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Proposed Residential Subdivision - Hillview East, Louth Park

Stormwater Management Strategy

NEWPRO25 Pty Ltd

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LAND DEVELOPMENT • BUILDINGS • INFRASTRUCTURE

CIVIL, STRUCTURAL & ENVIRONMENTAL ENGINEERING,
WATER & WASTEWATER, BUILDING DESIGN & PROJECT ADVISORY

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1	Original Issue	TS	04/11/22	IH	04/11/22	IH	04/11/22

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List of Acronyms

AEP	Annual Exceedance Probability
LGA	Local Government Area
MCC	Maitland City Council
MOES	Manual of Engineering Standards
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
OSD	Onsite Stormwater Detention
SQUIDS	Stormwater Quality Improvement Devices

1 Introduction

1.1 Background

This stormwater strategy is to support the proposed residential development on 442 Louth Park Road, Louth Park, which will be known as Hillview East.

Centralised stormwater management controls at the subdivision level have been designed to limit post development peak flows to predevelopment conditions for all critical storm durations.

This report shows that the overall post development stormwater runoff quantity will not impact on downstream flooding. This report also demonstrates that the retention of nominated pollutants (Total Suspended Solids, Nitrogen, Phosphorous and Gross Pollutants) will meet Maitland City Councils (MCC's) current nominated targets.

1.2 Site description

The subject land is known as 442 Louth Park Road, Louth Park (Lot 1 DP221762). It comprises approximately 7.6 hectares of currently semi-rural land. The Site is bound to the east by an unnamed first order tributary of Wallis Creek and to the west by the Hillview Estate residential subdivision (Lot 2000 and Lot 2001 DP1129126). A locality plan has been provided in Figure 1.

The proposed development will outlet along its northern boundary to an existing watercourse which flows to an existing online detention basin that was designed and constructed during Stage 1 works of the adjoining Hillview Estate Subdivision. It is proposed to augment and improve the performance of this existing online detention basin as required to serve both the existing and proposed residential developments.

The Site is currently undeveloped and zoned R5 (Large Lot Residential) pursuant to Maitland Local Environmental Plan 2011. The Site is wholly within the MCC LGA.

1.3 Proposed development

The proposed development consists of 31 Lots ranging from 1500m^2 to 4000m^2. A Site layout plan is shown in Figure 2.

To ensure runoff from the proposed development is in accordance with MCC's guidelines, stormwater detention is to be provided by augmenting the previously approved detention basin to the north of the Site.

1.4 Previous reports

The previously approved "Flood Study and Water Cycle Management Strategy for Proposed Residential Development" by PCB dated November 2016 (Rev C) proposed an offline water quality basin and an online detention basin immediately downstream to cater for the adjacent Hillview Estate subdivision.

The Site was considered within the study as undeveloped. The water quality treatment devices noted in this previous strategy were not sized to cater for the proposed subdivision.

A copy of this approved PCB strategy is provided in Appendix A.

1.5 Objectives

The objectives of this report are to investigate the likely impacts of the interaction of the development with its stormwater and flooding environment and make recommendations to meet guidelines regarding volume rate of flow and runoff quality.

1.6 Available data

The following information was utilised in the preparation of this strategy:

- A proposed subdivision layout plan by GCA Engineering Solutions. A copy of the subdivision plan is shown in Figure 2.
- MCCs Manual of Engineering Standards (MOES) – Stormwater Drainage)
- Australian Rainfall and Runoff, Institution of Engineers 1998.
- Land Information Centre Digital Elevation Model (LIC DEM).
- Aerial Imagery (SIX Maps, Nearmaps).
- “Flood Study and Water Cycle Management Strategy for Proposed Residential Development” by PCB dated November 2016 (Rev C).

2 Stormwater Management Strategy

The proposed stormwater management strategy for the development is outlined below. The predevelopment and post development catchment plans are provided in Figures 3 and 4, respectively. A general arrangement of the proposed stormwater network is provided in Figure 5. Subsequent sections of this report will demonstrate that the stormwater strategy will achieve all the relevant target criteria.

2.1 Catchment plan

To ensure that the relevant environmental objectives are achieved in a financially sustainable manner, water quality and detention measures have been considered during the initial development stage. It is proposed to utilise the existing online detention basin located to the north of the proposed development that was designed as part of the existing Hillview Estate Subdivision. The existing basin will be augmented as required to serve both the existing and proposed residential developments.

This report will utilise the same catchment areas modelled in the approved Water Cycle Management Strategy for the Hillview Estate Subdivision (PCB, Rev C, 19/12/16) with some adjustments to account for the proposed development (an increase in impervious area). The previous catchment plans have been included in Appendix A for reference.

Catchments 4C – 4E will be urbanised during the proposed development. Once developed, stormwater runoff from the entirety of the proposed residential development will be directed into the existing detention basin.

Lot and road areas will be drained by a conventional pit and pipe network located in or in inter-allotment drainage where required. The pipe network will comprise the minor system subject to MCC's minor design standard of 10% AEP. The road network would form the majority of the major network standard of 1% AEP.

Discharge from the existing basin is currently controlled by an inlet pit, a low-level outlet pipe and a spillway. This has been revised and is further discussed in Section 3.

Water quality for the system as a whole will meet MCC's targets as outlined in the MOES. This will be achieved by a treatment train approach comprising gross pollutant traps (GPTs), grass lined swales and bio-retention swales as indicated on Figure 7. Water quality and modelling is discussed in detail in Section 4.

3 Volume Rate of Flow

3.1 Criteria

Discharge from the proposed and existing development has been limited to the predevelopment rates for all AEP events.

3.2 Methodology

For large developments utilising detention basin storages, the Time Area Hydrograph Routing method is considered to be the most appropriate tool for determining basin volumes. The DRAINS software package, published by Watercom Pty Ltd, has been used to investigate the catchments and the ameliorating effects of the proposed basin. This works by translating rainfall hyetographs into runoff hydrographs over sub catchments and subsequently adding the resulting hydrographs together to quantify design rates of flow and runoff volumes.

3.2.1 Catchment hydrology

MCC's MOES published parameters to be adopted in DRAINS models as provided in Table 3-1 below.

Table 3-1: MCC's MOES modelling parameters.

Parameter	Value
Antecedent Moisture Content	3
Grassed Depression	5mm
Paved Depression Storage	1mm

The existing Site consists of vegetated rural land with shrub and tree coverage. In accordance with MOES, a surface roughness coefficient (n*) 0.35, 0.21 and 0.01 was adopted for predeveloped pervious catchment areas, developed pervious catchment areas and impervious catchment areas, respectively. MOES also requires that residential development (lot sizes >1000m^2) adopt a site impervious percentage of 0.4 or 40%, and road reserve adopt an impervious percentage of 0.7 or 70%. The impervious percentage of undeveloped land was calculated according to existing infrastructure.

The existing Hillview Estate residential development was modelled using parameters outlined in the previously approved Water Cycle Management Strategy by PCB (provided in Appendix A).

3.3 Results

3.3.1 Detention basin

The existing detention basin is located north of the proposed development. It is proposed to provide additional detention storage volume as opposed to creating a smaller separate storage within the Site. This will ultimately reduce Councils ongoing maintenance requirements. Details for the existing detention basin compared to the augmented basin are provided in Table 3-2. The modification of the existing basin as part of the proposed development works is shown in Figure 6.

Table 3-2: Comparison of existing and augmented detention basin.

	Existing Detention Basin	Augmented Detention Basin
Embankment level	R.L. 9.30	R.L. 9.30
Q_{100} Top Water Level	R.L. 8.91	R.L. 9.27
Detention Invert Level	R.L. 7.85	R.L. 6.90
Proposed Outlet Control Pit	-	3.9m x 1.2m – 3.9m of pit at R.L. 8.00, 6.3m of pit at R.L. 8.70 and I.L. 6.90
Proposed Inlet Orifice	-	4x ø600mm inlet orifices at I.L. 6.90
Proposed Outlet Pipe	-	2x ø1350mm at I.L. 6.90
Existing Outlet Control Pit	3.9m x 1.2m raised grate R.L. 7.85 & R.L. 8.43 and I.L. 6.79	Concrete lid and I.L. 6.79
Existing Outlet Pipe	2x ø1350mm at I.L. 6.79	2x ø1350mm at I.L. 6.79
Spillway	15m long at R.L. 8.70	10m long at R.L. 9.00

The following modifications are proposed to the previously approved detention basin to account for the proposed residential development:

- The existing outlet control pit was enlarged, and a concrete lid was added (as shown on Figure 6).
- An additional outlet control pit is proposed slightly upstream of the existing outlet control pit. The proposed outlet control pit is 3.9m x 1.2m (3.9m of pit at R.L. 8.00, 6.3m of pit at R.L. 8.70 and I.L. 6.90), with 4x ø600mm inlet orifices at R.L. 6.90 and 2x ø1350mm outlet pipes at R.L. 6.90 which connect into the existing outlet control pit.
- The spillway was reduced from 15m to 10m and was raised from R.L. 8.70 to R.L. 9.00.

The Q_{100} detention volume of the proposed basin is 20885m^3.

Note that the detention basin ultimately drains to a twin cell ø1350mm culvert that runs beneath Louth Park Road. It is not proposed to modify this existing infrastructure.

3.3.2 Discharge rates

The DRAINS model for predevelopment, and post development scenarios for the 10%, 5%, 2% and 1% AEP events are presented in Appendix B, and the results are shown in Appendix C.

A predevelopment model was created and calibrated against the model provided by PCB until good agreement was found. The predevelopment discharge rates provided by PCB have been compared to the rates calculated in this study in Table 3-3.

Table 3-3: Predevelopment discharge rate comparison.

Event	Predevelopment discharge rate (PCB) (m^3/s)	Predevelopment discharge rate (m^3/s)	Difference (%)
10%	8.4	7.7	-8.3
5%	11.1	10.4	-6.3
2%	13.7	13.6	-0.7
1%	15.9	16.8	+5.7

Results for outflow of the predevelopment and post development catchments at the catchment outlet are summarised in Table 3-4.

Table 3-4: Discharge rates – Predevelopment and post development.

Event	Predevelopment discharge rate (m^3/s)	Post development discharge rate with modified detention basin (m^3/s)	Difference (%)
10%	7.7	7.1	-7.4
5%	10.4	9.2	-11.9
2%	13.6	10.4	-23.5
1%	16.8	12.9	-23.2

3.4 Discussion

With modifications to the previously approved detention basin volume and outlet structure, the proposed residential development will not produce an outflow larger than predevelopment flow rates.

Key points to note in the new design are:

- The new 1% AEP event top water level is 9.27m which still provides in excess of 500mm of freeboard to the lowest existing lot which is noted as R.L. 10.00m.
- The storage volume of the existing detention basin has been significantly increased to account for the increase in peak flows. However minimum cover over the existing sewer line is maintained.
- The spillway has been raised and reduced in length to ensure the flow over the spillway is no greater than that calculated in the original PCB report.

4 Stormwater Quality Management

4.1 Criteria

Treatment targets for the proposed development were adopted from MCC's MOES and are shown in Table 4-1.

Table 4-1: Stormwater treatment objectives.

Pollutant	Stormwater treatment objective
Total Suspended Solids (TSS)	80% retention of average annual load
Total Phosphorous (TP)	45% retention of average annual load
Total Nitrogen (TN)	45% retention of average annual load
Gross Pollutants (GP)	70% retention of average annual load

4.2 Methodology

The development was modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) published by eWATER Limited, which is the current best practice tool for estimating the ameliorating effects of proposed stormwater quality improvement devices (SQUIDS) in a treatment train approach.

MUSIC uses real historical continuous rainfall records (over several years) as input and compares the theoretical pollutant generation within the catchment to the final theoretical export rate (usually expressed in kg/year) to determine a treatment train effectiveness expressed in percentage points that are directly comparable to the guidelines in Table 4-1.

Stormwater quality for the existing Hillview Estate residential development was addressed in the previous water quality report. This water quality model did not cater for the proposed subdivision's catchment, so water quality improvement devices are required.

The proposed treatment train for the proposed subdivision is outlined below and displayed in Figure 7.

4.2.1 Rainwater tanks

Rainwater tanks will be the primary treatment device for all roof areas within the subdivision. Table 4-2 outlines the parameters used when modelling each rainwater tank in MUSIC.

Table 4-2: Rainwater tank parameters.

Parameter	Value
Rainwater tank volume	$3.0m^3$ (3000L)
Initial tank volume	$1.5m^3$ (1500L) (Conservatively assumed as half full at start of storm)
Re-use	0.36 kL/day (Draft NSW MUSIC Modelling Guidelines – assumed average of 3 occupants per dwelling with re-use for toilets and laundry)

4.2.2 Gross pollutant trap

A gross pollutant trap (Humes Humegard) is proposed as a secondary treatment device for the road reserve areas and any lot areas which outlet to the street drainage network. Table 4-3 provides the parameters utilised when modelling the GPT within MUSIC.

Table 4-3: Gross pollutant trap parameters.

Parameter	Value
High Flow Bypass (Treatment Flow Rate)	1.05m^3/s (assumed as a Humegard HG24, this flow will be a minimum treatable flow rate)
Total Suspended Solids (TSS) Removal Efficiency	50%
Total Phosphorous (TP) Removal Efficiency	20%
Total Nitrogen (TN) Removal Efficiency	20%
Gross Pollutant (GP) Removal Efficiency	99%

4.2.3 Grassed lined swales

Grassed lined swales are proposed at the rear of lots to convey flow from pervious areas to the drainage network and provide treatment to stormwater. Table 4-4 provides the parameters utilised when modelling the grass lined swales within MUSIC.

Table 4-4: Grass Lined Swale Parameters

Parameter	Value
Base Width	1m
Depth	0.25m
Top Width	3m
Batter Slopes	1v:4h
Longitudinal Grade	Varies
Vegetation Height	0.10m

4.2.4 Bioretention swales

Bioretention swales are proposed as a tertiary treatment device. Due to the large size of the proposed lots and the lack of proximity to an existing drainage reserve, bioretention swales are proposed along the boundary of Lots 101 and 131 where existing longitudinal grades are relatively flat. Table 4-5 provides the parameters utilised when modelling the bioretention swales within MUSIC.

Table 4-5: Bioretention Swale Parameters

Parameter	Lot 101 Bioretention	Lot 131 Bioretention
Invert Surface Area	125m^2 (5m x 25m)	150m^2 (3m x 50m)
Extended Detention Depth	0.3m	0.3m
Filter Media Surface Area	120m^2	145m^2
Filter Media Depth	0.4m	0.4m
Filter Media Saturated Hydraulic Conductivity	180mm/hr	180mm/hr

4.3 Results

The MUSIC model layout is provided in Appendix D. The achieved pollutant retention achieved by the treatment train is provided in Table 4-6.

Table 4-6: Achieved pollutant retention.

Pollutant	Average Annual Surface Generation	Average Annual Export	Achieved Reduction (Pollutants Retained)	Target Reduction (Pollutants Retained)
Total Suspended Solids (TSS; kg/year)	1810	225	87.5%	80%
Total Phosphorous (TP; kg/year)	4.39	2.40	45.2%	45%
Total Nitrogen (TN; kg/year)	42.9	18.2	57.6%	45%
Gross Pollutants (GP; kg/year)	448	0	100%	70%

4.4 Discussion

The proposed treatment train achieves MCC's stormwater treatment objectives for the proposed development. The above results indicate the proposed stormwater drainage strategy will produce an outcome for the proposed development that complies with Council's standards for water quality control.

5 Summary and Conclusions

The strategy for management of stormwater runoff for the proposed development includes:

- Capture of stormwater from lot and road areas by conventional pit and pipe networks located in the street or in inter-allotment drainage where required.
- Increasing the volume of the previously approved detention basin at the catchment outlet to the north of the Site as opposed to constructing a separate detention structure within the Site. It is also proposed to modify the existing outlet structure and spillway.

Post development outflows are less than or equal to predevelopment outflows for all events. The development will not increase the risk or likelihood of mainstream erosion in smaller flood events or flooding in larger events.

Water quality modelling indicates that a treatment train approach including a GPT, grass lined swales and bio-retention swales will allow the proposed development to meet regional guidelines for the best practice of TSS, TN, TP, and GP (80%, 45%, 45% and 70%, respectively).

Based on this report, stormwater management and flooding are successfully managed in accordance with MCC guidelines by improving the storage volume of the existing basin and limiting Council's long-term maintenance.

Figures

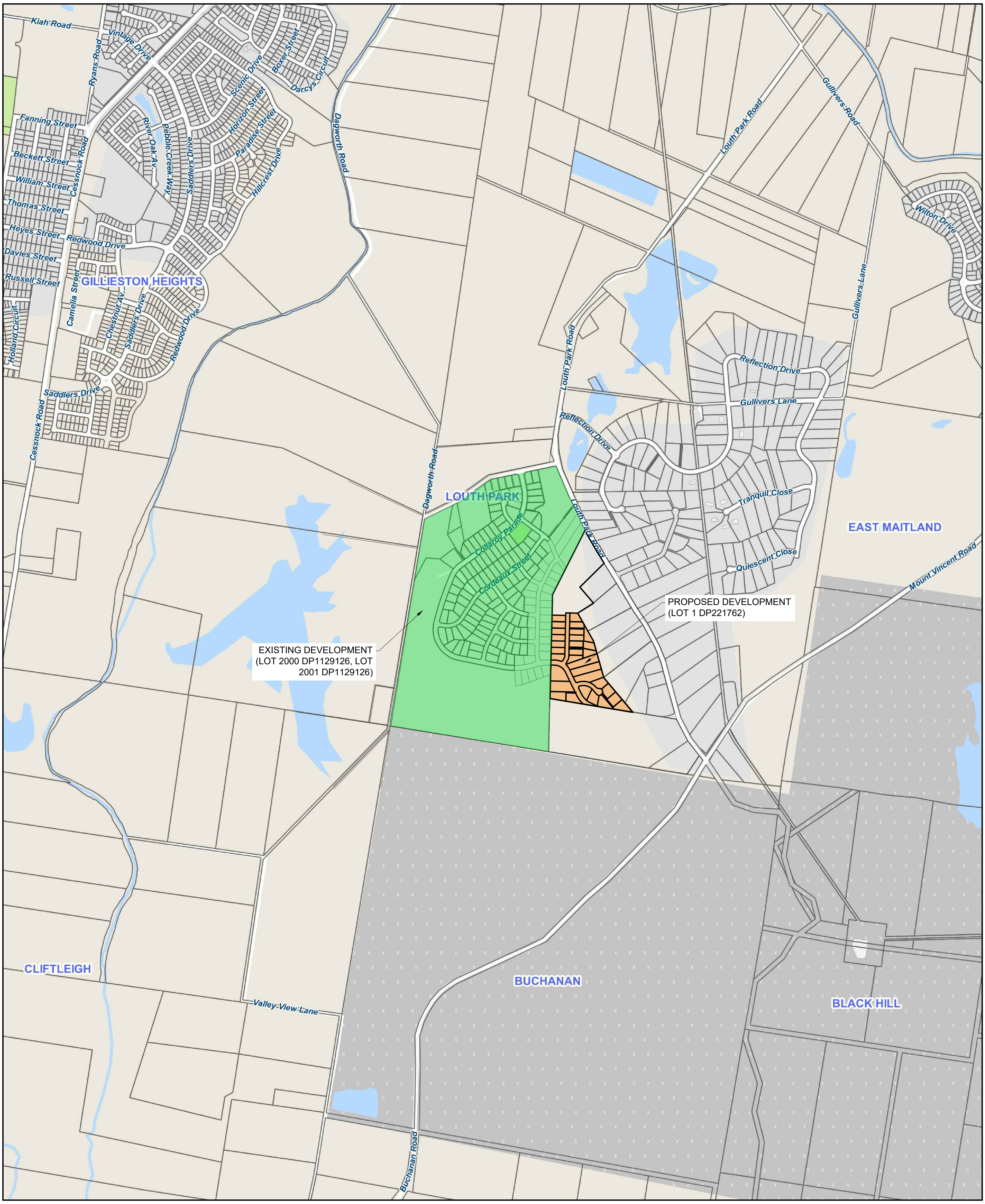
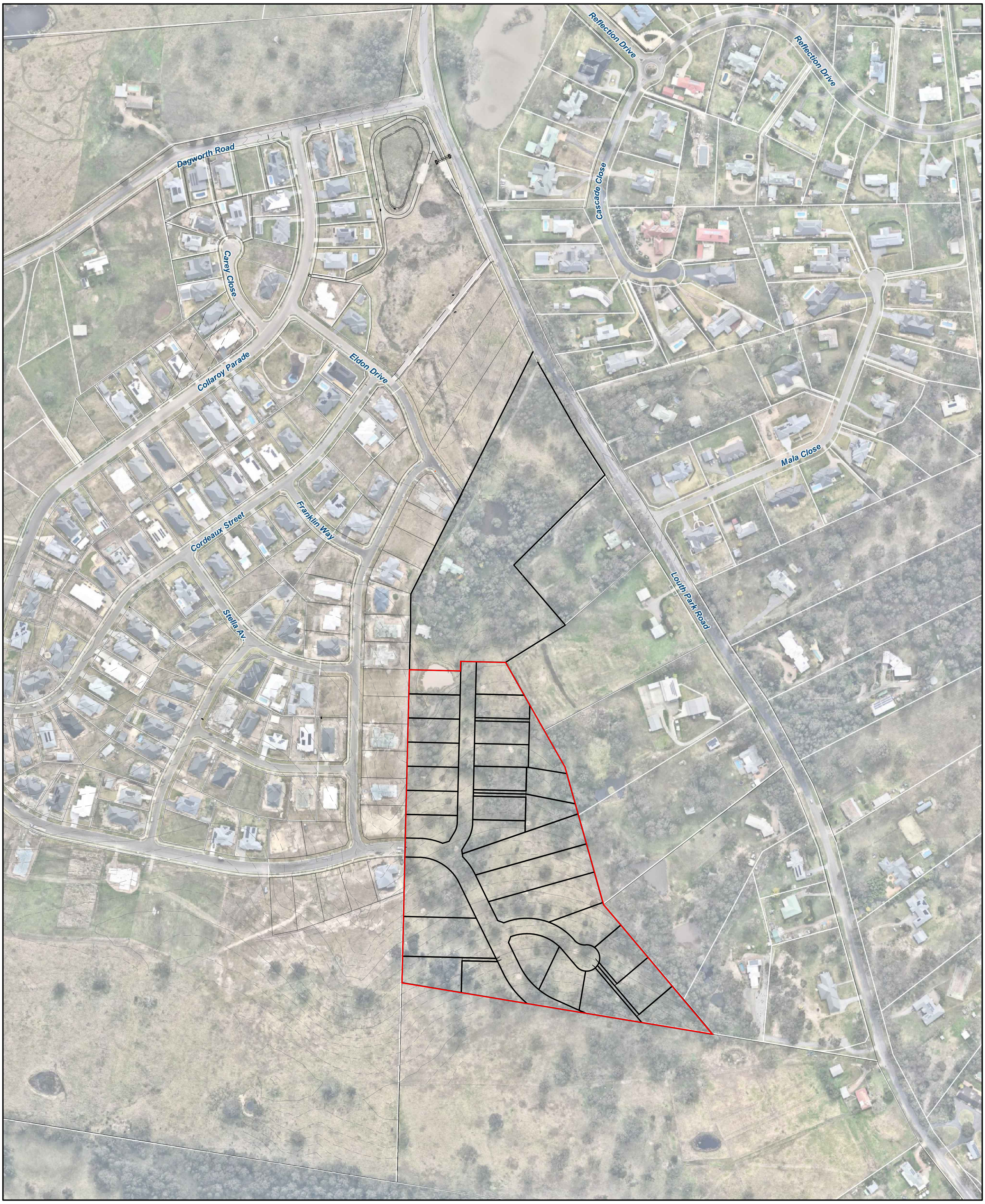


FIGURE 1
LOCALITY PLAN

1:15000 — 0, 300, 600, 900 m

DATE: 02/11/22

DWG REF: 21360C F01 LOCALITY r1



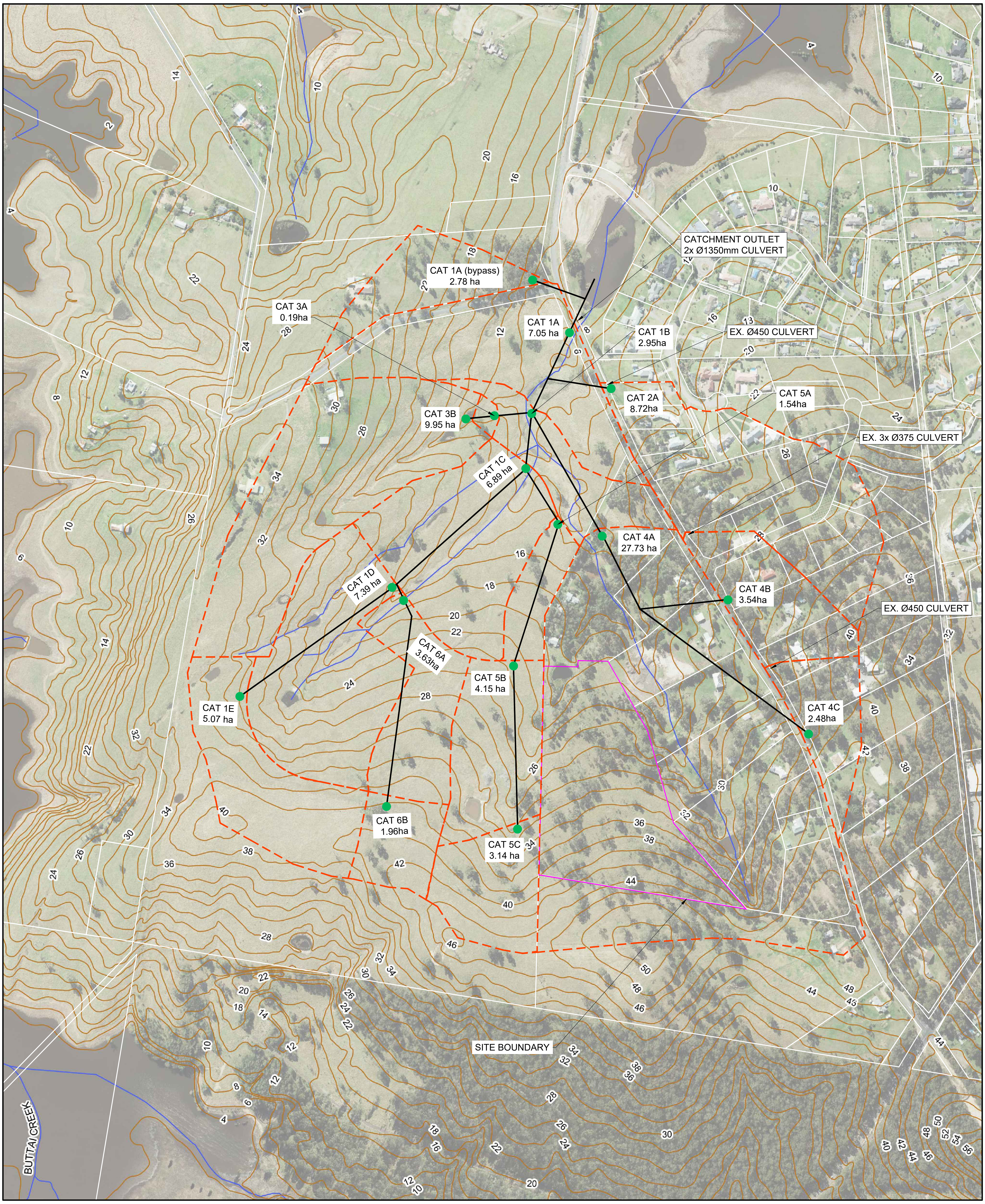
LEGEND

MAJOR NATURAL CONTOURS (5m INTERVAL)

FIGURE 2
SITE PLAN

1:4000 — 0, 80, 160, 240 m

DATE: 02/11/22



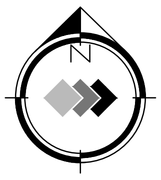


FIGURE 3
PREDEVELOPMENT CATCHMENT PLAN

1:6000 0 120 240 360m

DATE: 02/11/22

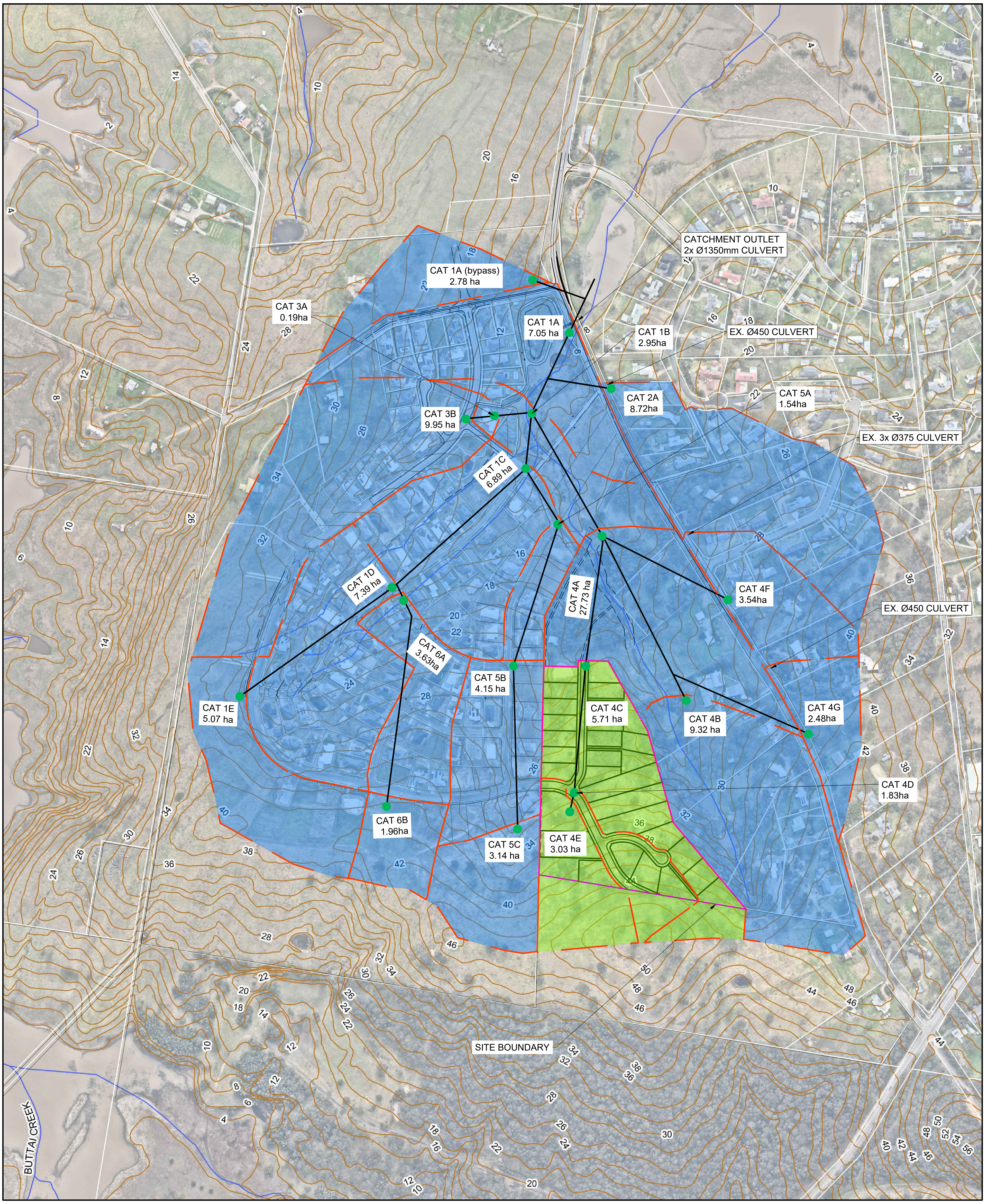


FIGURE 4

POST DEVELOPMENT CATCHMENT PLAN

1:6000 0 120 240 360m

DATE: 02/11/22

DWG REF: 21360C F04 POSTDEV CATCHMENT r1

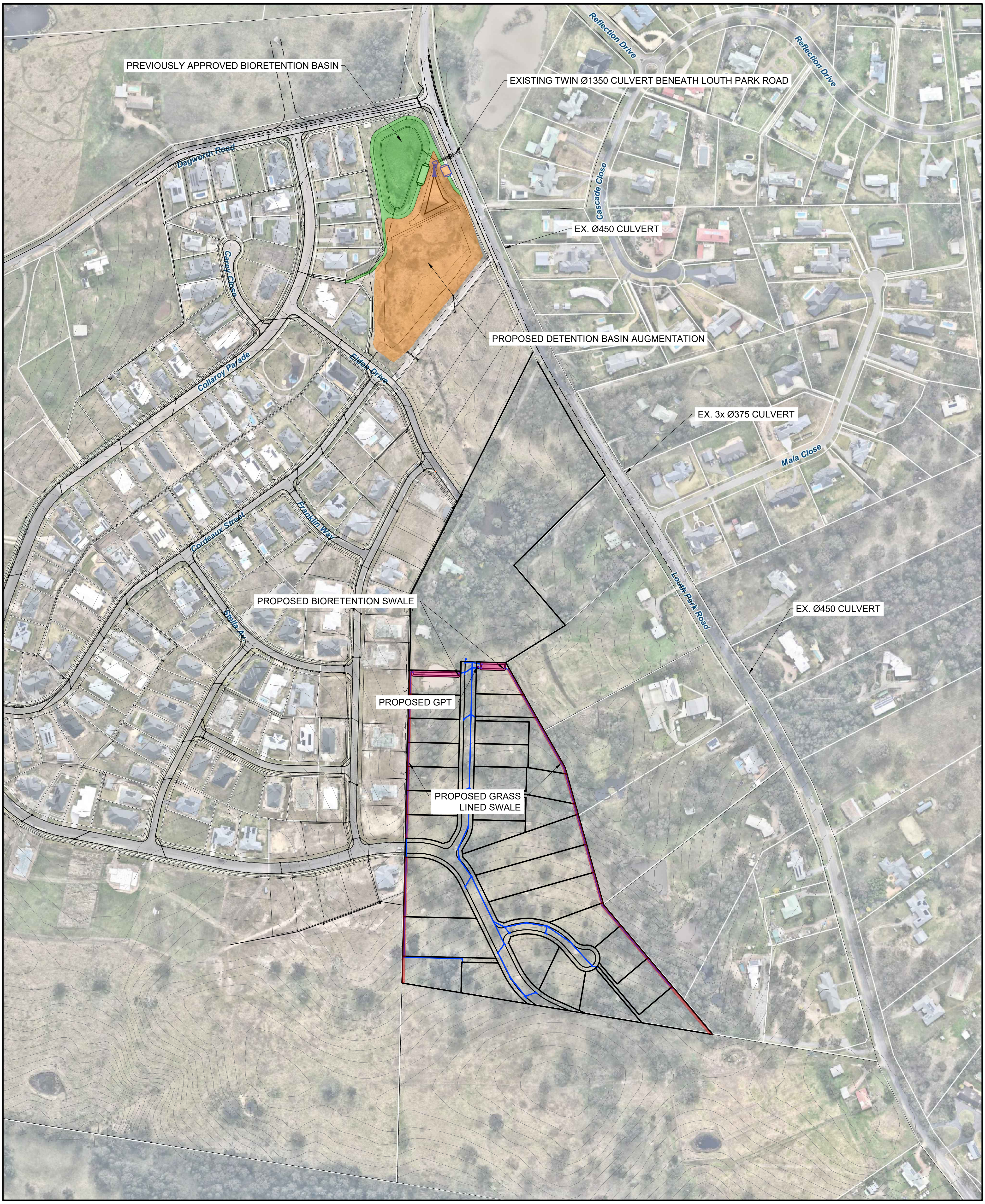
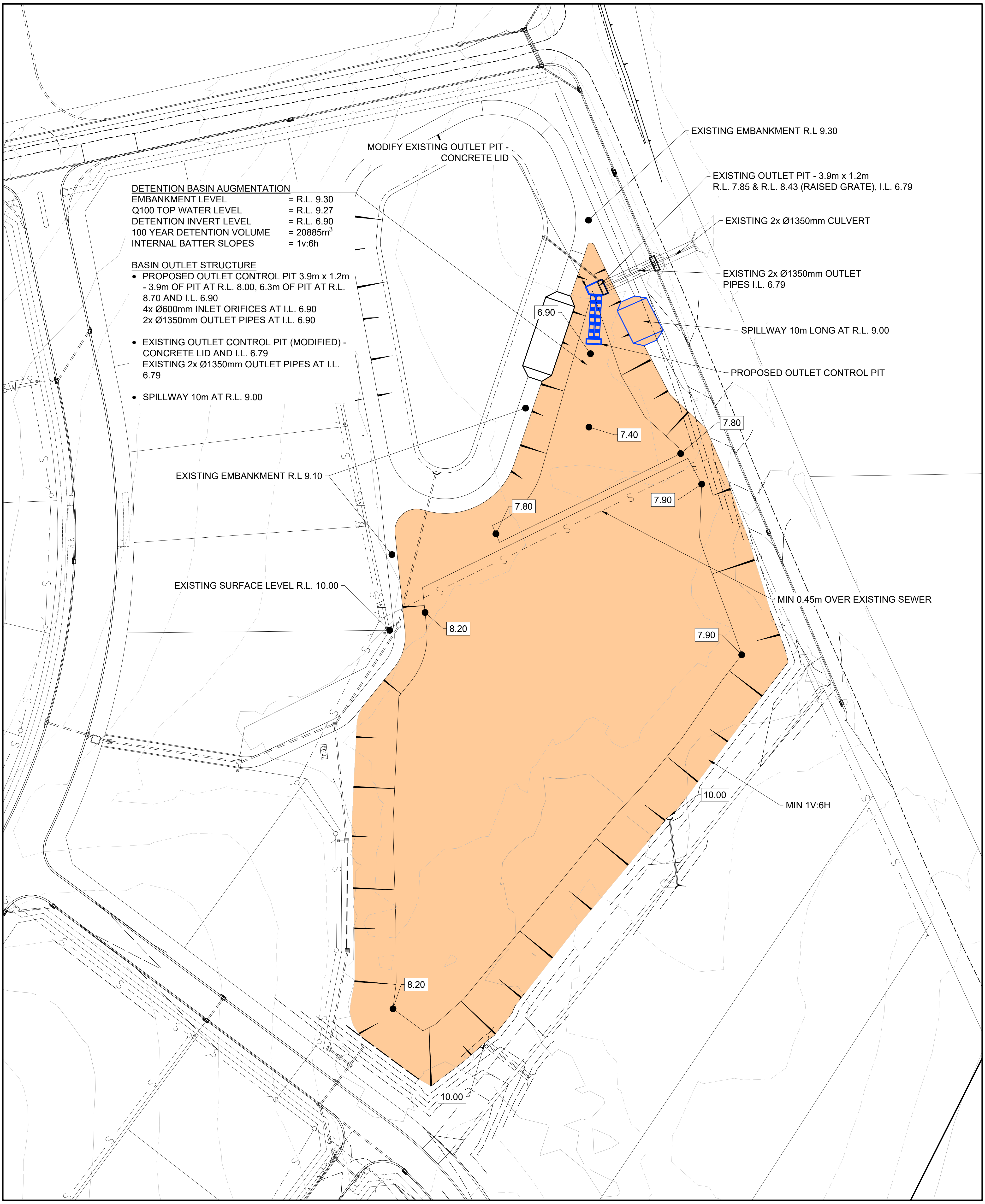


FIGURE 5
STORMWATER MANAGEMENT PLAN

1:4000 0 80 160 240 m

DATE: 02/11/22

DWG REF: 21360C F05 STORMWATER MGT PLAN r1



LEGEND

PROPOSED WORKS

FIGURE 6
PROPOSED BASIN AUGMENTATION

1:4000 0 80 160 240 m

DATE: 02/11/22

DWG REF: 21360C F06 BASIN AUGMENTATION r1

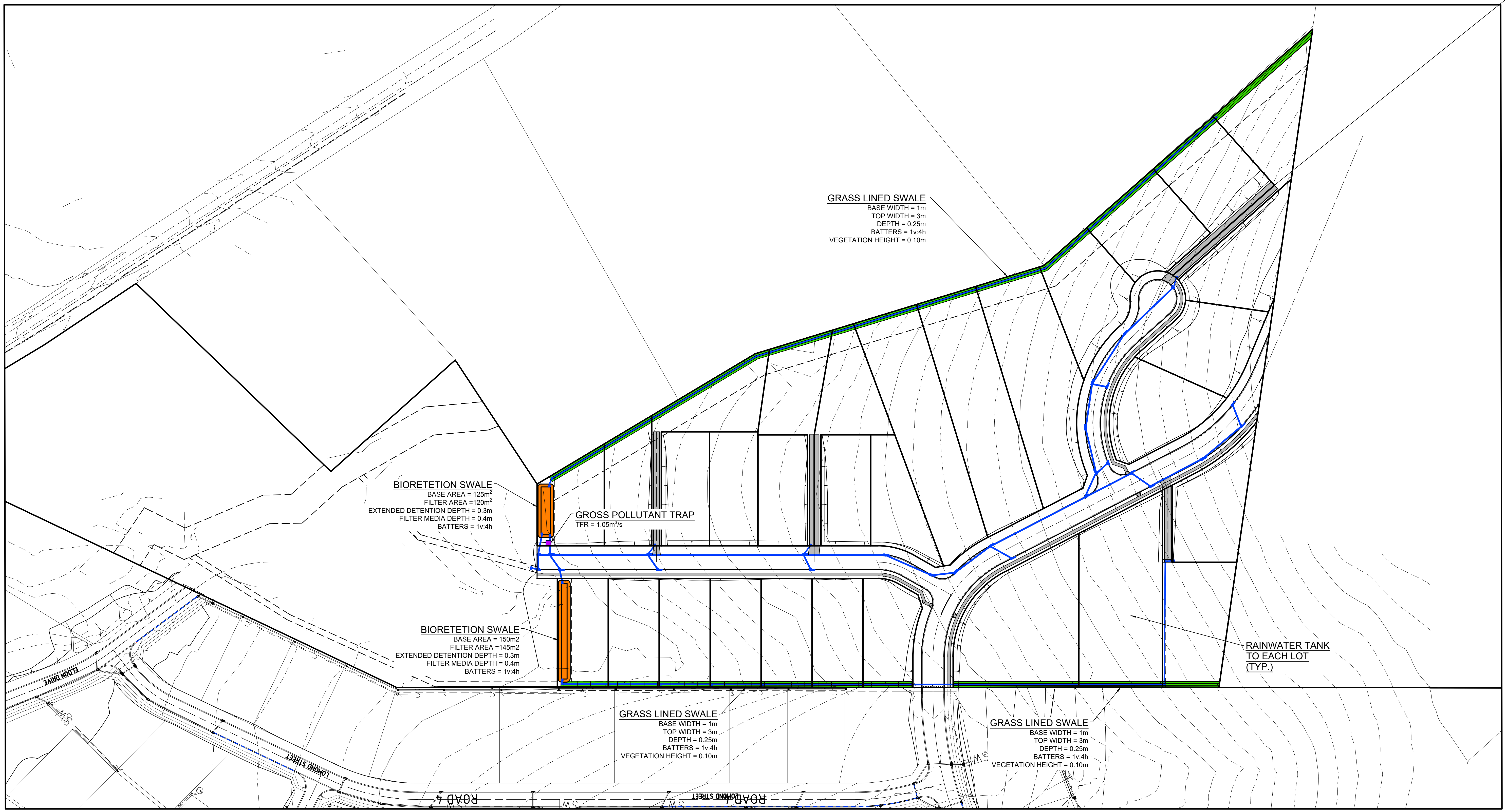


FIGURE 7
WATER QUALITY PLAN

1:1000 0 20 40 60 m

DATE: 03/11/22

Appendix A

PCB Water Cycle Management Report

FLOOD STUDY AND WATER CYCLE STRATEGY FOR PROPOSED RESIDENTIAL DEVELOPMENT

DAGWORTH ROAD AND LOUTH PARK ROAD LOUTH PARK

Project: 13/30
November 2016

PREPARED FOR:

Valhalla Investments

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Report Title:	**Flood Study and Water Cycle Strategy**
Project:	Lots 2000 & 2001 DP 1129126 314 Dagworth Road, Louth Park
Reference:	13/30
Client:	Valhalla Investments
Prepared For:	Maitland City Council
DA/CC Reference:	-
Document Number:	92153
Draft/Final:	For DA lodgement

Document Register

Issue	Details of Change	Prepared	Reviewed	Date
A	Initial Issue	BC	--	16/12/2015
B	Revised Lot Layout and Drainage Strategy	BC	DE	05/08/2016
C	Revised Layout/Bio-retention design	BC	DE	19/12/2016

EXECUTIVE SUMMARY

This flood and storm water strategy has been prepared on behalf of Valhalla Investments to support a proposed residential subdivision at Louth Park. The study considers the stormwater impacts with respect to Maitland City Council's (MCC) planning controls to ensure the development will not negatively impact the local or regional environment.

The proposal has been planned and designed to suit the site constraints and appropriately managed using source, conveyance and discharge controls that satisfy planning guidelines. A portion of the subject land is affected by backwater flooding from the Hunter River as well as local flooding due to flows from the watercourses within the site.

The proposal utilises conventional pit and pipe conveyance to the site outlets, where water quality is improved through a treatment train including a gross pollutant trap, bio-retention basin and detention basin before discharge offsite. A MUSIC model was prepared to simulate the performance and treatment train effectiveness of the adopted system with respect to MCC's treatment targets. The results summarised below show that water quality is satisfactorily treated to MCC's Stormwater Treatment Targets.

	% Reduction	Target Removal	Objective Met
Total Suspended Solids (<5mm)	85%	80%	Y
Total Phosphorus	51%	45%	Y
Total Nitrogen	45%	45%	Y
Gross Pollutants	99%	100%	Y

Managing the flood peak is not only essential for ensuring that local site flooding is minimised, but to ensure that urbanisation will not cause an increase in flows, exacerbating downstream flooding conditions. Results from the hydraulic simulation, presented below, show that the proposed stormwater controls will significantly reduce peak site discharge from the development.

SUMMARY	1YR	5YR	10YR	20YR	50YR	100YR
	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
Pre-developed Peak	1.96	6.40	8.36	11.06	13.73	15.88
Developed Peak	1.94	6.22	7.29	8.60	9.65	10.27

This study shows that the environmental impacts associated with urbanisation are either reduced, minimised or managed in accordance with MCC's Engineering Guidelines and planning controls.

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1.0 INTRODUCTION

This flood study and water cycle strategy has been prepared on behalf of Valhalla Investments to support a development application for a 176 lot rural residential subdivision at Louth Park. Increased density associated with urban development of the land will see impacts on the water quality, aesthetic and recreational value of the land. The proposed development will be subject to Maitland City Council's Development Control plans and Manual of Engineering Standards. This study considers stormwater in the context of water cycle management.

Increased development activity on the proposed site will tend to decrease the quality of stormwater runoff through higher pollutant loads and sediments. Managing these risks through water quality treatment facilities will reduce the impact of this development on downstream waterways. This strategy will outline the impacts of such treatment controls and recommend a solution that satisfies the development objectives.

Stormwater detention is usually required in developments to reduce and delay the stormwater flow peak arriving at the system outlet. Without stormwater detention, increased peak flows would negatively impact downstream properties through increased flood inundation and erosion. This study considers a scheme of stormwater controls as a means of managing water quantity and therefore the downstream flood risks.

Any adopted stormwater management controls within a development will require on-going maintenance. As this burden will be carried by Maitland City Council, consideration has been given in this report to the appropriate selection based on maintenance and ongoing cost.

The subject land is situated in an area subject to inundation due to floodwaters and is also intersected by natural watercourses that channel water from a catchment which extends beyond the limits of the land. An assessment is made in this report to the quantity of storm water draining onto and beyond the site and the means by which this water will be safely managed.

1.1 OBJECTIVES

The following objectives are identified in the DCP as guiding subdivision design with respect to the stormwater impacts:

- Provide an effective stormwater management system that is sustainable and requires minimal maintenance;
- Protect and enhance water quality/quantity and habitat value of downstream waterways and environment;
- Prevent erosion and runoff during site preparation, construction and ongoing use of the land to minimise cumulative impacts on receiving waterways;
- Retard the flow of water into the natural drainage system and mitigate impacts from stormwater runoff, ensuring that the rate of post-development stormwater discharge is no greater than the pre-development stormwater discharge;
- Cater for flows entering the site and ensure that there are no adverse effects from flows leaving the site;
- Encourage the use of rainwater tanks as a means of reducing separate stormwater detention requirements and achieving more sustainable water re-use within the dwelling and for landscaping purposes;
- Ensure that drainage systems are designed for safety and that the systems avoid any potential for stormwater inundation of habitable floor areas;
- To maintain and enhance the quality of water and catchment health.

2.0 THE DEVELOPMENT

A proposed plan to subdivide one parcel of rural land into approximately 176 rural residential lots at Louth Park is to be submitted to Maitland City Council (MCC) for assessment and approval. The land, defined by Lots 2000 and 2001 DP1129126 is located at 314 Dagworth Road, Louth Park. The property is substantially surrounded by large lot rural land, with the exception of smaller lots being part of Waterford Estate to the east.

Vehicular access to the proposed development will be off Dagworth Road, which has an intersection with Louth Park Road at the northern corner of the site. The subject land is highlighted in Exhibit A.

The subject land is contained to the central precinct of the Louth Park Urban Release Area (URA), which stretches from Dagworth Road south to the ridge and east along the southern boundary of the subject land.

2.1 SITE DESCRIPTION

The subject land is vacant and currently used for livestock grazing. Ground cover over the surface contains grasses being largely cleared of vegetation. Topography of the subject land is gently sloping towards a number of small watercourses over an elevation range from RL46m to RL6m Australian Height Datum (AHD). Soils occurring on site are assumed to contain high clay content and therefore of low infiltration potential.

Lot 520 DP563545 fronting Dagworth Road is to remain as a standalone parcel surrounded by the development. The proposed drainage reserve in the northern corner of the subject land will contain a raised embankment for online detention control and an off-line bioretention basin for water quality control.

2.2 STORMWATER CATCHMENTS

The subject land drains to a low point in the northern corner adjacent to Louth Park Road and Dagworth Road which then flows through an existing twin cell culvert under Louth Park Road before draining out to a series of wetlands adjacent to Waterford Estate. These wetlands are connected to a tributary of Wallis Creek that drains to the Hunter River near Horseshoe Bend.

The western extent of the catchment coincides with a ridge that approximately continues along the line of the unformed crown road on the western boundary of the site. The eastern extent of the catchment extends toward Mount Vincent Road to the south east.

A portion of this catchment drains from the eastern side of Louth Park Road through roadside table drains before being piped under the road at three locations. The total 101ha contributing catchment is presented in Exhibit B.

Stormwater Catchments - Precinct

Exhibit B shows the entire catchment extents defined by the outlet culvert under Louth Park Road. This catchment is further subdivided into the central and southern precincts, relatively consistent with the precincts of the Louth Park URA. The southernmost extent of the northern precinct is assumed to have separate water quantity and water quality controls. Stormwater controls discussed through the remaining sections of this strategy are designed for the central precinct only. Runoff from the catchments on the eastern side of Louth Park Road and northern side of Dagworth Road are included in the storm water modelling but are assumed to have separate on-site controls. The modelled impervious fraction for these peripheral catchments was set to zero for both the pre-developed and developed scenarios.

Table 2.1 Catchment Summary

	Area (ha)
Louth Park North precinct draining to Node 'A'	5.70
Louth Park Central precinct	55.73
Louth Park Southern precinct	25.40
Louth Park Combined central/southern	81.13
East of Louth Park Road draining to Node 'A'	14.80
Pre-developed Model – Total Area	101.6
Developed Model – Total Area	101.6

A summary of the catchments considered in the analysis, shown in Exhibit B, are presented in Table 2.1. The modelled impervious fraction adopted for the developed site model, which includes the southern precinct, are presented in Table 2.2.

Table 2.2 Model Impervious Fraction (F/I)

	Per Lot F/I	Per Lot Area	Ratio of Total Precinct
Large Lot Rural (4000m^2 minimum area)	20%	800	33%
Small Lot Rural (1500m^2 minimum area)	40%	600	46%
Roads	55%	-	12%
Drainage Reserve	0%	-	7%
Developed Site Fraction Impervious Central Precinct	28%	Impervious Area = 15.54ha	

The modelled developed site Fraction Impervious was determined from the ratio of cumulative impervious surfaces for each sub-catchment across the total catchment, divided by the total catchment area. This figure was confirmed by adding the impervious road surfaces, in Table 2.3 and the impervious lot surfaces in Table 2.4.

Table 2.3 – Summary of Road Impervious Areas

	Width(m)	Length(m)	Area (ha)
ROAD1	12	1355	1.626
ROAD2	8	368	0.294
ROAD3	8	605	0.48
ROAD4	8	456	0.365
ROAD5	8	128	0.102
ROAD6	8	243	0.194
ROAD7	8	260	0.208
ROAD8	8	187	0.15
ROAD9	8	108	0.086
DAGWORTH ROAD	11	450	0.495
LOUTH PARK ROAD	14	360	0.504
TOTAL IMPERVIOUS			4.51 ha

Table 2.4 – Summary of Lot Impervious Areas

	No. Small Lots 600m^2	No. Large Lots 800m^2	Total for Stage
STG1	35	0	35
STG2	27	3	30
STG3	27	0	27
STG4	29	0	29
STG5	27	0	27
STG6	0	8	8
STG7	0	15	15
STG8	5	0	5
TOTAL	150	26	176
AREA	9ha	2.08ha	11.08ha

Commentary on Sub-Catchment Modelling

Inter-allotment drains were typically modelled to receive catchment flows from the full lot using the fraction impervious percentages as outlined in Table 2.2. Some minor concentrations of flow will occur along the boundary lines associated with earthworks immediately surrounding dwelling construction and these are represented in the sub-catchment modelling. This assumption results in the inter-allotment system being adequately sized for the worst case scenario, where future development on lots would direct all runoff to the IAD system.

3.0 PLANNING GUIDELINES

3.1 MAITLAND CITY COUNCIL

Developments within the Louth Park Urban Release Area (URA) are subject to Council's Development Control Plan (DCP Part F) as well as the general provisions of Design Part C[(1)] and Environmental Guidelines Part B[(2)]. One of the general provisions of Subdivision Design is "to ensure that the principles of Ecologically Sustainable Development (ESD) are applied to the design of subdivisions and subsequent housing."

Domestic Development

Future domestic housing construction on the subject land, once the subdivision works are complete, would be subject to the general requirements Council's DCP Part B[(2)]. Domestic stormwater must be controlled through the use of on-site stormwater harvesting and retention systems to the requirements of the NSW State Government's Building Sustainability Index (BASIX). The implementation of stormwater harvesting on-site ensures a controlled release of stormwater from each allotment through to Council's street or Inter-allotment drainage system. The connection of internal harvested rain water and disposal of overflow from these systems would be designed and constructed by future developers in accordance with AS3500.3 (2005).

Subdivision Development

Council's objectives for planning a stormwater system are summarised in the objectives in Section 1.1. These objectives are achieved and detailed in the remaining sections of this Flooding and Storm Water Strategy. Principles for subdivision design are provided in Council's Manual of Engineering Standards[(3)].

3.2 OFFICE OF WATER

The 1:25,000 scale aerial photo and topographic map prepared by the NSW Land and Property Information (LPI) shows three watercourses within or across the subject land. The watercourse of interest to the NSW Department of Primary Industries – Office of Water (DPI Water) is a second order stream as classified under the Strahler System of ordering watercourses. The DPI Water Riparian Corridor Matrix[(4)] allows for on-line detention basins, road/culvert crossings and stream re-alignment for second order streams. Referral with DPI Water was sought as part of integrated development application and preliminary advice was issued on the 8th of February 2016. In this correspondence, the DPI Water advised that on-line detention is permissible, provided that:

- The Basin must be dry and vegetated;
- The Basin must be for temporary flood detention only, with no permanent water holding;
- The Basin have an equivalent Vegetated Riparian Zone for the corresponding watercourse order;
- The Basin must not be used for water quality treatment purposes.

The proposal outlined in Sections 4-8 provides for an off-line water quality basin, beyond the limits of the Vegetated Riparian Zone. On-line storage will be provided upstream of the embankment.

A separate application would be required for a controlled activity approval (CAA) under the Water Management Act for any works within 40m of the easternmost watercourse of interest to DPI Water.

4.0 WATER CYCLE MANAGEMENT STRATEGY

Proposals such as this study require a planning approach adopting water cycle management, which includes source, conveyance and discharge controls. Construction related impacts are also identified as relevant to the proposal.

4.1 WATER CYCLE MANAGEMENT

Water Harvesting and Re-Use

The principles of storing rain water on site through above or below ground rainwater tanks have been shown to have a beneficial effect through reduced mains water (potable) demand and decrease in storm water runoff, to counter the impacts of urbanisation. Rainwater tanks are typically required for residential development to comply with the NSW State Government's Building Sustainability Index (BASIX) requirements to provide water efficiency among other building efficiency measures. Rainwater tanks are not considered in hydrological modelling or water quality modelling for the purposes of this report.

Water Infrastructure

Potable water will be supplied through the development to provide adequate water pressure for drinking water and fire-fighting purposes. This is to be separately considered as part of an application for Section 50 Certificate under the Hunter Water Act 1991.

Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) is considered as part the whole life of a development, including the planning phase. The principals of WSUD include consideration to improving water efficiency, water harvesting, reducing impervious surfaces, and implementation of stormwater controls as part of a subdivision design to reduce stormwater runoff and improve stormwater quality.

4.2 EROSION AND SEDIMENT CONTROLS

Temporary measures adopted to control erosion during the construction phase would be maintained by the civil works contractor. This may include a sediment fence or bund on the lots to minimise sediment transfer until the turf or grass is established. Diversion banks or cut-off drains may also be formed for the construction phase to limit mixing of dirty and clean water for the period where the site is disturbed during bulk earthworks. A Soil and Water Management Plan would be required prior to commencement of construction works in accordance with the Blue Book(5) so as to prevent erosion and runoff during site construction to minimise impacts on receiving waterways.

4.3 STORMWATER MANAGEMENT CONTROLS

Controls are devices, structures or materials used to contain, convey or treat stormwater. These are divided into source, conveyance and discharge controls. The following controls may be implemented in a stormwater management plan. The following controls may be implemented as part of the future design of the subdivisions:

Table 4.1: Stormwater Management Controls

Control	Effect
	Conveyance Controls
These controls are the link between the source and the outlet controls, and include:	
Roads, kerb & gutter	As required by Maitland City Council's Manual of Engineering Standards, kerb and gutter is required on both sides of the road carriageway, as a clear edge to the pavement in an urban environment. The conventional approach is to use the gutter to intercept runoff from the lots and road and direct this runoff toward a kerb inlet pit. A network of underground pipes conveys this water to the outlet.
Inter-Allotment Drains (IAD)	Any lots that cannot adequately drain to the street will have an inter-allotment drainage line with an inlet pit installed in the lowest corner of the lot. These IAD lines connect to the pipes under the roads.
	Discharge Controls – Primary Treatment
Gross Pollutant Trap (GPT)	Gross pollutant traps are proposed for the end of the conveyance system, prior to discharge to the outlet structures. A GPT may capture any combination of coarse sediment, litter, sludge, oil and grease, depending on the configuration and installation. A Proprietary GPT's will be specified on the construction plans.
	Discharge Controls – Secondary Treatment
Bio-retention Basin	By storing stormwater in an above-ground basin and slowly releasing the water, the peak flow and velocities can be decreased to an acceptable limit. The floor of the detention basin will be generally dry, and planted with select species over an engineered soil media that will reduce nutrient concentrations for stormwater outflows.
	Discharge Controls – Tertiary Treatment
On-line Detention Basin	By storing stormwater in an above-ground basin and slowly releasing the water, the peak flow and velocities can be decreased to an acceptable limit. The basin will drain to empty and be vegetated with species suitable for short-term periodic inundation of floodwater.

4.4 STORMWATER MANAGEMENT PLAN

In accordance with MCC's planning guidelines, a Stormwater Management Plan has been prepared as part of a development application lodgement with Council. This plan, presented in **Exhibit C**, shows a combination of stormwater controls to mitigate the effects of flooding, and treatment of nutrients to ensure the stormwater leaving the subject land satisfies the development objectives. Further discussion to the effectiveness of these controls is included in the following sections of this strategy.

Adopting a combination of controls in a sequence is an acceptable form of management. A treatment train has been adopted as part of the Stormwater Management Plan and includes the following controls:

Development→Gross Pollutant Trap→Bio-retention Basin→Detention Basin→Outlet

Primary Treatment – Gross Pollutant Trap

Installed within the roadway for easy access and maintenance, this structure will have a trash rack for litter removal and a sump for coarse sediment capture. The Gross Pollutant Trap will be installed as a proprietary in-ground structure prior to discharge to the secondary treatment.

Water Quality Control – Bioretention Basin

Piped drainage from the roads discharges to the bio-retention basin aligned along the western edge of the drainage reserve. The bio-retention basin has been designed with 450mm filter depth, 150mm transition layer and 200mm drainage layer. A subsoil drainage system, at a level approximately 800mm below the bio-retention basin floor, will drain to the culvert outlet. The bio-retention basin is designed to store up to 200mm depth before discharge occurs to the outlet.

Stormwater Detention Basin

A raised embankment will be constructed adjacent to Louth Park and Dagworth Roads, to provide on-line detention storage of the main watercourse immediately upstream of the road crossing. Construction of the embankment will be considered under geotechnical design and construction supervision, with a clay core and cut-off walls to limit piping failure of the embankment. The embankment will be constructed to a level at RL9.3m AHD. The twin cell 1350mm diameter culvert under Louth Park Road will be extended to a new oversize kerb inlet pit under the proposed kerb line and further extended under the embankment to provide the outflow for the watercourse under the embankment.

The ground surface upstream of the embankment will be landscaped as a vegetated riparian zone. No additional regrade is anticipated within the remainder of the drainage reserve.

Details of the outlet structure from the watercourse are outlined on the Concept Engineering Plans.

5.0 HYDROLOGY & FLOOD MODELLING

A small portion of land along the northern boundary of the subject site is mapped as flood prone by Council. This relates to flooding associated with the Hunter River and flows in the watercourse due to a locally occurring extreme weather event.

5.1 FLOOD LEVELS – REGIONAL EVENT

Peak water levels within Swamp Creek and Wallis Creek are hydraulically governed by tail water levels due to flooding from the Hunter River. The adopted tail water levels, as outlined in Table 5.1, were provided by Maitland City Council.

Table 5.1: Adopted Flood Levels (mAHD) – Dagworth Bridge

	1% Annual Exceedance Probability (AEP)
Flood Level (Adopted)	**9.73**

Excavation below natural ground levels for the bio-retention basin will result in an increase in the flood storage upstream of Louth Park Road. A regional flood will cause backwater flooding through the Louth Park Road culvert and into the Drainage Reserve. All of the lots, with the exception of the three large lots fronting Louth Park Road, are flood-free. Flooding associated with the regional event is viewed as being discreet to flooding associated with the local event.

6.0 WATER QUALITY

Frequent, low-intensity rainfall events tend to mobilise harmful pollutants such as suspended solids, nutrients and litter into the stormwater streams. Best management practice suggests water quality controls are designed to treat stormwater runoff from the frequent rainfall events.

6.1 WATER QUALITY ANALYSIS

Water quality modelling was performed in the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) program, which uses temporal (time variable) rainfall data to simulate stormwater runoff and pollutant concentrations through a continuous time series. Unlike hydrological/hydraulic modelling based on event rainfall, for example temporal patterns of rainfall bursts as outlined in Australian Rainfall and Runoff (AR&R), MUSIC continuously models the pollutant loads through the treatment train to determine mean annual loads and effectiveness of the water treatment controls over one or more years. This approach is determined to be the best practice for simulating stormwater quality, as pollutant concentrations tend to be randomly sampled about a log-normal distribution.

MUSIC simulated results can be provided in the form of treatment train effectiveness, and directly compared with MCC's water quality standards(3), as listed in Table 6.1. These standards are represented as a percentage target removal for each treatment category.

Treatment Controls

Gross pollutants and course suspended sediment are to be treated in a trash rack and sump prior to discharge to the basin. This was modelled by a GPT device with 98% capture efficiency for gross pollutants and 40% capture efficiency for coarse suspended sediment.

The bio-retention basin was modelled as a bio-retention node, with surface area and filter parameters consistent with the concept design. The bioretention node utilised the default Continuously Stirred Treatment Reaction (CSTR) cell configuration. Rainwater tanks for each lot were not modelled for simplicity. The MUSIC model schematic and treatment node parameters are provided in Appendix A.

Results

The modelled mean annual concentrations for each pollutant type; Total Suspended Sediment (TSS), Total Phosphorus (TP), Total Nitrogen (TN) and Gross Pollutants (GP) are presented in Table 6.1 for each treatment node, to demonstrate the effectiveness of each treatment node.

Table 6.1: MUSIC modelling analysis

	TSS	TP	TN	GP
	(ML/yr)	kg/yr	kg/yr	kg/yr
Combined				
Catchment (SOURCE)	19800	46	398	5360
Tertiary Treatment	3000	23	220	42.4
%Reduction at Receiving Node (Residual)	85%	51%	45%	99%
Target Reduction	80%	45%	45%	70%
Target Met	Yes	Yes	Yes	Yes

MUSIC model results presented in Table 6.1 shows the treatment train effectiveness due to the combined impact of the treatment train. Reduction ratios fall within or greater than the target removal efficiencies as per MCC's water quality standards.

7.0 WATER QUANTITY

Urbanisation of a catchment tends to increase flows, which results in greater flooding risks downstream. The development can be regarded as satisfying water quantity control measures if the developed peak stormwater discharge is no greater than the pre-developed peak stormwater discharge. By providing detention storage and sizing an outlet structure that releases water in a controlled manner, the peak stormwater flow from a defined storm event can be shown to be sufficiently reduced to be less than the pre-developed flow targets.

7.1 FLOOD/FLOW MODELLING

A computer model was established intrinsically with the 12d dynamic drainage module, which uses event-based simulation of storm events to determine the runoff quantities, before simulating through pipe and drainage network. 1, 5, 10, 20 and 100 year Average Recurrence Interval (ARI) rainfall events were used as inputs to the 12d drainage network model. Appendix B shows the analysis of the same broad-scale catchment area simulated in an alternate hydrological model (RAFTS). This modelling was shown to be relatively consistent for each of the modelled storms for larger duration storm events.

Water quantity is typically measured in peak volumetric flow rates for both the pre-developed and developed site for a range of storm frequencies and durations. The cumulative storm water volume for each outlet are represented by outlet hydrographs.

7.2 HYDROLOGY

Hydrology was based on the ILSAX model as implemented in 12d software's dynamic drainage modules. The functionality of 12d enables the hydrology to be calculated at each node before being 'routed' through the 1D drainage network using the full St Venant equations. The modelling also includes non-uniform gradually varied flow in open channels. Once depression stores and infiltration losses are removed from the rainfall, the remainder of the water depth is routed to runoff by the time-area method, the rate of which is defined by the time of concentration.

Rainfall

Rainfall at each node was simulated from temporal patterns for storm events ranging from 20 minutes through to 720minutes in the design storms in accordance with Australian Rainfall and Runoff(6). The average rate of rainfall was provided by the standard Intensity Frequency Duration tables for the Louth Park area.

Fraction Impervious

The pre-developed site was modelled with an impervious fraction of zero. Development within the central and southern precincts of the Louth Park Urban Release Area was modelled with fraction impervious values as outlined in Table 2.2.

Loss Model

Horton infiltration (ILSAX) was utilised for a soil type of 3.5, and Antecedent Moisture Condition (AMC) of 3, representing relatively wet conditions prior to start of storm.

The comparison RAFTS model utilised initial loss values of 1mm for the impervious surfaces and 0mm for the pervious surfaces, whilst the continuing loss value adopted for the pervious surfaces was 4.5mm/hr. This is relatively consistent with the asymptote of the ILSAX soil/loss model.

Time of Concentration

Time of concentration for each of the model nodes was based on the Kinematic Wave equations adopted in AR&R(4). The surface roughness coefficients adopted was n=0.021 for urban lots and n=0.035 for residue rural lots in accordance with MoES(3). The results of such analysis generally gave minimum times of 5 minutes for directly connected impervious surfaces such as roads and roofs, and pervious area times dependent on flow path length, slope and roughness. The values calculated in the analysis are presented in Appendix C.

The peak rate of flow, volume and hydrograph shape from 12d software was generally consistent with the results from the same storm simulation in the XP-RAFTS comparison model. Appendix B provides a graphical output from the XP-RAFTS model

Gutter and pipe flow times were included in the analysis as part of 12d dynamic drainage module calculations.

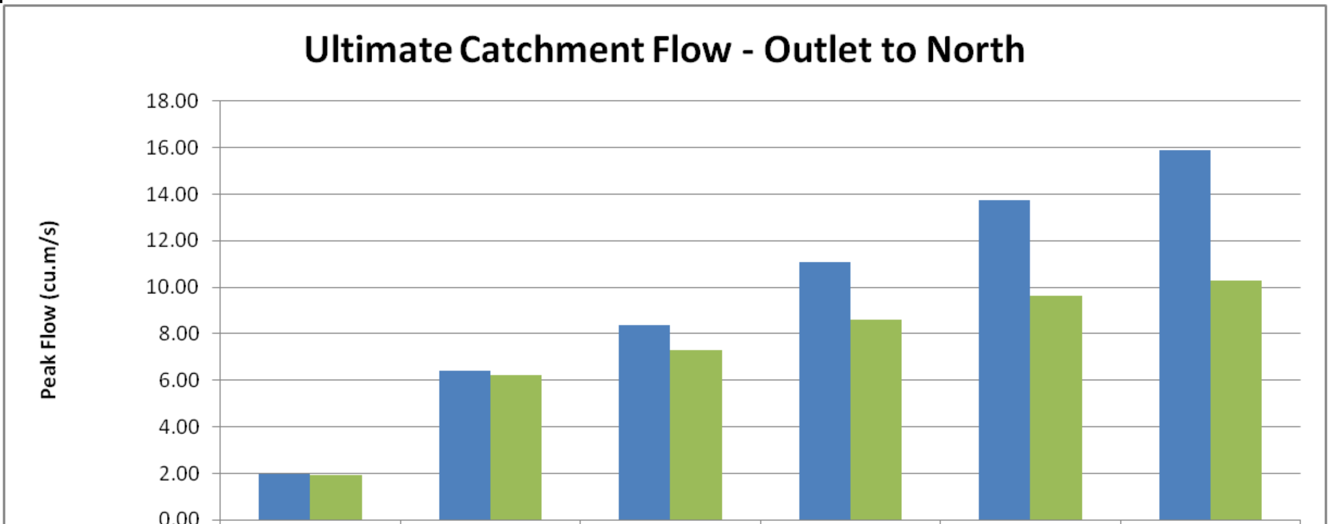
7.3 STORMWATER DETENTION

Detention volume was initially estimated by direct comparison of the 2 hour 100 year storm duration off the pre-developed and developed site.

The configuration of storage, outlet pipes, pits and weirs are as documented on the concept design plans. The outlet structure and configuration is presented in **Exhibit C**.

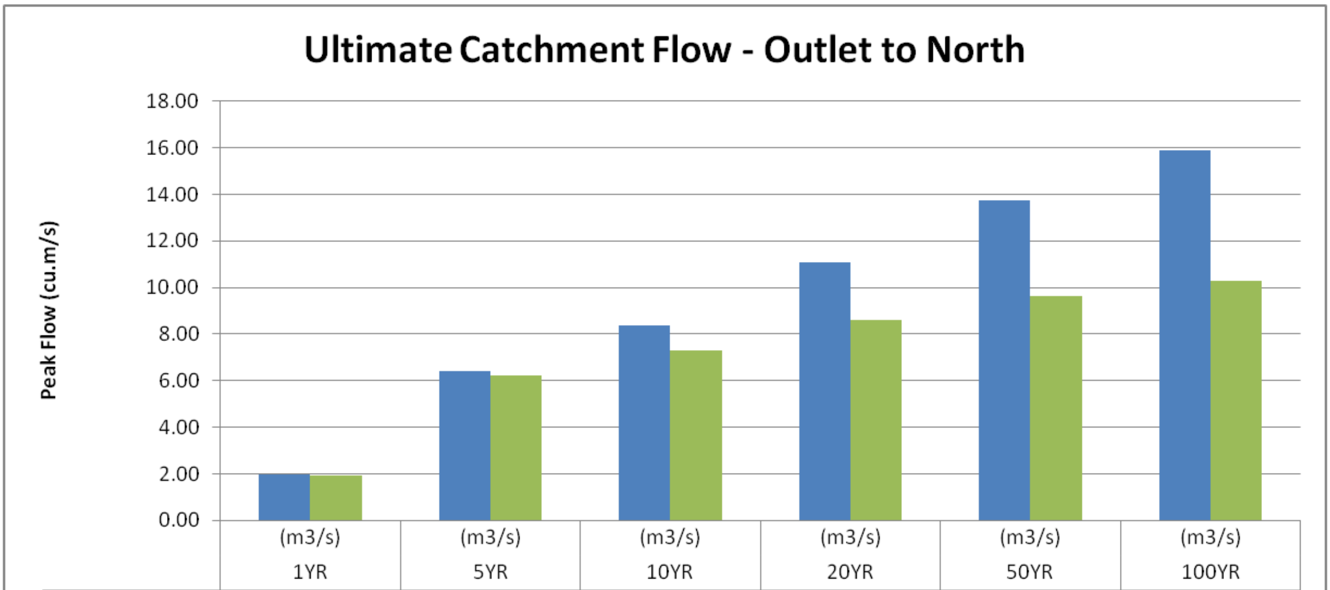
7.4 PEAK SITE DISCHARGE SUMMARY

A graphical comparison was made between the pre-developed flows and the developed flows. This graph, presented in



	(m3/s) 1YR	(m3/s) 5YR	(m3/s) 10YR	(m3/s) 20YR	(m3/s) 50YR	(m3/s) 100YR
PREDEVELOPED	1.96	6.40	8.36	11.06	13.73	15.88
CONTROLLED	1.94	6.22	7.29	8.60	9.65	10.27

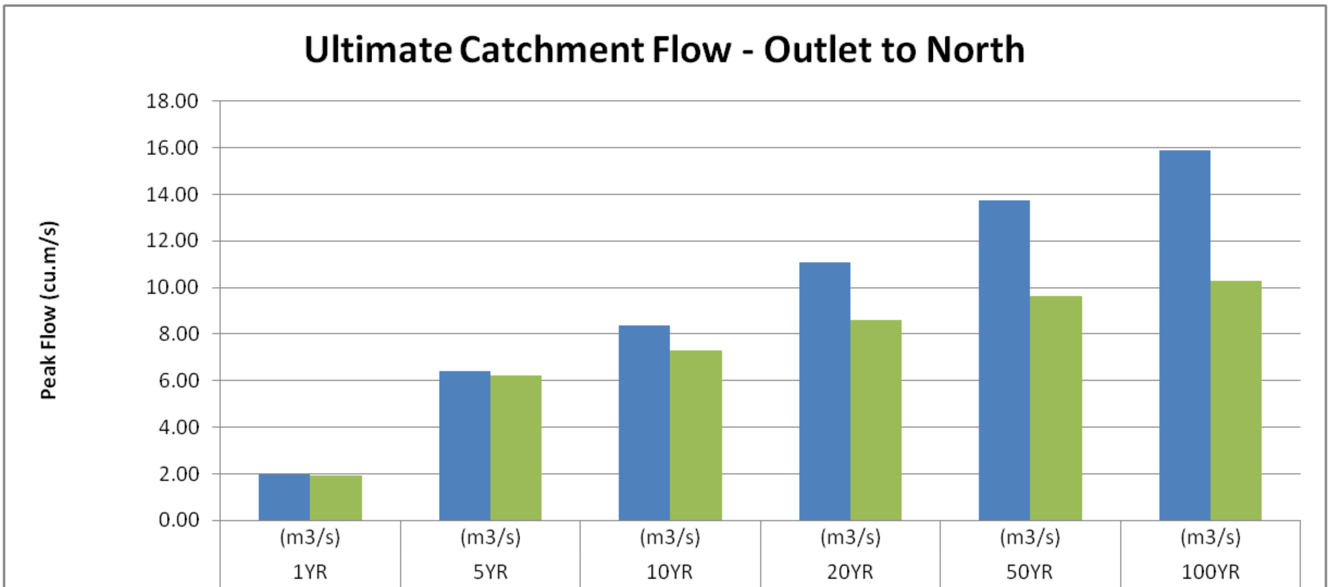
Figure 7.1 Peak Flow Summary For On-Site Development Works



	(m3/s) 1YR	(m3/s) 5YR	(m3/s) 10YR	(m3/s) 20YR	(m3/s) 50YR	(m3/s) 100YR
PREDEVELOPED	1.96	6.40	8.36	11.06	13.73	15.88
CONTROLLED	1.94	6.22	7.29	8.60	9.65	10.27

Figure 7.1, shows a summary of peak flows for the 1, 5, 10, 20 and 100 year ARI storm. The results indicate that the developed system satisfies peak stormwater flow reduction targets for all storm events.

Further refinements to the outlet structure would be considered as part of the detail design phase. The figures indicate that the detention volume provided across the natural surface and bio-retention basin upstream of the raised embankment is sufficient to reduce outflows and satisfy water quantity objectives.



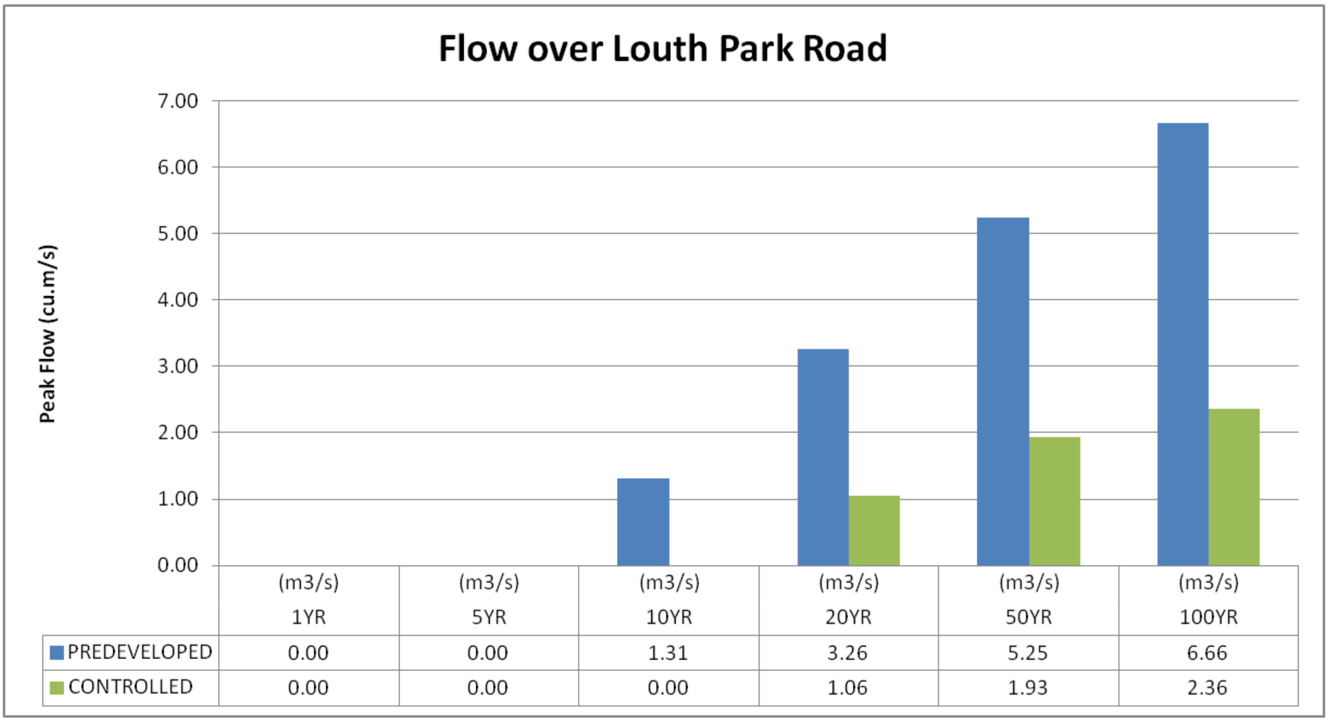
	(m3/s) 1YR	(m3/s) 5YR	(m3/s) 10YR	(m3/s) 20YR	(m3/s) 50YR	(m3/s) 100YR
PREDEVELOPED	1.96	6.40	8.36	11.06	13.73	15.88
CONTROLLED	1.94	6.22	7.29	8.60	9.65	10.27

Figure 7.1 Peak Flow Summary For On-Site Development Works

Hydrographs representing the modelled flows are presented in Figure 7.3 and Figure 7.4Figure 7.3. The hydrographs show that the cumulative flow from the pre-developed site is not exceeded by the controlled discharge of developed flows from the site.

7.5 CULVERT FLOWS ANALYSIS

Runoff from the catchment drains under Louth Park Road through a twin cell 1350mm diameter pipe culvert. This culvert is located a short distance upstream of the tail water of an existing constructed wetland as part of the adjoining Waterford Estate. Tail water levels in the downstream wetlands are not known and not considered in this analysis. The existing culvert was included in the pre-developed model to determine the peak rate of stormwater exceeding the culvert capacity flowing over Louth Park Road. Flows exceeding the proposed sag pit inlet capacity and flowing across Louth Park Road from the developed model are included in Figure 7.2.



	(m3/s) 1YR	(m3/s) 5YR	(m3/s) 10YR	(m3/s) 20YR	(m3/s) 50YR	(m3/s) 100YR
PREDEVELOPED	0.00	0.00	1.31	3.26	5.25	6.66
CONTROLLED	0.00	0.00	0.00	1.06	1.93	2.36

Figure 7.2 Flows across the crown of Louth Park Road

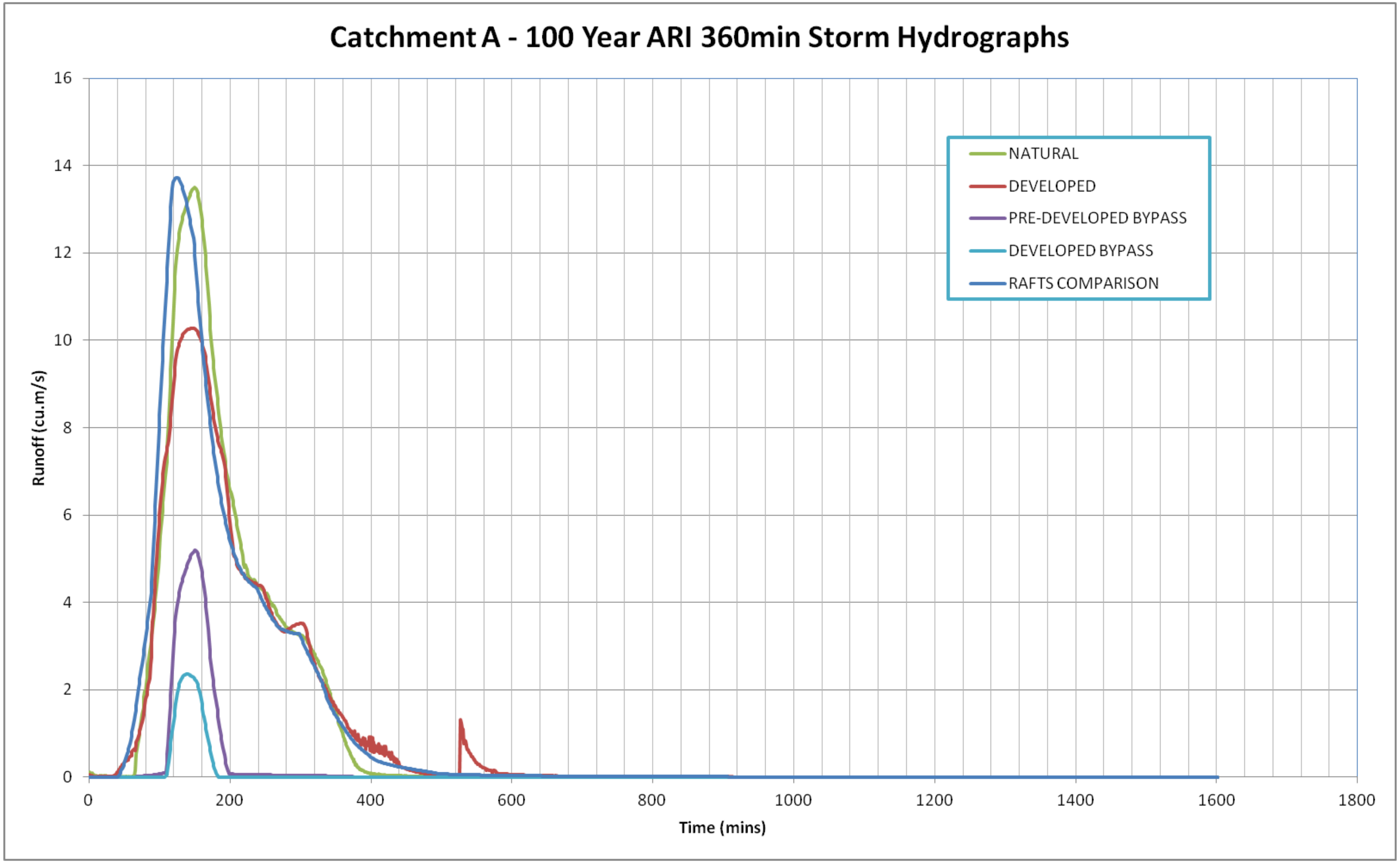


Figure 7.3 Peak Flood Hydrograph including On-Site flows 1 in 100year ARI

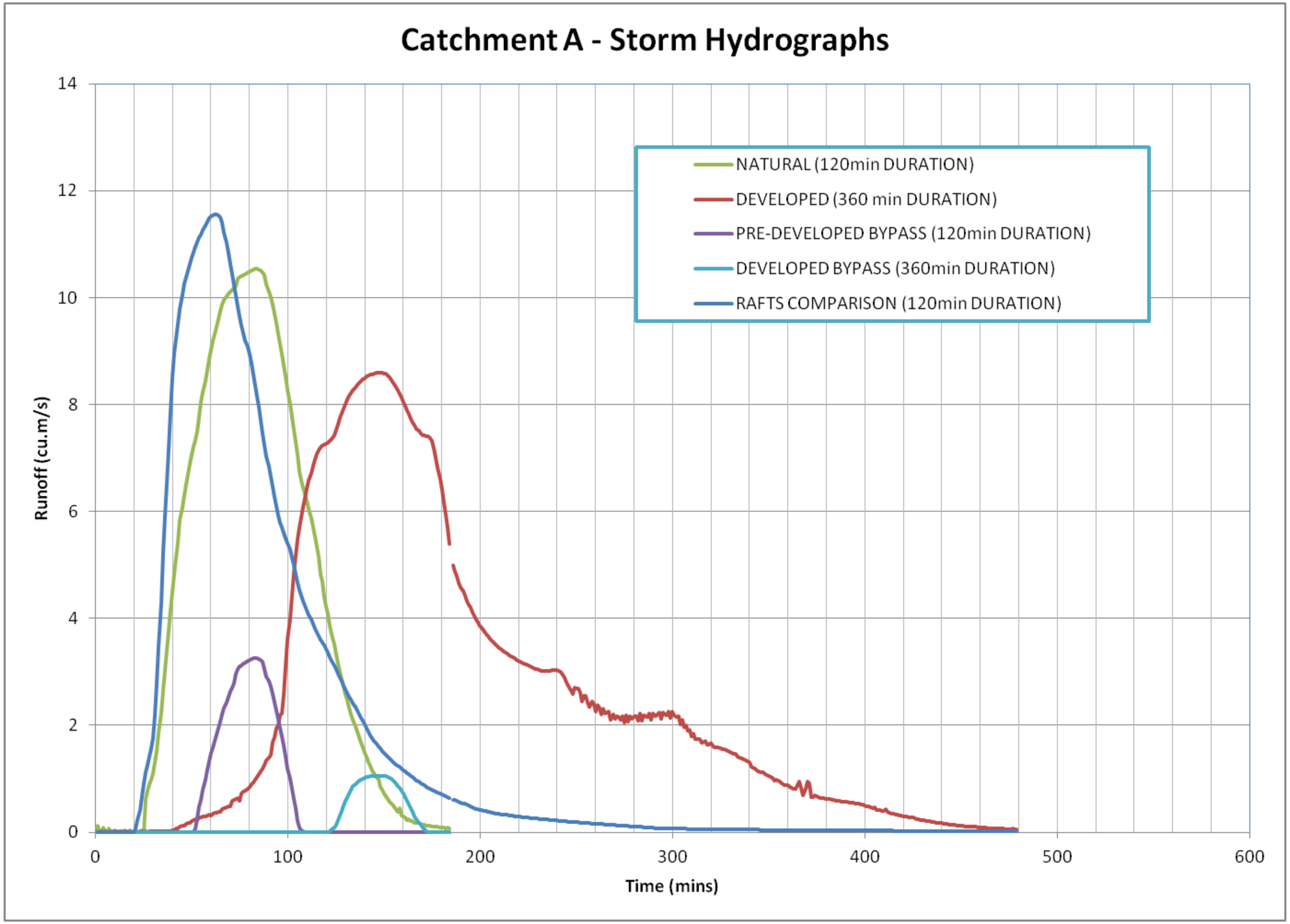


Figure 7.4 Peak Flood Hydrograph including On-Site flows 1 in 20 year ARI

8.0 MAINTENANCE

Stormwater controls located in the road reserve or drainage reserve are to be ultimately managed and maintained by Maitland City Council. Stormwater pipes laid to no flatter than 0.5% grade tend to be self-cleansing, so pipes can be assumed to have a negligible maintenance requirement. Sediments and gross pollutants will be collected in a gross pollutant trap, located near the road carriageway. The GPT unit should be cleaned out every twelve months or as required, with an inspection carried out once in every three months.

The maintenance burden for the detention basin and bio-retention basin will be fully borne by Council. Landscaping around the basins should be carefully selected to reduce the impact of weed infestation and limit the need for slashing or mowing. For a well designed and constructed basin, maintenance should be limited to periodic cleaning of debris, weeds and garbage, should these pollutants bypass the gross pollutant trap.

A higher sediment load can be expected during construction, so the bioretention basin should not be planted until at least 70% of the development has been established. Adequate on-site erosion and sedimentation controls should be implemented for each stage of the subdivision construction and individually for each dwelling construction.

After completion of the subdivision and as adequate ground cover is established, coarse sediments should largely be captured by the gross pollutant trap and the finer sediments would be captured in the bio-retention basin. Outlet structures from both basins would need to be inspected once in every three months and cleaned out as required. The embankment should also be inspected after every major storm event to identify any weaknesses or possible seepage.

Basins are susceptible to inundation during a storm event. This presents a safety risk to Council; appropriate signage would be required to warn the public of the danger.

The frequency of maintenance is higher for the primary treatment (GPT) and lesser for the secondary treatment (bio-retention). The configuration of these control structures would be designed to reflect the need to access these for maintenance purposes based on the maintenance frequency.

9.0 RECOMMENDATIONS/CONCLUSION

*Based on the findings of this report, it is recommended that the Stormwater Management Plan, as shown in **Exhibit C**, be accepted as stormwater management strategy for this development, as it satisfies the objectives of the report.*

Objective	Achieved
Provide an effective stormwater management system that is sustainable and requires minimal maintenance	Yes
Protect and enhance water quality/quantity and habitat value of downstream waterways and environment	Yes
Prevent erosion and runoff during site preparation and construction and ongoing use of the land to minimise cumulative impacts on receiving waterways	Yes
To retard the flow of water into the natural drainage system and mitigate impacts from stormwater runoff; ensuring that the rate of post-development stormwater discharge should be no greater than that of the pre-development stormwater discharge	Yes
Cater for flows entering the site and ensure that there are no adverse effects from flows leaving the site	Yes
Encourage the use of rainwater tanks as a means of reducing separate stormwater detention requirements and achieving more sustainable water re-use within the dwelling and for landscaping purposes	Yes
Ensure that drainage systems are designed for safety and that the systems avoid any potential for stormwater inundation of habitable floor areas	Yes
To maintain and enhance the quality of water and catchment health	Yes

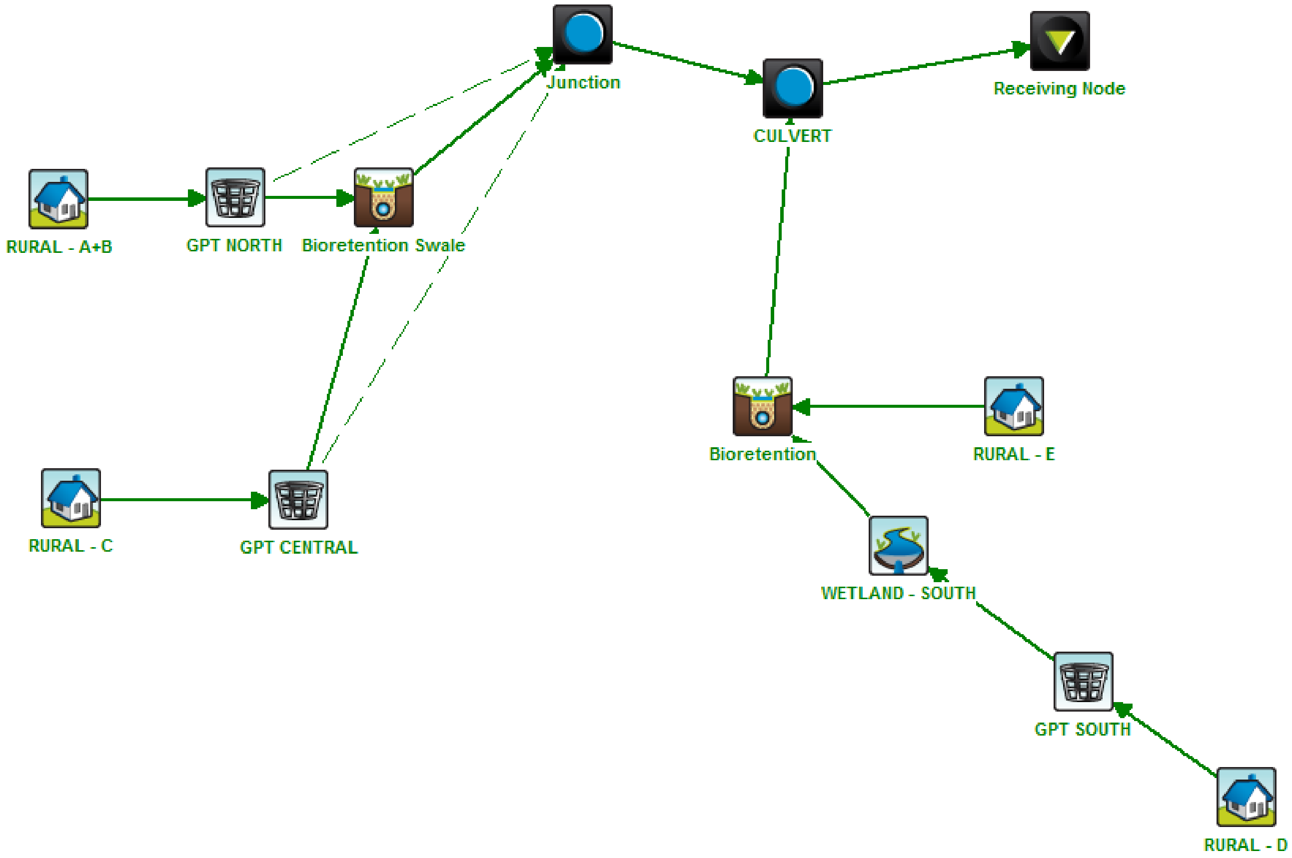
- The developable area of the subject land is elevated above the level of flooding associated with the 1 in 100 year flood from the Hunter River and adjoining flood storage areas;
- Erosion and sedimentation controls will be implemented throughout construction so as to reduce sediment transfer off site during runoff producing rain and therefore minimise cumulative impacts on receiving waterway;
- Runoff from urban areas will be piped to the site outlets under the street system or through inter-allotment drains for any lot that cannot adequately drain to the street;
- A gross pollutant trap will be utilised to remove rubbish and coarse sediment from the storm water, prior to the stormwater draining to the water quality basins;
- Continuous rain and pollutant modelling of the treatment train indicates that water quality is adequately treated to MCC targets for the proposed management controls. Consequently, as the water quality is improved, so is the Habitat value of downstream waterways;
- Event based hydraulic simulations show that the proposed development will not cause an increase in the peak run-off leaving the subject land
- Maintenance of the stormwater system will be borne by Maitland City Council.

The development plans as proposed generally show a negligible impact on the downstream watercourse with regard to possible risks.

10.0 REFERENCES

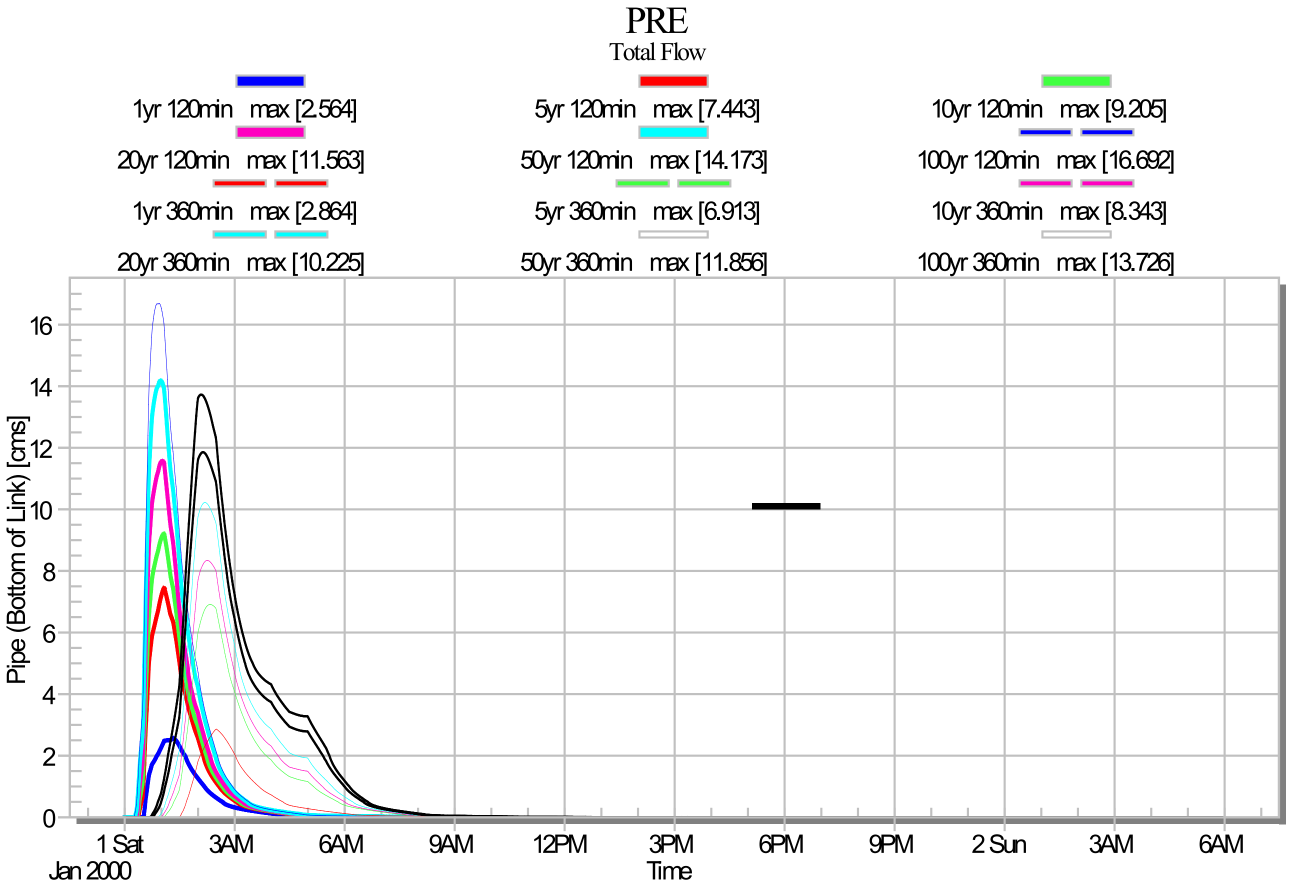
(1) Maitland City Council – Development Control Plan (DCP) Part C : Design Guidelines 2011
(2) Maitland City Council – Development Control Plan (DCP) Part C : Environmental Guidelines 2011
(3) Maitland City Council – Manual of Engineering Standards 2008
(4) NSW Department of Primary Industries Office of Water 2012, 'Guidelines for Riparian Corridors on Waterfront land.'
(5) Landcom, Managing Urban Stormwater: Soils and Construction, March 2004
(6) Institution of Engineers, Australia 1987, Australian Rainfall and Runoff – A guide to Flood estimation

APPENDIX A MUSIC MODELLING



Flow (ML/yr)	202	194	4.0
Total Suspended Solids (kg/yr)	19.8E3	3.0E3	85.0
Total Phosphorus (kg/yr)	46	22.5	51.0
Total Nitrogen (kg/yr)	398	220	44.8
Gross Pollutants (kg/yr)	5.36E3	42.4	99.2

APPENDIX B COMPARISON MODELLING



APPENDIX C HYDROLOGY TABLES

CATCHMENT SUMMARY

Pit Name	Pit Type	Catchment1 Area	Impervious	Impervious	Pervious	SubCat Flow	Catchment2 Area	Impervious	Impervious	Pervious	SubCat Flow2	Total Flow
	-	(Ha)	%	tc	tc	L/s	(Ha)	%	tc	tc	L/s	L/s
PITA01/1	2.4 EKI	0.326829	55	7	8	100		0	8	23		100
PITA01/2	2.4 EKI	0.067771	55	5	5	23		0	8	23		23
PITA01 BYPASS/1	HEADWALL		40	5	10			0	8	23		
PITA02/1	HEADWALL		0	5	37		5.699165	0	8	23	679	679
PITA02/2	1.8 EKI		40	5	10			0	8	23		
PITA02/3	1.8 EKI	0.121623	55	5	6	40		0	8	23		40
PITA02/4	1.8 EKI	0.093241	55	5	6	31		0	8	23		31
PITA02/5	1.8 EKI		40	5	10			0	8	23		
PITA03/1	1.8 EKI	0.056989	55	5	6	19		0	8	23		19
PITA03/2	1.8 EKI	0.126803	55	5	6	42		0	8	23		42
PITA03/3	1.8 EKI	0.051329	55	5	6	17		0	8	33		17
PITA03/4	1.8 EKI	0.058009	55	5	6	19		0	8	23		19
PITA04/1	HEADWALL		0	5	57		8.799366	0	8	35	703	703
PITA04/2			40					0				
PITB01/1	IAD PIT	0.330563	20	5	19	54		0	8	23		54
PITB01/2	IAD PIT	0.150397	40	5	8	43		0	8	23		43
PITB01/3	IAD PIT	0.150079	40	5	8	43		0	8	23		43
PITB01/4	IAD PIT		40	5	4			0	8	23		
PITB01/5	IAD PIT	0.150035	40	5	8	43		0	8	23		43
PITB01/6	1.8 EKI	0.220513	40	5	13	50		0	8	23		50
PITB01/7	1.8 EKI	0.272703	40	5	11	69		0	8	23		69
PITB01/8	3.0 SAG	0.492668	40	5	22	96		0	8	23		96
PITB01/9	1.8 EKI	0.153324	55	5	6	50		0	8	23		50
PITB01/10	GJP		40	5	10			0	8	23		
PITB01/11	GJP	0.579736	40	5	10	154		0	8	23		154
PITB02/1	IAD PIT	0.132707	40	5	13	31		0	8	23		31
PITB03/1	1.8 EKI	0.05115	55	5	6	17		0	8	23		17
PITB04/1	IAD PIT	0.152159	40	5	9	43		0	8	23		43
PITB04/2	IAD PIT	0.151987	40	5	9	41		0	8	23		41
PITB04/3	IAD PIT	0.165101	40	5	14	37		0	8	23		37
PITB04/4	IAD PIT	0.165137	40	5	15	35		0	8	23		35
PITB04/5	IAD PIT	0.183818	40	5	17	38		0	8	23		38
PITB05/1	IAD PIT	2.41311	8	7	23	315		0	8	23		315
PITB05/2	1.8 EKI	0.527318	40	5	22	103		0	8	23		103
PITB05/3	1.8 EKI	0.132018	40	5	12	31		0	8	23		31
PITB05/4	1.8 EKI	0.225846	40	5	16	48		0	8	23		48
PITB05/5	1.8 EKI	0.07789	55	5	6	26		0	8	23		26
PITB05/6	1.8 EKI	0.215846	40	5	15	47		0	8	23		47

PITB05/7	1.8 EKI	0.113899	40	5	10	30		0	8	23		30
PITB06/1	2.4 EKI	0.395541	20	5	18	68		0	8	23		68
PITB06/2	1.8 EKI		25	5	12			0	8	23		
PITB06/3	2.4 EKI	0.410395	20	5	10	110		0	8	23		110
PITB06/4	3.0 EKI	0.869183	20	5	19	143		0	8	23		143
PITB06/5	1.8 EKI	0.606738	20	5	18	102		0	8	23		102
PITB06/6	3.6 EKI	0.230546	40	5	21	46		0	8	23		46
PITB06/7	3.6 EKI	0.355791	40	5	23	69		0	8	23		69
PITB06/8	3.6 EKI	0.352543	40	5	18	72		0	8	23		72
PITB06/9	3.6 EKI	0.349727	40	5	27	66		0	8	23		66
PITB07/1	1.8 EKI	0.106184	55	5	6	35		0	8	23		35
PITB08/1	1.8 EKI	0.104376	55	5	6	34		0	8	23		34
PITB09/1	1.8 EKI	0.094177	55	5	6	31		0	8	23		31
PITB10/1	IAD PIT	0.399362	20	5	10	105		0	8	23		105
PITB10/2	IAD PIT	0.355158	20	5	10	94		0	8	23		94
PITB11/1	1.8 EKI	0.104616	55	5	6	34		0	8	23		34
PITB12/1	IAD PIT	0.191597	20	5	12	43		0	8	23		43
PITB12/2	IAD PIT	0.245555	20	5	14	51		0	8	23		51
PITBIO WEIR/1			40	5	10			0	8	23		
PITBIO WEIR/2	BASIN		40	5	10			0	8	23		
PITC01/HW	HEADWALL		40	5	10			0	8	23		
BIORETENTION	BASIN		40	5	10		0.583817	0	8	5	186	186
PITC01/1	3.6 EKI	0.344741	20	5	6	107		0	8	23		107
PITC01/2	3.6 EKI	0.401218	20	5	24	56		0	8	23		56
PITC01/3	3.6 EKI	0.859608	20	5	25	119		0	8	23		119
PITC01/4	3.6 EKI	1.061874	20	5	29	134		0	8	23		134
PITC01/5	3.6 EKI	1.257716	20	5	28	163		0	8	23		163
PITC01/6	3.6 EKI	0.80621	20	5	21	125		0	8	23		125
PITC01/7	3.6 EKI	0.447352	20	5	18	76		0	8	23		76
PITC01/8	3.6 EKI	0.377689	20	5	19	63		0	8	23		63
PITC01/9	3.6 EKI	0.301606	20	5	17	53		0	8	23		53
PITC01/10	3.6 EKI	0.621002	20	5	19	103		0	8	23		103
PITC01/11	1.8 EKI	0.068158	55	5	6	22		0	8	23		22
PITC01/12	1.8 EKI	0.015945	55	5	5	6		0	8	23		6
PITC01/13	1.8 EKI	0.120622	40	5	5	41		0	8	23		41
PITC01/14	2.4 EKI	0.041287	55	5	6	14		0	8	23		14
PITC01/15	2.4 EKI	0.216106	40	5	15	46		0	8	23		46
PITC01/16	2.4 EKI	0.221511	40	5	12	53		0	8	23		53
PITC01/17	2.4 EKI	0.364004	40	5	11	90		0	8	23		90
PITC01/18	2.4 EKI	0.355282	40	5	17	74		0	8	23		74
PITC01/19	1.8 EKI	0.188466	40	5	18	38		0	8	23		38
PITC01/20	1.8 EKI	0.171779	40	5	18	35		0	8	23		35

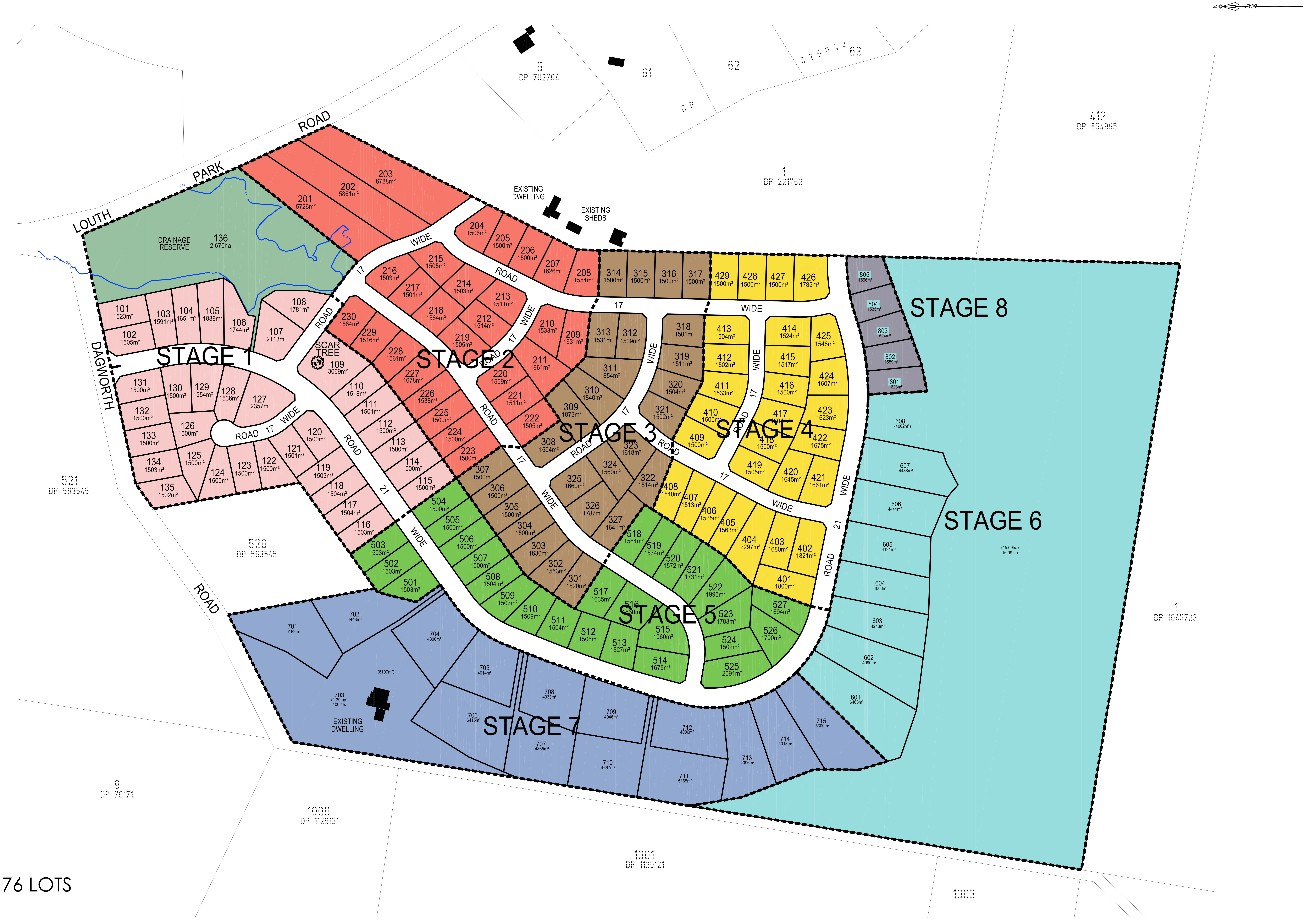
PITC01/21	2.4 EKI	0.32532	40	5	18	67	0	8	23	67
PITC01/22	1.8 EKI	0.171556	40	5	17	36	0	8	23	36
PITC01/23	1.8 EKI	0.170998	40	5	17	35	0	8	23	35
PITC01/24	2.4 EKI	0.343071	40	5	16	73	0	8	23	73
PITC01/25	1.8 EKI	0.199331	40	5	16	42	0	8	23	42
PITC01/26	2.4 EKI	0.015769	40	5	15	3	0	8	23	3
PITC01/27	2.4 EKI	0.349226	40	5	18	71	0	8	23	71
PITC01/28	2.4 SAG	0.096711	40	5	18	20	0	8	23	20
PITC01/29	2.4 SAG	0.142297	40	5	13	32	0	8	23	32
PITC01/30	1.8 EKI		40	5	10		0	8	23	
PITC01/31	GJP		40	5	10		0	8	23	
PITC01/32	GLJP		40				0			
PITC01/33	GLJP		40				0			
PITC01/34	GJP		40	5	2		0	8	23	
PITC01/35	GLJP		40				0			
PITC01/36	GJP		40				0			
PITC02/1	1.8 EKI	0.110061	55	5	6	36	0	8	23	36
PITC03/1	1.8 EKI	0.110676	55	5	5	38	0	8	23	38
PITC04/1	1.8 EKI	0.085358	55	5	5	30	0	8	23	30
PITC05/1	3.6 EKI	0.434986	20	5	17	79	0	8	23	79
PITC05/2	1.8 EKI	0.270134	20	5	16	49	0	8	23	49
PITC05/3	3.0 SAG	0.643487	20	5	17	112	0	8	23	112
PITC05/4	1.8 EKI	0.091892	55	5	5	32	0	8	23	32
PITC06/1	IAD PIT	0.111351	20	5	10	29	0	8	23	29
PITC06/2	IAD PIT	0.251856	20	5	10	66	0	8	23	66
PITC07/1	IAD PIT	0.06	100	5	10	23	0	8	23	23
PITC07/2	IAD PIT	0.06	100	5	10	23	0	8	23	23
PITC07/3	IAD PIT	0.06	100	5	10	23	0	8	23	23
PITC07/4	IAD PIT	0.06	100	5	10	23	0	8	23	23
PITC07/5	IAD PIT		40	5	10		0	8	23	
PITC07/6	3.6 EKI	0.459417	40	5	21	91	0	8	23	91
PITC08/1	IAD PIT	0.06	100	5	10	23	0	8	23	23
PITC09/1	IAD PIT	0.067635	40	5	9	19	0	8	23	19
PITC09/2	IAD PIT		40	5	7		0	8	23	
PITC10/1	3.6 EKI	0.595305	23	5	27	82	0	8	23	82
PITC11/1	3.6 EKI	0.802646	40	5	25	153	0	8	23	153
PITC12/1	IAD PIT	0.174389	40	5	17	36	0	8	23	36
PITC12/2	IAD PIT	0.156355	40	5	13	36	0	8	23	36
PITC12/3	IAD PIT	0.152556	40	5	9	42	0	8	23	42
PITC12/4	IAD PIT	0.151316	40	5	8	43	0	8	23	43
PITC12/5	IAD PIT	0.154041	40	5	9	43	0	8	23	43
PITC12/6	IAD PIT		40	5	5		0	8	23	
PITC12/7	IAD PIT	0.151939	40	5	9	41	0	8	23	41
PITC12/8	IAD PIT		40	5	10		0	8	23	
PITC12/9	3.6 EKI	0.371647	40	5	14	83	0	8	23	83

PITC13/1	2.4 EKI	0.199818	40	5	10	53	0	8	23	53
PITC14/1	IAD PIT	0.152494	40	5	13	36	0	8	23	36
PITC14/2	IAD PIT	0.150267	40	5	12	36	0	8	23	36
PITC14/3	IAD PIT		40	5	7		0	8	23	
PITC14/4	IAD PIT	0.150654	40	5	11	37	0	8	23	37
PITC14/5	IAD PIT	0.15057	40	5	14	33	0	8	23	33
PITC14/6	IAD PIT	0.150607	40	5	12	36	0	8	23	36
PITC14/7	IAD PIT	0.149203	40	5	10	40	0	8	23	40
PITC15/1	1.8 EKI	0.207022	40	5	15	44	0	8	23	44
PITC16/1	1.8 EKI	0.04854	55	5	6	16	0	8	23	16
PITC16/2	1.8 EKI	0.223573	40	5	13	52	0	8	23	52
PITC16/3	1.8 EKI	0.038431	40	5	10	10	0	8	23	10
PITC16/4	1.8 EKI	0.037839	55	5	6	12	0	8	23	12
PITC16/5	2.4 SAG	0.342342	40	5	14	76	0	8	23	76
PITC16/6	1.8 EKI	0.083184	55	5	6	27	0	8	23	27
PITC16/7	1.8 EKI		40	5	10		0	8	23	
PITC16/8	1.8 EKI	0.029667	55	5	6	10	0	8	23	10
PITC16/9	1.8 EKI	0.166025	40	5	10	44	0	8	23	44
PITC16/10	2.4 SAG	0.182924	40	5	10	47	0	8	23	47
PITC16/11	1.8 EKI	0.099984	55	5	6	33	0	8	23	33
PITC16/12	1.8 EKI		55	5	5		0	8	23	
PITC16/13	1.8 EKI	0.193218	40	5	14	43	0	8	23	43
PITC16/14	2.4 SAG	0.367905	40	5	10	97	0	8	23	97
PITC16/15	1.8 EKI	0.09579	55	5	6	31	0	8	23	31
PITC17/1	IAD PIT	0.160463	40	5	11	39	0	8	23	39
PITC17/2	IAD PIT		40	5	10		0	8	23	
PITC17/3	IAD PIT	0.162167	40	5	11	41	0	8	23	41
PITC17/4	IAD PIT	0.167498	40	5	13	38	0	8	23	38
PITC17/5	IAD PIT	0.142662	40	5	11	36	0	8	23	36
PITC18/1	2.4 EKI	0.263485	40	5	13	59	0	8	23	59
PITC19/1	1.8 EKI	0.094328	55	5	5	33	0	8	23	33
PITC20/1	IAD PIT	0.152633	40	5	11	39	0	8	23	39
PITC20/2	IAD PIT	0.150056	40	5	10	40	0	8	23	40
PITC21/1	1.8 EKI	0.21027	40	5	14	46	0	8	23	46
PITC22/1	1.8 EKI	0.052387	55	5	6	17	0	8	23	17
PITC23/1	IAD PIT	0.153099	40	5	9	42	0	8	23	42
PITC23/2	IAD PIT	0.184273	40	5	14	40	0	8	23	40
PITC23/3	IAD PIT	0.183598	40	5	15	39	0	8	23	39
PITC23/4	IAD PIT	0.187352	40	5	15	40	0	8	23	40
PITC23/5	IAD PIT	0.131158	40	5	10	35	0	8	23	35
PITC23/6	2.4 EKI	0.221686	40	5	14	48	0	8	23	48
PITC24/1	IAD PIT	0.150002	40	5	10	40	0	8	23	40
PITC24/2	IAD PIT	0.150002	40	5	10	39	0	8	23	39
PITC24/3	IAD PIT	0.150002	40	5	10	39	0	8	23	39
PITC24/4	IAD PIT	0.150002	40	5	11	38	0	8	23	38

PITC24/5	IAD PIT	0.150002	40	5	11	38	0	8	23		38
PITC24/6	IAD PIT	0.150002	40	5	11	37	0	8	23		37
PITC25/1	IAD PIT	0.16277	40	5	10	43	0	8	23		43
PITC25/2	1.8 EKI	0.123959	40	5	11	32	0	8	23		32
PITC25/3	1.8 EKI	0.240829	40	5	9	65	0	8	23		65
PITC25/4	2.4 SAG	0.163263	40	5	14	36	0	8	23		36
PITC25/5	1.8 EKI	0.06895	55	5	6	23	0	8	23		23
PITC26/1	1.8 EKI	0.215542	40	5	13	48	0	8	23		48
PITC27/1	IAD PIT	0.143756	40	5	11	35	0	8	23		35
PITC27/2	IAD PIT	0.151156	40	5	10	39	0	8	23		39
PITC27/3	1.8 EKI	0.200826	40	5	10	52	0	8	23		52
PITC28/1	1.8 EKI	0.01345	55	5	6	4	0	8	23		4
PITC29/1	1.8 EKI	0.351509	40	5	19	71	0	8	23		71
PITC30/1	2.4 SAG	0.102398	40	5	10	27	0	8	23		27
PITC31/1	3.6 EKI	0.309991	20	5	5	102	0	8	23		102
PITC31/2	1.8 EKI	0.042919	20	5	5	14	0	8	23		14
PITC31/3	1.8 EKI		40	5	10		0	8	23		
PITC31/4	1.8 EKI	0.099944	55	5	5	35	0	8	23		35
PITC31/5	1.8 EKI	0.021126	55	5	6	7	0	8	23		7
PITC31/6	1.8 EKI	0.170036	40	5	10	44	0	8	23		44
PITC31/7	1.8 EKI	0.102585	40	5	14	22	0	8	23		22
PITC31/8	1.8 EKI		45	5	5		0	8	23		
PITC31/9	1.8 EKI	0.186972	40	5	14	41	0	8	23		41
PITC31/10	1.8 EKI	0.076083	40	5	10	20	0	8	23		20
PITC31/11	1.8 EKI		45	5	10		0	8	23		
PITC31/12	1.8 EKI	0.186051	40	5	13	43	0	8	23		43
PITC31/13	1.8 EKI	0.02523	55	5	6	8	0	8	23		8
PITC31/14	1.8 EKI	0.02874	55	5	6	9	0	8	23		9
PITC31/15	1.8 EKI		40	5	10		0	8	23		
PITC31/16	1.8 EKI	0.053416	55	5	6	18	0	8	23		18
PITC31/17	1.8 EKI	0.023946	55	5	6	8	0	8	23		8
PITC31/18	2.4 SAG	0.052441	55	5	6	17	0	8	23		17
PITC31/19	1.8 EKI		40	5	10		0	8	23		
PITC31/20	1.8 EKI	0.170626	40	5	14	38	0	8	23		38
PITC31/21	1.8 EKI	0.044664	40	5	10	12	0	8	23		12
PITC31/22	1.8 EKI	0.089684	40	5	18	18	0	8	23		18
PITC32/1	1.8 EKI		40	5	10		0	8	23		
PITC32/2	1.8 EKI		40	5	10		0	8	23		
PITC32/3	3.6 EKI	0.959303	2	5	30	88	0	8	23		88
PITC32/4	3.6 SAG	0.392255	20	5	19	64	0	8	23		64
PITC32/5	1.8 EKI	0.459525	20	5	22	69	0	8	23		69
PITC33/1	HEADWALL		40	5	10	4.209373	0	8	40	295	295
PITC33/2	GJP		40	5	10		0	8	23		
PITC33/3	GJP		40	5	10		0	8	23		
PITC34/1	1.8 EKI	0.038378	55	5	6	13	0	8	23		13

PITC35/1	1.8 EKI	0.063844	55	5	6	21		0	8	23		21
PITC36/1	1.8 EKI	0.13149	40	5	13	30		0	8	23		30
PITC36/2	2.4 SAG	0.275722	40	5	13	64		0	8	23		64
PITC36/3	1.8 EKI	0.078542	55	5	6	26		0	8	23		26
PITC37/1	IAD PIT	0.150204	40	5	11	39		0	8	23		39
PITC38/1	1.8 EKI	0.097383	55	5	6	32		0	8	23		32
PITC39/1	2.4 SAG	0.323286	40	5	12	77		0	8	23		77
PITC39/2	1.8 EKI	0.05727	55	5	6	19		0	8	23		19
PITC40/1	1.8 EKI	0.083535	55	5	6	27		0	8	23		27
PITC41/1	2.4 SAG	0.077093	40	5	8	22		0	8	23		22
PITC41/2	1.8 EKI	0.030429	55	5	6	10		0	8	23		10
PITC42/1	1.8 EKI	0.089124	55	5	6	29		0	8	23		29
PITC43/1	IAD PIT	0.178147	40	5	8	52		0	8	23		52
PITC43/2	IAD PIT	0.150023	40	5	7	44		0	8	23		44
PITC43/3	IAD PIT	0.15	40	5	8	44		0	8	23		44
PITC43/4	IAD PIT	0.15	40	5	9	42		0	8	23		42
PITC43/5	IAD PIT	0.15	40	5	11	37		0	8	23		37
PITC43/6	IAD PIT	0.15	40	5	11	37		0	8	23		37
PITC43/7	IAD PIT	0.15	40	5	11	38		0	8	23		38
PITC43/8	IAD PIT	0.15	40	5	12	36		0	8	23		36
PITC43/9	IAD PIT	0.155066	40	5	10	40		0	8	23		40
PITC43/10	IAD PIT	0.162169	40	5	10	42		0	8	23		42
PITC43/11	IAD PIT	0.15	40	5	10	40		0	8	23		40
PITC43/12	IAD PIT	0.15	40	5	9	42		0	8	23		42
PITC43/13	1.8 EKI		40	5	10			0	8	23		
PITC43/14	1.8 EKI	0.057656	40	5	10	15		0	8	23		15
PITC43/15	2.4 SAG	0.189669	40	5	10	51		0	8	23		51
PITC44/1	1.8 EKI	0.026782	55	5	6	9		0	8	23		9
PITC45/1	IAD PIT	0.143904	40	5	13	33		0	8	23		33
PITC46/1	1.8 EKI	0.07167	55	5	6	23		0	8	23		23
PITC47/1	2.4 SAG	0.092165	55	5	6	30		0	8	23		30
PITC48/1	1.8 EKI	0.051088	55	5	6	17		0	8	23		17
PITC49/1	IAD PIT	0.150002	40	5	12	36		0	8	23		36
PITC49/2	IAD PIT	0.150002	40	5	12	37		0	8	23		37
PITC49/3	IAD PIT	0.15014	40	5	11	38		0	8	23		38
PITC49/4	IAD PIT	0.152484	40	5	11	38		0	8	23		38
PITC49/5	IAD PIT	0.153762	40	5	10	41		0	8	23		41
PITC50/1	1.8 EKI	0.080585	55	5	6	26		0	8	23		26
PITC50/2	1.8 EKI	0.022262	55	5	6	7		0	8	23		7
PITC50/3	1.8 EKI	0.196567	40	5	10	52		0	8	23		52
PITC50/4	1.8 EKI		40	5	10			0	8	23		
PITC51/1	GJP		40	5	10			0	8	23		
NODE1			40	5	10		6.287308	0	8	35	509	509
NODE2			40	5	10		7.114554	0	8	52	386	386
NODE3			40	5	10		8.039971	0	8	41	550	550

NODE4			40	5	10		1.715014	0	8	46	104	
NODE5	BASIN		40	5	10		2.194841	0	8	55	112	314
NODE10			40	5	10		3.958339	0	8	63	177	177
NODE15			40	5	30		2.474537	0	8	23	295	295
NODE16			40	5	30		3.515625	0	8	23	419	419
NODE21	BASIN	0.768149	20	5	23	112		0	8	23		
CUL2	HEADWALL		40	5	10			0	8	23		
OUTLET			40					0				
PRIMARY	HEADWALL		40	5	10			0	8	23		
PITF01/5	2.4 SAG	0.069951	40	5	10	19		0	8	23		19
CUL1			40					0				



STAGE 1	LOTS = 35
STAGE 2	LOTS = 30
STAGE 3	LOTS = 27
STAGE 4	LOTS = 29
STAGE 5	LOTS = 27
STAGE 6	LOTS = 8
STAGE 7	LOTS = 15
STAGE 8	LOTS = 5

TOTAL LOTS = 176 LOTS

INSTRUCTION NUMBER: 13/30
FILE ID: 112600
SURVEYED: ----
DESIGNED: ----
DRAWN: DKH
CHECKED: MD/DJE
DATUM: AHD
CONTOUR INTERVAL: ----

NO.	DESCRIPTION	DRAWN	DATE
F	----	----	----
E	----	----	----
D	AMEND LOT BOUNDARIES/STAGING	BC	6/11/2016
C	AMEND LOT BOUNDARIES/STAGING	MAC	8/06/2016
B	AMEND LOT BOUNDARIES	DKH	19/10/2015
A	ISSUED FOR APPROVAL	DKH	12/10/15

pcb PULVER COOPER & BLACKLEY
SURVEYORS TOWN PLANNERS
CIVIL ENGINEERS PROJECT MANAGERS

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98 LAWES STREET
EAST MAITLAND 2323
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Fax (02) 4934 3027

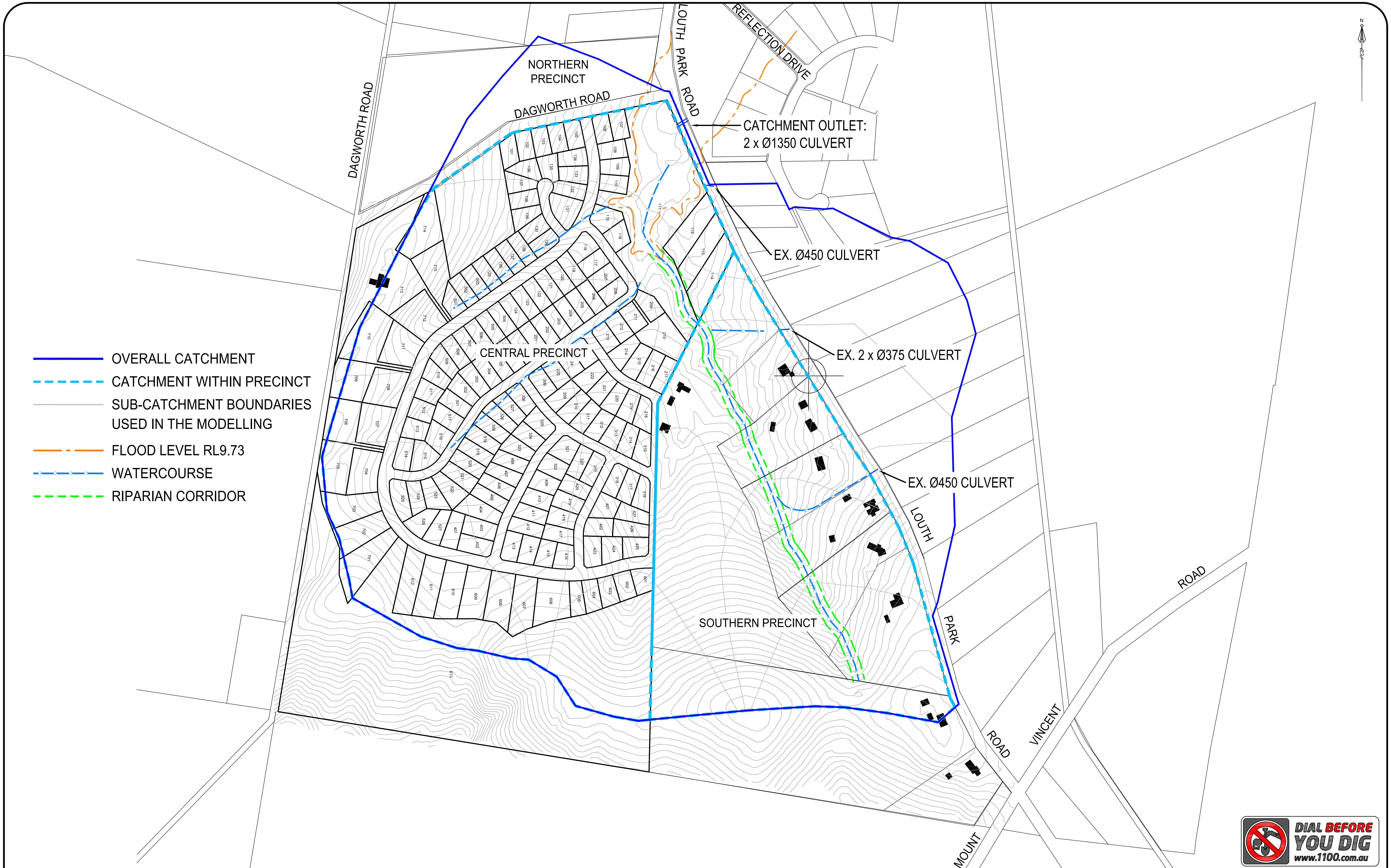
PLAN:
SUBDIVISION/STAGING PLAN
LOTS 2000 & 2001 DP 1129126
314 DAGWORTH ROAD
LOUTH PARK

CLIENT:
VALHALLA INVESTMENTS PTY LTD

40 20 0 40 80 120
Horizontal Scale 1:2000 (A1)
1:4000 (A3)

No. OF SHEETS
1
SHEET No.
1

Plot Date: 06/12/2016 Cad File: 13_30 - Subdivision Plan Master Plan (ID 112600)



INSTRUCTION NUMBER: 13/30
FILE ID: 90155
SURVEYED: PCB
DESIGNED: BC
DRAWN: BC
CHECKED: BC
DATUM: AHD
CONTOUR INTERVAL: 1m

NO.	DESCRIPTION	DRAWN	DATE
----	----	----	----
----	----	----	----
----	----	----	----
----	----	----	----
B	AMENDED LOT LAYOUT	DKH	20/10/2015
A	ISSUE FOR DA PURPOSES	BC	25/09/15

pcb PULVER COOPER & BLACKLEY
SURVEYORS TOWN PLANNERS
CIVIL ENGINEERS PROJECT MANAGERS

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EAST MAITLAND 2323
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Fax (02) 4934 3027

PLAN:
CATCHMENT PLAN
LOUTH PARK - CENTRAL AND SOUTHERN PRECINCTS

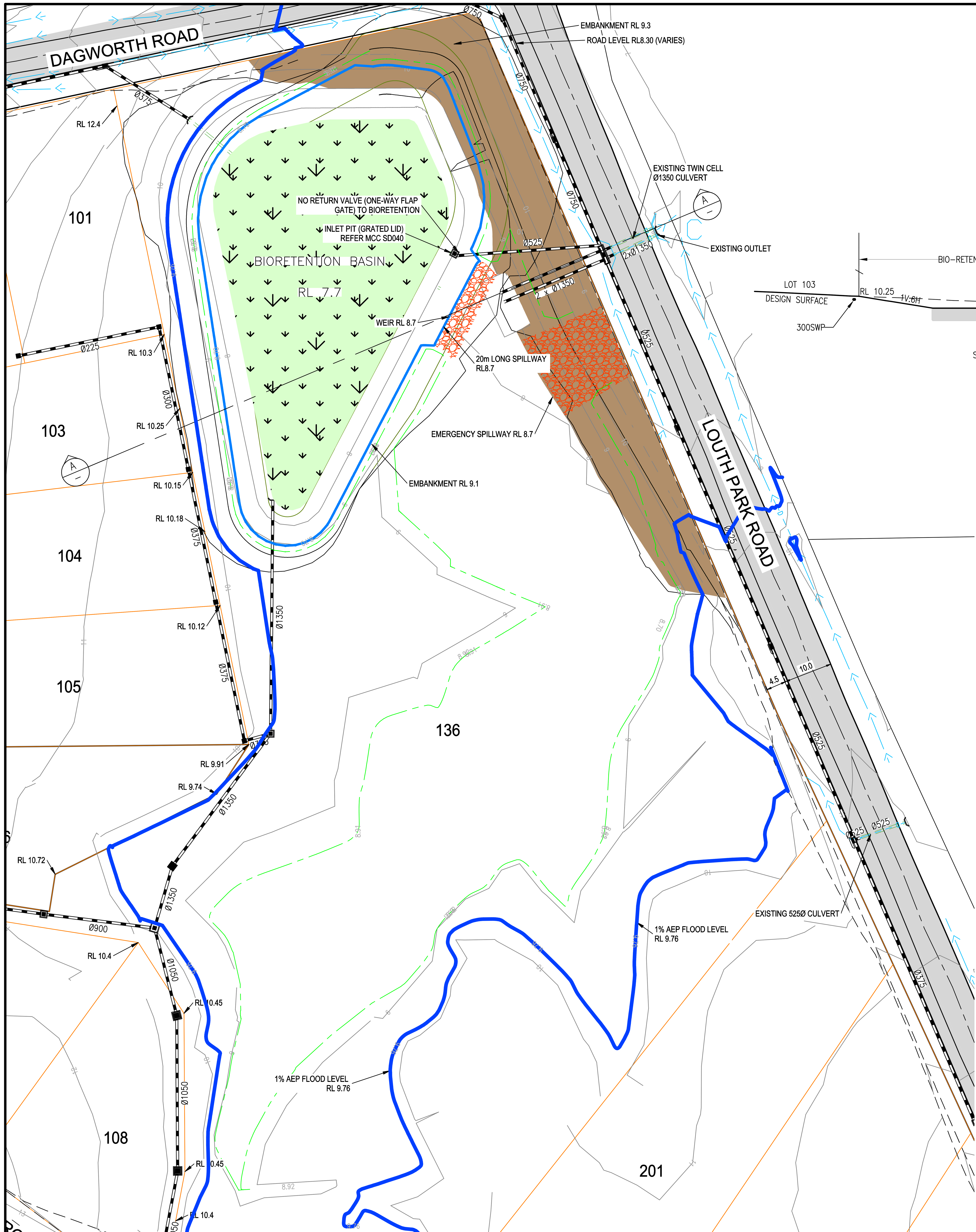
CLIENT:
VALHALLA INVESTMENTS PTY LTD

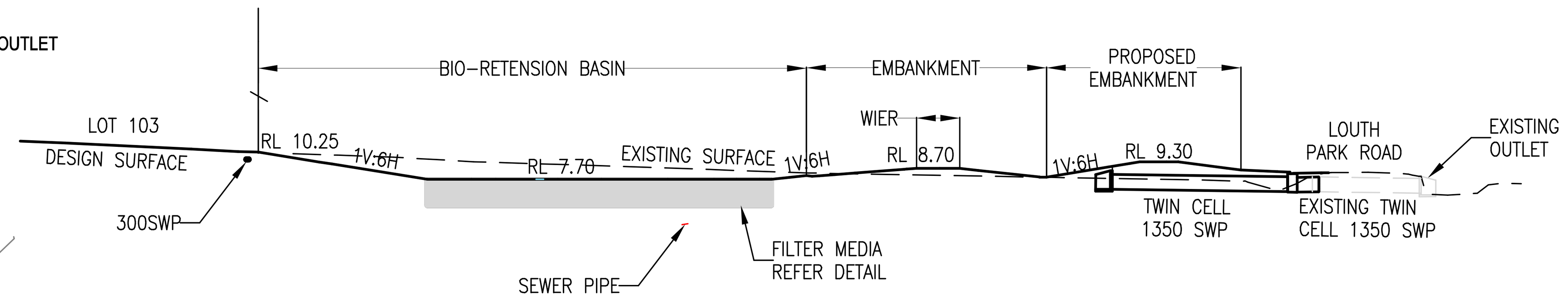
Vertical Scale 1:3000 (A1)
100 50 0 50 100 150
NO HORIZONTAL SCALE SET

No. OF SHEETS
1

SHEET No.
1

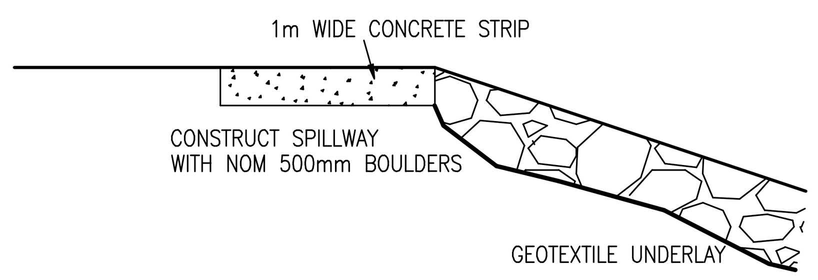
Plot Date: 23/10/2015 Cad File: 13_30 – Catchment Plan (ID 90155)





SECTION A - A

SCALE 1:500



SPILLWAY DIAGRAM

NOT TO SCALE

BIORETENTION SWALE MATERIAL SPECIFICATIONS

FILTER MEDIA – GENERAL DESCRIPTION:

THE MATERIAL CAN BE OF SILICEOUS OR CALCAREOUS ORIGIN. THE MATERIAL MUST BE TESTED FOR DESIRED HYDRAULIC CONDUCTIVITY USING THE AUSTRALIAN STANDARD (AS4419–2003). REFER TYPICAL SPECIFICATION BELOW.

SPECIFICATION FOR BIO–RETENTION FILTER MEDIA:

FILTRATION LAYER (200mm DEPTH):

BIORETENTION FILTER MEDIA SHALL COMPRISE OF THREE LAYERS 1. THE FILTRATION LAYER PLACED TO THE REQUIRED THICKNESS IS TO CONSIST OF TWO DISTINCT LAYERS. BOTH LAYERS ARE TO BE COMPRISED OF THE SAME MATERIAL AND CONFORM TO THE FOLLOWING SOIL SPECIFICATIONS:

pH	5.5 – 7.5 (pH 1:5 IN WATER)	
ELECTRICAL CONDUCTIVITY (dS/cm)	< 1.2	
TOTAL SALTS (ppm)	< 600	
CLAY	2 – 4%	(<0.002mm)
SILT	4 – 8%	(0.002 – 0.05mm)
VERY FINE SAND	5 – 10%	(0.05 – 0.15mm)
FINE SAND	10 – 25%	(0.15 – 0.25mm)
MEDIUM TO COARSE SAND	60 – 70%	(0.25 – 1.0mm)
COARSE SAND	7 – 10%	(1.0 – 2.0mm)
FINE GRAVEL	< 3%	(2.0 – 3.4mm)
HYDRAULIC CONDUCTIVITY (mm/hr)	200 (+/– 20%)	

THE TOP 100mm OF THE FILTER WILL BE AMELIORATED TO PROVIDE ADEQUATE INITIAL GROWTH. THIS LAYER IS TO CONSIST OF PREMIXED ZEOLITE 20 BY VOLUME PRIOR TO DELIVERY AND PLACEMENT. PRIOR TO PLANTING THE FOLLOWING SHALL BE INCORPORATED BY POWER HARROWS INTO THE TOP 75MM.

AGRICULTURAL LIME – RATE TO BE DETERMINED DEPENDING ON SELECTED FILTER MATERIAL
10–30 kg/100sq.m INDICATIVE RANGE

SUPERPHOSPHATE AT	2 kg/100sq.m
MAGNESIUM SULPHATE AT	3 kg/100sq.m
POTASSIUM SULPHATE AT	2 kg/sq.m
TRACE ELEMENTS MIX	1 kg/100sq.m
FERTILISER NPK16.4.14 AT	4 kg/100sq.m.

TRANSITION LAYER (100mm DEPTH):

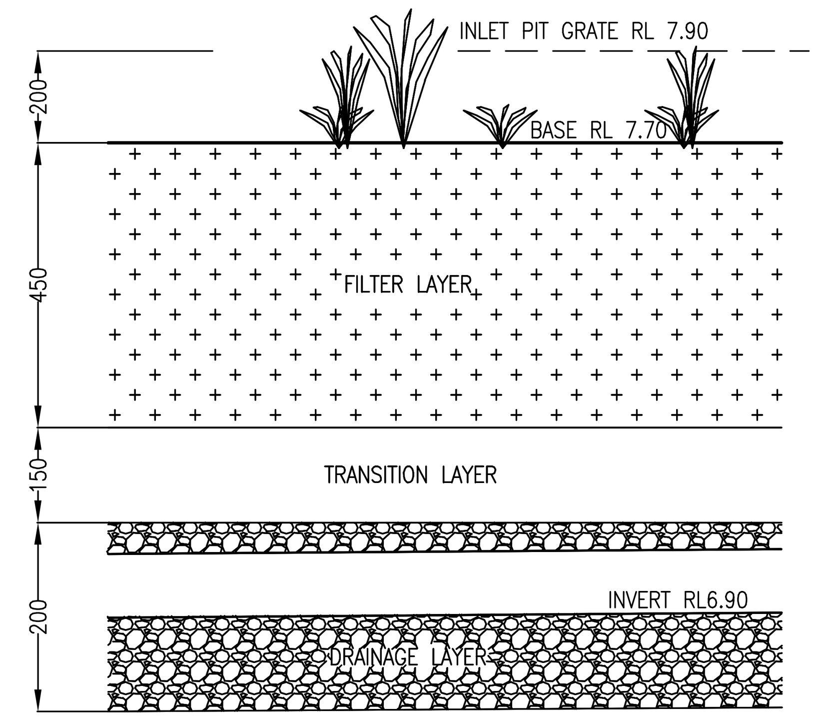
A TRANSITION LAYER OF COARSE SAND CONSISTING OF WASHED A2 FILTER SAND WITH 90 PARTICLES RETAINED ABOVE 0.25mm SHALL BE PLACED ABOVE THE DRAINAGE LAYER. THIS COARSE SAND SHALL BE PREMIXED WITH RECYCLED HARDWOOD CHIPS AT 10 BY VOLUME. HARDWOOD CHIPS WILL BE CLEAN AND HAVE LESS THAN 2 OF MATERIAL PASSING A 10mm SIEVE.

DRAINAGE LAYER (100mm DEPTH):

THE DRAINAGE LAYER IS TO BE COARSE, POORLY – GRADED (THAT IS WITH A NARROW RANGE OF PARTICLE SIZE DISTRIBUTION) IN THE RANGE AS FOLLOWS.

PARTICLE SIZE (mm)	RETAINED
GREATER THAN 10.0	0
4.0 – 10.0	>70
2.0 – 4.0	<20
LESS THAN 2.0	0

INSTALATION OF THE BIORETENTION LAYERS SHALL BE IN NOT GREATER THAN 250mm LIFTS. EACH LIFT LIGHTLY COMPACTED TO AVOID FUTURE SUBSIDENCE. THERE SHOULD BE NO GEOFABRIC INTERFACE BETWEEN THE LAYERS



BIORETENTION FILTER DETAIL

NOT TO SCALE

LEGEND

- PROPOSED STORMWATER
- EXISTING CHANNEL
- 100YR FLOOD EXTENTS (REGIONAL EVENT)
- 1YR EVENT IN BIO/RETENTION BASIN
- 100YR EVENT IN BIO/RETENTION BASIN

DETENTION BASIN SUMMARY	
SITE CATCHMENT AREA (ha)	50.29
SITE AREA DRAINED (ha)	50.29
SURFACE AREA (m²)	3830
BANK TOP RL (m)	9.3
SPILL RL (m)	8.7
OUTLET INVERT (m)	6.788
OUTLET Ø (mm)	1350 (x2)
OSD STORAGE TO SPILL RL (m³)	950
OSD STORAGE TO BANK RL (m³)	5510

BIORETENTION SUMMARY	
SURFACE AREA (m²)	4615
FILTER AREA (m²)	2575
FILTER DEPTH (m)	0.45
BASE RL (m)	7.7
INVERT RL (m)	6.9
OUTLET PIT GRATE RL (m)	7.9
OUTLET PIPE (Ømm)	525
EDD	0.2
SPILL RL (m)	8.7
TOP BANK RL (m)	9.1
OSD DEPTH (m)	1.4
OSD VOLUME TO SPILL RL (m³)	3300
OSD VOLUME TO TWL RL (m³)	5060

CONCEPT ONLY
NOT FOR CONSTRUCTION

DIAL BEFORE YOU DIG www.1100.com.au

JOB NUMBER: 13/30
FILE ID: 101384
SURVEYED:
DESIGNED: BC
DRAWN: DOB
CHECKED: DE
DATUM: AHD
CONTOUR INTERVAL: 1.0m

NO.	DESCRIPTION	DRAWN	DATE
B	COUNCIL RFI	DOB	13/12/2016
A	CONCEPT PLAN	DOB	25/08/2016

pcb PULVER COOPER & BLACKLEY
SURVEYORS
TOWN PLANNERS
CIVIL ENGINEERS
PROJECT MANAGERS
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98 LAWES STREET EAST MAITLAND 2323 Ph (02) 4934 3026

PLAN:
BIORETENTION BASIN AND DETAIL PLAN

CLIENT:
VALHALLA INVESTMENTS PTY LTD

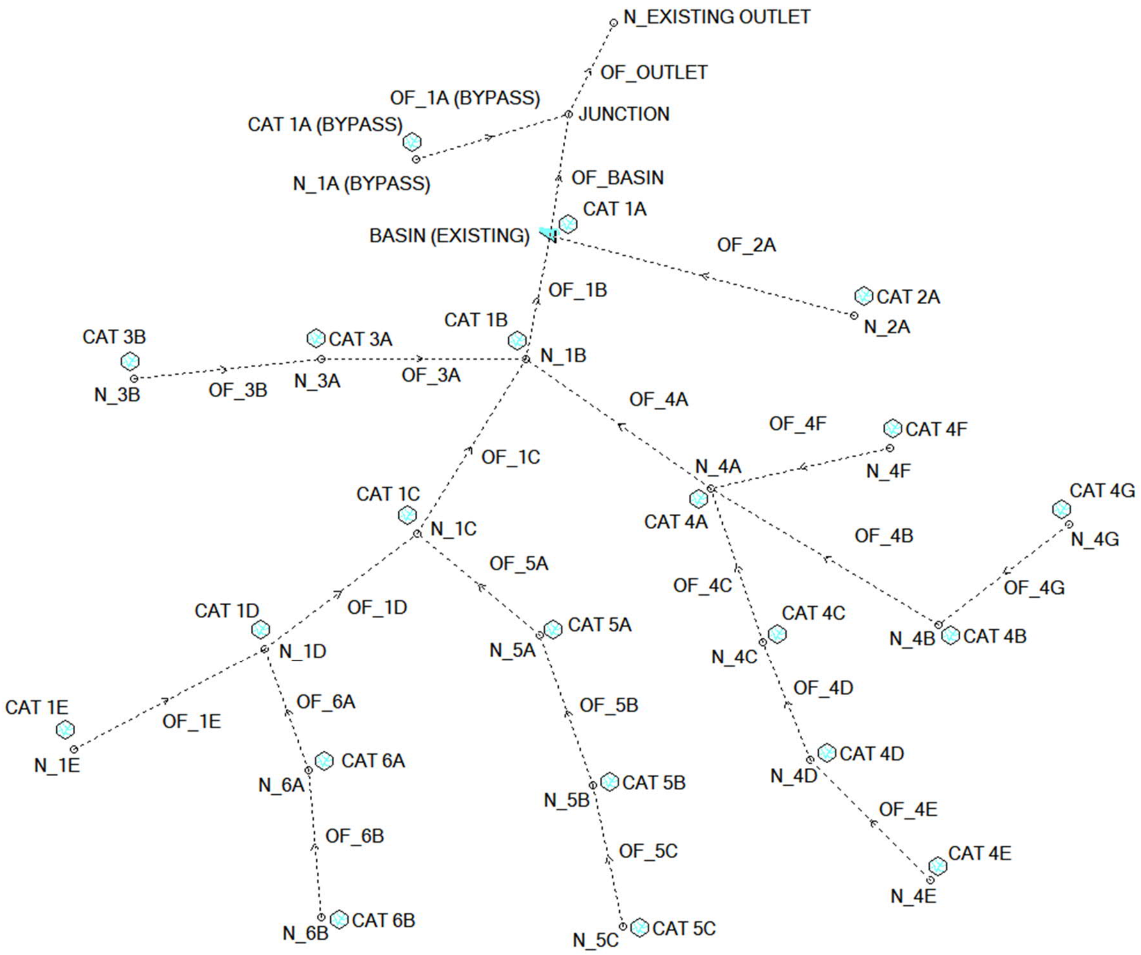
Horizontal Scale 1:500 (A1) 1:1000 (A3)

TOTAL SHEETS 31
SHEET No. 29

Plot Date: Mon Dec 19 09:16:07 2016 Project X:\13_030_DATASETS\OPT D FOR DA\DRAFTING

Appendix B

DRAINS Data



N_EXISTING OUTLET
OF_OUTLET
OF_1A (BYPASS)
JUNCTION
CAT 1A (BYPASS)
N_1A (BYPASS)
OF_BASIN
CAT 1A
BASIN (EXISTING)
OF_2A
OF_1B
CAT 2A
N_2A
CAT 1B
CAT 3B
CAT 3A
N_1B
N_3B
OF_3B
N_3A
OF_3A
OF_4A
OF_4F
CAT 4F
N_4F
OF_1C
N_4A
CAT 4G
CAT 1C
CAT 4A
N_4G
N_1C
OF_5A
OF_4B
OF_4C
OF_4G
CAT 1D
OF_1D
CAT 4C
CAT 5A
N_1D
N_5A
N_4C
N_4B
CAT 4B
OF_6A
OF_5B
OF_4D
CAT 1E
OF_1E
N_1E
CAT 6A
CAT 4D
N_6A
CAT 5B
N_4D
N_5B
OF_4E
OF_6B
OF_5C
CAT 4E
N_4E
N_6B
CAT 6B
CAT 5C
N_5C

DRAINS DATA (UNDEV)

PIT / NODE DETAILS Version 15

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss	Inflow Hydrograph	Pit is	Internal Width (mm)	Inflow is Misaligned	Minor Safe Pond Depth (m)	Major Safe Pond Depth (m)
JUNCTION	Node					7		0		465	-62		788		No					
N_1B	Node					10		0		428	-274		802		No					
N_1C	Node					12		0		334	-426		803		No					
N_1D	Node					18		0		202	-525		804		No					
N_3A	Node					12		0		251	-274		805		No					
N_3B	Node					12.5		0		89	-292		806		No					
N_4A	Node					10		0		588	-387		807		No					
N_4B	Node					28		0		751	-397		809		No					
N_2A	Node					18		0		748	-177		810		No					
N_4C	Node					38		0		704	-506		811		No					
N_5A	Node					14		0		441	-513		821		No					
N_5B	Node					24		0		486	-644		822		No					
N_5C	Node					32		0		512	-765		823		No					
N_6A	Node					16		0		240	-630		830		No					
N_6B	Node					38		0		251	-757		831		No					
N_1E	Node					30		0		37	-612		832		No					
N_1A	Node					8		0		449	-162		13376		No					
N_EXISTIN	Node					6		0		504	17		30504		No					
N_1A (BYP.	Node					10		0		333	-101		30511		No					

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Not Used	Outlet Typ	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Leng	id

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough	Lag Time or Factor	Gutter Length (m)	Gutter Slope %	Gutter FlowFacto	Rainfall Multiplier
CAT 1B	N_1B	2.95	0	100	0	0	0	0	0	100	-1	0	5	-1	0	0.35	-1	0				1
CAT 1C	N_1C	6.89	0	100	0	0	0	0	0	150	-1	0	5	-1	0	0.35	-1	0				1
CAT 1D	N_1D	7.39	0	100	0	0	0	0	0	200	-1	0	7	-1	0	0.35	-1	0				1
CAT 3A	N_3A	0.19	0	100	0	0	0	0	0	40	-1	0	3	-1	0	0.35	-1	0				1
CAT 3B	N_3B	9.95	0	100	0	0	0	0	0	150	-1	0	5	-1	0	0.35	-1	0				1
CAT 4A	N_4A	27.73	5	95	0	0	0	0	50	300	-1	5	6	-1	0.01	0.35	-1	0				1
CAT 4B	N_4B	3.54	0	100	0	0	0	0	50	230	-1	5	4	-1	0.01	0.35	-1	0				1
CAT 2A	N_2A	8.72	0	100	0	0	0	0	50	200	-1	5	4	-1	0.01	0.35	-1	0				1
CAT 4C	N_4C	2.48	0	100	0	0	0	0	50	160	-1	5	4	-1	0.01	0.35	-1	0				1
CAT 5A	N_5A	1.54	0	100	0	0	0	0	0	230	-1	0	5	-1	0	0.35	-1	0				1
CAT 5B	N_5B	4.15	0	100	0	0	0	0	0	270	-1	0	2	-1	0	0.35	-1	0				1
CAT 5C	N_5C	3.14	0	100	0	0	0	0	0	200	-1	0	5	-1	0	0.35	-1	0				1
CAT 6A	N_6A	4.15	0	100	0	0	0	0	0	300	-1	0	5	-1	0	0.35	-1	0				1
CAT 6B	N_6B	1.96	0	100	0	0	0	0	0	100	-1	0	4	-1	0	0.35	-1	0				1
CAT 1E	N_1E	5.07	0	100	0	0	0	0	0	100	-1	0	6	-1	0	0.35	-1	0				1
CAT 1A	N_1A	7.05	12	88	0	0	0	0	350	80	-1	5	6	-1	0.01	0.35	-1	0				1
CAT 1A (BY	N_1A (BYP.	2.78	0	100	0	0	0	0	20	200	-1	2	5	-1	0.01	0.35	-1	0				1

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	RI (m)	Chg (m)	RL (m)	etc (m)

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)	Height of S (m)	etc etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Widtl (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Stor (m)	SafeDepth Minor Stor (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id			
OF_OUTLE	JUNCTION	N_EXISTIN	0.1				Overflow	0.3	0.3	0.4	5	100	30506			1
OF_1B	N_1B	N_1A	0.1				Overflow	0.3	0.3	0.4	5	100	812			1
OF_1C	N_1C	N_1B	0.1				Overflow	0.3	0.3	0.4	5	100	815			1
OF_1D	N_1D	N_1C	0.1				Overflow	0.3	0.3	0.4	5	100	816			1
OF_3A	N_3A	N_1B	0.1				Overflow	0.3	0.3	0.4	5	100	814			1
OF_3B	N_3B	N_3A	0.1				Overflow	0.3	0.3	0.4	1	100	813			1
OF_4A	N_4A	N_1B	0.1				Overflow	0.3	0.3	0.4	5	100	11012			1
OF_4B	N_4B	N_4A	0.1				Overflow	0.3	0.3	0.4	5	100	819			1
OF_2A	N_2A	N_1A	0.1				Overflow	0.3	0.3	0.4	5	100	818			1
OF_4C	N_4C	N_4A	0.1				Overflow	0.3	0.3	0.4	5	100	820			1
OF_5A	N_5A	N_1C	0.1				Overflow	0.3	0.3	0.4	5	100	824			1
OF_5B	N_5B	N_5A	0.1				Overflow	0.3	0.3	0.4	5	100	825			1
OF_5C	N_5C	N_5B	0.1				Overflow	0.3	0.3	0.4	5	100	826			1
OF_6A	N_6A	N_1D	0.1				Overflow	0.3	0.3	0.4	5	100	834			1
OF_6B	N_6B	N_6A	0.1				Overflow	0.3	0.3	0.4	5	100	835			1
OF_1E	N_1E	N_1D	0.1				Overflow	0.3	0.3	0.4	5	100	833			1
OF_EX OU	N_1A	JUNCTION	0.1				Overflow	0.3	0.3	0.4	5	100	799			1
OF_1A (BYI	N_1A (BYP.	JUNCTION	0.1				Overflow	0.3	0.3	0.4	5	100	30514			1

PIPE COVER DETAILS

Name	Type	Dia (mm)	Safe Cover	Cover (m)

This model has no pipes with non-return valves

DRAINS DATA (POST DEV)

PIT / NODE DETAILS Version 15

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss	Inflow Hydrograph	Pit is	Internal Width (mm)	Inflow is Misaligned	Minor Safe Pond Depth (m)	Major Safe Pond Depth (m)
JUNCTION	Node					6		0		465	-62		788		No					
N_1B	Node					10		0		428	-274		802		No					
N_1C	Node					12		0		334	-426		803		No					
N_1D	Node					18		0		202	-525		804		No					
N_3A	Node					12		0		251	-274		805		No					
N_3B	Node					12.5		0		89	-292		806		No					
N_4A	Node					10		0		588	-386		807		No					
N_4F	Node					28		0		743	-351		809		No					
N_2A	Node					18		0		712	-236		810		No					
N_4G	Node					38		0		898	-417		811		No					
N_5A	Node					14		0		441	-513		821		No					
N_5B	Node					24		0		486	-644		822		No					
N_5C	Node					32		0		512	-765		823		No					
N_6A	Node					16		0		240	-630		830		No					
N_6B	Node					38		0		251	-757		831		No					
N_1E	Node					30		0		37	-612		832		No					
N_EXISTIN	Node					5.5		0		504	17		30504		No					
N_1A (BYP	Node					10		0		333	-101		30511		No					
N_4B	Node					22		0		785	-504		55305		No					
N_4C	Node					20		0		633	-519		55309		No					
N_4D	Node					32		0		674	-621		55313		No					
N_4E	Node					34		0		778	-725		55314		No					

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Not Used	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Leng	id
BASIN (EXI	6.9	449		None						449	-167	No			48718
	7.8	2732													
	8	4462													
	8.2	13519													
	8.4	14376													
	8.6	15254													
	8.8	16325													
	9	17241													
	9.2	18987													
	9.4	19908													
	9.6	20636													
	9.8	21360													
	10	22110													

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough	Lag Time or Factor	Gutter Length (m)	Gutter Slope %	Gutter FlowFactor	Rainfall Multiplier
CAT 1B	N_1B	2.95	16	84	0	0	0	0	50	50	-1	5	5	-1	0.01	0.21	-1	0				1
CAT 1C	N_1C	6.89	42	58	0	0	0	0	290	50	-1	4	4	-1	0.01	0.21	-1	0				1
CAT 1D	N_1D	7.39	43	57	0	0	0	0	600	50	-1	4	4	-1	0.01	0.21	-1	0				1
CAT 3A	N_3A	0.19	40	60	0	0	0	0	30	40	-1	3	3	-1	0.01	0.21	-1	0				1
CAT 3B	N_3B	9.95	16	84	0	0	0	0	580	80	-1	5	5	-1	0.01	0.21	-1	0				1
CAT 4A	N_4A	7.8	3	97	0	0	0	0	50	100	-1	5	5	-1	0.01	0.35	-1	0				1
CAT 4F	N_4F	3.54	0	100	0	0	0	0	50	230	-1	5	5	-1	0.01	0.35	-1	0				1
CAT 2A	N_2A	8.72	0	100	0	0	0	0	50	200	-1	5	4	-1	0.01	0.35	-1	0				1
CAT 4G	N_4G	2.48	0	100	0	0	0	0	50	160	-1	4	4	-1	0.01	0.35	-1	0				1
CAT 5A	N_5A	1.54	45	55	0	0	0	0	160	50	-1	5	5	-1	0.01	0.21	-1	0				1
CAT 5B	N_5B	4.15	43	57	0	0	0	0	300	50	-1	5	3	-1	0.01	0.21	-1	0				1
CAT 5C	N_5C	3.14	20	80	0	0	0	0	50	50	-1	5	5	-1	0.01	0.21	-1	0				1
CAT 6A	N_6A	4.15	28	72	0	0	0	0	370	50	-1	5	5	-1	0.01	0.21	-1	0				1
CAT 6B	N_6B	1.96	20	80	0	0	0	0	50	50	-1	5	4	-1	0.01	0.21	-1	0				1
CAT 1E	N_1E	5.07	20	80	0	0	0	0	50	50	-1	4	4	-1	0.01	0.21	-1	0				1
CAT 1A (BY	N_1A (BYP.	2.78	0	100	0	0	0	0	20	200	-1	2	5	-1	0.01	0.35	-1	0				1
CAT 1A	BASIN (EXI	7.05	27	73	0	0	0	0	350	80	-1	5	6	-1	0.01	0.35	-1	0				1
CAT 4B	N_4B	9.32	0	100	0	0	0	0	50	200	-1	4	4	-1	0.01	0.35	-1	0				1
CAT 4C	N_4C	5.71	42	58	0	0	0	0	200	50	-1	4	4	-1	0.01	0.21	-1	0				1
CAT 4D	N_4D	1.83	50	50	0	0	0	0	200	50	-1	5	5	-1	0.01	0.21	-1	0				1
CAT 4E	N_4E	3.03	41	59	0	0	0	0	50	50	-1	5	5	-1	0.01	0.21	-1	0				1

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	RI (m)	Chg (m)	RL (m)	etc (m)

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)	Height of S (m)	etc etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Widtl (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Stor (m)	SafeDepth Minor Stor (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id	
OF_OUTLE	JUNCTION	N_EXISTIN	0.1				Overflow	0.3	0.3	0.4	5	100	30506	1
OF_1B	N_1B	BASIN (EXI	0.1				Overflow	0.3	0.3	0.4	5	100	812	1
OF_1C	N_1C	N_1B	0.1				Overflow	0.3	0.3	0.4	5	100	815	1
OF_1D	N_1D	N_1C	0.1				Overflow	0.3	0.3	0.4	5	100	816	1
OF_3A	N_3A	N_1B	0.1				Overflow	0.3	0.3	0.4	5	100	814	1
OF_3B	N_3B	N_3A	0.1				Overflow	0.3	0.3	0.4	1	100	813	1
OF_4A	N_4A	N_1B	0.1				Overflow	0.3	0.3	0.4	5	100	11012	1
OF_4F	N_4F	N_4A	0.1				Overflow	0.3	0.3	0.4	5	100	819	1
OF_2A	N_2A	BASIN (EXI	0.1				Overflow	0.3	0.3	0.4	5	100	818	1
OF_4G	N_4G	N_4B	0.1				Overflow	0.3	0.3	0.4	5	100	55315	1
OF_5A	N_5A	N_1C	0.1				Overflow	0.3	0.3	0.4	5	100	824	1
OF_5B	N_5B	N_5A	0.1				Overflow	0.3	0.3	0.4	5	100	825	1
OF_5C	N_5C	N_5B	0.1				Overflow	0.3	0.3	0.4	5	100	826	1
OF_6A	N_6A	N_1D	0.1				Overflow	0.3	0.3	0.4	5	100	834	1
OF_6B	N_6B	N_6A	0.1				Overflow	0.3	0.3	0.4	5	100	835	1
OF_1E	N_1E	N_1D	0.1				Overflow	0.3	0.3	0.4	5	100	833	1
OF_1A (BY	N_1A (BYP.	JUNCTION	0.1				Overflow	0.3	0.3	0.4	5	100	30514	1
OF_BASIN	BASIN (EXI	JUNCTION	0.1	6.9			Overflow	0.3	0.3	0.4	5	100	799	1
OF_4B	N_4B	N_4A	0.1				Overflow	0.3	0.3	0.4	5	100	820	1
OF_4C	N_4C	N_4A	0.1				Overflow	0.3	0.3	0.4	5	100	55318	1
OF_4D	N_4D	N_4C	0.1				Overflow	0.3	0.3	0.4	5	100	55316	1
OF_4E	N_4E	N_4D	0.1				Overflow	0.3	0.3	0.4	5	100	55319	1

PIPE COVER DETAILS

Name	Type	Dia (mm)	Safe Cover	Cover (m)

This model has no pipes with non-return valves

BASIN 1 - STAGE / DISCHARGE RELATIONSHIP FOR BASIN WITH STAGED CONTROL STRUCTURE

	MAIN CONTROL STRUCTURES								OVERFLOW STRUCTURES					
Elevation	**Pipe**		**Pit**		**Pit**		**Spillway 1**		**Spillway 2**		**Check Pipe Inlet Control**		**Stage**	**Total Outflow**
RL	For H/D < 1.2 : Q=1.32D^.87H^1.63		Q=1.67LH^1.5		Q=1.67LH^1.5		Q=1.67LH^1.5		Q=1.67LH^1.5		For H/D < 1.2 : Q=1.32D^.87H^1.63			
	For H/D > 1.2 : Q=1.62D^1.87H^.63										For H/D > 1.2 : Q=1.62D^1.87H^.63			
	Pipe Dia (D), m	0.600	Weir Length (L), m	3.9	Weir Length (L), m	6.3	Weir Length (L), m	10	Weir Length (L), m	65	Pipe Dia (D), m	1.350		
	Assuming Square Edged		Pit Inlet (RL), m	8.00	Pit Inlet (RL), m	8.70	Weir Invert (RL), m	9.00	Weir Invert (RL), m	9.30	*Assuming Square Edged*			
				7.70		8.63								
Increment	Pipe Invert (RL), m	6.90									Pipe Invert (RL), m	6.79		
0.1														
	No. Pipes	4									No. Pipes	2		
	H (m)	Q (cumecs)	H (m)	Q (cumecs)	H (m)	Q (cumecs)	H (m)	Q (cumecs)	H (m)	Q (cumecs)	H (m)	Q (cumecs)		
6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.09	6.90	0.00
7.00	0.10	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.27	7.00	0.08
7.10	0.20	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.51	7.10	0.25
7.20	0.30	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.80	7.20	0.48
7.30	0.40	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	1.14	7.30	0.76
7.40	0.50	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	1.53	7.40	1.09
7.50	0.60	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	1.96	7.50	1.47
7.60	0.70	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	2.43	7.60	1.89
7.70	0.80	2.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.91	2.94	7.70	2.17
7.80	0.90	2.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.01	3.48	7.80	2.33
7.90	1.00	2.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	4.06	7.90	2.49
8.00	1.10	2.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.21	4.68	8.00	2.65
8.10	1.20	2.80	0.10	0.21	0.00	0.00	0.00	0.00	0.00	0.00	1.31	5.32	8.10	3.00
8.20	1.30	2.94	0.20	0.58	0.00	0.00	0.00	0.00	0.00	0.00	1.41	6.00	8.20	3.52
8.30	1.40	3.08	0.30	1.07	0.00	0.00	0.00	0.00	0.00	0.00	1.51	6.71	8.30	4.15
8.40	1.50	3.22	0.40	1.65	0.00	0.00	0.00	0.00	0.00	0.00	1.61	7.45	8.40	4.87
8.50	1.60	3.35	0.50	2.30	0.00	0.00	0.00	0.00	0.00	0.00	1.71	7.96	8.50	5.65
8.60	1.70	3.48	0.60	3.03	0.00	0.00	0.00	0.00	0.00	0.00	1.81	8.25	8.60	6.51
8.70	1.80	3.61	0.70	3.81	0.00	0.00	0.00	0.00	0.00	0.00	1.91	8.54	8.70	7.42
8.80	1.90	3.74	0.80	4.66	0.10	0.33	0.00	0.00	0.00	0.00	2.01	8.82	8.80	8.73
8.90	2.00	3.86	0.90	5.56	0.20	0.94	0.00	0.00	0.00	0.00	2.11	9.09	8.90	9.09
9.00	2.10	3.98	1.00	6.51	0.30	1.73	0.00	0.00	0.00	0.00	2.21	9.36	9.00	9.36
9.10	2.20	4.10	1.10	7.51	0.40	2.66	0.10	0.53	0.00	0.00	2.31	9.62	9.10	10.15
9.20	2.30	4.21	1.20	8.56	0.50	3.72	0.20	1.49	0.00	0.00	2.41	9.88	9.20	11.38
9.30	2.40	4.33	1.30	9.65	0.60	4.89	0.30	2.74	0.00	0.00	2.51	10.14	9.30	12.88
9.40	2.50	4.44	1.40	10.79	0.70	6.16	0.40	4.22	0.10	3.43	2.61	10.39	9.40	18.05
9.50	2.60	4.55	1.50	11.97	0.80	7.53	0.50	5.90	0.20	9.71	2.71	10.64	9.50	26.26
9.60	2.70	4.66	1.60	13.18	0.90	8.98	0.60	7.76	0.30	17.84	2.81	10.89	9.60	36.49
9.70	2.80	4.77	1.70	14.44	1.00	10.52	0.70	9.78	0.40	27.46	2.91	11.13	9.70	48.37
9.80	2.90	4.88	1.80	15.73	1.10	12.14	0.80	11.95	0.50	38.38	3.01	11.37	9.80	61.70
9.90	3.00	4.98	1.90	17.06	1.20	13.83	0.90	14.26	0.60	50.45	3.11	11.61	9.90	76.31
10.00	3.10	5.08	2.00	18.42	1.30	15.59	1.00	16.70	0.70	63.57	3.21	11.84	10.00	92.11

Appendix C

DRAINS Results

DRAINS - PREDEV 10% AEP RESULTS
DRAINS results prepared from Version 2022.012

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT 1B	0.331	0	0.331	0	31.53	0	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
CAT 1C	0.621	0	0.621	0	40.22	0	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
CAT 1D	0.622	0	0.622	0	47.62	0	AR&R 10 year, 1.5 hours storm, average 34.9 mm/h, Zone 1
CAT 3A	0.028	0	0.028	0	21.21	0	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
CAT 3B	0.896	0	0.896	0	40.22	0	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
CAT 4A	1.806	0.488	1.747	2.91	68.21	0	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
CAT 4B	0.244	0	0.244	2.91	65.69	0	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
CAT 2A	0.651	0	0.651	2.91	60.4	0	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
CAT 4C	0.203	0	0.203	2.72	49.26	0	AR&R 10 year, 1.5 hours storm, average 34.9 mm/h, Zone 1
CAT 5A	0.113	0	0.113	0	61.43	0	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
CAT 5B	0.218	0	0.218	0	98.43	0	AR&R 10 year, 3 hours storm, average 22.8 mm/h, Zone 1
CAT 5C	0.248	0	0.248	0	56.49	0	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
CAT 6A	0.262	0	0.262	0	72.05	0	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
CAT 6B	0.207	0	0.207	0	33.72	0	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
CAT 1E	0.593	0	0.593	0	29.85	0	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
CAT 1A	0.942	0.308	0.702	6.53	21.54	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 1A (BYPASS)	0.219	0	0.219	2.21	56.49	0	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1

Outflow Volumes for Total Catchment (2.23 impervious + 97.4 pervious = 99.7 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 10 year, 5 minutes storm, average 147 mm/h, Zone 1	12210.8	1277.95 (10.5%)	251.16 (91.8%)	1026.80 (8.6%)
AR&R 10 year, 10 minutes storm, average 112 mm/h, Zone 1	18606.94	4579.88 (24.6%)	394.41 (94.6%)	4185.47 (23.0%)
AR&R 10 year, 15 minutes storm, average 93.0 mm/h, Zone 1	23175.6	7706.41 (33.3%)	496.73 (95.7%)	7209.67 (31.8%)
AR&R 10 year, 20 minutes storm, average 81.0 mm/h, Zone 1	26913.6	10198.89 (37.9%)	580.45 (96.3%)	9618.44 (36.6%)
AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1	29904	11890.38 (39.8%)	647.43 (96.7%)	11242.95 (38.5%)
AR&R 10 year, 30 minutes storm, average 66.0 mm/h, Zone 1	32894.4	13325.62 (40.5%)	714.40 (97.0%)	12611.22 (39.2%)
AR&R 10 year, 45 minutes storm, average 53.0 mm/h, Zone 1	39623.63	17945.17 (45.3%)	865.11 (97.5%)	17080.06 (44.1%)
AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1	44357.6	20962.72 (47.3%)	971.14 (97.8%)	19991.59 (46.1%)
AR&R 10 year, 1.5 hours storm, average 34.9 mm/h, Zone 1	52180.81	25089.21 (48.1%)	1146.35 (98.1%)	23942.86 (46.9%)
AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1	58414.15	28103.64 (48.1%)	1285.96 (98.3%)	26817.69 (47.0%)
AR&R 10 year, 3 hours storm, average 22.8 mm/h, Zone 1	68178.64	33006.81 (48.4%)	1504.65 (98.5%)	31502.16 (47.3%)
AR&R 10 year, 4.5 hours storm, average 17.7 mm/h, Zone 1	79397.61	36617.03 (46.1%)	1755.92 (98.7%)	34861.11 (44.9%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF_OUTLET	7.654	7.654	0	0.318	0.22	35.03	0.69	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_1B	6.101	6.85	0	0.297	0.2	35.03	0.66	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_1C	2.757	3.085	0	0.184	0.09	35.02	0.48	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_1D	1.631	2.23	0	0.151	0.06	35.02	0.42	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_3A	0.902	1.218	0	0.105	0.03	35.01	0.33	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_3B	0.896	0.902	0	0.142	0.03	35.01	0.18	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_4A	2.245	2.46	0	0.161	0.07	35.02	0.44	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_4B	0.244	2.045	0	0.144	0.06	35.01	0.41	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
OF_2A	0.651	1.456	0	0.117	0.04	35.01	0.36	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_4C	0.203	2.006	0	0.142	0.06	35.01	0.4	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
OF_5A	0.567	1.166	0	0.102	0.03	35.01	0.33	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_5B	0.455	0.567	0	0.067	0.02	35.01	0.24	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
OF_5C	0.248	0.455	0	0.058	0.01	35.01	0.22	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
OF_6A	0.45	1.06	0	0.097	0.03	35.01	0.31	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_6B	0.207	0.45	0	0.058	0.01	35.01	0.22	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_1E	0.593	1.19	0	0.104	0.03	35.01	0.33	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_EX OUTLET	7.449	7.449	0	0.313	0.21	35.03	0.68	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_1A (BYPASS)	0.219	0.219	0	0.038	0.01	35	0.17	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level

CONTINUITY CHECK for AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
JUNCTION	28103.7	28103.69	0	0
N_1B	22718.73	22718.72	0	0
N_1C	9439.62	9439.6	0	0
N_1D	5131.35	5131.35	0	0
N_3A	2808.5	2808.51	0	0
N_3B	2755.24	2755.24	0	0
N_4A	9649.16	9649.15	0	0
N_4B	969.14	969.14	0	0
N_2A	2396.7	2396.7	0	0
N_4C	684.85	684.85	0	0
N_5A	2400.35	2400.35	0	0
N_5B	1977.39	1977.38	0	0
N_5C	865.3	865.3	0	0
N_6A	1674.81	1674.81	0	0
N_6B	544.89	544.89	0	0
N_1E	1413.81	1413.81	0	0
N_1A	27337.59	27337.61	0	0
N_EXISTING OUTLET	28103.69	28103.69	0	0
N_1A (BYPASS)	766.1	766.1	0	0

Run Log for 21360 run at 16:31:39 on 3/11/2022 using version 2022.012

DRAINS - PREDEV 5% AEP RESULTS
DRAINS results prepared from Version 2022.012

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT 1B	0.452	0	0.452	0	29.63	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 1C	0.871	0	0.871	0	37.79	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 1D	0.877	0	0.877	0	40.6	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 3A	0.037	0	0.037	0	19.93	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 3B	1.258	0	1.258	0	37.79	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 4A	2.503	0.567	2.444	2.74	64.2	0	AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1
CAT 4B	0.339	0	0.339	2.74	61.82	0	AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1
CAT 2A	0.889	0	0.889	2.74	56.85	0	AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1
CAT 4C	0.285	0	0.285	2.32	42	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 5A	0.155	0	0.155	0	57.82	0	AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1
CAT 5B	0.305	0	0.305	0	83.79	0	AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1
CAT 5C	0.339	0	0.339	0	44.91	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 6A	0.365	0	0.365	0	67.81	0	AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1
CAT 6B	0.287	0	0.287	0	31.68	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 1E	0.808	0	0.808	0	28.05	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 1A	1.253	0.365	1.001	6.14	20.25	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 1A (BYPASS)	0.3	0	0.3	1.76	44.91	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1

Outflow Volumes for Total Catchment (2.23 impervious + 97.4 pervious = 99.7 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 20 year, 5 minutes storm, average 170 mm/h, Zone 1	14121.33	2468.80 (17.5%)	293.95 (92.9%)	2174.85 (15.8%)
AR&R 20 year, 10 minutes storm, average 130 mm/h, Zone 1	21597.34	7597.99 (35.2%)	461.38 (95.4%)	7136.60 (33.8%)
AR&R 20 year, 15 minutes storm, average 109 mm/h, Zone 1	27162.8	11767.85 (43.3%)	586.03 (96.3%)	11181.82 (42.1%)
AR&R 20 year, 20 minutes storm, average 94.0 mm/h, Zone 1	31233.06	14588.85 (46.7%)	677.19 (96.8%)	13911.66 (45.6%)
AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1	34888	16914.86 (48.5%)	759.05 (97.1%)	16155.81 (47.4%)
AR&R 20 year, 30 minutes storm, average 76.0 mm/h, Zone 1	37878.4	18198.09 (48.0%)	826.02 (97.4%)	17372.06 (46.9%)
AR&R 20 year, 45 minutes storm, average 61.0 mm/h, Zone 1	45604.43	23763.56 (52.1%)	999.06 (97.8%)	22764.50 (51.1%)
AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1	51833.6	28228.40 (54.5%)	1138.57 (98.1%)	27089.83 (53.5%)
AR&R 20 year, 1.5 hours storm, average 40.6 mm/h, Zone 1	60705.95	33370.31 (55.0%)	1337.29 (98.4%)	32033.02 (54.0%)
AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1	67981.77	37329.82 (54.9%)	1500.24 (98.5%)	35829.58 (53.9%)
AR&R 20 year, 3 hours storm, average 26.5 mm/h, Zone 1	79245.6	43713.43 (55.2%)	1752.51 (98.7%)	41960.92 (54.2%)
AR&R 20 year, 4.5 hours storm, average 20.6 mm/h, Zone 1	92398.36	49121.18 (53.2%)	2047.09 (98.9%)	47074.09 (52.1%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Widtl	Max V	Due to Storm
OF_OUTLET	10.44	10.44	6.94	0.384	0.3	35.04	0.78	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_1B	8.403	9.316	6.94	0.359	0.27	35.04	0.74	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_1C	3.78	4.211	6.94	0.222	0.12	35.02	0.54	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_1D	2.224	3.043	6.94	0.182	0.09	35.02	0.48	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_3A	1.269	1.67	6.94	0.127	0.05	35.01	0.37	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_3B	1.258	1.269	3.104	0.175	0.04	35.02	0.21	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_4A	3.089	3.381	6.94	0.195	0.1	35.02	0.5	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_4B	0.339	2.837	6.94	0.175	0.08	35.02	0.46	AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1
OF_2A	0.889	1.969	6.94	0.14	0.06	35.01	0.4	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_4C	0.285	2.754	6.94	0.171	0.08	35.02	0.46	AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1
OF_5A	0.777	1.635	6.94	0.125	0.05	35.01	0.37	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_5B	0.624	0.777	6.94	0.081	0.02	35.01	0.28	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_5C	0.339	0.624	6.94	0.071	0.02	35.01	0.25	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_6A	0.624	1.474	6.94	0.118	0.04	35.01	0.36	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_6B	0.287	0.624	6.94	0.071	0.02	35.01	0.25	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_1E	0.808	1.623	6.94	0.125	0.05	35.01	0.37	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_EX OUTLET	10.152	10.152	6.94	0.377	0.29	35.04	0.77	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_1A (BYPASS)	0.3	0.3	6.94	0.045	0.01	35	0.19	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level

CONTINUITY CHECK for AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
JUNCTION	37329.95	37330	0	0
N_1B	30226.49	30226.45	0	0
N_1C	12613.67	12613.65	0	0
N_1D	6852.23	6852.25	0	0
N_3A	3747.24	3747.24	0	0
N_3B	3676.25	3676.25	0	0
N_4A	12769.03	12769.03	0	0
N_4B	1295.55	1295.55	0	0
N_2A	3200.18	3200.18	0	0
N_4C	913.6	913.6	0	0
N_5A	3215.77	3215.76	0	0
N_5B	2650.9	2650.9	0	0
N_5C	1154.61	1154.61	0	0
N_6A	2240.89	2240.89	0	0
N_6B	727.51	727.51	0	0
N_1E	1886.36	1886.36	0	0
N_1A	36307.71	36307.71	0	0
N_EXISTING OUTLET	37330	37330	0	0
N_1A (BYPASS)	1022.23	1022.23	0	0

Run Log for 21360 run at 16:22:55 on 4/11/2022 using version 2022.012

DRAINS - PREDEV 2% AEP RESULTS
DRAINS results prepared from Version 2022.012

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT 1B	0.591	0	0.591	0	25.87	0	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
CAT 1C	1.18	0	1.18	0	32.99	0	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
CAT 1D	1.195	0	1.195	0	35.45	0	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
CAT 3A	0.051	0	0.051	0	14.66	0	AR&R 50 year, 20 minutes storm, average 112 mm/h, Zone 1
CAT 3B	1.704	0	1.704	0	32.99	0	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
CAT 4A	3.42	0.624	3.299	2.56	59.99	0	AR&R 50 year, 2 hours storm, average 40.4 mm/h, Zone 1
CAT 4B	0.458	0	0.458	2.17	48.99	0	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
CAT 2A	1.214	0	1.214	2.17	45.05	0	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
CAT 4C	0.388	0	0.388	2.02	36.67	0	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
CAT 5A	0.211	0	0.211	0	45.82	0	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
CAT 5B	0.424	0	0.424	0	78.3	0	AR&R 50 year, 2 hours storm, average 40.4 mm/h, Zone 1
CAT 5C	0.462	0	0.462	0	42.13	0	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
CAT 6A	0.501	0	0.501	0	63.36	0	AR&R 50 year, 2 hours storm, average 40.4 mm/h, Zone 1
CAT 6B	0.377	0	0.377	0	27.66	0	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
CAT 1E	1.047	0	1.047	0	24.49	0	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
CAT 1A	1.561	0.412	1.347	5.48	18.05	0	AR&R 50 year, 20 minutes storm, average 112 mm/h, Zone 1
CAT 1A (BYPASS)	0.409	0	0.409	1.65	42.13	0	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1

Outflow Volumes for Total Catchment (2.23 impervious + 97.4 pervious = 99.7 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 50 year, 5 minutes storm, average 202 mm/h, Zone 1	16779.46	4828.14 (28.8%)	353.48 (94.1%)	4474.66 (27.3%)
AR&R 50 year, 10 minutes storm, average 155 mm/h, Zone 1	25750.67	11808.36 (45.9%)	554.40 (96.1%)	11253.96 (44.7%)
AR&R 50 year, 15 minutes storm, average 129 mm/h, Zone 1	32146.8	16785.04 (52.2%)	697.66 (96.9%)	16087.39 (51.2%)
AR&R 50 year, 20 minutes storm, average 112 mm/h, Zone 1	37213.86	20531.29 (55.2%)	811.14 (97.3%)	19720.15 (54.2%)
AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1	41533.34	23292.43 (56.1%)	907.88 (97.6%)	22384.54 (55.1%)
AR&R 50 year, 30 minutes storm, average 91.0 mm/h, Zone 1	45354.4	25343.73 (55.9%)	993.46 (97.8%)	24350.27 (54.9%)
AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1	54574.8	32435.44 (59.4%)	1199.97 (98.2%)	31235.47 (58.5%)
AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1	60804.8	36744.28 (60.4%)	1339.50 (98.4%)	35404.78 (59.6%)
AR&R 50 year, 1.5 hours storm, average 48.2 mm/h, Zone 1	72068.63	44298.57 (61.5%)	1591.77 (98.6%)	42706.80 (60.6%)
AR&R 50 year, 2 hours storm, average 40.4 mm/h, Zone 1	80541.44	49511.03 (61.5%)	1781.53 (98.8%)	47729.50 (60.6%)
AR&R 50 year, 3 hours storm, average 31.4 mm/h, Zone 1	93898.56	57584.46 (61.3%)	2080.69 (98.9%)	55503.77 (60.5%)
AR&R 50 year, 4.5 hours storm, average 24.4 mm/h, Zone 1	109453.63	65366.31 (59.7%)	2429.08 (99.1%)	62937.24 (58.8%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF_OUTLET	13.614	13.614	6.94	0.451	0.39	35.05	0.86	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
OF_1B	11.093	12.13	6.94	0.42	0.35	35.04	0.82	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
OF_1C	4.935	5.505	6.94	0.261	0.16	35.03	0.6	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_1D	2.892	3.969	6.94	0.214	0.11	35.02	0.53	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_3A	1.724	2.185	6.94	0.15	0.06	35.01	0.42	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_3B	1.704	1.724	3.104	0.21	0.05	35.02	0.23	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_4A	4.125	4.517	6.94	0.232	0.13	35.02	0.56	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_4B	0.458	3.858	6.94	0.21	0.11	35.02	0.52	AR&R 50 year, 2 hours storm, average 40.4 mm/h, Zone 1
OF_2A	1.214	2.541	6.94	0.164	0.07	35.02	0.44	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_4C	0.388	3.68	6.94	0.205	0.11	35.02	0.51	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_5A	1.059	2.212	6.94	0.151	0.06	35.02	0.42	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_5B	0.85	1.059	6.94	0.097	0.03	35.01	0.31	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
OF_5C	0.462	0.85	6.94	0.084	0.02	35.01	0.29	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
OF_6A	0.821	1.954	6.94	0.14	0.06	35.01	0.4	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_6B	0.377	0.821	6.94	0.083	0.02	35.01	0.28	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_1E	1.047	2.106	6.94	0.146	0.06	35.01	0.41	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_EX OUTLET	13.235	13.235	6.94	0.443	0.38	35.04	0.85	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
OF_1A (BYPASS)	0.409	0.409	6.94	0.054	0.01	35.01	0.22	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level

CONTINUITY CHECK for AR&R 50 year, 2 hours storm, average 40.4 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
JUNCTION	49511.11	49511.08	0	0
N_1B	40132.79	40132.92	0	0
N_1C	16806.74	16806.77	0	0
N_1D	9125.24	9125.25	0	0
N_3A	4992.46	4992.47	0	0
N_3B	4897.97	4897.97	0	0
N_4A	16874.78	16874.76	0	0
N_4B	1725.82	1725.82	0	0
N_2A	4263.82	4263.82	0	0
N_4C	1217.63	1217.63	0	0
N_5A	4289.85	4289.84	0	0
N_5B	3537.26	3537.27	0	0
N_5C	1538.72	1538.72	0	0
N_6A	2984.25	2984.25	0	0
N_6B	968.17	968.17	0	0
N_1E	2509.49	2509.49	0	0
N_1A	48148.85	48148.8	0	0
N_EXISTING OUTLET	49511.08	49511.08	0	0
N_1A (BYPASS)	1362.3	1362.3	0	0

Run Log for 21360 run at 16:23:27 on 4/11/2022 using version 2022.012

DRAINS - PREDEV 1% AEP RESULTS
DRAINS results prepared from Version 2022.012

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT 1B	0.717	0	0.717	0	26.46	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 1C	1.446	0	1.446	0	33.75	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 1D	1.469	0	1.469	0	36.25	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 3A	0.062	0	0.062	0	13.99	0	AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1
CAT 3B	2.088	0	2.088	0	33.75	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 4A	4.231	0.692	4.158	2.07	48.43	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 4B	0.577	0	0.577	2.07	46.63	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 2A	1.524	0	1.524	2.07	42.88	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 4C	0.48	0	0.48	2.07	37.51	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 5A	0.265	0	0.265	0	43.61	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 5B	0.523	0	0.523	0	69.72	0	AR&R 100 year, 1.5 hours storm, average 54.0 mm/h, Zone 1
CAT 5C	0.578	0	0.578	0	40.1	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 6A	0.622	0	0.622	0	51.15	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 6B	0.458	0	0.458	0	28.29	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 1E	1.279	0	1.279	0	20.64	0	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
CAT 1A	1.905	0.468	1.689	5.22	17.22	0	AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1
CAT 1A (BYPASS)	0.511	0	0.511	1.57	40.1	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1

Outflow Volumes for Total Catchment (2.23 impervious + 97.4 pervious = 99.7 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, average 227 mm/h, Zone 1	18856.13	6989.25 (37.1%)	399.99 (94.7%)	6589.26 (35.7%)
AR&R 100 year, 10 minutes storm, average 173 mm/h, Zone 1	28741.07	14887.40 (51.8%)	621.38 (96.5%)	14266.02 (50.8%)
AR&R 100 year, 15 minutes storm, average 145 mm/h, Zone 1	36134	20850.97 (57.7%)	786.95 (97.2%)	20064.02 (56.8%)
AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1	41865.6	25248.39 (60.3%)	915.32 (97.6%)	24333.07 (59.5%)
AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1	46517.34	28337.34 (60.9%)	1019.51 (97.9%)	27317.83 (60.1%)
AR&R 100 year, 30 minutes storm, average 102 mm/h, Zone 1	50836.8	30867.81 (60.7%)	1116.25 (98.0%)	29751.56 (59.9%)
AR&R 100 year, 45 minutes storm, average 81.0 mm/h, Zone 1	60555.61	38436.75 (63.5%)	1333.92 (98.4%)	37102.83 (62.7%)
AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1	68779.2	44664.54 (64.9%)	1518.10 (98.6%)	43146.44 (64.2%)
AR&R 100 year, 1.5 hours storm, average 54.0 mm/h, Zone 1	80740.8	52890.01 (65.5%)	1786.00 (98.8%)	51104.01 (64.7%)
AR&R 100 year, 2 hours storm, average 45.3 mm/h, Zone 1	90308.44	59167.33 (65.5%)	2000.28 (98.9%)	57167.05 (64.8%)
AR&R 100 year, 3 hours storm, average 35.3 mm/h, Zone 1	105558.64	68974.66 (65.3%)	2341.84 (99.1%)	66632.81 (64.6%)
AR&R 100 year, 4.5 hours storm, average 27.4 mm/h, Zone 1	122902.95	78522.21 (63.9%)	2730.29 (99.2%)	75791.92 (63.1%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Widtl	Max V	Due to Storm
OF_OUTLET	16.843	16.843	0	0.513	0.48	35.05	0.94	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_1B	13.833	14.979	0	0.478	0.43	35.05	0.89	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_1C	6.118	6.699	0	0.293	0.19	35.03	0.65	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_1D	3.516	4.855	0	0.242	0.14	35.02	0.57	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_3A	2.112	2.688	0	0.169	0.08	35.02	0.45	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_3B	2.088	2.112	0	0.238	0.06	35.02	0.25	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_4A	5.153	5.609	0	0.264	0.16	35.03	0.61	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_4B	0.577	4.786	0	0.24	0.14	35.02	0.57	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_2A	1.524	3.055	0	0.183	0.09	35.02	0.48	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_4C	0.48	4.581	0	0.234	0.13	35.02	0.56	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_5A	1.324	2.711	0	0.17	0.08	35.02	0.45	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_5B	1.063	1.324	0	0.111	0.04	35.01	0.34	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_5C	0.578	1.063	0	0.097	0.03	35.01	0.31	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_6A	0.997	2.418	0	0.159	0.07	35.02	0.44	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_6B	0.458	0.996	0	0.093	0.03	35.01	0.31	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_1E	1.279	2.568	0	0.165	0.07	35.02	0.45	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_EX OUTLET	16.362	16.362	0	0.504	0.47	35.05	0.93	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_1A (BYPASS)	0.511	0.511	0	0.062	0.01	35.01	0.24	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level

CONTINUITY CHECK for AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
JUNCTION	44661.88	44661.14	0	0
N_1B	36205.89	36205.17	0	0
N_1C	15189.4	15188.74	0	0
N_1D	8262.65	8262.65	0	0
N_3A	4522.33	4522.33	0	0
N_3B	4436.27	4436.27	0	0
N_4A	15169.85	15169.85	0	0
N_4B	1557.48	1557.48	0	0
N_2A	3851.9	3851.9	0	0
N_4C	1101.48	1101.48	0	0
N_5A	3855.42	3854.8	0	0
N_5B	3175.72	3175.72	0	0
N_5C	1390.93	1390.93	0	0
N_6A	2695.82	2695.82	0	0
N_6B	878.73	878.73	0	0
N_1E	2280.27	2280.27	0	0
N_1A	43431.09	43430.42	0	0
N_EXISTING OUTLET	44661.14	44661.14	0	0
N_1A (BYPASS)	1231.46	1231.46	0	0

Run Log for 21360 run at 16:34:06 on 3/11/2022 using version 2022.012

DRAINS - POSTDEV 10% AEP RESULTS
DRAINS results prepared from Version 2022.012

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT 1B	0.615	0.184	0.459	2.03	12.63	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 1C	1.714	1.065	0.696	6.24	13.51	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 1D	1.754	1.071	0.734	9.65	13.51	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 3A	0.049	0.03	0.021	1.74	12.88	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 3B	1.643	0.545	1.205	8.85	16.75	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 4A	0.863	0.081	0.848	2.46	31.53	0	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
CAT 4F	0.26	0	0.26	2.91	61.43	0	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
CAT 2A	0.651	0	0.651	2.91	60.4	0	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
CAT 4G	0.203	0	0.203	2.9	49.26	0	AR&R 10 year, 1.5 hours storm, average 34.9 mm/h, Zone 1
CAT 5A	0.417	0.27	0.157	4.09	12.63	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 5B	1.017	0.664	0.382	5.96	14.72	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 5C	0.681	0.245	0.465	2.03	12.63	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 6A	0.939	0.42	0.553	6.76	12.63	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 6B	0.407	0.153	0.273	2.03	13.51	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 1E	1.054	0.395	0.706	2.17	13.51	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 1A (BYPASS)	0.219	0	0.219	2.21	56.49	0	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
CAT 1A	1.219	0.693	0.582	6.53	21.54	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 4B	0.696	0	0.696	3.11	60.4	0	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
CAT 4C	1.473	0.935	0.577	4.99	13.51	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 4D	0.516	0.357	0.169	4.67	12.63	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
CAT 4E	0.795	0.484	0.331	2.03	12.63	0	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1

Outflow Volumes for Total Catchment (20.6 impervious + 79.1 pervious = 99.6 total ha)

Storm	Total Rainfall cu.m	Total Runo cu.m (Runo	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 10 year, 5 minutes storm, average 147 mm/h, Zone 1	12205.9	3827.56 (3	2315.02 (91.8%)	1512.54 (15.6%)
AR&R 10 year, 10 minutes storm, average 112 mm/h, Zone 1	18599.47	8213.17 (4	3635.45 (94.6%)	4577.72 (31.0%)
AR&R 10 year, 15 minutes storm, average 93.0 mm/h, Zone 1	23166.3	11608.49 (	4578.62 (95.7%)	7029.87 (38.2%)
AR&R 10 year, 20 minutes storm, average 81.0 mm/h, Zone 1	26902.8	14342.98 (	5350.28 (96.3%)	8992.70 (42.1%)
AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1	29892	16336.86 (	5967.61 (96.7%)	10369.25 (43.7%)
AR&R 10 year, 30 minutes storm, average 66.0 mm/h, Zone 1	32881.2	18109.67 (	6584.96 (97.0%)	11524.71 (44.2%)
AR&R 10 year, 45 minutes storm, average 53.0 mm/h, Zone 1	39607.73	22664.42 (	7974.15 (97.5%)	14690.27 (46.7%)
AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1	44339.8	25694.24 (	8951.39 (97.8%)	16742.85 (47.6%)
AR&R 10 year, 1.5 hours storm, average 34.9 mm/h, Zone 1	52159.88	30325.22 (	10566.47 (98.1%)	19758.76 (47.7%)
AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1	58390.71	33878.19 (	11853.31 (98.3%)	22024.88 (47.5%)
AR&R 10 year, 3 hours storm, average 22.8 mm/h, Zone 1	68151.28	39652.13 (	13869.10 (98.5%)	25783.03 (47.7%)
AR&R 10 year, 4.5 hours storm, average 17.7 mm/h, Zone 1	79365.75	44679.02 (	16185.11 (98.7%)	28493.91 (45.2%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF_OUTLET	7.132	7.132	6.94	0.305	0.2	35.03	0.67	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_1B	14.457	15.645	6.94	0.491	0.45	35.05	0.91	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_1C	7.912	8.494	6.94	0.339	0.24	35.03	0.71	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_1D	4.136	5.826	6.94	0.27	0.17	35.03	0.62	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_3A	1.689	2.285	6.94	0.154	0.07	35.02	0.42	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_3B	1.643	1.691	3.104	0.207	0.05	35.02	0.23	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_4A	4.3	4.895	6.94	0.243	0.14	35.02	0.58	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_4F	0.26	1.104	6.94	0.099	0.03	35.01	0.32	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_2A	0.651	1.67	6.94	0.127	0.05	35.01	0.37	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_4G	0.203	0.886	6.94	0.086	0.03	35.01	0.29	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
OF_5A	2.093	3.783	6.94	0.208	0.11	35.02	0.52	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_5B	1.688	2.098	6.94	0.146	0.06	35.01	0.41	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_5C	0.681	1.693	6.94	0.128	0.05	35.01	0.38	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_6A	1.341	3.088	6.94	0.184	0.09	35.02	0.48	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_6B	0.407	1.344	6.94	0.112	0.04	35.01	0.34	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_1E	1.054	2.803	6.94	0.173	0.08	35.02	0.46	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_1A (BYPASS)	0.219	0.219	6.94	0.038	0.01	35	0.17	AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1
OF_BASIN	6.925	6.925	6.94	0.299	0.2	35.03	0.66	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_4B	0.886	1.704	6.94	0.128	0.05	35.01	0.38	AR&R 10 year, 1 hour storm, average 44.5 mm/h, Zone 1
OF_4C	2.761	3.489	6.94	0.198	0.1	35.02	0.5	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_4D	1.302	2.768	6.94	0.172	0.08	35.02	0.46	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1
OF_4E	0.795	1.306	6.94	0.11	0.04	35.01	0.34	AR&R 10 year, 25 minutes storm, average 72.0 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
BASIN (EXISTING)	8.65	10168.9	6.925	0	6.925

CONTINUITY CHECK for AR&R 10 year, 2 hours storm, average 29.3 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
JUNCTION	33875.33	33875.3	0	0
N_1B	28179.91	28179.9	0	0
N_1C	13099.96	13099.9	0	0
N_1D	6913.14	6913.14	0	0
N_3A	3336.71	3336.72	0	0
N_3B	3260.9	3260.9	0	0
N_4A	10774.66	10774.7	0	0
N_4F	972.28	972.28	0	0
N_2A	2396.7	2396.7	0	0
N_4G	684.85	684.85	0	0
N_5A	3397.18	3397.18	0	0
N_5B	2759.9	2759.9	0	0
N_5C	1067.91	1067.91	0	0
N_6A	2175.65	2175.65	0	0
N_6B	666.33	666.33	0	0
N_1E	1723.62	1723.62	0	0
N_EXISTING OUTLET	33875.29	33875.3	0	0
N_1A (BYPASS)	766.1	766.1	0	0
BASIN (EXISTING)	33112.14	33109.2	2.88	0
N_4B	3246.45	3246.45	0	0
N_4C	4314.28	4314.28	0	0
N_4D	2002.43	2002.43	0	0
N_4E	1218.14	1218.14	0	0

Run Log for 21360 run at 10:30:44 on 9/11/2022 using version 2022.012

The maximum flow in these overflow routes is unsafe: OF_OUTLET, OF_1C, OF_1B

DRAINS - POSTDEV 5% AEP RESULTS
DRAINS results prepared from Version 2022.012

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT 1B	0.82	0.215	0.633	1.91	11.88	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 1C	2.177	1.262	0.968	5.87	12.7	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 1D	2.227	1.263	1.02	9.08	12.7	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 3A	0.062	0.035	0.029	1.64	12.11	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 3B	2.181	0.643	1.684	8.32	15.74	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 4A	1.179	0.094	1.159	2.32	29.63	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 4F	0.357	0	0.357	2.74	57.82	0	AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1
CAT 2A	0.889	0	0.889	2.74	56.85	0	AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1
CAT 4G	0.285	0	0.285	2.48	42	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 5A	0.522	0.315	0.216	3.84	11.88	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 5B	1.282	0.787	0.533	5.6	13.84	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 5C	0.899	0.286	0.641	1.91	11.88	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 6A	1.227	0.497	0.763	6.35	11.88	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 6B	0.537	0.178	0.38	1.91	12.7	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 1E	1.39	0.461	0.982	2.04	12.7	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 1A (BYPASS)	0.3	0	0.3	1.76	44.91	0	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
CAT 1A	1.558	0.821	0.831	6.14	20.25	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 4B	0.95	0	0.95	2.93	56.85	0	AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1
CAT 4C	1.849	1.091	0.802	4.7	12.7	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 4D	0.64	0.416	0.234	4.39	11.88	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
CAT 4E	1.002	0.565	0.457	1.91	11.88	0	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1

Outflow Volumes for Total Catchment (20.6 impervious + 79.1 pervious = 99.6 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 20 year, 5 minutes storm, average 170 mm/h, Zone 1	14115.67	5507.09 (39.0%)	2709.44 (92.9%)	2797.66 (25.0%)
AR&R 20 year, 10 minutes storm, average 130 mm/h, Zone 1	21588.67	11237.18 (52.1%)	4252.80 (95.4%)	6984.37 (40.8%)
AR&R 20 year, 15 minutes storm, average 109 mm/h, Zone 1	27151.9	15601.97 (57.5%)	5401.74 (96.3%)	10200.24 (47.3%)
AR&R 20 year, 20 minutes storm, average 94.0 mm/h, Zone 1	31220.53	18670.81 (59.8%)	6242.00 (96.8%)	12428.81 (50.2%)
AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1	34874	21293.57 (61.1%)	6996.48 (97.1%)	14297.09 (51.7%)
AR&R 20 year, 30 minutes storm, average 76.0 mm/h, Zone 1	37863.2	23084.36 (61.0%)	7613.84 (97.4%)	15470.52 (51.5%)
AR&R 20 year, 45 minutes storm, average 61.0 mm/h, Zone 1	45586.13	28507.26 (62.5%)	9208.82 (97.8%)	19298.44 (53.4%)
AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1	51812.8	32984.66 (63.7%)	10494.80 (98.1%)	22489.86 (54.7%)
AR&R 20 year, 1.5 hours storm, average 40.6 mm/h, Zone 1	60681.59	38668.53 (63.7%)	12326.35 (98.4%)	26342.19 (54.7%)
AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1	67954.49	43208.94 (63.6%)	13828.50 (98.5%)	29380.44 (54.5%)
AR&R 20 year, 3 hours storm, average 26.5 mm/h, Zone 1	79213.8	50430.30 (63.7%)	16153.59 (98.7%)	34276.72 (54.5%)
AR&R 20 year, 4.5 hours storm, average 20.6 mm/h, Zone 1	92361.29	57268.93 (62.0%)	18868.97 (98.9%)	38399.95 (52.4%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF_OUTLET	9.163	9.163	6.94	0.355	0.26	35.04	0.74	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_1B	18.763	20.28	6.94	0.574	0.58	35.06	1.01	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_1C	10.172	10.953	6.94	0.395	0.31	35.04	0.79	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_1D	5.359	7.506	6.94	0.315	0.21	35.03	0.68	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_3A	2.239	3.036	6.94	0.182	0.09	35.02	0.48	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_3B	2.181	2.241	3.104	0.247	0.06	35.02	0.26	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_4A	5.599	6.396	6.94	0.286	0.18	35.03	0.64	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_4F	0.357	1.508	6.94	0.12	0.04	35.01	0.36	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_2A	0.889	2.19	6.94	0.15	0.06	35.01	0.42	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_4G	0.285	1.224	6.94	0.106	0.03	35.01	0.33	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_5A	2.675	4.823	6.94	0.241	0.14	35.02	0.57	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_5B	2.169	2.681	6.94	0.169	0.08	35.02	0.45	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_5C	0.899	2.175	6.94	0.149	0.06	35.01	0.42	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_6A	1.758	3.975	6.94	0.214	0.11	35.02	0.53	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_6B	0.537	1.761	6.94	0.131	0.05	35.01	0.38	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_1E	1.39	3.61	6.94	0.203	0.1	35.02	0.51	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_1A (BYPASS)	0.3	0.3	6.94	0.045	0.01	35	0.19	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_BASIN	8.873	8.873	6.94	0.348	0.25	35.03	0.73	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_4B	1.224	2.327	6.94	0.155	0.07	35.02	0.43	AR&R 20 year, 1 hour storm, average 52.0 mm/h, Zone 1
OF_4C	3.462	4.463	6.94	0.23	0.13	35.02	0.55	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_4D	1.63	3.47	6.94	0.198	0.1	35.02	0.5	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1
OF_4E	1.002	1.636	6.94	0.125	0.05	35.01	0.37	AR&R 20 year, 25 minutes storm, average 84.0 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
BASIN (EXISTING)	8.84	13278.4	8.873	0	8.873

CONTINUITY CHECK for AR&R 20 year, 2 hours storm, average 34.1 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
JUNCTION	43202.83	43202.7	0	0
N_1B	35788.89	35788.86	0	0
N_1C	16338.24	16338.27	0	0
N_1D	8665.48	8665.5	0	0
N_3A	4287.83	4287.82	0	0
N_3B	4194.03	4194.03	0	0
N_4A	13916.86	13916.84	0	0
N_4F	1298.46	1298.46	0	0
N_2A	3200.18	3200.18	0	0
N_4G	913.6	913.6	0	0
N_5A	4231.23	4231.22	0	0
N_5B	3448.08	3448.08	0	0
N_5C	1363.5	1363.5	0	0
N_6A	2751.52	2751.52	0	0
N_6B	850.77	850.77	0	0
N_1E	2200.71	2200.71	0	0
N_EXISTING OUTLET	43202.7	43202.7	0	0
N_1A (BYPASS)	1022.23	1022.23	0	0
BASIN (EXISTING)	42186.59	42180.61	6.03	0
N_4B	4333.98	4333.98	0	0
N_4C	5314.8	5314.8	0	0
N_4D	2462.66	2462.67	0	0
N_4E	1504.85	1504.85	0	0

Run Log for 21360 run at 10:32:24 on 9/11/2022 using version 2022.012

DRAINS - POSTDEV 2% AEP RESULTS
DRAINS results prepared from Version 2022.012

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT 1B	1.019	0.235	0.852	1.7	10.59	0	AR&R 50 year, 20 minutes storm, average 112 mm/h, Zone 1
CAT 1C	2.549	1.375	1.232	5.47	11.84	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
CAT 1D	2.67	1.43	1.365	8.09	11.32	0	AR&R 50 year, 20 minutes storm, average 112 mm/h, Zone 1
CAT 3A	0.072	0.037	0.036	1.53	11.29	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
CAT 3B	2.797	0.728	2.294	7.41	14.03	0	AR&R 50 year, 20 minutes storm, average 112 mm/h, Zone 1
CAT 4A	1.55	0.1	1.517	2.02	25.87	0	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
CAT 4F	0.485	0	0.485	2.17	45.82	0	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
CAT 2A	1.214	0	1.214	2.17	45.05	0	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
CAT 4G	0.388	0	0.388	2.16	36.67	0	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
CAT 5A	0.603	0.337	0.274	3.58	11.08	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
CAT 5B	1.494	0.858	0.686	5.22	12.91	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
CAT 5C	1.096	0.305	0.814	1.78	11.08	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
CAT 6A	1.483	0.542	0.968	5.92	11.08	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
CAT 6B	0.651	0.191	0.483	1.78	11.84	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
CAT 1E	1.684	0.493	1.25	1.91	11.84	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
CAT 1A (BYPASS)	0.409	0	0.409	1.65	42.13	0	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
CAT 1A	1.846	0.895	1.169	5.73	18.89	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
CAT 4B	1.297	0	1.297	2.32	45.05	0	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
CAT 4C	2.138	1.166	1.021	4.38	11.84	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
CAT 4D	0.733	0.445	0.296	4.1	11.08	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
CAT 4E	1.167	0.604	0.579	1.78	11.08	0	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1

Outflow Volumes for Total Catchment (20.6 impervious + 79.1 pervious = 99.6 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 50 year, 5 minutes storm, average 202 mm/h, Zone 1	16772.73	8112.73 (48.4%)	3258.18 (94.1%)	4854.55 (36.5%)
AR&R 50 year, 10 minutes storm, average 155 mm/h, Zone 1	25740.34	15414.97 (59.9%)	5110.18 (96.1%)	10304.79 (50.5%)
AR&R 50 year, 15 minutes storm, average 129 mm/h, Zone 1	32133.9	20551.92 (64.0%)	6430.63 (96.9%)	14121.30 (55.4%)
AR&R 50 year, 20 minutes storm, average 112 mm/h, Zone 1	37198.93	24542.36 (66.0%)	7476.63 (97.3%)	17065.74 (57.8%)
AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1	41516.67	27647.04 (66.6%)	8368.39 (97.6%)	19278.64 (58.5%)
AR&R 50 year, 30 minutes storm, average 91.0 mm/h, Zone 1	45336.2	30332.32 (66.9%)	9157.20 (97.8%)	21175.12 (58.9%)
AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1	54552.91	37220.46 (68.2%)	11060.69 (98.2%)	26159.78 (60.4%)
AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1	60780.4	41606.14 (68.5%)	12346.81 (98.4%)	29259.32 (60.7%)
AR&R 50 year, 1.5 hours storm, average 48.2 mm/h, Zone 1	72039.72	49730.69 (69.0%)	14672.26 (98.6%)	35058.43 (61.3%)
AR&R 50 year, 2 hours storm, average 40.4 mm/h, Zone 1	80509.13	55539.97 (69.0%)	16421.56 (98.8%)	39118.41 (61.2%)
AR&R 50 year, 3 hours storm, average 31.4 mm/h, Zone 1	93860.89	64515.54 (68.7%)	19178.67 (98.9%)	45336.88 (60.9%)
AR&R 50 year, 4.5 hours storm, average 24.4 mm/h, Zone 1	109409.71	73697.85 (67.4%)	22390.14 (99.1%)	51307.71 (59.1%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF_OUTLET	10.378	10.378	6.94	0.382	0.3	35.04	0.78	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
OF_1B	22.556	24.371	6.94	0.642	0.7	35.06	1.08	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_1C	12.094	13.069	6.94	0.44	0.37	35.04	0.85	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_1D	6.415	8.94	6.94	0.35	0.26	35.04	0.73	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_3A	2.861	3.864	6.94	0.21	0.11	35.02	0.52	AR&R 50 year, 20 minutes storm, average 112 mm/h, Zone 1
OF_3B	2.797	2.862	3.104	0.286	0.08	35.03	0.29	AR&R 50 year, 20 minutes storm, average 112 mm/h, Zone 1
OF_4A	6.738	7.727	6.94	0.32	0.22	35.03	0.69	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_4F	0.485	1.98	6.94	0.141	0.06	35.01	0.4	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_2A	1.214	2.665	6.94	0.168	0.08	35.02	0.45	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_4G	0.388	1.663	6.94	0.126	0.05	35.01	0.38	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_5A	3.162	5.687	6.94	0.266	0.16	35.03	0.61	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_5B	2.578	3.168	6.94	0.187	0.09	35.02	0.48	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_5C	1.096	2.584	6.94	0.166	0.07	35.02	0.45	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_6A	2.13	4.761	6.94	0.239	0.14	35.02	0.57	AR&R 50 year, 20 minutes storm, average 112 mm/h, Zone 1
OF_6B	0.651	2.132	6.94	0.147	0.06	35.01	0.41	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_1E	1.684	4.321	6.94	0.225	0.12	35.02	0.55	AR&R 50 year, 20 minutes storm, average 112 mm/h, Zone 1
OF_1A (BYPASS)	0.409	0.409	6.94	0.054	0.01	35.01	0.22	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
OF_BASIN	9.981	9.981	6.94	0.373	0.29	35.04	0.76	AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1
OF_4B	1.663	3.051	6.94	0.183	0.09	35.02	0.48	AR&R 50 year, 45 minutes storm, average 73.0 mm/h, Zone 1
OF_4C	4.003	5.27	6.94	0.254	0.15	35.03	0.59	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_4D	1.886	4.013	6.94	0.215	0.11	35.02	0.53	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1
OF_4E	1.167	1.893	6.94	0.137	0.05	35.01	0.39	AR&R 50 year, 25 minutes storm, average 100 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
BASIN (EXISTING)	9.08	17363.2	9.981	0	9.981

CONTINUITY CHECK for AR&R 50 year, 1 hour storm, average 61.0 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
JUNCTION	37676.7	37633.13	0	0.1
N_1B	34380.95	34380.91	0	0
N_1C	15507.04	15507.03	0	0
N_1D	8260.19	8260.19	0	0
N_3A	4168.33	4168.33	0	0
N_3B	4079.92	4079.92	0	0
N_4A	13491.7	13491.69	0	0
N_4F	1281.16	1281.16	0	0
N_2A	3159.04	3159.04	0	0
N_4G	904.72	904.72	0	0
N_5A	4011.2	4011.2	0	0
N_5B	3277.29	3277.29	0	0
N_5C	1320.26	1320.26	0	0
N_6A	2642.94	2642.94	0	0
N_6B	823.51	823.51	0	0
N_1E	2130.19	2130.19	0	0
N_EXISTING OUTLET	37633.13	37633.13	0	0
N_1A (BYPASS)	1010.79	1010.79	0	0
BASIN (EXISTING)	40595.35	36665.91	3940.35	0
N_4B	4281.13	4281.13	0	0
N_4C	4990.95	4990.95	0	0
N_4D	2309.46	2309.46	0	0
N_4E	1416.81	1416.81	0	0

Run Log for 21360 run at 10:32:56 on 9/11/2022 using version 2022.012

DRAINS - POSTDEV 1% AEP RESULTS
DRAINS results prepared from Version 2022.012

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
CAT 1B	1.228	0.264	1.03	1.63	10.1	0	AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1
CAT 1C	3.013	1.558	1.482	5.23	11.32	0	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
CAT 1D	3.171	1.622	1.683	7.72	10.8	0	AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1
CAT 3A	0.085	0.041	0.044	1.46	10.79	0	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
CAT 3B	3.42	0.825	2.819	7.07	13.39	0	AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1
CAT 4A	1.871	0.117	1.838	2.07	26.46	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 4F	0.61	0	0.61	2.07	43.61	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 2A	1.524	0	1.524	2.07	42.88	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 4G	0.48	0	0.48	2.21	37.51	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 5A	0.708	0.377	0.331	3.42	10.59	0	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
CAT 5B	1.764	0.972	0.828	4.99	12.34	0	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
CAT 5C	1.323	0.342	0.981	1.7	10.59	0	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
CAT 6A	1.781	0.614	1.167	5.66	10.59	0	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
CAT 6B	0.79	0.22	0.626	1.63	10.8	0	AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1
CAT 1E	2.043	0.568	1.62	1.74	10.8	0	AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1
CAT 1A (BYPASS)	0.511	0	0.511	1.57	40.1	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 1A	2.194	1.013	1.408	5.48	18.05	0	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
CAT 4B	1.629	0	1.629	2.21	42.88	0	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
CAT 4C	2.512	1.306	1.228	4.18	11.32	0	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
CAT 4D	0.856	0.498	0.358	3.91	10.59	0	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
CAT 4E	1.375	0.676	0.698	1.7	10.59	0	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1

Outflow Volumes for Total Catchment (20.6 impervious + 79.1 pervious = 99.6 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, average 227 mm/h, Zone 1	18848.57	10251.69 (54.4%)	3686.89 (94.7%)	6564.80 (43.9%)
AR&R 100 year, 10 minutes storm, average 173 mm/h, Zone 1	28729.54	18452.33 (64.2%)	5727.56 (96.5%)	12724.77 (55.8%)
AR&R 100 year, 15 minutes storm, average 145 mm/h, Zone 1	36119.5	24559.30 (68.0%)	7253.74 (97.2%)	17305.55 (60.4%)
AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1	41848.8	29198.82 (69.8%)	8436.94 (97.6%)	20761.87 (62.5%)
AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1	46498.67	32616.40 (70.1%)	9397.31 (97.9%)	23219.09 (62.9%)
AR&R 100 year, 30 minutes storm, average 102 mm/h, Zone 1	50816.41	35804.92 (70.5%)	10288.99 (98.0%)	25515.93 (63.3%)
AR&R 100 year, 45 minutes storm, average 81.0 mm/h, Zone 1	60531.32	43190.43 (71.4%)	12295.34 (98.4%)	30895.10 (64.3%)
AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1	68751.6	49531.76 (72.0%)	13992.91 (98.5%)	35538.85 (65.1%)
AR&R 100 year, 1.5 hours storm, average 54.0 mm/h, Zone 1	80708.41	58339.91 (72.3%)	16462.39 (98.8%)	41877.52 (65.4%)
AR&R 100 year, 2 hours storm, average 45.3 mm/h, Zone 1	90272.2	65228.48 (72.3%)	18437.49 (98.9%)	46790.99 (65.3%)
AR&R 100 year, 3 hours storm, average 35.3 mm/h, Zone 1	105516.29	75966.91 (72.0%)	21585.57 (99.1%)	54381.34 (65.0%)
AR&R 100 year, 4.5 hours storm, average 27.4 mm/h, Zone 1	122853.63	86927.20 (70.8%)	25166.86 (99.2%)	61760.33 (63.4%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF_OUTLET	12.932	12.932	6.94	0.437	0.37	35.04	0.85	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_1B	26.968	29.115	6.94	0.715	0.83	35.07	1.16	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_1C	14.387	15.55	6.94	0.489	0.44	35.05	0.91	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_1D	7.704	10.646	6.94	0.388	0.3	35.04	0.78	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_3A	3.496	4.678	6.94	0.237	0.13	35.02	0.56	AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1
OF_3B	3.42	3.498	3.104	0.323	0.1	35.03	0.31	AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1
OF_4A	8.096	9.283	6.94	0.358	0.27	35.04	0.74	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_4F	0.61	2.392	6.94	0.158	0.07	35.02	0.43	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_2A	1.524	3.211	6.94	0.189	0.09	35.02	0.49	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_4G	0.48	2.064	6.94	0.144	0.06	35.01	0.41	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_5A	3.758	6.738	6.94	0.294	0.19	35.03	0.65	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_5B	3.067	3.766	6.94	0.207	0.11	35.02	0.52	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_5C	1.323	3.078	6.94	0.184	0.09	35.02	0.48	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_6A	2.552	5.686	6.94	0.266	0.16	35.03	0.61	AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1
OF_6B	0.79	2.559	6.94	0.165	0.07	35.02	0.44	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_1E	2.043	5.201	6.94	0.252	0.15	35.03	0.59	AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1
OF_1A (BYPASS)	0.511	0.511	6.94	0.062	0.01	35.01	0.24	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_BASIN	12.434	12.434	6.94	0.427	0.36	35.04	0.83	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_4B	2.065	3.693	6.94	0.205	0.11	35.02	0.52	AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1
OF_4C	4.704	6.271	6.94	0.282	0.18	35.03	0.64	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_4D	2.216	4.716	6.94	0.238	0.13	35.02	0.57	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1
OF_4E	1.375	2.224	6.94	0.151	0.06	35.02	0.42	AR&R 100 year, 25 minutes storm, average 112 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
BASIN (EXISTING)	9.27	20947.5	12.434	0	12.434

CONTINUITY CHECK for AR&R 100 year, 1 hour storm, average 69.0 mm/h, Zone 1

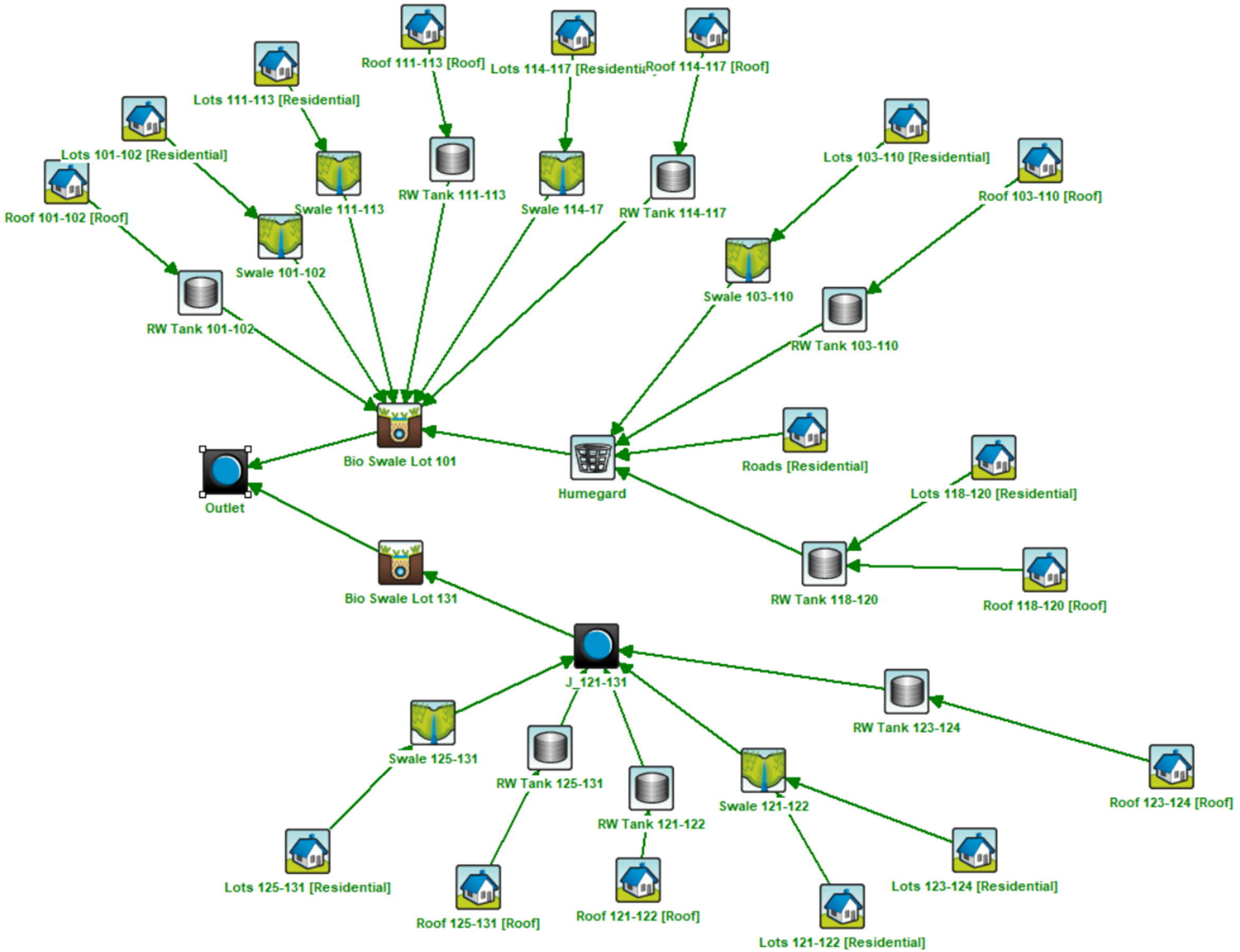
Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
JUNCTION	44461.88	44412	0	0.1
N_1B	40832.43	40832.39	0	0
N_1C	18238.11	18238.08	0	0
N_1D	9738.9	9738.9	0	0
N_3A	4974.36	4974.36	0	0
N_3B	4870.82	4870.82	0	0
N_4A	16171.44	16171.43	0	0
N_4F	1562.42	1562.42	0	0
N_2A	3851.9	3851.9	0	0
N_4G	1101.48	1101.48	0	0
N_5A	4714.5	4714.5	0	0
N_5B	3857.85	3857.84	0	0
N_5C	1570.09	1570.09	0	0
N_6A	3129.27	3129.28	0	0
N_6B	979.47	979.47	0	0
N_1E	2533.62	2533.62	0	0
N_EXISTING OUTLET	44412	44412	0	0
N_1A (BYPASS)	1231.46	1231.46	0	0
BASIN (EXISTING)	48300.37	43230.42	5082.43	0
N_4B	5218.43	5218.42	0	0
N_4C	5833.31	5833.31	0	0
N_4D	2696.79	2696.79	0	0
N_4E	1658.23	1658.23	0	0

Run Log for 21360 run at 10:34:56 on 9/11/2022 using version 2022.012

The maximum flow in these overflow routes is unsafe: OF_OUTLET, OF_4A, OF_1D, OF_1C, OF_3B, OF_1B, OF_BASIN

Appendix D

MUSIC Model Layout



Roof 111-113 [Roof]
Lots 114-117 [Residentia
Roof 114-117 [Roof]
Lots 111-113 [Residential]
Lots 101-102 [Residential]
Roof 101-102 [Roof]
Swale 111-113
RW Tank 111-113
Swale 114-17
RW Tank 114-117
Lots 103-110 [Residential]
Roof 103-110 [Roof]
Swale 101-102
Swale 103-110
RW Tank 101-102
RW Tank 103-110
Bio Swale Lot 101
Humegard
Roads [Residential]
Outlet
Lots 118-120 [Residential]
RW Tank 118-120
Roof 118-120 [Roof]
Bio Swale Lot 131
J_121-131
RW Tank 123-124
Swale 125-131
RW Tank 125-131
RW Tank 121-122
Swale 121-122
Roof 123-124 [Roof]
Lots 125-131 [Residential]
Lots 123-124 [Residential]
Roof 125-131 [Roof]
Roof 121-122 [Roof]
Lots 121-122 [Residential]