

Final Report

Central Road Drysdale – Stormwater Management Plan

MCLEODS DEVELOPMENTS PTY LTD

May 2019





Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
V02	Draft Report	CBD	CBD	04/07/2017
V03	Final	CBD	BFS	06/07/2017
V04	Final	WAB	BFS	11/07/2017
V05	Final	JLS	BFS	19/12/2017
V06	Final	TJC	TJC	24/05/2019

Project Details

Project Name	Central Road Drysdale – Stormwater Management Plan
Client	MCLEODS DEVELOPMENTS PTY LTD
Client Project Manager	Gareth Bellchambers
Water Technology Project Manager	Bertrand Salmi
Water Technology Project Director	Luke Cunningham
Authors	Bertrand F. Salmi
Document Number	4663-01_R01v06



COPYRIGHT

Water Technology Pty Ltd has produced this document in accordance with instructions from MCLEODS DEVELOPMENTS PTY LTD for their use only. The concepts and information contained in this document are the copyright of Water Technology Pty Ltd. Use or copying of this document in whole or in part without written permission of Water Technology Pty Ltd constitutes an infringement of copyright.

Water Technology Pty Ltd does not warrant this document is definitive nor free from error and does not accept liability for any loss caused, or arising from, reliance upon the information provided herein.

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



4663-01_R06b



CONTENTS

1	INTRODUCTION	5
2	BACKGROUND	6
2.1	Existing Flood Risk	6
2.2	Designated Waterways	7
2.2.1	Site constraints and conditions	8
3	RETARDING BASINS	10
3.1	Hydrological Analysis	10
3.2	Retarding Basin Sizing	14
3.3	Interim Arrangement	15
4	FLOOD MODELLING	17
4.1	Existing Conditions	17
4.2	Development Scenario	19
5	WATER QUALITY MANAGEMENT	22
5.1	Catchment Analysis	23
5.2	Water Quality Assets	24
5.3	Water Quality Benefits	25
5.3.1	Rainwater Tanks	26
6	SURFACE WATER STRATEGY	27
6.1	Existing Conditions	27
6.2	Post-Development	32
6.3	Shared Footpath	40
7	SUMMARY	44

APPENDICES

Appendix A – Stage / storage relation

LIST OF FIGURES

Figure 2-1 – Subject Site	6
Figure 2-2 – Preliminary Flood Modelling Results Extent (1%AEP)	7
Figure 2-3 – Preliminary Flood Modelling Results – Jetty Road (1%AEP)	8
Figure 3-1 – Upstream Catchment Delineation	10
Figure 3-2 – Subject Site Catchment Delineation	11
Figure 3-3 – Properties within Special Charge Scheme	12
Figure 3-4 – Retarding Basins and Contributing Catchments	14

4663-01_R06b



Figure 4-1 – Model Extent	17
Figure 4-2 – Draft Framework Plan (Source: St Quentin)	19
Figure 4-3 – Development Model Extent - Site	20
Figure 4-4 – Development Model Extent - Jetty Road	21
Figure 5-1 - MUSIC Model Layout	23
Figure 6-1 – Indicative 1% AEP Flood Extent (1 hour duration)	27
Figure 6-2 – Indicative 1% AEP Flood Extent - Jetty Road (1 hour duration)	29
Figure 6-3 – Indicative 1% AEP Flood Velocities - Jetty Road (1 hour duration)	30
Figure 6-4 – Indicative 1% AEP Flood Hazard - Jetty Road (1 hour and 12 hour durations)	31
Figure 6-5 – Indicative Post-Development 1% AEP Flood Extent (1 hour duration)	32
Figure 6-6 – Indicative Post-Development 1% AEP Flood Extent - Jetty Road (1 hour duration)	34
Figure 6-7 – Water Surface Elevation Difference Plot between Existing and Developed Conditions (1 hour)	35
Figure 6-8 – Water Surface Elevation Difference Plot between Existing and Developed Conditions (12 hour)	36
Figure 6-9 – Post-Development Flood Velocities	38
Figure 6-10 – Post-Development 100% AEP Flood Hazard - Jetty Road (1 hour and 12 hour durations)	39
Figure 6-11 – Indicative 10% AEP Flood Extent (9 hour duration)	41
Figure 6-12 – Schematic of a drown-out arrangement (source Melbourne Water’s Shared Pathways Guidelines)	42

LIST OF TABLES

Table 3-1 – IDF Parameters	13
Table 3-2 – Key RORB Modelling Parameters	13
Table 3-3 – Existing and Developed Flows for Critical Storm Duration	14
Table 3-4 – 100 Year ARI Existing and Developed Retarded Flows (Critical Storm Duration)	15
Table 3-5 – Retarding Basin Details	15
Table 4-1 – Key Modelling Information	18
Table 5-1 – Catchment delimitation and fraction effective impervious	23
Table 5-2 – Proposed WSUD Assets	24
Table 5-3 – MUSIC Modelling Results	25
Table 6-1 – Flood Safety Hazard Risk	28
Table 6-2 – 100 Year ARI Existing and Modelled Retarded Flows (1hr)	33



1 INTRODUCTION

This report sets out a recommended Stormwater Management Strategy for a proposed development at Central Road, Drysdale. Water Technology understands the proposal involves sub-division of the site for private sale and residential development. The investigation identified on-site stormwater management solutions under developed conditions, and identified a concept drainage design for the site that would:

- Ensure the development attenuates post-development runoff to pre-development levels;
- Achieve best practice targets; and
- Alleviate impact of the development on downstream environment.

The Stormwater Management Strategy for the site is founded on best practice principles and achieves compliance with the requirements of the Water Act 1989 and Best Practice Guidelines and Standards for water quality treatment. The following report presents the results of the hydraulic modelling undertaken to assess flood risk, including flood depths, water surface elevations and flood velocities for existing and developed flood conditions. It also demonstrates that the concept drainage design for the site results in no adverse impacts off-site.

Discussions with relevant drainage authorities, Corangamite Catchment Management Authority (CCMA) and the City of Greater Geelong (CoGG) were conducted to inform the strategy and site conditions are discussed within this report.



2 BACKGROUND

The subject site consists of 27 parcels of land located within Drysdale, as shown in Figure 2-1. The subject site is located east of Jetty Road, Drysdale and includes Central Road and Thomas Street. Wyndham Street is located immediately south of the site and Ada Street immediately north. The land is currently zoned Rural Living Zone (RLZ) and has been identified for future residential development.

Current flood mapping available from the City of Greater Geelong (CoGG) has identified the site as being subject to flooding from Griggs Creek and its tributaries. The Corangamite Catchment Management Authority (CCMA) has also provided information which indicates that two designated waterways pass through this location.

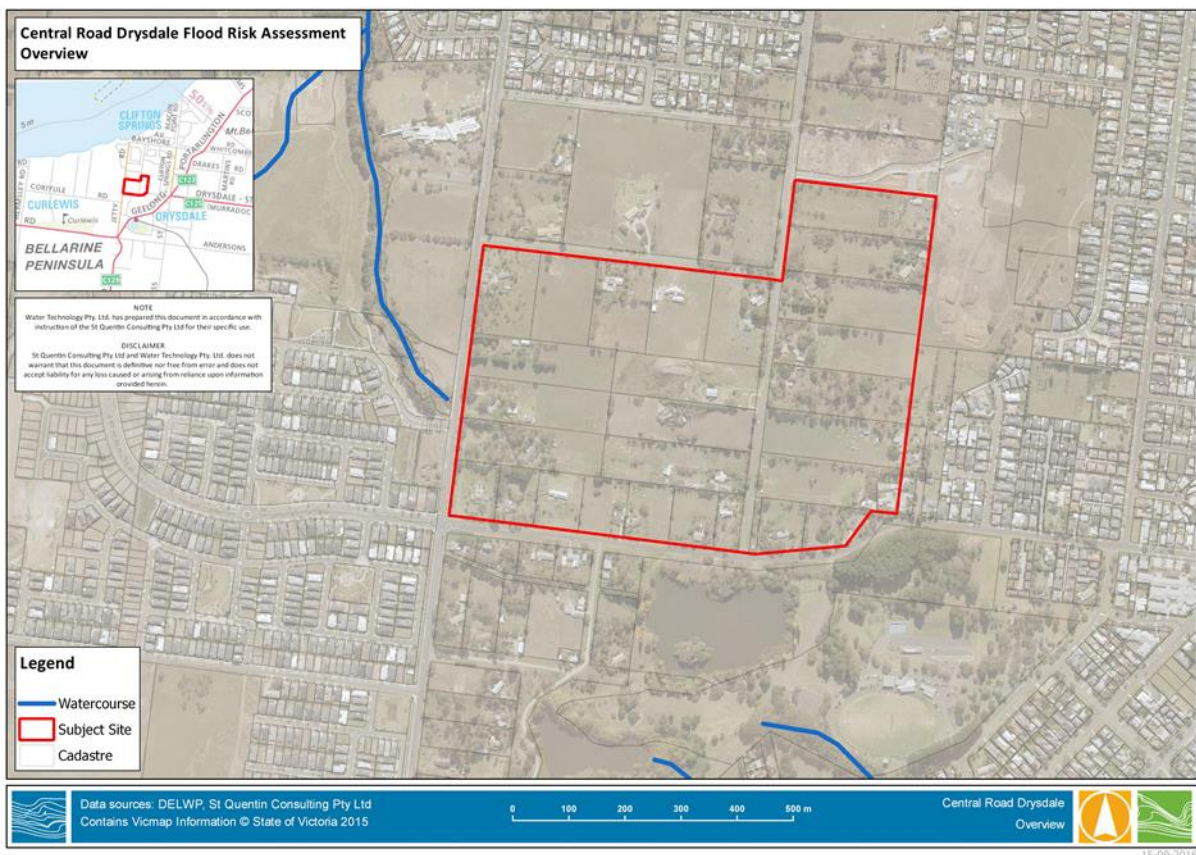


Figure 2-1 – Subject Site

2.1 Existing Flood Risk

Hydrological (RORB) and hydraulic modelling (TUFLOW) were previously undertaken to assess existing flood risk at the site (Water Technology, September 2016). This model allowed for catchment delineation and estimated fraction imperviousness based on existing planning zones and planned development.

The baseline TUFLOW model was created using LiDAR topography and survey collected in 2007. The model build was guided by current best practice approaches and standards, including the Infrastructure Design Manual.

4663-01_R06b



Additional detail of the methodology and assumptions used to model existing flood risk can be found in Water Technology's report dated September 2016.

The modelling undertaken shows the site to be at risk of flooding during the 1% Annual Exceedance Probability (AEP), as shown in Figure 2-2.

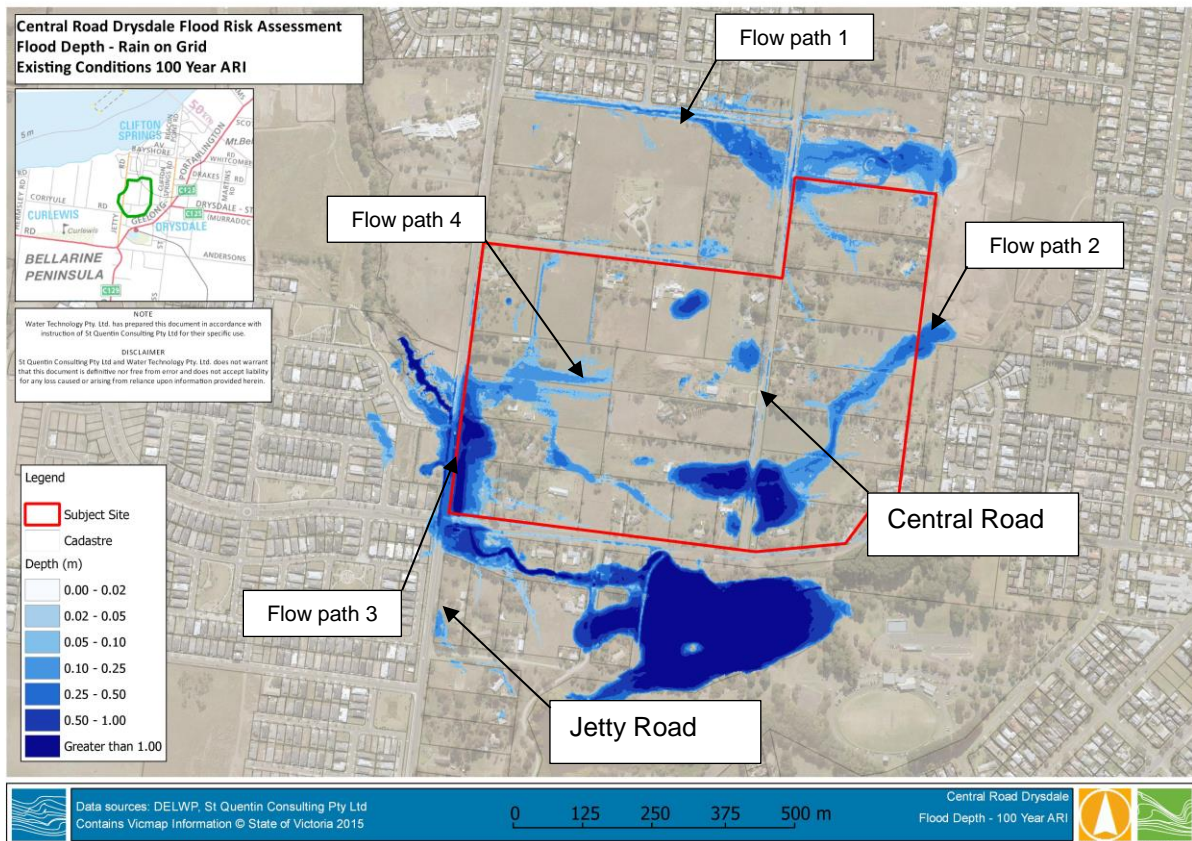


Figure 2-2 – Preliminary Flood Modelling Results Extent (1%AEP)

Four overland flow paths were identified in the catchment within or around the site. Three of them (Flow path 1-3) are associated with external catchments while one appears to be the result of local run off (Flow path 4). Two regions of significant ponding were also identified within the site, including:

- Central Road (150 m north of Wyndham Street) - Flooding as a result of water pooling is on both sides of the road and (excluding the farm dam) shows low areas inundated to depths greater than 1.5 m; and
- Jetty Road (From Wyndham Street to the Griggs Creek Crossing under Jetty Road) - Most flooding in this area is found on the east side of the road (inside the study area) and is greater than 1.2 m deep in channelised sections of the flow path.

2.2 Designated Waterways

A review of the current state government watercourse layers, planning overlays, imagery and LiDAR suggests there are no obvious watercourses within the subject site and discussions were held with the CCMA to confirm this. The outcomes of these discussions were considered as part of this study to ensure that any detrimental impact from the development of the site are mitigated.

4663-01_R06b



2.2.1 Site constraints and conditions

Based on the results of the preliminary flood modelling and subsequent discussions, it was agreed with the CCMA that:

- There are no designated waterways located on the site, however, the development layout must maintain conveyance capacity of Flow path 3;
- The proposed development must not result in afflux for a range of events up to and including the 1% AEP event;
- The proposed development layout ensures there is no net loss of flood storage within the site; and
- No new lots can be created within the post developed mapped 1% AEP flood extent.

As shown in Figure 2-3, the area immediately east of Jetty Road acts as a drainage corridor and conveys significant volumes of floodwaters during 1% AEP events. As a result, a minimum 30m buffer was nominated for public open space east of the main channel to:

- Maintain conveyance capacity and the drainage function of Flow path 3; and
- Maintain/enhance landscape values of the existing drainage corridor.

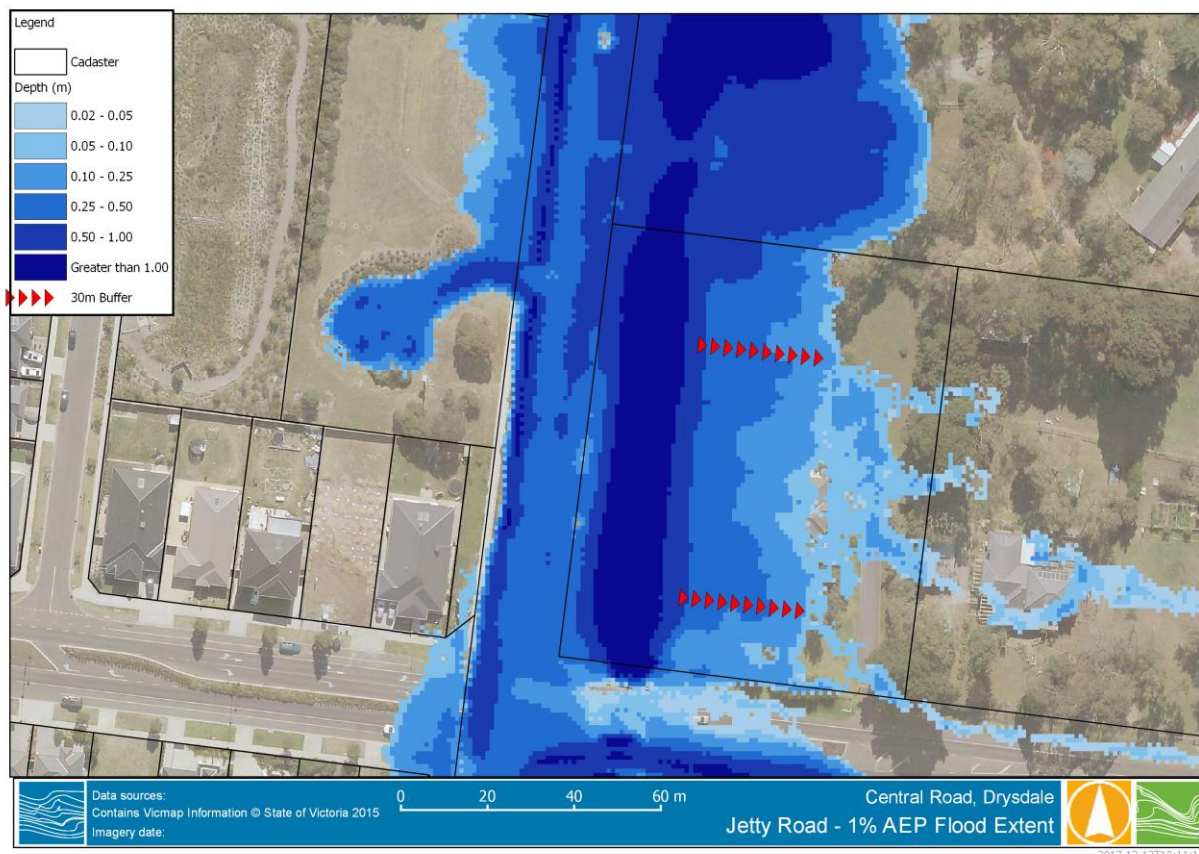


Figure 2-3 – Preliminary Flood Modelling Results – Jetty Road (1%AEP)

4663-01_R06b



Additional setback distance was provided immediately upstream of the culvert under Jetty Road to:

- Maintain flood storage in the area;
- Integrate proposed retardation and water quality treatment measures; and
- Preserve existing floodplains for wetlands and retention basins.

We note that the above uses are permitted by Clause 14.02 of the Greater Geelong Planning Scheme. Additionally, as demonstrated in the following sections of the SWMS, maintaining this buffer is critical in ensuring there is no detrimental impacts within the catchment. It is considered that any reduction of this buffer would result in loss of storage and/or conveyance, and would therefore result in off-site impacts without major works (e.g. culvert upgrades).

The above items have been considered as part of the Stormwater Management Strategy and additional flood modelling was undertaken to ensure the concept design considered the listed conditions.

3 RETARDING BASINS

This Section documents the hydrological modelling undertaken for the retardation basins, which are to be located within the proposed residential subdivisions at the subject site.

3.1 Hydrological Analysis

The catchment runoff routing model, RORB, has been selected as the principal tool for the hydrologic analysis of this study. RORB is a non-linear rainfall runoff and stream flow routing model for calculation of flow hydrographs in drainage and stream networks.

A RORB model was created, based on proposed development and catchment plans for the site. The RORB model developed for this study built on the previous RORB model used to estimate the rainfall runoff relationship from the external catchments that impact the study area (Water Technology 2016).

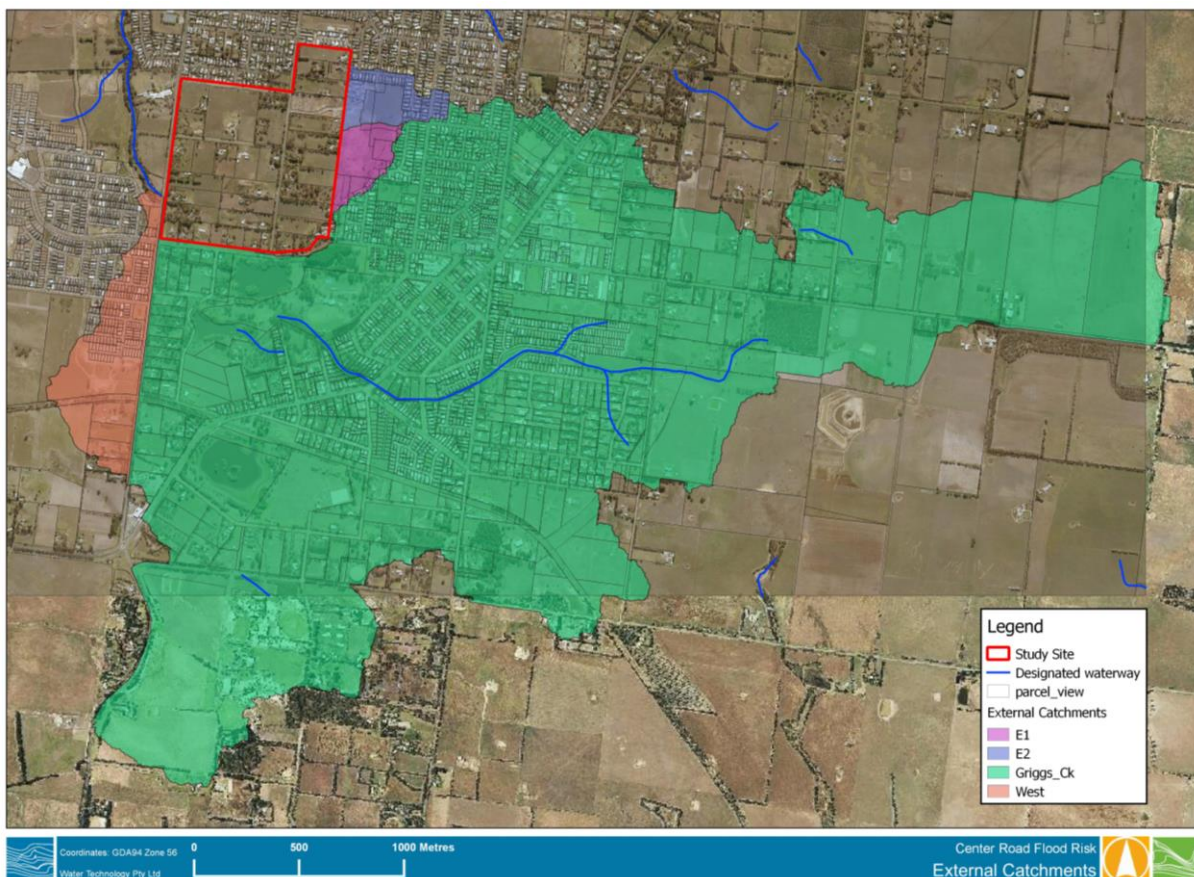


Figure 3-1 – Upstream Catchment Delineation

A site-specific RORB model, shown in Figure 3-2 was created to estimate the magnitude of overland flows within the subject site, excluding all areas under the Special Charge Scheme show in Figure 3-3. A schematic of the RORB model is shown in Figure 3-2. The properties located immediately north of Thomas Street and catchments M and H (shown in Figure 3-2) are also covered by a *Development Overlay* and scheduled to be developed in the future. We understand that the drainage infrastructure will re-direct the flows away from the subject site. The flows from this catchment were therefore excluded from the analysis.

4663-01_R06b

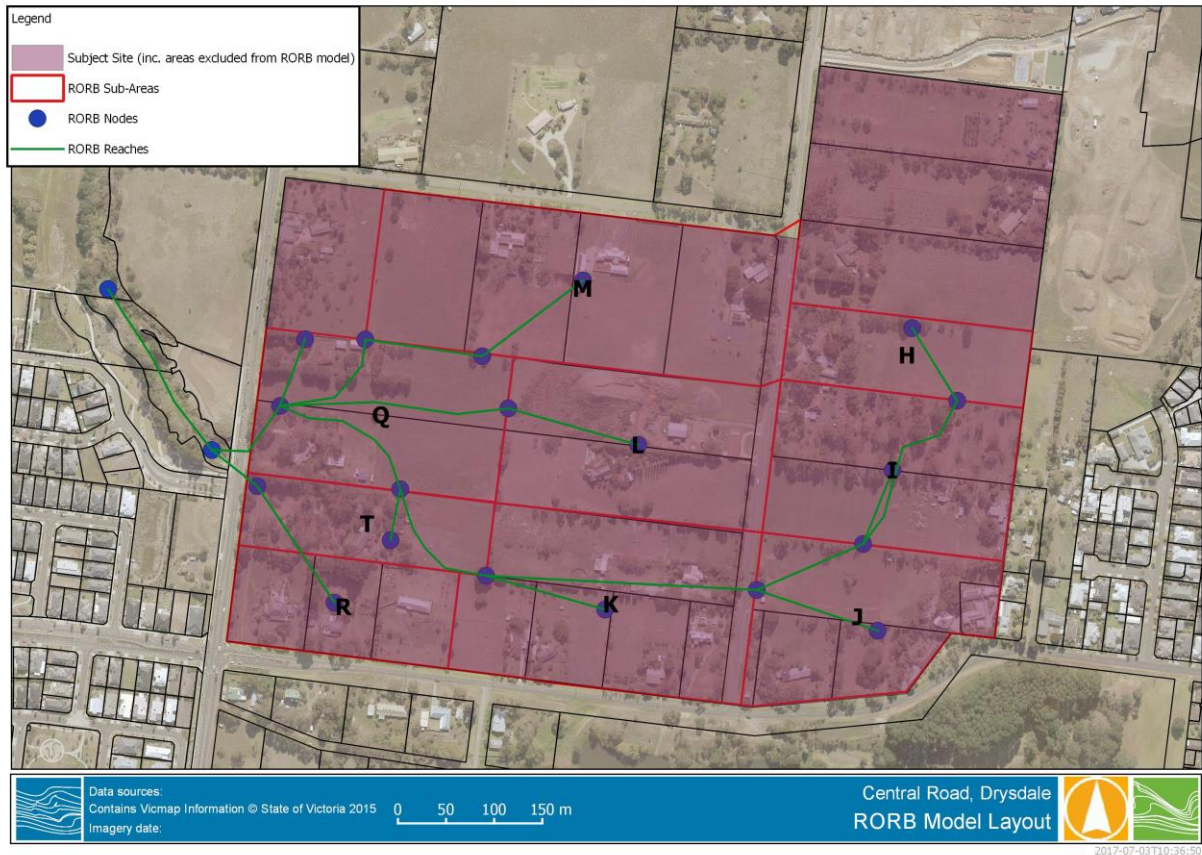


Figure 3-2 – Subject Site Catchment Delineation

4663-01_R06b

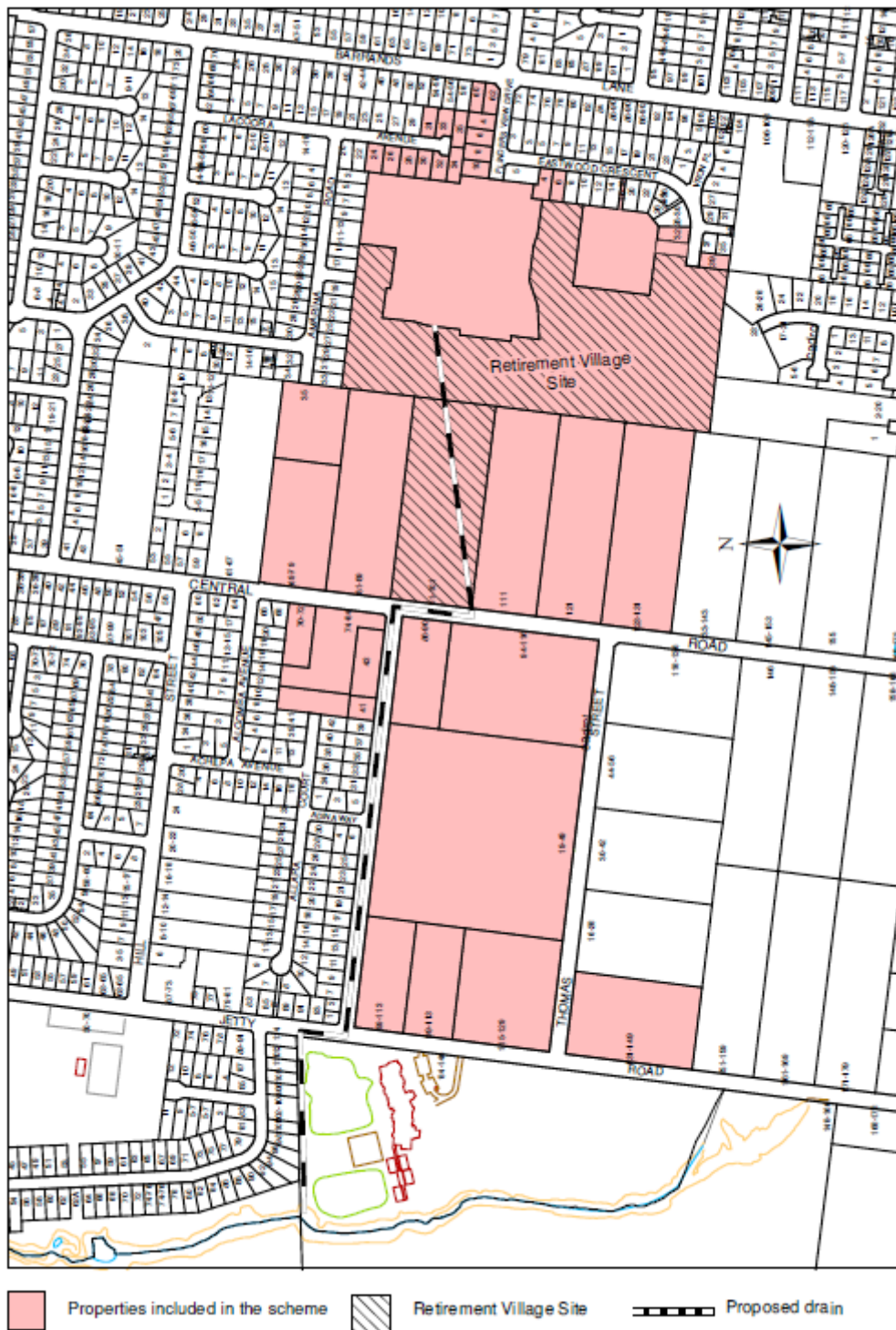


Figure 3-3 – Properties within Special Charge Scheme

4663-01_R06b

Site flows from the existing conditions model were extracted at different discharge points; where basins will be constructed to detain flows. Flows were extracted from these points to allow a flow comparison between pre- and post-developed conditions to be made.

For the setup of the existing conditions RORB model, the following parameters were applied:



- All sub catchments were assigned a fraction impervious value of 0.2 representative of rural living area;
- All reaches were modelled with a reach type 1 (natural); and
- An initial loss of 20 mm was adopted.

The model was run and compared with industry accepted methods as outlined in Australian Rainfall and Runoff Volume 1 and 2 (AR&R). Intensity-Frequency–Duration (IFD) design rainfalls were obtained from the Bureau of Meteorology website and are summarised in Table 3-1.

The existing conditions RORB model kc value for the site catchment was reconciled to the calculated Rational Method 100 year ARI peak flow immediately upstream of Jetty Road.

For comparison, the VicRoads Method - assuming a C₁₀ value of 11 - results in a pre-development discharge of 1.79 m³/s for the subject site. The Rational Method results in a higher rainfall and stormwater runoff for the post-development scenario, which would in turn result in higher storage requirements. It was therefore adopted for conservatism.

Table 3-1 – IDF Parameters

Parameters	
1 hr 2 year ARI	17.97 mm/hr
12 hr 2 year ARI	3.61 mm/hr
72 hr 2 year ARI	0.91 mm/hr
1 hr 50 year ARI	34.07 mm/hr
12 hr 50 year ARI	6.43 mm/hr
72 hr 50 year ARI	1.87 mm/hr
G (skewness)	0.41 mm/hr
F2 Geo factor 2 ARI	4.28
F50 Geo factor 50 ARI	14.86

A volumetric runoff coefficient of 0.6 was used to estimate flows from the 100 year ARI events.

For the developed model, the model parameters for the subject site were adjusted to consider the extent of urbanisation:

- A revised fraction impervious value was used for the development area within subject site (corresponding to residential lots);
- Reaches were modelled with a reach type 3 (lined channels), with slopes obtained from the LiDAR dataset; and
- A lower initial loss of 10 mm was adopted.

Key modelling parameters for pre- and post-development catchments are detailed in Table 3-2.

Table 3-2 – Key RORB Modelling Parameters

Location	Existing Conditions			Developed Conditions (no RB)		
	kc	d _{av} (m)	IL (mm)	kc	d _{av} (m)	IL (mm)
Subject Site	0.48	0.74	20	0.48	0.74	10

4663-01_R06b



Existing and developed flows at the site are shown in Table 3-3.

Table 3-3 – Existing and Developed Flows for Critical Storm Duration

Location	Existing Flows (m ³ /s)			Developed Flows (m ³ /s)
	100 year ARI (RORB)	Rational Method (100 Year ARI)	Modified Rational (VicRoads) (100 Year ARI)	100 year ARI (RORB)
Upstream Central Road	0.96(2 hr)	0.76	0.68	3.09(15 min)
Upstream Jetty Road	2.02 (1 hr)	2.02	1.79	8.19(15 min)

3.2 Retarding Basin Sizing

The retarding basins were modelled in RORB to ensure that the peak post-development flow rates do not exceed the pre-development discharges for the 100 year ARI events.

Contributing catchments, upstream of each retarding basin, are shown in Figure 3-4.

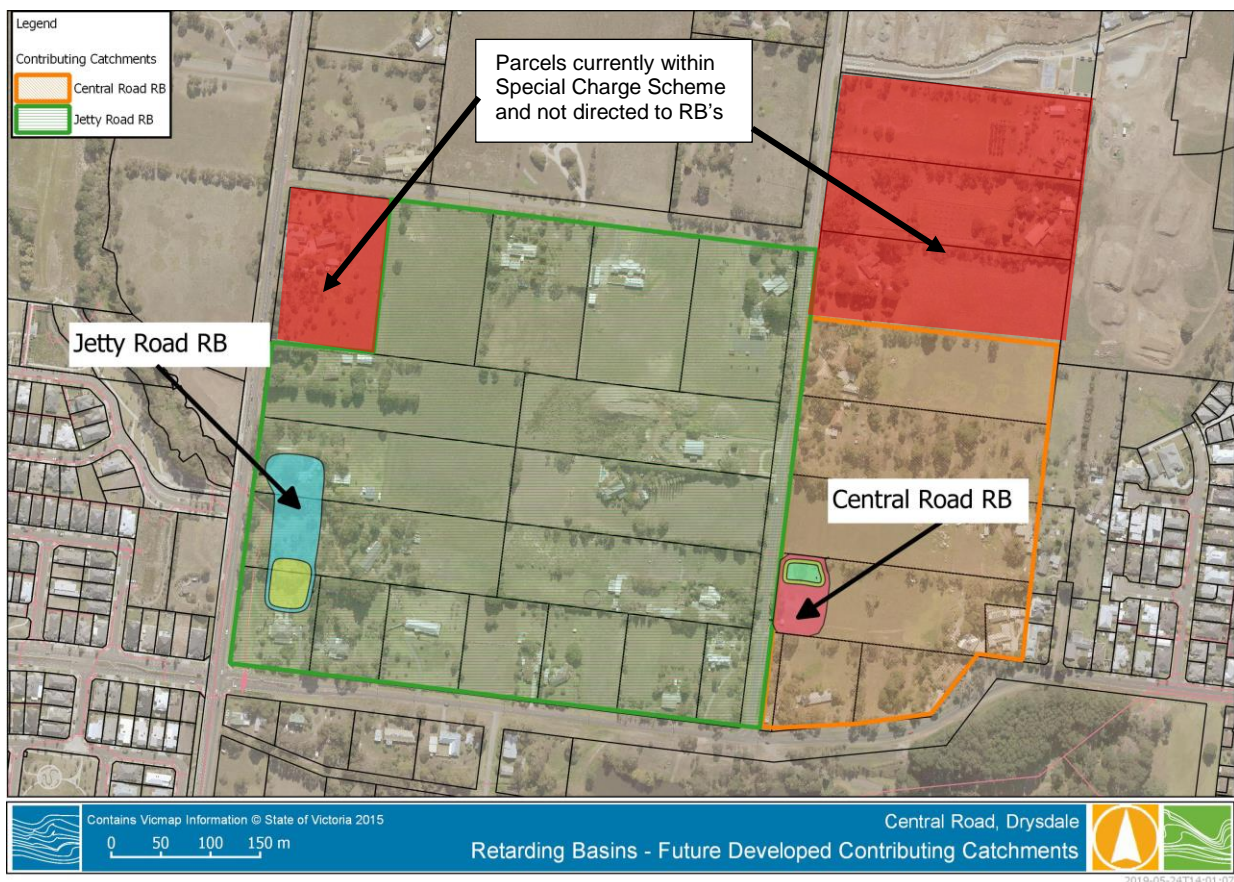


Figure 3-4 – Retarding Basins and Future Developed Contributing Catchments

4663-01_R06b



A flow comparison is presented in Table 3-4 below, showing that the 100 year mitigated flows are successfully retarded back to pre-development flow rates.

Table 3-4 – 100 Year ARI Existing and Developed Retarded Flows (Critical Storm Duration)

Location	Existing Flows (m ³ /s)	Mitigated Developed Flows (m ³ /s)
Upstream Central Road	0.96 (2 hr)	0.61 (1 hr)
Upstream Jetty Road	2.02 (1 hr)	1.91 (1 hr)

The configurations of the two retarding basins are shown in Table 3-5. It was assumed that the outlet pipes were located at the base of the storage basin, with a secondary outlet triggered once water depth reaches a certain level within the basin. The spillway for the downstream retarding basin would also activate in a controlled spill during the design 100 year ARI events.

Table 3-5 – Retarding Basin Details

Retarding Basin Details	Upstream Central Road	Upstream Jetty Road
Storage Volume (m ³)	1,610	4,820
Critical Duration (in the 100 year ARI)	1 hr	1 hr
Peak 100 year ARI Outflow (m ³ /s)	0.61	1.91
No. of Pipes (primary outlet)	1	3
Pipe IL (primary outlet) (m AHD)	46.0	39.5
Pipe Diameter (mm)	525	900
Spillway Length (m)	25	25
Spillway Elevation (m AHD)	47.20	40.9

An indicative layout of these retarding basins is shown in Figure 4-3. The outlet details may vary based on the final shape (stage-storage) of the basins.

3.3 Interim Arrangement

The above retarding basins allow for the whole subject site to be developed, with allowance for area where development is likely to be restricted by the existing floodplain. Provided that the elevation-volume relationship provided by the retarding basin is similar to the retarding basin model in RORB, the layout of the system can be adjusted to take into account of existing features. As an example, careful design of the retarding basin upstream of Jetty Road should permit for the existing dwelling to be maintained.

Additionally, it is likely that the development will be staged. It will be possible to stage the construction of the westernmost retarding basin to be in-line with how the residential development will unfold. It is anticipated that development of the lots fronting Wyndham St will occur at a later stage. The retarding basin will therefore be built in stage, and its size will be designed to cater for each interim stage. This is likely to be beneficial from a water quality perspective as it would minimise the risk of the proposed treatment wetland to receive insufficient inflows during the early stage of the development.

For the interim scenario, the RORB model parameters for the subject site were iteratively adjusted to assess the extent of urbanisation and estimate the maximum development area that can be catered by the interim retarding basin:

4663-01_R06b



- A revised fraction impervious value was used for the development area within subject site (corresponding to residential lots);
- Reaches were modelled with a reach type 3 (lined channels) if downstream of developed areas; and
- A lower initial loss was adopted, as per area developed.

This iterative process indicated that up to 16 ha would be developable under the interim scenario without exceeding pre-development discharge rate (2.02 m³/s). This is equivalent to between 160 lots (600 m² average parcel size) and 193 lots (500 m² average parcel size), when allowing for roads.

Up to 25.5 ha would be developable if the assets immediately upstream of Central Road is also constructed. This is equivalent to between 255 lots (600 m² average parcel size) and 305 lots (500 m² average parcel size), when allowing for roads. Please note that the above lot estimation utilises a lot to reserve (roads and POS) of 60/40. A more specific definition of the number of lots available under the interim basin scenario will be required to be confirmed once further subdivision design is undertaken.



4 FLOOD MODELLING

4.1 Existing Conditions

A broad-scale TUFLOW model of the entire study area was developed. TUFLOW is a widely-used model that is suitable for the analysis of overland flows in urban areas. The TUFLOW model routes flows overland across the topographic surface (2D Domain) to create flood extents, depths and velocities.

Table 4-1 below shows key modelling information used in the development of this hydraulic model, including:

- Topography data;
- Manning's roughness;
- Hydrological input (upstream boundary conditions); and
- Drainage infrastructure.

The TUFLOW model was used to apply rainfall (1% Annual Exceedance Probability) and then route flows through the catchment to assess overland flow paths during extreme rainfall events. The aim of the model was to assess the performance of the two proposed retarding basins. The extent of the model, shown in Figure 4-1, was delineated to ensure all runoff from the subject site was treated by the proposed retarding basins prior to discharge to the environment. Thus, a small area of the subject site, which naturally drains to the north, was excluded from the TUFLOW model. Stormwater runoff from this area and the area north of Thomas Street, was still applied to the site for the development scenario and routed through the retarding basins.

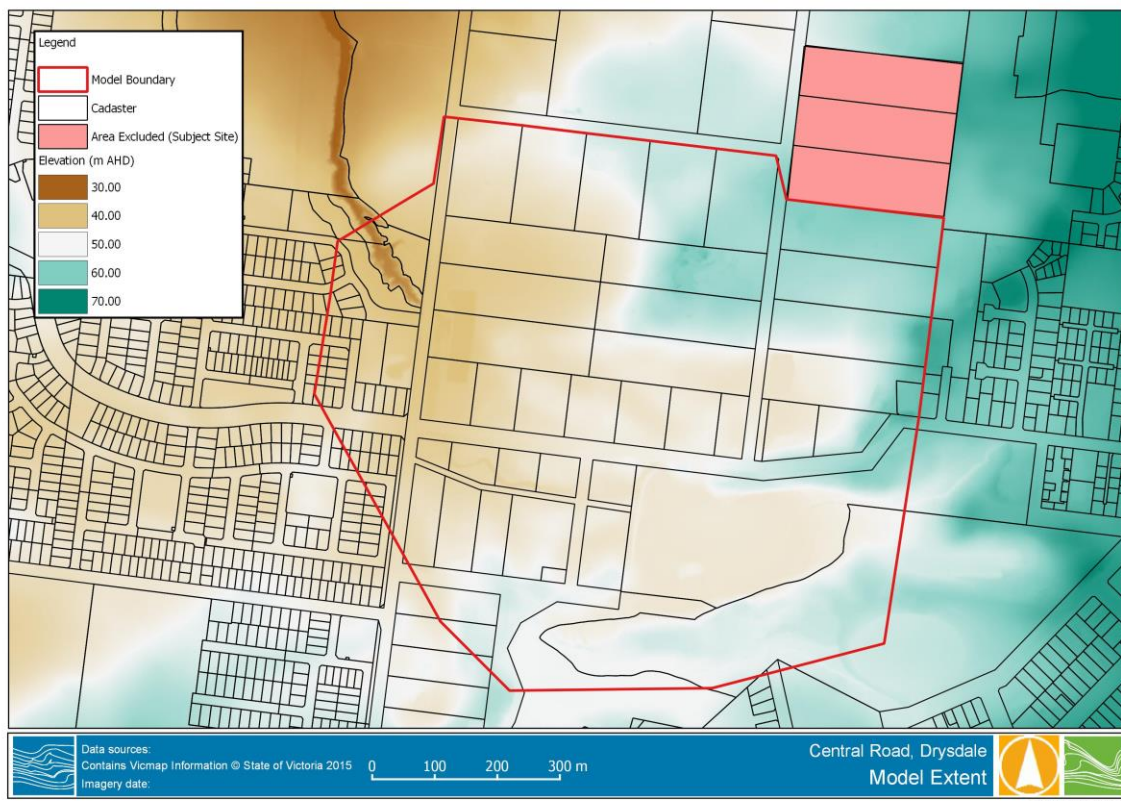


Figure 4-1 – Model Extent



Table 4-1 – Key Modelling Information

Survey	LiDAR (2007)
Upstream boundary	<ul style="list-style-type: none"> • Rainfall Data from RORB Model • RORB Inflow for Griggs Creek • Rain-on-Grid Rainfall data for parcels outside subject site
Modelled storm durations	<ul style="list-style-type: none"> • 1 hour (critical) • 12 hour
Downstream boundary	'HQ' boundaries were used to convey the overland flow out of the catchment in a steady manner
Model type	TUFLOW 2d
Model build	2013-12-AD-iDP-w64
Inflow type	<ul style="list-style-type: none"> • 2d_sa for subject site • 2d_sa for Griggs Creek (upstream catchment) • 2d_rf for parcels outside subject site
Inflow regime	Unsteady State (hydrograph)
Roughness parameters	Roughness was based on planning zone types and was validated using recent aerial imagery within the subject site.
Model timestep (2d)	1 seconds
Model timestep (1d)	0.5 second
Model start time	0 hours
Model end time	<ul style="list-style-type: none"> • 3 hours for 1 hr duration event • 26 hours for 12 hr duration event
Model grid size	2 m ²
Final cumulative mass error	-0.26 (1hr) and -0.70% (12Hr) Existing Scenario -0.20 (1hr) and -0.65% (12Hr) Development Scenario

It is noted that the adopted modelling approach allows for minor changes to the road and development layout, as the critical factor influencing flood risk is storage available in the retarding basins. Provided that the elevation-volume relationship is maintained, changes to the layout of the development (that don't significantly impact overall density) can be accommodated to take into account existing features and constraints. As an example, we understand that a retarding basin is to be constructed at the south-east corner of the retirement village site, adjacent to 133-143 central Road. The final design of the framework plan would need to allow for conveyance of overland flows from its spillway either via a designated overland flow path or within the road. This will not impact on the flood and water quality results presented in this report and it is therefore appropriate to allow for the details of how overland flows will be conveyed in the event the basin overtop to be finalised at the detailed design stage.



4.2 Development Scenario

A development scenario model was built to assess the performance of the proposed retarding basins and was informed by a preliminary framework plan for the site, shown in Figure 4-2. It must be noted that there are slight differences in the road layout between the preliminary framework plan and the modelled road layout. It is however, anticipated that the sizes, locations and outlet characteristics of the proposed retarding basins will be the main factors influencing flood behaviour in the catchment and the differences in the road layout will have little incidence on off-site flood impacts.

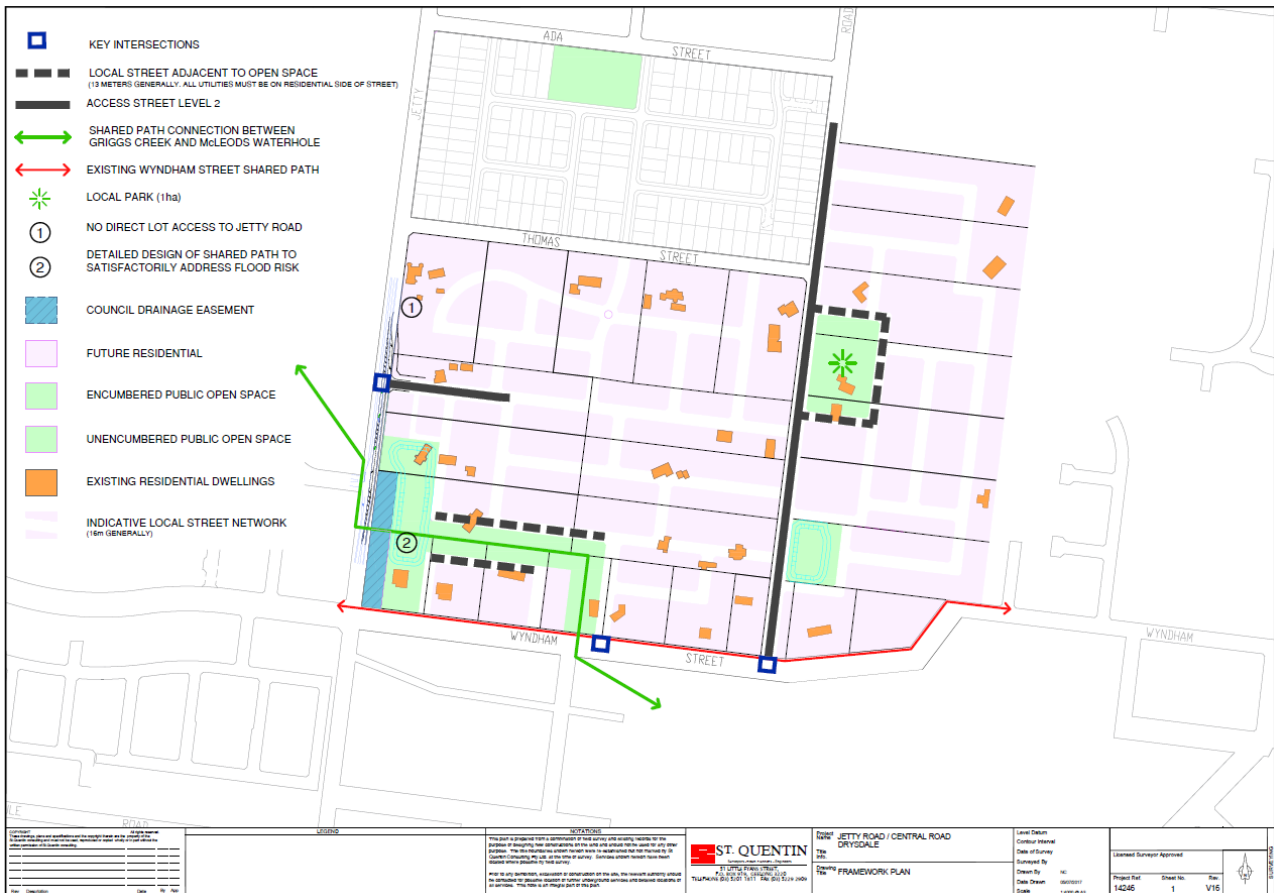


Figure 4-2 – Draft Framework Plan (Source: St Quentin)

The model extent for the development scenario is shown for the catchment in Figure 4-3 and Figure 4-4.

Changes to the model are summarised below:

- Rainfall data (IFD) was adopted from the RORB modelling for the development scenario. Areas outside of the subject site (ie Rain-on-Grid Rainfall) were not modified.
- The topographical model (2D Domain) was amended to integrate the two proposed retarding basins. For conservatism, the downstream basin was smaller than the one modelled in RORB. Additionally, outlet pipes and pits (1d_nwk) were modelled to ensure a control discharge.
- Other localised fixes (2d_zsh) were applied within the road network to minimise low points and ensure that runoff from the site is contained within the site and directed towards the basin. It is likely that pipes

4663-01_R06b



will also drain the proposed lots and roads, however, these were not modelled. They are likely to provide additional storage during extreme rainfall events.

- An embankment was created using a 2d_zsh layer between Jetty Road and the proposed downstream basin. This area could act as an esplanade or a dewatering area for the wetland and would provide an additional level of protection to the proposed child care centre proposed west of Jetty Road.
- Areas destined for development (in pink in Figure 4-2) were elevated above existing ground levels (and road levels), to represent future infill. This was important as no new lots can be created within the post developed mapped 1% AEP flood extent.
- Roughness factors within the subject site were adjusted to reflect proposed development scenario and road layout.

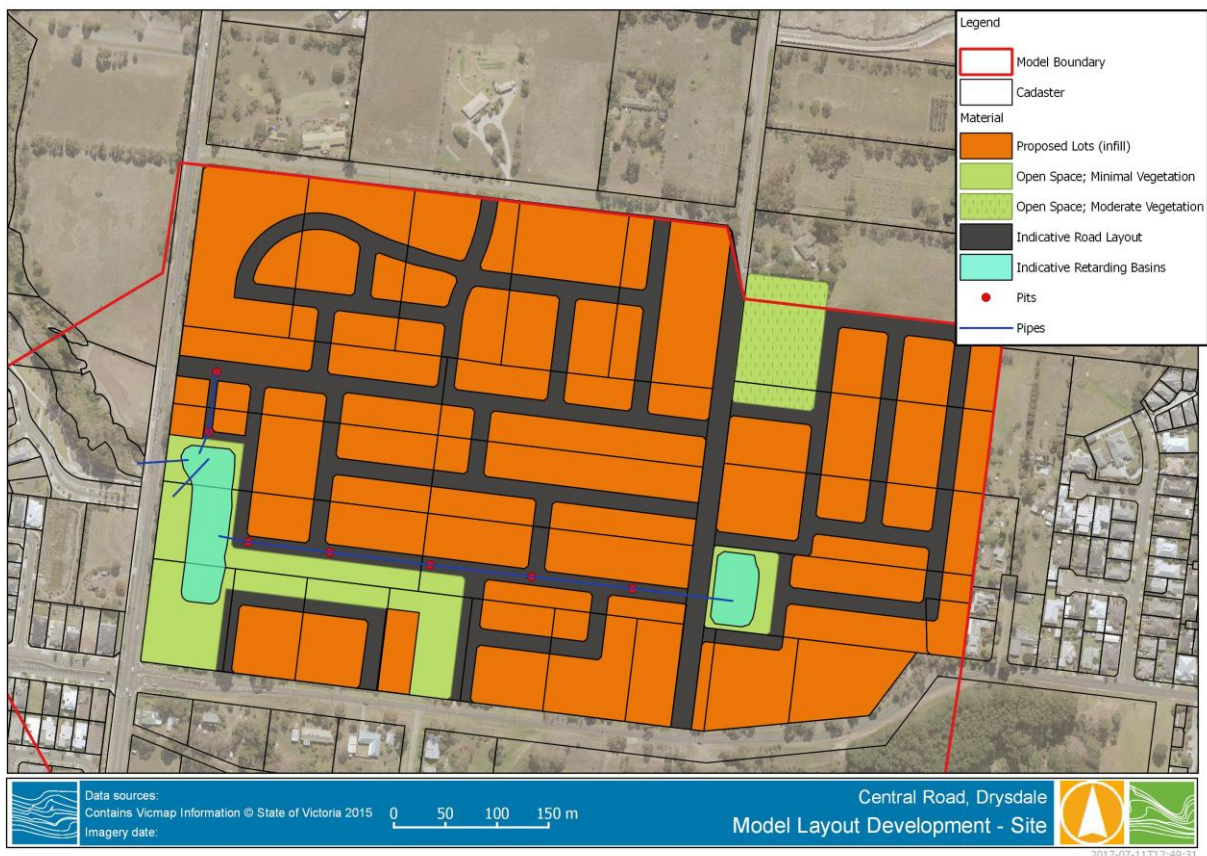


Figure 4-3 – Development Model Extent - Site

4663-01_R06b

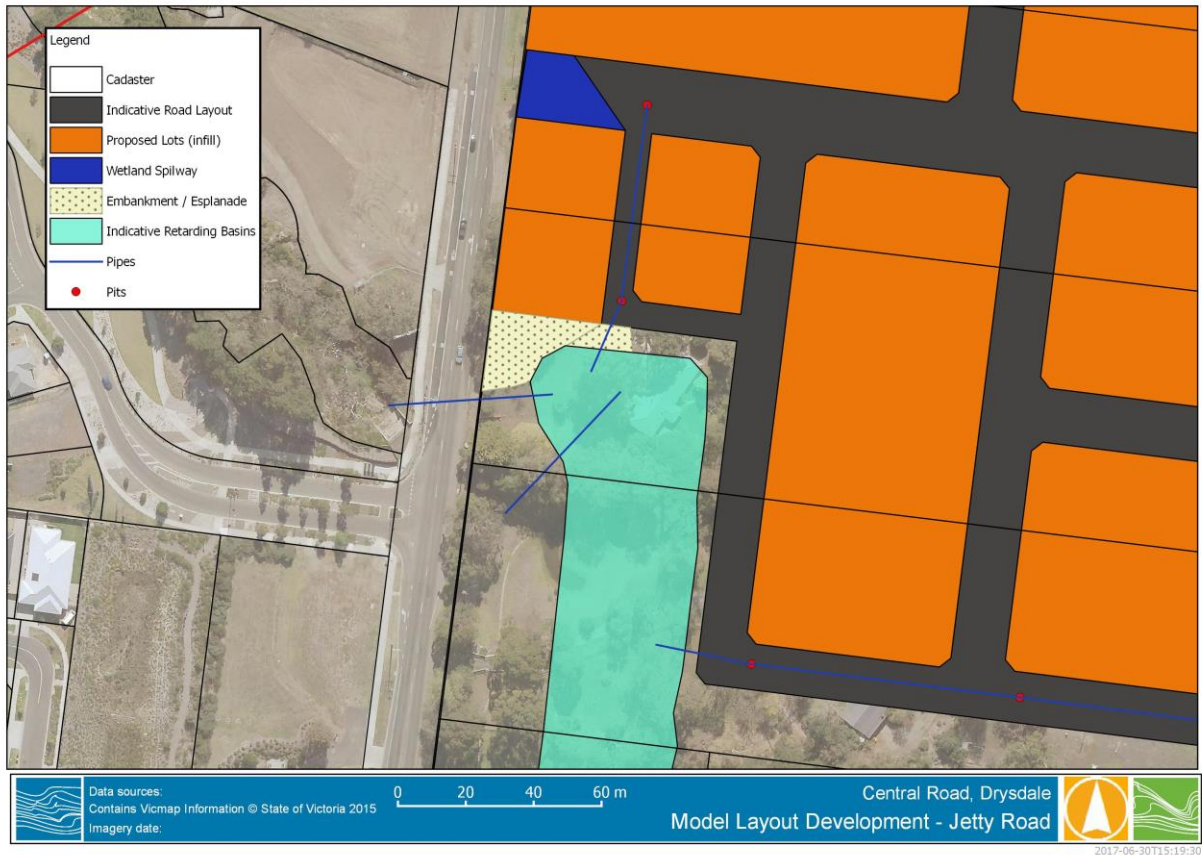


Figure 4-4 – Development Model Extent - Jetty Road

4663-01_R06b



5 WATER QUALITY MANAGEMENT

This Section of the Stormwater Management Plan details the Water Sensitive Urban Design (WSUD) assets proposed to treat runoff from the development. The preliminary designs were revised, taking into consideration catchment drainage characteristics and the existing flood extent.

Two WSUD systems are proposed:

- A sedimentation basin and constructed wetland to be located within the proposed retarding basin upstream of Central Road; and
- A sedimentation basin and constructed wetland to be located within the proposed retarding basin upstream of Jetty Road.

Stormwater modelling was carried out with regards to best practice industry methods and the City of Greater Geelong guidelines, as well as Melbourne Water's latest guidelines.

The water quality treatment targets established by the Urban Stormwater Best Practice Guidelines (CSIRO, 1999) should be achieved as a minimum to protect river health values. The removal rate targets for key pollutants are as follows:

- 80% of total suspended sediments;
- 45% of total nitrogen;
- 45% total phosphorous; and,
- 70% gross pollutants.

A MUSIC model (Version 6.2) was constructed for a preliminary analysis of the water quality requirements for the development. A MUSIC model with a 6-minute time interval was run using the Geelong North pluviograph station data (Station Number 87133) was used in the MUSIC modelling for the year 1985 (mean annual rainfall). We understand that the 1985 data "accurately represents the long-term meteorological records for Geelong"¹. Monthly evapotranspiration data recorded at the same station was also used.

The water quality model layout for the site is shown in Figure 5-1 and the parameters adopted for the modelling are discussed in the following Section.

¹ <http://www.geelongaustralia.com.au/idm/article/item/8cf5f1e495a0bea.aspx>

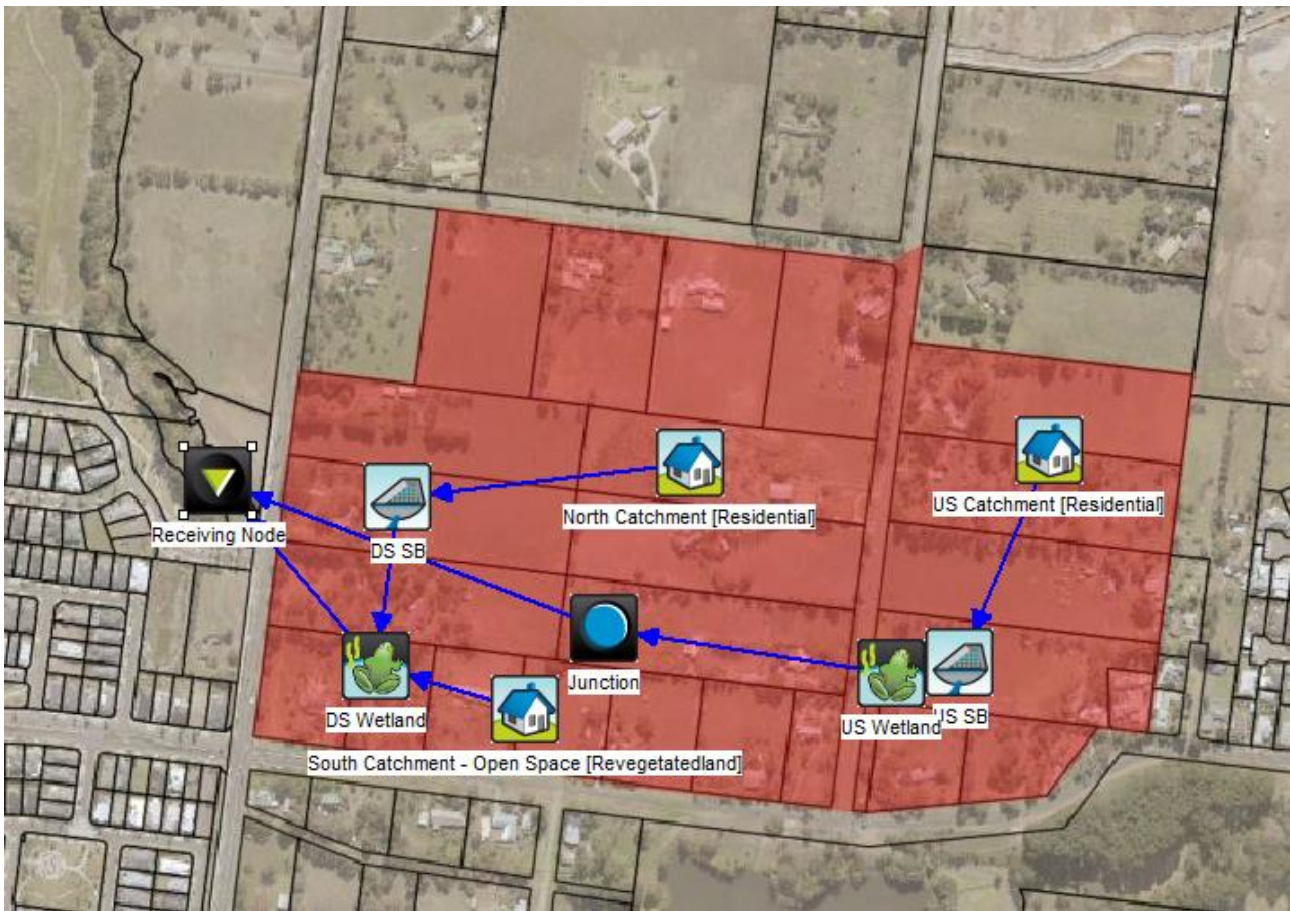


Figure 5-1 – MUSIC Model Layout

5.1 Catchment Analysis

The catchment parameters adopted for the RORB model (i.e. area and fraction impervious) were used to model the development site, however, sub-areas upstream of proposed assets were combined where appropriate. A summary of sub-catchment parameters is shown in Table 5-1.

Table 5-1 – Catchment delimitation and fraction effective impervious

Sub-Catchment	Type	Area (ha)	Adopted percentage effective impervious (%)
US Catchment	Residential	9.6	70
North Catchment	Residential	22.2	70
South Catchment	Revegetated land	2.33	20

The properties located immediately north of Thomas Street and catchments M and H (shown in Figure 3-2) are currently covered by a *Development Plan Overlay* and likely to be developed in the future. As mentioned

4663-01_R06b



in Section 3.1 future drainage infrastructure will re-direct runoff and prevent flows through the subject site. It is also considered that the runoff will be treated prior to its discharge to the downstream environment and these parcels were excluded from this analysis.

5.2 Water Quality Assets

Modelling parameters for the proposed assets are shown in Table 5-2. The two sedimentation basins were sized to allow for a five-year clean-out frequency (minimum). High flow bypasses were also integrated in the model (3 month ARI).

Table 5-2 – Proposed WSUD Assets

System	Location	Surface Area at the NWL (m ²)	Extended Detention Depth (m)	Permanent Pool Volume (m ³)	Notional Detention Time (hrs)
Sedimentation basin	Upstream Central Road	400	0.50	355	13.4
Wetland	Upstream Central Road	770	0.50	236	55.4
Sedimentation basin	Upstream Jetty Road	748	0.50	609	12.3
Wetland	Upstream Jetty Road	2,211	0.50	790	49.4



5.3 Water Quality Benefits

The proposed treatment train ensures best practice stormwater management targets are met and exceeded at the site, as shown in Table 5-3. The proposed WSUD strategy would also result in reduction in all pollutant bar Total Nitrogen compared to existing agricultural conditions (agricultural catchment node with a fraction impervious of 0.15).

Table 5-3 – MUSIC Modelling Results

UPSTREAM CENTRAL ROAD			
Component	Source Load	Residual Load	Reduction (%)
Total Suspended Solids (kg/yr)	5,000	525	89.5
Total Phosphorus (kg/yr)	7.72	2.08	73.1
Total Nitrogen (kg/yr)	59.3	31.1	47.5
Gross Pollutants (kg/yr)	1,280	33	97.4
UPSTREAM JETTY ROAD			
Component	Source Load	Residual Load	Reduction (%)
Total Suspended Solids (kg/yr)	12,100	1,450	88
Total Phosphorus (kg/yr)	18	5.09	71.8
Total Nitrogen (kg/yr)	143	77.1	46.1
Gross Pollutants (kg/yr)	3,050	31.7	99
WHOLE DEVELOPMENT SITE			
Component	Source Load	Residual Load	Reduction (%)
Total Suspended Solids (kg/yr)	17,000	1,870	89
Total Phosphorus (kg/yr)	26.8	7.25	72.9
Total Nitrogen (kg/yr)	199	109	45.4
Gross Pollutants (kg/yr)	4,330	64.7	98.5

4663-01_R06b



The proposed WSUD strategy relies on single site treatment trains. This approach has ‘obvious maintenance advantage’³, as it centralises the WSUD assets in one location, minimising time loss to travel during maintenance operations. The WSUD assets are also located in public open spaces and are integrated as water features, they therefore add amenity value to the site’s reserves.

5.3.1 Rainwater Tanks

Although not considered in this strategy, it is likely that some property owners will construct rainwater tanks on their lot. These assets will reduce stormwater runoff volumes by capturing rainwater from roofs for toilet flushing, laundry and possibly irrigation. This would provide additional water quality benefits at the development scale.

Recent studies in Australia show that integrated water management approach can also alleviate flood risk. Burns et al. (2010) report that “the application of allotment scale rainwater harvesting can moderately reduce flood risk” as well as provide environmental benefits (i.e. protect urban stream health). Other more recent studies, including by the City of Port Phillip, have also shown that RWTs and WSUD assets could mitigate flood risk and reduce flood damage.

³ From <http://www.melbournewater.com.au/wsud>



6 SURFACE WATER STRATEGY

6.1 Existing Conditions

The site is shown to be at risk of flooding during the 1% AEP, 1 hour duration event, with significant flood storage located immediately upstream of Jetty Road. Figure 6-1 and Figure 6-2 show the area currently impacted by flooding, which is similar to the flood extents defined by previous modelling for the site.

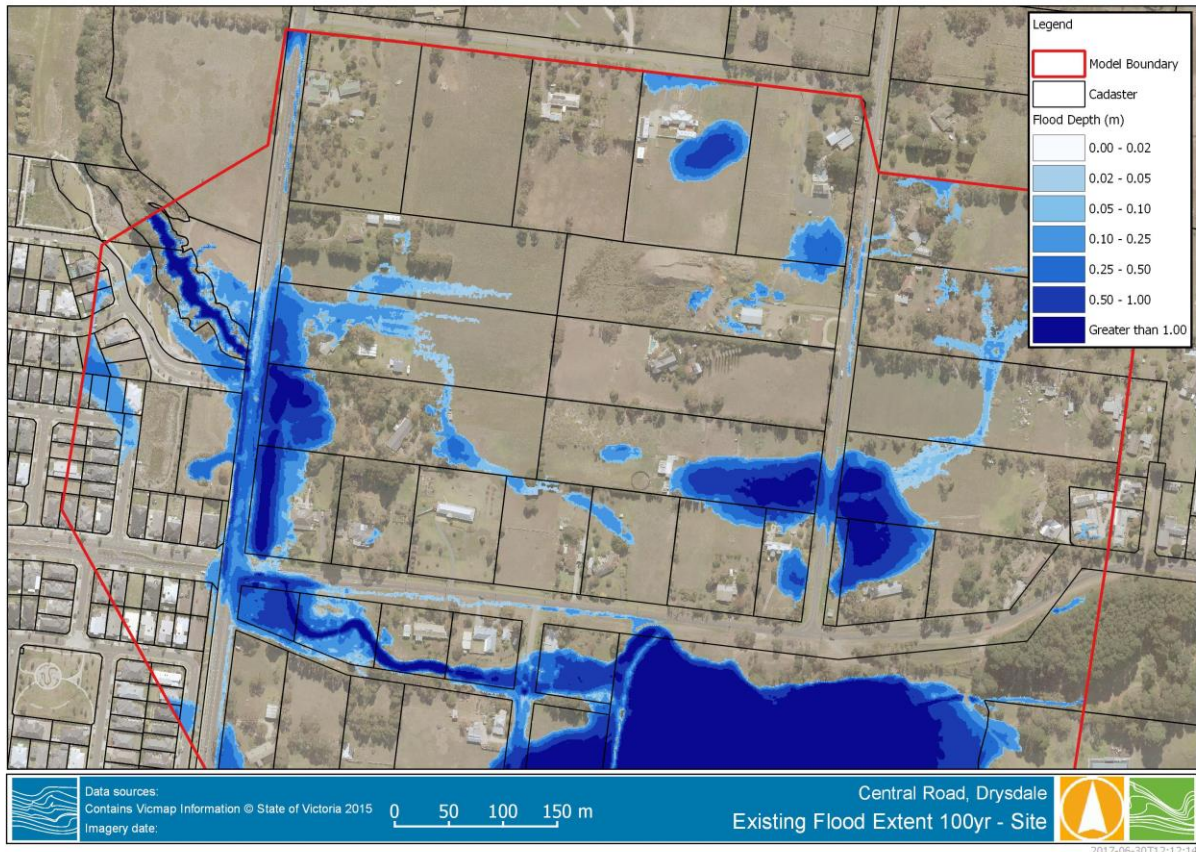


Figure 6-1 – Indicative 1% AEP Flood Extent (1 hour duration)

Flood velocities adjacent to the Jetty Road are generally above 1.0 m/s as shown in Figure 6-3, with significant velocities within the waterway and on Jetty Road itself.

Flood Risk along Jetty Road and within Flow path 3 is generally considered to be unsafe, as shown in Figure 6-4. Definition of each Hazard Category is shown in Table 6-1. These categories are consistent with Melbourne Water's guidelines for residential areas⁴.

4663-01_R06b

⁴ And similar to the new ARR 2016 Guidelines' vulnerability threshold for vehicle, people and buildings (0.3 m or m²/s).



Table 6-1 – Flood Safety Hazard Risk

Hazard Category	Velocity x Depth Criteria (m ² /s)	Depth Criteria (m)	Velocity (m/s)
Safe	<0.35	<0.35	<1.5
Unsafe	≥0.35	≥0.35	≥1.5

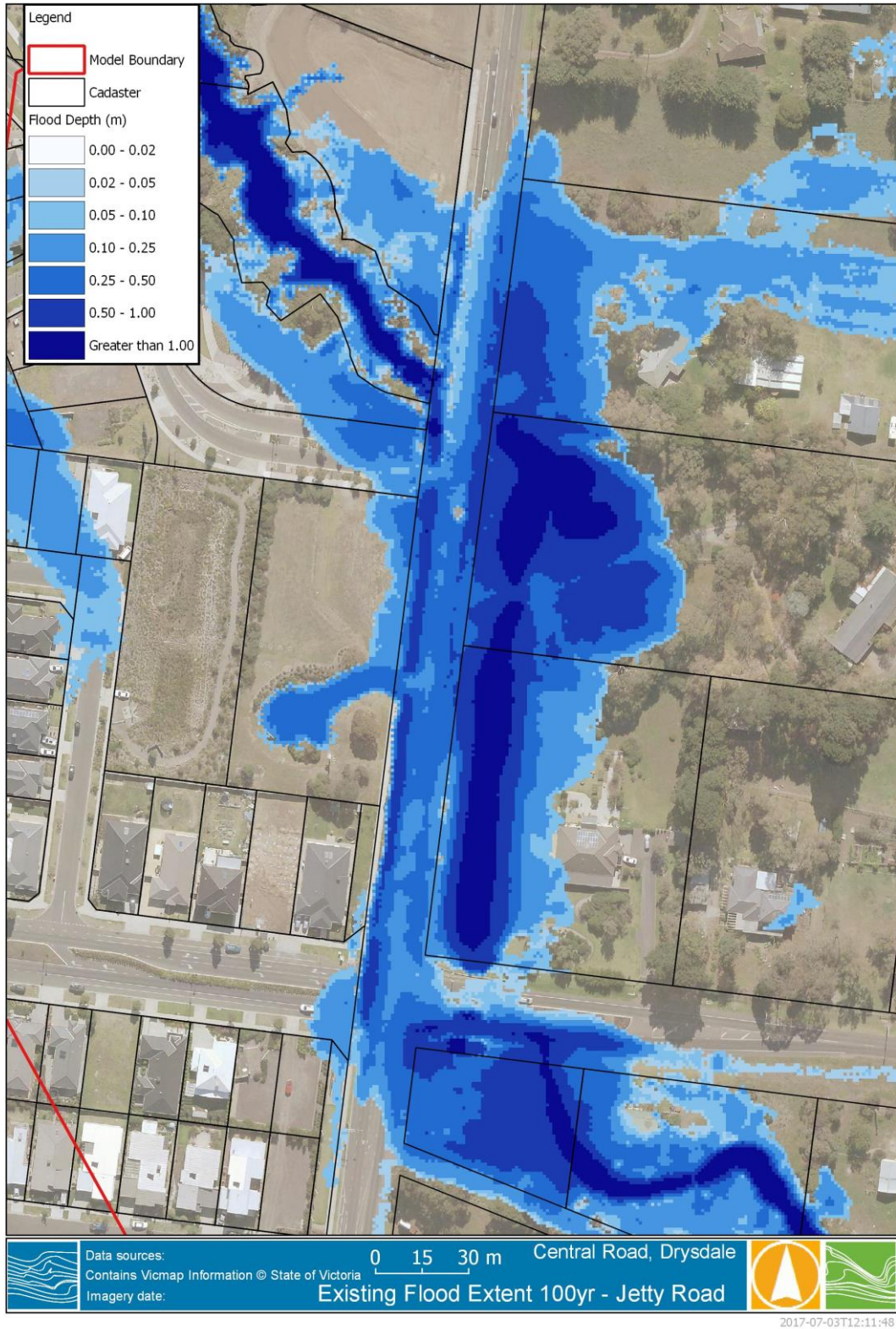


Figure 6-2 – Indicative 1% AEP Flood Extent - Jetty Road (1 hour duration)

4663-01_R06b

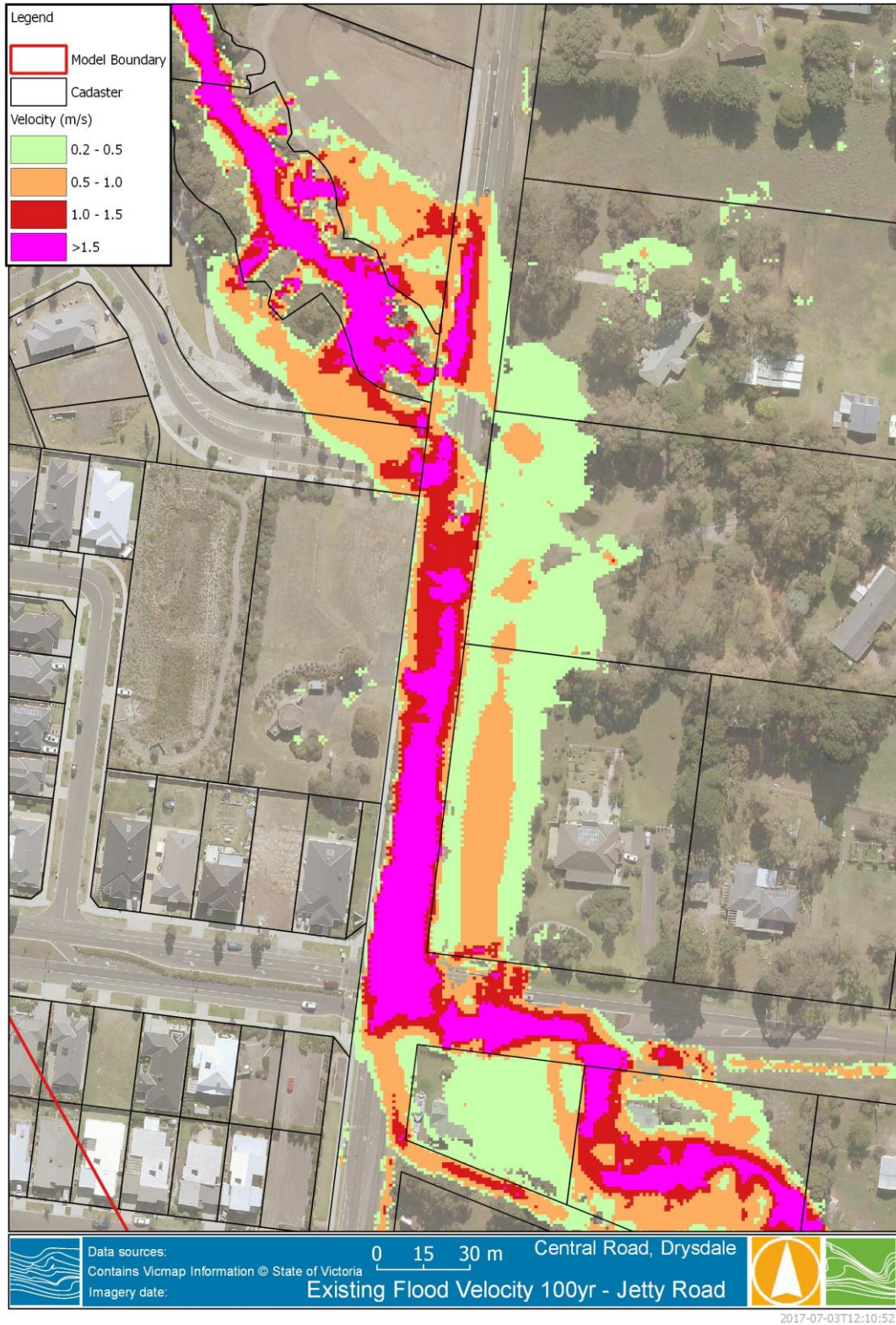
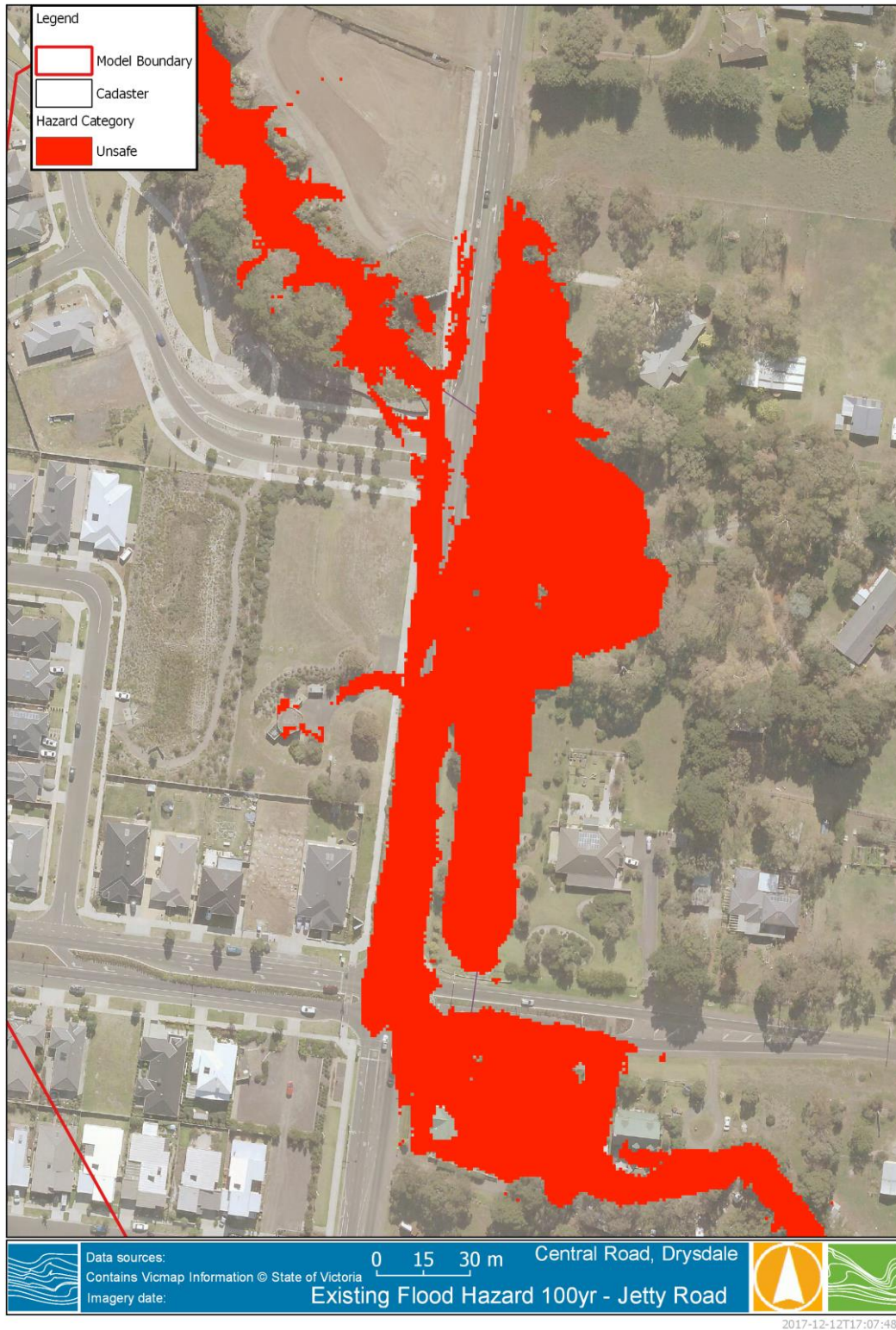


Figure 6-3 – Indicative 1% AEP Flood Velocities - Jetty Road (1 hour duration)

4663-01_R06b



4663-01_R06b

Figure 6-4 – Indicative 1% AEP Flood Hazard - Jetty Road (1 hour and 12 hour durations)



6.2 Post-Development

Whilst the site is shown to be at risk of flooding during the 1% AEP, 1 hour duration event following development, as shown in Figure 6-5 and Figure 6-6, the development layout maintains conveyance capacity of Flow path 3. Additionally, new lots are outside the post developed mapped 1% AEP flood extent.

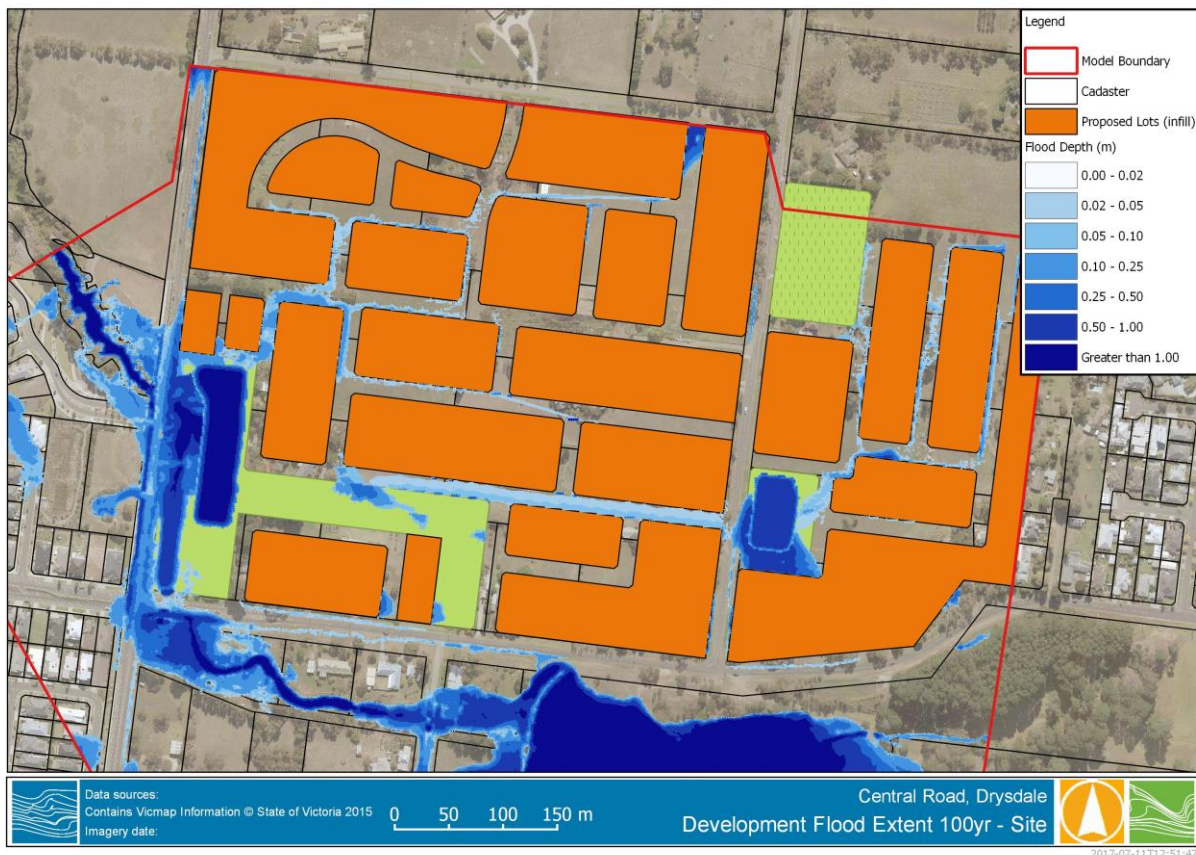


Figure 6-5 – Indicative Post-Development 1% AEP Flood Extent (1 hour duration)

The proposed wetland is outside the major flow path – i.e. Flow path 3 – and the impacts of the proposed development on flow conveyance are therefore limited. Whilst the proposed development results in localised afflux for the 1% AEP event (1 hour and 12 hour duration events), the proposed drainage system and retarding basin generally result in a significant reduction in flood depths along Flow path 3 and, importantly, in an adjacent property. Any afflux is limited to road infrastructure and the waterway and, given the reduction in flood depths observed elsewhere, the proposed stormwater strategy provides betterment compared to the existing conditions in respect to flow conveyance, as shown in Figure 6-7 and Figure 6-8.

Overall, the results indicate that there is no net loss of flood storage within the site.

The main outlet of the downstream wetland would need to discharge downstream of Jetty Road, as existing levels may not allow a gravity discharge from the wetland (bed level at 39.5 m AHD). This should be confirmed during the detailed design stage. Importantly, pipe discharge rates from both wetland outlets (including spillway) do not exceed existing flow rates modelled in RORB for the 1% AEP events, as shown in Table 6-2.

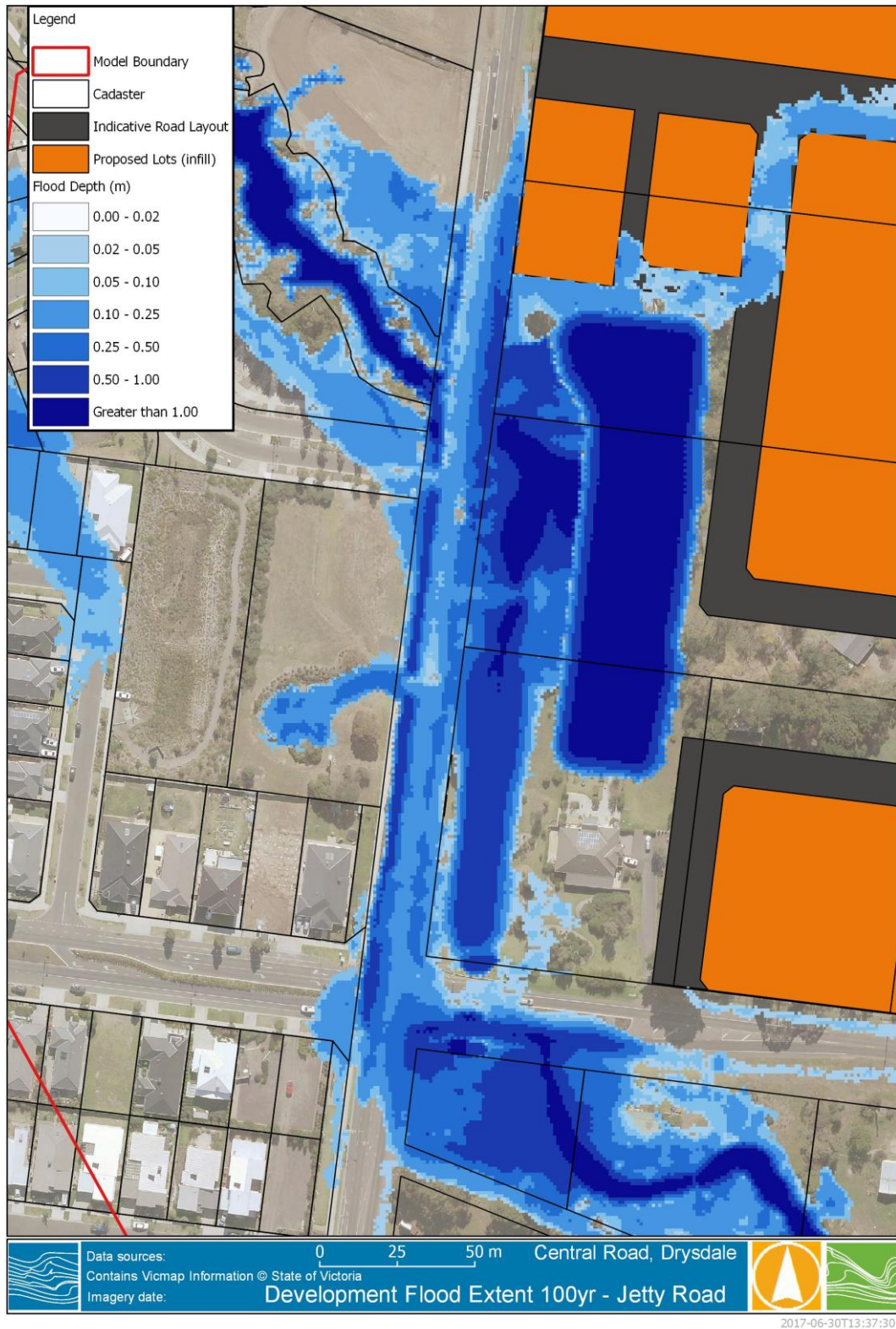
4663-01_R06b



Table 6-2 – 100 Year ARI Existing and Modelled Retarded Flows (1hr)

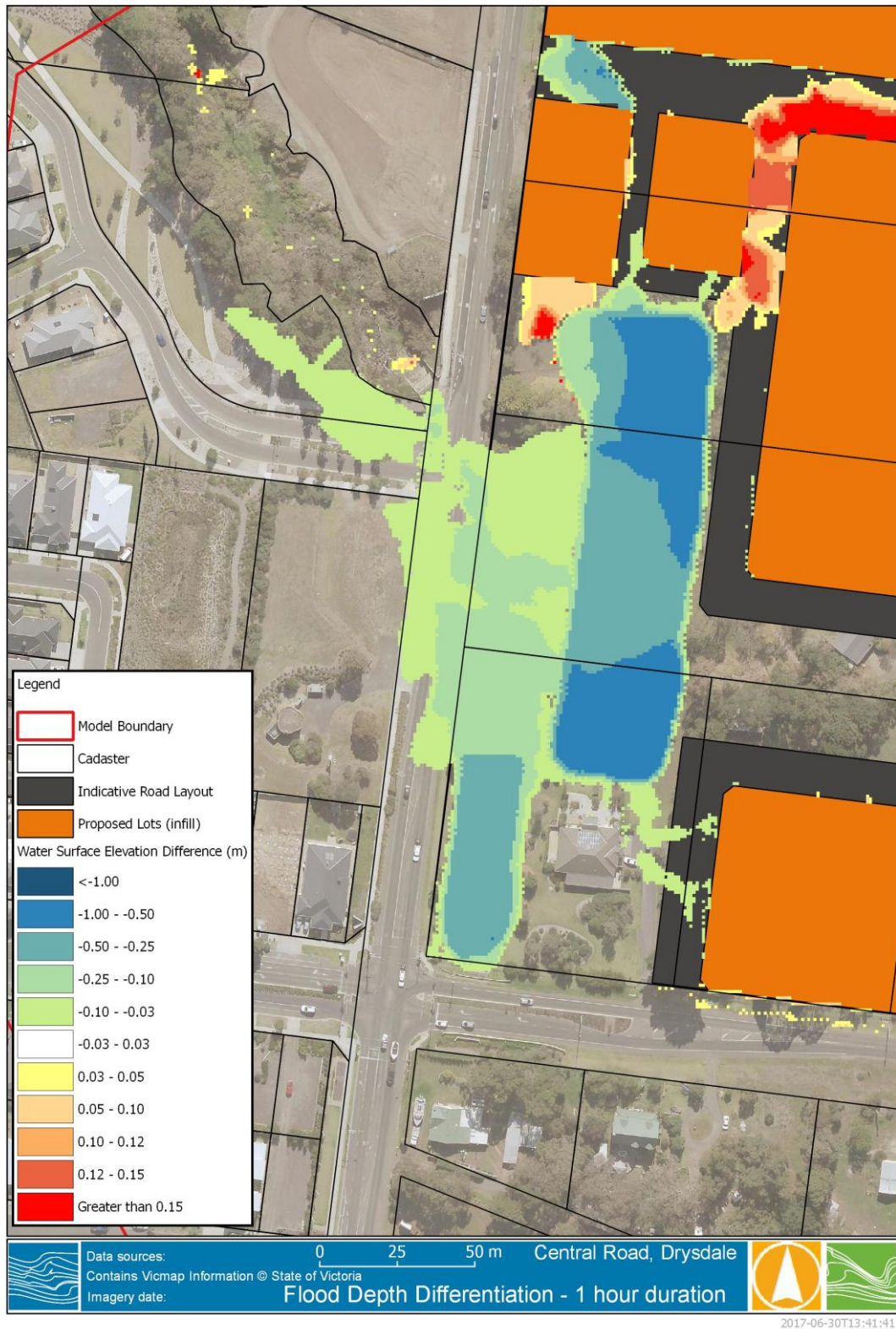
Location	Existing Flows (m ³ /s)	Mitigated Developed Flows (m ³ /s)
Upstream Central Road	0.96(2 hr)	<0.50
Upstream Jetty Road	2.02 (1 hr)	<1.9

The mitigated post-development flows are below the pre-development flows estimated from using the VicRoads Method. It is of note however, that floodwater from the existing Flow path 3 may overtop the retarding basin embankment. The impact on flood risk (shown in Figure 6-8) indicates that there is no adverse impact on adjacent properties due to the overtopping. The impact is restricted to roads and waterways, with significant betterment along existing Flow path 3. This should be considered during the detailed design stage, to minimise risk of scouring, whether by raising the embankment crest or spillway with adequate rock protection.



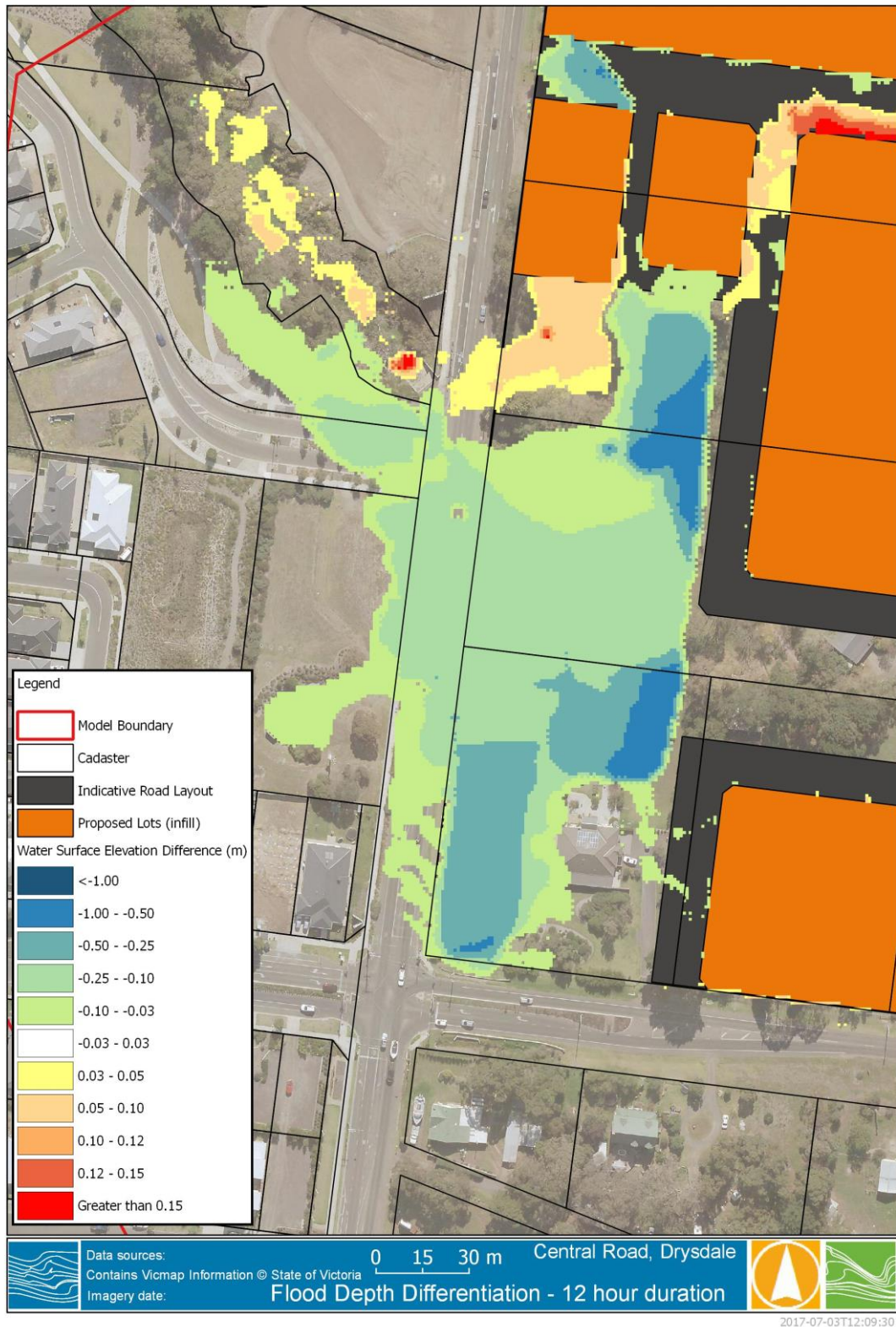
4663-01_R06b

Figure 6-6 – Indicative Post-Development 1% AEP Flood Extent - Jetty Road (1 hour duration)



4663-01_R06b

Figure 6-7 – Water Surface Elevation Difference Plot between Existing and Developed Conditions (1 hour)



4663-01_R06b

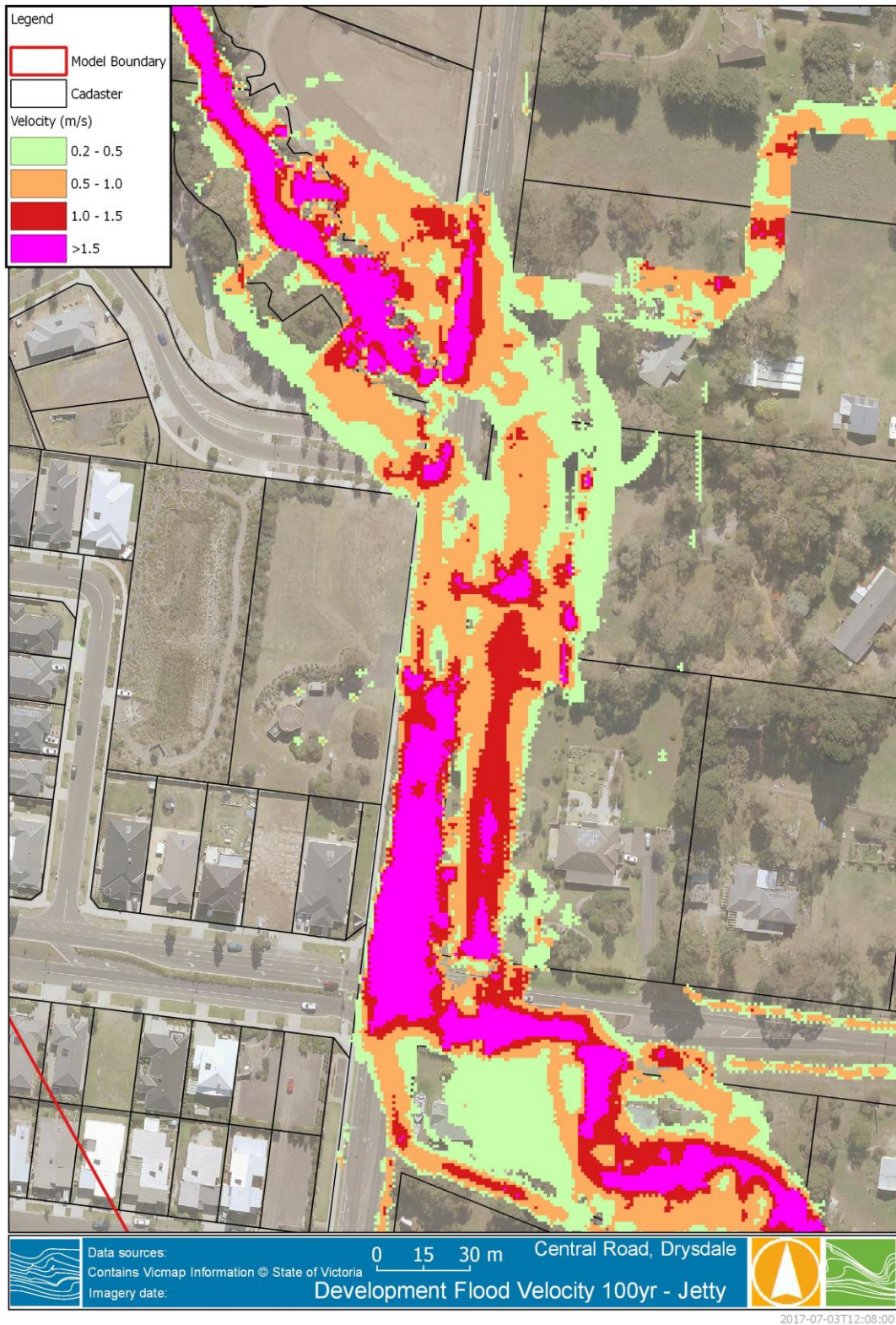
Figure 6-8 – Water Surface Elevation Difference Plot between Existing and Developed Conditions (12 hour)



Flood velocities adjacent to the Jetty Road are generally above 1.0 m/s as shown in Figure 6-9, with significant velocities within the waterway and on Jetty Road itself. Velocities within Flow path 3, east of Jetty Road, increases compared to existing conditions, however, combined with the predicted depth reduction, flood hazard is reduced within the site and along Jetty Road. Flood Risk along Jetty Road and within Flow path 3 is generally considered unsafe, as shown in Figure 6-10.

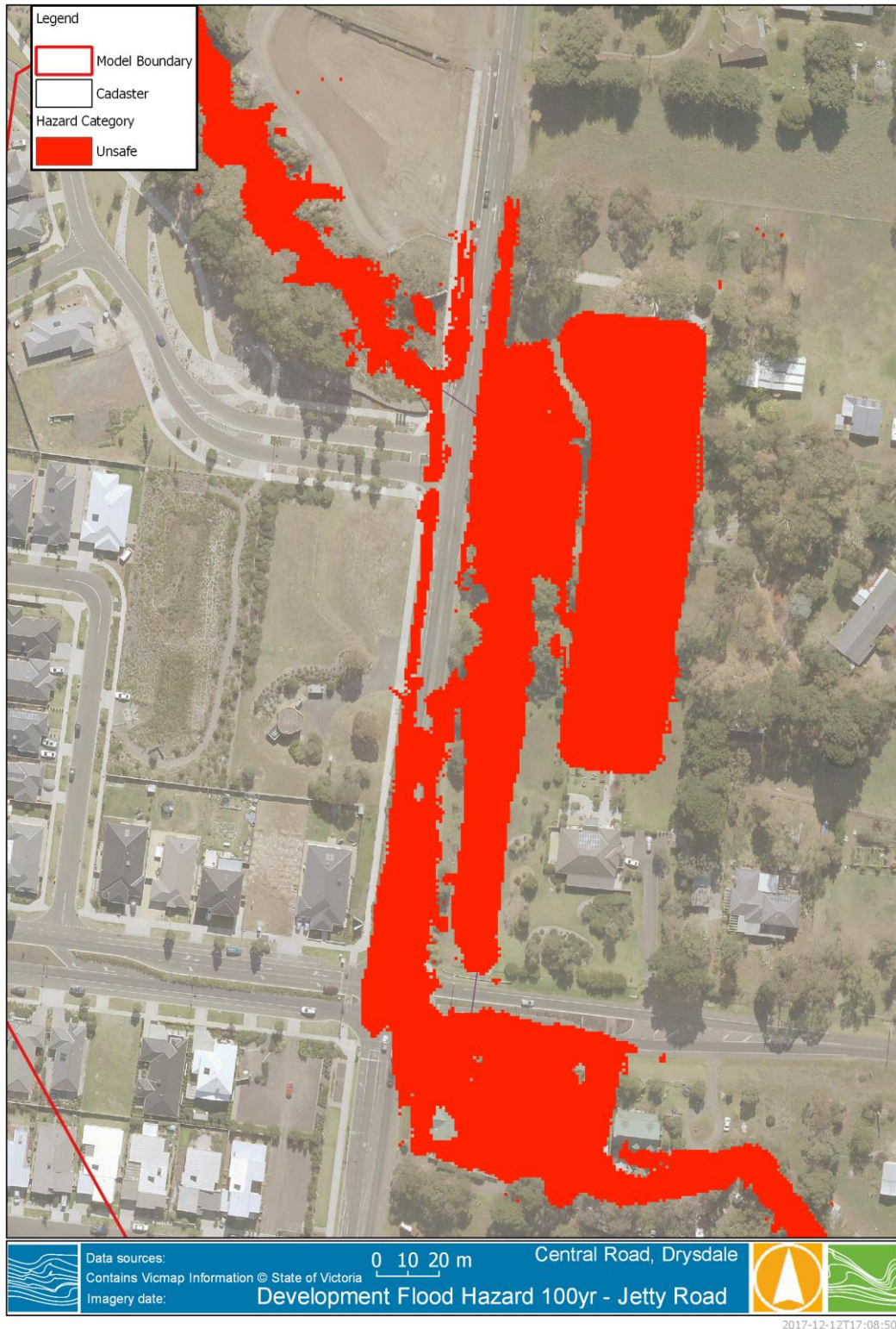
Flood Hazard within the two retarding basins is considered high, with depth exceeding 1 m depth in both systems. Batter slopes will be designed so as to allow for safety requirements.

It is of note that the Hazard Category for Jetty Road is already unsafe under existing conditions and we recommend road closure during a large event should be considered to mitigate existing and future flood risks.



4663-01_R06b

Figure 6-9 – Post-Development Flood Velocities



4663-01_R06b

Figure 6-10 – Post-Development 100% AEP Flood Hazard - Jetty Road (1 hour and 12 hour durations)



6.3 Shared Footpath

In line with their vision to enhance amenity and liveability for the development, McLeods Developments is aiming to design a walking trail within the site, integrating where possible, existing and proposed water assets. We understand that the City of Greater Geelong is supportive of the arrangement.

Figure 6-11 shows an indicative 10% AEP flood extent and the proposed location of the shared path entry point into the site from Jetty Road. While its specific alignment will be determined at detailed design stage, within the subject site the proposed trail will be partially located within the 1% AEP floodplain, with sections flood-prone during 10% AEP events. It is not considered feasible or practical to raise the footpath above the 1% AEP flood levels along the whole section of the trail and crossing above the 10% AEP extent may be required. Consequently, the design will need to:

- Allow for crossing structures (e.g. pedestrian bridge);
- Allow for well-marked refuge areas; and,
- Give path users advanced warning of moderate and high hazard areas.



Figure 6-11 – Indicative 10% AEP Flood Extent (9 hour duration)

4663-01_R06b



Drown-outs should be used immediately upstream and downstream of sections of the trail where flood water results in unsafe depth or velocities. A schematic of this system is shown in Figure 6-12. These drown-outs will warn users of potentially dangerous situations ahead and prevent access to those areas in the event of flooding.

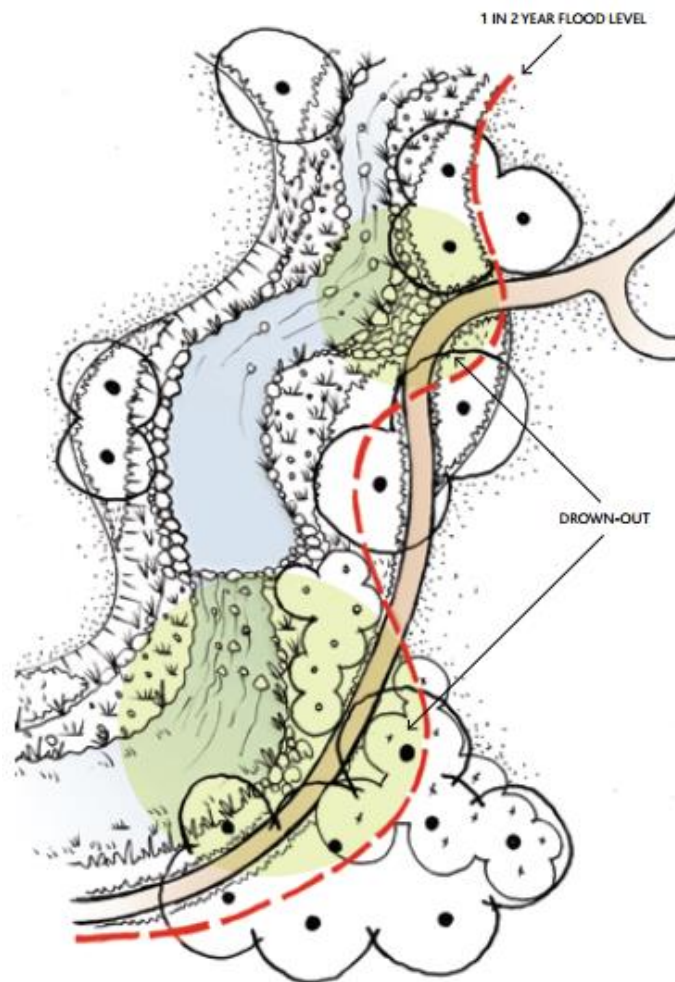


Figure 6-12 – Schematic of a drown-out arrangement (source Melbourne Water's Shared Pathways Guidelines)

A drown-out relies on shallow inundated barrier that deter entry to other flooded sections of trail, with unsafe depth. Drown outs should include signage directing path users to a safer alternate route and, if possible, will allow reconnection to the path. Drown outs can also be used to signal approaches to waterway crossing, if the crossing structure is a risk of being inundated.

- Other measures may include:
- Flood-activated boom gates or other barriers to block access to the inundated section of the path in the event of a flood;
- Additional signage (eg depth markers with colour coding); and,
- Non-structural measures, such as integrating response as part of Council's Flood Response Plan.

4663-01_R06b



A flood activated boom gate would be an effective mean to prevent path user entering the trail, as the trail would only have one point of entry, however, it would require to be operated by Council.



7 SUMMARY

This report sets out a recommended Stormwater Management Strategy for a proposed development at Central Road, Drysdale. Water Technology has developed a concept design to manage 1% AEP flood flows across the subject site under developed conditions. The modelling has demonstrated that the proposed retarding basins result in no adverse on-site impacts in the 1% AEP flood event and generally reduce flood risk compared to the existing conditions in respect to flow conveyance.

As agreed with Corangamite Catchment Management Authority, the proposed Stormwater Strategy shows that:

- The development layout maintains conveyance capacity of Flow path 3;
- The proposed development layout ensures there is no net loss of flood storage within the site; and
- No new lots are created within the post developed mapped 1% AEP flood extent.

Importantly, the downstream retarding basin (east of Jetty Road), is not located within the major flow path.

Whilst the proposed development results in localised afflux for the 1% AEP event (1 hour and 12 hour duration events), the proposed drainage system and retarding basin generally results in a significant reduction in flood depths along Flow path 3 and in an adjacent property. This afflux is limited to road infrastructure and downstream waterway and does not impact on flood depths on downstream properties. Importantly, flood hazard is generally reduced within the site and along Jetty Road. This is of importance as a footpath is proposed within the site and the proposed stormwater strategy will overall reduce risk to future users.

Water quality management is achieved through WSUD assets, including two sediment basins and two wetlands. These are located at the bases of each retarding basins and have been sized based on land availability and the load reduction resulting from the water quality strategy meets or exceeds best management practice targets. The proposed on-site stormwater management and water quality features are also compatible with existing drainage features.

As demonstrated in the SWMS, the public open space along Jetty Road acts as a waterway buffer and ensures there is no detrimental impacts within the catchment. It is considered that any reduction of this buffer would result in loss of storage and/or conveyance, and would therefore result in off-site impacts without major works (e.g. culvert upgrades).

Based on the outcomes of this report, Water Technology concludes that the proposed development will not have any unacceptable impacts on flood safety and water quality.



APPENDIX A– STAGE / STORAGE RELATION

RORB Modelling

Upstream Central Road

Height (m)	Storage (m ³)
46.5	0.0
47.0	1,050
47.5	2,340

East of Jetty Road

Height (m)	Storage (m ³)
40.0	0.0
40.5	2,195
41.0	4,835
41.2	6,025
41.5	6,025



Melbourne

15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800
Fax (03) 9558 9365

Wangaratta

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

Geelong

PO Box 436
Geelong VIC 3220
Telephone 0458 015 664

Wimmera

PO Box 584
Stawell VIC 3380
Telephone 0438 510 240

Brisbane

Level 3, 43 Peel Street
South Brisbane QLD 4101
Telephone (07) 3105 1460
Fax (07) 3846 5144

Perth

PO Box 362
Subiaco WA 6904
Telephone 0438 347 968

Gippsland

154 Macleod Street
Bairnsdale VIC 3875
Telephone (03) 5152 5833

www.watertech.com.au

info@watertech.com.au

