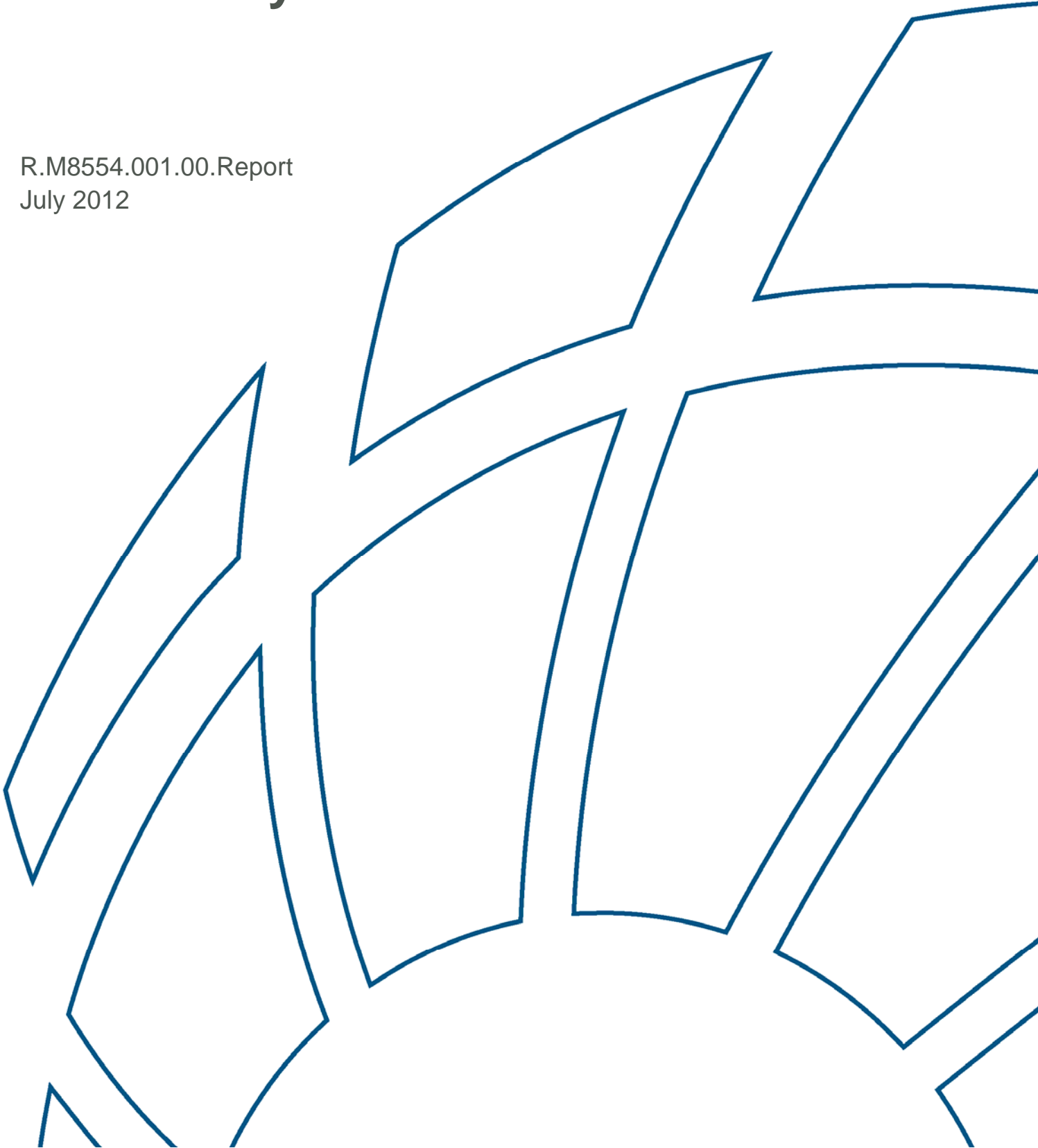


# 200 Matthews Road Flood Impact Assessment and Water Yield Analyses

R.M8554.001.00.Report  
July 2012





# 200 Matthews Road Flood Impact Assessment and Water Yield Analyses

Prepared For: Flentac Pty Ltd

Prepared By: BMT WBM Pty Ltd (Member of the BMT group of companies)

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<b>Title :</b>	200 Matthews Road Flood Impact Assessment and Water Yield Analyses
<b>Author :</b>	Michael Turnley and Andrew Grant
<b>Synopsis :</b>	The report summarises the findings of flood impact and water yield assessments of the proposed development at 200 Matthews Road, Corio.

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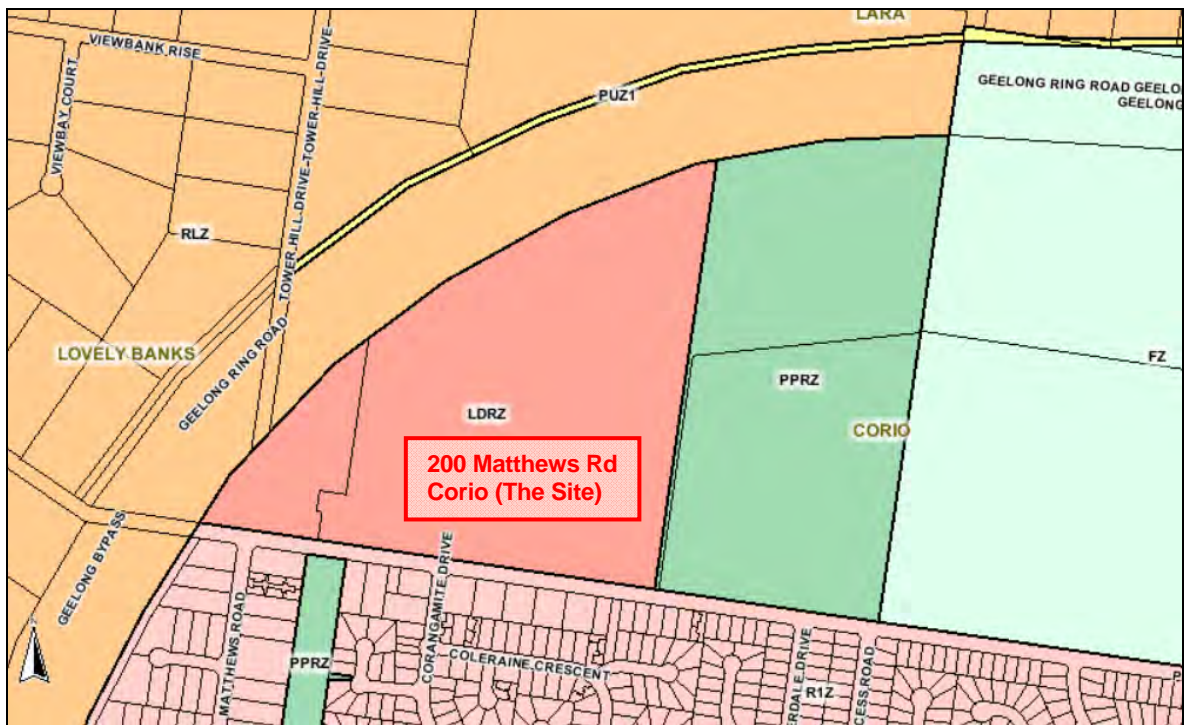
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# 1 INTRODUCTION

BMT WBM Pty Ltd was engaged to undertake the following assessments of the proposed development of 200 Matthews Road, Corio (The Site), and to document the findings in a concise report:

- Flood impact/mitigation option assessment
- Water harvesting yield analyses

The proposed development includes rezoning the site from Low Density Residential Zone (LDRZ) to Residential Zone One (R1Z) to accommodate a 298 lot residential development. The site's existing LDRZ zoning is shown in Figure 1-1. The proposed development, known as Sub-Divisional Concept Option 6, is outlined in Figure 1-2. The following sections outline the methodology and results of the assessments.



Source: Land Victoria (<http://services.land.vic.gov.au/maps/pmo.jsp>)

**Figure 1-1 Existing land use zonings**



Figure 1-2 Proposed development layout (Sub-Divisional Concept Option 6)

## 2 FLOOD IMPACT ASSESSMENT

### 2.1 Overview

The site falls within the catchment investigated as part of the Kosciusko Avenue Main Drain Catchment Drainage / Flood Study (BMT WBM, 2011) undertaken for the City of Greater Geelong (CoGG). The primary objectives of that study were to characterise existing flooding and to develop an appropriate flood management strategy to mitigate stormwater flooding in the area. Runoff (flow) from the catchment was determined using a hydrological model called RORB. Flood levels and extents within the study area were determined using a hydraulic (flood) model called TUFLOW. CoGG provided permission to use the RORB and TUFLOW models for the current assessment.

### 2.2 Methodology

As the Site is within the Kosciusko Main Drain catchment, it was included in the RORB hydrological model in BMT WBM (2011). However, the Site is outside the flood mapping area in BMT WBM (2011), and hence no mapping of the Site was undertaken as part of that study. The previously developed RORB model was used to undertake a preliminary assessment of the likely impact of the proposed development on flow rates. The existing flood mapping was extended so as to assess the impact of the proposed development on flood levels (presented as flood depths) and flood extents. This required that the TUFLOW model be extended in accordance with the methodology outlined in the original study (BMT WBM, 2011).

The outcomes of the assessment of existing and developed conditions are discussed in more detail below.

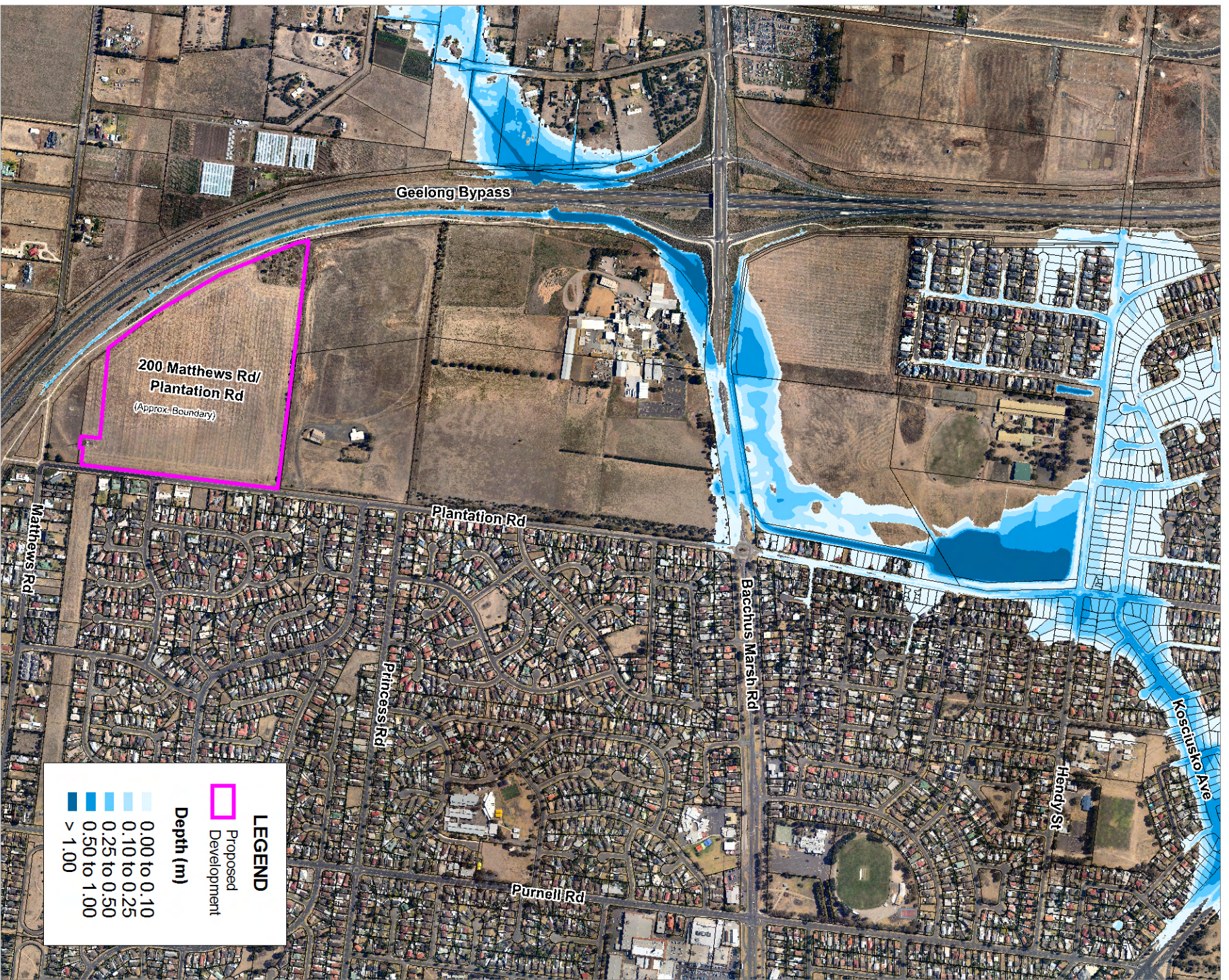
### 2.3 Existing Conditions

Peak existing condition flow rates for the site were derived using the RORB model for the full range of standard AEP flood events and storm durations. The flows for the three key AEP events analysed for the Kosciusko Avenue Main Drain Catchment Drainage/Flood Study, namely the 1%, 5% and 20% AEP flood events, are summarised in Table 2-1.

The RORB flows were applied to the extended TUFLOW flood model. The model was run for the same range of AEP and storm events as the Kosciusko Avenue Main Drain Catchment Drainage/Flood Study. The resulting flood depths and extents for the 1%, 5% and 20% AEP flood events are shown in Figure 2-1 to Figure 2-3 respectively.

**Table 2-1 Peak flows off site (RORB)**

% AEP	Flow (m <sup>3</sup> /sec)	Critical Storm Duration
1%	2.3	2 hour
5%	1.0	2 hour
20%	0.3	2 and 4.5 hour









**Title:**  
**200 Matthews Road / Plantation Road, Corio**  
**1% AEP Peak Flood Depth - Existing Conditions**

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Approx. Scale

LEGEND	
	Proposed Development
<b>Depth (m)</b>	
	0.00 to 0.10
	0.10 to 0.25
	0.25 to 0.50
	0.50 to 1.00
	> 1.00

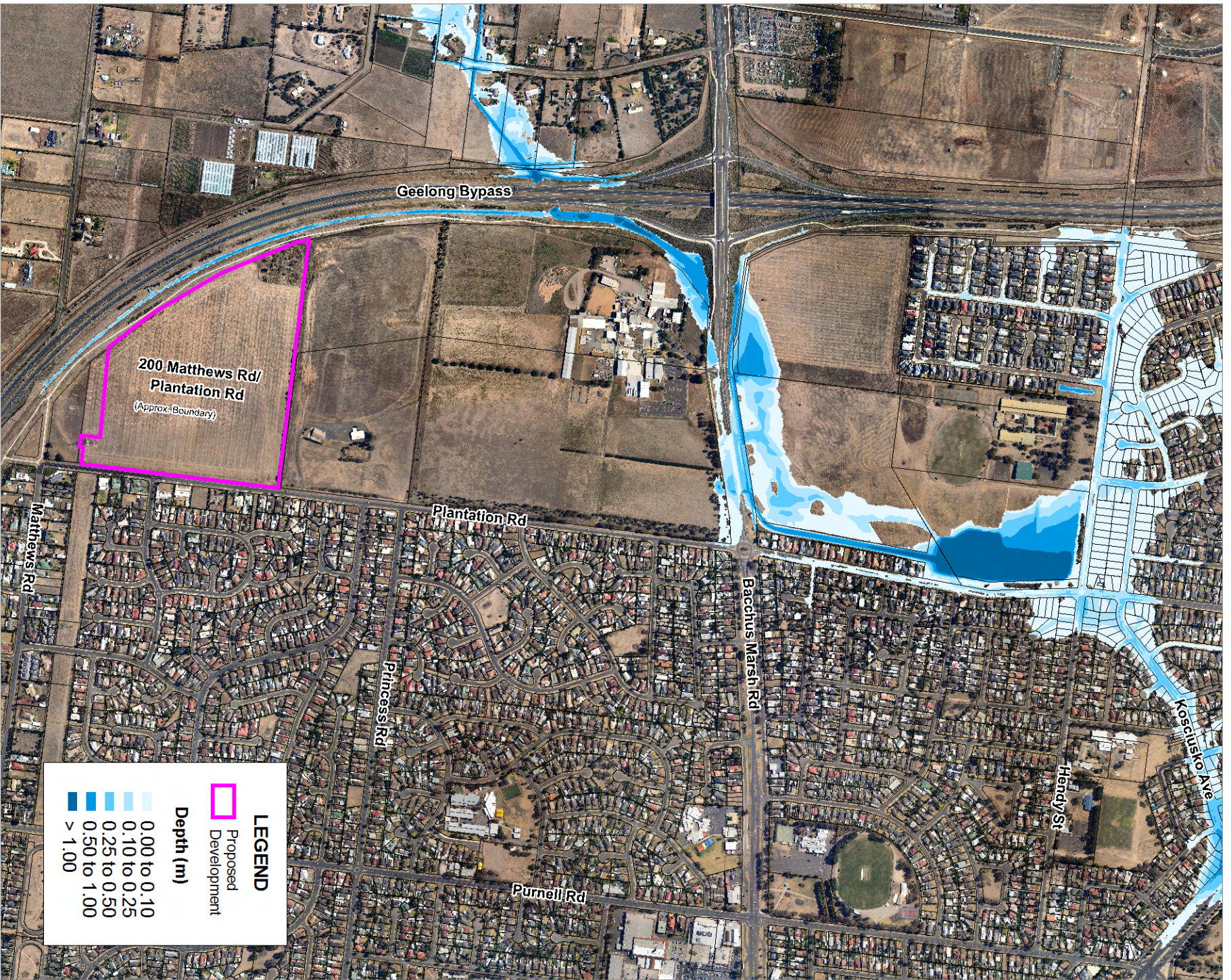
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**BMT WBM**





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**LEGEND**

 Proposed Development

**Depth (m)**

-  0.00 to 0.10
-  0.10 to 0.25
-  0.25 to 0.50
-  0.50 to 1.00
-  > 1.00

**Title:**  
**200 Matthews Road / Plantation Road, Corio**  
**5% AEP Peak Flood Depth - Existing Conditions**

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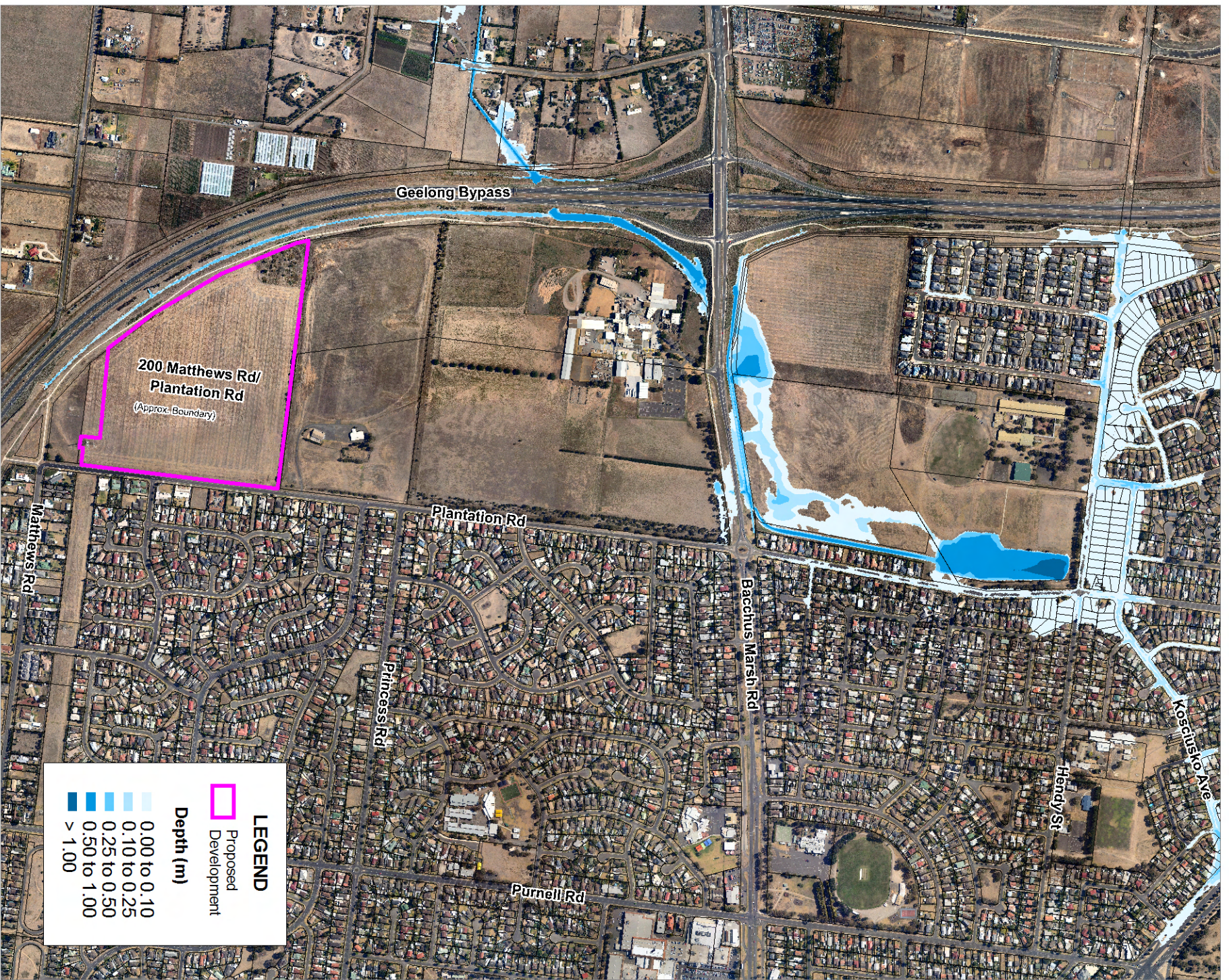
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Title:

**200 Matthews Road / Plantation Road, Corio**  
**20% AEP Peak Flood Depth - Existing Conditions**

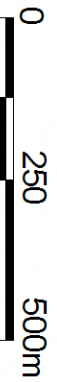
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## 2.4 Developed Conditions

The current proposed development layout is illustrated in Figure 1-2. Based on advice from the civil designers/planners, the layout includes up to 298 residential allotments, 2 integrated medium density sites and public open space. The proposed densities are no greater than approximately 16 lots/hectare, with lot sizes ranging from approximately 330 m<sup>2</sup> to 670 m<sup>2</sup>. The average estimated lot size is approximately 450 m<sup>2</sup>. These densities and lot sizes were used to determine a fraction impervious (FI) value for use in the RORB model of developed conditions. While the proposed densities may alter as part of future detailed design, providing that the area of medium density development does not significantly increase and that the densities are no greater than approximately 16 lots/hectare, the hydrologic and hydraulic analyses will be considered valid.

The RORB model was updated and run to determine peak flows from the development. The FI value used in RORB for the development was determined using CoGG and Melbourne Water guidance on fraction impervious for different land-uses and lots sizes. Based on the lot sizes, a fraction impervious of 75% was determined. This value was incorporated into the RORB model, which was re-run to assess the change in runoff from the site. The developed case peak flows are summarised in Table 2-2.

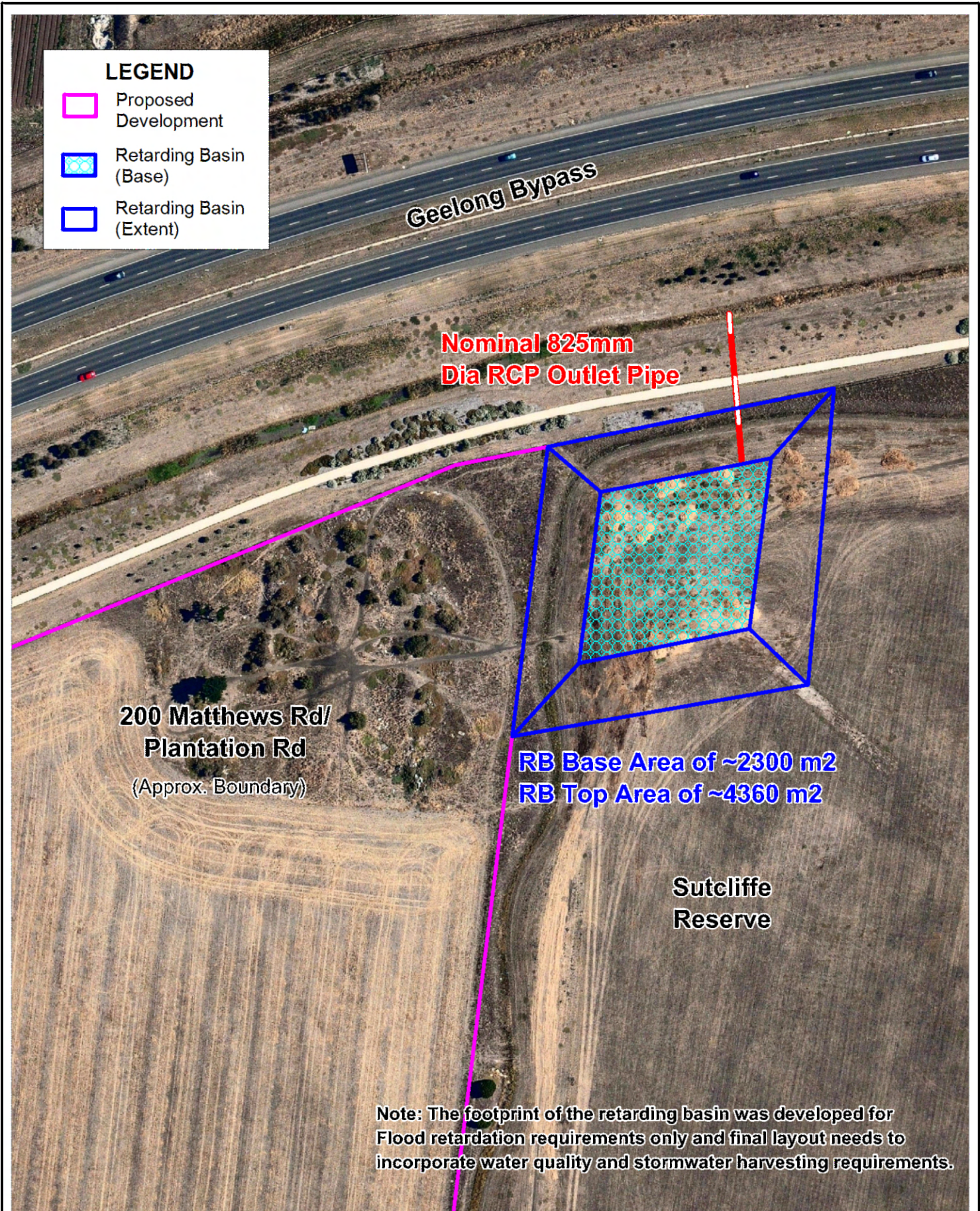
**Table 2-2 Peak flows off site (RORB: Developed Conditions)**

% AEP	Flow (m <sup>3</sup> /sec)	Critical Storm Duration
1%	5.0	15 min
5%	3.1	30 min
20%	1.9	2 hour

A comparison between the flow rates in Table 2-2 and Table 2-1 illustrates that the peak flows from the site have increased under developed conditions, as expected. To limit the peak flows back to existing conditions, a conceptual retarding basin was sized using RORB. The details of the retarding basin are summarised in Table 2-3, with the layout of the basin illustrated in Figure 2-4.

**Table 2-3 Details of conceptual retarding basin**

Item	Details
Base of the storage: Level	Approx. 18.1 m AHD
Base of the storage: Dimensions height x width (area)	Approx. 48 m x 48 m (2300 m <sup>2</sup> )
Side slopes	Assumed 1 in 5
Top of the storage: Embankment Level	19.9 m AHD
Top of the storage: Dimensions height x width (area)	Approx. 66 m x 66 m (4360 m <sup>2</sup> )
Outlet (approx. dimensions)	825 mm diameter RCP. Upstream IL = 18.1 m AHD, downstream IL = 17.96 m AHD, slope ~ 1 in 300, length 43 m.



**LEGEND**

- Proposed Development
- Retarding Basin (Base)
- Retarding Basin (Extent)

**Geelong Bypass**

**Nominal 825mm  
Dia RCP Outlet Pipe**

**200 Matthews Rd/  
Plantation Rd**  
(Approx. Boundary)

**RB Base Area of ~2300 m<sup>2</sup>  
RB Top Area of ~4360 m<sup>2</sup>**

**Sutcliffe  
Reserve**

**Note: The footprint of the retarding basin was developed for Flood retardation requirements only and final layout needs to incorporate water quality and stormwater harvesting requirements.**

Title: <b>Conceptual Retarding Basin Layout</b>		Figure: <b>2-4</b>	Rev: <b>A</b>
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The hydraulic performance of the retarding basin was tested using the TUFLOW flood model. The model was run for the nominated AEP events and storm durations. The resulting changes in flood depths (impacts) were determined and mapped. The impacts for the 1%, 5% and 20% AEP flood events are shown in Figure 2-5 to Figure 2-7 respectively.

Each figure's legend describes the impacts based on a colour coding system. Yellow represents what are considered to be negligible impacts, while green and pink areas are decreases in flood level. The figures do not show the flood extent within the rezoned property as it would be subject to internal drainage design and specific changes to the site topography required to contain the sites runoff and discharge it to the retarding basin. The modelling undertaken takes into account the increased runoff from the site, and applies it to the proposed RB in the hydraulic model. The specific results are discussed below.

The 1% AEP impacts are shown in Figure 2-5. From the figure it can be seen that the impacts are generally within the negligible range, -0.03 m to 0.03 m. There is also a section of the table drain from the site east toward Bacchus Marsh Road that has reductions in flood levels of up to ~0.15 m. The reductions are a result of the efficacy of the RB at reducing developed flows below existing flow conditions. From the modelling, the following was observed:

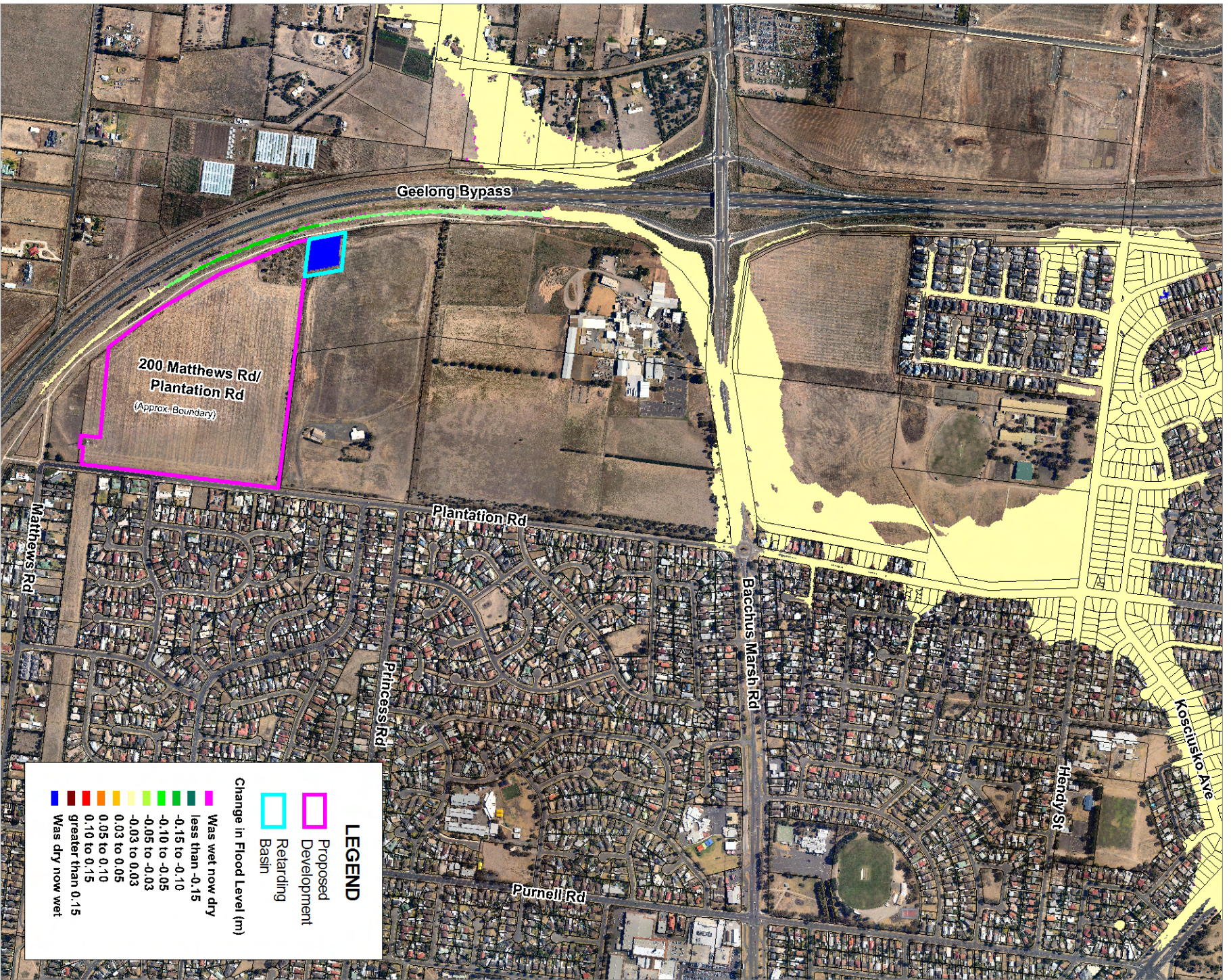
- Peak developed flows from the site/RB were ~1.2 m<sup>3</sup>/s. The peak flowrate under existing conditions was ~2.3 m<sup>3</sup>/s (RORB)
- Peak water level in the RB was ~19.48 m
- Peak stored volume in the RB was ~4230 m<sup>3</sup>

The 5% AEP impacts are shown in Figure 2-6. From the figure it can be seen that the impacts are generally within the negligible range, -0.03 m to 0.03 m. There is also a section of the table drain from the site east toward Bacchus Marsh Road that has reductions in flood levels of up to ~0.10 m. The reductions are a result of the efficacy of the RB at reducing developed flows below existing flow conditions. From the modelling, the following was observed:














- Peak developed flows from the site/RB were ~0.9 m<sup>3</sup>/s. The peak flowrate under existing conditions was ~1.0 m<sup>3</sup>/s (RORB)
- Peak water level in the RB was ~19.09 m
- Peak stored volume in the RB was ~2800 m<sup>3</sup>

The 20% AEP impacts are shown in Figure 2-7. From the figure it can be seen that the impacts are generally within the negligible range, -0.03 m to 0.03 m. The levels within the Plantations Road RB have nominally gone up by 0.06 m. There is also a section of the table drain from the site east toward Bacchus Marsh Road that has increased by up ~0.10 m. **These increases would be overcome by further retarding the flows using a staged outlet structure.** From the modelling, the following was observed:

- Peak developed flows from the site/RB were ~0.6 m<sup>3</sup>/s. The peak flowrate under existing conditions was ~0.3 m<sup>3</sup>/s (RORB)
- Peak water level in the RB was ~18.82 m
- Peak stored volume in the RB was ~ 1930 m<sup>3</sup>



**LEGEND**

	Proposed Development
	Retarding Basin
<b>Change in Flood Level (m)</b>	
	Was wet now dry
	less than -0.15
	-0.15 to -0.10
	-0.10 to -0.05
	-0.05 to -0.03
	-0.03 to 0.03
	0.03 to 0.05
	0.05 to 0.10
	0.10 to 0.15
	greater than 0.15
	Was dry now wet

**Title:**  
**200 Matthews Road / Plantation Road, Corio**  
**Impact on 1% AEP Peak Flood Level**

**Figure:** 2-5  
**Rev:** A

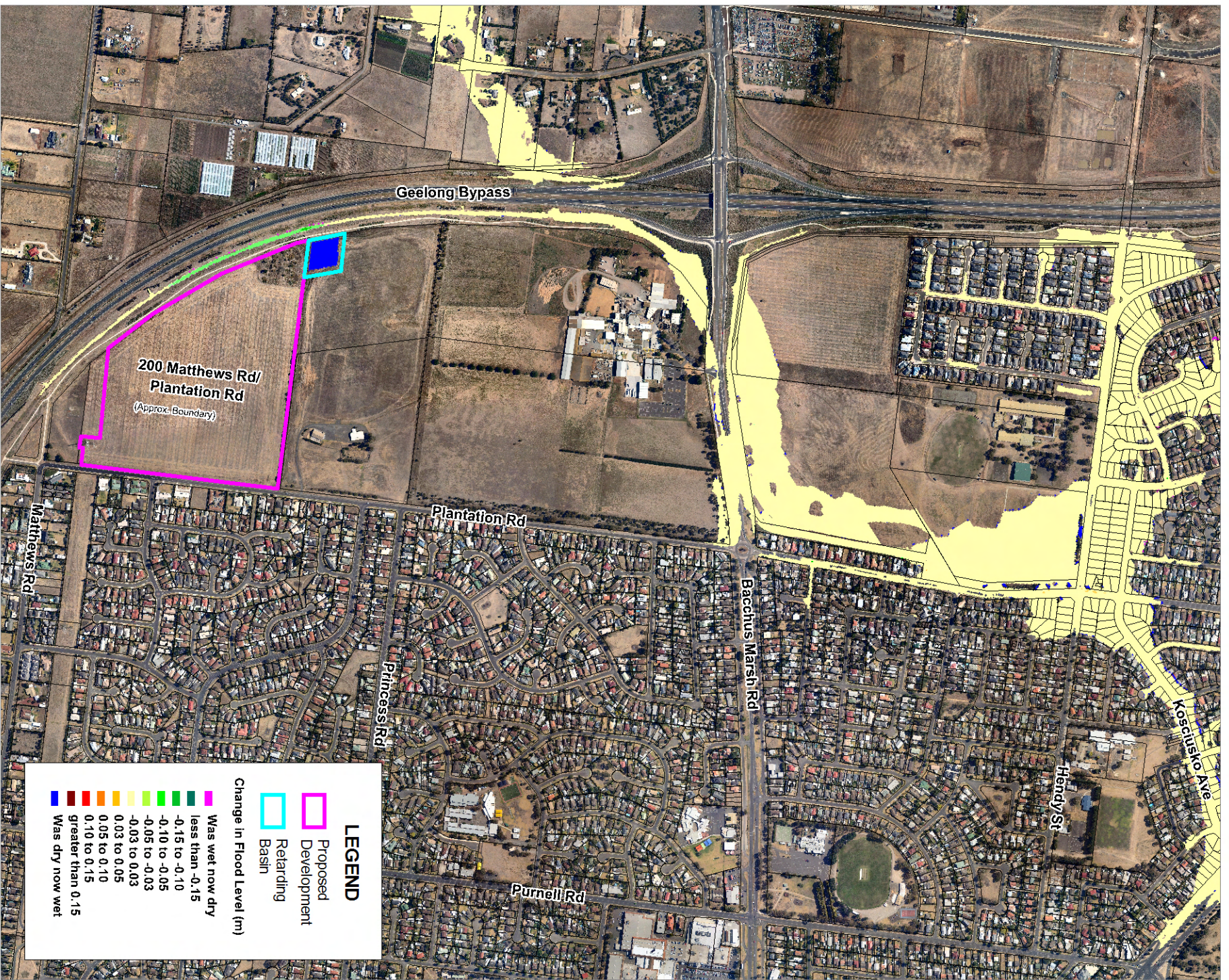
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**LEGEND**

	Proposed Development Retarding Basin
	Basin

**Change in Flood Level (m)**

	Was wet now dry
	less than -0.15
	-0.15 to -0.10
	-0.10 to -0.05
	-0.05 to -0.03
	-0.03 to 0.03
	0.03 to 0.05
	0.05 to 0.10
	0.10 to 0.15
	greater than 0.15
	Was dry now wet

**Title:**  
**200 Matthews Road / Plantation Road, Corio**  
**Impact on 5% AEP Peak Flood Level**

**Figure:** 2-6  
**Rev:** A

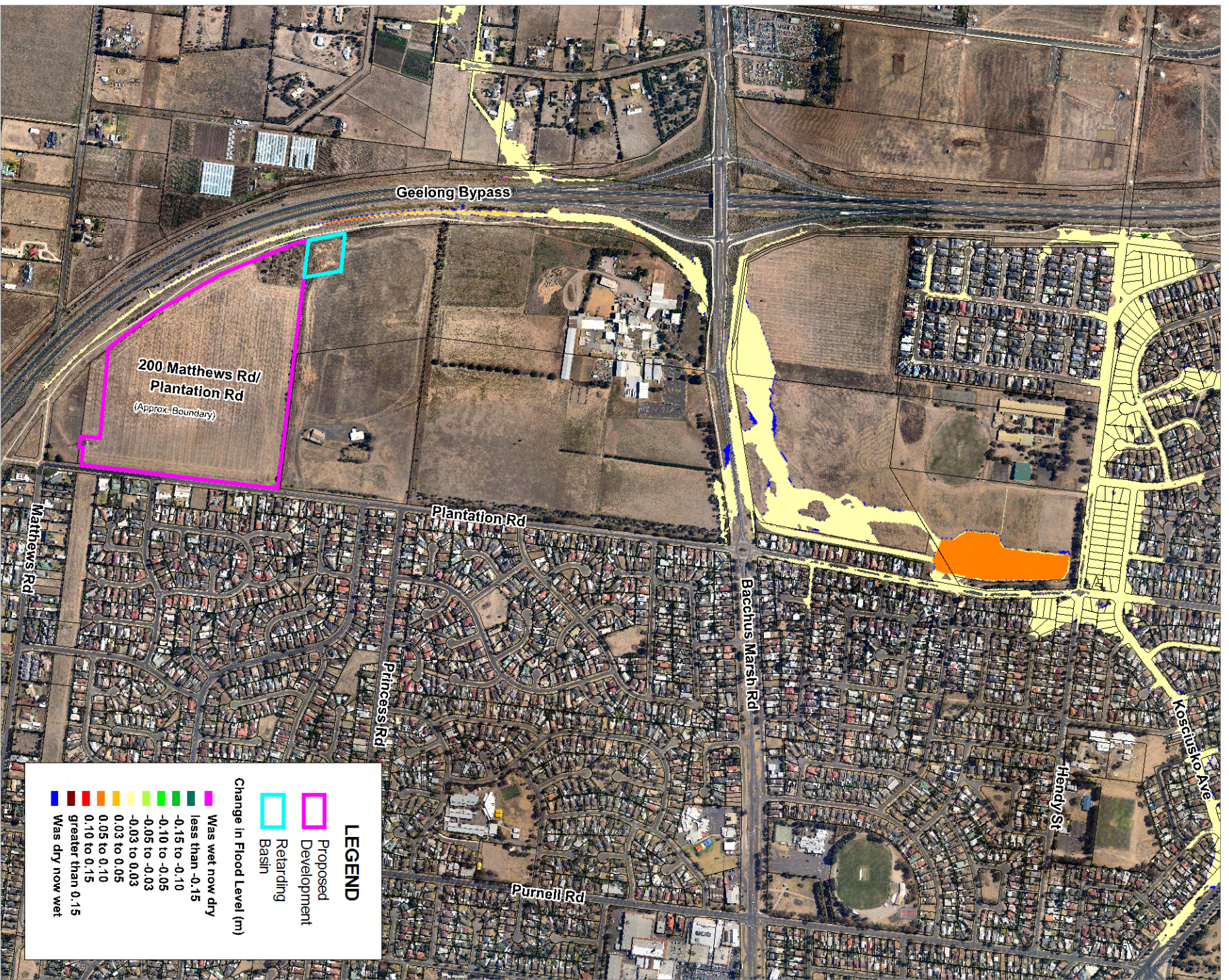
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**LEGEND**

	Proposed Development
	Retarding Basin

**Change in Flood Level (m)**

	Was wet now dry
	less than -0.15
	-0.15 to -0.10
	-0.10 to -0.05
	-0.05 to -0.03
	-0.03 to 0.03
	0.03 to 0.05
	0.05 to 0.10
	0.10 to 0.15
	greater than 0.15
	Was dry now wet

**Title:**  
**200 Matthews Road / Plantation Road, Corio**  
**Impact on 20% AEP Peak Flood Level**

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**Figure:**  
**2-7**

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## 3 WATER YIELD ASSESSMENT

### 3.1 Overview

A stormwater harvesting yield assessment has been undertaken to confirm:

- Whether it is feasible, from a stormwater quantity perspective, for stormwater runoff from the development at 200 Matthews Road to be captured, stored and harvested to supply irrigation to the proposed sporting ovals upon Sutcliffe Reserve.

It is understood that:

- Council are interested in harvesting stormwater to irrigate proposed ovals at Sutcliffe Reserve;
- The required irrigation volume is 4.5 ML/y to a high level of reliability;
- A wetland / harvesting pond will potentially be located upon Sutcliffe Reserve and will receive inflows from the 200 Matthews Road development.

A description of the methodology and detailed description of yield assessment results is described below.

### 3.2 Methodology

#### 3.2.1 Climate File

Daily time-step rainfall and pan evaporation data for Geelong was obtained for the period 1900 – 2008. The data were obtained from SILO data drill ([www.derm.qld.gov.au](http://www.derm.qld.gov.au)) and had an average annual rainfall of 553 mm and pan evaporation of 1325 mm.

#### 3.2.2 Climate change

As a conservative approach, the rainfall and evaporation series have been adjusted to consider the impact of climate change upon yield by considering a 50th percentile ('best estimate') impact on rainfall and evaporation due to climate change in the year 2070. These estimates are derived from IPCC carbon emission projections and climate models and further information can be found at <http://www.climatechangeinaustralia.com.au>. The resultant time series has an average annual rainfall of 505 mm and pan evaporation of 1442 mm.

The daily rainfall and evaporation series were uniformly adjusted as described in Table 3-1.

**Table 3-1 Climate change adjustment factors**

Season	Rainfall	Evaporation
Summer	-7.5%	+6%
Autumn	-3.5%	+10%
Winter	-7.5%	+14%
Spring	-15%	+10%

It should be noted that this climate change assessment does not consider the uncertainties associated with climate change (and the potential impacts on yield); however, the approach is conservative in that:

- It considers climate change impacts (rather than historical rainfall and evaporation)
- It considers the year 2070 (rather than the years of 2030 and 2050 which are offered by <http://www.climatechangeinaustralia.com.au>)
- The climate projections for the years 2030 and 2050 are likely to show reduced increases in evaporation and decreases in rainfall, and hence less adverse impact on yield compared to the year 2070.

For these reasons, the approach adopted here can be considered as a 'worst case scenario' and therefore appropriately considers the risk of climate change impacting upon yield.

### 3.2.3 Rainfall Runoff modelling

In lieu of local information regarding estimates of runoff, a rainfall runoff model was developed using recommended MUSIC parameters for Melbourne (MUSIC User Manual, 2011). These values are shown in Table 3-2 below.

**Table 3-2 Recommended MUSIC parameters**

Source Node Parameters	Value
Rainfall Threshold	1
Soil Storage Capacity (mm)	30
Initial Storage (% of Capacity)	30
Field Capacity (mm)	20
Infiltration Capacity Coefficient-a	200
Infiltration Capacity Exponent-b	1
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	5
Daily Deep Seepage Rate (%)	0

### 3.2.4 Irrigation Demand

A daily time series of irrigation was developed by calculating the deficit between rainfall and evaporation and uniformly multiplying this time series to achieve an average annual irrigation volume of 4.5 ML/y.

## 3.3 Yield Assessment Results

The resultant rainfall runoff model produced an average annual runoff volume of 59 ML/y, with an Annual Volumetric Runoff Coefficient (AVRC), i.e. the average annual volume of runoff divided by the average annual volume of rainfall, of 0.59. This value is consistent with estimations of AVRC for similar rainfall and fraction impervious values as described in Fletcher et al. (2004).

Water balance modelling indicates that the required 4.5 ML/y irrigation volume can be achieved to a high reliability. There is also potential to harvest greater volumes to a high level of reliability if so desired. Figure 3-1 and Figure 3-2 describe the relationship between pond area, drawdown depths, yield and volumetric reliability.

A volumetric reliability of 100% can be achieved for ponds in the order of 2500 m<sup>2</sup> for a pond with a depth of 2 metres and an allowable drawdown level of 1 metre (Figure 3-1). This area is equivalent to approximately 1.3% of the upstream area (wetlands typically require in the order of 2-4% of the upstream area to meet best practice guidelines for water quality). Very high reliabilities (i.e. >95%) can be achieved for pond sizes in the order of 750 m<sup>2</sup> and greater (Figure 3-1).

If the pond/wetland is assumed to have a depth of 1 metre, an area of 2000 m<sup>2</sup>, the drawdown level required to achieve 100% volumetric reliability is in the order of 0.8 m. Very high reliabilities (i.e. >95%) can be achieved for drawdown levels greater than 0.4 m (Figure 3-2).

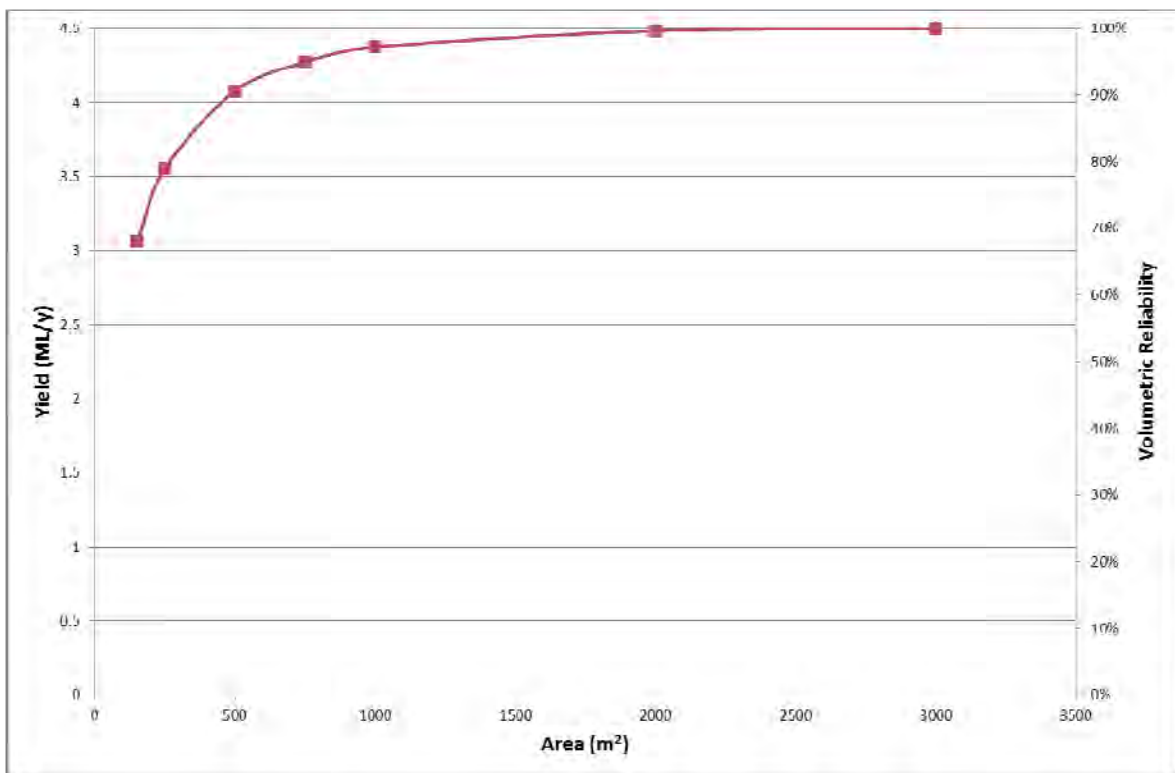


Figure 3-1 Yield versus Area (for pond depth of 2 metres and drawdown level of 1 metre)

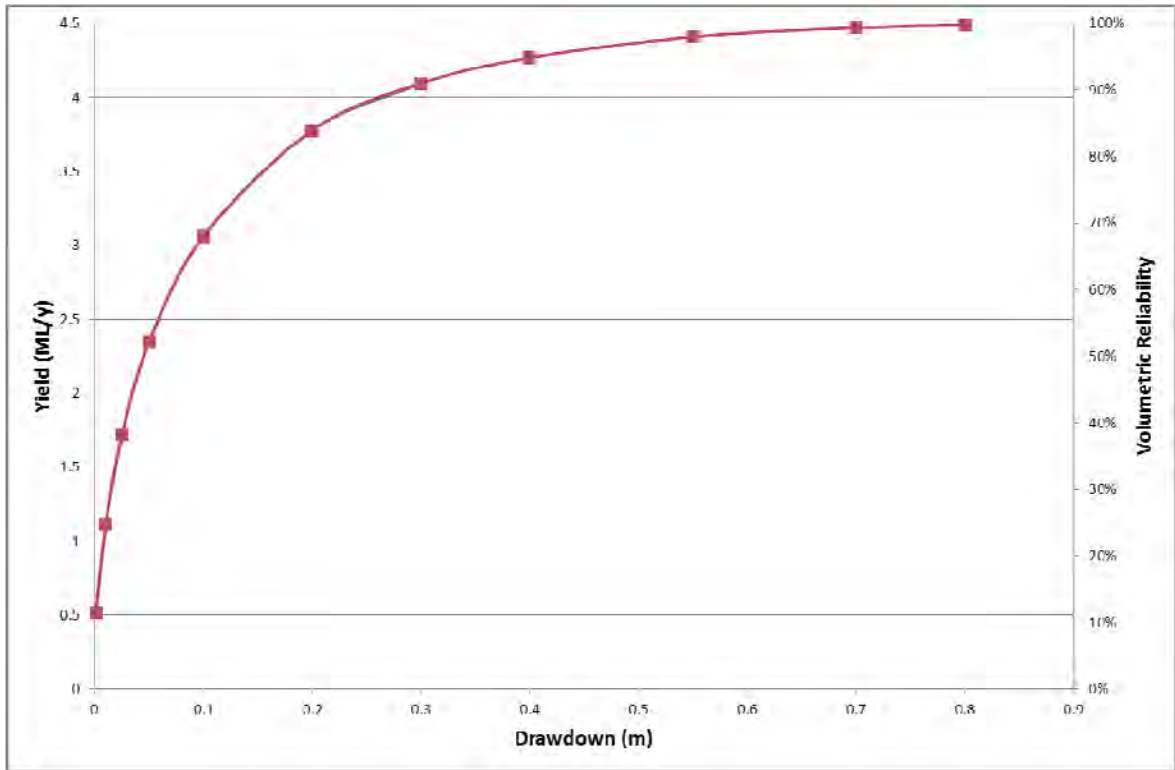


Figure 3-2 Yield versus Drawdown (for pond area of 2000 m<sup>2</sup>)

## 4 CONCLUSIONS

The analyses of the development scenario have been undertaken using comprehensive hydrological and hydraulic computer models. The results of the rezoning change have been assessed with these models, and a potential mitigation solution identified. The modelling results demonstrate that there are generally either negligible changes to flooding, or reductions in flooding. Minor increase in flood levels during the 20% AEP event have been predicted, however these are expected to be eliminated by the addition of a wetland into the retarding basin and associated design of a staged outlet structure to further attenuate low flow rates and provide for extended detention (typically a storage 0.25 m to 0.5 m deep). It is recommended that the final RB and wetland design be tested using the hydraulic model to verify negligible impacts.

The analyses of the RB has been undertaken to demonstrate that there is a feasible solution for the development scenario. Further assessment would be undertaken as part of any subsequent detailed design, and the assumed RB volume and outlet size adjusted accordingly.

The water yield assessment confirmed that the target minimum yield of 4.5 ML/y can be harvested to a high reliability. A storage pond in the order of 2000 m<sup>2</sup> and 1 m depth would suffice to provide a volumetric reliability of greater than 95%. It should be further added that there is potential to harvest greater volumes to a high reliability if so desired.

The water harvesting storage would need to be designed to also accommodate both the water quality and retardation requirements for the site. The exact configuration would need to be determined following further discussions with CoGG regarding their stormwater harvesting yield requirements.

## 5 REFERENCES

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