Final Report

375 Swansea Road, Lilydale – Stormwater Management Plan

Lilydale Management Services

May 2022

ADVERTISED

Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
01	Draft	Luke Cunningham	Luke Cunningham	24/04/2018
02	Draft	Luke Cunningham	Luke Cunningham	17/08/2018
03	Draft	Luke Cunningham	Luke Cunningham	30/08/2018
04	Draft	Thomas Cousland	Thomas Cousland	02/05/2019
05	Draft	Bertrand Salmi	Thomas Cousland	16/08/2019
06	Final	Thomas Cousland	Thomas Cousland	28/10/2019
07	Final	Bertrand Salmi	Bertrand Salmi	08/11/2019
08	Final	Aaron Vendargon	Aaron Vendargon	12/11/2019
09	Final	Aaron Vendargon	Aaron Vendargon	05/02/2020
10	Final	Bertrand Salmi	Bertrand Salmi	03/05/2022

Project Details

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CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

This report sets out a recommended Stormwater Management Strategy for a proposed residential village at 375 Swansea Road, Lilydale. The Stormwater Management Strategy sets out a concept design to manage stormwater runoff from the proposed development and meet Melbourne Water's requirements for development in flood-prone areas.

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 treatment targets; and
- Alleviate flood impact of the development on downstream environment.

We understand that this Stormwater Management Strategy has been prepared following discussion with Melbourne Water to support a planning application to Yarra Ranges Council.

1.1 Objectives

The objectives of the Stormwater Management Strategy are to:

- Size a retardation asset, as per legal point of discharge and allowable discharge rate;
- Identify possible mitigation measures to prevent contaminated surface run-off from discharging to surface water (Olinda Creek); and,
- Ensure the proposed development complies with criteria set in Melbourne Water's *Guidelines for Development in Flood Prone Areas*.

2 BACKGROUND

The proposed development at 375 Swansea Road, Lilydale, is situated approximately 40 km east of Melbourne's CBD. It is bounded by Swansea Road to the east, Olinda Creek to the west and Lilydale Lake parkland to the north, as shown in Figure 2-1.

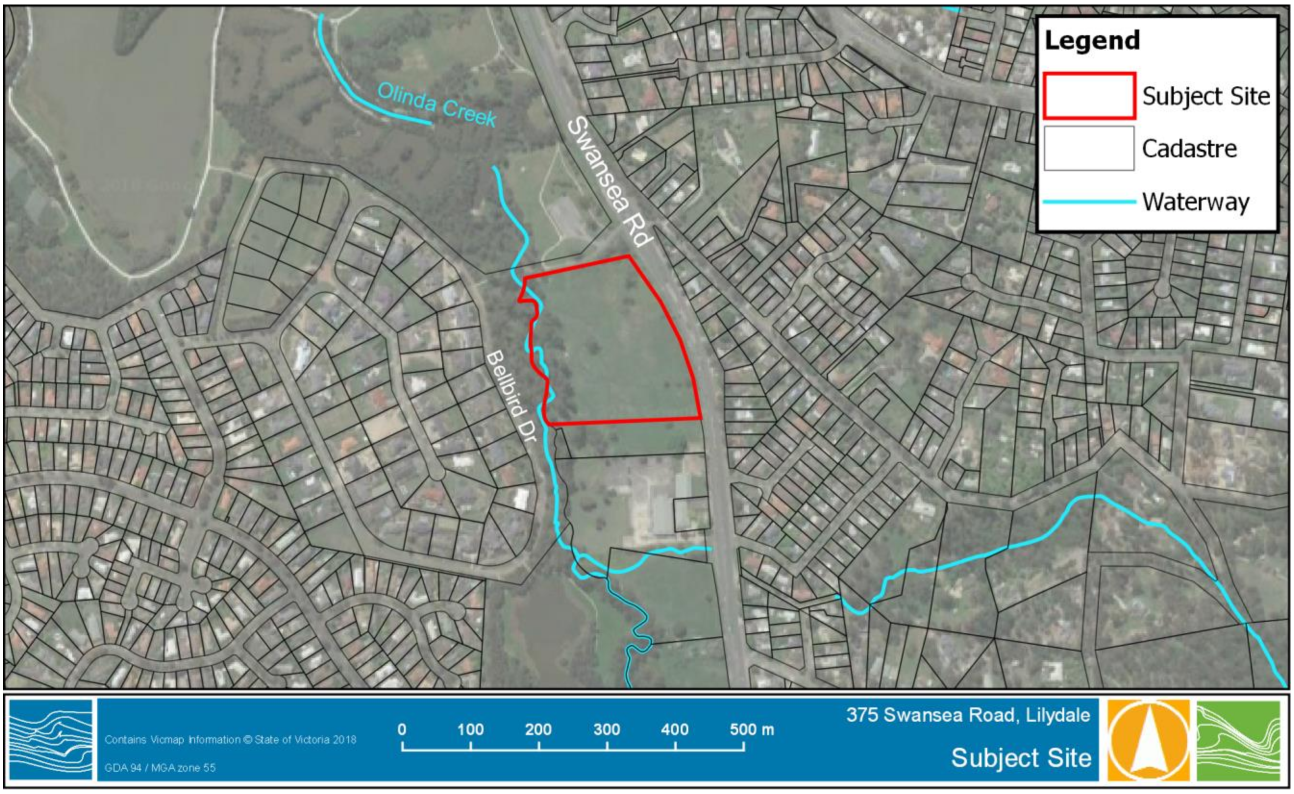

Figure 2-1 Subject Site

The site is zoned Rural Living Zone (Schedule 2) and is covered by several overlays shown on Figure 2-2, including a Land Subject to Inundation Overlay (LSIO).

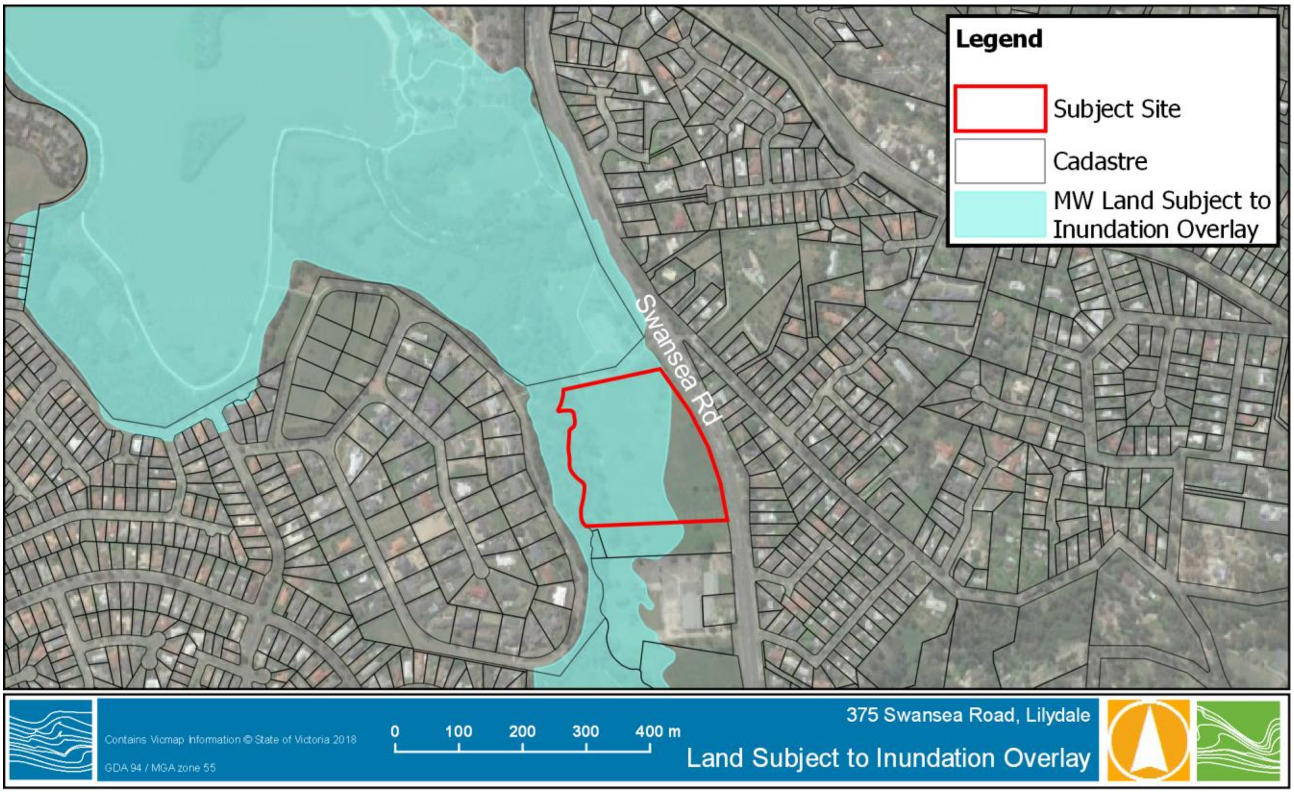

Figure 2-2 Land Subject to Inundation Overlay

The site has an area of 4.7 ha and is generally characterised by open grass paddock. It drains via earth drains, which flow to Olinda Creek to the west. Levels within the site vary from around 113.0 m to 108.0 m AHD, generally sloping in a north-western direction, as shown in the topography and features survey (Appendix A).

2.1 Site Opportunities and Constraints

For the study area, a number of opportunities and constraints were identified that would need to be considered when designing drainage infrastructure for the site. These include:

- Opportunities
  - The legal point of discharge for the site would be Olinda Creek and will necessitate an application to Melbourne Water's Asset Services team in due course:
    - Development flows to be retarded back to pre-development levels;
  - A 30 m setback is required from Olinda Creek, according to the Strahler stream order of Olinda Creek and Melbourne Water's Corridor Guidelines, however Melbourne Water's pre-development advice (dated 14 November 2017) indicates that the existing flood extent may be appropriate for setback requirements; and
  - Remnant native vegetation cover across the subject site is severely depleted, providing opportunities to promote local plants in the design of drainage assets;
    - Funding is available for revegetation program within the riparian corridor, such as Melbourne Water's Corridors of Green funding (up to $20,000).
- Constraints

- The site is impacted by a Land Subject to Inundation Overlay (LSIO) which will trigger a referral to Melbourne Water as the Floodplain Authority. Melbourne Water has advised that the flood level grades from 109.8 metres to Australian Height Datum (AHD) at the southern boundary, down to 108.5 metres to AHD at the northern boundary.
  - The dwellings/main buildings to be constructed with finished floor levels set a minimum of 600mm above the applicable flood level;
  - Any garages/outbuildings must be constructed with finished surface levels set a minimum of 300mm above the applicable flood level; and
  - Compensatory floodplain storage (cut) will be required between Olinda Creek and the development area, due to fill required to build up the proposed fillpad above 1% AEP flood levels.

2.2 Proposed Development

The proposed development is for a residential village, west of Swansea Road. The previously proposed development layout has been revised in accordance with discussions with Council. The village will contain approximately 50 units (previously 80 units) and access will be via Akarana Road. The development, including the internal road network, will be raised to ensure sufficient freeboard is provided above applicable flood levels. Development levels will be achieved via a combination of fill and cantilevers. Fill will result in floodplain loss however; compensatory cut will be provided west of the development to mitigate the proposed fill. Even though the development density has decreased from the last layout, the overall footprint area remained unchanged. Therefore, the extent of the fill pad was assumed to be remained same as the pervious design iteration (2018)

The current development line allows for the compensatory cut to be placed between Olinda Creek and the development area, with the invert level of the cut area approximately 1.5 m above the invert of Olinda Creek at the northern end of the property. Melbourne Water has agreed (in-principle) to the use of cantilever over the proposed cut, which would allow additional compensatory storage to be provided[1]. There is therefore some flexibility in the design going forward.

Confirmation has been sought from Melbourne Water as to whether the cut area could be placed within the 30 m setback area. Preliminary advice from Melbourne Water, given during the meeting on April 6 April 2018, suggested that the setback was to-built-form and that minor works may be allowed in the setback. Melbourne Water have confirmed that they support the increase in riparian vegetation along the Olinda Creek, provided that the planting is consistent with other works undertaken by Melbourne Water and Yarra Ranges Council in the local area[2].

The proposed development layout is shown in Figure 2-3.

[1] Email from Emma Tame (Melbourne Water) dated 21 June 2018.
[2] Email from Emma Tame (Melbourne Water) dated 28 June 2018.

Figure 2-3 Proposed Development Layout (Source: Hamilton Corporation)

3 LOCAL CATCHMENT MODELLING

This Section of the Stormwater Management Plan details the Retardation Asset and Water Sensitive Urban Design (WSUD) assets proposed to treat runoff from the development. The preliminary designs were assessed, taking into consideration floodplain characteristics.

3.1 Storage Requirements

A Boyd's Method calculation was adopted to estimate storage requirements to retard flows from the 2.4 ha development. It is considered that this methodology is acceptable for a preliminary estimate or conceptual design of storage volumes and in accordance with current practices.

The existing flows for the site was estimated using a regional flow estimate (using Adam's Method time of concentration). The peak 1% AEP was estimated to be 0.11 m^3/s. Maximum flood storage requirements were estimated to be about 360 m^3, as shown in Table 3-1, based on a runoff coefficient of 0.65.

Table 3-1 Storage Requirements (Boyd's calculation)

Storm Duration (hr)	Rainfall Intensity I_{100yr} ARI (mm/hr)	Peak Inflow I_p (m^3/s)	Peak outflow Q_p (m^3/s)	Inflow Volume V_{dev} (m^3)	Storage Volume S_{max} (m^3)
10	133.54	0.57	0.11	341	275
15	108.64	0.46	0.11	417	318
20	92.72	0.40	0.11	474	342
25	81.48	0.35	0.11	521	356
30	73.04	0.31	0.11	560	362
45	**56.65**	0.24	0.11	652	355
60	46.95	0.20	0.11	720	324
90	36.34	0.15	0.11	836	242
120	30.19	0.13	0.11	926	134

Flood storage will be provided via an underground tank. Preliminary calculations indicate that a 225 mm or 300 mm diameter would be sufficient to control flows to pre-development conditions. It is appropriate to allow for the details of the outlet to be finalised at the functional design stage, as it will also be dictated by the dimensions of the tank.

3.2 Internal Drainage Network

The proposed internal drainage pipes are to be designed with capacity to convey 10-year ARI events. An indicative stormwater layout, showing proposed water quality assets (see Section 3.3) and onsite detention (underground tank) is shown in Figure 3-1. A summary of estimated catchment flows entering each pipe and pipe sizing is presented in Appendix C.

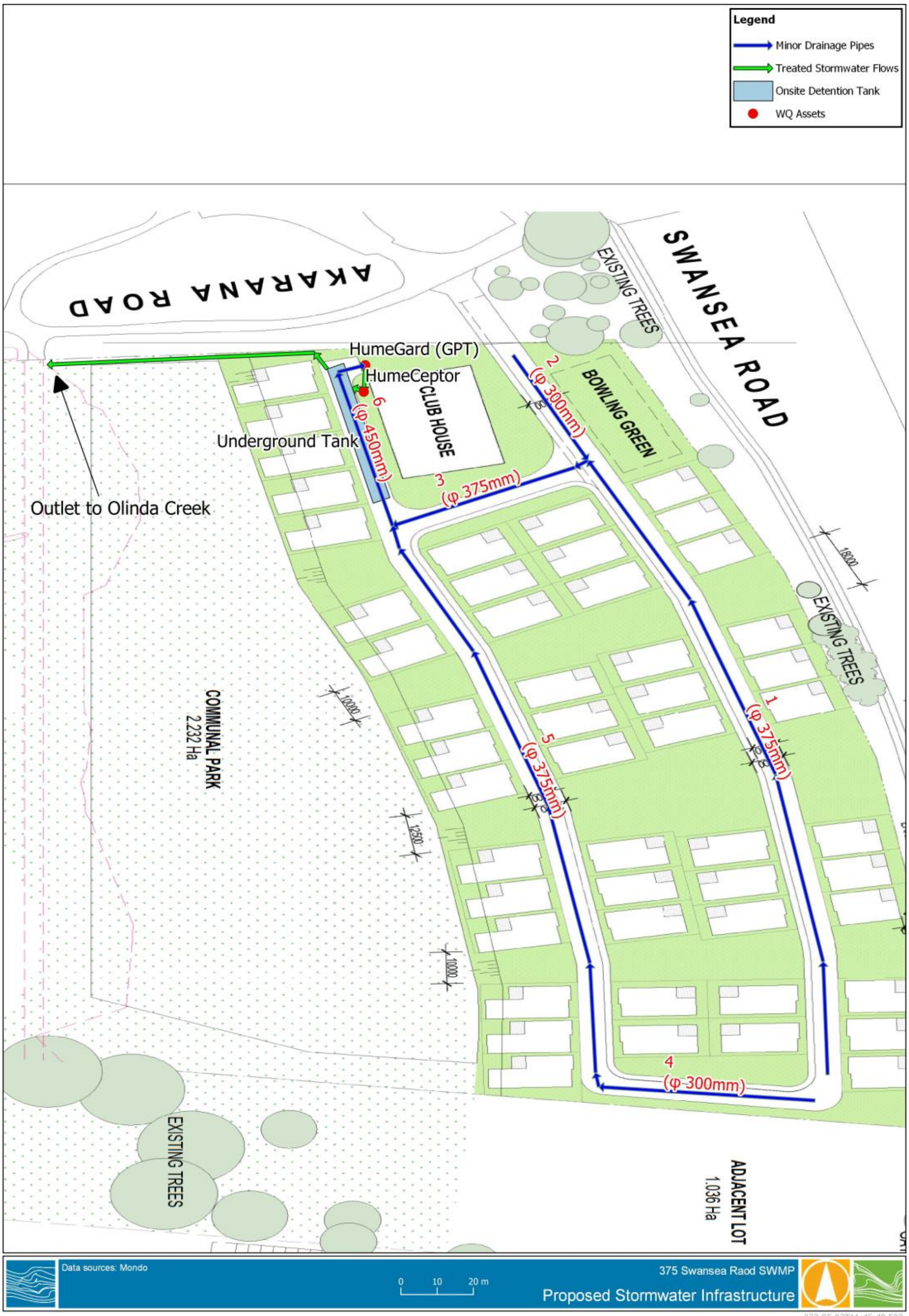

Figure 3-1 Indicative Drainage Infrastructure

The level strategy of the site will need to ensure that stormwater runoff is conveyed towards the underground retardation asset when the capacity of the pipes is exceeded (i.e., greater than 10-year ARI events). Future roads or open space reserves are likely to act as overland flow paths and pits are to be designed at the lowest points to capture 100-year ARI flows and direct them to the underground storage system. The capacity of the 7 m wide road reserves to convey the overland flow at the downstream end of the drainage network was also assessed (refer to Appendix D for detailed calculations). Assuming an average longitudinal slope of 1% (similar to internal pipe network), the 100-year ARI flood flows is contained within the road reserve.

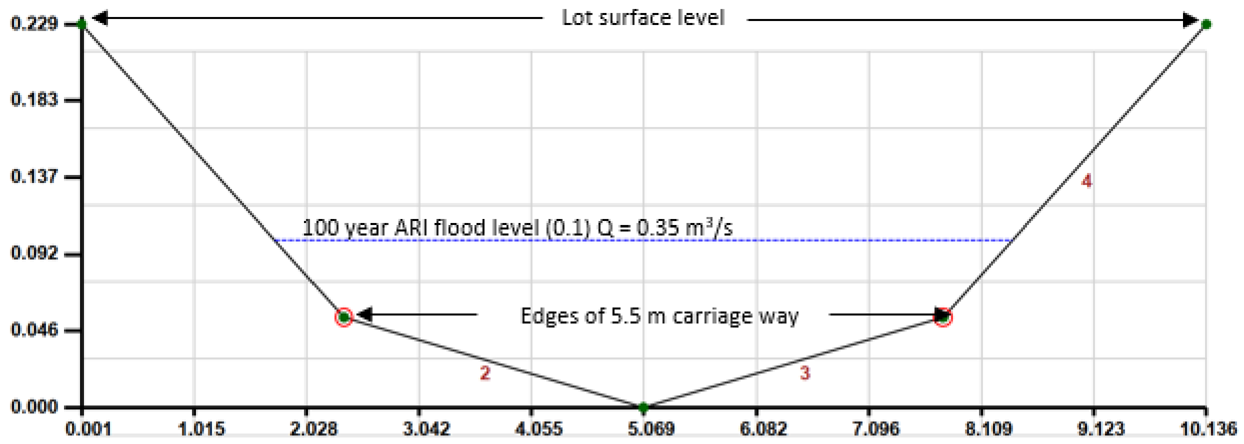

Figure 3-2 100 year ARI overland flow assessmetn of typical 5.5 m road cross section (1% longitidinal slope)

It is appropriate to allow for the details of the drainage infrastructure, including pipe/pit schedule, overland flow paths, underground storage and easement, to be conditioned by permit conditions and finalised at the detailed design stage.

3.3 Water Quality Modelling

Stormwater modelling was carried out with regards to best practice industry methods. 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.

The MUSIC model (Version 6.2) was built to identify requirements for water sensitive urban design assets to service the proposed residential development. A schematic of the model is shown in Figure 3-3.

The model was run using the Narre Warren North rainfall gauge, as per Melbourne Water's MUSIC Guidelines. Default parameters recommended in Melbourne Water's guidelines (2018) were adopted elsewhere for the modelling (e.g. field capacity), including a fraction impervious of 0.50.

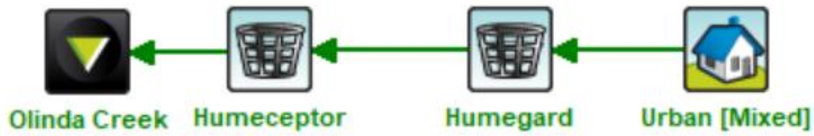

Figure 3-3 MUSIC Model

The treatment train includes an end-of line proprietary stormwater treatment assets. Traditional WSUD assets (i.e., raingardens, wetlands) were not proposed due to site specific constraints such as hydraulic gradient and risk of frequent flooding from Olinda Creek.

An end of line Gross Pollutant Trap and (GPT) (HumeGard®)[3] followed by a hydrodynamic separator (HumeCeptor®)[4] is proposed for the stormwater treatment. Pollutant capture efficiencies provided by the supplier was used in the MUSIC model. Asset design flow rate was set to 3-month ARI flow (~50 l/s)

Table 3-2 Pollutant Removal Efficiency (%) for Treatment Assets

Pollutant	HumeGard® [3]	HumeCeptor® [4]
Gross Pollutants	90	< 1
Total Suspended Solids	49	80
Total Phosphorus	40	53
Total Nitrogen	26	37

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[3]https://www.holcim.com.au/humes/precast-concrete-solutions/stormwater-solutions/stormwater-treatment/primary [27 April 2022]
[4]https://www.holcim.com.au/humes/precast-concrete-solutions/stormwater-solutions/stormwater-treatment/secondary [27 April 2022]

Figure 3-4 Proposed Stormwater Treatment Train with HumeGard® in left and HumeCeptor® in right

Other proprietary systems may provide similar level of treatment and this can be further investigated during the detailed design stage.

It is proposed that stormwater treatment assets to Treatment Gross Pollutant Trap will connect to OSD Olinda Creek. Although no detailed design has been undertaken on the outlet configuration of the system, preliminary checks on existing invert levels were carried out however, this should be considered further at the detailed design stage.

3.3.1 Water Quality Benefits

The proposed treatment train ensures best practice stormwater management targets are met and exceeded at the site, as shown in Table 3-3. The WSUD assets would also capture more than 90% of gross pollutants generated on site.

Table 3-3 MUSIC Modelling Results for the Proposed Site

Component	Source Load	Residual Load	Reduction (%)
Gross Pollutants (kg/yr)	446	49.5	**88.9**
Total Suspended Solids (kg/yr)	1,990	246	**87.6**
Total Phosphorus (kg/yr)	4.42	1.94	**56.2**
Total Nitrogen (kg/yr)	33.8	47.2	**47.2**

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Benefits associated with the proposed treatment train include:

- Relatively easy installation of precast units
- Underground assets that meet best practice with minimum footprint area
- Additional proprietary system, such as EnvissSentinelTM (or equivalent)[5] could also integrated into the treatment train, to treat runoff from roads;
- Although initially considered, traditional WSUD assets have been discounted:
  - Due to levels of Olinda Creek, a raingarden may necessitate shallower filter media, compromising long-term effectiveness;
  - Modelled flood depths in floodplain (>2 m) would likely result in excessive loading onto above assets and the resuspension of pollutants.

3.4 *Eucalyptus ovata*

Considering the adjacent Olinda Creek, Water Technology have also considered an alternative non-typical approach to treat stormwater. This Section details an alternative approach, based on wastewater treatment and disposal principles. Whilst the supporting science (i.e., *Eucalyptus'* nutrient uptake capabilities) is well established and used to design conventional wastewater treatment system, it is a relatively new concept in the urban stormwater management. For this site, this approach, if deemed acceptable by Council and Melbourne Water, would:

- Reduce the size of the bio-retention system and minimise the extent of work within the floodplain,
- Promote local trees and pre-European Ecological Vegetation Classes and assist in the revegetation of the site; and
- Assist in the revegetation of the site, including enhance existing riparian environment.

We note that the entire site is within the Gippsland Plain Bioregion, and the vegetation prior to European Settlement has been modelled to have been Swampy Riparian Complex (EVC 126). The EVC contains species, which are tolerant of intermittent to seasonal inundation, such as *Eucalyptus ovata* (Swamp Gum). *Eucalyptus* species have a proven ability to uptake nitrogen and phosphorus[6]:

- Up to of 90kg of TN per ha per year; and
- Up to 15kg of TP per ha per year.

The nutrient uptake associated with *Eucalyptus* could be accounted for in the overall site treatment train. As a result, planting of a Swamp Gum woodland within the site and existing grass paddocks, could form part of the treatment train and potentially reduce the size of other WSUD assets (i.e. bio-retention system). The planting of gum trees would also promote plants from local EVCs and a landscape sympathetic to riparian corridor of Olinda Creek.

Benefits associated with the use of a Swamp Gum woodland to treat stormwater runoff include:

- Promoting plants representative of local Ecological Vegetation Classes (EVCs);
- Potentially reduce operation requirements compared to traditional WSUD assets (i.e. no filter media);
- Potential reduction in renewal/decommissioning costs (compared to a bio-retention system) as nutrient uptake basis is based on “dry matter” (i.e. growth);

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[5] https://www.enviss.com.au/sentinel-pits/ [27 April 2022]
[6] EPA Publication 168 (p51)

- Potential delivery of vegetation off-sets.

Assuming an area of 10,000m^2 (approximately equivalent to cut floodplain area) would be planted with Swamp Gums[7], those trees may remove up to 90 kg of TN and 15 kg of TP per year, based on the nitrogen and phosphorus uptake capabilities of *Eucalyptus* species. Importantly, from a biodiversity perspective, associated planting will be consistent with the Olinda Creek floodplain.

Whilst still a novel approach, Water Technology has recommended similar principles in stormwater management plans for development across Victoria, including in Casey, Shepparton, Horsham and Bairnsdale. Importantly, this would be in addition to the treatment provided by the constructed WSUD assets (see Section 3.3) and is not required to meet stormwater quality objectives for the proposed development.

3.5 External Catchments

Council drainage assets convey stormwater runoff from the eastern catchment (including David Hill Estate) towards Swansea Road. These Council pipes discharge into the swale drain along Swansea Road and through the site, which discharges to Olinda Creek. The proposed infill within the subject may sever a portion of flows over the existing floodplain:

A RORB model was created for the upstream catchment with the RORB model delineation shown in Figure 3-5. The RORB model was setup and run consistent with ARR2019 parameters and Melbourne Water Flood Mapping Technical Specification document (November 2018). The run parameters used in the modelling are shown in Table 3-4.

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Figure 3-5 Cherry Creek RORB Model Setup

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[7] About 500 trees

Table 3-4 RORB Run Parameters

Parameter	Value		Parameter	Value
Initial Loss	25 mm (From BOM data Hub)		M	0.8
Continuing Loss	3.9 mm (From BOM data Hub)		Kc	0.48 (Pearse et al., 2002 =1.25*Dav)
Directly Connected Initial Loss	1.5 mm			
Directly Connected Continuing Loss	0 mm			
Indirectly Connected Initial Loss	17.5 mm			
Indirectly Connected Continuing Loss	2.5 mm			

The resultant box and whisker plots and peak rates from the upstream catchment inflow is shown Figure 3-6 and Table 3-5.

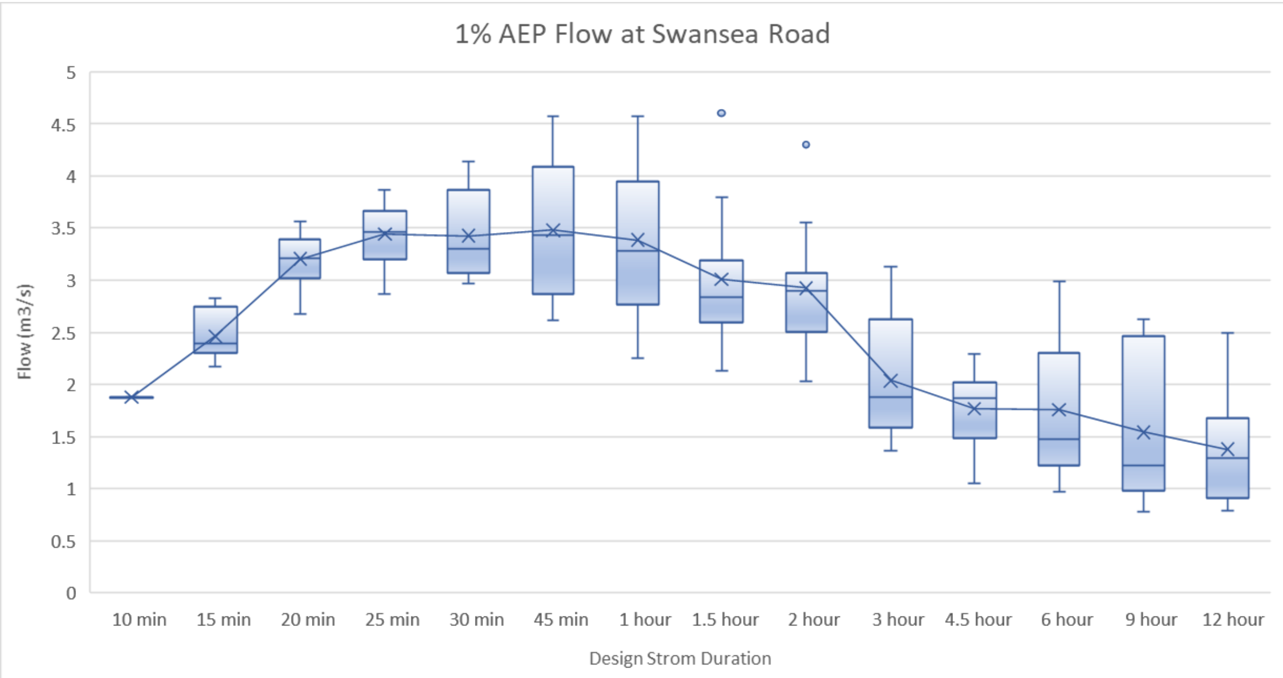

Figure 3-6 RORB Box and Whisker Results Plot

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Table 3-5 1% AEP RORB Modelling Results

	Flow (m^3/s)	Temporal Pattern	Duration
Upstream flow at Swansea Road	3.23	28	20 minute
	3.51	23	25 minute
	3.44	21	30 minute
	3.56	26	45 minute
	3.66	26	60 minute

The TUFLOW model presented in section 4, was adapted specifically to test the impact of the development fill pad on the council drainage system at the Swansea Road interface, and flow conditions within the drainage channel around the site. Figure 3-7 shows the details of the TULFOW model adopted for this modelling exercise. The flood model's inflow boundary was input into the drainage pit (i.e. using TUFLOW's '1d_bc' layer) located at the sag point on the east side of Swansea Road. This was seen as an effective way to model distribution of flow across Swansea Road.

A preliminary culvert sizing was undertaken for the driveway entrance to the development, with blockage factors consistent with Book 6, Chapter 6 of Australian Rainfall and Runoff 2019 applied in the design and subsequent modelling. The culvert sizing was undertaken in the culvert software package HY-8 with the details of the culvert analysis shown in Table 3-6, with the ARR19 blockage factor determination shown in Table 3-7. A 2d_zshp file representing the driveway was also included in the TUFLOW modelling.

Table 3-6 Driveway Culvert Details

Driveway Culvert Details		
Design Flow Rate	3.66	m^3/s
Culvert Height	1,200	mm
Culvert Width	1,500	mm
US IL	107.0	m AHD
DS IL	106.8	m AHD
Blockage Factor	15%	
Headwater Level	108.65	m AHD
Culvert Barrels	1	

Table 3-7 Culvert Blockage Factor Determination (ARR19)

1	**Choose Debris Availability**		
	(H,M or L)	Medium	
2	**Choose Debris Mobility**		
	(H,M or L)	Medium	
3	**Choose Debris Transportability**		
	(H,M or L)	High	

5	**Adjustment for AEP**		
	Chooses AEP	1	%
6	**Design Blockage Level (inlet)**		
	L10	1.5	m (1.5 for Urban)
	Culvert W	1.5	m
	Culvert H	1.2	m
	Inlet Blockage	10	%
7	**Vertical check not required**		
	Vertical Blockage		
	adjust L10	NA	m
	Inlet Blockage	NA	%
8	**Barrel Blockage**		
	Estimate Velocity	0.5	m/s
	Mean Sediment Size	Sand	
	Likelihood	Low	
	Adjusted Debris Potential	Medium	
	Barrel Blockage	15	%
	Blockage Factor		
	15	**%**	

The model was run for all five design storm events presented in Table 3-5. All five hydraulic modelling runs presented similar results in terms of peak flood level, velocity and hazard. For a simpler view, only the 45 minute duration results are presented in this report as it was found to result in the highest depth and hazard.

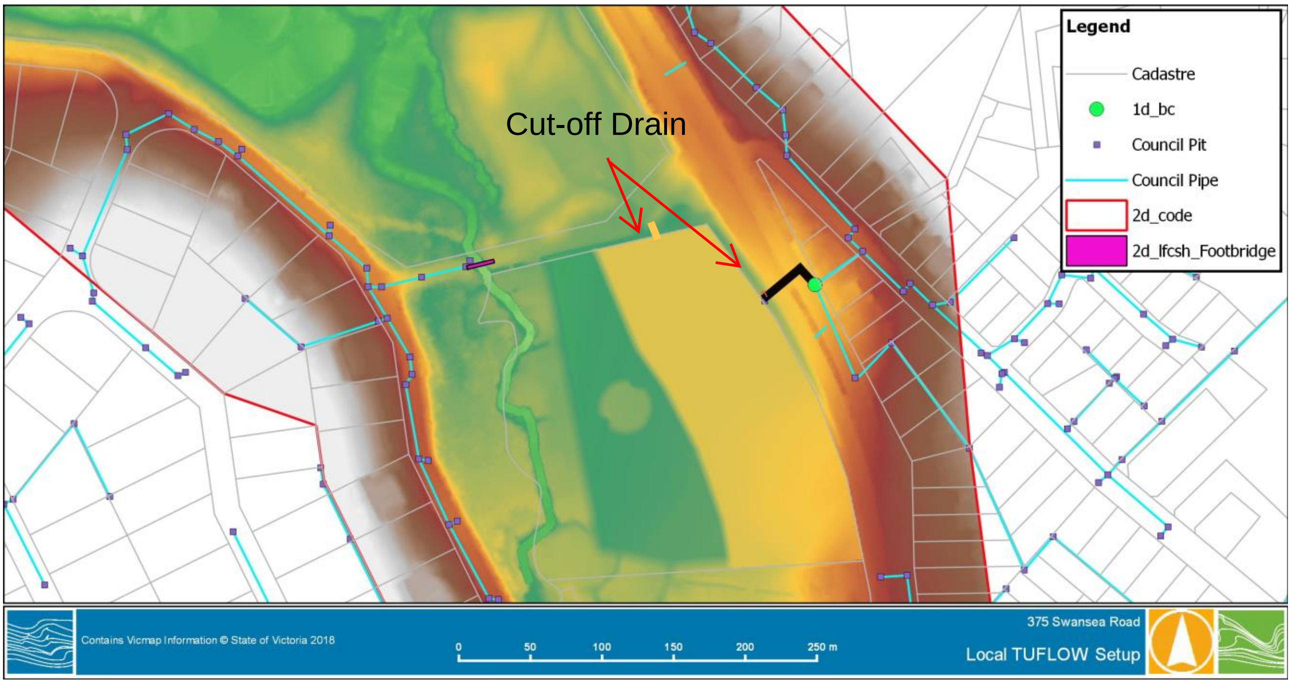

Figure 3-7 Local Catchment TUFLOW Setup

Figure 3-8 to Figure 3-13 show the existing and developed conditions peak flood depths, flood velocity and 'depth x velocity' plots for the modelled 1% AEP flood event from the local external catchment. For clarity, the colour banding on these maps corresponds to the criteria outlined in Council's email on the matter (email dated 23 October 2019).

Flood level and flood velocity difference plots (showing the changes between developed and existing conditions), for the local catchment 1% AEP event, are shown in Figure 3-14 and Figure 3-15 respectively.

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Figure 3-8 Existing Conditions 1% AEP Peak Flood Depths - from Local External Catchment

Figure 3-9 Developed Conditions 1% AEP Peak Flood Depths - from Local External Catchment

Figure 3-10 Existing Conditions 1% AEP Peak Flood Velocity - from Local External Catchment

Figure 3-11 Developed Conditions 1% AEP Peak Flood Velocity - from Local External Catchment

Figure 3-12 Existing Conditions 1% AEP Peak Flood Hazard (Depth x Vel) - from Local External Catchment

Figure 3-13 Developed Conditions 1% AEP Peak Flood Hazard (Depth x Vel) - from Local External Catchment

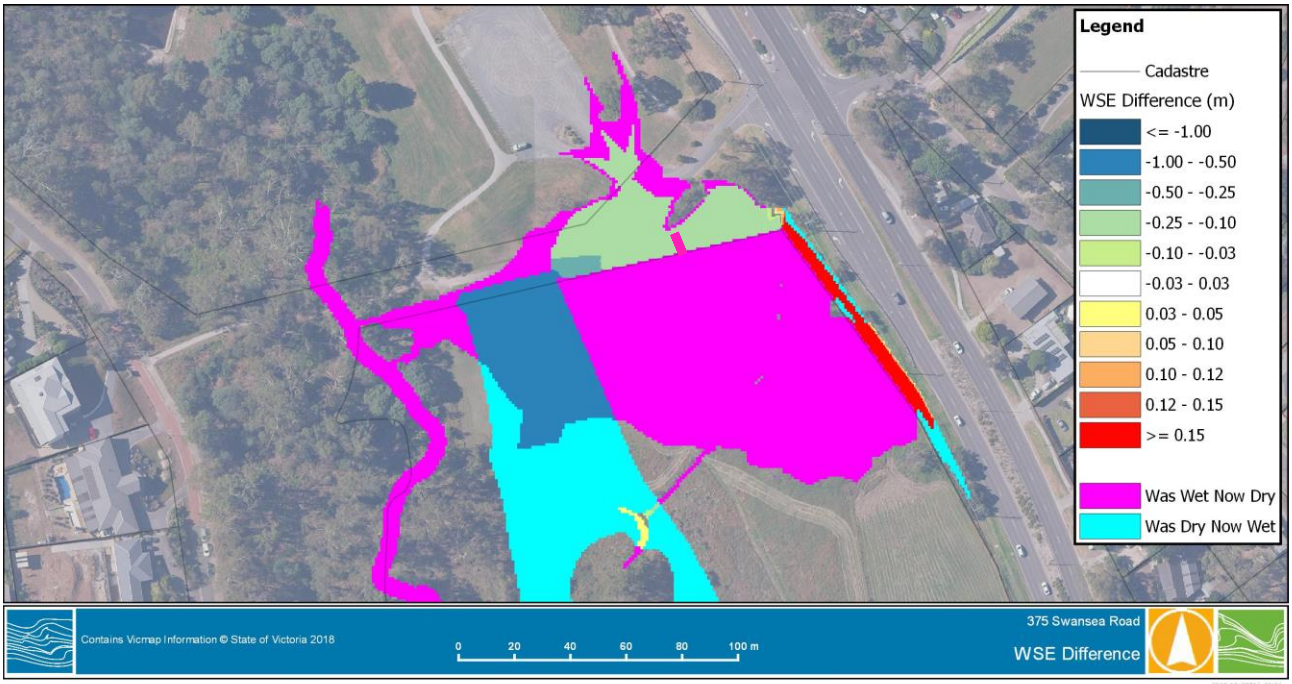

Figure 3-14 Water Surface Elevation Difference

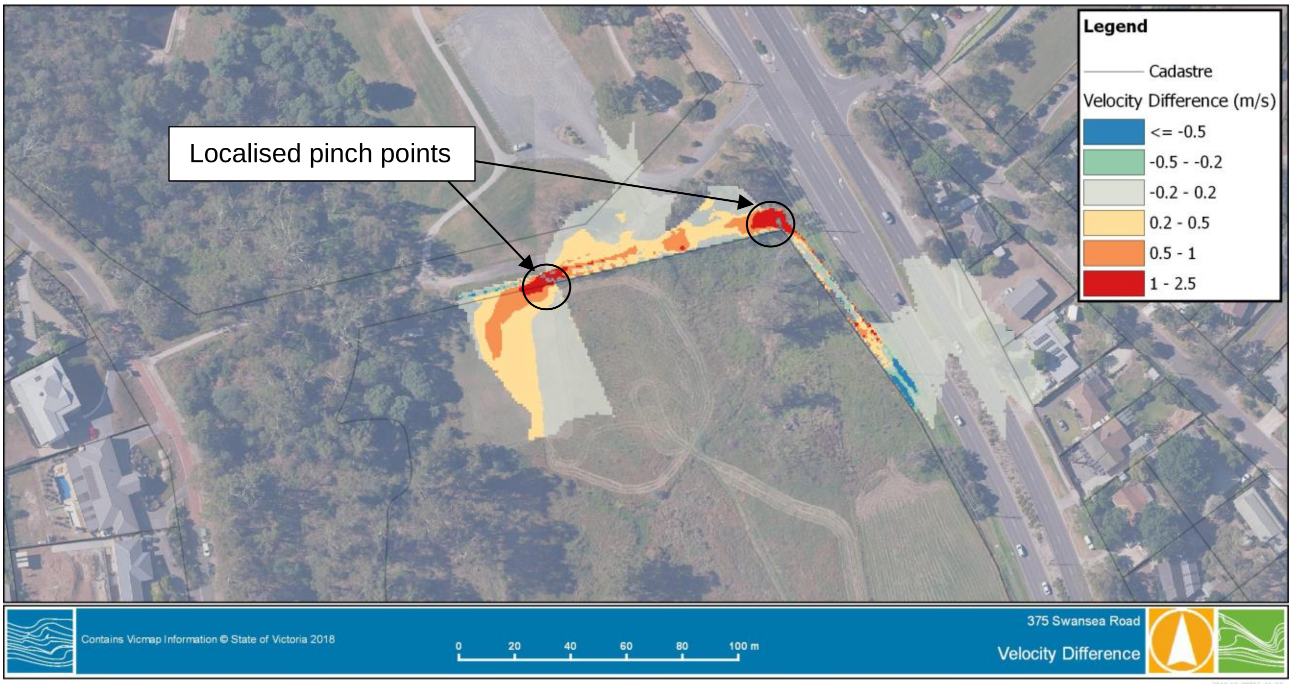

Figure 3-15 Difference in Velocity

Due to the relatively steep topography upstream of the site, the redirection of the 1% AEP flows from Swansea Road around the site has resulted in flood level increase within the redirected drainage channel only. Private properties, public roads and the upstream Council drainage network are not adversely impact by the redirection of flow around the site. Flood levels within Akarana Road have decreased due to the additional new flood storage made available by the development

Due to the confinement of flows around the site compared to existing conditions, flow depths and velocities in portion of the drainage channel around the site have increased, as seen in Figure 3-14 and Figure 3-15. Of particular note are the increases in velocities at two pinch points indicated in Figure 3-15, it is recommended that some form of rock armouring or dense vegetation be placed in these specific locations to mitigate erosion potential.

The existing accessible batter slopes leading to the section of channel running adjacent to Swansea Road are very steep (1 in 2 or greater). As is it proposed to have a new pedestrian path parallel to Swansea Road, it is recommended that the batter slope leading to the channel be, if not already, densely vegetated as part of the footpath works to limit pedestrian access to the channel.

Melbourne Water's Land Development Manual states that floodways are required to provide an average velocity of less than 1.5 m/s. The TULFOW model does not produce a cross section average velocity, therefore sample cross sections of the channel velocity have been taken a regular intervals shown in Figure 3-16, with the average velocities shown in Table 3-8. Melbourne Water's guidelines also state that child safety is to be maintained out to depths of at least 0.4 m on banks where free access is available.

Figure 3-16 1% AEP Maximum Velocity

Table 3-8 Average Velocity Results

Cross Section	Average Velocity (m/s)	V*d at depth of 0.4 m*
1	1.17	0.45
2	1.49	0.70
3	1.13	0.46
4	0.90	0.41
5	1.46	0.25
6	0.35	0.19
7	0.72	0.26

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Cross Section	Average Velocity (m/s)	V*d at depth of 0.4 m*
8	0.61	0.28
9	0.69	0.29

*Note that the raw V*d results for TULFOW are represented here at a depth of 0.4 m whereas the guidelines state the average bank velocity to be used. This makes this figure a conservative measure.

The results show that the average velocity within the channel is generally within acceptable limits according Melbourne Water's Land Development Manual guidelines. Higher velocities at the aforementioned 'pinch points' will be required to be address as part of the final landscape plan for the site. It is also shown in the results (in Table 3-8) that safe access to the drainage channel is available for the channel section alongside Akarana Road, whilst limits are exceeded adjacent to Swansea Road. Given the existing limited access to this channel due to existing batter grades and vegetation alongside Swansea Road, plus the recommendation to further densely plant the steep batters, it can be considered that free access is not available to this section of channel, and therefore the exceeded Depth*Velocity criteria is acceptable at this location.

It is noted that updated child flood safety criteria is stated in the latest Australian Rainfall and Runoff 2019 guidelines where velocities and depths thresholds are greater than what is stated in the Land Development Manual (LDM) guidelines. However, the applicability of the new guidelines, specifically to floodway design in the Melbourne Water region, have yet to be formulated and therefore Melbourne Water's LDM is believed to be the most applicable guidelines in this instance.

4 HYDRAULIC MODELLING OF OLINDA CREEK

4.1 Methodology

A hydraulic model (TUFLOW) of the site was constructed to model overland flooding under existing conditions. TUFLOW is widely used software 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; and
- Hydrological input (upstream boundary conditions).

Table 4-1 Key Modelling Information

Terrain data	LiDAR (2008) and survey Proposed Development level strategy (cut & fill)
Model type	TUFLOW 2d
Model build	TUFLOW.2017-09-AC-w64
Inflow type	2D_SA_Inflow located upstream of subject site.
Inflow regime	Hydrograph
Peak inflow rate	Unsteady - 12hr and 36hr hydrographs (as provided by Melbourne Water)
Downstream boundary	'HQ' boundary, with a 0.5% hydraulic gradient.
Roughness parameters	Materials file which applied a Manning's n roughness value to the various land uses: ■ Residential – 0.35 ■ Roads/car parks - 0.02; ■ Open Space – 0.03 to 0.09 (dependent on vegetation)
Model timestep (2d)	0.5 seconds
Model start time	0 hours
Model grid size	1 m^2
Peak cumulative mass error	-0.83 & -1.00% Existing Scenarios -0.86 & -1.01% Development Scenarios

The model extent and other key modelling details are shown in Figure 4-1.

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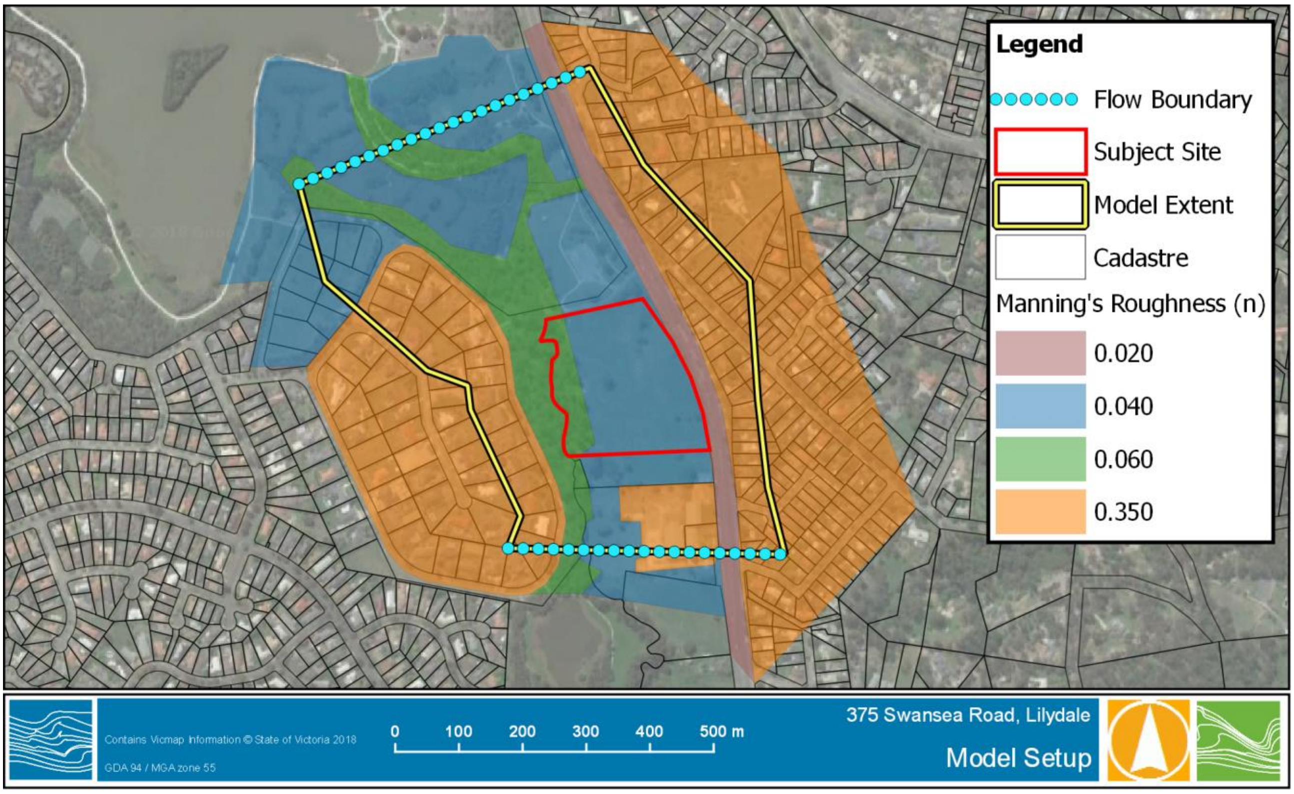

Figure 4-1 Model Extent

The 1% AEP hydrographs for the critical 12hr and 36hr storm durations, as provided by Melbourne Water, are shown in Figure 4-2.

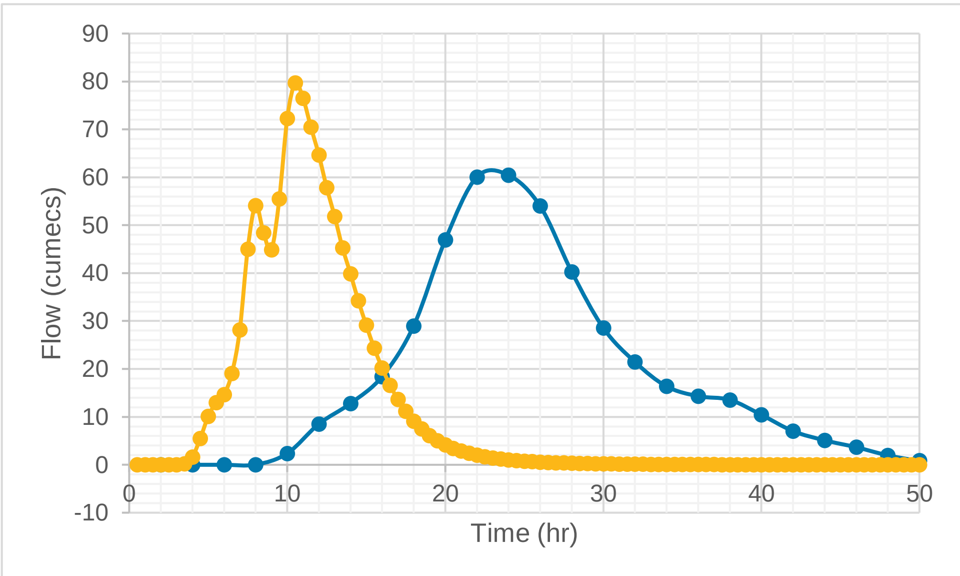

Figure 4-2 1% AEP Hydrographs for 12hr (orange) and 36hr (blue) Storm Durations

4.2 Results

Detailed TUFLOW modelling was completed for the site for existing and proposed developed conditions, and the results are discussed in this Section. This section focuses on the 12hr storm duration scenarios as they result in higher flood levels across the subject site.

Maps for the 36hr storm scenario are shown in Appendix B.

It should be noted that the TUFLOW modelling was reported in the following sections, was based on the previous development layout. Since the development footprint remained same, it was assumed that the reduction in the number of dwellings will not change the area proposed to be filled and, thus, the offset storage within Olinda Creek will remain the same. Therefore, it was assumed that the previous flood impact assessment is fit for purpose.

4.2.1 Existing

Our model results show the majority of the site to be at risk of flooding from Olinda Creek and Figure 4-3 presents the flood depths for the area. The flood line for the property grades from approximately 109.5 m AHD along the south boundary to approximately 109.1 m AHD along the north boundary. The 1% AEP flood levels at the northern end of the property are approximately 109.1 m AHD which is approximately 500mm above the quoted 1% AEP flood level in Melbourne Water latest advice.

Flood velocities within the floodplain and the site vary but are generally above 0.5 m/s (as shown in Figure 4-4). Importantly, velocities exceed 1.5 m/s in places.

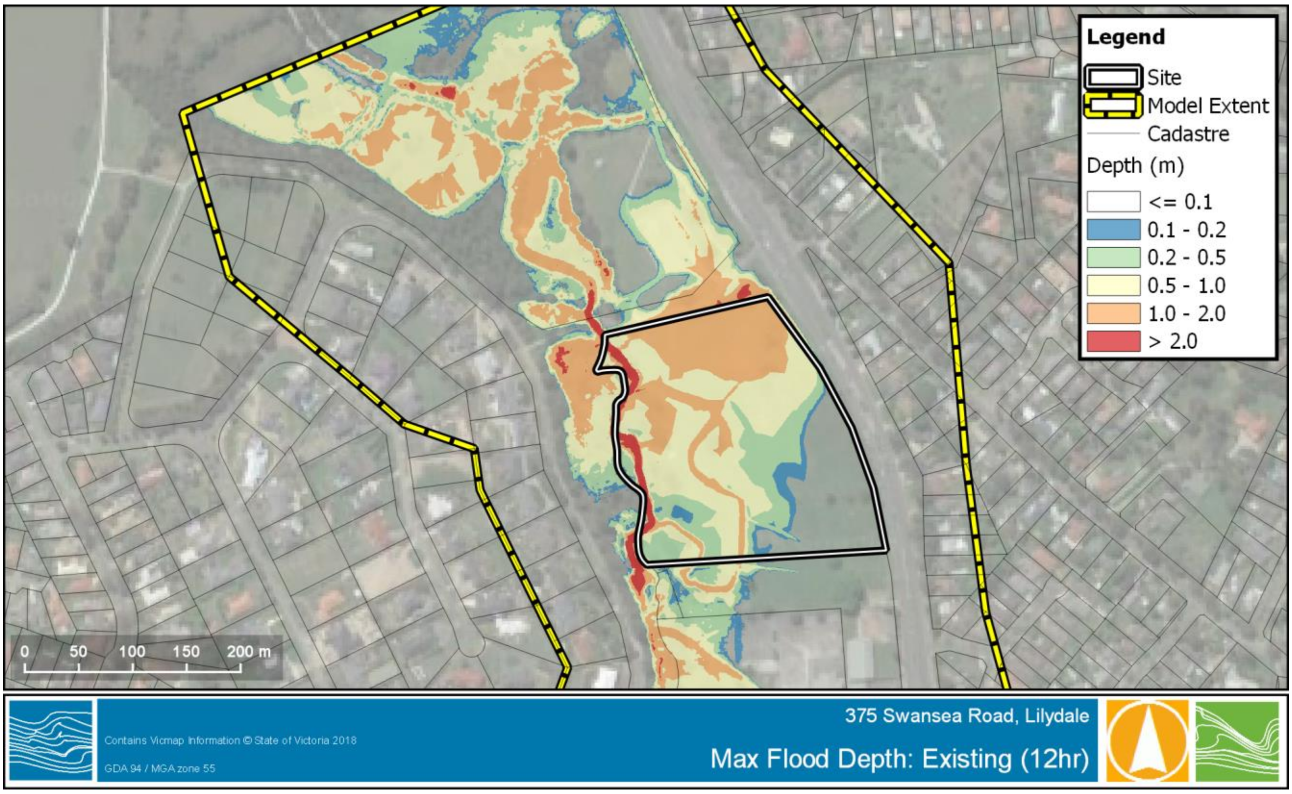

Figure 4-3 Existing Flood Depths within the Subject Site

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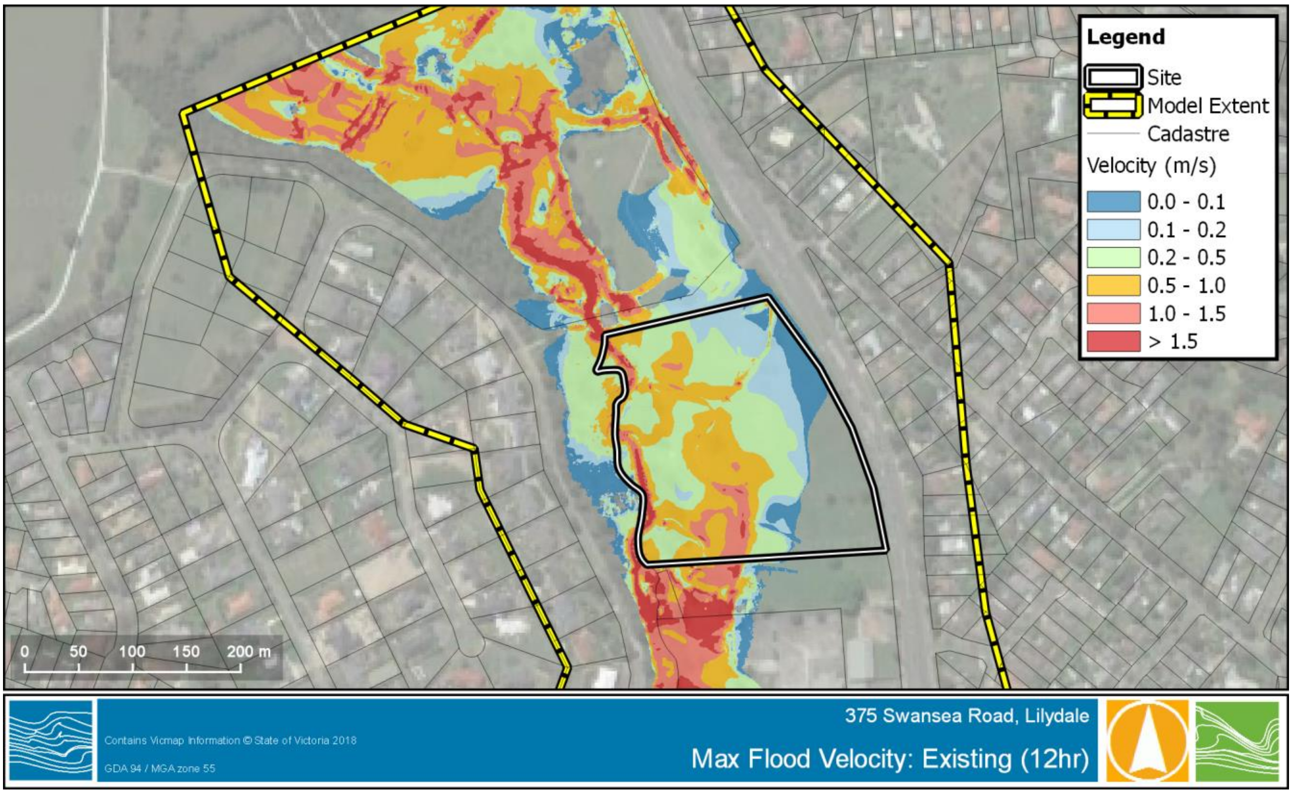

Figure 4-4 Existing Flood Velocities

4.2.2 Proposed Cut & Fill Strategy

The current development line allows for the compensatory cut to be placed between Olinda Creek and the development area, with the invert level of the cut area approximately 1.5 m above the invert of Olinda Creek at the northern end of the property. The modelled cut & fill strategy, showing proposed fill pads, is shown in Figure 4-5. It must be noted that there is therefore some flexibility in the design going forward.

Melbourne Water's initial advice stated that development would not be allowed in areas where greater than 1 m of flooding occurs. As a result of the increase in flood depths modelled, the proposed development is partially located above areas where greater than 1 m of flooding occurs. The fill pad would however ensure that the development is above the 1% AEP flood level, and therefore the requirement would no longer be applicable as the development area would now not be subject to flooding.

Preliminary advice from Melbourne Water, given during the meeting on April 6 April 2018, concurred that the above requirement may no longer apply and this was confirmed in later correspondence[8]. As requested by Melbourne Water, Appendix C includes five cross-sections showing existing and proposed terrain profile along the waterway and extending out into the floodplain.

Additional details will be required at the detailed design stage, including:

- Detailed cross-section of the constriction and bridge structure; and
- Detailed design drawings showing proposed outfalls and low flow channels;

[8] Email from Emma Tame (Melbourne Water) dated 30 May 2018.

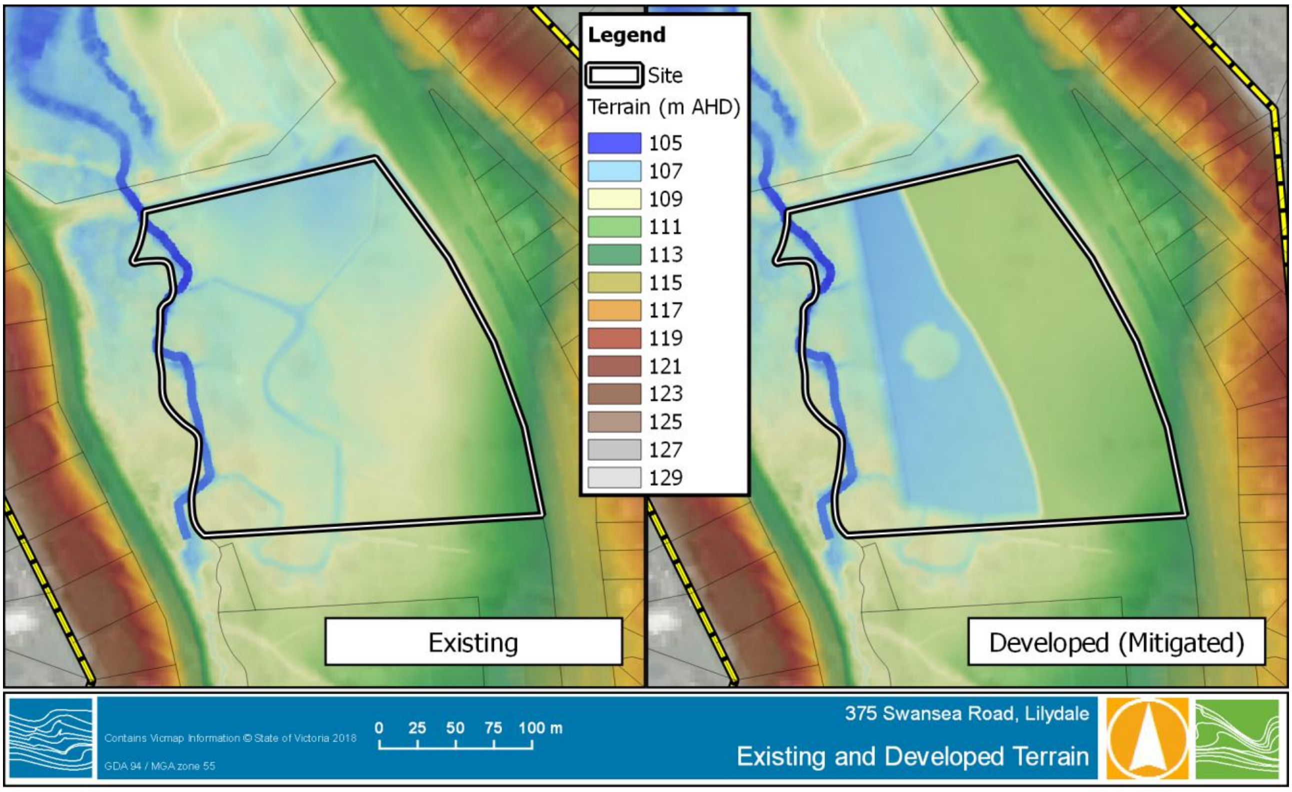

Figure 4-5 Existing (left) and Development (right) Terrain

The proposed level strategy for developed conditions aims to maintain the conveyance capacity of the existing overland flow path within the site. The model shows the fill areas to be flood-free however, areas where cantilevers are proposed will be above the floodplain. Figure 4-6 presents the flood depths for the wider floodplain under developed conditions.

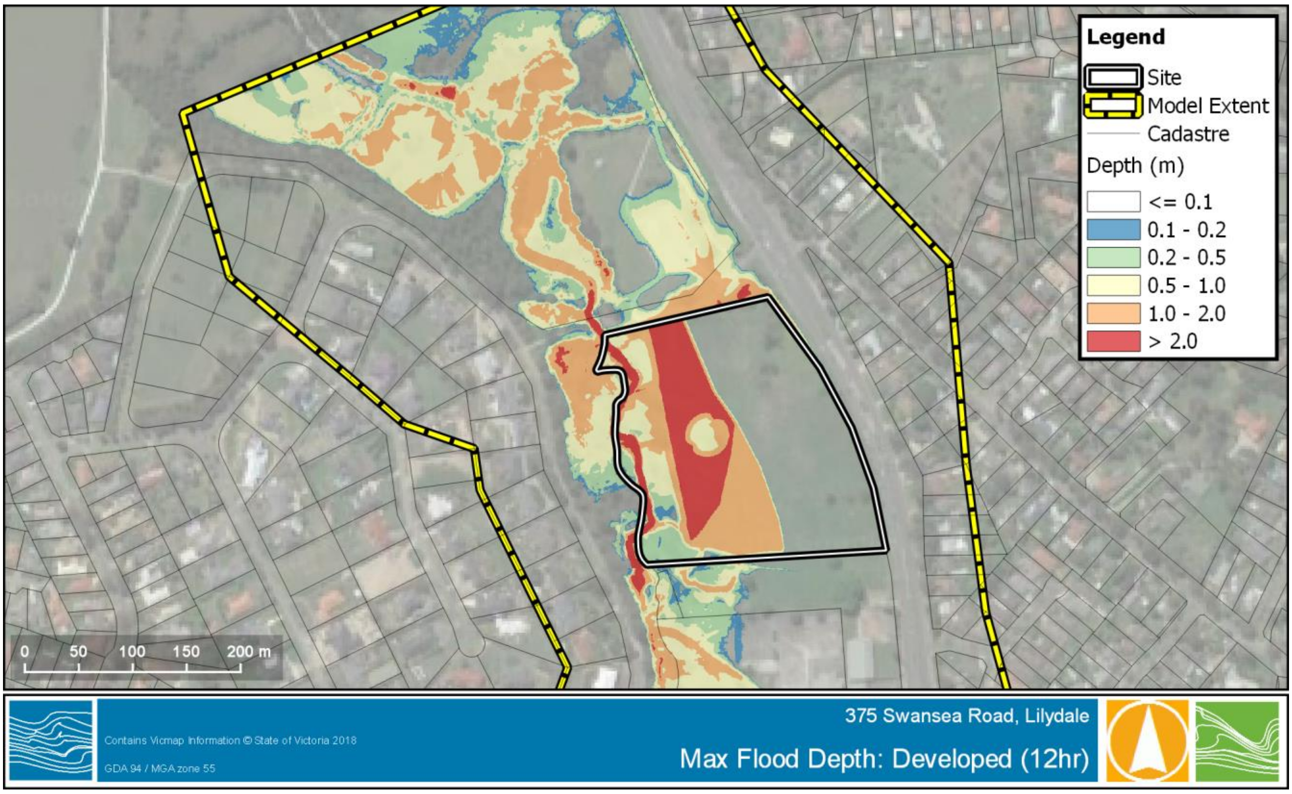

Figure 4-6 Flood Depths under the Development Scenario

Flood velocities within the site vary but are generally above 0.5 m/s (as shown Figure 4-7). Importantly, whilst velocities may still exceed 1.5 m/s within the subject site, velocities are shown to be significantly reduced compared to existing conditions. Velocities do exceed 1.5 m/s in Ankara Road however, they are more generally below 0.5 m/s.

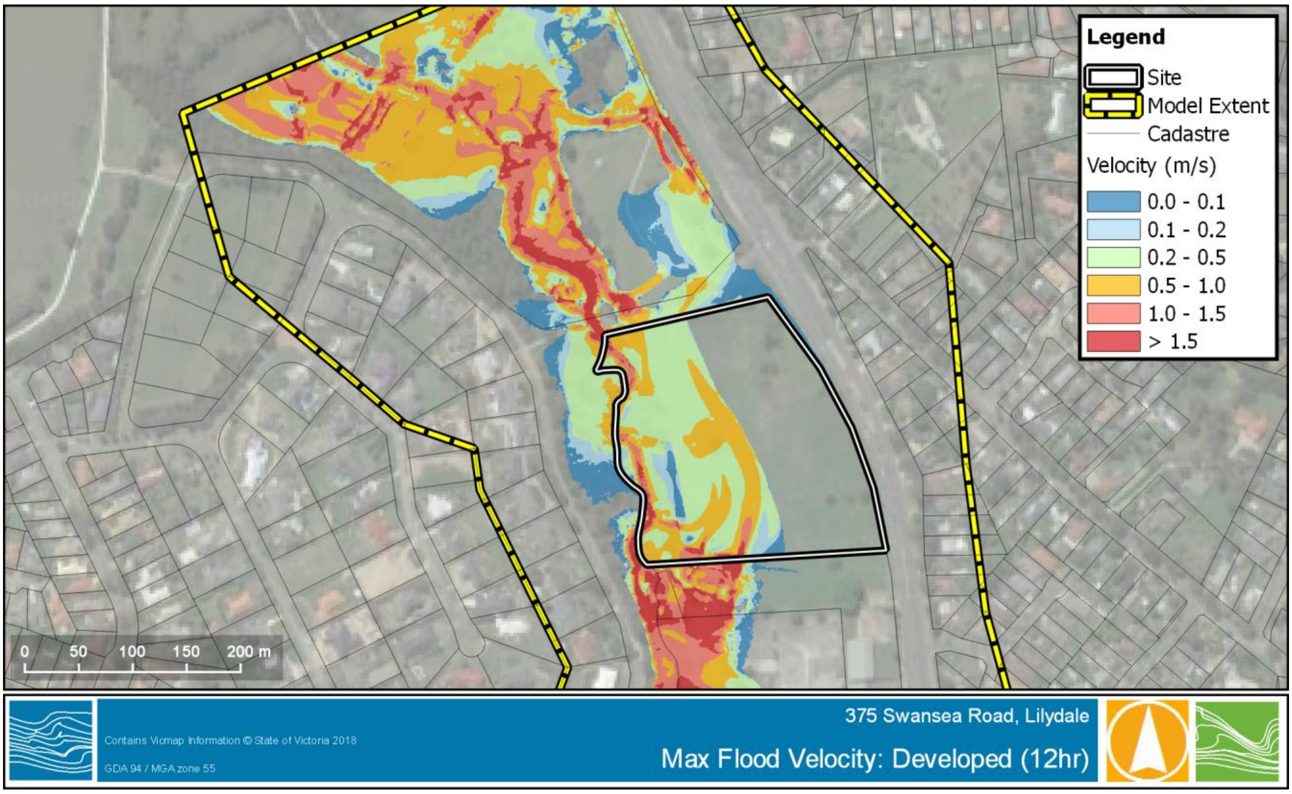

Figure 4-7 Flood Velocities under the Development Scenario

5 FLOOD IMPACT ASSESSMENT

The *Guidelines for Development in Flood Affected Areas* (DELWP, 2019) outlines four guiding principles in relation to proposed development. The principles aim to:

- Protect human life and health and provide safety from flood hazard;
- Minimise flood damage to property and associated infrastructure;
- Maintain free passage and temporary storage of floodwaters; and,

Protect and enhance the environmental features of waterways and floodplains. The guiding principles are discussed further below with reference to the impacts on conveyance from the proposed development at the subject site.

5.1 Objective 1 – Flood Safety

"Protect human life and health, and provide safety from flood hazard" (DELWP, 2019)

Flood hazard is generally assessed in terms of flood depth and flood velocity. The product of flood depth and flood velocity is often referred to as the flood hazard, with flood depth also being considered to drive the hazard if above the velocity and depth product. Flood Risk is categorised by considering criteria detailed in Table 5-1.

Table 5-1 Flood Safety Hazard Risk

Flood characteristic	Threshold for safety
Depth (m)	0.35
Velocity x Depth (m^2/s)	0.35
Velocity (m/s)	1.5

Figure 5-1 and Figure 5-2 show Flood Risk within the subject site and its vicinity for existing and developed conditions respectively. As the proposed residential development will be raised relative to Olinda Creek floodplain, the site is shown to be flood-free.

Flood hazard from Olinda Creek is therefore not a consideration of this SWMP however, any shared path must be set back within the proposed fill pad with provisions made to tie back into existing and proposed sections of shared pathway. It is appropriate for this to be considered at the detailed design stage.

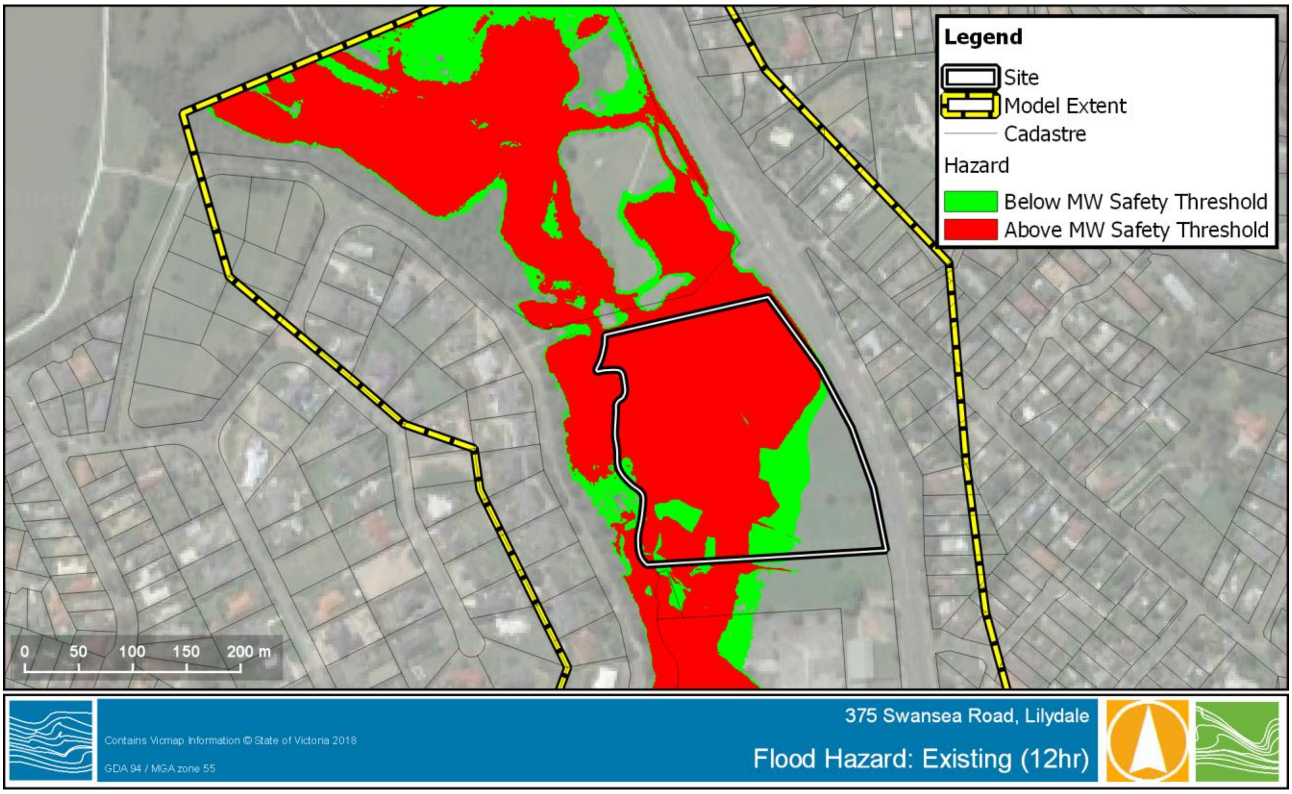

Figure 5-1 Flood Hazard under the Existing Scenario

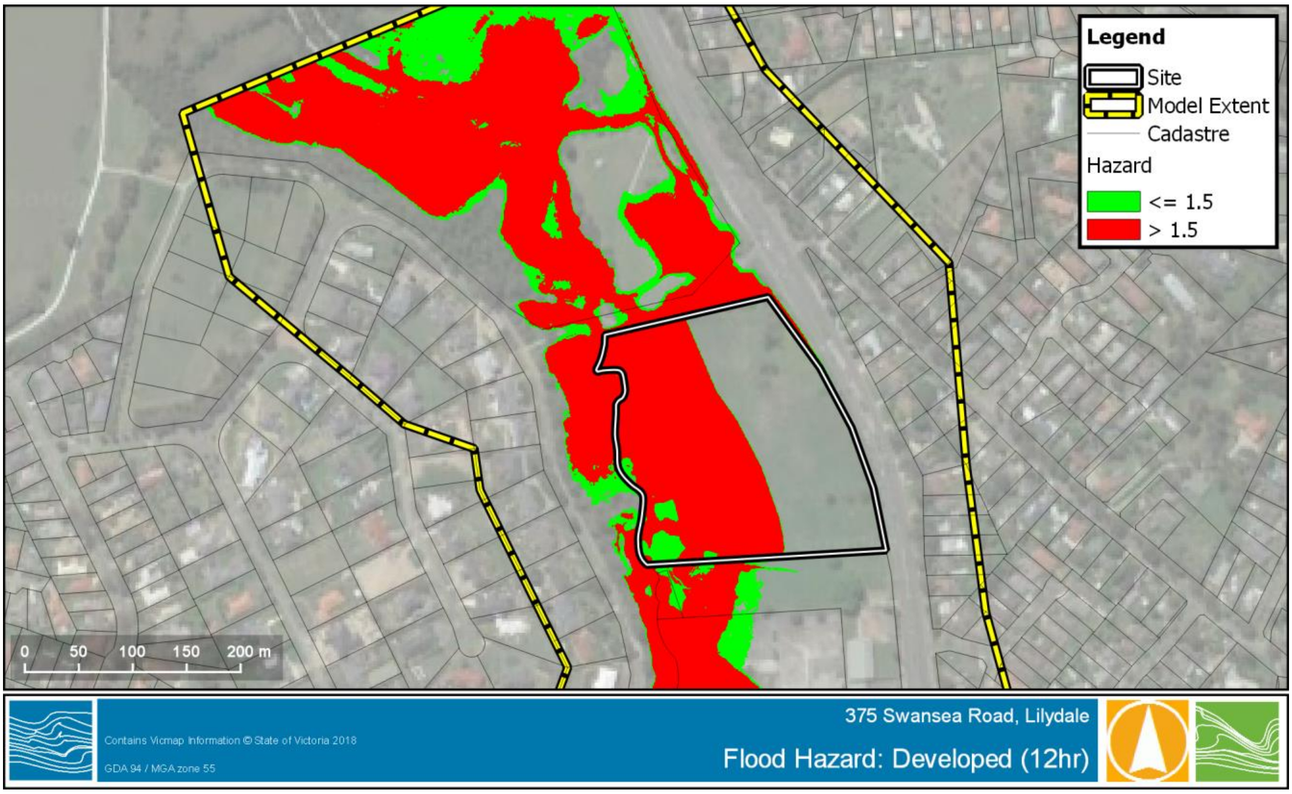

Figure 5-2 Flood Hazard under the Development Scenario

Road within the development will need to be designed to ensure safe conveyance of local flows. Based on flow estimates for the overall site and width of road (6m), it is considered that the road network will provide ample capacity for overland flows. it is appropriate to allow for the details of the overland flow paths to be finalised at the detailed design stage.

5.1.1 Access Safety

"Any development cannot be allowed in circumstances where the depth and flow of floodwater affecting access to the property is hazardous." (MW, 2008)

Flood hazard is generally assessed in terms of flood depth and flood velocity. The product of flood depth and flood velocity is often referred to as the flood hazard, with flood depth also being considered to drive the hazard if above the velocity and depth product. With regards to access safety, criteria exist to ensure safe passage of occupants or emergency services personal in a flood event.

Site egress is shown on the development plan with pedestrian egress to Swansea Road being completely flood free. Emergency vehicle access is also provided at this point and is also flood free for safe access to the entire development during a flood event.

A safe egress route may also be possible via Akarana Road, although the road is flooded in large events. Lifting the road level may be an option to provide secondary access, although this is thought to not be required. Signage should be installed at the exit to Akarana Road to actively discourage access to and from the site during a flood event and directing to safe egress at Swansea Road. Importantly, any changes to Akarana Rd levels will not impact flood levels, from a hydraulic perspective (see Section 5.3.1 and 5.2).

It is therefore considered that the site access safety requirements for the site **have been** met.

5.2 Objective 2 – Flood Damage

"Minimise flood damage to property and associated infrastructure" (DELWP, 2019)

Finished Floor Levels (FFL) must be raised above applicable flood levels, to mitigate against potential flood damage. Freeboard must be added to the applicable 1% AEP flood level to provide reasonable certainty of a desired level of service.

Any development within the site must be constructed with finished floor levels 600 mm above applicable flood levels. The development will be raised relative to the Olinda Creek floodplain and sufficient freeboard will therefore be provided. Fill and cantilevers will be used to raise building above flood levels and provide freeboard.

Applicable flood levels for the site will need to be confirmed by Melbourne Water. As aforementioned, the 1% AEP flood levels at the northern end of the property are approximately 500mm above the quoted 1% AEP flood level in Melbourne Water latest advice. The discrepancies have been discussed with Melbourne Water during the meeting on 6 April 2018 and Melbourne Water are to confirm which levels should be used to set Finished Floor Levels.

5.3 Objective 3 - Flood Impact

"Maintain free passage and temporary storage of floodwaters" (DELWP, 2019)

Detailed TUFLOW modelling for the 1% AEP event was completed for the site, for existing and the proposed developed conditions. The results from both scenarios were compared to determine if the proposed development would have the potential to alter flow conveyance and flood storage, and cause adverse flood impacts, through the areas adjacent to, upstream or downstream of the subject site.

5.3.1 Flood Flow

The development must neither divert floodwaters nor increase flood levels to the detriment of adjoining properties. TUFLOW modelling results of a mitigation solution including a preliminary compensatory cut area show that no adverse afflux results from the development of the land during the 1% AEP flood event on Olinda Creek. The hydraulic model therefore indicates that the impacts of the proposed development on flow conveyance are limited, as shown in Figure 5-3.

Whilst there is some afflux shown north of the subject site, the afflux is limited to Akarana Road, the existing riparian environment and Lilydale Lake Playground. The model also shows reduction in flood levels elsewhere, especially near the south-west corner of the subject site. Importantly, the afflux was mapped with a very fine scale in Figure 5-3. It is generally less than 10 mm except for localised flooding where afflux is between 10 mm and 25 mm (shown in orange in the figure below).

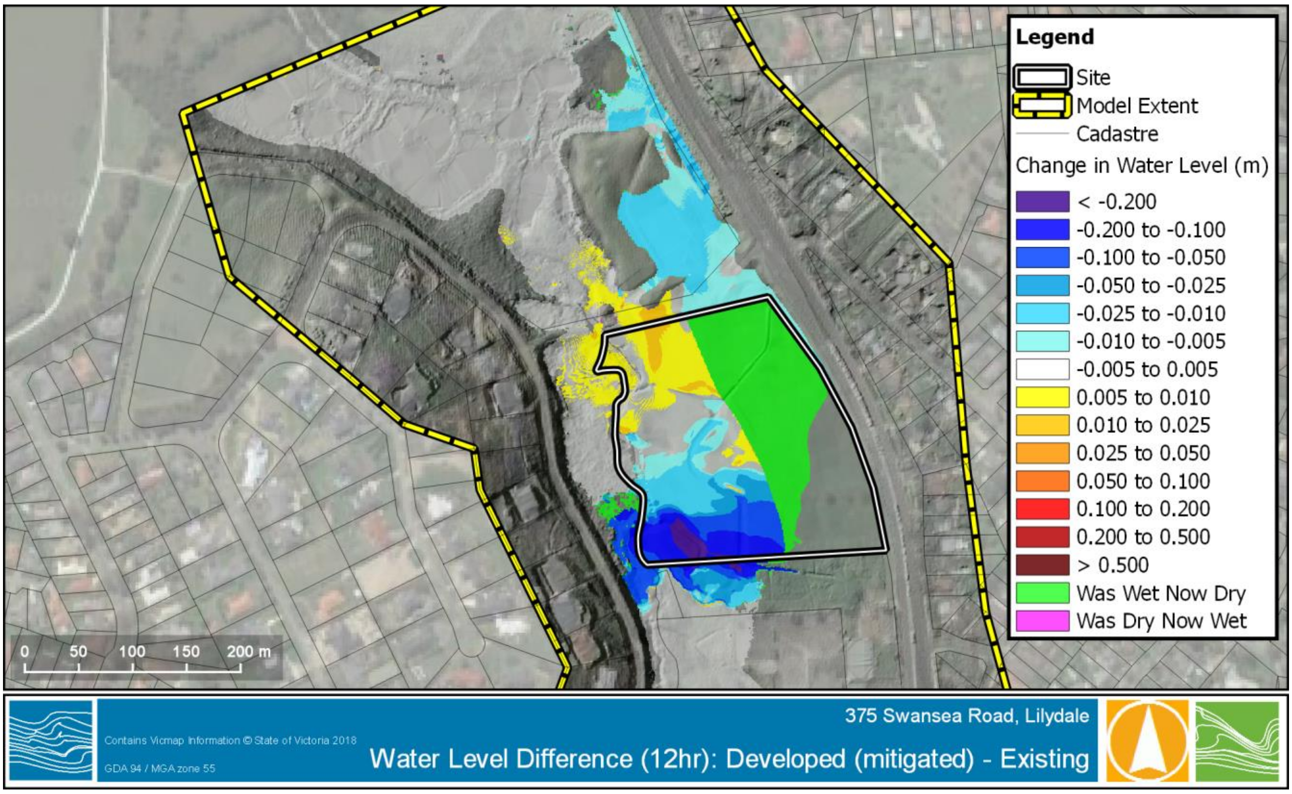

Figure 5-3 Water Surface Elevation Difference Plot (Developed minus Existing Conditions)

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5.3.2 Flood Storage

The flood modelling results presented above in Section 5.3.1 show minimal offsite impacts on flood levels. The results also suggest that the potential change to floodplain storage does not cause any significant adverse impacts downstream of the site.

Flood storage calculations indicate that there is no significant change in flood storage across the two sites in the 1% AEP event. As shown in Table 5-2, the model indicates an overall gain of about 13,000 m^3. Greater gains were modelled for the 36hr storm duration.

Table 5-2 Flood Storage Calculations (12hr duration)

Location	Flood Storage Existing (m^3)	Flood Storage Mitigated (m^3)
Subject Site	143,095	158,316
Model Extent	421,520	434,790

5.4 Objective 4 - Waterway and Floodplain Protection

"Protect and enhance the environmental features of waterways and floodplains" (DELWP, 2019)

Development potentially impacting on waterways and floodplains must look to maintain their environmental functions. Development should therefore (*verbatim)*:

- maintain or improve waterway and floodplain conditions;
- allow access to maintain riparian corridors;
- maintain or improve water quality
- maintain (by avoidance or offset) the natural function of floodplains and waterways in storing and conveying floodwater; and
- retain or improve significant vistas or landscapes within the riparian corridor.

It is noted that remnant native vegetation cover across the subject site is severely depleted. As part of this development, it is anticipated that a revegetation program be undertaken, at the very least, across the length of the waterway adjacent to the development. Species to be planted in the channel bed should comprise indigenous aquatic and semi aquatic species as approved by Melbourne Water and Council.

In accordance with Melbourne Water's requirements, the proposed development will also ensure:

  - Adequate setbacks from the top of bank to ensure significant flora and fauna values are protected and to ensure the natural bank profile is maintained; and
  - Re-vegetation of the Olinda Creek floodplain, with the creation of a 2.2 ha communal park.

6 SUMMARY AND CONCLUSION

This report sets out a recommended Stormwater Management Strategy for a proposed residential development at 375 Swansea Road, Lilydale. Water Technology has undertaken hydrological and water quality modelling to design a concept design for stormwater management to comply with stormwater quality best management practice objectives. A Flood Impact Assessment was also completed to demonstrate that the site would comply with criteria set in Melbourne Water's *Guidelines for Development in Flood Prone Area*

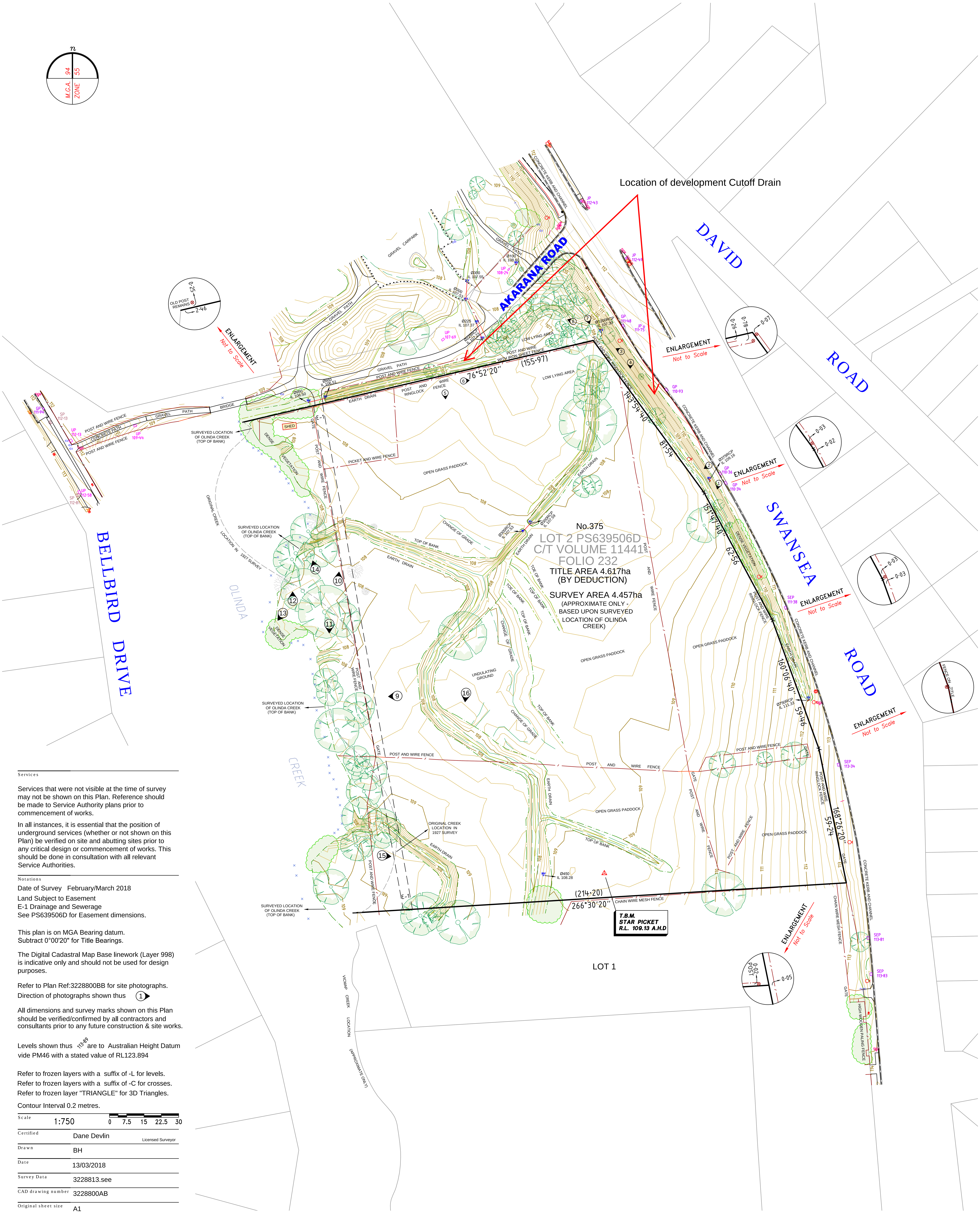
The stormwater management plan for the site has demonstrated that:

- Runoff from the development are retarded to pre-development 1% AEP discharge at the catchment outlet.
- All stormwater discharges from the subdivision will meet the 'Urban Stormwater Best Practice Environmental Management Guidelines' (CSIRO, 1999).
- A cut-off drain along Swansea Road and Akarana Road will capture and convey $Q_{1\%\ AEP}$ peak flows from external upstream catchments can redirect it appropriately to Olinda Creek. Private properties, public roads and the upstream Council drainage network will not be adversely impact by the redirection of flow around the site.
- The proposed floodplain compensatory storage ensures there is no significant reduction in the 1% AEP flood storage volume and no significant impacts on offsite flood levels.

Water quality management can be achieved through a treatment train consisting of proprietary treatment products. Alternatively, the creation of Swamp Gum Woodlands (including swampy areas) within the site and along Olinda Creek may form part of the treatment train, based on known uptake nitrogen and phosphorus of *Eucalyptus* trees. Both these on-site stormwater management options would ensure that the pollutant load reduction resulting from the water quality strategy meets or exceeds best management practice targets.

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

APPENDIX A
LEVEL AND FEATURE SURVEY



Services

Services that were not visible at the time of survey may not be shown on this Plan. Reference should be made to Service Authority plans prior to commencement of works.

In all instances, it is essential that the position of underground services (whether or not shown on this Plan) be verified on site and abutting sites prior to any critical design or commencement of works. This should be done in consultation with all relevant Service Authorities.

Notations

Date of Survey February/March 2018

Land Subject to Easement
E-1 Drainage and Sewerage
See PS639506D for Easement dimensions.

This plan is on MGA Bearing datum.
Subtract 0°00'20" for Title Bearings.

The Digital Cadastral Map Base linework (Layer 998) is indicative only and should not be used for design purposes.

Refer to Plan Ref:3228800BB for site photographs.
Direction of photographs shown thus (1)

All dimensions and survey marks shown on this Plan should be verified/confirmed by all contractors and consultants prior to any future construction & site works.

Levels shown thus 113.89 are to Australian Height Datum vide PM46 with a stated value of RL123.894

Refer to frozen layers with a suffix of -L for levels.
Refer to frozen layers with a suffix of -C for crosses.
Refer to frozen layer "TRIANGLE" for 3D Triangles.

Contour Interval 0.2 metres.

Scale	1:750 (0 7.5 15 22.5 30)
Certified	Dane Devlin, Licensed Surveyor
Drawn	BH
Date	13/03/2018
Survey Data	3228813.see
CAD drawing number	3228800AB
Original sheet size	A1
Client	Hamilton Corporation c/- Rhys Monteath
Project	375 Swansea Road Lilydale
Details	Boundary Re-establishment, Feature and Level Survey Volume 11441 Folio 232
Sheet	1 of 1
Job Number	32288

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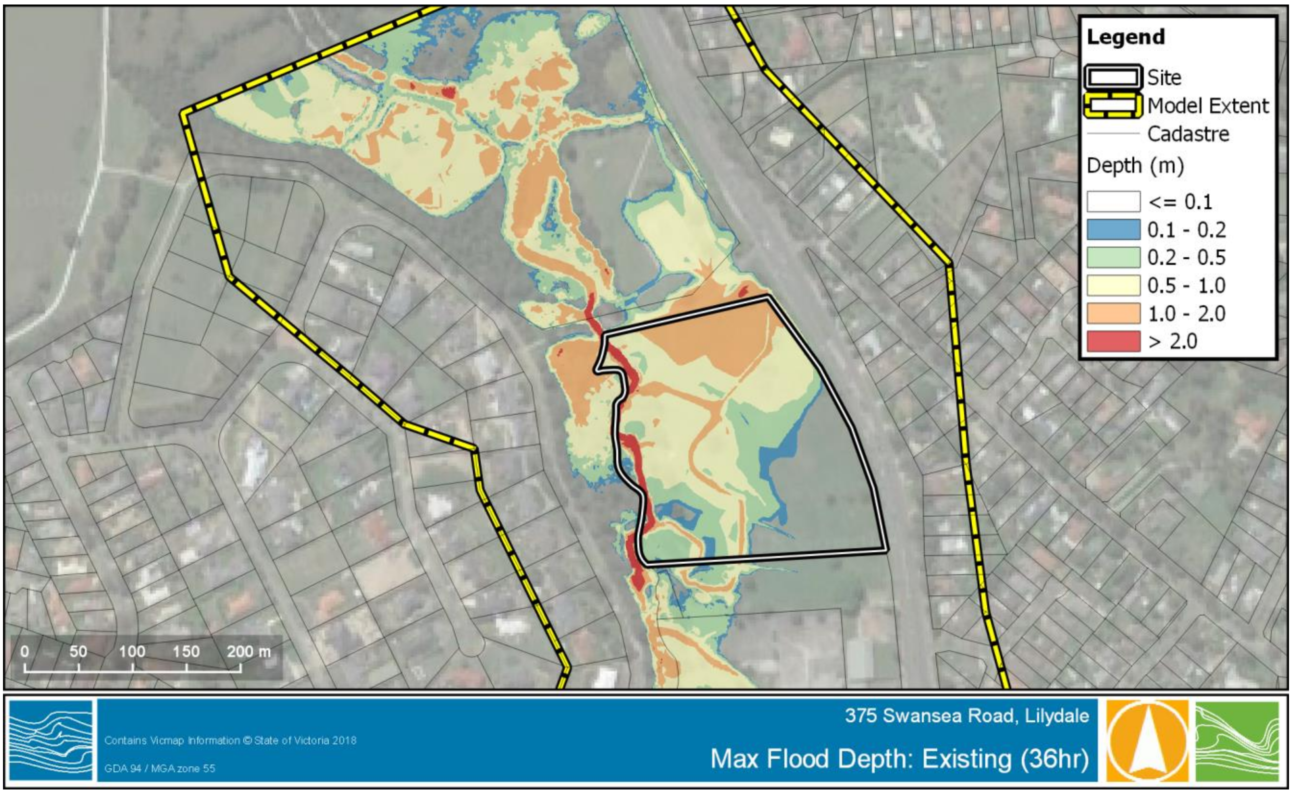
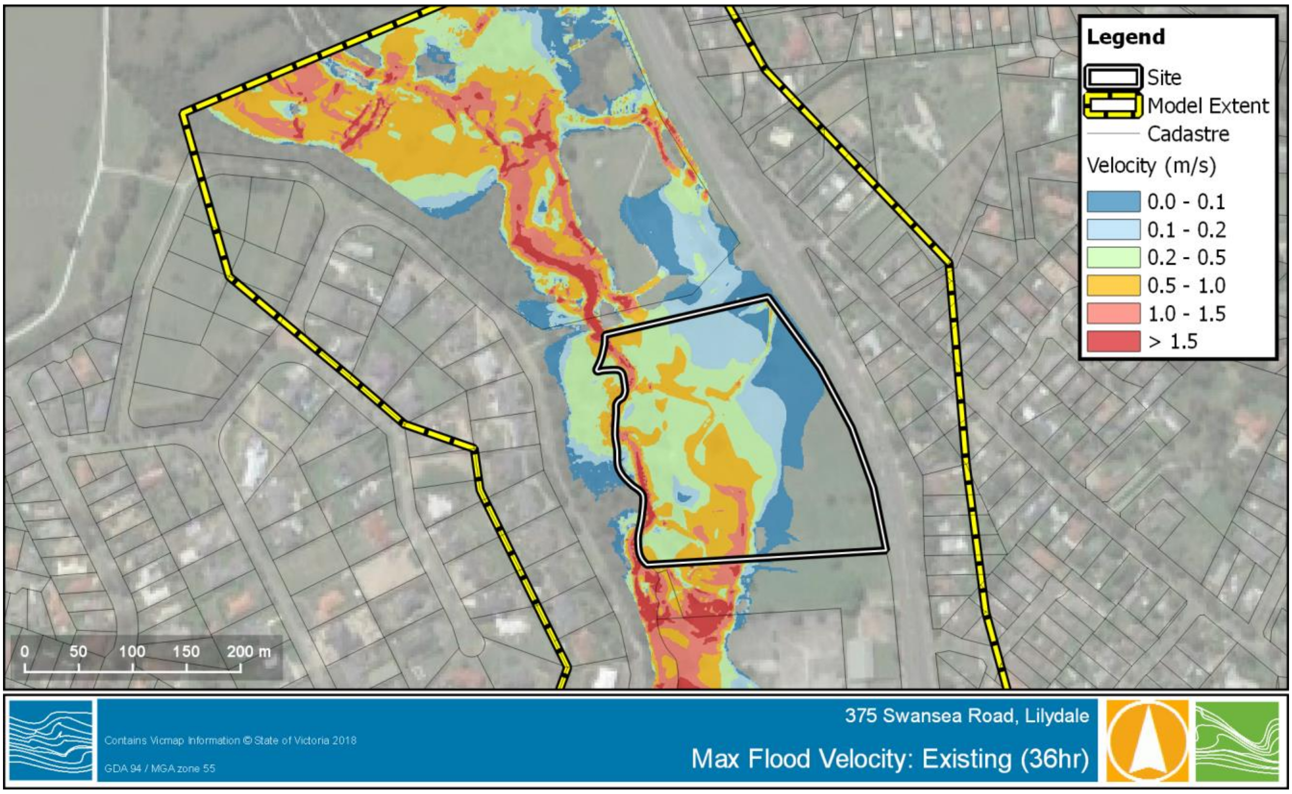
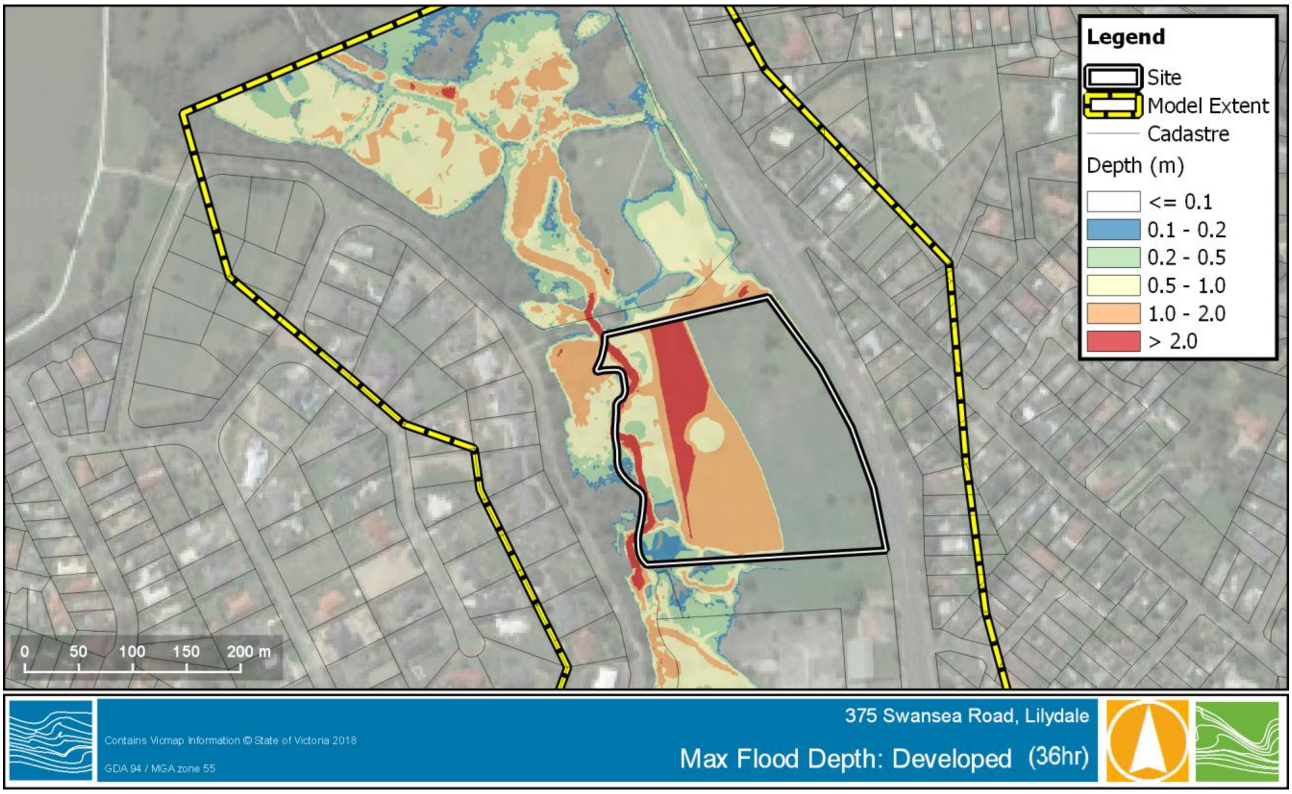
Legend

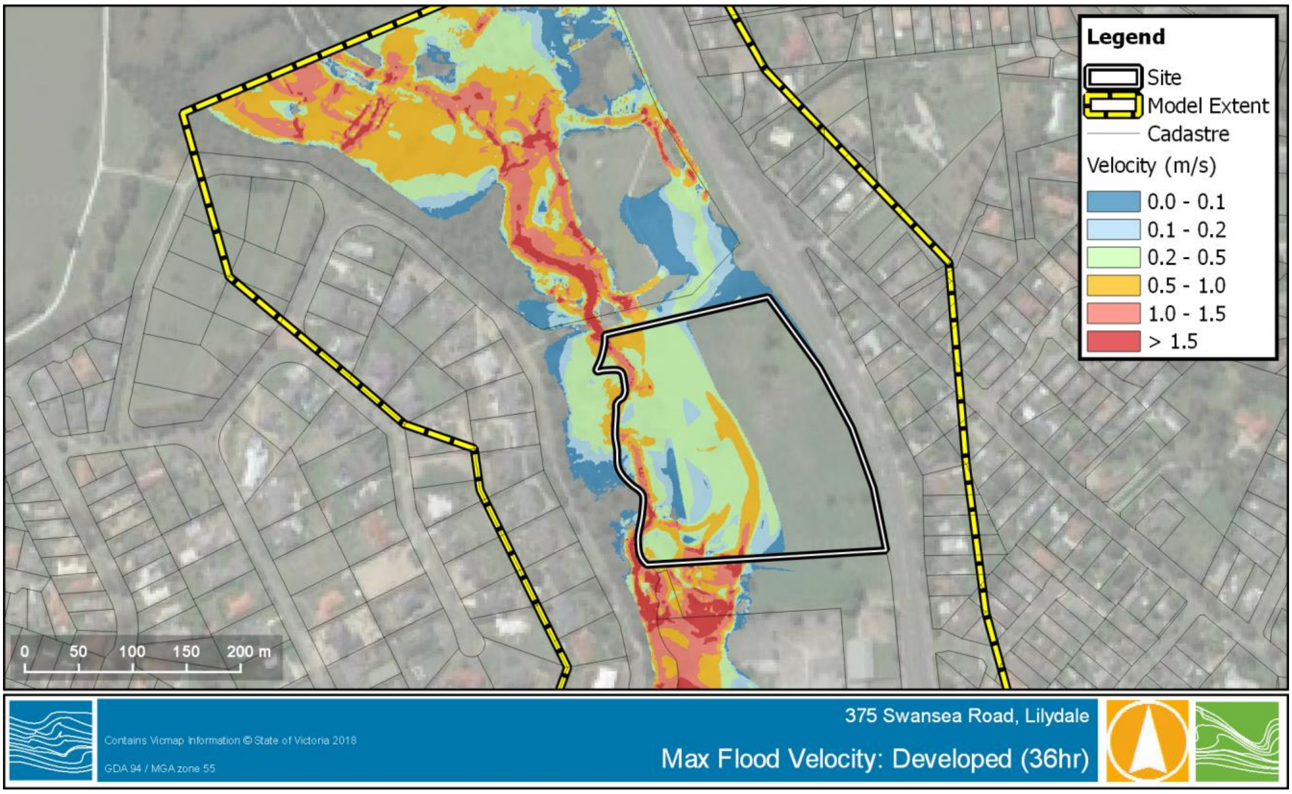
4	TBM	310	Junction Pit	419	Edge of Concrete		
102	Top of Bank	318	Endwall	421	Edge of Paving	741	Sewerage Pit
103	Toe of Bank	321	Invert Pipe or Pit	501	Guard Rail	751	Stop Valve
104	Existing Surface	402	Spot on Bitumen	503	Sign	753	Fire Hydrant
110	Change of Grade	403	Edge of Bitumen	504	Postbox	754	Water Meter
201	Tree	405	Edge of Formation	507	Traffic Signal Pit	758	Water Tap/Connection
203	Dense Vegetation	406	Lip of Kerb/Channel	521	Bollard	762	Unclassified Pit
205	Garden Bed	407	Invert of Kerb/Channel	602	Shed	765	Unclassified Utility
206	Dead Tree	408	Back of Kerb/Channel	651	Bridge	903	Fence
302	Creek Location in 1927 Survey	410	Pedestrian Path	711	Light Pole	904	Gate
303	Creek Bed	411	Driveway	712	Electricity Pole	950	Title
304	Reinforced Concrete Pipe	412	Track (Vehicular)	716	Electricity Pit	990	Easement
308	Side Entry Pit	418	Lane Lines	721	Telecom Pit	998	Digital Cadastral Map Base
309	Grated Pit						

APPENDIX B
36HR STORM DURATION - TUFLOW RESULTS


Legend
Site
Model Extent
Cadastre
Depth (m)
<= 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 2.0
> 2.0
0 50 100 150 200 m
Contains Vicmap Information © State of Victoria 2018
GDA 94 / MGA zone 55
375 Swansea Road, Lilydale
Max Flood Depth: Existing (36hr)


Legend
Site
Model Extent
Cadastre
Velocity (m/s)
0.0 - 0.1
0.1 - 0.2
0.2 - 0.5
0.5 - 1.0
1.0 - 1.5
> 1.5
0 50 100 150 200 m
Contains Vicmap Information © State of Victoria 2018
GDA 94 / MGA zone 55
375 Swansea Road, Lilydale
Max Flood Velocity: Existing (36hr)





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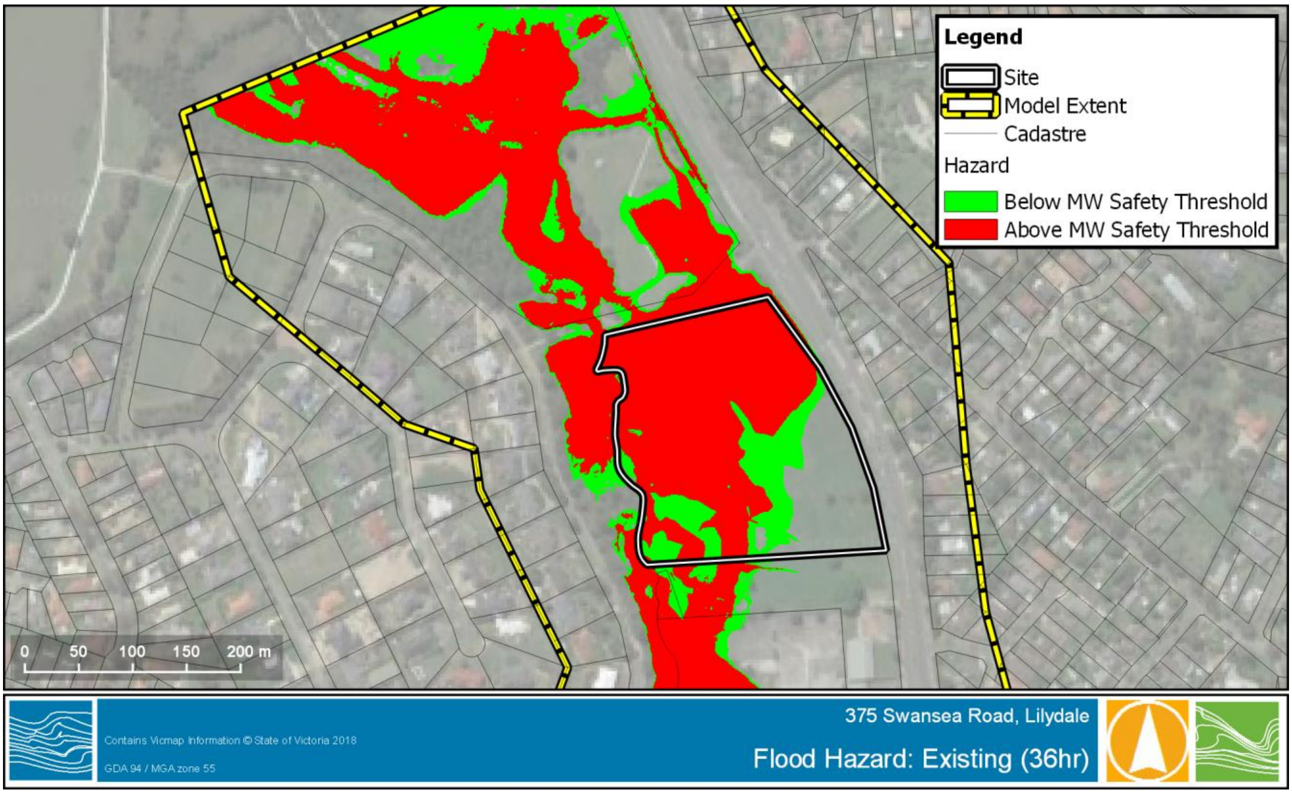

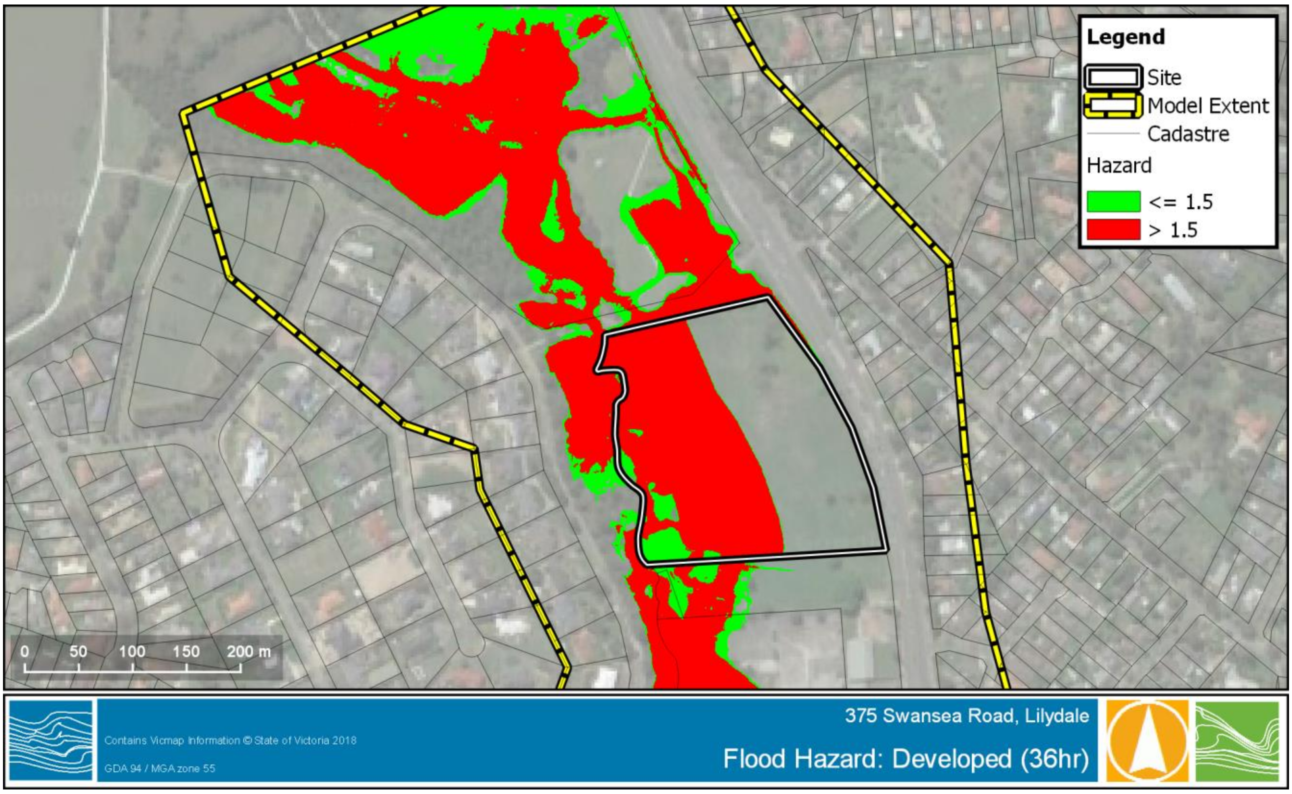

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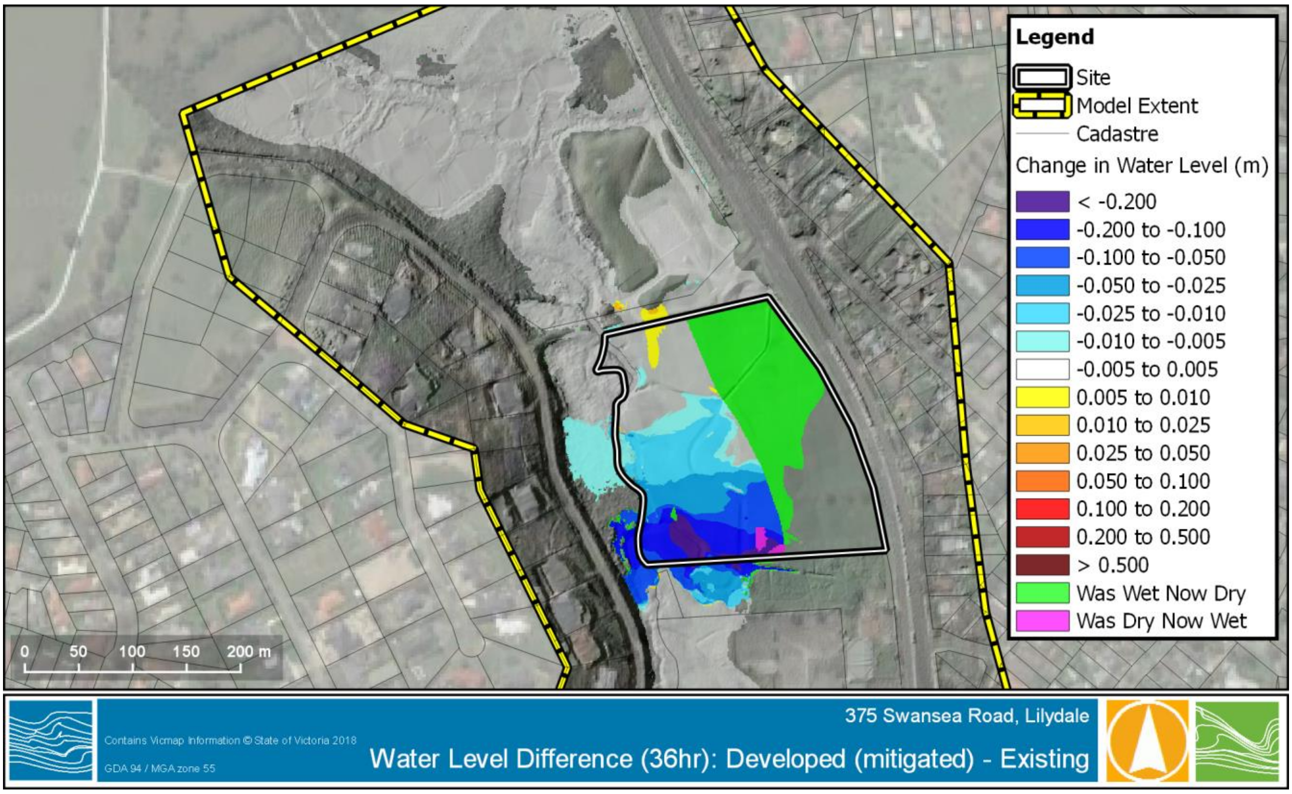

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APPENDIX C
INTERNAL DRAINAGE ASSESSMENT

Internal Drainage Network Assessment

10-year ARI Event

Pipe Ref.	Upstream Area A	Cumulative Upstream Area ΣA	10 Year ARI Runoff Coefficient C_5	ARI (y)	Effective Area A_e	Cumulative Effective Area ΣA_e	Time of Concentration t_c	Rainfall Intensity I_y	Design Flow Q_y	Length L	Slope S	Pipe Diameter	Full Flow Q_{full}	Full Velocity v_{full}	Time in Pipe t_{pipe}
	ha	ha			ha	ha	min	mm/hr	m^3/s	m	1 in	mm	m^3/s	m/s	min
1	1.00	1.00	0.50	10	0.50	0.50	9.0	80.84	0.11	190	100	375	0.18	1.59	1.99
2	0.03	0.03	0.50	10	0.02	0.02	7.4	87.90	0.00	36	100	300	0.10	1.37	0.44
3	0.30	1.33	0.80	10	0.24	0.76	9.6	78.65	0.16	53	100	375	0.18	1.59	0.56
4	0.06	0.06	0.80	10	0.05	0.05	0.8	126.85	0.02	64	100	300	0.10	1.37	0.78
5	0.90	0.96	0.50	10	0.45	0.50	8.7	81.98	0.11	164	100	375	0.18	1.59	1.72
6	0.09	2.38	0.50	10	0.05	1.30	10.0	77.06	0.28	46	100	450	0.29	1.79	0.43

100-year ARI Event

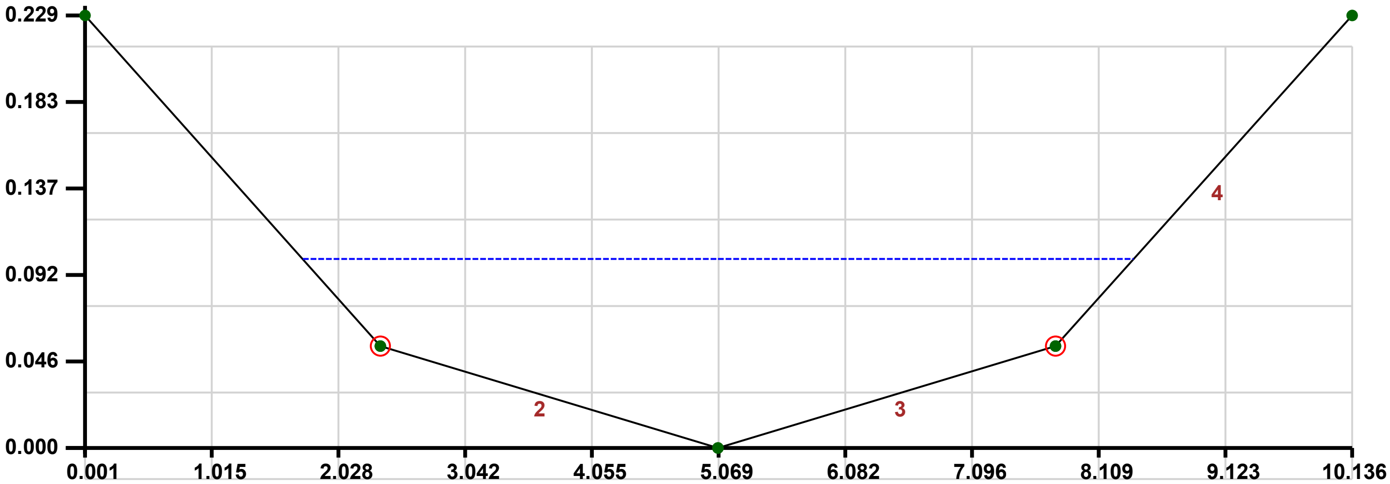
Pipe Ref.	Upstream Area A	Cumulative Upstream Area ΣA	100 Year ARI Runoff Coefficient	ARI (y)	Effective Area A_e	Cumulative Effective Area ΣA_e	Time of Concentration t_c	Rainfall Intensity I_y	Design Flow Q_{100}	Length L	Slope S	Pipe Diameter	Full Flow Q_{full}	Full Velocity v_{full}	Time in Pipe t_{pipe}	Gap Flow $Q_{100} - Q_{full}$
	ha	ha			ha	ha	min	mm/hr	m^3/s	m	1 in …	mm	m^3/s	m/s	min	m^3/s
1	1.00	1.00	0.65	100	0.65	0.65	9.0	141.19	0.25	190	100	375	0.18	1.59	1.99	0.08
2	0.03	0.03	0.65	100	0.02	0.02	7.4	154.22	0.01	36	100	300	0.10	1.37	0.44	-0.09
3	0.30	1.33	0.90	100	0.27	0.94	9.6	137.13	0.36	53	100	375	0.18	1.59	0.56	0.18
4	0.06	0.06	0.90	100	0.05	0.05	0.8	127.57	0.02	64	100	300	0.10	1.37	0.78	-0.08
5	0.90	0.96	0.65	100	0.59	0.64	8.7	143.29	0.25	164	100	375	0.18	1.59	1.72	0.08
6	0.09	2.38	0.90	100	0.08	1.66	10.0	134.20	0.62	46	100	450	0.29	1.79	0.43	0.33

APPENDIX D
OVERLAND FLOW ASSESSMENT

Document Set ID: 7945665
Version: 2, Version Date: 28/07/2023

<u>PROJECT: 375 Swansea Road - Internal Road Layout</u>
Print-out date: 02/05/2022 - Time: 1:12
Data File: Local_Raod_CrossSection_v02.dat

1. CROSS-SECTION



2. DISCHARGE INFORMATION

100 year (1%) storm event
Design discharge after construction of retarding basin

Required overland / channel / watercourse discharge = 0.34 cumecs

3. RESULTS Water surface elevation = 0.100 m

High Flow Channel grade = 1 in 100, Main Channel / Low Flow Channel grade = 1 in 100.

	LEFT OVERBANK	MAIN CHANNEL	RIGHT OVERBANK	TOTAL CROSS-SECTION
Discharge (cumecs):	0.003	0.344	0.003	0.351
D(Max) = Max. Depth (m):	0.046	0.100	0.046	0.100
D(Ave) = Ave. Depth (m):	0.023	0.073	0.023	0.073
V = Ave. Velocity (m/s):	0.231	0.873	0.231	0.830
D(Max) x V (cumecs/m):	0.011	0.087	0.011	0.083
D(Ave) x V (cumecs/m):	0.005	0.064	0.005	0.061
Froude Number:	0.486	1.032	0.486	0.856
Area (m^2):	0.014	0.394	0.014	0.423
Wetted Perimeter (m):	0.623	5.401	0.625	6.649
Flow Width (m):	0.621	5.400	0.624	6.645
Hydraulic Radius (m):	0.023	0.073	0.023	0.064
Composite Manning's n:	0.035	0.020	0.035	0.024
Split Flow?	-	-	-	No

4. CROSS-SECTION DATA

	LEFT HAND POINT		RIGHT HAND POINT		
SEGMENT NO.	CHAINAGE (m)	R.L. (m)	CHAINAGE (m)	R.L. (m)	MANNING'S N
1	0.001	0.229	2.363	0.054	0.035
2	2.363	0.054	5.063	0.000	0.020
3	5.063	0.000	7.763	0.054	0.020
4	7.763	0.054	10.136	0.229	0.035

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