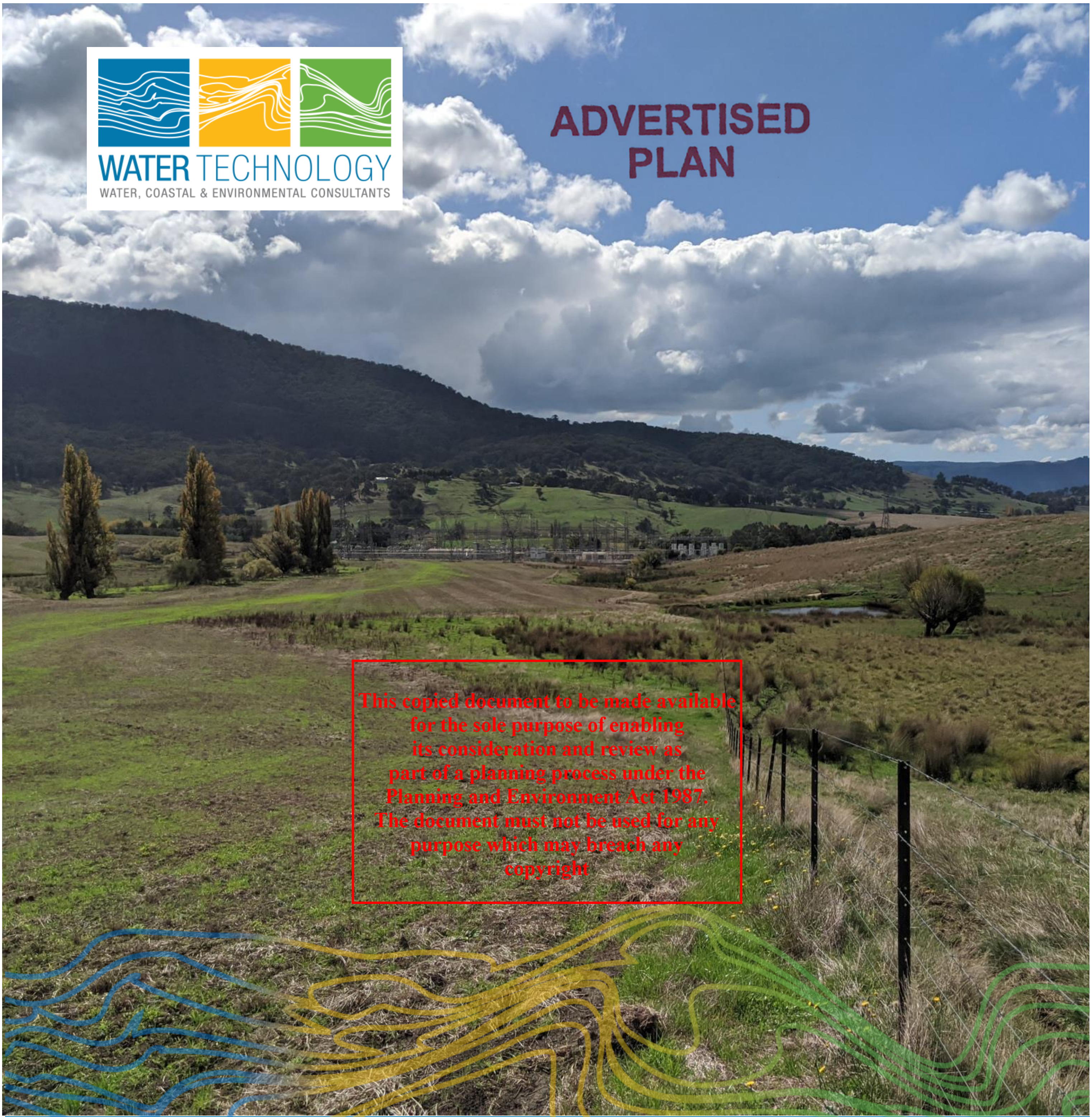


WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Surface Water Assessment

Dederang BESS

Mint Renewables

25 October 2024

Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
V04	Report	J Theilemann	J Theilemann	25/10/2024

Project Details

Project Name	Dederang BESS
Client	Mint Renewables
Client Project Manager	Cara Layton
Water Technology Project Manager	Alex Barton NER RPEng
Water Technology Project Director	Lachlan Inglis
Authors	Roxanne Frost, Alex Barton, Jorja Strack
Document Number	23010340_Dederang_BESS_R01_v04.docx

15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800
Fax (03) 9558 9365
ACN 093 377 283
ABN 60 093 377 283

Quality ISO 9001 SAI GLOBAL
Environment ISO 14001 SAI GLOBAL
OHS ISO 45001 SAI GLOBAL

ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present.

Artwork by Maurice Goolagong 2023. This piece was commissioned by Water Technology and visualises the important connections we have to water, and the cultural significance of journeys taken by traditional custodians of our land to meeting places, where communities connect with each other around waterways.

The symbolism in the artwork includes:

- *Seven circles representing each of the States and Territories in Australia where we do our work*
- *Blue dots between each circle representing the waterways that connect us*
- *The animals that rely on healthy waterways for their home*
- *Black and white dots representing all the different communities that we visit in our work*
- *Hands that are for the people we help on our journey*

CONTENTS

1	INTRODUCTION	5
1.1	Overview	5
1.2	Assessment Objectives and Scope	5
2	PROJECT OVERVIEW	7
2.1	Project Description	7
2.2	Catchment Area and Waterway Considerations	9
2.2.1	Proposed Design	9
2.2.2	Change from Existing Conditions	9
2.3	Available Data	13
3	HYDROLOGY	14
3.1	Overview	14
3.2	RORB Modelling	14
3.2.1	Model Setup	14
3.2.2	Design Flows – Existing Conditions	19
3.2.3	Adopted Design Flood Hydrographs	21
4	HYDRAULIC MODEL DEVELOPMENT	22
4.1	Model Schematic	22
4.1.1	Model Limitation	22
5	HYDRAULIC MODELLING RESULTS	24
5.1	Flood Hazard Classification	24
5.2	Existing Conditions	25
5.3	Developed Hydraulic Model	28
5.4	Results	29
5.5	Climate Change Results	34
5.6	Afflux Assessment	39
6	STORM WATER QUALITY MANAGEMENT RECOMMENDATIONS	42
7	SUMMARY	46

APPENDICES

No table of contents entries found.

LIST OF FIGURES

Figure 1-1	Proposed Study Area	6
Figure 2-1	Site Layout	8
Figure 2-2	Site Catchment	11
Figure 2-3	Indicative Site Layout and Waterways	12
Figure 2-4	Western Waterway	12
Figure 2-5	Eastern Waterway	13

Figure 3-1	RORB model schematisation	15
Figure 3-2	Temporal pattern bins	17
Figure 3-3	Temporal Pattern and Peak Flows	19
Figure 4-1	TUFLOW Model Schematic	23
Figure 5-1	Combined flood hazard curves	24
Figure 5-2	1% AEP Maximum Flood Depth (for depths greater than 0.02 m)	26
Figure 5-3	1% AEP Maximum Flood Depth with Climate Change (for depths greater than 0.02 m)	27
Figure 5-4	Indicative development modelled surface elevations	28
Figure 5-5	Indicative Culvert Specification	29
Figure 5-6	1% AEP Flood Depth – Indicative Developed Conditions	30
Figure 5-7	1% AEP Flood Water Surface Elevation – Indicative Developed Conditions	31
Figure 5-8	1% AEP Flood Velocity – Indicative Developed Conditions	32
Figure 5-9	1% AEP Flood Hazard – Indicative Developed Conditions	33
Figure 5-10	1% AEP Flood Depth CC – Indicative Developed Conditions	35
Figure 5-11	1% AEP Flood Water Surface Elevation CC – Indicative Developed Conditions	36
Figure 5-12	1% AEP Flood Velocity CC – Indicative Developed Conditions	37
Figure 5-13	1% AEP Flood Hazard CC – Indicative Developed Conditions	38
Figure 5-14	1% AEP Flood Level Difference	40
Figure 5-15	1% AEP Flood Level Difference CC	41
Figure 6-1	Indicative Concept Drainage Layout	44

LIST OF TABLES

Table 3-1	Design Rainfall Depth (mm) for storm Frequency and Duration	16
Table 3-2	Calculated kc parameters	18
Table 3-3	Design Loss Parameter Estimates	18
Table 3-4	1% AEP RORB Ensemble mean peak flow	20
Table 3-5	Design Flow comparison	20
Table 3-6	Adopted Flows and Temporal Patterns	21
Table 4-1	Land Use Manning's 'n' Roughness values	22
Table 5-1	Hazard classification (ARR, 2016)	24
Table 6-1	1 in 1.5 YR ARI Boyd's Calculation	45
Table 6-2	1 in 100 YR ARI Boyd's Calculation	45

1 INTRODUCTION

1.1 Overview

Water Technology has been engaged by Mint Renewables Pty Ltd (the Proponent) to undertake a surface water assessment of Dederang Battery Energy Storage System (BESS) (the Project) to support an application for a planning permit from the Minister for Planning. The proposed battery storage facilities will be located approximately 2 km north-west of Dederang, in the Alpine Shire, Victoria, adjacent to the Dederang Terminal Station (DDTS), owned and operated by AusNet Services (AusNet). The location of the study area is shown in Figure 1-1.

1.2 Assessment Objectives and Scope

The objective of this assessment was to provide advice regarding flooding, drainage and the potential impacts within and outside the Project extents. The specific objectives of this investigation outlined in this report include:

- Understand the hydrology of the site and its interaction with catchments both upstream and downstream of the Project extent.
- Determine flood depths and extents at the site to inform finished surface levels and appropriate drainage infrastructure.
- Assess the potential implications to flood behaviour of the proposed Dederang BESS.
- Provide guidance regarding the type of water quality treatment required to meet Best Practice Environmental Management Guidelines (BPEM).

The assessment outlined in this report, included the following scope:

- A review of the site and catchment to inform the hydrological, hydraulic modelling and water quality advice.
- Development of catchment hydrology using RORB rainfall routing modelling software.
  - Flows developed as part of the RORB model were used as inflow boundaries to a TUFLOW 2D hydraulic model.
- Development of site-specific hydraulic model using TUFLOW.
  - The TUFLOW model defined flood depth, extent and velocity during both a 1% AEP flood event and a 1% AEP with climate conditions for the year 2090 (RCP 8.5) at the subject site in accordance with Australian Rainfall and Runoff 2019 (ARR2019) guidelines.
- Overview of Water Quality requirements.

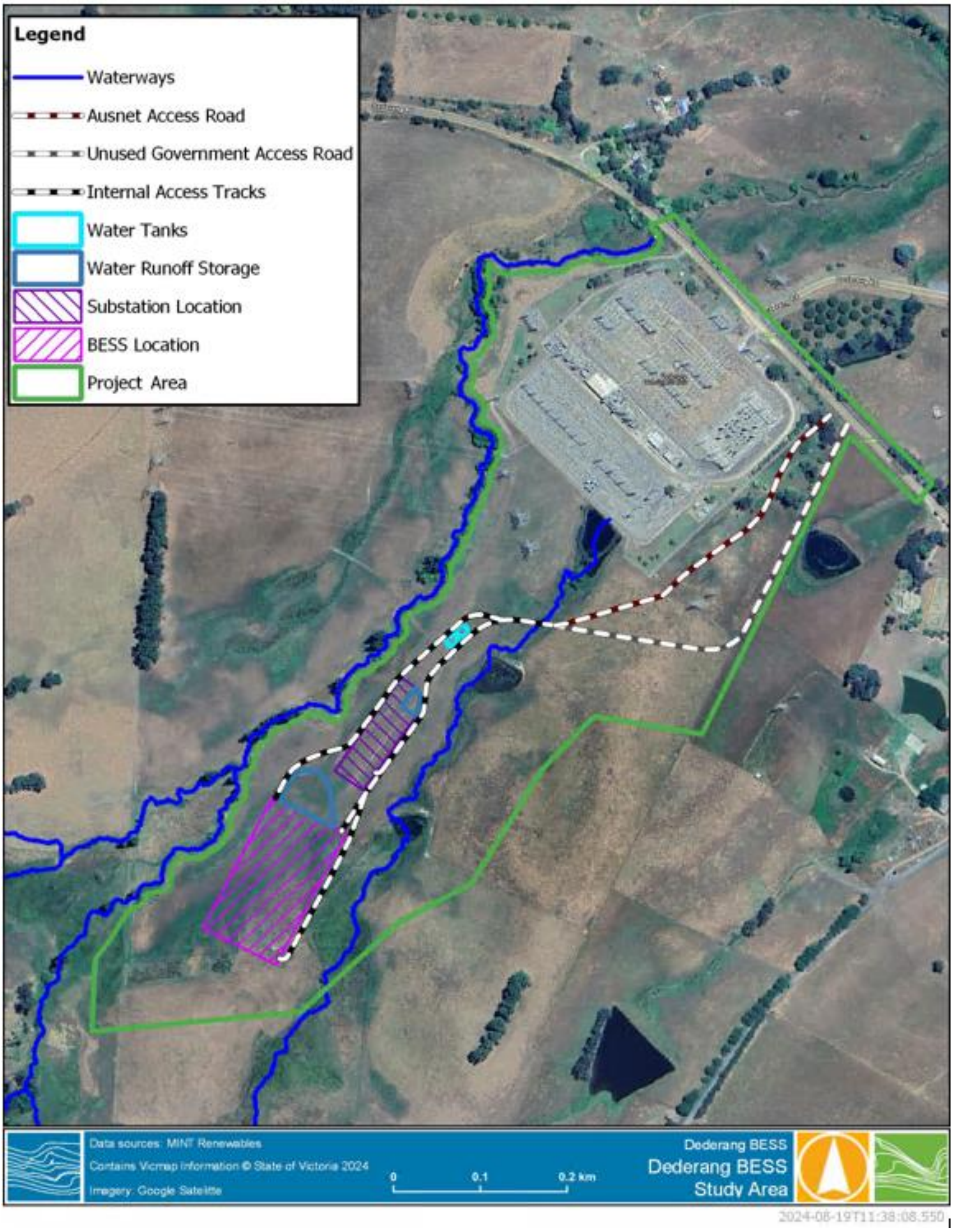


Figure 1-1 Proposed Study Area

2 PROJECT OVERVIEW

2.1 Project Description

The Dederang Battery Energy Storage System (BESS) (the Project) is proposed to have a nominal installed capacity of 400MWh, with an indicative development footprint of approximately 4 ha. The final size and footprint location of the Project will be highly dependent on the environmental constraints of the site (as well as the final selected BESS model).

The Project will include:

- BESS modules, inverters and transformers;
- Civil and structural works including laying of crushed rock;
- Construction of internal access roads and access (and egress) points;
- Underground cabling (33kV) to provide a connection between the battery modules and inverters and on-site substation;
- On-site substation (including transformer to step up from 33 kV to the connection voltage (either 220 kV or 330 kV) and potentially reactive power equipment);
- Underground cabling (220kV or 330kV) to connect the onsite substation to the adjoining DDTS;
- Permanent Operations and Maintenance Facility;
- Water storage (including firefighting water supply and fire water runoff containment);
- Temporary disturbance for construction compound and laydown and work areas;
- Security fencing;
- Car parking; and
- Business identification signage, at site entry.

The final location of infrastructure will be determined through the detailed design, once a BESS supplier has been selected, and generally in accordance with commitments made within the planning permit application. The site is proposed to be accessed of Yackandandah-Dederang Road, via one of two options:

- *AusNet Access Option:* Access via land adjacent to the DDTS, outside the fenced terminal station.
- *Government Road Access Option:* Access via the unused government road which runs between AusNet land and the adjoining private property.

The current proposed indicative layout (provided to Water Technology by the Proponent), is provided in Figure 2-1. This layout is accessed via the Government Road and was adopted for the basis of modelling, noting that access via the AusNet roadway would not change the findings of this report.

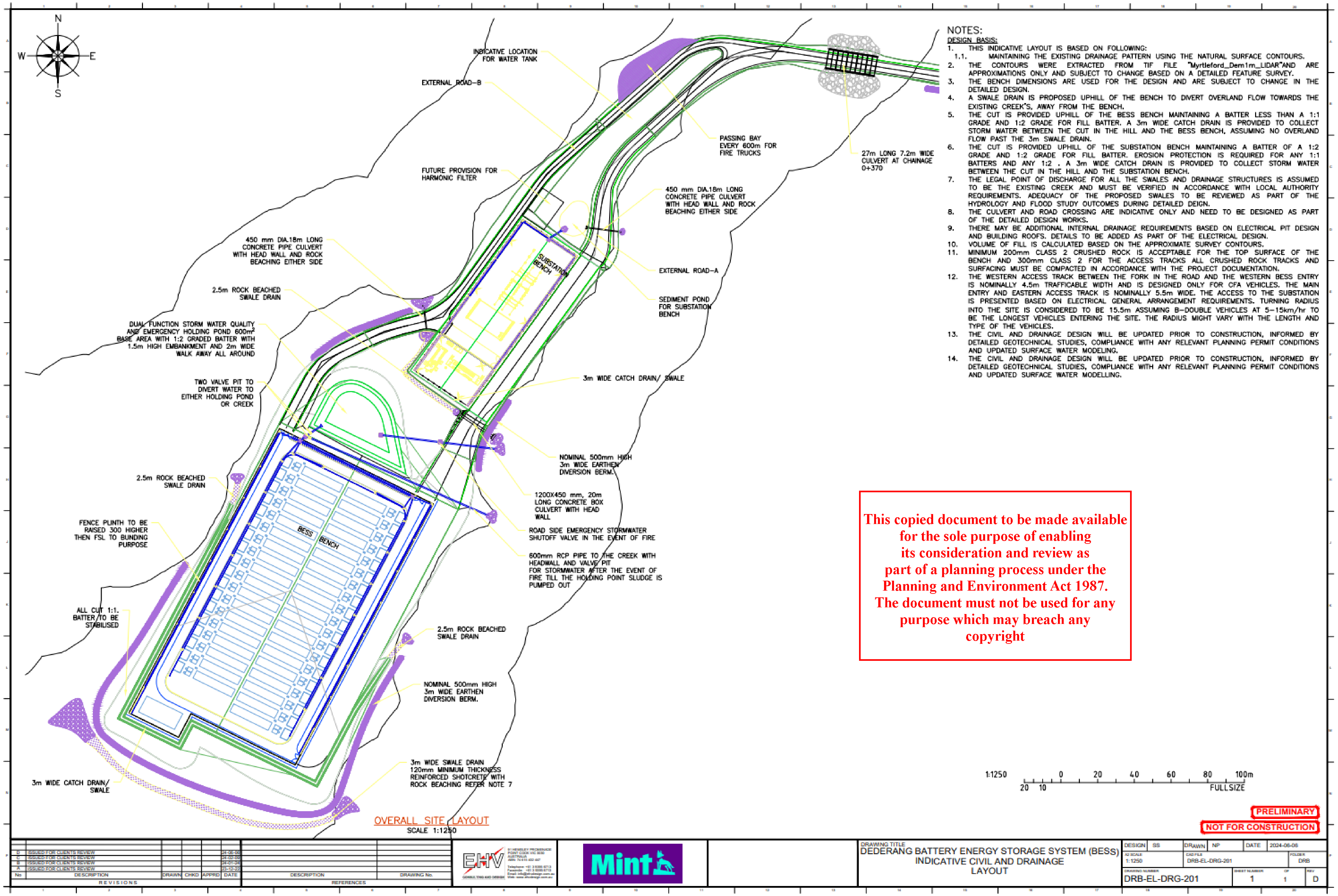


Figure 2-1 Site Layout

2.2 Catchment Area and Waterway Considerations

The study area is within the Glen Creek catchment, which includes several small tributaries upstream of the proposed study area. The proposed project is located on the high ground between two defined flow paths. The tributaries, site and catchment are shown by the red outline in Figure 2-2, covering an area of 6.5 km^2.

These flow paths were identified as potential waterways, recommended to have 30m offsets of infrastructure to maintain waterway health and habitat. While Water Technology cannot provide definitive advice on the classifications of the flow paths, an assessment in consultation with Northeast Catchment Management Authority (NECMA) alongside a review of the Waterway Identification Guidelines 2022[1] was undertaken. The assessment identified the following:

- The flow path adjacent to the western side of the proposed layout is a waterway (based on Decision 1 criteria), the required offset and level of acceptable encroachment will be determined by NECMA, in general a 30 m offset will be required. Based on the following:
  - Decision 1 – An unnamed stream / watercourse is identified on Parish Plans.
- The flow path adjacent to the eastern side of the proposed layout is a likely waterway (based on decision 2 criteria), offset requirements will be determined by NECMA. Based on the following:
  - Decision 2 – There is a natural channel with a defined bed and banks, where water flows in a confined manner.

2.2.1 Proposed Design

The Proponent has undertaken several design reviews to respond to the proximity of proposed infrastructure to waterways (and other constraints). This has included consultation with NECMA to understand the expectations and flexibility within the identified waterway buffers. Based upon this consultation it is understood that the NECMA are open to some encroachment into the eastern waterway buffer, which would be further assessed formally through the planning permit application referral process and subsequent works on waterways permit process under the *Water Act 1989*.

As such, the Proponent has developed an indicative design which achieves minimal encroachment into the eastern waterway buffer and avoidance of the western waterway buffer (Figure 2-1). Indicative encroachment within the eastern waterway buffer includes:

- The earthworks related to the batters of the access road and BESS and substation benches adjacent to the eastern waterway.
- The proposed access road over the eastern waterway, would be subject to a works on waterways permit.

2.2.2 Change from Existing Conditions

The existing land-use is primarily cattle farming, with cattle having access to both the western and eastern waterways. The western waterway is relatively natural with erosion evident and likely the result of a loss of riparian vegetation (Figure 2-4). The eastern waterway is heavily modified with a series of farm dams situated along its alignment and the existing Dederang Terminal Station constructed over the waterway (Figure 2-5). These changes and ongoing cattle access would have significantly impacted the waterway since European settlement.

[1] https://www.waterregister.vic.gov.au/images/documents/WaterwayIdentificationGuidelines2022.pdf

It will be a requirement that the Project has minimal influence on the health of the neighbouring waterways. The influence of the land-use changes from the BESS will be managed on-site via appropriate stormwater quality treatment & management and off-site via vegetation establishment and rehabilitation. In areas where the Project encroaches on the waterway; the proponent has stated a willingness to establish vegetation and undertaken remedial works to protect the waterway. While the Project will influence the land-use it may also enable the following benefits:

- Removal of cattle from accessing the waterway.
- Establishment of exclusion zone.
- Establishment of riparian vegetation.

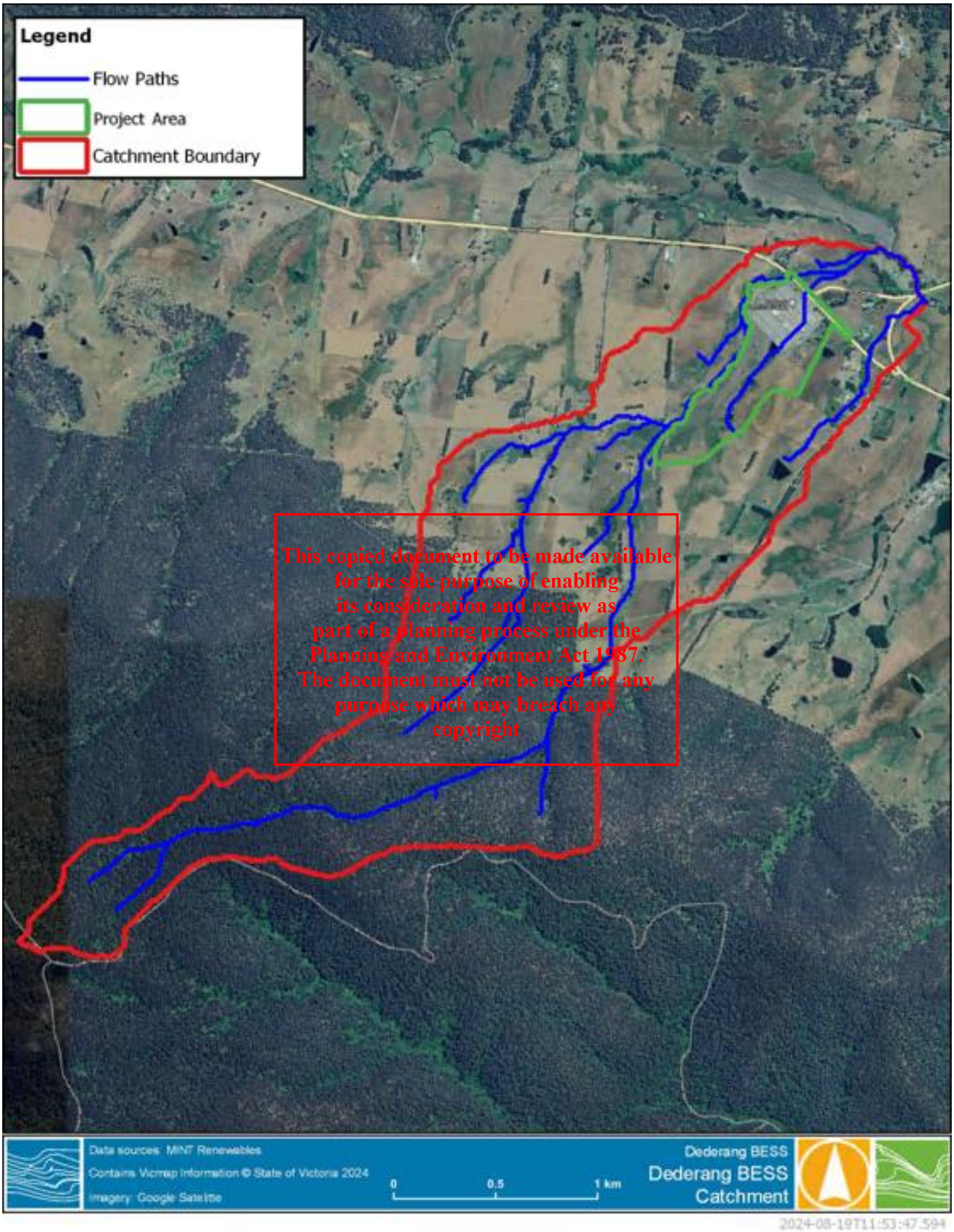


Figure 2-2 Site Catchment

Figure 2-3 Indicative Site Layout and Waterways

Figure 2-4 Western Waterway

Figure 2-5 Eastern Waterway

2.3 Available Data

The investigation utilised existing spatial datasets available from the Department of Energy, Environment and Climate Action (DEECA) and NECMA including:

- Topography – Myrtleford Light Detection and Ranging (LiDAR):
  - 1m resolution, flown January 2022 (DEECA)
- Spatial Data – VicMap – 2016 (DEECA)
- Indicative development design surface – Mint Renewables (July 2024)

3 HYDROLOGY

3.1 Overview

A hydrologic model of tributaries of Glen Creek was developed to determine design flow hydrographs at several locations within the catchment to be used as inflow boundary conditions in the hydraulic model.

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 described below is based on current guidelines described in the 2019 revision of Australian Rainfall and Runoff (ARR2019). An ensemble approach was used in this assessment. The ensemble approach modelled 10 available temporal patterns for each duration recommended in ARR2019 with the temporal pattern which determined the median peak flow for each duration adopted.

3.2 RORB Modelling

3.2.1 Model Setup

3.2.1.1 Sub-area and Reach Delineation

Sub-area boundaries and reaches were delineated using the hydrological processing algorithms in QGIS/SAGA GIS and revised as necessary. Delineation was based on the available 1m LiDAR datasets listed in Section 2.3 above. Nodes were placed at areas of interest (to extract flow hydrographs), the centroid of each sub-area and the junction of any two reaches. Nodes were then connected by RORB reaches, each representing the length, slope and reach type. The RORB model has 22 sub-areas ranging in area from 0.06 – 0.84 km^2. The sub-catchment delineation and reach network is shown in Figure 3-1.

The RORB model was constructed using ArcRORB (ArcMap RORB tools) and RORBWIN V6.45.

3.2.1.2 Fraction Impervious

Fraction Impervious (FI) values were calculated using ArcRORB. Default sub-area FI values were based on aerial imagery. The catchment consists of native bushland, agricultural land and the existing Dederang BESS.

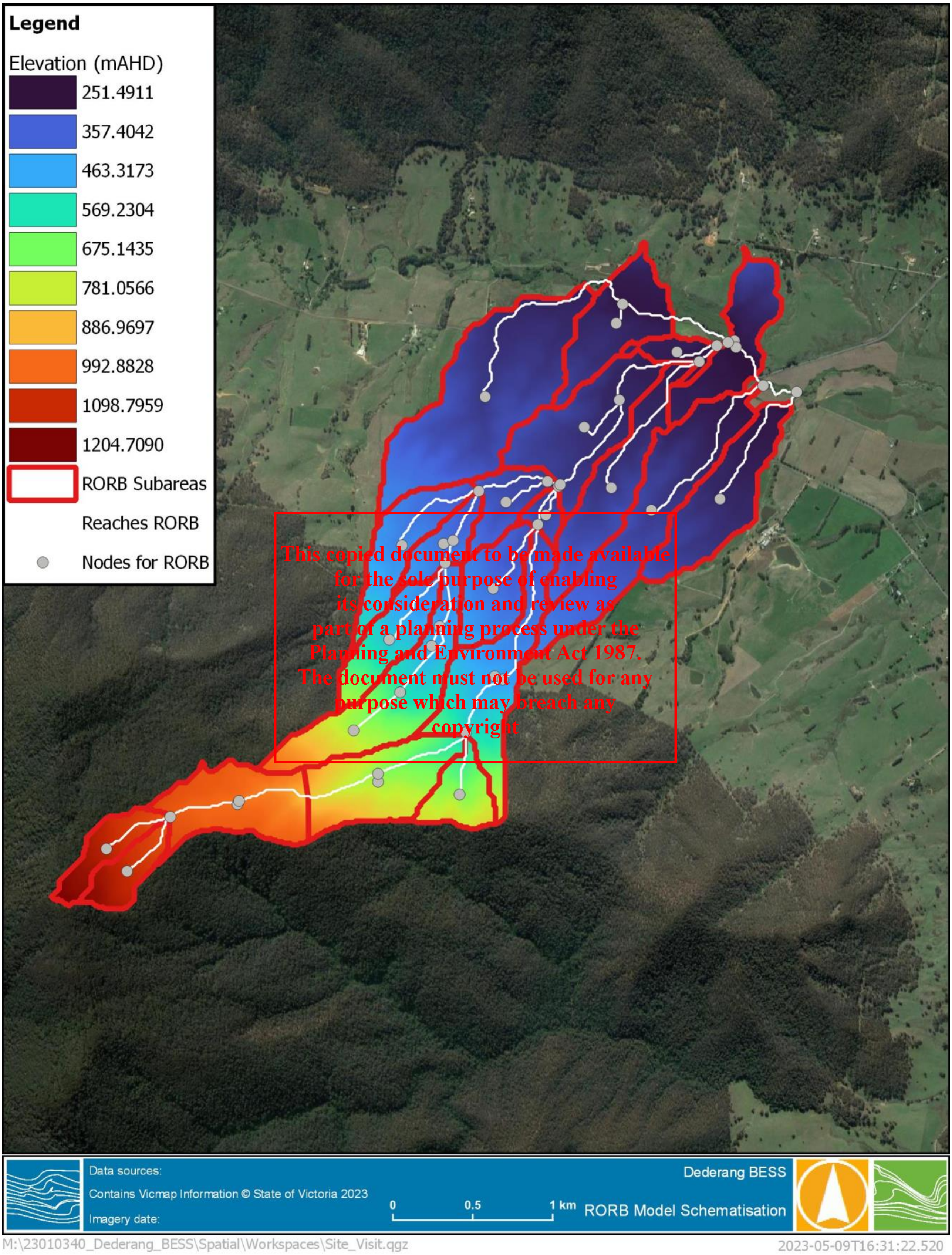


Figure 3-1 **RORB model schematisation**

3.2.1.3 Design Rainfall

Design rainfall depths were determined using the Bureau of Meteorology online IFD tool[2]. The rainfall Intensity Frequency Duration (IFD) parameters were generated for a location in the centre of the modelled catchment (36.46S, 146.99E) and are shown in Table 3-1 below.

Table 3-1 Design Rainfall Depth (mm) for storm Frequency and Duration

Duration	Exceedance per Year (EY)	Annual Exceedance Probability (AEP)					
	1EY	50%	20%	10%	5%	2%	1%
1 hour	18.8	21.1	28.3	33.4	38.4	45.1	50.2
1.5 hour	21.5	24.0	32.0	37.6	43.2	50.5	56.1
2 hour	23.7	26.4	35.0	40.9	46.9	54.7	60.6
3 hour	27.4	30.4	39.9	46.4	52.8	61.3	67.8
4.5 hour	32.0	35.3	45.8	53.0	60.0	69.3	76.5
6 hour	35.8	39.5	50.8	58.5	66.1	76.1	83.9
9 hour	42.1	46.3	59.3	68.0	76.3	87.7	96.6
12 hour	47.2	51.9	66.4	75.9	84.9	97.6	108
18 hour	55.2	60.9	77.8	88.8	99.2	114	126
24 hour	61.4	67.7	86.9	99.2	111	128	141
30 hour	66.2	73.3	94.3	108	120	140	155
36 hour	70.2	77.8	101	115	129	150	166
48 hour	76.5	85.0	111	127	142	166	184
72 hour	85.1	94.9	124	143	160	188	209
96 hour	91.1	102	133	153	171	201	224
120 hour	96.0	107	139	159	178	208	232
144 hour	100	112	144	164	181	211	236
168 hour	105	116	148	167	183	211	237

3.2.1.4 Temporal Patterns

Temporal patterns from ARR2019 were utilised in the analysis and extracted from the AR&R data hub. As previously described and Ensemble approach was undertaken. The range of temporal patterns modelled are included in Appendix A, with relevant ID numbers assigned as referred to in the RORB model output. The Murray Basin (Vic/NSW) Zone of temporal patterns was utilised. The ARR2019 temporal patterns are based on historical storms using the extensive network of pluviograph data collected by the Bureau of Meteorology (BoM).

[2] Bureau of Meteorology Web Tool, http://www.bom.gov.au/water/designRainfalls/revised-ifd/

The ARR2019 design temporal patterns are broken into several AEP groupings, or bins. These are:

- Very Rare – Rarest 10 within region
- Rare – Suitable AEP range 3.2% AEP and rarer
- Intermediate – Suitable for AEP range 3.2% - 14.4%
- Frequent – Suitable for AEP range more frequent than 14.4%

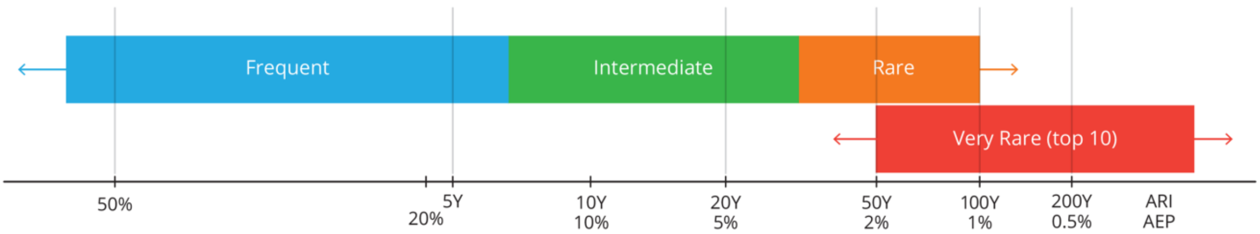


Figure 3-2 Temporal pattern bins

Previous assessment in accordance with ARR1987 used a single temporal pattern across all design events. The ARR2019 approach recommends that at least 10 temporal patterns be used for each event. These 10 temporal patterns change depending on the duration and the event considered providing a broader assessment of potential storm types.

RORB's internal "filter embedded burst" feature was used for all ensemble runs to ensure any embedded bursts were smoothed out and would not influence results. Embedded bursts are sub-durations of rainfall within the temporal pattern which have a rarer Annual Exceedance Probability (AEP) than the duration and pattern being modelled.

3.2.1.5 Areal Reduction Factors

Areal reduction factors were used to convert point rainfall to areal estimates and are used to account for the variation of rainfall intensities over a large catchment. AR&R2019 areal reduction factors were applied to the catchment area and extracted from the AR&R data hub[3]. The catchment lies within the Southern Temperate Zone of areal reduction factors, and these were applied for all design modelling.

3.2.1.6 Regional *kc*

kc is the primary routing parameter in RORB. As the modelled catchment is an ungauged with no streamflow record, it is not possible to calibrate the RORB model against known catchment flows and rainfall records. As such, a comparison between empirical regional equation estimates was made and a reasonable value within this range adopted. The Pearse et. al. *kc* prediction equation method is based on Victorian data and has been shown to provide an accurate match to Flood Frequency Analysis (FFA) across several Victorian flood investigations[4] and was used in this project, adopting a *kc* value of 5.75.

[3] AR&R 2016 Data Hub, http://data.arr-software.org/
[4] Tarrawingee Flood Investigation (Water Technology, 2021)

Table 3-2 Calculated kc parameters

kc Equations	k_c
Default RORB Eqn.	5.60
Victoria data (Pearse et al, 2002)	**5.75**
Aust Wide Dyer (1994) (Pearse et al)	5.25
Aust Wide Yu (1989) (Pearse et al)	4.42
Victoria Mean Annual Rainfall > 800mm	5.95

3.2.1.7 Routing Parameter – m

The RORB 'm' value is typically set at 0.8 as recommended in the RORB User Manual. This value remains unchanged and is an acceptable value for the degree of non-linearity of catchment response (Australian Rainfall and Runoff, 1987). It is rare to vary the 'm' value and there were no reasons to do so in this study, particularly given the lack of calibration data.

3.2.1.8 Design Losses and Pre-burst Losses

ARRR2019, Book 5 Chapter 5 (Hill and Thomson, 2015) contains new recommended initial and continuing losses, as shown below. A web tool has also been developed to derive initial and continuing loss values[5], which was used to extract loss values for this project. The information generated from this web tool in shown in Table 3-3 for the modelled catchment.

Table 3-3 Design Loss Parameter Estimates

Source	IL (mm)	CL (mm/h)
ARR 2016 (VIC)	29	3.9

Pre-burst rainfall depths were obtained from the ARR datahub. Pre-burst depths are subtracted from the initial loss value for each storm duration and AEP to provide a duration-AEP specific initial loss for the design rainfall burst in accordance with the below equation (ARR2019 Book 2 Chapter 5).

$$IL_s - \text{Pre-burst} = IL_b$$

For the 1% AEP event, pre-burst rainfall depths ranged from 0.4 – 7.6 mm for durations up to 12 hours. In consideration of an average pre-burst depth of 4.0 mm, the initial loss of 29 mm was reduced to 25 mm.

3.2.1.9 Spatial Patterns

The ARR2019 guidelines recommend for non-uniform spatial patterns for catchment areas of more than 20 km^2. The catchment upstream of the study area is 6.5 km^2, therefore a uniform spatial pattern was applied in design modelling

[5] ARR2019 - http://data.arr-software.org

3.2.2 Design Flows – Existing Conditions

3.2.2.1 RORB – Ensemble

Peak flows for the 1% Annual Exceedance Probability (AEP) flood event were calculated within the RORB model for durations between the 1 hour and 168 hour duration events. An ensemble of the 10 available temporal patterns applicable to the 1% AEP event were run and the event with the median peak flow for each of the modelled durations was adopted.

The whisker plot shown in Figure 3-3 shows the upper and lower limits of the calculated peak flows for each of the 10 temporal patters for each duration, along with the corresponding median for each storm duration.

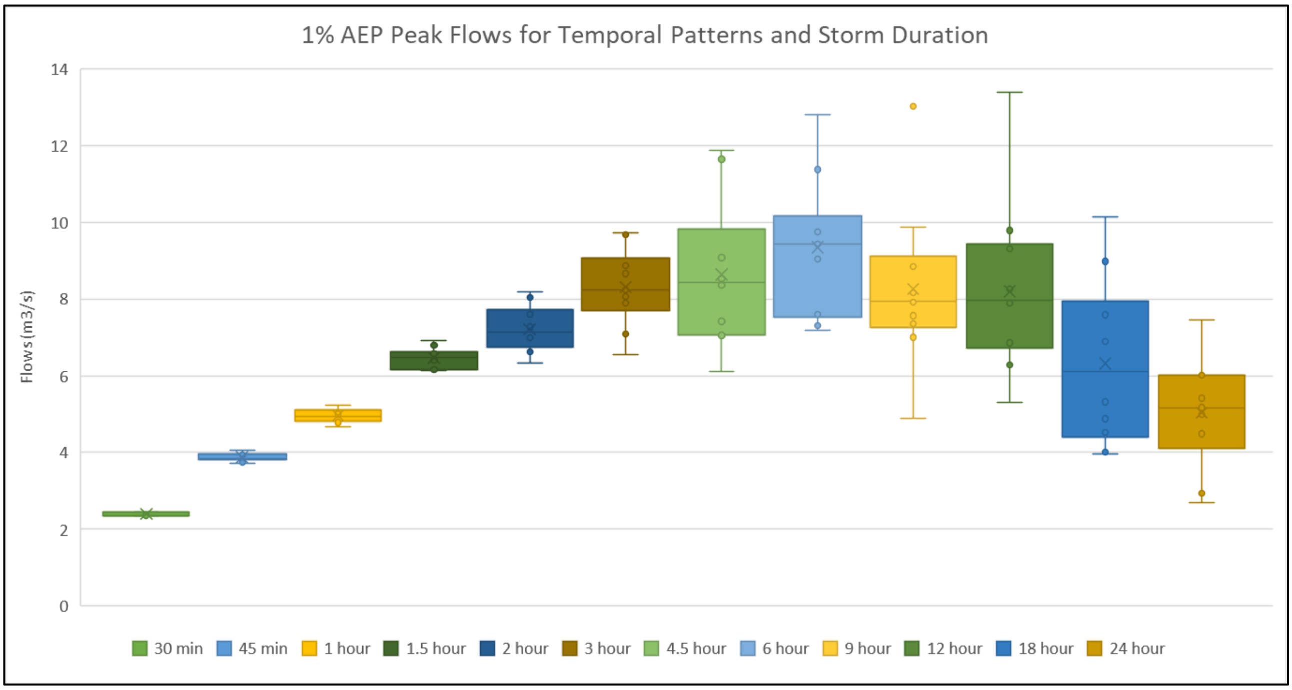


Figure 3-3 Temporal Pattern and Peak Flows

The event duration which yielded the highest median peak flow was 6 hours. Within the ensemble of temporal patterns, the temporal pattern which gave the peak flow closest (above) the mean was TP23. The mean flows generated by each ensemble for the 1% AEP event are shown in Table 3-4. The highest median results from the ensemble modelling are emboldened and form the hydrologic input for the modelled 1% AEP peak flows.

Many of the main reaches through the catchment could be considered as lined channels rather than natural reaches. As a sensitivity test, this process of modelling the ensemble of temporal patterns, identifying the maximum of the median ensemble results and selecting the best fit single storm duration and temporal pattern was also undertaken considering the main channel through the catchment was a lined channel instead of a natural channel. The event duration which yielded the highest median peak flow was also 6 hours. Within the ensemble of temporal patterns, the temporal pattern which gives the peak flow closest (above) the mean was TP22. The mean flows generated by each ensemble for the 1% AEP event are shown in Table 3-4.

Table 3-4 1% AEP RORB Ensemble mean peak flow

Duration	Natural Channels (m^3/s)	Lined Channels (m^3/s)
30 minutes	2.36	5.46
45 minutes	3.84	7.93
1 hour	4.95	9.15
1.5 hour	6.48	10.94
2 hour	7.13	10.52
3 hour	8.24	12.11
4.5 hour	8.44	10.56
6 hour	**9.44**	**12.84**
9 hour	7.94	9.54
12 hour	7.96	9.50
18 hour	6.10	7.34
24 hour	5.15	6.08

3.2.2.2 Flow Verification – Regional Estimations

The modelled catchment is ungauged, in the place of observed data the adopted design flows were compared against a range of other flow estimate methods including Rational Method, Regional Flood Frequency Estimation and the Grayson Method as shown in Table 3-5. The Rational Method (VicRoads) and the Regional Flood Frequency Estimator (RFFE) produced similar peak flows of 14.62 and 15.50 m^3/s, respectively. These flows are slightly higher than the lined channel peak flow results and higher than the natural channel peak flow results. The Rational Method (Adams) produced a peak flow of 8.24 m^3/s which is lower than both peak outflows estimated by RORB. The Grayson Method (rural) was significantly higher than the other flow estimation methods. It is noted that the Grayson Method considers catchment area only and that the catchment is characterised by an “unusual”, narrow shape. Due to the shape of the catchment, it is considered likely that the peak catchment response may occur before the time of concentration is reached, and that methods which rely on area alone for estimation with no consideration of flood routing will have even further reduced reliability. Overall, the RORB estimates produced similar flows to the flow estimate methods, providing confidence in the results.

Whilst these estimation methods are considered to have high uncertainty, they demonstrate that based on the adopted catchment RORB parameters, reasonable flows based on catchment area and IFD parameters have been produced. It is also noted that the estimation methods used rely on the now superseded ARR1987 methods and rainfall IFDs.

Table 3-5 Design Flow comparison

	1% AEP Flow (m^3/s)
Rational (Adams)	8.24
Rational (VicRoads)	14.62
RFFE (Rural)	15.50
Grayson (Rural)	19.48

	1% AEP Flow (m^3/s)	
1% AEP RORB Median Ensemble Results (Outlet)		
	Natural	Lined
30 minutes	2.36	5.46
45 minutes	3.84	7.93
1 hour	4.95	9.15
1.5 hour	6.48	10.94
2 hour	7.13	10.52
3 hour	8.24	12.11
4.5 hour	8.44	10.56
6 hour	**9.44**	**12.84**
9 hour	7.94	9.54
12 hour	7.96	9.50
18 hour	6.10	7.34
24 hour	5.15	6.08

3.2.3 Adopted Design Flood Hydrographs

Flows on the various flows paths were extracted immediately upstream of the proposed study area. The adopted peak flows, temporal patterns, and critical durations for the 1%AEP and 1%AEP with climate change conditions (RCP 8.5 year 2090) are shown in Table 3-6.

Table 3-6 Adopted Flows and Temporal Patterns

Critical Storm	Upstream of Bridge (Peak Flow, TP)
1% AEP (Crit duration 6 Hr)	12.84 m^3/s, TP22
1% AEP CC (Crit duration 6 Hr)	16.37 m^3/s, TP22

4 HYDRAULIC MODEL DEVELOPMENT

4.1 Model Schematic

A TUFLOW 2D domain model resolution of 3 m was adopted for the study area based upon the Myrtleford 2022 LiDAR dataset, with the model extending 3 km along the waterways, encompassing an area of 6.9 km^2. A 3 m grid size represents a detailed hydraulic modelling, ensuring the capacity of the waterway and hydraulics is captured in high detail.

The model adopted a single inflow hydrograph from the RORB model at the upstream extent of the model as well as five (5) excess hydrographs from the within the study area as shown in section 3.2.1.1. A downstream boundary was placed upstream of Kiewa Valley Highway, adopting a water level vs flow (stage-discharge) curve automatically calculated based upon a longitudinal gradient of 1 in 100 (estimated from the downstream topography).

To compliment the terrain and define important drainage characteristics of the catchment, a Manning's (n) roughness map was developed based on aerial imagery and planning layers Figure 4-1. The surface roughness represents how rough or smooth the land is which impacts the velocity and depth of water travelling across the surface. Flow across a smoother surface (sealed road) travel faster with subsequent shallower depths as compared to a rougher surface like grass or vegetated surfaces. The adopted roughness layer values are presented in Table 4-1. The adopted schematic is presented in Figure 4-1.

4.1.1 Model Limitation

The hydraulic modelling has been developed to assess flooding across the subject site and in the location of the Project. While culverts and drainage information has been included in key locations, drainage infrastructure information under the existing terminal station was not able to be obtained. As such it is expected that flood mapping produced overstates the inundation over the terminal station. Importantly, the exclusion of this information does not influence flood modelling across the subject site.

Table 4-1 Land Use Manning's 'n' Roughness values

Material	Area Applied	Manning's n Roughness
Paved Roads	Road	0.025
Waterways/Lakes - Minimal Vegetation	Tributaries	0.080
Residential - Urban	Developed Areas	0.150
Open pervious area – Minimal Vegetation	Other	0.040

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

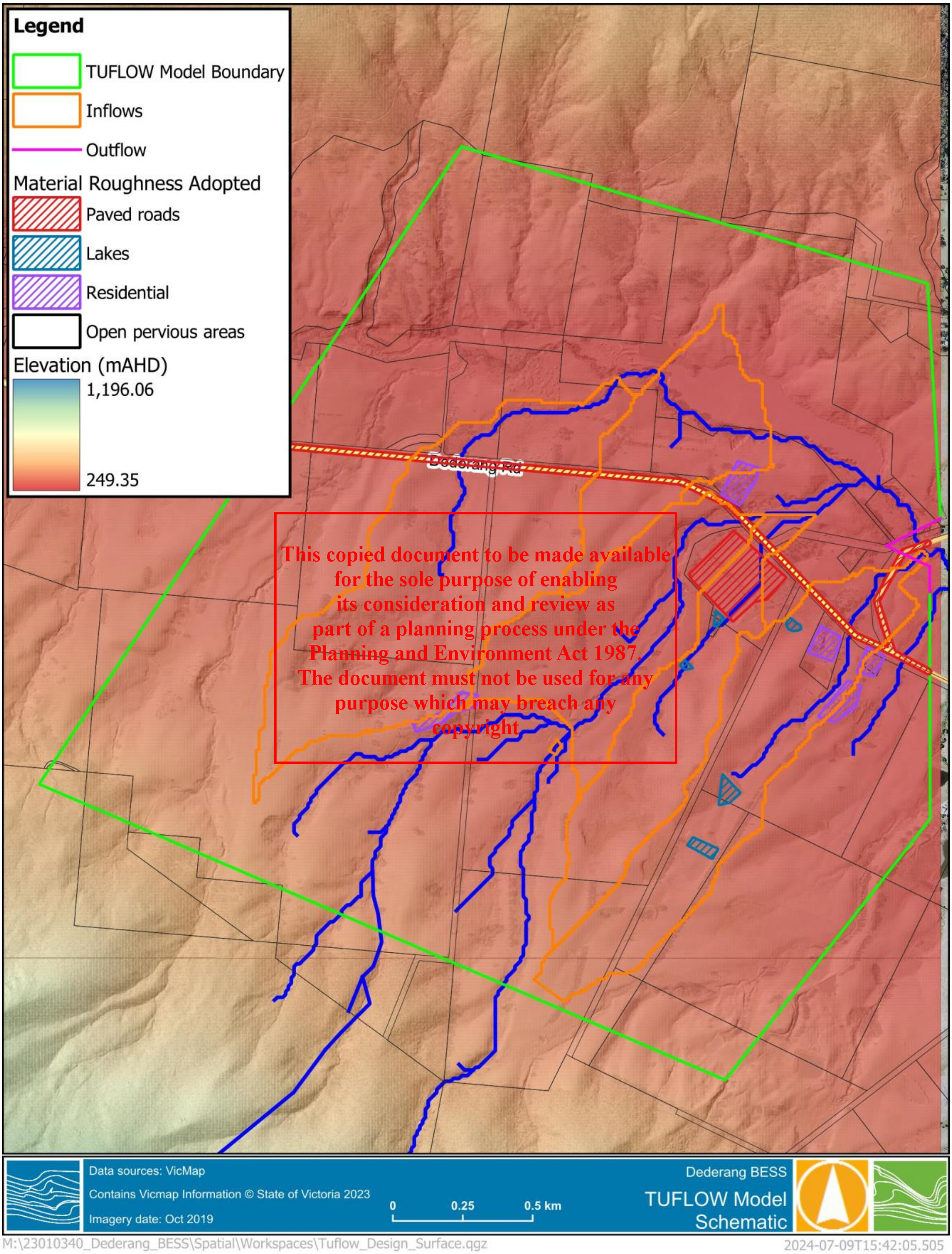


Figure 4-1 TUFLOW Model Schematic

5 HYDRAULIC MODELLING RESULTS

The TUFLOW model was run for the 1% AEP event and 1% AEP climate change conditions (CC - RCP 8.5 year 2090) for all modelled scenarios.

5.1 Flood Hazard Classification

Floods can be hazardous, producing harm to people, damage to infrastructure and potentially loss of life. In examining potential flood hazard, there are several factors to be considered, as outlined in ARR 2019 (Book 6 Chapter 7)[6]. An assessment of flood hazard should consider:

- Velocity of floodwater.
- Depth of floodwater.
- Combination of velocity and depth of floodwater.
- Isolation during a flood.
- Effective warning time.
- Rate of rise of floodwater.

The flood hazard of the site was assessed in accordance with ARR2019, which defines six hazard categories. The combined flood hazard curves are presented in Figure 5-1 and vulnerability thresholds classifications are tabulated in Table 5-1.

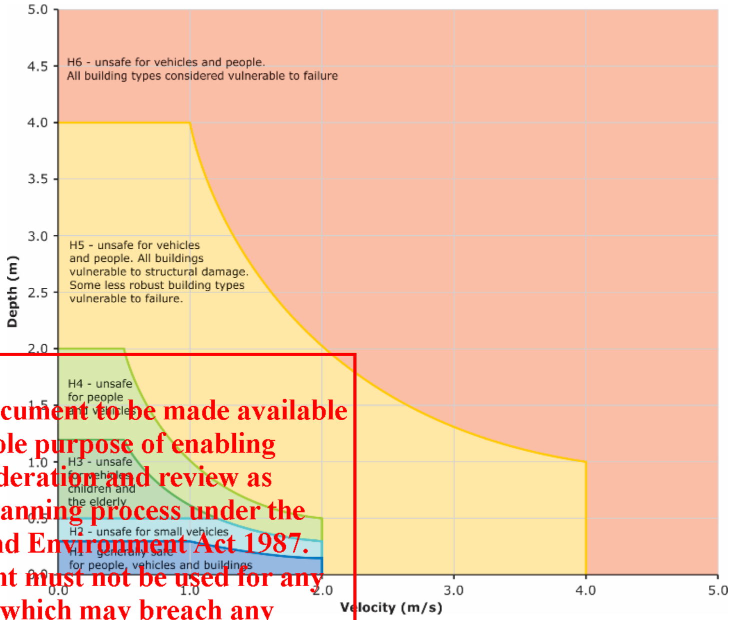


Figure 5-1 Combined flood hazard curves

Table 5-1 Hazard classification (ARR, 2016)

Hazard Vulnerability Classification	Classification Limit	Limiting Still Water Depth (D)	Limiting Velocity (V)	Description
H1	D*V ≤ 0.3	0.3	2.0	Generally safe for vehicles, people and buildings.
H2	D*V ≤ 0.6	0.5	2.0	Unsafe for small vehicles.
H3	D*V ≤ 0.6	1.2	2.0	Unsafe for vehicles. Children and the elderly.
H4	D*V ≤ 1.0	2.0	2.0	Unsafe for vehicles and people.
H5	D*V ≤ 4.0	4.0	4.0	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	D*V > 4.0	-	-	Unsafe for vehicles and people. All building types considered vulnerable to failure.

[6] http://book.arr.org.au.s3-website-ap-southeast-2.amazonaws.com/

5.2 Existing Conditions

Under existing conditions due to the incised nature of the tributaries, flows for all events remain confined to a narrow flow width, all contained within the creeks floodplain. An assessment for each event is provided below:

- 1% AEP event – The flows are confined within Glen Creek tributaries, proposed access roads and BESS Bench. Key hydraulic measures in the vicinity of the BESS bench and Substation bench location includes:
  - Flood depths are up to approximately 1.1m, corresponding a maximum water level of approximately 313.22 m AHD.
  - Velocities are between 0.5 m/s and 3.2 m/s in the vicinity of the tributaries adjacent to the bench sites.
  - The hazard classification in the vicinity of the tributaries range from H1 to H5.
- 1% CC AEP event – The flows are confined within Glen Creek tributaries, proposed access roads and BESS Bench. Key hydraulic measures in the vicinity of the BESS bench and Substation bench:
  - Flood depths are up to approximately 1.2 m, corresponding a maximum water level of approximately 313.24 m AHD.
  - Velocities are in general between 0.5 m/s and 3.7 m/s in the vicinity of the tributaries adjacent to the bench sites.
  - The hazard classification in the vicinity of the tributaries range from H1 to H5.

Flood depths during the 1% AEP and 1% AEP climate change conditions (CC - RCP 8.5 year 2090) events for existing conditions show that property site, proposed access roads and BESS bench experience some inundation. The resulting depth maps are shown in Figure 5-2 and Figure 5-3 respectively.

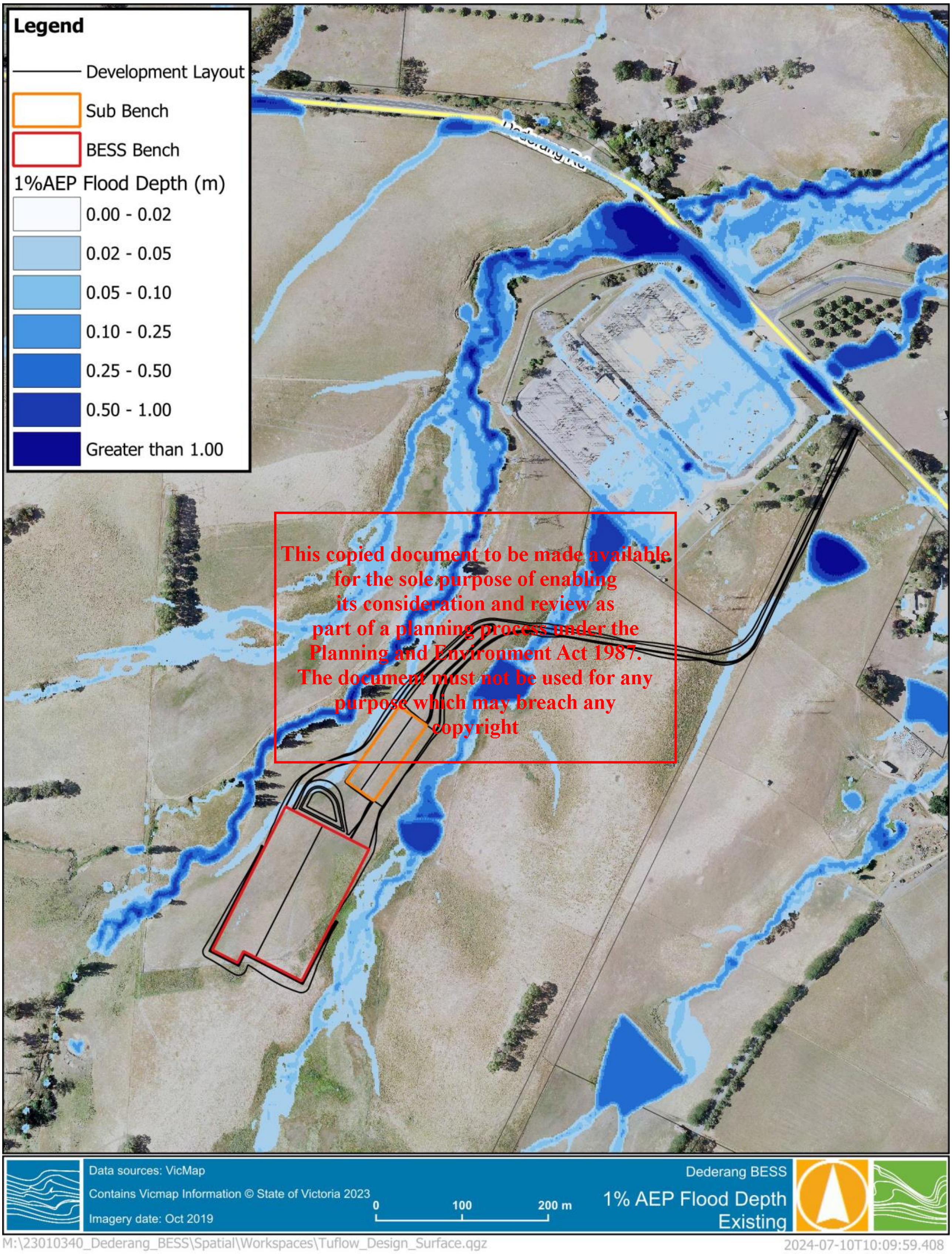
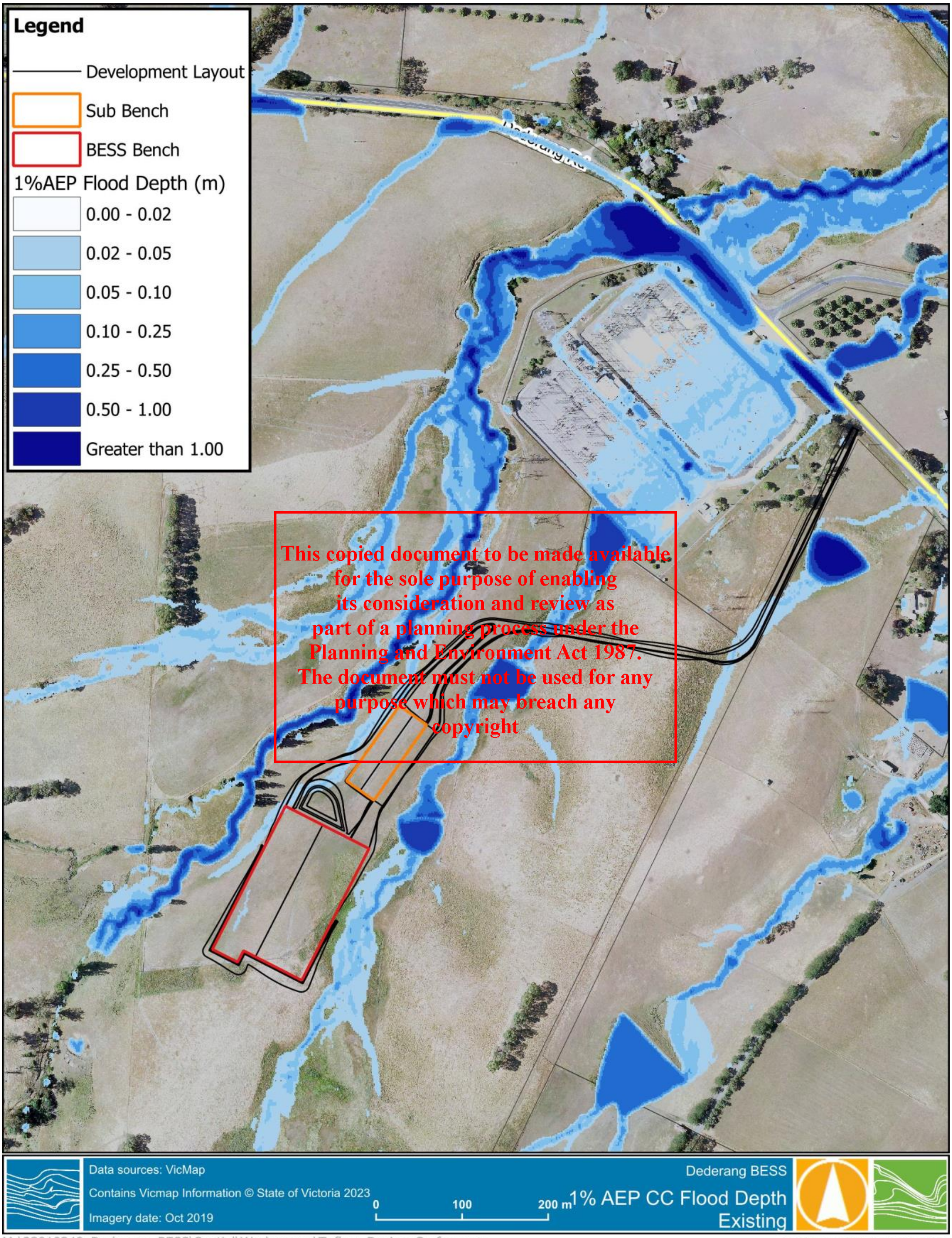


Figure 5-2 1% AEP Maximum Flood Depth (for depths greater than 0.02 m)



M:\23010340_Dederang_BESS\Spatial\Workspaces\Tuflow_Design_Surface.qgz 2024-07-10T10:12:05.312

Figure 5-3 1% AEP Maximum Flood Depth with Climate Change (for depths greater than 0.02 m)

5.3 Developed Hydraulic Model

The proposed development elevations provided by the Proponent, including the Government Road Access Option, were combined with the existing LiDAR data in TUFLOW to produce the 2D domain. The developed model topography is illustrated in Figure 5-4. As per the supplied design, an indicative culvert crossing was added in addition to the design surface. 10 culverts of 2.3m W x 1.4m H were added as per Figure 5-5.

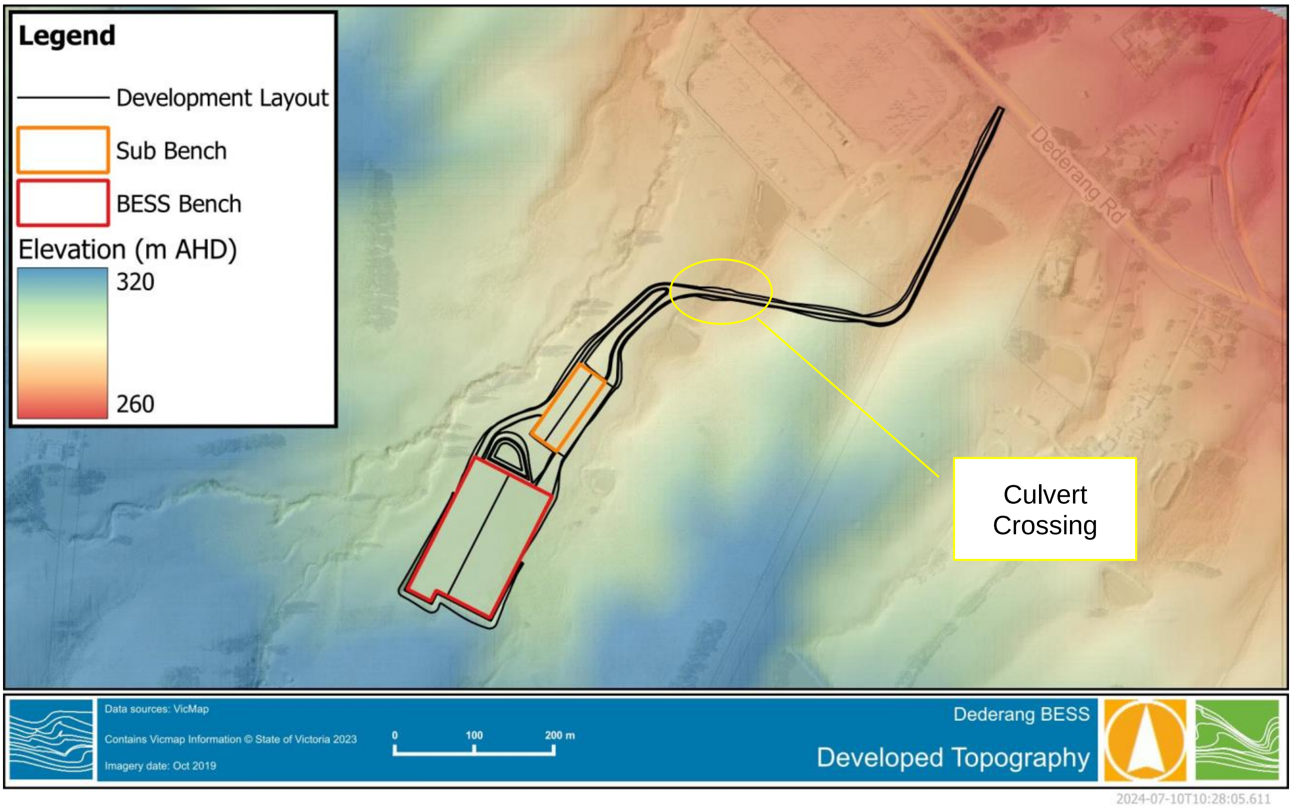


Figure 5-4 Indicative development modelled surface elevations

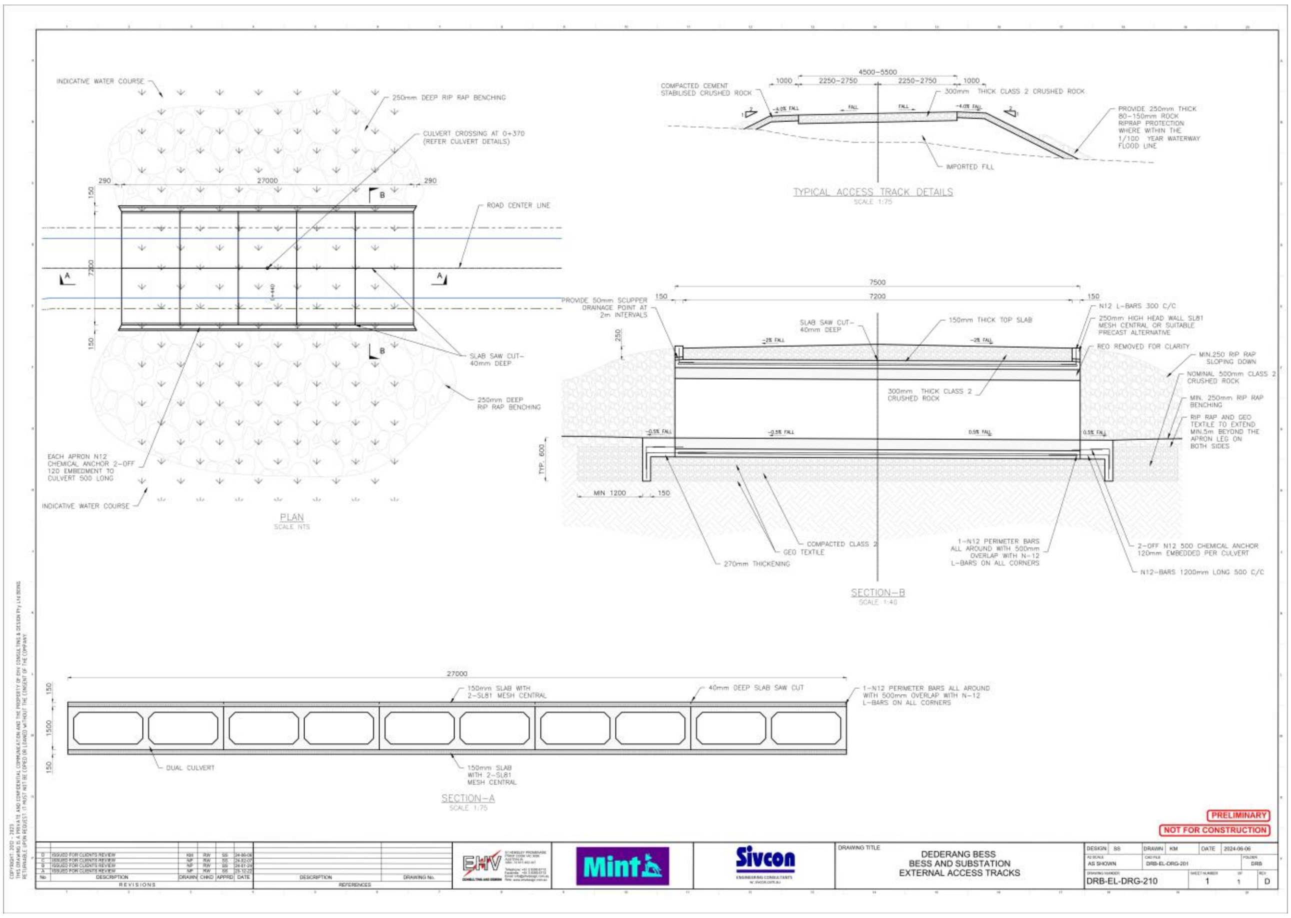


Figure 5-5 Indicative Culvert Specification

5.4 Results

Under developed conditions, due to the nature of primary flow paths, flows remain confined to a narrow flow width, all contained within the creeks floodplain. An assessment for the 1% AEP event is shown below. The flows are confined within Glen Creek tributaries and proposed access roads. Key hydraulic measures in the vicinity of the BESS bench and Substation bench location includes:

- Flood depths are up to approximately 1.0m, corresponding a maximum water level of approximately 313.21 m AHD.
- Velocities are between 0.5 m/s and 3.4 m/s in the vicinity of the tributaries adjacent to the bench sites.
- The hazard classification in the vicinity of the tributaries range from H1 to H5. The hazard classification at the access road crossings are H1 and below, which is generally safe for vehicles, people and buildings.

Flood depths during the 1% AEP event for developed conditions show that property site and access roads experiences some inundation, but the BESS bench and Substation bench does not indicate any inundation. The resulting depth, water surface elevation, velocity and hazard maps are shown in Figure 5-6 to Figure 5-9.

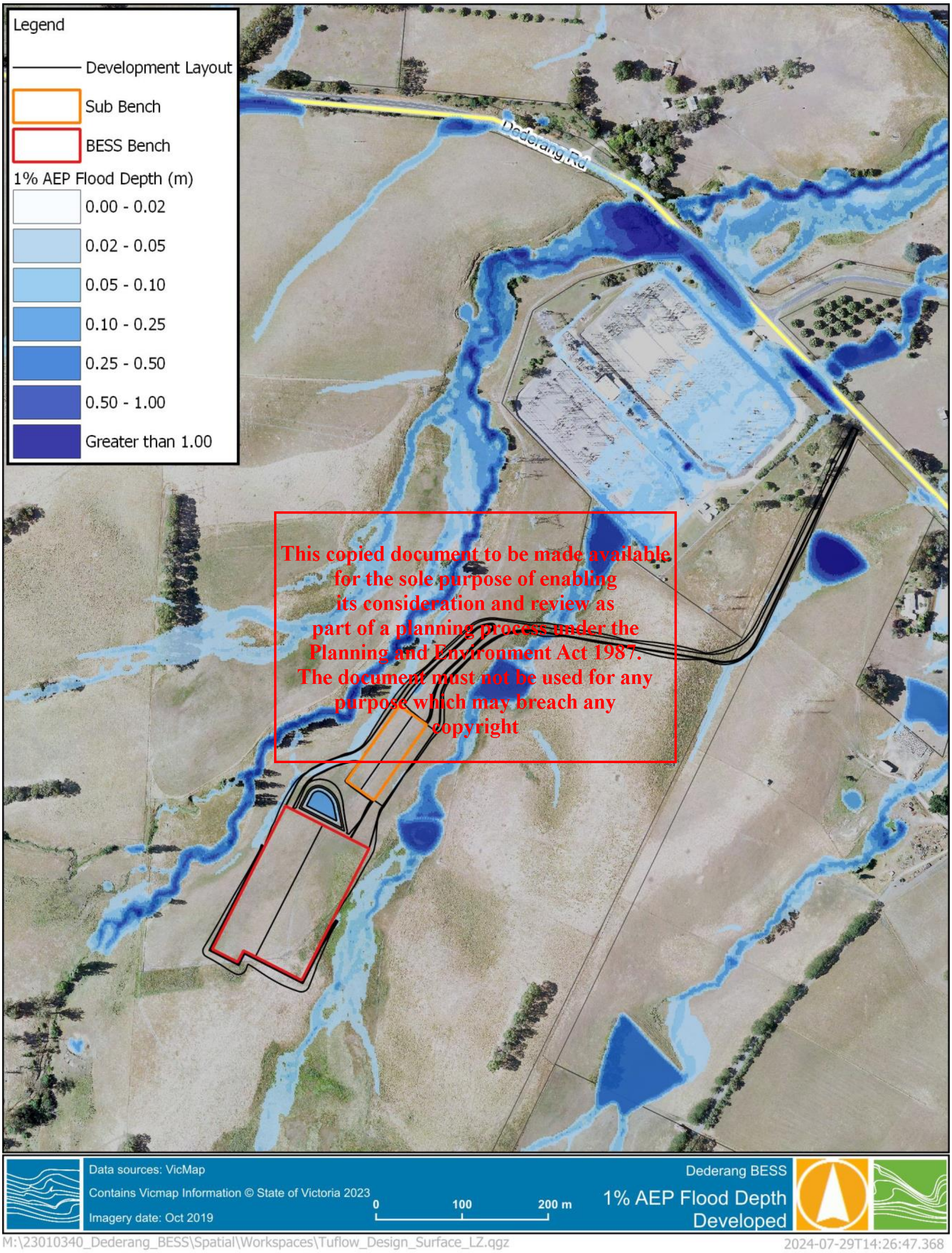


Figure 5-6 1% AEP Flood Depth – Indicative Developed Conditions

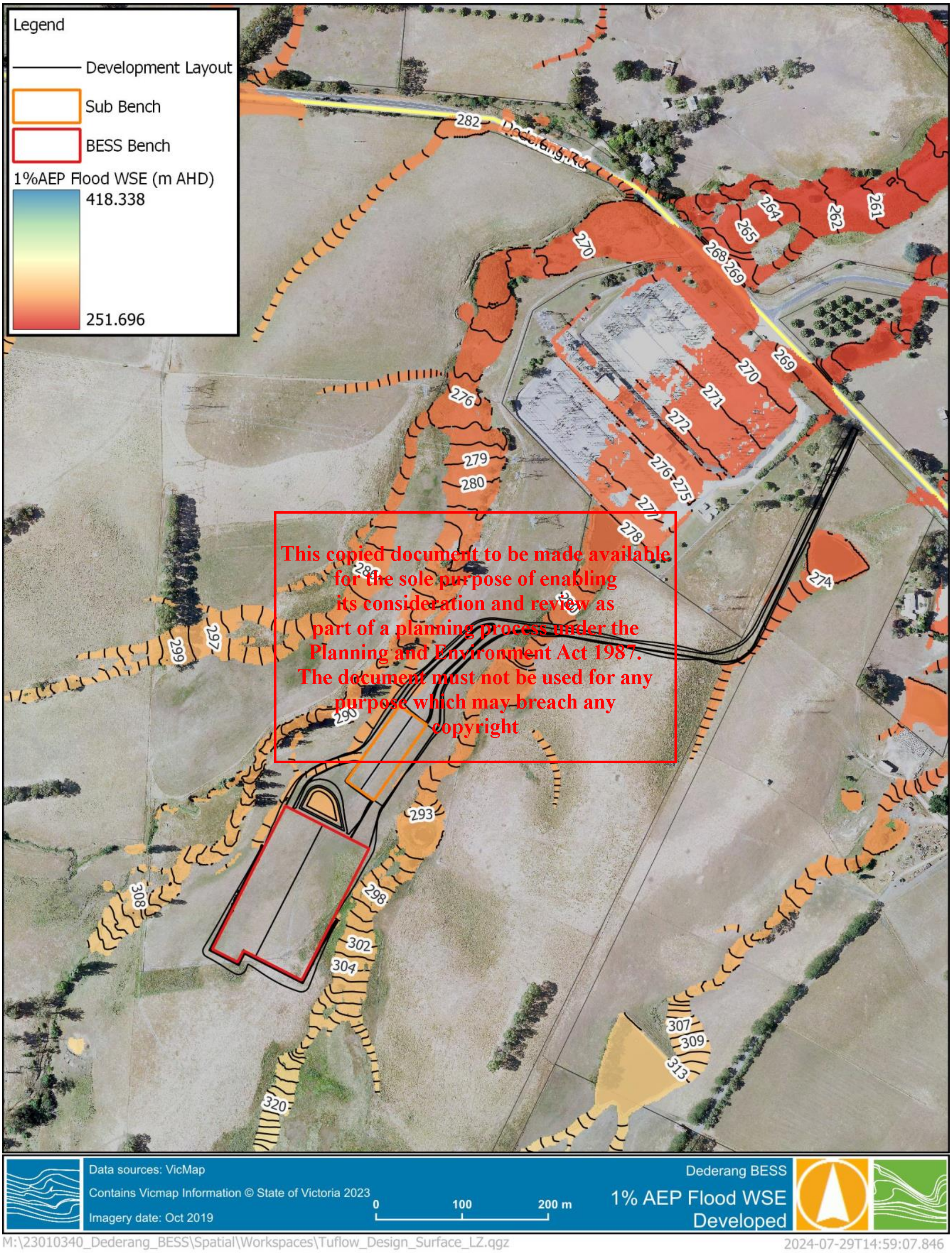


Figure 5-7 1% AEP Flood Water Surface Elevation – Indicative Developed Conditions

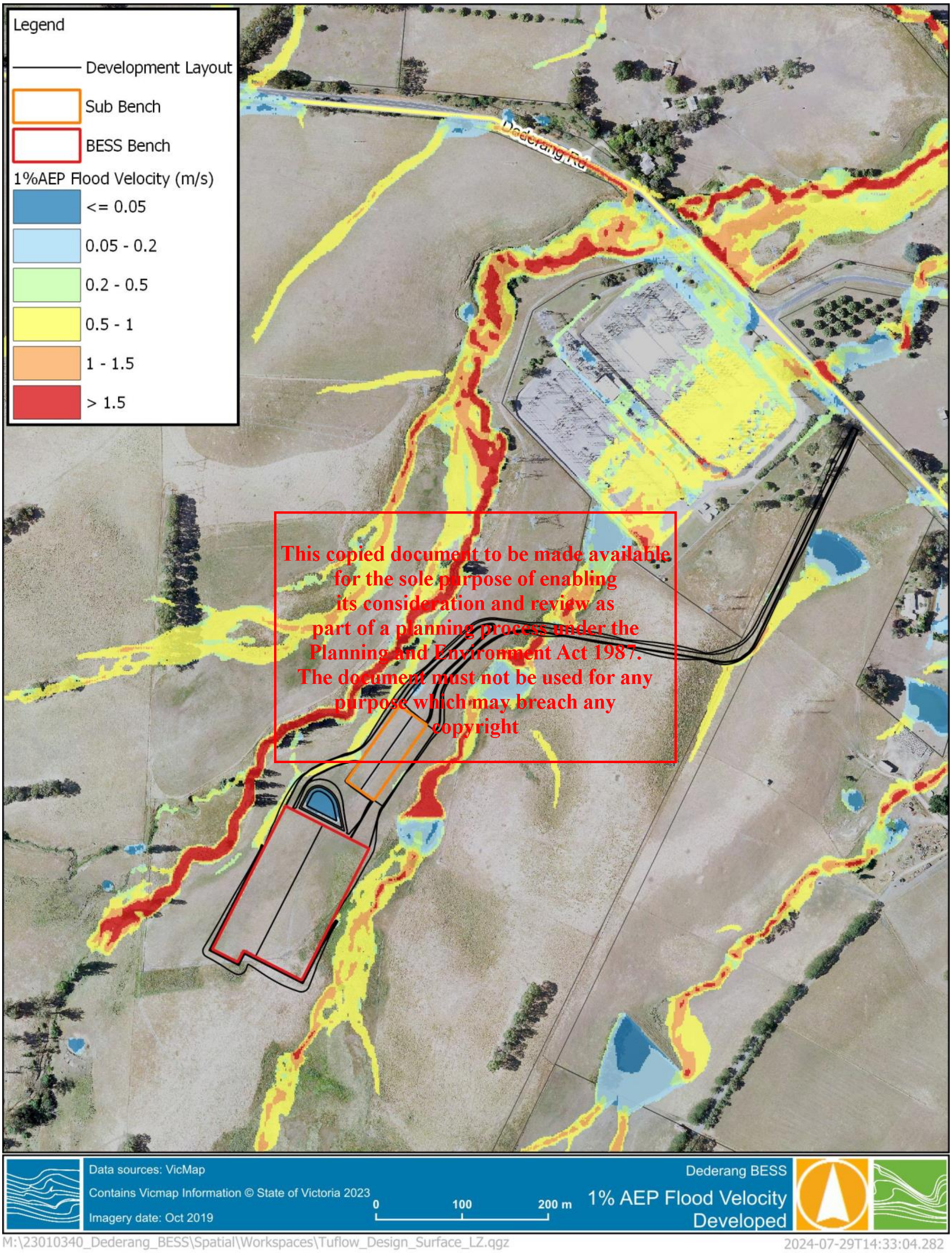


Figure 5-8 1% AEP Flood Velocity – Indicative Developed Conditions

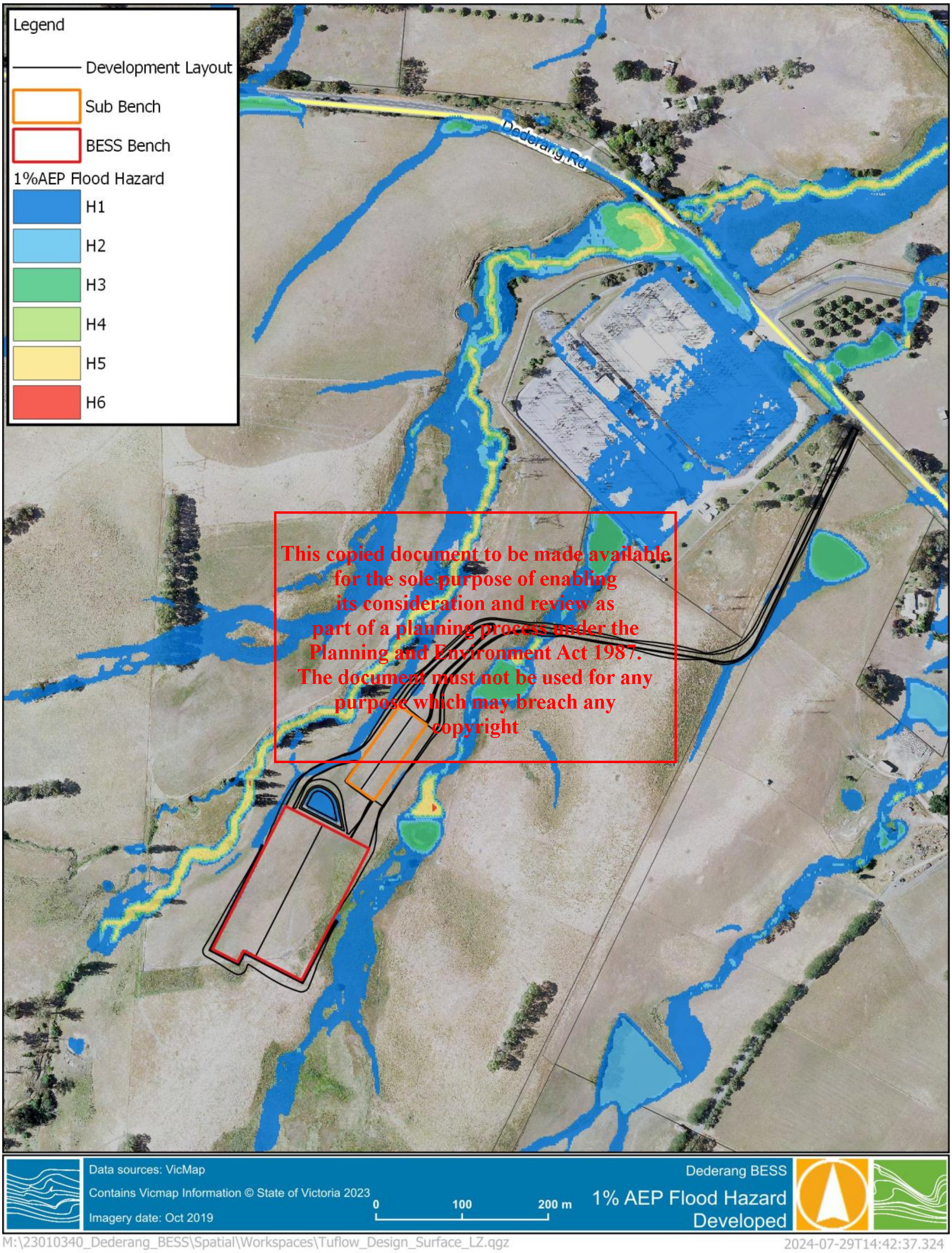


Figure 5-9 1% AEP Flood Hazard – Indicative Developed Conditions

5.5 Climate Change Results

When considering the 1% CC AEP event, the flows are confined within Glen Creek tributaries, with depths varying up to 1.20 m along the waterway. Key hydraulic measures in the vicinity of the BESS bench and Substation bench:

- Flood depths are up to approximately 1.2m, corresponding a maximum water level of approximately 313.22 m AHD.
- Velocities are between 0.5 m/s and 3.5 m/s in the vicinity of the tributaries adjacent to the bench sites.
- The hazard classification in the vicinity of the tributaries range from H1 to H5. The hazard classification at the access road crossings are H1 and below, which is generally safe for vehicles, people and buildings.

Flood depths during the 1% AEP climate change conditions (CC - RCP 8.5, year 2090) event for developed conditions show that property site and access roads experiences some inundation, but the BESS bench and Substation bench does not indicate any inundation. The resulting depth, water surface elevation, velocity and hazard maps are shown in Figure 5-10 to Figure 5-13.

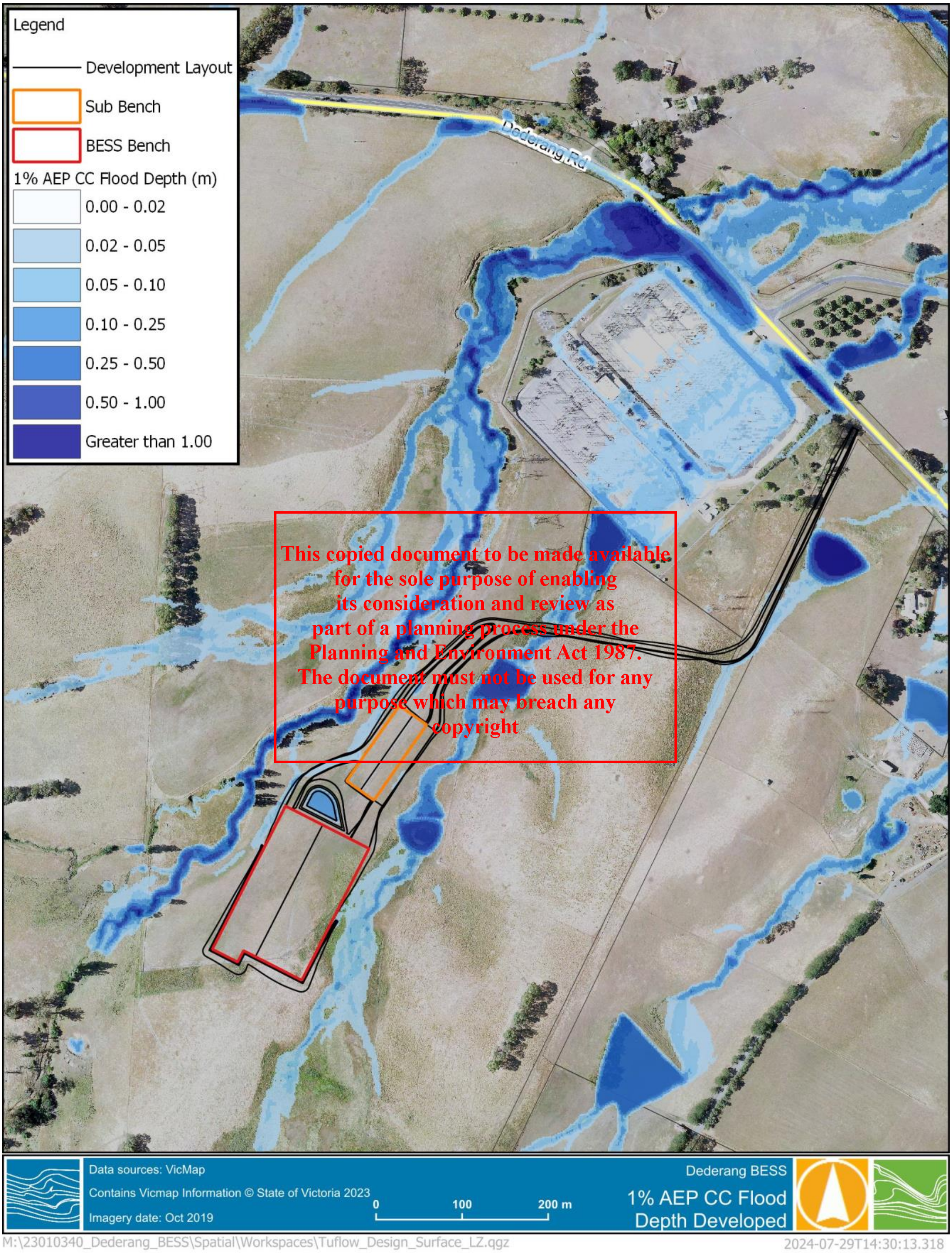


Figure 5-10 1% AEP Flood Depth CC – Indicative Developed Conditions

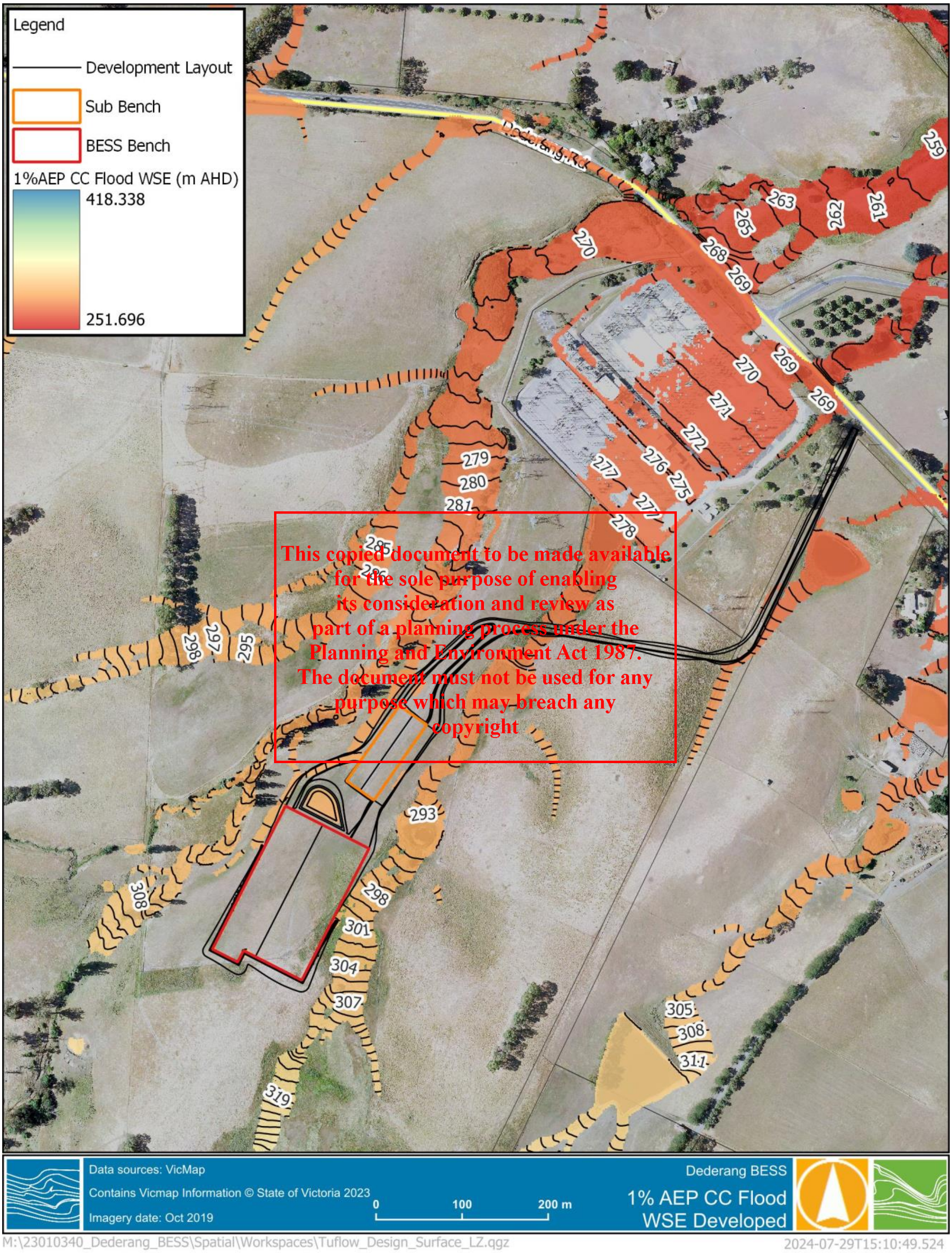


Figure 5-11 1% AEP Flood Water Surface Elevation CC – Indicative Developed Conditions

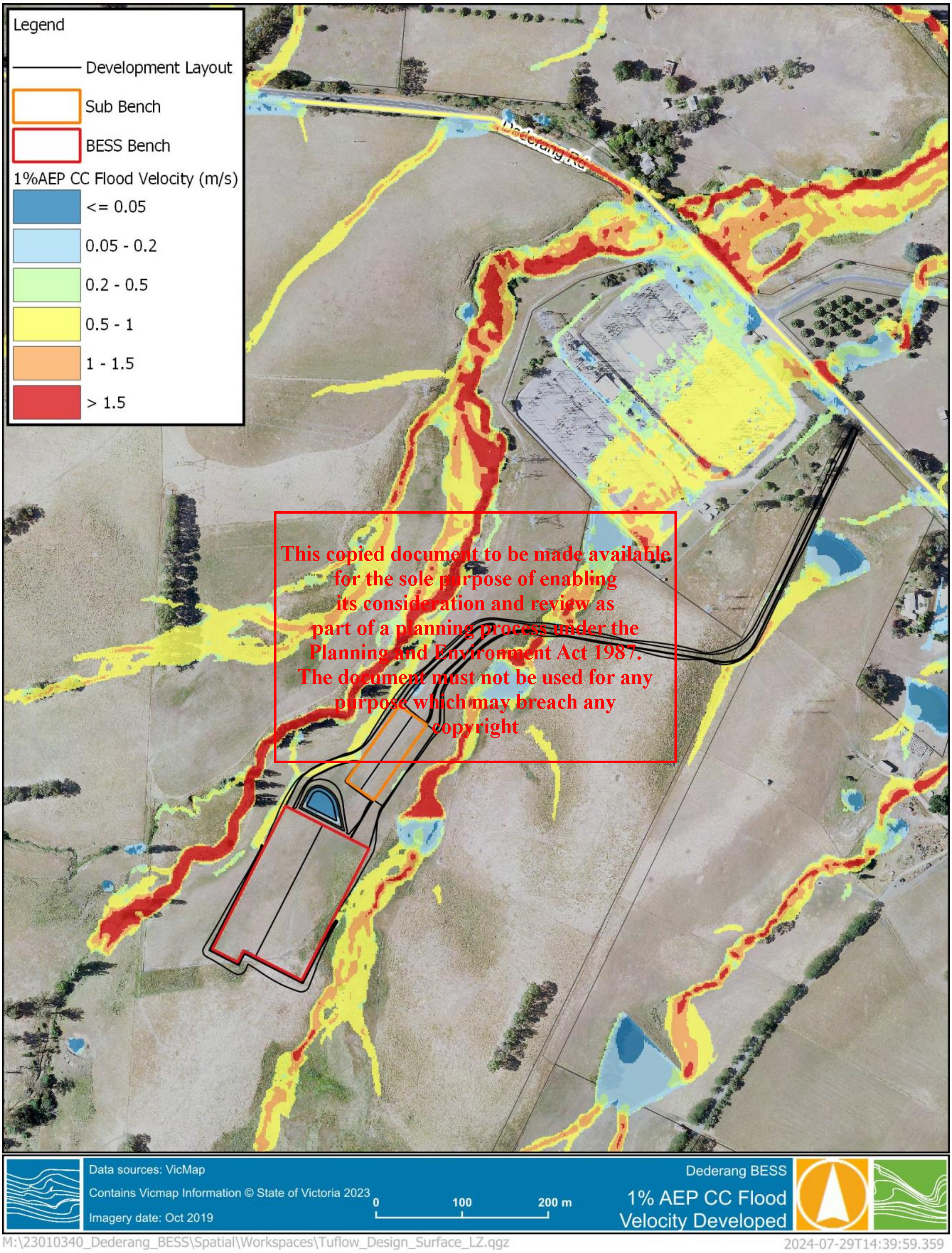


Figure 5-12 1% AEP Flood Velocity CC – Indicative Developed Conditions

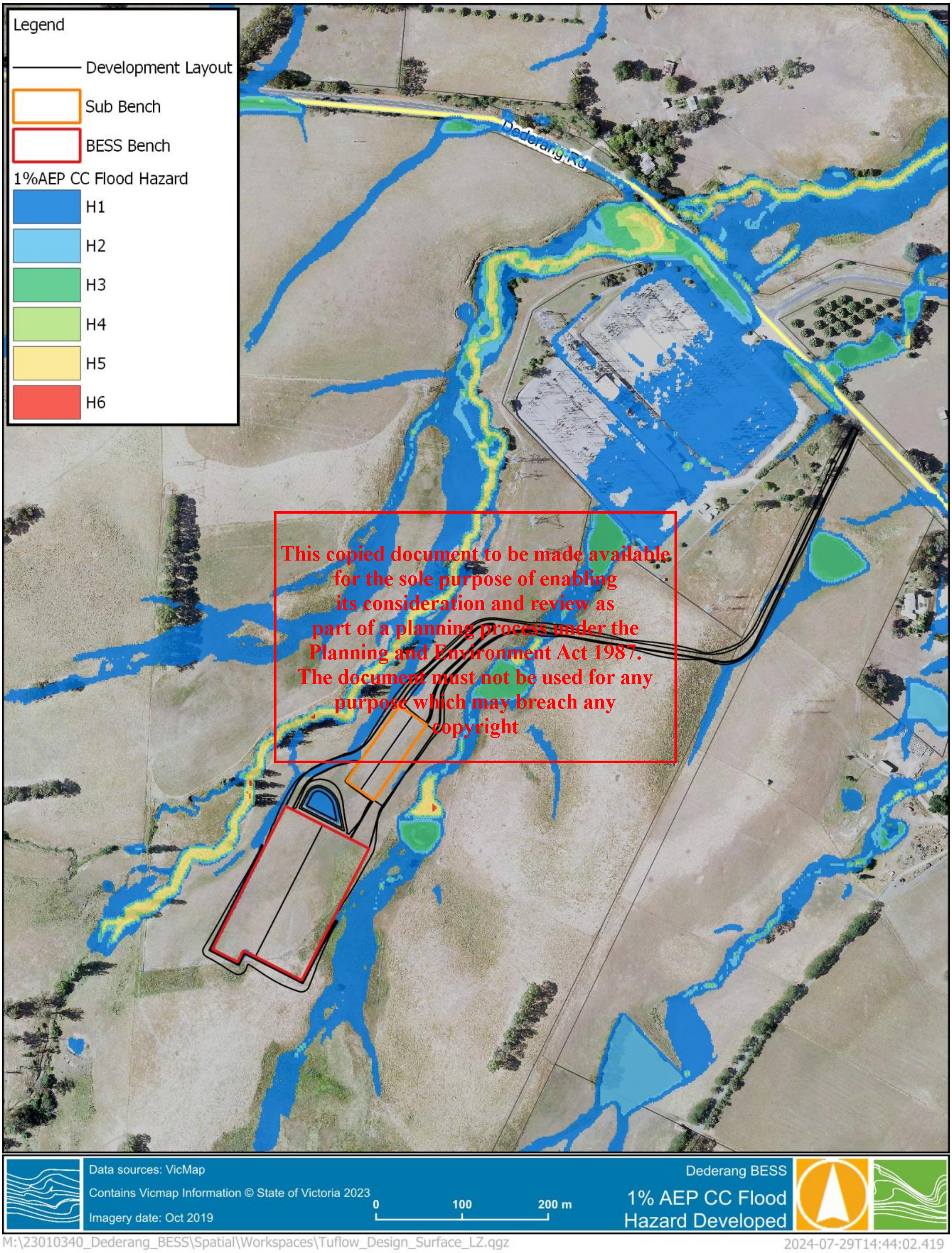


Figure 5-13 1% AEP Flood Hazard CC – Indicative Developed Conditions

5.6 Afflux Assessment

Existing and developed depths were compared for the 1% AEP critical duration (6-hour) and 1% AEP with climate change events to highlight any impact the proposed development may have neighbouring properties. This comparison was determined by subtracting the existing conditions flood depths from the developed conditions, as shown in the equation below.

$$Change\ in\ Flood\ Depth = Developed\ Conditions\ Flood\ Depth - Existing\ Conditions\ Flood\ Depth$$

Increases in flood depths as a result of the proposed development occur for the critical duration event but are largely confined to Glen Creek tributaries and access roads. The depth at the access road and creek crossing increases 1.3m for the 1% AEP event and 1.35m for the 1% AEP event with climate change.

For both events, previously inundated areas within the BESS bench footprint are now dry and the flow path of tributaries across the proposed access roads have been realigned. These changes are minor and are not considered to adversely influence flood behaviour. The remainder of the site is largely unchanged.

The afflux mapping for the 1% AEP and 1% AEP with climate change events is shown in Figure 5-14 and Figure 5-15 respectively.

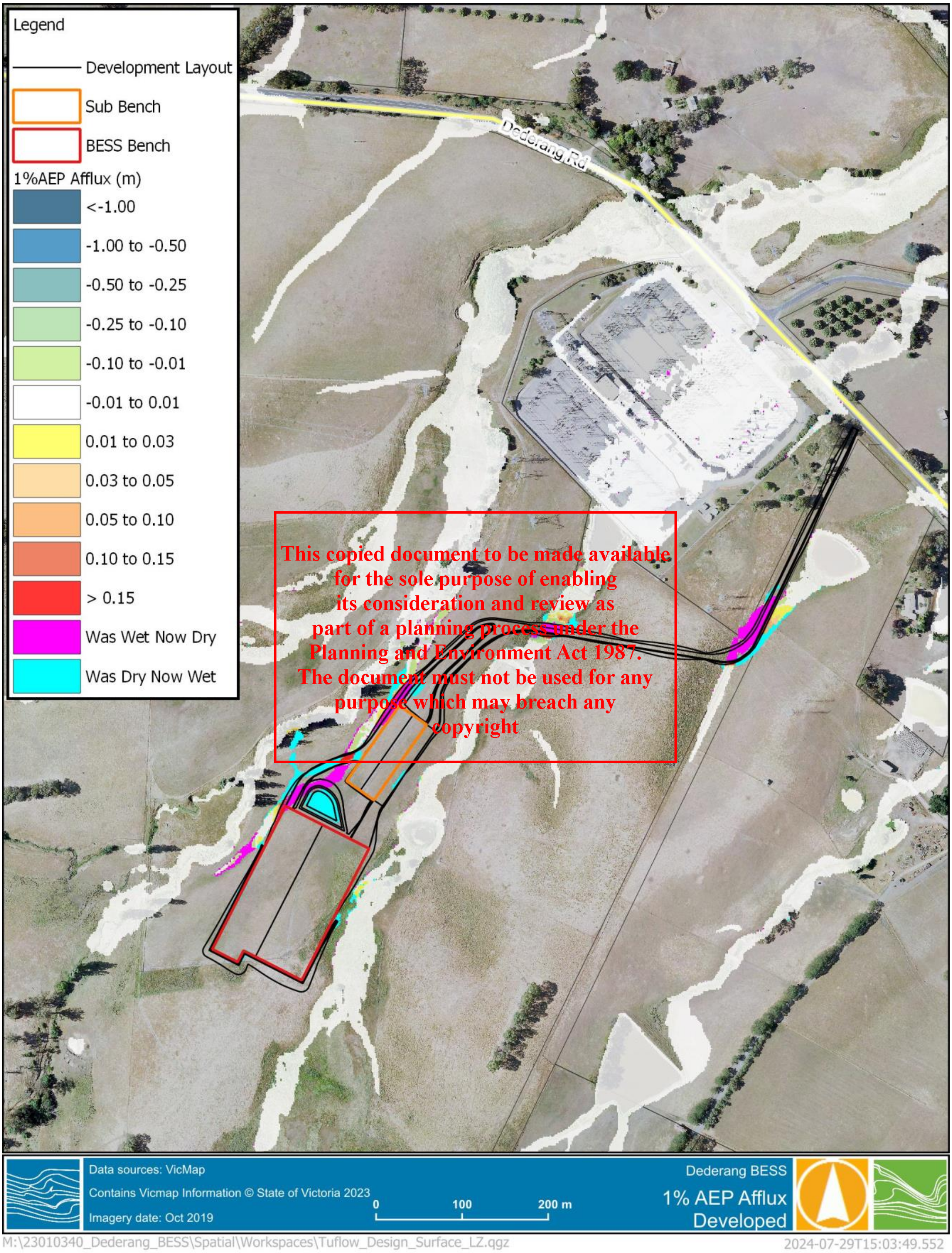


Figure 5-14 1% AEP Flood Level Difference

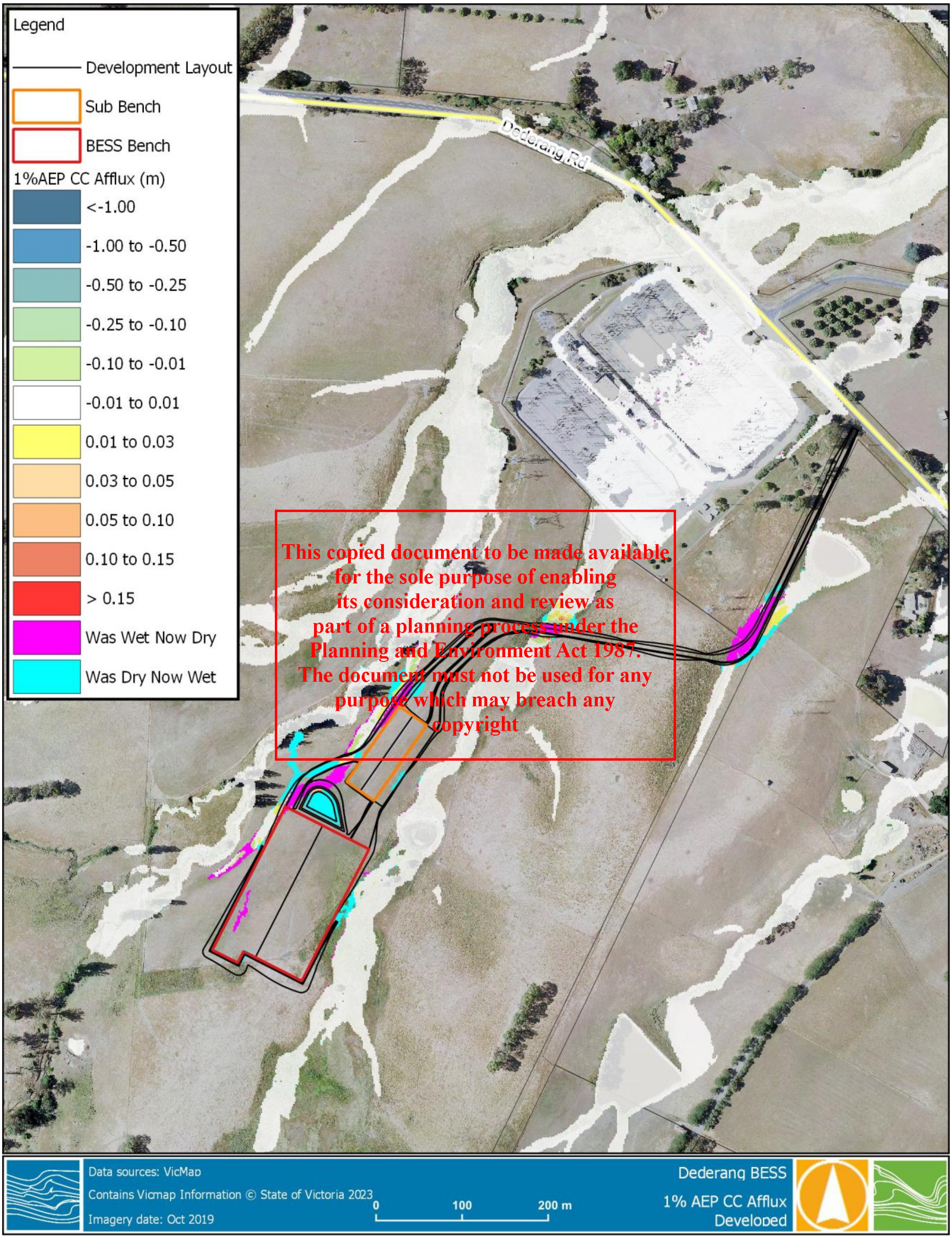


Figure 5-15 1% AEP Flood Level Difference CC

6 STORM WATER QUALITY MANAGEMENT RECOMMENDATIONS

The Project will be required to manage, treat and control stormwater run-off from various hardstand areas within the site. This section provides advice on stormwater water quality management, that can inform a formal Stormwater Water Quality Management Plan (SWMP) during further design phases. Standard developments are required to treat and manage stormwater run-off in line with Best-Practice Environmental Management Guidelines (BPEM). The Project will need to meet the following minimal objectives (during normal operation):

- 80% retention in Total Suspended Solids (TSS).
- 45% retention in Total Phosphorus (TP)
- 45% retention in Total Nitrogen (TN)
- 70% reduction in Litter
- Maintain discharges for the 1 in 1.5-year ARI flow rate at pre-development levels.
- Maintain discharge rate for the 1 in 100-year ARI flow rate at pre-development levels.

There are several methods that are generally used to meet the required objectives, including a water quality treatment asset and a suitable retarding basin and pit design to control flows to pre-developed rates. For the Project it is expected that traditional water quality assets requiring a significant footprint will be unsuitable due to the catchment size and availability of land. Therefore, water quality will have to be managed by alternatives methods. There are several ways and / or proprietary systems which can be utilized to achieve stormwater quality objectives. It is understood that water quality treatment will be considered during further design phases.

Based upon the indicative design layout for the Project the following recommendations are made, with preferred drainage layout is provided in Figure 6-1.

- All external catchment areas draining to the Project are intercepted by bunding and drains and directed to neighbouring waterways. The current plan has a 3 m swale drain proposed to capture these external flows.
- All hardstand and developed areas are designed to drain to retention basins prior to draining to neighbouring areas.
- Areas onsite which drain directly to waterway's will be rehabilitated to provide supplementary water quality treatment.

Flows will be required to be retarded to pre-development flows via the suitable sizing and design of storages. A high-level Boyd calculation has been undertaken to provide indicative volumes required for retardation. This assessment split the site into two catchments. The BESS area of 2.22 ha will drain to the currently proposed retention basin and the Substation area of 0.60 ha will drain to the currently proposed sediment basin. An area of 0.35 ha across the site will be rehabilitated and drain directly to neighbouring waterways.

The external catchment flows were directed around the site to neighbouring waterways. To ensure the basins are adequately sized for both the 1 in 1.5 YR ARI and 1 in 100 YR ARI, both events were assessed. The required storage volume is based on a comparison between pre and post development flows rates. Based upon this analysis, storage volumes of at least 500 m^3 and 125 m^3 are required for the southern and northern basins respectively as shown in Table 6-1.

The existing proposed basin within the BESS catchment (~900 m^3 as shown in Figure 2-1) exceeds the 500 m^3 and contains sufficient headroom for additional volume necessary for firefighting, understood to be sized by another consultancy. The required substation basin is expected to be able to fit in between the proposed access roads. The catchments are shown in Figure 6-1 with the findings of the assessment provided in Table 6-1 and Table 6-2.

A summary of considerations for the future stormwater management plan (SWMP) of the Project to be resolved as part of future design phases includes :

- The external drainage network to be designed to convey overland flow paths around the site.
- The Internal drainage network (pipes and overland flow paths) to be designed to convey up to the 1% AEP event for the site to retarding basins / assets.
- The retarding basins / assets are to be designed to have sufficient storage as shown in Table 6-1 and Table 6-2.
- The retarding basins / assets to have outlet configuration which reduce developed flows rate back to pre-development rates for both the 1 in 1.5 YR and 1 in 100 YR ARI events.
- The retarding basins / assets to have sufficient storage capacity for stormwater runoff and firefighting water run off.
- Water quality treatment will be required to ensure discharge from the site meets state guidelines (in line with SEPP and BPEM).

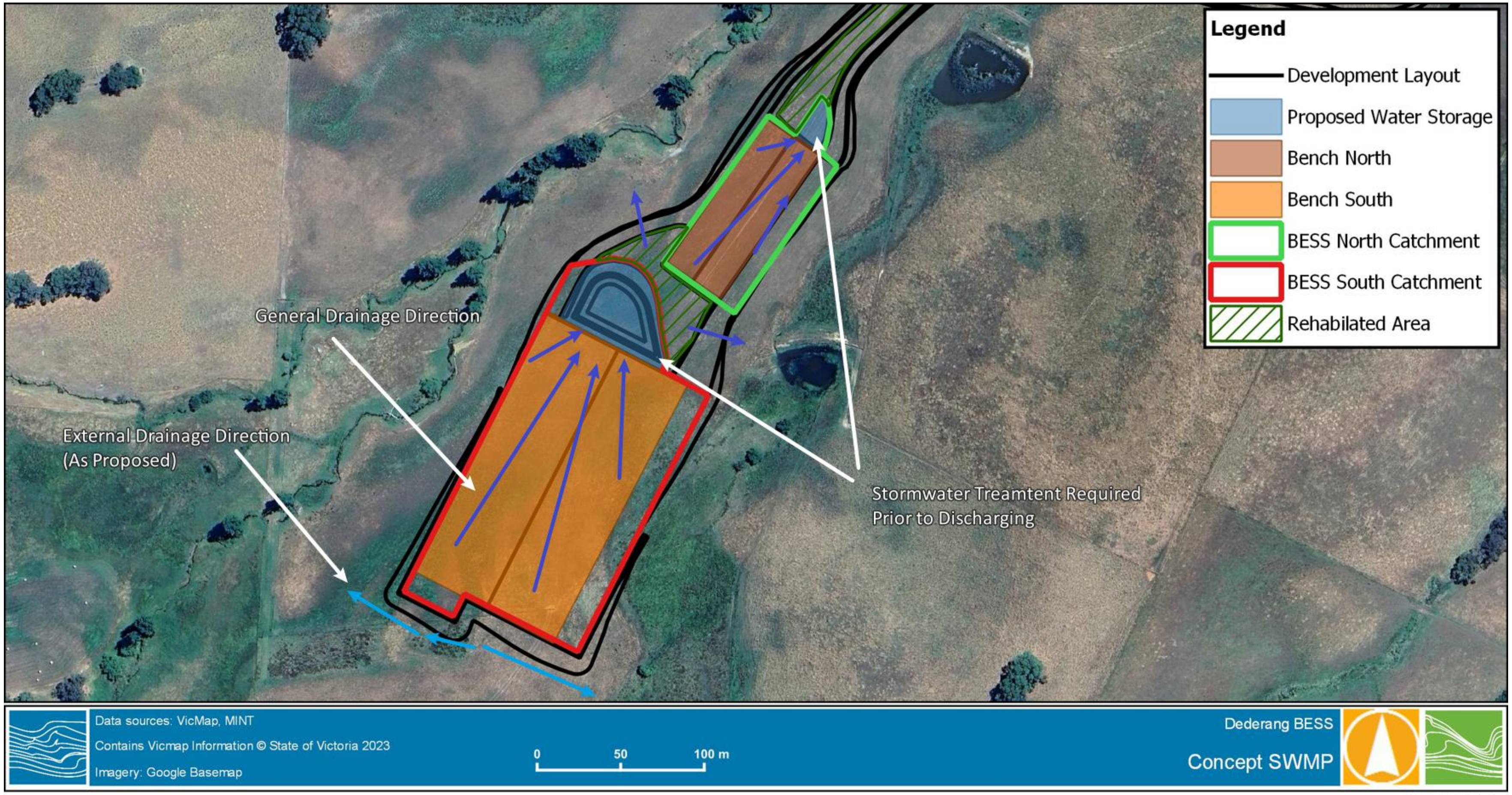


Figure 6-1 Indicative Concept Drainage Layout

Table 6-1 1 in 1.5 YR ARI Boyd's Calculation

Catchment	Area (ha)	Fraction Impervious	Post-Development Flow Rate	Existing Development Flow Rate	Minimum Required Storage (m^3)
Substation	0.6	0.9	0.07 m^3/s	0.02 m^3/s	40 m^3
BESS	2.22	0.9	0.22 m^3/s	0.07 m^3/s	155 m^3

Table 6-2 1 in 100 YR ARI Boyd's Calculation

Catchment	Area (ha)	Fraction Impervious	Post-Development Flow Rate	Existing Development Flow Rate	Minimum Required Storage
Substation	0.6	0.9	0.23 m^3/s	0.07 m^3/s	125 m^3
BESS	2.22	0.9	0.74 m^3/s	0.22 m^3/s	500 m^3

7 SUMMARY

This report details the findings of a surface water and concept SWMP assessment for the Dederang BESS site. The assessment undertaken detailed hydraulic modelling based on the Project indicative civil plan, utilising an unused Government Road to access the site. Following the results of this investigation, the following conclusions can be made:

- The indicative design for the Project will slightly encroach the eastern 30 m waterway buffer, this encroachment is not considered to threaten the health or function of the waterway.
- Under developed conditions for the 1% AEP event and 1% AEP climate change conditions (CC - RCP 8.5 year 2090) , flows for all events remain confined to a narrow flow width, all contained within the incised creeks floodplain. The flows are confined within the Glen Creek tributaries and proposed access roads. The key findings of the flood modelling include:
  - Flood depths are up to approximately 1.2m maximum, corresponding to a maximum water level of approximately 313.22 m AHD.
  - Velocities are between 0.5 m/s and 3.5 m/s in the vicinity of the tributaries adjacent to the bench sites.
  - The hazard classification in the vicinity of the tributaries range from H1 to H5. The hazard classification at the access road crossings is H1 and below, which is generally safe for vehicles, people and buildings.
- In terms of flooding considerations in any post-development scenario, it is important to note that:
  - *Objective* - Flood safety hazard is not increased to a detrimental level
    - **Outcome –** achieved by the proposed plan.
  - *Objective* - There is no increase in flood levels on adjoining properties.
    - **Outcome** – achieved by the proposed plan.
  - *Objective* - There is no loss of conveyance
    - **Outcome** – the proposed plan causes minor changes to conveyance over site, however not off-site impact.
  - *Objective* - Access is maintained
    - **Outcome** – achieved by the proposed plan. It is noted that safe access will be achieved irrespective of which access track is adopted (AusNet or Government Road).
- The Project will be required to be designed to manage and treat stormwater run-off. Advice on stormwater management is provided in Section 6, this advice will be required to be developed into a formal SWMP prior to commencement of the Project.

Based on the assessment completed, the Project site is expected to be able to satisfy criteria for appropriate management of water quality and flood impacts.

Melbourne

15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800

Sydney

Suite 3, Level 1, 20 Wentworth Street
Parramatta NSW 2150
Telephone (02) 9354 0300

Brisbane

Level 5, 43 Peel Street
South Brisbane QLD 4101
Telephone (07) 3105 1460

Adelaide

1/198 Greenhill Road
Eastwood SA 5063
Telephone (08) 8378 8000

Perth

Level 1, 21 Adelaide Street
Fremantle WA 6160
Telephone (08) 6555 0105

New Zealand

7/3 Empire Street
Cambridge New Zealand 3434
Telephone +64 27 777 0989

Wangaratta

First Floor, 40 Rowan Street
Wangaratta VIC 3677
Telephone (03) 5721 2650

Geelong

51 Little Fyans Street
Geelong VIC 3220
Telephone (03) 8526 0800

Wimmera

597 Joel South Road
Stawell VIC 3380
Telephone 0438 510 240

Gold Coast

Suite 37, Level 4, 194 Varsity Parade
Varsity Lakes QLD 4227
Telephone (07) 5676 7602

watertech.com.au