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West Gippsland Catchment Management Authority

WGCMA Floodplain Mapping Program

Floodplain mapping for Bruthen Creek

March 2026

Document Details

Project name	Floodplain mapping for Bruthen Creek
Township	Mcloughlins, Woodside Beach, Woodside, Woodside East, Balloong Town
Author	
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Hydraulics software	TUFLOW
Hydraulics dimensionality	2D

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1. Introduction

This study updates existing flood study for the Bruthen Creek Area. This flood study is an update of an existing flood study of Bruthen Creek which was completed in 2015. This study will deliver a comprehensive and updated analysis of current flood risks. This project is part of the Student Floodplain Mapping Program which aims to develop details flood risk information of areas within the West Gippsland by producing the details different AEP (Annual Exceedance Probability) flood extent maps, utilizing software tools such as ArcGIS Pro, TUFLOW, TUFLOW FLIKE, and RORB.

The purpose this study is to understand which towns and surrounding areas may be impacted by flooding from the Bruthen Creek, Reedy Creek and Toms Creek. This flood study maps flooding from the Bruthen Creek and includes the following towns in study area:

- Mcloughlins,
- Woodside Beach,
- Woodside,
- Woodside East
- Balloong Town

2. Catchment

2.1. Catchment description

The Bruthen Creek catchment spans a total area of 234.47 square kilometres. In the upstream channels there are mainly three channels, these are:

- The **Bruthen creek channel**, which starts from the west of Carrajung,
- The **Reedy Creek channel**, which starts from the Southeast of the Carrajung, and
- The **Toms Cap Creek channel** is started from the Northwest of 'Willung South'.

Toms Cap Creek channels merge with reedy Creek channel at the Northeast of 'Carrajung South' and the Reedy Creek Channel merged at South of Carrajung South forming a single channel that flows through woodside North, Woodside and into the ocean.

The Bruthen Creek catchment includes the following townships.

Township	Population (2021 Census)	Dwellings (2021 Census)
Woodside	374	223
Carrajung	100	55
Carrajung South	42	15
Carrajung Lower	129	59
Willung South	146	63
Won Wron	196	95

The topography of the catchment varies, at the north of Carrajung is 618m and at North of Willung South it is 310m decreasing gradually towards south direction and at the middle of the catchment and forming the three mainstreams. The west part is at 204m and east part at 185m. the topography where three stream meet is 90m, which is decreasing slowing at south and sea level at the outlet of the catchment.

2.2. Previous Flood Mapping

The list of the previous flood study is shown below in the table below.

Table 1: List of previous flood study

Study Name	Year undertaken	Consultant	Purpose
Floodplain mapping for Bruthen creek	2015	WGCMA	To determine the nature and extent of flooding through the estimation of design flood flows, levels and velocity
Corner Inlet Dynamic Storm Tide Modelling Assessment	2014	Water Technology	The study identifies areas potentially affected by flooding from the Bruthen Creek system.

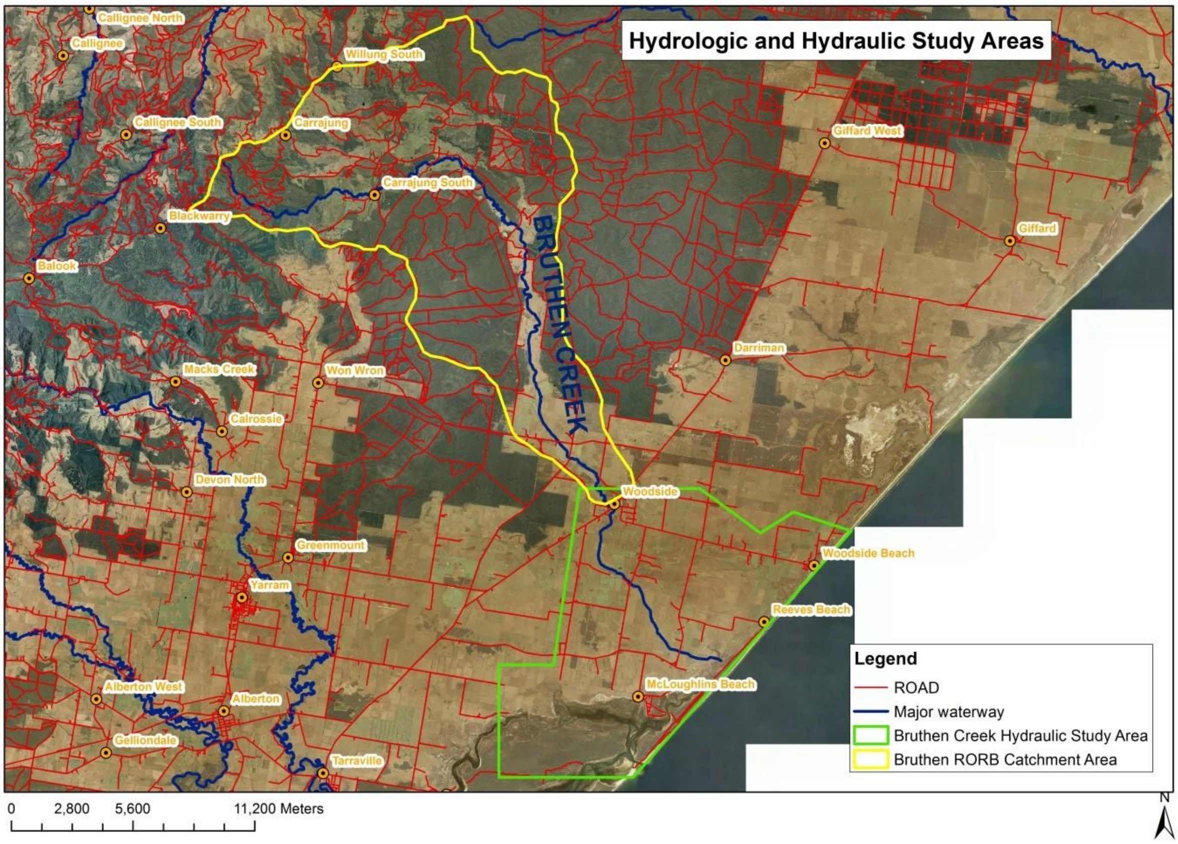


Figure 1: 2015 Bruthen Creek Flood Study Area

2.3. Land use

Most of the land of the catchment is covered by farmland and forest. Only a few areas of the catchment are covered by the residential zone, public park, road etc. where more managed vegetation, such as lawns, ornamentals plants, and street trees are present. Forests and farmlands have higher water absorption capacity due to their dense root systems, which can help mitigate flooding, whereas managed vegetation areas, with their less extensive root systems, may not absorb water as effectively, potentially increasing runoff and flood risk.

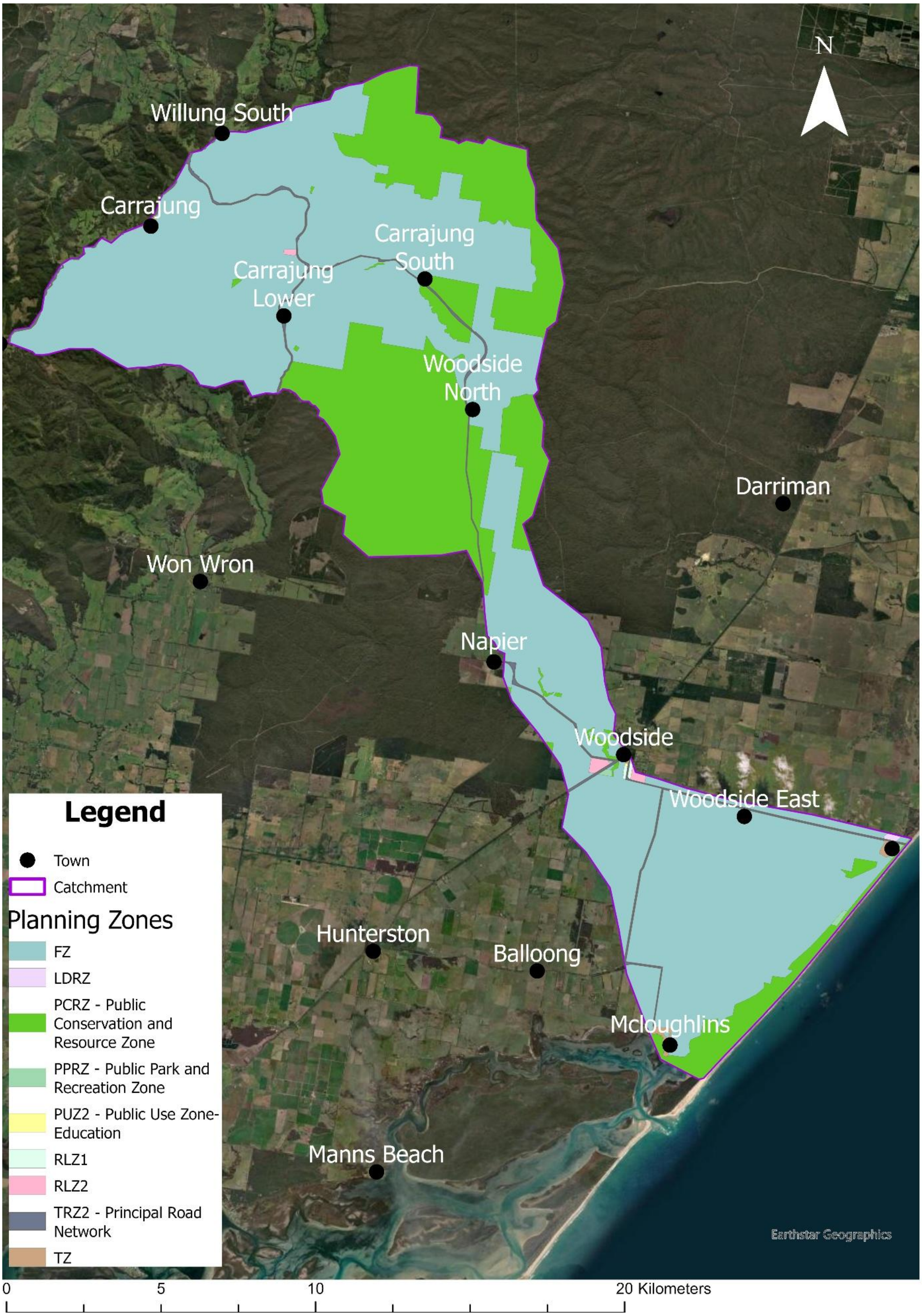


Figure 2: Map showing the catchment area and local planning zones

2.4. Elevation model

The lidar available lidar for this project is given in Table 2. The age of lidar is different and each lidar covers certain parts of the catchment. The lidar has been combined in ArcPro using the ‘Mosaic to new Raster’ tool, prioritizing the age of the lidar. All the lidar pick up the waterways properly so there was no need to adjust the lidar around the waterway. Balook Lidar covers Woodside North and the area above it. Bruthen Creek lidar covers area around the Woodside. DEM_Rivers_Mosaic lidar is covering the river area of the whole catchment. DEM lidar covers the south part of the catchment and Digital Terrain Model covers the whole area of the catchment and least accurate lidar available lidar for the project.

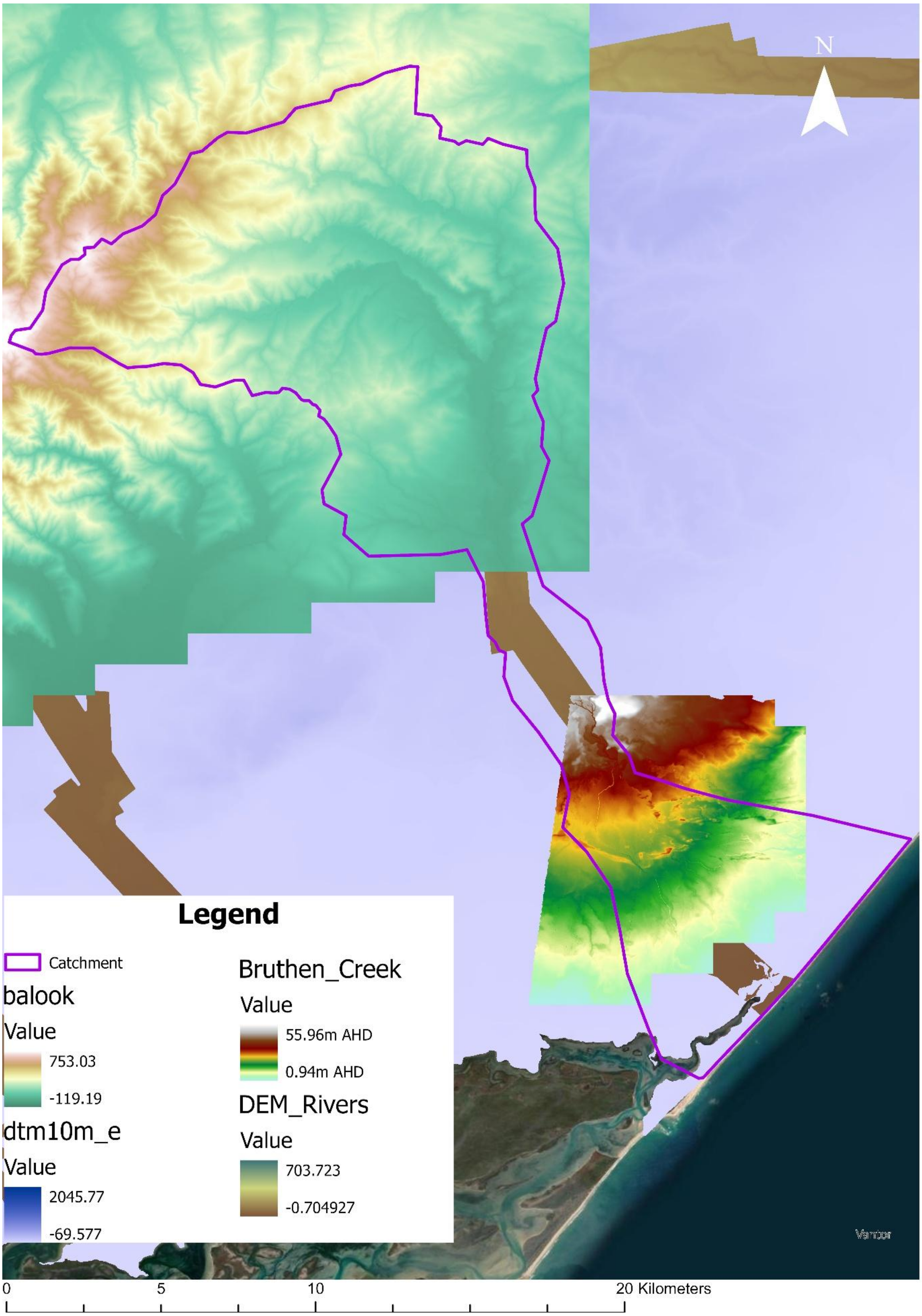


Figure 3: Different lidar used for the study

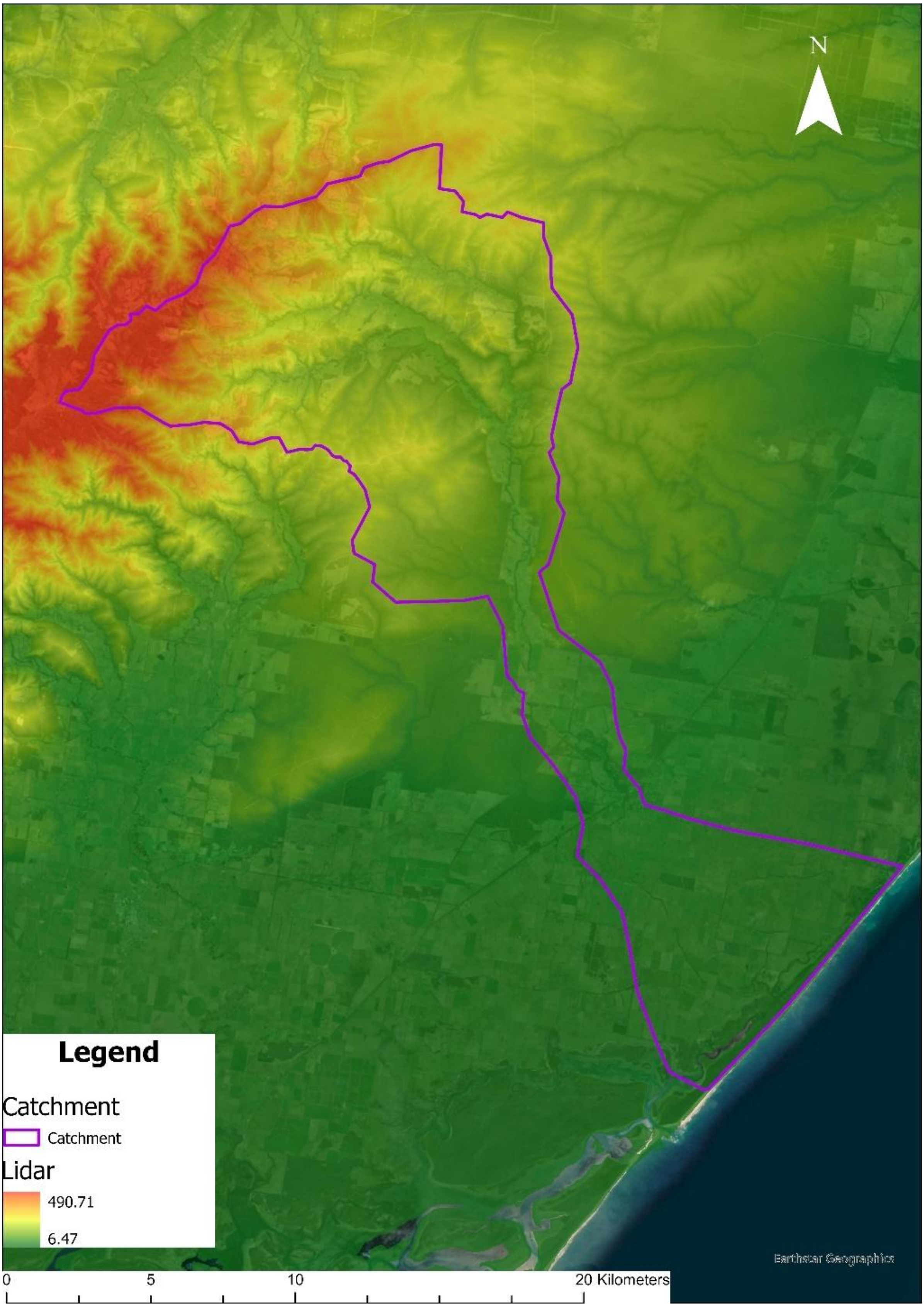
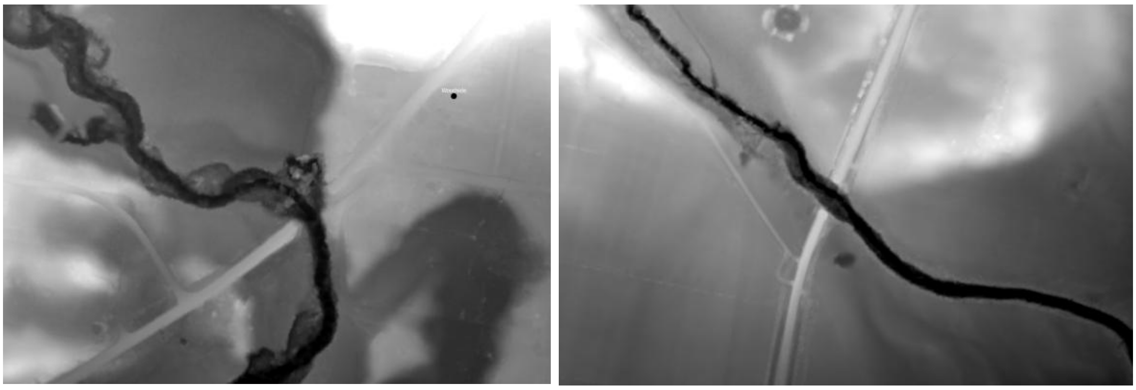


Figure 4: Combined Lidar dataset used for the study

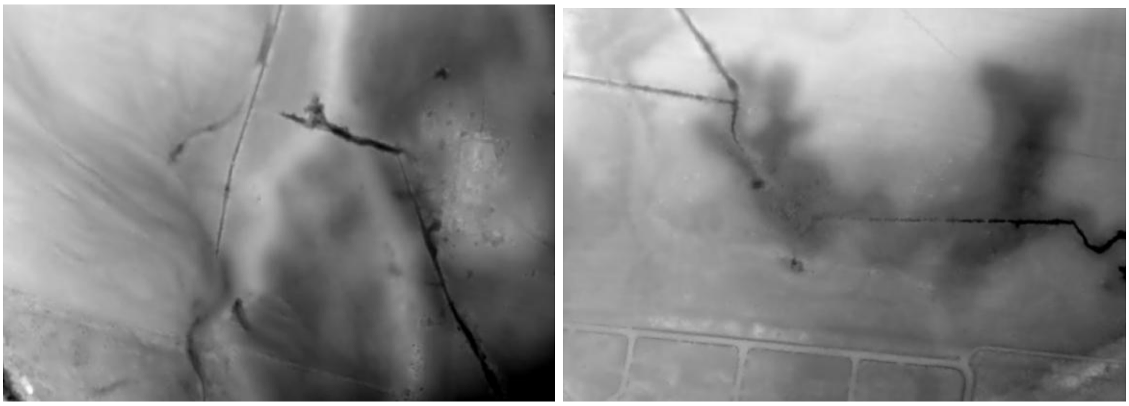
Table 2: Table listing the lidars qualities

Lidar	Age of Lidar	Vertical Accuracy	Horizontal Accuracy
Balook	2024	0.1m @ 68% CL flat, open ground	0.3m @ 67% CL
Bruthen_Creek	2014	±0.10m @ 1σ	±0.18m @ 1σ
DEM_Rivers_Mosaic	2011	Not Available	Not Available
DEM	2008	+/- 10 cm	+/- 25 cm
Dtm10m_e	Various	Not Available	Not Available

It accurately detects the stream in most cases, although sometimes it has trouble differentiating between road and stream. Alongside some minor errors are present, which need to be considered when interpreting the results for the analysis and planning purposes. Overall, the lidar offers reliable and precise data for the study area. A few lidar artifacts and glitches are shown below.



A LiDAR interpolation artefact where missing or misclassified ground returns near the creek and road create an unrealistic smooth elevation mound that distorts the true topography.



This LiDAR surface shows a diffuse interpolation artefact where missing or poor ground returns create broad, blurry elevation patches that obscure the true terrain.

Figure 5: Lidar artifacts and glitches

2.5. Hydraulic controls

A map has been created showing all bridges and culverts, identifying any major dams on the waterways, and highlighting any levees or highways that could potentially hold back flow.

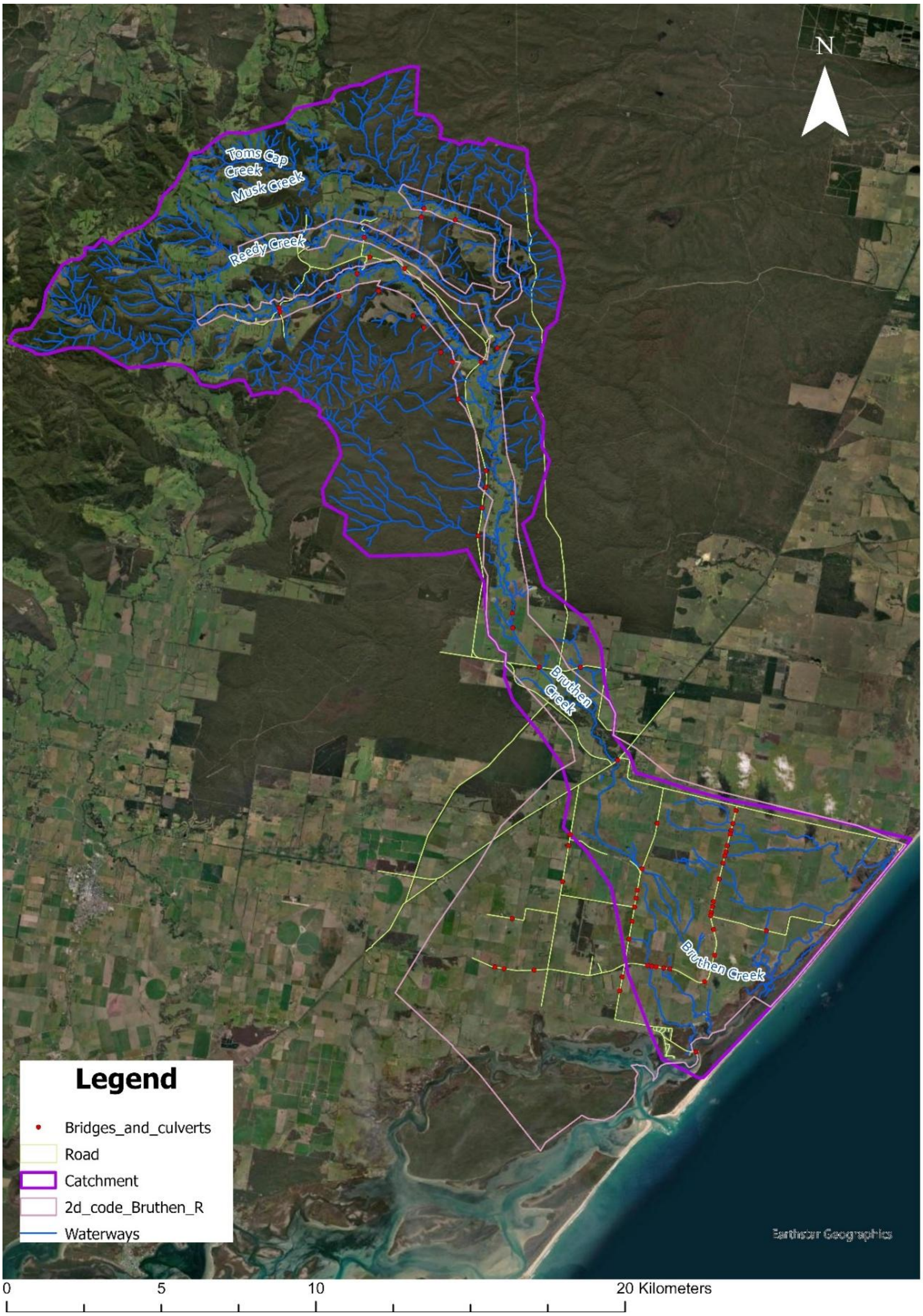


Figure 6: A map showing all bridges, road and culverts

2.6. Soil type

Throughout the catchment, different types of soil are found. At the riverside, soil type ‘riv’ is found, whereas in the forest area, soil types ‘Wg’, ‘Go’, and ‘Sd’ are present. Most of the farmland area is covered with soil types ‘Bl’, ‘Go/Sd’, ‘Sz’, ‘Yr’, ‘Wd’, and ‘riv’. The detailed map showing soil types in the catchment is given below.

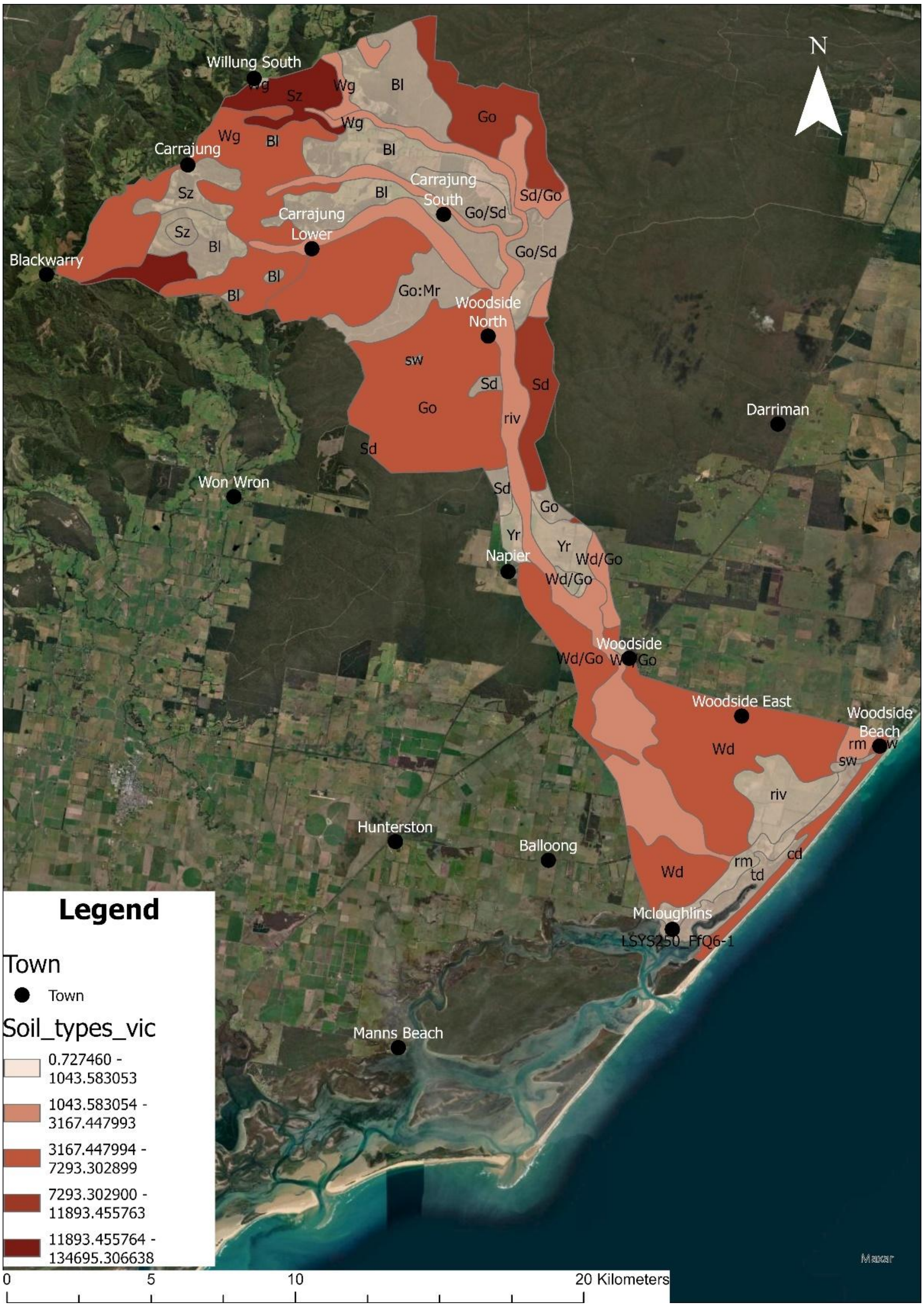


Figure 7: A map showing soil type

2.7. Flood history

The flood history from the Trove is found that the Bruthen Creek area and its south area are flood risk areas. In the Trove newspaper it is mentioned that Bruthen Creek "was a country of mountains and floods"(Trove). Going through different newspapers it was found that the past floods have destroyed agricultural land, crops and few bridges.

In the past report of this area, the "***2014 Bruthen Creek Flood Study***" found that the aerial flood photography captured by the staff at WGCMA of Bruthen Creek flood extents in the vicinity of Balloong Road in 2013, which is shown in Figure 8: Bruthen Creek flood extents in the vicinity of Balloong Road in 2013.

Figure 8: Bruthen Creek flood extents in the vicinity of Balloong Road in 2013

There was a recent flood in 2023 which was covered by the local news media. Where flood water from Bruthen creek reached woodside and flooding in a home at the intersection of South Gippsland Highway and Woodside Carrajung. The flood water spilled out into the Woodside Recreation Reserve surrounds, flooding their gym. The water had to recede, and roads also closed.

Figure 9: Flood waters from Bruthen Creek reached woodside in 2023

Figure 10: Map showing the location of the recreation reserve, and intersection relative to the flood extents in Woodside

3. Hydrology

3.1. Hydrology model

For the hydrology set up of the catchment, a polygon layer was created using the create feature class in the ArcGIS Pro. The boundary of the catchment is drawn with the help of Available lidar, and the watercourse network of that area. Then a new polygon was created in the ArcGIS Pro to divide the catchment into the sub catchment using the available lidar, waterways layer and VICMAP DTM. The sub catchment is divided in such as that there are least 5 upstream sub catchments before the hydrology model meets the hydraulic model.

In sub catchment attribute table, x-coordinate and y-coordinate field are added in the ArcGIS Pro and the centroid of the sub catchment was calculated using the calculated geometry tools. Then the attribute table is converted into the table using the Export table tools. Then from the table, centroid point was created using the Create Points from Table tools.

The junctions point layer was created and nodes were placed in the intersection between two sub catchments with the help of watercourse network. For reaches, a new line layer was created, and a line was drawn connecting between the next downstream centroid nodes and junction nodes.

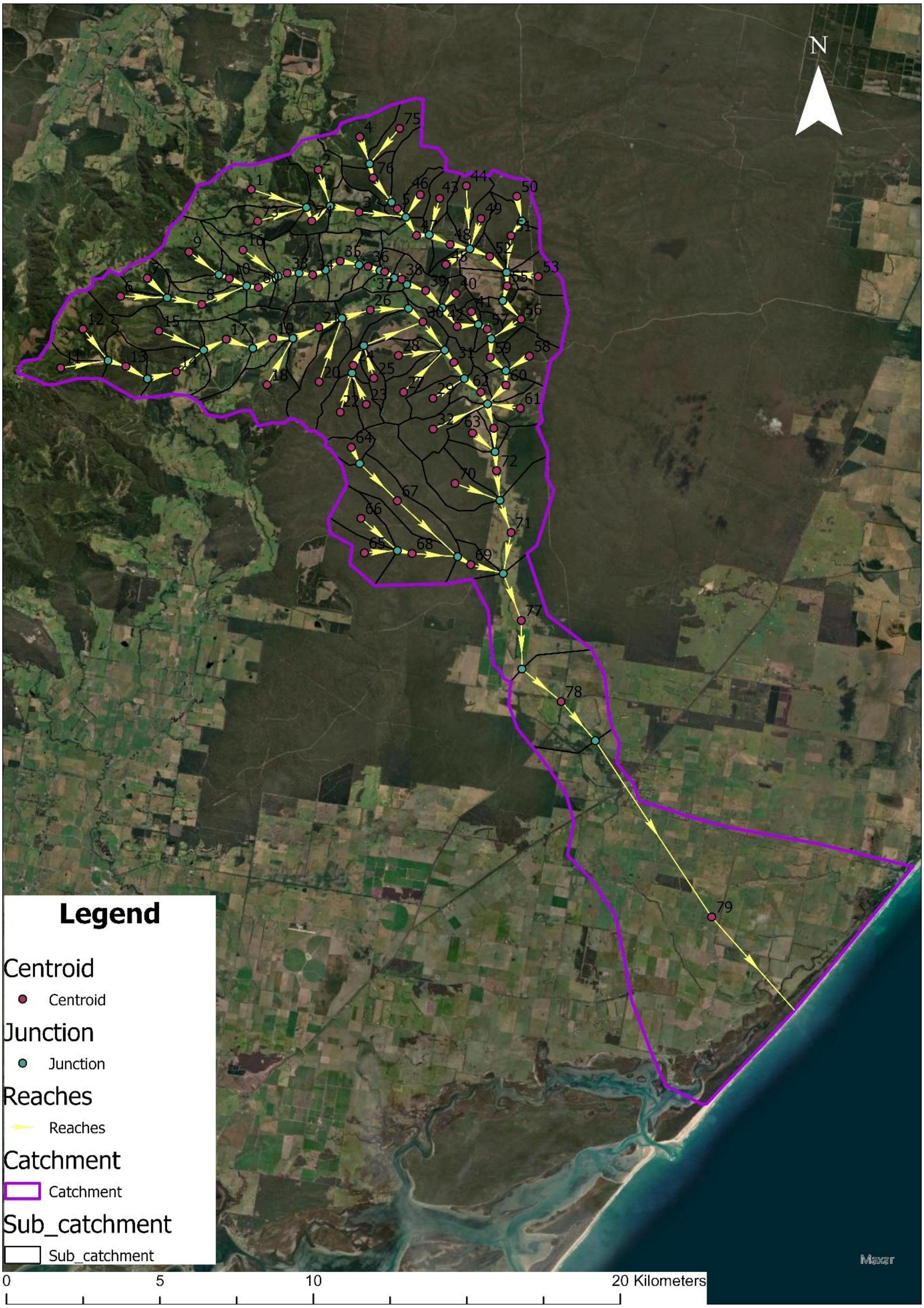


Figure 11: map showing all sub-catchment, reaches and nodes.

3.2. Rainfall gauges

The list of the rainfall gauges near and within the catchment was collected from the BOM Climate Data Online and WMIS. During the preparation of this project, Yarram Airport rainfall gauge was inadvertently omitted from the project. This oversight has been identified, and measures are being implemented to ensure all necessary data is included in the future project. Also, the omission of Yarran Airport did not affect that much during the calibration because Woodside streamflow gauges were not selected for the calibration due to lack of data. The list of the rainfall gauges is given below in the table with data ranges of these gauges and frequency of reading.

Table 3: Rainfall Gauges and Frequency of reading

Gauges	Site ID	Date ranges	Reading type
Balook	226818	1999-cuurrent	Daily
Mt Tassie	226814	1998-current	Daily
Merriman Creek	227239	2006-currernt	Daily

3.3. Streamflow gauges

The stream flow data within the catchment is collected from WMIS. Due to lack of flow data, Woodside streamflow gauges were not included in the calibration process. The list of the streamflow gauges is given below in the table with data ranges of these gauges and frequency of reading.

Table 4: Streamflow Gauges and Frequency of reading

Gauges	Site ID	Date ranges	Reading type
Carrajung Lower	227210	1952-cuurrent	Daily
Reedy Creek	227243	1992-2012	Daily
Woodside	227201	1946-1951	Daily

Analysis of the streamflow records shows that the largest and most significant flood events in the catchment occurred in 1969 (1537 ML/day), 1993 (1033 ML/day), 2001 (1220 ML/day), 2012 (605 ML/day) and 2021 (300 ML/day). These major events are clearly captured in the long-term dataset at Carrajung Lower, which provides a reliable and continuous record from 1952 to the present, and they are also partly reflected in the medium-length record at Reedy Creek. Together, these gauges provide consistent, well-defined peaks supported by stable rating curves and adequate high-flow gauging, making them suitable for calibration. In contrast, the Woodside gauge ceased operation in 1951, meaning it does not record any of these modern flood events and offers only a short, outdated five-year dataset with limited gauging and a weak high-flow rating relationship. Because Woodside fails to capture the catchment's major flood history and lacks the data integrity required for robust calibration, its omission is well-justified.

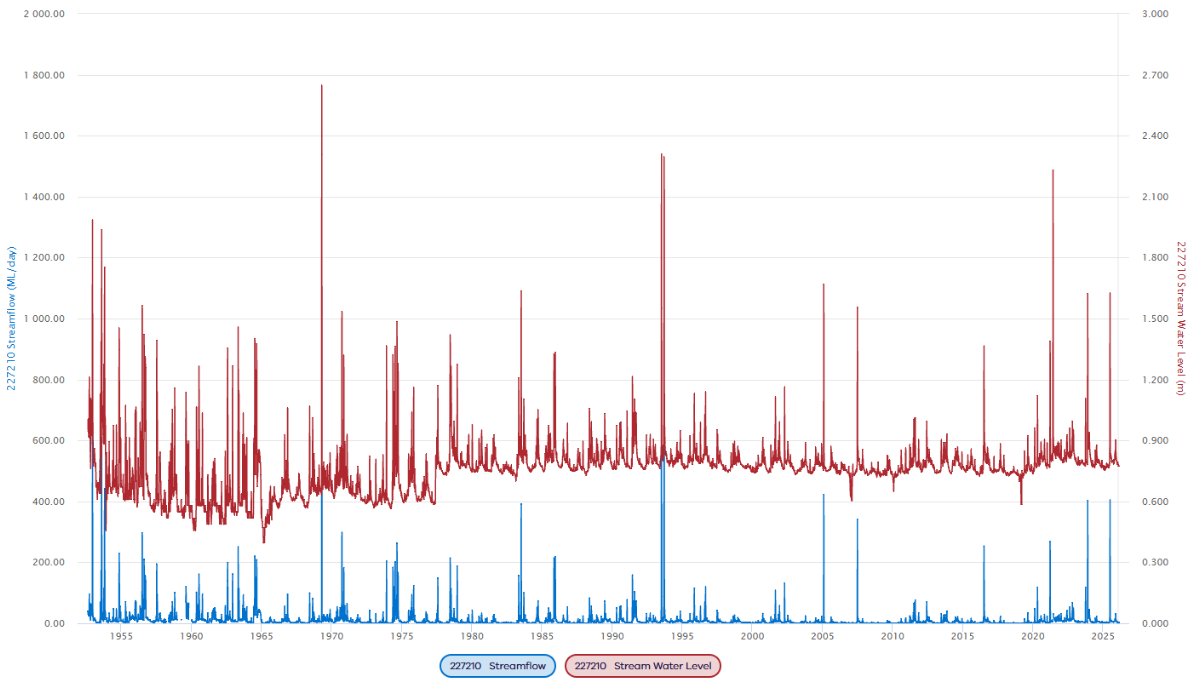


Figure 12: Time-series plot of streamflow and stream water level, highlighting major flow peaks and long-term hydrological behaviour for Carrajung Lower

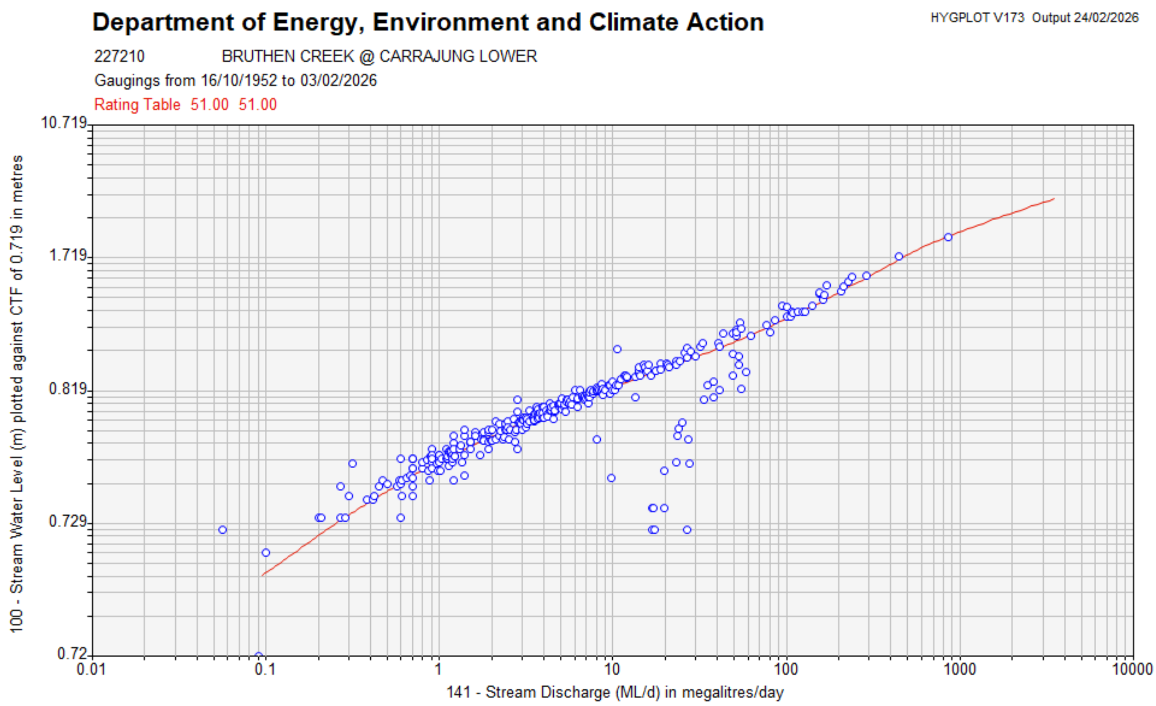


Figure 13: Rating curve for Bruthen Creek at Carrajung Lower, showing the relationship between stream water level and stream discharge using long-term gauging data

Rating Table - 227210 - Bruthen Creek @ Carrajung Lower

Table: 51 **Table name:** 51.00 **Effective as at:** Wed 25th Feb 2026

GH	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0					0	0	0	0	5	30
1	69	115	166	217	274	332	389	450	518	591
2	678	782	895	1019	1153	1298	1452	1621	1801	2007
3	2226	2445	2677	2922	3199	3491				

Rows: **4** Total Rows: **4**

Figure 14: Rating table for Bruthen Creek at Carrajung Lower showing gauge height and corresponding stream discharge values

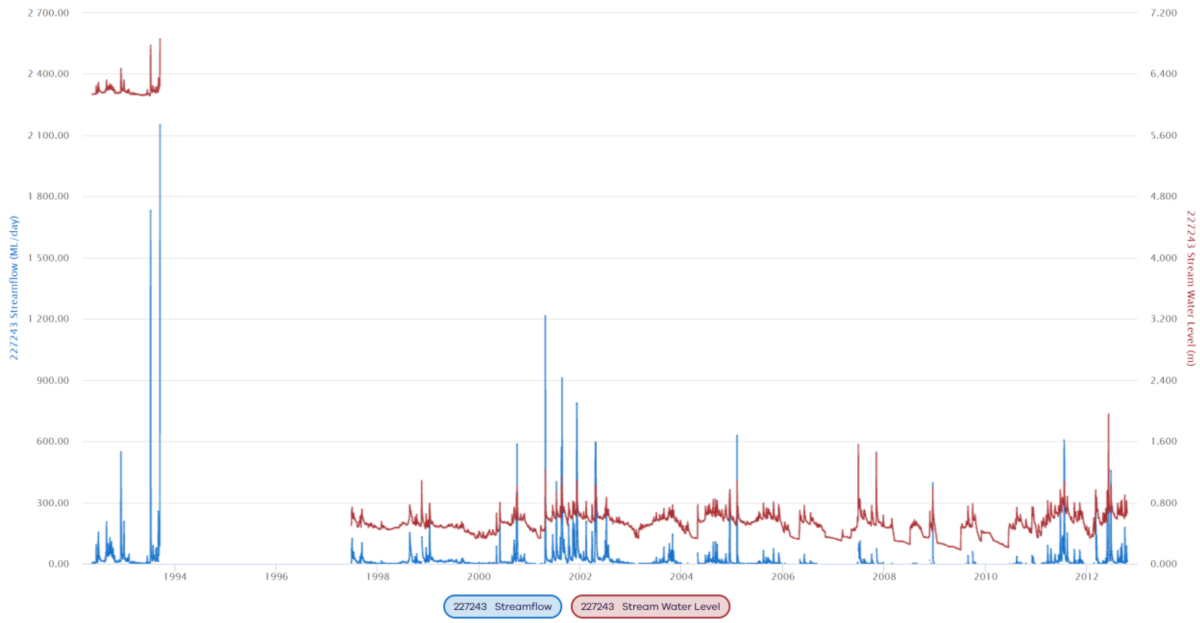


Figure 15: Time-series plot of streamflow and stream water level, highlighting major flow peaks and long-term hydrological behaviour for Reedy Creek

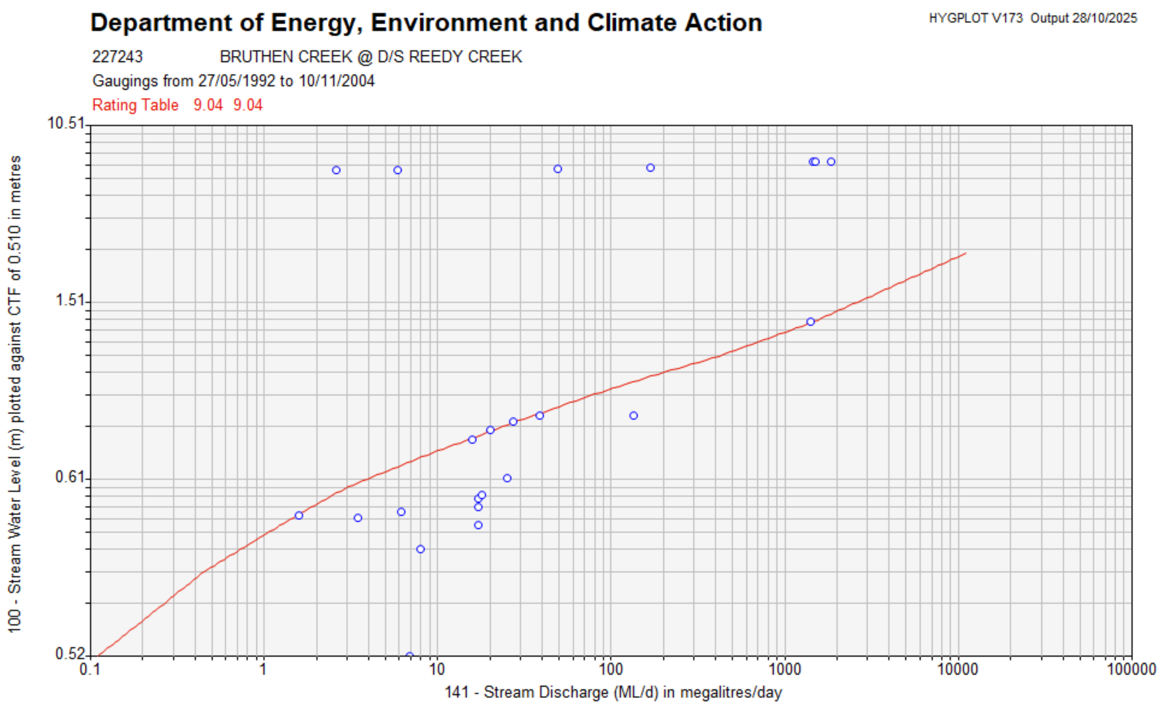


Figure 16: Rating curve for Bruthen Creek at Reedy Creek, showing the relationship between stream water level and stream discharge using long-term gauging data

Rating Table - 227243 - Bruthen Creek @ D/S Reedy Creek

Table: 9 **Table name:** 9.0 **Effective as at:** Wed 25th Feb 2026

GH	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0	0	0	0	0	0	3	21	70	180
1	400	674	1046	1526	2103	2800				

Rows: 2 Total Rows: 2

Figure 17: Rating table for Bruthen Creek at Reedy Creek showing gauge height and corresponding stream discharge values

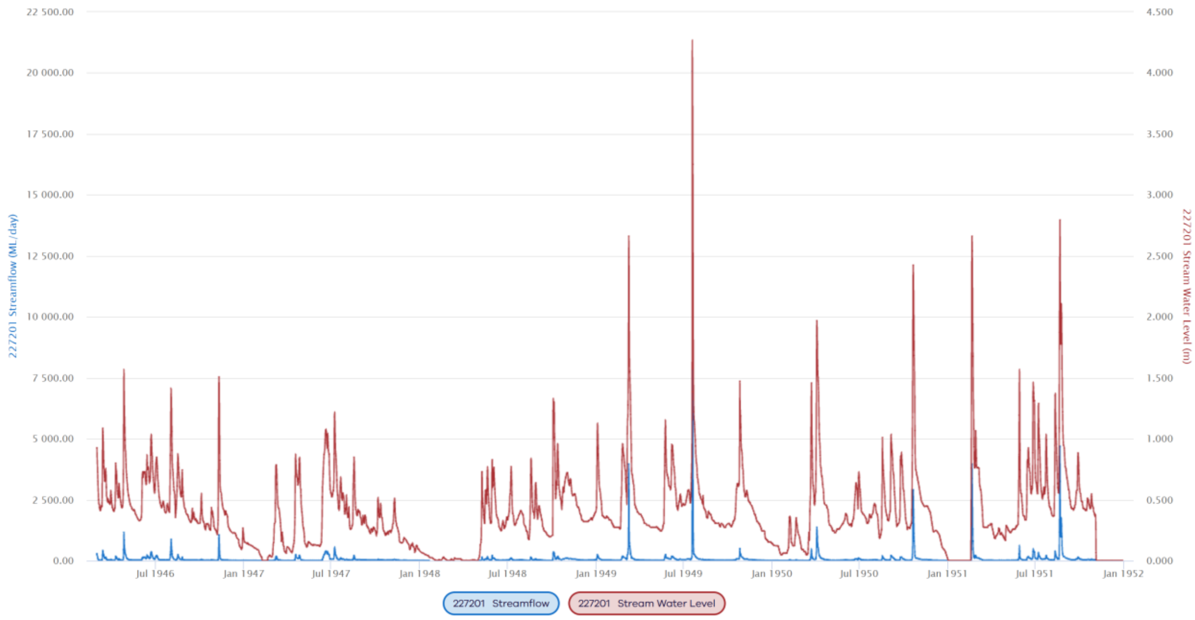


Figure 18: Time-series plot of streamflow and stream water level, highlighting major flow peaks and long-term hydrological behaviour for Woodside

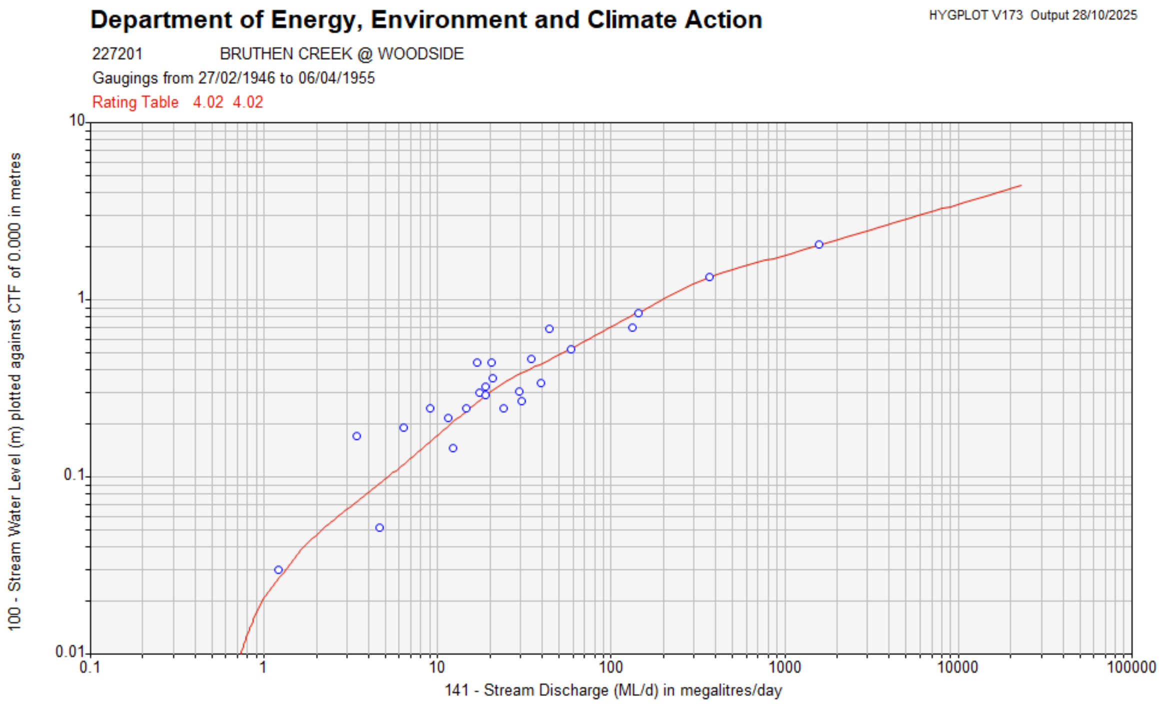


Figure 19: Rating curve for Bruthen Creek at Woodside, showing the relationship between stream water level and stream discharge using long-term gauging data

Going through history, in 1969 and 1993 was a large flow event. In 1969 the flow is 1537 ML/day and in 1993 is 1033 ML/day. Another, large flow in recently was in 2001, which is 1220 ML/day. Look through history and see if there are any large events. Comment on this. For the calibration, the recent large flow event 2001 (1220 ML/day), 2012 (605 ML/day) and 2021 (300 ML/day) is selected.

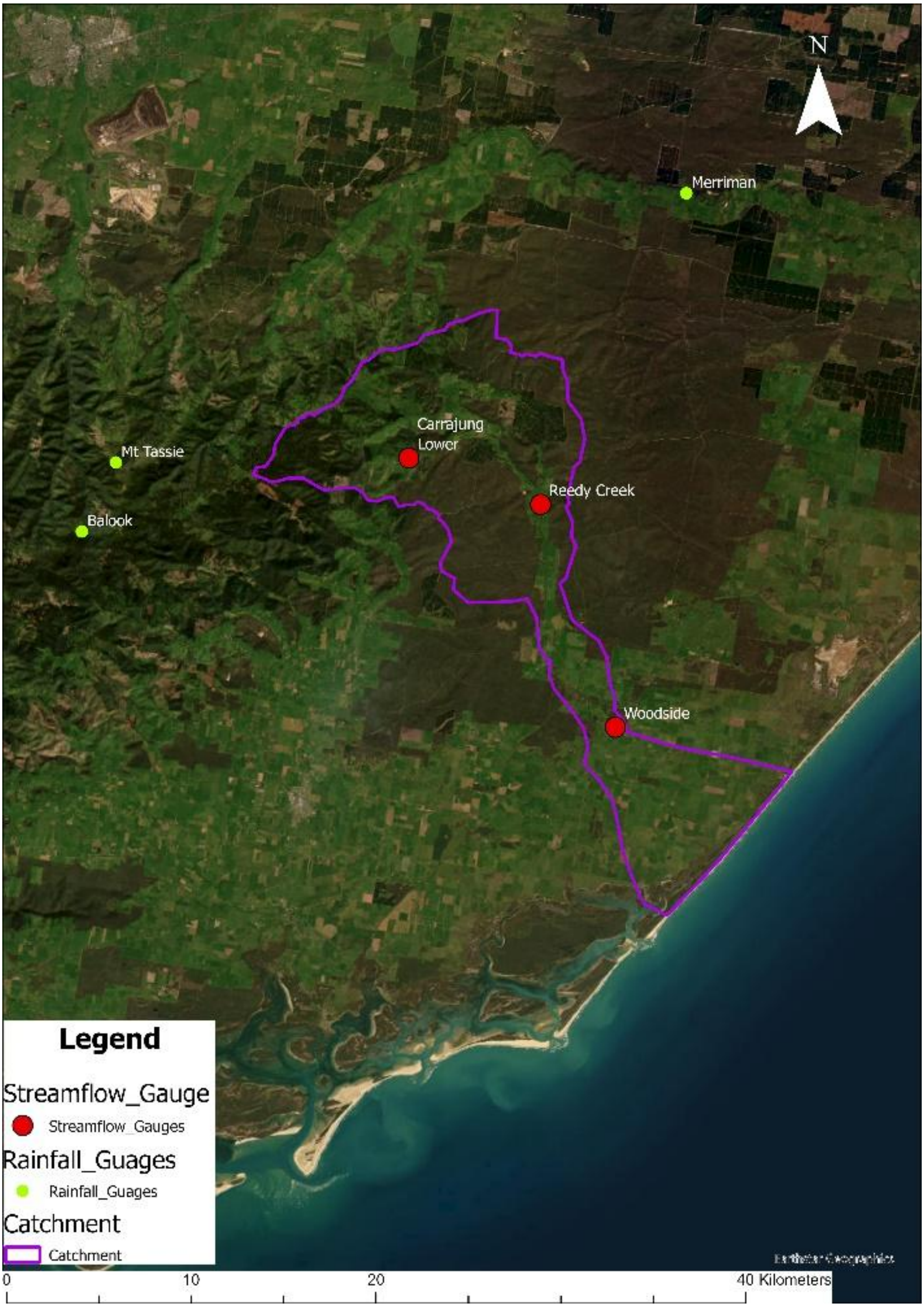


Figure 20: Map showing the catchment a nearby gauges

3.4. Losses

Table 5: Initial Loss, Continuing Loss - Comparisons from others studies

Catchment	Event	Model	IL (mm)	CL (mm/hr)	Distance from Bruthen Creek (km)	Study
Shady Creek	2012	RORB	29	3.8	45	Rosedale Flood Study 2016
Bruthen Creek	-	RORB	9.1	3.62	0	Traralgon Flood Study (2015)
Latrobe River @ Rosedale	-	RORB	20	1 - 6.8	25	Latrobe Flood Study (2015)
Traralgon Creek	-	RORB	35	3.3	30	Traralgon Flood Study (2016)
Tarra	-	RORB	22	2.5	20	Tarra Catchment Hydrologic Analysis report

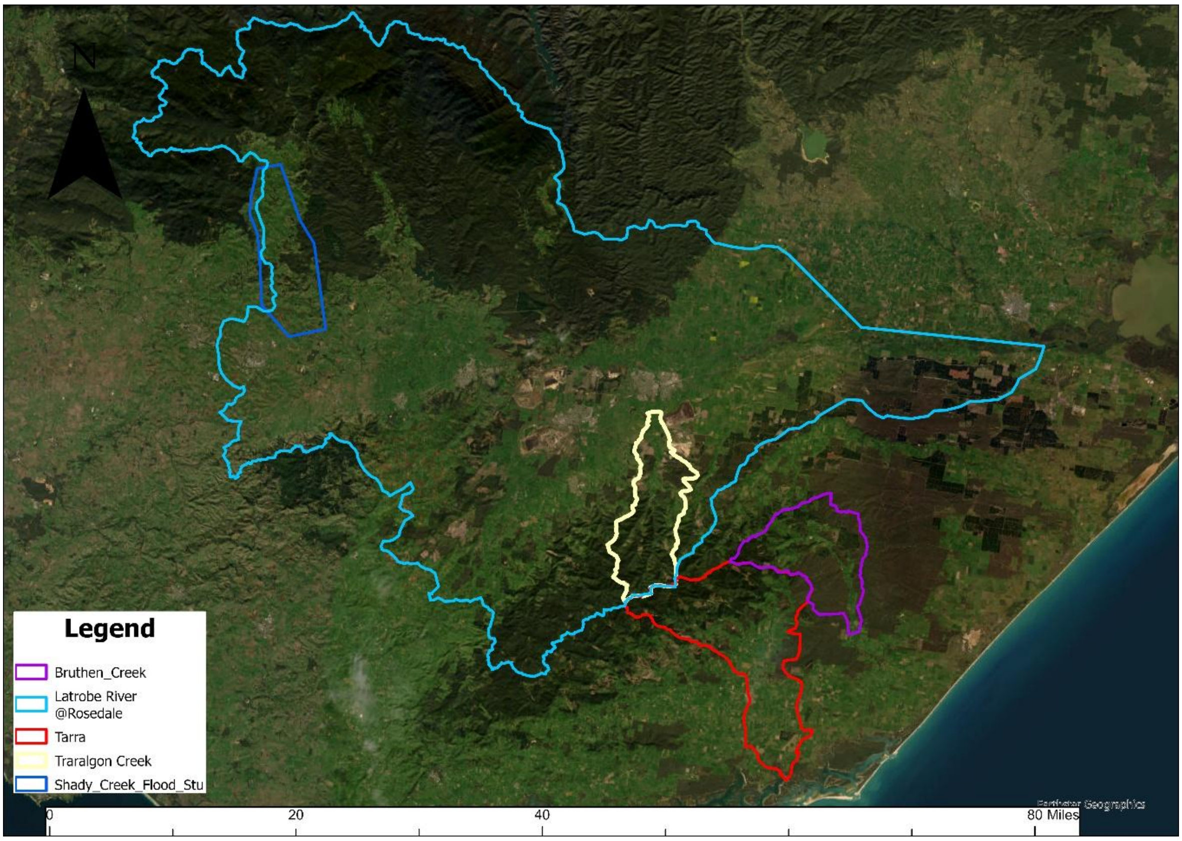


Figure 21: Catchment locations used for comparison of initial loss and continuing loss values from previous studies

3.5. Areal Reduction Factors

The Areal Reduction Factor coefficients for the SE Coast zone were obtained from the ARR DataHub and are presented in the table below.

Zone	a	b	c	d	e	f	g	h	i
SE Coast	0.06	0.361	0.0	0.317	8.11e-05	0.651	0.0	0.0	0.0

3.6. Intensity Frequency Duration

The tables below show rainfall intensity (mm/hr) downloaded from BOM IFD for various storm duration (1 min-168 hrs) and Annual Exceedance Probabilities (AEP), which indicate the likelihood of a rainfall event occurring in any year. Lower AEP values represent rarer, more extreme events, while higher AEP values indicate more frequent events.

Table 6: Intensity Frequency duration for Different AEP

	Annual Exceedance Probability (AEP)										
Duration	63.2%	50%	20%	10%	5%	2%	1%	1 in 200	1 in 500	1 in 1000	1 in 2000
1 min	1.51	1.75	2.54	3.12	3.72	4.57	5.27	5.91	6.89	7.68	8.53
2 min	2.49	2.88	4.18	5.14	6.12	7.56	8.74	9.84	11.4	12.8	14.1
3 min	3.38	3.91	5.67	6.97	8.3	10.2	11.8	13.3	15.5	17.3	19.1
4 min	4.17	4.82	6.98	8.58	10.2	12.6	14.6	16.3	19	21.2	23.5
5 min	4.85	5.61	8.14	10	11.9	14.7	16.9	19	22.1	24.7	27.4
10 min	7.38	8.53	12.4	15.2	18.2	22.3	25.7	28.8	33.5	37.4	41.6
15 min	9.05	10.5	15.2	18.7	22.3	27.4	31.5	35.3	41.1	45.9	51
20 min	10.3	11.9	17.3	21.3	25.4	31.1	35.8	40.2	46.8	52.2	58
25 min	11.3	13.1	19	23.3	27.8	34.2	39.3	44.1	51.4	57.3	63.7
30 min	12.1	14	20.4	25.1	29.9	36.7	42.3	47.4	55.2	61.6	68.4
45 min	14.1	16.3	23.7	29.1	34.6	42.6	49.1	55.1	64.2	71.6	79.5
1 hour	15.6	18	26.1	32.1	38.3	47.1	54.4	61	71	79.2	87.9
1.5 hour	18	20.8	30	36.8	43.9	54.1	62.5	70.1	81.7	91.1	101
2 hour	20	23	33.2	40.7	48.5	59.8	69	77.5	90.2	101	112
3 hour	23.3	26.8	38.4	47	56.1	69	79.8	89.5	104	116	129
4.5 hour	27.4	31.4	44.8	54.8	65.4	80.4	92.8	104	121	135	150
6 hour	30.9	35.3	50.4	61.5	73.3	90	104	116	136	151	168
9 hour	36.8	42.1	59.8	72.9	86.8	106	122	137	160	179	199
12 hour	41.9	47.8	67.8	82.6	98.3	120	138	155	180	201	224
18 hour	50.1	57.2	81	98.6	117	143	163	183	214	238	265
24 hour	56.7	64.7	91.7	112	132	161	184	206	240	268	297
30 hour	62.1	71	101	122	145	175	200	225	262	291	323
36 hour	66.7	76.3	108	131	155	188	214	241	280	311	345
48 hour	73.9	84.6	120	146	172	208	236	267	309	344	381
72 hour	83.5	95.6	135	164	193	233	265	299	347	387	428

96 hour	89.2	102	144	174	205	247	280	317	369	411	456
120 hour	92.7	106	149	180	211	254	289	326	380	424	471
144 hour	94.9	108	151	182	214	257	292	330	385	429	478
168 hour	96.1	109	151	182	215	258	293	330	386	429	480

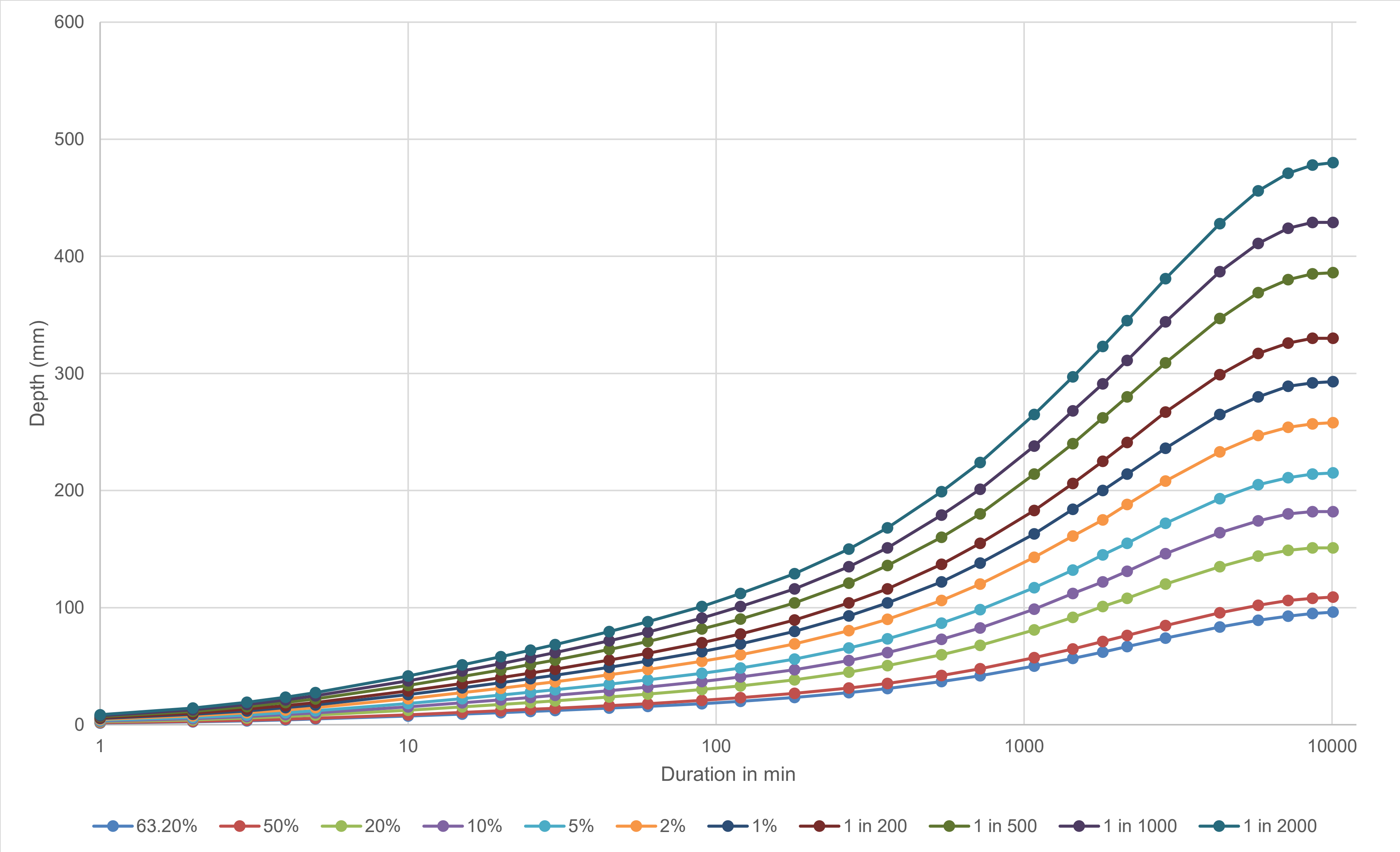


Figure 22: Graph showing rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probability (AEP)

3.7. Pre-Burst Rainfall

From the ARR data hub '75% Preburst Depth' data is applied during the RORB simulation to ensures the catchment is not completely dry before the main storm, improves accuracy of simulation which affects runoff and infiltration, and aligns with design standards for better flood predictions.

Table 7: 75% Preburst Depth

min (h)\AEP(5)	50	20	10	5	2	1
60 (1)	0.106	0.078	0.066	0.058	0.031	0.017
90 (1.5)	0.088	0.068	0.059	0.052	0.023	0.008
120 (2.0)	0.131	0.085	0.066	0.053	0.048	0.044
180 (3)	0.234	0.14	0.102	0.075	0.06	0.052
360 (6)	0.039	0.14	0.176	0.196	0.136	0.102
720 (12)	0.008	0.067	0.088	0.101	0.111	0.115
1080 (18)	0.014	0.035	0.043	0.048	0.062	0.069
1440 (24)	0	0.017	0.024	0.028	0.045	0.053
2160 (36)	0	0.002	0.003	0.004	0.005	0.005
2880 (48)	0	0	0	0	0	0
4320 (72)	0	0	0	0	0	0

4. RORB hydrologic model

4.1. Flood Frequency Analysis

The two graphs present flood frequency curve from model verification at Carrajung (Figure 20) and Ready (Figure 21), comparing peak discharge (m^3/s) against Annual Exceedance probability (AEP) on a logarithmic scale. In both graphs, the expected value represents the model's best estimate of flood peak for various AEPs, while the upper and lower confidence limits indicate uncertainty bounds, the RORB model results are also plotted for verification. At Carrajung, the discharge values remain relatively low, with a narrower confidence interval and lower peak flow, while Reedy shows significantly higher peak discharges and a wider confidence range.

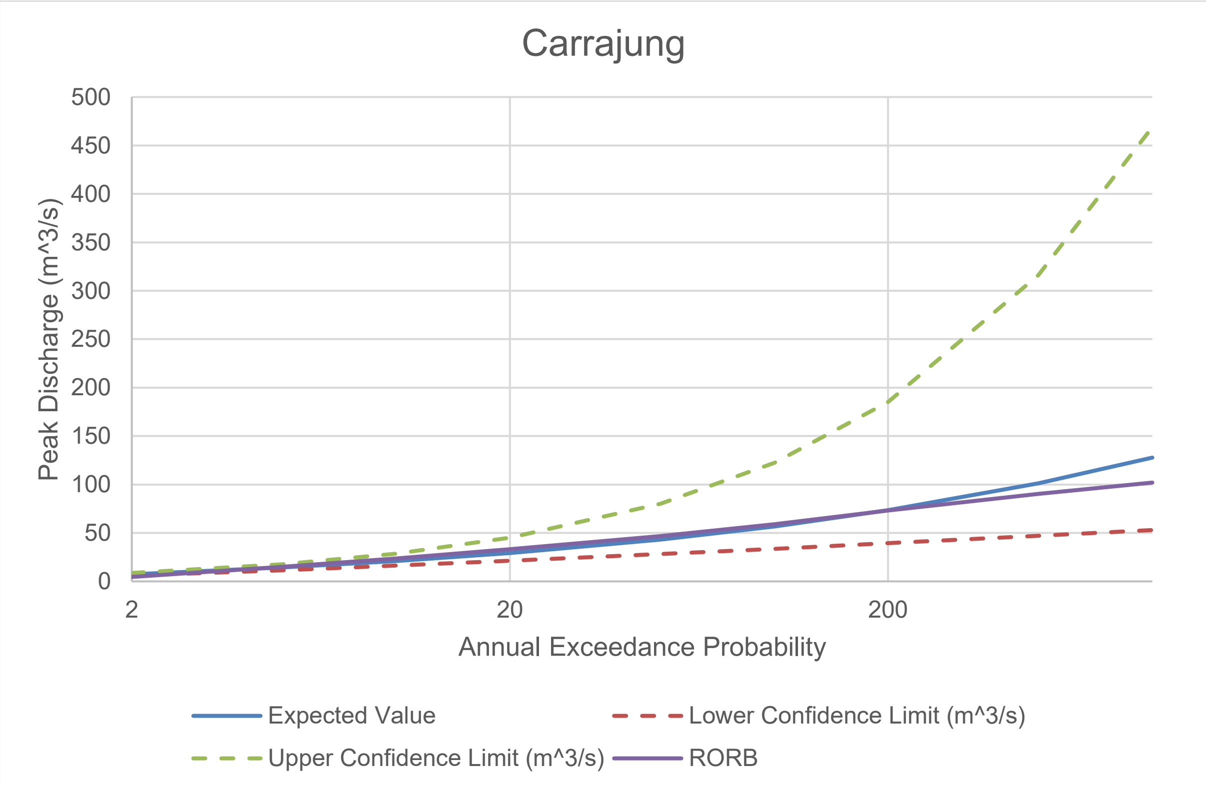


Figure 23: Flood frequency curve from verification at Carrajung

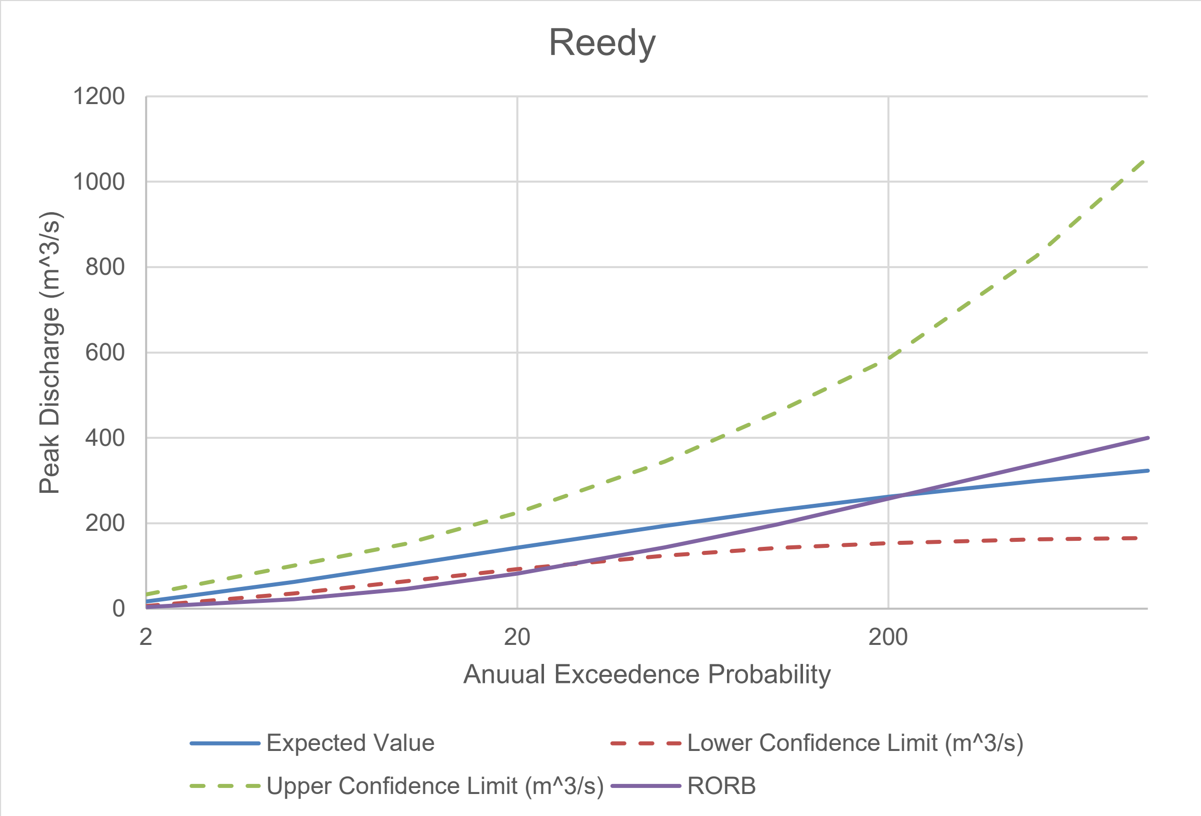


Figure 24: Flood frequency curve from verification at Reedy

4.2. Calibration

Calibration is essential to ensure that the model accurately represents the real-world hydrological behavior of a catchment. This is achieved by adjusting the model parameters such as initial loss (IL), continuing loss (CL), and the empirical coefficient (k) until the modelled flows align with recorded flow data for the selected calibration periods.

After reviewing the available riverine and rainfall data, April 2001, June 2012, and March 2021 flood event were initially considered for the calibration due to the size of the event and the data availability. However, the June 2012 event was excluded. The event-specific parameters required to achieve a good model fit for June 2012 differed significantly from those obtained for the 2001 and 2021 events. In addition, the available flow data for June 2012 did not align well with the parameter sets calibrated for the other events, resulting in inconsistencies that reduced confidence in its suitability for calibration. For those reasons, the 2001 and 2021 events were selected as the final calibrated periods.

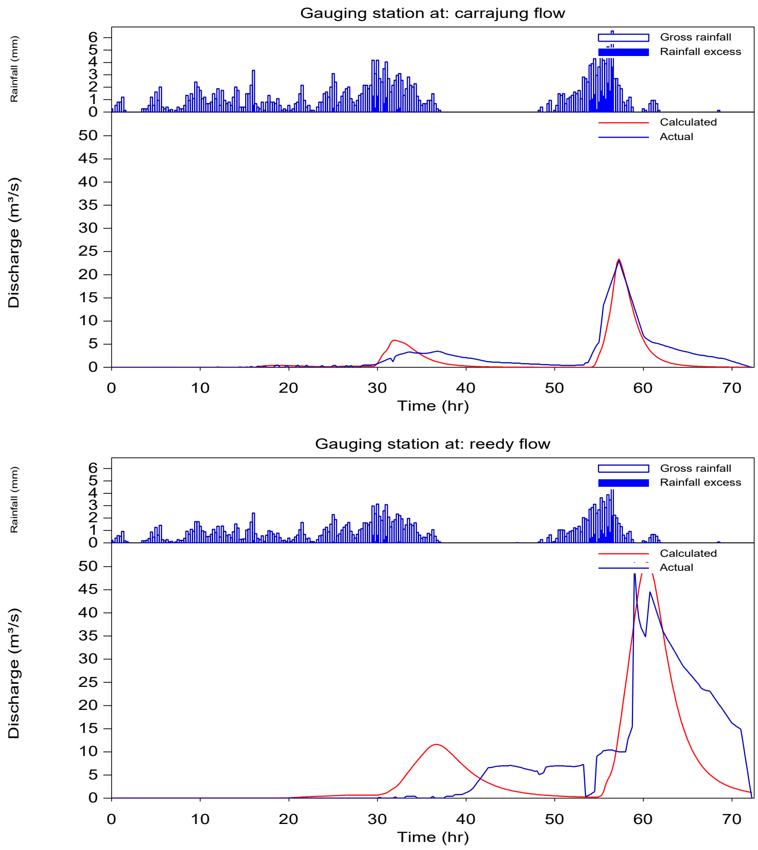


Figure 25: Final calibration hydrograph for 21-23 April 2001 Event

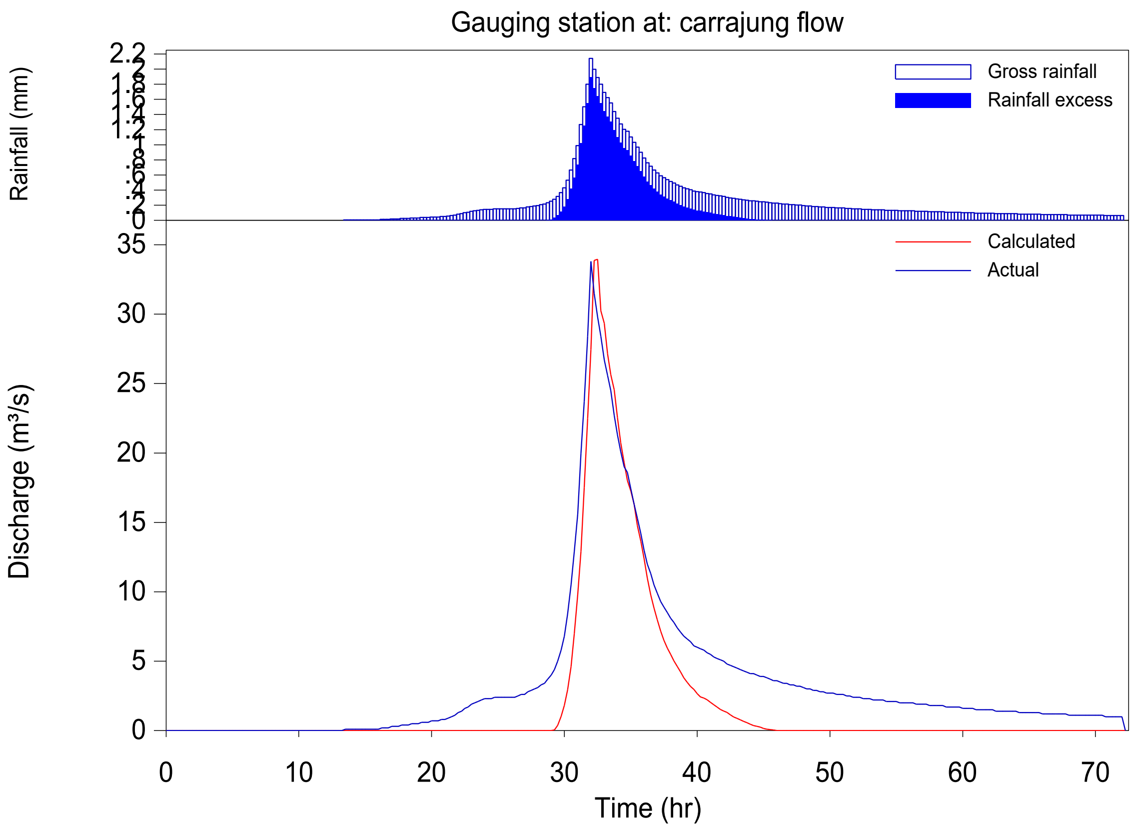


Figure 26: Final calibration hydrograph for 23-25 March 2021 Event

4.2.1. Rainfall and riverine data

All rainfall and streamflow gauges located within or near the catchment area were first identified.

For streamflow analysis, annual recorded data from the relevant flow gauges Carrajung, Reedy, and Woodside were reviewed to select a year with a significant peak flow event. Once the peak flow year was identified, the specific months and days of peak flow were determined from the flow data.

Subsequently, rainfall data for at least three days surrounding the peak flow event were downloaded from Victoria's Water Measurement Information System (WMIS). To facilitate easier calculations, the rainfall data were converted into 0.25-hour intervals.

Figures 27, 13, and 14 below illustrate the relationship between rainfall depth and streamflow for different events.

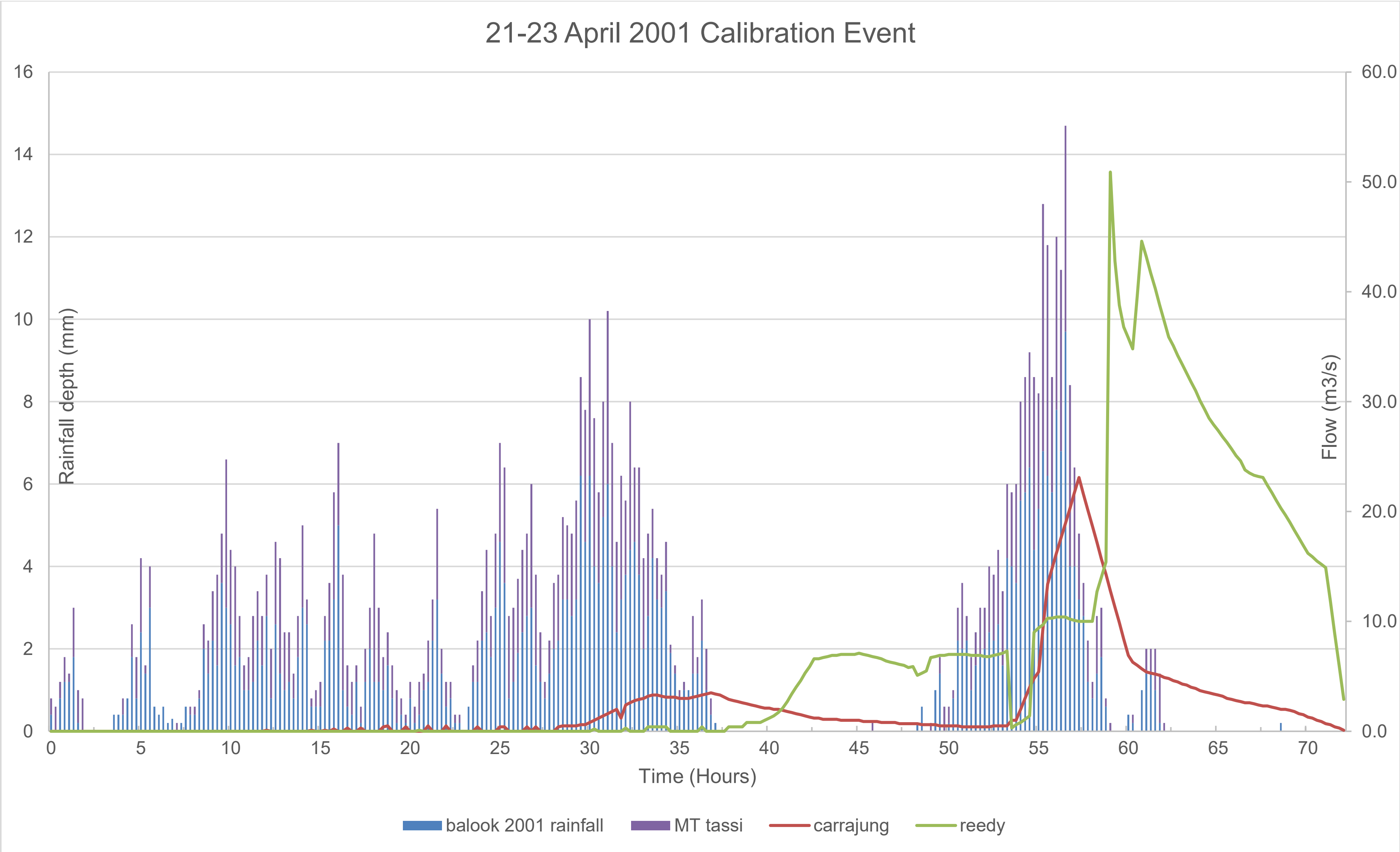


Figure 27: Calibration Rainfall and Flow Input Data (2001)

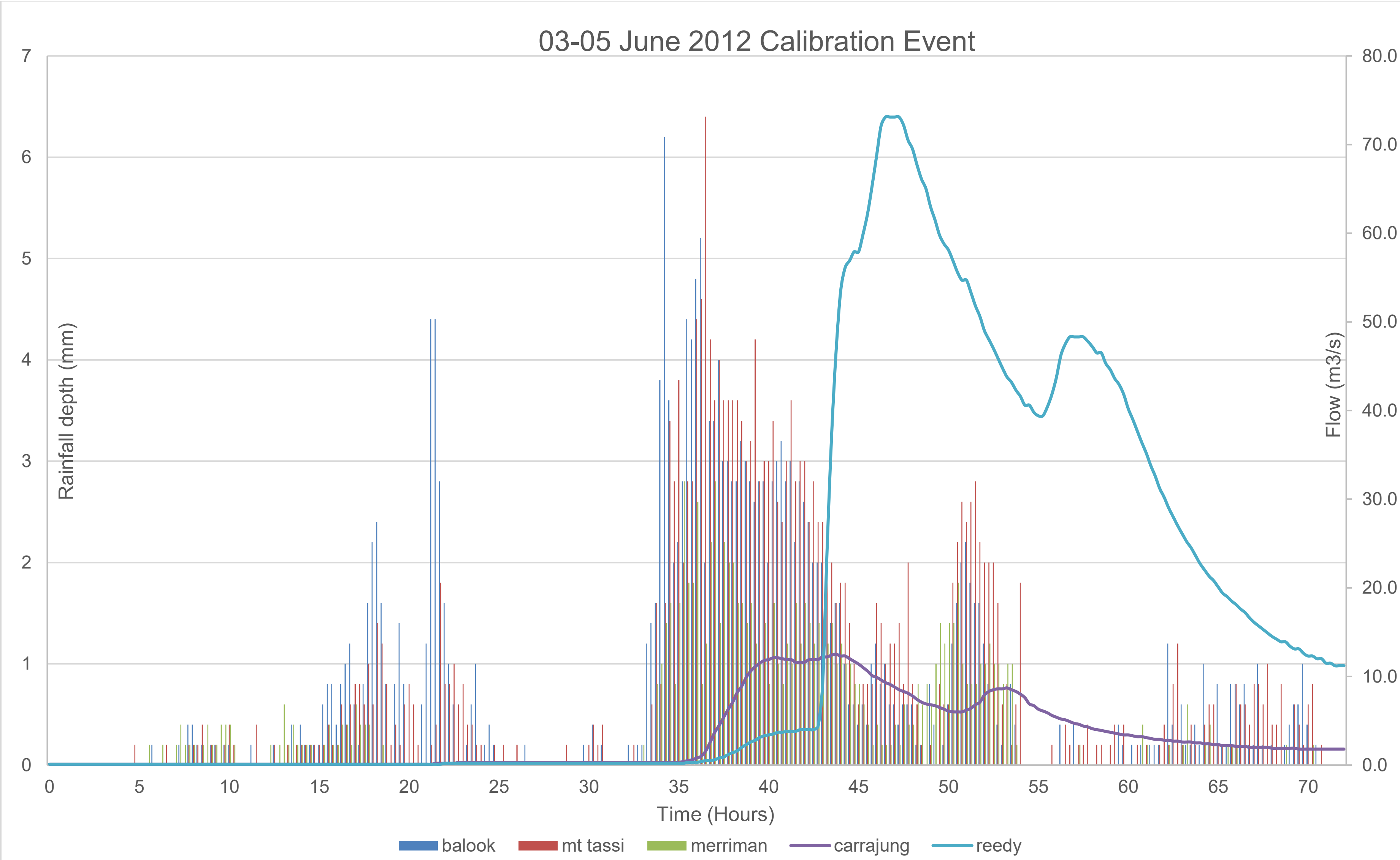


Figure 28: Calibration Rainfall and Flow Input Data (2012)

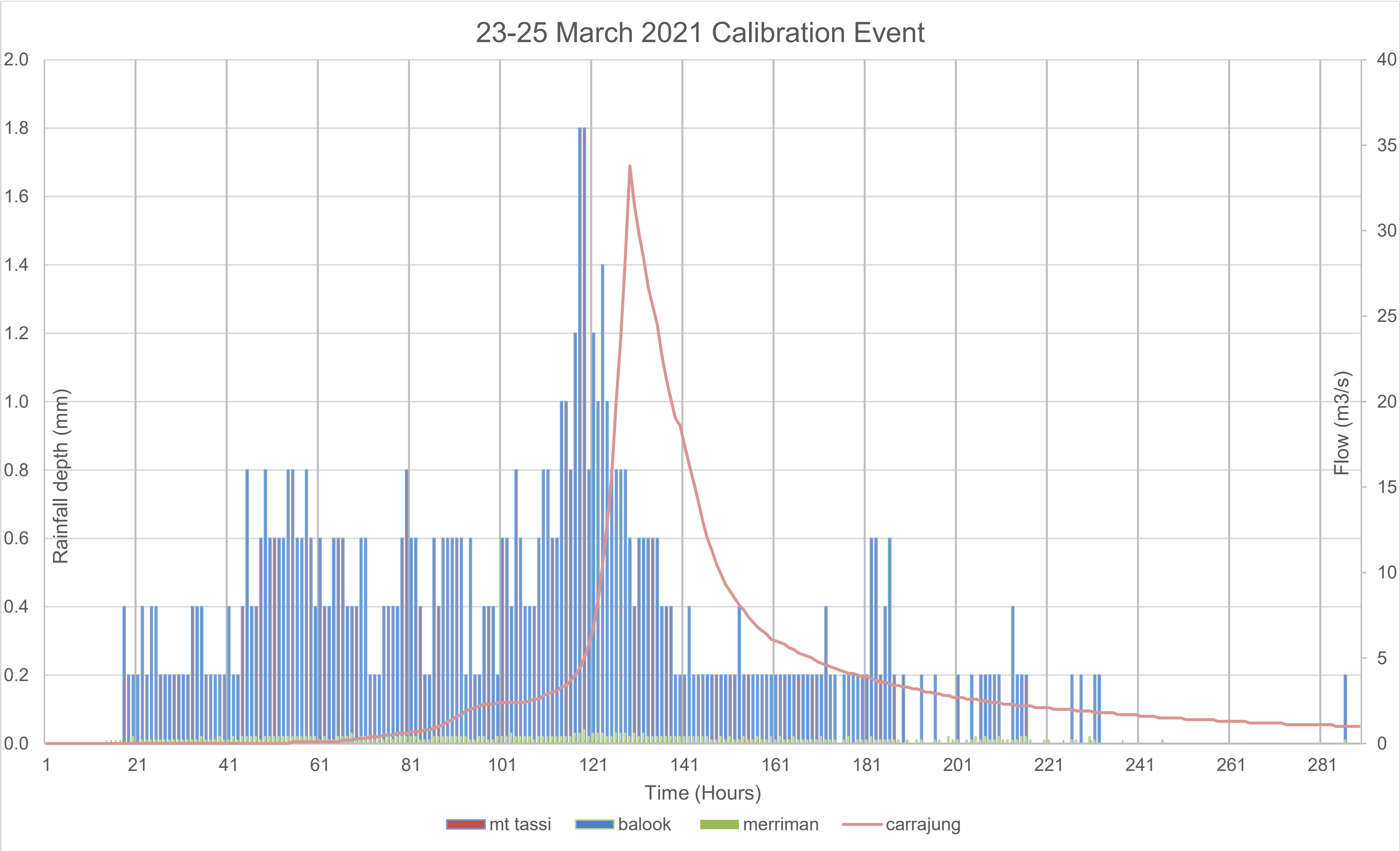


Figure 29: Calibration Rainfall and Flow Input Data (2021)

4.3. Design run

Table of adopted RORB parameters used in the design runs

Table 8: Parameters

Parameters	
kc	m
20	0.8

Table 9: Loss parameters

	Loss Parameters	
	Initial Loss (mm)	Continuous Loss (mm/h)
Carrajung	22	3
Reedy	15	9
Catchment Outlet	20	3

4.4. RORB results

Table 10: Design flows at Carrajung from RORB model

Average Recurrence Interval (ARI)	Flow at outlet based on RORB design run model
Years	m^3/s
2	4.589
5	15.646
10	23.638
20	33.077
50	46.666
100	59.056
200	73.208
500	90.202
1000	101.973

Table 11: Design flows at Reedy from RORB model

Average Recurrence Interval (ARI)	Flow at outlet based on RORB design run model
Years	m^3/s
2	3.783
5	22.5346
10	46.087
20	82.120
50	143.586
100	196.873
200	257.499
500	338.972
1000	400.064

The graphs presented illustrated rainfall-excess above Carrajung, Ready, and the catchment outlet for a range of Annual Exceedance Probabilities (AEPs), providing insight into how rainfall intensity varies with event rarity. As shown in Figure 17, 18, and 19 the data spans a 12-hour period from 24 hours to 36, with rainfall intensity measured in millimeters per hour. Each line represents a different AEP, from frequent events to rarer events.

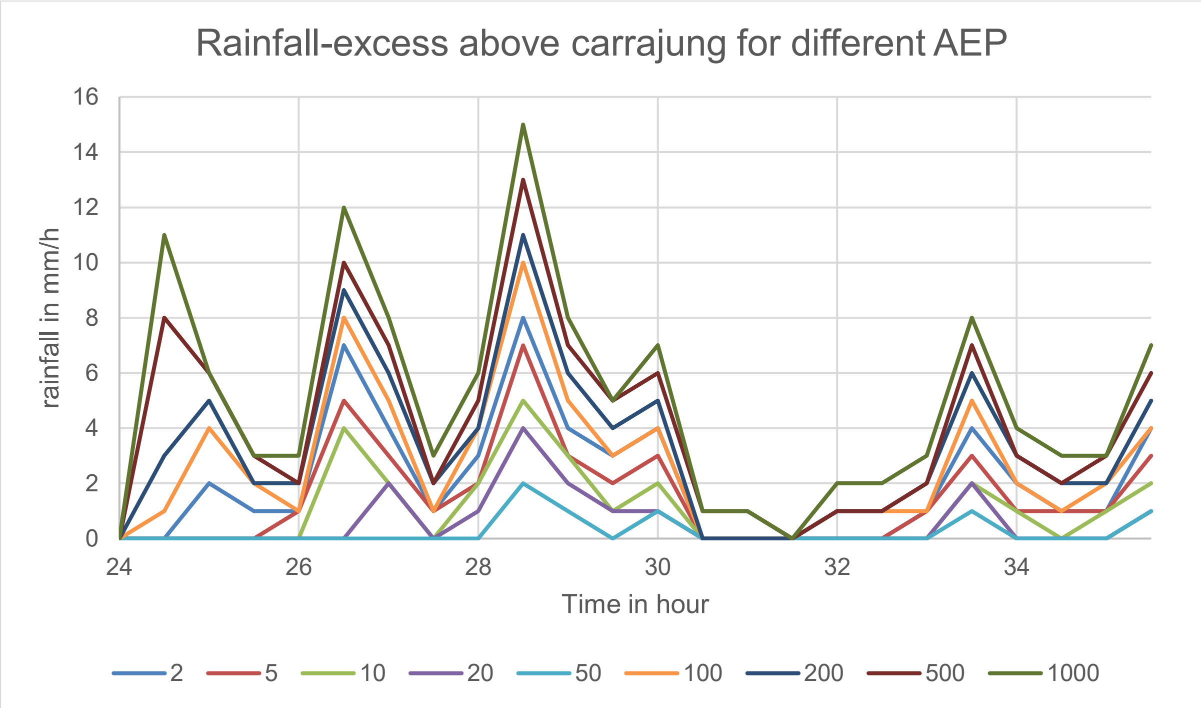


Figure 30: Rainfall-excess above Carrajung for different AEP

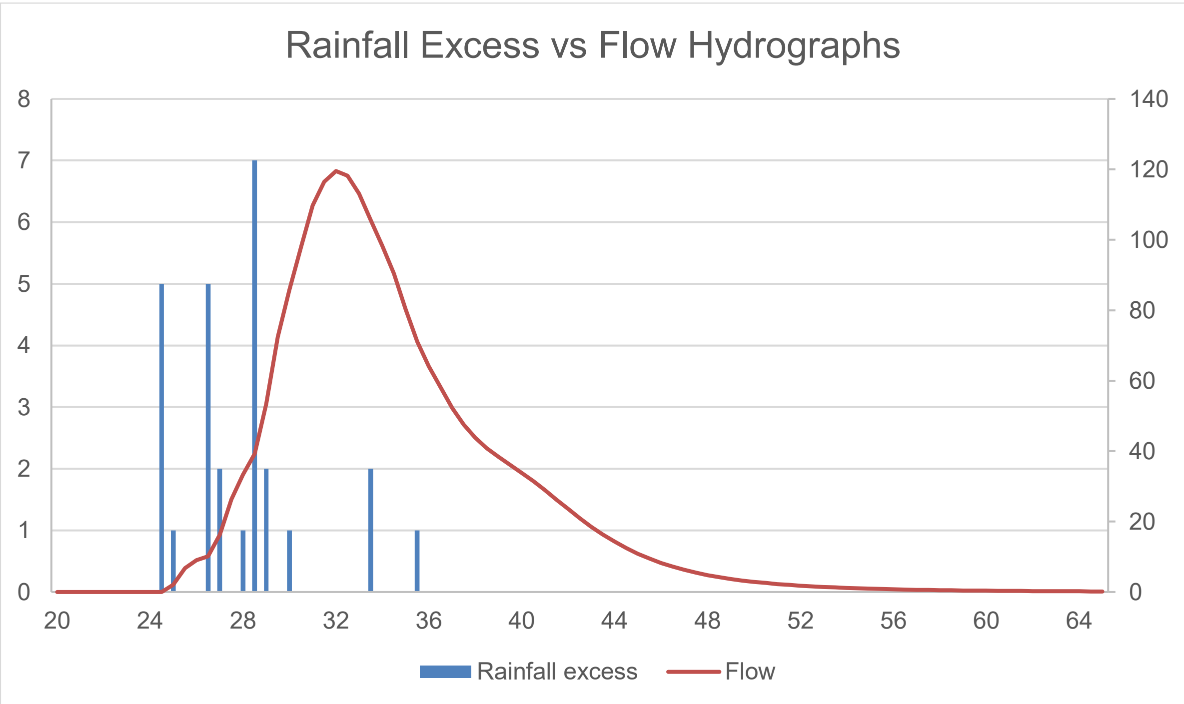


Figure 31: Rainfall Excess vs Flow at Reedy Gauge (1% AEP)

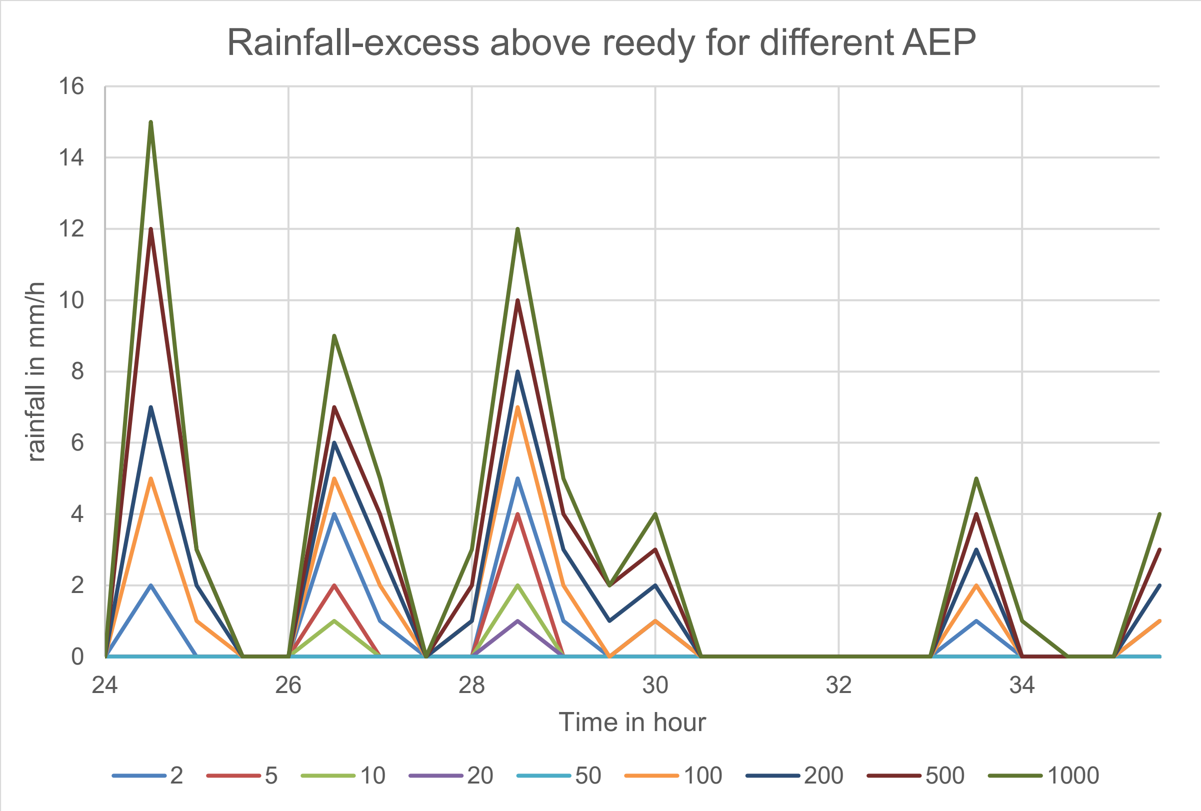


Figure 32: Rainfall-excess above reedy for different AEP

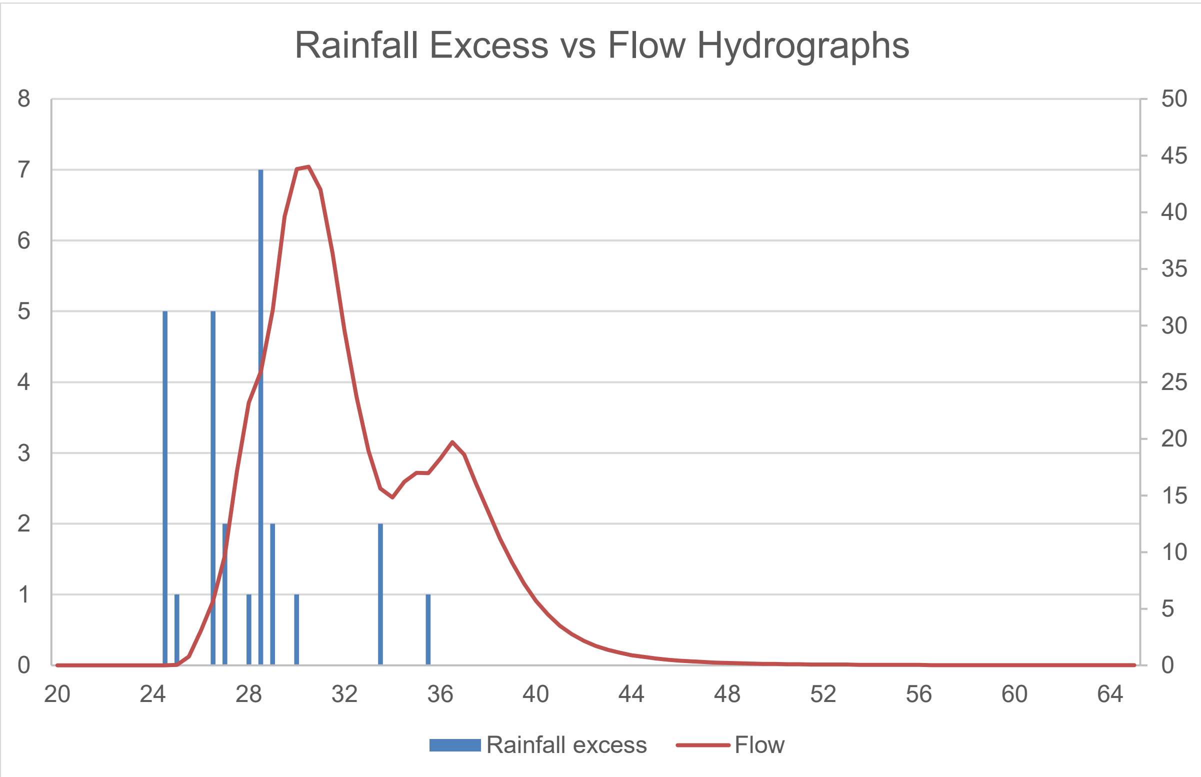


Figure 33: Rainfall Excess vs Flow at Carrajung Gauge (1% AEP)

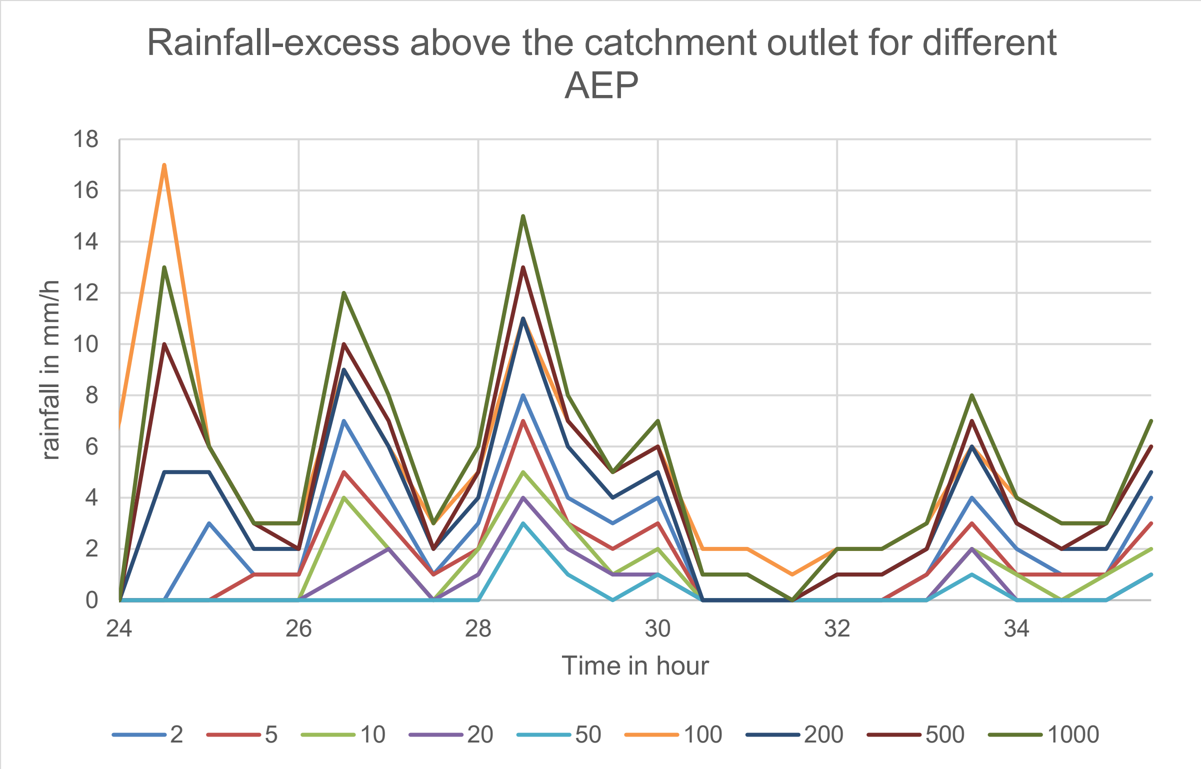


Figure 34: Rainfall-excess above catchment outlet for different AEP

5. TUFLOW hydraulic Model

5.1. Description of hydraulic modelling approach adopted

The hydraulic analysis of Bruthen Creek was performed through a hydraulic modelling program called TUFLOW. The hydraulic model of the catchment is 2D (2-Dimensional). The floodplain topography and other significant hydraulic features, such as road and bridges were represented within the 2D domains. A 2D domain with a 3m grid resolution was used to represent the floodplain. The external inflows boundaries were applied to the model to represent flow.

5.2. Data Available

- Aerial photography was used to identify materials and hydraulic structures within the floodplain, detect defects in LiDAR datasets, and confirm features like dense vegetation and fences and other feature had possible been picked up.

- For this component of the study, the primary concerns with the elevation datasets were their accuracy and resolution. The coverage of the elevation was less of a concern, as the hydraulic extent needed to be reduced to improve runtime. The LiDAR dataset is adequate for capturing the extent of flooding through Bruthen Creek, Reedy Creek, and Thoms Cap Creek along the main branch of Bruthen Creek in the southern part of the catchment. However, it misses several potentially significant waterways that branch off Bruthen Creek below the Woodside area. The dataset for the northern part of the catchment, known as the Balook LiDAR, is the most accurate and detailed. In contrast, the LiDAR dataset available for the southern part of the catchment is very poor in accuracy, although its resolution is sufficient to run the simulation.

5.3. Key hydraulic features

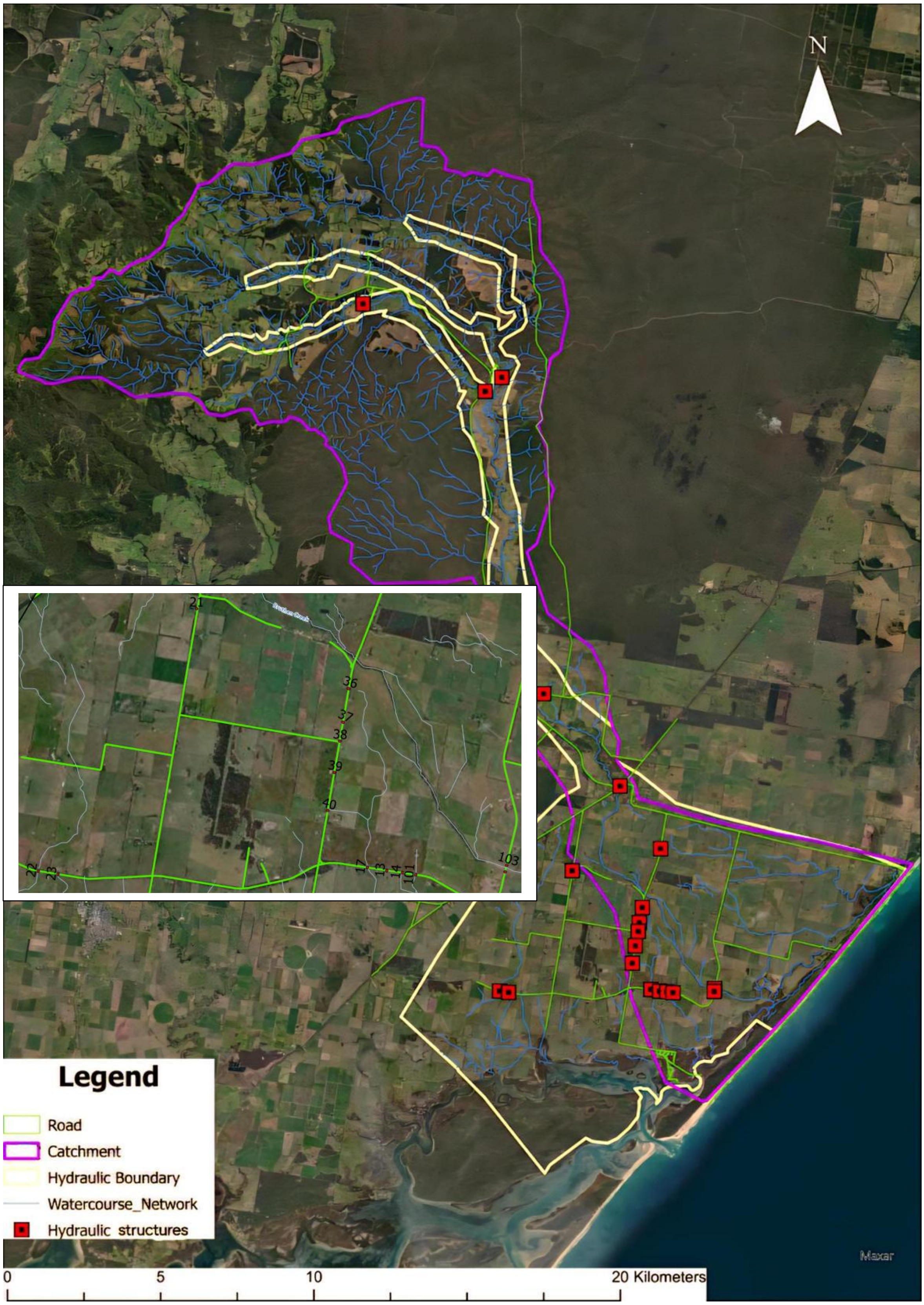


Figure 35: Map showing key hydraulic features and catchment layout.


17

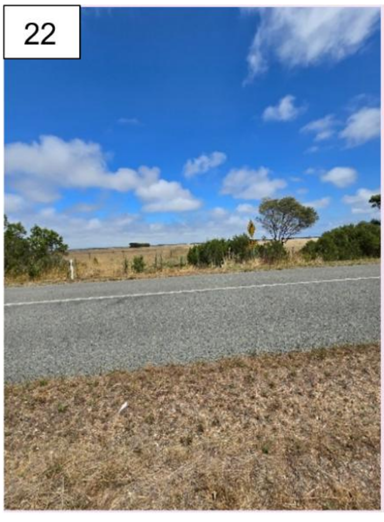

14


14


102


101


101


22


23


23

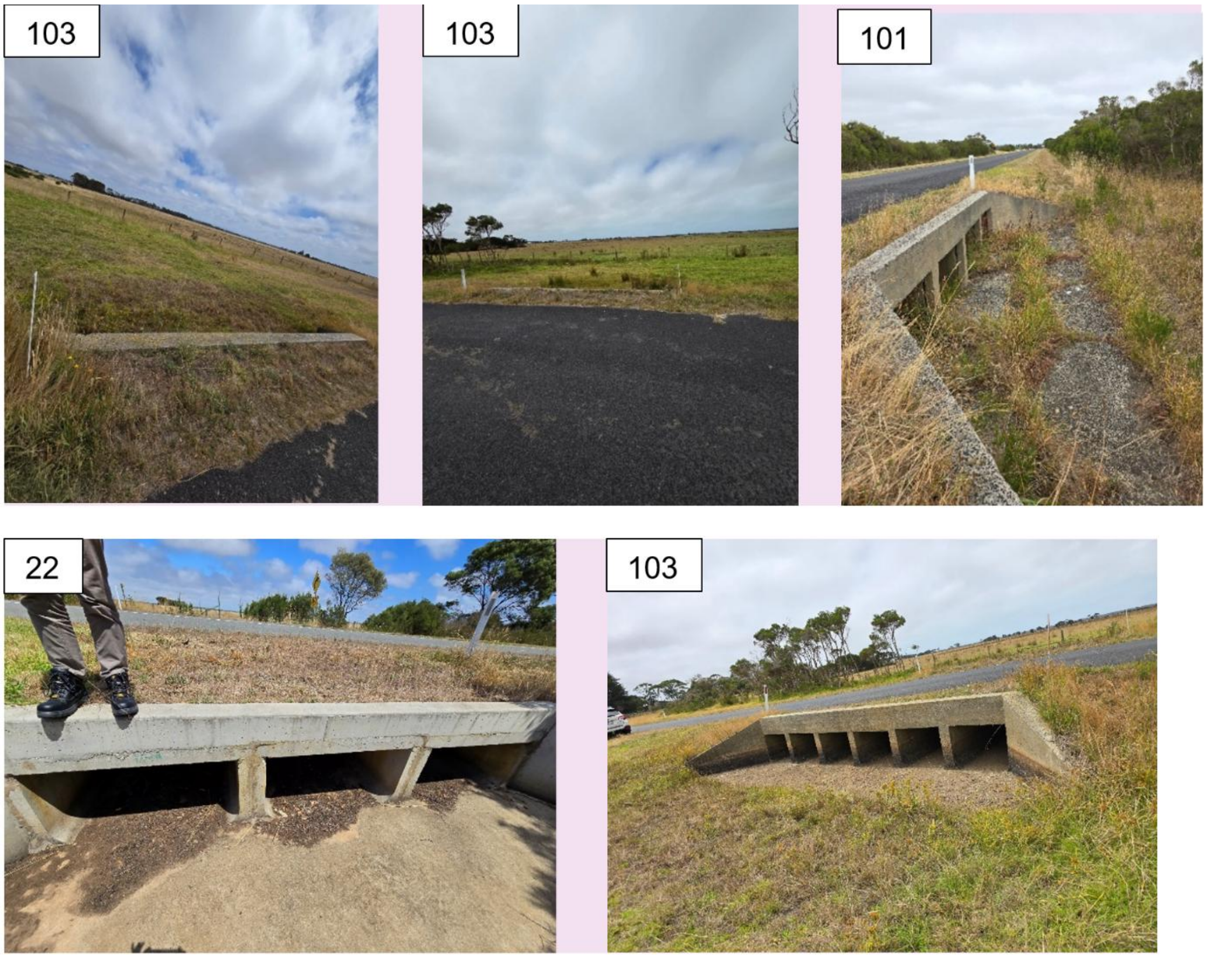


Figure 36: Site photos showing the drainage channel and nearby vegetation

5.4. Model extent

5.4.1. Grid Resolution

Grid resolution is a key factor influencing the accuracy and performance of hydraulic models. While a 2 m grid is ideal for fully representing narrow waterways, a 3 m grid was adopted for this study as it provided sufficient detail across the catchment while maintaining efficient model performance. In most areas, the 3 m resolution adequately captures the waterway geometry, with only a few southern section's requiring finer detail to resolve small channels.

5.4.2. Signification Areas

The hydraulic model was extended far enough south to include the Mcloughlins Beach area to ensure that the downstream boundary was in a stable and realistic part of the system. Although this area is near the coast, the model does not explicitly simulate tides, waves, or coastal storm effects. Instead, the inclusion of this area allows the model to capture the natural drainage pathways and ensures that water leaving the catchment is correctly routed through the downstream system. Extending the model to this location provides a more reliable downstream boundary and improves overall model behaviour.

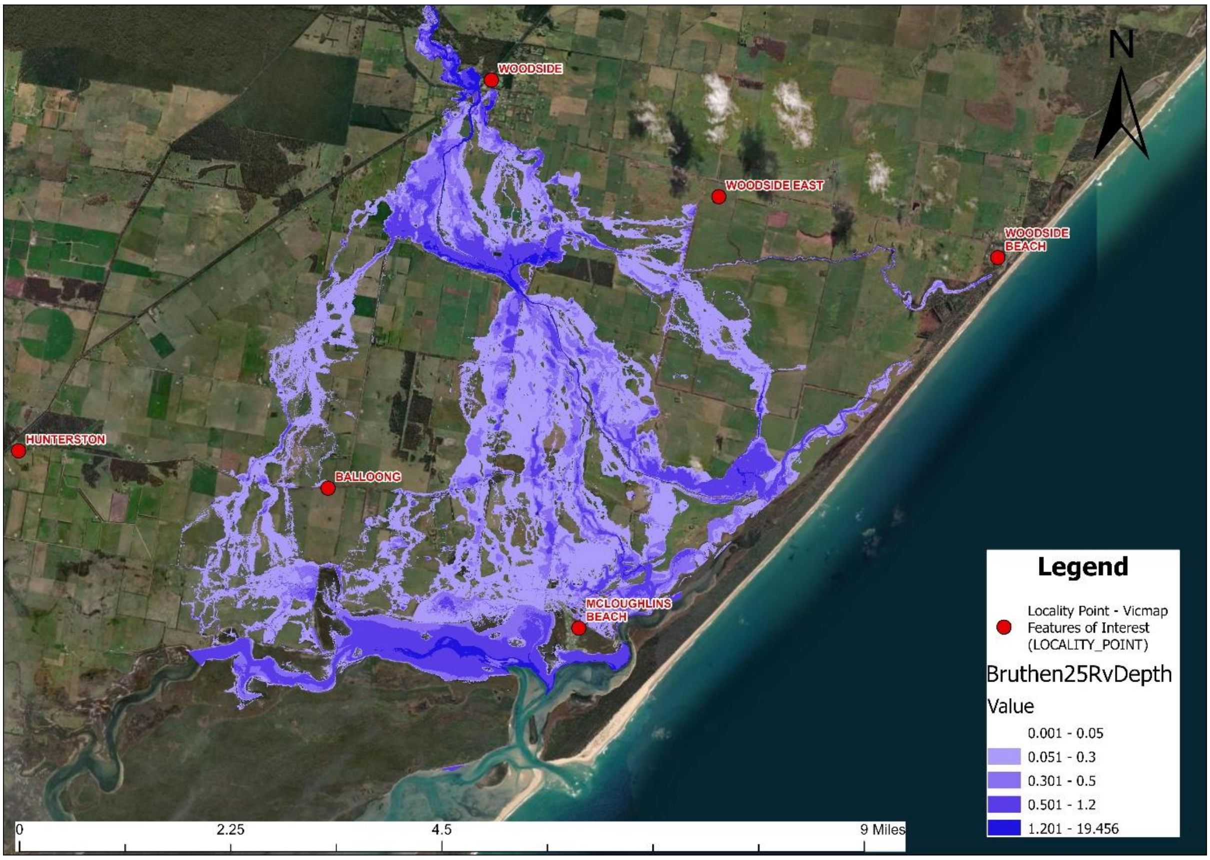


Figure 37: Flood extent map illustrating why the model domain includes the Mcloughlins Beach area

5.4.3. Flood Data

Rainfall data from the BOM was used in an initial run of hydraulic model to help refine the model extent. This first run gave an early indication of which areas were likely to be affected by flooding under the given rainfall conditions. Any areas that did not show flooding during this preliminary run were removed from the model domain as they were not contributing to the overall flood behavior. Removing these non-flooded areas helps the model to be more focused and easier to work with. It ensures that the model only concentrates on locations where water is expected to accumulate or flow, rather than spending time calculating areas that remain dry. This approach not only improvise the clarity and usefulness of the results but also reduces the total computation time needed for the full simulation, allowing the model to run faster and more efficiently.

5.5. Input data

5.5.1. Gridded elevation data

The topography data input into the TUFLOW was done using a Digital Elevation model (DEM). The DEM input into the TUFLOW had a 1-meter resolution. The digital elevation grid was altered using zsh shape and commands in TUFLOW. The bridges had been removed from the dataset as a part of its post processing and the lfcsh command raised the elevation around the bridges to equivalent height of the bridge.

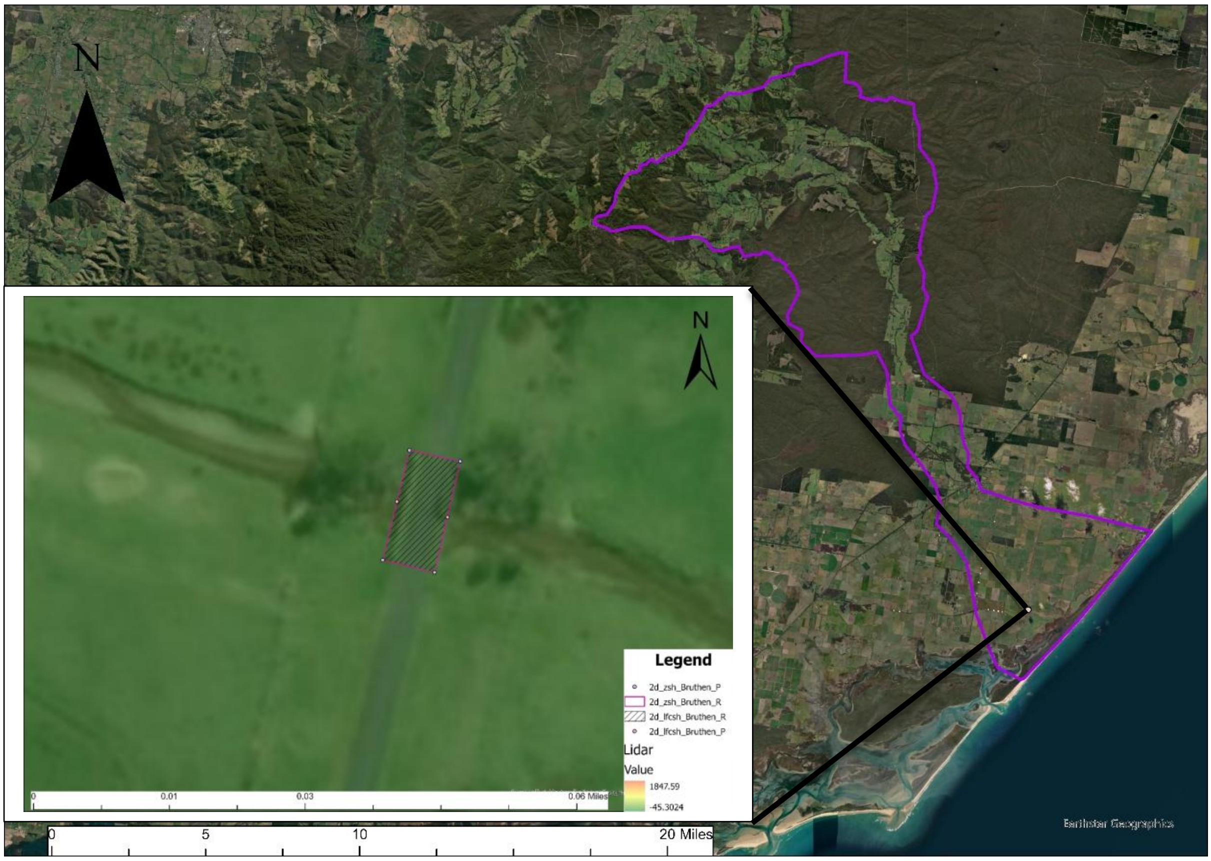


Figure 38: Gridded elevation dataset (DEM) showing modified bridge area and surveyed break lines used in TUFLOW model preprocessing

5.5.2. Flow data

Flow hydrographs generated from the RORB were input into the hydraulic model. The flow data was input into TUFLOW using the 2d_bc_L boundary shape file. The shapefile referenced flow vs time plot from the external csv directed by the boundary condition database. The shape file was based on whether the source of flow originated from inside or outside of the hydraulic boundary.

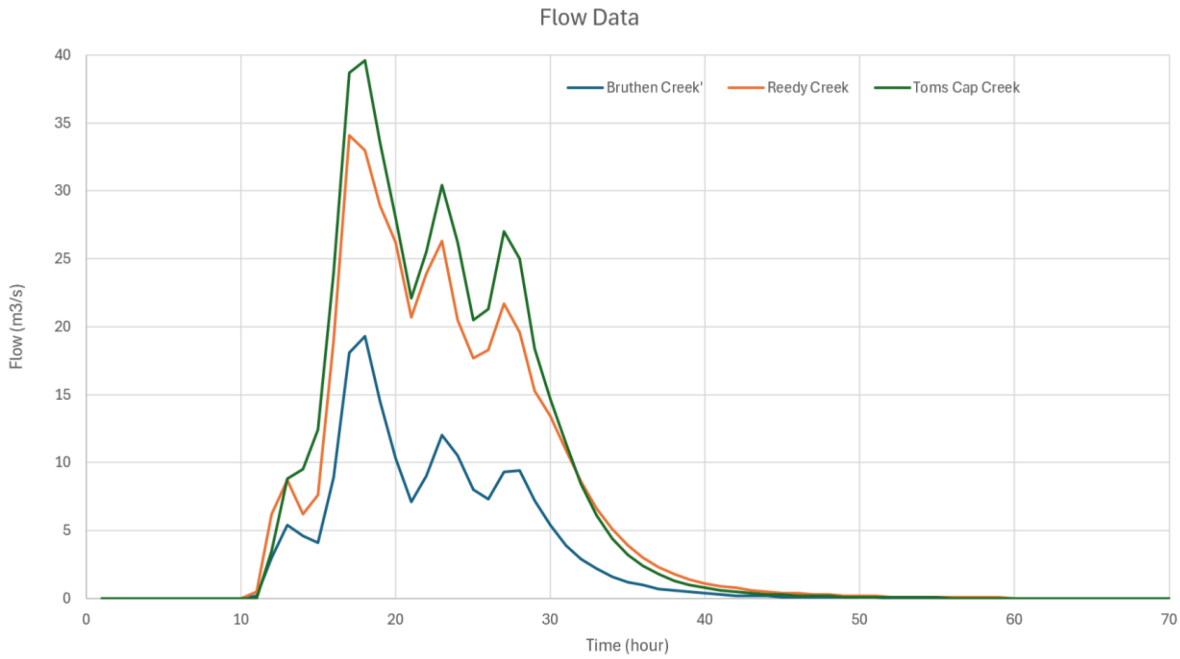


Figure 39: Flow hydrographs for Bruthen, Reedy and Toms Cap Creeks

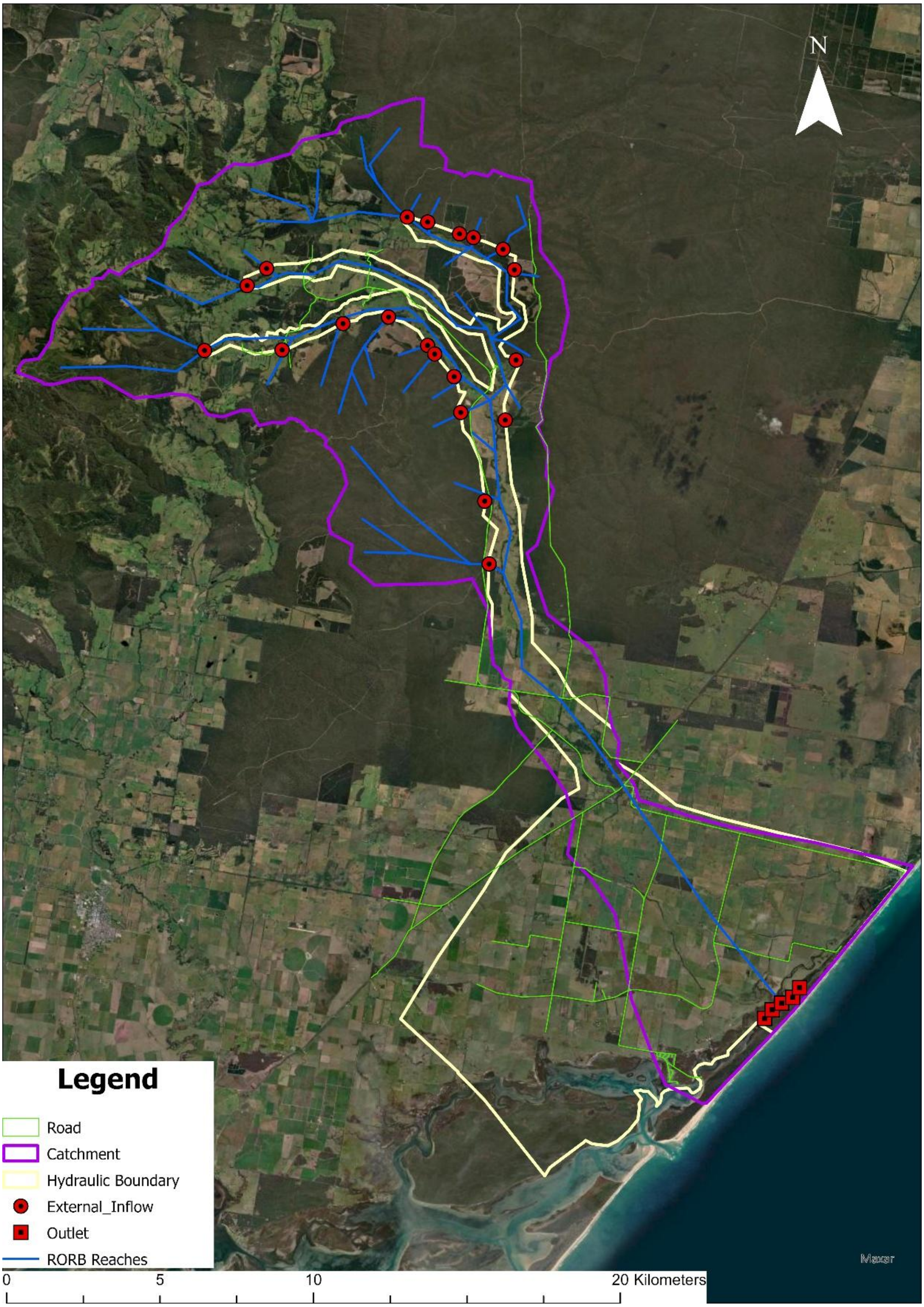


Figure 40: Location of model inflows and outflows

5.5.3. Materials

Materials layer is defined in TUFLOW using the mat shape file. This helps accurately represent the varying roughness and hydraulic properties of different surfaces. The Mannings coefficient were varied spatially using materials shape file. The model was divided into different material types. The digitization of these material types was done primarily using the area imagery and land use layer.

Material ID	Manning’s n	Description
1	0.01	roads
2	0.03	buildings
3	0.04	Moderate vegetation
4	0.05	vegetation creek

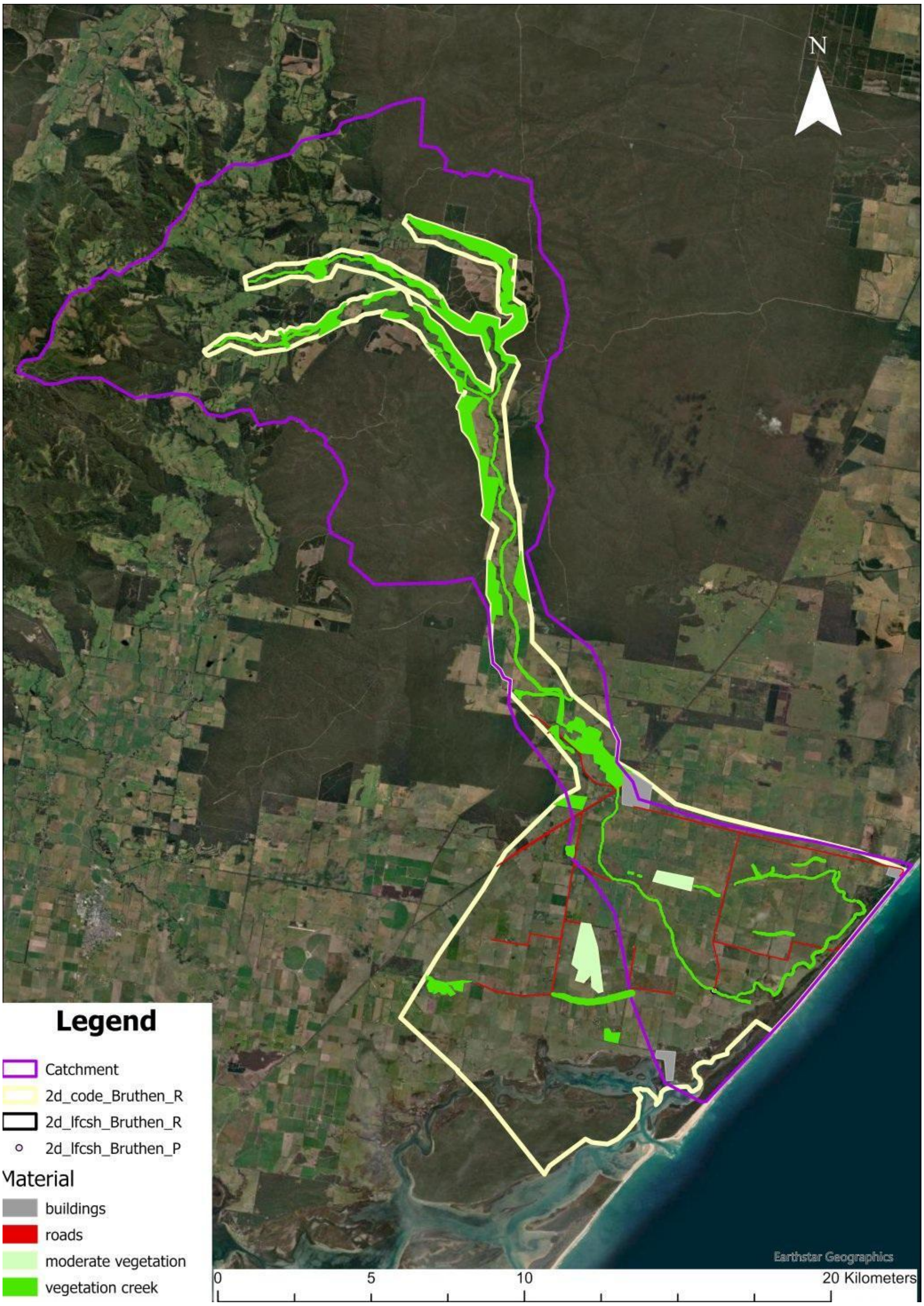


Figure 41: Material Layer

5.6. Assumptions

5.6.1. Loss model

Losses were modelled during the hydrology modelling stage. This means that all water entering the hydraulic model will either exit through the outlet or remain in the model until the simulation finishes within the selected time. This can cause water to become trapped in small depressions during the hydrology modelling phase. However, the volume of water lost because of this is likely to be negligible.

A mass balance check at the end of the simulation confirms that the total inflow, minus total outflow and final storage, is within acceptable tolerance, indicating that no significant numerical losses occurred within the hydraulic model.

5.6.2. Waterway delineation

Some minor overland flow paths were not captured during the hydrology-phase waterway extraction. These shallow pathways normally direct small amounts of runoff toward Bruthen Creek, Reedy Creek, and Toms Cap Creek, but were simplified or omitted during processing. These areas mostly involve short duration sheet flow in small depressions, so their absence may cause a few localised wet areas mainly in the southern part of catchment to be under-represented.

This does not significantly affect the model because the main creek channels were accurately mapped, the missed pathways carry only small flows, overall flood behaviour is driven by larger floodplain and channel features, and water will still follow the terrain even without a mapped line. As a result, any impacts are minor and do not change the overall flood behaviour of the Bruthen Creek system.

assumptions made during the delineation of waterways as part of the hydrology phase has caused some minor flow path into the Bruthen Creek, Reedy Creek, and Toms Cap Creek and downstream Bruthen Creek channels to be omitted. While this may result in some localized inundation around the south edges of the model being missed, omitting this flow path is unlikely to have a significant effect on the overall flood behavior of the Bruthen Creek.

5.7. Parameters and settings

TUFLOW's HPC simulation mode uses an adaptive timestep. The grid cell size adopted for this model is 3 x 3 meters. This grid size allowed the model to finish its simulation in approximately 3 days, while still being fine enough to represent the main channel with at least 3 cells in the lowermost area of the study and 2D_BC polylines for type CN and SX.

5.8. Boundary conditions

Boundary conditions in hydrological and hydraulic modeling define how the water enters, exits, or interacts within the model domain. The TUFLOW model for Bruthen Creek has modelled with five external flow vs time (QT) upstream boundaries, the largest of which is associated with Bruthen Creek, Reedy Creek, and Toms Cap Creek. The model outflow boundaries were applied as Head versus Time (HT) boundaries which assigns a water level to the node based on a water level versus time. Water levels on the estuary/outflow side were set at 0.63m in accordance with current climate water levels for Port Welshpool (Table 5 storm surge height return levels for selected Victorian locations under current climate conditions and climate change scenarios, (McInnes, Macadam, and O'Grady, 2009)).

Location	Current Climate	2030			2070			2100			
		1	2	3	1	2	3	1	2	3	4
Port Welshpool	0.63	0.78	0.83	0.83	1.1	1.26	1.33	1.45	1.68	1.73	2.03

5.9. Results

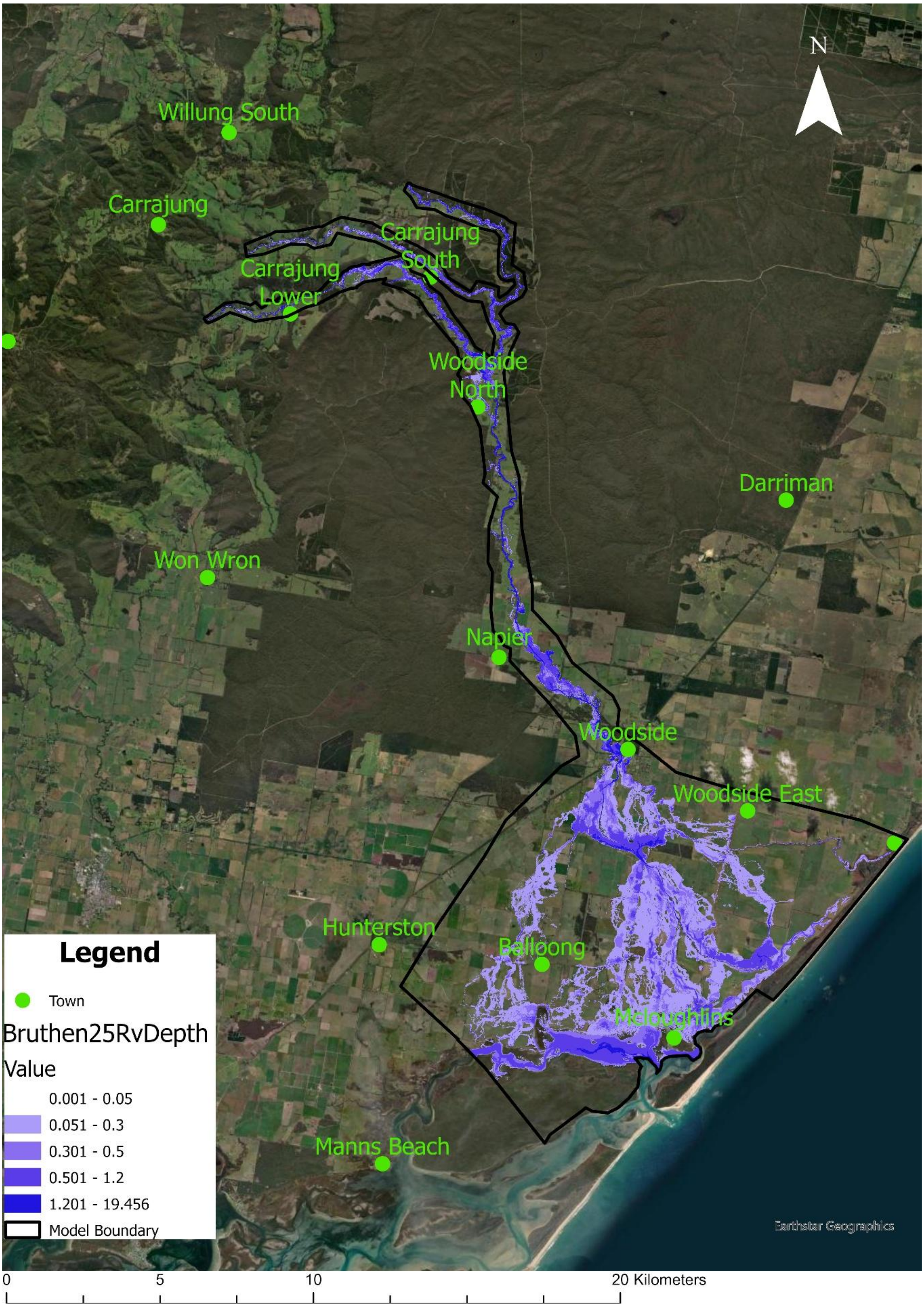


Figure 42: 1% AEP flood depth results