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23-47 Villiers Street, North Melbourne

Stormwater Management Plan

Project No.: 22106M
28 August 2024
Revision No. 1

REVISION	DATE	COMMENT	AUTHOR	CHECKER
1	*28 August 2024*	Final	GS	ES

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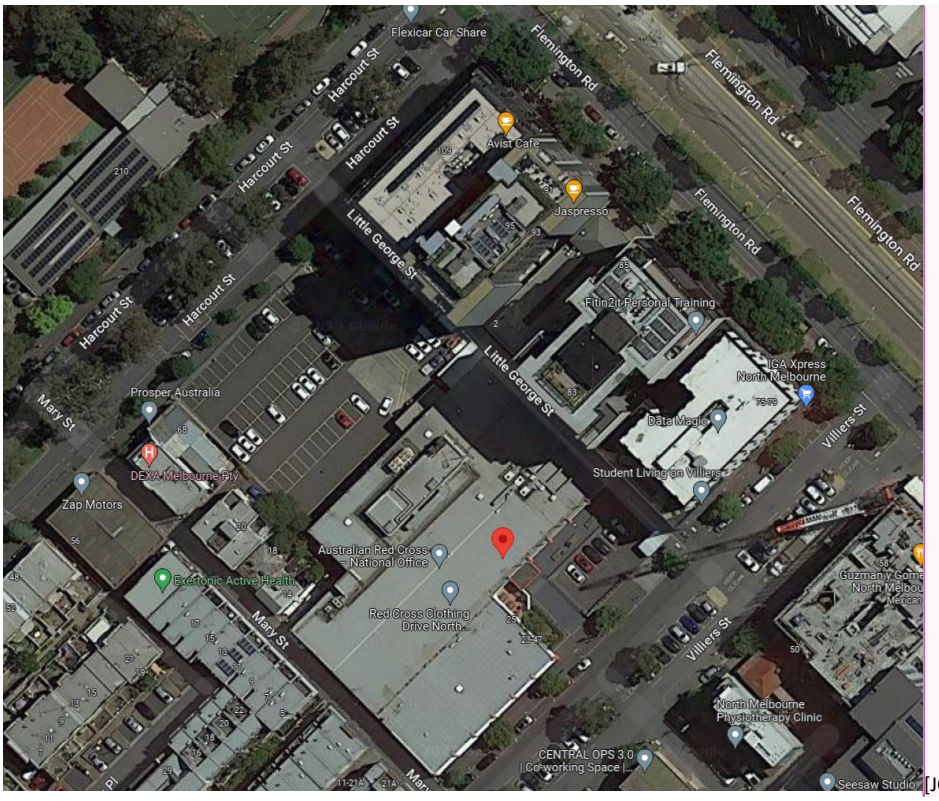
1 Introduction

1.1 Site Description

This report relates to the construction of a proposed eleven-storey (Building A – Villiers St) and twelve-storey (Building B – Harcourt St) building located at 23-47 Villiers Street in North Melbourne. The south-eastern portion of the subject site is currently occupied by the existing Australian Red Cross head office (single storey building with a lower ground level / basement) and the north-western portion is occupied by an existing paved car park. The new development comprises a residential tower over a four-level podium and two levels (Basement 01 and Lower Ground 2) of basement car parking.

The subject site fronts Mary Street to the west, Harcourt Street to the north, Little George Street to the east, and Villiers Street to the south. The subject site covers a total combined area of 6,528m2.

This Stormwater Management Plan provides an outline of the proposed design criteria for the development.



[JO1]

Figure 1 - Site Location of the Proposed Development

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1.2 Regulatory Requirements

The following standards and guidance documents were referred to in preparation of the SWMP.

- AS/NZS 3500.3:2018 – Plumbing and Drainage Part 3: Stormwater Drainage
- Stormwater Drainage Design Guidelines – City of Melbourne, April 2023
- Infrastructure Design Manual Version 5.40 released 1st September 2022
- Best Practice Environmental Management Guidelines for Urban Stormwater (CSIRO 1999) (BPEM)
- Urban stormwater management guidance (EPA Victoria 2021)
- WSUD Engineering Procedures: Stormwater (CSIRO 2005 EPS)
- WSUD Maintenance Guidelines – A guide for asset managers (Melbourne Water)
- MUSIC Guidelines – Input parameters and modelling approaches for MUSIC users in Melbourne Water's service area (Melbourne Water)
- Bureau of Meteorology for Rainfall Data and IFD Charts
- Melbourne Planning Scheme (Clauses 15.01-2L-01 and 53.18)

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2 Proposed Stormwater Management System

The design approach for the stormwater system of the development will be based on water sensitive urban design (WSUD) principles. The adopted principles for stormwater design will be consistent with Urban Stormwater Best-Practice Environmental Management Guidelines (CSIRO 2006). The following items will be considered during the design:

- Provide adequate drainage to ensure a free draining development.
- Pavement levels and drainage design to ensure ponding does not occur on adjacent properties.
- The discharge volume, timing, and velocity of stormwater runoff from the subject site has no adverse effect on any surrounding properties or receiving waters.
- The pollutant discharge from the subject site is minimised so that the environmental value of surrounding properties and receiving water is maintained.
- Major overland flow paths / systems are considered in the design.

2.1 Stormwater Design Parameters

Referring to the Stormwater Drainage Design Guidelines for City of Melbourne published in April 2023, 23-47 Villiers Street sits within 'Region 1 – Central Business District and Growth Areas' for the purpose of on-subject site detention requirements. The subject site location is indicated on the below map from Appendix A of this document using a green cross.

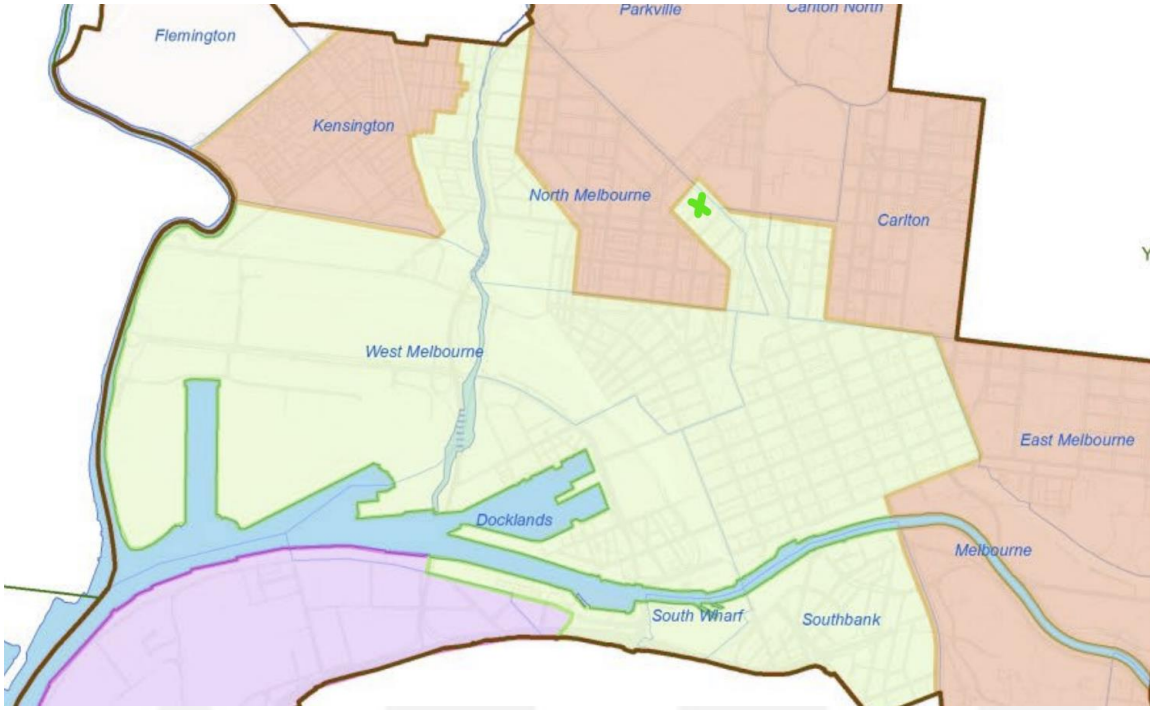

Figure 2 – City of Melbourne Drainage Regions Map

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Referring to section 3.1 of this document the following design criteria apply for sites in region 1.

Permissable Site Discharge

The purpose of the Permissible Site Discharge is to limit the site discharge to a pre-determined rate. Within Region 1 (Central Business District and Growth Areas), the Permissible Site Discharge is calculated as the runoff generated from the pre-developed site during a 20% Annual Exceedance Probability design storm event of 5 minute duration.

The Permissible Site Discharge is calculated using the Rational Method Formula. The value for I is taken from the Bureau of Meteorology for Rainfall Data and IFD Charts, using the coordinates of the subject site.

$$\text{Permissible Site Discharge (litres/s)} = \frac{C_{20} \times I_{20}^{5} \times A}{3600}$$

Where,

C_{20} = 20% Annual Exceedance Probability Runoff Coefficient

= $0.95 \times [F_{imp} \times 0.9 + (1-F_{imp}) \times 0.143]$

F_{imp} = Fraction Impervious for Pre-Developed Site

I_{20}^{5} = Rainfall Intensity for 20% Annual Exceedance Probability event of 5 minute duration (mm/hr)

A = Site Area (m^2)

Site Storage Requirement

The Site Storage Requirement in Region 1 (Central Business District and Growth Area) is calculated from the post development runoff generated from a 100 year Average Recurrence Interval rainfall event (1% Annual Exceedance Probability). The difference between the maximum post development flow considering this occurrence, and the permissable site discharge calculated above gives the site storage required in terms of detention. In accordance with the guidance in the document a factor of 18.5% is to be applied to this result to account for increased rainfall intensity due to climate change.

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2.2 Legal Point of Discharge (LPD)

The Council-nominated discharge points for stormwater on this development site are the current council drain located at Harcourt Street and the pit in Villiers Street. To maintain the current stormwater discharge plan and prevent strain on the existing external Council infrastructure, part of the stormwater will be routed to Harcourt Street through a detention pipe, while the remainder will flow to Villiers Street via a detention tank. Matter Consulting has collaborated with the City of Melbourne Council, Ark Resources (ESD), and Collective Engineering (Building Services) to guarantee the attainment of water quality standards and permissible site discharge goals.

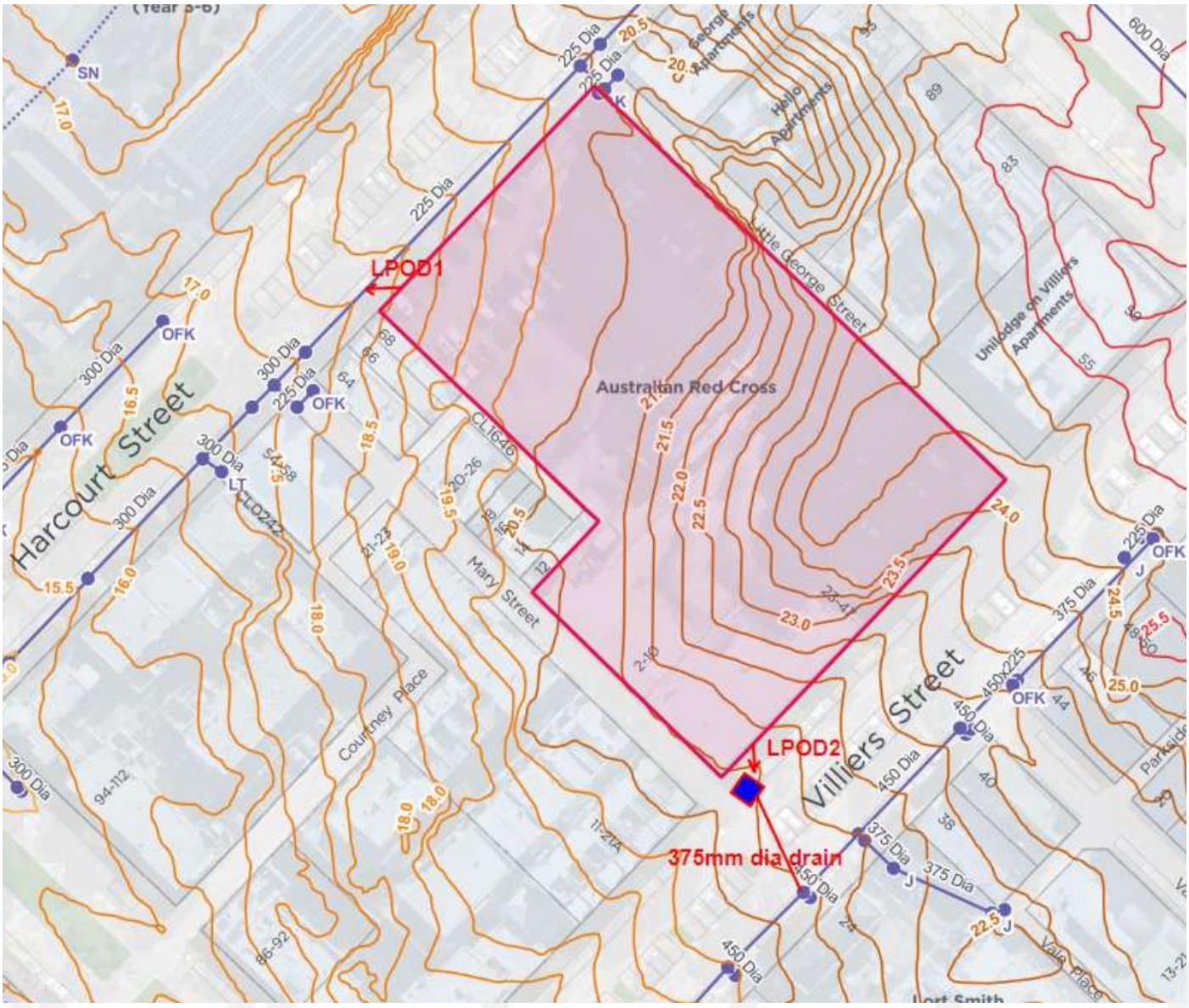

Figure 3 – Legal Points of Discharge

2.3 Catchment Areas Breakdown

2.3.1 Pre-Development Area

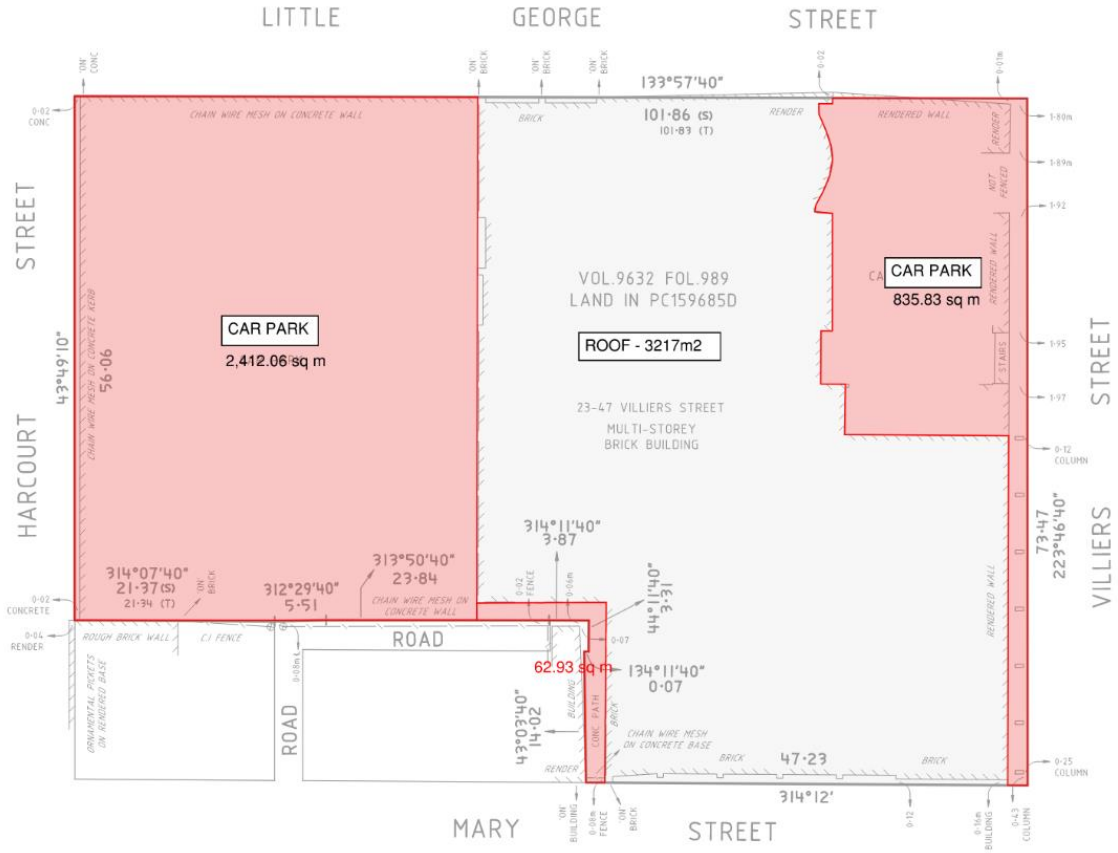

Figure 4 – Existing site areas

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2.3.2 Post- Development Area

The below image is a snapshot from the Ark Resources Sustainability Management plan to ensure accurate run-off coeeficients are used in our detention voume calculation.

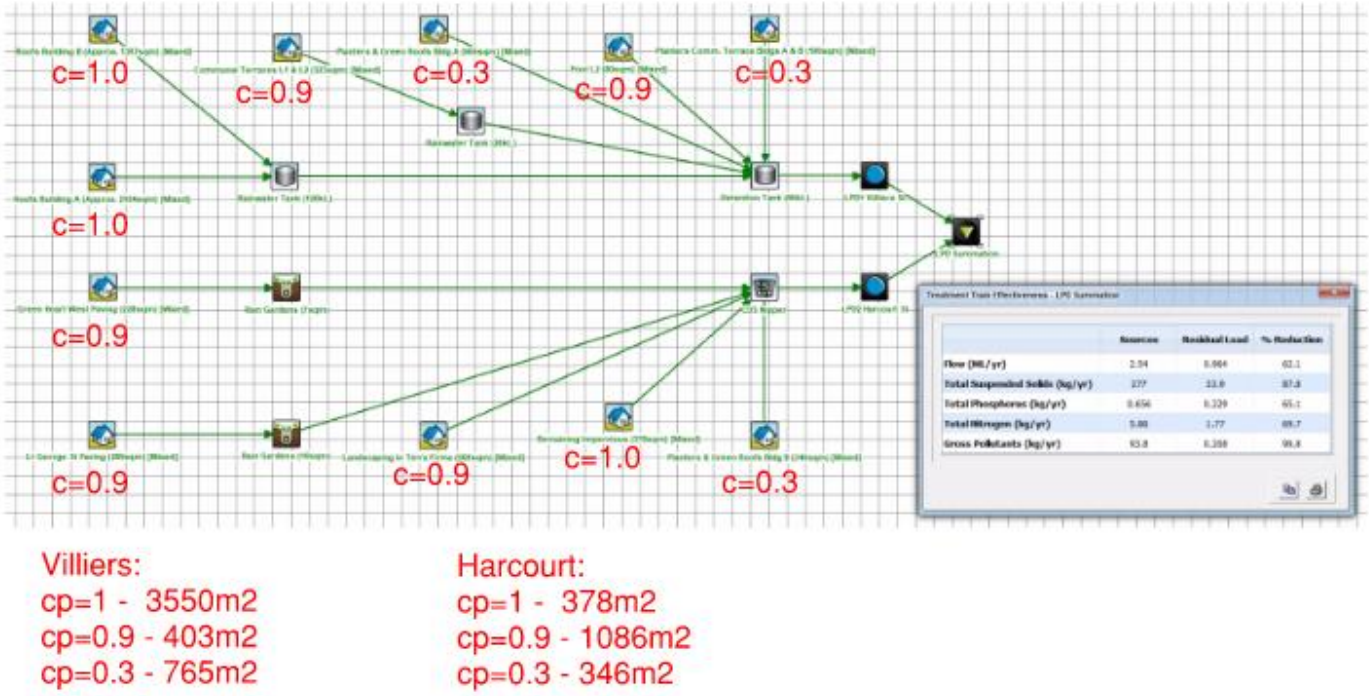

Figure 5 – MUSIC treatment train from ARK Resources Sustainability Management Plan

Summary of Assumed Catchment Areas

Surface Type	*Pre-Development*		*Post-Development*		
	Area (m2)	**Coefficient of Runoff**	**Area (m2) Harcourt**	**Area (m2) Villiers**	**Coefficient of Runoff**
Roof	3311[ES2]	-	378	3550	1.0
Concrete Paving	3217	-	1086	403	0.9
Soft Landscaping	0	-	346	765	0.3
Total	6528	0.855 (Refer Section 2.1)	1810	4718	0.806 / 0.878

Figure 6 – Run-off area summary table

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2.4 Detention Volume Calculation

Permissible site discharge calculations have been conducted in accordance with the design parameters.

On-site detention volume required has been calculated with the rational method and with the following parameters.

- **AEP Pre-development:** 20% (1:5 Years)
- **AEP Post-development:** 1% (1:100 Years)
- **Coefficient of Runoff Pre-Development:** 0.855
- **Catchment area combined:** 6528 m2

As the following calculations show, the detention requirement for the site is 50,054L, which needs to be factored up by 18.5% giving a total detention tank size of **59,313L.**

Calculations M A T T E R

Project: **23-47 Villiers Street**

Storm water design - Melbourne IFD Table

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Rainfall Depth (mm)

	Annual exceedance probability (AEP)						
Duration	63.20%	50%	20%	10%	5%	2%	1%
5	5.00	5.60	7.67	9.26	10.97	13.45	16
6	5.59	6.27	8.62	10.42	12.36	15.21	18
10	7.42	8.35	11.58	14.06	16.72	20.69	24
20	10.26	11.56	16.06	19.52	23.26	28.83	34
30	12.10	13.60	18.82	22.84	27.19	33.65	39
60	15.61	17.44	23.81	28.73	34.06	41.88	49
120	19.79	21.97	29.54	35.37	41.67	50.86	59
180	22.69	25.12	33.54	40.00	46.94	57.08	66
360	28.66	31.73	42.22	50.10	58.43	70.73	81
720	36.10	40.24	54.03	64.08	74.47	89.87	102
1440	44.83	50.62	69.36	82.57	95.92	115.35	131
2880	54.01	61.82	86.65	103.84	120.94	144.65	163
4320	59.01	67.83	95.85	115.31	134.63	160.40	180

Intensity (mm/hr)

	Annual exceedance probability (AEP)						
Duration	63.20%	50%	20%	10%	5%	2%	1%
5	60.05	67.25	92.09	111.13	131.62	161.45	186.84
6	55.92	62.72	86.23	104.25	123.63	152.06	176.24
10	44.52	50.10	69.47	84.33	100.32	124.12	144.36
20	30.79	34.67	48.17	58.55	69.77	86.49	100.77
30	24.21	27.20	37.64	45.68	54.38	67.29	78.35
60	15.61	17.44	23.81	28.73	34.06	41.88	48.59
120	9.90	10.99	14.77	17.68	20.83	25.43	29.36
180	7.56	8.37	11.18	13.33	15.65	19.03	21.90
360	4.78	5.29	7.04	8.35	9.74	11.79	13.50
720	3.01	3.35	4.50	5.34	6.21	7.49	8.54
1440	1.87	2.11	2.89	3.44	4.00	4.81	5.46
2880	1.13	1.29	1.81	2.16	2.52	3.01	3.40
4320	0.82	0.94	1.33	1.60	1.87	2.23	2.51

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Figure 7 – Melbourne Rainfall Data used in analysis

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2.5 Harcourt Street Legal Point of Discharge – OSD Calculation

Stormwater detention/infiltration design (via Modified Rational Method)					
Location of design		Melbourne			
Pre-development flows					
AEP adopted for pre-development		*20.00%*			
EQUIVALENT ARI IS 4.48 YEAR					
Pre-development time of concentration		*5*	minutes		
Design Rainfall Intensity		*92.09*	mm/hr		
Development areas					
Roof	(c=1.0)	*378*	m^2		
Concrete paving	(c=0.9)	*1086*	m^2		
Bitumen paving	(c=0.7)	*0*	m^2		
Soft landscaping	(c=0.3)	*346*	m^2		
sum		1810	m^2		
Pre-development weighted C		0.806		User override C	*0.855*
Adopted pre-development C		0.855			
Maximum Pre-development flow		**39.59**	**l/s**		
Post-development flows					
AEP adopted for post-development		*1.00%*			
EQUIVALENT ARI IS 100 YEAR					
Post-development time of concentration		*10*	minutes		
Design Rainfall Intensity		*144.36*	mm/hr		
Development areas					
Roof	(c=1.0)	*378*	m^2		
Concrete paving	(c=0.9)	*1086*	m^2		
Bitumen paving	(c=0.7)	*0*	m^2		
Soft landscaping	(c=0.3)	*346*	m^2		
sum		1810	m^2		
Post-development weighted C		0.806		User override C	
Adopted pre-development C		0.806			
Maximum Post-devleopment flow		**58.51**	**l/s**		
Difference between pre and post areas		**0**			
Soil infiltration					
Infiltration rate (l/s/m2)		*0*			
Infiltration area		*0*			
Infiltration system absorption rate (l/s)		*0.0*			
Required detention system capacity (l)		**11858.6**	for a 7.78 minute event duration		

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2.6 Villiers Street Legal Point of Discharge – OSD Calculation

Stormwater detention/infiltration design (via Modified Rational Method)					
Location of design		Melbourne			
Pre-development flows					
AEP adopted for pre-development		*20.00%*			
		EQUIVALENT ARI IS 4.48 YEAR			
Pre-development time of concentration		*5*	minutes		
Design Rainfall Intensity		*92.09*	mm/hr		
Development areas					
Roof	(c=1.0)	*3550*	m^2		
Concrete paving	(c=0.9)	*403*	m^2		
Bitumen paving	(c=0.7)	*0*	m^2		
Soft landscaping	(c=0.3)	*765*	m^2		
sum		4718	m^2		
Pre-development weighted C		0.878		User override C	*0.855*
Adopted pre-development C		0.855			
Maximum Pre-development flow		**103.19**	**l/s**		
Post-development flows					
AEP adopted for post-development		*1.00%*			
		EQUIVALENT ARI IS 100 YEAR			
Post-development time of concentration		*10*	minutes		
Design Rainfall Intensity		*144.36*	mm/hr		
Development areas					
Roof	(c=1.0)	*3550*	m^2		
Concrete paving	(c=0.9)	*403*	m^2		
Bitumen paving	(c=0.7)	*0*	m^2		
Soft landscaping	(c=0.3)	*765*	m^2		
sum		4718	m^2		
Post-development weighted C		0.878		User override C	
Adopted pre-development C		0.878			
Maximum Post-devleopment flow		**166.10**	**l/s**		
Difference between pre and post areas		**0**			
Soil infiltration					
Infiltration rate (l/s/m2)		*0*			
Infiltration area		*0*			
Infiltration system absorption rate (l/s)		*0.0*			
Required detention system capacity (l)		**38195.6**	for a 8.69 minute event duration		
Required detention system capacity (m^3)		38.19562812			

2.7 Controlled Site Discharge

2.7.1 Detention Pipe to Harcourt Street LPoD

A pit on the site at ground level contains two chambers separated by a baffle wall. The baffle wall includes an orifice to limit discharge to the pre-development flow of 39.59 l/s.

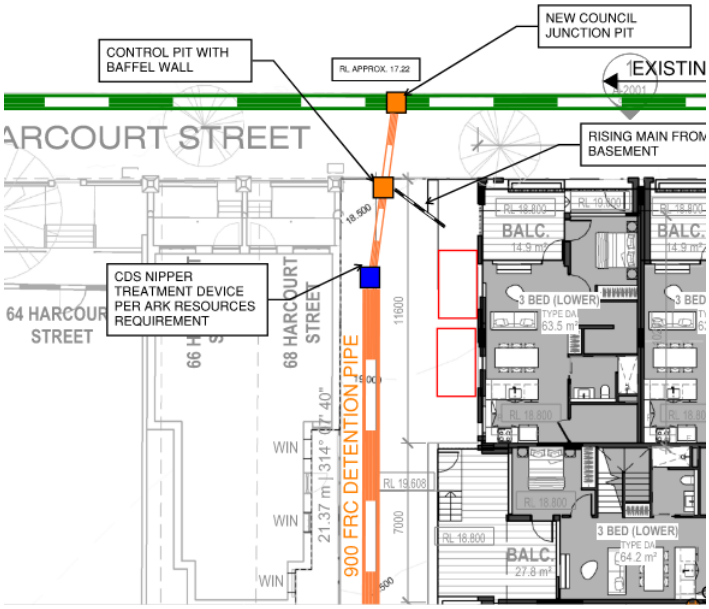

Figure 8 – Harcourt Street point of discharge

Up to the 1% AEP event, the baffle wall backfills the detention pipes while discharging at a controlled flow of 39.59 l/s, matching the 20% AEP pre-development flow. Over the 1% AEP event, stormwater bypasses the orifice by overflowing the baffle wall and discharging to the legal point of discharge.

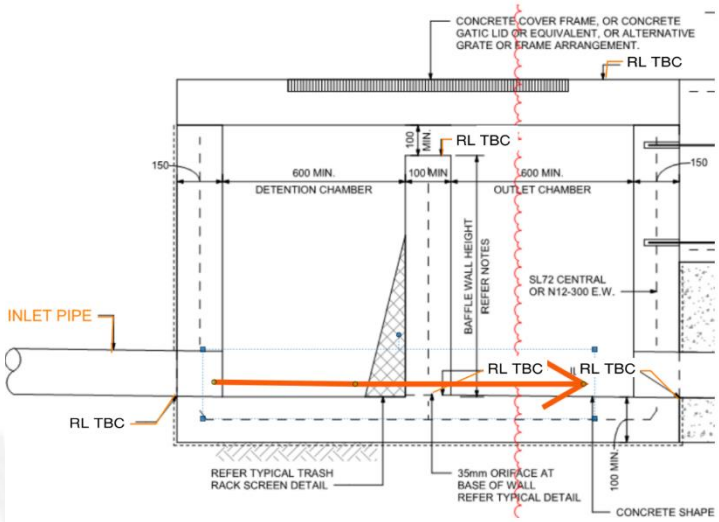

Figure 9 – Harcourt Street detention schematic

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[JO3]

2.7.2 Detention Tank to Villiers Street LPoD

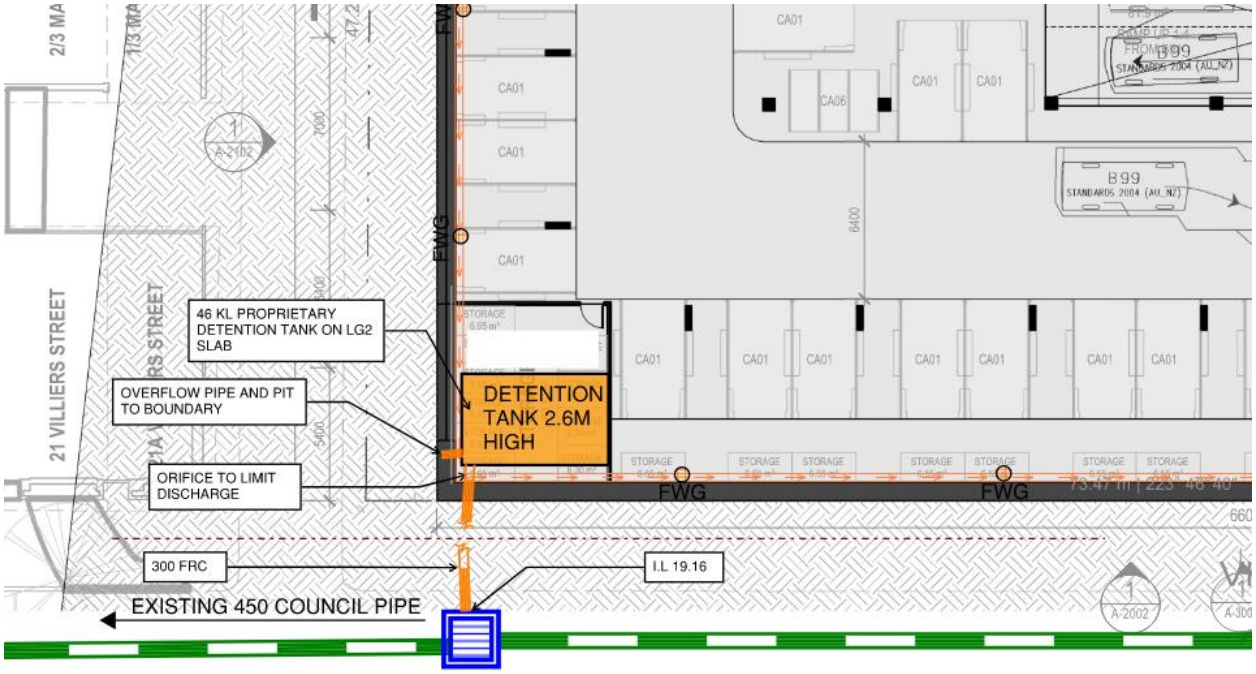

Figure 10 – Villiers Street detention schematic

2.7.3 Flow Control Orifice Calculations

To limit site discharge to the 20% AEP pre-development flow rates, orifice plates will be specified based on the pressure head from the highest point of the water in the detention tank and pipes depending on the pit levels on the site.

2.7.4 Primary Overflow Path

Over the 100-year ARI event, stormwater bypasses the orifice by overflowing the baffle wall and discharging to the legal point of discharge on Harcourt Street, and discharging via an overflow pit on Villiers Street.

[JO4]

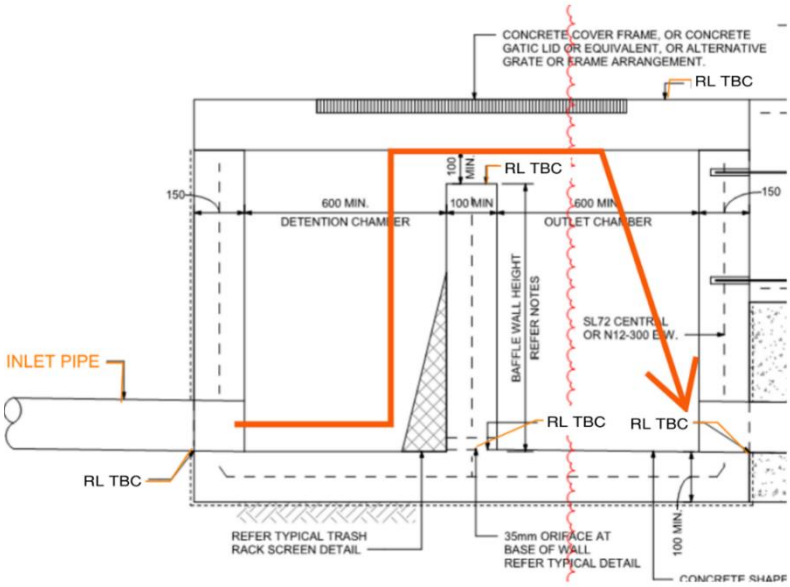

Figure 11 – Harcourt Street overflow schematic

2.8 Rainwater Tank

Rainwater harvesting and reuse is proposed for the development. It will reduce the overall volume of stormwater load going to the receiving water course. It is proposed to provide rainwater harvesting tanks (RWT's) to capture roof runoff for re-use as irrigation and toilet flushing etc. The use of rainwater tanks will allow for a reduction of TSS by the settling of particles over time and through the screening of water before it enters the tank. These tanks will be installed when the development is constructed.

Two rainwater tanks have been proposed by ESD Consultant ARK Resources to reuse water for irrigation and toilet flushing respectively.

2.9 Other treatment devices

As illustrated in section 2.3.2, two raingardens and a CDS Nipper treatment device will further treat stormwater to achieve the project's stormwater objectives. Refer to Ark Resource's report for a detailed analysis.

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3 Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Analysis

A MUSIC analysis has been carried out by Ark Resources. This will allow confirmation that the levels of gross pollutants required by the literature to achieve a 5-star Green Building will be exceeded.

4 Construction & Maintenance Plan

The following construction & maintenance requirements are intended to inform the site management plan in matters relating to stormwater management. Relevant principles per the EPA Environmental Guidelines for Major Construction Sites, and measures as per Urban Stormwater Best Practice Environmental Management Guidelines Section 6.3 are shown below.

The site management plan should restrict runoff to adjoining properties and ensure minimal earth disturbance occurs during construction. Additionally, building waste, dangerous chemicals and food waste must be managed to prevent damage to flora and fauna, or build up or blockage in drains and nearby creeks.

Construction Phase

Item	Associated issues	Measure
Fences	Porous fences allow stormwater runoff to carry sediment across the site and discharge into the stormwater network.	Mesh fabric and silt fences to be installed on fences where site includes slopes greater than 1:20. Hay bales may also be suitable for larger sites.
Pit inlets	Without sediment filters, pit inlets allow sediment to enter the stormwater network causing sediment build-up downstream.	Sediment traps or drain filters should be installed on all pit inlets.
Downpipes	Localised flooding due to lack of site drainage.	Temporary downpipes to be installed as soon as roofing is installed to minimise overland flow across the site (see plastic tube roll image below). These should be connected to the rainwater tank where possible.
Vehicle traffic on site	Areas of vehicle traffic are subject to disturbance of soil.	Use stabilised vehicle entrances, with crushed rock or other suitable material. Include rumble grates, track mats (where access is over sand), and physically remove mud from tyres of vehicles prior to leaving the site.

Mounded earth	Unsecured mounds create significant issues with sedimentation after rainfall.	Use erosion control blankets for mounded earth. Ensure correct installation, and incorporate secondary measures such as silt fences on steep sites.
Bins	Where suitable bins are not provided, litter can be washed from the site.	Ensure appropriate bins are provided for construction workers and staff, particularly where food is consumed.
Waste material	Pollution of stormwater can occur where appropriate disposal methods for waste materials are not established on site.	Provide separate bins for paints and solvents to allow safe removal and disposal at accredited locations. Ensure all staff are aware of correct disposal methods.
Stockpiles	Incorrect stockpiling can lead to stormwater contamination, and site pollution.	Locate stockpiles away from drainage paths, and construct stockpiles with gentle slopes (max 1:2).

In addition, the contractor will be required to:

- Identify and document, prior to construction commencing, where these measures will be installed, and how erosion and loose waste will be managed.
- Install tarps on site waste bins every night.
- Avoid overfilling vehicles or cover all soil loads being taken offsite.
- Sweep up the site every day when works occur on site to ensure loose waste does not blow around the site and into the surrounding streets.
- Ensure erosion and sediment control measures are maintained through weekly checks – maintenance measures may include removing sediment trapped in filters and topping up gravel on the vehicle entry path.

The following maintenance schedule is to be used as a guide for raingarden maintenance. It is based on average maintenance requirements for rainwater tanks in Victoria, and timings may need to be adjusted to suit specific site assets. Regular inspections should be undertaken every three months. Inspection and maintenance of all rainwater tanks will be the responsibility of the owner's corporation.
Refer to the Melbourne Water WSUD Maintenance Guidelines for further details.

Maintenance Phase

Item	What to check for	Action	Frequency
Inlet	No evidence of erosion, blockage, damage or standing water.	Clear inlet of accumulated sediment or debris. Eroded areas should be locally re-profiled or reinforced, and re-planted if necessary. Refer to Water by Design (2012) Rectifying Vegetated Stormwater Treatment Assets if the erosion is either recurring or severe.	Storm events 3 months
Outlet	No evidence of erosion, blockage, damage or standing water Outlet freely draining.	Clear outlet of accumulated sediment or debris. Refer to Water by Design (2012) Rectifying Vegetated Stormwater Treatment Assets if standing (backwatering into the raingarden) is present.	Storm events 3 months
Other structures	No evidence of erosion and damage to other structures, e.g. pits, pipes, access ramps, walls and rock protection.	Repair minor damage to structures. Eroded areas should be repaired (reinforced). This may involve minor re-profiling or re-planting works. For severe damage, i.e. where flows have scoured down the side of a structure refer to Water by Design (2012) Rectifying Vegetated Stormwater Treatment Assets.	3 months
Batters and bunds	No evidence of erosion.	Eroded areas should be locally re-profiled or reinforced, and re-planted if necessary.	Annually

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Hydraulic conductivity	Filter media is draining freely. No water ponded on the surface of the raingarden for more than 12 hours after rainfall.	If water is ponded on the surface of the raingarden for more than 12 hours after rainfall, refer to Water by Design (2012) Rectifying Vegetated Stormwater Treatment Assets. Note: the disposal of raingarden filter material must comply with EPA Victoria guidelines for the disposal of contaminated soil (Appendix C).	Storm events
Sediment accumulation	Sediment forebay less than 75% full. No major sediment accumulation on surface of the raingarden.	Clean out accumulated sediment from the sediment forebay Accumulated sediment to be removed from the surface of the raingarden and the system replanted as required.	Annually
Filter media surface	Sediment forebay less than 75% full.	Filter surface to be repaired. This may involve evening out the surface, importing additional filter media and replanting	3 months
Fine sediment surface crust	No major sediment accumulation on surface of the raingarden. No major surface crusting (<3mm depth across less than 10% of the filter area is permissible).	Repair surface layer by scarify filter media surface, re-profiling and re-establishing vegetation, if required. If the problem persists refer to Water by Design (2012) Rectifying Vegetated Stormwater Treatment Assets.	3 months
Mulch layer	Even depth and distribution of the mulch layer. Surface of the mulch layer is at least 100 mm below the top of the outflow pit. Mulch is not touching the plant stems No major algal growth (less than 10% of raingarden area is permissible).	Re-distribute or replace mulch that has been washed out or displaced. This may involve retaining mulch using jute mats or nets. Remove mulch that is touching plant stems.	3 months

Algal or moss growth	No major algal growth (less than 10% of raingarden area is permissible). No moss growth.	If significant patches of algal growth or moss persist across the surface of the raingarden (i.e. greater than 10% of the surface then refer to Water by Design (2012) Rectifying Vegetated Stormwater Treatment Assets.	3 months
Inspection opening	Water level is below filter media layer. No sediment accumulation in underdrain system.	Refer to Water by Design (2012) Rectifying Vegetated Stormwater Treatment Assets if standing water is present in the filter media layer. Flush the underdrain system using low pressure water jet to remove accumulated sediment.	Annually
Vegetation cover – filter media	Greater than 90% vegetation cover. Plants healthy, free from disease and vigorously growing.	Remove any dead or diseased vegetation. Replant individual bare patches (greater than 5% of the area) using either new plants or by dividing and translocating existing plants. If bare areas represent greater than 30% of the raingarden area, refer to Water by Design (2012) Rectifying Vegetated Stormwater Treatment Assets.	3 months
Vegetation cover – batters	Continuous vegetation cover along the lower batter. Greater than 90% vegetation cover. Plants healthy, free from disease and vigorously growing.		Annually
Weeds – filter media – batters	Less than 10% of the filter media surface area and batters covered in weeds.	Physically remove weeds from filter media surface and batters. Do not use herbicides as these may harm the desirable raingarden vegetation and contaminate the filter media. Refer to Water by Design (2012) Rectifying Vegetated Stormwater Treatment Assets if weed ingress is a persistent problem (i.e. weed coverage is persistently greater than 30%).	3 months

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Litter	Filter media surface and batters free of litter (i.e. less than 1 piece litter per 4m2).	Remove all litter and excessive debris	3 months
Pests	No damage by pest animals and insects.	Seek specialist advice if persistent insect damage is observed. Refer to Water by Design (2012) Rectifying Vegetated Stormwater Treatment Assets if there is evidence of pest animal damage.	3 months

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5 Summary

The entire subject site development has been considered in the calculation of the detention requirements. A 1 in 100-year, 5-minute duration event, gives a required detention capacity of **59.3 kL** which the proposed solution provides across both the Villiers Street and Harcourt Street legals points of stormwater discharge.

In accordance with the Infrastructure Design Manual a MUSIC analysis has been carried out for this development (refer to Ark MUSIC modelling). The treatment train effectiveness of the proposed treatment system is designed to fully achieve the stormwater discharge quality targets of the recommendations of the 'Urban Stormwater: Best practice Environmental Management Guidelines' (1999) published by the CSIRO and what is required for a 5-star Green Building.