	0.420	0.533
86.01	12 hours	0.060	6261	0.060	0.076
87.01	12 hours	0.300	6262	0.320	0.406
87.02	12 hours	0.560	6262	0.590	0.749
88.01	12 hours	0.120	6262	0.130	0.165
89.01	12 hours	0.180	6262	0.190	0.241
90.01	12 hours	0.120	6262	0.130	0.165
91.01	12 hours	0.340	6262	0.370	0.470
92.01	12 hours	0.580	6266	0.590	0.749
92.02	12 hours	2.34	6261	2.35	2.98
92.03	12 hours	2.48	6261	2.52	3.20
92.04	12 hours	3.64	6261	3.73	4.74
93.01	12 hours	0.180	6262	0.190	0.241
94.01	12 hours	0.210	6262	0.220	0.279
95.01	12 hours	0.260	6262	0.270	0.343
96.01	12 hours	0.110	6262	0.120	0.152
97.01	12 hours	0.120	6262	0.130	0.165
98.01	12 hours	0.350	6262	0.370	0.470
99.01	12 hours	2.08	6262	2.09	2.65
99.02	12 hours	2.77	6261	2.86	3.63
100.01	12 hours	0.060	6262	0.060	0.076
101.01	12 hours	0.050	6261	0.050	0.064
102.01	12 hours	0.080	6262	0.080	0.102
103.01	12 hours	0.050	6261	0.050	0.064
104.01	12 hours	0.160	6262	0.170	0.216
104.02	12 hours	0.420	6262	0.440	0.559
105.01	12 hours	0.040	6261	0.040	0.051
106.01	18 hours	4.31	6350	4.33	5.50
106.02	18 hours	6.17	6355	6.21	7.89
107.01	12 hours	2.03	6266	2.03	2.58
108.01	12 hours	1.38	6261	1.41	1.79
108.02	12 hours	1.40	6261	1.44	1.83
109.01	12 hours	2.79	6262	2.79	3.54
110.01	12 hours	1.63	6266	1.64	2.08
111.01	12 hours	0.750	6262	0.780	0.991
112.01	12 hours	0.570	6262	0.600	0.762
113.01	12 hours	0.280	6262	0.280	0.356

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
114.01	12 hours	9.16	6262	9.21	11.7
114.02	12 hours	13.9	6262	13.9	17.7
114.03	12 hours	27.0	6262	27.1	34.4
114.04	18 hours	43.8	6355	44.2	56.1
114.05	18 hours	58.4	6357	58.5	74.3
114.06	12 hours	137	6261	139	177
114.07	12 hours	148	6261	151	192
114.08	12 hours	161	6261	164	209
114.09	12 hours	165	6261	168	214
114.10	12 hours	174	6261	177	225
114.11	12 hours	186	6261	190	241
114.12	12 hours	188	6261	192	244
114.13	12 hours	213	6261	219	278
114.14	12 hours	222	6261	228	290
114.15	12 hours	223	6261	229	291
114.16	12 hours	478	6261	490	622
114.17	12 hours	509	6261	524	665
114.18	12 hours	519	6261	533	677
114.19	12 hours	523	6261	538	683
114.20	12 hours	528	6261	544	690
114.21	12 hours	569	6261	588	747
114.22	12 hours	575	6266	594	754
114.23	12 hours	577	6266	596	757
114.24	12 hours	582	6266	601	764
114.25	12 hours	592	6266	610	775
115.01	12 hours	4.33	6262	4.34	5.51
116.01	12 hours	8.22	6262	8.27	10.5
117.01	12 hours	5.64	6266	5.65	7.18
118.01	18 hours	14.8	6350	14.9	18.9
119.01	12 hours	15.9	6266	16.3	20.7
119.02	12 hours	24.6	6261	24.9	31.7
119.03	12 hours	66.1	6261	66.5	84.4
119.04	12 hours	76.5	6261	77.1	97.9
120.01	12 hours	6.22	6262	6.22	7.90
121.01	12 hours	8.64	6259	10.0	12.7
121.02	12 hours	22.4	6262	22.4	28.4
121.03	12 hours	29.1	6259	33.7	42.8
121.04	12 hours	38.6	6266	38.8	49.3
122.01	12 hours	10.4	6259	12.2	15.5
123.01	12 hours	5.34	6259	6.20	7.87
124.01	12 hours	8.04	6262	8.07	10.2
125.01	12 hours	6.56	6259	7.66	9.73
126.01	12 hours	11.2	6261	11.5	14.6
127.01	12 hours	7.98	6266	8.04	10.2
128.01	12 hours	6.50	6261	6.53	8.29
129.01	12 hours	5.22	6266	5.24	6.65
129.02	12 hours	9.80	6262	9.96	12.6
129.03	12 hours	12.6	6262	12.9	16.3
130.01	12 hours	3.16	6266	3.17	4.03
131.01	12 hours	2.42	6266	2.55	3.24

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
131.02	12 hours	10.5	6258	10.6	13.5
131.03	12 hours	16.2	6261	16.6	21.0
132.01	12 hours	4.12	6262	4.19	5.32
133.01	12 hours	12.6	6262	12.7	16.1
133.02	12 hours	27.1	6259	31.4	39.9
133.03	12 hours	44.1	6261	44.2	56.2
133.04	12 hours	49.9	6266	50.3	63.9
133.05	12 hours	62.7	6261	62.8	79.7
133.06	12 hours	63.0	6261	63.1	80.1
133.07	12 hours	113	6261	115	146
133.08	12 hours	114	6261	116	147
133.09	12 hours	136	6261	139	176
133.10	12 hours	150	6261	153	194
133.11	12 hours	170	6261	173	220
133.12	12 hours	235	6261	239	304
133.13	12 hours	247	6261	253	321
133.14	12 hours	251	6261	257	327
134.01	12 hours	9.42	6259	10.9	13.9
135.01	12 hours	12.2	6262	12.2	15.5
136.01	12 hours	4.34	6262	4.49	5.70
137.01	12 hours	5.35	6266	5.36	6.81
138.01	18 hours	20.2	6350	20.3	25.8
138.02	18 hours	24.9	6350	25.1	31.9
138.03	18 hours	42.4	6350	43.0	54.6
139.01	12 hours	8.50	6262	8.54	10.8
139.02	12 hours	16.4	6261	16.7	21.3
140.01	12 hours	0.880	6262	0.910	1.16
141.01	12 hours	12.4	6259	14.4	18.3
141.02	12 hours	14.7	6259	17.0	21.6
142.01	12 hours	1.55	6262	1.63	2.07
143.01	12 hours	9.61	6262	9.67	12.3
144.01	12 hours	9.20	6266	9.21	11.7
145.01	12 hours	6.71	6259	7.82	9.93
145.02	12 hours	18.8	6261	18.9	24.1
145.03	12 hours	29.1	6261	29.4	37.3
145.04	12 hours	55.9	6261	56.7	72.0
145.05	12 hours	56.0	6261	56.8	72.2
145.06	12 hours	64.3	6261	65.1	82.6
146.01	12 hours	9.18	6261	9.34	11.9
147.01	12 hours	5.09	6266	5.11	6.49
148.01	12 hours	13.3	6261	13.7	17.3
148.02	12 hours	20.1	6261	20.6	26.2
148.03	12 hours	26.5	6261	27.1	34.5
149.01	12 hours	5.82	6261	5.82	7.39
150.01	12 hours	5.52	6261	5.57	7.07
151.01	12 hours	4.69	6259	5.46	6.93
152.01	12 hours	1.92	6262	2.03	2.58
153.01	12 hours	6.30	6266	6.38	8.10
154.01	12 hours	2.55	6266	2.56	3.25
154.02	12 hours	3.36	6262	3.47	4.41

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
155.01	12 hours	9.85	6267	9.85	12.5
155.02	12 hours	9.97	6267	9.98	12.7
155.03	12 hours	16.6	6258	16.7	21.2
155.04	12 hours	17.3	6258	17.3	22.0
155.05	12 hours	27.4	6261	27.9	35.4
155.06	12 hours	32.3	6261	32.9	41.8
156.01	12 hours	5.59	6262	5.62	7.14
156.02	12 hours	5.82	6262	5.83	7.40
157.01	12 hours	4.11	6262	4.14	5.26
158.01	12 hours	2.16	6259	2.50	3.18
159.01	12 hours	2.07	6266	2.08	2.64
160.01	12 hours	4.30	6262	4.31	5.47
160.02	12 hours	4.61	6261	4.64	5.89
161.01	12 hours	8.59	6261	8.84	11.2
162.01	12 hours	0.720	6262	0.750	0.953
162.02	12 hours	5.23	6261	5.37	6.82
162.03	12 hours	5.33	6261	5.46	6.93
163.01	12 hours	1.06	6262	1.12	1.42
163.02	12 hours	3.19	6266	3.30	4.19
163.03	12 hours	9.78	6261	9.90	12.6
163.04	12 hours	14.9	6261	15.2	19.3
163.05	12 hours	32.2	6258	32.6	41.4
163.06	12 hours	33.5	6258	33.9	43.0
164.01	18 hours	11.6	6350	11.7	14.8
165.01	12 hours	5.58	6258	5.68	7.21
165.02	12 hours	6.45	6258	6.54	8.31
166.01	12 hours	1.66	6262	1.71	2.17
166.02	12 hours	3.52	6259	4.10	5.21
166.03	12 hours	6.11	6261	6.15	7.81
167.01	12 hours	1.28	6266	1.34	1.70
167.02	12 hours	2.43	6266	2.53	3.21
168.01	12 hours	3.52	6262	3.53	4.48
168.02	12 hours	3.55	6262	3.56	4.52
169.01	12 hours	6.45	6261	6.49	8.24
169.02	12 hours	7.31	6261	7.34	9.32
170.01	12 hours	1.06	6262	1.14	1.45
171.01	12 hours	1.20	6262	1.23	1.56
172.01	12 hours	0.760	6262	0.800	1.02
173.01	12 hours	1.46	6262	1.54	1.96
173.02	12 hours	11.4	6266	11.9	15.1
173.03	12 hours	22.3	6261	22.3	28.4
173.04	12 hours	24.3	6261	24.5	31.1
173.05	12 hours	31.0	6261	31.7	40.2
173.06	12 hours	40.0	6261	41.3	52.4
173.07	12 hours	72.1	6261	73.6	93.5
174.01	12 hours	1.15	6262	1.22	1.55
175.01	12 hours	0.920	6262	0.970	1.23
176.01	12 hours	0.830	6262	0.870	1.10
176.02	12 hours	4.52	6266	4.59	5.83
177.01	18 hours	3.64	6357	3.66	4.65

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
178.01	12 hours	2.59	6262	2.61	3.31
179.01	12 hours	0.460	6266	0.460	0.584
180.01	18 hours	3.76	6350	3.77	4.79
180.02	18 hours	4.16	6350	4.17	5.30
181.01	12 hours	2.67	6266	2.68	3.40
182.01	12 hours	0.370	6262	0.390	0.495
183.01	12 hours	3.77	6266	3.87	4.91
183.02	12 hours	7.20	6262	7.22	9.17
183.03	12 hours	12.9	6266	13.1	16.7
183.04	12 hours	20.4	6266	21.0	26.7
183.05	12 hours	21.3	6266	21.8	27.7
183.06	12 hours	32.1	6266	32.6	41.4
184.01	12 hours	0.690	6262	0.730	0.927
184.02	12 hours	4.43	6266	4.52	5.74
185.01	12 hours	0.860	6262	0.890	1.13
185.02	12 hours	3.67	6266	3.84	4.88
186.01	12 hours	1.66	6266	1.71	2.17
187.01	12 hours	2.08	6266	2.09	2.65
187.02	12 hours	3.97	6266	3.97	5.04
188.01	12 hours	0.650	6262	0.690	0.876
189.01	12 hours	0.680	6262	0.710	0.902
190.01	12 hours	0.460	6262	0.480	0.610
191.01	12 hours	1.27	6266	1.29	1.64
192.01	12 hours	1.48	6262	1.54	1.96
193.01	12 hours	1.26	6262	1.30	1.65
194.01	12 hours	0.220	6262	0.230	0.292
195.01	12 hours	0.440	6262	0.460	0.584
196.01	12 hours	0.500	6262	0.520	0.660
197.01	12 hours	0.410	6262	0.430	0.546
198.01	12 hours	0.590	6262	0.610	0.775
199.01	12 hours	1.28	6262	1.35	1.71
199.02	12 hours	1.74	6262	1.84	2.34
200.01	12 hours	0.230	6262	0.240	0.305
201.01	12 hours	0.550	6262	0.570	0.724
202.01	12 hours	4.86	6258	4.95	6.29
203.01	12 hours	0.780	6262	0.810	1.03
204.01	12 hours	0.540	6262	0.570	0.724
205.01	12 hours	0.690	6262	0.720	0.914
206.01	12 hours	0.180	6261	0.190	0.241
207.01	12 hours	0.650	6262	0.690	0.876
208.01	12 hours	0.930	6262	0.990	1.26
208.02	12 hours	1.31	6262	1.39	1.77
208.03	12 hours	2.45	6262	2.61	3.31
208.04	12 hours	4.73	6261	4.96	6.30
208.05	12 hours	5.97	6261	6.27	7.96
208.06	18 hours	7.32	6350	7.46	9.47
209.01	12 hours	0.170	6261	0.180	0.229
210.01	12 hours	0.330	6262	0.340	0.432
211.01	12 hours	0.340	6262	0.350	0.445
211.02	12 hours	0.390	6262	0.410	0.521

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
211.03	12 hours	1.40	6262	1.47	1.87
212.01	12 hours	0.160	6261	0.170	0.216
_junc_10	12 hours	31.9	6261	32.5	41.3
_junc_108	12 hours	0.600	6262	0.630	0.800
_junc_11	12 hours	508	6261	523	664
_junc_111	12 hours	3.42	6266	3.57	4.53
_junc_114	12 hours	2.08	6262	2.09	2.65
_junc_12	12 hours	15.9	6266	16.5	20.9
_junc_13	12 hours	156	6261	159	202
_junc_138	12 hours	10.8	6266	10.8	13.8
_junc_14	12 hours	132	6261	135	171
_junc_142	12 hours	8.35	6266	8.40	10.7
_junc_143	12 hours	250	6261	256	325
_junc_15	12 hours	474	6261	486	618
_junc_16	12 hours	518	6261	533	676
_junc_165	12 hours	35.3	6261	35.4	45.0
_junc_168	12 hours	33.0	6266	34.6	44.0
_junc_17	12 hours	148	6261	151	191
_junc_174	12 hours	24.0	6266	24.5	31.1
_junc_18	18 hours	58.3	6357	58.3	74.1
_junc_181	12 hours	0.100	6261	0.100	0.127
_junc_185	12 hours	0.110	6262	0.120	0.152
_junc_186	12 hours	0.330	6262	0.350	0.445
_junc_187	12 hours	2.70	6261	2.78	3.53
_junc_19	12 hours	204	6261	209	265
_junc_193	12 hours	11.6	6266	11.8	15.0
_junc_194	12 hours	16.5	6266	17.0	21.6
_junc_199	12 hours	20.3	6261	20.3	25.8
_junc_2	12 hours	240	6261	245	312
_junc_20	12 hours	171	6261	175	222
_junc_204	12 hours	9.04	6266	9.07	11.5
_junc_21	12 hours	185	6261	189	240
_junc_22	12 hours	527	6261	543	690
_junc_228	12 hours	0.550	6262	0.590	0.749
_junc_23	12 hours	534	6261	550	699
_junc_231	12 hours	217	6261	222	282
_junc_232	12 hours	27.2	6266	28.2	35.8
_junc_233	12 hours	38.7	6266	39.7	50.4
_junc_234	12 hours	515	6266	525	666
_junc_24	12 hours	32.6	6262	32.7	41.5
_junc_25	12 hours	25.8	6258	26.2	33.2
_junc_26	12 hours	22.2	6262	22.2	28.2
_junc_263	12 hours	12.8	6261	12.8	16.3
_junc_265	12 hours	12.5	6266	12.9	16.4
_junc_27	12 hours	13.5	6262	13.5	17.2
_junc_28	12 hours	577	6266	596	757
_junc_29	12 hours	575	6266	594	754
_junc_3	12 hours	21.3	6261	21.8	27.7
_junc_30	12 hours	580	6266	599	761
_junc_31	12 hours	16.8	6266	17.3	21.9

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_32	12 hours	589	6266	608	772
_junc_324	12 hours	520	6266	531	674
_junc_328	12 hours	604	6266	616	782
_junc_329	12 hours	34.7	6261	35.7	45.3
_junc_33	12 hours	16.3	6266	17.1	21.7
_junc_330	12 hours	71.8	6261	73.2	92.9
_junc_331	12 hours	1262	6266	1276	1621
_junc_34	12 hours	26.5	6266	27.3	34.6
_junc_35	12 hours	8.98	6266	9.41	12.0
_junc_36	12 hours	505	6261	516	655
_junc_37	12 hours	19.3	6262	19.4	24.6
_junc_38	12 hours	15.2	6266	15.3	19.4
_junc_39	12 hours	561	6266	572	726
_junc_4	12 hours	22.0	6261	22.4	28.4
_junc_40	12 hours	27.7	6262	27.8	35.3
_junc_41	12 hours	16.9	6266	17.0	21.6
_junc_42	12 hours	31.8	6261	32.1	40.8
_junc_43	12 hours	81.0	6261	81.5	104
_junc_44	12 hours	526	6266	537	682
_junc_45	12 hours	470	6261	480	610
_junc_46	12 hours	40.6	6262	40.6	51.5
_junc_47	12 hours	532	6266	543	690
_junc_48	12 hours	387	6261	395	502
_junc_49	12 hours	18.7	6266	19.4	24.7
_junc_5	12 hours	19.1	6259	22.2	28.2
_junc_50	12 hours	59.8	6261	60.9	77.3
_junc_51	12 hours	379	6261	386	491
_junc_52	12 hours	68.6	6261	69.6	88.4
_junc_53	12 hours	18.9	6261	19.4	24.6
_junc_54	12 hours	95.5	6261	96.6	123
_junc_55	12 hours	108	6261	109	139
_junc_56	12 hours	348	6261	354	449
_junc_57	12 hours	144	6261	146	186
_junc_58	12 hours	330	6261	335	426
_junc_59	12 hours	309	6261	313	398
_junc_6	12 hours	63.0	6261	63.4	80.5
_junc_60	12 hours	322	6261	327	415
_junc_61	12 hours	30.1	6261	30.5	38.7
_junc_62	12 hours	147	6261	148	188
_junc_63	12 hours	131	6261	131	167
_junc_64	12 hours	59.6	6266	59.9	76.0
_junc_65	12 hours	16.8	6266	16.9	21.5
_junc_66	12 hours	112	6261	112	143
_junc_67	12 hours	66.8	6266	67.1	85.2
_junc_68	12 hours	47.5	6266	47.6	60.5
_junc_69	12 hours	35.5	6266	35.7	45.4
_junc_7	12 hours	72.5	6261	72.9	92.6
_junc_70	12 hours	27.1	6266	27.2	34.6
_junc_71	12 hours	23.1	6266	23.7	30.1
_junc_72	12 hours	40.5	6261	41.2	52.3

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_73	12 hours	19.3	6259	22.4	28.5
_junc_74	12 hours	12.7	6262	12.7	16.1
_junc_75	18 hours	40.7	6350	41.2	52.3
_junc_76	12 hours	15.8	6261	15.9	20.2
_junc_77	12 hours	39.0	6261	39.1	49.6
_junc_78	12 hours	48.3	6261	48.3	61.4
_junc_79	12 hours	55.2	6266	55.5	70.5
_junc_8	12 hours	27.7	6259	32.2	40.9
_junc_80	12 hours	22.1	6259	25.6	32.5
_junc_81	12 hours	104	6261	106	134
_junc_82	12 hours	23.7	6261	23.9	30.3
_junc_83	12 hours	19.0	6261	19.5	24.8
_junc_84	12 hours	128	6261	130	165
_junc_85	12 hours	25.6	6261	26.2	33.2
_junc_86	12 hours	159	6261	161	205
_junc_87	12 hours	55.5	6261	56.3	71.5
_junc_88	12 hours	60.6	6261	61.4	78.0
_junc_89	12 hours	145	6261	148	188
_junc_9	12 hours	37.1	6266	37.2	47.2
_junc_90	12 hours	233	6261	237	301
_junc_91	12 hours	15.7	6258	15.8	20.0

1% AEP XP-RAFTS Peak Flows

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
1.01	12 hours	17.8	6262	17.9	21.2
1.02	12 hours	23.1	6259	26.6	31.4
1.03	12 hours	32.2	6266	32.3	38.1
1.04	12 hours	45.8	6262	45.8	54.0
1.05	12 hours	58.5	6262	58.7	69.3
1.06	12 hours	59.7	6262	59.9	70.7
1.07	12 hours	71.2	6262	71.5	84.4
1.08	12 hours	78.3	6262	78.6	92.8
1.09	12 hours	80.6	6262	80.9	95.5
1.10	12 hours	132	6262	132	156
1.11	12 hours	159	6262	159	187
1.12	12 hours	178	6266	180	212
1.13	12 hours	362	6266	366	432
1.14	12 hours	377	6262	377	445
1.15	12 hours	377	6262	378	445
1.16	12 hours	384	6262	384	454
1.17	12 hours	414	6262	414	489
1.18	12 hours	444	6262	445	525
1.19	12 hours	451	6262	452	534
1.20	12 hours	550	6262	552	651
1.21	12 hours	553	6262	555	655
1.22	12 hours	593	6262	595	702
1.23	12 hours	603	6262	605	714
1.24	12 hours	603	6262	605	714
1.25	12 hours	606	6262	608	717
1.26	12 hours	612	6262	614	725
1.27	12 hours	619	6262	621	733
1.28	12 hours	620	6262	622	734
1.29	12 hours	654	6262	656	774
1.30	12 hours	656	6262	658	777
1.31	12 hours	708	6262	710	837
1.32	12 hours	708	6262	710	838
1.33	12 hours	1395	6266	1396	1647
1.34	12 hours	1396	6262	1399	1651
1.35	12 hours	1473	6262	1477	1743
1.36	12 hours	1475	6262	1479	1745
1.37	12 hours	1475	6262	1480	1746
1.38	12 hours	1477	6262	1482	1748
1.39	12 hours	1484	6262	1491	1759
1.40	12 hours	1496	6262	1504	1775
2.01	12 hours	4.50	6262	4.73	5.58
3.01	12 hours	8.13	6262	8.32	9.82
4.01	12 hours	8.67	6262	8.71	10.3
5.01	12 hours	8.93	6262	9.02	10.6
6.01	12 hours	9.20	6266	9.27	10.9
7.01	12 hours	5.91	6266	5.96	7.03
8.01	12 hours	16.8	6266	17.2	20.2
8.02	12 hours	32.7	6262	32.9	38.8
8.03	12 hours	32.8	6262	32.9	38.8

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
8.04	12 hours	47.6	6262	47.8	56.3
8.05	12 hours	49.0	6262	49.2	58.1
9.01	12 hours	10.3	6261	10.4	12.3
10.01	12 hours	6.07	6262	6.10	7.20
10.02	12 hours	14.7	6262	14.8	17.4
11.01	12 hours	8.55	6262	8.61	10.2
12.01	12 hours	7.09	6262	7.31	8.63
12.02	12 hours	12.3	6262	12.6	14.9
12.03	12 hours	19.7	6262	20.1	23.7
13.01	12 hours	2.34	6266	2.46	2.90
14.01	12 hours	5.84	6262	5.87	6.93
14.02	12 hours	7.05	6262	7.07	8.34
15.01	12 hours	0.980	6262	1.03	1.22
16.01	12 hours	7.68	6266	7.88	9.30
16.02	12 hours	11.5	6266	11.7	13.9
17.01	12 hours	11.7	6266	11.7	13.8
17.02	12 hours	26.9	6261	27.2	32.0
17.03	12 hours	34.5	6262	34.9	41.2
17.04	12 hours	49.2	6266	49.4	58.3
17.05	12 hours	57.9	6266	58.2	68.6
17.06	12 hours	72.3	6262	72.6	85.7
17.07	12 hours	82.6	6262	82.7	97.5
17.08	12 hours	113	6261	115	135
17.09	12 hours	116	6261	117	138
17.10	12 hours	125	6262	125	148
17.11	12 hours	176	6261	179	211
17.12	12 hours	179	6261	182	215
17.13	12 hours	181	6261	184	217
18.01	12 hours	10.8	6261	10.8	12.8
19.01	12 hours	5.27	6266	5.29	6.24
20.01	12 hours	13.0	6266	13.3	15.7
21.01	12 hours	10.7	6266	10.9	12.9
21.02	12 hours	11.9	6261	12.2	14.4
22.01	12 hours	7.83	6262	8.04	9.49
23.01	12 hours	6.46	6261	6.46	7.62
23.02	12 hours	20.7	6261	20.7	24.4
23.03	12 hours	28.1	6262	28.2	33.3
23.04	12 hours	28.5	6262	28.6	33.7
24.01	12 hours	8.32	6262	8.37	9.88
25.01	12 hours	2.85	6266	2.94	3.47
26.01	12 hours	9.02	6262	9.12	10.8
26.02	12 hours	9.14	6262	9.23	10.9
27.01	12 hours	11.5	6261	11.5	13.6
27.02	12 hours	25.0	6262	25.1	29.6
27.03	12 hours	42.7	6266	43.5	51.4
28.01	12 hours	2.32	6266	2.45	2.89
28.02	12 hours	3.15	6266	3.31	3.91
29.01	12 hours	9.94	6266	9.98	11.8
30.01	12 hours	2.89	6262	2.91	3.43
31.01	12 hours	2.11	6262	2.13	2.51

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
32.01	12 hours	12.2	6262	12.3	14.5
33.01	12 hours	5.85	6266	5.90	6.96
34.01	12 hours	8.58	6261	8.62	10.2
34.02	12 hours	20.9	6266	20.9	24.7
34.03	12 hours	21.2	6266	21.3	25.1
35.01	12 hours	5.95	6266	6.00	7.08
35.02	12 hours	12.6	6266	12.8	15.1
35.03	12 hours	16.9	6266	17.2	20.3
35.04	12 hours	17.1	6266	17.5	20.7
35.05	12 hours	26.9	6262	27.1	31.9
36.01	12 hours	0.720	6266	0.740	0.873
37.01	12 hours	5.02	6262	5.08	5.99
38.01	12 hours	5.17	6262	5.21	6.15
38.02	12 hours	6.31	6261	6.45	7.61
39.01	12 hours	6.92	6261	6.97	8.22
39.02	12 hours	14.3	6266	14.6	17.2
39.03	12 hours	20.9	6262	21.0	24.8
39.04	12 hours	41.8	6261	41.8	49.3
39.05	12 hours	53.0	6261	53.1	62.6
39.06	12 hours	97.5	6262	97.6	115
40.01	12 hours	3.69	6266	3.84	4.53
41.01	12 hours	4.68	6266	4.93	5.82
42.01	12 hours	9.86	6261	9.87	11.6
43.01	12 hours	3.10	6262	3.18	3.75
44.01	12 hours	10.7	6262	10.7	12.6
44.02	12 hours	26.9	6266	26.9	31.8
44.03	12 hours	41.2	6262	41.2	48.6
45.01	12 hours	7.01	6262	7.34	8.66
46.01	12 hours	10.2	6262	10.2	12.1
47.01	12 hours	9.02	6262	9.07	10.7
47.02	12 hours	12.6	6262	12.6	14.9
47.03	12 hours	13.7	6262	13.8	16.2
47.04	12 hours	28.2	6261	28.2	33.3
47.05	12 hours	36.4	6266	37.0	43.6
48.01	12 hours	3.41	6262	3.48	4.11
49.01	12 hours	4.98	6262	5.17	6.10
49.02	12 hours	5.68	6266	5.75	6.79
49.03	12 hours	5.75	6266	5.85	6.90
50.01	12 hours	0.940	6262	0.990	1.17
51.01	12 hours	3.28	6262	3.40	4.01
52.01	12 hours	1.48	6266	1.54	1.82
52.02	12 hours	3.60	6266	3.65	4.31
53.01	12 hours	5.30	6261	5.32	6.28
54.01	12 hours	2.03	6262	2.04	2.41
54.02	12 hours	2.97	6262	3.04	3.59
54.03	12 hours	3.36	6262	3.44	4.06
55.01	12 hours	2.46	6262	2.59	3.06
56.01	12 hours	3.39	6262	3.58	4.22
56.02	12 hours	5.68	6262	5.90	6.96
56.03	12 hours	6.69	6262	6.91	8.15

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
57.01	12 hours	2.93	6266	2.93	3.46
57.02	12 hours	7.22	6267	7.26	8.57
58.01	12 hours	5.49	6262	5.52	6.51
58.02	12 hours	8.01	6262	8.08	9.53
58.03	12 hours	11.6	6262	11.7	13.7
58.04	12 hours	19.4	6259	22.2	26.2
58.05	12 hours	21.0	6266	21.0	24.8
58.06	12 hours	30.5	6261	30.5	36.0
58.07	12 hours	34.8	6261	35.0	41.2
59.01	12 hours	2.44	6262	2.52	2.97
60.01	12 hours	2.26	6266	2.31	2.73
60.02	12 hours	2.91	6266	2.94	3.47
60.03	12 hours	6.35	6262	6.36	7.50
61.01	12 hours	1.86	6262	1.90	2.24
62.01	12 hours	0.430	6266	0.460	0.543
63.01	12 hours	0.040	6262	0.040	0.047
64.01	12 hours	1.25	6266	1.29	1.52
64.02	12 hours	7.04	6262	7.15	8.44
65.01	12 hours	0.720	6266	0.760	0.897
66.01	12 hours	0.890	6262	0.950	1.12
66.02	12 hours	3.28	6262	3.29	3.88
67.01	12 hours	0.170	6261	0.180	0.212
68.01	12 hours	0.270	6261	0.270	0.319
69.01	12 hours	0.270	6261	0.280	0.330
69.02	12 hours	0.470	6262	0.500	0.590
70.01	12 hours	0.200	6261	0.200	0.236
71.01	12 hours	0.230	6261	0.230	0.271
72.01	12 hours	0.260	6261	0.270	0.319
73.01	12 hours	0.190	6261	0.190	0.224
74.01	12 hours	1.72	6262	1.80	2.12
75.01	36 hours	1.86	6536	1.87	2.21
75.02	36 hours	2.19	6531	2.21	2.61
76.01	12 hours	1.21	6266	1.22	1.44
76.02	12 hours	1.32	6262	1.35	1.59
77.01	12 hours	2.92	6262	3.02	3.56
77.02	12 hours	6.44	6262	6.71	7.92
77.03	12 hours	12.4	6266	12.6	14.8
77.04	12 hours	13.9	6266	14.0	16.6
77.05	12 hours	14.8	6266	15.0	17.7
77.06	12 hours	15.0	6266	15.2	17.9
77.07	12 hours	29.3	6266	30.5	36.0
77.08	12 hours	30.0	6266	31.3	36.9
77.09	12 hours	30.2	6266	31.6	37.2
77.10	12 hours	30.8	6266	32.1	37.9
77.11	12 hours	35.2	6266	36.5	43.1
77.12	12 hours	39.3	6261	39.3	46.4
77.13	12 hours	47.9	6261	48.7	57.4
78.01	12 hours	2.75	6262	2.78	3.28
78.02	12 hours	6.71	6266	7.07	8.34
79.01	12 hours	1.84	6266	1.90	2.24

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
80.01	12 hours	0.810	6262	0.860	1.01
81.01	12 hours	1.84	6266	1.84	2.17
81.02	12 hours	2.04	6266	2.07	2.44
81.03	12 hours	4.07	6266	4.23	4.99
81.04	12 hours	7.47	6262	7.93	9.36
82.01	12 hours	0.390	6262	0.410	0.484
82.02	12 hours	1.67	6266	1.77	2.09
82.03	12 hours	1.91	6266	2.02	2.38
83.01	12 hours	1.21	6259	1.29	1.52
83.02	12 hours	2.39	6262	2.56	3.02
83.03	12 hours	2.65	6262	2.84	3.35
84.01	12 hours	0.230	6262	0.240	0.283
84.02	12 hours	0.840	6262	0.890	1.05
85.01	12 hours	0.460	6262	0.490	0.578
86.01	12 hours	0.070	6261	0.070	0.083
87.01	12 hours	0.340	6262	0.360	0.425
87.02	12 hours	0.640	6262	0.680	0.802
88.01	12 hours	0.140	6262	0.150	0.177
89.01	12 hours	0.200	6262	0.220	0.260
90.01	12 hours	0.130	6262	0.150	0.177
91.01	12 hours	0.390	6259	0.420	0.496
92.01	12 hours	0.670	6262	0.690	0.814
92.02	12 hours	2.71	6261	2.72	3.21
92.03	12 hours	2.87	6261	2.92	3.45
92.04	12 hours	4.22	6261	4.31	5.09
93.01	12 hours	0.200	6262	0.220	0.260
94.01	12 hours	0.230	6262	0.250	0.295
95.01	12 hours	0.290	6262	0.310	0.366
96.01	12 hours	0.120	6262	0.140	0.165
97.01	12 hours	0.140	6262	0.150	0.177
98.01	12 hours	0.400	6262	0.430	0.507
99.01	12 hours	2.41	6266	2.43	2.87
99.02	12 hours	3.20	6261	3.30	3.89
100.01	12 hours	0.070	6262	0.070	0.083
101.01	12 hours	0.050	6261	0.050	0.059
102.01	12 hours	0.090	6262	0.100	0.118
103.01	12 hours	0.060	6261	0.060	0.071
104.01	12 hours	0.180	6262	0.190	0.224
104.02	12 hours	0.470	6262	0.500	0.590
105.01	12 hours	0.040	6261	0.050	0.059
106.01	18 hours	5.14	6350	5.17	6.10
106.02	18 hours	7.30	6355	7.34	8.66
107.01	12 hours	2.33	6262	2.34	2.76
108.01	12 hours	1.61	6262	1.62	1.91
108.02	12 hours	1.65	6262	1.65	1.95
109.01	12 hours	3.21	6262	3.24	3.82
110.01	12 hours	1.88	6266	1.90	2.24
111.01	12 hours	0.850	6262	0.890	1.05
112.01	12 hours	0.660	6262	0.690	0.814
113.01	12 hours	0.320	6262	0.330	0.389

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
114.01	12 hours	10.6	6262	10.7	12.7
114.02	12 hours	16.1	6262	16.2	19.1
114.03	12 hours	31.3	6266	31.5	37.1
114.04	18 hours	51.6	6355	52.0	61.4
114.05	18 hours	68.9	6355	69.8	82.3
114.06	12 hours	160	6266	162	191
114.07	12 hours	173	6266	175	207
114.08	12 hours	188	6266	191	225
114.09	12 hours	193	6266	195	230
114.10	12 hours	203	6266	206	243
114.11	12 hours	217	6266	220	260
114.12	12 hours	220	6266	223	264
114.13	12 hours	249	6266	254	300
114.14	12 hours	260	6266	265	313
114.15	12 hours	261	6266	267	315
114.16	12 hours	558	6266	569	671
114.17	12 hours	595	6266	606	715
114.18	12 hours	606	6266	617	728
114.19	12 hours	610	6266	622	734
114.20	12 hours	617	6266	629	742
114.21	12 hours	666	6266	679	801
114.22	12 hours	673	6266	686	810
114.23	12 hours	675	6266	689	812
114.24	12 hours	681	6266	695	820
114.25	12 hours	692	6266	705	832
115.01	12 hours	4.99	6261	5.00	5.90
116.01	12 hours	9.51	6261	9.59	11.3
117.01	12 hours	6.51	6262	6.54	7.72
118.01	18 hours	17.4	6350	17.6	20.7
119.01	12 hours	18.6	6262	18.8	22.1
119.02	12 hours	28.6	6262	28.8	33.9
119.03	12 hours	76.5	6262	76.5	90.3
119.04	12 hours	88.6	6266	88.7	105
120.01	12 hours	7.17	6262	7.21	8.51
121.01	12 hours	9.91	6262	10.0	11.8
121.02	12 hours	25.7	6262	25.9	30.6
121.03	12 hours	33.4	6262	33.6	39.6
121.04	12 hours	44.5	6262	44.6	52.6
122.01	12 hours	12.0	6262	12.1	14.3
123.01	12 hours	6.14	6262	6.26	7.39
124.01	12 hours	9.28	6266	9.31	11.0
125.01	12 hours	7.55	6262	7.59	8.96
126.01	12 hours	13.1	6262	13.3	15.6
127.01	12 hours	9.18	6262	9.23	10.9
128.01	12 hours	7.52	6266	7.53	8.89
129.01	12 hours	6.01	6262	6.09	7.19
129.02	12 hours	11.3	6266	11.4	13.5
129.03	12 hours	14.5	6266	14.7	17.3
130.01	12 hours	3.64	6262	3.83	4.52
131.01	12 hours	2.77	6266	2.89	3.41

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
131.02	12 hours	12.3	6261	12.6	14.9
131.03	12 hours	18.9	6261	19.3	22.7
132.01	12 hours	4.77	6262	4.98	5.88
133.01	12 hours	14.5	6262	14.6	17.3
133.02	12 hours	31.1	6262	31.3	36.9
133.03	12 hours	50.9	6262	51.0	60.2
133.04	12 hours	57.5	6259	66.2	78.2
133.05	12 hours	72.4	6262	72.4	85.4
133.06	12 hours	72.7	6259	83.6	98.7
133.07	12 hours	131	6261	133	157
133.08	12 hours	132	6261	135	159
133.09	12 hours	159	6261	161	190
133.10	12 hours	174	6261	177	209
133.11	12 hours	198	6261	201	238
133.12	12 hours	273	6266	277	327
133.13	12 hours	288	6266	293	346
133.14	12 hours	293	6266	298	352
134.01	12 hours	10.8	6262	11.0	13.0
135.01	12 hours	14.1	6266	14.2	16.8
136.01	12 hours	5.01	6262	5.26	6.21
137.01	12 hours	6.16	6262	6.33	7.47
138.01	18 hours	23.5	6350	23.8	28.1
138.02	18 hours	29.1	6350	29.5	34.8
138.03	18 hours	49.7	6357	49.9	58.9
139.01	12 hours	9.81	6261	9.89	11.7
139.02	12 hours	19.1	6262	19.2	22.6
140.01	12 hours	1.00	6262	1.05	1.24
141.01	12 hours	14.2	6262	14.3	16.9
141.02	12 hours	16.9	6262	16.9	20.0
142.01	12 hours	1.78	6262	1.90	2.24
143.01	12 hours	11.1	6262	11.4	13.4
144.01	12 hours	10.6	6262	10.6	12.6
145.01	12 hours	7.72	6262	7.79	9.19
145.02	12 hours	21.7	6266	21.9	25.8
145.03	12 hours	33.6	6266	33.8	39.9
145.04	12 hours	64.7	6261	65.4	77.2
145.05	12 hours	64.9	6261	65.6	77.4
145.06	12 hours	74.4	6261	75.1	88.6
146.01	12 hours	10.7	6262	10.8	12.7
147.01	12 hours	5.85	6262	6.07	7.16
148.01	12 hours	15.5	6262	15.6	18.4
148.02	12 hours	23.3	6261	23.8	28.1
148.03	12 hours	30.7	6261	31.3	36.9
149.01	12 hours	6.69	6262	6.71	7.92
150.01	12 hours	6.37	6266	6.38	7.53
151.01	12 hours	5.42	6262	5.52	6.51
152.01	12 hours	2.21	6266	2.31	2.73
153.01	12 hours	7.27	6266	7.27	8.58
154.01	12 hours	2.93	6262	3.06	3.61
154.02	12 hours	3.85	6266	3.99	4.71

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
155.01	12 hours	11.7	6258	11.8	13.9
155.02	12 hours	11.8	6258	11.9	14.1
155.03	12 hours	19.5	6261	20.0	23.5
155.04	12 hours	20.3	6261	20.7	24.4
155.05	12 hours	32.1	6261	32.7	38.6
155.06	12 hours	37.8	6261	38.5	45.4
156.01	12 hours	6.48	6266	6.51	7.68
156.02	12 hours	6.75	6262	6.77	7.99
157.01	12 hours	4.79	6266	4.80	5.66
158.01	12 hours	2.48	6262	2.50	2.95
159.01	12 hours	2.38	6262	2.47	2.91
160.01	12 hours	4.99	6262	5.02	5.92
160.02	12 hours	5.34	6262	5.35	6.31
161.01	12 hours	10.0	6262	10.1	11.9
162.01	12 hours	0.820	6262	0.870	1.03
162.02	12 hours	6.11	6261	6.26	7.39
162.03	12 hours	6.22	6261	6.37	7.52
163.01	12 hours	1.21	6262	1.29	1.52
163.02	12 hours	3.66	6266	3.73	4.40
163.03	12 hours	11.4	6261	11.5	13.6
163.04	12 hours	17.4	6262	17.4	20.6
163.05	12 hours	38.1	6258	38.3	45.2
163.06	12 hours	39.6	6258	39.8	47.0
164.01	18 hours	13.7	6350	13.9	16.4
165.01	12 hours	6.60	6258	6.64	7.84
165.02	12 hours	7.61	6258	7.64	9.02
166.01	12 hours	1.92	6262	2.01	2.37
166.02	12 hours	4.06	6262	4.08	4.81
166.03	12 hours	7.09	6262	7.09	8.37
167.01	12 hours	1.47	6266	1.53	1.81
167.02	12 hours	2.79	6266	2.88	3.40
168.01	12 hours	4.06	6262	4.09	4.83
168.02	12 hours	4.09	6262	4.12	4.86
169.01	12 hours	7.48	6262	7.52	8.87
169.02	12 hours	8.47	6261	8.50	10.0
170.01	12 hours	1.21	6259	1.30	1.53
171.01	12 hours	1.38	6266	1.41	1.66
172.01	12 hours	0.870	6262	0.930	1.10
173.01	12 hours	1.68	6266	1.78	2.10
173.02	12 hours	13.2	6266	13.6	16.0
173.03	12 hours	25.9	6266	26.4	31.2
173.04	12 hours	28.3	6261	28.3	33.4
173.05	12 hours	36.2	6261	36.9	43.5
173.06	12 hours	46.9	6266	48.1	56.7
173.07	12 hours	84.1	6266	85.6	101
174.01	12 hours	1.32	6262	1.41	1.66
175.01	12 hours	1.06	6266	1.11	1.31
176.01	12 hours	0.950	6262	1.01	1.19
176.02	12 hours	5.24	6266	5.26	6.21
177.01	18 hours	4.42	6357	4.43	5.23

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
178.01	12 hours	3.01	6261	3.04	3.59
179.01	12 hours	0.530	6262	0.550	0.649
180.01	18 hours	4.47	6350	4.50	5.31
180.02	18 hours	4.93	6350	4.96	5.85
181.01	12 hours	3.10	6261	3.13	3.69
182.01	12 hours	0.430	6262	0.450	0.531
183.01	12 hours	4.34	6266	4.45	5.25
183.02	12 hours	8.34	6266	8.40	9.91
183.03	12 hours	14.9	6262	14.9	17.6
183.04	12 hours	23.7	6266	24.1	28.5
183.05	12 hours	24.7	6266	25.1	29.6
183.06	12 hours	37.1	6266	37.4	44.1
184.01	12 hours	0.790	6262	0.840	0.991
184.02	12 hours	5.13	6266	5.19	6.12
185.01	12 hours	0.980	6262	1.03	1.22
185.02	12 hours	4.24	6262	4.28	5.05
186.01	12 hours	1.92	6266	1.96	2.31
187.01	12 hours	2.40	6262	2.46	2.90
187.02	12 hours	4.56	6262	4.60	5.43
188.01	12 hours	0.740	6262	0.790	0.932
189.01	12 hours	0.770	6262	0.810	0.956
190.01	12 hours	0.530	6262	0.560	0.661
191.01	12 hours	1.46	6266	1.47	1.73
192.01	12 hours	1.69	6262	1.78	2.10
193.01	12 hours	1.44	6262	1.50	1.77
194.01	12 hours	0.250	6262	0.260	0.307
195.01	12 hours	0.510	6262	0.530	0.625
196.01	12 hours	0.570	6262	0.600	0.708
197.01	12 hours	0.470	6262	0.500	0.590
198.01	12 hours	0.670	6262	0.710	0.838
199.01	12 hours	1.47	6266	1.56	1.84
199.02	12 hours	2.00	6259	2.13	2.51
200.01	12 hours	0.260	6262	0.280	0.330
201.01	12 hours	0.630	6262	0.660	0.779
202.01	12 hours	5.75	6258	5.79	6.83
203.01	12 hours	0.890	6262	0.940	1.11
204.01	12 hours	0.620	6262	0.650	0.767
205.01	12 hours	0.790	6262	0.820	0.968
206.01	12 hours	0.210	6261	0.210	0.248
207.01	12 hours	0.740	6262	0.800	0.944
208.01	12 hours	1.07	6262	1.14	1.35
208.02	12 hours	1.49	6262	1.60	1.89
208.03	12 hours	2.81	6262	3.02	3.56
208.04	12 hours	5.52	6261	5.76	6.80
208.05	12 hours	6.98	6261	7.35	8.67
208.06	18 hours	8.69	6350	8.88	10.5
209.01	12 hours	0.200	6261	0.200	0.236
210.01	12 hours	0.370	6262	0.390	0.460
211.01	12 hours	0.390	6262	0.410	0.484
211.02	12 hours	0.450	6262	0.470	0.555

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
211.03	12 hours	1.60	6262	1.71	2.02
212.01	12 hours	0.190	6261	0.200	0.236
_junc_10	12 hours	37.3	6261	38.0	44.9
_junc_108	12 hours	0.680	6262	0.730	0.861
_junc_11	12 hours	594	6266	605	714
_junc_111	12 hours	3.94	6266	4.08	4.81
_junc_114	12 hours	2.41	6266	2.43	2.87
_junc_12	12 hours	18.4	6266	18.8	22.2
_junc_13	12 hours	182	6266	184	217
_junc_138	12 hours	12.4	6262	12.5	14.7
_junc_14	12 hours	155	6266	157	185
_junc_142	12 hours	9.64	6262	9.92	11.7
_junc_143	12 hours	291	6266	297	350
_junc_15	12 hours	554	6266	565	666
_junc_16	12 hours	605	6266	616	727
_junc_165	12 hours	40.9	6261	41.0	48.4
_junc_168	12 hours	38.2	6266	39.6	46.7
_junc_17	12 hours	173	6266	175	206
_junc_174	12 hours	27.7	6266	28.0	33.0
_junc_18	18 hours	68.7	6355	69.6	82.1
_junc_181	12 hours	0.110	6261	0.110	0.130
_junc_185	12 hours	0.120	6262	0.140	0.165
_junc_186	12 hours	0.370	6262	0.400	0.472
_junc_187	12 hours	3.13	6261	3.21	3.79
_junc_19	12 hours	238	6266	242	286
_junc_193	12 hours	13.4	6262	13.5	15.9
_junc_194	12 hours	19.1	6262	19.2	22.7
_junc_199	12 hours	23.4	6262	23.4	27.6
_junc_2	12 hours	280	6266	284	335
_junc_20	12 hours	200	6266	202	239
_junc_204	12 hours	10.4	6262	10.5	12.4
_junc_21	12 hours	216	6266	219	259
_junc_22	12 hours	616	6266	628	741
_junc_228	12 hours	0.630	6262	0.670	0.791
_junc_23	12 hours	624	6266	636	751
_junc_231	12 hours	253	6266	258	305
_junc_232	12 hours	31.4	6266	32.2	37.9
_junc_233	12 hours	44.8	6266	45.5	53.7
_junc_234	12 hours	598	6262	600	708
_junc_24	12 hours	37.8	6266	37.9	44.7
_junc_25	12 hours	30.4	6258	30.7	36.2
_junc_26	12 hours	25.6	6266	25.7	30.3
_junc_263	12 hours	14.8	6262	14.8	17.5
_junc_265	12 hours	14.4	6266	14.7	17.3
_junc_27	12 hours	15.6	6262	15.7	18.5
_junc_28	12 hours	675	6266	688	812
_junc_29	12 hours	673	6266	686	809
_junc_3	12 hours	25.0	6261	25.5	30.1
_junc_30	12 hours	679	6266	692	817
_junc_31	12 hours	19.4	6266	19.7	23.2

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_32	12 hours	689	6266	702	828
_junc_324	12 hours	605	6262	607	716
_junc_328	12 hours	703	6262	704	831
_junc_329	12 hours	40.7	6261	41.8	49.3
_junc_33	12 hours	18.9	6262	18.9	22.3
_junc_330	12 hours	83.7	6261	85.1	100
_junc_331	12 hours	1472	6262	1476	1742
_junc_34	12 hours	30.6	6266	31.2	36.8
_junc_35	12 hours	10.4	6266	10.7	12.7
_junc_36	12 hours	588	6262	590	696
_junc_37	12 hours	22.4	6262	22.7	26.7
_junc_38	12 hours	17.6	6262	17.8	21.0
_junc_39	12 hours	652	6262	654	772
_junc_4	12 hours	25.7	6262	25.9	30.5
_junc_40	12 hours	32.1	6262	32.4	38.3
_junc_41	12 hours	19.5	6259	22.3	26.3
_junc_42	12 hours	36.9	6266	37.1	43.8
_junc_43	12 hours	94.0	6262	94.1	111
_junc_44	12 hours	612	6262	614	724
_junc_45	12 hours	547	6262	549	647
_junc_46	12 hours	47.3	6266	47.5	56.0
_junc_47	12 hours	619	6262	621	733
_junc_48	12 hours	451	6262	451	533
_junc_49	12 hours	21.7	6266	22.2	26.2
_junc_5	12 hours	21.9	6262	22.1	26.0
_junc_50	12 hours	69.8	6262	70.2	82.8
_junc_51	12 hours	441	6262	441	521
_junc_52	12 hours	79.8	6262	80.0	94.4
_junc_53	12 hours	22.1	6262	22.1	26.1
_junc_54	12 hours	111	6262	111	131
_junc_55	12 hours	125	6262	125	148
_junc_56	12 hours	404	6262	405	477
_junc_57	12 hours	168	6261	170	201
_junc_58	12 hours	383	6262	383	452
_junc_59	12 hours	359	6266	363	428
_junc_6	12 hours	72.9	6266	73.0	86.1
_junc_60	12 hours	374	6262	374	441
_junc_61	12 hours	34.9	6262	35.1	41.5
_junc_62	12 hours	170	6262	170	201
_junc_63	12 hours	151	6262	151	179
_junc_64	12 hours	68.8	6262	69.0	81.4
_junc_65	12 hours	19.3	6262	19.7	23.2
_junc_66	12 hours	129	6262	129	153
_junc_67	12 hours	77.1	6262	77.4	91.3
_junc_68	12 hours	54.7	6262	54.8	64.6
_junc_69	12 hours	40.9	6259	47.0	55.4
_junc_7	12 hours	83.9	6262	84.0	99.1
_junc_70	12 hours	31.2	6259	35.8	42.3
_junc_71	12 hours	27.0	6262	27.1	31.9
_junc_72	12 hours	47.1	6262	47.3	55.8

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_73	12 hours	22.2	6262	22.3	26.3
_junc_74	12 hours	14.6	6262	14.7	17.4
_junc_75	18 hours	47.6	6357	48.0	56.6
_junc_76	12 hours	18.3	6266	18.5	21.8
_junc_77	12 hours	45.0	6262	45.0	53.1
_junc_78	12 hours	55.7	6259	64.2	75.7
_junc_79	12 hours	63.6	6259	73.1	86.3
_junc_8	12 hours	31.8	6262	32.0	37.8
_junc_80	12 hours	25.3	6262	25.4	30.0
_junc_81	12 hours	121	6261	123	145
_junc_82	12 hours	27.4	6261	27.6	32.6
_junc_83	12 hours	22.1	6262	22.1	26.1
_junc_84	12 hours	149	6261	151	178
_junc_85	12 hours	29.6	6261	30.2	35.6
_junc_86	12 hours	185	6261	187	221
_junc_87	12 hours	64.3	6261	65.0	76.7
_junc_88	12 hours	70.2	6261	70.9	83.6
_junc_89	12 hours	169	6261	171	202
_junc_9	12 hours	42.6	6262	42.8	50.5
_junc_90	12 hours	271	6266	275	324
_junc_91	12 hours	18.5	6261	19.0	22.4

0.5% AEP XP-RAFTS Peak Flows

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
1.01	12 hours	21.3	6262	21.4	22.4
1.02	12 hours	27.7	6266	27.8	29.1
1.03	12 hours	38.6	6266	38.7	40.7
1.04	12 hours	54.8	6262	55.5	58.3
1.05	12 hours	70.0	6262	70.9	74.4
1.06	12 hours	71.4	6262	72.4	76.0
1.07	12 hours	85.0	6262	85.1	89.4
1.08	12 hours	93.6	6262	93.6	98.3
1.09	12 hours	96.2	6262	96.3	101
1.10	12 hours	159	6266	159	167
1.11	12 hours	190	6266	190	200
1.12	12 hours	214	6261	214	225
1.13	12 hours	435	6261	438	459
1.14	12 hours	453	6261	456	479
1.15	12 hours	453	6261	457	480
1.16	12 hours	462	6261	465	488
1.17	12 hours	497	6262	498	522
1.18	12 hours	534	6262	535	561
1.19	12 hours	542	6262	543	570
1.20	12 hours	661	6262	663	696
1.21	12 hours	665	6262	667	700
1.22	12 hours	713	6262	715	751
1.23	12 hours	724	6262	726	763
1.24	12 hours	724	6262	727	763
1.25	12 hours	728	6262	730	766
1.26	12 hours	735	6262	737	774
1.27	12 hours	744	6262	746	783
1.28	12 hours	745	6262	747	784
1.29	12 hours	786	6262	788	827
1.30	12 hours	789	6262	791	830
1.31	12 hours	851	6262	852	895
1.32	12 hours	851	6262	853	895
1.33	12 hours	1675	6262	1678	1761
1.34	12 hours	1676	6262	1680	1764
1.35	12 hours	1769	6262	1774	1863
1.36	12 hours	1771	6262	1776	1865
1.37	12 hours	1772	6262	1777	1866
1.38	12 hours	1773	6262	1779	1868
1.39	12 hours	1782	6262	1790	1879
1.40	12 hours	1796	6262	1806	1896
2.01	12 hours	5.39	6266	5.44	5.71
3.01	12 hours	9.71	6262	10.0	10.5
4.01	12 hours	10.3	6262	10.4	10.9
5.01	12 hours	10.7	6262	10.9	11.5
6.01	12 hours	11.0	6266	11.0	11.6
7.01	12 hours	7.10	6266	7.13	7.49
8.01	12 hours	20.4	6266	20.8	21.8
8.02	12 hours	39.5	6262	39.7	41.7
8.03	12 hours	39.5	6262	39.8	41.8

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
8.04	12 hours	57.3	6262	57.5	60.4
8.05	12 hours	59.0	6262	59.2	62.2
9.01	12 hours	12.4	6261	12.5	13.1
10.01	12 hours	7.26	6262	7.29	7.65
10.02	12 hours	17.6	6262	17.6	18.5
11.01	12 hours	10.2	6262	10.3	10.8
12.01	12 hours	8.49	6262	8.81	9.25
12.02	12 hours	14.7	6266	14.8	15.5
12.03	12 hours	23.5	6266	23.6	24.7
13.01	12 hours	2.79	6262	2.95	3.10
14.01	12 hours	6.98	6262	7.03	7.38
14.02	12 hours	8.44	6262	8.57	9.00
15.01	12 hours	1.16	6262	1.22	1.28
16.01	12 hours	9.25	6262	9.28	9.74
16.02	12 hours	13.9	6262	14.0	14.7
17.01	12 hours	14.0	6261	14.2	14.9
17.02	12 hours	32.2	6261	32.4	34.1
17.03	12 hours	41.4	6261	41.6	43.6
17.04	12 hours	59.1	6266	59.3	62.3
17.05	12 hours	69.6	6266	69.7	73.2
17.06	12 hours	86.9	6262	87.3	91.6
17.07	12 hours	99.2	6261	99.9	105
17.08	12 hours	136	6261	136	143
17.09	12 hours	139	6261	139	146
17.10	12 hours	150	6261	151	158
17.11	12 hours	212	6261	214	225
17.12	12 hours	216	6261	218	228
17.13	12 hours	217	6261	219	230
18.01	12 hours	12.9	6261	12.9	13.6
19.01	12 hours	6.29	6262	6.31	6.63
20.01	12 hours	15.7	6266	16.0	16.8
21.01	12 hours	12.9	6262	12.9	13.6
21.02	12 hours	14.4	6261	14.7	15.5
22.01	12 hours	9.35	6262	9.68	10.2
23.01	12 hours	7.72	6266	7.72	8.11
23.02	12 hours	24.7	6262	24.9	26.2
23.03	12 hours	33.6	6262	33.7	35.4
23.04	12 hours	34.1	6266	34.1	35.8
24.01	12 hours	9.92	6262	9.98	10.5
25.01	12 hours	3.40	6266	3.56	3.74
26.01	12 hours	10.9	6266	10.9	11.5
26.02	12 hours	11.0	6262	11.1	11.6
27.01	12 hours	13.8	6262	13.9	14.5
27.02	12 hours	30.1	6261	30.2	31.7
27.03	12 hours	51.5	6261	52.3	54.9
28.01	12 hours	2.76	6262	2.92	3.07
28.02	12 hours	3.75	6262	3.97	4.17
29.01	12 hours	11.9	6266	11.9	12.5
30.01	12 hours	3.45	6262	3.50	3.68
31.01	12 hours	2.51	6262	2.53	2.66

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
32.01	12 hours	14.7	6266	14.9	15.6
33.01	12 hours	7.03	6266	7.04	7.39
34.01	12 hours	10.3	6262	10.3	10.8
34.02	12 hours	25.0	6266	25.1	26.3
34.03	12 hours	25.3	6266	25.5	26.7
35.01	12 hours	7.14	6266	7.17	7.53
35.02	12 hours	15.2	6262	15.2	16.0
35.03	12 hours	20.4	6262	20.5	21.5
35.04	12 hours	20.7	6262	20.7	21.8
35.05	12 hours	32.5	6262	32.6	34.3
36.01	12 hours	0.860	6266	0.910	0.956
37.01	12 hours	6.02	6261	6.05	6.35
38.01	12 hours	6.22	6262	6.28	6.59
38.02	12 hours	7.59	6261	7.68	8.06
39.01	12 hours	8.30	6261	8.31	8.73
39.02	12 hours	17.2	6266	17.7	18.6
39.03	12 hours	25.2	6262	25.5	26.8
39.04	12 hours	50.2	6266	51.2	53.8
39.05	12 hours	63.6	6266	64.5	67.7
39.06	12 hours	117	6266	118	124
40.01	12 hours	4.43	6262	4.72	4.96
41.01	12 hours	5.61	6262	5.97	6.27
42.01	12 hours	11.8	6262	11.9	12.5
43.01	12 hours	3.72	6262	3.85	4.04
44.01	12 hours	12.8	6262	12.8	13.4
44.02	12 hours	32.3	6266	32.4	34.1
44.03	12 hours	49.5	6261	49.8	52.2
45.01	12 hours	8.40	6266	8.43	8.85
46.01	12 hours	12.4	6262	12.4	13.1
47.01	12 hours	10.8	6262	10.9	11.4
47.02	12 hours	15.1	6262	15.3	16.1
47.03	12 hours	16.4	6266	16.6	17.4
47.04	12 hours	33.8	6266	34.7	36.5
47.05	12 hours	43.6	6262	43.7	45.9
48.01	12 hours	4.10	6262	4.22	4.43
49.01	12 hours	5.96	6262	6.24	6.55
49.02	12 hours	6.80	6266	6.95	7.30
49.03	12 hours	6.89	6266	7.07	7.42
50.01	12 hours	1.12	6262	1.18	1.24
51.01	12 hours	3.93	6262	4.10	4.31
52.01	12 hours	1.78	6262	1.89	1.98
52.02	12 hours	4.31	6266	4.40	4.62
53.01	12 hours	6.34	6262	6.37	6.69
54.01	12 hours	2.42	6262	2.46	2.58
54.02	12 hours	3.55	6266	3.63	3.81
54.03	12 hours	4.01	6262	4.12	4.33
55.01	12 hours	2.93	6262	3.09	3.24
56.01	12 hours	4.07	6266	4.12	4.33
56.02	12 hours	6.79	6262	7.07	7.42
56.03	12 hours	7.99	6262	8.30	8.72

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
57.01	12 hours	3.50	6266	3.53	3.71
57.02	12 hours	8.77	6258	8.83	9.27
58.01	12 hours	6.55	6262	6.57	6.90
58.02	12 hours	9.55	6262	9.61	10.1
58.03	12 hours	13.8	6262	13.9	14.6
58.04	12 hours	23.2	6259	26.5	27.8
58.05	12 hours	25.0	6266	25.1	26.4
58.06	12 hours	36.4	6266	36.9	38.7
58.07	12 hours	41.6	6266	42.0	44.1
59.01	12 hours	2.90	6262	3.00	3.15
60.01	12 hours	2.70	6266	2.77	2.91
60.02	12 hours	3.46	6266	3.53	3.71
60.03	12 hours	7.59	6262	7.67	8.05
61.01	12 hours	2.22	6262	2.28	2.39
62.01	12 hours	0.520	6259	0.550	0.578
63.01	12 hours	0.040	6262	0.040	0.042
64.01	12 hours	1.49	6266	1.56	1.64
64.02	12 hours	8.39	6262	8.57	9.00
65.01	12 hours	0.860	6262	0.920	0.966
66.01	12 hours	1.06	6262	1.13	1.19
66.02	12 hours	3.90	6262	3.93	4.13
67.01	12 hours	0.200	6261	0.210	0.221
68.01	12 hours	0.320	6261	0.320	0.336
69.01	12 hours	0.320	6261	0.330	0.347
69.02	12 hours	0.550	6262	0.590	0.620
70.01	12 hours	0.240	6261	0.240	0.252
71.01	12 hours	0.270	6261	0.280	0.294
72.01	12 hours	0.310	6261	0.310	0.326
73.01	12 hours	0.220	6261	0.230	0.242
74.01	12 hours	2.05	6266	2.07	2.17
75.01	36 hours	2.30	6536	2.32	2.44
75.02	36 hours	2.72	6536	2.75	2.89
76.01	12 hours	1.45	6266	1.47	1.54
76.02	12 hours	1.58	6262	1.62	1.70
77.01	12 hours	3.47	6266	3.49	3.66
77.02	12 hours	7.67	6266	7.71	8.10
77.03	12 hours	14.9	6266	15.0	15.8
77.04	12 hours	16.6	6266	16.8	17.7
77.05	12 hours	17.7	6262	17.7	18.6
77.06	12 hours	17.9	6262	18.0	18.8
77.07	12 hours	35.1	6262	35.2	36.9
77.08	12 hours	36.0	6266	37.7	39.6
77.09	12 hours	36.3	6266	38.0	39.9
77.10	12 hours	36.9	6266	38.7	40.6
77.11	12 hours	42.2	6266	44.0	46.1
77.12	12 hours	47.2	6266	49.1	51.6
77.13	12 hours	57.6	6261	58.2	61.1
78.01	12 hours	3.28	6262	3.32	3.49
78.02	12 hours	8.08	6266	8.61	9.04
79.01	12 hours	2.19	6266	2.29	2.40

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
80.01	12 hours	0.960	6262	1.02	1.07
81.01	12 hours	2.19	6266	2.23	2.34
81.02	12 hours	2.43	6266	2.50	2.63
81.03	12 hours	4.86	6266	5.12	5.38
81.04	12 hours	8.89	6262	9.43	9.90
82.01	12 hours	0.470	6262	0.500	0.525
82.02	12 hours	1.99	6262	2.13	2.24
82.03	12 hours	2.28	6262	2.43	2.55
83.01	12 hours	1.44	6259	1.54	1.62
83.02	12 hours	2.84	6262	3.03	3.18
83.03	12 hours	3.15	6262	3.36	3.53
84.01	12 hours	0.270	6262	0.280	0.294
84.02	12 hours	1.00	6262	1.06	1.11
85.01	12 hours	0.540	6262	0.580	0.609
86.01	12 hours	0.080	6261	0.080	0.084
87.01	12 hours	0.400	6262	0.430	0.452
87.02	12 hours	0.750	6262	0.800	0.840
88.01	12 hours	0.160	6262	0.170	0.179
89.01	12 hours	0.240	6262	0.260	0.273
90.01	12 hours	0.160	6262	0.170	0.179
91.01	12 hours	0.460	6259	0.490	0.515
92.01	12 hours	0.800	6262	0.820	0.861
92.02	12 hours	3.23	6266	3.30	3.47
92.03	12 hours	3.43	6261	3.45	3.62
92.04	12 hours	5.05	6262	5.06	5.31
93.01	12 hours	0.240	6262	0.260	0.273
94.01	12 hours	0.280	6262	0.300	0.315
95.01	12 hours	0.340	6262	0.360	0.378
96.01	12 hours	0.150	6261	0.150	0.158
97.01	12 hours	0.160	6261	0.170	0.179
98.01	12 hours	0.480	6262	0.520	0.546
99.01	12 hours	2.88	6261	2.91	3.06
99.02	12 hours	3.82	6261	3.92	4.12
100.01	12 hours	0.080	6262	0.090	0.095
101.01	12 hours	0.060	6261	0.060	0.063
102.01	12 hours	0.110	6262	0.120	0.126
103.01	12 hours	0.070	6261	0.070	0.074
104.01	12 hours	0.210	6262	0.230	0.242
104.02	12 hours	0.560	6262	0.590	0.620
105.01	12 hours	0.050	6261	0.050	0.053
106.01	18 hours	6.19	6350	6.23	6.54
106.02	18 hours	8.78	6355	8.89	9.33
107.01	12 hours	2.76	6262	2.81	2.95
108.01	12 hours	1.94	6262	1.96	2.06
108.02	12 hours	1.98	6262	1.99	2.09
109.01	12 hours	3.83	6262	3.91	4.11
110.01	12 hours	2.24	6266	2.28	2.39
111.01	12 hours	1.01	6262	1.06	1.11
112.01	12 hours	0.780	6262	0.820	0.861
113.01	12 hours	0.380	6262	0.390	0.410

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
114.01	12 hours	12.7	6262	12.8	13.5
114.02	12 hours	19.3	6262	19.3	20.3
114.03	12 hours	37.4	6266	37.5	39.4
114.04	18 hours	62.1	6355	62.9	66.1
114.05	18 hours	83.0	6355	84.4	88.6
114.06	12 hours	192	6261	194	204
114.07	12 hours	208	6261	211	221
114.08	12 hours	226	6261	229	240
114.09	12 hours	231	6261	235	246
114.10	12 hours	244	6266	247	259
114.11	12 hours	260	6261	264	277
114.12	12 hours	264	6261	268	281
114.13	12 hours	299	6261	305	320
114.14	12 hours	313	6261	319	335
114.15	12 hours	314	6261	321	337
114.16	12 hours	669	6261	681	715
114.17	12 hours	714	6266	727	763
114.18	12 hours	727	6266	740	777
114.19	12 hours	733	6266	746	783
114.20	12 hours	740	6266	754	791
114.21	12 hours	800	6266	814	855
114.22	12 hours	808	6266	823	864
114.23	12 hours	811	6266	826	867
114.24	12 hours	818	6266	833	874
114.25	12 hours	831	6266	845	887
115.01	12 hours	5.92	6262	5.93	6.23
116.01	12 hours	11.3	6261	11.4	11.9
117.01	12 hours	7.80	6262	7.82	8.21
118.01	18 hours	20.9	6350	21.1	22.1
119.01	12 hours	22.2	6262	22.5	23.6
119.02	12 hours	34.1	6262	34.3	36.0
119.03	12 hours	91.0	6266	91.2	95.7
119.04	12 hours	106	6266	106	111
120.01	12 hours	8.52	6262	8.56	8.99
121.01	12 hours	11.8	6262	12.1	12.7
121.02	12 hours	30.6	6262	30.8	32.3
121.03	12 hours	39.8	6262	40.3	42.3
121.04	12 hours	52.8	6259	60.7	63.7
122.01	12 hours	14.3	6262	14.3	15.0
123.01	12 hours	7.31	6262	7.52	7.90
124.01	12 hours	11.1	6262	11.1	11.7
125.01	12 hours	8.96	6262	9.05	9.50
126.01	12 hours	15.8	6266	16.0	16.8
127.01	12 hours	10.9	6262	10.9	11.5
128.01	12 hours	9.00	6262	9.02	9.47
129.01	12 hours	7.21	6262	7.39	7.76
129.02	12 hours	13.6	6266	13.9	14.6
129.03	12 hours	17.4	6266	17.7	18.6
130.01	12 hours	4.37	6266	4.42	4.64
131.01	12 hours	3.28	6266	3.47	3.64

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
131.02	12 hours	14.9	6261	15.1	15.8
131.03	12 hours	22.8	6261	23.1	24.3
132.01	12 hours	5.72	6262	6.00	6.30
133.01	12 hours	17.3	6262	17.4	18.3
133.02	12 hours	37.0	6262	37.7	39.6
133.03	12 hours	60.6	6259	69.9	73.3
133.04	12 hours	68.4	6266	68.4	71.9
133.05	12 hours	86.1	6259	99.0	104
133.06	12 hours	86.5	6259	99.5	104
133.07	12 hours	157	6261	159	167
133.08	12 hours	158	6261	160	168
133.09	12 hours	189	6261	191	201
133.10	12 hours	208	6261	210	221
133.11	12 hours	237	6261	240	252
133.12	12 hours	326	6261	330	346
133.13	12 hours	345	6261	349	367
133.14	12 hours	351	6261	356	373
134.01	12 hours	12.9	6262	13.3	13.9
135.01	12 hours	16.9	6266	16.9	17.8
136.01	12 hours	5.95	6266	5.97	6.27
137.01	12 hours	7.32	6262	7.59	7.97
138.01	18 hours	28.2	6350	28.5	29.9
138.02	18 hours	34.9	6350	35.2	37.0
138.03	18 hours	59.4	6357	59.4	62.4
139.01	12 hours	11.7	6261	11.7	12.3
139.02	12 hours	22.9	6262	22.9	24.0
140.01	12 hours	1.18	6262	1.23	1.29
141.01	12 hours	16.9	6262	17.0	17.8
141.02	12 hours	20.0	6262	20.2	21.2
142.01	12 hours	2.11	6262	2.24	2.35
143.01	12 hours	13.2	6262	13.6	14.3
144.01	12 hours	12.6	6262	12.6	13.2
145.01	12 hours	9.18	6262	9.36	9.83
145.02	12 hours	25.9	6261	26.0	27.3
145.03	12 hours	40.0	6261	40.1	42.1
145.04	12 hours	77.2	6261	77.6	81.5
145.05	12 hours	77.4	6261	77.9	81.8
145.06	12 hours	88.8	6261	89.0	93.5
146.01	12 hours	12.8	6266	12.9	13.5
147.01	12 hours	6.95	6262	7.25	7.61
148.01	12 hours	18.5	6262	18.7	19.6
148.02	12 hours	27.8	6261	28.4	29.8
148.03	12 hours	36.7	6261	37.2	39.1
149.01	12 hours	7.95	6262	7.97	8.37
150.01	12 hours	7.62	6266	7.63	8.01
151.01	12 hours	6.48	6262	6.68	7.01
152.01	12 hours	2.63	6266	2.77	2.91
153.01	12 hours	8.70	6266	8.76	9.20
154.01	12 hours	3.50	6266	3.50	3.68
154.02	12 hours	4.60	6262	4.80	5.04

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
155.01	12 hours	14.2	6266	14.5	15.2
155.02	12 hours	14.3	6266	14.8	15.5
155.03	12 hours	23.5	6261	23.9	25.1
155.04	12 hours	24.4	6261	24.9	26.1
155.05	12 hours	38.5	6261	39.1	41.1
155.06	12 hours	45.3	6261	45.9	48.2
156.01	12 hours	7.77	6266	7.79	8.18
156.02	12 hours	8.08	6262	8.09	8.49
157.01	12 hours	5.72	6266	5.73	6.02
158.01	12 hours	2.95	6262	2.97	3.12
159.01	12 hours	2.82	6262	2.94	3.09
160.01	12 hours	5.94	6262	5.96	6.26
160.02	12 hours	6.37	6266	6.44	6.76
161.01	12 hours	12.1	6262	12.2	12.8
162.01	12 hours	0.980	6262	1.03	1.08
162.02	12 hours	7.33	6261	7.44	7.81
162.03	12 hours	7.46	6261	7.57	7.95
163.01	12 hours	1.45	6262	1.54	1.62
163.02	12 hours	4.36	6266	4.49	4.71
163.03	12 hours	13.7	6261	13.7	14.4
163.04	12 hours	20.9	6262	21.0	22.0
163.05	12 hours	46.1	6266	47.2	49.6
163.06	12 hours	48.0	6266	49.1	51.6
164.01	18 hours	16.5	6350	16.7	17.5
165.01	12 hours	8.01	6261	8.24	8.65
165.02	12 hours	9.21	6261	9.42	9.89
166.01	12 hours	2.28	6266	2.29	2.40
166.02	12 hours	4.83	6262	4.90	5.15
166.03	12 hours	8.47	6262	8.47	8.89
167.01	12 hours	1.76	6266	1.87	1.96
167.02	12 hours	3.33	6266	3.51	3.69
168.01	12 hours	4.86	6262	4.97	5.22
168.02	12 hours	4.90	6262	5.00	5.25
169.01	12 hours	8.92	6262	8.96	9.41
169.02	12 hours	10.1	6266	10.2	10.8
170.01	12 hours	1.44	6262	1.54	1.62
171.01	12 hours	1.65	6266	1.70	1.79
172.01	12 hours	1.03	6262	1.10	1.16
173.01	12 hours	2.00	6262	2.13	2.24
173.02	12 hours	15.8	6266	16.2	17.0
173.03	12 hours	31.0	6266	31.7	33.3
173.04	12 hours	33.8	6266	34.6	36.3
173.05	12 hours	43.5	6261	44.1	46.3
173.06	12 hours	56.4	6261	57.8	60.7
173.07	12 hours	101	6261	102	107
174.01	12 hours	1.57	6262	1.67	1.75
175.01	12 hours	1.26	6262	1.34	1.41
176.01	12 hours	1.13	6262	1.19	1.25
176.02	12 hours	6.29	6266	6.38	6.70
177.01	18 hours	5.40	6357	5.42	5.69

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
178.01	12 hours	3.60	6261	3.63	3.81
179.01	12 hours	0.630	6266	0.630	0.662
180.01	18 hours	5.39	6350	5.43	5.70
180.02	18 hours	5.94	6350	5.98	6.28
181.01	12 hours	3.71	6261	3.74	3.93
182.01	12 hours	0.510	6262	0.540	0.567
183.01	12 hours	5.21	6266	5.44	5.71
183.02	12 hours	10.0	6266	10.2	10.7
183.03	12 hours	17.9	6262	18.2	19.1
183.04	12 hours	28.4	6266	29.1	30.6
183.05	12 hours	29.5	6266	30.3	31.8
183.06	12 hours	44.4	6262	44.7	46.9
184.01	12 hours	0.940	6262	1.00	1.05
184.02	12 hours	6.14	6266	6.27	6.58
185.01	12 hours	1.16	6262	1.22	1.28
185.02	12 hours	5.07	6262	5.17	5.43
186.01	12 hours	2.28	6266	2.36	2.48
187.01	12 hours	2.85	6262	2.93	3.08
187.02	12 hours	5.42	6262	5.51	5.79
188.01	12 hours	0.880	6262	0.930	0.977
189.01	12 hours	0.920	6262	0.970	1.02
190.01	12 hours	0.630	6262	0.660	0.693
191.01	12 hours	1.74	6266	1.79	1.88
192.01	12 hours	2.02	6262	2.11	2.22
193.01	12 hours	1.71	6262	1.78	1.87
194.01	12 hours	0.300	6262	0.310	0.326
195.01	12 hours	0.600	6262	0.630	0.662
196.01	12 hours	0.680	6262	0.710	0.746
197.01	12 hours	0.560	6262	0.590	0.620
198.01	12 hours	0.800	6262	0.830	0.872
199.01	12 hours	1.76	6262	1.88	1.97
199.02	12 hours	2.39	6262	2.55	2.68
200.01	12 hours	0.310	6262	0.330	0.347
201.01	12 hours	0.750	6262	0.780	0.819
202.01	12 hours	6.97	6266	7.14	7.50
203.01	12 hours	1.06	6262	1.11	1.17
204.01	12 hours	0.740	6262	0.770	0.809
205.01	12 hours	0.930	6262	0.980	1.03
206.01	12 hours	0.250	6261	0.250	0.263
207.01	12 hours	0.880	6262	0.940	0.987
208.01	12 hours	1.27	6262	1.35	1.42
208.02	12 hours	1.78	6262	1.89	1.98
208.03	12 hours	3.33	6262	3.58	3.76
208.04	12 hours	6.63	6261	6.88	7.22
208.05	12 hours	8.41	6261	8.85	9.29
208.06	18 hours	10.5	6350	10.7	11.2
209.01	12 hours	0.230	6261	0.240	0.252
210.01	12 hours	0.440	6262	0.470	0.494
211.01	12 hours	0.460	6262	0.480	0.504
211.02	12 hours	0.530	6262	0.560	0.588

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
211.03	12 hours	1.90	6262	2.04	2.14
212.01	12 hours	0.220	6261	0.230	0.242
_junc_10	12 hours	44.8	6261	45.4	47.7
_junc_108	12 hours	0.810	6262	0.860	0.903
_junc_11	12 hours	712	6266	725	762
_junc_111	12 hours	4.70	6266	4.93	5.18
_junc_114	12 hours	2.88	6261	2.91	3.06
_junc_12	12 hours	22.0	6266	22.6	23.7
_junc_13	12 hours	218	6261	221	232
_junc_138	12 hours	14.9	6262	15.1	15.9
_junc_14	12 hours	186	6261	188	197
_junc_142	12 hours	11.6	6266	11.6	12.1
_junc_143	12 hours	349	6261	353	371
_junc_15	12 hours	664	6261	676	710
_junc_16	12 hours	726	6266	738	775
_junc_165	12 hours	49.0	6266	51.0	53.5
_junc_168	12 hours	45.8	6266	47.6	50.0
_junc_17	12 hours	207	6261	210	221
_junc_174	12 hours	33.1	6266	33.4	35.1
_junc_18	18 hours	82.8	6355	84.2	88.4
_junc_181	12 hours	0.130	6261	0.130	0.137
_junc_185	12 hours	0.150	6261	0.150	0.158
_junc_186	12 hours	0.440	6261	0.440	0.462
_junc_187	12 hours	3.74	6261	3.78	3.97
_junc_19	12 hours	286	6261	291	305
_junc_193	12 hours	16.1	6262	16.4	17.2
_junc_194	12 hours	23.0	6262	23.4	24.5
_junc_199	12 hours	28.0	6266	28.0	29.4
_junc_2	12 hours	335	6261	338	355
_junc_20	12 hours	240	6266	243	255
_junc_204	12 hours	12.4	6262	12.5	13.1
_junc_21	12 hours	259	6261	263	276
_junc_22	12 hours	740	6266	753	790
_junc_228	12 hours	0.750	6262	0.800	0.840
_junc_23	12 hours	749	6266	763	801
_junc_231	12 hours	305	6261	310	326
_junc_232	12 hours	37.7	6266	38.6	40.5
_junc_233	12 hours	53.8	6266	54.8	57.6
_junc_234	12 hours	719	6262	721	757
_junc_24	12 hours	45.2	6266	45.2	47.5
_junc_25	12 hours	36.9	6266	37.7	39.6
_junc_26	12 hours	30.6	6261	30.7	32.3
_junc_263	12 hours	17.7	6262	17.7	18.6
_junc_265	12 hours	17.3	6266	17.6	18.5
_junc_27	12 hours	18.6	6261	18.7	19.6
_junc_28	12 hours	811	6266	825	867
_junc_29	12 hours	808	6266	822	864
_junc_3	12 hours	30.1	6261	30.6	32.1
_junc_30	12 hours	815	6266	830	871
_junc_31	12 hours	23.3	6266	23.6	24.8

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_32	12 hours	827	6266	842	884
_junc_324	12 hours	727	6262	729	766
_junc_328	12 hours	844	6262	845	888
_junc_329	12 hours	49.1	6261	50.1	52.6
_junc_33	12 hours	22.7	6262	23.0	24.1
_junc_330	12 hours	100	6261	101	107
_junc_331	12 hours	1768	6262	1773	1861
_junc_34	12 hours	36.7	6262	36.8	38.6
_junc_35	12 hours	12.5	6266	13.0	13.6
_junc_36	12 hours	706	6262	708	744
_junc_37	12 hours	26.9	6261	27.1	28.4
_junc_38	12 hours	21.1	6262	21.6	22.7
_junc_39	12 hours	784	6262	786	825
_junc_4	12 hours	30.6	6262	30.8	32.4
_junc_40	12 hours	38.5	6261	38.7	40.6
_junc_41	12 hours	23.2	6259	26.5	27.8
_junc_42	12 hours	44.4	6261	44.6	46.8
_junc_43	12 hours	113	6266	114	119
_junc_44	12 hours	735	6262	737	774
_junc_45	12 hours	657	6262	659	692
_junc_46	12 hours	56.8	6266	57.0	59.8
_junc_47	12 hours	744	6262	746	783
_junc_48	12 hours	541	6262	542	569
_junc_49	12 hours	26.0	6266	26.8	28.1
_junc_5	12 hours	26.0	6262	26.2	27.6
_junc_50	12 hours	83.9	6262	84.3	88.6
_junc_51	12 hours	529	6262	530	557
_junc_52	12 hours	95.9	6262	96.0	101
_junc_53	12 hours	26.7	6262	26.8	28.1
_junc_54	12 hours	133	6261	133	140
_junc_55	12 hours	150	6261	151	158
_junc_56	12 hours	486	6262	486	510
_junc_57	12 hours	201	6261	203	213
_junc_58	12 hours	460	6261	464	487
_junc_59	12 hours	431	6261	433	455
_junc_6	12 hours	86.8	6266	87.0	91.3
_junc_60	12 hours	449	6261	452	475
_junc_61	12 hours	41.9	6262	42.1	44.2
_junc_62	12 hours	204	6266	204	215
_junc_63	12 hours	181	6266	182	191
_junc_64	12 hours	82.1	6262	82.2	86.3
_junc_65	12 hours	23.1	6262	23.8	24.9
_junc_66	12 hours	155	6266	155	163
_junc_67	12 hours	92.1	6262	92.2	96.8
_junc_68	12 hours	65.4	6262	66.4	69.7
_junc_69	12 hours	48.9	6262	49.5	52.0
_junc_7	12 hours	99.8	6266	99.9	105
_junc_70	12 hours	37.4	6266	37.4	39.2
_junc_71	12 hours	32.6	6262	32.8	34.5
_junc_72	12 hours	56.7	6262	57.0	59.9

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_73	12 hours	26.5	6262	26.6	27.9
_junc_74	12 hours	17.5	6262	17.6	18.4
_junc_75	18 hours	57.0	6357	57.2	60.0
_junc_76	12 hours	21.8	6261	21.9	23.0
_junc_77	12 hours	53.5	6259	61.7	64.8
_junc_78	12 hours	66.3	6259	76.3	80.2
_junc_79	12 hours	75.6	6259	86.9	91.3
_junc_8	12 hours	37.8	6262	38.3	40.2
_junc_80	12 hours	30.1	6262	30.6	32.2
_junc_81	12 hours	144	6261	146	153
_junc_82	12 hours	32.7	6266	33.0	34.6
_junc_83	12 hours	26.4	6261	26.8	28.2
_junc_84	12 hours	178	6261	179	188
_junc_85	12 hours	35.4	6261	35.9	37.7
_junc_86	12 hours	220	6261	222	233
_junc_87	12 hours	76.7	6261	77.1	81.0
_junc_88	12 hours	83.7	6261	84.1	88.3
_junc_89	12 hours	202	6261	203	214
_junc_9	12 hours	50.6	6262	50.7	53.2
_junc_90	12 hours	324	6261	327	343
_junc_91	12 hours	22.3	6261	22.7	23.8

0.2% AEP XP-RAFTS Peak Flows

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
1.01	12 hours	25.7	6262	25.9	23.8
1.02	12 hours	33.6	6266	33.7	31.0
1.03	12 hours	46.9	6266	47.1	43.3
1.04	12 hours	66.5	6262	68.1	62.7
1.05	12 hours	85.1	6262	87.1	80.2
1.06	12 hours	86.8	6262	89.0	81.8
1.07	12 hours	103	6262	105	96.5
1.08	12 hours	114	6262	115	106
1.09	12 hours	117	6262	118	109
1.10	12 hours	193	6266	193	178
1.11	12 hours	231	6266	232	213
1.12	12 hours	260	6266	263	242
1.13	12 hours	530	6266	536	493
1.14	12 hours	552	6261	553	508
1.15	12 hours	553	6261	554	509
1.16	12 hours	563	6261	564	519
1.17	12 hours	607	6261	608	559
1.18	12 hours	651	6262	651	599
1.19	12 hours	661	6262	662	609
1.20	12 hours	806	6261	807	742
1.21	12 hours	810	6261	811	746
1.22	12 hours	868	6261	869	799
1.23	12 hours	882	6261	883	812
1.24	12 hours	882	6261	883	812
1.25	12 hours	886	6261	887	816
1.26	12 hours	896	6261	896	825
1.27	12 hours	906	6261	908	835
1.28	12 hours	908	6261	909	836
1.29	12 hours	957	6261	958	882
1.30	12 hours	961	6261	962	885
1.31	12 hours	1037	6261	1037	954
1.32	12 hours	1037	6261	1037	954
1.33	12 hours	2041	6262	2045	1882
1.34	12 hours	2043	6262	2049	1885
1.35	12 hours	2157	6261	2163	1990
1.36	12 hours	2159	6261	2164	1991
1.37	12 hours	2160	6261	2164	1991
1.38	12 hours	2162	6261	2165	1992
1.39	12 hours	2173	6261	2173	2000
1.40	12 hours	2190	6262	2203	2027
2.01	12 hours	6.54	6266	6.68	6.15
3.01	12 hours	11.8	6262	12.3	11.3
4.01	12 hours	12.6	6262	12.8	11.8
5.01	12 hours	13.0	6262	13.4	12.3
6.01	12 hours	13.5	6266	13.5	12.4
7.01	12 hours	8.66	6261	8.67	7.98
8.01	12 hours	24.9	6262	25.0	23.0
8.02	12 hours	48.1	6262	48.5	44.6
8.03	12 hours	48.2	6262	48.5	44.6

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
8.04	12 hours	69.7	6262	69.8	64.2
8.05	12 hours	71.9	6262	71.9	66.2
9.01	12 hours	15.1	6262	15.2	14.0
10.01	12 hours	8.81	6262	8.88	8.17
10.02	12 hours	21.3	6262	21.3	19.6
11.01	12 hours	12.4	6262	12.5	11.5
12.01	12 hours	10.3	6262	10.8	9.90
12.02	12 hours	17.9	6266	18.0	16.6
12.03	12 hours	28.6	6266	28.8	26.5
13.01	12 hours	3.38	6262	3.58	3.29
14.01	12 hours	8.50	6262	8.67	7.98
14.02	12 hours	10.3	6262	10.6	9.71
15.01	12 hours	1.41	6262	1.48	1.36
16.01	12 hours	11.3	6262	11.4	10.5
16.02	12 hours	17.0	6262	17.2	15.8
17.01	12 hours	17.1	6261	17.2	15.9
17.02	12 hours	39.3	6262	39.5	36.3
17.03	12 hours	50.4	6262	50.7	46.6
17.04	12 hours	72.1	6266	72.3	66.5
17.05	12 hours	84.9	6261	85.2	78.4
17.06	12 hours	106	6262	106	97.8
17.07	12 hours	121	6261	121	112
17.08	12 hours	166	6266	168	154
17.09	12 hours	169	6266	172	158
17.10	12 hours	183	6266	185	170
17.11	12 hours	259	6261	260	239
17.12	12 hours	263	6261	264	243
17.13	12 hours	265	6261	266	245
18.01	12 hours	15.7	6262	15.7	14.5
19.01	12 hours	7.66	6262	7.68	7.07
20.01	12 hours	19.3	6262	19.4	17.8
21.01	12 hours	15.8	6262	15.9	14.6
21.02	12 hours	17.6	6261	17.9	16.5
22.01	12 hours	11.3	6262	11.8	10.9
23.01	12 hours	9.36	6262	9.36	8.61
23.02	12 hours	30.1	6262	30.2	27.8
23.03	12 hours	40.8	6266	40.8	37.6
23.04	12 hours	41.4	6262	41.5	38.2
24.01	12 hours	12.1	6262	12.1	11.1
25.01	12 hours	4.13	6262	4.40	4.05
26.01	12 hours	13.3	6266	13.4	12.3
26.02	12 hours	13.4	6262	13.5	12.5
27.01	12 hours	16.7	6262	16.8	15.5
27.02	12 hours	36.6	6266	37.0	34.1
27.03	12 hours	63.1	6261	63.8	58.7
28.01	12 hours	3.34	6262	3.54	3.26
28.02	12 hours	4.54	6262	4.81	4.43
29.01	12 hours	14.5	6261	14.6	13.4
30.01	12 hours	4.20	6262	4.32	3.97
31.01	12 hours	3.04	6262	3.07	2.82

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
32.01	12 hours	18.0	6266	18.1	16.7
33.01	12 hours	8.57	6262	8.61	7.92
34.01	12 hours	12.5	6262	12.6	11.5
34.02	12 hours	30.4	6266	30.6	28.2
34.03	12 hours	30.8	6266	31.2	28.7
35.01	12 hours	8.70	6262	8.74	8.04
35.02	12 hours	18.6	6262	18.7	17.2
35.03	12 hours	25.0	6262	25.0	23.0
35.04	12 hours	25.3	6262	25.3	23.3
35.05	12 hours	39.7	6262	39.8	36.6
36.01	12 hours	1.04	6262	1.11	1.02
37.01	12 hours	7.33	6266	7.34	6.75
38.01	12 hours	7.61	6262	7.66	7.05
38.02	12 hours	9.26	6261	9.36	8.61
39.01	12 hours	10.1	6262	10.1	9.32
39.02	12 hours	20.9	6262	21.2	19.5
39.03	12 hours	30.6	6262	31.3	28.8
39.04	12 hours	60.9	6266	62.4	57.4
39.05	12 hours	77.3	6266	78.4	72.1
39.06	12 hours	143	6266	143	132
40.01	12 hours	5.38	6262	5.73	5.27
41.01	12 hours	6.79	6262	7.22	6.64
42.01	12 hours	14.4	6262	14.4	13.3
43.01	12 hours	4.53	6262	4.73	4.35
44.01	12 hours	15.5	6262	15.8	14.5
44.02	12 hours	39.2	6266	39.4	36.3
44.03	12 hours	60.3	6266	60.6	55.7
45.01	12 hours	10.2	6266	10.3	9.47
46.01	12 hours	15.1	6262	15.2	14.0
47.01	12 hours	13.1	6262	13.4	12.4
47.02	12 hours	18.4	6266	18.4	16.9
47.03	12 hours	19.9	6266	20.3	18.7
47.04	12 hours	41.2	6262	41.3	38.0
47.05	12 hours	53.1	6262	53.7	49.4
48.01	12 hours	5.00	6266	5.01	4.61
49.01	12 hours	7.22	6266	7.27	6.69
49.02	12 hours	8.24	6266	8.51	7.83
49.03	12 hours	8.35	6266	8.65	7.96
50.01	12 hours	1.35	6262	1.42	1.31
51.01	12 hours	4.78	6266	4.81	4.43
52.01	12 hours	2.15	6262	2.28	2.10
52.02	12 hours	5.22	6266	5.34	4.91
53.01	12 hours	7.71	6262	7.74	7.12
54.01	12 hours	2.92	6262	3.00	2.76
54.02	12 hours	4.29	6266	4.40	4.05
54.03	12 hours	4.84	6262	4.99	4.59
55.01	12 hours	3.55	6266	3.59	3.30
56.01	12 hours	4.95	6266	5.13	4.72
56.02	12 hours	8.25	6266	8.37	7.70
56.03	12 hours	9.71	6266	9.80	9.02

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
57.01	12 hours	4.25	6266	4.36	4.01
57.02	12 hours	10.8	6261	10.9	10.0
58.01	12 hours	7.95	6262	7.97	7.33
58.02	12 hours	11.6	6262	11.7	10.7
58.03	12 hours	16.8	6262	16.8	15.5
58.04	12 hours	28.1	6266	28.1	25.9
58.05	12 hours	30.4	6266	30.6	28.1
58.06	12 hours	44.2	6266	44.9	41.3
58.07	12 hours	50.6	6266	51.1	47.0
59.01	12 hours	3.51	6262	3.67	3.38
60.01	12 hours	3.26	6266	3.39	3.12
60.02	12 hours	4.19	6266	4.33	3.98
60.03	12 hours	9.21	6266	9.36	8.61
61.01	12 hours	2.68	6262	2.78	2.56
62.01	12 hours	0.630	6259	0.680	0.626
63.01	12 hours	0.050	6262	0.050	0.046
64.01	12 hours	1.81	6262	1.93	1.78
64.02	12 hours	10.2	6262	10.5	9.62
65.01	12 hours	1.04	6262	1.12	1.03
66.01	12 hours	1.28	6262	1.35	1.24
66.02	12 hours	4.73	6262	4.79	4.41
67.01	12 hours	0.240	6261	0.250	0.230
68.01	12 hours	0.390	6261	0.390	0.359
69.01	12 hours	0.390	6261	0.400	0.368
69.02	12 hours	0.670	6262	0.710	0.653
70.01	12 hours	0.290	6261	0.290	0.267
71.01	12 hours	0.320	6261	0.330	0.304
72.01	12 hours	0.370	6261	0.380	0.350
73.01	12 hours	0.270	6261	0.270	0.248
74.01	12 hours	2.48	6266	2.50	2.30
75.01	36 hours	2.91	6531	2.96	2.72
75.02	36 hours	3.44	6536	3.49	3.21
76.01	12 hours	1.76	6266	1.83	1.68
76.02	12 hours	1.93	6262	1.99	1.83
77.01	12 hours	4.22	6266	4.28	3.94
77.02	12 hours	9.34	6266	9.54	8.78
77.03	12 hours	18.1	6262	18.2	16.8
77.04	12 hours	20.2	6262	20.5	18.8
77.05	12 hours	21.6	6262	21.9	20.1
77.06	12 hours	21.8	6262	22.2	20.4
77.07	12 hours	42.8	6262	43.2	39.7
77.08	12 hours	43.9	6262	44.0	40.5
77.09	12 hours	44.2	6262	44.3	40.7
77.10	12 hours	45.0	6262	45.0	41.4
77.11	12 hours	51.4	6262	51.7	47.5
77.12	12 hours	57.5	6266	60.0	55.2
77.13	12 hours	70.3	6261	70.7	65.0
78.01	12 hours	3.98	6262	4.08	3.75
78.02	12 hours	9.89	6266	10.6	9.73
79.01	12 hours	2.64	6266	2.79	2.57

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
80.01	12 hours	1.17	6262	1.24	1.14
81.01	12 hours	2.64	6266	2.69	2.47
81.02	12 hours	2.93	6266	3.03	2.79
81.03	12 hours	5.88	6262	6.22	5.72
81.04	12 hours	10.7	6262	11.4	10.5
82.01	12 hours	0.570	6262	0.600	0.552
82.02	12 hours	2.43	6262	2.59	2.38
82.03	12 hours	2.77	6262	2.95	2.71
83.01	12 hours	1.74	6262	1.86	1.71
83.02	12 hours	3.44	6262	3.65	3.36
83.03	12 hours	3.81	6262	4.04	3.72
84.01	12 hours	0.320	6262	0.340	0.313
84.02	12 hours	1.20	6262	1.27	1.17
85.01	12 hours	0.660	6262	0.700	0.644
86.01	12 hours	0.090	6261	0.100	0.092
87.01	12 hours	0.490	6262	0.520	0.478
87.02	12 hours	0.910	6262	0.960	0.883
88.01	12 hours	0.190	6262	0.210	0.193
89.01	12 hours	0.290	6262	0.310	0.285
90.01	12 hours	0.190	6262	0.200	0.184
91.01	12 hours	0.550	6262	0.600	0.552
92.01	12 hours	0.970	6266	0.980	0.902
92.02	12 hours	3.91	6266	3.98	3.66
92.03	12 hours	4.15	6266	4.31	3.97
92.04	12 hours	6.11	6262	6.20	5.70
93.01	12 hours	0.290	6262	0.310	0.285
94.01	12 hours	0.330	6262	0.350	0.322
95.01	12 hours	0.410	6262	0.440	0.405
96.01	12 hours	0.180	6261	0.180	0.166
97.01	12 hours	0.200	6261	0.200	0.184
98.01	12 hours	0.580	6262	0.620	0.570
99.01	12 hours	3.51	6261	3.54	3.26
99.02	12 hours	4.64	6261	4.75	4.37
100.01	12 hours	0.100	6262	0.110	0.101
101.01	12 hours	0.080	6261	0.080	0.074
102.01	12 hours	0.130	6262	0.140	0.129
103.01	12 hours	0.080	6261	0.080	0.074
104.01	12 hours	0.260	6262	0.270	0.248
104.02	12 hours	0.670	6262	0.700	0.644
105.01	12 hours	0.060	6261	0.060	0.055
106.01	18 hours	7.62	6350	7.71	7.09
106.02	18 hours	10.8	6355	11.0	10.1
107.01	12 hours	3.35	6262	3.43	3.16
108.01	12 hours	2.36	6262	2.37	2.18
108.02	12 hours	2.41	6262	2.42	2.23
109.01	12 hours	4.68	6262	4.84	4.45
110.01	12 hours	2.71	6266	2.76	2.54
111.01	12 hours	1.23	6262	1.27	1.17
112.01	12 hours	0.940	6262	0.990	0.911
113.01	12 hours	0.460	6262	0.480	0.442

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
114.01	12 hours	15.5	6261	15.5	14.3
114.02	12 hours	23.4	6266	23.5	21.6
114.03	12 hours	45.4	6266	45.4	41.8
114.04	18 hours	75.9	6355	77.2	71.1
114.05	18 hours	101	6355	103	95.1
114.06	12 hours	233	6261	235	216
114.07	12 hours	253	6261	255	235
114.08	12 hours	275	6261	277	255
114.09	12 hours	281	6261	284	261
114.10	12 hours	296	6261	299	275
114.11	12 hours	317	6261	319	294
114.12	12 hours	321	6261	324	298
114.13	12 hours	365	6261	370	340
114.14	12 hours	381	6261	387	356
114.15	12 hours	383	6261	389	358
114.16	12 hours	815	6261	825	759
114.17	12 hours	870	6261	881	811
114.18	12 hours	885	6261	897	826
114.19	12 hours	893	6261	905	833
114.20	12 hours	902	6261	915	842
114.21	12 hours	976	6261	991	912
114.22	12 hours	986	6261	1001	921
114.23	12 hours	989	6261	1005	924
114.24	12 hours	997	6261	1013	932
114.25	12 hours	1013	6261	1029	946
115.01	12 hours	7.15	6262	7.24	6.66
116.01	12 hours	13.7	6262	13.8	12.7
117.01	12 hours	9.46	6262	9.62	8.85
118.01	18 hours	25.5	6350	25.7	23.7
119.01	12 hours	26.9	6266	27.0	24.8
119.02	12 hours	41.3	6261	41.5	38.2
119.03	12 hours	110	6266	110	101
119.04	12 hours	128	6266	128	118
120.01	12 hours	10.3	6262	10.3	9.48
121.01	12 hours	14.3	6262	14.7	13.6
121.02	12 hours	37.0	6262	37.8	34.8
121.03	12 hours	48.1	6262	49.4	45.4
121.04	12 hours	63.9	6262	64.5	59.4
122.01	12 hours	17.2	6262	17.4	16.0
123.01	12 hours	8.83	6262	9.16	8.43
124.01	12 hours	13.4	6262	13.5	12.4
125.01	12 hours	10.8	6262	11.1	10.2
126.01	12 hours	19.4	6266	19.6	18.0
127.01	12 hours	13.2	6262	13.2	12.2
128.01	12 hours	10.9	6262	10.9	10.0
129.01	12 hours	8.75	6262	9.05	8.33
129.02	12 hours	16.5	6266	17.0	15.6
129.03	12 hours	21.2	6266	21.8	20.0
130.01	12 hours	5.32	6266	5.47	5.03
131.01	12 hours	3.96	6262	4.21	3.87

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
131.02	12 hours	18.2	6261	18.4	16.9
131.03	12 hours	27.8	6261	28.1	25.8
132.01	12 hours	6.93	6266	6.98	6.42
133.01	12 hours	20.9	6262	21.4	19.6
133.02	12 hours	44.7	6262	46.1	42.4
133.03	12 hours	73.2	6266	73.2	67.4
133.04	12 hours	82.7	6262	82.8	76.1
133.05	12 hours	104	6266	104	96.1
133.06	12 hours	105	6266	105	96.7
133.07	12 hours	191	6261	193	177
133.08	12 hours	192	6261	194	178
133.09	12 hours	230	6261	231	213
133.10	12 hours	253	6261	254	234
133.11	12 hours	288	6261	291	267
133.12	12 hours	397	6261	399	367
133.13	12 hours	419	6261	423	389
133.14	12 hours	426	6261	430	396
134.01	12 hours	15.6	6262	16.2	14.9
135.01	12 hours	20.5	6266	20.6	19.0
136.01	12 hours	7.17	6266	7.30	6.72
137.01	12 hours	8.85	6266	8.86	8.15
138.01	18 hours	34.6	6350	34.9	32.1
138.02	18 hours	42.7	6350	43.1	39.6
138.03	18 hours	72.6	6350	73.2	67.3
139.01	12 hours	14.2	6262	14.2	13.1
139.02	12 hours	27.8	6262	27.8	25.6
140.01	12 hours	1.42	6262	1.48	1.36
141.01	12 hours	20.5	6262	20.8	19.1
141.02	12 hours	24.2	6262	24.8	22.8
142.01	12 hours	2.53	6262	2.68	2.47
143.01	12 hours	15.9	6262	16.6	15.3
144.01	12 hours	15.2	6262	15.5	14.2
145.01	12 hours	11.1	6262	11.4	10.5
145.02	12 hours	31.4	6266	31.5	29.0
145.03	12 hours	48.5	6266	48.8	44.9
145.04	12 hours	93.4	6266	95.0	87.4
145.05	12 hours	93.7	6266	95.3	87.7
145.06	12 hours	107	6266	110	101
146.01	12 hours	15.5	6266	15.6	14.3
147.01	12 hours	8.40	6266	8.48	7.80
148.01	12 hours	22.5	6262	22.6	20.8
148.02	12 hours	33.7	6261	34.1	31.3
148.03	12 hours	44.5	6261	44.7	41.1
149.01	12 hours	9.61	6266	9.62	8.85
150.01	12 hours	9.24	6262	9.26	8.52
151.01	12 hours	7.87	6266	7.87	7.24
152.01	12 hours	3.18	6262	3.36	3.09
153.01	12 hours	10.6	6266	10.6	9.71
154.01	12 hours	4.25	6266	4.31	3.97
154.02	12 hours	5.58	6262	5.86	5.39

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
155.01	12 hours	17.5	6261	17.9	16.4
155.02	12 hours	17.7	6261	18.1	16.7
155.03	12 hours	28.8	6261	29.2	26.9
155.04	12 hours	29.9	6261	30.4	27.9
155.05	12 hours	47.1	6261	47.6	43.8
155.06	12 hours	55.3	6261	55.9	51.4
156.01	12 hours	9.43	6262	9.46	8.70
156.02	12 hours	9.81	6266	9.88	9.09
157.01	12 hours	6.96	6262	6.98	6.42
158.01	12 hours	3.57	6262	3.63	3.34
159.01	12 hours	3.42	6262	3.58	3.29
160.01	12 hours	7.21	6262	7.24	6.66
160.02	12 hours	7.73	6266	7.82	7.19
161.01	12 hours	14.8	6266	14.9	13.7
162.01	12 hours	1.19	6262	1.24	1.14
162.02	12 hours	8.96	6261	9.06	8.34
162.03	12 hours	9.11	6261	9.22	8.48
163.01	12 hours	1.76	6262	1.87	1.72
163.02	12 hours	5.28	6266	5.53	5.09
163.03	12 hours	16.7	6266	17.0	15.6
163.04	12 hours	25.5	6262	25.5	23.5
163.05	12 hours	56.7	6266	57.9	53.3
163.06	12 hours	59.1	6266	60.3	55.5
164.01	18 hours	20.3	6350	20.5	18.9
165.01	12 hours	9.82	6261	10.0	9.24
165.02	12 hours	11.3	6261	11.5	10.6
166.01	12 hours	2.75	6266	2.78	2.56
166.02	12 hours	5.85	6262	5.97	5.49
166.03	12 hours	10.3	6262	10.3	9.50
167.01	12 hours	2.13	6262	2.26	2.08
167.02	12 hours	4.05	6262	4.30	3.96
168.01	12 hours	5.91	6262	6.10	5.61
168.02	12 hours	5.95	6262	6.14	5.65
169.01	12 hours	10.8	6262	10.9	10.0
169.02	12 hours	12.3	6266	12.4	11.4
170.01	12 hours	1.75	6262	1.87	1.72
171.01	12 hours	2.00	6266	2.10	1.93
172.01	12 hours	1.25	6262	1.33	1.22
173.01	12 hours	2.42	6262	2.56	2.36
173.02	12 hours	19.2	6266	19.8	18.2
173.03	12 hours	37.6	6266	38.5	35.4
173.04	12 hours	41.1	6266	42.1	38.7
173.05	12 hours	53.2	6261	53.6	49.3
173.06	12 hours	69.1	6261	70.4	64.7
173.07	12 hours	123	6261	124	114
174.01	12 hours	1.91	6262	2.03	1.87
175.01	12 hours	1.53	6262	1.62	1.49
176.01	12 hours	1.36	6262	1.44	1.32
176.02	12 hours	7.63	6266	7.77	7.15
177.01	18 hours	6.69	6350	6.74	6.20

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
178.01	12 hours	4.40	6261	4.43	4.08
179.01	12 hours	0.760	6266	0.770	0.708
180.01	18 hours	6.61	6350	6.69	6.15
180.02	18 hours	7.28	6350	7.35	6.76
181.01	12 hours	4.54	6261	4.56	4.20
182.01	12 hours	0.620	6262	0.650	0.598
183.01	12 hours	6.31	6266	6.69	6.15
183.02	12 hours	12.2	6266	12.5	11.5
183.03	12 hours	21.8	6266	22.3	20.5
183.04	12 hours	34.6	6262	34.8	32.0
183.05	12 hours	36.0	6262	36.2	33.3
183.06	12 hours	54.1	6266	54.7	50.3
184.01	12 hours	1.14	6262	1.20	1.10
184.02	12 hours	7.46	6262	7.49	6.89
185.01	12 hours	1.41	6262	1.47	1.35
185.02	12 hours	6.19	6262	6.40	5.89
186.01	12 hours	2.76	6266	2.86	2.63
187.01	12 hours	3.45	6262	3.58	3.29
187.02	12 hours	6.58	6262	6.73	6.19
188.01	12 hours	1.06	6262	1.13	1.04
189.01	12 hours	1.11	6262	1.16	1.07
190.01	12 hours	0.760	6262	0.790	0.727
191.01	12 hours	2.12	6266	2.21	2.03
192.01	12 hours	2.43	6262	2.54	2.34
193.01	12 hours	2.07	6262	2.16	1.99
194.01	12 hours	0.360	6262	0.380	0.350
195.01	12 hours	0.730	6262	0.760	0.699
196.01	12 hours	0.820	6262	0.860	0.791
197.01	12 hours	0.680	6262	0.720	0.662
198.01	12 hours	0.960	6262	1.01	0.929
199.01	12 hours	2.13	6262	2.26	2.08
199.02	12 hours	2.89	6262	3.07	2.82
200.01	12 hours	0.380	6262	0.400	0.368
201.01	12 hours	0.900	6262	0.940	0.865
202.01	12 hours	8.58	6266	8.75	8.05
203.01	12 hours	1.28	6262	1.33	1.22
204.01	12 hours	0.890	6262	0.930	0.856
205.01	12 hours	1.13	6262	1.18	1.09
206.01	12 hours	0.290	6261	0.300	0.276
207.01	12 hours	1.06	6262	1.13	1.04
208.01	12 hours	1.54	6262	1.63	1.50
208.02	12 hours	2.15	6262	2.28	2.10
208.03	12 hours	4.03	6262	4.31	3.97
208.04	12 hours	8.10	6261	8.39	7.72
208.05	12 hours	10.3	6261	10.8	9.94
208.06	18 hours	12.9	6350	13.1	12.0
209.01	12 hours	0.280	6261	0.280	0.258
210.01	12 hours	0.530	6262	0.570	0.524
211.01	12 hours	0.560	6262	0.590	0.543
211.02	12 hours	0.650	6262	0.680	0.626

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
211.03	12 hours	2.30	6262	2.46	2.26
212.01	12 hours	0.260	6261	0.280	0.258
_junc_10	12 hours	54.7	6261	55.2	50.8
_junc_108	12 hours	0.980	6262	1.04	0.957
_junc_11	12 hours	868	6261	879	809
_junc_111	12 hours	5.69	6262	6.02	5.54
_junc_114	12 hours	3.51	6261	3.54	3.26
_junc_12	12 hours	26.7	6262	26.8	24.6
_junc_13	12 hours	266	6261	268	246
_junc_138	12 hours	18.1	6262	18.6	17.1
_junc_14	12 hours	226	6261	228	210
_junc_142	12 hours	14.1	6266	14.2	13.1
_junc_143	12 hours	424	6261	428	393
_junc_15	12 hours	809	6261	819	754
_junc_16	12 hours	884	6261	896	824
_junc_165	12 hours	59.8	6266	62.3	57.3
_junc_168	12 hours	55.8	6262	55.9	51.4
_junc_17	12 hours	252	6261	255	234
_junc_174	12 hours	40.2	6262	40.4	37.1
_junc_18	18 hours	101	6355	103	94.9
_junc_181	12 hours	0.160	6261	0.160	0.147
_junc_185	12 hours	0.180	6261	0.180	0.166
_junc_186	12 hours	0.530	6262	0.570	0.524
_junc_187	12 hours	4.53	6266	4.81	4.43
_junc_19	12 hours	349	6261	352	324
_junc_193	12 hours	19.6	6266	20.1	18.5
_junc_194	12 hours	28.0	6266	28.7	26.4
_junc_199	12 hours	33.9	6266	34.1	31.4
_junc_2	12 hours	407	6261	409	376
_junc_20	12 hours	292	6261	294	271
_junc_204	12 hours	15.1	6262	15.2	14.0
_junc_21	12 hours	316	6261	318	293
_junc_22	12 hours	901	6261	914	841
_junc_228	12 hours	0.900	6262	0.960	0.883
_junc_23	12 hours	913	6261	926	852
_junc_231	12 hours	371	6261	376	346
_junc_232	12 hours	45.9	6262	46.3	42.6
_junc_233	12 hours	65.3	6266	66.8	61.4
_junc_234	12 hours	875	6261	876	806
_junc_24	12 hours	54.8	6262	54.8	50.4
_junc_25	12 hours	45.3	6261	46.3	42.6
_junc_26	12 hours	37.1	6262	37.2	34.2
_junc_263	12 hours	21.4	6262	21.5	19.7
_junc_265	12 hours	21.0	6266	21.4	19.7
_junc_27	12 hours	22.6	6262	22.7	20.9
_junc_28	12 hours	989	6261	1005	924
_junc_29	12 hours	985	6261	1001	921
_junc_3	12 hours	36.9	6261	37.3	34.3
_junc_30	12 hours	994	6261	1010	929
_junc_31	12 hours	28.3	6266	29.0	26.6

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_32	12 hours	1008	6261	1025	943
_junc_324	12 hours	885	6261	886	815
_junc_328	12 hours	1029	6262	1030	947
_junc_329	12 hours	60.2	6261	61.1	56.2
_junc_33	12 hours	27.6	6262	28.2	25.9
_junc_330	12 hours	122	6261	123	113
_junc_331	12 hours	2156	6261	2162	1989
_junc_34	12 hours	44.7	6262	45.3	41.7
_junc_35	12 hours	15.2	6266	15.8	14.5
_junc_36	12 hours	860	6261	861	792
_junc_37	12 hours	32.8	6262	33.0	30.3
_junc_38	12 hours	25.6	6262	26.5	24.4
_junc_39	12 hours	955	6261	956	879
_junc_4	12 hours	37.1	6266	37.2	34.2
_junc_40	12 hours	46.9	6262	47.1	43.3
_junc_41	12 hours	28.2	6266	28.2	25.9
_junc_42	12 hours	54.1	6266	54.4	50.1
_junc_43	12 hours	137	6266	138	127
_junc_44	12 hours	895	6261	896	824
_junc_45	12 hours	801	6261	802	738
_junc_46	12 hours	69.4	6262	69.8	64.2
_junc_47	12 hours	906	6261	907	835
_junc_48	12 hours	660	6262	661	608
_junc_49	12 hours	31.7	6266	32.8	30.2
_junc_5	12 hours	31.5	6262	32.2	29.6
_junc_50	12 hours	102	6262	103	94.6
_junc_51	12 hours	646	6262	646	594
_junc_52	12 hours	117	6261	117	108
_junc_53	12 hours	32.6	6262	32.6	30.0
_junc_54	12 hours	162	6266	164	151
_junc_55	12 hours	183	6266	185	170
_junc_56	12 hours	592	6261	593	545
_junc_57	12 hours	246	6261	246	227
_junc_58	12 hours	561	6261	562	517
_junc_59	12 hours	525	6266	530	488
_junc_6	12 hours	105	6266	105	96.7
_junc_60	12 hours	548	6261	548	504
_junc_61	12 hours	51.1	6266	51.2	47.1
_junc_62	12 hours	248	6266	249	229
_junc_63	12 hours	220	6266	221	204
_junc_64	12 hours	99.8	6262	101	93.2
_junc_65	12 hours	28.1	6266	28.2	25.9
_junc_66	12 hours	188	6266	189	174
_junc_67	12 hours	112	6262	113	104
_junc_68	12 hours	79.5	6262	81.5	75.0
_junc_69	12 hours	59.4	6266	59.5	54.7
_junc_7	12 hours	121	6266	121	111
_junc_70	12 hours	45.3	6266	45.4	41.8
_junc_71	12 hours	39.8	6262	40.1	36.9
_junc_72	12 hours	69.1	6262	69.2	63.7

Subcatchment	Critical Duration	Average Discharge (m^3/s)	Adopted TP ID	Raw Discharge (m^3/s)	Factored Discharge (m^3/s)
_junc_73	12 hours	32.2	6262	32.7	30.1
_junc_74	12 hours	21.2	6262	21.3	19.6
_junc_75	18 hours	69.6	6350	70.3	64.6
_junc_76	12 hours	26.4	6266	26.6	24.4
_junc_77	12 hours	64.7	6266	64.9	59.7
_junc_78	12 hours	80.1	6266	80.4	74.0
_junc_79	12 hours	91.4	6262	91.9	84.5
_junc_8	12 hours	45.8	6262	46.9	43.2
_junc_80	12 hours	36.5	6262	37.5	34.5
_junc_81	12 hours	175	6261	177	163
_junc_82	12 hours	39.5	6266	40.0	36.8
_junc_83	12 hours	31.9	6261	32.2	29.6
_junc_84	12 hours	216	6261	217	200
_junc_85	12 hours	42.9	6261	43.2	39.7
_junc_86	12 hours	267	6261	268	247
_junc_87	12 hours	92.8	6266	94.2	86.7
_junc_88	12 hours	101	6266	103	94.8
_junc_89	12 hours	245	6261	246	226
_junc_9	12 hours	61.2	6262	61.8	56.8
_junc_90	12 hours	393	6261	395	364
_junc_91	12 hours	27.3	6261	27.7	25.5

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
1.01	4 hours	72.7
1.02	3 hours	96.3
1.03	3 hours	137
1.04	3 hours	194
1.05	3 hours	249
1.06	3 hours	255
1.07	4 hours	301
1.08	4 hours	329
1.09	4 hours	339
1.1	4 hours	537
1.11	4 hours	658
1.12	4 hours	733
1.13	4 hours	1571
1.14	4 hours	1638
1.15	4 hours	1641
1.16	4 hours	1672
1.17	4 hours	1811
1.18	4 hours	1979
1.19	4 hours	2022
1.2	4 hours	2625
1.21	4 hours	2644
1.22	4 hours	2867
1.23	4 hours	2918
1.24	4 hours	2919
1.25	4 hours	2932
1.26	4 hours	2963
1.27	4 hours	2992
1.28	4 hours	2994
1.29	4 hours	3153
1.3	4 hours	3161
1.31	4 hours	3375
1.32	4 hours	3375
1.33	4 hours	6176
1.34	4 hours	6179
1.35	4 hours	6452
1.36	4 hours	6453
1.37	4 hours	6453
1.38	4 hours	6454
1.39	4 hours	6471
1.4	4 hours	6497
2.01	3 hours	21.7
3.01	3 hours	36.1
4.01	4 hours	36.3
5.01	3 hours	38.7
6.01	4 hours	36.6
7.01	4 hours	23.2
8.01	4 hours	55.4
8.02	4 hours	117
8.03	4 hours	118

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
8.04	4 hours	179
8.05	4 hours	185
9.01	4 hours	39.8
10.01	4 hours	27.0
10.02	4 hours	62.9
11.01	4 hours	35.6
12.01	3 hours	34.8
12.02	3 hours	60.2
12.03	3 hours	94.5
13.01	2 hours	13.1
14.01	4 hours	26.9
14.02	3 hours	32.8
15.01	1.50 hour	6.58
16.01	4 hours	29.5
16.02	4 hours	46.4
17.01	4 hours	48.2
17.02	4 hours	120
17.03	4 hours	156
17.04	4 hours	214
17.05	4 hours	262
17.06	4 hours	323
17.07	4 hours	381
17.08	4 hours	528
17.09	4 hours	543
17.1	4 hours	584
17.11	4 hours	795
17.12	4 hours	810
17.13	4 hours	818
18.01	4 hours	50.5
19.01	4 hours	24.6
20.01	5 hours	50.9
21.01	5 hours	42.9
21.02	4 hours	48.0
22.01	3 hours	51.5
23.01	4 hours	29.4
23.02	4 hours	94.9
23.03	4 hours	133
23.04	4 hours	135
24.01	4 hours	37.2
25.01	2 hours	17.8
26.01	4 hours	40.4
26.02	4 hours	40.9
27.01	4 hours	46.9
27.02	4 hours	103
27.03	4 hours	172
28.01	2 hours	13.1
28.02	2 hours	17.7
29.01	4 hours	40.8
30.01	3 hours	18.6

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
31.01	3 hours	13.0
32.01	4 hours	52.9
33.01	4 hours	27.3
34.01	4 hours	40.5
34.02	3 hours	109
34.03	3 hours	111
35.01	4 hours	35.5
35.02	5 hours	67.3
35.03	5 hours	91.1
35.04	5 hours	92.1
35.05	4 hours	152
36.01	2 hours	5.38
37.01	4 hours	33.9
38.01	5 hours	34.7
38.02	4 hours	42.4
39.01	4 hours	35.4
39.02	3 hours	84.3
39.03	3 hours	129
39.04	3 hours	251
39.05	3 hours	326
39.06	4 hours	629
40.01	2 hours	28.4
41.01	2 hours	36.3
42.01	4 hours	58.2
43.01	3 hours	24.9
44.01	3 hours	70.3
44.02	3 hours	180
44.03	4 hours	278
45.01	3 hours	51.9
46.01	5 hours	67.5
47.01	3 hours	58.5
47.02	3 hours	82.8
47.03	3 hours	90.2
47.04	3 hours	183
47.05	3 hours	240
48.01	3 hours	23.2
49.01	3 hours	38.4
49.02	3 hours	43.5
49.03	3 hours	43.9
50.01	1.50 hour	8.29
51.01	3 hours	22.7
52.01	2 hours	11.4
52.02	3 hours	24.0
53.01	4 hours	31.5
54.01	3 hours	13.1
54.02	3 hours	19.3
54.03	3 hours	21.5
55.01	3 hours	17.3
56.01	3 hours	23.5

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
56.02	3 hours	36.5
56.03	3 hours	42.2
57.01	3 hours	17.8
57.02	3 hours	32.3
58.01	3 hours	30.3
58.02	3 hours	43.3
58.03	3 hours	62.0
58.04	3 hours	111
58.05	3 hours	116
58.06	3 hours	162
58.07	3 hours	181
59.01	3 hours	14.1
60.01	2 hours	16.5
60.02	2 hours	21.1
60.03	3 hours	40.1
61.01	3 hours	11.8
62.01	2 hours	2.73
63.01	30 min	0.360
64.01	2 hours	7.83
64.02	3 hours	38.9
65.01	2.50 hours	4.45
66.01	1.50 hour	6.39
66.02	3 hours	17.5
67.01	30 min	1.58
68.01	30 min	2.55
69.01	30 min	2.62
69.02	30 min	4.06
70.01	30 min	1.83
71.01	30 min	2.12
72.01	30 min	2.44
73.01	30 min	1.86
74.01	3 hours	8.93
75.01	6 hours	3.09
75.02	6 hours	3.79
76.01	3 hours	6.51
76.02	3 hours	6.84
77.01	3 hours	17.1
77.02	3 hours	38.2
77.03	3 hours	63.8
77.04	3 hours	71.7
77.05	3 hours	76.4
77.06	3 hours	77.4
77.07	3 hours	151
77.08	3 hours	153
77.09	3 hours	154
77.1	3 hours	156
77.11	3 hours	175
77.12	3 hours	189
77.13	3 hours	217

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
78.01	3 hours	15.2
78.02	3 hours	35.2
79.01	2 hours	11.4
80.01	1.50 hour	5.41
81.01	3 hours	9.68
81.02	3 hours	10.7
81.03	3 hours	21.5
81.04	1.50 hour	39.8
82.01	1.50 hour	2.74
82.02	2 hours	9.12
82.03	1.50 hour	10.5
83.01	2 hours	6.96
83.02	1.50 hour	14.2
83.03	1.50 hour	15.7
84.01	45 min	1.62
84.02	1.50 hour	5.61
85.01	1.50 hour	3.05
86.01	30 min	0.610
87.01	1.50 hour	2.38
87.02	45 min	4.50
88.01	45 min	1.05
89.01	1.50 hour	1.29
90.01	1.50 hour	0.900
91.01	15 min	2.49
92.01	3 hours	3.05
92.02	4 hours	11.8
92.03	4 hours	12.4
92.04	3 hours	18.0
93.01	1.50 hour	1.35
94.01	45 min	1.70
95.01	45 min	2.07
96.01	45 min	0.980
97.01	45 min	1.06
98.01	1.50 hour	2.52
99.01	4 hours	9.38
99.02	4 hours	12.4
100.01	45 min	0.520
101.01	30 min	0.460
102.01	45 min	0.660
103.01	30 min	0.530
104.01	1.50 hour	1.25
104.02	1.50 hour	3.22
105.01	30 min	0.420
106.01	6 hours	14.9
106.02	4 hours	23.7
107.01	3 hours	10.7
108.01	4 hours	6.01
108.02	4 hours	6.13
109.01	3 hours	15.5

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
110.01	3 hours	9.99
111.01	1.50 hour	5.78
112.01	1.50 hour	4.49
113.01	45 min	2.29
114.01	4 hours	46.9
114.02	4 hours	71.7
114.03	4 hours	134
114.04	4 hours	214
114.05	4 hours	269
114.06	4 hours	660
114.07	4 hours	729
114.08	4 hours	798
114.09	4 hours	820
114.1	4 hours	877
114.11	4 hours	954
114.12	4 hours	970
114.13	4 hours	1092
114.14	4 hours	1137
114.15	4 hours	1142
114.16	4 hours	2295
114.17	4 hours	2445
114.18	4 hours	2487
114.19	4 hours	2504
114.2	4 hours	2530
114.21	4 hours	2748
114.22	4 hours	2775
114.23	4 hours	2782
114.24	4 hours	2804
114.25	4 hours	2844
115.01	4 hours	22.7
116.01	4 hours	38.9
117.01	3 hours	34.7
118.01	6 hours	58.6
119.01	4 hours	67.3
119.02	4 hours	111
119.03	4 hours	321
119.04	4 hours	377
120.01	4 hours	31.0
121.01	3 hours	44.3
121.02	4 hours	113
121.03	4 hours	148
121.04	4 hours	195
122.01	4 hours	52.3
123.01	3 hours	28.2
124.01	4 hours	38.4
125.01	3 hours	38.0
126.01	5 hours	67.9
127.01	3 hours	44.7
128.01	3 hours	45.3

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
129.01	3 hours	39.4
129.02	3 hours	76.2
129.03	3 hours	98.7
130.01	3 hours	25.9
131.01	2 hours	16.9
131.02	4 hours	52.3
131.03	4 hours	82.8
132.01	3 hours	29.1
133.01	4 hours	58.8
133.02	3 hours	131
133.03	4 hours	202
133.04	4 hours	231
133.05	4 hours	293
133.06	4 hours	294
133.07	4 hours	482
133.08	4 hours	486
133.09	4 hours	595
133.1	4 hours	665
133.11	4 hours	755
133.12	4 hours	1055
133.13	4 hours	1115
133.14	4 hours	1138
134.01	3 hours	47.7
135.01	4 hours	49.3
136.01	3 hours	24.8
137.01	3 hours	28.8
138.01	6 hours	67.1
138.02	6 hours	85.7
138.03	4 hours	158
139.01	4 hours	36.0
139.02	4 hours	67.3
140.01	1.50 hour	6.13
141.01	4 hours	63.1
141.02	4 hours	75.1
142.01	2 hours	10.8
143.01	3 hours	59.3
144.01	4 hours	46.4
145.01	3 hours	34.2
145.02	4 hours	85.7
145.03	4 hours	135
145.04	4 hours	256
145.05	4 hours	257
145.06	4 hours	302
146.01	4 hours	38.3
147.01	3 hours	27.8
148.01	4 hours	54.5
148.02	4 hours	86.4
148.03	4 hours	120
149.01	4 hours	29.0

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
150.01	4 hours	28.4
151.01	3 hours	26.4
152.01	2 hours	12.7
153.01	3 hours	38.0
154.01	3 hours	17.5
154.02	3 hours	22.7
155.01	6 hours	41.6
155.02	6 hours	42.0
155.03	4 hours	73.9
155.04	4 hours	77.0
155.05	4 hours	127
155.06	4 hours	152
156.01	4 hours	27.7
156.02	4 hours	28.7
157.01	4 hours	20.6
158.01	4 hours	11.7
159.01	3 hours	12.1
160.01	4 hours	22.4
160.02	4 hours	23.9
161.01	4 hours	38.6
162.01	1.50 hour	5.57
162.02	4 hours	24.3
162.03	4 hours	24.6
163.01	1.50 hour	9.83
163.02	2 hours	25.5
163.03	3 hours	63.9
163.04	4 hours	90.2
163.05	5 hours	179
163.06	5 hours	185
164.01	6 hours	62.7
165.01	5 hours	27.6
165.02	5 hours	31.4
166.01	3 hours	9.98
166.02	3 hours	19.4
166.03	4 hours	31.0
167.01	2 hours	9.37
167.02	2 hours	17.0
168.01	3 hours	22.4
168.02	3 hours	22.5
169.01	4 hours	36.9
169.02	3 hours	41.5
170.01	2 hours	7.04
171.01	3 hours	7.25
172.01	1.50 hour	5.22
173.01	2 hours	8.75
173.02	4 hours	52.4
173.03	4 hours	103
173.04	4 hours	111
173.05	4 hours	138

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
173.06	4 hours	170
173.07	4 hours	324
174.01	1.50 hour	7.49
175.01	2 hours	5.41
176.01	1.50 hour	5.49
176.02	3 hours	23.6
177.01	6 hours	11.5
178.01	4 hours	11.7
179.01	3 hours	2.50
180.01	6 hours	13.2
180.02	6 hours	14.1
181.01	4 hours	12.2
182.01	1.50 hour	2.64
183.01	3 hours	23.0
183.02	3 hours	40.5
183.03	3 hours	67.7
183.04	3 hours	104
183.05	3 hours	109
183.06	4 hours	156
184.01	1.50 hour	4.58
184.02	4 hours	21.3
185.01	1.50 hour	6.62
185.02	3 hours	20.2
186.01	3 hours	10.3
187.01	3 hours	10.9
187.02	3 hours	19.9
188.01	1.50 hour	4.58
189.01	1.50 hour	5.01
190.01	1.50 hour	3.28
191.01	3 hours	7.27
192.01	1.50 hour	11.5
193.01	1.50 hour	9.59
194.01	45 min	1.83
195.01	1.50 hour	3.33
196.01	1.50 hour	3.65
197.01	45 min	3.08
198.01	1.50 hour	4.30
199.01	2 hours	7.72
199.02	2 hours	10.4
200.01	45 min	1.91
201.01	1.50 hour	4.04
202.01	4 hours	18.8
203.01	1.50 hour	5.63
204.01	45 min	4.23
205.01	45 min	5.15
206.01	45 min	1.55
207.01	45 min	4.94
208.01	1.50 hour	6.06
208.02	1.50 hour	8.16

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
208.03	2 hours	13.8
208.04	3 hours	21.6
208.05	3 hours	25.4
208.06	4 hours	28.8
209.01	45 min	1.41
210.01	1.50 hour	2.31
211.01	1.50 hour	2.45
211.02	1.50 hour	2.85
211.03	1.50 hour	7.66
212.01	30 min	1.58
_junc_10	4 hours	151
_junc_108	1.50 hour	4.58
_junc_11	4 hours	2440
_junc_111	3 hours	20.9
_junc_114	4 hours	9.38
_junc_12	3 hours	75.6
_junc_13	4 hours	771
_junc_138	3 hours	81.8
_junc_14	4 hours	638
_junc_142	3 hours	64.8
_junc_143	4 hours	1130
_junc_15	4 hours	2277
_junc_16	4 hours	2483
_junc_165	3 hours	195
_junc_168	3 hours	186
_junc_17	4 hours	727
_junc_174	3 hours	152
_junc_18	4 hours	268
_junc_181	30 min	0.970
_junc_185	45 min	0.980
_junc_186	45 min	2.71
_junc_187	4 hours	13.4
_junc_19	4 hours	1053
_junc_193	3 hours	61.1
_junc_194	3 hours	87.8
_junc_199	4 hours	108
_junc_2	4 hours	1088
_junc_20	4 hours	860
_junc_204	3 hours	56.8
_junc_21	4 hours	950
_junc_22	4 hours	2527
_junc_228	45 min	3.95
_junc_23	4 hours	2561
_junc_231	4 hours	1112
_junc_232	3 hours	205
_junc_233	3 hours	274
_junc_234	4 hours	2895
_junc_24	4 hours	167
_junc_25	5 hours	148

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
_junc_26	4 hours	110
_junc_263	4 hours	66.5
_junc_265	4 hours	60.2
_junc_27	4 hours	69.2
_junc_28	4 hours	2782
_junc_29	4 hours	2774
_junc_3	4 hours	97.3
_junc_30	4 hours	2796
_junc_31	3 hours	134
_junc_32	4 hours	2835
_junc_324	4 hours	2929
_junc_328	4 hours	3360
_junc_329	4 hours	151
_junc_33	3 hours	116
_junc_330	4 hours	323
_junc_331	4 hours	6451
_junc_34	3 hours	186
_junc_35	3 hours	57.5
_junc_36	4 hours	2838
_junc_37	4 hours	98.2
_junc_38	3 hours	122
_junc_39	4 hours	3147
_junc_4	4 hours	97.1
_junc_40	4 hours	144
_junc_41	3 hours	111
_junc_42	4 hours	244
_junc_43	4 hours	602
_junc_44	4 hours	2961
_junc_45	4 hours	2606
_junc_46	4 hours	205
_junc_47	4 hours	2991
_junc_48	4 hours	2017
_junc_49	3 hours	113
_junc_5	4 hours	96.1
_junc_50	4 hours	310
_junc_51	4 hours	1958
_junc_52	4 hours	365
_junc_53	4 hours	125
_junc_54	4 hours	514
_junc_55	4 hours	583
_junc_56	4 hours	1763
_junc_57	4 hours	754
_junc_58	4 hours	1667
_junc_59	4 hours	1551
_junc_6	4 hours	305
_junc_60	4 hours	1624
_junc_61	4 hours	144
_junc_62	4 hours	704
_junc_63	4 hours	623

PMF XP-RAFTS ARR 2019 Peak Flows		
Subcatchment	Critical Duration	Adopted Discharge (m3/s)
_junc_64	4 hours	289
_junc_65	3 hours	92.9
_junc_66	4 hours	523
_junc_67	4 hours	323
_junc_68	3 hours	233
_junc_69	3 hours	173
_junc_7	4 hours	358
_junc_70	3 hours	132
_junc_71	4 hours	94.1
_junc_72	4 hours	177
_junc_73	3 hours	92.4
_junc_74	4 hours	62.6
_junc_75	4 hours	150
_junc_76	4 hours	70.7
_junc_77	4 hours	178
_junc_78	4 hours	223
_junc_79	4 hours	259
_junc_8	4 hours	141
_junc_80	4 hours	106
_junc_81	4 hours	446
_junc_82	4 hours	111
_junc_83	4 hours	81.8
_junc_84	4 hours	557
_junc_85	4 hours	115
_junc_86	4 hours	708
_junc_87	4 hours	255
_junc_88	4 hours	282
_junc_89	4 hours	644
_junc_9	4 hours	186
_junc_90	4 hours	1043
_junc_91	4 hours	69.6

APPENDIX I

HYDRAULIC CATEGORY VERIFICATION

HYDRAULIC CATEGORY VERIFICATION

Floodway

By definition, a floodway is an area that if only partially blocked would produce a significant impact on upstream water levels (NSW Government, 2005). Accordingly, the suitability of the delineated floodways was verified by partially blocking the floodways at various locations and quantifying the impact that this blockage had on peak 1% AEP flood levels. This approach is in accordance with recommendations outlined in the Office of Environment and Heritage's 'Floodway Definition' guideline (2007).

The TUFLOW hydraulic model was updated to include partial blockage of the delineated floodways at several locations across the catchment and was re-run for the 1% AEP event. The peak 1% AEP flood levels from the partly obstructed floodway models runs were compared against 'existing' 1% AEP flood levels to create flood level difference maps (i.e., maps showing the location and magnitude of changes in flood level). The difference maps are shown in **Plate I1** to **Plate I4**.

Plate I1 to **Plate I4** show that the obstructions increase peak 1% AEP flood levels by at least 0.2 metres upstream of each blockage location. In some areas, the flood level increases approach 0.4 metres. This is considered to be a 'significant impact' on upstream water levels.

Overall, the partial blockage of the delineated floodways is predicted to produce significant impacts on upstream water levels. Therefore, it is considered that the delineated floodway extents conform to the *'Floodplain Development Manual'* definitions and are suitable for application across the catchment.

Flood Storage

Flood storage areas are important for the temporary storage of floodwaters during the passage of a flood. They are areas that, if filled/removed, would result in flood levels in nearby areas increasing.

To confirm the suitability of the flood storage areas, all flood storage areas were assigned a high Manning's "n" value of 1.0. This will still allow water to be "stored" but will inhibit the conveyance of water. Therefore, it will assist in confirming that they are storage areas and not flow conveyance/floodway areas. Flood Fringe areas were also assigned a high roughness as part of the flood storage assessment.

The updated model was used to re-simulate the 1% AEP flood. Peak 1% AEP flood levels were compared against 'existing' 1% AEP flood levels and the resulting difference mapping is shown in **Plate I5** for the most extensive flood storage area located south of Pambula.

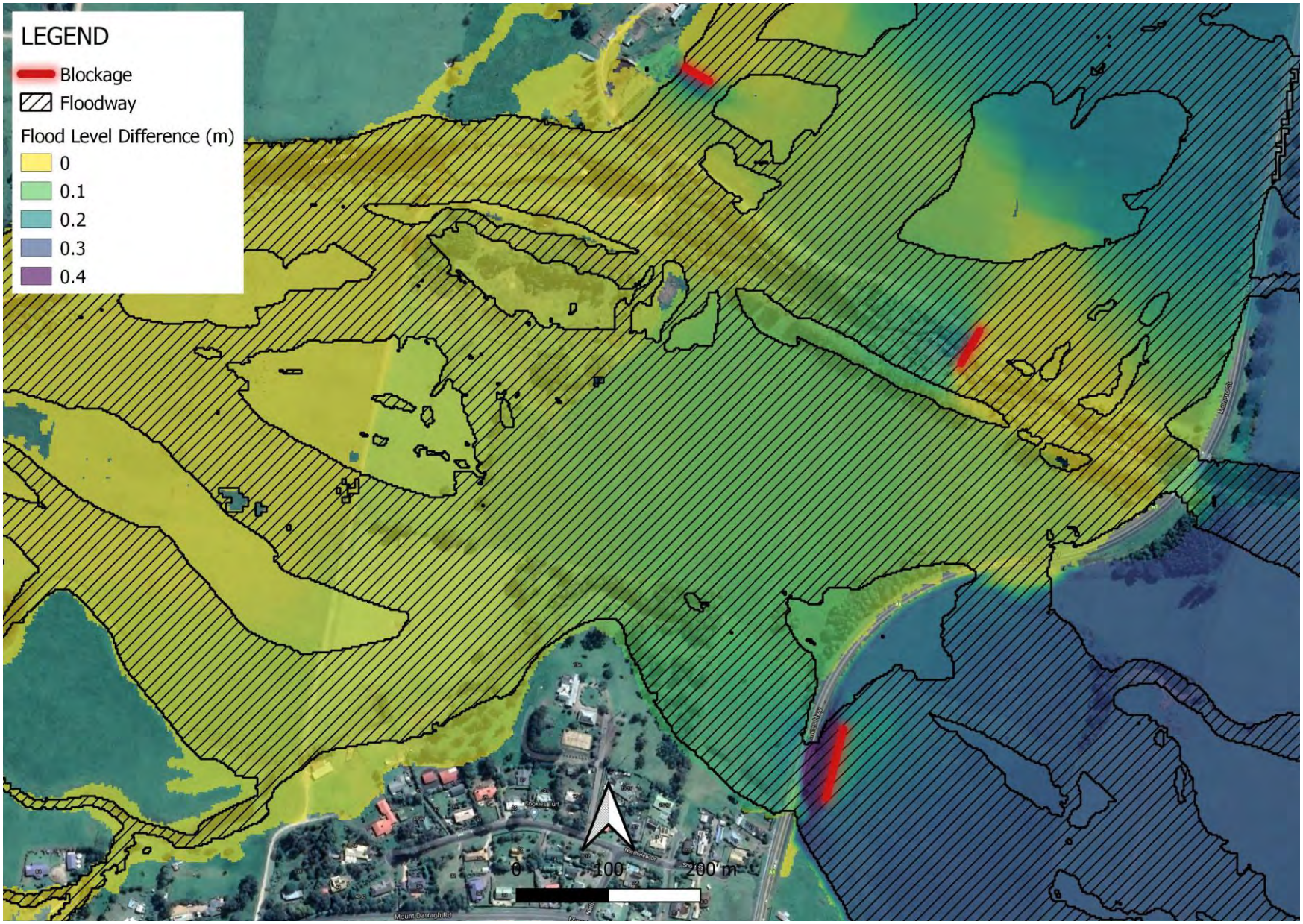


Plate I1 1% AEP Flood Level Differences associated with partial obstruction of floodways in the vicinity of South Pambula

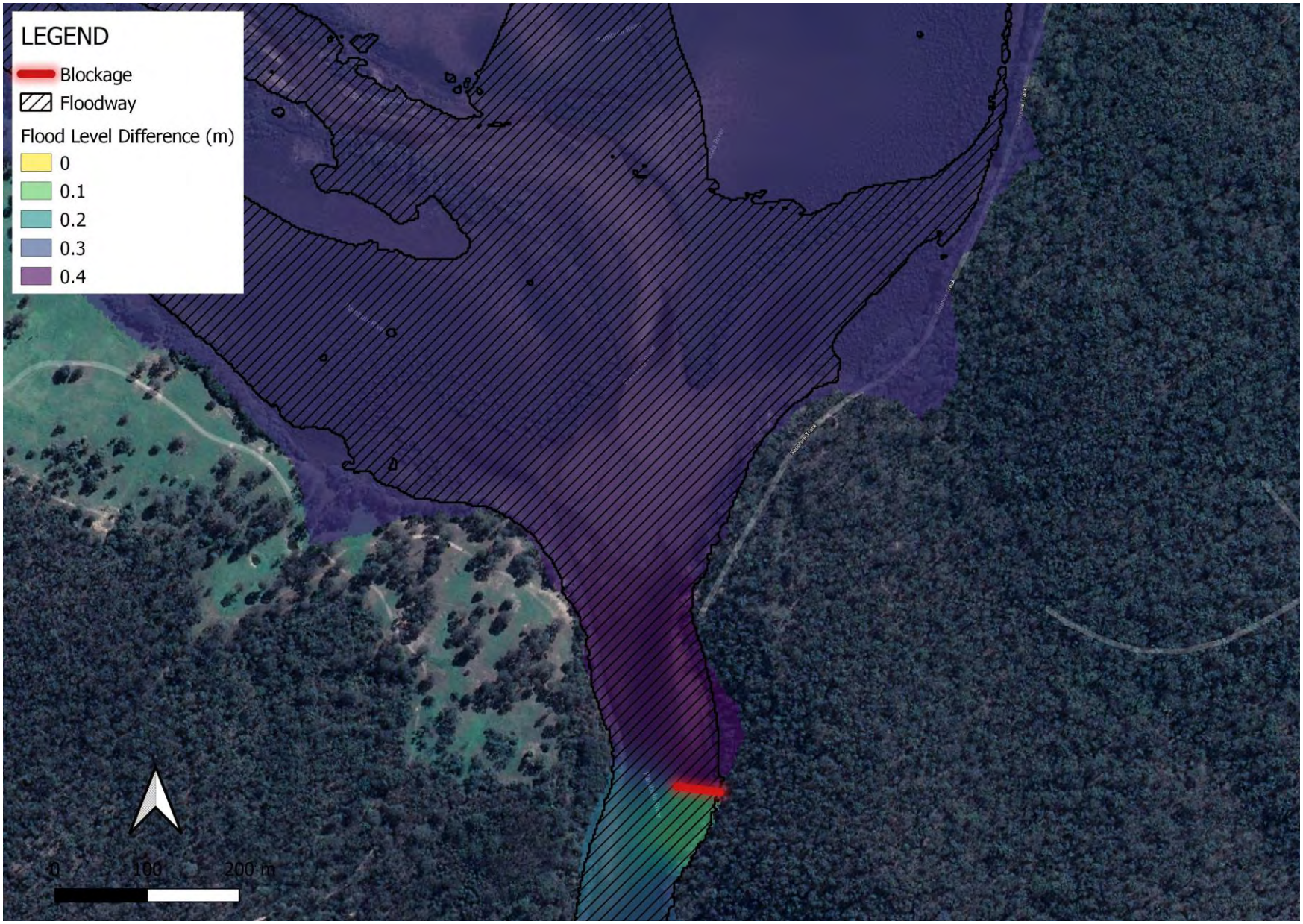


Plate I2 **1% AEP Flood Level Differences for Pambula River associated with obstruction of floodway upstream of the Yowaka River confluence**

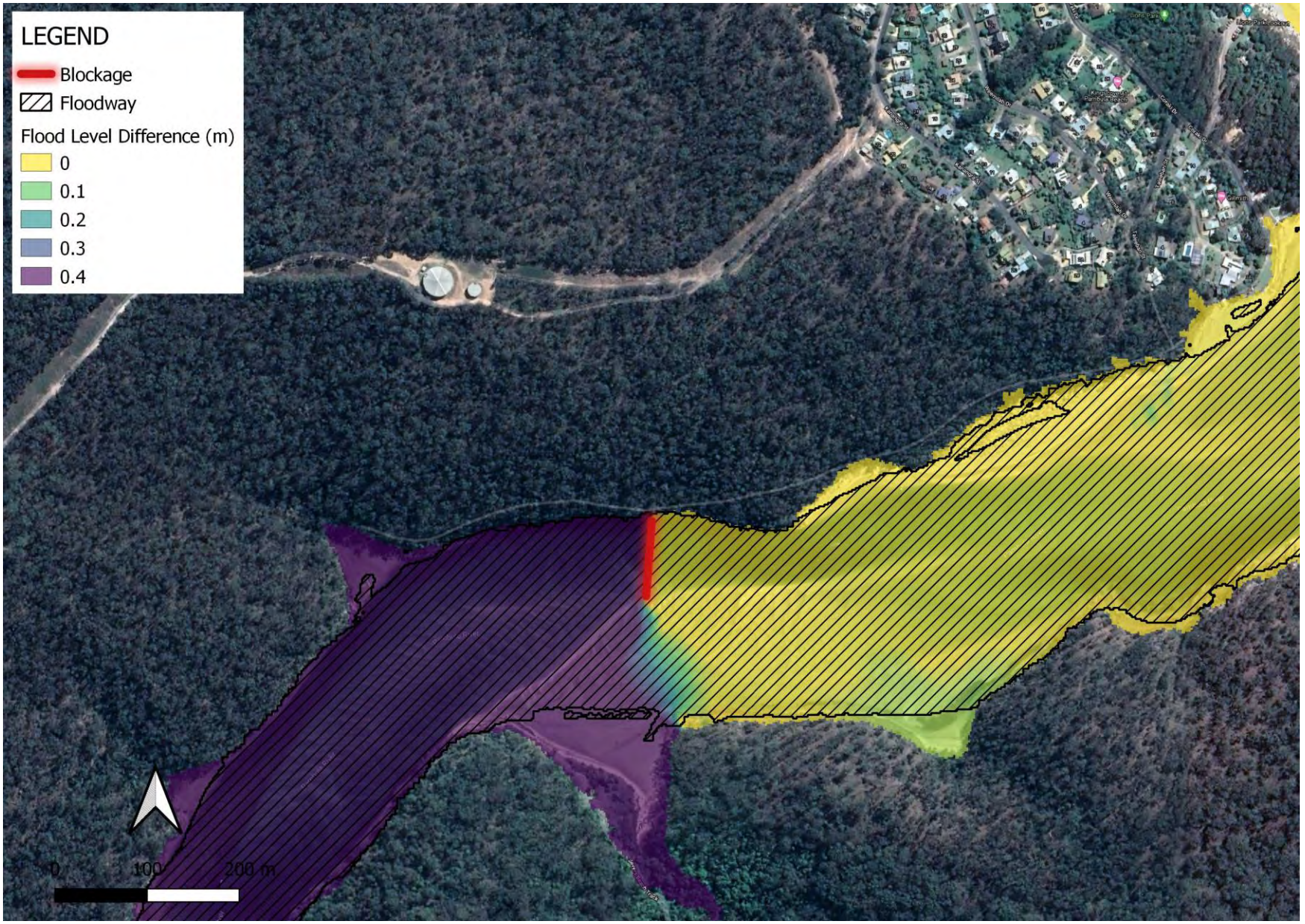


Plate I3 **1% AEP Flood Level Differences associated with obstruction of floodway along lower Pambula River**

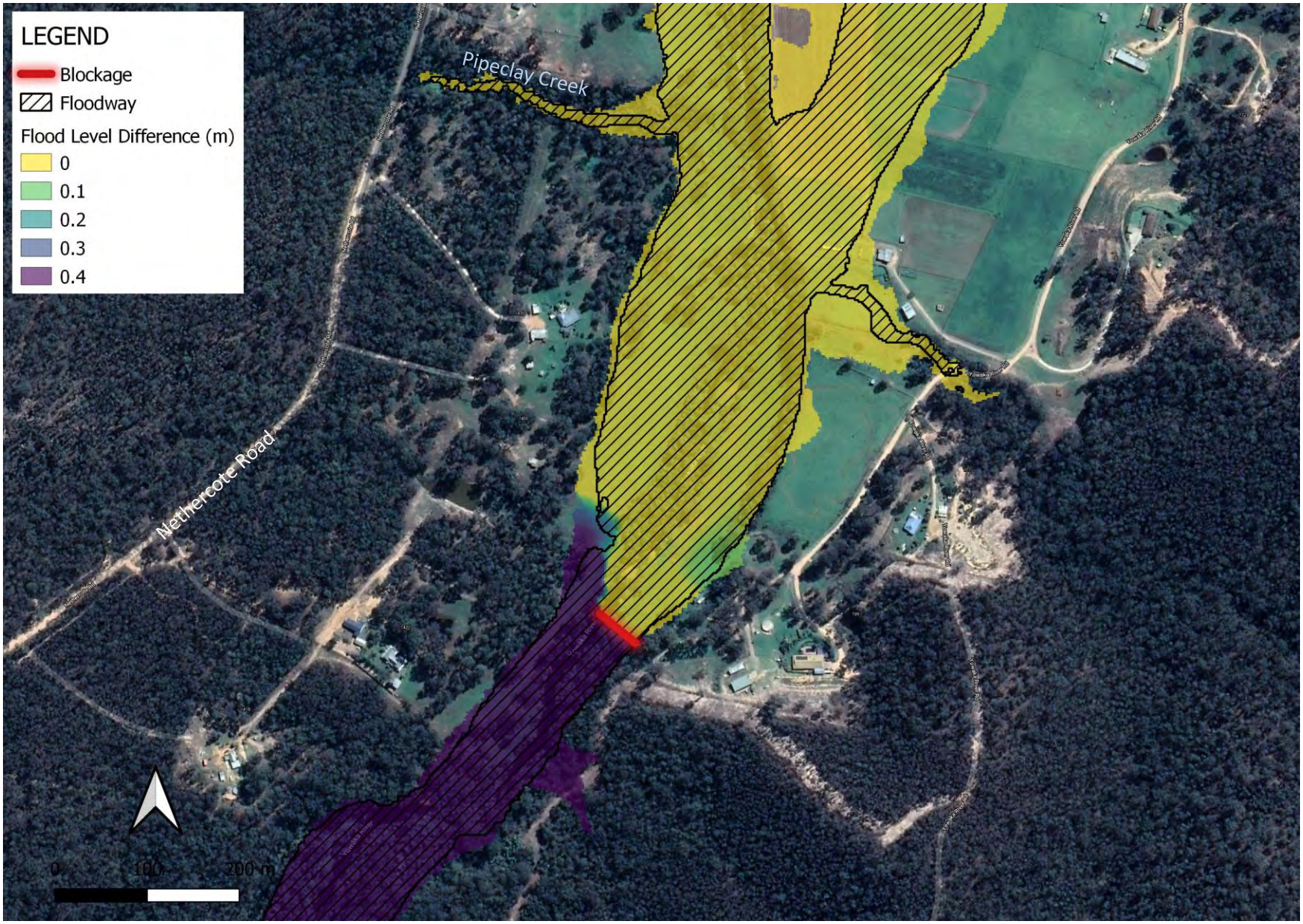


Plate I4 **1% AEP Flood Level Differences associated with obstruction of floodway along Yowaka River south of Griegs Flat**

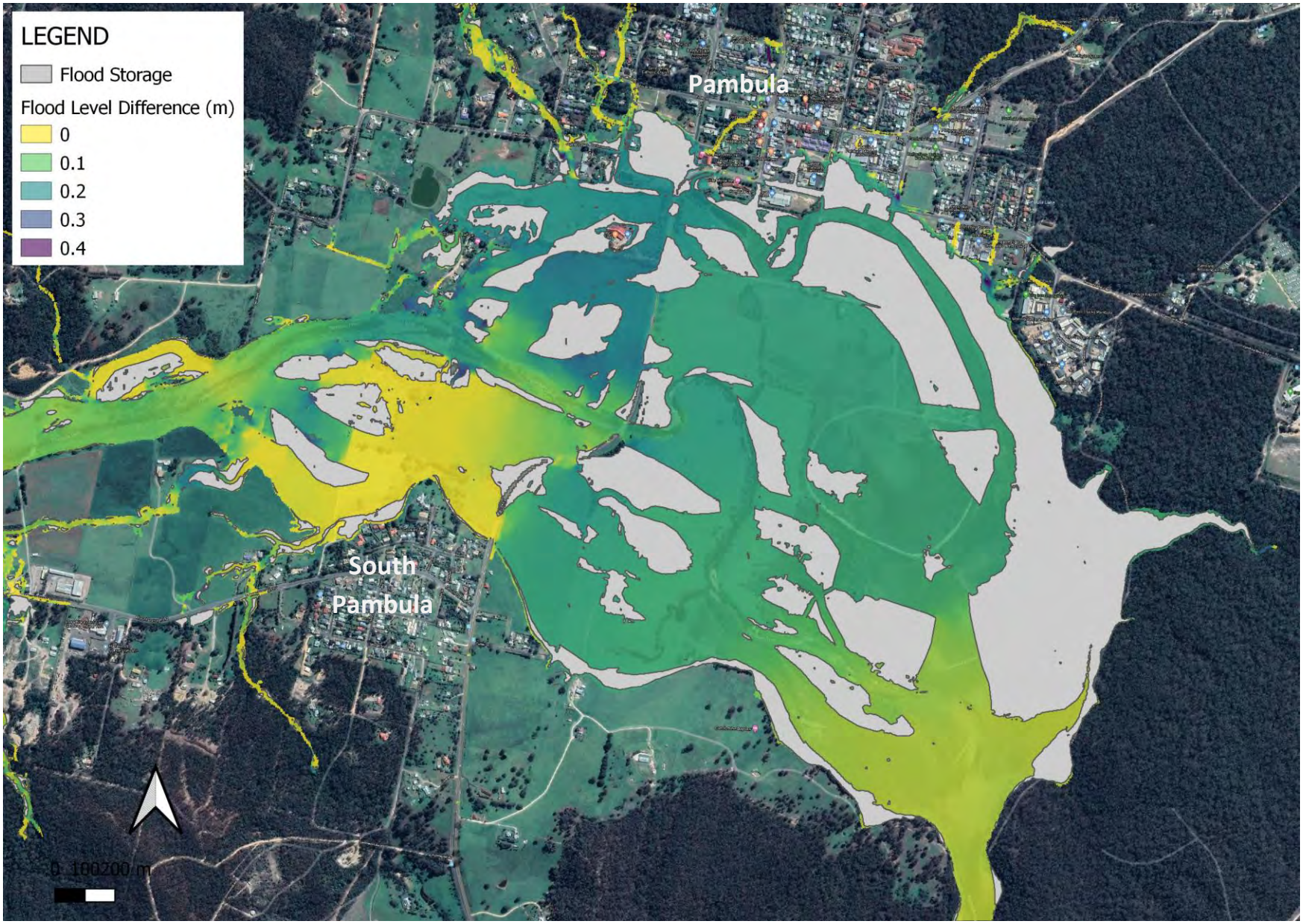


Plate I5 **1% AEP flood Level differences associated with filling across Flood Storage and Flood Fringe Areas south of Pambula.**

The difference map show that removal of all flood storage areas would increase peak 1% AEP flood levels by at least 0.05 metres, but more commonly between 0.1 and 0.2 metres. Accordingly, the impacts of filling of storage areas are predicted to be less significant than the partial floodway obstruction. Nevertheless, these flood level impacts are still considered to be "significant" indicating that the "filled" areas are affording important storage across the catchment.

Accordingly, it is considered that the extent of the delineated flood storages is appropriate and suitable for application across the catchment.

Flood Fringe

Flood Fringe areas are the remaining sections of flood-affected land after floodway and flood storage areas have been defined. They are areas that, if filled, would not have a significant impact on the pattern of flood flow and/or flood levels. Accordingly, verification of the delineated flood fringe extents was completed by filling all flood fringe areas, re-running the 1% AEP event and quantifying the impact that the filling had on flood behaviour.

Flood level difference mapping was prepared for select locations and is shown in **Plate I6** to **Plate I7**.

The difference mapping shows that filling of all flood fringe areas will increase peak flood level by less than 0.1 metres at all locations. This is considered to be a relatively minor impact on peak flood levels. That is, filling of flood fringe areas is not predicted to have any significant impact on flooding and indicates that the delineated flood fringe extents conform to the *'Floodplain Development Manual'* definitions and are suitable for application across the catchment.

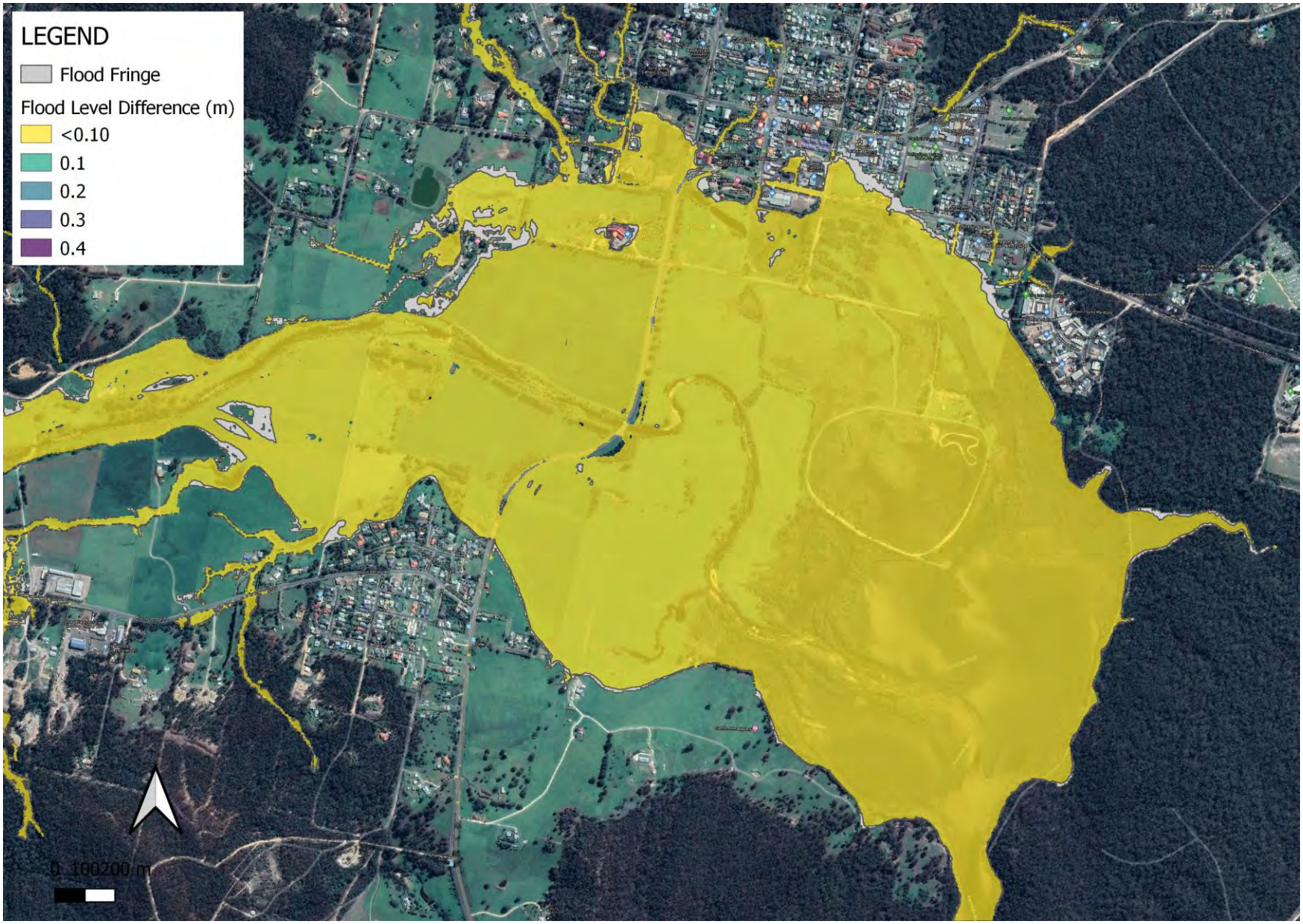


Plate I6 1% AEP flood level differences associated with filling of Flood Fringe Areas near Pambula

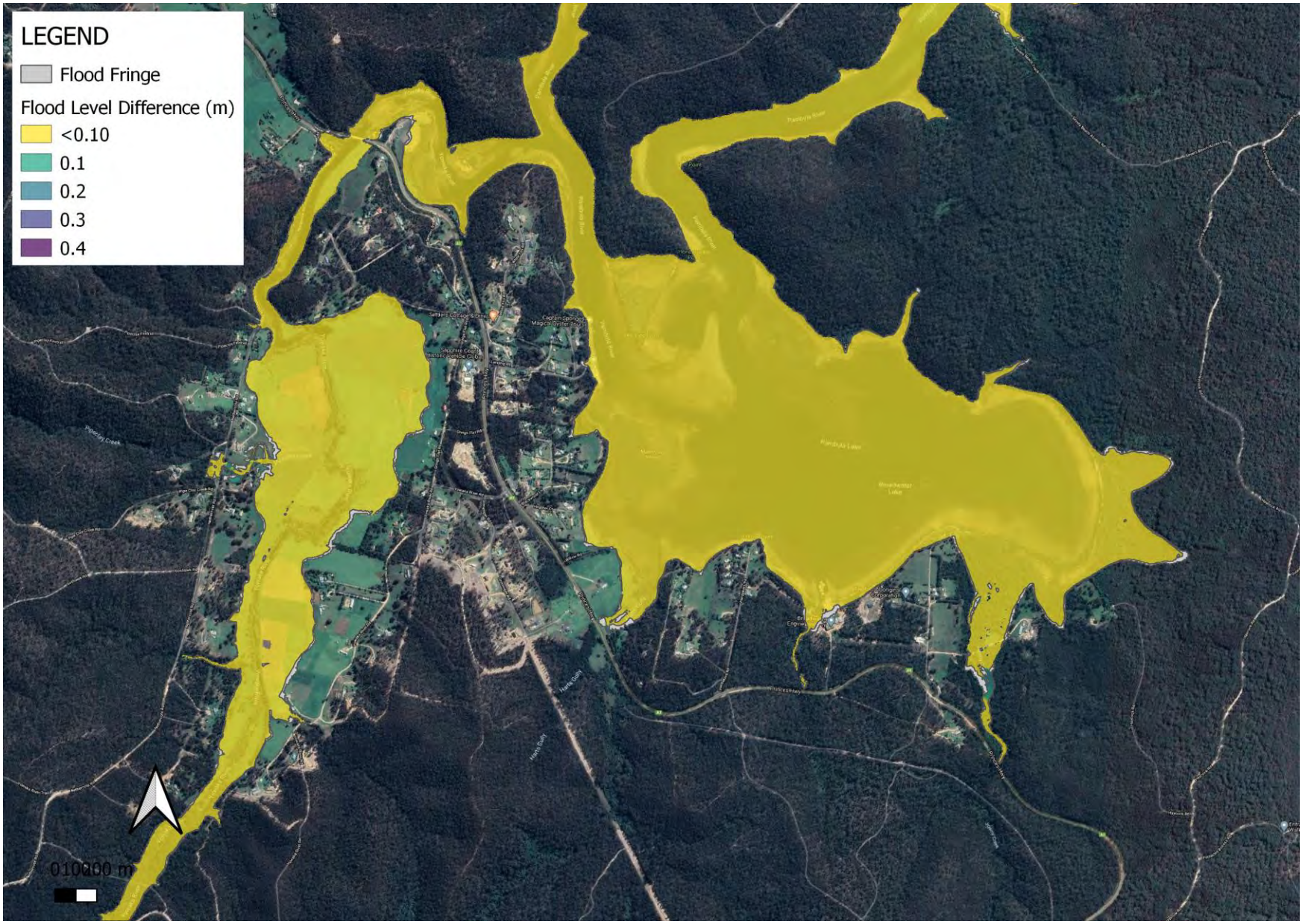
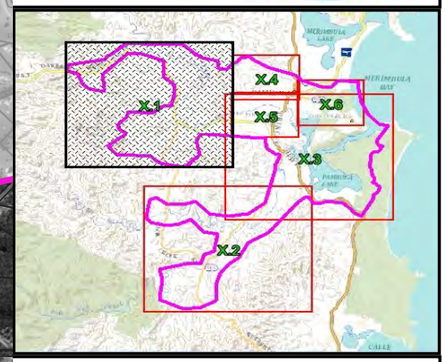


Plate I7 **1% AEP flood level differences associated with filling of Flood Fringe Areas near Greigs Flat and Pambula Lake**

APPENDIX J
ROADWAY INUNDATION INFORMATION

bega valley shire council



LEGEND

- 5% AEP Flood Inundation Extent
- 1% AEP Flood Inundation Extent
- 0.5% AEP Flood Inundation Extent
- PMF Inundation Extent
- Road Overtopping Point

Notes:
Aerial photograph: Google Satellite 2019
Only areas subject to inundation depths of more than 0.1 metres are displayed

N
W E
S

Scale 1:27,000 (at A3)

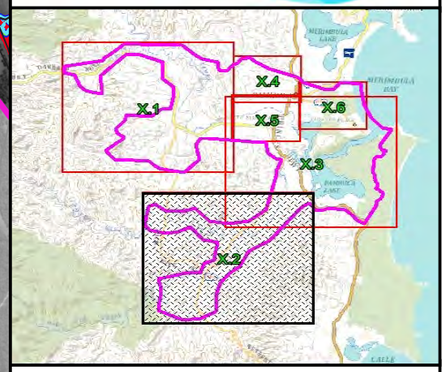
0 0.75 1.5

Figure J1.1
Road Overtopping Points

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure J1 Road Overtopping Points

bega valley shire council



LEGEND

- 5% AEP Flood Inundation Extent
- 1% AEP Flood Inundation Extent
- 0.5% AEP Flood Inundation Extent
- PMF Inundation Extent
- Road Overtopping Point

Notes:
Aerial photograph: Google Satellite 2019
Only areas subject to inundation depths of more than 0.1 metres are displayed

N
W E
S

Scale 1:27,000 (at A3)

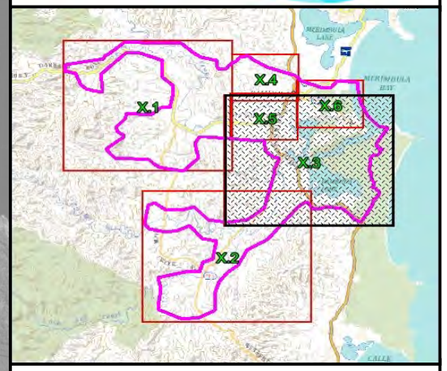
0 0.75 1.5

Figure J1.2
Road Overtopping Points

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure J1 Road Overtopping Points

bega valley shire council



LEGEND

- 5% AEP Flood Inundation Extent
- 1% AEP Flood Inundation Extent
- 0.5% AEP Flood Inundation Extent
- PMF Inundation Extent
- Road Overtopping Point

Notes:
Aerial photograph: Google Satellite 2019
Only areas subject to inundation depths of more than 0.1 metres are displayed

N
W E
S

Scale 1:27,000 (at A3)

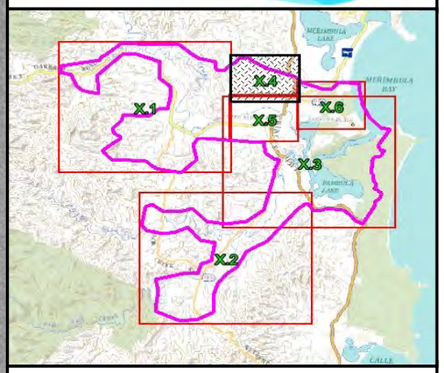
0 0.75 1.5

Figure J1.3
Road Overtopping Points

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure J1 Road Overtopping Points

bega valley shire council



LEGEND

- 5% AEP Flood Inundation Extent
- 1% AEP Flood Inundation Extent
- 0.5% AEP Flood Inundation Extent
- PMF Inundation Extent
- Road Overtopping Point

Notes:
Aerial photograph: Google Satellite 2019
Only areas subject to inundation depths of more than 0.1 metres are displayed

N
W E
S

Scale 1:10,000 (at A3)

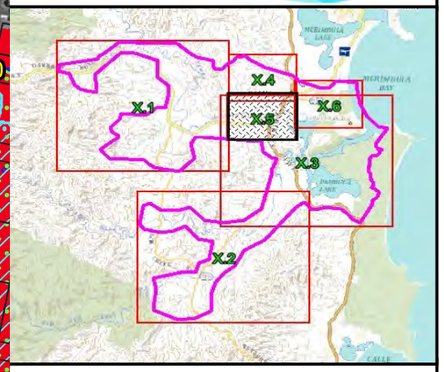
0 0.3 0.6

Figure J1.4
Road Overtopping Points

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure J1 Road Overtopping Points

bega valley shire council



LEGEND

- 5% AEP Flood Inundation Extent
- 1% AEP Flood Inundation Extent
- 0.5% AEP Flood Inundation Extent
- PMF Inundation Extent
- Road Overtopping Point

Notes:
Aerial photograph: Google Satellite 2019
Only areas subject to inundation depths of more than 0.1 metres are displayed

N
W E
S

Scale 1:10,000 (at A3)

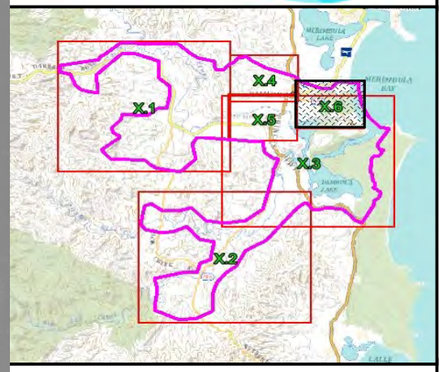
0 0.3 0.6

Figure J1.5
Road Overtopping Points

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure J1 Road Overtopping Points

bega valley shire council



LEGEND

- 5% AEP Flood Inundation Extent
- 1% AEP Flood Inundation Extent
- 0.5% AEP Flood Inundation Extent
- PMF Inundation Extent
- Road Overtopping Point

Notes:
Aerial photograph: Google Satellite 2019
Only areas subject to inundation depths of more than 0.1 metres are displayed

N
W E
S

Scale 1:10,000 (at A3)

0 0.3 0.6

Figure J1.6
Road Overtopping Points

Prepared By:
Catchment Simulation Solutions
Suite 10.01, 70 Phillip St
Sydney, NSW 2000

File Name: Figure J1 Road Overtopping Points

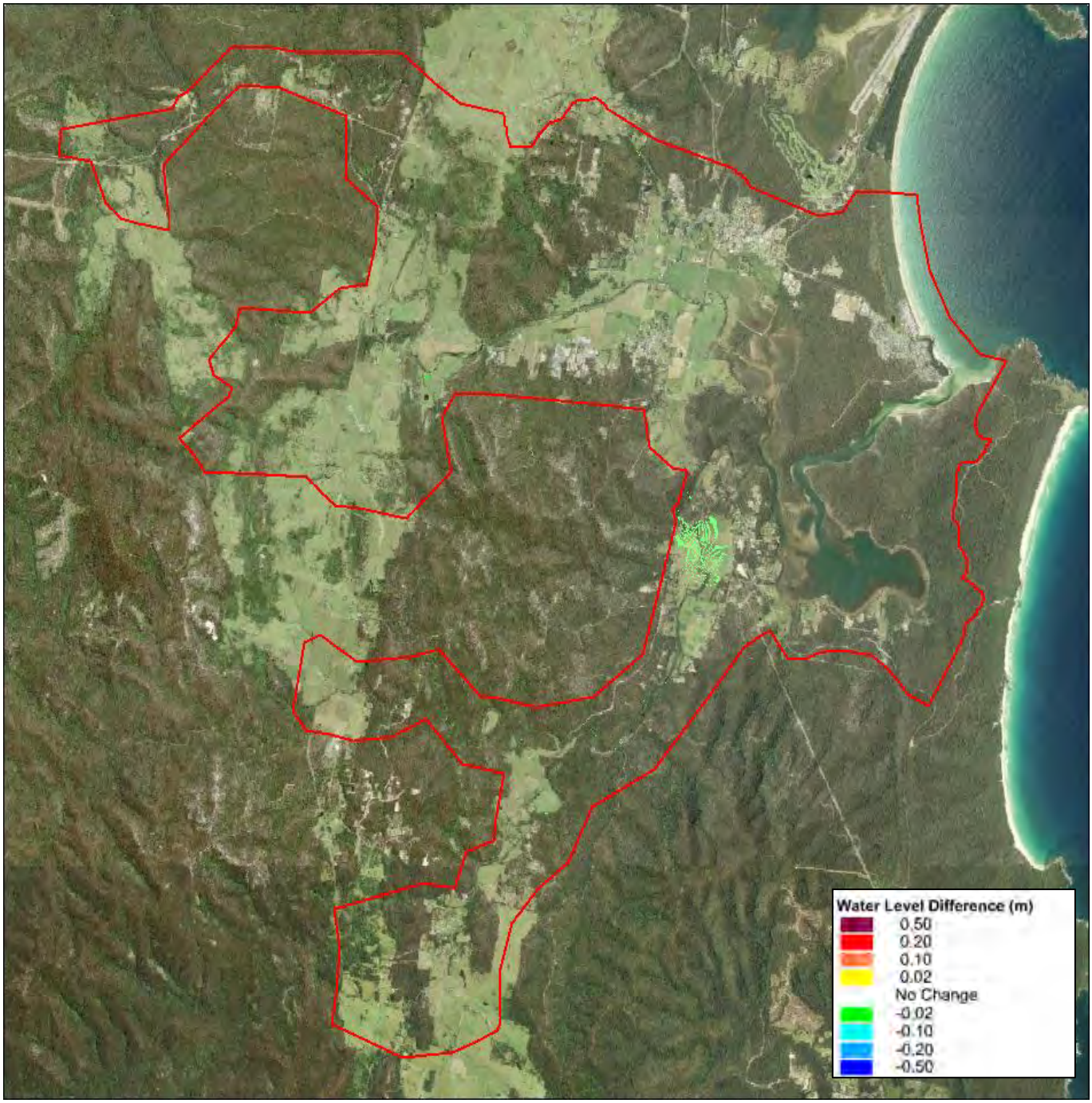
ID	Road Name	5%AEP			1%AEP			0.5%AEP			PMF		
		Time Road First Inundated (hours)	Duration Inundated (hours)	Peak Hazard	Time Road First Inundated (hours)	Duration Inundated (hours)	Peak Hazard	Time Road First Inundated (hours)	Duration Inundated (hours)	Peak Hazard	Time Road First Inundated (hours)	Duration Inundated (hours)	Peak Hazard
1	Mount Darragh Rd										0.41	5.60	H6
2	Mount Darragh Rd										1.51	4.59	H4
3	Mount Darragh Rd										1.72	3.13	H2
4	Mount Darragh Rd										1.81	3.66	H6
5	off Blairlands Rd	2.02	12.49	H5	1.49	12.61	H5	1.39	12.63	H5	0.43	5.85	H6
6	Blairlands Rd										1.45	3.25	H5
7	Back Creek Rd										1.31	3.43	H5
8	Mount Darragh Rd										1.43	4.98	H6
9	Mount Darragh Rd	2.31	1.11	H1	6.75	3.06	H1	5.64	4.30	H1	1.26	4.98	H2
10	Mount Darragh Rd	0.16	0.46	H1	0.13	0.50	H1	0.12	0.51	H1	1.00	4.16	H2
11	off Northview Dr							5.16	0.76	H1	2.28	3.83	H5
12	off Oaklands Rd	4.97	3.62	H1	4.81	5.20	H2	4.53	5.70	H2	0.61	5.21	H4
13	Oaklands Rd							1.48	4.88	H1	1.18	4.67	H3
14	Bega St							2.44	9.81	H3	1.79	5.32	H6
15	Toallo St										0.76	3.58	H2
16	Monaro St	6.35	6.75	H3	5.51	7.58	H3	5.30	7.80	H3	1.23	4.84	H6
17	A1 Princes Hwy				9.70	5.30	H1	9.00	12.00	H2	2.25	10.00	H5
18	A1 Princes Hwy										3.34	2.77	H5
19	Bullara St	9.61	7.17	H3	6.84	8.50	H4	6.48	8.72	H4	1.96	5.12	H6
20	Merimbola St				9.58	3.50	H3	8.96	4.11	H3	2.86	3.16	H6
21	Martin St							3.57	3.27	H1	1.01	5.35	H5
22	Narregol St										4.06	2.08	H5
23	Toallo St										1.76	3.05	H1
24	Arthur Kaine Dr										1.00	5.36	H3
25	Bullara St				10.55	2.37	H2	9.91	3.28	H3	2.53	4.27	H5
26	A1 Princes Hwy				7.75	5.00	H1	7.25	6.75	H2	2.25	10.75	H5
27	A1 Princes Hwy										4.43	1.68	H4
28	A1 Princes Hwy	7.26	5.74	H1	6.22	6.78	H5	7.26	7.03	H5	2.13	3.99	H5
29	Jinjera Parade										0.56	1.03	H1
30	A1 Princes Hwy							6.18	6.88	H2	3.06	2.95	H5
31	A1 Princes Hwy										3.54	2.52	H6
32	Nethercote Rd	5.59	7.44	H5	4.80	8.23	H6	4.59	8.44	H6	1.66	4.41	H6
33	Broadwater Rd										2.07	4.05	H6
34	Nethercote Rd				6.20	8.80	H5	6.00	7.30	H5	1.42	4.65	H6
35	Nethercote Rd										0.72	5.41	H6
36	Nethercote Rd	5.43	7.85	H5	4.46	8.86	H5	4.14	9.14	H5	0.85	5.19	H6
37	Ruggs Rd	5.00	8.50	H5	3.25	12.75	H4	1.25	20.25	H4	0.50	8.70	H5

APPENDIX K
SENSITIVITY ANALYSIS DIFFERENCE MAPS

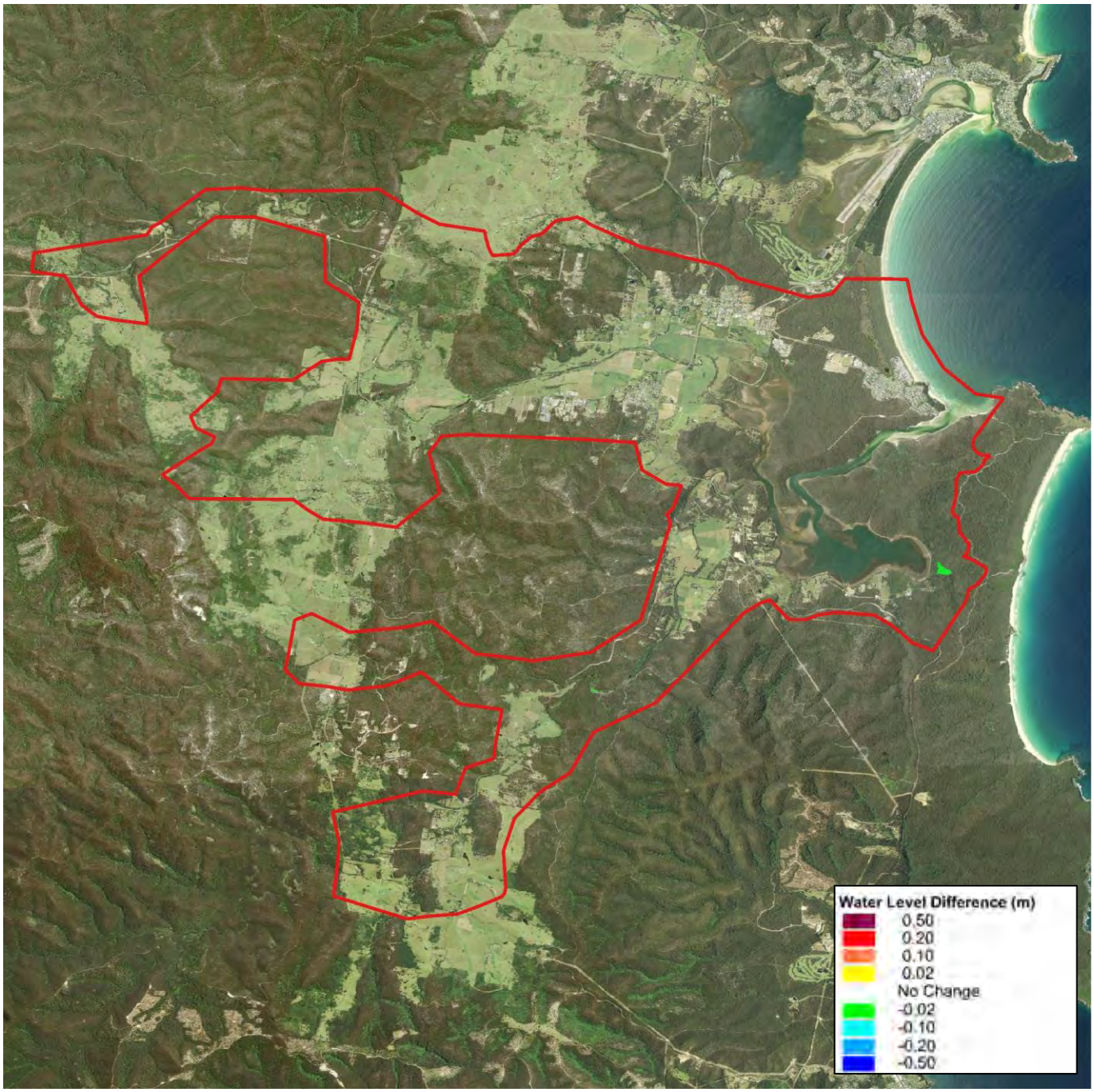
Initial Loss

Initial loss increased by 20%

1% AEP

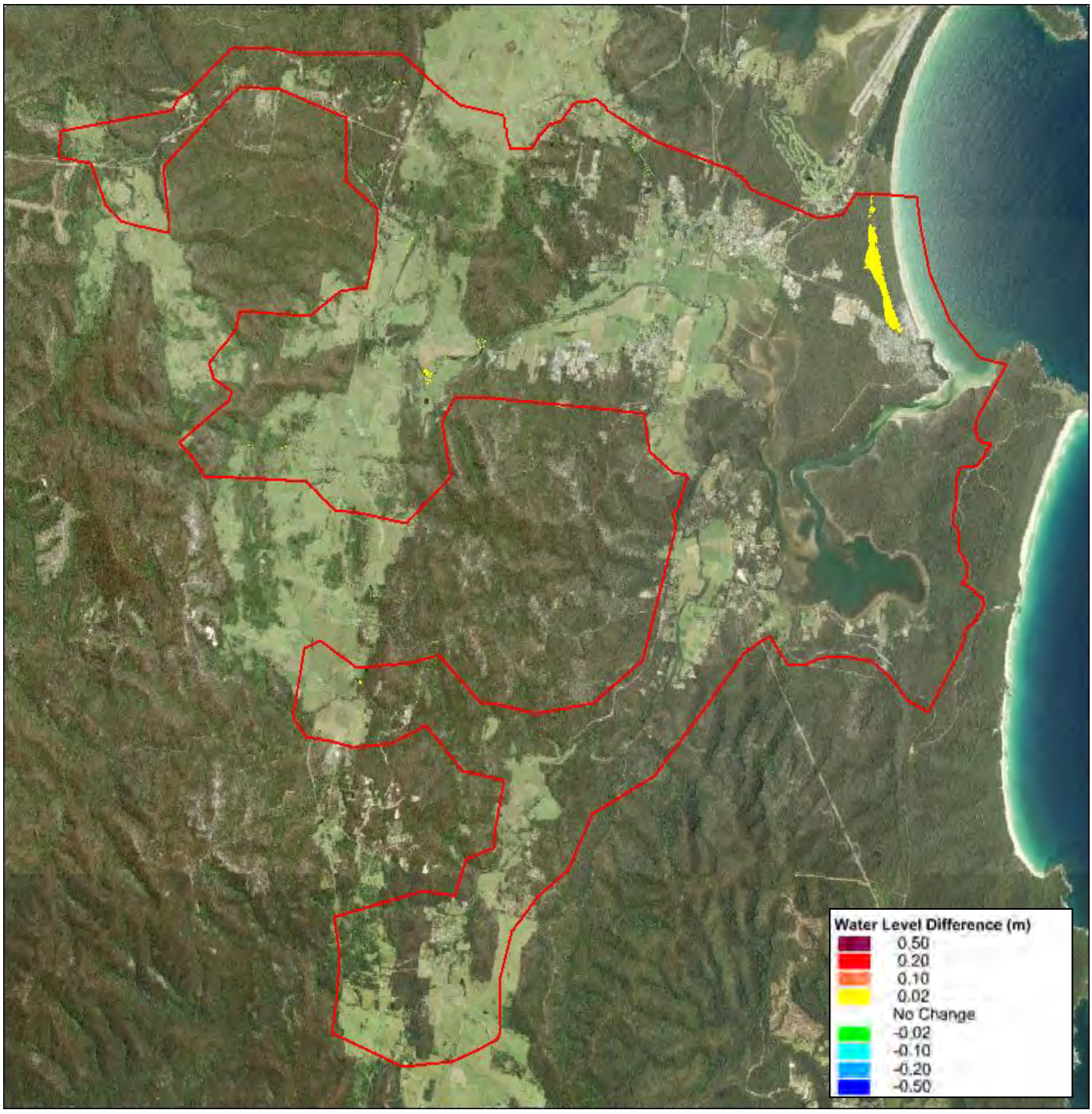


5% AEP

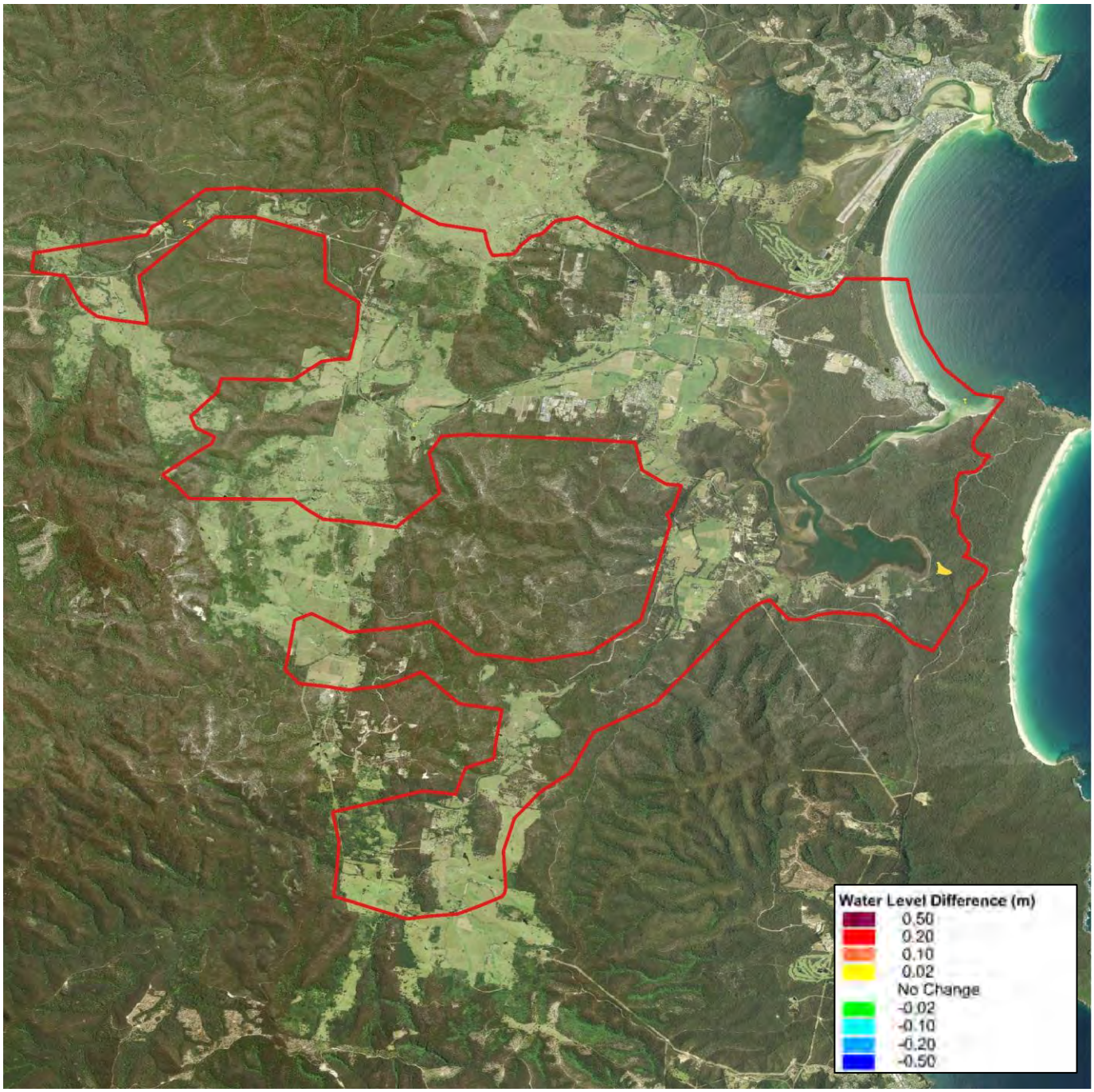

Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

Initial loss reduced by 20%

1% AEP



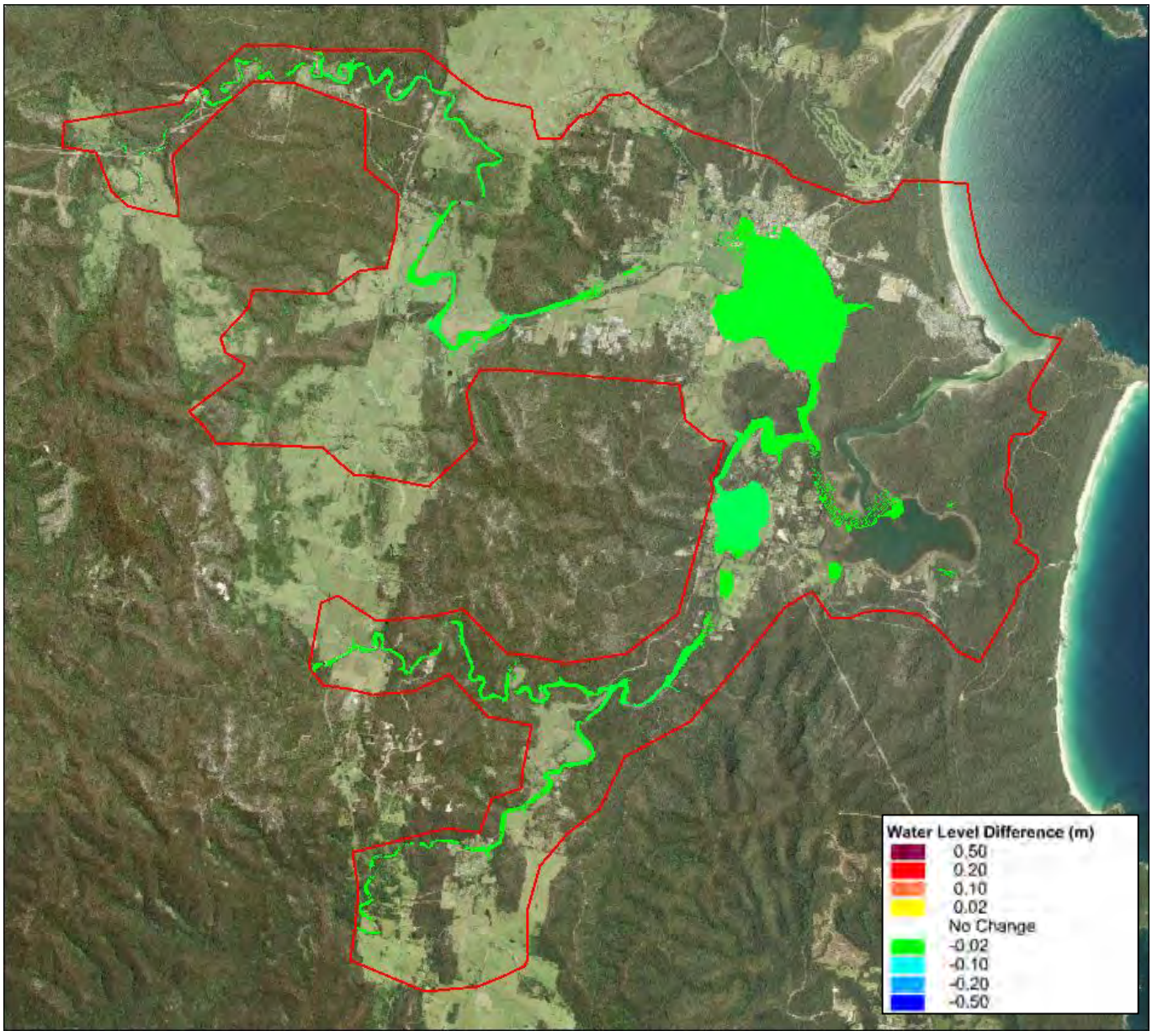
5% AEP


Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

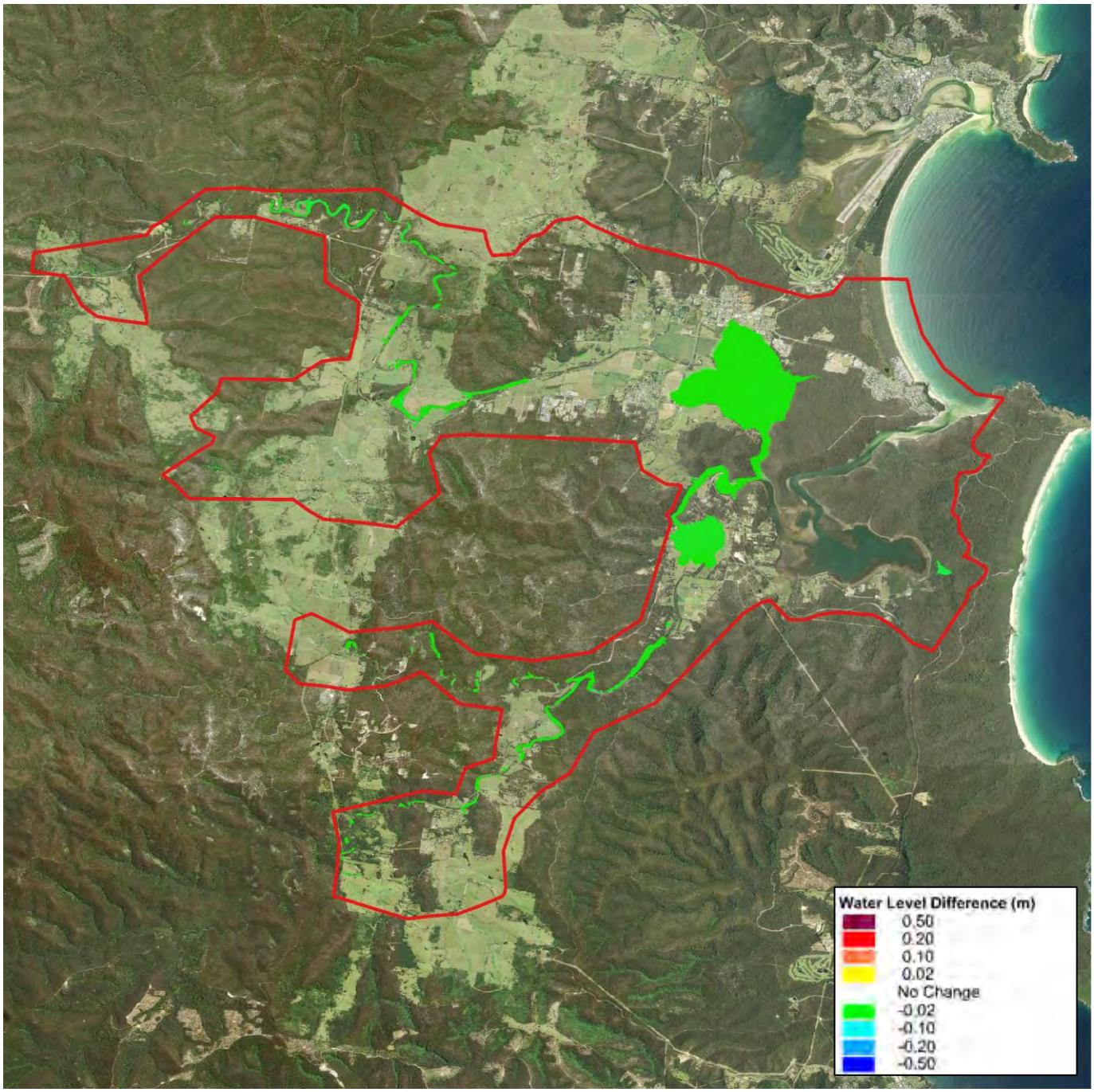
Continuing Loss Rate

Continuing loss rate increased by 20%

1% AEP

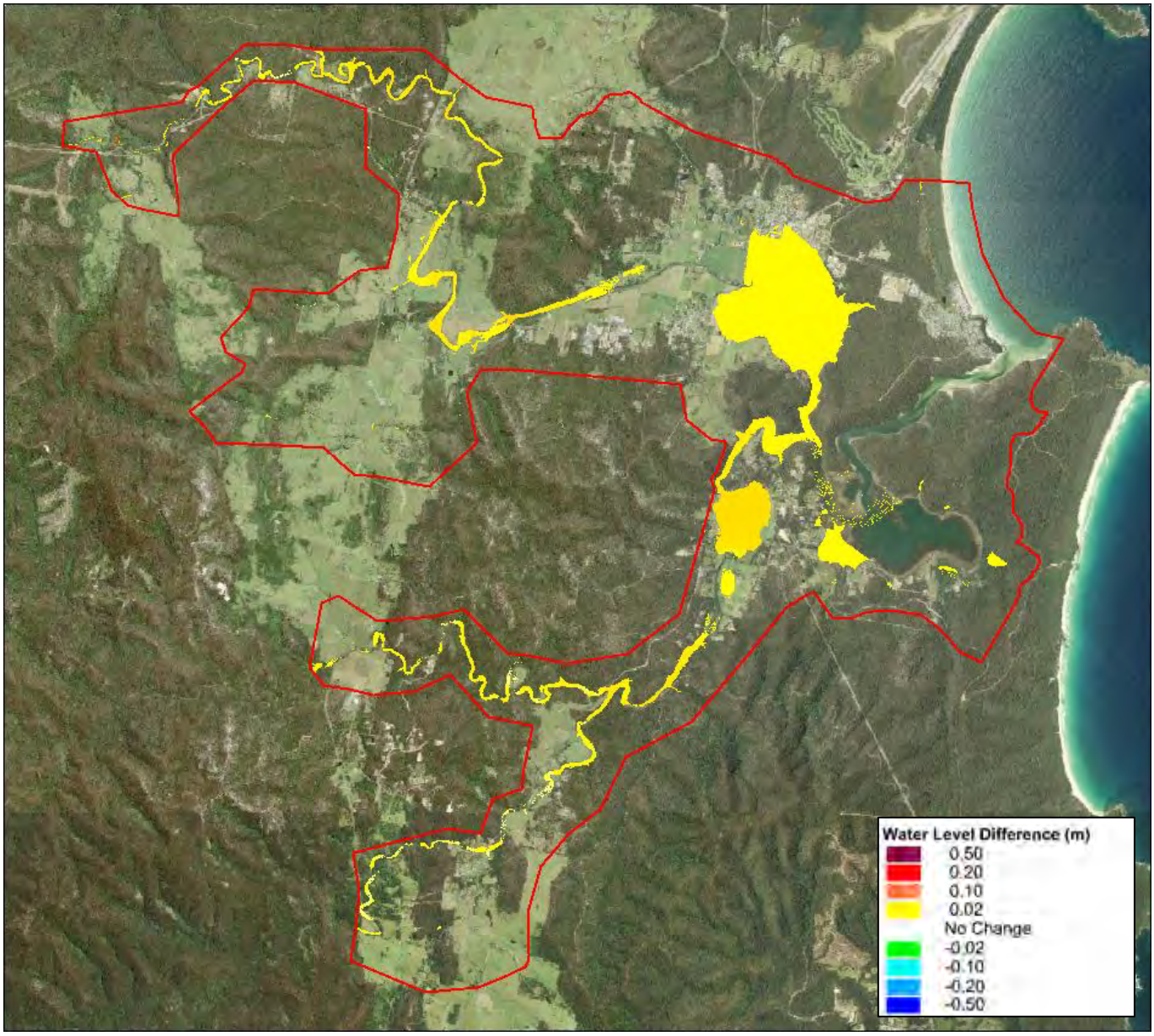


5% AEP

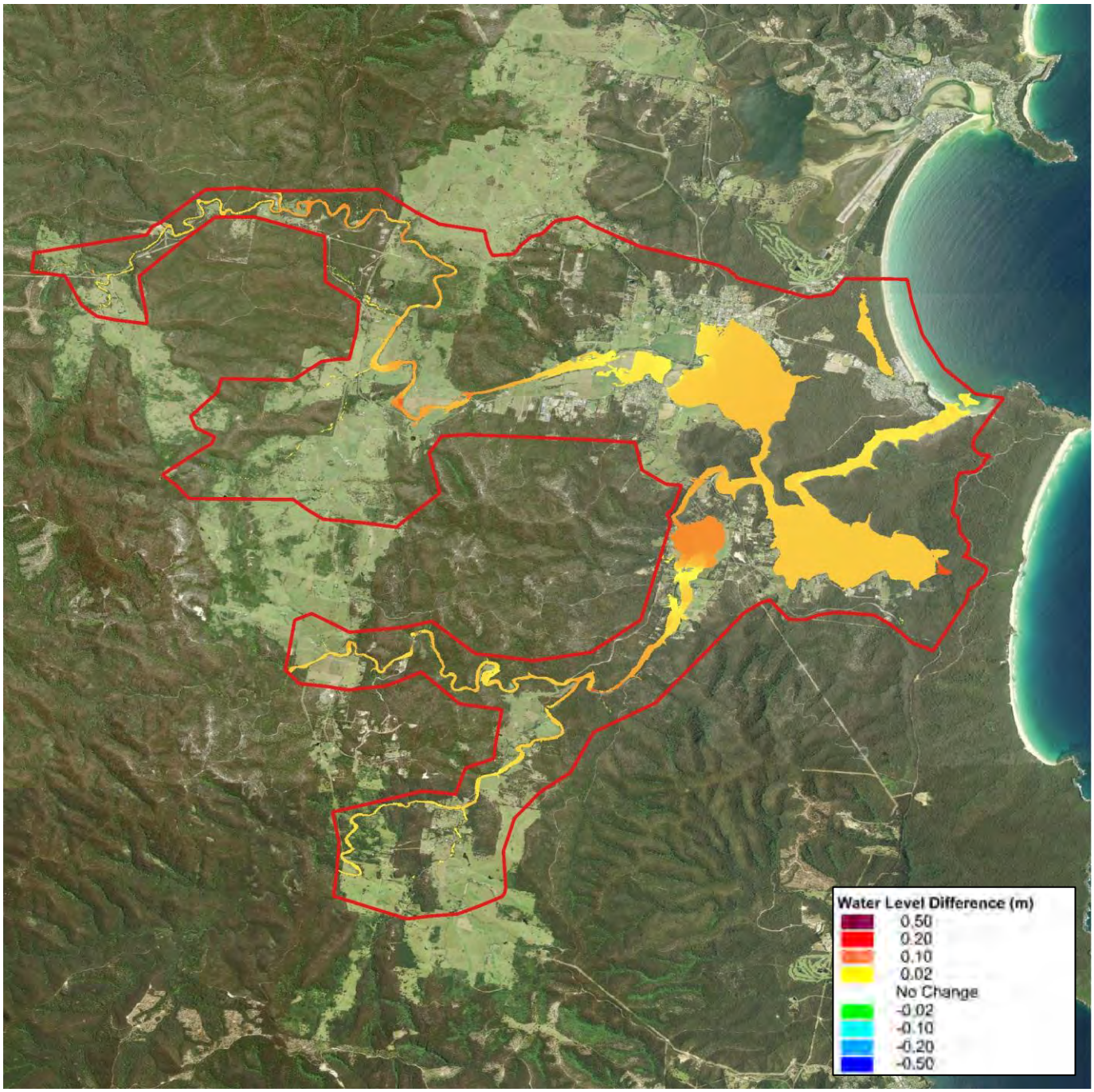

Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

Continuing loss rate reduced by 20%

1% AEP



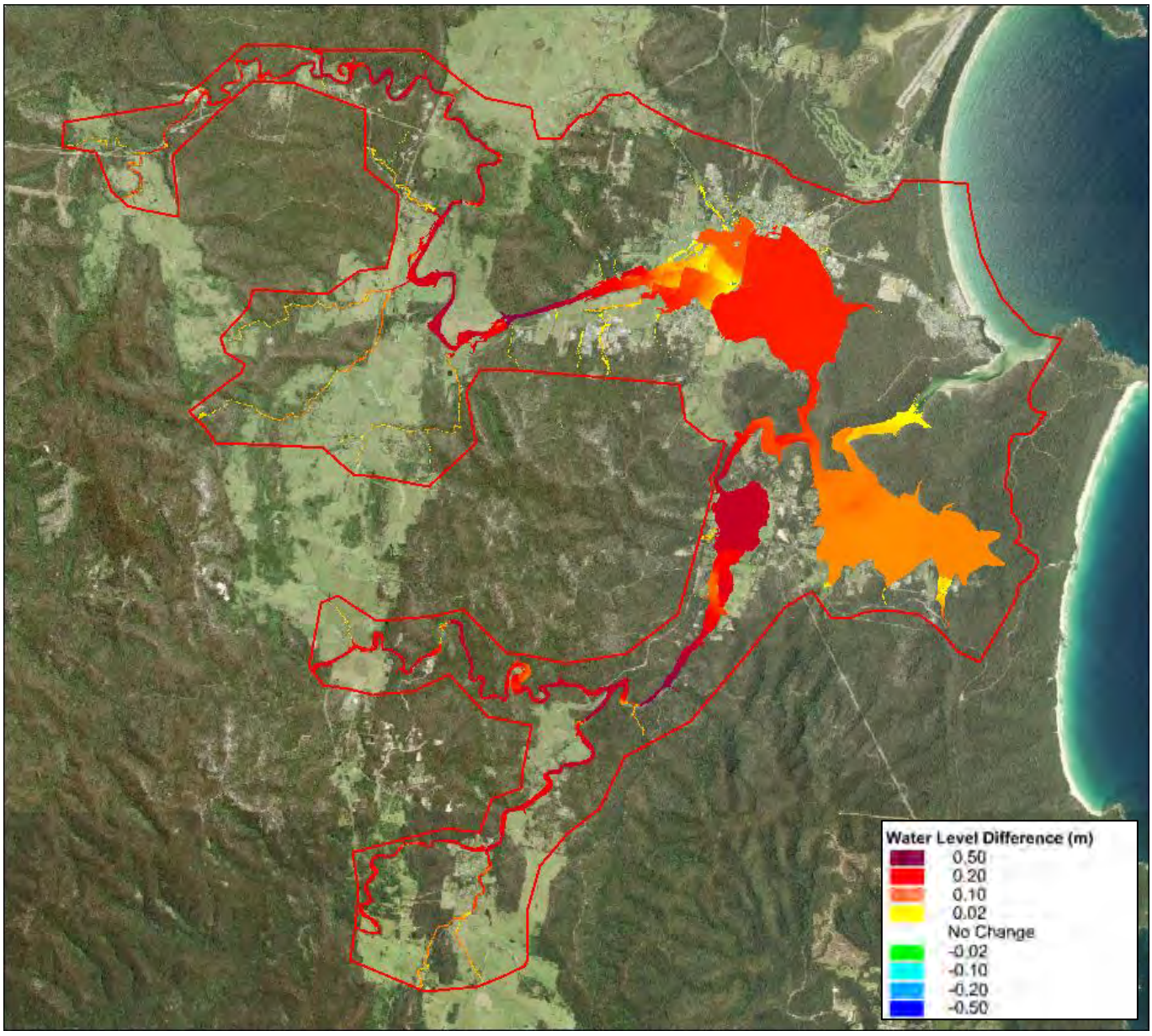
5% AEP


Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

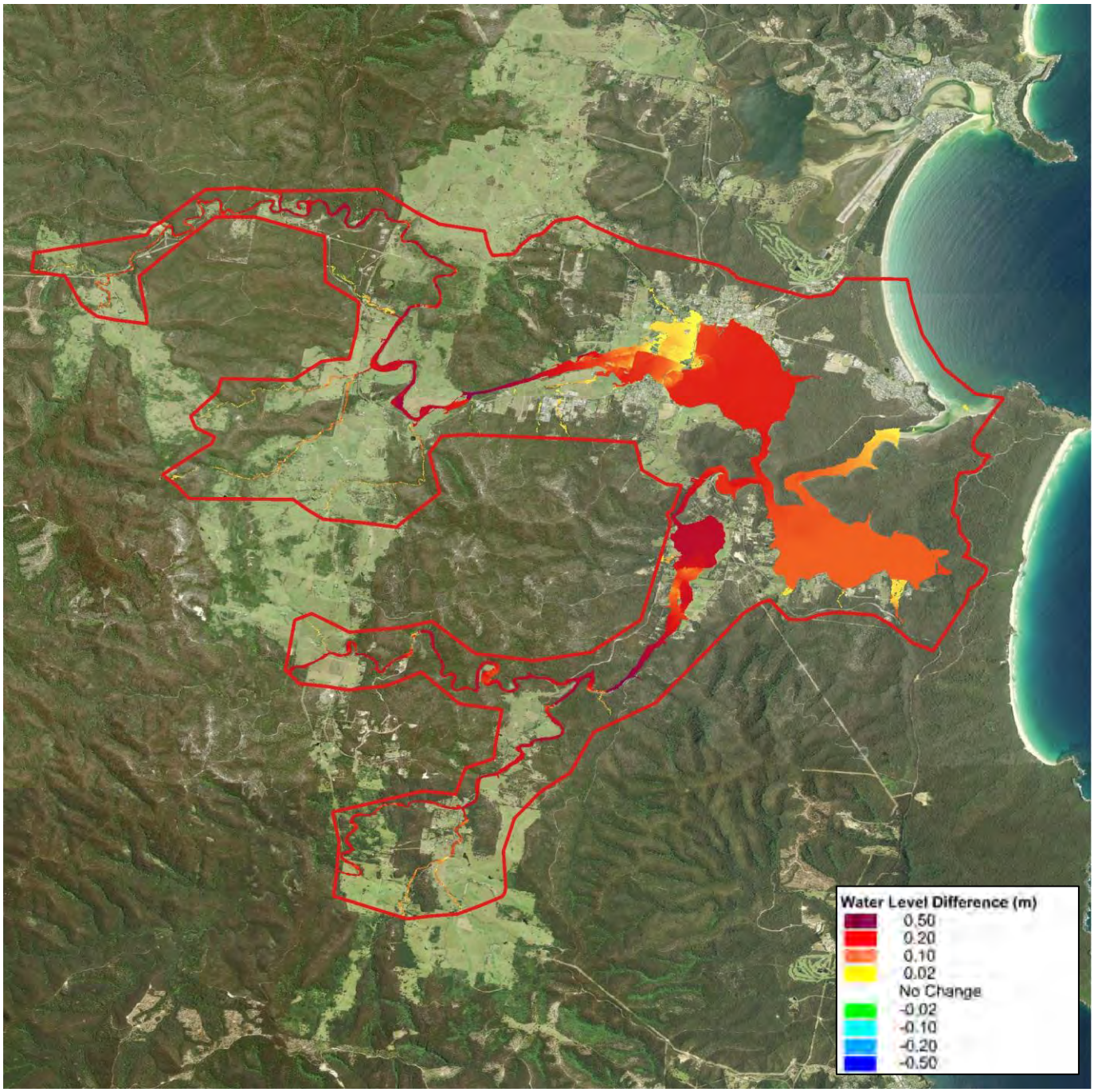
Manning's "n" Roughness

Manning's "n" increased by 20%

1% AEP

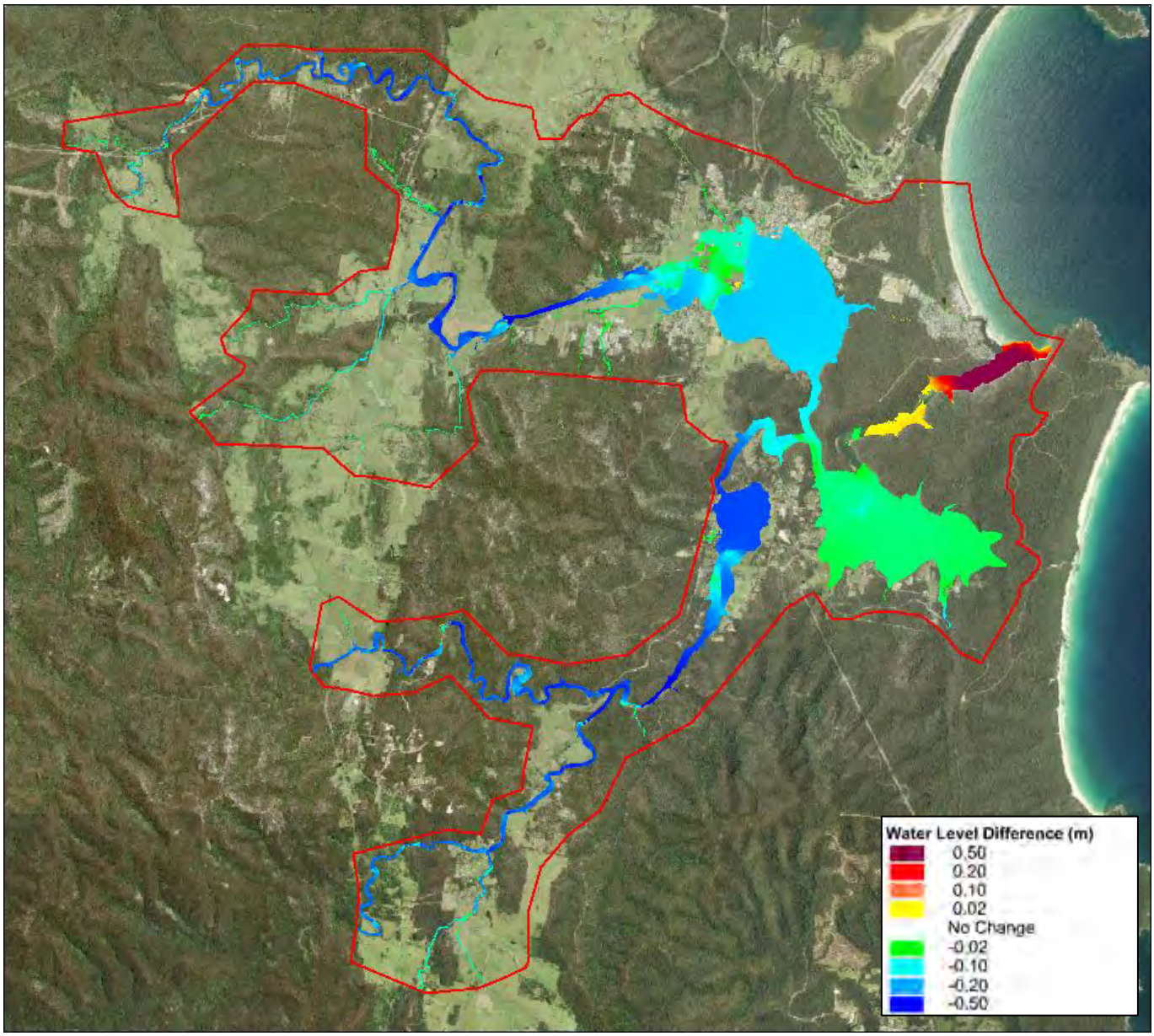


5% AEP

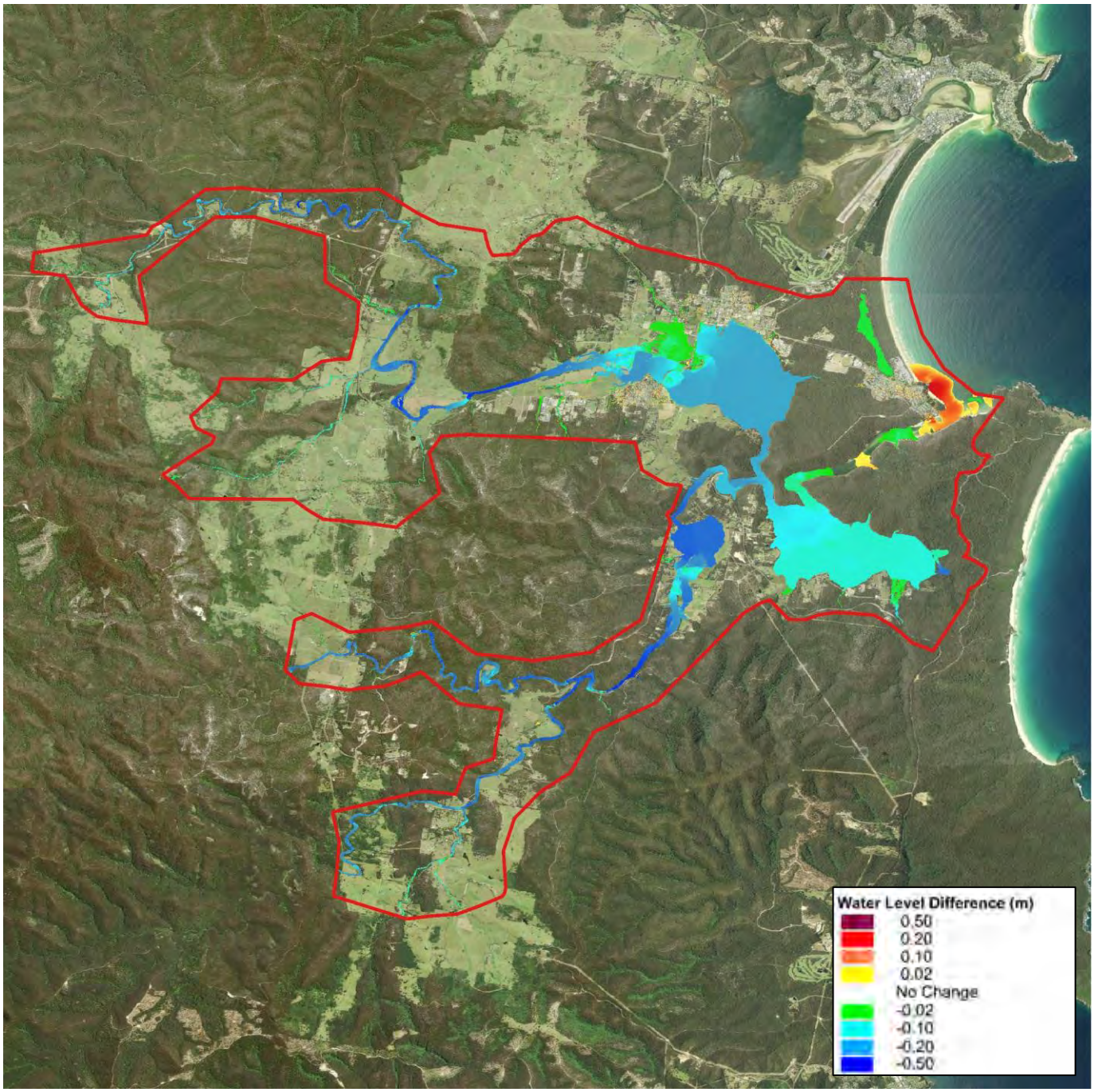

Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

Manning's "n" reduced by 20%

1% AEP



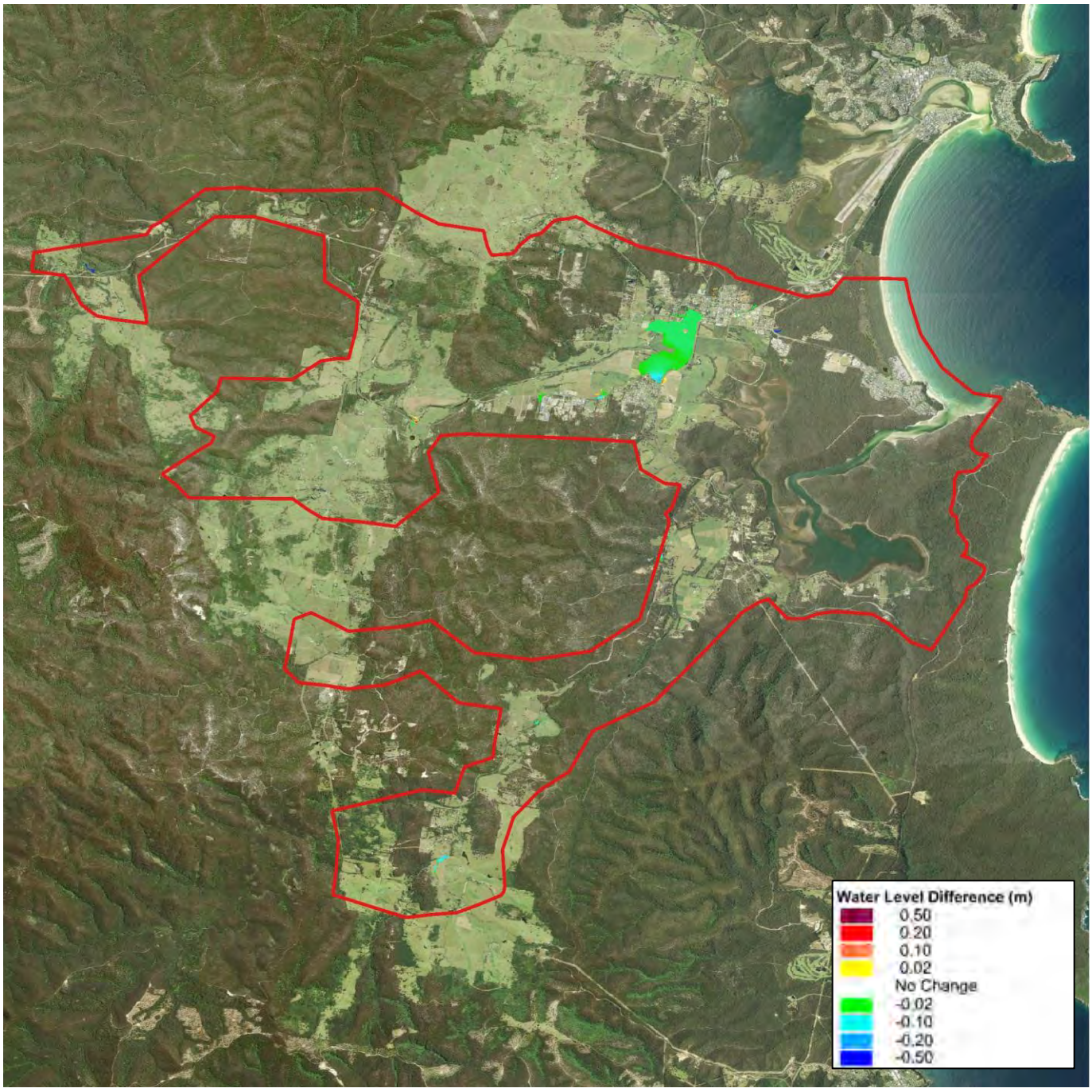
5% AEP


Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

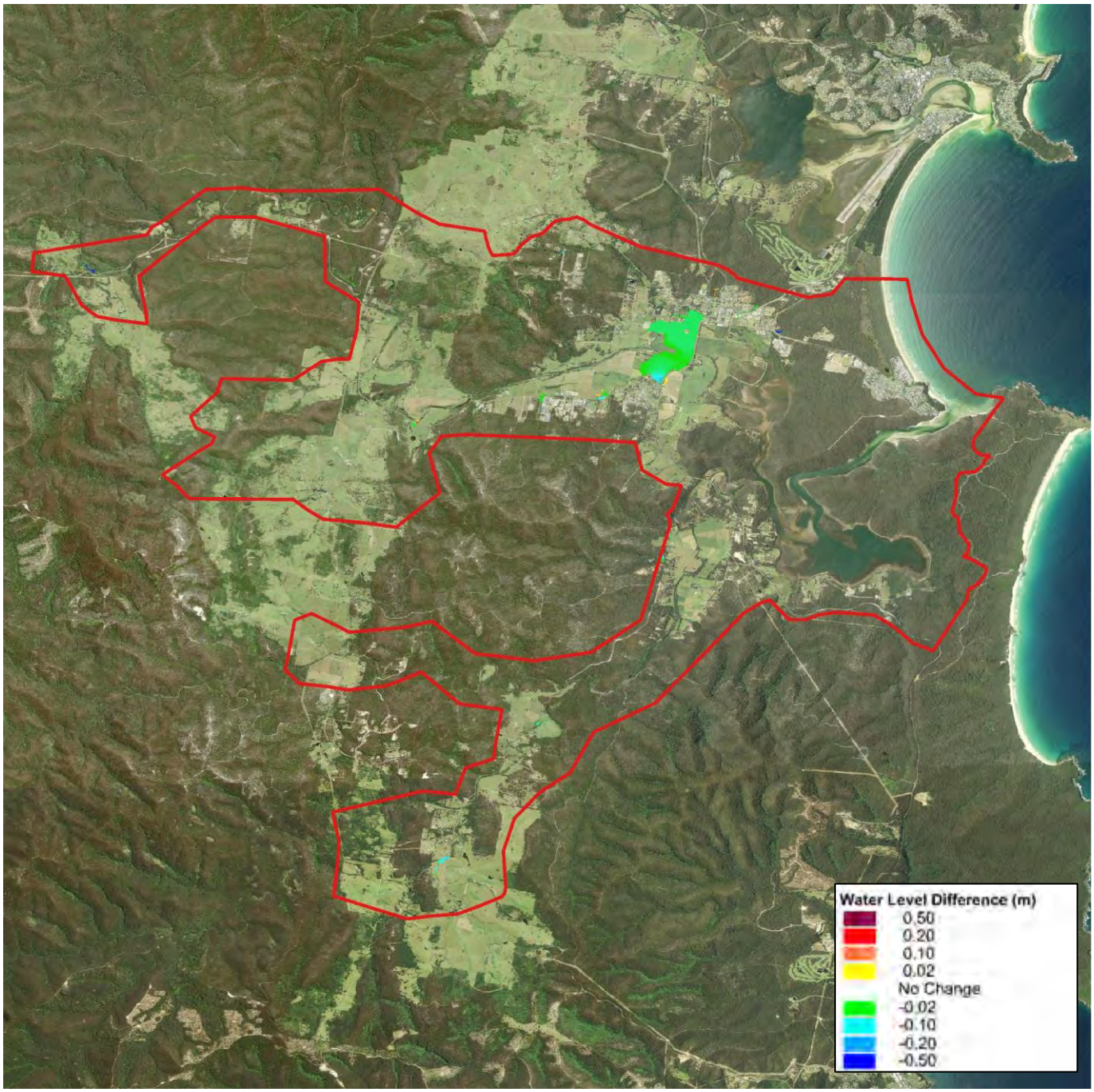
Blockage

No blockage

1% AEP

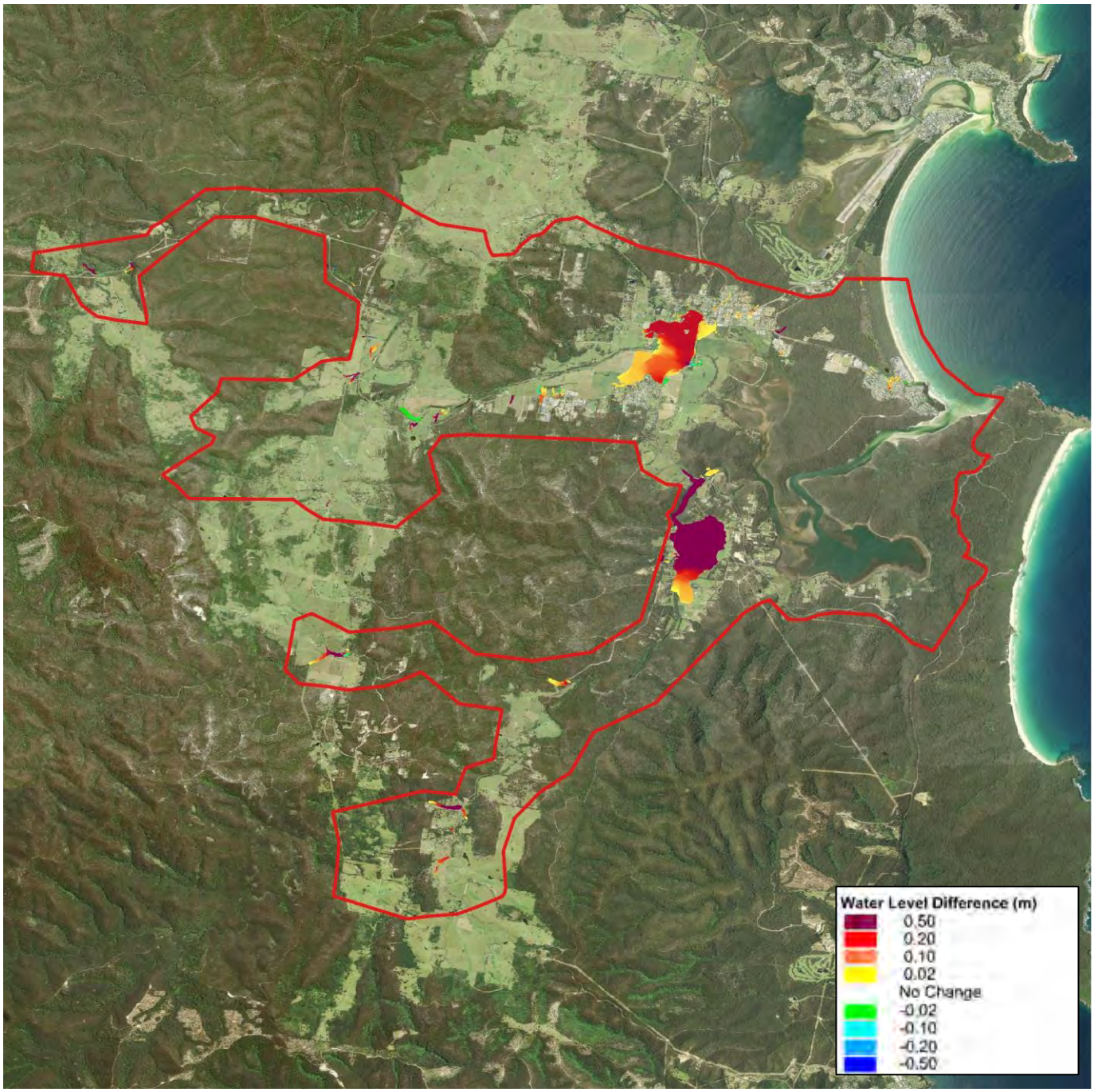


5% AEP

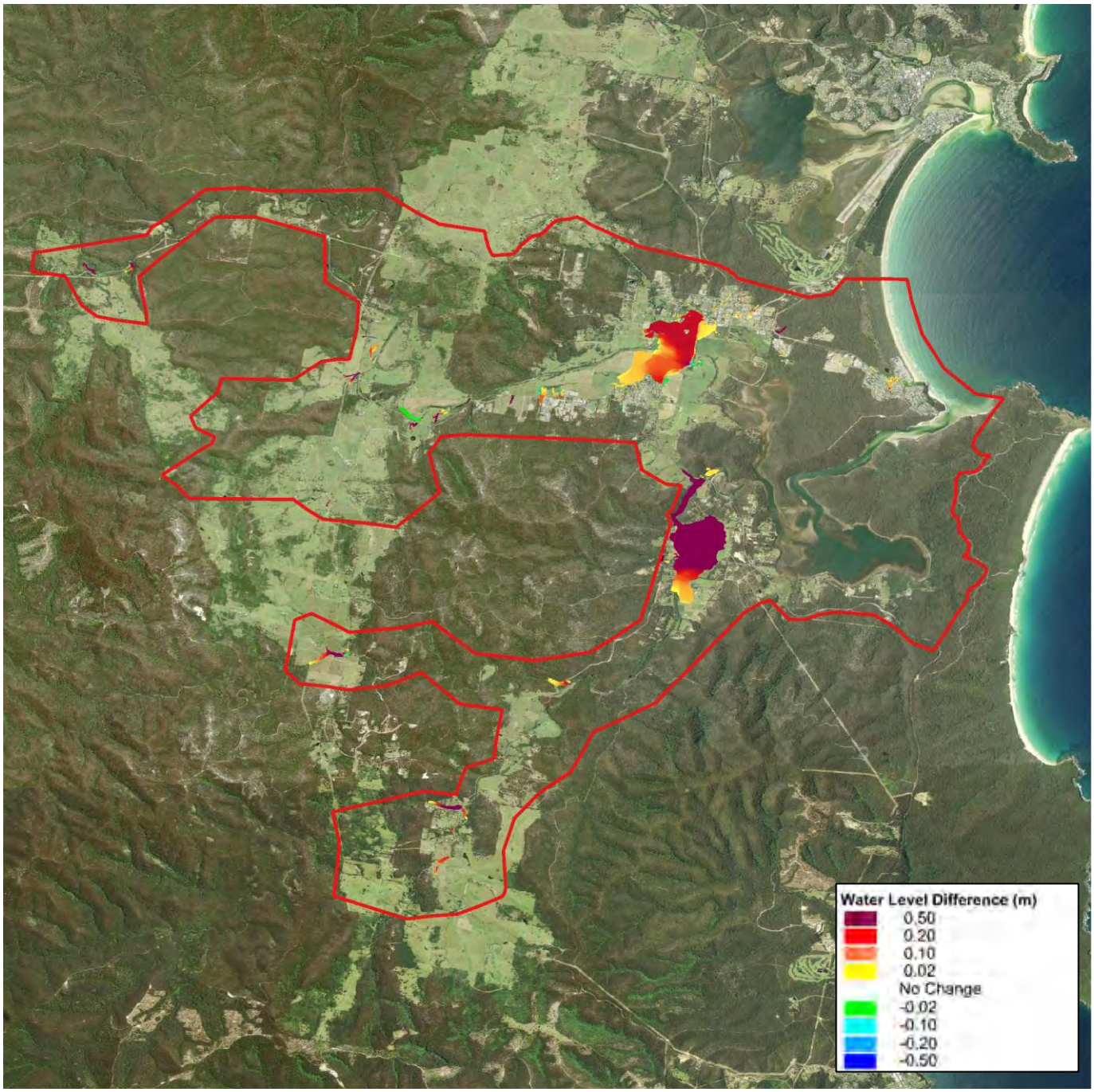

Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

Severe Blockage

1% AEP

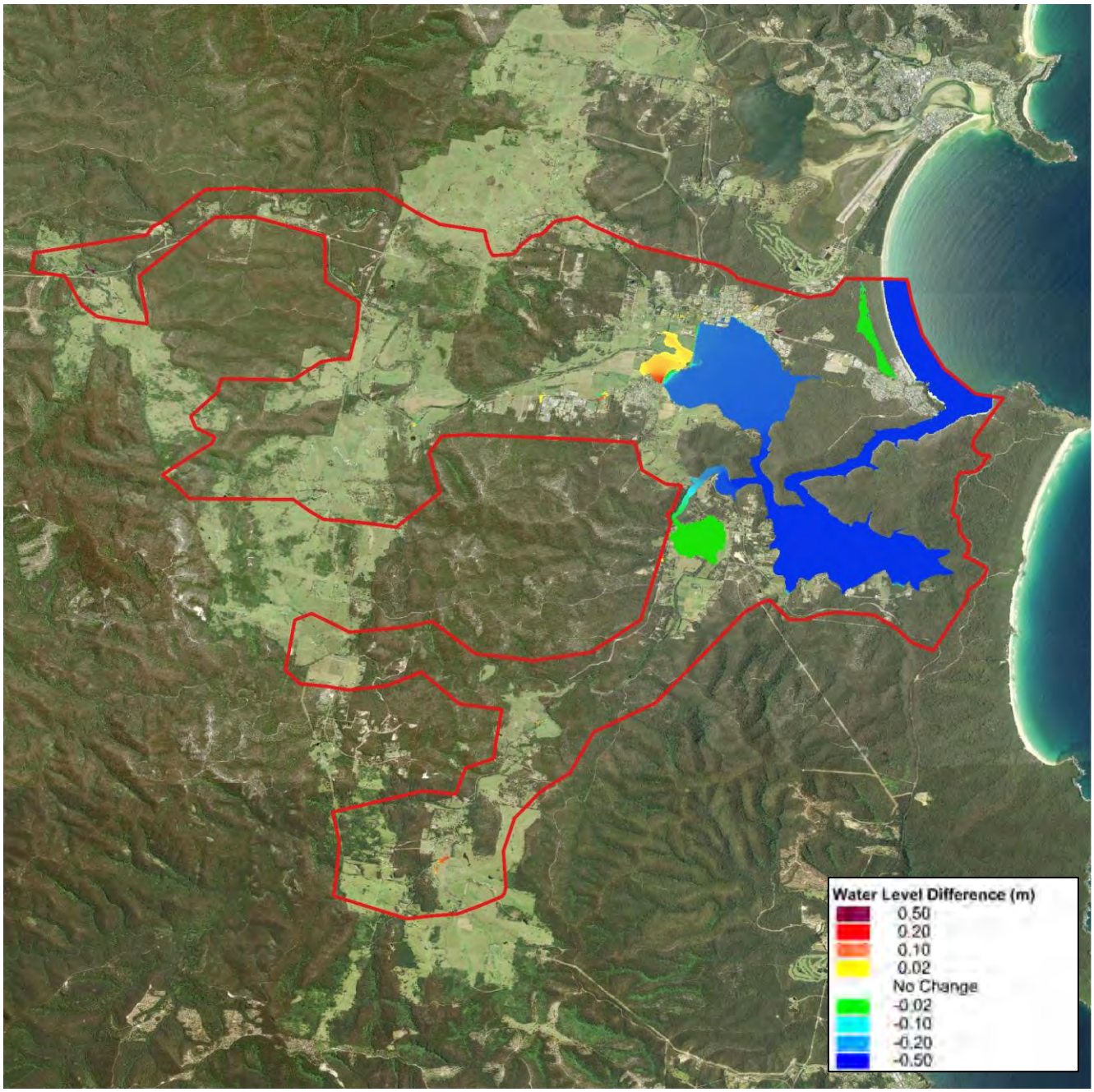


5% AEP


Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

Peak Ocean Level

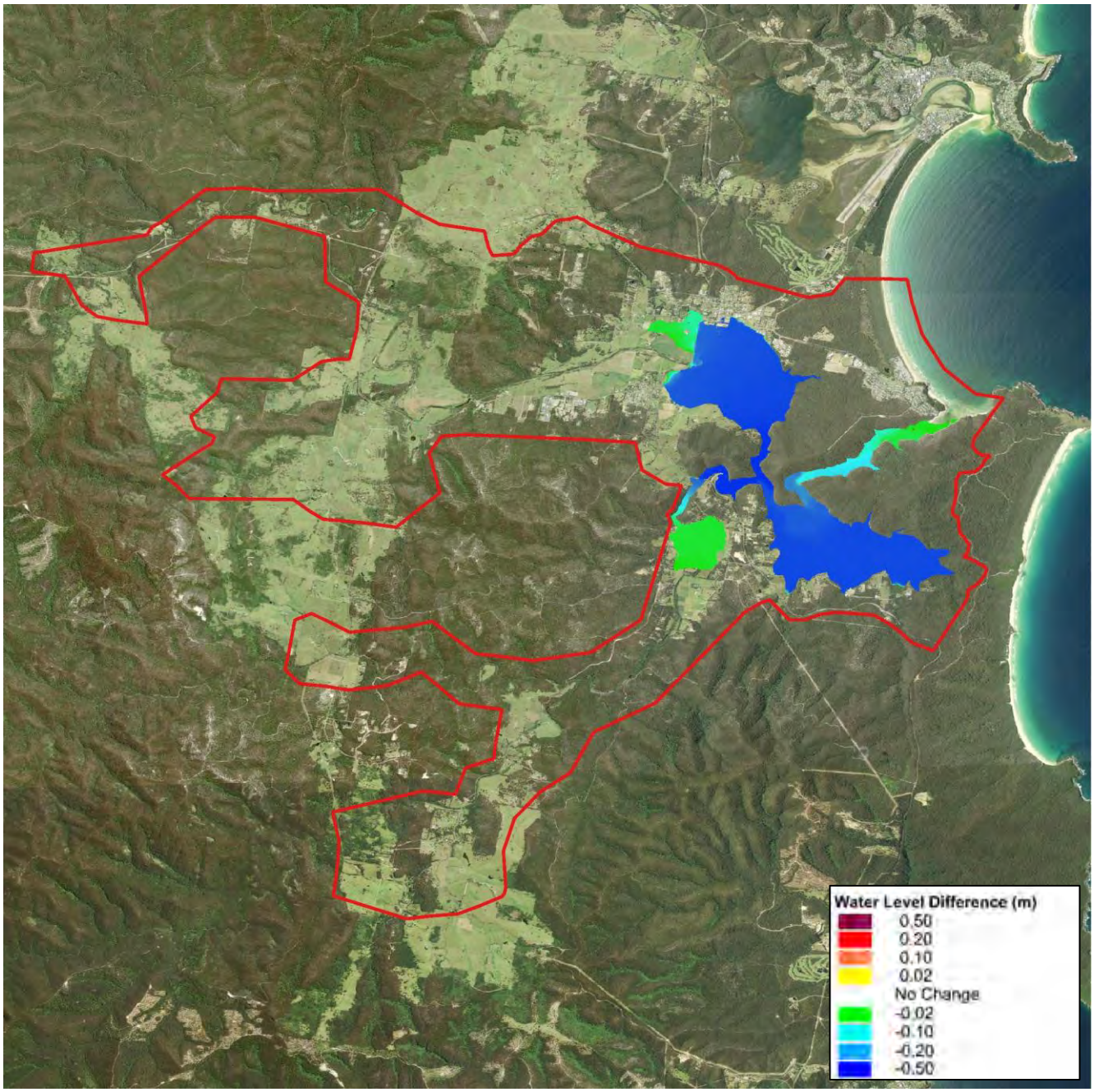
1% AEP flood with ISLW Tide vs 5% AEP Tide



Timing of Pambula River and Yowaka River Flows

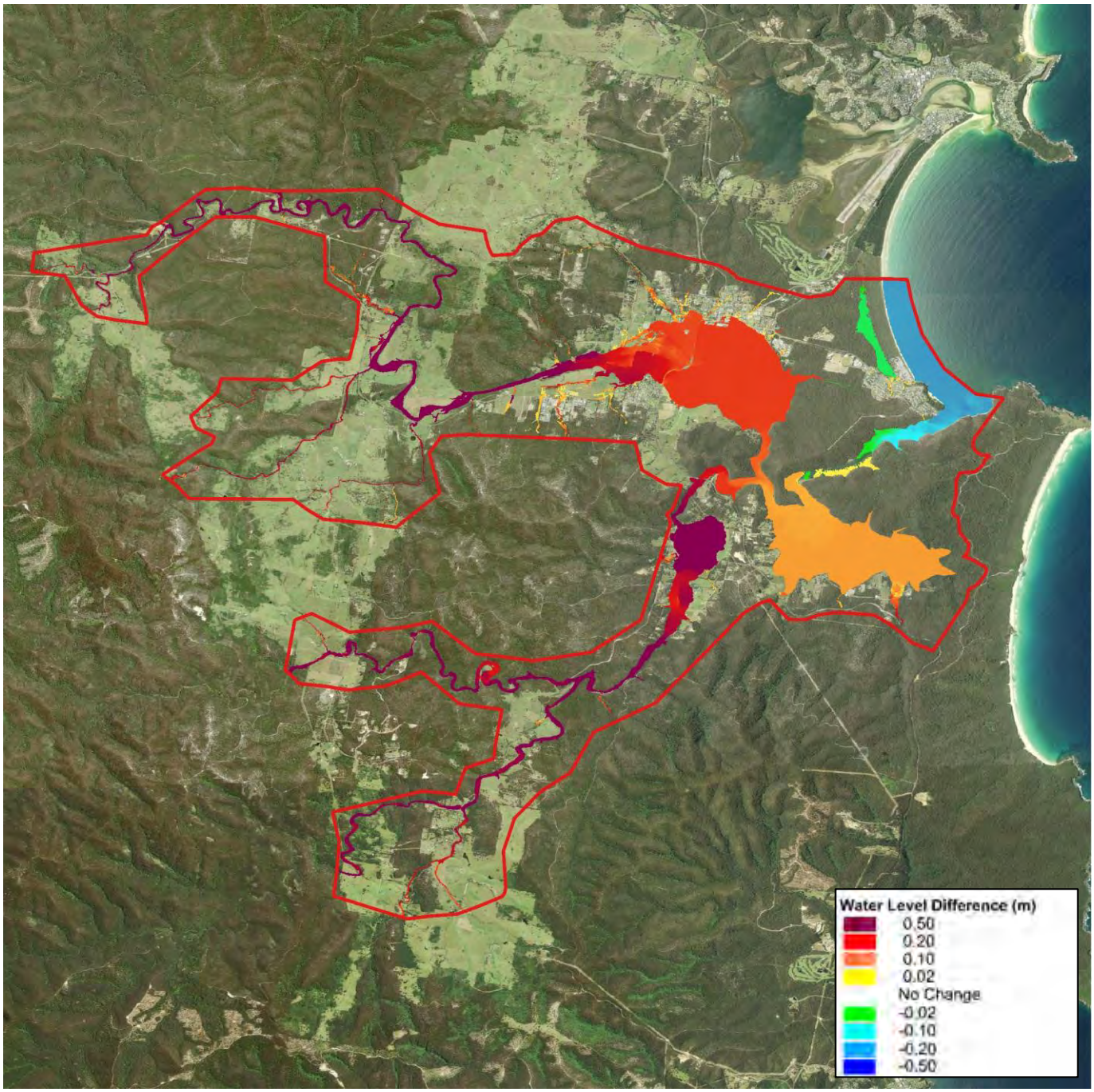
Timing Adjusted to Minimise Flood Levels

1% AEP

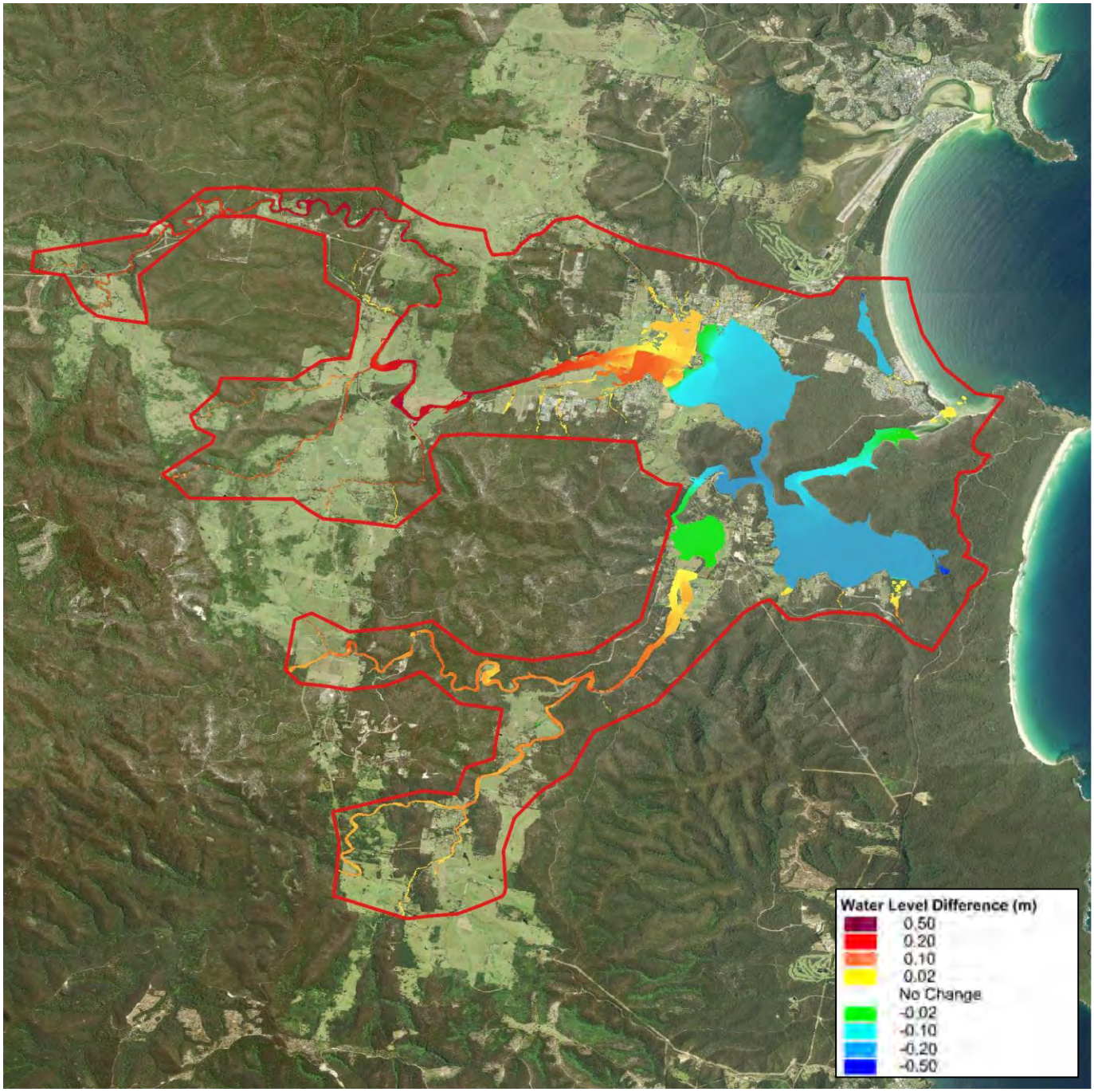


ARR87

1%AEP


Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

5%AEP


Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

APPENDIX L
XP-RAFTS ARR1987 OUTPUTS

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
1.01	12 hours	10.3	12 hours	15.2
1.02	12 hours	13.6	9 hours	20.5
1.03	12 hours	18.9	9 hours	29.2
1.04	12 hours	26.8	9 hours	41.3
1.05	12 hours	34.0	9 hours	52.8
1.06	12 hours	34.7	9 hours	53.9
1.07	12 hours	41.3	9 hours	62.8
1.08	12 hours	45.4	9 hours	68.4
1.09	12 hours	46.7	9 hours	70.3
1.10	12 hours	76.3	12 hours	110
1.11	12 hours	91.6	9 hours	133
1.12	12 hours	102	12 hours	147
1.13	12 hours	208	12 hours	295
1.14	12 hours	217	12 hours	306
1.15	12 hours	217	12 hours	306
1.16	12 hours	221	12 hours	312
1.17	12 hours	238	12 hours	336
1.18	12 hours	256	12 hours	360
1.19	12 hours	260	12 hours	365
1.20	12 hours	318	12 hours	445
1.21	12 hours	319	12 hours	447
1.22	12 hours	342	12 hours	480
1.23	12 hours	348	12 hours	488
1.24	12 hours	348	12 hours	488
1.25	12 hours	350	12 hours	490
1.26	12 hours	353	12 hours	495
1.27	12 hours	358	12 hours	500
1.28	12 hours	358	12 hours	500
1.29	12 hours	377	12 hours	525
1.30	12 hours	379	12 hours	527
1.31	12 hours	408	12 hours	564
1.32	12 hours	408	12 hours	564
1.33	12 hours	794	12 hours	1066
1.34	12 hours	794	12 hours	1067
1.35	12 hours	836	12 hours	1120
1.36	12 hours	836	12 hours	1120
1.37	12 hours	836	12 hours	1120
1.38	12 hours	837	12 hours	1121
1.39	12 hours	840	12 hours	1125
1.40	12 hours	845	12 hours	1131
2.01	12 hours	2.63	9 hours	4.60
3.01	12 hours	5.61	9 hours	7.63
4.01	12 hours	5.09	9 hours	7.64
5.01	12 hours	5.21	9 hours	8.18
6.01	12 hours	5.31	12 hours	7.39
7.01	12 hours	3.34	12 hours	4.78
8.01	18 hours	9.14	12 hours	12.1
8.02	12 hours	18.1	12 hours	25.2
8.03	12 hours	18.2	12 hours	25.3
8.04	12 hours	27.2	12 hours	37.8

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
8.05	12 hours	28.1	12 hours	39.1
9.01	12 hours	5.97	12 hours	8.48
10.01	12 hours	3.50	9 hours	5.24
10.02	12 hours	8.46	12 hours	12.5
11.01	12 hours	4.93	12 hours	7.26
12.01	12 hours	4.91	9 hours	6.76
12.02	12 hours	7.17	9 hours	11.8
12.03	12 hours	11.4	9 hours	18.6
13.01	12 hours	1.42	9 hours	2.67
14.01	12 hours	3.38	9 hours	5.21
14.02	12 hours	4.77	9 hours	6.42
15.01	12 hours	0.610	6 hours	1.27
16.01	18 hours	4.18	12 hours	5.68
16.02	12 hours	6.36	12 hours	8.67
17.01	12 hours	6.74	12 hours	9.29
17.02	12 hours	15.5	12 hours	21.9
17.03	12 hours	19.9	12 hours	28.4
17.04	12 hours	28.3	12 hours	39.4
17.05	12 hours	33.4	12 hours	46.5
17.06	12 hours	41.7	12 hours	57.5
17.07	12 hours	47.5	12 hours	66.3
17.08	12 hours	65.2	12 hours	92.4
17.09	12 hours	66.7	12 hours	94.6
17.10	12 hours	72.0	12 hours	102
17.11	12 hours	101	12 hours	141
17.12	12 hours	103	12 hours	144
17.13	12 hours	104	12 hours	145
18.01	12 hours	6.20	12 hours	8.91
19.01	12 hours	3.04	12 hours	4.40
20.01	18 hours	7.04	12 hours	9.41
21.01	12 hours	5.79	12 hours	7.88
21.02	12 hours	6.50	12 hours	8.91
22.01	12 hours	5.41	9 hours	7.39
23.01	12 hours	3.75	12 hours	5.52
23.02	12 hours	11.9	12 hours	17.6
23.03	12 hours	16.3	9 hours	24.2
23.04	12 hours	16.5	9 hours	24.5
24.01	12 hours	4.79	12 hours	7.08
25.01	12 hours	1.72	9 hours	3.18
26.01	12 hours	5.04	12 hours	7.06
26.02	12 hours	5.11	12 hours	7.16
27.01	12 hours	6.62	12 hours	9.59
27.02	12 hours	14.4	12 hours	20.3
27.03	12 hours	23.6	12 hours	33.3
28.01	12 hours	1.42	9 hours	2.67
28.02	12 hours	1.92	9 hours	3.59
29.01	12 hours	5.74	12 hours	8.03
30.01	12 hours	2.00	9 hours	2.67
31.01	12 hours	1.22	9 hours	1.86
32.01	12 hours	6.80	12 hours	9.46

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
33.01	12 hours	3.33	12 hours	4.78
34.01	12 hours	5.00	12 hours	7.12
34.02	12 hours	12.1	9 hours	18.9
34.03	12 hours	12.3	9 hours	19.2
35.01	12 hours	3.40	12 hours	4.87
35.02	18 hours	6.84	12 hours	9.51
35.03	12 hours	9.33	12 hours	13.0
35.04	12 hours	9.46	12 hours	13.2
35.05	12 hours	14.8	12 hours	21.1
36.01	12 hours	0.430	9 hours	0.800
37.01	12 hours	2.85	12 hours	4.04
38.01	12 hours	2.83	12 hours	3.97
38.02	12 hours	3.47	12 hours	4.90
39.01	12 hours	3.97	12 hours	5.72
39.02	12 hours	8.21	9 hours	13.0
39.03	12 hours	12.5	9 hours	20.0
39.04	12 hours	23.8	9 hours	35.1
39.05	12 hours	30.2	9 hours	43.9
39.06	12 hours	55.6	12 hours	79.3
40.01	12 hours	2.24	9 hours	4.19
41.01	12 hours	2.79	9 hours	5.31
42.01	12 hours	5.65	12 hours	8.17
43.01	12 hours	2.15	9 hours	2.98
44.01	12 hours	6.11	9 hours	9.37
44.02	12 hours	15.3	9 hours	22.6
44.03	12 hours	23.4	12 hours	33.2
45.01	12 hours	4.83	9 hours	6.95
46.01	12 hours	5.62	12 hours	7.61
47.01	12 hours	5.24	9 hours	8.04
47.02	12 hours	7.34	9 hours	11.3
47.03	12 hours	7.94	9 hours	12.5
47.04	12 hours	16.3	9 hours	24.8
47.05	12 hours	20.9	9 hours	32.6
48.01	12 hours	2.02	9 hours	3.23
49.01	12 hours	3.40	9 hours	4.86
49.02	12 hours	3.32	9 hours	5.63
49.03	12 hours	3.38	9 hours	5.70
50.01	12 hours	0.590	6 hours	1.28
51.01	12 hours	1.91	9 hours	3.23
52.01	12 hours	0.890	9 hours	1.65
52.02	12 hours	2.10	9 hours	3.52
53.01	12 hours	2.98	12 hours	4.39
54.01	12 hours	1.36	9 hours	1.83
54.02	12 hours	1.75	9 hours	2.86
54.03	12 hours	2.02	9 hours	3.29
55.01	12 hours	1.68	9 hours	2.49
56.01	12 hours	2.00	9 hours	3.54
56.02	12 hours	3.32	9 hours	5.49
56.03	12 hours	3.91	9 hours	6.35
57.01	12 hours	1.71	9 hours	3.01

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
57.02	12 hours	4.01	9 hours	5.29
58.01	12 hours	3.11	9 hours	4.38
58.02	12 hours	4.56	9 hours	6.42
58.03	12 hours	6.63	9 hours	9.42
58.04	12 hours	11.1	9 hours	16.5
58.05	12 hours	11.9	9 hours	17.4
58.06	12 hours	17.3	9 hours	25.0
58.07	12 hours	19.9	9 hours	28.1
59.01	12 hours	1.68	9 hours	2.22
60.01	12 hours	1.32	9 hours	2.41
60.02	12 hours	1.72	9 hours	3.05
60.03	12 hours	3.67	9 hours	5.73
61.01	12 hours	1.26	9 hours	1.64
62.01	12 hours	0.260	9 hours	0.480
63.01	12 hours	0.020	2 hours	0.080
64.01	12 hours	0.740	9 hours	1.30
64.02	12 hours	4.02	9 hours	6.55
65.01	12 hours	0.430	9 hours	0.770
66.01	12 hours	0.560	9 hours	1.05
66.02	12 hours	1.88	9 hours	2.93
67.01	12 hours	0.110	1.50 hour	0.450
68.01	12 hours	0.170	2 hours	0.610
69.01	12 hours	0.170	1.50 hour	0.720
69.02	12 hours	0.300	1.50 hour	1.01
70.01	12 hours	0.130	1.50 hour	0.440
71.01	12 hours	0.150	1.50 hour	0.580
72.01	12 hours	0.170	1.50 hour	0.620
73.01	12 hours	0.120	2 hours	0.440
74.01	12 hours	0.990	9 hours	1.63
75.01	48 hours	0.770	2 hours	0.760
75.02	48 hours	0.920	2 hours	0.810
76.01	12 hours	0.710	9 hours	1.20
76.02	12 hours	0.760	9 hours	1.26
77.01	12 hours	1.72	9 hours	2.71
77.02	12 hours	3.80	9 hours	6.13
77.03	12 hours	7.17	9 hours	10.4
77.04	12 hours	7.99	9 hours	11.9
77.05	12 hours	8.51	9 hours	12.8
77.06	12 hours	8.63	9 hours	13.0
77.07	12 hours	16.7	9 hours	26.7
77.08	12 hours	17.1	9 hours	27.1
77.09	12 hours	17.2	9 hours	27.3
77.10	12 hours	17.5	9 hours	27.8
77.11	12 hours	20.1	9 hours	31.7
77.12	12 hours	22.5	9 hours	34.7
77.13	12 hours	27.3	9 hours	40.1
78.01	12 hours	1.60	9 hours	2.38
78.02	12 hours	3.75	9 hours	5.81
79.01	12 hours	1.09	9 hours	1.90
80.01	12 hours	0.500	9 hours	0.900

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
81.01	12 hours	1.07	9 hours	1.77
81.02	12 hours	1.18	9 hours	1.99
81.03	12 hours	2.41	9 hours	4.26
81.04	12 hours	4.49	9 hours	8.34
82.01	12 hours	0.240	4.50 hours	0.600
82.02	12 hours	1.01	9 hours	1.83
82.03	12 hours	1.15	9 hours	2.12
83.01	12 hours	0.750	9 hours	1.37
83.02	12 hours	1.50	9 hours	2.90
83.03	12 hours	1.66	2 hours	3.24
84.01	12 hours	0.150	1.50 hour	0.450
84.02	12 hours	0.530	2 hours	1.39
85.01	12 hours	0.280	4.50 hours	0.680
86.01	12 hours	0.040	1.50 hour	0.220
87.01	12 hours	0.220	1.50 hour	0.710
87.02	12 hours	0.400	4.50 hours	1.13
88.01	12 hours	0.080	4.50 hours	0.260
89.01	12 hours	0.130	1.50 hour	0.280
90.01	12 hours	0.080	1.50 hour	0.250
91.01	12 hours	0.250	2 hours	0.850
92.01	12 hours	0.380	9 hours	0.600
92.02	12 hours	1.58	9 hours	2.18
92.03	12 hours	1.70	9 hours	2.33
92.04	12 hours	2.50	2 hours	4.14
93.01	12 hours	0.130	6 hours	0.260
94.01	12 hours	0.150	1.50 hour	0.500
95.01	12 hours	0.190	1.50 hour	0.650
96.01	12 hours	0.080	1.50 hour	0.320
97.01	12 hours	0.090	3 min	0.360
98.01	12 hours	0.250	6 hours	0.490
99.01	12 hours	1.37	12 hours	1.80
99.02	12 hours	1.85	9 hours	2.44
100.01	12 hours	0.040	1.50 hour	0.140
101.01	12 hours	0.030	1.50 hour	0.150
102.01	12 hours	0.060	1.50 hour	0.210
103.01	12 hours	0.040	3 min	0.200
104.01	12 hours	0.110	3 min	0.390
104.02	12 hours	0.300	2 hours	0.920
105.01	12 hours	0.030	3 min	0.160
106.01	18 hours	2.65	12 hours	2.72
106.02	18 hours	3.85	12 hours	4.60
107.01	12 hours	1.57	9 hours	2.00
108.01	12 hours	0.890	12 hours	1.16
108.02	12 hours	0.910	12 hours	1.19
109.01	12 hours	1.86	9 hours	2.83
110.01	12 hours	1.09	9 hours	1.83
111.01	12 hours	0.530	6 hours	1.19
112.01	12 hours	0.400	4.50 hours	0.940
113.01	12 hours	0.190	4.50 hours	0.550
114.01	12 hours	6.13	12 hours	8.64

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
114.02	12 hours	9.27	12 hours	13.0
114.03	12 hours	18.1	12 hours	24.4
114.04	18 hours	27.8	12 hours	37.6
114.05	18 hours	37.4	12 hours	47.3
114.06	12 hours	91.2	12 hours	120
114.07	12 hours	98.8	12 hours	130
114.08	12 hours	107	12 hours	141
114.09	12 hours	110	12 hours	145
114.10	12 hours	116	12 hours	153
114.11	12 hours	124	12 hours	165
114.12	12 hours	126	12 hours	168
114.13	12 hours	142	12 hours	188
114.14	12 hours	148	12 hours	195
114.15	12 hours	149	12 hours	196
114.16	12 hours	320	12 hours	419
114.17	12 hours	341	12 hours	446
114.18	12 hours	348	12 hours	453
114.19	12 hours	350	12 hours	456
114.20	12 hours	354	12 hours	461
114.21	12 hours	382	12 hours	494
114.22	12 hours	386	12 hours	499
114.23	12 hours	387	12 hours	501
114.24	12 hours	390	12 hours	505
114.25	12 hours	396	12 hours	513
115.01	12 hours	2.88	9 hours	4.07
116.01	12 hours	5.52	12 hours	7.23
117.01	12 hours	3.72	9 hours	5.73
118.01	18 hours	9.39	12 hours	9.60
119.01	12 hours	10.4	12 hours	13.1
119.02	12 hours	16.5	12 hours	21.1
119.03	12 hours	44.2	12 hours	59.4
119.04	12 hours	51.3	12 hours	68.8
120.01	12 hours	4.14	12 hours	5.72
121.01	12 hours	5.82	9 hours	8.53
121.02	12 hours	15.0	9 hours	21.5
121.03	12 hours	19.6	9 hours	28.3
121.04	12 hours	25.9	9 hours	36.5
122.01	12 hours	6.99	9 hours	9.79
123.01	12 hours	4.21	9 hours	5.36
124.01	12 hours	5.38	12 hours	7.06
125.01	12 hours	4.39	9 hours	6.33
126.01	12 hours	7.24	12 hours	10.0
127.01	12 hours	5.37	9 hours	7.40
128.01	12 hours	4.36	9 hours	6.34
129.01	12 hours	4.04	9 hours	5.51
129.02	12 hours	6.64	9 hours	11.1
129.03	12 hours	8.53	9 hours	14.4
130.01	12 hours	2.14	9 hours	3.77
131.01	12 hours	1.69	9 hours	2.95
131.02	12 hours	6.76	12 hours	9.10

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
131.03	12 hours	10.4	12 hours	14.2
132.01	12 hours	3.26	9 hours	4.68
133.01	12 hours	8.50	9 hours	12.1
133.02	12 hours	18.2	9 hours	26.6
133.03	12 hours	29.5	9 hours	40.2
133.04	12 hours	33.3	9 hours	46.4
133.05	12 hours	42.0	9 hours	57.9
133.06	12 hours	42.2	9 hours	58.2
133.07	12 hours	73.4	12 hours	97.0
133.08	12 hours	76.0	12 hours	97.8
133.09	12 hours	91.1	12 hours	118
133.10	12 hours	100	12 hours	131
133.11	12 hours	114	12 hours	147
133.12	12 hours	157	12 hours	206
133.13	12 hours	165	12 hours	216
133.14	12 hours	168	12 hours	220
134.01	12 hours	6.35	9 hours	9.42
135.01	12 hours	8.18	12 hours	10.5
136.01	12 hours	3.45	9 hours	4.75
137.01	12 hours	4.25	9 hours	5.46
138.01	18 hours	12.9	12 hours	13.8
138.02	18 hours	15.9	12 hours	17.7
138.03	18 hours	27.5	12 hours	33.2
139.01	12 hours	5.69	12 hours	7.53
139.02	12 hours	10.7	12 hours	14.0
140.01	12 hours	0.620	6 hours	1.37
141.01	12 hours	8.33	9 hours	11.7
141.02	12 hours	9.84	9 hours	14.1
142.01	12 hours	1.10	9 hours	1.92
143.01	12 hours	6.47	9 hours	9.84
144.01	12 hours	6.16	9 hours	8.78
145.01	12 hours	4.51	9 hours	6.61
145.02	12 hours	12.6	12 hours	16.6
145.03	12 hours	19.5	12 hours	26.1
145.04	12 hours	37.4	12 hours	49.5
145.05	12 hours	37.5	12 hours	49.7
145.06	12 hours	43.0	12 hours	57.9
146.01	12 hours	5.97	12 hours	7.77
147.01	12 hours	4.05	9 hours	5.32
148.01	12 hours	8.66	12 hours	11.1
148.02	12 hours	13.5	12 hours	17.3
148.03	12 hours	17.8	12 hours	23.2
149.01	12 hours	3.92	9 hours	5.52
150.01	12 hours	3.66	12 hours	5.01
151.01	12 hours	3.65	9 hours	5.02
152.01	12 hours	1.32	9 hours	2.45
153.01	12 hours	4.22	9 hours	6.33
154.01	12 hours	1.70	9 hours	2.95
154.02	12 hours	2.24	9 hours	4.05
155.01	18 hours	6.26	12 hours	7.45

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
155.02	18 hours	6.35	12 hours	7.58
155.03	12 hours	10.5	12 hours	13.6
155.04	12 hours	11.0	12 hours	14.2
155.05	12 hours	17.7	12 hours	23.2
155.06	12 hours	20.8	12 hours	27.7
156.01	12 hours	3.67	12 hours	4.96
156.02	12 hours	3.83	12 hours	5.16
157.01	12 hours	2.72	12 hours	3.68
158.01	12 hours	1.42	9 hours	2.10
159.01	12 hours	1.64	9 hours	2.19
160.01	12 hours	2.82	12 hours	3.92
160.02	12 hours	3.04	9 hours	4.24
161.01	12 hours	5.53	12 hours	7.02
162.01	12 hours	0.510	6 hours	1.13
162.02	12 hours	3.36	12 hours	4.49
162.03	12 hours	3.42	12 hours	4.58
163.01	12 hours	0.740	9 hours	1.43
163.02	12 hours	2.11	9 hours	3.80
163.03	12 hours	6.45	12 hours	9.03
163.04	12 hours	9.84	12 hours	13.3
163.05	18 hours	20.4	12 hours	26.5
163.06	18 hours	21.2	12 hours	27.5
164.01	18 hours	7.31	12 hours	8.46
165.01	18 hours	3.50	12 hours	4.29
165.02	12 hours	4.06	12 hours	5.10
166.01	12 hours	1.30	9 hours	1.82
166.02	12 hours	2.33	9 hours	3.50
166.03	12 hours	4.05	12 hours	5.46
167.01	12 hours	0.880	9 hours	1.56
167.02	12 hours	1.66	9 hours	2.92
168.01	12 hours	2.75	9 hours	3.53
168.02	12 hours	2.36	9 hours	3.55
169.01	12 hours	4.29	12 hours	5.82
169.02	12 hours	4.88	9 hours	6.69
170.01	12 hours	0.750	9 hours	1.39
171.01	12 hours	0.830	9 hours	1.36
172.01	12 hours	0.550	9 hours	1.00
173.01	12 hours	1.02	9 hours	1.82
173.02	12 hours	7.52	9 hours	10.7
173.03	12 hours	14.7	9 hours	20.6
173.04	12 hours	16.1	9 hours	22.0
173.05	12 hours	20.6	9 hours	27.0
173.06	12 hours	26.8	12 hours	33.6
173.07	12 hours	48.5	9 hours	65.0
174.01	12 hours	0.810	9 hours	1.55
175.01	12 hours	0.640	9 hours	1.13
176.01	12 hours	0.590	6 hours	1.13
176.02	12 hours	3.08	9 hours	4.81
177.01	18 hours	2.24	30 hours	2.19
178.01	12 hours	1.73	12 hours	2.29

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
179.01	12 hours	0.360	9 hours	0.490
180.01	18 hours	2.34	12 hours	2.47
180.02	18 hours	2.59	12 hours	2.75
181.01	12 hours	1.78	12 hours	2.38
182.01	12 hours	0.260	6 hours	0.580
183.01	12 hours	2.56	9 hours	4.52
183.02	12 hours	4.90	9 hours	7.78
183.03	12 hours	8.80	9 hours	13.3
183.04	12 hours	13.5	9 hours	20.0
183.05	12 hours	14.1	9 hours	20.9
183.06	12 hours	21.4	9 hours	31.9
184.01	12 hours	0.490	6 hours	0.950
184.02	12 hours	2.93	9 hours	4.23
185.01	12 hours	0.610	6 hours	1.34
185.02	12 hours	2.60	9 hours	3.92
186.01	12 hours	1.13	9 hours	1.91
187.01	12 hours	1.64	9 hours	2.13
187.02	12 hours	3.08	9 hours	3.93
188.01	12 hours	0.460	9 hours	0.880
189.01	12 hours	0.480	6 hours	1.00
190.01	12 hours	0.320	4.50 hours	0.780
191.01	12 hours	0.860	9 hours	1.45
192.01	12 hours	1.04	6 hours	2.35
193.01	12 hours	0.880	4.50 hours	2.20
194.01	12 hours	0.160	4.50 hours	0.490
195.01	12 hours	0.300	4.50 hours	0.850
196.01	12 hours	0.350	4.50 hours	0.910
197.01	12 hours	0.290	1.50 hour	0.920
198.01	12 hours	0.410	4.50 hours	1.09
199.01	12 hours	0.900	9 hours	1.61
199.02	12 hours	1.21	9 hours	2.29
200.01	12 hours	0.160	4.50 hours	0.510
201.01	12 hours	0.380	4.50 hours	1.05
202.01	18 hours	3.03	12 hours	3.70
203.01	12 hours	0.550	4.50 hours	1.34
204.01	12 hours	0.370	4.50 hours	1.12
205.01	12 hours	0.490	4.50 hours	1.36
206.01	12 hours	0.130	1.50 hour	0.540
207.01	12 hours	0.470	3 min	1.74
208.01	12 hours	0.660	9 hours	1.26
208.02	12 hours	0.940	12 hours	1.84
208.03	12 hours	1.74	12 hours	3.32
208.04	12 hours	3.21	9 hours	4.99
208.05	12 hours	3.82	9 hours	5.70
208.06	18 hours	4.62	9 hours	6.36
209.01	12 hours	0.120	3 min	0.530
210.01	12 hours	0.240	3 min	0.710
211.01	12 hours	0.240	4.50 hours	0.670
211.02	12 hours	0.280	4.50 hours	0.770
211.03	12 hours	0.980	1.50 hour	2.20

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
212.01	12 hours	0.110	1.50 hour	0.630
_junc_10	12 hours	20.6	12 hours	27.4
_junc_108	12 hours	0.430	1.50 hour	1.10
_junc_11	12 hours	341	12 hours	445
_junc_111	12 hours	2.33	9 hours	4.10
_junc_114	12 hours	1.37	12 hours	1.80
_junc_12	12 hours	10.5	9 hours	15.5
_junc_13	12 hours	104	12 hours	137
_junc_138	12 hours	7.23	9 hours	11.2
_junc_14	12 hours	88.3	12 hours	116
_junc_142	12 hours	5.56	9 hours	9.25
_junc_143	12 hours	167	12 hours	219
_junc_15	12 hours	317	12 hours	416
_junc_16	12 hours	347	12 hours	453
_junc_165	12 hours	23.4	9 hours	35.7
_junc_168	12 hours	21.8	9 hours	34.0
_junc_17	12 hours	98.5	12 hours	130
_junc_174	12 hours	15.8	9 hours	23.4
_junc_18	18 hours	37.3	12 hours	47.1
_junc_181	12 hours	0.070	1.50 hour	0.340
_junc_185	12 hours	0.080	1.50 hour	0.320
_junc_186	12 hours	0.240	1.50 hour	0.860
_junc_187	12 hours	1.87	9 hours	2.71
_junc_19	12 hours	137	12 hours	182
_junc_193	12 hours	7.93	9 hours	12.0
_junc_194	12 hours	11.4	9 hours	17.1
_junc_199	12 hours	13.6	9 hours	20.1
_junc_2	12 hours	161	12 hours	212
_junc_20	12 hours	114	12 hours	151
_junc_204	12 hours	5.95	9 hours	8.61
_junc_21	12 hours	124	12 hours	165
_junc_22	12 hours	354	12 hours	461
_junc_228	12 hours	0.400	2 hours	1.31
_junc_23	12 hours	358	12 hours	466
_junc_231	12 hours	145	12 hours	191
_junc_232	12 hours	18.1	9 hours	28.0
_junc_233	12 hours	25.6	9 hours	38.1
_junc_234	12 hours	345	12 hours	484
_junc_24	12 hours	21.7	12 hours	29.9
_junc_25	18 hours	16.4	12 hours	21.8
_junc_26	12 hours	14.8	12 hours	20.3
_junc_263	12 hours	8.50	12 hours	12.6
_junc_265	12 hours	8.32	9 hours	12.4
_junc_27	12 hours	8.97	12 hours	12.6
_junc_28	12 hours	387	12 hours	501
_junc_29	12 hours	386	12 hours	499
_junc_3	12 hours	13.8	12 hours	17.9
_junc_30	12 hours	389	12 hours	504
_junc_31	12 hours	11.2	9 hours	18.2
_junc_32	12 hours	395	12 hours	511

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
_junc_324	12 hours	349	12 hours	489
_junc_328	12 hours	405	12 hours	561
_junc_329	12 hours	23.2	12 hours	29.6
_junc_33	12 hours	11.3	9 hours	18.1
_junc_330	12 hours	48.1	9 hours	64.8
_junc_331	12 hours	836	12 hours	1120
_junc_34	12 hours	17.5	9 hours	27.7
_junc_35	12 hours	5.97	9 hours	9.17
_junc_36	12 hours	339	12 hours	476
_junc_37	12 hours	12.9	12 hours	18.2
_junc_38	12 hours	10.2	9 hours	16.2
_junc_39	12 hours	376	12 hours	524
_junc_4	12 hours	14.3	12 hours	18.8
_junc_40	12 hours	18.5	12 hours	26.3
_junc_41	12 hours	11.1	9 hours	16.5
_junc_42	12 hours	21.0	12 hours	29.6
_junc_43	12 hours	53.6	9 hours	76.5
_junc_44	12 hours	353	12 hours	494
_junc_45	12 hours	316	12 hours	442
_junc_46	12 hours	27.1	12 hours	37.8
_junc_47	12 hours	357	12 hours	499
_junc_48	12 hours	260	12 hours	364
_junc_49	12 hours	12.4	9 hours	18.8
_junc_5	12 hours	12.9	9 hours	18.3
_junc_50	12 hours	40.2	12 hours	55.4
_junc_51	12 hours	254	12 hours	356
_junc_52	12 hours	45.9	12 hours	63.9
_junc_53	12 hours	12.2	12 hours	17.3
_junc_54	12 hours	63.7	12 hours	90.3
_junc_55	12 hours	71.9	12 hours	102
_junc_56	12 hours	233	12 hours	329
_junc_57	12 hours	96.4	12 hours	135
_junc_58	12 hours	220	12 hours	311
_junc_59	12 hours	206	12 hours	292
_junc_6	12 hours	42.1	12 hours	56.5
_junc_60	12 hours	215	12 hours	304
_junc_61	12 hours	20.2	12 hours	28.3
_junc_62	12 hours	98.0	12 hours	141
_junc_63	12 hours	87.4	9 hours	127
_junc_64	12 hours	39.9	9 hours	60.6
_junc_65	12 hours	13.3	9 hours	18.2
_junc_66	12 hours	74.5	12 hours	108
_junc_67	12 hours	44.7	9 hours	67.1
_junc_68	12 hours	31.9	9 hours	49.5
_junc_69	12 hours	23.7	9 hours	36.8
_junc_7	12 hours	48.6	12 hours	65.4
_junc_70	12 hours	18.3	9 hours	28.1
_junc_71	12 hours	15.0	12 hours	20.6
_junc_72	12 hours	26.9	12 hours	37.5
_junc_73	12 hours	12.9	9 hours	19.6

10% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
_junc_74	12 hours	8.42	12 hours	12.5
_junc_75	18 hours	26.3	12 hours	31.5
_junc_76	12 hours	10.5	12 hours	13.9
_junc_77	12 hours	26.1	9 hours	35.9
_junc_78	12 hours	32.3	9 hours	44.8
_junc_79	12 hours	36.8	9 hours	51.8
_junc_8	12 hours	18.7	9 hours	26.9
_junc_80	12 hours	14.8	9 hours	21.5
_junc_81	12 hours	69.4	12 hours	90.0
_junc_82	12 hours	15.9	9 hours	21.5
_junc_83	12 hours	12.7	12 hours	16.4
_junc_84	12 hours	85.5	12 hours	111
_junc_85	12 hours	17.1	12 hours	22.3
_junc_86	12 hours	106	12 hours	139
_junc_87	12 hours	37.2	12 hours	49.2
_junc_88	12 hours	40.5	12 hours	54.3
_junc_89	12 hours	97.2	12 hours	127
_junc_9	12 hours	24.8	9 hours	34.9
_junc_90	12 hours	156	12 hours	204
_junc_91	12 hours	9.93	12 hours	12.7

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
1.01	12 hours	12.4	9 hours	19.7
1.02	12 hours	16.2	9 hours	26.5
1.03	12 hours	22.6	9 hours	37.8
1.04	12 hours	32.1	9 hours	53.4
1.05	12 hours	41.1	9 hours	68.1
1.06	12 hours	41.9	9 hours	69.6
1.07	12 hours	49.8	9 hours	81.3
1.08	12 hours	54.7	9 hours	88.7
1.09	12 hours	56.3	9 hours	91.1
1.10	12 hours	91.7	9 hours	142
1.11	12 hours	110	9 hours	173
1.12	12 hours	123	9 hours	189
1.13	12 hours	249	12 hours	378
1.14	12 hours	259	12 hours	393
1.15	12 hours	260	12 hours	393
1.16	12 hours	264	12 hours	401
1.17	12 hours	285	12 hours	431
1.18	12 hours	305	12 hours	462
1.19	12 hours	310	12 hours	469
1.20	12 hours	378	12 hours	571
1.21	12 hours	380	12 hours	574
1.22	12 hours	408	9 hours	616
1.23	12 hours	414	9 hours	627
1.24	12 hours	415	9 hours	627
1.25	12 hours	416	9 hours	630
1.26	12 hours	421	9 hours	637
1.27	12 hours	425	9 hours	643
1.28	12 hours	426	9 hours	644
1.29	12 hours	449	9 hours	678
1.30	12 hours	451	9 hours	680
1.31	12 hours	486	9 hours	732
1.32	12 hours	486	9 hours	732
1.33	12 hours	953	9 hours	1375
1.34	12 hours	954	9 hours	1377
1.35	12 hours	1006	9 hours	1450
1.36	12 hours	1007	9 hours	1451
1.37	12 hours	1008	9 hours	1451
1.38	12 hours	1009	9 hours	1452
1.39	12 hours	1014	9 hours	1458
1.40	12 hours	1022	9 hours	1467
2.01	12 hours	3.15	9 hours	5.84
3.01	12 hours	5.71	9 hours	9.82
4.01	12 hours	6.08	9 hours	9.86
5.01	12 hours	6.28	9 hours	10.5
6.01	12 hours	6.34	12 hours	9.51
7.01	12 hours	4.06	12 hours	6.16
8.01	18 hours	11.3	12 hours	16.1
8.02	12 hours	22.3	12 hours	32.9
8.03	12 hours	22.3	12 hours	32.9
8.04	12 hours	32.6	12 hours	48.8

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
8.05	12 hours	33.6	12 hours	50.4
9.01	12 hours	7.16	12 hours	10.9
10.01	12 hours	4.24	9 hours	6.80
10.02	12 hours	10.3	9 hours	16.2
11.01	12 hours	5.96	9 hours	9.39
12.01	12 hours	4.99	9 hours	8.68
12.02	12 hours	8.66	9 hours	15.2
12.03	12 hours	13.8	9 hours	24.0
13.01	12 hours	1.66	9 hours	3.36
14.01	12 hours	4.10	9 hours	6.71
14.02	12 hours	4.96	9 hours	8.27
15.01	12 hours	0.690	6 hours	1.62
16.01	12 hours	5.17	12 hours	7.51
16.02	12 hours	7.81	12 hours	11.4
17.01	12 hours	8.04	12 hours	12.0
17.02	12 hours	18.6	12 hours	28.1
17.03	12 hours	23.9	12 hours	36.3
17.04	12 hours	33.8	12 hours	50.7
17.05	12 hours	39.8	12 hours	59.9
17.06	12 hours	49.7	12 hours	74.3
17.07	12 hours	56.8	12 hours	85.2
17.08	12 hours	78.3	9 hours	119
17.09	12 hours	80.1	9 hours	122
17.10	12 hours	86.3	12 hours	130
17.11	12 hours	121	12 hours	182
17.12	12 hours	123	12 hours	185
17.13	12 hours	124	12 hours	187
18.01	12 hours	7.49	12 hours	11.4
19.01	12 hours	3.65	12 hours	5.62
20.01	12 hours	8.71	12 hours	12.5
21.01	12 hours	7.20	12 hours	10.4
21.02	12 hours	8.07	12 hours	11.7
22.01	12 hours	5.50	9 hours	9.50
23.01	12 hours	4.52	9 hours	7.13
23.02	12 hours	14.4	9 hours	22.5
23.03	12 hours	19.6	9 hours	31.4
23.04	12 hours	19.9	9 hours	31.8
24.01	12 hours	5.81	9 hours	9.18
25.01	12 hours	2.03	9 hours	4.02
26.01	12 hours	6.17	12 hours	9.18
26.02	12 hours	6.26	12 hours	9.31
27.01	12 hours	8.01	12 hours	12.3
27.02	12 hours	17.3	12 hours	26.0
27.03	12 hours	29.1	12 hours	43.2
28.01	12 hours	1.64	9 hours	3.35
28.02	12 hours	2.23	9 hours	4.52
29.01	12 hours	6.86	12 hours	10.3
30.01	12 hours	2.05	9 hours	3.43
31.01	12 hours	1.48	9 hours	2.40
32.01	12 hours	8.35	12 hours	12.3

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
33.01	12 hours	4.03	12 hours	6.12
34.01	12 hours	5.96	12 hours	9.11
34.02	12 hours	14.7	9 hours	24.4
34.03	12 hours	14.9	9 hours	24.7
35.01	12 hours	4.11	12 hours	6.23
35.02	12 hours	8.46	12 hours	12.5
35.03	12 hours	11.5	12 hours	17.0
35.04	12 hours	11.6	12 hours	17.2
35.05	12 hours	18.3	12 hours	27.3
36.01	12 hours	0.510	9 hours	1.01
37.01	12 hours	3.42	12 hours	5.16
38.01	12 hours	3.47	12 hours	5.16
38.02	12 hours	4.26	12 hours	6.31
39.01	12 hours	4.80	12 hours	7.31
39.02	12 hours	9.97	9 hours	16.8
39.03	12 hours	14.5	9 hours	25.6
39.04	12 hours	28.9	9 hours	45.6
39.05	12 hours	36.5	9 hours	57.1
39.06	12 hours	67.1	9 hours	103
40.01	12 hours	2.60	9 hours	5.26
41.01	12 hours	3.27	9 hours	6.66
42.01	12 hours	6.84	9 hours	10.5
43.01	12 hours	2.19	9 hours	3.81
44.01	12 hours	7.44	9 hours	12.1
44.02	12 hours	18.6	9 hours	29.3
44.03	12 hours	28.2	9 hours	42.6
45.01	12 hours	4.90	9 hours	8.82
46.01	12 hours	6.88	12 hours	9.99
47.01	12 hours	6.30	9 hours	10.3
47.02	12 hours	8.81	9 hours	14.6
47.03	12 hours	9.54	9 hours	16.1
47.04	12 hours	19.6	9 hours	32.0
47.05	12 hours	25.3	9 hours	42.0
48.01	12 hours	2.40	9 hours	4.14
49.01	12 hours	3.46	9 hours	6.19
49.02	12 hours	3.94	9 hours	7.21
49.03	12 hours	3.99	9 hours	7.31
50.01	12 hours	0.660	6 hours	1.61
51.01	12 hours	2.30	9 hours	4.11
52.01	12 hours	1.04	9 hours	2.08
52.02	12 hours	2.50	9 hours	4.49
53.01	12 hours	3.64	9 hours	5.65
54.01	12 hours	1.41	9 hours	2.35
54.02	12 hours	2.06	9 hours	3.66
54.03	12 hours	2.32	9 hours	4.21
55.01	12 hours	1.73	9 hours	3.15
56.01	12 hours	2.39	9 hours	4.48
56.02	12 hours	3.98	9 hours	6.97
56.03	12 hours	4.68	9 hours	8.07
57.01	12 hours	2.07	9 hours	3.83

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
57.02	12 hours	4.84	9 hours	6.82
58.01	12 hours	3.80	9 hours	5.65
58.02	12 hours	5.56	9 hours	8.27
58.03	12 hours	8.05	9 hours	12.1
58.04	12 hours	13.5	9 hours	21.1
58.05	12 hours	14.5	9 hours	22.3
58.06	12 hours	21.0	9 hours	32.0
58.07	12 hours	24.0	9 hours	36.1
59.01	12 hours	1.71	9 hours	2.82
60.01	12 hours	1.59	9 hours	3.05
60.02	12 hours	2.04	9 hours	3.84
60.03	12 hours	4.41	9 hours	7.30
61.01	12 hours	1.30	9 hours	2.08
62.01	12 hours	0.300	9 hours	0.590
63.01	12 hours	0.030	2 hours	0.110
64.01	12 hours	0.880	9 hours	1.63
64.02	12 hours	4.89	9 hours	8.32
65.01	12 hours	0.510	9 hours	0.960
66.01	12 hours	0.630	6 hours	1.32
66.02	12 hours	2.27	9 hours	3.75
67.01	12 hours	0.120	1.50 hour	0.570
68.01	12 hours	0.200	2 hours	0.780
69.01	12 hours	0.200	1.50 hour	0.910
69.02	12 hours	0.340	1.50 hour	1.27
70.01	12 hours	0.150	1.50 hour	0.560
71.01	12 hours	0.160	1.50 hour	0.730
72.01	12 hours	0.190	1.50 hour	0.790
73.01	12 hours	0.140	2 hours	0.570
74.01	12 hours	1.20	9 hours	2.05
75.01	48 hours	1.06	2 hours	0.910
75.02	36 hours	1.25	36 hours	1.07
76.01	12 hours	0.850	9 hours	1.50
76.02	12 hours	0.910	9 hours	1.58
77.01	12 hours	2.06	9 hours	3.45
77.02	12 hours	4.54	9 hours	7.79
77.03	12 hours	8.65	9 hours	13.4
77.04	12 hours	9.67	9 hours	15.1
77.05	12 hours	10.3	9 hours	16.3
77.06	12 hours	10.5	9 hours	16.5
77.07	12 hours	20.3	9 hours	33.9
77.08	12 hours	20.8	9 hours	34.4
77.09	12 hours	20.9	9 hours	34.6
77.10	12 hours	21.3	9 hours	35.2
77.11	12 hours	24.3	9 hours	40.2
77.12	12 hours	27.2	9 hours	44.0
77.13	12 hours	32.8	9 hours	51.2
78.01	12 hours	1.94	9 hours	3.04
78.02	12 hours	4.59	9 hours	7.37
79.01	12 hours	1.29	9 hours	2.38
80.01	12 hours	0.570	9 hours	1.12

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
81.01	12 hours	1.28	9 hours	2.22
81.02	12 hours	1.42	9 hours	2.52
81.03	12 hours	2.86	9 hours	5.35
81.04	12 hours	5.28	9 hours	10.3
82.01	12 hours	0.280	4.50 hours	0.780
82.02	12 hours	1.18	9 hours	2.28
82.03	12 hours	1.35	9 hours	2.63
83.01	12 hours	0.850	9 hours	1.70
83.02	12 hours	1.70	4.50 hours	3.65
83.03	12 hours	1.89	4.50 hours	4.04
84.01	12 hours	0.160	1.50 hour	0.560
84.02	12 hours	0.600	2 hours	1.73
85.01	12 hours	0.320	4.50 hours	0.870
86.01	12 hours	0.050	1.50 hour	0.270
87.01	12 hours	0.250	1.50 hour	0.880
87.02	12 hours	0.460	4.50 hours	1.41
88.01	12 hours	0.100	4.50 hours	0.320
89.01	12 hours	0.150	1.50 hour	0.340
90.01	12 hours	0.090	1.50 hour	0.300
91.01	12 hours	0.280	2 hours	1.02
92.01	12 hours	0.470	9 hours	0.760
92.02	12 hours	1.88	9 hours	2.81
92.03	12 hours	2.00	9 hours	3.02
92.04	12 hours	2.91	9 hours	5.08
93.01	12 hours	0.150	6 hours	0.330
94.01	12 hours	0.170	1.50 hour	0.620
95.01	12 hours	0.210	1.50 hour	0.800
96.01	12 hours	0.090	1.50 hour	0.400
97.01	12 hours	0.100	1.50 hour	0.440
98.01	12 hours	0.280	6 hours	0.620
99.01	12 hours	1.66	12 hours	2.31
99.02	12 hours	2.21	9 hours	3.14
100.01	12 hours	0.050	1.50 hour	0.170
101.01	12 hours	0.040	1.50 hour	0.180
102.01	12 hours	0.060	1.50 hour	0.250
103.01	12 hours	0.040	1.50 hour	0.240
104.01	12 hours	0.130	1.50 hour	0.480
104.02	12 hours	0.340	2 hours	1.14
105.01	12 hours	0.030	1.50 hour	0.190
106.01	18 hours	3.30	12 hours	3.66
106.02	18 hours	4.76	12 hours	6.01
107.01	12 hours	1.63	9 hours	2.55
108.01	12 hours	1.09	12 hours	1.50
108.02	12 hours	1.12	12 hours	1.53
109.01	12 hours	2.26	9 hours	3.60
110.01	12 hours	1.31	9 hours	2.30
111.01	12 hours	0.610	4.50 hours	1.51
112.01	12 hours	0.470	4.50 hours	1.22
113.01	12 hours	0.230	4.50 hours	0.700
114.01	12 hours	7.35	12 hours	11.1

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
114.02	12 hours	11.2	12 hours	16.7
114.03	12 hours	21.7	12 hours	31.3
114.04	18 hours	34.4	12 hours	48.9
114.05	18 hours	45.9	12 hours	62.1
114.06	12 hours	109	12 hours	154
114.07	12 hours	118	12 hours	168
114.08	12 hours	128	12 hours	182
114.09	12 hours	132	12 hours	187
114.10	12 hours	139	12 hours	198
114.11	12 hours	148	12 hours	213
114.12	12 hours	150	12 hours	216
114.13	12 hours	170	12 hours	242
114.14	12 hours	177	12 hours	252
114.15	12 hours	178	12 hours	253
114.16	12 hours	381	12 hours	539
114.17	12 hours	406	12 hours	574
114.18	12 hours	413	12 hours	583
114.19	12 hours	416	12 hours	587
114.20	12 hours	421	12 hours	593
114.21	12 hours	453	12 hours	638
114.22	12 hours	458	12 hours	644
114.23	12 hours	460	12 hours	646
114.24	12 hours	464	12 hours	652
114.25	12 hours	471	12 hours	662
115.01	12 hours	3.49	9 hours	5.27
116.01	12 hours	6.59	12 hours	9.27
117.01	12 hours	4.54	9 hours	7.37
118.01	18 hours	11.6	12 hours	12.9
119.01	12 hours	12.7	12 hours	17.2
119.02	12 hours	19.7	12 hours	27.2
119.03	12 hours	53.3	9 hours	76.8
119.04	12 hours	61.7	9 hours	88.8
120.01	12 hours	5.04	9 hours	7.42
121.01	12 hours	7.01	9 hours	11.0
121.02	12 hours	18.2	9 hours	27.7
121.03	12 hours	23.6	9 hours	36.5
121.04	12 hours	31.3	9 hours	47.2
122.01	12 hours	8.47	9 hours	12.7
123.01	12 hours	4.33	9 hours	6.89
124.01	12 hours	6.45	12 hours	9.04
125.01	12 hours	5.33	9 hours	8.14
126.01	12 hours	8.90	12 hours	13.0
127.01	12 hours	6.45	9 hours	9.59
128.01	12 hours	5.23	9 hours	8.20
129.01	12 hours	4.20	9 hours	7.08
129.02	12 hours	7.87	9 hours	14.2
129.03	12 hours	10.1	9 hours	18.3
130.01	12 hours	2.56	9 hours	4.78
131.01	12 hours	1.98	9 hours	3.72
131.02	12 hours	8.32	12 hours	11.9

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
131.03	12 hours	12.8	12 hours	18.5
132.01	12 hours	3.32	9 hours	5.96
133.01	12 hours	10.2	9 hours	15.6
133.02	12 hours	21.9	9 hours	34.1
133.03	12 hours	35.6	9 hours	52.3
133.04	12 hours	40.3	9 hours	60.1
133.05	12 hours	50.6	9 hours	75.1
133.06	12 hours	50.9	9 hours	75.4
133.07	12 hours	90.1	12 hours	125
133.08	12 hours	90.9	12 hours	126
133.09	12 hours	109	12 hours	152
133.10	12 hours	120	12 hours	168
133.11	12 hours	135	12 hours	189
133.12	12 hours	188	12 hours	264
133.13	12 hours	197	12 hours	278
133.14	12 hours	201	12 hours	283
134.01	12 hours	7.67	9 hours	12.1
135.01	12 hours	9.74	12 hours	13.5
136.01	12 hours	3.51	9 hours	6.03
137.01	12 hours	4.34	9 hours	7.02
138.01	18 hours	15.9	12 hours	18.7
138.02	18 hours	19.6	12 hours	23.8
138.03	18 hours	33.4	12 hours	43.8
139.01	12 hours	6.84	12 hours	9.62
139.02	12 hours	13.1	12 hours	18.1
140.01	12 hours	0.710	4.50 hours	1.79
141.01	12 hours	10.0	9 hours	15.1
141.02	12 hours	11.9	9 hours	18.2
142.01	12 hours	1.26	9 hours	2.41
143.01	12 hours	7.81	9 hours	12.6
144.01	12 hours	7.46	9 hours	11.3
145.01	12 hours	5.46	9 hours	8.49
145.02	12 hours	15.1	12 hours	21.3
145.03	12 hours	23.4	9 hours	33.6
145.04	12 hours	44.9	12 hours	63.3
145.05	12 hours	45.0	12 hours	63.5
145.06	12 hours	51.7	9 hours	74.8
146.01	12 hours	7.35	12 hours	10.1
147.01	12 hours	4.11	9 hours	6.80
148.01	12 hours	10.6	12 hours	14.5
148.02	12 hours	16.1	12 hours	22.3
148.03	12 hours	21.3	12 hours	29.7
149.01	12 hours	4.72	9 hours	7.10
150.01	12 hours	4.42	9 hours	6.42
151.01	12 hours	3.77	9 hours	6.45
152.01	12 hours	1.55	9 hours	3.08
153.01	12 hours	5.08	9 hours	8.14
154.01	12 hours	2.07	9 hours	3.74
154.02	12 hours	2.73	9 hours	5.13
155.01	12 hours	7.75	12 hours	9.91

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
155.02	12 hours	7.84	12 hours	10.1
155.03	12 hours	13.1	12 hours	17.6
155.04	12 hours	13.7	12 hours	18.3
155.05	12 hours	21.8	12 hours	29.7
155.06	12 hours	25.7	12 hours	35.3
156.01	12 hours	4.47	12 hours	6.29
156.02	12 hours	4.65	12 hours	6.55
157.01	12 hours	3.28	12 hours	4.67
158.01	12 hours	1.74	9 hours	2.68
159.01	12 hours	1.66	9 hours	2.78
160.01	12 hours	3.44	9 hours	5.06
160.02	12 hours	3.69	9 hours	5.45
161.01	12 hours	6.77	12 hours	9.16
162.01	12 hours	0.590	4.50 hours	1.41
162.02	12 hours	4.13	12 hours	5.77
162.03	12 hours	4.20	12 hours	5.88
163.01	12 hours	0.860	9 hours	1.79
163.02	12 hours	2.56	9 hours	4.83
163.03	12 hours	7.79	9 hours	11.8
163.04	12 hours	11.8	12 hours	17.2
163.05	12 hours	25.3	12 hours	34.9
163.06	12 hours	26.3	12 hours	36.2
164.01	18 hours	9.12	12 hours	11.5
165.01	12 hours	4.35	12 hours	5.69
165.02	12 hours	5.04	12 hours	6.68
166.01	12 hours	1.33	9 hours	2.29
166.02	12 hours	2.83	9 hours	4.47
166.03	12 hours	4.90	9 hours	7.04
167.01	12 hours	1.04	9 hours	1.95
167.02	12 hours	1.97	9 hours	3.65
168.01	12 hours	2.84	9 hours	4.49
168.02	12 hours	2.86	9 hours	4.52
169.01	12 hours	5.18	9 hours	7.45
169.02	12 hours	5.88	9 hours	8.61
170.01	12 hours	0.860	9 hours	1.72
171.01	12 hours	0.970	9 hours	1.71
172.01	12 hours	0.620	9 hours	1.24
173.01	12 hours	1.18	9 hours	2.27
173.02	12 hours	9.11	9 hours	13.8
173.03	12 hours	17.9	9 hours	26.5
173.04	12 hours	19.4	9 hours	28.3
173.05	12 hours	24.7	9 hours	34.9
173.06	12 hours	31.8	9 hours	43.3
173.07	12 hours	57.6	9 hours	83.5
174.01	12 hours	0.940	6 hours	1.96
175.01	12 hours	0.740	9 hours	1.41
176.01	12 hours	0.670	6 hours	1.45
176.02	12 hours	3.65	9 hours	6.12
177.01	18 hours	2.77	30 hours	2.95
178.01	12 hours	2.08	12 hours	2.91

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
179.01	12 hours	0.360	9 hours	0.620
180.01	18 hours	2.90	12 hours	3.31
180.02	18 hours	3.22	12 hours	3.68
181.01	12 hours	2.15	12 hours	3.03
182.01	12 hours	0.300	6 hours	0.720
183.01	12 hours	3.05	9 hours	5.66
183.02	12 hours	5.80	9 hours	9.85
183.03	12 hours	10.4	9 hours	16.9
183.04	12 hours	16.4	9 hours	25.6
183.05	12 hours	17.1	9 hours	26.7
183.06	12 hours	25.9	9 hours	40.7
184.01	12 hours	0.560	6 hours	1.21
184.02	12 hours	3.55	9 hours	5.45
185.01	12 hours	0.690	4.50 hours	1.67
185.02	12 hours	2.96	9 hours	5.02
186.01	12 hours	1.34	9 hours	2.41
187.01	12 hours	1.68	9 hours	2.72
187.02	12 hours	3.19	9 hours	5.01
188.01	12 hours	0.530	6 hours	1.12
189.01	12 hours	0.550	6 hours	1.26
190.01	12 hours	0.370	4.50 hours	1.01
191.01	12 hours	1.03	9 hours	1.83
192.01	12 hours	1.20	4.50 hours	2.98
193.01	12 hours	1.02	4.50 hours	2.85
194.01	12 hours	0.180	2 hours	0.620
195.01	12 hours	0.360	4.50 hours	1.08
196.01	12 hours	0.410	4.50 hours	1.17
197.01	12 hours	0.340	1.50 hour	1.15
198.01	12 hours	0.480	4.50 hours	1.39
199.01	12 hours	1.04	9 hours	2.00
199.02	12 hours	1.41	9 hours	2.84
200.01	12 hours	0.190	4.50 hours	0.630
201.01	12 hours	0.450	4.50 hours	1.34
202.01	12 hours	3.78	12 hours	4.92
203.01	12 hours	0.630	4.50 hours	1.74
204.01	12 hours	0.440	4.50 hours	1.41
205.01	12 hours	0.560	4.50 hours	1.72
206.01	12 hours	0.150	1.50 hour	0.680
207.01	12 hours	0.530	1.50 hour	2.11
208.01	12 hours	0.760	6 hours	1.59
208.02	12 hours	1.06	12 hours	2.30
208.03	12 hours	2.00	12 hours	4.13
208.04	12 hours	3.75	9 hours	6.26
208.05	12 hours	4.72	9 hours	7.22
208.06	18 hours	5.68	9 hours	8.11
209.01	12 hours	0.140	1.50 hour	0.650
210.01	12 hours	0.270	1.50 hour	0.870
211.01	12 hours	0.280	4.50 hours	0.840
211.02	12 hours	0.320	4.50 hours	0.960
211.03	12 hours	1.14	1.50 hour	2.71

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
212.01	12 hours	0.130	1.50 hour	0.780
_junc_10	12 hours	25.4	12 hours	34.9
_junc_108	12 hours	0.490	4.50 hours	1.38
_junc_11	12 hours	405	12 hours	572
_junc_111	12 hours	2.77	9 hours	5.15
_junc_114	12 hours	1.66	12 hours	2.31
_junc_12	12 hours	12.7	9 hours	19.9
_junc_13	12 hours	124	12 hours	177
_junc_138	12 hours	8.70	9 hours	14.4
_junc_14	12 hours	106	12 hours	149
_junc_142	12 hours	6.73	9 hours	11.8
_junc_143	12 hours	200	12 hours	281
_junc_15	12 hours	378	12 hours	536
_junc_16	12 hours	413	12 hours	582
_junc_165	12 hours	28.2	9 hours	45.4
_junc_168	12 hours	26.4	9 hours	43.2
_junc_17	12 hours	118	12 hours	167
_junc_174	12 hours	19.3	9 hours	30.0
_junc_18	18 hours	45.8	12 hours	61.9
_junc_181	12 hours	0.080	1.50 hour	0.420
_junc_185	12 hours	0.090	1.50 hour	0.400
_junc_186	12 hours	0.270	1.50 hour	1.06
_junc_187	12 hours	2.17	9 hours	3.47
_junc_19	12 hours	163	12 hours	234
_junc_193	12 hours	9.34	9 hours	15.3
_junc_194	12 hours	13.4	9 hours	21.8
_junc_199	12 hours	16.3	9 hours	26.0
_junc_2	12 hours	192	12 hours	272
_junc_20	12 hours	136	12 hours	194
_junc_204	12 hours	7.25	9 hours	11.0
_junc_21	12 hours	148	12 hours	212
_junc_22	12 hours	420	12 hours	593
_junc_228	12 hours	0.450	2 hours	1.63
_junc_23	12 hours	426	12 hours	600
_junc_231	12 hours	173	12 hours	247
_junc_232	12 hours	21.8	9 hours	36.1
_junc_233	12 hours	31.0	9 hours	49.3
_junc_234	12 hours	411	9 hours	621
_junc_24	12 hours	26.2	12 hours	38.2
_junc_25	12 hours	20.3	12 hours	28.6
_junc_26	12 hours	17.8	12 hours	25.9
_junc_263	12 hours	10.3	9 hours	16.3
_junc_265	12 hours	10.1	9 hours	16.1
_junc_27	12 hours	10.8	12 hours	16.1
_junc_28	12 hours	460	12 hours	646
_junc_29	12 hours	458	12 hours	644
_junc_3	12 hours	16.9	12 hours	23.0
_junc_30	12 hours	462	12 hours	650
_junc_31	12 hours	13.5	9 hours	23.3
_junc_32	12 hours	469	12 hours	659

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
_junc_324	12 hours	416	9 hours	629
_junc_328	12 hours	482	9 hours	726
_junc_329	12 hours	27.6	9 hours	38.0
_junc_33	12 hours	13.1	9 hours	23.2
_junc_330	12 hours	57.3	9 hours	83.2
_junc_331	12 hours	1006	9 hours	1449
_junc_34	12 hours	21.3	9 hours	35.7
_junc_35	12 hours	7.23	9 hours	11.9
_junc_36	12 hours	404	12 hours	610
_junc_37	12 hours	15.5	12 hours	23.3
_junc_38	12 hours	12.3	9 hours	20.8
_junc_39	12 hours	448	9 hours	676
_junc_4	12 hours	17.7	12 hours	24.3
_junc_40	12 hours	22.2	12 hours	33.7
_junc_41	12 hours	13.5	9 hours	21.1
_junc_42	12 hours	25.3	9 hours	38.1
_junc_43	12 hours	64.7	9 hours	99.6
_junc_44	12 hours	421	9 hours	636
_junc_45	12 hours	376	12 hours	568
_junc_46	12 hours	32.5	12 hours	48.8
_junc_47	12 hours	425	9 hours	643
_junc_48	12 hours	309	12 hours	468
_junc_49	12 hours	15.0	9 hours	23.9
_junc_5	12 hours	15.5	9 hours	23.6
_junc_50	12 hours	47.9	12 hours	71.6
_junc_51	12 hours	303	12 hours	458
_junc_52	12 hours	54.9	12 hours	82.3
_junc_53	12 hours	15.0	12 hours	22.4
_junc_54	12 hours	76.5	12 hours	116
_junc_55	12 hours	86.3	12 hours	130
_junc_56	12 hours	278	12 hours	422
_junc_57	12 hours	115	12 hours	174
_junc_58	12 hours	264	12 hours	399
_junc_59	12 hours	247	12 hours	374
_junc_6	12 hours	50.8	9 hours	73.3
_junc_60	12 hours	257	12 hours	390
_junc_61	12 hours	24.1	12 hours	36.3
_junc_62	12 hours	118	9 hours	183
_junc_63	12 hours	105	9 hours	165
_junc_64	12 hours	48.1	9 hours	78.4
_junc_65	12 hours	13.6	9 hours	23.5
_junc_66	12 hours	89.7	9 hours	139
_junc_67	12 hours	53.8	9 hours	87.1
_junc_68	12 hours	38.4	9 hours	63.9
_junc_69	12 hours	28.7	9 hours	47.6
_junc_7	12 hours	58.5	9 hours	84.8
_junc_70	12 hours	21.9	9 hours	36.4
_junc_71	12 hours	18.3	12 hours	26.9
_junc_72	12 hours	32.3	12 hours	48.4
_junc_73	12 hours	15.6	9 hours	25.3

5% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
_junc_74	12 hours	10.2	9 hours	16.2
_junc_75	18 hours	32.1	12 hours	41.7
_junc_76	12 hours	12.7	12 hours	17.8
_junc_77	12 hours	31.5	9 hours	46.5
_junc_78	12 hours	39.0	9 hours	58.0
_junc_79	12 hours	44.6	9 hours	67.0
_junc_8	12 hours	22.5	9 hours	34.6
_junc_80	12 hours	17.9	9 hours	27.6
_junc_81	12 hours	83.1	12 hours	115
_junc_82	12 hours	19.2	9 hours	27.8
_junc_83	12 hours	15.3	12 hours	21.1
_junc_84	12 hours	102	12 hours	143
_junc_85	12 hours	20.5	12 hours	28.6
_junc_86	12 hours	127	12 hours	178
_junc_87	12 hours	44.6	12 hours	62.9
_junc_88	12 hours	48.7	9 hours	69.6
_junc_89	12 hours	116	12 hours	163
_junc_9	12 hours	30.0	9 hours	45.1
_junc_90	12 hours	186	12 hours	262
_junc_91	12 hours	12.4	12 hours	16.6

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
1.01	12 hours	15.4	9 hours	25.9
1.02	12 hours	20.1	9 hours	34.9
1.03	12 hours	28.0	9 hours	49.4
1.04	12 hours	39.8	9 hours	69.9
1.05	12 hours	50.9	9 hours	89.2
1.06	12 hours	51.9	9 hours	91.1
1.07	12 hours	61.8	9 hours	107
1.08	12 hours	67.9	9 hours	117
1.09	12 hours	69.8	9 hours	120
1.10	12 hours	114	9 hours	188
1.11	12 hours	137	9 hours	229
1.12	12 hours	153	9 hours	251
1.13	12 hours	312	9 hours	501
1.14	12 hours	324	9 hours	520
1.15	12 hours	325	9 hours	521
1.16	12 hours	331	9 hours	530
1.17	12 hours	356	9 hours	571
1.18	12 hours	382	9 hours	611
1.19	12 hours	388	9 hours	620
1.20	12 hours	473	9 hours	758
1.21	12 hours	476	9 hours	762
1.22	12 hours	510	9 hours	819
1.23	12 hours	519	9 hours	833
1.24	12 hours	519	9 hours	833
1.25	12 hours	521	9 hours	837
1.26	12 hours	526	9 hours	846
1.27	12 hours	532	9 hours	855
1.28	12 hours	533	9 hours	855
1.29	12 hours	562	9 hours	900
1.30	12 hours	564	9 hours	903
1.31	12 hours	608	9 hours	970
1.32	12 hours	609	9 hours	971
1.33	12 hours	1196	9 hours	1827
1.34	12 hours	1197	9 hours	1829
1.35	12 hours	1263	9 hours	1924
1.36	12 hours	1264	9 hours	1925
1.37	12 hours	1265	9 hours	1926
1.38	12 hours	1266	9 hours	1927
1.39	12 hours	1272	9 hours	1935
1.40	12 hours	1282	9 hours	1947
2.01	12 hours	3.90	9 hours	7.50
3.01	12 hours	7.04	9 hours	12.8
4.01	12 hours	7.53	9 hours	12.9
5.01	12 hours	7.77	9 hours	13.8
6.01	12 hours	7.93	12 hours	12.2
7.01	12 hours	5.10	12 hours	7.89
8.01	18 hours	14.3	12 hours	21.4
8.02	12 hours	28.0	12 hours	42.7
8.03	12 hours	28.1	12 hours	42.8
8.04	12 hours	40.8	9 hours	62.8

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
8.05	12 hours	42.1	9 hours	64.9
9.01	12 hours	8.93	9 hours	14.1
10.01	12 hours	5.27	9 hours	8.93
10.02	12 hours	12.7	9 hours	21.4
11.01	12 hours	7.41	9 hours	12.4
12.01	12 hours	6.15	9 hours	11.2
12.02	12 hours	10.7	9 hours	19.7
12.03	12 hours	17.1	9 hours	31.1
13.01	12 hours	2.05	9 hours	4.25
14.01	12 hours	5.09	9 hours	8.79
14.02	12 hours	6.15	9 hours	10.8
15.01	12 hours	0.850	6 hours	2.09
16.01	12 hours	6.53	12 hours	9.89
16.02	12 hours	9.83	12 hours	15.0
17.01	12 hours	10.0	12 hours	15.4
17.02	12 hours	23.1	9 hours	36.4
17.03	12 hours	29.8	9 hours	47.4
17.04	12 hours	42.2	9 hours	65.3
17.05	12 hours	49.8	9 hours	77.2
17.06	12 hours	62.1	9 hours	95.7
17.07	12 hours	71.0	9 hours	112
17.08	12 hours	97.7	9 hours	158
17.09	12 hours	100.0	9 hours	162
17.10	12 hours	108	9 hours	173
17.11	12 hours	152	9 hours	239
17.12	12 hours	154	9 hours	243
17.13	12 hours	155	9 hours	245
18.01	12 hours	9.30	9 hours	15.0
19.01	12 hours	4.55	9 hours	7.42
20.01	12 hours	11.0	12 hours	16.6
21.01	12 hours	9.10	12 hours	13.7
21.02	12 hours	10.2	12 hours	15.3
22.01	12 hours	6.78	9 hours	12.3
23.01	12 hours	5.60	9 hours	9.36
23.02	12 hours	17.9	9 hours	29.8
23.03	12 hours	24.4	9 hours	41.4
23.04	12 hours	24.7	9 hours	42.0
24.01	12 hours	7.21	9 hours	12.1
25.01	12 hours	2.49	9 hours	5.10
26.01	12 hours	7.76	12 hours	11.9
26.02	12 hours	7.86	12 hours	12.0
27.01	12 hours	9.93	9 hours	16.2
27.02	12 hours	21.6	9 hours	34.4
27.03	12 hours	36.5	12 hours	55.9
28.01	12 hours	2.03	9 hours	4.24
28.02	12 hours	2.76	9 hours	5.72
29.01	12 hours	8.58	12 hours	13.2
30.01	12 hours	2.51	9 hours	4.48
31.01	12 hours	1.84	9 hours	3.14
32.01	12 hours	10.5	12 hours	16.0

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
33.01	12 hours	5.06	9 hours	7.89
34.01	12 hours	7.42	9 hours	12.0
34.02	12 hours	18.2	9 hours	31.9
34.03	12 hours	18.4	9 hours	32.3
35.01	12 hours	5.14	9 hours	8.06
35.02	12 hours	10.7	12 hours	16.3
35.03	12 hours	14.5	12 hours	22.0
35.04	12 hours	14.7	12 hours	22.3
35.05	12 hours	23.1	12 hours	35.2
36.01	12 hours	0.630	9 hours	1.28
37.01	12 hours	4.30	9 hours	6.69
38.01	12 hours	4.41	12 hours	6.65
38.02	12 hours	5.39	9 hours	8.22
39.01	12 hours	5.97	9 hours	9.57
39.02	12 hours	12.4	9 hours	21.9
39.03	12 hours	18.1	9 hours	33.1
39.04	12 hours	36.0	9 hours	60.1
39.05	12 hours	45.6	9 hours	75.4
39.06	12 hours	84.0	9 hours	137
40.01	12 hours	3.21	9 hours	6.64
41.01	12 hours	4.06	9 hours	8.40
42.01	12 hours	8.53	9 hours	13.8
43.01	12 hours	2.69	9 hours	4.91
44.01	12 hours	9.24	9 hours	15.7
44.02	12 hours	23.2	9 hours	38.4
44.03	12 hours	35.4	9 hours	56.5
45.01	12 hours	6.08	9 hours	11.3
46.01	12 hours	8.72	12 hours	13.0
47.01	12 hours	7.84	9 hours	13.5
47.02	12 hours	10.9	9 hours	19.0
47.03	12 hours	11.8	9 hours	21.0
47.04	12 hours	24.4	9 hours	41.9
47.05	12 hours	31.5	9 hours	54.8
48.01	12 hours	2.96	9 hours	5.34
49.01	12 hours	4.29	9 hours	7.93
49.02	12 hours	4.90	9 hours	9.29
49.03	12 hours	4.97	9 hours	9.41
50.01	12 hours	0.820	6 hours	2.04
51.01	12 hours	2.84	9 hours	5.27
52.01	12 hours	1.29	9 hours	2.63
52.02	12 hours	3.11	9 hours	5.79
53.01	12 hours	4.56	9 hours	7.46
54.01	12 hours	1.75	9 hours	3.06
54.02	12 hours	2.56	9 hours	4.73
54.03	12 hours	2.89	9 hours	5.43
55.01	12 hours	2.15	9 hours	4.04
56.01	12 hours	2.95	9 hours	5.73
56.02	12 hours	4.93	9 hours	8.92
56.03	12 hours	5.80	9 hours	10.3
57.01	12 hours	2.55	9 hours	4.90

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
57.02	12 hours	6.11	9 hours	8.97
58.01	12 hours	4.75	9 hours	7.35
58.02	12 hours	6.94	9 hours	10.8
58.03	12 hours	10.1	9 hours	15.7
58.04	12 hours	16.8	9 hours	27.3
58.05	12 hours	18.1	9 hours	29.0
58.06	12 hours	26.3	9 hours	41.6
58.07	12 hours	30.0	9 hours	47.0
59.01	12 hours	2.12	9 hours	3.61
60.01	12 hours	1.97	9 hours	3.88
60.02	12 hours	2.54	9 hours	4.88
60.03	12 hours	5.48	9 hours	9.41
61.01	12 hours	1.61	9 hours	2.68
62.01	12 hours	0.380	9 hours	0.740
63.01	12 hours	0.030	2 hours	0.140
64.01	12 hours	1.09	9 hours	2.05
64.02	12 hours	6.09	9 hours	10.7
65.01	12 hours	0.630	9 hours	1.20
66.01	12 hours	0.780	6 hours	1.72
66.02	12 hours	2.83	9 hours	4.85
67.01	12 hours	0.150	1.50 hour	0.710
68.01	12 hours	0.240	2 hours	1.02
69.01	12 hours	0.240	1.50 hour	1.14
69.02	12 hours	0.410	2 hours	1.62
70.01	12 hours	0.180	2 hours	0.730
71.01	12 hours	0.200	1.50 hour	0.920
72.01	12 hours	0.230	2 hours	1.01
73.01	12 hours	0.170	2 hours	0.750
74.01	12 hours	1.48	9 hours	2.60
75.01	48 hours	1.46	36 hours	1.31
75.02	48 hours	1.72	36 hours	1.58
76.01	12 hours	1.06	9 hours	1.90
76.02	12 hours	1.14	9 hours	2.01
77.01	12 hours	2.54	9 hours	4.42
77.02	12 hours	5.60	9 hours	9.93
77.03	12 hours	10.8	9 hours	17.3
77.04	12 hours	12.0	9 hours	19.6
77.05	12 hours	12.8	9 hours	21.0
77.06	12 hours	13.0	9 hours	21.3
77.07	12 hours	25.3	9 hours	43.4
77.08	12 hours	25.8	9 hours	44.0
77.09	12 hours	26.0	9 hours	44.3
77.10	12 hours	26.5	9 hours	45.1
77.11	12 hours	30.3	9 hours	51.4
77.12	12 hours	33.9	9 hours	56.5
77.13	12 hours	41.1	9 hours	66.0
78.01	12 hours	2.39	9 hours	3.92
78.02	12 hours	5.74	9 hours	9.46
79.01	12 hours	1.59	9 hours	2.99
80.01	12 hours	0.700	6 hours	1.42

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
81.01	12 hours	1.59	9 hours	2.83
81.02	12 hours	1.76	9 hours	3.19
81.03	12 hours	3.54	9 hours	6.72
81.04	12 hours	6.51	9 hours	12.8
82.01	12 hours	0.340	2 hours	0.980
82.02	12 hours	1.46	9 hours	2.84
82.03	12 hours	1.67	9 hours	3.29
83.01	12 hours	1.06	6 hours	2.13
83.02	12 hours	2.09	4.50 hours	4.58
83.03	12 hours	2.32	2 hours	5.14
84.01	12 hours	0.200	1.50 hour	0.700
84.02	12 hours	0.730	2 hours	2.20
85.01	12 hours	0.400	4.50 hours	1.09
86.01	12 hours	0.060	1.50 hour	0.330
87.01	12 hours	0.300	1.50 hour	1.09
87.02	12 hours	0.560	2 hours	1.80
88.01	12 hours	0.120	2 hours	0.410
89.01	12 hours	0.180	1.50 hour	0.420
90.01	12 hours	0.120	1.50 hour	0.370
91.01	12 hours	0.340	2 hours	1.23
92.01	12 hours	0.580	9 hours	0.980
92.02	12 hours	2.34	9 hours	3.67
92.03	12 hours	2.48	9 hours	3.95
92.04	12 hours	3.64	9 hours	6.44
93.01	12 hours	0.180	6 hours	0.420
94.01	12 hours	0.210	1.50 hour	0.770
95.01	12 hours	0.260	1.50 hour	0.990
96.01	12 hours	0.110	1.50 hour	0.500
97.01	12 hours	0.120	1.50 hour	0.550
98.01	12 hours	0.350	6 hours	0.790
99.01	12 hours	2.08	12 hours	2.92
99.02	12 hours	2.77	9 hours	4.12
100.01	12 hours	0.060	2 hours	0.220
101.01	12 hours	0.050	1.50 hour	0.230
102.01	12 hours	0.080	1.50 hour	0.310
103.01	12 hours	0.050	1.50 hour	0.290
104.01	12 hours	0.160	1.50 hour	0.590
104.02	12 hours	0.420	2 hours	1.44
105.01	12 hours	0.040	1.50 hour	0.230
106.01	18 hours	4.31	12 hours	5.00
106.02	18 hours	6.17	12 hours	7.89
107.01	12 hours	2.03	9 hours	3.30
108.01	12 hours	1.38	12 hours	1.92
108.02	12 hours	1.40	12 hours	1.96
109.01	12 hours	2.79	9 hours	4.64
110.01	12 hours	1.63	9 hours	2.91
111.01	12 hours	0.750	2 hours	1.97
112.01	12 hours	0.570	2 hours	1.58
113.01	12 hours	0.280	4.50 hours	0.860
114.01	12 hours	9.16	9 hours	14.3

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
114.02	12 hours	13.9	9 hours	22.0
114.03	12 hours	27.0	9 hours	40.7
114.04	18 hours	43.8	12 hours	63.6
114.05	18 hours	58.4	12 hours	81.7
114.06	12 hours	137	9 hours	201
114.07	12 hours	148	9 hours	218
114.08	12 hours	161	9 hours	237
114.09	12 hours	165	9 hours	242
114.10	12 hours	174	9 hours	257
114.11	12 hours	186	9 hours	279
114.12	12 hours	188	9 hours	283
114.13	12 hours	213	9 hours	316
114.14	12 hours	222	9 hours	329
114.15	12 hours	223	9 hours	331
114.16	12 hours	478	9 hours	708
114.17	12 hours	509	9 hours	754
114.18	12 hours	519	9 hours	766
114.19	12 hours	523	9 hours	771
114.20	12 hours	528	9 hours	779
114.21	12 hours	569	9 hours	834
114.22	12 hours	575	9 hours	842
114.23	12 hours	577	9 hours	845
114.24	12 hours	582	9 hours	853
114.25	12 hours	592	9 hours	866
115.01	12 hours	4.33	9 hours	6.91
116.01	12 hours	8.22	9 hours	12.0
117.01	12 hours	5.64	9 hours	9.62
118.01	18 hours	14.8	12 hours	17.8
119.01	12 hours	15.9	12 hours	22.5
119.02	12 hours	24.6	9 hours	35.2
119.03	12 hours	66.1	9 hours	102
119.04	12 hours	76.5	9 hours	117
120.01	12 hours	6.22	9 hours	9.75
121.01	12 hours	8.64	9 hours	14.3
121.02	12 hours	22.4	9 hours	36.3
121.03	12 hours	29.1	9 hours	47.8
121.04	12 hours	38.6	9 hours	61.9
122.01	12 hours	10.4	9 hours	16.6
123.01	12 hours	5.34	9 hours	8.98
124.01	12 hours	8.04	9 hours	11.7
125.01	12 hours	6.56	9 hours	10.7
126.01	12 hours	11.2	12 hours	16.9
127.01	12 hours	7.98	9 hours	12.6
128.01	12 hours	6.50	9 hours	10.7
129.01	12 hours	5.22	9 hours	9.19
129.02	12 hours	9.80	9 hours	18.3
129.03	12 hours	12.6	9 hours	23.6
130.01	12 hours	3.16	9 hours	6.11
131.01	12 hours	2.42	9 hours	4.71
131.02	12 hours	10.5	12 hours	15.4

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
131.03	12 hours	16.2	12 hours	23.9
132.01	12 hours	4.12	9 hours	7.64
133.01	12 hours	12.6	9 hours	20.4
133.02	12 hours	27.1	9 hours	44.6
133.03	12 hours	44.1	9 hours	68.8
133.04	12 hours	49.9	9 hours	79.0
133.05	12 hours	62.7	9 hours	98.8
133.06	12 hours	63.0	9 hours	99.3
133.07	12 hours	113	9 hours	163
133.08	12 hours	114	9 hours	165
133.09	12 hours	136	9 hours	200
133.10	12 hours	150	9 hours	221
133.11	12 hours	170	9 hours	249
133.12	12 hours	235	9 hours	348
133.13	12 hours	247	9 hours	366
133.14	12 hours	251	9 hours	373
134.01	12 hours	9.42	9 hours	15.8
135.01	12 hours	12.2	12 hours	17.4
136.01	12 hours	4.34	9 hours	7.75
137.01	12 hours	5.35	9 hours	9.10
138.01	18 hours	20.2	12 hours	25.5
138.02	18 hours	24.9	12 hours	32.2
138.03	18 hours	42.4	12 hours	58.0
139.01	12 hours	8.50	9 hours	12.6
139.02	12 hours	16.4	12 hours	23.4
140.01	12 hours	0.880	4.50 hours	2.30
141.01	12 hours	12.4	9 hours	19.8
141.02	12 hours	14.7	9 hours	23.8
142.01	12 hours	1.55	9 hours	3.05
143.01	12 hours	9.61	9 hours	16.4
144.01	12 hours	9.20	9 hours	14.8
145.01	12 hours	6.71	9 hours	11.1
145.02	12 hours	18.8	9 hours	28.2
145.03	12 hours	29.1	9 hours	44.4
145.04	12 hours	55.9	9 hours	83.7
145.05	12 hours	56.0	9 hours	83.9
145.06	12 hours	64.3	9 hours	98.9
146.01	12 hours	9.18	12 hours	13.1
147.01	12 hours	5.09	9 hours	8.76
148.01	12 hours	13.3	12 hours	18.8
148.02	12 hours	20.1	9 hours	28.8
148.03	12 hours	26.5	9 hours	38.8
149.01	12 hours	5.82	9 hours	9.32
150.01	12 hours	5.52	9 hours	8.39
151.01	12 hours	4.69	9 hours	8.35
152.01	12 hours	1.92	9 hours	3.89
153.01	12 hours	6.30	9 hours	10.7
154.01	12 hours	2.55	9 hours	4.81
154.02	12 hours	3.36	9 hours	6.52
155.01	12 hours	9.85	12 hours	13.2

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
155.02	12 hours	9.97	12 hours	13.4
155.03	12 hours	16.6	12 hours	22.7
155.04	12 hours	17.3	12 hours	23.6
155.05	12 hours	27.4	9 hours	38.4
155.06	12 hours	32.3	9 hours	46.0
156.01	12 hours	5.59	9 hours	8.19
156.02	12 hours	5.82	9 hours	8.56
157.01	12 hours	4.11	9 hours	6.10
158.01	12 hours	2.16	9 hours	3.47
159.01	12 hours	2.07	9 hours	3.54
160.01	12 hours	4.30	9 hours	6.60
160.02	12 hours	4.61	9 hours	7.11
161.01	12 hours	8.59	12 hours	11.9
162.01	12 hours	0.720	2 hours	1.85
162.02	12 hours	5.23	12 hours	7.38
162.03	12 hours	5.33	12 hours	7.51
163.01	12 hours	1.06	6 hours	2.29
163.02	12 hours	3.19	9 hours	6.17
163.03	12 hours	9.78	9 hours	15.6
163.04	12 hours	14.9	9 hours	22.4
163.05	12 hours	32.2	12 hours	46.0
163.06	12 hours	33.5	12 hours	47.7
164.01	18 hours	11.6	12 hours	15.6
165.01	12 hours	5.58	12 hours	7.52
165.02	12 hours	6.45	12 hours	8.72
166.01	12 hours	1.66	9 hours	2.91
166.02	12 hours	3.52	9 hours	5.76
166.03	12 hours	6.11	9 hours	9.25
167.01	12 hours	1.28	9 hours	2.44
167.02	12 hours	2.43	9 hours	4.58
168.01	12 hours	3.52	9 hours	5.80
168.02	12 hours	3.55	9 hours	5.83
169.01	12 hours	6.45	9 hours	9.75
169.02	12 hours	7.31	9 hours	11.2
170.01	12 hours	1.06	6 hours	2.19
171.01	12 hours	1.20	9 hours	2.17
172.01	12 hours	0.760	6 hours	1.61
173.01	12 hours	1.46	6 hours	2.85
173.02	12 hours	11.4	9 hours	18.0
173.03	12 hours	22.3	9 hours	34.7
173.04	12 hours	24.3	9 hours	37.1
173.05	12 hours	31.0	9 hours	45.9
173.06	12 hours	40.0	9 hours	57.2
173.07	12 hours	72.1	9 hours	109
174.01	12 hours	1.15	6 hours	2.54
175.01	12 hours	0.920	9 hours	1.77
176.01	12 hours	0.830	6 hours	1.87
176.02	12 hours	4.52	9 hours	7.85
177.01	18 hours	3.64	30 hours	3.98
178.01	12 hours	2.59	9 hours	3.74

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
179.01	12 hours	0.460	9 hours	0.790
180.01	18 hours	3.76	12 hours	4.49
180.02	18 hours	4.16	12 hours	4.97
181.01	12 hours	2.67	9 hours	3.92
182.01	12 hours	0.370	2 hours	0.940
183.01	12 hours	3.77	9 hours	7.12
183.02	12 hours	7.20	9 hours	12.6
183.03	12 hours	12.9	9 hours	21.8
183.04	12 hours	20.4	9 hours	33.2
183.05	12 hours	21.3	9 hours	34.7
183.06	12 hours	32.1	9 hours	52.5
184.01	12 hours	0.690	6 hours	1.56
184.02	12 hours	4.43	9 hours	7.12
185.01	12 hours	0.860	2 hours	2.19
185.02	12 hours	3.67	9 hours	6.45
186.01	12 hours	1.66	9 hours	3.04
187.01	12 hours	2.08	9 hours	3.49
187.02	12 hours	3.97	9 hours	6.47
188.01	12 hours	0.650	6 hours	1.44
189.01	12 hours	0.680	2 hours	1.61
190.01	12 hours	0.460	4.50 hours	1.27
191.01	12 hours	1.27	9 hours	2.32
192.01	12 hours	1.48	2 hours	3.89
193.01	12 hours	1.26	2 hours	3.61
194.01	12 hours	0.220	2 hours	0.810
195.01	12 hours	0.440	4.50 hours	1.33
196.01	12 hours	0.500	2 hours	1.46
197.01	12 hours	0.410	1.50 hour	1.43
198.01	12 hours	0.590	2 hours	1.73
199.01	12 hours	1.28	6 hours	2.52
199.02	12 hours	1.74	6 hours	3.55
200.01	12 hours	0.230	2 hours	0.830
201.01	12 hours	0.550	4.50 hours	1.65
202.01	12 hours	4.86	12 hours	6.53
203.01	12 hours	0.780	2 hours	2.22
204.01	12 hours	0.540	2 hours	1.73
205.01	12 hours	0.690	4.50 hours	2.11
206.01	12 hours	0.180	1.50 hour	0.850
207.01	12 hours	0.650	1.50 hour	2.60
208.01	12 hours	0.930	6 hours	2.07
208.02	12 hours	1.31	4.50 hours	2.87
208.03	12 hours	2.45	2 hours	5.05
208.04	12 hours	4.73	9 hours	7.94
208.05	12 hours	5.97	9 hours	9.28
208.06	18 hours	7.32	9 hours	10.5
209.01	12 hours	0.170	1.50 hour	0.800
210.01	12 hours	0.330	1.50 hour	1.08
211.01	12 hours	0.340	4.50 hours	1.03
211.02	12 hours	0.390	2 hours	1.25
211.03	12 hours	1.40	2 hours	3.40

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
212.01	12 hours	0.160	1.50 hour	0.940
_junc_10	12 hours	31.9	9 hours	45.5
_junc_108	12 hours	0.600	1.50 hour	1.72
_junc_11	12 hours	508	9 hours	752
_junc_111	12 hours	3.42	9 hours	6.48
_junc_114	12 hours	2.08	12 hours	2.92
_junc_12	12 hours	15.9	9 hours	25.8
_junc_13	12 hours	156	9 hours	230
_junc_138	12 hours	10.8	9 hours	18.8
_junc_14	12 hours	132	9 hours	195
_junc_142	12 hours	8.35	9 hours	15.2
_junc_143	12 hours	250	9 hours	370
_junc_15	12 hours	474	9 hours	702
_junc_16	12 hours	518	9 hours	765
_junc_165	12 hours	35.3	9 hours	58.4
_junc_168	12 hours	33.0	9 hours	55.4
_junc_17	12 hours	148	9 hours	217
_junc_174	12 hours	24.0	9 hours	38.8
_junc_18	18 hours	58.3	12 hours	81.4
_junc_181	12 hours	0.100	1.50 hour	0.520
_junc_185	12 hours	0.110	1.50 hour	0.500
_junc_186	12 hours	0.330	1.50 hour	1.32
_junc_187	12 hours	2.70	9 hours	4.48
_junc_19	12 hours	204	9 hours	306
_junc_193	12 hours	11.6	9 hours	19.7
_junc_194	12 hours	16.5	9 hours	28.1
_junc_199	12 hours	20.3	9 hours	34.3
_junc_2	12 hours	240	9 hours	358
_junc_20	12 hours	171	9 hours	253
_junc_204	12 hours	9.04	9 hours	14.3
_junc_21	12 hours	185	9 hours	278
_junc_22	12 hours	527	9 hours	778
_junc_228	12 hours	0.550	2 hours	2.07
_junc_23	12 hours	534	9 hours	787
_junc_231	12 hours	217	9 hours	323
_junc_232	12 hours	27.2	9 hours	47.2
_junc_233	12 hours	38.7	9 hours	64.9
_junc_234	12 hours	515	9 hours	826
_junc_24	12 hours	32.6	9 hours	50.2
_junc_25	12 hours	25.8	12 hours	37.6
_junc_26	12 hours	22.2	9 hours	33.9
_junc_263	12 hours	12.8	9 hours	21.4
_junc_265	12 hours	12.5	9 hours	21.3
_junc_27	12 hours	13.5	9 hours	21.2
_junc_28	12 hours	577	9 hours	845
_junc_29	12 hours	575	9 hours	842
_junc_3	12 hours	21.3	12 hours	29.4
_junc_30	12 hours	580	9 hours	850
_junc_31	12 hours	16.8	9 hours	30.4
_junc_32	12 hours	589	9 hours	862

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
_junc_324	12 hours	520	9 hours	836
_junc_328	12 hours	604	9 hours	964
_junc_329	12 hours	34.7	9 hours	50.2
_junc_33	12 hours	16.3	9 hours	30.0
_junc_330	12 hours	71.8	9 hours	109
_junc_331	12 hours	1262	9 hours	1923
_junc_34	12 hours	26.5	9 hours	46.6
_junc_35	12 hours	8.98	9 hours	15.6
_junc_36	12 hours	505	9 hours	811
_junc_37	12 hours	19.3	9 hours	30.1
_junc_38	12 hours	15.2	9 hours	27.0
_junc_39	12 hours	561	9 hours	898
_junc_4	12 hours	22.0	12 hours	31.3
_junc_40	12 hours	27.7	9 hours	43.7
_junc_41	12 hours	16.9	9 hours	27.4
_junc_42	12 hours	31.8	9 hours	50.5
_junc_43	12 hours	81.0	9 hours	132
_junc_44	12 hours	526	9 hours	846
_junc_45	12 hours	470	9 hours	753
_junc_46	12 hours	40.6	12 hours	62.6
_junc_47	12 hours	532	9 hours	854
_junc_48	12 hours	387	9 hours	619
_junc_49	12 hours	18.7	9 hours	30.7
_junc_5	12 hours	19.1	9 hours	30.9
_junc_50	12 hours	59.8	12 hours	92.1
_junc_51	12 hours	379	9 hours	605
_junc_52	12 hours	68.6	9 hours	107
_junc_53	12 hours	18.9	12 hours	28.8
_junc_54	12 hours	95.5	9 hours	153
_junc_55	12 hours	108	9 hours	173
_junc_56	12 hours	348	9 hours	559
_junc_57	12 hours	144	9 hours	228
_junc_58	12 hours	330	9 hours	529
_junc_59	12 hours	309	9 hours	496
_junc_6	12 hours	63.0	9 hours	96.8
_junc_60	12 hours	322	9 hours	517
_junc_61	12 hours	30.1	9 hours	47.6
_junc_62	12 hours	147	9 hours	243
_junc_63	12 hours	131	9 hours	218
_junc_64	12 hours	59.6	9 hours	103
_junc_65	12 hours	16.8	9 hours	30.5
_junc_66	12 hours	112	9 hours	184
_junc_67	12 hours	66.8	9 hours	114
_junc_68	12 hours	47.5	9 hours	83.6
_junc_69	12 hours	35.5	9 hours	62.4
_junc_7	12 hours	72.5	9 hours	112
_junc_70	12 hours	27.1	9 hours	47.6
_junc_71	12 hours	23.1	12 hours	35.1
_junc_72	12 hours	40.5	12 hours	62.2
_junc_73	12 hours	19.3	9 hours	33.2

2% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
_junc_74	12 hours	12.7	9 hours	21.3
_junc_75	18 hours	40.7	12 hours	55.3
_junc_76	12 hours	15.8	9 hours	23.5
_junc_77	12 hours	39.0	9 hours	61.2
_junc_78	12 hours	48.3	9 hours	76.2
_junc_79	12 hours	55.2	9 hours	88.0
_junc_8	12 hours	27.7	9 hours	45.3
_junc_80	12 hours	22.1	9 hours	36.2
_junc_81	12 hours	104	9 hours	152
_junc_82	12 hours	23.7	9 hours	36.7
_junc_83	12 hours	19.0	9 hours	27.2
_junc_84	12 hours	128	9 hours	188
_junc_85	12 hours	25.6	9 hours	37.1
_junc_86	12 hours	159	9 hours	235
_junc_87	12 hours	55.5	9 hours	83.2
_junc_88	12 hours	60.6	9 hours	92.0
_junc_89	12 hours	145	9 hours	215
_junc_9	12 hours	37.1	9 hours	59.2
_junc_90	12 hours	233	9 hours	345
_junc_91	12 hours	15.7	12 hours	21.5

1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
1.01	12 hours	17.8	9 hours	31.2
1.02	12 hours	23.1	9 hours	41.9
1.03	12 hours	32.2	9 hours	59.2
1.04	12 hours	45.8	9 hours	83.8
1.05	12 hours	58.5	9 hours	107
1.06	12 hours	59.7	9 hours	109
1.07	12 hours	71.2	9 hours	128
1.08	12 hours	78.3	9 hours	140
1.09	12 hours	80.6	9 hours	144
1.10	12 hours	132	9 hours	227
1.11	12 hours	159	9 hours	276
1.12	12 hours	178	9 hours	303
1.13	12 hours	362	9 hours	606
1.14	12 hours	377	9 hours	629
1.15	12 hours	377	9 hours	630
1.16	12 hours	384	9 hours	641
1.17	12 hours	414	9 hours	690
1.18	12 hours	444	9 hours	739
1.19	12 hours	451	9 hours	750
1.20	12 hours	550	9 hours	916
1.21	12 hours	553	9 hours	921
1.22	12 hours	593	9 hours	990
1.23	12 hours	603	9 hours	1007
1.24	12 hours	603	9 hours	1007
1.25	12 hours	606	9 hours	1011
1.26	12 hours	612	9 hours	1022
1.27	12 hours	619	9 hours	1033
1.28	12 hours	620	9 hours	1034
1.29	12 hours	654	9 hours	1087
1.30	12 hours	656	9 hours	1090
1.31	12 hours	708	9 hours	1170
1.32	12 hours	708	9 hours	1170
1.33	12 hours	1395	9 hours	2205
1.34	12 hours	1396	9 hours	2207
1.35	12 hours	1473	9 hours	2320
1.36	12 hours	1475	9 hours	2321
1.37	12 hours	1475	9 hours	2322
1.38	12 hours	1477	9 hours	2323
1.39	12 hours	1484	9 hours	2333
1.40	12 hours	1496	9 hours	2347
2.01	12 hours	4.50	9 hours	8.94
3.01	12 hours	8.13	9 hours	15.2
4.01	12 hours	8.67	9 hours	15.5
5.01	12 hours	8.93	9 hours	16.5
6.01	12 hours	9.20	9 hours	14.7
7.01	12 hours	5.91	9 hours	9.57
8.01	12 hours	16.8	12 hours	26.1
8.02	12 hours	32.7	12 hours	51.5
8.03	12 hours	32.8	12 hours	51.5
8.04	12 hours	47.6	9 hours	76.3

1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
8.05	12 hours	49.0	9 hours	78.8
9.01	12 hours	10.3	9 hours	17.1
10.01	12 hours	6.07	9 hours	10.7
10.02	12 hours	14.7	9 hours	25.7
11.01	12 hours	8.55	9 hours	14.9
12.01	12 hours	7.09	9 hours	13.4
12.02	12 hours	12.3	9 hours	23.5
12.03	12 hours	19.7	9 hours	37.2
13.01	12 hours	2.34	6 hours	5.06
14.01	12 hours	5.84	9 hours	10.6
14.02	12 hours	7.05	9 hours	13.0
15.01	12 hours	0.980	6 hours	2.49
16.01	12 hours	7.68	12 hours	12.0
16.02	12 hours	11.5	12 hours	18.1
17.01	12 hours	11.7	12 hours	18.6
17.02	12 hours	26.9	9 hours	44.1
17.03	12 hours	34.5	9 hours	57.3
17.04	12 hours	49.2	9 hours	79.3
17.05	12 hours	57.9	9 hours	93.7
17.06	12 hours	72.3	9 hours	116
17.07	12 hours	82.6	9 hours	135
17.08	12 hours	113	9 hours	190
17.09	12 hours	116	9 hours	195
17.10	12 hours	125	9 hours	209
17.11	12 hours	176	9 hours	289
17.12	12 hours	179	9 hours	295
17.13	12 hours	181	9 hours	297
18.01	12 hours	10.8	9 hours	18.0
19.01	12 hours	5.27	9 hours	8.92
20.01	12 hours	13.0	12 hours	20.1
21.01	12 hours	10.7	12 hours	16.6
21.02	12 hours	11.9	12 hours	18.5
22.01	12 hours	7.83	9 hours	14.7
23.01	12 hours	6.46	9 hours	11.3
23.02	12 hours	20.7	9 hours	35.8
23.03	12 hours	28.1	9 hours	49.8
23.04	12 hours	28.5	9 hours	50.5
24.01	12 hours	8.32	9 hours	14.5
25.01	12 hours	2.85	9 hours	6.05
26.01	12 hours	9.02	12 hours	14.2
26.02	12 hours	9.14	12 hours	14.4
27.01	12 hours	11.5	9 hours	19.5
27.02	12 hours	25.0	9 hours	41.7
27.03	12 hours	42.7	9 hours	67.5
28.01	12 hours	2.32	6 hours	5.09
28.02	12 hours	3.15	6 hours	6.86
29.01	12 hours	9.94	9 hours	16.0
30.01	12 hours	2.89	9 hours	5.36
31.01	12 hours	2.11	9 hours	3.78
32.01	12 hours	12.2	12 hours	19.2

1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
33.01	12 hours	5.85	9 hours	9.58
34.01	12 hours	8.58	9 hours	14.4
34.02	12 hours	20.9	9 hours	38.3
34.03	12 hours	21.2	9 hours	38.7
35.01	12 hours	5.95	9 hours	9.77
35.02	12 hours	12.6	12 hours	19.7
35.03	12 hours	16.9	12 hours	26.5
35.04	12 hours	17.1	12 hours	26.9
35.05	12 hours	26.9	12 hours	42.2
36.01	12 hours	0.720	9 hours	1.52
37.01	12 hours	5.02	9 hours	8.10
38.01	12 hours	5.17	12 hours	7.97
38.02	12 hours	6.31	9 hours	9.95
39.01	12 hours	6.92	9 hours	11.6
39.02	12 hours	14.3	9 hours	26.2
39.03	12 hours	20.9	9 hours	39.6
39.04	12 hours	41.8	9 hours	72.3
39.05	12 hours	53.0	9 hours	90.8
39.06	12 hours	97.5	9 hours	165
40.01	12 hours	3.69	6 hours	7.92
41.01	12 hours	4.68	6 hours	10.1
42.01	12 hours	9.86	9 hours	16.6
43.01	12 hours	3.10	9 hours	5.83
44.01	12 hours	10.7	9 hours	18.9
44.02	12 hours	26.9	9 hours	46.2
44.03	12 hours	41.2	9 hours	68.0
45.01	12 hours	7.01	9 hours	13.5
46.01	12 hours	10.2	12 hours	15.7
47.01	12 hours	9.02	9 hours	16.1
47.02	12 hours	12.6	9 hours	22.7
47.03	12 hours	13.7	9 hours	25.2
47.04	12 hours	28.2	9 hours	50.4
47.05	12 hours	36.4	9 hours	65.8
48.01	12 hours	3.41	9 hours	6.38
49.01	12 hours	4.98	9 hours	9.45
49.02	12 hours	5.68	9 hours	11.1
49.03	12 hours	5.75	9 hours	11.2
50.01	12 hours	0.940	4.50 hours	2.42
51.01	12 hours	3.28	9 hours	6.28
52.01	12 hours	1.48	6 hours	3.11
52.02	12 hours	3.60	9 hours	6.91
53.01	12 hours	5.30	9 hours	8.95
54.01	12 hours	2.03	9 hours	3.66
54.02	12 hours	2.97	9 hours	5.65
54.03	12 hours	3.36	9 hours	6.47
55.01	12 hours	2.46	9 hours	4.80
56.01	12 hours	3.39	9 hours	6.79
56.02	12 hours	5.68	9 hours	10.6
56.03	12 hours	6.69	9 hours	12.3
57.01	12 hours	2.93	9 hours	5.82

1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
57.02	12 hours	7.22	9 hours	10.8
58.01	12 hours	5.49	9 hours	8.75
58.02	12 hours	8.01	9 hours	12.8
58.03	12 hours	11.6	9 hours	18.7
58.04	12 hours	19.4	9 hours	32.6
58.05	12 hours	21.0	9 hours	34.6
58.06	12 hours	30.5	9 hours	49.6
58.07	12 hours	34.8	9 hours	56.2
59.01	12 hours	2.44	9 hours	4.26
60.01	12 hours	2.26	9 hours	4.59
60.02	12 hours	2.91	9 hours	5.77
60.03	12 hours	6.35	9 hours	11.2
61.01	12 hours	1.86	9 hours	3.18
62.01	12 hours	0.430	9 hours	0.860
63.01	12 hours	0.040	2 hours	0.160
64.01	12 hours	1.25	9 hours	2.41
64.02	12 hours	7.04	9 hours	12.6
65.01	12 hours	0.720	9 hours	1.40
66.01	12 hours	0.890	6 hours	2.05
66.02	12 hours	3.28	9 hours	5.77
67.01	12 hours	0.170	1.50 hour	0.830
68.01	12 hours	0.270	2 hours	1.21
69.01	12 hours	0.270	1.50 hour	1.35
69.02	12 hours	0.470	2 hours	1.91
70.01	12 hours	0.200	2 hours	0.870
71.01	12 hours	0.230	1.50 hour	1.08
72.01	12 hours	0.260	2 hours	1.19
73.01	12 hours	0.190	2 hours	0.880
74.01	12 hours	1.72	9 hours	3.08
75.01	36 hours	1.86	36 hours	1.68
75.02	36 hours	2.19	36 hours	2.02
76.01	12 hours	1.21	9 hours	2.25
76.02	12 hours	1.32	9 hours	2.38
77.01	12 hours	2.92	9 hours	5.24
77.02	12 hours	6.44	9 hours	11.7
77.03	12 hours	12.4	9 hours	20.6
77.04	12 hours	13.9	9 hours	23.3
77.05	12 hours	14.8	9 hours	24.9
77.06	12 hours	15.0	9 hours	25.3
77.07	12 hours	29.3	9 hours	51.4
77.08	12 hours	30.0	9 hours	52.2
77.09	12 hours	30.2	9 hours	52.5
77.10	12 hours	30.8	9 hours	53.4
77.11	12 hours	35.2	9 hours	60.9
77.12	12 hours	39.3	9 hours	66.9
77.13	12 hours	47.9	9 hours	78.6
78.01	12 hours	2.75	9 hours	4.68
78.02	12 hours	6.71	9 hours	11.3
79.01	12 hours	1.84	9 hours	3.52
80.01	12 hours	0.810	6 hours	1.71

1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
81.01	12 hours	1.84	9 hours	3.34
81.02	12 hours	2.04	9 hours	3.76
81.03	12 hours	4.07	9 hours	7.90
81.04	12 hours	7.47	9 hours	15.0
82.01	12 hours	0.390	4.50 hours	1.17
82.02	12 hours	1.67	9 hours	3.34
82.03	12 hours	1.91	9 hours	3.86
83.01	12 hours	1.21	6 hours	2.57
83.02	12 hours	2.39	4.50 hours	5.49
83.03	12 hours	2.65	2 hours	6.08
84.01	12 hours	0.230	1.50 hour	0.820
84.02	12 hours	0.840	2 hours	2.60
85.01	12 hours	0.460	4.50 hours	1.30
86.01	12 hours	0.070	1.50 hour	0.380
87.01	12 hours	0.340	1.50 hour	1.27
87.02	12 hours	0.640	2 hours	2.15
88.01	12 hours	0.140	2 hours	0.490
89.01	12 hours	0.200	1.50 hour	0.490
90.01	12 hours	0.130	1.50 hour	0.440
91.01	12 hours	0.390	2 hours	1.41
92.01	12 hours	0.670	9 hours	1.16
92.02	12 hours	2.71	9 hours	4.37
92.03	12 hours	2.87	9 hours	4.73
92.04	12 hours	4.22	9 hours	7.60
93.01	12 hours	0.200	2 hours	0.500
94.01	12 hours	0.230	1.50 hour	0.910
95.01	12 hours	0.290	1.50 hour	1.15
96.01	12 hours	0.120	1.50 hour	0.580
97.01	12 hours	0.140	1.50 hour	0.640
98.01	12 hours	0.400	6 hours	0.940
99.01	12 hours	2.41	9 hours	3.53
99.02	12 hours	3.20	9 hours	4.95
100.01	12 hours	0.070	2 hours	0.260
101.01	12 hours	0.050	1.50 hour	0.270
102.01	12 hours	0.090	1.50 hour	0.370
103.01	12 hours	0.060	1.50 hour	0.340
104.01	12 hours	0.180	1.50 hour	0.690
104.02	12 hours	0.470	2 hours	1.69
105.01	12 hours	0.040	1.50 hour	0.260
106.01	18 hours	5.14	12 hours	6.15
106.02	18 hours	7.30	12 hours	9.58
107.01	12 hours	2.33	9 hours	3.92
108.01	12 hours	1.61	12 hours	2.29
108.02	12 hours	1.65	12 hours	2.34
109.01	12 hours	3.21	9 hours	5.50
110.01	12 hours	1.88	9 hours	3.44
111.01	12 hours	0.850	2 hours	2.36
112.01	12 hours	0.660	2 hours	1.88
113.01	12 hours	0.320	2 hours	1.01
114.01	12 hours	10.6	9 hours	17.3

1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
114.02	12 hours	16.1	9 hours	26.5
114.03	12 hours	31.3	9 hours	49.3
114.04	18 hours	51.6	12 hours	76.8
114.05	18 hours	68.9	12 hours	99.2
114.06	12 hours	160	9 hours	243
114.07	12 hours	173	9 hours	264
114.08	12 hours	188	9 hours	287
114.09	12 hours	193	9 hours	294
114.10	12 hours	203	9 hours	312
114.11	12 hours	217	9 hours	337
114.12	12 hours	220	9 hours	342
114.13	12 hours	249	9 hours	383
114.14	12 hours	260	9 hours	399
114.15	12 hours	261	9 hours	401
114.16	12 hours	558	9 hours	856
114.17	12 hours	595	9 hours	911
114.18	12 hours	606	9 hours	926
114.19	12 hours	610	9 hours	932
114.20	12 hours	617	9 hours	942
114.21	12 hours	666	9 hours	1009
114.22	12 hours	673	9 hours	1019
114.23	12 hours	675	9 hours	1022
114.24	12 hours	681	9 hours	1031
114.25	12 hours	692	9 hours	1047
115.01	12 hours	4.99	9 hours	8.31
116.01	12 hours	9.51	9 hours	14.5
117.01	12 hours	6.51	9 hours	11.5
118.01	18 hours	17.4	12 hours	22.2
119.01	12 hours	18.6	12 hours	27.1
119.02	12 hours	28.6	9 hours	42.7
119.03	12 hours	76.5	9 hours	122
119.04	12 hours	88.6	9 hours	142
120.01	12 hours	7.17	9 hours	11.7
121.01	12 hours	9.91	9 hours	17.1
121.02	12 hours	25.7	9 hours	43.6
121.03	12 hours	33.4	9 hours	57.2
121.04	12 hours	44.5	9 hours	74.4
122.01	12 hours	12.0	9 hours	20.0
123.01	12 hours	6.14	9 hours	10.7
124.01	12 hours	9.28	9 hours	14.2
125.01	12 hours	7.55	9 hours	12.8
126.01	12 hours	13.1	12 hours	20.2
127.01	12 hours	9.18	9 hours	15.1
128.01	12 hours	7.52	9 hours	12.9
129.01	12 hours	6.01	9 hours	11.0
129.02	12 hours	11.3	9 hours	21.9
129.03	12 hours	14.5	9 hours	28.1
130.01	12 hours	3.64	9 hours	7.26
131.01	12 hours	2.77	6 hours	5.59
131.02	12 hours	12.3	9 hours	18.6

1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
131.03	12 hours	18.9	9 hours	28.8
132.01	12 hours	4.77	9 hours	9.09
133.01	12 hours	14.5	9 hours	24.5
133.02	12 hours	31.1	9 hours	53.4
133.03	12 hours	50.9	9 hours	82.7
133.04	12 hours	57.5	9 hours	95.0
133.05	12 hours	72.4	9 hours	119
133.06	12 hours	72.7	9 hours	120
133.07	12 hours	131	9 hours	198
133.08	12 hours	132	9 hours	200
133.09	12 hours	159	9 hours	242
133.10	12 hours	174	9 hours	268
133.11	12 hours	198	9 hours	301
133.12	12 hours	273	9 hours	421
133.13	12 hours	288	9 hours	442
133.14	12 hours	293	9 hours	450
134.01	12 hours	10.8	9 hours	18.9
135.01	12 hours	14.1	12 hours	20.8
136.01	12 hours	5.01	9 hours	9.23
137.01	12 hours	6.16	9 hours	10.8
138.01	18 hours	23.5	12 hours	31.6
138.02	18 hours	29.1	12 hours	39.6
138.03	18 hours	49.7	12 hours	70.5
139.01	12 hours	9.81	9 hours	15.2
139.02	12 hours	19.1	12 hours	28.2
140.01	12 hours	1.00	4.50 hours	2.79
141.01	12 hours	14.2	9 hours	23.8
141.02	12 hours	16.9	9 hours	28.6
142.01	12 hours	1.78	6 hours	3.66
143.01	12 hours	11.1	9 hours	19.5
144.01	12 hours	10.6	9 hours	17.8
145.01	12 hours	7.72	9 hours	13.3
145.02	12 hours	21.7	9 hours	34.0
145.03	12 hours	33.6	9 hours	53.5
145.04	12 hours	64.7	9 hours	101
145.05	12 hours	64.9	9 hours	101
145.06	12 hours	74.4	9 hours	119
146.01	12 hours	10.7	12 hours	15.7
147.01	12 hours	5.85	9 hours	10.5
148.01	12 hours	15.5	12 hours	22.5
148.02	12 hours	23.3	9 hours	34.8
148.03	12 hours	30.7	9 hours	46.9
149.01	12 hours	6.69	9 hours	11.2
150.01	12 hours	6.37	9 hours	9.99
151.01	12 hours	5.42	9 hours	9.94
152.01	12 hours	2.21	9 hours	4.60
153.01	12 hours	7.27	9 hours	12.8
154.01	12 hours	2.93	9 hours	5.72
154.02	12 hours	3.85	9 hours	7.72
155.01	12 hours	11.7	12 hours	16.0

1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
155.02	12 hours	11.8	12 hours	16.2
155.03	12 hours	19.5	12 hours	27.2
155.04	12 hours	20.3	12 hours	28.3
155.05	12 hours	32.1	9 hours	46.2
155.06	12 hours	37.8	9 hours	55.3
156.01	12 hours	6.48	9 hours	9.82
156.02	12 hours	6.75	9 hours	10.2
157.01	12 hours	4.79	9 hours	7.31
158.01	12 hours	2.48	9 hours	4.13
159.01	12 hours	2.38	9 hours	4.18
160.01	12 hours	4.99	9 hours	7.86
160.02	12 hours	5.34	9 hours	8.51
161.01	12 hours	10.0	12 hours	14.2
162.01	12 hours	0.820	2 hours	2.22
162.02	12 hours	6.11	9 hours	8.82
162.03	12 hours	6.22	9 hours	9.03
163.01	12 hours	1.21	6 hours	2.78
163.02	12 hours	3.66	9 hours	7.32
163.03	12 hours	11.4	9 hours	18.8
163.04	12 hours	17.4	9 hours	27.2
163.05	12 hours	38.1	12 hours	55.8
163.06	12 hours	39.6	12 hours	57.9
164.01	18 hours	13.7	12 hours	19.3
165.01	12 hours	6.60	12 hours	9.12
165.02	12 hours	7.61	12 hours	10.5
166.01	12 hours	1.92	9 hours	3.44
166.02	12 hours	4.06	9 hours	6.85
166.03	12 hours	7.09	9 hours	11.1
167.01	12 hours	1.47	6 hours	2.89
167.02	12 hours	2.79	6 hours	5.41
168.01	12 hours	4.06	9 hours	6.89
168.02	12 hours	4.09	9 hours	6.93
169.01	12 hours	7.48	9 hours	11.6
169.02	12 hours	8.47	9 hours	13.5
170.01	12 hours	1.21	6 hours	2.63
171.01	12 hours	1.38	9 hours	2.55
172.01	12 hours	0.870	6 hours	1.93
173.01	12 hours	1.68	6 hours	3.42
173.02	12 hours	13.2	9 hours	21.5
173.03	12 hours	25.9	9 hours	41.6
173.04	12 hours	28.3	9 hours	44.6
173.05	12 hours	36.2	9 hours	55.2
173.06	12 hours	46.9	9 hours	68.9
173.07	12 hours	84.1	9 hours	130
174.01	12 hours	1.32	6 hours	3.04
175.01	12 hours	1.06	6 hours	2.11
176.01	12 hours	0.950	6 hours	2.22
176.02	12 hours	5.24	9 hours	9.32
177.01	18 hours	4.42	12 hours	4.83
178.01	12 hours	3.01	9 hours	4.51

1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
179.01	12 hours	0.530	9 hours	0.940
180.01	18 hours	4.47	12 hours	5.54
180.02	18 hours	4.93	12 hours	6.12
181.01	12 hours	3.10	9 hours	4.72
182.01	12 hours	0.430	2 hours	1.13
183.01	12 hours	4.34	9 hours	8.37
183.02	12 hours	8.34	9 hours	14.9
183.03	12 hours	14.9	9 hours	25.9
183.04	12 hours	23.7	9 hours	39.6
183.05	12 hours	24.7	9 hours	41.3
183.06	12 hours	37.1	9 hours	62.3
184.01	12 hours	0.790	6 hours	1.85
184.02	12 hours	5.13	9 hours	8.50
185.01	12 hours	0.980	2 hours	2.63
185.02	12 hours	4.24	9 hours	7.66
186.01	12 hours	1.92	9 hours	3.58
187.01	12 hours	2.40	9 hours	4.13
187.02	12 hours	4.56	9 hours	7.68
188.01	12 hours	0.740	6 hours	1.71
189.01	12 hours	0.770	2 hours	1.90
190.01	12 hours	0.530	4.50 hours	1.53
191.01	12 hours	1.46	9 hours	2.73
192.01	12 hours	1.69	2 hours	4.66
193.01	12 hours	1.44	4.50 hours	4.26
194.01	12 hours	0.250	2 hours	0.970
195.01	12 hours	0.510	4.50 hours	1.58
196.01	12 hours	0.570	4.50 hours	1.73
197.01	12 hours	0.470	1.50 hour	1.69
198.01	12 hours	0.670	4.50 hours	2.05
199.01	12 hours	1.47	6 hours	3.03
199.02	12 hours	2.00	6 hours	4.27
200.01	12 hours	0.260	2 hours	0.990
201.01	12 hours	0.630	4.50 hours	1.95
202.01	12 hours	5.75	12 hours	7.93
203.01	12 hours	0.890	2 hours	2.62
204.01	12 hours	0.620	2 hours	2.07
205.01	12 hours	0.790	4.50 hours	2.49
206.01	12 hours	0.210	1.50 hour	1.00
207.01	12 hours	0.740	1.50 hour	3.05
208.01	12 hours	1.07	6 hours	2.47
208.02	12 hours	1.49	4.50 hours	3.45
208.03	12 hours	2.81	2 hours	5.89
208.04	12 hours	5.52	9 hours	9.40
208.05	12 hours	6.98	9 hours	11.1
208.06	18 hours	8.69	9 hours	12.6
209.01	12 hours	0.200	1.50 hour	0.940
210.01	12 hours	0.370	1.50 hour	1.26
211.01	12 hours	0.390	2 hours	1.23
211.02	12 hours	0.450	2 hours	1.50
211.03	12 hours	1.60	2 hours	3.99

1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
212.01	12 hours	0.190	1.50 hour	1.09
_junc_10	12 hours	37.3	9 hours	54.6
_junc_108	12 hours	0.680	2 hours	2.03
_junc_11	12 hours	594	9 hours	909
_junc_111	12 hours	3.94	9 hours	7.62
_junc_114	12 hours	2.41	9 hours	3.53
_junc_12	12 hours	18.4	9 hours	30.7
_junc_13	12 hours	182	9 hours	278
_junc_138	12 hours	12.4	9 hours	22.5
_junc_14	12 hours	155	9 hours	236
_junc_142	12 hours	9.64	9 hours	18.1
_junc_143	12 hours	291	9 hours	448
_junc_15	12 hours	554	9 hours	850
_junc_16	12 hours	605	9 hours	925
_junc_165	12 hours	40.9	9 hours	69.2
_junc_168	12 hours	38.2	9 hours	65.6
_junc_17	12 hours	173	9 hours	263
_junc_174	12 hours	27.7	9 hours	46.3
_junc_18	18 hours	68.7	12 hours	98.9
_junc_181	12 hours	0.110	1.50 hour	0.610
_junc_185	12 hours	0.120	1.50 hour	0.580
_junc_186	12 hours	0.370	1.50 hour	1.55
_junc_187	12 hours	3.13	9 hours	5.34
_junc_19	12 hours	238	9 hours	370
_junc_193	12 hours	13.4	9 hours	23.4
_junc_194	12 hours	19.1	9 hours	33.4
_junc_199	12 hours	23.4	9 hours	41.3
_junc_2	12 hours	280	9 hours	433
_junc_20	12 hours	200	9 hours	306
_junc_204	12 hours	10.4	9 hours	17.0
_junc_21	12 hours	216	9 hours	336
_junc_22	12 hours	616	9 hours	941
_junc_228	12 hours	0.630	2 hours	2.43
_junc_23	12 hours	624	9 hours	952
_junc_231	12 hours	253	9 hours	391
_junc_232	12 hours	31.4	9 hours	56.7
_junc_233	12 hours	44.8	9 hours	78.1
_junc_234	12 hours	598	9 hours	998
_junc_24	12 hours	37.8	9 hours	60.6
_junc_25	12 hours	30.4	12 hours	45.5
_junc_26	12 hours	25.6	9 hours	41.0
_junc_263	12 hours	14.8	9 hours	25.8
_junc_265	12 hours	14.4	9 hours	25.7
_junc_27	12 hours	15.6	9 hours	25.5
_junc_28	12 hours	675	9 hours	1022
_junc_29	12 hours	673	9 hours	1019
_junc_3	12 hours	25.0	9 hours	35.3
_junc_30	12 hours	679	9 hours	1028
_junc_31	12 hours	19.4	9 hours	36.4
_junc_32	12 hours	689	9 hours	1043

1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
_junc_324	12 hours	605	9 hours	1011
_junc_328	12 hours	703	9 hours	1162
_junc_329	12 hours	40.7	9 hours	60.4
_junc_33	12 hours	18.9	9 hours	35.9
_junc_330	12 hours	83.7	9 hours	130
_junc_331	12 hours	1472	9 hours	2319
_junc_34	12 hours	30.6	9 hours	55.9
_junc_35	12 hours	10.4	9 hours	18.7
_junc_36	12 hours	588	9 hours	980
_junc_37	12 hours	22.4	9 hours	36.5
_junc_38	12 hours	17.6	9 hours	32.2
_junc_39	12 hours	652	9 hours	1084
_junc_4	12 hours	25.7	12 hours	37.6
_junc_40	12 hours	32.1	9 hours	53.0
_junc_41	12 hours	19.5	9 hours	32.6
_junc_42	12 hours	36.9	9 hours	60.9
_junc_43	12 hours	94.0	9 hours	159
_junc_44	12 hours	612	9 hours	1022
_junc_45	12 hours	547	9 hours	910
_junc_46	12 hours	47.3	9 hours	75.8
_junc_47	12 hours	619	9 hours	1032
_junc_48	12 hours	451	9 hours	748
_junc_49	12 hours	21.7	9 hours	36.5
_junc_5	12 hours	21.9	9 hours	37.1
_junc_50	12 hours	69.8	9 hours	111
_junc_51	12 hours	441	9 hours	732
_junc_52	12 hours	79.8	9 hours	130
_junc_53	12 hours	22.1	12 hours	34.7
_junc_54	12 hours	111	9 hours	185
_junc_55	12 hours	125	9 hours	209
_junc_56	12 hours	404	9 hours	676
_junc_57	12 hours	168	9 hours	277
_junc_58	12 hours	383	9 hours	639
_junc_59	12 hours	359	9 hours	600
_junc_6	12 hours	72.9	9 hours	116
_junc_60	12 hours	374	9 hours	625
_junc_61	12 hours	34.9	9 hours	57.7
_junc_62	12 hours	170	9 hours	293
_junc_63	12 hours	151	9 hours	263
_junc_64	12 hours	68.8	9 hours	124
_junc_65	12 hours	19.3	9 hours	36.4
_junc_66	12 hours	129	9 hours	222
_junc_67	12 hours	77.1	9 hours	138
_junc_68	12 hours	54.7	9 hours	100
_junc_69	12 hours	40.9	9 hours	74.7
_junc_7	12 hours	83.9	9 hours	135
_junc_70	12 hours	31.2	9 hours	57.1
_junc_71	12 hours	27.0	12 hours	42.4
_junc_72	12 hours	47.1	9 hours	75.5
_junc_73	12 hours	22.2	9 hours	39.9

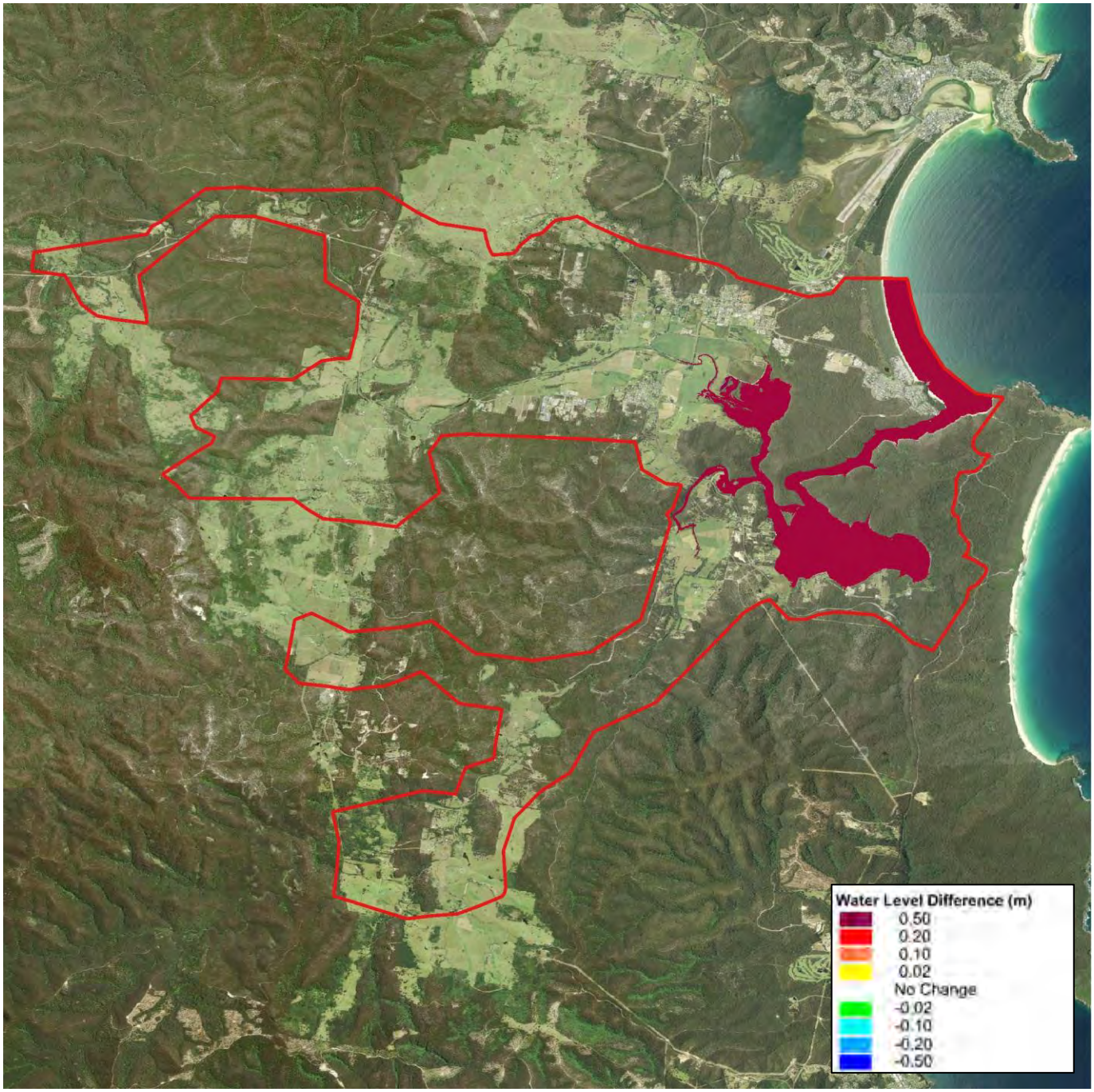
1% AEP Storm

Subcatchment	ARR2019 Critical Duration	ARR2019 Adopted Discharge (m^3/s)	ARR1987 Critical Duration	ARR1987 Discharge (m^3/s)
_junc_74	12 hours	14.6	9 hours	25.6
_junc_75	18 hours	47.6	12 hours	67.4
_junc_76	12 hours	18.3	9 hours	28.3
_junc_77	12 hours	45.0	9 hours	73.6
_junc_78	12 hours	55.7	9 hours	91.7
_junc_79	12 hours	63.6	9 hours	106
_junc_8	12 hours	31.8	9 hours	54.3
_junc_80	12 hours	25.3	9 hours	43.3
_junc_81	12 hours	121	9 hours	184
_junc_82	12 hours	27.4	9 hours	44.1
_junc_83	12 hours	22.1	9 hours	32.9
_junc_84	12 hours	149	9 hours	227
_junc_85	12 hours	29.6	9 hours	44.8
_junc_86	12 hours	185	9 hours	285
_junc_87	12 hours	64.3	9 hours	100
_junc_88	12 hours	70.2	9 hours	111
_junc_89	12 hours	169	9 hours	260
_junc_9	12 hours	42.6	9 hours	71.1
_junc_90	12 hours	271	9 hours	417
_junc_91	12 hours	18.5	12 hours	25.8

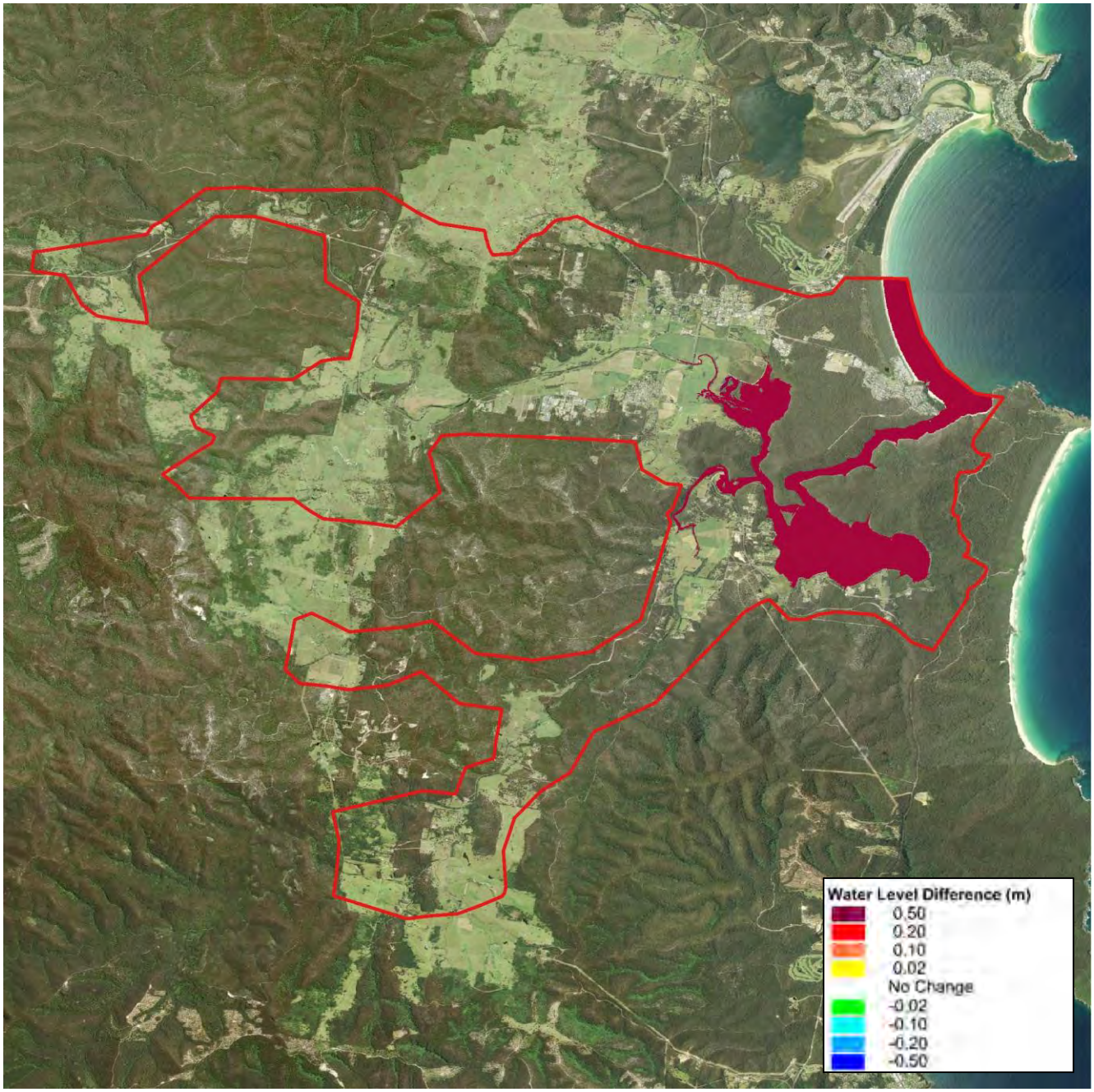
APPENDIX M
CLIMATE CHANGE DIFFERENCE MAPS

Sea Level Increase Scenarios

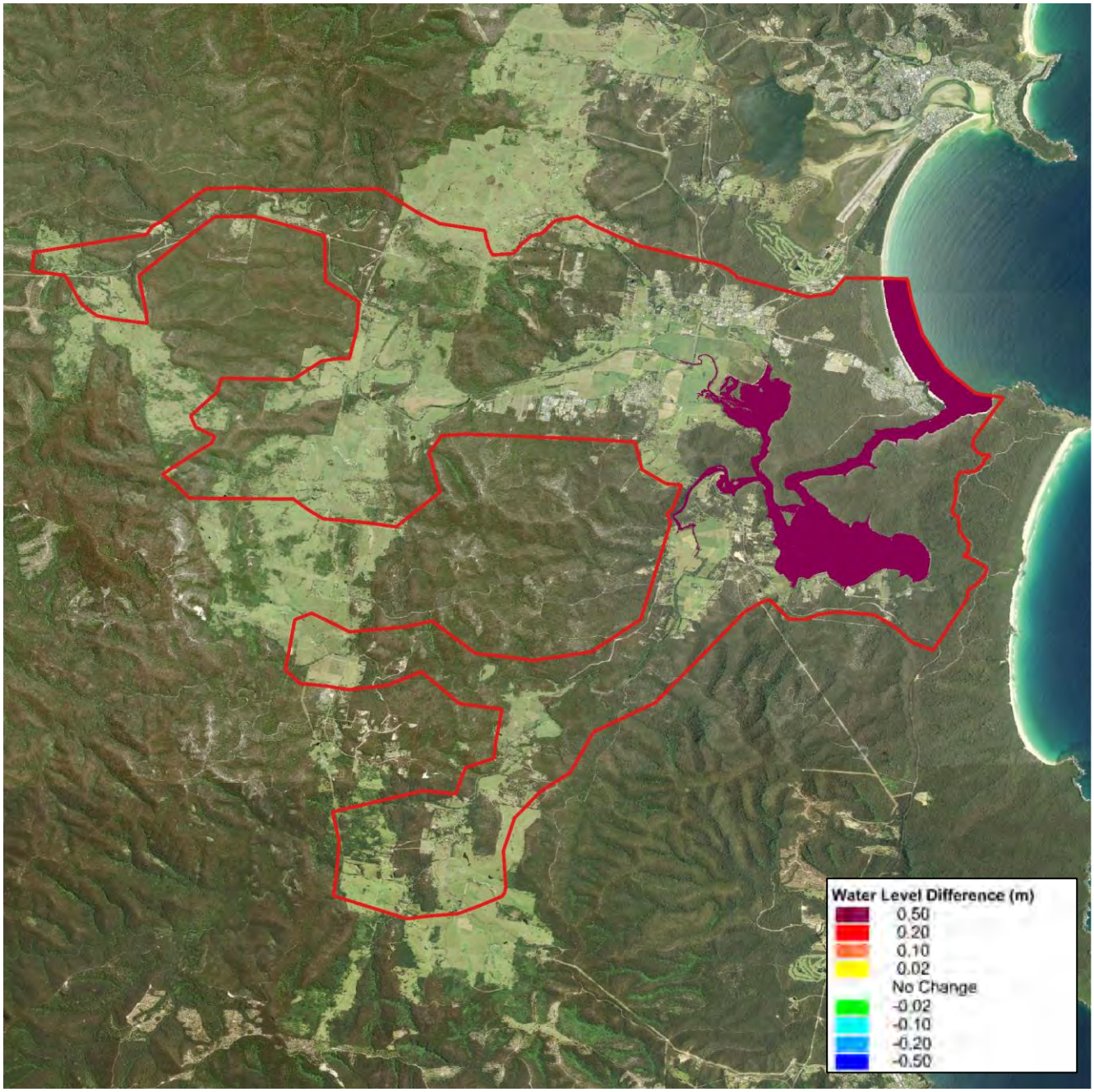
HHWS Tide with 0.4m Sea Level Rise



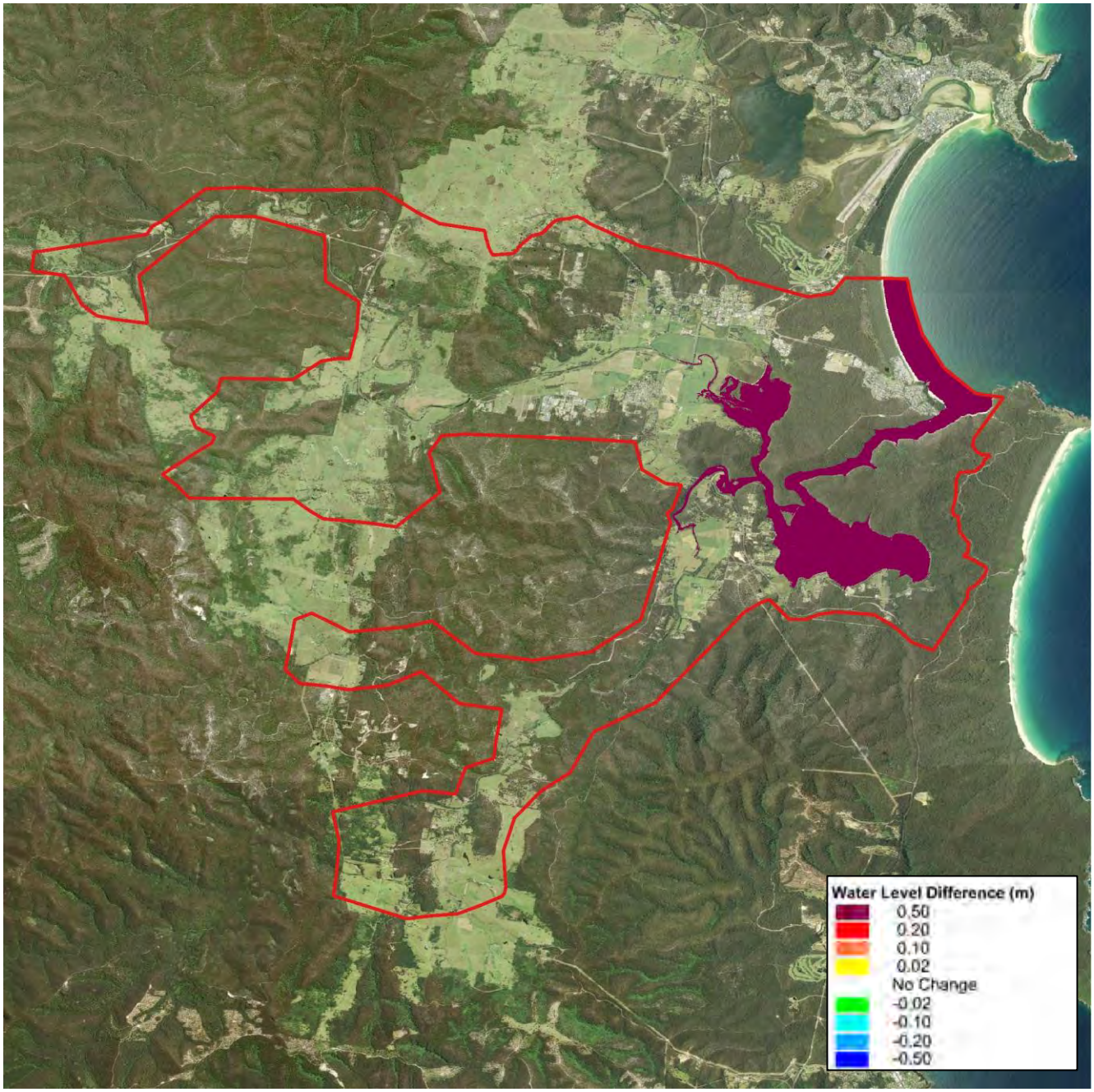
HHWS Tide with 0.4m Sea Level Rise and 0.4m Increase in River Entrance Elevation



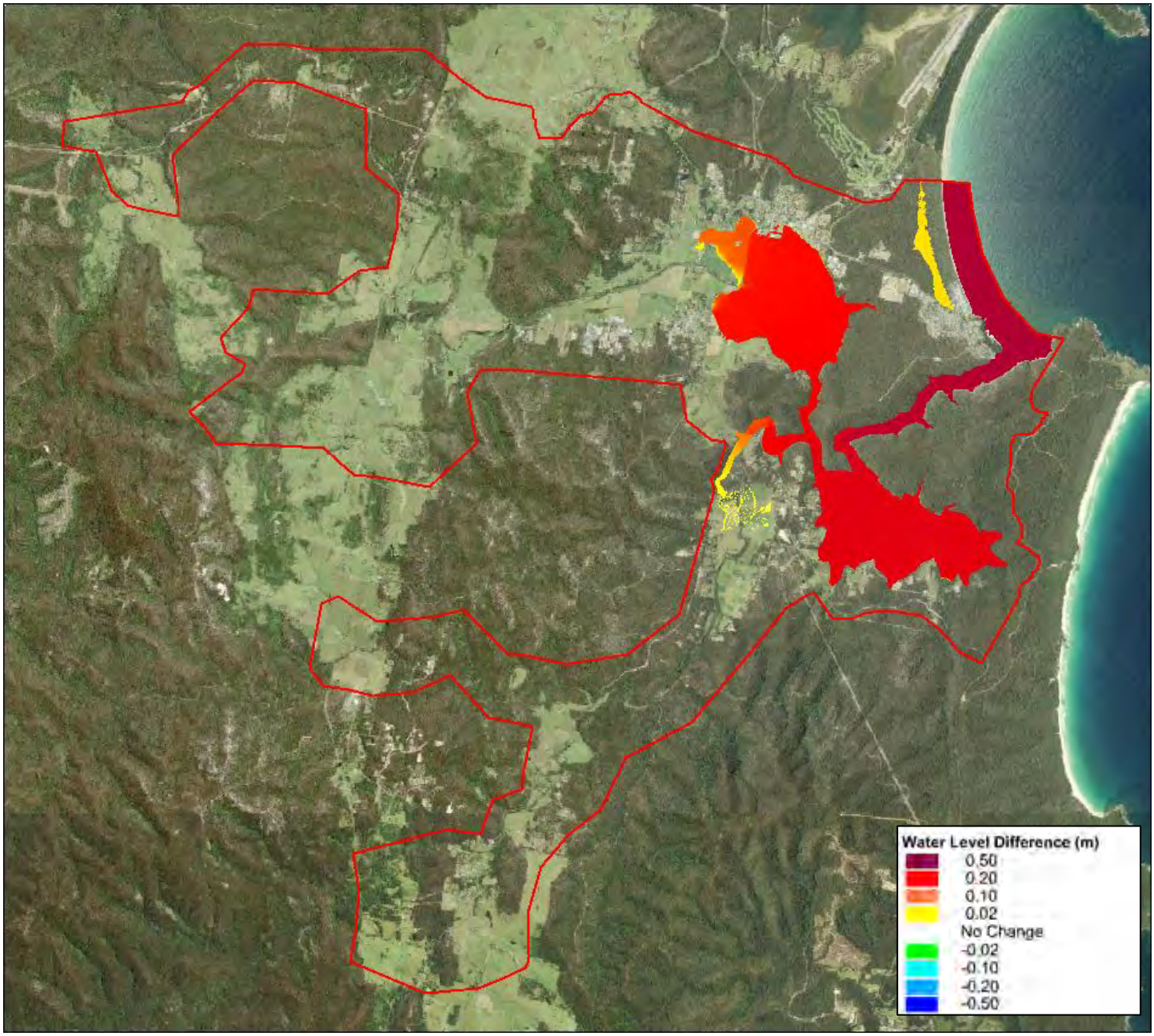
HHWS Tide with 0.9m Sea Level Rise



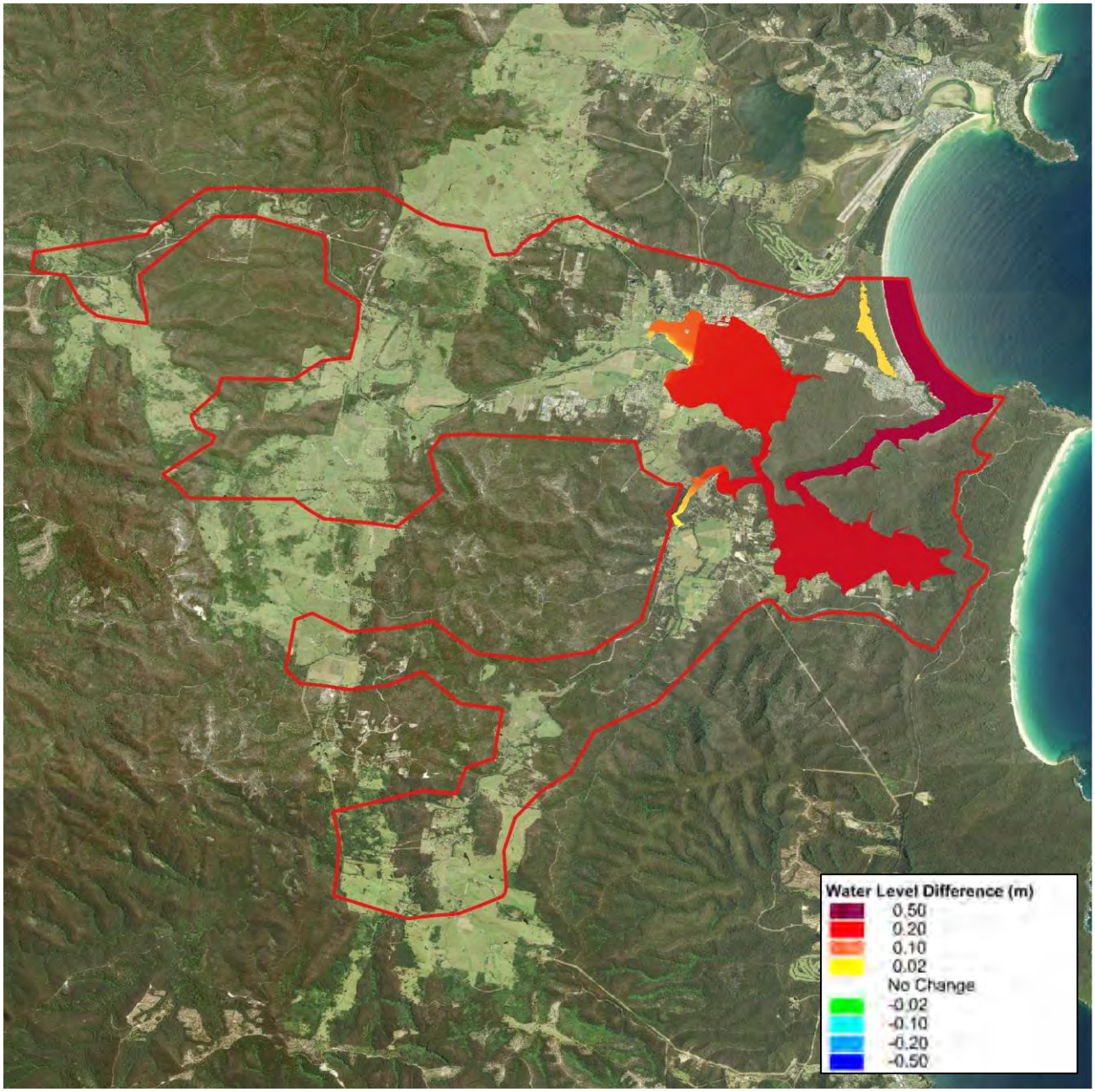
HHWS Tide with 0.9m Sea Level Rise and 0.9m Increase in River Entrance Elevation



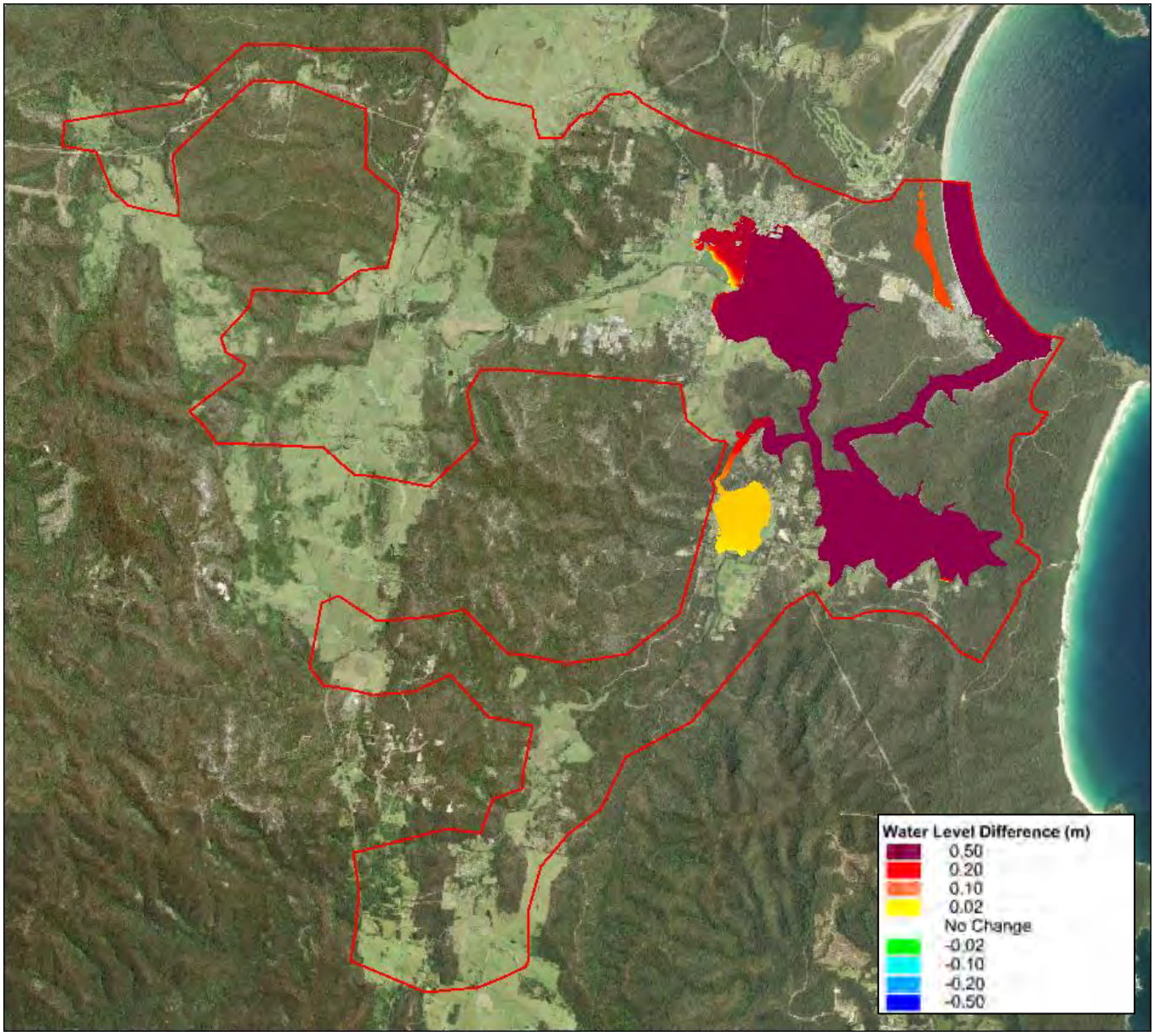
1% AEP Flood with 0.4m Sea Level Rise



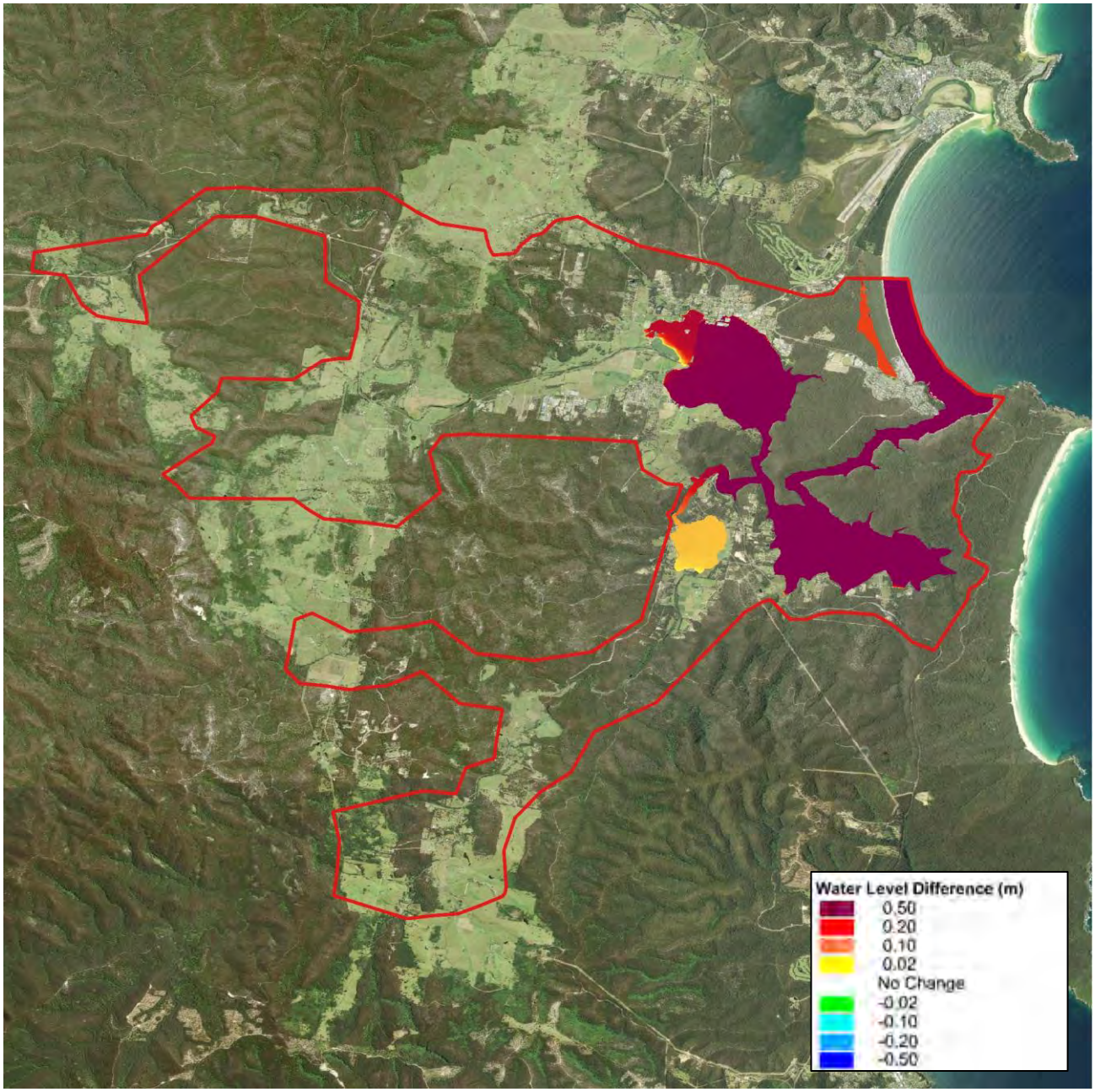
1% AEP Flood with 0.4m Sea Level Rise and 0.4m Increase in River Entrance Elevation



1% AEP Flood with 0.9m Sea Level Rise

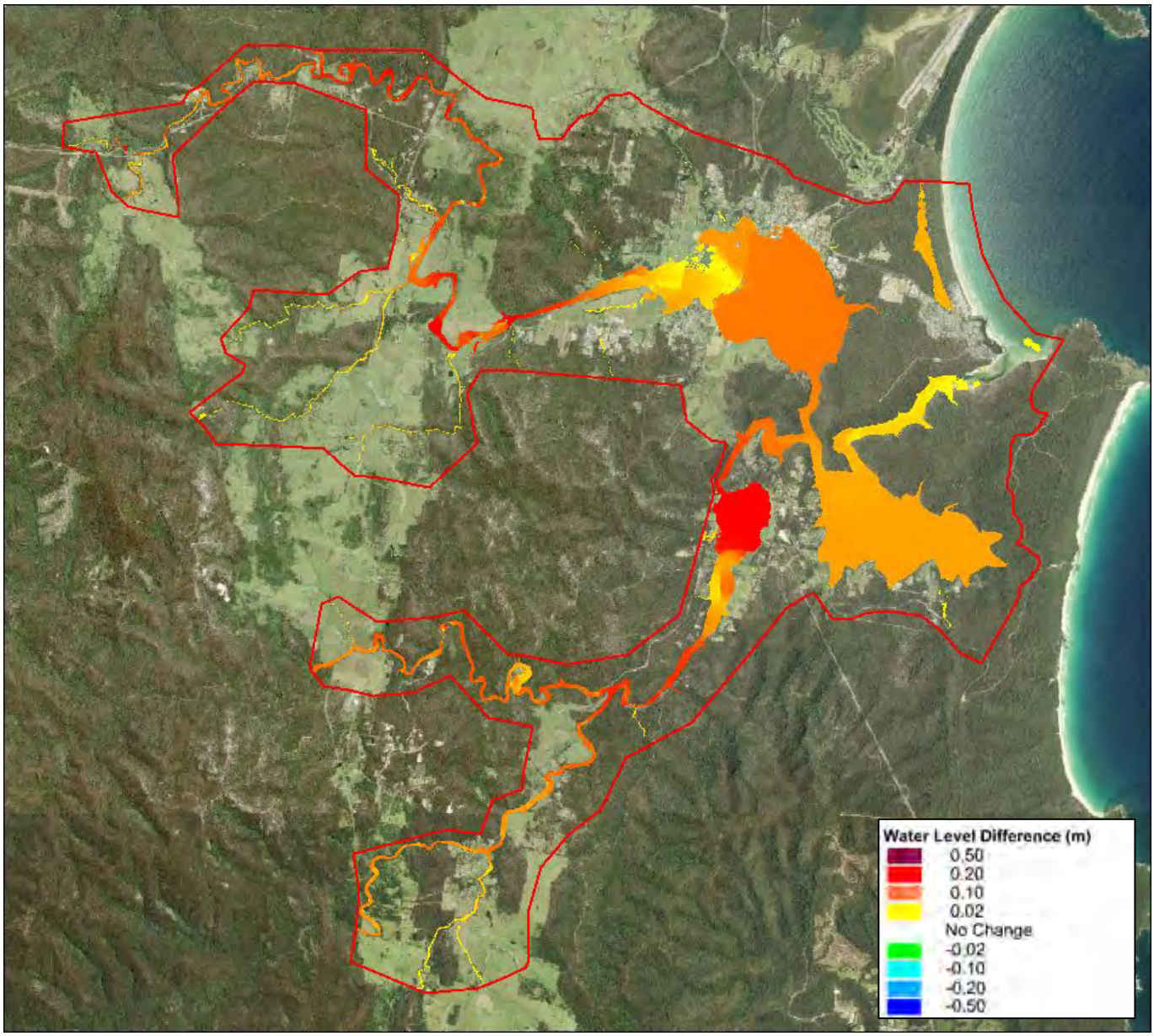


1% AEP Flood with 0.9m Sea Level Rise and 0.9m Increase in River Entrance Elevation

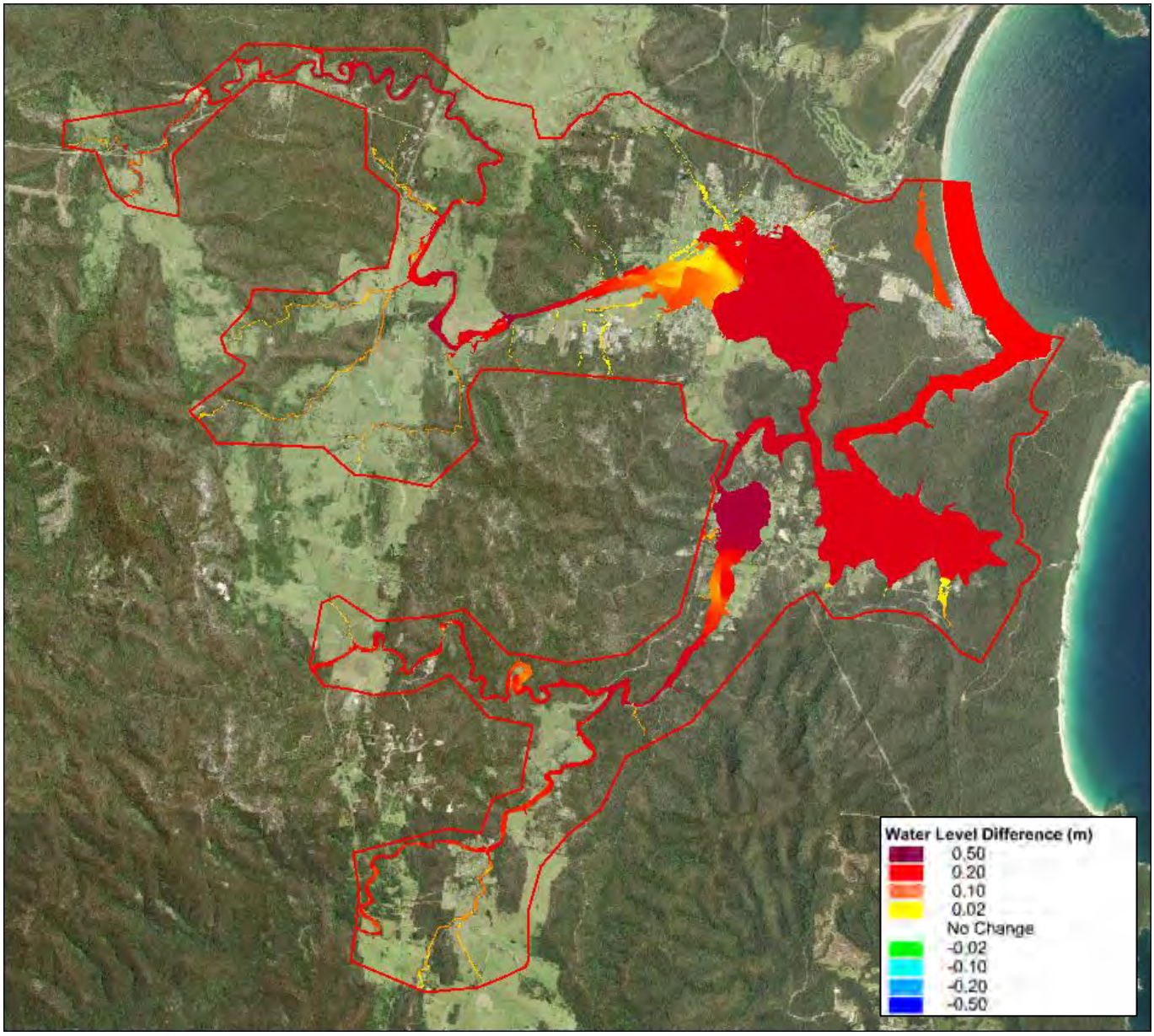


Rainfall Increase Scenarios

1% AEP Flood with 18% increase in Rainfall

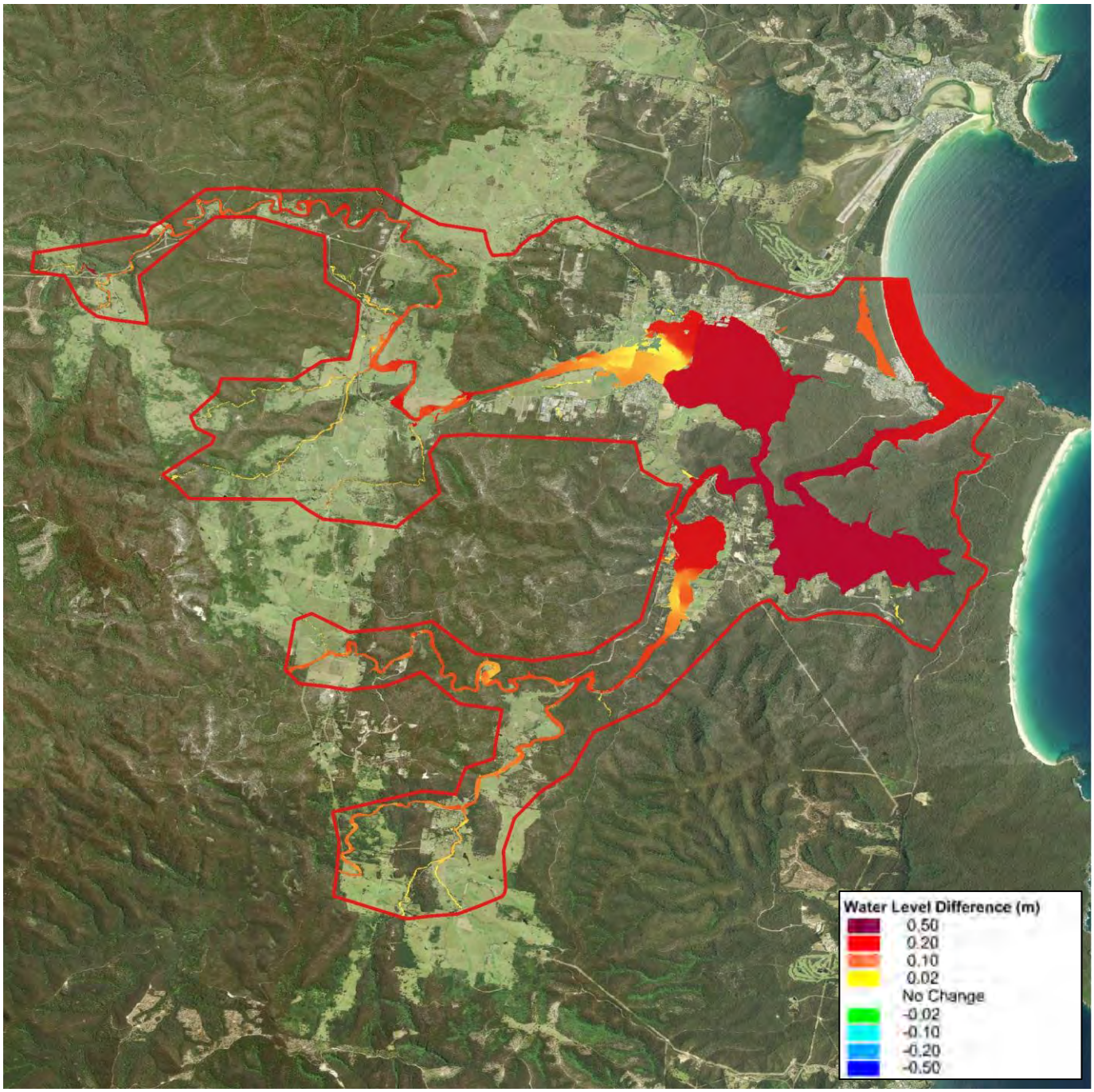


1% AEP Flood with 41% increase in Rainfall

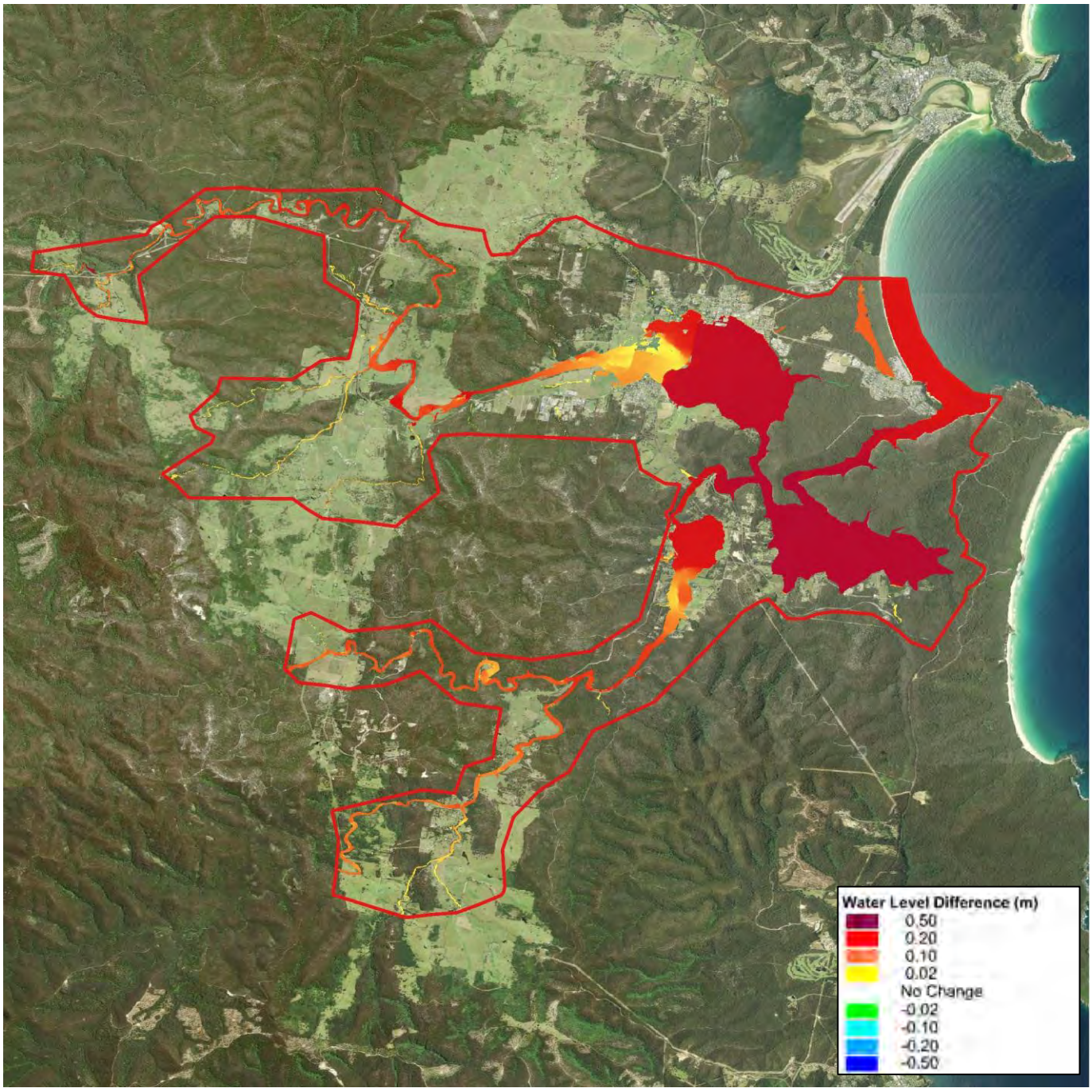


Sea Level and Rainfall Increase Scenarios

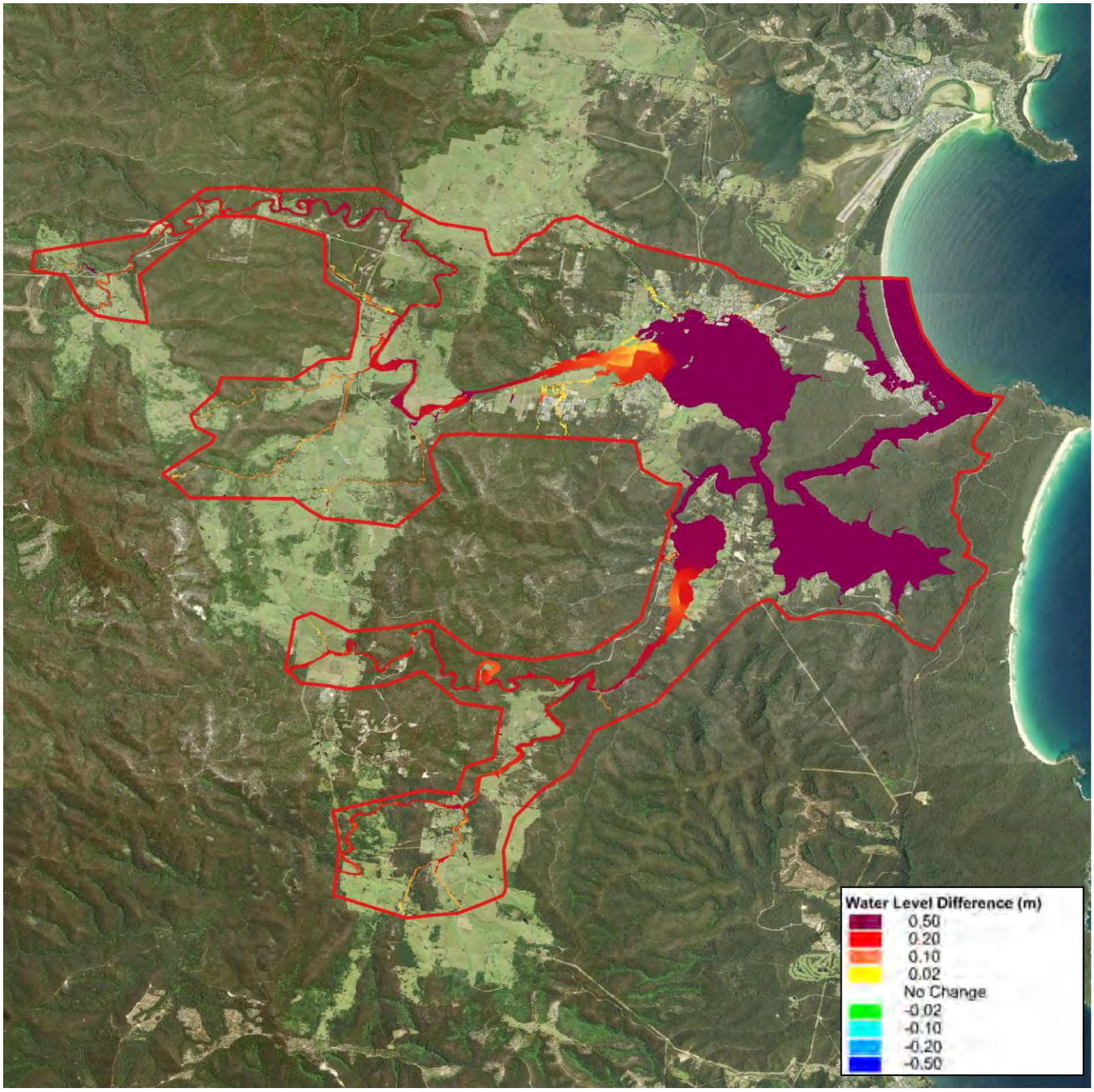
1% AEP Flood with 18% increase in rainfall with 0.4m Sea Level Rise



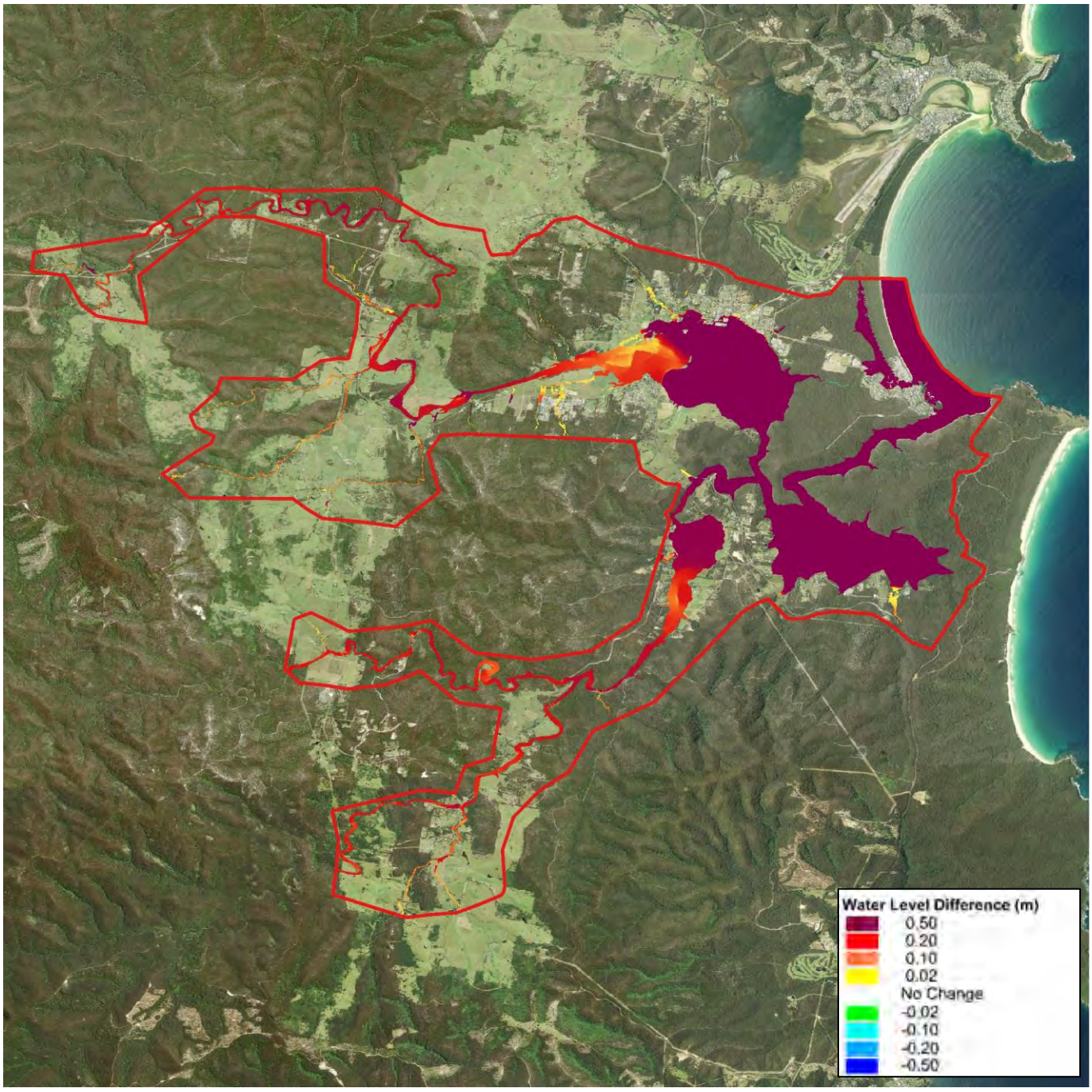
1% AEP Flood with 18% increase in rainfall with 0.4m Sea Level Rise and 0.4m Increase in River Entrance Elevation



1% AEP Flood with 41% increase in rainfall with 0.9m Sea Level Rise



1% AEP Flood with 41% increase in rainfall with 0.9m Sea Level Rise and 0.9m Increase in River Entrance Elevation



APPENDIX N
FUTURE CATCHMENT SCENARIO OUTPUTS

	5% AEP Peak Discharge (m^3/s)		1% AEP Peak Discharge (m^3/s)		0.2% AEP Peak Discharge (m^3/s)		PMF Peak Discharge (m^3/s)	
Subcatchment ID	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future
1.01	12.5	12.5	17.9	18.0	25.9	25.9	72.7	72.7
1.02	16.4	16.4	26.6	23.2	33.7	33.7	95.6	95.6
1.03	22.9	22.9	32.3	32.3	47.1	47.1	135	135
1.04	32.3	32.3	45.8	45.8	68.1	68.2	193	193
1.05	41.2	41.3	58.7	58.7	87.1	87.2	248	248
1.06	42.1	42.1	59.9	59.9	89.0	89.0	254	254
1.07	50.1	50.2	71.5	71.5	105	105	301	301
1.08	55.1	55.2	78.6	78.6	115	115	329	329
1.09	56.6	56.8	80.9	80.9	118	118	339	339
1.10	92.5	92.6	132	133	193	193	537	537
1.11	111	111	159	159	232	232	658	658
1.12	125	125	180	180	263	263	733	733
1.13	254	254	366	367	536	537	1571	1571
1.14	264	265	377	377	553	553	1638	1638
1.15	265	265	378	382	554	554	1641	1641
1.16	270	270	384	385	564	564	1672	1672
1.17	291	291	414	415	608	608	1811	1811
1.18	313	313	445	445	651	652	1979	1979
1.19	318	318	452	452	662	662	2022	2022
1.20	387	388	552	552	807	807	2625	2625
1.21	390	390	555	555	811	812	2644	2644
1.22	418	418	595	595	869	869	2867	2867
1.23	425	425	605	604	883	883	2918	2918
1.24	425	425	605	605	883	883	2919	2919
1.25	427	427	608	607	887	887	2932	2932
1.26	432	431	614	614	896	896	2963	2963
1.27	437	437	621	621	908	907	2992	2992
1.28	437	437	622	621	909	908	2994	2994
1.29	461	459	656	654	958	956	3153	3153
1.30	463	461	658	656	962	959	3161	3161
1.31	498	496	710	708	1037	1037	3375	3375
1.32	498	496	710	708	1037	1037	3375	3375
1.33	971	971	1396	1399	2045	2049	6176	6176
1.34	972	972	1399	1401	2049	2050	6179	6179
1.35	1023	1023	1477	1479	2163	2165	6452	6452
1.36	1023	1024	1479	1481	2164	2166	6453	6453
1.37	1024	1024	1480	1482	2164	2167	6453	6453
1.38	1024	1024	1482	1484	2165	2168	6454	6454
1.39	1028	1029	1491	1493	2173	2177	6471	6471
1.40	1034	1035	1504	1506	2203	2207	6497	6497
2.01	3.22	3.22	4.73	4.73	6.68	6.68	20.1	20.1
3.01	6.76	6.77	8.32	8.32	12.3	12.3	35.4	35.4
4.01	6.11	6.16	8.71	8.73	12.8	12.8	36.3	36.3
5.01	7.46	7.47	9.02	9.01	13.4	13.4	38.4	38.4
6.01	6.44	6.47	9.27	9.32	13.5	13.5	36.6	36.6
7.01	4.13	4.13	5.96	5.96	8.67	8.67	23.2	23.2
8.01	11.4	11.5	17.2	17.2	25.0	25.1	55.4	55.4
8.02	22.9	22.9	32.9	33.0	48.5	48.6	117	117
8.03	22.9	23.0	32.9	33.0	48.5	48.6	118	118
8.04	33.3	33.4	47.8	47.9	69.8	70.3	179	179
8.05	34.3	34.4	49.2	49.4	71.9	72.4	185	185
9.01	7.16	7.24	10.4	10.4	15.2	15.2	39.8	39.8
10.01	4.25	4.25	6.10	6.10	8.88	8.86	27.0	27.0
10.02	10.3	10.3	14.8	14.8	21.3	21.4	62.9	62.9
11.01	5.97	6.04	8.61	8.62	12.5	12.5	35.6	35.6
12.01	5.90	5.02	7.31	7.34	10.8	10.3	33.8	33.8
12.02	8.78	8.82	12.6	12.6	18.0	18.1	58.2	58.2
12.03	13.9	14.0	20.1	20.1	28.8	28.9	92.4	92.4
13.01	1.74	1.74	2.46	2.48	3.58	3.59	11.7	11.7
14.01	4.10	4.83	5.87	5.88	8.67	8.71	26.9	26.9
14.02	5.86	4.97	7.07	7.09	10.6	10.4	32.7	32.7
15.01	0.730	0.730	1.03	1.04	1.48	1.48	5.15	5.15
16.01	5.23	5.23	7.88	7.89	11.4	11.4	29.5	29.5
16.02	7.84	7.87	11.7	11.8	17.2	17.2	46.4	46.4
17.01	8.21	8.22	11.7	11.7	17.2	17.3	48.2	48.2
17.02	18.6	18.9	27.2	27.2	39.5	39.5	120	120
17.03	23.9	24.0	34.9	34.9	50.7	50.7	156	156
17.04	34.4	34.5	49.4	49.6	72.3	72.4	214	214
17.05	40.6	40.7	58.2	58.3	85.2	85.3	262	262
17.06	50.7	50.8	72.6	72.8	106	106	323	323
17.07	57.8	57.9	82.7	82.9	121	121	381	381
17.08	79.3	79.6	115	115	168	168	528	528
17.09	81.2	81.4	117	117	172	172	543	543
17.10	87.6	87.8	125	126	185	185	584	584
17.11	123	124	179	179	260	260	795	795
17.12	125	126	182	182	264	264	810	810

	5% AEP Peak Discharge (m^3/s)		1% AEP Peak Discharge (m^3/s)		0.2% AEP Peak Discharge (m^3/s)		PMF Peak Discharge (m^3/s)	
Subcatchment ID	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future
17.13	127	127	184	184	266	267	818	818
18.01	7.49	7.62	10.8	10.9	15.7	15.8	50.5	50.5
19.01	3.66	3.67	5.29	5.30	7.68	7.69	24.6	24.6
20.01	8.84	8.88	13.3	13.4	19.4	19.5	50.3	50.3
21.01	7.29	7.33	10.9	11.0	15.9	16.0	42.5	42.5
21.02	8.15	8.20	12.2	12.2	17.9	18.0	48.0	48.0
22.01	6.52	5.53	8.04	8.06	11.8	11.4	48.4	48.4
23.01	4.57	4.60	6.46	6.48	9.36	9.43	29.4	29.4
23.02	14.5	14.5	20.7	20.8	30.2	30.2	94.9	94.9
23.03	19.7	19.8	28.2	28.3	40.8	41.1	133	133
23.04	20.0	20.1	28.6	28.6	41.5	41.6	135	135
24.01	5.81	5.85	8.37	8.38	12.1	12.1	37.2	37.2
25.01	2.11	2.11	2.94	2.94	4.40	4.40	15.8	15.8
26.01	6.34	6.34	9.12	9.12	13.4	13.4	40.4	40.4
26.02	6.42	6.42	9.23	9.23	13.5	13.5	40.9	40.9
27.01	8.04	8.05	11.5	11.6	16.8	16.8	46.9	46.9
27.02	17.6	17.6	25.1	25.1	37.0	37.1	103	103
27.03	30.0	30.0	43.5	43.6	63.8	63.9	172	172
28.01	1.73	1.73	2.45	2.47	3.54	3.55	11.7	11.7
28.02	2.35	2.35	3.31	3.33	4.81	4.82	15.8	15.8
29.01	6.96	7.01	9.98	10.1	14.6	14.6	40.8	40.8
30.01	2.05	2.06	2.91	2.92	4.32	4.33	17.9	17.9
31.01	1.73	1.73	2.13	2.12	3.07	3.06	12.7	12.7
32.01	8.60	8.59	12.3	12.3	18.1	18.2	52.9	52.9
33.01	4.09	4.11	5.90	5.92	8.61	8.60	27.3	27.3
34.01	5.97	6.03	8.62	8.61	12.6	12.6	40.5	40.5
34.02	14.9	15.0	20.9	21.1	30.6	30.8	105	105
34.03	15.2	15.2	21.3	21.4	31.2	31.3	107	107
35.01	4.17	4.20	6.00	6.03	8.74	8.74	35.5	35.5
35.02	8.52	8.55	12.8	12.9	18.7	18.7	66.9	66.9
35.03	11.5	11.5	17.2	17.3	25.0	25.1	91.1	91.1
35.04	11.6	11.7	17.5	17.5	25.3	25.7	92.0	92.0
35.05	18.7	18.8	27.1	27.0	39.8	39.8	152	152
36.01	0.530	0.530	0.740	0.740	1.11	1.10	4.64	4.64
37.01	3.47	3.49	5.08	5.07	7.34	7.35	33.9	33.9
38.01	3.56	3.58	5.21	5.21	7.66	7.66	34.7	34.7
38.02	4.35	4.35	6.45	6.47	9.36	9.39	42.4	42.4
39.01	4.82	4.84	6.97	6.96	10.1	10.1	35.4	35.4
39.02	10.3	10.4	14.6	14.7	21.2	21.2	80.2	80.2
39.03	15.2	15.2	21.0	21.1	31.3	31.3	120	120
39.04	29.0	29.1	41.8	41.8	62.4	62.4	249	249
39.05	36.9	36.9	53.1	53.1	78.4	78.6	325	325
39.06	67.8	67.8	97.6	97.9	143	144	629	629
40.01	2.70	2.72	3.84	3.87	5.73	5.74	24.4	24.4
41.01	3.40	3.43	4.93	5.00	7.22	7.25	31.2	31.2
42.01	6.88	6.92	9.87	9.93	14.4	14.4	58.2	58.2
43.01	2.19	2.21	3.18	3.19	4.73	4.55	23.5	23.5
44.01	7.50	7.56	10.7	10.7	15.8	15.8	69.1	69.1
44.02	18.7	18.8	26.9	27.0	39.4	39.7	179	179
44.03	28.6	28.7	41.2	41.5	60.6	60.8	278	278
45.01	4.94	4.96	7.34	7.37	10.3	10.4	47.9	47.9
46.01	6.91	6.92	10.2	10.2	15.2	15.2	67.0	67.0
47.01	6.34	6.40	9.07	9.08	13.4	13.2	57.0	57.0
47.02	8.93	9.01	12.6	12.7	18.4	18.6	79.7	79.7
47.03	9.84	9.91	13.8	13.8	20.3	20.5	86.3	86.3
47.04	19.6	19.7	28.2	28.3	41.3	41.5	178	178
47.05	26.1	26.2	37.0	37.0	53.7	53.8	232	232
48.01	2.42	2.44	3.48	3.50	5.01	5.09	21.8	21.8
49.01	4.09	4.10	5.17	5.20	7.27	7.38	35.7	35.7
49.02	4.02	4.04	5.75	5.79	8.51	8.56	40.4	40.4
49.03	4.09	4.11	5.85	5.88	8.65	8.69	40.9	40.9
50.01	0.700	0.700	0.990	1.00	1.42	1.43	6.19	6.19
51.01	2.31	2.32	3.40	3.40	4.81	4.87	20.9	20.9
52.01	1.09	1.09	1.54	1.54	2.28	2.28	9.78	9.78
52.02	2.56	2.67	3.65	3.79	5.34	5.53	22.3	22.3
53.01	3.67	3.67	5.32	5.32	7.74	7.74	31.5	31.5
54.01	1.67	1.68	2.04	2.04	3.00	3.01	12.6	12.6
54.02	2.12	2.35	3.04	3.26	4.40	4.67	18.1	18.1
54.03	2.45	2.68	3.44	3.73	4.99	5.31	20.1	20.1
55.01	1.76	1.75	2.59	2.60	3.59	3.63	15.8	15.8
56.01	2.40	2.42	3.58	3.40	5.13	5.16	21.5	21.5
56.02	4.00	4.00	5.90	5.90	8.37	8.39	33.6	33.6
56.03	4.70	4.70	6.91	6.90	9.80	9.81	39.2	39.2
57.01	2.12	2.13	2.93	2.97	4.36	4.43	16.2	16.2
57.02	4.92	4.94	7.26	7.27	10.9	10.9	31.8	31.8
58.01	3.81	3.81	5.52	5.51	7.97	7.97	30.1	30.1

	5% AEP Peak Discharge (m^3/s)		1% AEP Peak Discharge (m^3/s)		0.2% AEP Peak Discharge (m^3/s)		PMF Peak Discharge (m^3/s)	
Subcatchment ID	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future
58.02	5.57	5.57	8.08	8.07	11.7	11.7	43.0	43.0
58.03	8.07	8.34	11.7	11.8	16.8	17.0	61.3	61.3
58.04	13.6	14.4	22.2	20.4	28.1	29.2	107	107
58.05	14.5	15.8	21.0	22.3	30.6	31.8	113	113
58.06	21.1	23.8	30.5	33.7	44.9	47.0	158	158
58.07	24.2	26.9	35.0	38.3	51.1	53.5	178	178
59.01	2.03	2.03	2.52	2.53	3.67	3.68	13.2	13.2
60.01	1.61	1.62	2.31	2.32	3.39	3.41	14.8	14.8
60.02	2.05	2.07	2.94	2.96	4.33	4.36	19.0	19.0
60.03	4.48	4.69	6.36	6.83	9.36	9.97	37.6	37.6
61.01	1.54	1.54	1.90	1.90	2.78	2.78	11.2	11.2
62.01	0.320	0.420	0.460	0.580	0.680	0.820	2.43	2.43
63.01	0.030	0.030	0.040	0.040	0.050	0.060	0.200	0.200
64.01	0.910	1.21	1.29	1.58	1.93	2.22	7.02	7.02
64.02	5.20	5.99	7.15	8.40	10.5	11.8	36.1	36.1
65.01	0.540	0.730	0.760	1.02	1.12	1.42	4.00	4.00
66.01	0.660	0.660	0.950	0.950	1.35	1.36	5.14	5.14
66.02	2.27	2.54	3.29	3.78	4.79	5.41	16.6	16.6
67.01	0.130	0.130	0.180	0.180	0.250	0.260	0.870	0.870
68.01	0.210	0.210	0.270	0.290	0.390	0.420	1.43	1.43
69.01	0.200	0.210	0.280	0.290	0.400	0.420	1.42	1.42
69.02	0.360	0.360	0.500	0.500	0.710	0.710	2.45	2.45
70.01	0.160	0.160	0.200	0.220	0.290	0.310	1.05	1.05
71.01	0.160	0.170	0.230	0.240	0.330	0.340	1.16	1.16
72.01	0.200	0.200	0.270	0.280	0.380	0.400	1.35	1.35
73.01	0.150	0.150	0.190	0.210	0.270	0.290	1.00	1.00
74.01	1.21	1.21	1.80	1.80	2.50	2.50	8.42	8.42
75.01	0.660	0.660	1.06	1.07	1.70	1.73	2.71	2.71
75.02	0.770	0.790	1.27	1.28	2.04	2.08	3.30	3.30
76.01	0.860	0.870	1.22	1.23	1.83	1.84	6.05	6.05
76.02	0.920	0.920	1.35	1.36	1.99	1.99	6.41	6.41
77.01	2.06	2.13	3.02	2.95	4.28	4.33	15.7	15.7
77.02	4.60	4.61	6.71	6.49	9.54	9.65	35.0	35.0
77.03	8.70	8.70	12.6	12.5	18.2	18.3	61.9	61.9
77.04	9.69	9.70	14.0	14.1	20.5	20.5	69.1	69.1
77.05	10.3	10.6	15.0	15.0	21.9	21.9	73.5	73.5
77.06	10.5	10.8	15.2	15.2	22.2	22.2	74.4	74.4
77.07	21.4	21.7	30.5	30.7	43.2	43.4	143	143
77.08	22.0	21.0	31.3	31.6	44.0	44.3	145	145
77.09	22.1	21.1	31.6	31.8	44.3	44.6	146	146
77.10	21.3	21.5	32.1	32.3	45.0	45.4	148	148
77.11	24.4	24.6	36.5	36.5	51.7	52.1	167	167
77.12	27.4	27.8	39.3	39.8	60.0	59.9	183	183
77.13	33.4	33.9	48.7	49.2	70.7	71.2	213	213
78.01	1.94	1.96	2.78	2.78	4.08	4.03	14.6	14.6
78.02	4.59	4.60	7.07	7.09	10.6	10.6	33.0	33.0
79.01	1.32	1.33	1.90	1.92	2.79	2.80	10.3	10.3
80.01	0.600	0.600	0.860	0.860	1.24	1.24	4.63	4.63
81.01	1.29	1.30	1.84	1.87	2.69	2.73	9.03	9.03
81.02	1.45	1.46	2.07	2.09	3.03	3.05	9.93	9.93
81.03	2.96	2.96	4.23	4.27	6.22	6.22	20.0	20.0
81.04	5.48	5.60	7.93	8.09	11.4	11.6	36.0	36.0
82.01	0.290	0.290	0.410	0.420	0.600	0.600	2.02	2.02
82.02	1.23	1.23	1.77	1.79	2.59	2.59	8.32	8.32
82.03	1.41	1.41	2.02	2.04	2.95	2.95	9.51	9.51
83.01	0.900	0.970	1.29	1.38	1.86	1.95	6.22	6.22
83.02	1.80	1.93	2.56	2.72	3.65	3.86	11.9	11.9
83.03	1.99	2.13	2.84	3.00	4.04	4.24	13.2	13.2
84.01	0.170	0.180	0.240	0.250	0.340	0.350	1.09	1.09
84.02	0.630	0.650	0.890	0.920	1.27	1.31	4.16	4.16
85.01	0.340	0.350	0.490	0.500	0.700	0.720	2.30	2.30
86.01	0.050	0.050	0.070	0.070	0.100	0.100	0.320	0.320
87.01	0.260	0.270	0.360	0.380	0.520	0.540	1.66	1.66
87.02	0.490	0.510	0.680	0.680	0.960	0.970	3.10	3.10
88.01	0.100	0.110	0.150	0.160	0.210	0.220	0.660	0.660
89.01	0.160	0.160	0.220	0.220	0.310	0.310	1.03	1.03
90.01	0.100	0.110	0.150	0.160	0.200	0.220	0.660	0.660
91.01	0.300	0.340	0.420	0.480	0.600	0.670	1.90	1.90
92.01	0.480	0.490	0.690	0.700	0.980	1.04	2.99	2.99
92.02	1.90	2.03	2.72	2.88	3.98	4.06	11.8	11.8
92.03	2.04	2.18	2.92	3.09	4.31	4.36	12.4	12.4
92.04	3.01	3.35	4.31	4.59	6.20	6.66	17.7	17.7
93.01	0.150	0.170	0.220	0.240	0.310	0.340	1.07	1.07
94.01	0.180	0.190	0.250	0.270	0.350	0.380	1.12	1.12
95.01	0.220	0.230	0.310	0.330	0.440	0.470	1.39	1.39
96.01	0.090	0.100	0.140	0.140	0.180	0.200	0.590	0.590

	5% AEP Peak Discharge (m^3/s)		1% AEP Peak Discharge (m^3/s)		0.2% AEP Peak Discharge (m^3/s)		PMF Peak Discharge (m^3/s)	
Subcatchment ID	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future
97.01	0.100	0.110	0.150	0.160	0.200	0.220	0.650	0.650
98.01	0.300	0.340	0.430	0.480	0.620	0.680	2.07	2.07
99.01	1.68	1.78	2.43	2.56	3.54	3.66	9.38	9.38
99.02	2.27	2.47	3.30	3.54	4.75	5.08	12.4	12.4
100.01	0.050	0.060	0.070	0.080	0.110	0.120	0.340	0.340
101.01	0.040	0.040	0.050	0.060	0.080	0.080	0.250	0.250
102.01	0.070	0.070	0.100	0.100	0.140	0.140	0.440	0.440
103.01	0.040	0.040	0.060	0.060	0.080	0.080	0.280	0.280
104.01	0.140	0.150	0.190	0.210	0.270	0.300	0.860	0.860
104.02	0.360	0.410	0.500	0.570	0.700	0.790	2.28	2.28
105.01	0.030	0.030	0.050	0.050	0.060	0.060	0.210	0.210
106.01	3.13	3.14	4.94	4.99	7.46	7.51	13.8	13.8
106.02	4.70	4.74	7.27	7.31	10.8	10.9	23.7	23.7
107.01	1.93	1.93	2.34	2.34	3.43	3.43	10.6	10.6
108.01	1.12	1.46	1.62	1.98	2.37	2.91	6.01	6.01
108.02	1.15	1.48	1.65	2.00	2.42	2.95	6.13	6.13
109.01	2.66	2.66	3.24	3.24	4.84	4.84	15.3	15.3
110.01	1.35	1.32	1.90	1.90	2.76	2.76	9.31	9.31
111.01	0.630	0.640	0.890	0.900	1.27	1.29	4.39	4.39
112.01	0.490	0.490	0.690	0.690	0.990	0.990	3.36	3.36
113.01	0.230	0.230	0.330	0.330	0.480	0.490	1.59	1.59
114.01	7.45	7.49	10.7	10.7	15.5	15.6	46.9	46.9
114.02	11.3	11.4	16.2	16.2	23.5	23.6	71.7	71.7
114.03	21.9	22.0	31.5	31.5	45.4	45.5	134	134
114.04	35.3	35.4	52.0	52.1	76.8	77.0	214	214
114.05	45.4	45.7	67.9	68.2	100.0	100	269	269
114.06	112	112	162	162	235	235	660	660
114.07	121	121	175	175	255	255	729	729
114.08	132	132	191	191	277	277	798	798
114.09	135	135	195	195	284	284	820	820
114.10	142	142	206	206	299	299	877	877
114.11	152	152	220	220	319	319	954	954
114.12	154	154	223	223	324	324	970	970
114.13	174	175	254	254	370	370	1092	1092
114.14	182	182	265	265	387	387	1137	1137
114.15	183	183	267	267	389	389	1142	1142
114.16	391	392	569	569	825	825	2295	2295
114.17	418	419	606	607	881	882	2445	2445
114.18	426	426	617	618	897	898	2487	2487
114.19	429	430	622	623	905	905	2504	2504
114.20	434	435	629	629	915	915	2530	2530
114.21	469	469	679	680	991	992	2748	2748
114.22	474	474	686	687	1001	1002	2775	2775
114.23	475	476	689	689	1005	1005	2782	2782
114.24	479	480	695	695	1013	1014	2804	2804
114.25	487	487	705	705	1029	1029	2844	2844
115.01	3.50	3.50	5.00	5.01	7.24	7.23	22.7	22.7
116.01	6.66	6.70	9.59	9.54	13.8	13.8	38.9	38.9
117.01	4.55	4.58	6.54	6.55	9.62	9.63	34.0	34.0
118.01	11.0	11.0	16.7	16.8	25.0	25.1	54.4	54.4
119.01	13.1	13.1	18.8	18.8	27.0	27.2	67.3	67.3
119.02	20.1	20.2	28.8	28.8	41.5	41.7	111	111
119.03	53.8	53.9	76.5	76.8	110	111	321	321
119.04	62.3	62.5	88.7	88.9	128	128	377	377
120.01	5.10	5.13	7.21	7.20	10.3	10.3	31.0	31.0
121.01	8.32	7.08	10.0	10.1	14.7	14.8	44.2	44.2
121.02	18.2	18.4	25.9	26.0	37.8	38.0	113	113
121.03	23.6	23.8	33.6	33.6	49.4	49.5	148	148
121.04	31.5	31.6	44.6	44.7	64.5	64.8	195	195
122.01	8.51	8.59	12.1	12.1	17.4	17.5	52.3	52.3
123.01	5.15	5.16	6.26	6.29	9.16	8.90	27.9	27.9
124.01	6.52	6.57	9.31	9.39	13.5	13.5	38.4	38.4
125.01	5.34	5.39	7.59	7.60	11.1	11.1	37.3	37.3
126.01	9.18	9.17	13.3	13.3	19.6	19.6	67.7	67.7
127.01	6.51	6.49	9.23	9.25	13.2	13.3	44.2	44.2
128.01	5.33	5.36	7.53	7.55	10.9	11.0	45.0	45.0
129.01	4.97	4.97	6.09	6.10	9.05	8.83	37.6	37.6
129.02	8.04	8.11	11.4	11.5	17.0	17.1	70.3	70.3
129.03	10.3	10.4	14.7	14.7	21.8	21.8	90.9	90.9
130.01	2.57	2.59	3.83	3.65	5.47	5.52	23.8	23.8
131.01	2.08	2.08	2.89	2.90	4.21	4.22	14.8	14.8
131.02	8.45	8.46	12.6	12.6	18.4	18.4	52.3	52.3
131.03	12.8	12.8	19.3	19.3	28.1	28.0	82.8	82.8
132.01	3.92	3.92	4.98	4.98	6.98	7.02	26.9	26.9
133.01	12.1	12.1	14.6	14.6	21.4	21.4	58.8	58.8
133.02	26.0	26.1	31.3	31.4	46.1	46.3	131	131

	5% AEP Peak Discharge (m^3/s)		1% AEP Peak Discharge (m^3/s)		0.2% AEP Peak Discharge (m^3/s)		PMF Peak Discharge (m^3/s)	
Subcatchment ID	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future
133.03	35.7	35.8	51.0	51.0	73.2	73.5	202	202
133.04	40.6	40.8	66.2	66.3	82.8	83.0	231	231
133.05	50.7	50.8	72.4	72.5	104	105	293	293
133.06	50.9	51.0	83.6	83.7	105	105	294	294
133.07	92.0	92.2	133	134	193	193	482	482
133.08	92.7	93.0	135	135	194	194	486	486
133.09	111	111	161	161	231	232	595	595
133.10	122	122	177	177	254	254	665	665
133.11	139	139	201	202	291	291	755	755
133.12	191	192	277	277	399	399	1055	1055
133.13	202	202	293	293	423	423	1115	1115
133.14	206	206	298	298	430	431	1138	1138
134.01	7.68	7.77	11.0	11.1	16.2	15.7	47.4	47.4
135.01	9.94	9.95	14.2	14.3	20.6	20.6	49.3	49.3
136.01	3.56	3.58	5.26	5.06	7.30	7.41	23.3	23.3
137.01	5.17	5.18	6.33	6.36	8.86	8.97	28.2	28.2
138.01	15.4	15.5	22.9	23.0	34.0	34.2	65.0	65.0
138.02	19.0	19.1	28.8	28.9	43.1	43.5	84.4	84.4
138.03	33.7	33.9	49.6	49.8	74.0	74.2	158	158
139.01	6.90	6.94	9.89	9.85	14.2	14.2	36.0	36.0
139.02	13.5	13.5	19.2	19.2	27.8	27.8	67.3	67.3
140.01	0.740	0.740	1.05	1.05	1.48	1.48	4.64	4.64
141.01	10.0	10.1	14.3	14.4	20.8	20.6	63.1	63.1
141.02	11.9	12.0	16.9	17.0	24.8	24.4	75.1	75.1
142.01	1.32	1.32	1.90	1.90	2.68	2.68	9.43	9.43
143.01	7.85	7.93	11.4	11.4	16.6	16.0	56.1	56.1
144.01	7.52	7.59	10.6	10.6	15.5	15.5	46.4	46.4
145.01	5.46	5.50	7.79	7.81	11.4	11.4	34.2	34.2
145.02	15.3	15.4	21.9	22.0	31.5	31.7	85.7	85.7
145.03	23.7	23.8	33.8	33.9	48.8	48.9	135	135
145.04	45.6	45.6	65.4	65.5	95.0	95.1	256	256
145.05	45.7	45.8	65.6	65.7	95.3	95.5	257	257
145.06	52.4	52.4	75.1	75.2	110	110	302	302
146.01	7.52	7.54	10.8	10.8	15.6	15.7	38.3	38.3
147.01	4.89	4.90	6.07	6.08	8.48	8.56	26.8	26.8
148.01	10.9	10.9	15.6	15.6	22.6	22.6	54.5	54.5
148.02	16.5	16.6	23.8	23.9	34.1	34.2	86.4	86.4
148.03	21.7	21.8	31.3	31.4	44.7	44.9	120	120
149.01	4.76	4.79	6.71	6.71	9.62	9.70	29.0	29.0
150.01	4.42	4.52	6.38	6.41	9.26	9.27	28.4	28.4
151.01	4.47	4.49	5.52	5.55	7.87	7.98	26.0	26.0
152.01	1.61	1.62	2.31	2.33	3.36	3.38	11.6	11.6
153.01	5.15	5.18	7.27	7.30	10.6	10.7	37.5	37.5
154.01	2.10	2.10	3.06	3.06	4.31	4.36	16.0	16.0
154.02	2.78	2.78	3.99	4.00	5.86	5.88	20.7	20.7
155.01	7.81	7.83	11.8	11.8	17.9	17.9	41.5	41.5
155.02	7.92	7.93	11.9	12.0	18.1	18.1	41.9	41.9
155.03	13.3	13.3	20.0	19.9	29.2	29.4	73.9	73.9
155.04	13.8	13.8	20.7	20.7	30.4	30.5	77.0	77.0
155.05	22.3	22.2	32.7	32.7	47.6	47.6	127	127
155.06	26.1	26.1	38.5	38.4	55.9	55.7	152	152
156.01	4.47	4.57	6.51	6.53	9.46	9.45	27.7	27.7
156.02	4.72	4.75	6.77	6.77	9.88	9.83	28.7	28.7
157.01	3.29	3.29	4.80	4.83	6.98	6.98	20.6	20.6
158.01	2.05	1.75	2.50	2.50	3.63	3.63	11.7	11.7
159.01	1.98	1.98	2.47	2.47	3.58	3.58	11.6	11.6
160.01	3.45	3.45	5.02	5.00	7.24	7.23	22.4	22.4
160.02	3.71	3.72	5.35	5.41	7.82	7.86	23.9	23.9
161.01	6.79	6.80	10.1	10.1	14.9	14.9	38.6	38.6
162.01	0.610	0.610	0.870	0.870	1.24	1.24	4.24	4.24
162.02	4.23	4.24	6.26	6.26	9.06	9.09	24.3	24.3
162.03	4.30	4.31	6.37	6.37	9.22	9.25	24.6	24.6
163.01	0.900	0.910	1.29	1.30	1.87	1.89	8.17	8.17
163.02	2.61	2.63	3.73	3.75	5.53	5.55	23.3	23.3
163.03	7.92	7.91	11.5	11.5	17.0	17.0	63.6	63.6
163.04	12.1	12.1	17.4	17.4	25.5	25.6	90.2	90.2
163.05	25.3	25.4	38.3	38.4	57.9	58.1	177	177
163.06	26.7	26.4	39.8	39.9	60.3	60.4	183	183
164.01	8.78	8.77	13.5	13.5	20.5	20.5	58.6	58.6
165.01	4.36	4.37	6.64	6.65	10.0	10.0	26.9	26.9
165.02	5.04	5.06	7.64	7.66	11.5	11.5	31.1	31.1
166.01	1.35	1.36	2.01	1.93	2.78	2.79	9.39	9.39
166.02	3.35	3.35	4.08	4.09	5.97	5.98	19.1	19.1
166.03	4.94	4.95	7.09	7.10	10.3	11.9	31.0	31.0
167.01	1.08	1.08	1.53	1.53	2.26	2.26	8.26	8.26
167.02	2.04	2.05	2.88	2.90	4.30	4.31	15.3	15.3

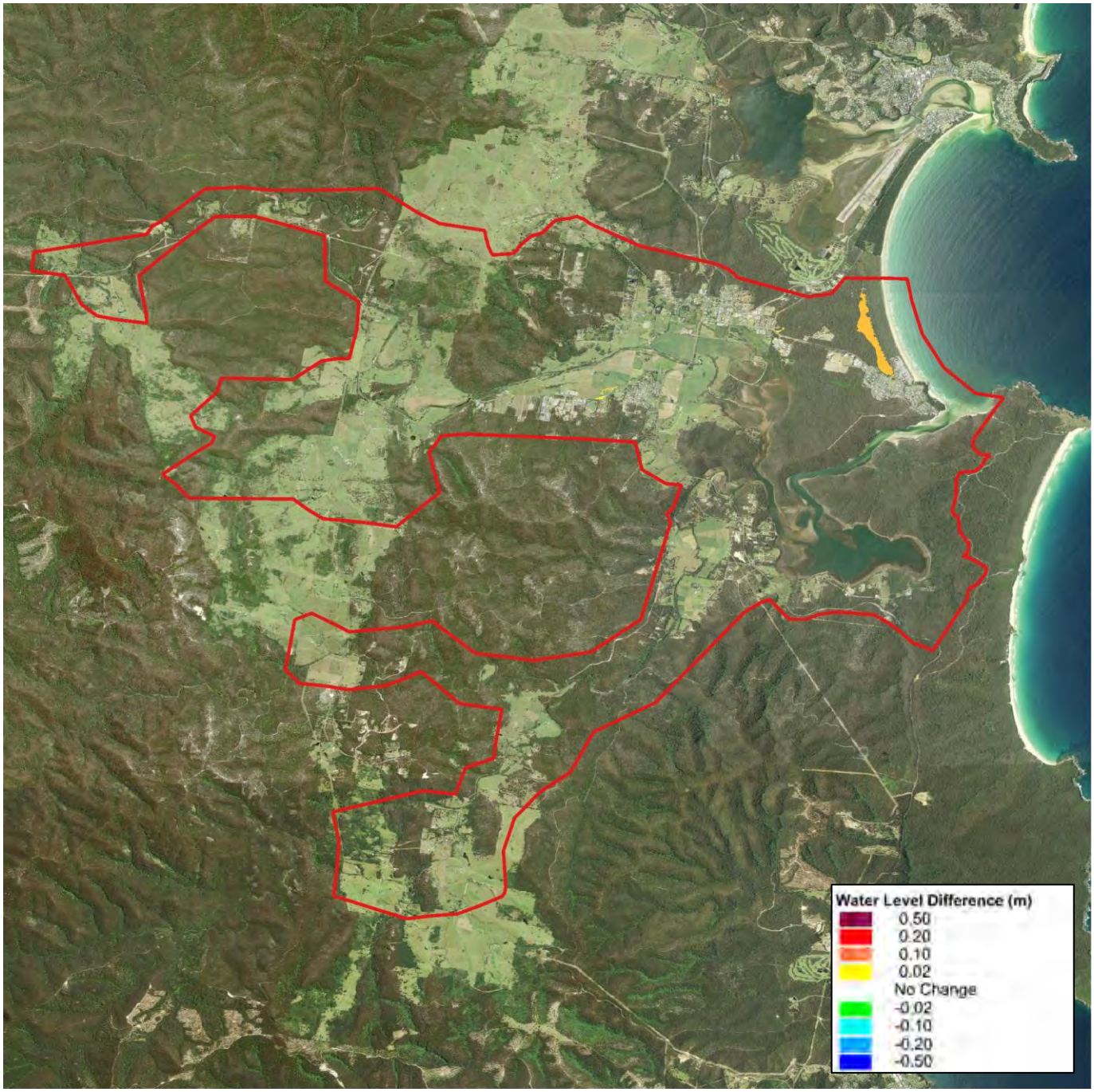
	5% AEP Peak Discharge (m^3/s)		1% AEP Peak Discharge (m^3/s)		0.2% AEP Peak Discharge (m^3/s)		PMF Peak Discharge (m^3/s)	
Subcatchment ID	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future
168.01	2.84	3.36	4.09	4.10	6.10	6.12	21.6	21.6
168.02	3.37	3.38	4.12	4.13	6.14	6.16	21.8	21.8
169.01	5.18	5.30	7.52	7.53	10.9	10.9	36.9	36.9
169.02	5.96	5.99	8.50	8.54	12.4	12.5	41.5	41.5
170.01	0.910	0.920	1.30	1.31	1.87	1.88	6.25	6.25
171.01	0.980	0.980	1.41	1.42	2.10	2.13	6.74	6.74
172.01	0.650	0.650	0.930	0.930	1.33	1.34	4.52	4.52
173.01	1.24	1.24	1.78	1.79	2.56	2.56	7.88	7.88
173.02	9.55	9.66	13.6	13.7	19.8	20.0	52.4	52.4
173.03	17.9	18.0	26.4	26.0	38.5	38.7	103	103
173.04	19.6	19.6	28.3	28.4	42.1	42.3	111	111
173.05	25.3	25.3	36.9	36.9	53.6	53.8	138	138
173.06	32.9	33.0	48.1	48.2	70.4	70.5	170	170
173.07	59.0	59.1	85.6	85.7	124	124	324	324
174.01	0.990	0.990	1.41	1.41	2.03	2.03	6.39	6.39
175.01	0.770	0.770	1.11	1.11	1.62	1.62	4.96	4.96
176.01	0.700	0.700	1.01	1.01	1.44	1.44	4.57	4.57
176.02	3.70	3.73	5.26	5.31	7.77	7.82	22.9	22.9
177.01	2.48	2.47	3.98	3.96	6.23	6.23	10.2	10.2
178.01	2.11	2.11	3.04	3.05	4.43	4.45	11.7	11.7
179.01	0.430	0.440	0.550	0.550	0.770	0.770	2.38	2.38
180.01	2.78	2.78	4.30	4.30	6.63	6.52	12.5	12.5
180.02	3.12	3.13	4.80	4.82	7.22	7.24	13.4	13.4
181.01	2.15	2.15	3.13	3.13	4.56	4.56	12.2	12.2
182.01	0.310	0.310	0.450	0.460	0.650	0.650	2.04	2.04
183.01	3.10	3.12	4.45	4.49	6.69	6.70	21.4	21.4
183.02	5.89	5.90	8.40	8.42	12.5	12.5	38.4	38.4
183.03	10.6	10.6	14.9	15.0	22.3	22.3	66.1	66.1
183.04	16.9	16.9	24.1	24.1	34.8	34.8	104	104
183.05	17.6	17.6	25.1	25.1	36.2	36.3	108	108
183.06	26.3	26.2	37.4	37.3	54.7	54.5	156	156
184.01	0.590	0.590	0.840	0.840	1.20	1.20	3.81	3.81
184.02	3.64	3.57	5.19	5.23	7.49	7.52	21.3	21.3
185.01	0.730	0.730	1.03	1.03	1.47	1.47	5.04	5.04
185.02	3.13	3.16	4.28	4.30	6.40	6.41	19.7	19.7
186.01	1.37	1.39	1.96	2.00	2.86	2.91	9.54	9.54
187.01	2.01	2.01	2.46	2.46	3.58	3.58	10.7	10.7
187.02	3.78	3.78	4.60	4.59	6.73	6.72	19.9	19.9
188.01	0.570	0.570	0.790	0.800	1.13	1.14	3.81	3.81
189.01	0.580	0.580	0.810	0.820	1.16	1.17	3.91	3.91
190.01	0.390	0.390	0.560	0.560	0.790	0.800	2.49	2.49
191.01	1.05	1.06	1.47	1.49	2.21	2.24	6.73	6.73
192.01	1.25	1.25	1.78	1.79	2.54	2.54	8.72	8.72
193.01	1.06	1.06	1.50	1.51	2.16	2.17	7.09	7.09
194.01	0.190	0.190	0.260	0.260	0.380	0.380	1.14	1.14
195.01	0.370	0.370	0.530	0.540	0.760	0.760	2.40	2.40
196.01	0.420	0.420	0.600	0.600	0.860	0.860	2.69	2.69
197.01	0.350	0.350	0.500	0.500	0.720	0.720	2.12	2.12
198.01	0.500	0.500	0.710	0.710	1.01	1.01	3.15	3.15
199.01	1.09	1.09	1.56	1.56	2.26	2.26	6.94	6.94
199.02	1.48	1.49	2.13	2.13	3.07	3.08	9.42	9.42
200.01	0.200	0.200	0.280	0.280	0.400	0.400	1.21	1.21
201.01	0.460	0.470	0.660	0.660	0.940	0.950	2.92	2.92
202.01	3.84	3.85	5.79	5.80	8.75	8.75	18.8	18.8
203.01	0.660	0.660	0.940	0.940	1.33	1.34	4.22	4.22
204.01	0.460	0.460	0.650	0.660	0.930	0.940	2.85	2.85
205.01	0.580	0.600	0.820	0.840	1.18	1.21	3.64	3.64
206.01	0.150	0.160	0.210	0.230	0.300	0.320	0.900	0.900
207.01	0.560	0.580	0.800	0.780	1.13	1.11	3.27	3.27
208.01	0.790	0.840	1.14	1.19	1.63	1.69	5.16	5.16
208.02	1.12	1.17	1.60	1.65	2.28	2.35	6.97	6.97
208.03	2.11	2.25	3.02	3.17	4.31	4.50	12.6	12.6
208.04	3.95	4.10	5.76	5.95	8.39	8.64	20.6	20.6
208.05	4.73	5.12	7.35	7.55	10.8	11.1	24.8	24.8
208.06	5.69	5.94	8.59	8.95	12.8	13.3	28.8	28.8
209.01	0.150	0.140	0.200	0.210	0.280	0.290	0.840	0.840
210.01	0.280	0.290	0.390	0.410	0.570	0.580	1.71	1.71
211.01	0.290	0.300	0.410	0.430	0.590	0.620	1.77	1.77
211.02	0.330	0.370	0.470	0.490	0.680	0.710	2.07	2.07
211.03	1.19	1.22	1.71	1.70	2.46	2.62	7.00	7.00
212.01	0.140	0.140	0.200	0.200	0.280	0.280	0.840	0.840
_junc_10	25.9	25.8	38.0	38.0	55.2	55.1	151	151
_junc_108	0.510	0.530	0.730	0.750	1.04	1.07	3.38	3.38
_junc_11	417	418	605	606	879	880	2440	2440
_junc_111	2.86	2.87	4.08	4.12	6.02	6.02	19.4	19.4
_junc_114	1.68	1.78	2.43	2.56	3.54	3.66	9.38	9.38

	5% AEP Peak Discharge (m^3/s)		1% AEP Peak Discharge (m^3/s)		0.2% AEP Peak Discharge (m^3/s)		PMF Peak Discharge (m^3/s)	
Subcatchment ID	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future
_junc_12	13.3	13.4	18.8	19.0	26.8	26.8	75.1	75.1
_junc_13	127	127	184	184	268	268	771	771
_junc_138	8.76	8.85	12.5	12.5	18.6	18.3	78.8	78.8
_junc_14	108	108	157	157	228	228	638	638
_junc_142	7.99	6.79	9.92	9.93	14.2	14.3	60.4	60.4
_junc_143	204	205	297	296	428	428	1130	1130
_junc_15	388	389	565	565	819	819	2277	2277
_junc_16	425	426	616	617	896	896	2483	2483
_junc_165	28.5	29.0	41.0	41.5	62.3	62.1	189	189
_junc_168	26.6	26.9	39.6	39.6	55.9	56.4	179	179
_junc_17	121	121	175	175	255	255	727	727
_junc_174	19.6	21.7	28.0	30.6	40.4	43.2	148	148
_junc_18	45.3	45.5	67.7	68.0	99.7	100	268	268
_junc_181	0.080	0.080	0.110	0.120	0.160	0.160	0.530	0.530
_junc_185	0.090	0.100	0.140	0.140	0.180	0.200	0.590	0.590
_junc_186	0.280	0.300	0.400	0.420	0.570	0.600	1.76	1.76
_junc_187	2.25	2.41	3.21	3.42	4.81	4.82	13.4	13.4
_junc_19	167	167	242	242	352	352	1053	1053
_junc_193	9.54	9.53	13.5	13.5	20.1	20.1	59.4	59.4
_junc_194	13.7	13.7	19.2	19.2	28.7	28.7	85.8	85.8
_junc_199	16.4	16.5	23.4	23.6	34.1	34.1	108	108
_junc_2	196	197	284	284	409	409	1088	1088
_junc_20	140	140	202	202	294	294	860	860
_junc_204	7.26	7.27	10.5	10.5	15.2	15.2	55.8	55.8
_junc_21	151	151	219	219	318	318	950	950
_junc_22	433	434	628	629	914	914	2527	2527
_junc_228	0.470	0.490	0.670	0.690	0.960	0.990	2.83	2.83
_junc_23	439	440	636	637	926	927	2561	2561
_junc_231	177	178	258	258	376	376	1112	1112
_junc_232	21.9	21.9	32.2	32.2	46.3	46.4	198	198
_junc_233	31.1	31.2	45.5	45.5	66.8	66.8	271	271
_junc_234	422	422	600	600	876	876	2895	2895
_junc_24	26.5	26.5	37.9	37.9	54.8	54.8	167	167
_junc_25	20.3	20.4	30.7	30.7	46.3	46.3	147	147
_junc_26	18.0	18.0	25.7	25.8	37.2	37.2	110	110
_junc_263	10.4	10.5	14.8	14.8	21.5	21.5	66.5	66.5
_junc_265	10.1	10.1	14.7	14.7	21.4	21.5	60.2	60.2
_junc_27	10.8	11.0	15.7	15.6	22.7	22.7	69.2	69.2
_junc_28	475	476	688	689	1005	1005	2782	2782
_junc_29	473	474	686	686	1001	1002	2774	2774
_junc_3	17.0	17.0	25.5	25.6	37.3	37.4	97.3	97.3
_junc_30	478	478	692	693	1010	1011	2796	2796
_junc_31	13.9	14.0	19.7	19.8	29.0	29.2	126	126
_junc_32	485	485	702	702	1025	1025	2835	2835
_junc_324	426	426	607	607	886	886	2929	2929
_junc_328	495	493	704	702	1030	1027	3360	3360
_junc_329	28.4	28.4	41.8	41.8	61.1	61.1	151	151
_junc_33	13.7	13.8	18.9	19.0	28.2	28.3	107	107
_junc_330	58.7	58.8	85.1	85.2	123	123	323	323
_junc_331	1023	1023	1476	1478	2162	2164	6451	6451
_junc_34	22.0	22.0	31.2	31.2	45.3	45.3	178	178
_junc_35	7.27	7.31	10.7	10.8	15.8	15.9	55.7	55.7
_junc_36	414	414	590	590	861	861	2838	2838
_junc_37	15.7	15.8	22.7	22.7	33.0	32.9	98.2	98.2
_junc_38	12.4	12.5	17.8	17.8	26.5	25.9	116	116
_junc_39	460	458	654	652	956	953	3147	3147
_junc_4	18.0	18.1	25.9	25.9	37.2	37.3	97.1	97.1
_junc_40	22.2	22.3	32.4	32.5	47.1	47.1	144	144
_junc_41	13.6	14.4	22.3	20.4	28.2	29.2	107	107
_junc_42	25.6	25.7	37.1	37.3	54.4	54.7	244	244
_junc_43	65.4	65.4	94.1	94.5	138	139	602	602
_junc_44	431	431	614	613	896	896	2961	2961
_junc_45	385	385	549	548	802	803	2606	2606
_junc_46	33.2	33.2	47.5	47.6	69.8	69.6	205	205
_junc_47	436	436	621	620	907	907	2991	2991
_junc_48	317	317	451	451	661	661	2017	2017
_junc_49	15.1	15.6	22.2	22.2	32.8	31.8	107	107
_junc_5	15.5	15.7	22.1	22.1	32.2	32.3	96.1	96.1
_junc_50	49.0	49.0	70.2	70.4	103	103	310	310
_junc_51	310	310	441	441	646	646	1958	1958
_junc_52	55.9	56.0	80.0	80.2	117	117	365	365
_junc_53	15.4	15.5	22.1	22.2	32.6	32.7	125	125
_junc_54	77.6	77.8	111	111	164	164	514	514
_junc_55	87.6	87.8	125	125	185	185	583	583
_junc_56	284	284	405	405	593	593	1763	1763
_junc_57	117	117	170	170	246	246	754	754

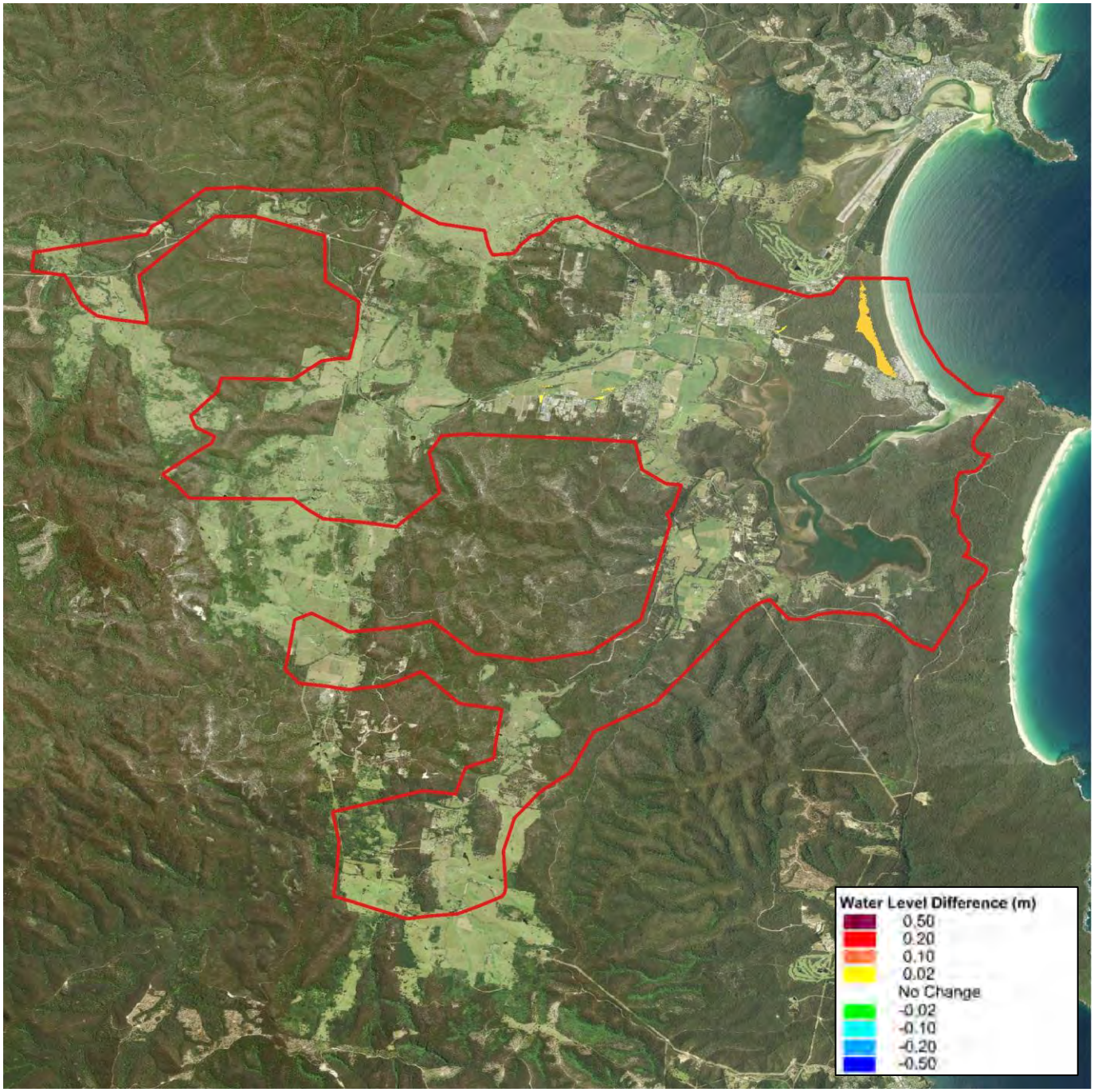
	5% AEP Peak Discharge (m^3/s)		1% AEP Peak Discharge (m^3/s)		0.2% AEP Peak Discharge (m^3/s)		PMF Peak Discharge (m^3/s)	
Subcatchment ID	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future	Existing	Cumulative Future
_junc_58	269	269	383	384	562	563	1667	1667
_junc_59	251	251	363	363	530	532	1551	1551
_junc_6	51.2	51.4	73.0	73.3	105	106	305	305
_junc_60	262	262	374	379	548	549	1624	1624
_junc_61	24.5	24.5	35.1	35.2	51.2	51.3	144	144
_junc_62	119	119	170	170	249	249	704	704
_junc_63	106	106	151	152	221	222	623	623
_junc_64	48.4	48.5	69.0	69.0	101	101	289	289
_junc_65	13.7	13.8	19.7	19.7	28.2	28.4	90.9	90.9
_junc_66	90.4	90.5	129	130	189	189	523	523
_junc_67	54.2	54.3	77.4	77.4	113	113	323	323
_junc_68	38.5	38.6	54.8	54.8	81.5	81.6	231	231
_junc_69	28.9	29.0	47.0	47.0	59.5	59.5	171	171
_junc_7	59.0	59.2	84.0	84.2	121	121	358	358
_junc_70	22.1	22.1	35.8	35.9	45.4	45.5	131	131
_junc_71	18.4	18.4	27.1	27.2	40.1	40.2	94.1	94.1
_junc_72	33.0	33.1	47.3	47.5	69.2	69.3	177	177
_junc_73	15.6	15.6	22.3	22.3	32.7	32.8	91.9	91.9
_junc_74	10.2	10.2	14.7	14.7	21.3	21.3	62.6	62.6
_junc_75	32.3	31.8	47.5	47.7	71.1	71.2	150	150
_junc_76	12.9	13.0	18.5	18.6	26.6	26.5	70.7	70.7
_junc_77	31.5	31.6	45.0	52.0	64.9	65.1	178	178
_junc_78	39.0	39.1	64.2	64.3	80.4	80.3	223	223
_junc_79	44.9	45.0	73.1	73.2	91.9	92.1	259	259
_junc_8	26.5	22.6	32.0	32.1	46.9	47.1	141	141
_junc_80	21.2	18.0	25.4	25.5	37.5	37.6	106	106
_junc_81	84.6	84.8	123	123	177	177	446	446
_junc_82	19.3	19.4	27.6	27.7	40.0	40.1	111	111
_junc_83	15.6	15.7	22.1	22.1	32.2	32.4	81.8	81.8
_junc_84	104	104	151	151	217	218	557	557
_junc_85	21.0	21.0	30.2	30.3	43.2	43.3	115	115
_junc_86	129	129	187	187	268	269	708	708
_junc_87	45.3	45.3	65.0	65.1	94.2	94.4	255	255
_junc_88	49.4	49.5	70.9	71.0	103	103	282	282
_junc_89	118	118	171	172	246	246	644	644
_junc_9	30.2	30.3	42.8	42.8	61.8	62.0	186	186
_junc_90	190	190	275	275	395	396	1043	1043
_junc_91	12.6	12.6	19.0	19.0	27.7	27.9	69.6	69.6

Cumulative Development

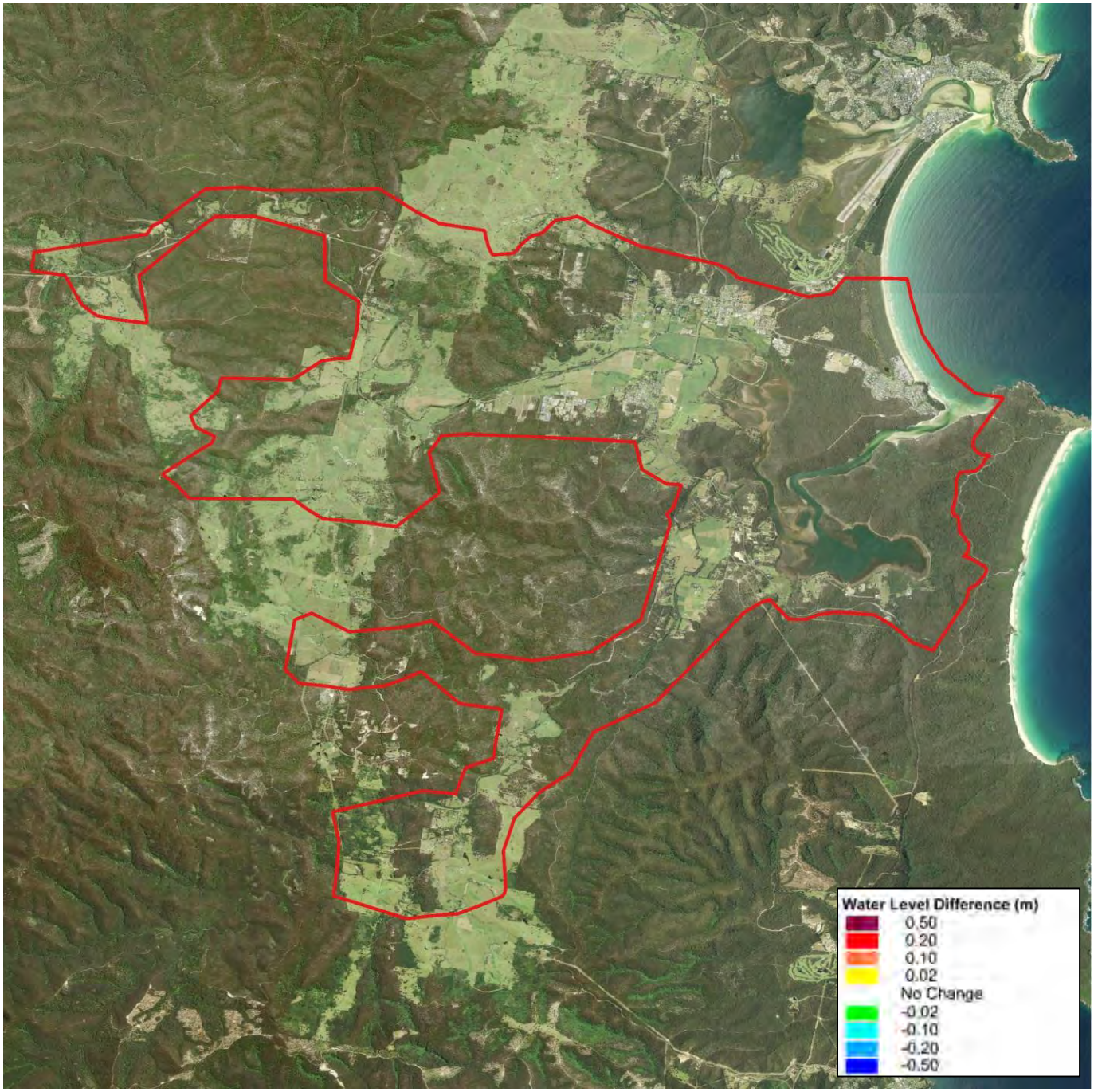
5% AEP



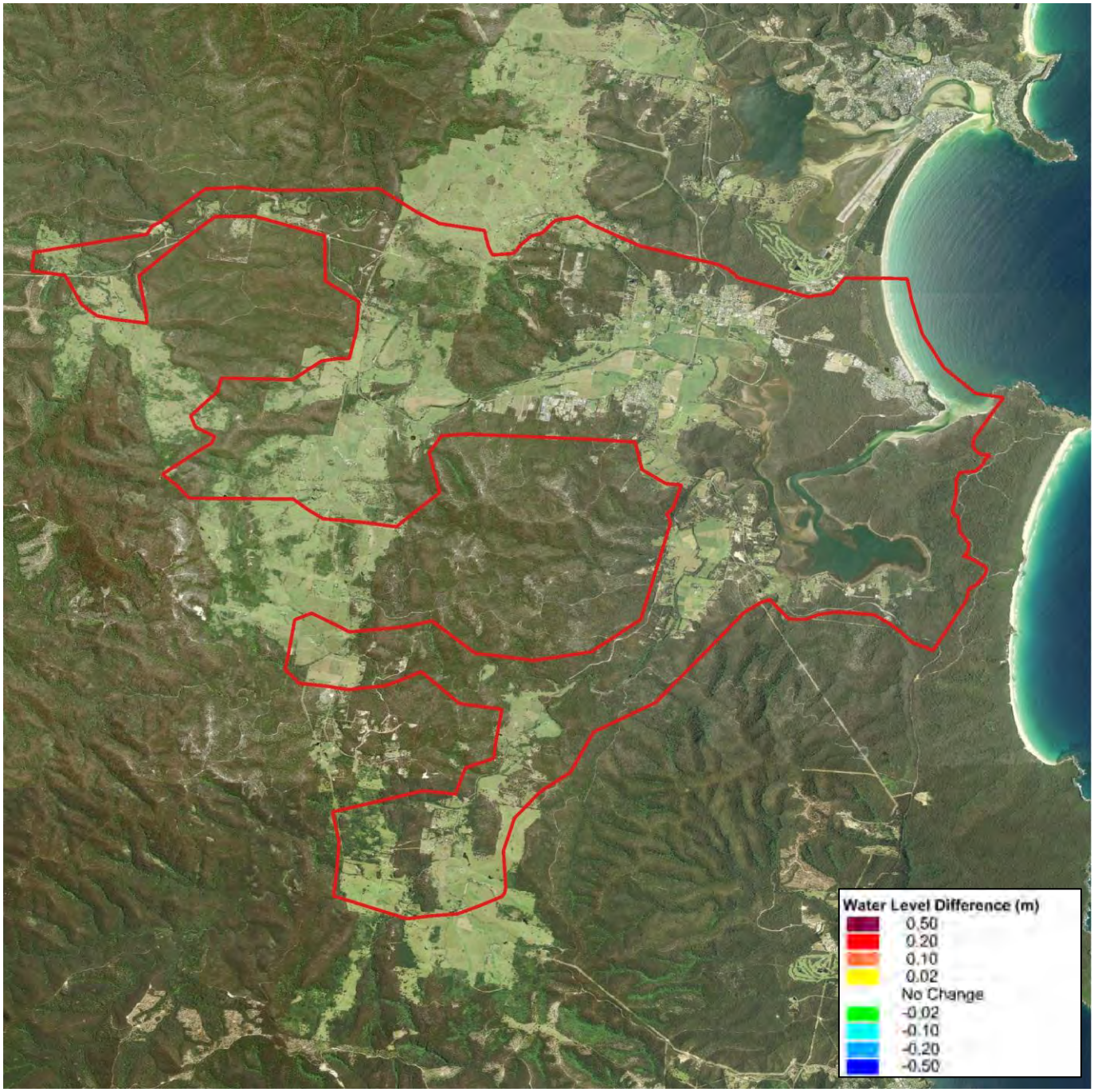
1% AEP


Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

0.2% AEP

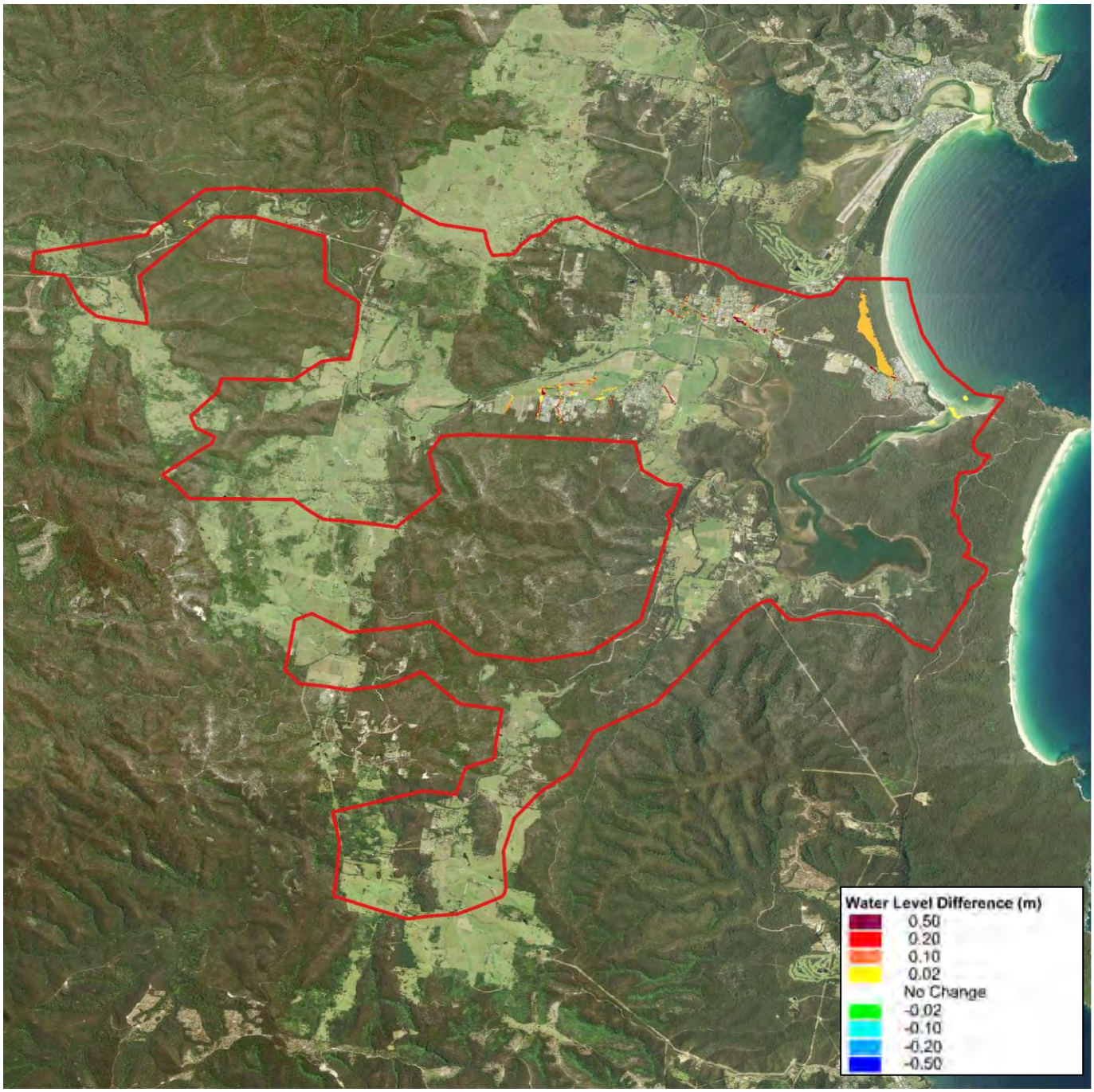

Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

PMF

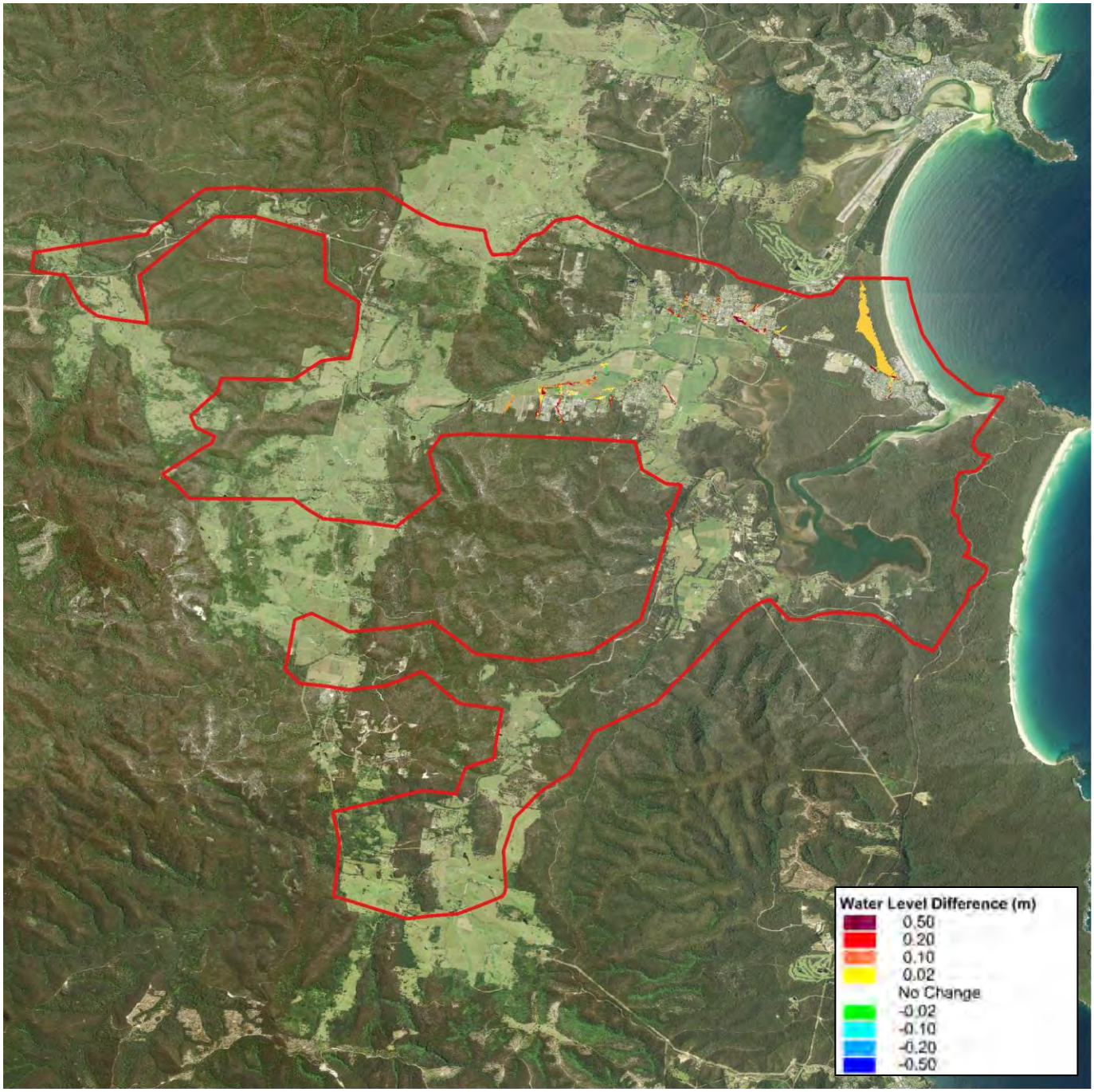

Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

Cumulative Development with Fill

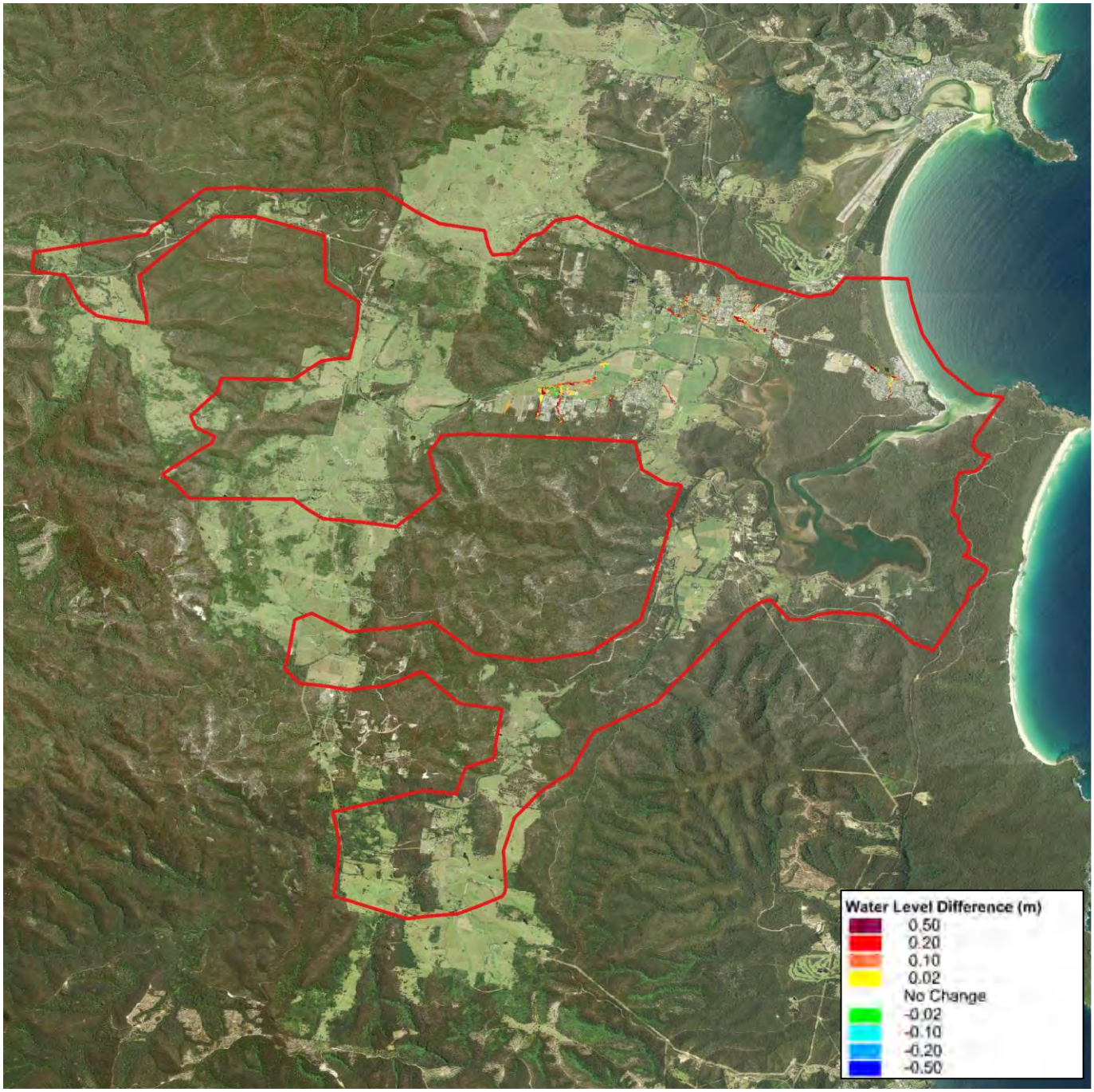
5% AEP



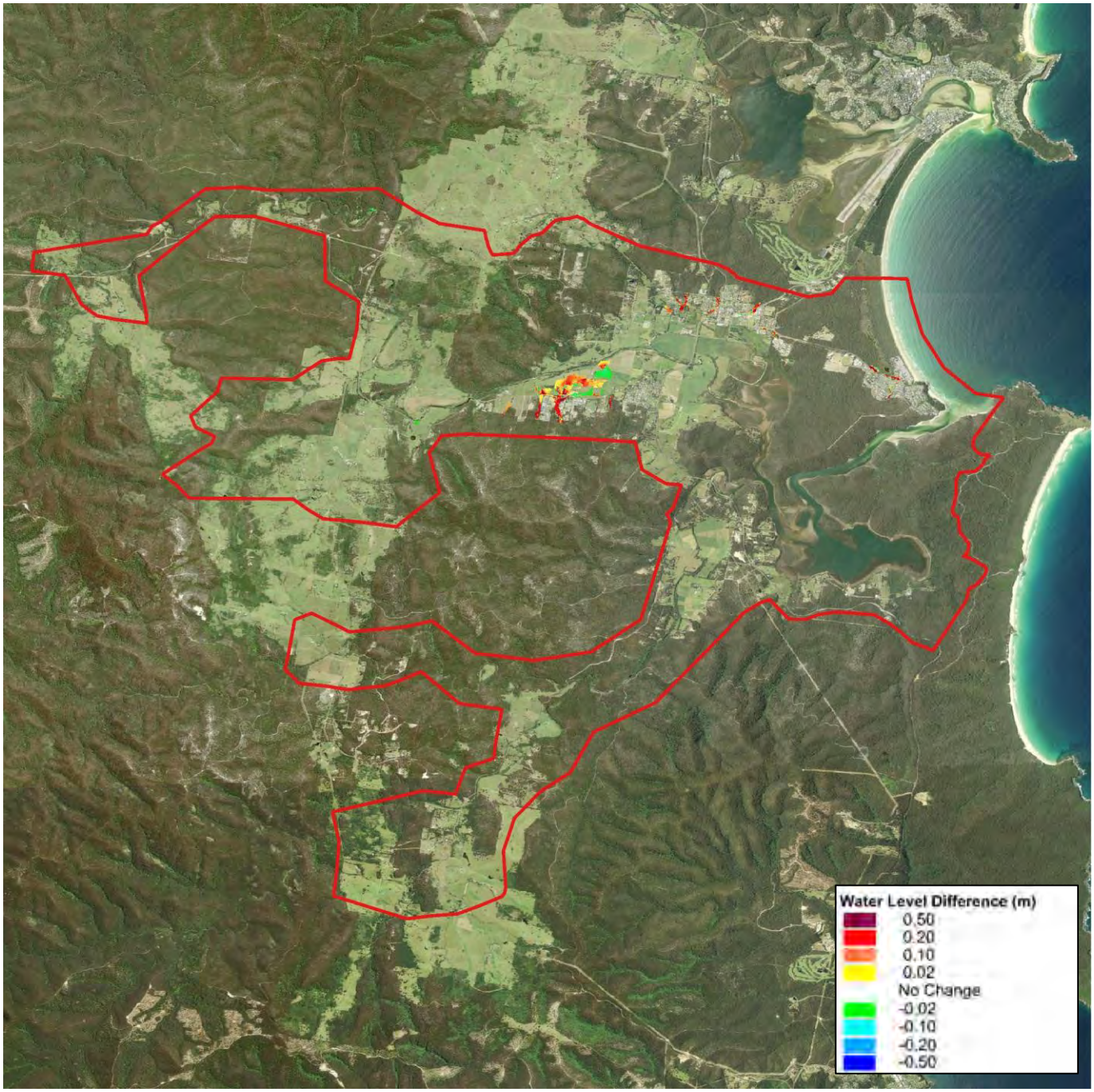
1% AEP


Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

0.2% AEP


Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50

PMF


Water Level Difference (m)
0.50
0.20
0.10
0.02
No Change
-0.02
-0.10
-0.20
-0.50