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STORMWATER MANAGEMENT STRATEGY

FOR

68 AIRE STREET SUBDIVISION

KIRKSTALL

PROJECT NUMBER: 24-106

DATE: 11TH OF OCTOBER 2024

Stuart Ian Titmus
MIEAust NER

ENGINEERS AUSTRALIA | National Engineering Register

Signature ______ Date 11/10/24

Registered on the NER in the area(s) of practice of Civil Engineering

VBA EC 58059 BLA PE0001386

QUALITY ISO 9001
SAFETY ISO 45001
ENVIRONMENT ISO 14001

Document Verification

Project Name	68 Aire Street Kirkstall
Client Contact	[redacted]
Project Number	21-106
Document Name	24-106 Aire Street, Kirkstall SWMS

Document History

Issued To	Date	Version	Author	Reviewer
Dan Pech Planning	11/10/2024	-	[redacted]	[redacted]
Dan Pech Planning	22/11/2024	A	[redacted]	[redacted]

Accreditation

Version: -

Author: [redacted]

Accreditation: BEng (Civil)(Hons), MIEAust

Reviewer: [redacted]

Accreditation: BEngSc (Civil), MEngTech (Civil), MIEAust

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Table of Contents

1 Introduction

SITEC has been engaged to compile a Storm Water Management Strategy for the 1.7-hectare development site, at 86 Aire Street, Kirkstall. It is proposed that the development site will contain a six-lot subdivision on behalf of Allison Morris and Adrian Leonard.

This document provides information about the site and the way in which storm water run-off will be conveyed to the nominated outfall points.

Figure 1 provides a locality plan and indicates the location of the proposed development.

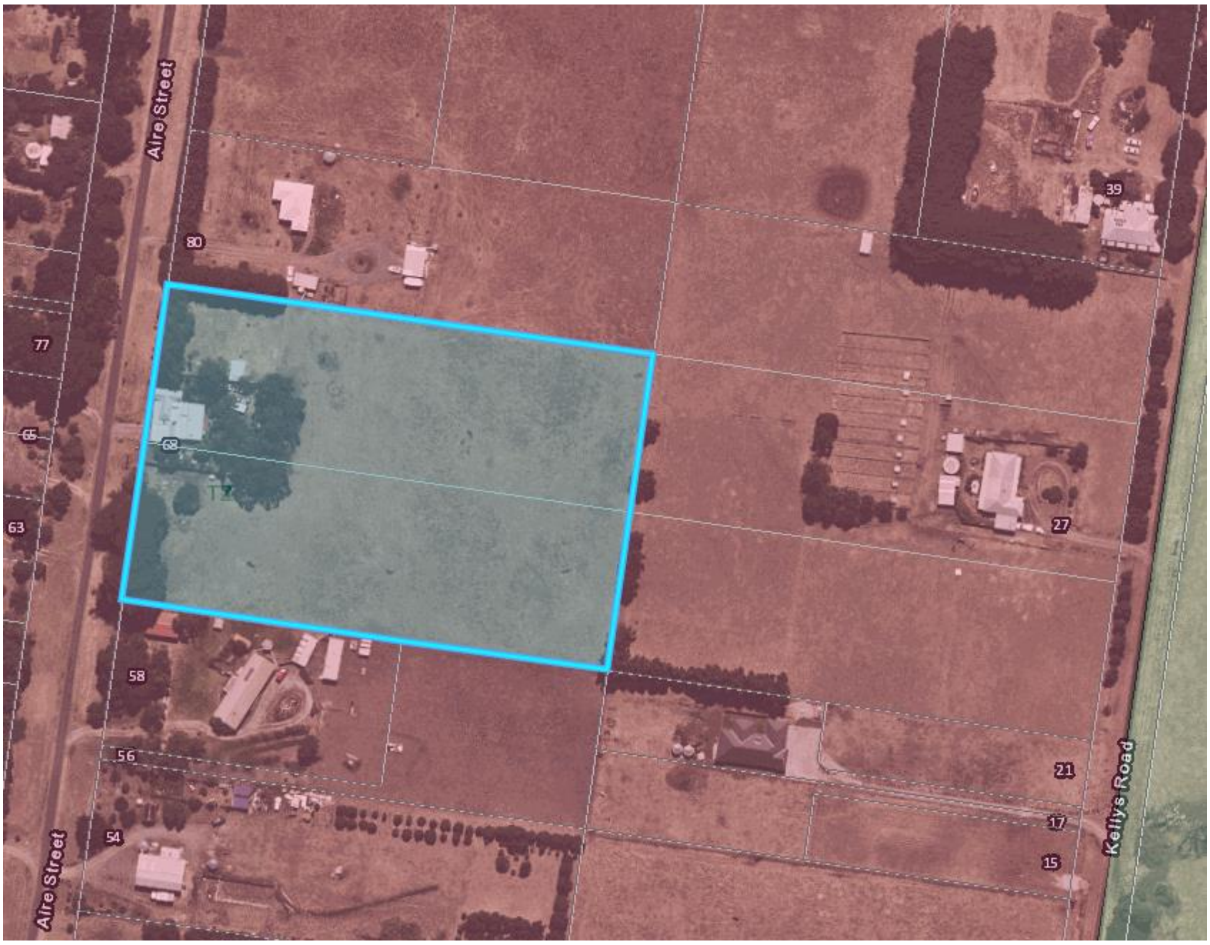

Figure 1 - Locality Plan

2 Site Description

The site is located within the Township Zoning and it is proposed to subdivision the land into 6 residential lots. The site contains an existing dwelling at the front on Aire Street with multiple sheds at the rear. There are also established gumtrees to the rear of the existing dwelling.

2.1 Proposed Development

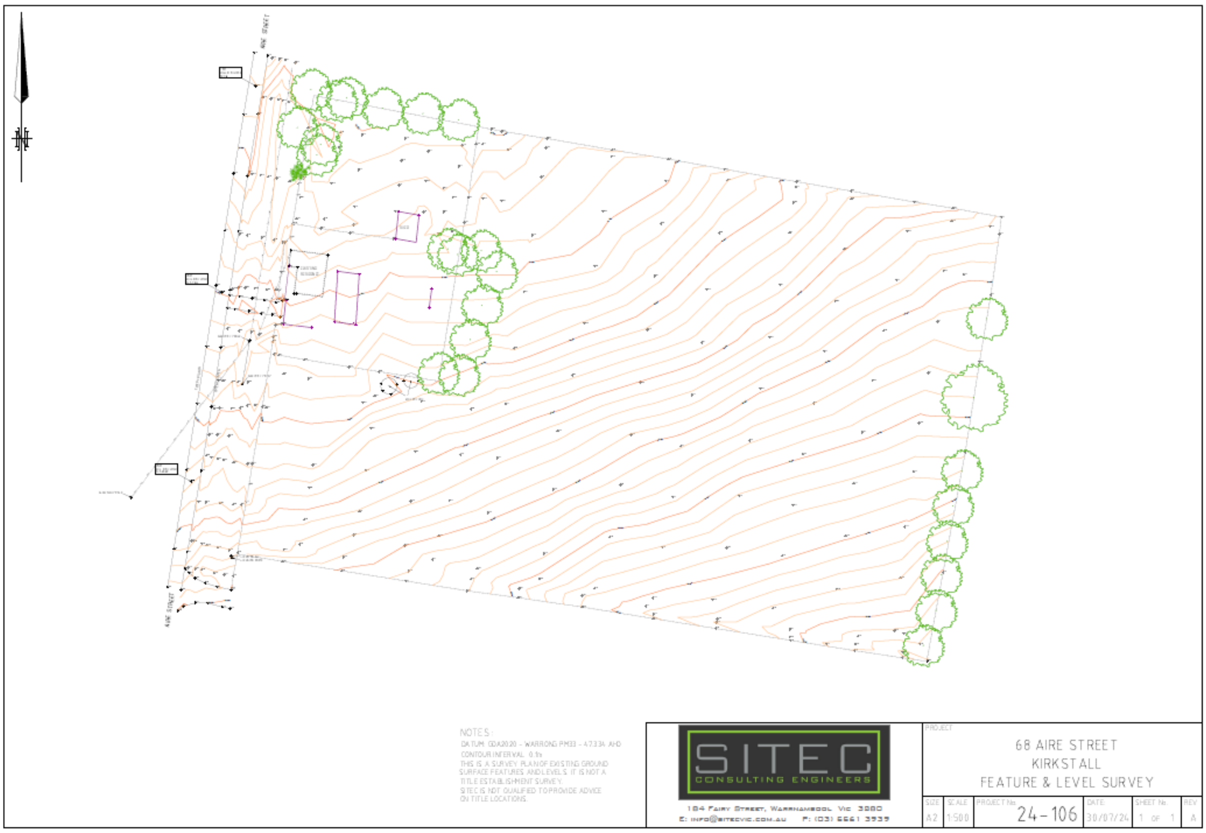

Figure 2 – Concept layout plan

2.2 Existing Catchment and Outfalls

The overall site has one simple catchment that discharge the stormwater that is generated on the land to the south-east corner of the site. The existing terrain demonstrated in the image below indicates that the site uniformly falls in this direction.

Figure 3 – Existing Terrain (Cypress trees in southwest corner have been removed since satellite image was taken)

The development sites high and low points to AHD heights are approximately 57.5m and 53.69m respectively with an average slope of 3% to the south-east.

The land upstream of the development site has the overland stormwater flows currently running through the proposed development area. Hence the upstream catchment area of 2.462ha will be included in this storm water strategy. Further information on the catchment plan is in the **Appendix B**.

Currently the existing terrain suggests that the overland flow path presents as a sheet flow effect across the property before entering the neighbouring property to the south. The development site is to capture and discharge the stormwater generated at predevelopment flows into the neighbouring open drain at the rear of 56 Aire Street. Following this the stormwater is directed into a semi formed drain in 11 Kellys Road that requires an easement be created. After passing through 11 Kellys Road, the stormwater enters the property at 15 Kirkstall-Koroit Road. This property requires a swale drain be formed and easement created over the drain area to adequately traverse the stormwater flows into the Kirkstall-Koroit Road, road reserve.

3 Requirements and Constraints

The proposed subdivision includes:

- The storm water discharge from the development will be limited to predevelopment runoff for a 20% AEP storm event.
- If the post development runoff is greater than the predevelopment runoff, on-site retention (storage) will be required.
- Swale drains located in easements will be required to convey stormwater to the LPOD.
- Stormwater generated from the proposed development will not further impede on the existing and neighbouring properties.
- Measures to enhance stormwater discharge quality from the site to protect downstream waterways will be required.
- Stormwater from a 1% AEP storm event is required to pass through the development via the drainage easement without impeding on facilities or neighbouring properties.
- Upstream catchment stormwater flows will need to be allowed for in the stormwater calculations for the development.

3.1 Flood Storage Requirements

Council will require runoff from the proposed subdivision to be restricted to pre-development levels. This has been taken as assuming the 20% AEP post-development outflows from the subject site must be restricted to pre-development flow rates.

3.2 Flood Level Requirements

The 20% AEP flood event will be required to be stored in the stormwater tanks, with discharge to be at or below predevelopment levels.

3.3 Water Sensitive Urban Design (WSUD) Requirements

Clause 56.07-4 of the Victorian State Planning provisions states that urban stormwater management systems must be designed to meet current best practice management performance objectives for stormwater quality management in the Urban Stormwater - Best Practice Environmental Management Guidelines (CSIRO 1999). The Best Practice Environmental Management Guidelines (BPEMG) objectives for environmental management of stormwater pollutants are:

- Total Suspended Solids (TSS) 80% retention of the typical urban annual load
- Total Phosphorus (TP) 45% retention of the typical urban annual load
- Total Nitrogen (TN) 45% retention of the typical urban annual load
- Gross Pollutants 70% retention of the typical urban annual load

3.4 Asset Ownership and Maintenance

As this site will be in private ownership the drainage infrastructure which includes the stormwater tanks and swale drain will be the responsibility of the private landowners.

3.5 Applicable Standards

All stormwater treatment elements and overland flow paths will be designed to the following:

- Australian Rainfall and Runoff 2019 (Ball et al. 2019);
- Infrastructure Design Manual (Local Government Infrastructure Design Association, V5.4, 2022);
- WSUD Engineering Procedures: Stormwater Melbourne (Melbourne Water, 2005).

4 Proposed Strategy

The SWMS proposed is briefly explained in ***Appendix C*** and will be further shown in the (Detailed Design) documents after the planning permit is issued. The sections below provide commentary on key aspects of the strategy.

4.1 Stormwater Treatment Elements

An appropriately sized stormwater tank will to be installed that will provide stormwater reuse throughout the house which will assist in achieving the WSUD treatment requirements. Details of the storage requirement can be found in ***Appendix C*** and further information will be provided in the detailed design documents.

After the stormwater is released at predevelopment flow rates from the tank, the stormwater will be directed into swale drain at the rear of each lot. The swale will further treat the stormwater and ensure treatment targets are met. The table below (reproduced from ***Appendix D***) demonstrates the treatment train effectiveness for the development. It also shows that the treatment elements outlined above can meet all BPEMG stormwater treatment requirements for the development. The treatment elements will be further shown in the (Detailed Design) documents after the planning permit is issued.

Table 1 - Expected Stormwater Pollutant Retention from Site

Pollutant	Pollutants generated from Development (kg/yr)	Pollutants Retained in Treatment Elements (kg/yr)	% Pollutants withheld relative to pollutant generation from development (%)
Total Suspended Solids	874	52.8	94
Total Phosphorus	1.79	0.481	73.1
Total Nitrogen	12.1	6.58	45.5
Gross Pollutants	236	0	100

4.2 Flood Storage Elements

For the development's catchment area, the post-development flows for the 20% AEP event are 0.064m^3/s. As this is greater than the pre-development flows of 0.040m^3/s, storage is required. During this event, 56m^3 of storage is required to contain the storm water generated from the development's catchment. The storage will be located onsite in above ground stormwater tanks on each lot. Each lot will contain a minimum of 20,000 litre (20m^3) stormwater tank of which half of the tank's capacity (10,000ltrs/10m^3) will be used for storage whilst the other half will be used for reuse purposes. As there are 6 lots, there will be 6 tanks with 10m^3 of storage each totally 60m^3 of storage available. This storage is greater than the required storage of 56m^3, hence the tanks will have the capacity to meet the subdivisions requirements. The calculations that were used to determine the storage requirements for the development can be found in ***Appendix C***. With detailed drawings for outfall restriction configuration to come once detailed design is undertaken post planning permit.

Table 2 - Pre- and Post-Development Flow Estimates

Location	Flow Estimate (m^3/sec)			
	Pre	**Critical Duration**	**Post**	**Critical Duration**
Upstream Catchment	**0.067**	**34-minutes**	**0.100**	**31-minutes**
Development Site Catchment	**0.040**	**39-minutes**	**0.068**	**32-minutes**

Note: All flows rounded to the nearest 0.001 m3/s due to storage modelling detail.

4.3 Flood Impact

No inundation of the lots is expected as stormwater flows will traverse down the swale drains and into the Kirkstall – Koroit Road, road reserve. The swale drain network will be designed to have the capacity to convey the stormwater generated in the 1% AEP event from the proposed subdivision and upstream catchments. The swale drain design and capacity checks will be submitted as part of the detailed design documents after the planning permit is issued.

4.4 Subdivision Drainage Layout

The Lots 1-6 (1.7Ha) make up the proposed subdivision's catchment that directs the stormwater into the neighbouring swale drain to the south-east corner of the development. As the catchments post development flows of 0.064m^3/s is greater than the predevelopment flow rate 0.040m^3/s, the additional flows will have to be retained in stormwater tanks. Following the storage, the stormwater is further treated in the swale drain prior to reaching the legal point of discharge. The stormwater will then make its way through the neighbouring properties prior to reaching the Kirkstall-Koroit Road, reserve.

4.5 Proposed Easement or Reserve

As the swale drains will be located through the lots, drainage easements will be required over these assets.

4.6 Wider Catchment Issues

The proposed stormwater management strategy will benefit the neighbouring properties with greater control of stormwater runoff compared to the exiting site.

5 Concluding Remarks and Further Work Required

The SWMP detailed within this report and associated documents, details the designs of assets required to service the proposed development. To ensure all applicable planning controls are met, the proposed development is to incorporate:

- A stormwater treatment facility to service lots 1-6 will be in the form of 20,000ltr stormwater tanks on each lot, followed by appropriately sized swale drains at the low side of each lot to enable WSUD treatment to occur.
- In a stormwater event that generates flows greater than the predevelopment flow rate, excess flow will be stored in the tanks.
- The development flows will be restricted to predevelopment level by an appropriately sized pipe acting as an orifice on the outfall of the stormwater tanks.
- Overland flows will not inundate the development or existing properties in the 1% AEP storm event as the swales will be appropriately designed to cater for this event.

As such, it is requested that Council approve the SWMS presented herein, allowing the planning process to progress.

6 Abbreviations, Descriptions and Definitions

The following table lists some common abbreviations and drainage system descriptions and their definitions which may be referred to in this report.

Table 3 - Common Abbreviations Associated with Stormwater Management Plans

Abbreviation / Descriptions	**Definition**
AHD - Australian Height Datum	Common base for all survey levels in Australia. Height in metres above mean sea level.
ARI - Average Recurrence Interval.	The average length of time in years between two floods of a given size or larger. A 100 Year ARI event has a 1 in 100 chances of occurring in any one year.
AEP – Annual Exceedance Probability	The chance of a storm (flow) of that magnitude (or larger) occurring in a given year. $\mathbf{AEP = 1 - e^{\left(\frac{-1}{ARI}\right)}}$. i.e. 18.13% AEP = 5 Year ARI
BPEMG	Best Practice Environmental Management Guidelines available from CSIRO (2009).
DSS or DS	Development Services Scheme (DSS) or Drainage Scheme (DS) is a master plan developed my MWC for drainage within a catchment area.
ED	Extended detention. A hight that corresponds to the vertical limit of a volume of water stored for treatment within a treatment element.
EY – Exceedances per year	The amount of times a storm (flow) of that magnitude is expected to be exceeded per year. i.e. 4 EY = 3 Month ARI
Hectare (ha)	10,000 square metres
HECRAS	A hydraulic software package that enables the calculations of flood levels and velocities along a waterway given a specified flow.
Kilometre (km)	1000 metres
m^3/s -cubic metre/second	Unit of discharge usually referring to a design flood flow along a stormwater conveyance system
Megalitre (ML) (1000 cubic metres)	1,000,000 litres = 1000 cubic metres. Often a unit of water body (e.g. pond) size
MUSIC	Hydrologic computer program used to calculate stormwater pollutant generation in a catchment and the amount of treatment which can be attributed to the WSUD elements placed in that catchment
MWC	Melbourne Water Corporation
Retarding basin	A flood storage dam which is normally empty. May contain a lake or wetland in its base

NWL - Normal Water Level	Water level of a wetland or pond defined by the lowest invert level of the outlet structure
NSL – Natural Surface Level	The surface level of the natural (existing) surface before works.
RORB	Hydrologic computer program used to calculate the design flood flow (in m^3/s) along a stormwater conveyance system (e.g. waterway)
RCP	Representative Concentration Pathway. A relative greenhouse gas concentration into the future. RCP 8.5 represents no significant reduction in emissions until 2100 resulting in significant global warming.
Sedimentation basin (Sediment pond)	A pond that is used to remove coarse sediments from inflowing water mainly by settlement processes.
Swale	A small shallow drainage line designed to convey stormwater discharge. A complementary function to the flood conveyance task is its WSUD role (where the vegetation in the base acts as a treatment swale).
TSS	Total Suspended Solids – a term for a particular stormwater pollutant parameter
TP	Total Phosphorus – a term for a particular stormwater pollutant parameter
TN	Total Nitrogen – a term for a particular stormwater pollutant parameter
WSUD - Water Sensitive Urban Design	Term used to describe the design of drainage systems used to: Convey stormwater safely Retain stormwater pollutants Enhance local ecology Enhance the local landscape and social amenity of built areas

Appendix A – Layout Plan

REVISION	DESCRIPTION	DATE		NAME	DATE
			DESIGN	G.SWARBRICK	10/24
			DRAWN	---	---
			CHECKED	---	---
			APPROVED		
-	INITIAL SUBMISSION	OCT 24			
			CAD FILE	---.dwg	

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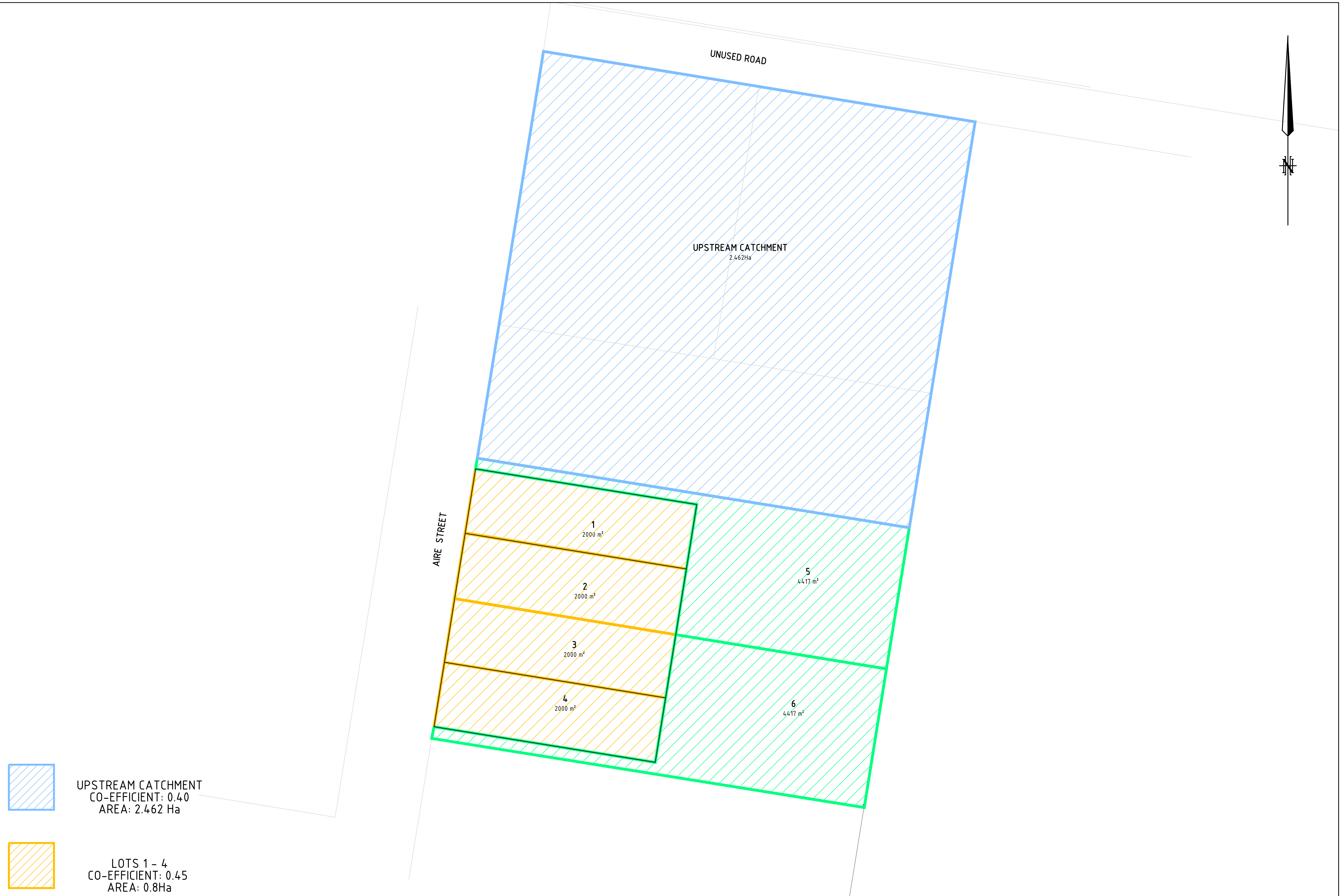
PLANNING PERMIT NUMBER P-------

68 AIRE STREET KIRKSTALL LAYOUT PLAN

SIZE	SCALE	PROJECT No.	SHEET No.	REV
A1	NTS	24-106	1 OF 2	-

Appendix B – Catchment Plan



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PLANNING PERMIT NUMBER P-------

68 AIRE STREET KIRKSTALL CATCHMENT PLAN

SIZE	SCALE	PROJECT No.	SHEET No.	REV
A1	NTS	24-106	2 OF 2	-

Appendix C – Hydrologic Modelling

The hydrologic calculations will be undertaken below on the proposed subdivision. The rational method (with current BoM rainfall intensity) and Boyd's method (or similar) can be used to define flood storage requirements. The storage indicated by these methods suggest it will be required to fit on site and consideration has been given to how the outlet may be configured. As there has been a basic initial concept layout plan already designed for the site, the development site conditions can be utilised to better design the storage and treatment assets. Typically used to determine the storage requirements, the Boyds formula utilises the IDM coefficients (table 10 Runoff Coefficients –residential lots).

Predevelopment Flows (Subdivision Catchment)

The predevelopment flows for the subdivision's catchment will be calculated using the rational method:

$$\boldsymbol{Q_{PRE-DEV}} = \frac{CAI_{20\%}}{360}$$

Where:

$Q_{PRE-DEV}$	= Pre development discharge (*m^3/s*)
C	= Run off co-efficient = 0.30
A	= Total Area (*Ha*) = 1.7 Ha
$I_{20\%}$	= 20% AEP Rainfall Intensity (mm/hr)

To calculate the 20% AEP Intensity, the Time of Concentration is calculated using iterations of the Kinetic Wave method:

- $T_c = \frac{6.94\,(L\,F_R)^{0.6}}{I^{0.4}S^{0.3}}$

  Where:

  T_c = Time of concentration

L	= Length of Overland Flow	*= 216m*
F_R	= Retardance Factor (VicRoads Manual)	= 0.1
I	= Rainfall Intensity for 5yr storm (Kirkstall)	*= 28.16 mm/hr*
S	= Slope of Hydraulic Grade line	*= 0.0176m/m*

T_c = 38.75minutes

I_{20} = 28.16mm/hr

$$\boldsymbol{Q_{PRE-DEV}} = \frac{0.3 \times 1.7 \times 28.16}{360} = 0.04m^3/s$$

This yields a total of $\boldsymbol{Q_{PRE-DEV}}$ = **0.04 m^3/s** of flow from the development site. These flows must be catered for in the drainage networks for the subdivision and conveyed to the discharge points.

Predevelopment Flows (Upstream Catchment)

The predevelopment flows for the subdivision's catchment will be calculated using the rational method:

$$Q_{PRE-DEV} = \frac{CAI_{20\%}}{360}$$

Where:

$Q_{PRE-DEV}$ = Pre development discharge (m^3/s)

C = Run off co-efficient = 0.30

A = Total Area (*Ha*) = 2.462 Ha

$I_{20\%}$ = 20% AEP Rainfall Intensity (mm/hr)

To calculate the 20% AEP Intensity, the Time of Concentration is calculated using iterations of the Kinetic Wave method:

- $T_c = \frac{6.94\ (L\ F_R)^{0.6}}{I^{0.4} S^{0.3}}$

  Where:

  T_c = Time of concentration

L	= Length of Overland Flow	*= 233m*
F_R	= Retardance Factor (VicRoads Manual)	= 0.1
I	= Rainfall Intensity for 5yr storm (Kirkstall)	*= 32.6mm/hr*
S	= Slope of Hydraulic Grade line	*= 0.0176m/m*

T_c = 31.08minutes

I_{20} = 32.6mm/hr

$$Q_{PRE-DEV} = \frac{0.3\ \times 2.462\ \times 32.6}{360} = 0.067 m^3/s$$

This yields a total of $Q_{PRE-DEV}$ = **0.067 m^3/s** of flow from the upstream catchment site. These flows from the upstream catchment must be catered for in the drainage networks for the subdivision and conveyed to the discharge points.

Post-development

Site Catchment

The post development flows for the site will be calculated using the rational method:

$\boldsymbol{Q_{Post-DEV}} = \frac{CAI_{20\%}}{360}$

Where:

$Q_{Post-DEV}$	= Post development discharge (*m³/s*)
C	= Run off co-efficient = 0.40 (Residential 4,000m²-1Ha)
	= 0.45 (Residential 2,000m²-4,000m²)
A	= Total Area (*Ha*) = 0.8 Ha (Residential 4,000m²-1Ha)
	+ 0.883Ha (Residential 2,000-4,000)
$I_{20\%}$	= 20% AEP Rainfall Intensity (mm/hr) = 31.93 mm/hr

T_c = 32.07 minutes
I_{20} = 31.93 mm/hr

$$\boldsymbol{Q_{Post-DEV}} = \frac{(0.72) \times 31.93}{360}$$

$$= 0.064 m^3/s$$

This yields a total of $\boldsymbol{Q_{Post-DEV}}$ **= 0.064 *m³/s*** of flow from the subdivisions catchment. These flows must be catered for in the drainage networks for the subdivision and conveyed to the discharge points.

Storage Sizing

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Stormwater Detention - Boyds Formula (20% AEP)

Boyds Formula (20% AEP)

West Catchment

Project:	86 Aire Street, Kirkstal
Job No:	24-106

IFD Region= Kirkstall

Eff Catchment Area (A) = 0.72 ha

Runoff Coefficient (20% AEP) = 1 due to varying Co-efficient 1

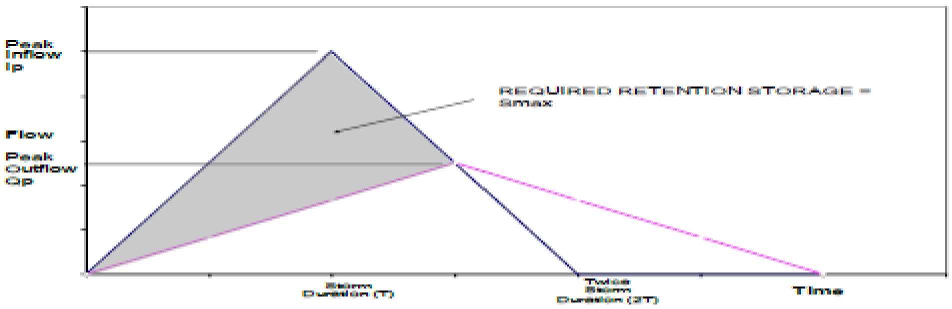
20% AEP Effective Catchment Area = ∑CA = 0.720 ha

Restricted outflow requirement = 0.04 m^3/s

Storage requirement is highest value of S_{max} calculated in the table below
Critical storm duration is the storm duration when S_{max} occurs

Continue table until a clear Smax is calculated

Storm Duration (min)	20% AEP Intensity (mm/hr)	I_p (m^3/s)	Q_p (m^3/s)	V_1 (m^3)	S_{max} (m^3)
1	136	0.27	0.040	16.320	13.920
5	85.5	0.171	0.04	51.3	39.3
10	63	0.126	0.04	75.6	51.6
15	50.7	0.1014	0.04	91.26	55.26
16	48.9	0.10	0.040	93.888	55.488
17	47.2	0.09	0.040	96.288	55.488
18	45.7	0.09	0.040	98.712	55.512
19	44.2	0.09	0.040	100.776	55.176
20	42.9	0.09	0.040	102.960	54.960
30	33.30	0.07	0.040	119.880	47.880



$$S_{max} = V_1 \, (1 - Q_p/I_p)$$

S_{max} = Maximum Volume of temporary Storage (m^3)
V_1 = Volume of inflow flood (m^3)
I_p = Peak discharge of inflow hydrograph (m^3/s)
Q_p = Peak discharge of outflow hydrograph (m^3/s)

Appendix D – Music Modelling

	Sources	Residual Load	% Reduction
Flow (ML/yr)	4.22	3.67	13
Total Suspended Solids (kg/yr)	874	52.8	94
Total Phosphorus (kg/yr)	1.79	0.481	73.1
Total Nitrogen (kg/yr)	12.1	6.58	45.5
Gross Pollutants (kg/yr)	236	0	100