

Bonshaw Creek Flood Mapping Project

Hydrology and Hydraulics Report

City of Ballarat

20 December 2023





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EXECUTIVE SUMMARY

Water Technology was engaged by the City of Ballarat (CoB) to review and update the existing hydrologic and hydraulic models used to develop Land Subject to Inundation (LSIO), Floodway Overlay (FO), Special Building Overlay (SBO) layers covering several waterways within the CoB municipality. The following report details the current hydrologic and hydraulic modelling for the Bonshaw Creek. A summary of the changes made to the hydrologic and hydraulic models since the original flood study in 2018 are listed below.

■ Hydrological Model (RORB) Changes

- Adjusted subarea 'A' to match its boundary to the Kensington Creek catchment along Wiltshire Lane.
- Added subareas 'AJ' and 'AI' to generate hydrographs for part of the southwest area of Victoria Park and industrial/commercial precinct west of Sutton Street.
- Split subarea 'H' to better represent the catchment of stormwater infrastructure feeding into Wallis Street.
- Increased the area of subarea 'AP' further east to capture the stormwater drainage network catchment east of Doug Dean Reserve.
- Increase area of subarea 'O' to capture the stormwater drainage network catchment of Shasta Drive and Tracey Court.
- Increased the area of subarea 'P' further east to capture the stormwater drainage network catchment of Baroga Court.
- Reduced the area of subarea 'U' to reflect the catchment associated with the residential development occurring south of Smythes Road and north of Webb Road.
- Subarea 'W' has been split into two subareas and has had its extents altered due to the development of Ploughman's Arms, Rivulet and Florian Estates.
 - Fraction impervious was increased to better represent the residential development within subareas O, P, U & W.
- Subarea 'V' extents have been altered based on new stormwater infrastructure and recent development.
- Subarea 'Y' has been split into three subareas to produce three inflows into the Bonshaw Creek and its extents have been reduced due to the development of Ploughman's Arms, Rivulet and Florian Estates.
- Reaches that represented large amounts of overland flow were changed from type 3 (Lined channel) to type 2 (excavated but unlined channel). Doing so is in line with Melbourne Water modelling technical specifications routing recommendations. Type 2 reaches have been shown to reflect more realistic during large storm events, as flows are not always contained within pipes/channels and shallow overland flows are present. This is particularly applicable to Banyule Drive where large pipes convey the Bonshaw Creek, but there is still a significant presence of overland flows.

■ Hydraulic Model (TUFLOW) Changes

- Updated base terrain to LiDAR captured in October 2019 with 1 metre grid resolution.
- The TUFLOW model was updated to the latest build (2023-03-AB) and run as HPC. This ensured that the updated model was utilising the most recent modelling approaches within the TUFLOW software package and the use of HPC reduced model run times.
- Revised inflow locations to match the changes made to the RORB structure.
- Inflow for subarea 'H' was changed to a pit inflow region to cover the main stormwater pipe down Wallis Street.



- Shifted inflow for subarea 'G' further upstream to include the storage behind the Winter Street roadway.
- Added an inflow north of Winter Street for subarea AJ.
- Inflow for subarea 'AI' was placed over the main stormwater pipe in the industrial precinct.
- Inflow for subarea 'L' was moved to the open channel, instead of on a parcel of land that has now been developed.
- Moved inflow for subarea 'AB' into open channel south of Stonepark Road, instead of on a parcel of land.
- Changed in inflow types of subareas 'Q' and 'R' from region to pit inflows.
- Inflows from subareas 'W' and 'X' were moved into RB26 located in Ploughman's Arms.
- Wetland/basin was included in the model terrain for the Rivulet development west of Bonshaw Creek and south of Ascot Gardens Drive. This was included using 2d_ztin layers within TUFLOW.

The inclusion of the intersection upgrade at La Trobe Street and Wiltshire Lane was not included due to design surfaces not being provided. Additionally, the stormwater infrastructure upgrades were also not included as it involved converting open channels into underground pipes. To include the stormwater upgrades and interpolate the surface elevations in TUFLOW to 'fill' the existing open channels, would likely result in the misrepresentation of overland flow paths.

The 1% AEP mapping was produced for review by Council and CMA. After approval, Water Technology will finalise the modelling by completing the remaining design events including climate change scenarios.



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1 INTRODUCTION

1.1 Background

Water Technology was commissioned by City of Ballarat (CoB) to carry out the Bonshaw Creek Flood Mapping Project in 2018¹. The initial project was commissioned to improve the flood risk knowledge, address information gaps and provide valuable planning and flood intelligence within Bonshaw Creek catchment.

Bonshaw Creek drains south from Victoria Park through a mixture of Industrial, Residential and Special Use zoned land. It passes through the eastern half of Delacombe, into an urban growth zone which consists of mostly under development pasture, low density housing and a number of small dams. Bonshaw Creek flows into Winter Creek immediately north of Bells Road, which then flows southeast to the Yarrowee River.

A map of the Bonshaw Creek catchment is shown in Figure 1-1.

The flood modelling and mapping undertaken in this project was based on the updated guidelines outlined in Australian Rainfall and Runoff (ARR) 2019². As identified above, this report has been updated based on changes made to the hydrologic and hydraulic models in response to recent development and newly available data within the catchment.

1.2 Structure of the Report

This report outlines the following:

- Hydrologic modelling of the Bonshaw Creek catchment including modelling methodology, flow inputs to the hydraulic model and results.
- Hydraulic modelling of Bonshaw Creek including modelling methodology, inputs to the hydraulic model and results.
- Flood mapping and discussion for the 1% AEP event, noting the remaining design events (20%, 10%, 5%, 2%, and the 0.5% AEP) flood events along with Climate Change are still to be modelled.

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¹ Bonshaw Creek Flood Mapping, prepared for City of Ballarat, 2018

² Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2016, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia



Figure 1-1 Bonshaw Creek Catchment



2 AVAILABLE INFORMATION

2.1 Overview

This section documents the data collated by Water Technology for the study. Data was sourced data from number of agencies and sources, including:

- City of Ballarat.
- Regional Roads Victoria (formerly VicRoads).
- Department of Energy, Environment and Climate Action (formerly DELWP).

2.2 Topographic Data

The topography data largely comprised of Light Distance and Ranging (LiDAR) data, which was used to generate a Digital Elevation Model (DEM). The DEM enabled delineation of the catchment for the hydrological model, completed in 2018, utilising LiDAR data captured in 2011. The hydraulic model utilised LiDAR data captured in 2019 (Ballarat2019Oct25_dem1m_v10cm).

2.3 Planning Scheme

The City of Ballarat Planning Scheme layers were used in conjunction with the available aerial photography to define the range of land uses within the catchment. The layers were used in the hydrologic and hydraulic models to define the Fraction Impervious (FI) and hydraulic roughness (Manning's 'n') respectively.

2.4 Drainage Information

City of Ballarat provided a GIS database containing information of Council drainage assets in the municipality, this included pit and pipe information. The provided layers were reasonably complete with pipe dimensions and pit depths. However, pit/pipe inverts were generally missing from the data sets. Where pit depths were available, inverts were assumed by subtracting these depths from the ground surface (based on LiDAR). Where the dataset was missing pit depths, invert levels were assumed by subtracting pipe diameter and standard pipe cover depth. The standard cover depth based on the pipe size outlined in Table 2-1.

Table 2-1 Standard cover levels for stormwater pipes

Pipe Size	Standard Cover Depth
≤ 900 mm	600 mm
≥ 900 mm	750 mm

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3 HYDROLOGY

3.1 Overview

RORB was adopted as the hydrology modelling software package for this study and the other flood mapping assessments being undertaken for Council. RORB was used to calculate inflow hydrographs from the available rainfall and catchment data. RORB is a non-linear rainfall runoff and streamflow routing model for calculation of flow hydrographs in drainage and stream networks. The model requires catchments to be divided into subareas, connected by a series of conceptual reaches and storage areas. Observed or design storm rainfall is input to the centroid of each subarea. Specific initial and continuing losses are then deducted, and the excess runoff is routed through the reach and storage network.

The adopted methodology was based on current guidelines described in the 2019 revision of Australian Rainfall and Runoff (ARR2019). The 20%, 10%, 5%, 2%, 1% and the 0.5% AEP flood events were modelled using Monte-Carlo and Ensemble approaches as recommended in ARR2019. There were no streamflow gauges within the catchment.

3.2 RORB Model Development

A RORB model is comprised of several key data inputs to produce accurate results, these include:

- Catchment delineation
- Fraction impervious
- Routing parameter (k_c)
- Design inputs
 - Rainfall depth
 - Temporal patterns
 - Spatial pattern
 - Losses

Each of these inputs are discussed in the following sections.

3.3 Catchment Delineation

The Bonshaw Creek catchment was delineated based on LiDAR (Light Detection and Ranging) data captured in 2011. The LiDAR data was processed in the ESRI terrain modelling software ArcHydro, delineating the Bonshaw Creek catchment into 26 sub catchments and associated drainage reaches. The sub catchments and associated reaches based on the LiDAR delineation are shown in Figure 3-1. Subarea Y was broken down into two further sections in the RORB model.

In general, a key component of the catchment delineation is to provide even distribution of similar sized catchments. Generally, three sub catchments are used prior to the generation of each inflow hydrograph into the main stream (Bonshaw Creek). However, the narrow profile of the Bonshaw Creek catchment makes this difficult and, in some instances, small single sub areas to drain into the main stream.

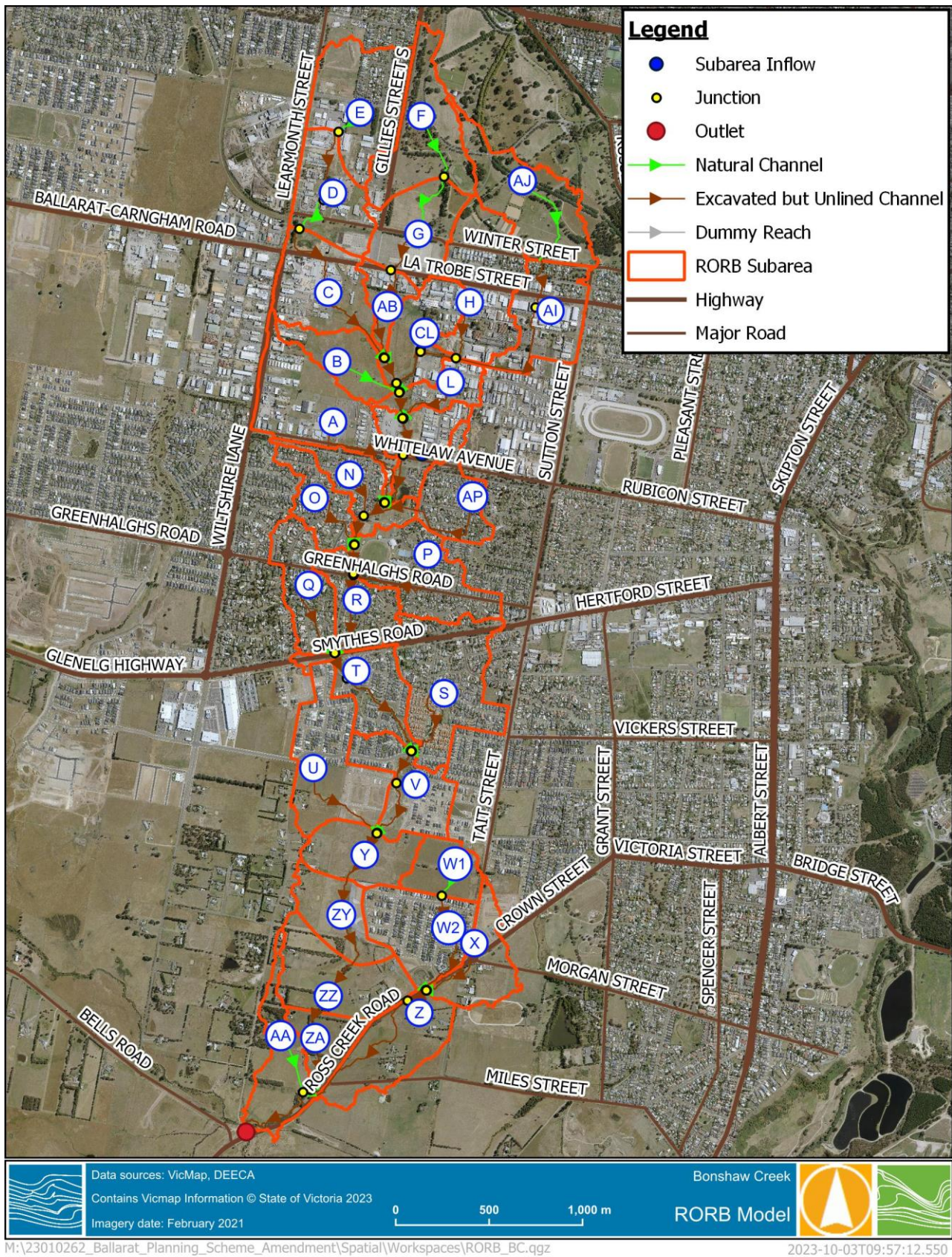


Figure 3-1 Bonshaw Creek RORB Model

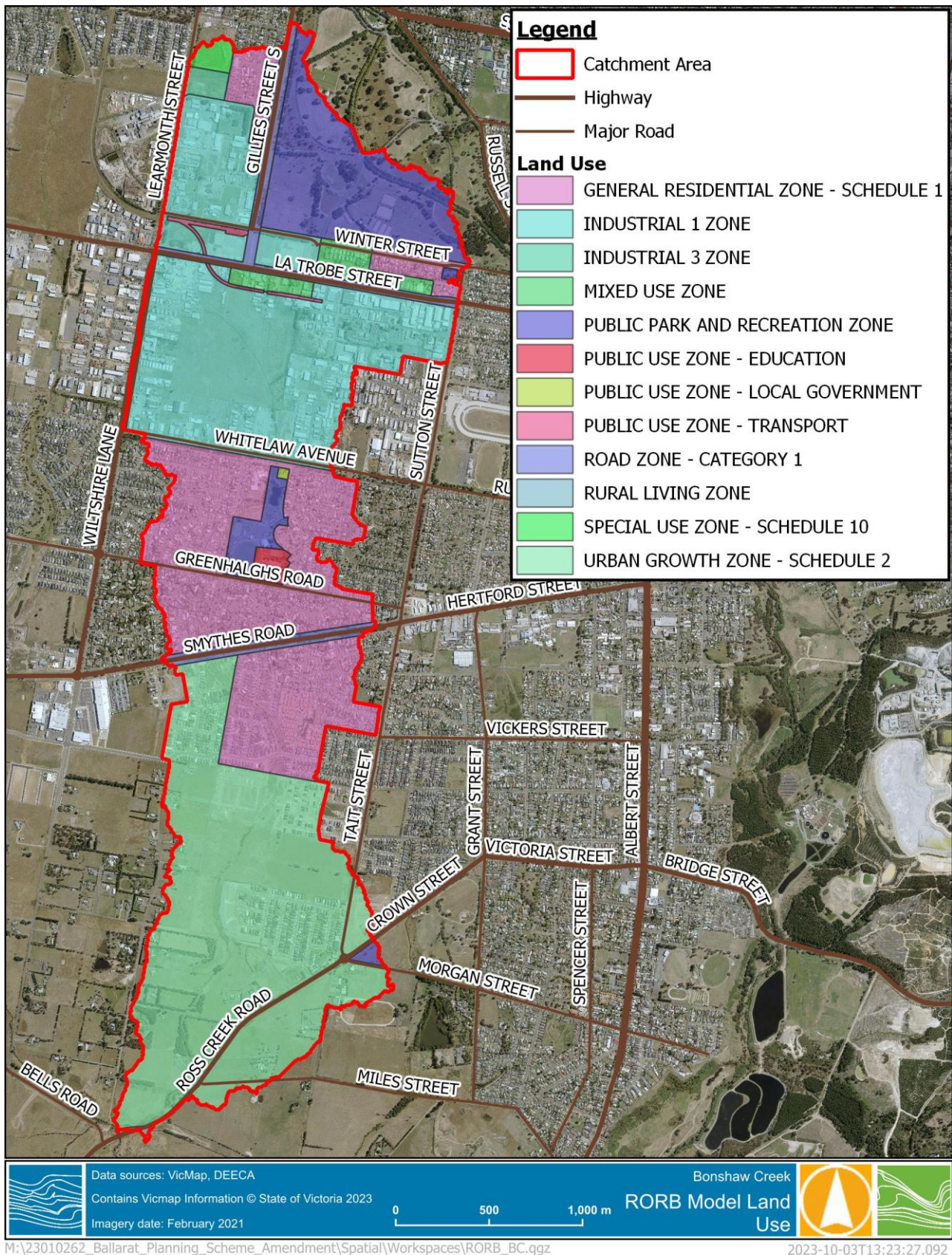


3.3.1 Fraction Impervious

The estimated percentage of impervious surface within each sub catchment was represented by a Fraction Impervious (FI). The varying FI throughout the Bonshaw Creek catchment was determined using satellite imagery from March 2015 and the planning area zones. Three main land uses were adopted, being Open Space (including farming and greenspace), Residential and Industrial. Table 3-1 shows the adopted FI value for each land use. To determine the most appropriate FI value for each sub area, a weighted average was used based on the percentage land use. Figure 3-2 and Figure 3-3 demonstrate the planning zone areas and determined FI values for each sub catchment respectively.

Table 3-1 Adopted FI Values for the Bonshaw Creek RORB Model

Land use	Adopted FI
Open space (including farming, greenspace and undeveloped future urban growth zones)	0.1
Residential	0.7
Industrial	0.9



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Figure 3-2 Land use areas based on planning Zones

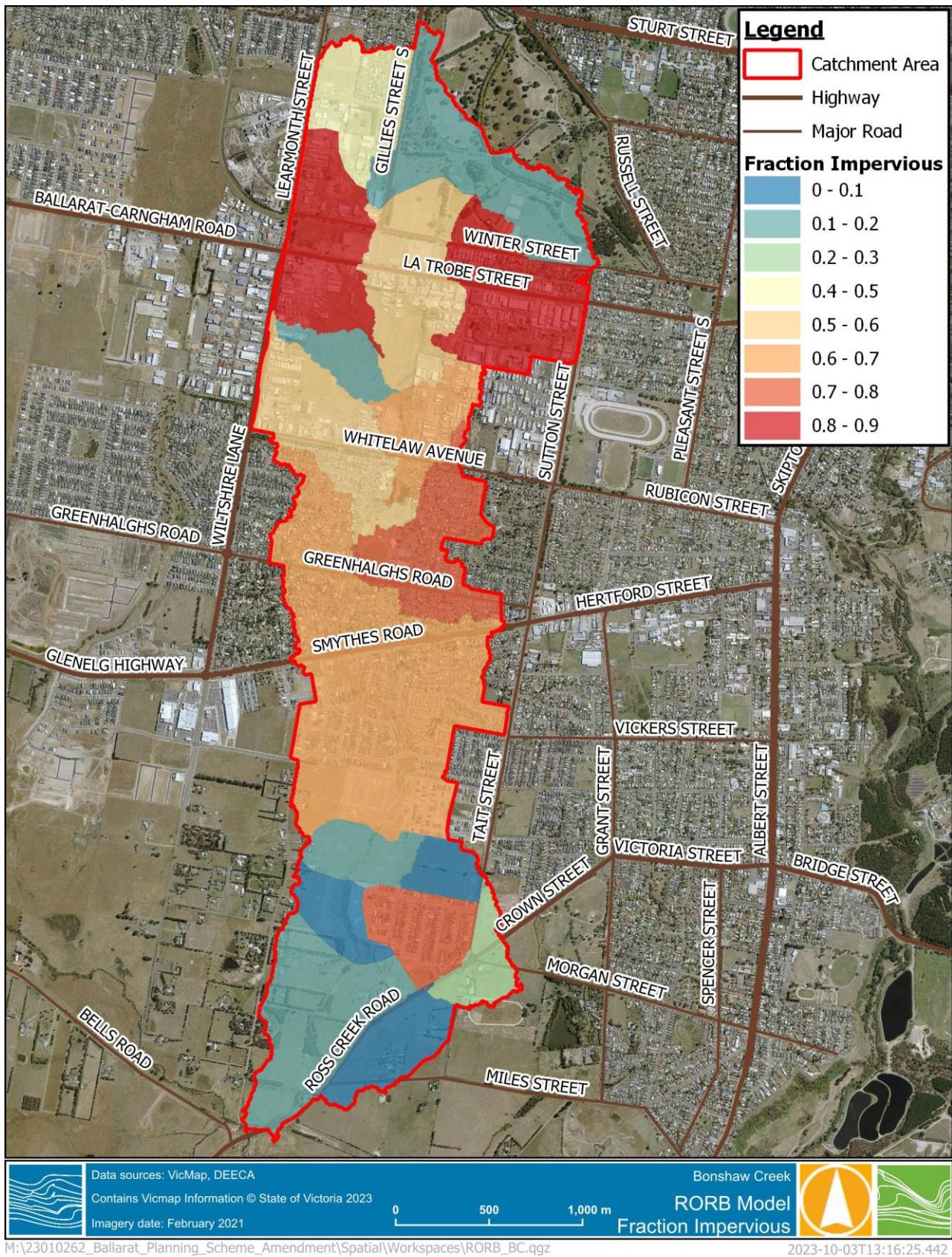


Figure 3-3 Sub Catchment FI Values



3.3.2 Routing Parameter (k_c)

K_c is a RORB model routing parameter, dictating attenuation along model reaches. In gauged catchments the k_c value is one of the major parameters used to calibrate the RORB model, varying peak flow and timing. In ungauged catchments, such as Bonshaw Creek, there are several ways to estimate the k_c value. These include empirical equation-based estimates of k_c and the adoption of a k_c value based on nearby calibrated RORB model. There are several different equation-based estimates available for Victoria, these are outlined in the RORB manual³ and summarised in Table 3-2. The parameters utilised within these equations are as follows:

$$A = \text{Area (km}^2\text{)}$$

$$D_{av} = \text{Average reach distance (km)}$$

Table 3-2 Equation Based k_c Estimates

Description	Equation	k_c estimate
Victoria (Mean Annual Rainfall <800mm)*	$kc = 0.49 * A^{0.65}$	1.65
Victorian based data (Pearse et al, 2002)	$kc = 1.25 * D_{av}$	5.37
Australian based data (Dyer, 1994)	$kc = 1.14 * D_{av}$	5.22
Australian based data (Yu, 1989)	$kc = 0.96 * D_{av}$	4.40

* Ballarat has a mean annual rainfall of 689.9mm.

As discussed previously, several RORB models have been developed in close proximity to Bonshaw Creek. These models include the Yarrowee River, Canadian Creek and Kensington Creek catchments. The ratio of k_c/D_{av} used in these models can be used as basis to estimate an appropriate k_c value for the Bonshaw Creek model. A comparison of the Yarrowee River, Canadian Creek and Kensington Creek model k_c values and associated Bonshaw Creek estimate is provided in . The Bonshaw Creek RORB model has a D_{av} of 4.58km. The Yarrowee River model is a calibrated model.

³ E.M. Laurenson, R.G. Mein, and R.J. Nathan (2010), RORB User Manual



Table 3-3 Estimates of k_c Based on Nearby Existing RORB Models

Model	k_c	D_{av} (km)	k_c / D_{av} ratio	Calculated Bonshaw Creek k_c
Yarrowee River	19	10.43	1.82	8.33
Canadian Creeks	8.46	3.56	2.38	10.9
Kensington Creek	5.6	4.52	1.24	5.67

The RORB model m was set at 0.8. This is the recommended value for ungauged catchments³.

3.3.3 Design Rainfall

Burst Depth

The rainfall burst depths for AEPs between 20% AEP and 0.5% AEP were extracted for the centroid of the catchment using the 2016 ARR IFD analysis available from the Bureau of Meteorology⁴.

Design rainfalls were derived for burst durations between 0.5 and 6 hours, based on the expectation that the critical storm duration for the study area would be relatively short.

Areal reduction factors

The point rainfall estimates were converted to catchment average values using the areal reduction factors developed for Victoria during the revision of ARR 2016⁵. Conceptually, this factor accounts for larger catchments which are less likely to experience high intensity rainfall over the whole of the catchment. Given the size of the Kensington Creek catchment, areal reduction was not applied.

Summary

The design rainfall totals for the catchment are shown in Table 3-4.

⁴ <http://www.bom.gov.au/water/designRainfalls/ifd/>

⁵ Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2016, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia, Book2, Chapter 4



Table 3-4 Design Rainfall Depths in mm for Varying Event Durations and AEP

Duration\AEP	20%	10%	5%	2%	1%	0.5%
30-min	17.6	21.9	26.4	32.9	38.3	44.05
1-hr	21.9	27.1	32.4	40.1	46.4	53.36
2-hr	27	32.9	39	47.6	54.7	62.91
3-hr	30.6	37	43.6	52.9	60.5	69.58
6-hr	38.8	46.2	53.8	64.7	73.6	84.64
12-hr	50	59.1	68.4	82	92.8	106.72
24-hr	64.3	76.2	88.3	106	119	137

3.3.3.1 Temporal patterns

The 10 temporal patterns as downloaded from ARR 2019 Data Hub⁶ were used to simulate the distribution of burst rainfall depth during each storm duration modelled.

3.3.3.2 Spatial patterns

The ARR2019 guidelines recommend non-uniform spatial patterns for catchment areas of more than 20 km². The catchment upstream of the study area is 6.29km², therefore a uniform spatial pattern was applied in design modelling.

3.3.3.3 Design Losses

An initial loss model was applied for the RORB modelling. The initial losses were determined based on the ARR online datahub⁸ suggests losses of 24 mm initial loss and 4.4 mm/hr continuing loss.

The Bonshaw Creek outfalls into the Winter Creek, approximately 2.8 km upstream of its confluence with the Yarrowee River. Calibration of the Yarrowee River and Gnarr Creek hydrological model was completed 2019 and determined that the recommended losses from ARR were too high and a continual loss of 2.0 mm/hr was more appropriate for the broader Ballarat area (based on the exclusion of 'pre-burst' rainfall). Considering the proximity of the Bonshaw Creek catchment, and the Ballarat region, the calibrated continuing loss of 2.0 mm/hr was adopted for this catchment.

The adopted modelling parameters for the Bonshaw Creek catchment are shown in **Error! Reference source not found.**

Table 3-5 Adopted RORB Model Parameters for Design Flood Modelling

Parameter	Adopted Value
m	0.8
kc	3.39
Initial Loss (mm)	25.0
Continuing Loss (mm/hr)	2.0

⁶ <http://data.arr-software.org/>



3.4 Design Modelling

As recommended in ARR2019, Monte Carlo analysis was used to determine design peak flows at key locations within the Chase Waterway catchment. RORB was then run using the Ensemble Modelling approach, and the most appropriate temporal patterns chosen for each event AEP to match the Monte Carlo produced peak flows. A flow chart showing the modelling process is shown in Figure 2 3. This process resulted in target critical durations and temporals at each key location for the design event.

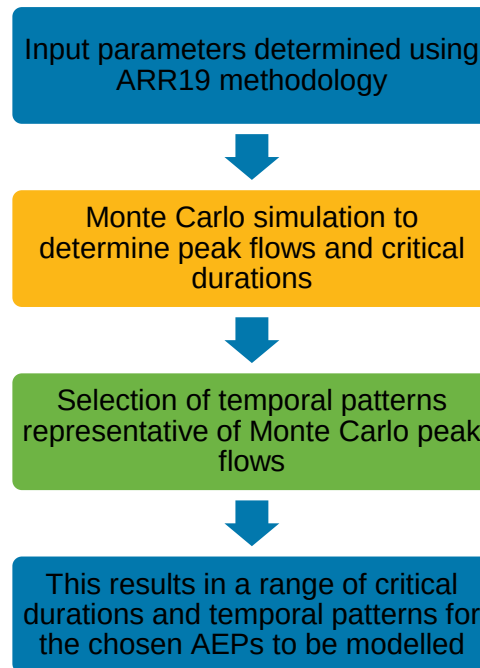


Figure 3-4 Design Modelling Flow Chart

3.4.1 Monte Carlo Analysis

The RORB Monte Carlo analysis was undertaken adopting the recommended losses and k_c value discussed in Section 3. During a Monte Carlo analysis, the RORB model is run many times, sampling for an extensive range of temporal patterns and rainfall initial loss. This is completed in combination with the other set model parameters of spatial pattern, continuing loss, aerial reduction factors, k_c and m . The model then takes the hydrographs from all model runs and produces a statistical design peak flow at each RORB output location. A schematic diagram of the Monte Carlo approach is presented in Figure 3-5. The critical duration for several important locations throughout the model is shown in Table 3-6. These print locations are also shown in Figure 3-7.

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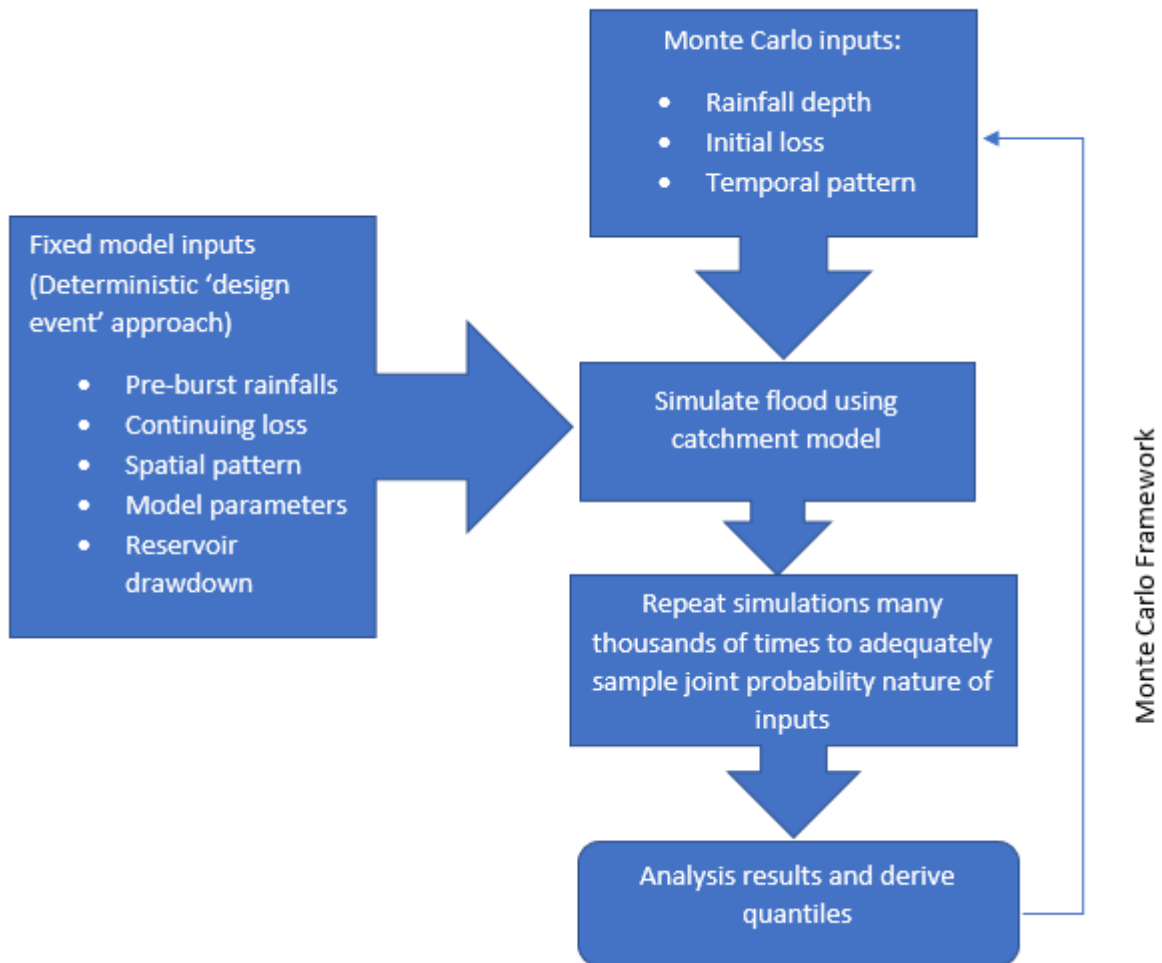


Figure 3-5 Overview of Monte Carlo Analysis



Table 3-6 RORB Critical Durations along Bonshaw Creek

Location	Critical Duration					
	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP
Upper Catchment	1-hr		30-min			
Mid Catchment A	1-hr					
Mid Catchment B	2-hr	1-hr	2-hr	1-hr		
Lower Catchment	2-hr					
End of Catchment	2-hr					

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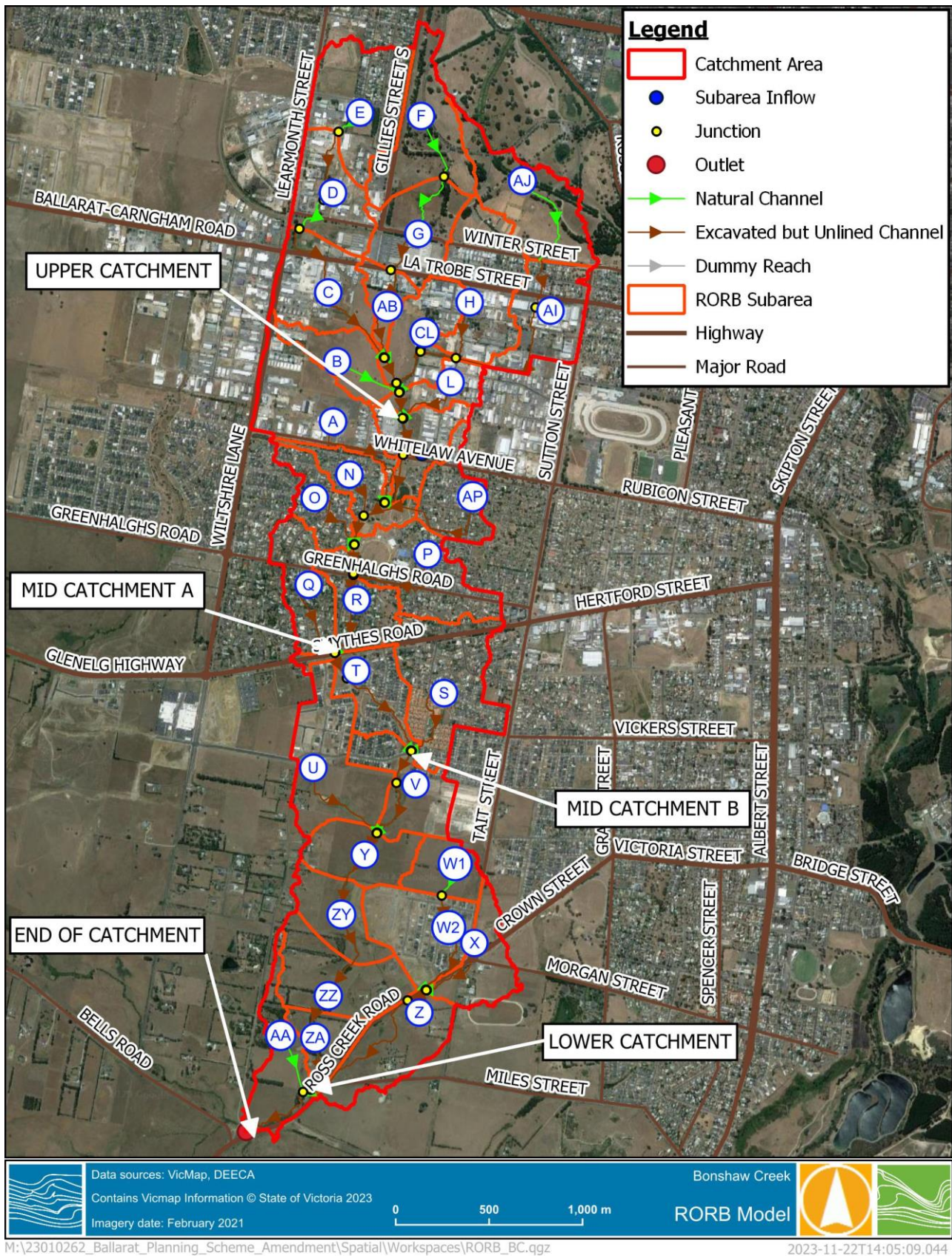


Figure 3-6 Bonshaw Creek Hydrograph Comparison Locations



3.4.2 Ensemble Analysis

The RORB model was run as an Ensemble Analysis following the Monte Carlo analysis. Using the determined k_c value of 3.39 and calibrated losses of 25 mm initial loss and 2.0 mm/hr continuing loss, the RORB Ensemble Analysis was run for all 10 ARR2016 recommended temporal patterns for each event duration and AEP. For this case, six design events were modelled, resulting in 60 design event temporal patterns for each of the six durations, 360 model simulations.

The temporal pattern resulting in an Ensemble Analysis peak flow closest to the Monte Carlo analysis peak flow was selected for each output location. To reduce the potential number of hydraulic model runs, temporal patterns that yielded peak flows similar to those produced in the Monte Carlo analysis at each of the key locations were simplified to produce a set of selected temporal patterns for each design event. These are summarised in Table 3-7 with the distribution of rainfall for the adopted design storms in the 1% AEP event displayed in Figure 3-7.

Table 3-7 Chosen Representative Critical Durations and Temporal Patterns

Critical Duration & Temporal Pattern	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP
	1hr, TP06	1hr, TP19	30m, TP20	30m, TP30	30m, TP30	30m, TP25
	1hr, TP10	1hr, TP20	1hr, TP20	1hr, TP28	1hr, TP29	1hr, TP29
	2hr, TP05	2hr, TP17	2hr, TP14	1hr, TP23	1hr, TP27	2hr, TP21
		2hr, TP19	2hr, TP17	2hr, TP24	2hr, TP24	2hr, TP28
			2hr, TP19		3hr, TP22	
					6hr, TP23	

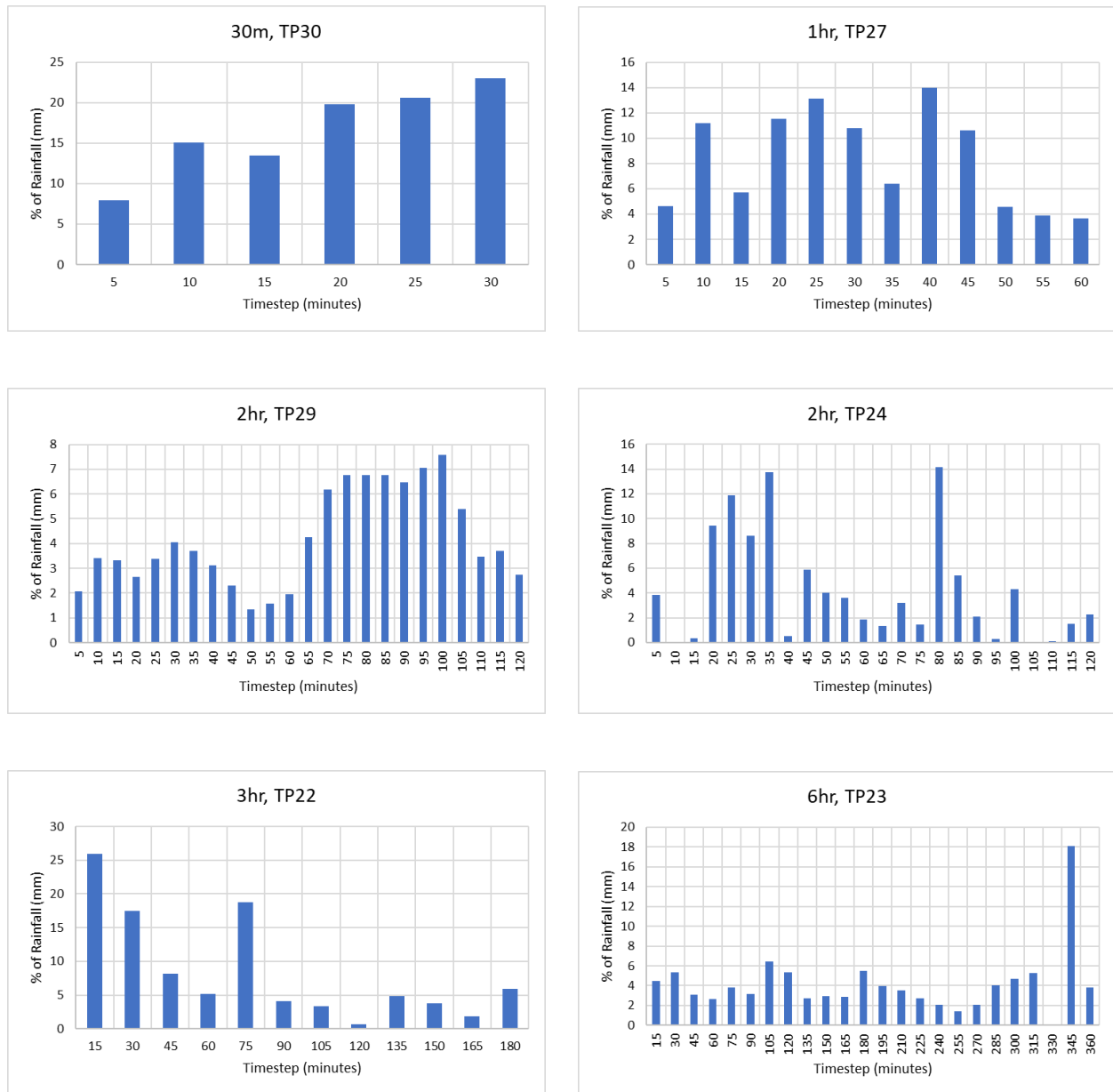


Figure 3-7 Adopted Temporal Patterns for 1% AEP Design Modelling

3.4.3 Design Simulations

Hydraulic model inflow hydrographs were produced for the 20%, 10%, 5%, 2%, 1% and 0.5% AEP events. The resulting Bonshaw Creek outflow to Winter Creek 1% AEP outflows for each duration event are plotted in Figure 3-8.

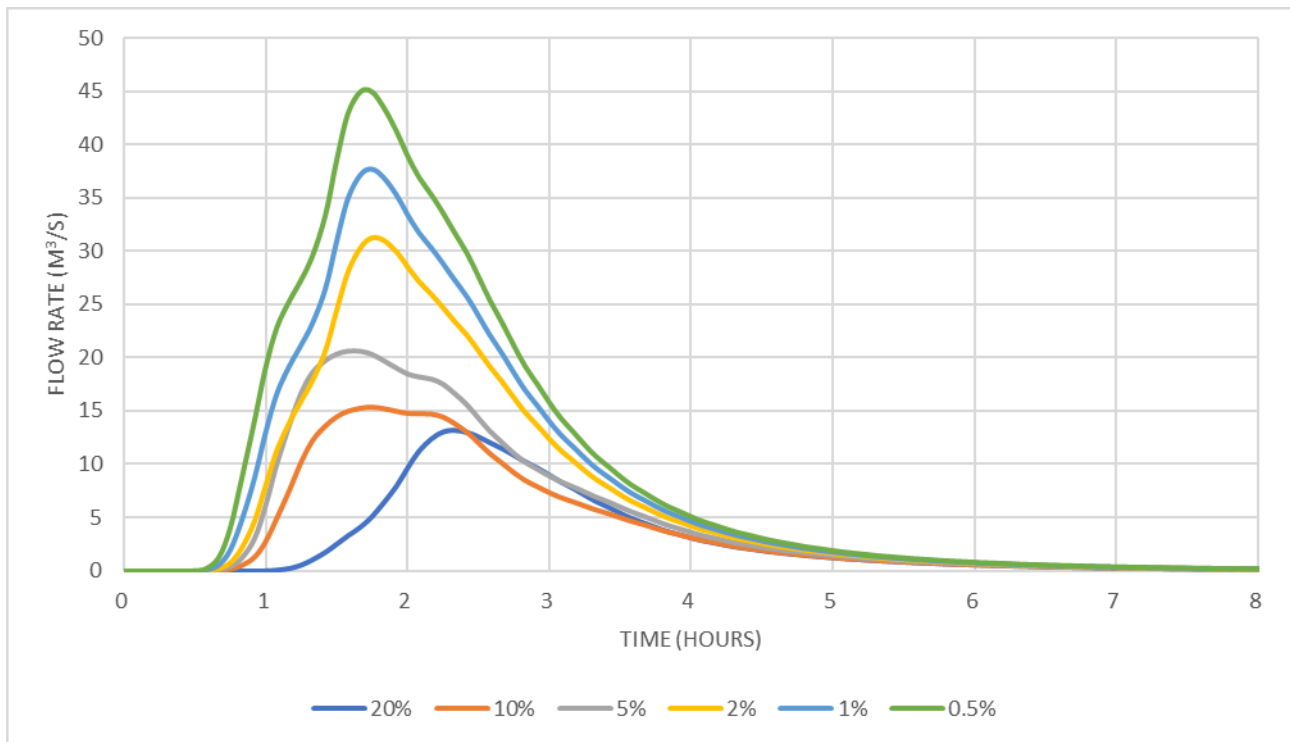


Figure 3-8 1% AEP inflows into Winter Creek for each Representative AEP Simulation



4 HYDRAULIC MODELLING

This section provides the description of the TUFLOW hydraulic model setup. Model runs were performed with a Highly Parallelised Computing (HPC) solution scheme using the 2023-03-AB build of TUFLOW. HPC technology enables 2D models to utilise the parallel processing ability of graphics cards, with many thousand processors operating in unison, significantly speeding up simulation run times compared to TUFLOW Classic.

Design flood modelling included the 20%, 10%, 5%, 2%, 1% and 0.5% AEP events along with the 1% AEP with the inclusion of climate change scenarios for the year 2100 under RCP 4.5, RCP 6 and RCP 8.5. Currently only the 1% AEP events have been modelled.

4.1 2D Domain

Hydraulic modelling covered the Bonshaw Creek from Victoria Park to the Winter Creek at Bells Road. An overview of the hydraulic model extent is shown in Figure 4-1.

One of the key considerations in establishing a 2D hydraulic model relates to the selection of an appropriate grid size. Grid size affects the representation of the physical properties of the study area as well as the size of the model and its resulting run times. Selecting a very small grid size will result in both higher resolution and longer model run times. In adopting the grid size for the model, the above issues were considered in conjunction with the final objectives of the study. To ensure accurate representation of flooding within the catchment, a grid size of 2 metres was adopted.

The Bonshaw Creek was represented in the 2D domain, typically 4-6 grid cells wide in the channel and 10-12 grid cells bank-to-bank. The raw LiDAR data was available at a 1 metre grid resolution, this was resampled to a 2-metre grid in the hydraulic model. The model topography is shown in Figure 4-2.

Manipulation of the LiDAR dataset using polygon and point layers (2d_ztin) in TUFLOW were incorporated to reflect changes in the terrain not captured by the LiDAR. Modified sites included:

- Wetland and basin in the Rivulet Estate, west of Bonshaw Creek and south of Ascot Gardens Drive.

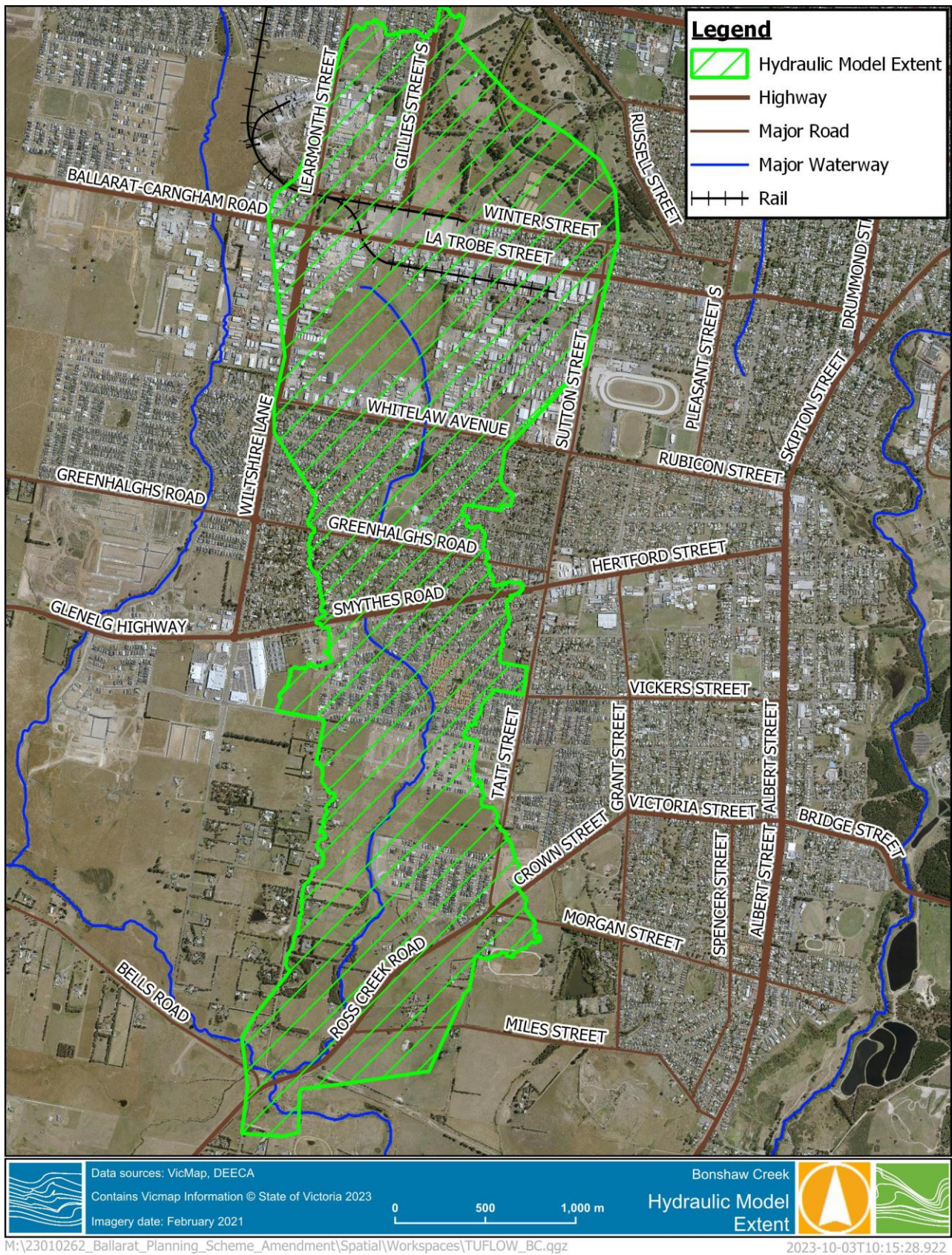


Figure 4-1 Bonshaw Creek Hydraulic Model Area

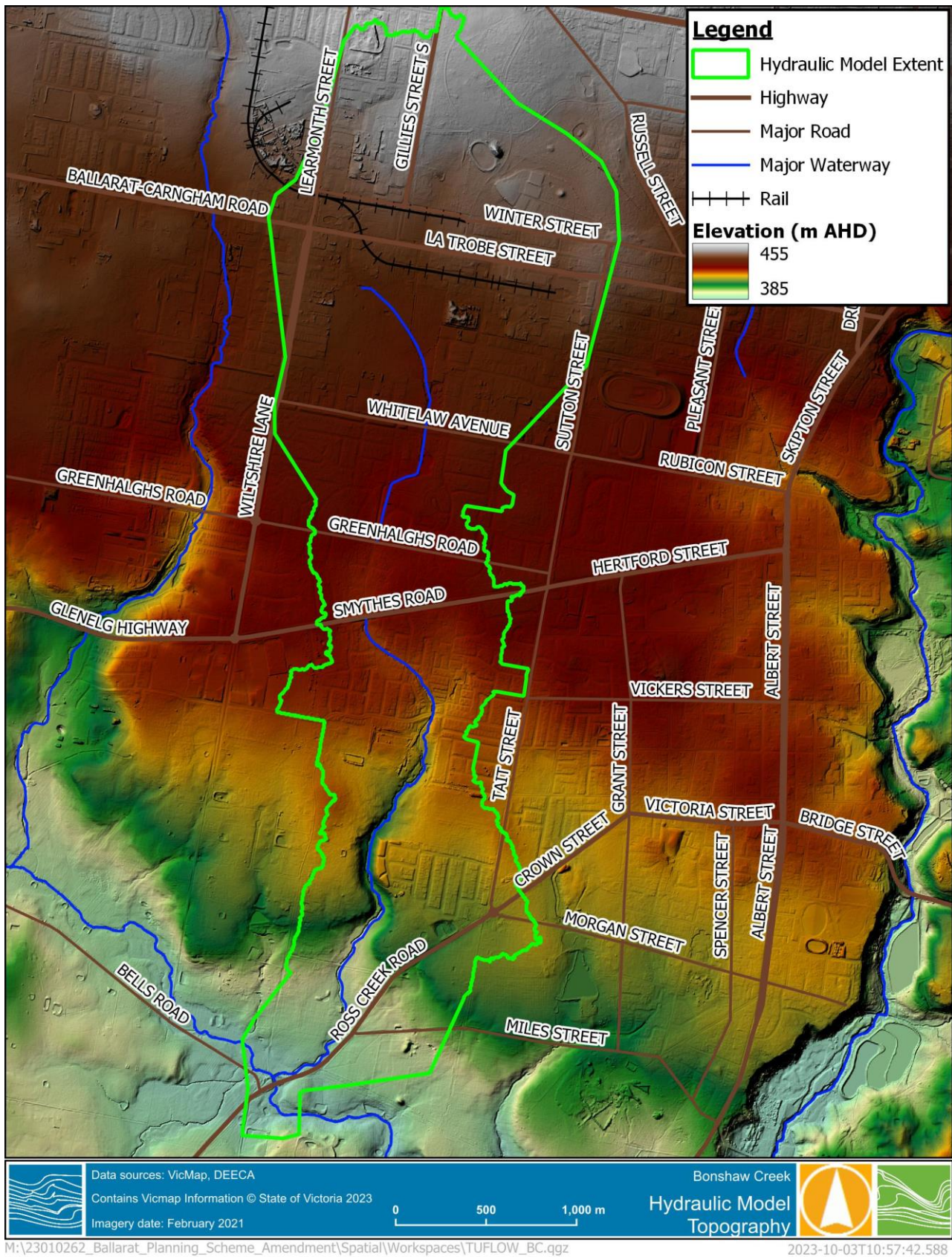


Figure 4-2 Digital Elevation Model in the Bonshaw Creek Region



4.2 Surface Roughness

Hydraulic model roughness was determined using City of Ballarat planning layers, along with aerial imagery for verification. Table 4-1 outlines the Manning's 'n' roughness values adopted within the Bonshaw Creek catchment and are shown in Figure 4-3. The adopted roughness's were based on values similar to those used in nearby studies in recent years.

Table 4-1 Mannings 'N' Values for Land Types in Bonshaw Catchment Area

Land Use	Manning's 'n'
Residential - Urban (higher density) - when building footprints and remainder of parcel are modelled together (with one roughness value)	0.35
Industrial/Commercial or large buildings on site	0.30
Open Space or Waterway - minimal vegetation	0.04
Open Space or Waterway - moderate vegetation	0.06
Car park/pavement/wide driveways/roads	0.02

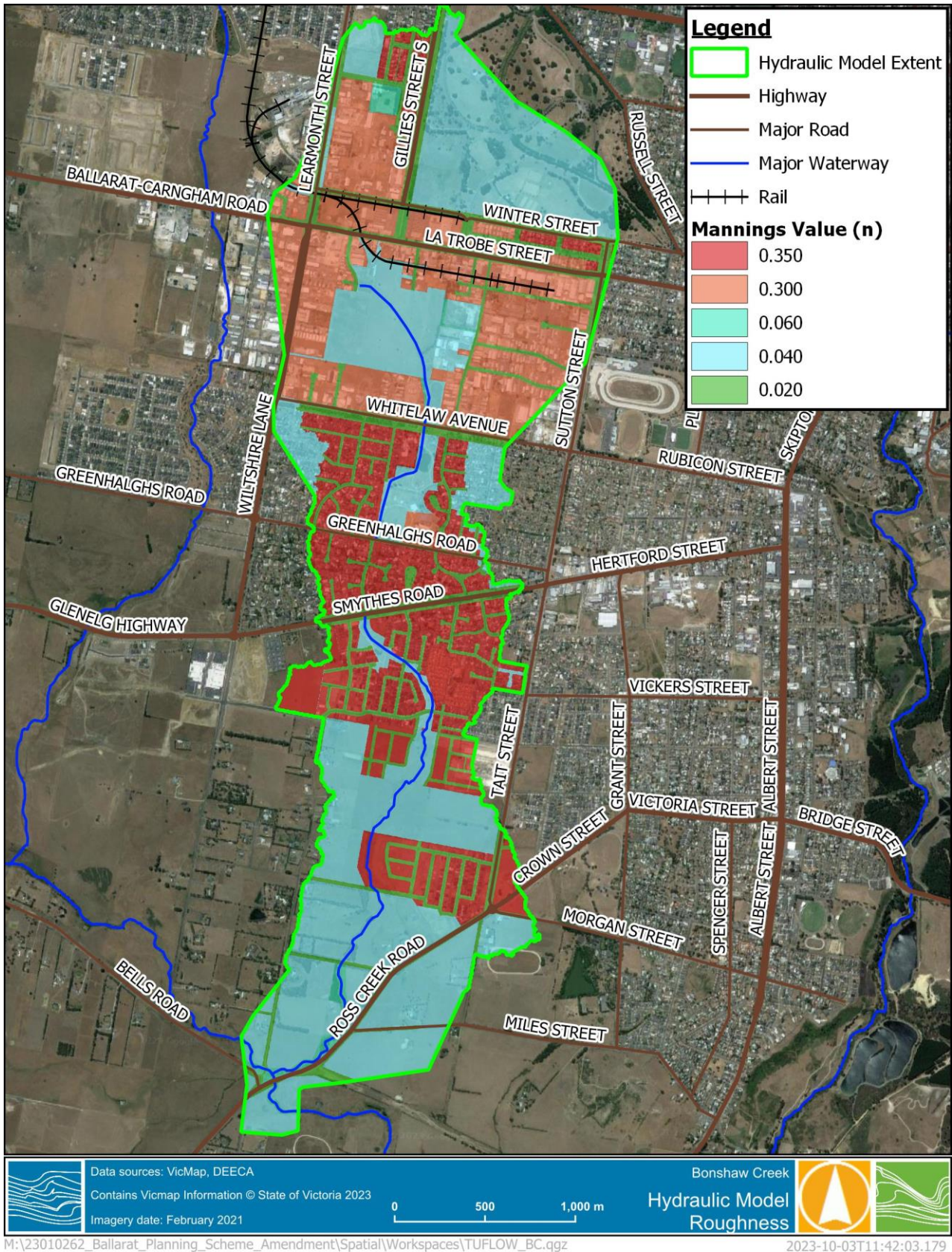


Figure 4-3 Surface Roughness Values for Bonshaw Creek Catchment



4.3 1D Network

Underground drainage infrastructure (culverts, pipes and pits) was modelled as a 1D network. CoB provided a GIS database containing information of Council drainage assets in the municipality. All relevant GIS databases were reviewed and combined into two GIS databases; one for pipes and one for pits. Pipes with a diameter equal to and greater than 300 mm were included in the model.

During the review process, gaps in the provided drainage network datasets were found and in some instances, it was possible to infer the missing information based on a site visit, engineering judgement, topographical information and cross-checks.

Pits were incorporated in the 1D network as 'weir pits' or 'rectangular pits' which was based on the pit being either a grated pit or side entry pit, respectively. Pits were connected to the surface with an SXL connection (an external connection that lowers the surrounding cells) which lowered them by 100 mm to encourage flow to enter the pits.

Based on the drainage network GIS database and the site visit, all pipes and culverts were modelled as reinforced concrete with a Manning's 'n' of 0.013 adopted. The culvert, pipes and pits modelled are shown in Figure 4-4.

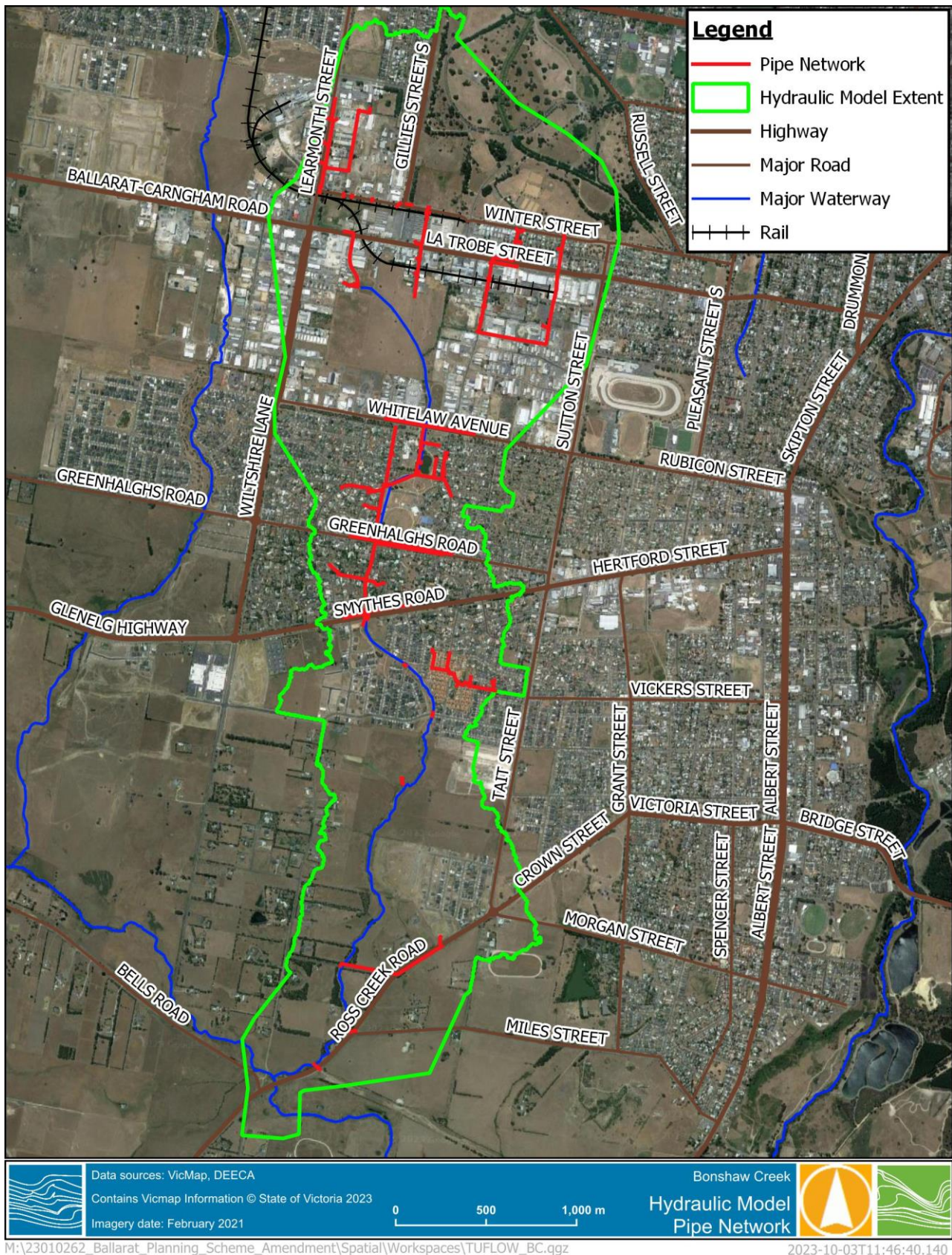


Figure 4-4 1d Pipe Network Throughout Bonshaw Creek



4.4 Boundary Conditions

The hydraulic model requires inflow and outlet boundaries to allow water into and out of the model. External inflow boundaries accounted for flow generated from outside of the model extent (external boundaries), whereas internal boundaries account for the runoff generated from within the model extent. Inflow boundaries were obtained from the RORB hydrological modelling described in Section 3.4.1.

Model Inflows

The TUFLOW model contained 29 inflow regions and 4 pit inflow regions. Inflow regions simulated flow into the main channel of Bonshaw Creek and pit inflow regions simulated runoff into the main stormwater drainage network. Inflows were extracted from the RORB model (as summarised in Section 2.2) at print locations into the hydraulic model as outlined in Figure 4-5 and Figure 4-6.

Model Outflows

Bonshaw Creek has two hydraulic outflows: one at the end of the model at Winter Creek, and another on the eastern boundary along Laidlaw Street and along Sutton Street. The Winter Creek boundary is the main outflow, located at the end of the model. However, during the 1% AEP storm event and up, some water exits the model at the Laidlaw Street and Sutton Street.

Outflows were modelled as flowrate/height boundaries (HQ), these boundaries allow water to exit the model based on a stage discharge curve generated by TUFLOW.

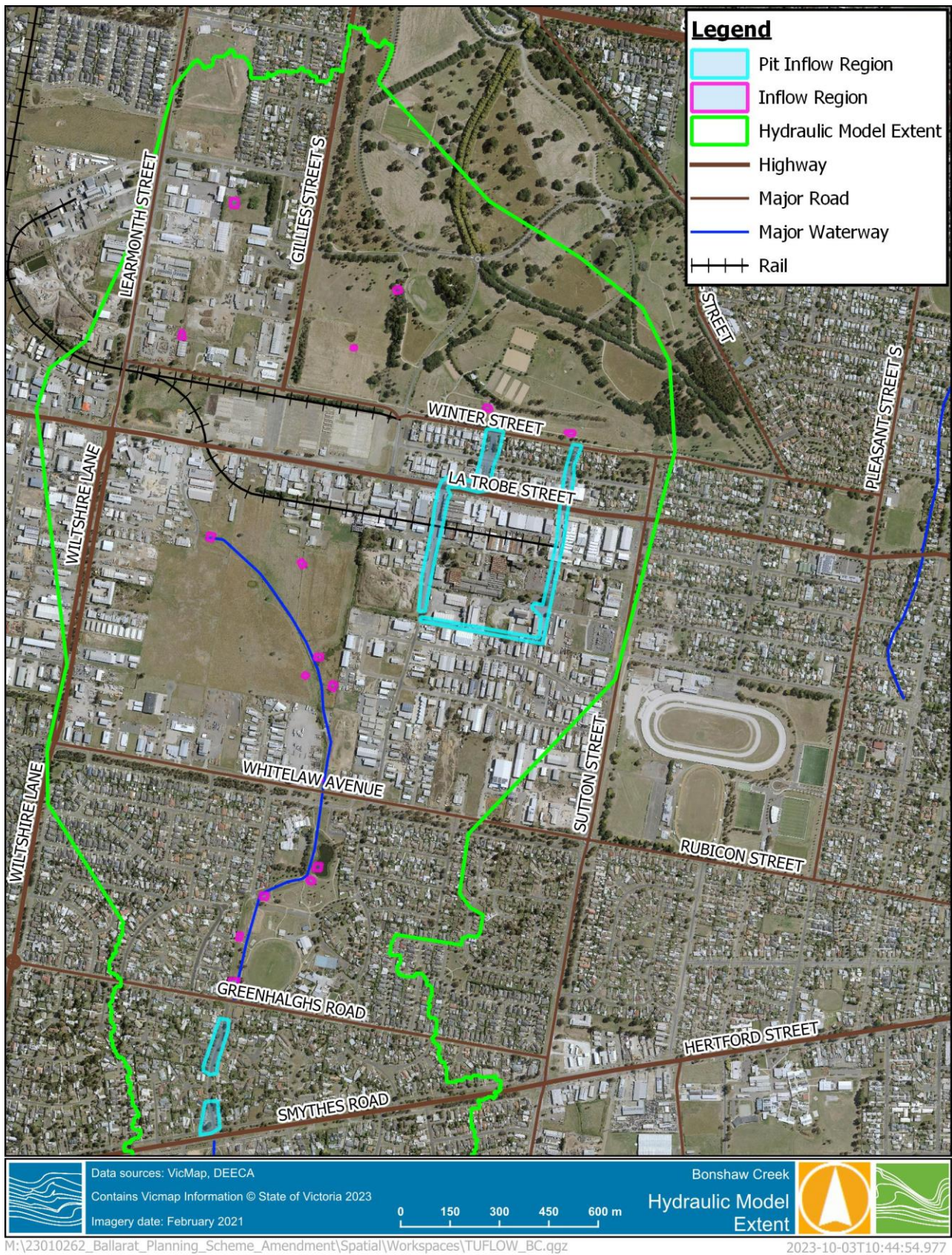


Figure 4-5 Inflow Locations (North)

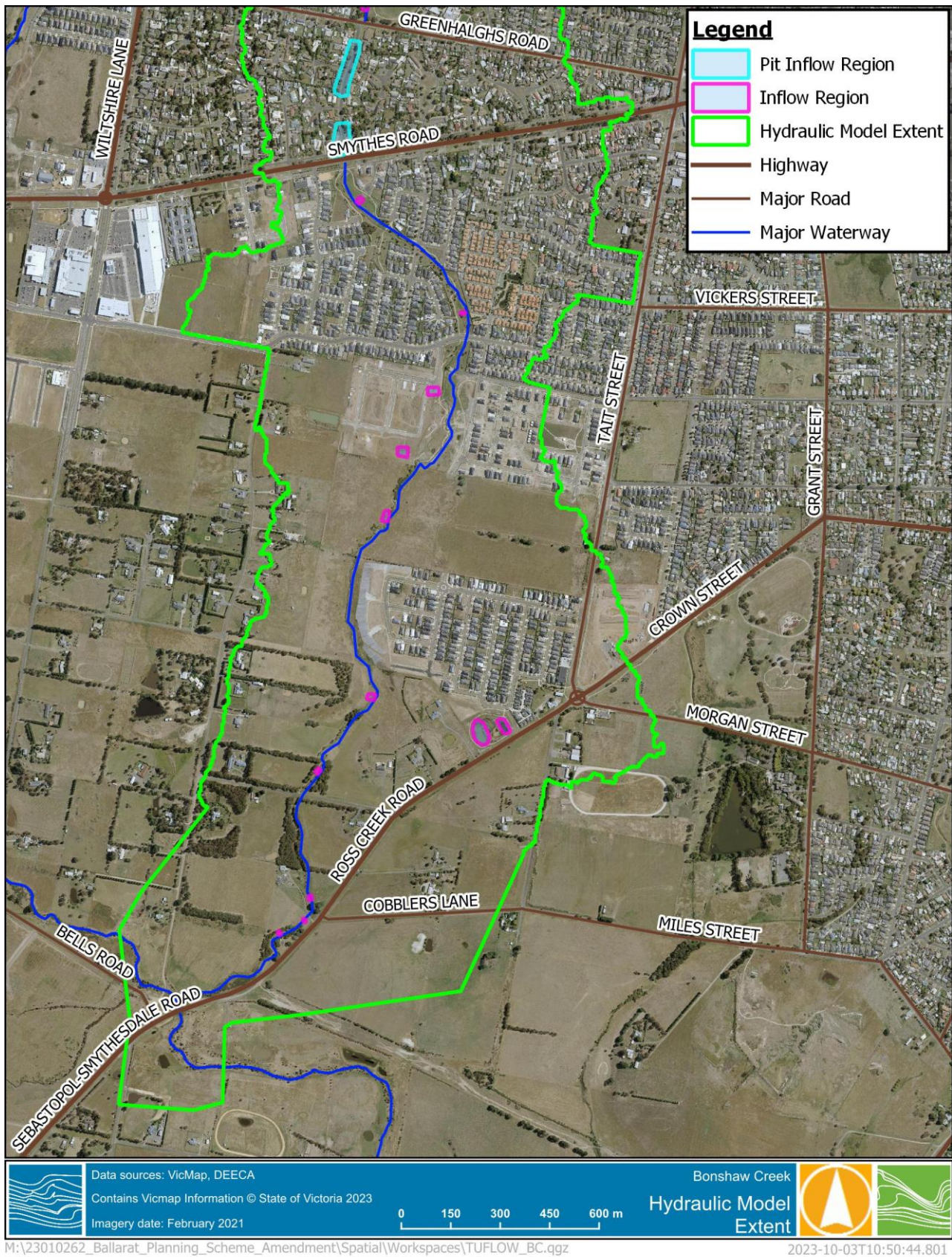


Figure 4-6 Inflow Locations (South)



5 HYDROLOGIC/HYDRAULIC MODEL COMPARISON

The hydraulic and hydrologic model flows were compared to gain an understanding of the differences in their results. The peak outlet flow in the TUFLOW model is significantly less than the RORB model. Peak flows at the Bonshaw Creek outlet are higher in the RORB model compared to the TUFLOW due to catchment wide floodplain storage being represented in the TUFLOW model based on the detailed LiDAR.

Areas where defacto storages are likely to impact flow include Banyule Drive (upstream of Smythes Road), upstream of Whitelaw Avenue and in the southern area of Victoria Park. These storages were not included in the RORB model, which routed all flows to the outlet of the Bonshaw Creek. The hydrographs for TUFLOW and RORB for a 2-hour 1% AEP storm with temporal pattern 24 are shown in Figure 5-1.

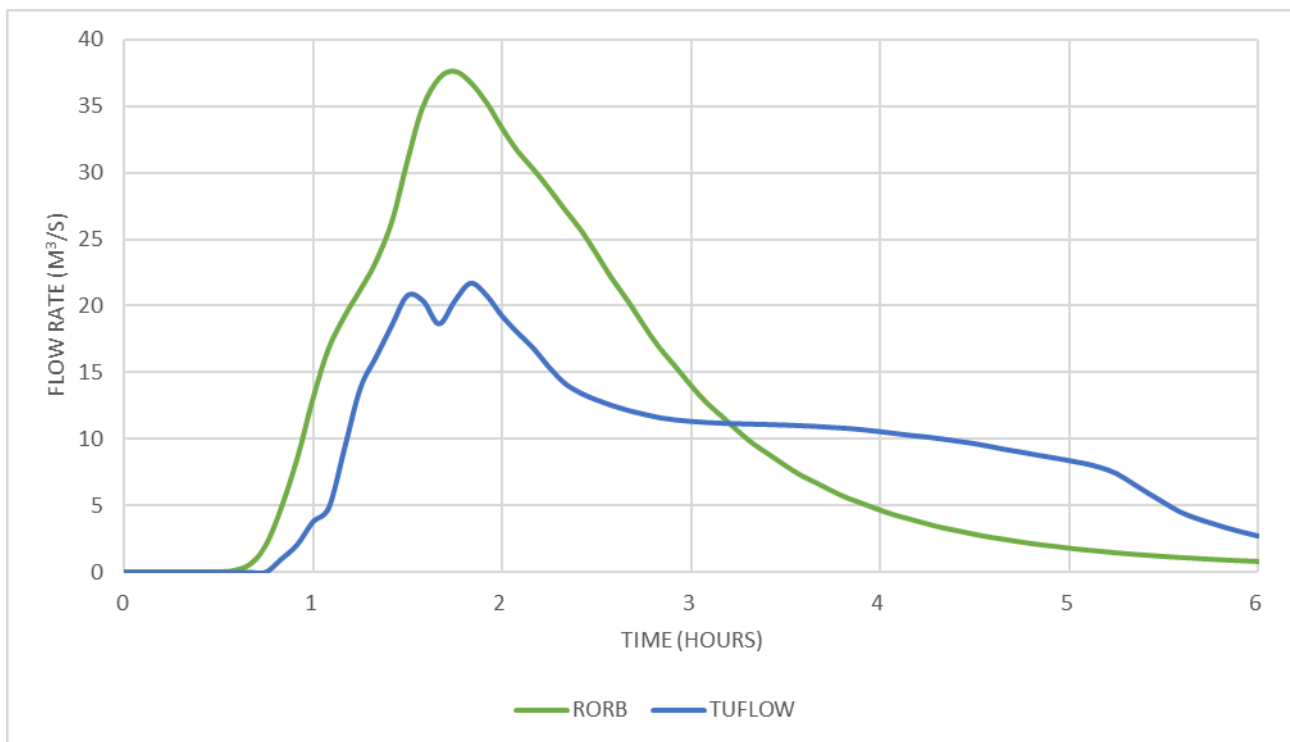


Figure 5-1 RORB and TUFLOW Comparison (2hr TP24 1% AEP Event)



6 FLOOD MAPPING AND RESULTS

This section provides an overview of the floodplain mapping process used in the study and presents a selection of the existing conditions mapping outputs. The model produced a series of gridded datasets defining peak water level, depth, velocity and flood hazard throughout the model.

1% AEP event flood depths are presented in Figure 6-1 to Figure 6-5 below.

Results show that the upper catchment, primarily north of La Trobe Street, is heavily impacted by overland flows, where several Industrial properties along Learmonth Street are inundated by depths ranging from 0.1 to 0.4 metres.

Inundation in the east of the catchment shows some overland flows spilling into the Redan Creek catchment by flowing east along Marin Drive and Laidlaw Drive. Flows pass through a large culvert under Wallis Street as well as overtopping the roadway, which acts as an overland flow path conveying flows south down to Whitelaw Avenue, before being directed west back into the Bonshaw Creek.

There are two prominent locations where flows in the Bonshaw Creek are restricted and accumulate behind hydraulic structures, the road embankments at the southeast corner of Stone Park Avenue (upstream of Whitelaw Avenue) as shown in Figure 6-2, and Banyule Drive (upstream of Smythes Road) as shown in Figure 6-3.

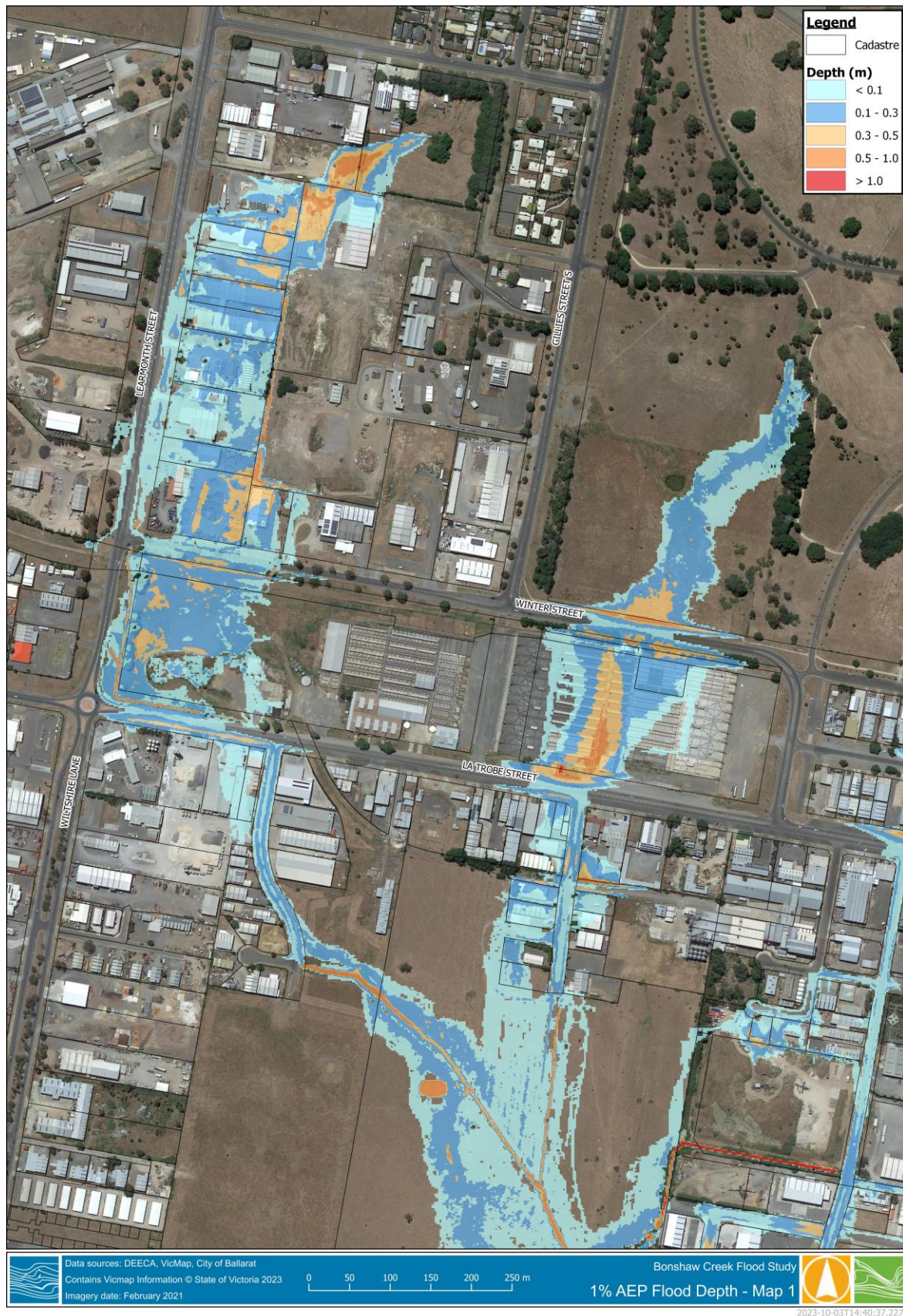


Figure 6-1 1% AEP Maximum Flood Depth – Map 1



Figure 6-2 1% AEP Maximum Flood Depth – Map 2



Figure 6-3 1% AEP Maximum Flood Depth – Map 3

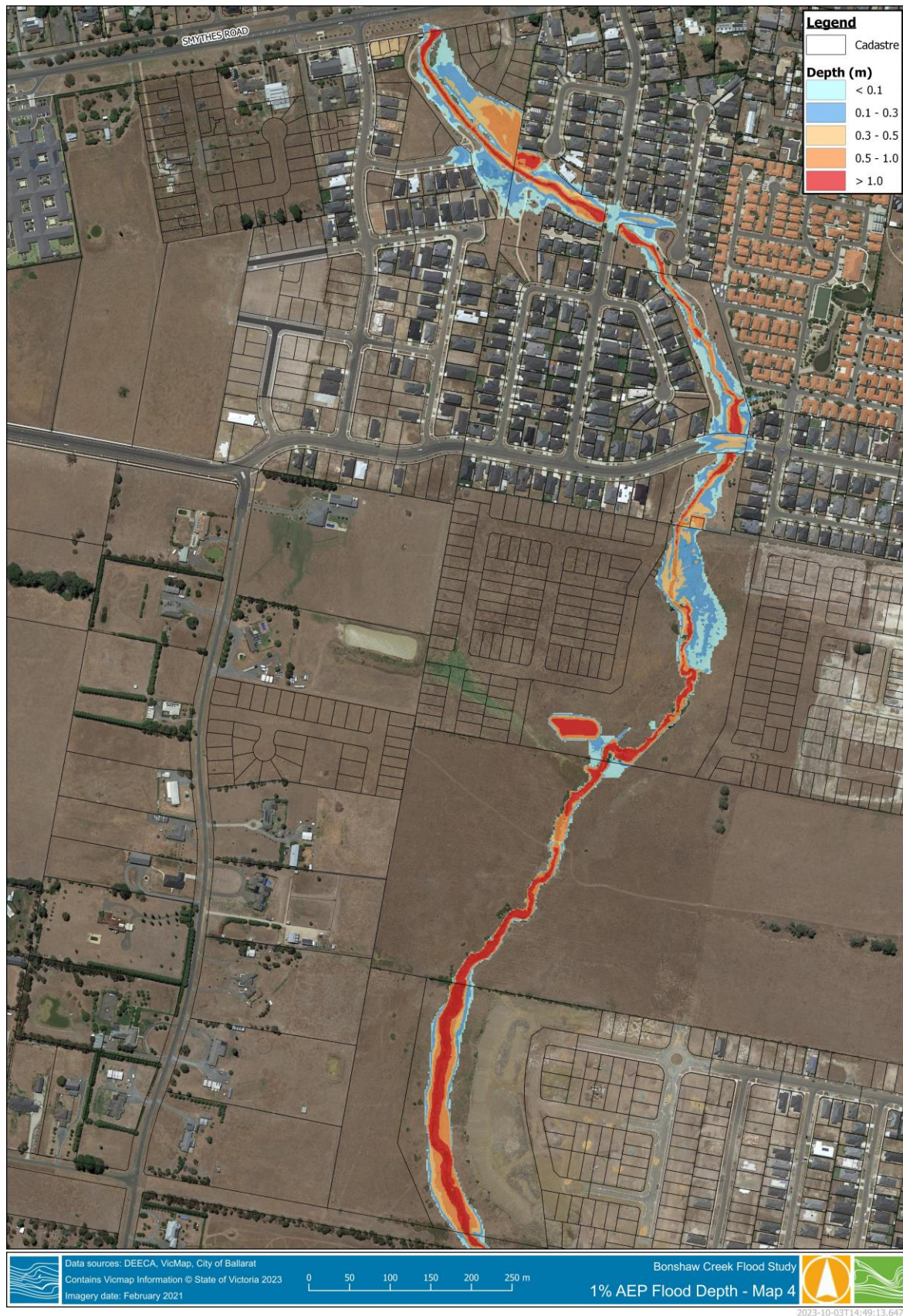


Figure 6-4 1% AEP Maximum Flood Depth – Map 4



Figure 6-5 1% AEP Maximum Flood Depth – Map 5

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