



**Freeway Business Park  
14 – 70 Wills Street and 110  
King Street, Warragul**

Stormwater Management Strategy

**Advantage All Group**

15 November 2021

Revision: 0

Reference: 1905

# Document control

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Document control					
<b>Report title</b>		Stormwater Management Strategy			
<b>Project number</b>		1905			
<b>File path</b>		D:\Incitus\Barich Consulting - Incitus\Projects\1900\1905 14 – 70 Wills Road & 110 King Street, Warragul SWS\Documents\Stormwater Strategy 14 - 70 Wills St Warragul Rev0.docx			
<b>Client</b>		Advantage All Group Pty Ltd			
Rev	Date	Revision details/status	Author	Reviewed	Approver
0	17 November 2021	Issued for authority approval	NJB	Reviewed 15.11.21	NJB

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# 1 Introduction

Advantage All Group Pty Ltd has engaged Incitus to undertake a Stormwater Management Strategy for the subdivision and proposed development of Freeway Business Park, located at 14 – 70 Wills Street and 110 King Street, Warragul.

The 9.7 ha site is located approximately 1 km south-west of the Warragul town centre. The site is located north of the Princes Freeway, west of King Street and south of Wills Street. The site is illustrated in **Figure 1.1** below.



**Figure 1.1** 14 – 70 Wills Street and 110 King Street, Warragul

Urbanisation leads to an increase in stormwater runoff and a subsequent increase in pollutant wash-off. It also has detrimental effects on the receiving waterways. In determining the urban structure, it is critical that assets required for drainage purposes are determined early so that the impacts from the increase of stormwater runoff due to urbanisation can be mitigated and all new development can proceed without the risk of flooding, of flooding neighbouring properties and without impacting on the natural environment and receiving waterways.

Undertaking a drainage assessment of the catchment that identifies the quantity of runoff, the conveyance of this runoff, the need to retard the runoff and the treatment and / or reuse of the runoff will assist in determining the assets and / or land-take required for the stormwater management of this catchment. It will also identify the location of all stormwater assets.

Liveability and resilience should be incorporated into all new developments. With respect to stormwater management, this involves utilising the stormwater as an asset for the community whilst ensuring fundamentals such as flood protection, safety with respect to flow management and water supply security are maintained. This can be achieved through incorporation of best planning practices for stormwater management during the development of the urban structure.

This Stormwater Management Strategy for the development of Freeway Business Park outlines a management plan for the stormwater that is generated from the urbanisation of the land. It identifies the assets required to manage the increased stormwater runoff from urbanisation and sets a framework to achieve the intent of the stormwater assets. The stormwater management for the site has been optimised and designed to achieve multiple benefits for the community and the environment.

## 2 Catchment Characteristics

Freeway Business Park, located at 14 – 70 Wills Street and 110 King Street, Warragul is located north of the Princes Freeway, west of King Street and south of Wills Street, and is approximately 9.7 ha in size.

The average annual rainfall for the region is approximately 1,000 mm. The site has had significant modification to the pre-European catchment form.

The site is traversed by Hazel Creek, which enters from a culvert crossing under the Princes Freeway at the western boundary of the site. Hazels Creek runs through the property towards the east and slightly north. A tributary of Hazel Creek enters the site from the Princes Freeway approximately 400 m east of the Hazel Creek culverts.

Hazels Creek runs through the property towards the east and slightly north. The creek is overgrown with weeds and has little value in its current state. Runoff from the upstream catchment of Hazel Creek is retarded in the Landsborough Road retarding basin prior to discharging across the Princes Freeway. The upstream catchment for Hazel Creek is approximately 11.2 km<sup>2</sup>.

The peak 1% AEP design flow in Hazel Creek at the crossing of the Princes Freeway is approximately 19.8 m<sup>3</sup>/s. A tributary of Hazel Creek enters the site at King Street. The peak 1% AEP design flow at King Street is approximately 1.7 m<sup>3</sup>/s. Another tributary of Hazel Creek enters the site via a cut drain from Wills Street through the property immediately to the west. The peak 1% AEP design flow at Wills Street is approximately 6.9 m<sup>3</sup>/s. The peak 1% AEP design flow in Hazel Creek at the confluence with the two tributaries in the west of the site is approximately 23.3 m<sup>3</sup>/s.

A tributary of Hazel Creek enters the site from the Princes Freeway approximately 400 m east of the Hazel Creek culverts. The stormwater runoff entering Hazel Creek from the tributary is unmitigated. The catchment for the tributary of Hazel Creek is approximately 93 ha. The peak 1% AEP design flow entering from the Tributary of Hazel Creek at the Princes Freeway is approximately 7.8 m<sup>3</sup>/s. The peak 1% AEP design flow at the confluence of Hazel Creek and the Tributary of Hazel Creek is approximately 28.6 m<sup>3</sup>/s.

Spring Creek joins Hazel Creek downstream of the site, converging immediately east of the crossing of Howitt Street, south of the Warragul Harness Racing track. Spring Creek crosses Howitt Street approximately 90 m north of the Hazel Creek crossing of Howitt Street. The peak 1% AEP design flow in Spring Creek upstream of the crossing of Howitt Street is approximately 30.5 m<sup>3</sup>/s. Whilst the Spring Creek crossing of Howitt Street is approximately 450 m east of the site, it has been included in the hydraulic model to account for any subcritical flow tailwater effects which may influence the flood levels through the site.

The peak 1% AEP design flows have been extracted from the Warragul PSP RORB model supplied by Baw Baw Shire Council. They are based on the ultimate development of the Warragul PSP area. The RORB details and hydrographs are included in **Appendix A**.

**Figure 2.1** depicts the general site characteristics.



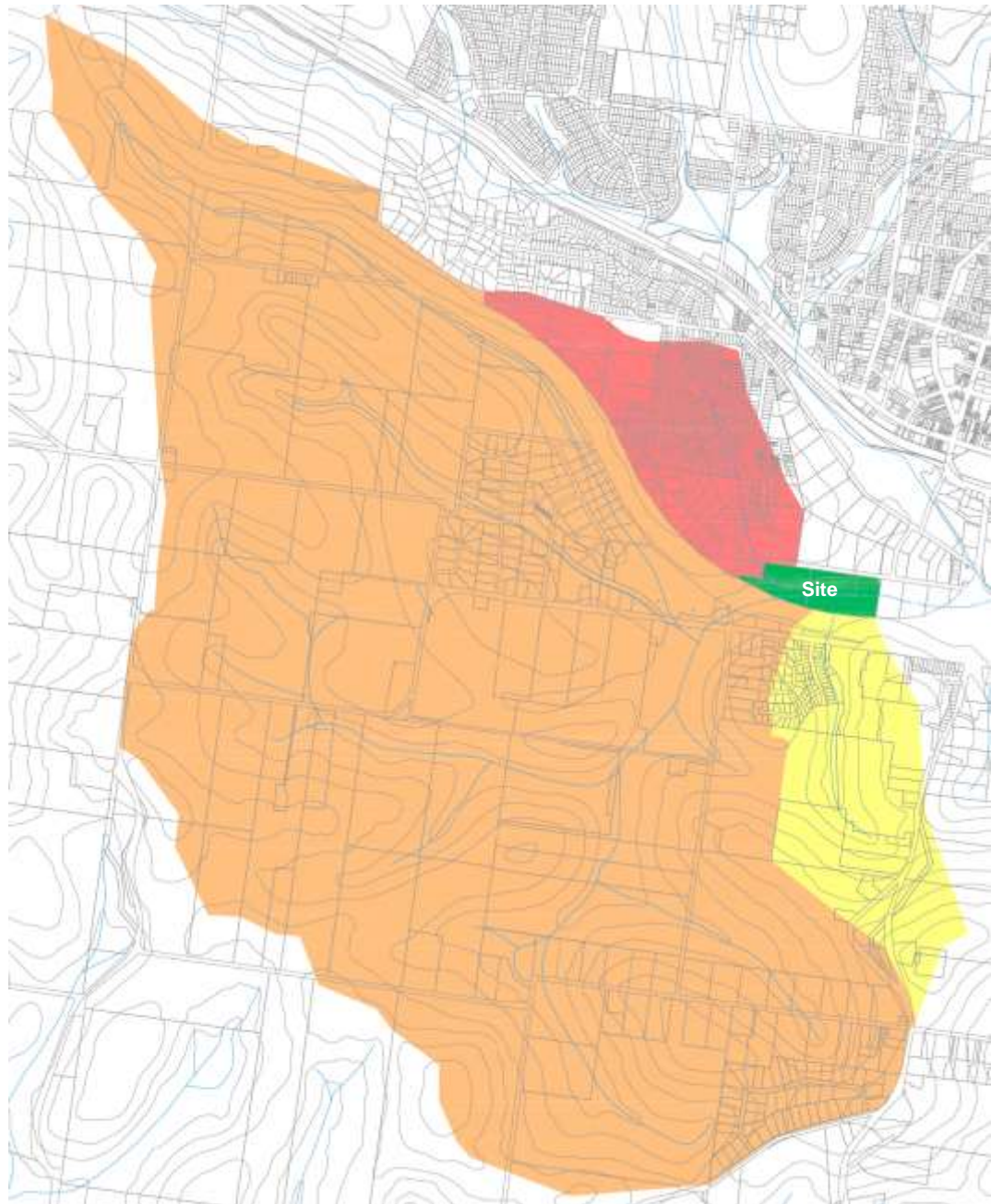


Figure 2.1 Catchment Characteristics of Freeway Business Park, Warragul

# 3 Stormwater Management Objectives

## 3.1 Victorian Planning Provision Objectives

In October 2018, the Victorian Government created the new Clause 53.18, Stormwater Management in Urban Development, in the Victorian Planning Provisions to ensure that stormwater generated from all forms of urban development is managed in an integrated way to mitigate the impacts of stormwater runoff on the environment, property and public safety, and to provide cooling, local habitat and amenity benefits.

One of the key elements to be met under Clause 53.18 of the VPPs is the stormwater management objectives and standards for subdivisions. The objectives for stormwater management for subdivisions are:

- To minimise damage to properties and inconvenience to the public from stormwater
- To ensure that the street operates adequately during major storm events and provides for public safety
- To minimise increases in stormwater and protect the environmental values and physical characteristics of receiving waters from degradation by stormwater
- To encourage stormwater management that maximises the retention and reuse of stormwater
- To encourage stormwater management that contributes to cooling, local habitat improvements and provision of attractive and enjoyable spaces

The stormwater management system should be:

- Designed and managed in accordance with the requirements and to the satisfaction of the relevant drainage authority.
- Designed and managed in accordance with the requirements and to the satisfaction of the water authority where use of stormwater is proposed
- Designed to meet the current best practice performance objectives for stormwater quality as contained in the Urban Stormwater-Best Practice Environmental Management Guidelines (Victorian Stormwater Committee, 1999).
- Designed to ensure that flows downstream of the subdivision site are restricted to pre-development levels unless increased flows are approved by the relevant drainage authority and there are no detrimental downstream impacts.
- Designed to contribute to cooling, improving local habitat and providing attractive and enjoyable spaces.
- The stormwater management system should be integrated with the overall development plan including the street and public open space networks and landscape design.

For all storm events up to and including the 20% Average Exceedance Probability (AEP) standard:

- Storm water flows should be contained within the drainage system to the requirements of the relevant authority.
- Ponding on roads should not occur for longer than 1 hour after the cessation of rainfall.



- For storm events greater than 20% AEP and up to and including 1% AEP standard: Provision must be made for the safe and effective passage of stormwater flows. All new lots should be free from inundation or to a lesser standard of flood protection where agreed by the relevant flood plain management authority.
- Ensure that streets, footpaths and cycle paths that are subject to flooding meet the safety criteria  $DV < 0.3 \text{ m}^2/\text{s}$  (where, D= depth in metres and V = velocity in metres per second).

The design of the local drainage network should:

- Ensure stormwater is retarded to a standard required by the responsible drainage authority.
- Ensure every lot is provided with drainage to a standard acceptable to the relevant drainage authority.
- Wherever possible, stormwater should be directed to the front of the lot and discharged into the street drainage system or legal point of discharge.
- Ensure that inlet and outlet structures take into account the effects of obstructions and debris build up.
- Any surcharge drainage pit should discharge into an overland flow in a safe and predetermined manner.
- Any flood mitigation works must be designed and constructed in accordance with the requirements of the relevant floodplain management authority.

## 4 Warragul Urban Drainage Strategy

Freeway Business Park is covered by the Warragul Urban Drainage Strategy, which is a plan of the overall stormwater management for the growth areas around Warragul. The strategy provides a holistic approach to the management of stormwater, positioning significant stormwater assets in best for the catchment locations and indicating legal points of discharge for the development parcels. The intent is to remove an ad-hoc approach to the stormwater management for the growth area and to minimise the number of significant assets that will be gifted to Baw Baw Shire Council for on-going ownership and maintenance.

The strategy proposes that the site drains into Hazel Creek and towards the proposed W9 wetland asset. This asset is partially located within the site, and in the property immediately to the east. The proposed Warragul Urban Drainage Strategy for Freeway Business Park is depicted in **Figure 4.1**.

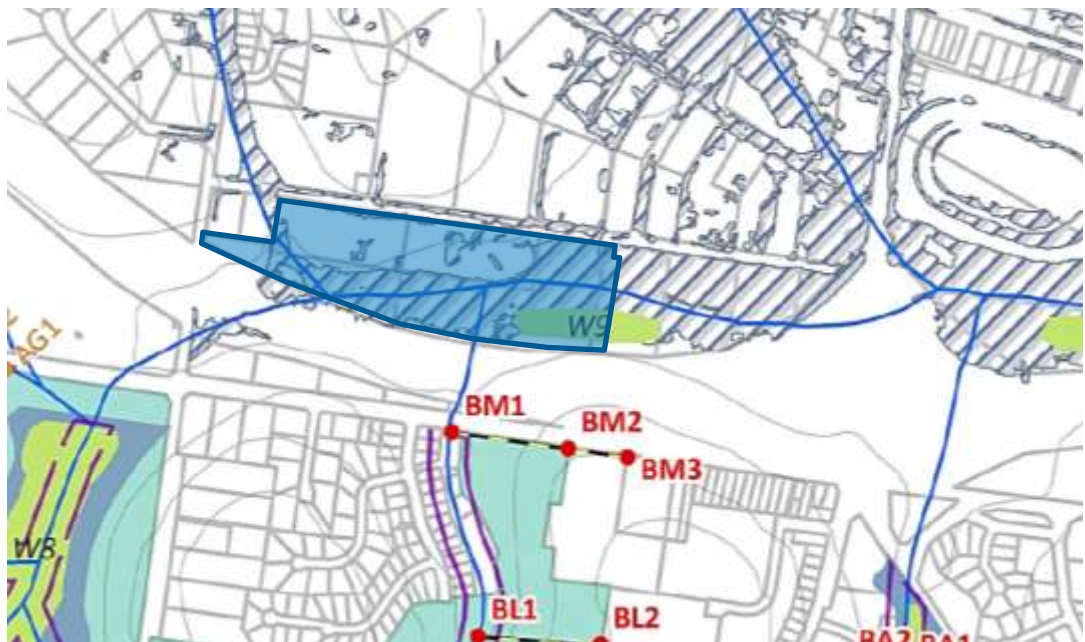


Figure 4.1 Warragul Urban Drainage Strategy

## 5 Hazel Creek Realignment

Freeway Business Park, Warragul is currently subject to inundation in a 1% Annual Exceedance Probability (AEP) storm event from Hazel Creek. To develop the site for industrial purposes, it is proposed to transform Hazel Creek to a constructed waterway, realigned along the boundary of the Princes Freeway. The constructed waterway will provide capacity to contain the 1% AEP flood flows, providing flood free land for development. The proposed works will enhance the values associated with this reach of Hazel Creek, through the creation of a compound form profile waterway with appropriate vegetation and the potential to incorporate habitat values.

The site will also provide an 8 m wide trapezoidal channel along the western boundary at 14 Wills Street to the drainage reserve. The channel will facilitate the conveyance of the flows from the tributary of Hazel Creek entering from Wills Street to Hazel Creek. The channel will have a base width of approximately 3 m and up to 1 in 3 side slopes. This channel will be fenced off from public access. The side slopes will be vegetated to prevent the requirement for mowing and minimise the maintenance associated with the channel.

It should be noted that this profile for the trapezoidal channel will match the existing channel through the site at 10 Wills Street, Warragul; and merely formalises the Tributary of Hazel Creek through the site to the confluence with Hazel Creek.

Whilst the land is not part of the Warragul Precinct Structure Plan (PSP), the drainage strategy for the PSP has nominated the inclusion of a constructed wetland system straddling this site and the property to the east to provide stormwater quality treatment to the runoff generated from the catchment contributing to the tributary of Hazel Creek. The intent of the Warragul PSP was to locate the wetland system in land which is currently subject to inundation, reducing the land acquisition cost associated with the asset. The PSP has proposed a wetland system with a drainage reserve of 1.06 ha across the 2 properties.

The site contains a significant water supply main, which needs to be cross by Hazel Creek, approximately 80 m downstream of the confluence with the tributary of Hazel Creek. The water main creates an obstruction to the construction of the wetland system. Adjacent to the eastern boundary of the site is a high-pressure gas main, which also creates an obstruction to the ability to construct a wetland system in this location. This will require a split wetland which essentially straddles the gas easement. Splitting the wetland facilitates a staged construction of the asset, allowing the inlet to be constructed with the development of this site, and the downstream portion in the neighbouring property to be constructed at a later date. The splitting of the wetland will not have any adverse effects to the treatment performance provided by the asset.

The development proposes to construct a portion of the wetland system between the water supply main and the eastern boundary / high-pressure gas main. Realignment of Hazel Creek to adjacent to the southern boundary provides a more optimum flow path through the section of wetland system to be located in the site.

The development will also provide a clean-out of Hazel Creek from the eastern site boundary to Howitt Street. This clean-out has been agreed to by the landowner and West Gippsland Catchment Management Authority. The intention is to remove the overgrown weeds from the drain and improve the flow along the invert.

**Figure 5.1** illustrates the proposed drainage reserve for the site, with the realignment of Hazel Creek to be contained within a 45 m wide waterway corridor and a drainage reserve located between the water supply main and the eastern boundary for the wetland system.

Whilst typically a 60 m wide waterway corridor is required, hydraulic modelling has demonstrated the flow can be contained in a 45 m corridor without adverse impacts to any surrounding properties and West Gippsland Catchment Management Authority (WGCMA) have approved the adoption of a 45 m wide corridor with the payment of an offset to compensate for the loss of flood plain habitat. This approval is included in **Appendix D**.

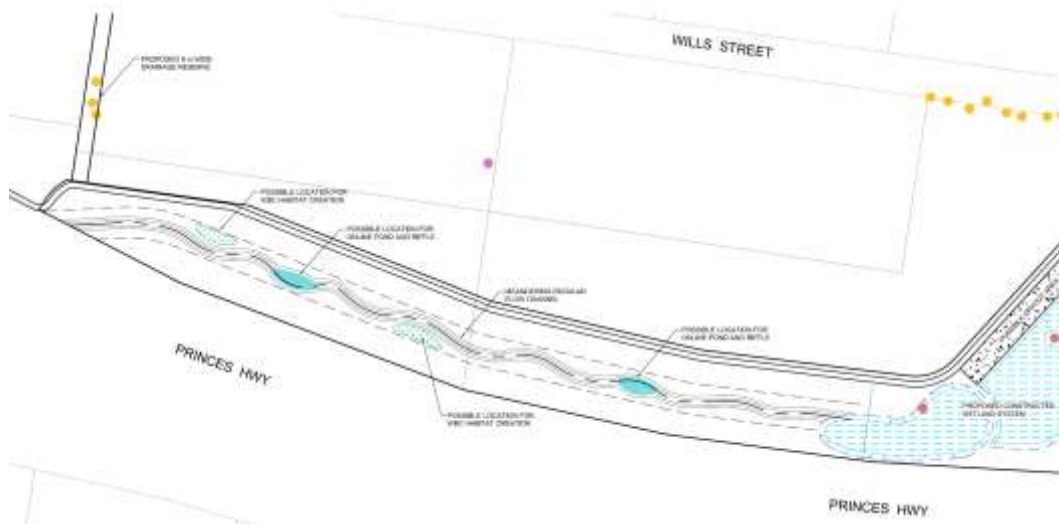


Figure 5.1 Proposed Development Layout with Hazel Creek Realignment

**Figure 5.2** illustrates the typical profile adopted of the constructed waterway for the realignment of Hazel Creek.

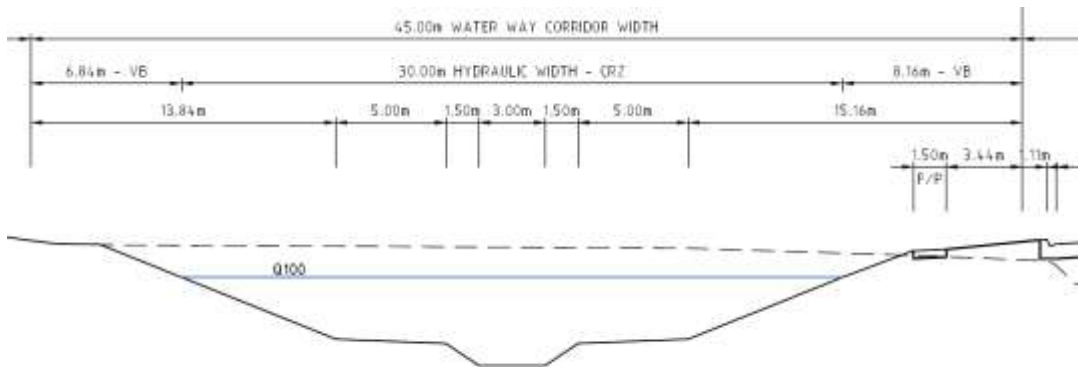


Figure 5.2 Proposed Constructed Waterway Profile

## 6 Stormwater Quantity

The drainage system for the development of Freeway Business Park, Warragul will be designed to prevent property flooding occurring in a 1% Average Exceedance Probability (AEP) storm event and provide safe conveyance of the stormwater runoff through the development. To achieve this, the development will adopt a minor / major drainage system philosophy.

### 6.1 Minor Drainage System

The minor drainage system will consist of a subsurface pipe network designed to capture and convey all stormwater runoff generated from the catchment for rainfall events up to and including the 10% Average Exceedance Probability (AEP) design storm for residential catchments.

The system will be designed in accordance with Baw Baw Shire Council standards.

A proposed layout for the minor drainage is illustrated in **Figure 6.1**. This layout may be subject to change throughout the functional and detailed design phase.

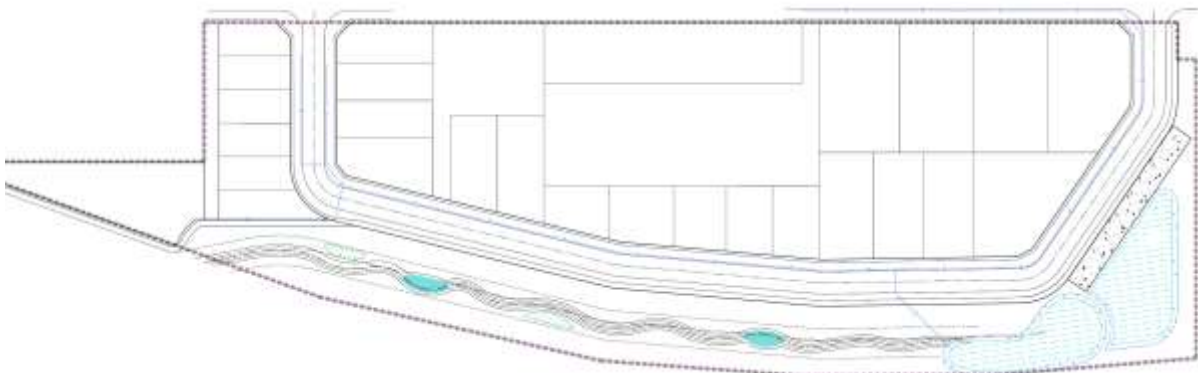


Figure 6.1 Freeway Business Park, Warragul Possible Minor Drainage Layout

### 6.2 Major Drainage System

The primary objective of the major drainage system is to provide flood protection for the allotments based on the 1% AEP storm event and to safely convey the overland flow through the development. This will be via overland flow paths contained within road reserves for the local development, and drainage reserves for the external catchment flows.

The site will provide a drainage reserve along the western boundary to convey the peak 1% AEP design flow of approximately 6.9 m<sup>3</sup>/s from an external catchment to the north-west of Wills Street.

The other external catchments entering the site will be conveyed and contained within Hazel Creek along the southern boundary of the site.

The development of Freeway Business Park, Warragul will be designed to ensure that all allotments will be set a minimum of 150 mm above the overland flow conveyed through the road reserves, and 600 mm above the 1% AEP flood level associated with Hazel Creek. The road reserve gradients are yet to be confirmed by the design phase.

Figure 5.2 illustrates the major catchments for the development.

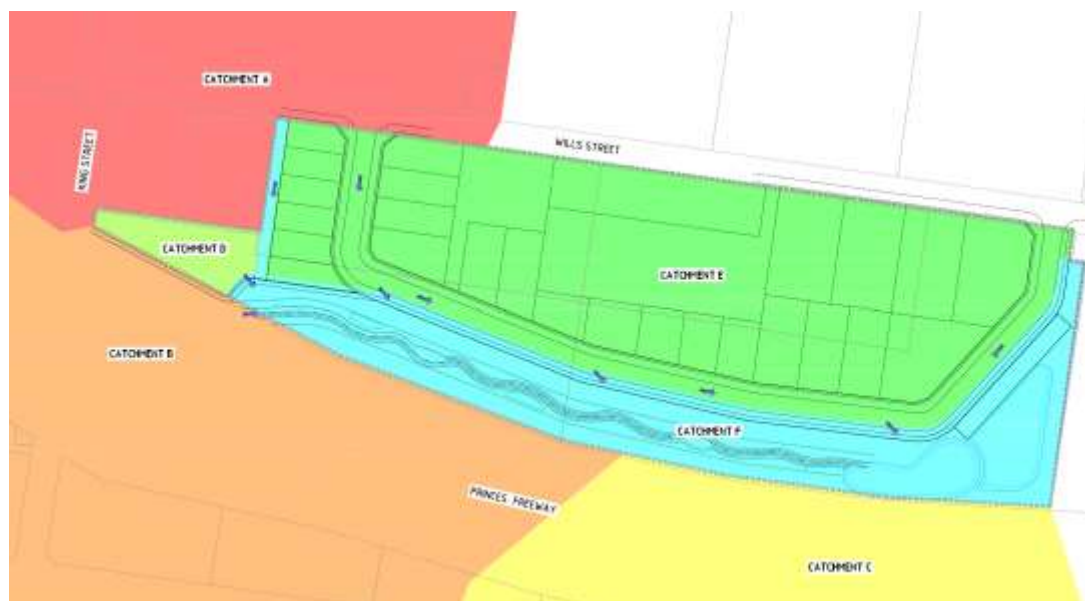


Figure 5.2 Freeway Business Park, Warragul Major Catchments and Overland Flow Paths

Table 6.1 outlines the runoff for the catchments and the anticipated overland flow conveyance.

Table 6.1 Major Drainage System Catchment Runoff

Catch	Area (ha)	AE (ha)	Additional catchment runoff	$\Sigma ae$ (ha)	Tc (mins)	I <sub>1%</sub> AEP (mm/h)	Q <sub>1%</sub> AEP (m <sup>3</sup> /s)	Q <sub>GAP</sub> (m <sup>3</sup> /s)
A	78	-	-	-	-	-	6.9	6.9
B	1804	-	-	-	-	-	19.8	19.8
C	97	-	-	-	-	-	7.8	7.8
D	0.31	0.31	-	0.31	10	114	0.10	0.05
E	6.33	6.23	-	6.23	12	106	1.83	0.92
F	3.00	-	A, B, C, D, E	-	-	-	29.0	29.0

### 6.3 Retardation

The development is located within Warragul Urban Drainage Strategy. The strategy provides for catchment scale retardation. Updating the catchment RORB model to account for the development of Freeway Business Park indicates no increase in the peak 1% AEP design flow in Hazel Creek at the site, therefore no on-site retardation is required.



## 6.4 Permissible Site Discharge

The development of Freeway Business Park, Warragul discharges to Hazel Creek.

**Table 6.2** outlines the maximum Permissible Site Discharge (PSD) for Freeway Business Park, Warragul.

Table 5.4 Permissible Site Discharge

Catchment	10% AEP Storm Event (m <sup>3</sup> /s)	1% AEP Storm Event (m <sup>3</sup> /s)
Site	0.96	1.93

## 6.5 Overland Flow Safety

It is imperative that the development conveys the overland flows safely along road reserves. This requires ensuring the overland flow along major flow paths complies with floodway safety requirements.

The recommended safety limits for industrial developments are as follows (from the *Guidelines for Development in Flood Affected Areas*):

- $V_{dmax} \leq 0.4 \text{ m}^2/\text{s}$
- $V_{max} \leq 2.0 \text{ m/s}$
- $d_{max} \leq 0.50 \text{ m}$

The recommended safety limits for waterways and drainage reserves are as follows (from Melbourne Water's website):

- Full child safety is to be maintained out to depths of at least 0.4 m on both banks wherever free access is available
- $V_{bank.dact} \leq 0.35 \text{ m}^2/\text{s}$
- $act \leq 0.40 \text{ m}$
- $V_{av} \leq 1.5 \text{ m/s}$  for  $act > 0.4$

For the minimum road grades to comply with the engineering standards, the maximum overland flow which can be safely conveyed along a typical 16 m road reserve including flow within allotments is 3 m<sup>3</sup>/s. These figures have been based on 1 dimensional steady state hydraulic modelling using the software program HEC-RAS.

For the maximum road grades to comply with the engineering standards, i.e. 10%; the maximum overland flow which can be safely conveyed along a typical 16 m road reserve is 1.3 m<sup>3</sup>/s. These figures have been based on 1 dimensional steady state hydraulic modelling using the software program HEC-RAS.

The major overland flow paths are depicted on the catchment plan. The maximum gap flow within a road reserve is less than the capacity to safely convey flows and is therefore okay.

The drainage reserves will be designed to comply with the requirements for child safety to a depth of at least 0.4 m in accordance with the relevant guidelines. Details will be provided with the detailed design of the assets.

# 7 Stormwater Quality Treatment

The State Environment Protection Policy (Waters of Victoria) defines the required water quality conditions for urban waterways. The aim of stormwater quality treatment is to reduce typical pollutant loads from urban areas to Best Management Practices as defined in the following targets:

Table 7.1 Best Practice Pollutant Reduction Targets

Pollutant	Performance Objective
Total Suspended Solids (TSS)	80% reduction from typical urban load
Total Phosphorous (TP)	45% reduction from typical urban load
Total Nitrogen (TN)	45% reduction from typical urban load
Gross Pollutants (GP)	70% reduction from typical urban load

Source: *Urban Stormwater: Best Practice Environmental Management Guidelines – Victorian Stormwater Committee, 1999.*

The Warragul Precinct Structure Plan and Warragul Urban Drainage Strategy have outlined a holistic approach to stormwater quality treatment that positions treatment assets at the optimum locations for the catchment and the community.

The inclusion of at-source stormwater quality treatment within this development is a possibility. This could be in the form of the inclusion of rainwater tanks for reuse on allotments or rain gardens within the car parking areas of allotments. For simplicity these options have not been considered for this development.

The Warragul Urban Drainage Strategy has adopted a holistic approach to stormwater quality treatment. This includes the construction of regional wetland systems to reduce the pollutants associated with the stormwater runoff generated from the urbanisation of the catchment. The wetland systems have been located strategically within the overall catchment to reduce footprints required for retarding basin assets and create multi-functional stormwater assets. This includes a portion of a constructed wetland within this site.

The Warragul PSP has allocated a drainage reserve of 1.06 ha, equally straddling this property and the property to the east.

The site contains a significant water supply main, which needs to be cross by Hazel Creek, approximately 80 m downstream of the confluence with the tributary of Hazel Creek. The water main creates an obstruction to the construction of the wetland system. Adjacent to the eastern boundary of the site is a high-pressure gas main, which also creates an obstruction to the ability to construct a wetland system in this location. This will require a split wetland which essentially straddles the gas easement. Splitting the wetland facilitates a staged construction of the asset, allowing the inlet to be constructed with the development of this site, and the downstream portion in the neighbouring property to be constructed at a later date. The splitting of the wetland will not have any adverse effects to the treatment

performance provided by the asset. The macrophyte zones will be connected by pipes under the existing water supply main.

The water supply main is a 450 mm diameter main with an invert level at the crossing location of approximately 105.75. The main has approximately 1.5 m of cover to the existing surface level. Typically, a 500 mm minimum clearance is required to cross a water supply main.

Due to the magnitude of the 1% AEP discharge, it is proposed to adopt a submerged crossing of the main, providing a small pond upstream of the crossing to connect to the downstream wetland. It is common to submerge a sizable outlet to a wetland to prevent public access to the outlet. It is anticipated that a block of 10 x 1200 mm diameter RCP culverts will be required to connect Hazel Creek to the proposed wetland.

To achieve the ability to cross the water supply main and obtain a free draining outfall for the drainage reserve at Alfred Street, the constructed wetland system will adopt a permanent water level of 105.0 m AHD. A total footprint at permanent water level of 0.45 ha for the wetland system can be achieved within the site.

The MUSIC model supplied by Council to simulate the treatment proposed in the PSP adopts a sediment pond with a surface area at permanent water level of 800 m<sup>2</sup>, combined with a wetland macrophyte zone of 8,000 m<sup>2</sup> at permanent water level. The nominated extended detention depth is 600 mm and the extended detention time adopted is 72 hours. It should be noted that a treatment system with a total footprint at permanent water level of 8,800 m<sup>2</sup> and a treatment depth of 600 mm will not fit within a 1.06 ha drainage reserve.

Updating the model to adopt the current recommended soil parameters, the PSP proposed system achieves the treatment performance listed in **Table 7.2**.

Table 7.2 Treatment Performance of PSP WL9

Pollutant	Source Load (kg/yr)	Residual Load (kg/yr)	Load Removed By Asset (kg/yr)	% Reduction
Total Suspended Solids (TSS)	635,000	354,000	71,600	44.2
Total Phosphorous (TP)	1,480	956	117	35.5
Total Nitrogen (TN)	11,600	9,200	370	20.9
Gross Pollutants (GP)	152,000	1,160	94,080	99.2

It should be noted that the catchment has an upstream treatment in the Landsborough Road retarding basin. The load removed by the asset is the difference between the load removed at this location in the treatment system and the load removed by the upstream treatment.

The treatment system has been modified to suit the proposed drainage reserve, site constraints and modified parameters to ensure a more sustainable asset. The system has increased the sediment pond surface area to 1,200 m<sup>2</sup>, and reduced the macrophyte zone to 5,200 m<sup>2</sup> based on the macrophyte zone which can be constructed in this site and in the 0.5 ha drainage reserve in the property to the east. All the flow from the catchment

upstream of the asset will route through this asset, achieving some level of treatment. The operating depth has been reduced to 350 mm to comply with the relevant guidelines and the extended detention time (operating time) for the asset has been reduced to 48 hours to minimise the likelihood of extended periods of inundation. **Table 7.3** outlines the revised treatment performance achieved by the asset.

**Table 7.3 Revised Treatment Performance of PSP WL9**

Pollutant	Source Load (kg/yr)	Residual Load (kg/yr)	Load Removed By Asset (kg/yr)	% Reduction
Total Suspended Solids (TSS)	631,000	320,000	109,000	49.3
Total Phosphorous (TP)	1,440	907	126	37.1
Total Nitrogen (TN)	11,700	9,160	500	21.5
Gross Pollutants (GP)	152,000	0	95,240	100

**Table 7.3** demonstrates that whilst the treatment asset footprint has reduced, there is no reduction in the performance of the system.

The site will provide a gross pollutant trap and connect directly to the wetland for treatment. **Table 7.4** outlines the treatment performance of the sediment pond and macrophyte zone within the site for the contributing site catchment only.

**Table 7.3 Revised Treatment Performance of PSP WL9**

Pollutant	Source Load (kg/yr)	Residual Load (kg/yr)	% Reduction
Total Suspended Solids (TSS)	11,000	592	94.6
Total Phosphorous (TP)	23	4.38	81
Total Nitrogen (TN)	167	68.5	59
Gross Pollutants (GP)	2,060	0	100

**Figure 7.1** illustrates the possible layout for the wetland within the site, including the allocation of a dry-out area. Maintenance access will be from the road reserve abutting the drainage reserve.

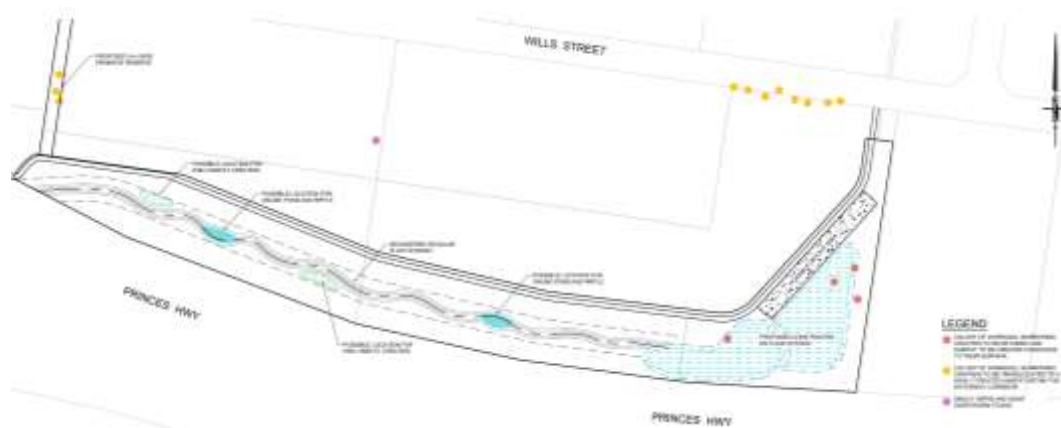


Figure 7.1 Proposed Constructed Wetland WL9 within Site

## 8 Outfall Arrangement

The development of Freeway Business Park will discharge to the constructed wetland WL9, partially located within the site.

The wetland will be constructed with the development and will have a free draining outfall.



## 9 Site Management

The proposed drainage system for the site ensures that receiving waters are protected from sediment runoff and other offensive pollutants.

During construction of the development, the contractor must have an approved Site Environmental Management Plan (SEMP) in place, which is to be complied for the duration of the construction phase. The plan should include measures comprising:

- Sandbags and filters to prevent sediment laden stormwater runoff from the site
- Dust suppressants
- Excess spoil to be removed from construction vehicles zone
- Securing of waste stockpiles
- Measures to protect the conservation zone

## 10 Conclusion

The development of Freeway Business Park, Warragul is covered by the Warragul Urban Drainage Strategy and is required to meet the drainage standards specified by Baw Baw Shire Council and Victorian Planning Authority.

The development will provide pipe drainage infrastructure to convey the 10% AEP design flows and minimise nuisance flooding occurrences in regular rainfall events. The gap flows, i.e. the difference between the 1% AEP design flows and the pipe flows, will be safely conveyed through the development along road reserve corridors. Where the gap flows cannot meet the relevant overland flow safety criteria, the pipe drainage infrastructure will be increased to reduce the gap flows so that safety criteria can be met.

Ultimate development of the overall catchment will include provision for conveyance of flows from external catchments via Hazel Creek as per the Warragul Urban Drainage Strategy.

Allotments will achieve relevant freeboard from the 1% AEP flood levels associated the overland flows in road reserves, or the 1% AEP flood levels associated with the drainage reserves, whichever is greater.

The Warragul Urban Drainage Strategy adopts a holistic approach to stormwater quality treatment, providing strategically positioned catchment scale assets. Stormwater quality for the development will be provided through these assets that provide a holistic approach to treatment of the stormwater runoff generated from the catchments. The development will construct the portion of the constructed wetland asset W9 within the site.

The outlet for the site is a Hazel Creek, which will be realigned and reconstructed with the site and will be free draining.

# 11 References

Alluvium, August 2014, Warragul Urban Drainage Strategy Update

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia

CSIRO, 2006, Urban Stormwater: Best Practice Environmental Management Guidelines

Department of Environment, Land, Water and Planning, February 2019, Guidelines for Development in Flood Affected Areas

Engineers Australia, 1987, Australian Rainfall and Runoff

Engineers Australia, June 2012, Australian Rainfall and Runoff Revision Project, Project 5 – Regional Flood Methods – Stage 2 Report

Local Government Infrastructure Design Association, 24 March 2020, Infrastructure Design Manual, Version 5.30

Melbourne Water, 2016, Guidelines for the Use of MUSIC

Melbourne Water, 2005, WSUD Engineering Procedures: Stormwater

Victorian Planning Authority, December 2019, Engineering Design and Construction Manual for Subdivision in Growth Areas

## Appendix A – RORB Parameters

### RORB Parameters

RORB File	HazelSpringsCreeks_Retention_NewUGB_190919.catg
kc	14.53
m	0.8
IL	25 mm
RoC	0.68 (100 year ARI)
Rainfall Location	Warragul
Temporal Pattern	Unfiltered
Aerial Pattern	Uniform
Aerial Reduction Factor	AR&R Bk II
Loss Factor	Constant Losses

### IFD Parameters

Location	Warragul
$2I_1$	18.15
$2I_{12}$	4.03
$2I_{72}$	1.13
$50I_1$	34.63
$50I_{12}$	7.86
$50I_{72}$	2.31
Skew	0.37
F2 Value	4.25
F50 Value	15.06
Zone	1

## Appendix B – Intensity Frequency Duration Data

### Warragul Intensity Frequency Duration Table

Label: Warragul  
 Latitude: -38.1493 Nearest grid cell: 38.1375 (S)  
 Longitude: 145.954 Nearest grid cell: 145.9625 (E)

Duration	Average Exceedance Probability						
	63.20%	50%#	20%*	10%	5%	2%	1%
1 min	79.9	90.6	125	149	173	206	232
2 min	69	77.5	104	123	141	164	181
3 min	61.8	69.6	94.4	111	128	150	166
4 min	56.4	63.6	86.8	103	119	140	155
5 min	52	58.8	80.6	95.7	111	131	147
10 min	38.4	43.6	60.5	72.4	84.3	101	114
15 min	31.2	35.5	49.2	59	68.8	82.4	93.3
20 min	26.6	30.2	41.9	50.2	58.5	70.1	79.3
25 min	23.4	26.6	36.8	44	51.2	61.2	69.2
30 min	21.1	23.9	32.9	39.3	45.8	54.6	61.6
45 min	16.5	18.6	25.5	30.4	35.2	41.8	47
1 hour	13.8	15.6	21.2	25.2	29.1	34.5	38.7
1.5 hour	10.8	12.1	16.3	19.3	22.3	26.3	29.4
2 hour	9.04	10.1	13.6	16	18.4	21.7	24.3
3 hour	7.05	7.86	10.5	12.3	14.2	16.7	18.7
4.5 hour	5.5	6.12	8.13	9.56	11	13	14.7
6 hour	4.62	5.13	6.8	8.02	9.26	11	12.4
9 hour	3.6	3.99	5.3	6.27	7.27	8.72	9.94
12 hour	3.01	3.34	4.44	5.26	6.14	7.41	8.5
18 hour	2.33	2.58	3.44	4.1	4.81	5.87	6.79
24 hour	1.94	2.14	2.86	3.42	4.03	4.95	5.74
30 hour	1.67	1.84	2.46	2.95	3.49	4.3	5.01

Duration	Average Exceedance Probability						
	63.20%	50%#	20%*	10%	5%	2%	1%
36 hour	1.48	1.63	2.18	2.61	3.1	3.82	4.45
48 hour	1.21	1.34	1.78	2.14	2.53	3.13	3.65
72 hour	0.916	1	1.32	1.58	1.87	2.3	2.67
96 hour	0.749	0.819	1.07	1.27	1.48	1.81	2.09
120 hour	0.641	0.7	0.903	1.06	1.23	1.49	1.7
144 hour	0.567	0.617	0.787	0.914	1.05	1.25	1.43
168 hour	0.512	0.557	0.702	0.806	0.912	1.08	1.23



## Appendix C – Flow Computations

### 1% AEP Design Flows

Catchment	T <sub>c</sub> (mins)	Area (ha)	C	A <sub>e</sub> (ha)	ΣA <sub>e</sub> (ha)	I <sub>100</sub> (mm/hr)	Q <sub>100</sub> (m <sup>3</sup> /s)
A*	-	78	-	-	-	-	6.9
B*	-	1804	-	-	-	-	19.8
C*	-	97	-	-	-	-	7.8
D	10	0.31	0.985	0.31	0.31	114	0.05
E	12	6.33	0.985	6.23	6.23	106	0.92
F*	-	3.00	-	-	-	-	29.0

\*Flows extracted from RORB model

Note: C<sub>10</sub> = 0.10532

For f = 90%; C<sub>1%</sub> = 0.985

#### Time of concentration:

Engineering judgement has been applied to the calculation of the time of concentration for use in the ration method calculations associated with the catchments.

Time of concentration for pipe flows has been based on the time in pipe.

Time of concentration for overland flows has been based on travel time along road reserves.

# Appendix D – WGCMA In-Principle Acceptance of Hazel Creek



**West Gippsland**  
Catchment Management Authority

**WGCMA Ref:** WGCMA-F-2020-00137  
**Document No:** 3  
**Date:** 09 November 2021

**OFFICIAL**

[trevor@madcatconstructions.com.au](mailto:trevor@madcatconstructions.com.au)

Trevor Reynolds  
Mad Cat Constructions (Vic) Pty Ltd

Dear Trevor,

**Application Number (CMA Ref):** WGCMA-F-2020-00137

**Property:**           **Street:**                   14-70 Wills Street Warragul 3820  
**Cadastral:**                   Lot 1 TP939243, Parish of Baw Baw

---

Thank you for your enquiry, received at the West Gippsland Catchment Management Authority ('the Authority') on 19 October 2021 in relation to request for letter of support for landscape and waterway management plans.

The Authority have reviewed the Site Landscaping Plan by Advantage All dated 06/10/2021 and Waterway Management Plan by Habitat Creations dated 07/10/2021 and is satisfied that these plans meet the requirements of the Authority. Based on these plans the Authority is willing to support the proposed rezoning and subdivision of the property.

The Authority notes that a waterway offset arrangement has also been agreed as part of the Authority's support for the rezoning of the Urban Flood Zone land to Industrial Zone..

Should you have any queries, please do not hesitate to contact Rhain Bateman on 1300 094 262 or email [planning@wgcm.vic.gov.au](mailto:planning@wgcm.vic.gov.au). To assist the Authority in handling any enquiries please quote **WGCMA-F-2020-00137** in your correspondence with us.

Yours sincerely,

**Adam Dunn**  
**Executive Manager - Statutory Planning**

The information contained in this correspondence is subject to the disclaimers and definitions attached.

## **Definitions and Disclaimers**

1. The area referred to in this letter as the 'proposed development location' is the land parcel(s) that, according to the Authority's assessment, most closely represent(s) the location identified by the applicant. The identification of the 'proposed development location' on the Authority's GIS has been done in good faith and in accordance with the information given to the Authority by the applicant(s) and/or the local government authority.
2. While every endeavour has been made by the Authority to identify the proposed development location on its GIS using VicMap Parcel and Address data, the Authority accepts no responsibility for or makes no warranty with regard to the accuracy or naming of this proposed development location according to its official land title description.
3. **AEP** as Annual Exceedance Probability – is the likelihood of occurrence of a flood of given size or larger occurring in any one year. AEP is expressed as a percentage (%) risk and may be expressed as the reciprocal of ARI (Average Recurrence Interval).

Please note that the 1% probability flood is not the probable maximum flood (PMF). There is always a possibility that a flood larger in height and extent than the 1% probability flood may occur in the future.

4. **AHD** as Australian Height Datum - is the adopted national height datum that generally relates to height above mean sea level. Elevation is in metres.
5. **ARI** as Average Recurrence Interval - is the likelihood of occurrence, expressed in terms of the long-term average number of years, between flood events as large as or larger than the design flood event. For example, floods with a discharge as large as or larger than the 100 year ARI flood will occur on average once every 100 years.
6. No warranty is made as to the accuracy or liability of any studies, estimates, calculations, opinions, conclusions, recommendations (which may change without notice) or other information contained in this letter and, to the maximum extent permitted by law, the Authority disclaims all liability and responsibility for any direct or indirect loss or damage which may be suffered by any recipient or other person through relying on anything contained in or omitted from this letter.
7. This letter has been prepared for the sole use by the party to whom it is addressed and no responsibility is accepted by the Authority with regard to any third party use of the whole or of any part of its contents. Neither the whole nor any part of this letter or any reference thereto may be included in any document, circular or statement without the Authority's written approval of the form and context in which it would appear.
8. The flood information provided represents the best estimates based on currently available information. This information is subject to change as new information becomes available and as further studies are carried out.



**West Gippsland**  
Catchment Management Authority

**WGCMA Ref:** WGCMA-F-2020-00137  
**Document No:** 02  
**Your Ref:** 1905 Rev 3  
**Date:** 17 November 2020

**OFFICIAL**

[nina.barich@incitus.com.au](mailto:nina.barich@incitus.com.au)

Nina Barich  
Incitus

Dear Nina,

**Application Number (CMA Ref):** WGCMA-F-2020-00137

**Property:** **Street:** 14-70 And 110 Wills and King Street Warragul Vic 3825  
**Cadastral:** Lot 1 TP939243, Parish of Drouin East

---

Thank you for your enquiry, received at the West Gippsland Catchment Management Authority ('the Authority') on 22 October 2020. The Authority understands you have supplied an updated flood modelling Rev 3 proposed realignment of Hazel Creek for Industrial Development and require flood advice based on this.

The Authority has reviewed the flood modelling provided in the 14 – 70 Wills Street and 110 King Street, Warragul Flood Modelling 15 October 2020 Revision: 3 Reference: 1905. The Authority is satisfied with the provided modelling.

The Authority would be **willing to support** rezoning the portion of the land that is currently UFZ to Industrial 1 Zone and the subsequent subdivision of the land as depicted in Figure 3.1 in the Flood Modelling Report, subject to (but not limited to) the following:

1. Prior to the commencement of any works related to the subdivision:
  - a. Payment of a waterway offset to compensate for the loss of floodplain habitat that will be impacted by the filling of the land that is currently zoned UFZ. The offset area must be agreed with the WGCMA and will be calculated at a rate of \$50,000 per hectare.
  - b. A Waterway Management Plan (WMP) must be endorsed in writing by the West Gippsland Catchment Management Authority. The WMP must include:
    - i. Details of existing environmental values.
    - ii. Details of any initial stabilisation and vegetation works.
    - iii. A landscape plan for revegetation of the waterway, drainage corridor and all water quality works, including a species list and proposed density of the plantings. The vegetation must be representative of the Ecological Vegetation Class for the site.
    - iv. A maintenance plan detailing the sequencing and periods of short, medium and long term actions, including inspections, and the parties responsible for each action.
  - c. A Stormwater Management Plan (SMP) which identifies appropriate Water Sensitive Urban Design features to provide stormwater treatment to meet best practice guidelines must be submitted to the satisfaction of West Gippsland Catchment Management Authority. The SMP must clearly identify how stormwater runoff from the entire development will be managed and treated prior to discharge to the designated waterways including the proposed timing of works.

Please note: The Authority has provided this advice as preliminary information only and has been based on the information you have provided. Any flood level advice provided is based on the most accurate information currently available and may change if new information becomes available.

The Authority can provide further information regarding any proposed development of the property in response to a planning permit application referred by the Baw Baw Shire Council in accordance with the *Planning and Environment Act 1987*.

Please refer to the attached **explanatory report** for further detail.

Should you have any queries, please do not hesitate to contact Rhain Bateman on 1300 094 262 or email [planning@wgcm.vic.gov.au](mailto:planning@wgcm.vic.gov.au). To assist the Authority in handling any enquiries please quote **WGCMA-F-2020-00137** in your correspondence with us.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'Adam Dunn', written in a cursive style.

**Adam Dunn**  
**Statutory Planning Manager**

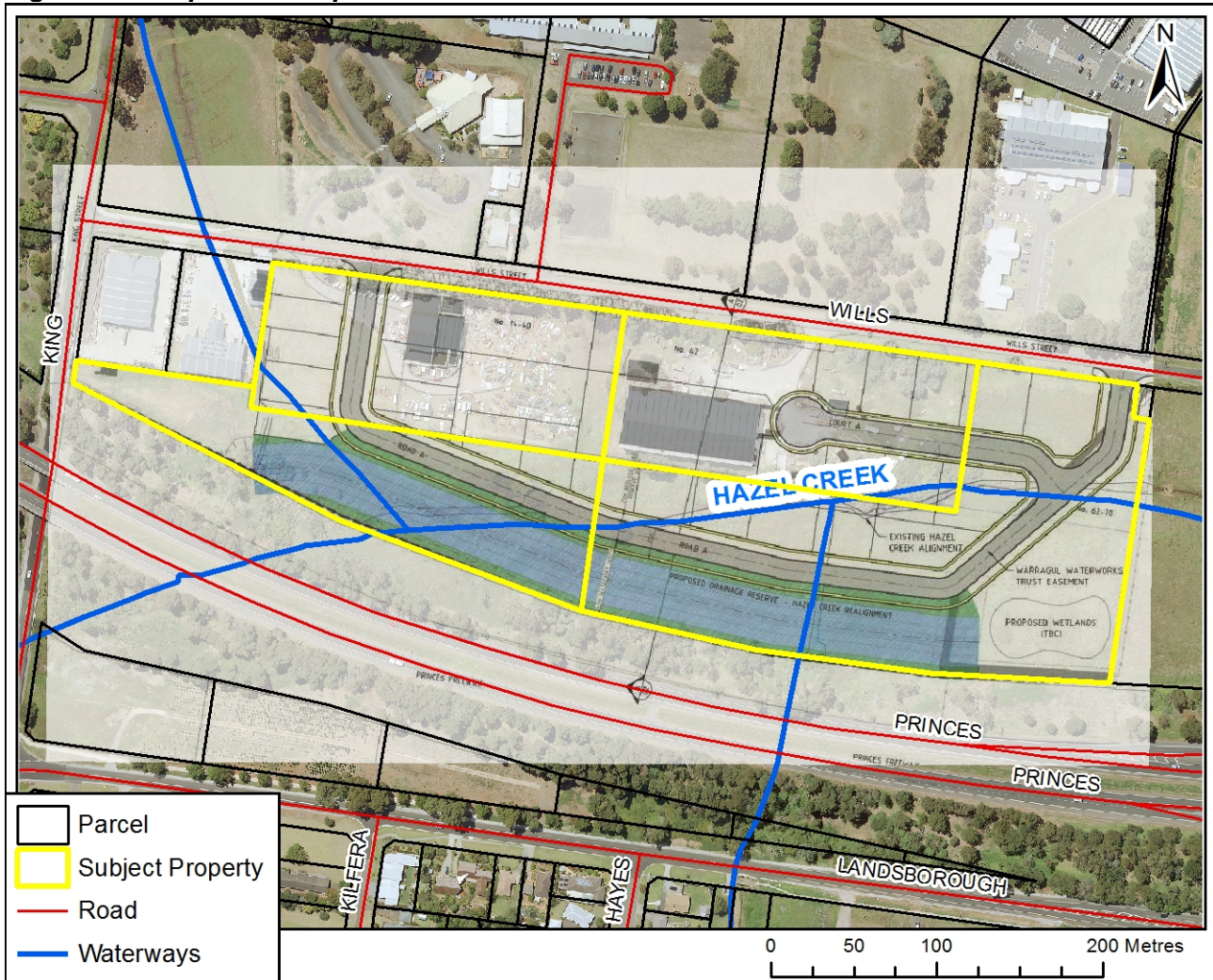
Cc: Baw Baw Shire Council

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## EXPLANATORY REPORT

Figure 1 – Proposed site plan



### Decision Guidelines

The West Gippsland Catchment Management Authority assesses all applications against the following National, State and Local Policies, Guidelines and Practice Notes:

1. [‘Technical Flood Risk Management Guideline: Flood Hazard’](#) (Australian Emergency Management Institute, 2014)
2. [‘Victorian Floodplain Management Strategy’](#) (Victoria State Government, 2016)
3. Council Planning Schemes ([Planning Schemes Online](#)), including the:
  - i. Planning Policy Framework
  - ii. Local Planning Policy Framework
  - iii. Relevant Zones and Overlays
4. [‘Guidelines for Coastal Catchment Management Authorities: Assessing development in relation to sea level rise’](#) (DSE, 2012)
5. [‘Applying for a Planning Permit under the Flood Provisions – A Guide for Councils, Referral Authorities and Applicants’](#) (DELWP, 2015)
6. [‘Flood Guidelines - Guidelines for development in flood prone areas’](#) (West Gippsland Catchment Management Authority, 2020)
7. [‘West Gippsland Waterway Strategy’](#) (2014-2022)
8. [‘West Gippsland Regional Catchment Strategy’](#) (2013-2019)
9. [‘West Gippsland Floodplain Management Strategy’](#) (2018-2027)

### **1% AEP<sup>3</sup> Flood Level Determination**

Floods are classified by the frequency at which they are likely to occur. In Victoria, all proposals for development on floodplains are assessed against a flood that, on average, will occur once every 100 years. A flood of this size has a 1% chance of occurring in any given year, and is known as either the 100 year Average Recurrence Interval (ARI<sup>5</sup>) flood or the 1% Annual Exceedance Probability (AEP) flood.

Please note that the 1% AEP flood is the minimum standard for planning in Victoria, and is not the largest flood that could occur. There is always a possibility that a flood larger in height and extent than the 1% AEP flood may occur in the future.

The Authority holds no information in relation to the arrangement and capacity of stormwater drainage infrastructure in the area and recommends that you contact Council for more information.

### **Flood Hazard Assessment**

The West Gippsland Catchment Management Authority's *'Flood Guidelines - Guidelines for development in flood prone areas'* (2020) state that where flood depth during a 1% AEP flood event is likely to exceed 0.3 metres over the development site or 0.3 metres over the vehicle route from the property, a proposal that seeks to intensify development through the creation of additional lots or dwellings is not supported as it would increase the amount of people and property exposed to the flood hazard.

The provided flood modelling demonstrates that the above criteria are **met**.

### **Waterways**

A designated waterway is located within the property boundaries. Clause 14.02-1S (Catchment planning and management) of the Planning Policy Framework (PPF) seeks to assist the protection and restoration of catchments, water bodies, groundwater and the marine environment through the following strategies:

- Ensure the continued availability of clean, high-quality drinking water by protecting water catchments and water supply facilities.
- Consider the impacts of catchment management on downstream water quality and freshwater, coastal and marine environments.
- Retain natural drainage corridors with vegetated buffer zones at least 30 metres wide along each side of a waterway to:
  - Maintain the natural drainage function, stream habitat and wildlife corridors and landscape values,
  - Minimise erosion of stream banks and verges, and
  - Reduce polluted surface runoff from adjacent land uses.
- Undertake measures to minimise the quantity and retard the flow of stormwater runoff from developed areas.
- Encourage measures to filter sediment and wastes from stormwater prior to its discharge into waterways, including the preservation of floodplain or other land for wetlands and retention basins.
- Ensure that works at or near waterways provide for the protection and enhancement of the environmental qualities of waterways and their instream uses.
- Ensure land use and development proposals minimise nutrient contributions to water bodies and the potential for the development of algal blooms.
- Require appropriate measures to restrict sediment discharges from construction sites.
- Ensure planning is coordinated with the activities of catchment management authorities.



## Stormwater Management

In regards to Water Sensitive Urban Design (WSUD) the following water quality objectives will need to be demonstrated to the satisfaction of the Authority:

- Integrate Water Sensitive Urban Design features to provide a high level of landscape amenity.
- Ensure both the quantity and quality of discharge arising from development meets best practice standards.
- Consider the long-term maintenance and operation costs in the design and location of WSUD features.
- Integrate WSUD components to provide environmental and recreational benefits wherever practical.
- The applicant must demonstrate (e.g. concept design using Model for Urban Stormwater Improvement Conceptualisation, MUSIC) that the stormwater discharge is treated to meet the objectives set out in the '*Urban Stormwater Best Practice Environmental Management Guidelines*' (CSIRO, 1999). These objectives are as follows:
  - 80 per cent retention of the typical urban annual load for Suspended solids (SS).
  - 45 per cent retention of the typical urban annual load for Total phosphorus (TP),
  - 45 per cent retention of the typical urban annual load for Total nitrogen (TN).
  - 70 per cent retention of typical urban annual load for Litter.
  - Maintain flow discharges for the 1.5 year ARI at pre-development levels

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Please note that the 1% probability flood is not the probable maximum flood (PMF). There is always a possibility that a flood larger in height and extent than the 1% probability flood may occur in the future.

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6. Nominal Flood Protection Level – is the minimum height required to protect a building or its contents, which includes a freeboard above the 1% AEP flood level.
7. No warranty is made as to the accuracy or liability of any studies, estimates, calculations, opinions, conclusions, recommendations (which may change without notice) or other information contained in this letter and, to the maximum extent permitted by law, the Authority disclaims all liability and responsibility for any direct or indirect loss or damage which may be suffered by any recipient or other person through relying on anything contained in or omitted from this letter.
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9. The flood information provided represents the best estimates based on currently available information. This information is subject to change as new information becomes available and as further studies are carried out.
10. Please note that land levels provided by the Authority are an estimate only and should not be relied on by the applicant. Prior to any detailed planning or building approvals, a licensed surveyor should be engaged to confirm the above levels.

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