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BARWON REGION WATER CORPORATION

69B HARVEY STREET, ANGLESEA

SITE STORMWATER MANAGEMENT PLAN

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1. EXECUTIVE SUMMARY

TGM Group Pty Ltd has been engaged by Barwon Region Water Corporation to provide a Site Stormwater Management Plan (SSMP) to address the stormwater management for the existing seven (7) lots at 69B Harvey Street, Anglesea.

The subject site is a 6,647 m^2 land parcel currently situated within the residential precinct of Anglesea. The subject land historically formed part of Barwon Water's water supply infrastructure and acted as a holding basin to supply potable water to the Anglesea Township. Barwon Water has decommissioned the existing basin and now wishes to have the land rezoned to allow development of the existing titles.

The proposed subdivision will result in a percentage increase in impervious surfaces resulting in an increase in stormwater runoff volumes. The following site stormwater management plan (SSMP) provides guidance on future stormwater mitigation processes required to support such a development.

The objective of the stormwater management plan is to meet the conditions and requirements, set out by the Surf Coast Shire (SCS) Council and the planning application for stormwater management. Stormwater mitigation systems are designed to ensure that stormwater quantity targets are met. The targets are:

1. No-worsening stormwater peak discharges

- During a 2 year ARI otherwise known as the 0.5 Exceedance per Year (EY) design storm event.
- Ensure pre-development flows are maintained for a 2 year ARI (0.5 EY) design storm.

The merit of stormwater treatment to water quality Best Practice reductions has been discussed with SCS Council Engineers. Council has advised that stormwater quality objectives will not be enforced and won't be a requirement on the Planning Permit.

Two (2) mitigation options have been considered to analyse the effectiveness of the proposed development to manage stormwater runoff from the developed Harvey Street catchment:

Option 1: Rainwater Tanks for onsite detention (OSD)
Option 2: Upsizing of existing drainage infrastructure for OSD

An integrated systems approach was used to create the stormwater management plan for the development of the proposed development site, located at 69B Harvey Street, by analysing the performance of the stormwater and water cycle management design option. This type of analysis is dependent on detailed inputs including topography, rainfall data, geology, hydrology and sound urban design principles.

The study shows that stormwater generated within the proposed subdivision site can be mitigated to meet stormwater quantity objectives. Stormwater peak discharges generated by a 2 year ARI storm event from the fully developed site can be managed to achieve a 'no-worsening' of pre-development discharges by integrating detention storage into the proposed development.

Rainwater tanks suit the aesthetic of the development and offer a suitable option to provide integrated OSD which helps to mitigate stormwater at its source and relieve pressure on Council drainage infrastructure. TGM recommend the use of 1.19 kL rainwater tanks per lot to account for the 8.3 m^3 detention storage volume required to mitigate stormwater runoff from the proposed developed site.

This report provides an empirical assessment of the proposed development of 69B Harvey Street to show that the stormwater runoff can be effectively managed to ensure no worsening of stormwater peak discharge for a 2 year ARI design storm event.

2. INTRODUCTION

TGM Group Pty Ltd has been engaged by Barwon Region Water Corporation to submit a Planning Scheme Amendment application for the rezoning of land at 69B Harvey Street, Anglesea, from Public Use Zone to General Residential Zone.

The amendment will allow development of the existing underlying (7 lot) subdivision of the site created as part of LP 20002, (Lots 116-122). These lot sizes are consistent with the surrounding low density residential zoning.

TGM Group has developed the following site stormwater management plan (SSMP) in support of the application for the planning scheme amendment to ensure stormwater objectives are achieved.

The subject site is situated within the residential precinct of Anglesea and is located to the southwest of the Anglesea Township, as depicted in Figure 1 below.

Figure 1: 69B Harvey Street Site Location

3. STUDY AREA

3.1 Site Description

The subject site is a 6,647 m^2 land parcel which is described as 69B Harvey Street, Anglesea. The subject land is located approximately 800 m off the Great Ocean Road and has three road frontages; Parker Street, Harvey Street and Sparrow Avenue. The site is irregular in shape with a northern frontage of approximately 200 m, an approximate average depth of 43 m and a southern frontage of 177 m. The site can be seen in Figure 2, below.

Figure 2: 69B Harvey Street (Aerial View)

The subject land (LP20002 lots 116-122) historically formed part of Barwon Water's water supply infrastructure and acted as a holding basin to supply potable water to the Anglesea Township. Barwon Water's operation of the basin ceased approximately 10 years ago when Anglesea's water supply network was connected as part of the broader regional water supply scheme which is supplied form the upper catchment of the Barwon and Moorabool Rivers.

Since the period operation the basin has remained unused and had fallen into disrepair. The basin was characterised as an empty concrete-lined basin that is surrounded on all sides by a cyclone wire fence. The basin is described as being a 'turkeys nest' design and is prominently situated above the levels of Harvey Street and Parker Street. A mixture of native vegetation and introduced plant species populate parts site surrounds and extend to the adjoining road reserves. In early 2016 Barwon Water undertook partial rehabilitation of the basin with filling it to approximately 1m of the top of the basin.

Outside of the basin area, but within the same land unit, the site has also been used as an office (converted dwelling) located on lot 122 LP20002 and sheds for storage. A water pump station which is maintained and operated by Barwon Water is located (lot 122 LP20002) in one of the onsite structures. More recently the CFA has used the sheds for storage of their fire prevention appliances. A telecommunications tower has also been erected for emergency services.

3.2 Catchment Characteristics

The site is situated upon a natural ridgeline which is elevated above most of residential Anglesea. The site is located at the top of the catchment and has no external contributing catchments. The natural topography of the site indicates a downhill grade from Harvey Street to Parker Street. Existing site levels range from approximately 94.6 m AHD to 93.0 m AHD. Refer Figure 3.

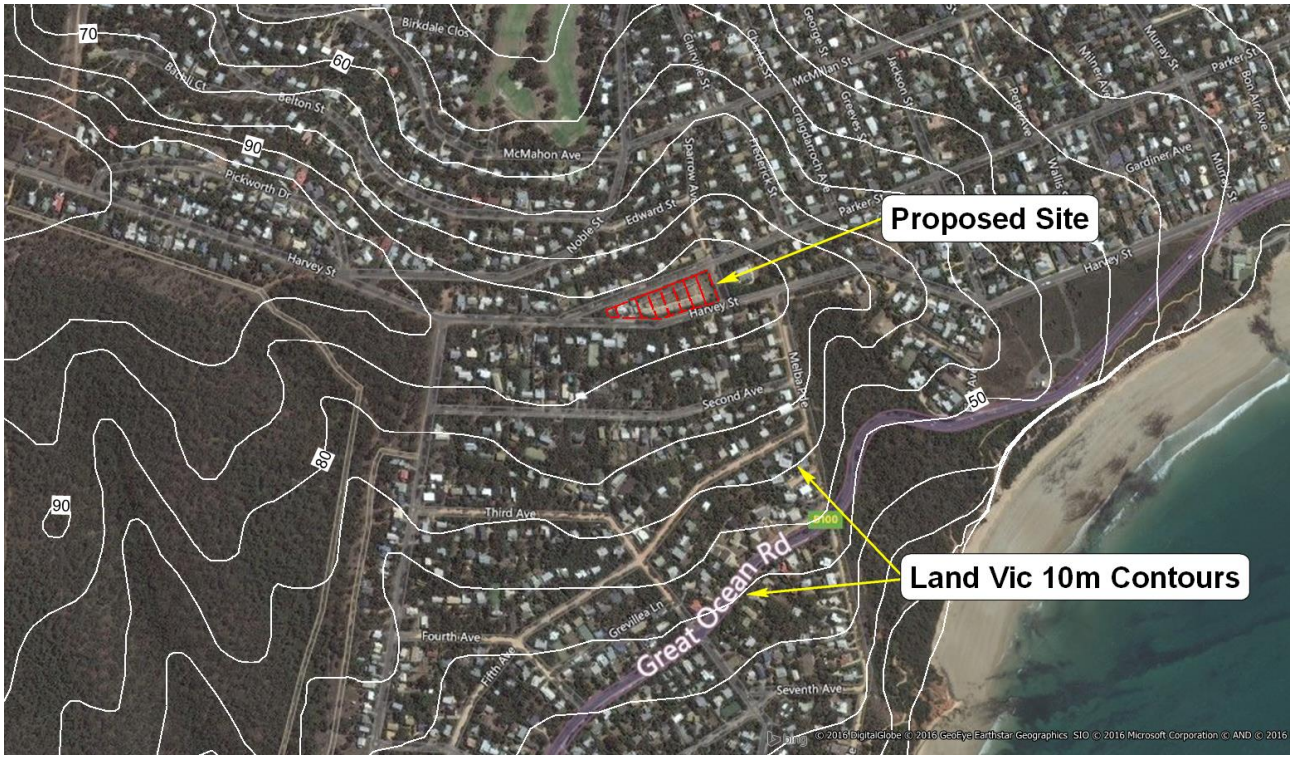


Figure 3: 42 Catchment Characteristics

The surrounding catchment is predominantly urban residential in the form of General Residential (GRZ) with nearby pockets of public conservation and special use zones. Neighbouring properties have been long established and mostly comprise detached housing on relatively large (approximately 1,000 m^2) residential titles.

3.3 Stormwater Catchments

3.3.1 Existing Site

The overall existing site forms a single catchment which contributes stormwater to the downstream environment. The existing catchment is shown in Figure 4 and detailed in Table 3.1.

Figure 4: Existing Site Discharge Locations

Table 3.1: Existing Catchment Details

Catchment	Area (m^2)	Point of Discharge
69B	6,647	Parker Street drainage network

TGM Group has undertaken detailed survey of the site and the internal catchment area and overland flow path are confirmed. The feature survey is depicted in Figure 5.

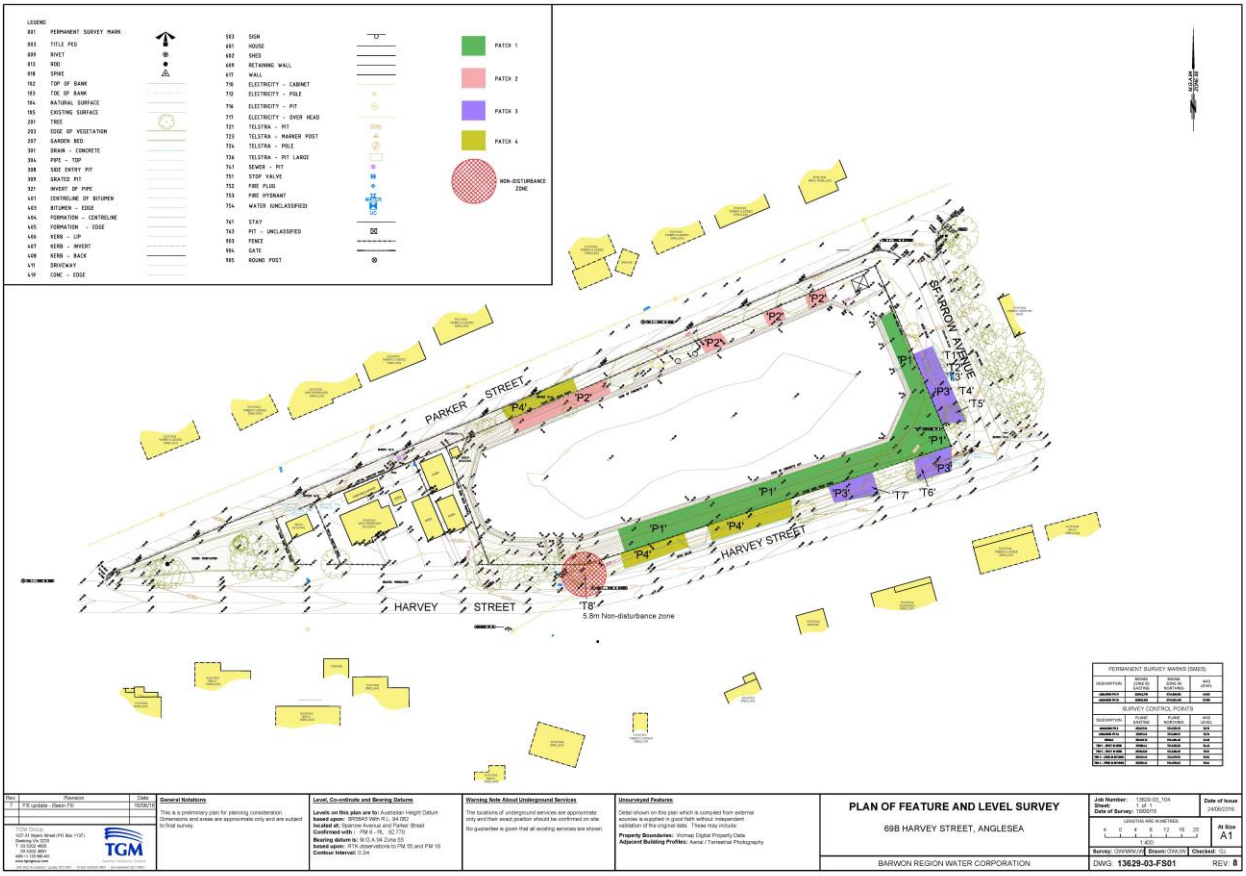


Figure 5: Feature Survey Plan (Drawing 13629-03-FS01)

Catchment 69B consists of the decommissioned water supply facility which includes a concrete-lined basin, overgrown vegetated areas and building structures. The building structures make up approximately 5% of the total catchment area.

Discussion was held with the Council Engineer on 14 August 2015 **[David Stacey, 2015[1]]** to determine a suitable method of assessing existing conditions runoff for the purpose of calculating a predevelopment flow rate. It was established that a percentage impervious equivalent to low density residential can be adopted for the site to accurately represent these calculations.

Details of the existing catchment are shown in Table 3.2.

Table 3.2: Existing Site

Lot	Area (m^2)	Land Use	Percentage Impervious (%)	Pervious Area (m^2)	Impervious Area (m^2)
69B	6,647	Public Use *(Equivalent – Low Density Residential)*	30	4,653	1,994

[1] Stacey, D. 2015. [69B Harvey Street stormwater objectives] (personal communication, 14 August)

3.3.2 Developed Site

The existing concrete-lined basin will be decommissioned and backfilled to geotechnical specification prior to development. The site will be levelled to match existing road levels. The proposed development will grade to Parker Street. Stormwater generated within the developed lots will be picked up by the Parker Street drainage system. The developed layout is depicted in Figure 6.

Figure 6: Developed Site Layout Plan

The proposed rezoning of the development site to General Residential Zone (GRZ1) will result in higher density land use than the current use. Proposed lot sizes range from 800 m² to 1012 m². With an average lot size of 915 m² (excluding reserve) the proposed development will be classified as having a moderate range of densities[2]. The proposed developed catchment is detailed in Table 3.3.

Table 3.3: Developed Catchments

Catchment	Area (m^2)	Land Use	Percentage Impervious (%)	Pervious Area (m^2)	Impervious Area (m^2)
Developed	6,647	Residential (GRZ1)	45	3,656	2,991

The existing subdivision will increase the amount of impervious surfaces within the 6,647 m^2 site by approximately 45%. The total impervious area will be approximately 2,991 m^2.

The increase in impervious surfaces results in a decrease in stormwater infiltration; this creates an increase in the stormwater runoff volumes, velocities and pollutant loads being generated within the site.

[2] MUSIC Guidelines. *Recommended input parameters and modelling approaches.* Melbourne Water Corporation, December 2010

Stormwater mitigation measures will be required to counteract the impact of the proposed development upon the downstream catchments and receiving environment. The Council infrastructure Development Department has been engaged to discuss proposed mitigation measure. Resulting stormwater objectives are discussed in Section 4 of the report.

4. STORMWATER OBJECTIVES

The objective of the stormwater management plan is to meet the conditions and requirements set by Surf Coast Shire Council for stormwater management. These requirements ensure that appropriate design and stormwater mitigation is applied to ensure that stormwater quantity targets are achieved and maintained.

Surf Coast Shire Council has been contacted **[David Stacey, 2015]** to discuss specific stormwater objectives in relation to the subject site. The below site stormwater objectives represent Council's preferred stormwater management strategy for the proposed development.

4.1 Site Stormwater Objectives

1. No-worsening stormwater peak discharges

i. Ensure pre-development flows are maintained for a 2 year ARI storm event

Note: The merit of stormwater treatment to water quality Best Practice reductions has been discussed with Council. Water quality treatment of a relatively small top-of-line catchment will have nominal impact on the receiving environment. Council has advised **[David Stacey, 2015]** that stormwater quality objectives will not be enforced and won't be a requirement on the Planning Permit.

5. METHODOLOGY

To create the stormwater management plan for the site, an integrated systems approach was used to analyse the performance of a range of stormwater and water cycle management options. This type of analysis is dependent on detailed inputs including topography, geology, hydrology and sound urban design principles.

5.1 Topography and existing infrastructure

The topographical data set used in this study to define the site and contributing catchment was composed of VicMap 10 m elevation contours[3], bolstered with detailed TGM ground survey data undertaken 4 May 2015 (refer Figure 5).

The proposed development site contains no significant drainage infrastructure. The overall site discharges to the Parker Street road network before entering the existing underground drainage network. The capacity of the existing drainage system to receive flow from the developed site is controlled by a constriction further downstream **[David Stacey, 2015].** As such, developed flows are to be restricted as per the stormwater objectives outlined in Section 4.

5.2 Geology

A geotechnical investigation of the existing site was conducted by Coffee Geotechnics[4]. Soil type was considered to be comprised of predominantly sand/clayey sand which is generally consistent with the geology of the surrounding region.

Field inspections indicated that the soils are typically an upper layer of sand/clayey sand to about 700 mm on top of a lower layer of moist and very stiff to hard clay.

This motivated the adoption predominantly clayey sand soil type (ILSAX soil type 2, moderate infiltration rates and moderately well drained) in the site hydrologic modelling.

Initial conditions were adopted for the impervious/pervious surfaces to represent the interaction between the land and rainfall runoff that is generated. The initial conditions are identified below in Table 5.1.

Table 5.1: Initial Conditions

	Initial Loss	Continuing Loss
Pervious Surface	20 mm	2.5 mm/hr
Impervious Surface	5 mm	N/A

5.3 Hydrology

It is an objective for this study that the proposed development should maintain the stormwater runoff volume and quantity discharge characteristics of the existing site for the 2 year ARI [0.5 EY] storm event.

5.3.1 Existing Site Hydrology

The assessment of the stormwater runoff characteristics of the existing site was undertaken using the XP-RAFTS hydrology model.

[3] Land Vic website, accessed 19th August 2015. www.land.vic.gov.au

[4] Anglesea – Preliminary Geotechnical Investigation (30th June 2015), Coffee Geotechnics

5.3.2 Validation of Existing Model

The existing hydrology model was validated against the Probabilistic Rational Method (PRM). PRM is suitable for non-developed rural catchments; therefore, the validation model assumes all catchments are undeveloped to determine model input parameters. Once the RAFTS model has been validated, the model is amended to reflect existing conditions. Validation parameters are shown below in Table 5.2.

Table 5.2: Rational Method parameters for development site

Parameter	Value	Notes
Area of internal catchments	6,647 m^2	69B Harvey St
Area of external catchments	N/A	No contributing catchment
C_{10}	0.08	Runoff coefficient
T_c	6.79 minutes	Time of concentration
F2	4.28	Geographical factor for a 6 minute, 2 year ARI
F50	14.79	Geographical factor for a 6 minute, 50 year ARI

Design storms were generated for all storm durations using a skew (G) of **0.45** and temporal pattern region **Zone 1** as defined from Australian Rainfall and Runoff.

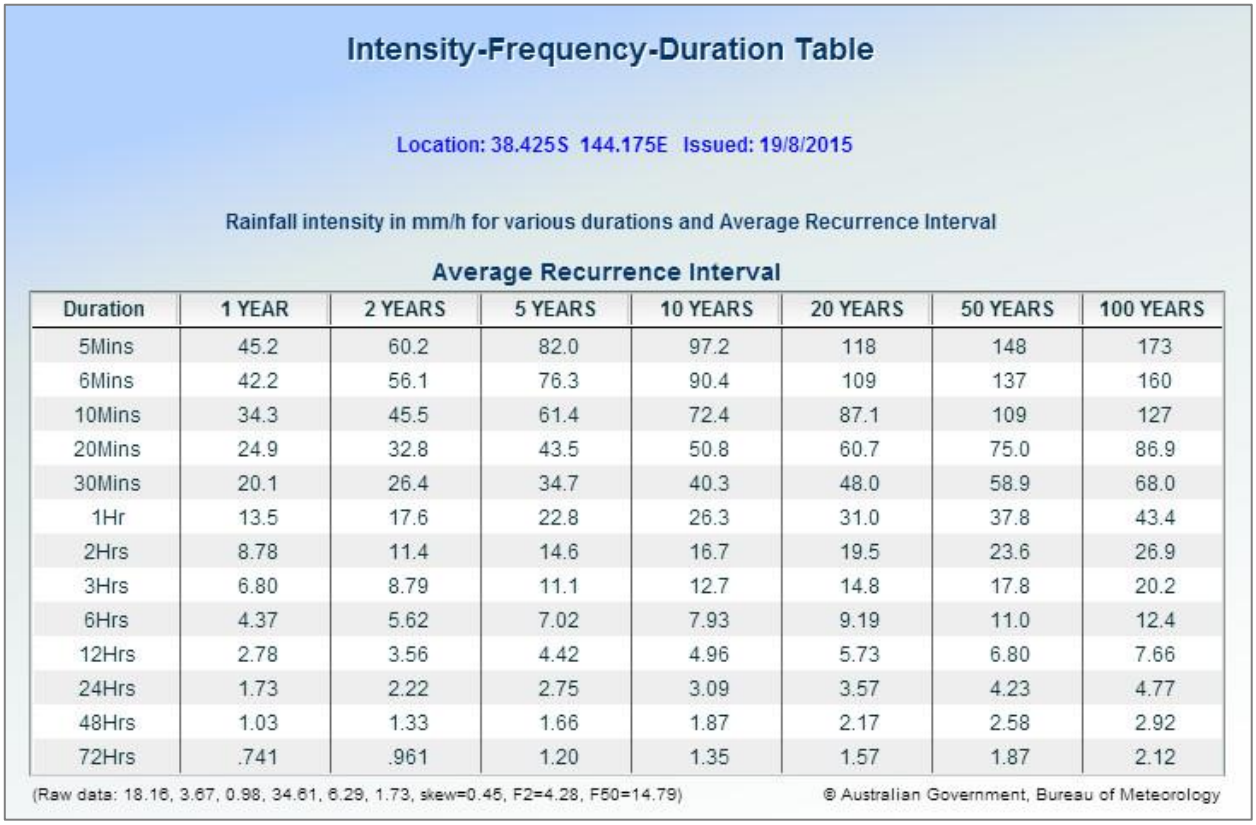
5.3.3 Intensity-Frequency-Discharge (IFD) Data

The intensity frequency duration (IFD) data used in the hydrology model to simulate the performance is shown in Table 5.3.

Table 5.3: IFD data for the Site (69B Harvey Street)

ARI (years)	Rainfall intensity (mm/hour) for a given duration (hours)		
	I_1	**I_{12}**	**I_{72}**
2	18.16	3.67	0.98
50	34.61	6.29	1.73

The resulting IFD table is shown in Figure 7, below:



Intensity-Frequency-Duration Table

Location: 38.425S 144.175E Issued: 19/8/2015

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

Average Recurrence Interval

Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	45.2	60.2	82.0	97.2	118	148	173
6Mins	42.2	56.1	76.3	90.4	109	137	160
10Mins	34.3	45.5	61.4	72.4	87.1	109	127
20Mins	24.9	32.8	43.5	50.8	60.7	75.0	86.9
30Mins	20.1	26.4	34.7	40.3	48.0	58.9	68.0
1Hr	13.5	17.6	22.8	26.3	31.0	37.8	43.4
2Hrs	8.78	11.4	14.6	16.7	19.5	23.6	26.9
3Hrs	6.80	8.79	11.1	12.7	14.8	17.8	20.2
6Hrs	4.37	5.62	7.02	7.93	9.19	11.0	12.4
12Hrs	2.78	3.56	4.42	4.96	5.73	6.80	7.66
24Hrs	1.73	2.22	2.75	3.09	3.57	4.23	4.77
48Hrs	1.03	1.33	1.66	1.87	2.17	2.58	2.92
72Hrs	.741	.961	1.20	1.35	1.57	1.87	2.12

(Raw data: 18.16, 3.67, 0.98, 34.61, 6.29, 1.73, skew=0.45, F2=4.28, F50=14.79)

Figure 7: IFD Table – 69B Harvey St site (Bureau of Meteorology)

The Rational method produced a 2 year ARI (Q_2) peak discharge which was used to validate the RAFTS model process. The validated peak discharges are depicted in Table 5.4.

Table 5.4: Validated Peak Discharges

		Rational	RAFTS Validation	RAFTS Exist
CATCHMENT LOCATION	**AREA (m^2)**	**Q_2 (L/s)**	**Q_2 (L/s)**	**Q_2 (L/s)**
69B Harvey Street	6,647	0.006	0.006	0.032

The RAFTS layout schematic is shown in Figure 8.

Figure 8: RAFTS model schematic layout (Existing Conditions)

The hydrological model is used to identify the requirement for stormwater flow mitigation and enable design of detention facilities to manage peak discharges up to and including the 2 year ARI storm event. Detention systems are designed to ensure pre-development flows are not exceeded.

5.3.4 Developed Site Hydrology

The assessment of the stormwater runoff characteristics of the developed site was undertaken using the XP-RAFTS hydrology model.

5.4 Discharge Target Objectives

The stormwater discharge targets for the developed site are detailed in Table 5.5.

Table 5.5: Permissible Site Discharge target for developed site

Catchment	Discharge (L/s)
	2 year ARI
Permissible Site Discharge Target (Restrict to Pre-developed Flow)	32

6. MITIGATION OPTIONS

Two design options will be assessed to understand how the developed site can achieve satisfactory detention storage as per the stormwater objectives identified in Section 4.

The overall development has a relatively small catchment. The required detention will not be a significant volume. Integration of mitigation facilities as on site detention (OSD) within the development will be ideal to manage stormwater flow close to its source of generation.

6.1 Option 1 – Rainwater Tanks

Rainwater tanks are often used for onsite detention (OSD) purposes on an individual lot basis. The majority of rainfall runoff generated within a residential development is sourced from impervious roof surfaces. Rainwater tanks are installed to collect and detain roof runoff for each lot. OSD systems utilised in this manner help mitigate stormwater at its source and relieve pressure on Council drainage infrastructure.

6.2 Option 2 – Upsize Underground Drainage Infrastructure

Allowance for detention storage in the underground drainage network is common method of OSD for small infill developments. Existing underground drainage infrastructure is located in Parker Street. It is considered unlikely that this system has extra capacity.

Pending further investigation, the existing network on the southern side of Parker Street could be retrofitted with upsized drainage culverts to cater for the required storage volume.

Note: Detention basins are typically designed and constructed to mitigate stormwater flows for regional events. Due to the small storage volume required and the large footprint required for a basin it is infeasible to utilise a basin for a development such as this.

7. RESULTS

The results of the stormwater hydrology analysis are shown in this section. The total onsite detention storage required to ensure that peak discharges from the 2 year ARI (0.5 EY) torm event do not exceed existing conditions and exceed the available capacity of existing infrastructure or negatively impact the receiving environment are presented.

7.1 Hydrology

Design storm events were used to evaluate the stormwater peak discharges generated by the contributing catchment area. A range of design storm events from 10 minute to 2 hour durations were used to assess the impact across the catchment.

The peak discharges from the site for Existing and Developed Condition are discussed in the following section.

7.1.1 Existing Conditions

The existing conditions create a peak discharge of **32 L/s** for the 2 year ARI storm event.

The existing conditions 'base-case' hydrograph is shown in Figure 9.

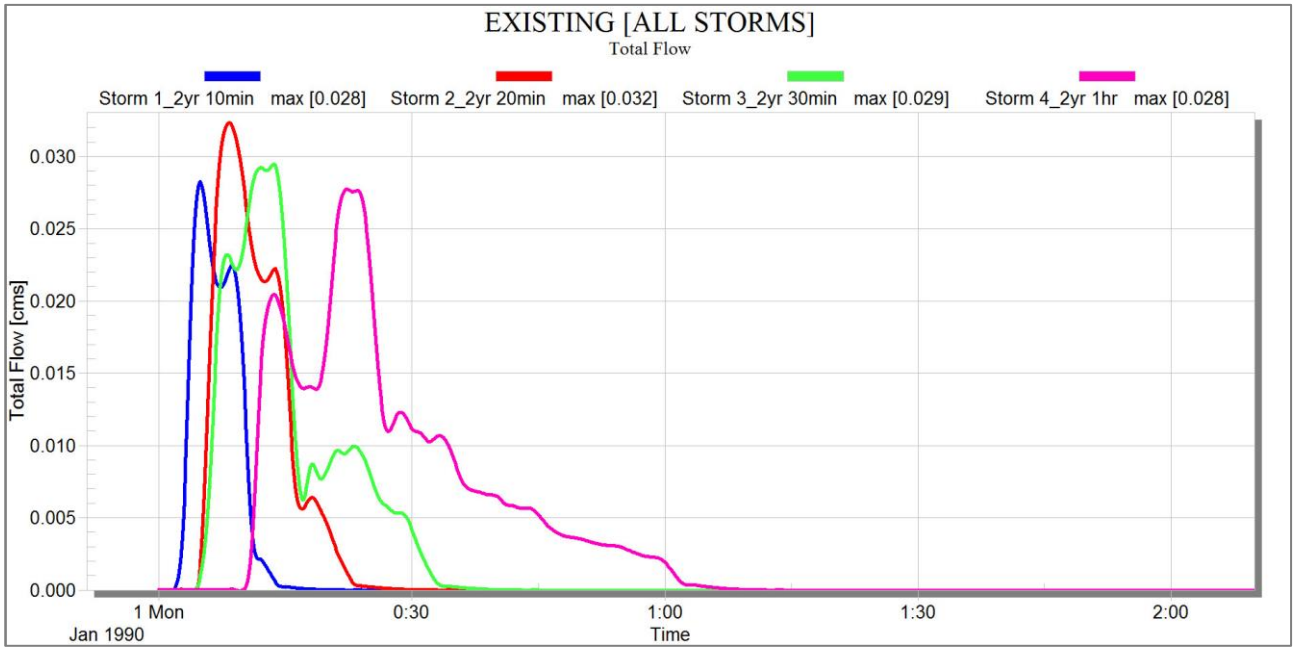


Figure 9: Existing Conditions Discharge Hydrograph (m^3/s)

7.1.2 Developed Conditions (unmitigated)

The developed conditions create a peak discharge of **46 L/s** for the 2 year ARI storm event.

The developed conditions hydrograph is shown in Figure 10.

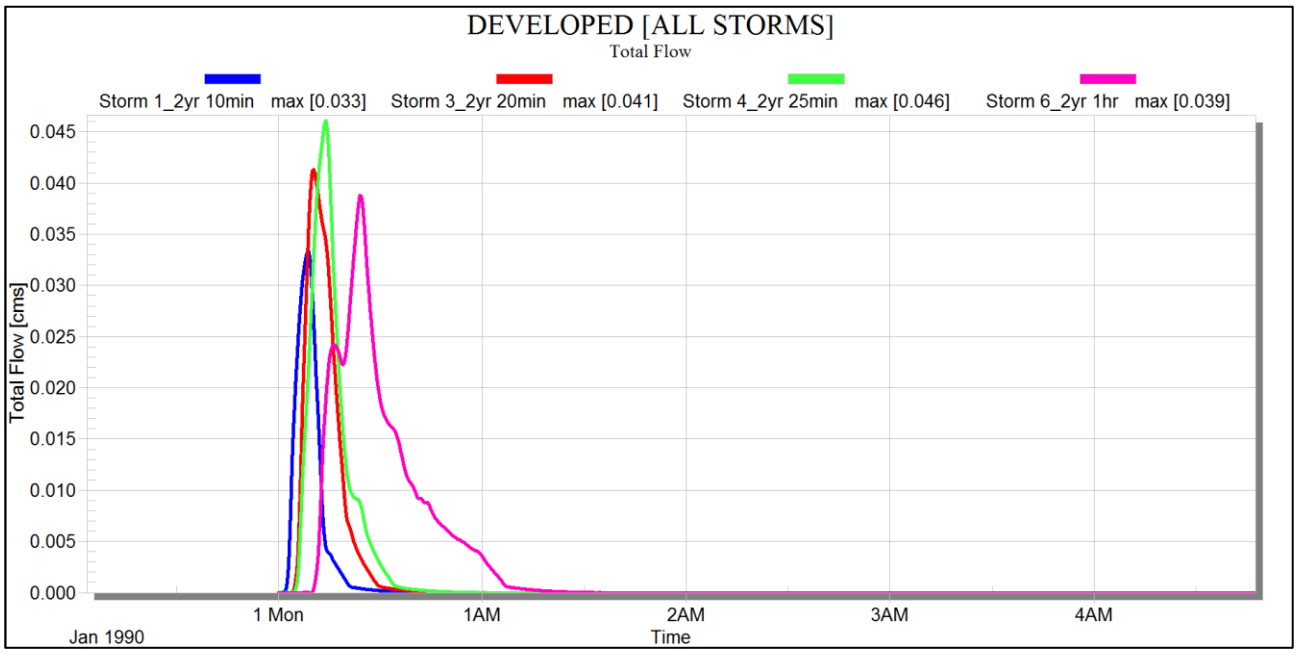


Figure 10: Developed Conditions Discharge Hydrograph (m^3/s)

7.1.3 Detention Storage Requirement

To ensure the developed site can achieve peak discharge objectives, in terms of 'no-worsening' impact over existing condition for a 2 year ARI storm event, detention storage with a volume of **8.3 m³** is required.

The critical storm which generates the maximum detention requirement is a 25 minute duration event. The detention storage graph is shown in Figure 11 below.

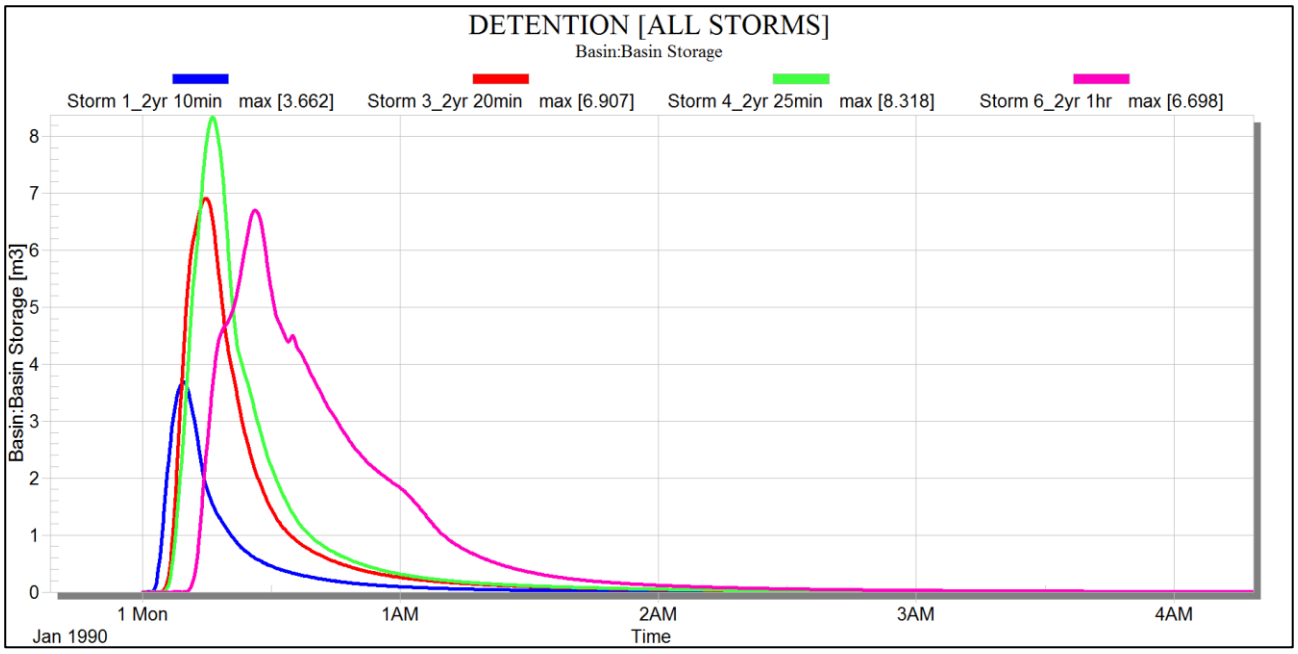


Figure 11: Detention Storage Graph (m^3)

7.1.4 Developed Conditions (mitigated)

The detention outflow graph is shown in Figure 12 below.

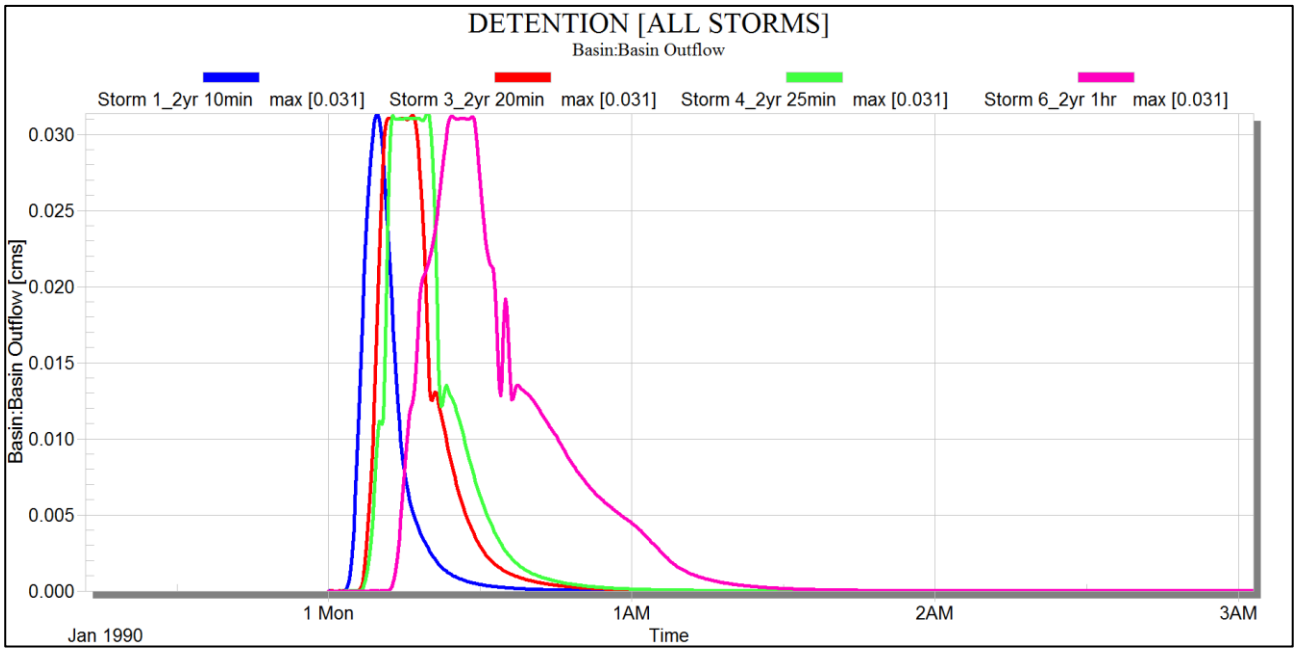


Figure 12: Detention Outflow Graph (m^3/s)

7.2 Mitigation Option Requirement

7.2.1 Option 1 – Rainwater Tanks

The 69B Harvey Street development comprises 7 proposed lots. The required detention storage for the total development is 8.3 m^3. Rainwater tanks with a minimum volume of 1,190 litres (1.19 kL) will be required for each lot to satisfy the detention requirement for the development.

Rainwater tanks will allow stormwater runoff to be mitigated close to its source of generation. Implementation of rainwater tanks for OSD will support 'no worsening' of stormwater runoff for a 2 year ARI storm event.

7.2.2 Option 2 – Upsize Underground Drainage Infrastructure

Incorporation of detention storage in the underground drainage network will require upsizing of the drainage infrastructure on the southern side of Parker Street. The required detention storage volume for the total development is 8.3 m^3. Based on preliminary calculations approximately 60 m of 675 mm diameter culvert infrastructure would be required to achieve suitable mitigation. A discharge control pit would be constructed to restrict flows into the existing infrastructure.

The underground drainage infrastructure will act as end-of-line detention treatment. Implementation of underground culverts for OSD will support 'no worsening' of stormwater runoff for a 2 year ARI storm event.

8. CONCLUSION

The report shows that stormwater peak discharges generated by a 2 year ARI storm event from the fully developed site can be managed to achieve a 'no-worsening' outcome when compared to existing conditions. Mitigation involves the use of rainwater tanks for OSD to control the rate of discharge from the developed site. Water quantity has been analysed using the hydrology model XP-RAFTS.

A summary of the stormwater management targets is shown in Table 8.1.

Table 8.1: Summary of hydrology model results

	Existing Condition (2yr ARI)	Developed Condition (2yr ARI)	Total Storage	Developed Condition (2yr ARI)
Stormwater Management Summary	32 L/s	46 L/s (unmitigated)	8.3 m³	31 L/s (mitigated)

Two (2) mitigation options exist to integrate a suitable detention facility into the proposed development:

- Rainwater Tanks
- Upsizing of underground drainage infrastructure

Rainwater tanks suit the aesthetic of the development and offer a suitable option to provide integrated OSD which helps to mitigate stormwater at its source and relieve pressure on Council drainage infrastructure.

Council have indicated that rainwater tanks are a suitable form of OSD and has been adopted in nearby developments. As such, TGM recommend the use of rainwater tanks for the proposed development.

At development it is recommended that a restriction be placed on the proposed title – this restriction will state that rainwater tanks with a minimum detention volume of 1,190 litres are to be installed for each allotment and are to be used for purpose of onsite stormwater detention only. Additional or upsized tanks may be used by future landowners if extra capacity is desired for private rainwater re-use applications.

8.1 Design Drainage Schematic (Conceptual)

The stormwater management strategy for the proposed development will mitigate stormwater runoff for the developed site. Flows will be mitigated in rainwater tanks and will discharge to a proposed underground drainage network which will connect into the existing drainage network in Parker Street.

The proposed drainage network will be designed to minimise impact on the existing system. The conceptual schematic can be seen in Figure 13.

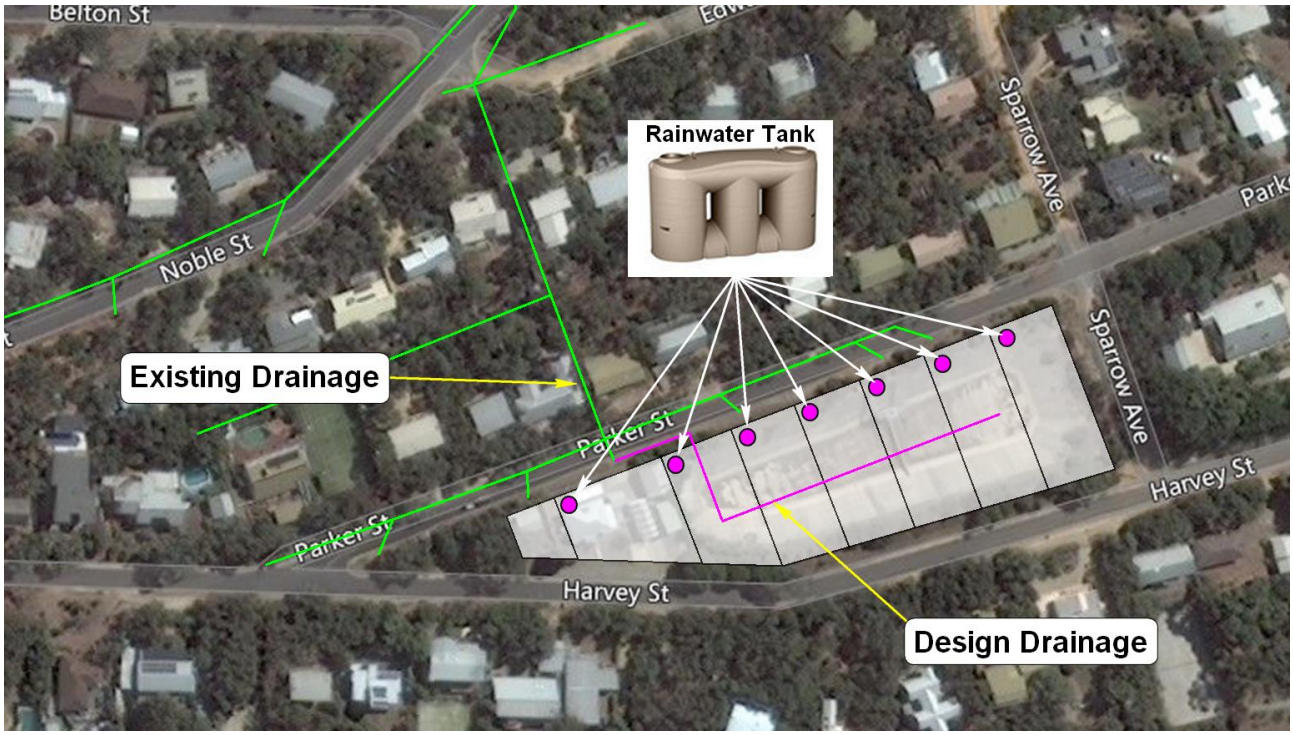


Figure 13: Detention Conceptual Stormwater Management Schematic

It noted that the concepts identified in this study may change or be refined during detailed design.