

# O'Connell Street, Caddens

## Stormwater Management Strategy Report Stages 5 to 6

Legacy Property  
January 2017





Quality  
Safety  
Environment

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CONSULTING CIVIL INFRASTRUCTURE ENGINEERS  
& PROJECT MANAGERS

# O'Connell Street, Caddens – Stormwater Management Strategy – Stages 5 to 6

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## 1 INTRODUCTION

J. Wyndham Prince Pty Ltd (JWP) have been engaged by *Legacy Property* to prepare a Stormwater Management Strategy (SWMS) report to support the approval of Stages 5 to 6 for the proposed subdivision at O'Connell Street, Caddens.

The overall development includes approximately 550 lots across a total of six (6) stages. In July, 2016, a Development Application (DA) was submitted to Penrith City Council (Council) and approved for 99 lots within Stage 1. A further DA submission for Stages 2 to 4 was then also submitted in October for an additional 257 lots. The current DA submission includes Stages 5 to 6 and includes the remaining 182 lots, whilst closely aligning with the previous development stages.

This report details the proposed Stormwater Management Strategy which will ensure that both water quantity and water quality are managed prior to discharge from Stages 5 to 6 in accordance with Penrith City Council's guidelines and policy documents.

The proposed works are detailed on engineering design drawings 110358/DA511 to 110358/DA512, which should be read in conjunction with this report.

### 1.1 Previous Studies and Reports

Several hydrological studies have previously been undertaken for the catchments in the immediate vicinity of the subject site. These are summarised below.

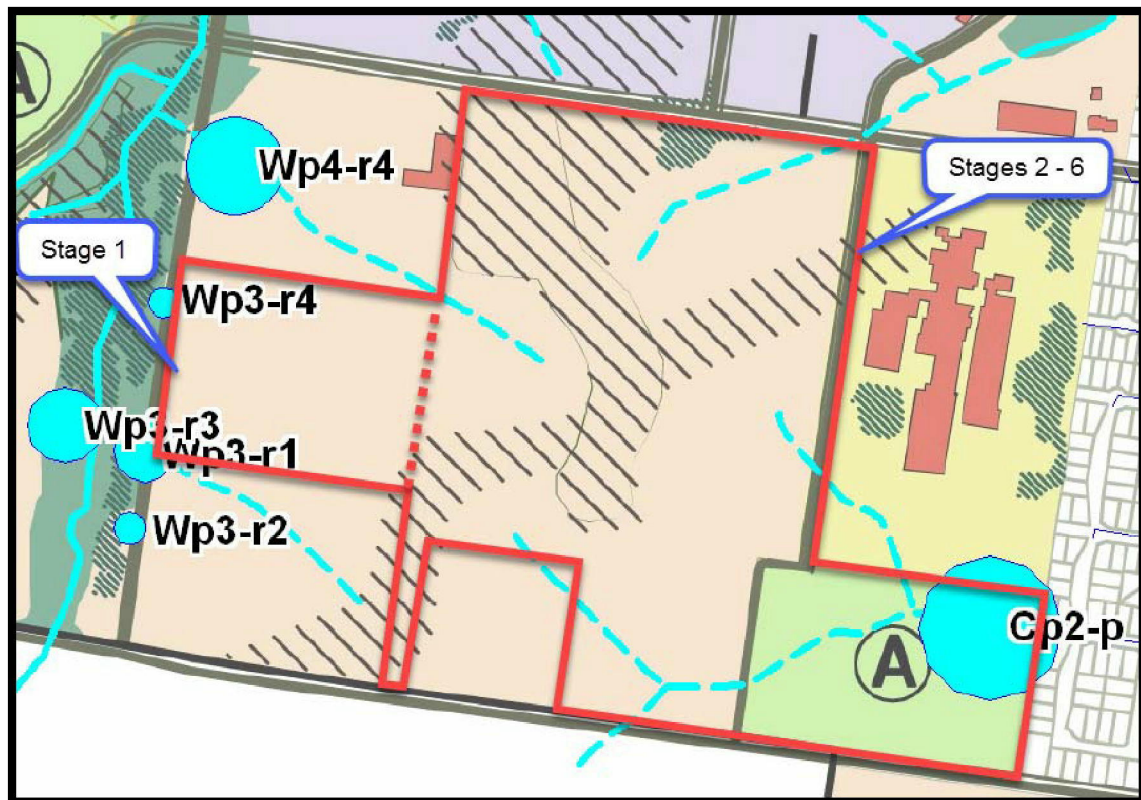
#### 1.1.1 *WELL Precinct – Hydrology and Catchment Management Study (Cardno, 2006)*

The Werrington Enterprise Living and Learning (WELL) Precinct covers approximately 670 hectares and includes the Caddens Release area. The *WELL Precinct – Hydrology and Catchment Management Study (2006)* was undertaken by Cardno/Willing on behalf of Penrith City Council.

The purpose of the study was to provide input for planning of the WELL Precinct, by identifying the basic water quality and quantity management principles and key management issues.

It is noted that the study was undertaken at a strategic level, and indicated that the results in the report are subject to review during future, more detailed planning investigations.

This strategy included regional basins across the WELL Precinct with several located in the vicinity of the current development. Refer to Plate 1.1 which also includes the approximate site boundary for the current development.



**Plate 1.1 – Caddens Release Area Basins (with current stage boundary overlay)  
(Extract: Cardno, 2006 Report)**

### 1.1.2 Caddens Release Area – Catchment Management, Hydrology and Water Quality Report

In 2007, Hughes Trueman were commissioned by Landcom to prepare a *Catchment Management, Hydrology and Water Quality Report* to assist with the rezoning and masterplanning infrastructure investigation for the Caddens release area at Penrith. The report built upon the *WELL Precinct – Hydrology and Catchment Management Study (2006)* by Cardno and subsequently the report (HT, 2007) developed water management strategies for the Caddens release area.

Regional detention basins were re-sized across the Caddens release area with volumes significantly reduced from those defined in the WELL Precinct study (Cardno, 2006).

Hughes Trueman provided discussion that a) the basin sizes are significantly smaller than the sizing put forth by Cardo (2006) b) the basin sizing by Cardno was not based upon hydrologic modelling; and c) the Upper Parramatta River Catchment Trust method adopted by Cardno may overestimate the required basin sizes.

### 1.1.3 Stormwater Management Strategy Report – Stage 1 (JWP, 2016a)

In July 2016, J. Wyndham Prince prepared the “*Stormwater Management Strategy – Stage 1 Report*” (JWP, 2016a) to support of Stage 1 (99 lots) fronting O’Connell Lane.

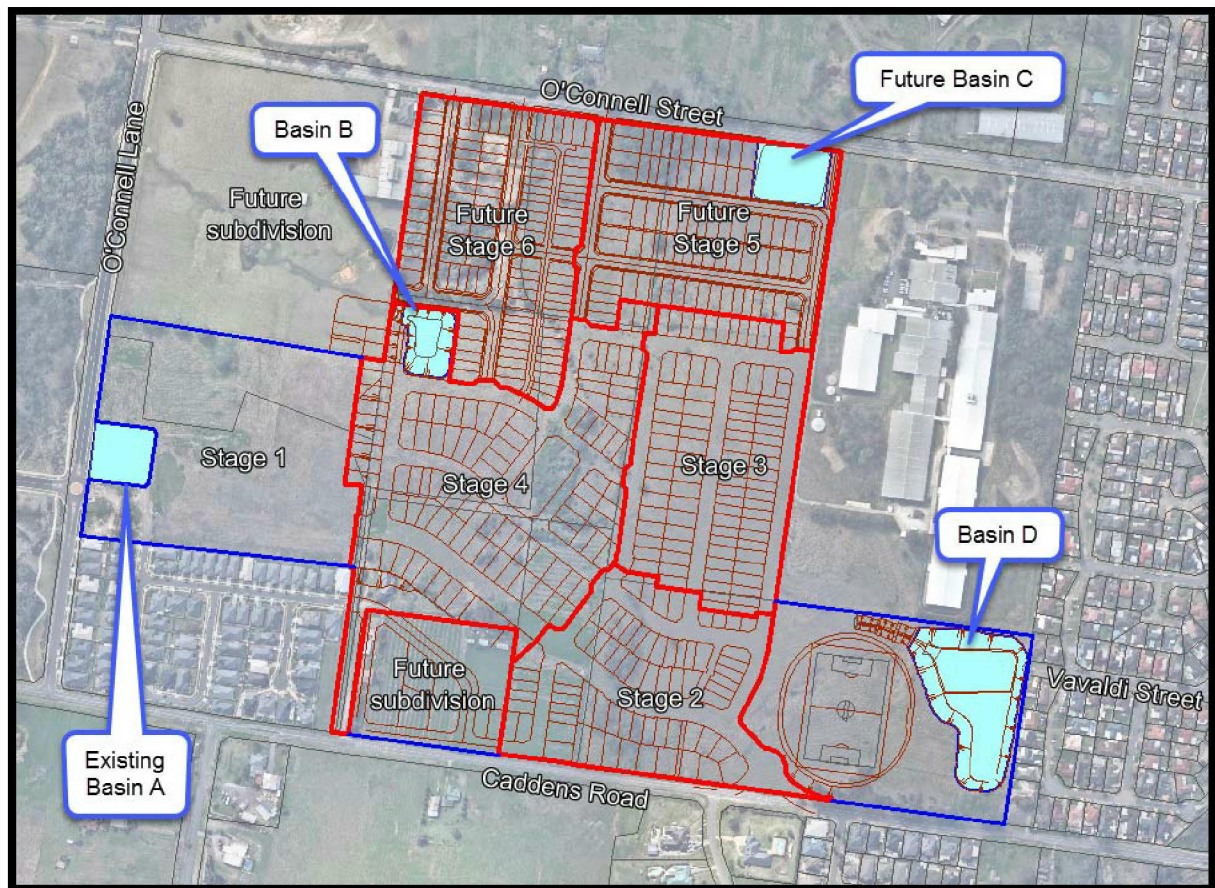
The report presented a Stormwater Strategy surrounding “Basin A” to ensure that peak post development flows do not exceed pre development flows at key locations. The strategy encompassed “Basin A” (constructed by others) as follows:

- Detention Basin with total active storage of 3790 m<sup>3</sup>
- Total Raingarden filter bed area of 1250 m<sup>2</sup>.

Results demonstrated that the existing “Basin A” would receive flows both from Stage 1 and the adjacent development to the south which fronts Caddens Road to achieve Council’s stormwater requirements.

### 1.1.4 Stormwater Management Strategy Report – Stages 2 to 4 (JWP, 2016b)

In October 2016, J. Wyndham Prince prepared a “*Stormwater Management Strategy – Stage 2 to 4 Report*” (JWP, 2016b) to support of Stage 2 to 4 works (257 lot subdivision) fronting Caddens Road. The report primarily focused upon Stages 2 to 4, however also considered the future stages 5 to 6. Refer to Plate 1.2.



**Plate 1.2 – Stage 2 to 4 Development**

The *Stage 2 to 4 Stormwater Management Strategy* (JWP, 2016b) encompassed two (2) detention basins “B” and “D”. Importantly, Basin “B” was sized to receive developed flows from both Stage 4 and part of Stage 6. Detention volumes were determined in XP-RAFTS to satisfy a pre-post comparison of peak flows at key locations. These include:

- Detention Basin “B” with a total active storage of approximately 1300 m<sup>3</sup>
- Detention Basin “D” with total active storage of 6950 m<sup>3</sup>

To achieve Penrith City Council’s water quality objectives, the *Stage 2 to 4 Stormwater Management Strategy* (JWP, 2016b) also included a “treatment train” of water quality devices which included on-lot rainwater tanks, gross pollutant traps and raingardens (co-located within detention basins). The size of the raingardens were determined within MUSIC to include:

- Raingarden filter bed area within Basin “B” of 860 m<sup>2</sup>
- Raingarden filter bed area within Basin “D” of 3100 m<sup>2</sup>

Results demonstrated that the proposed detention basins will ensure that peak post development discharges are restricted to less than the pre development levels at all key comparison locations. The proposed treatment train of water quality devices will also achieve Council’s pollutant removal targets.



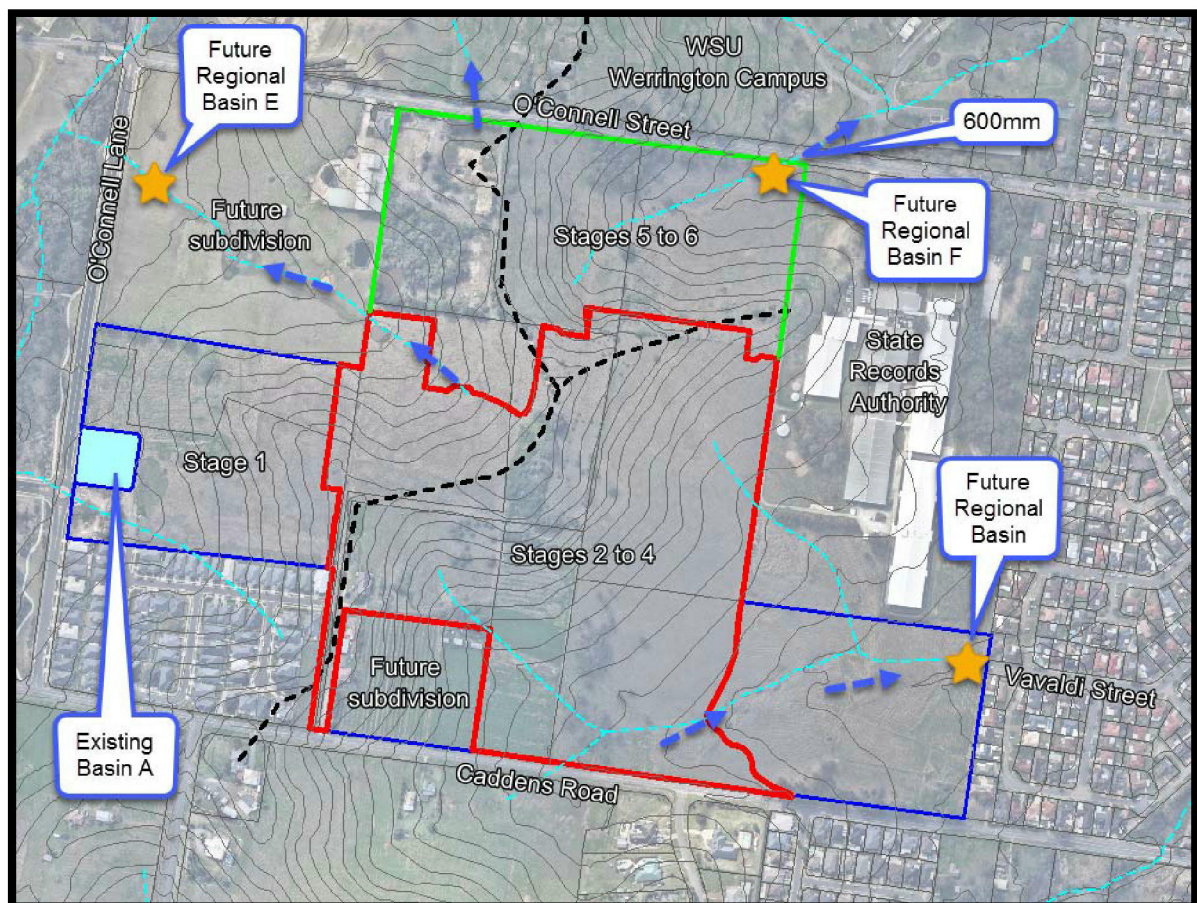
## 2 THE EXISTING SITE

The overall site is located wholly within the Penrith Local Government Area within the *Werrington Enterprise Living and Learning* (WELL) Precinct. The current zoning is "R1" General Residential.

The total site area (Stages 1 to 6) is approximately 38 ha and is predominantly rural grazing land. A number of dwellings and farm sheds are currently located on the site.

Stages 5 to 6 covers approximately 6.7 ha of the overall site and is bisected by a natural crestline. The terrain naturally grades into an adjacent property (future subdivision) to the west and O'Connell Street to the north. Refer to Plate 2.1.

O'Connell Street includes a table drain starting at the north-east corner of the site towards the east. A 600mm dia pipe also directs flows north-east to the natural watercourse through WSU – Werrington Campus land.



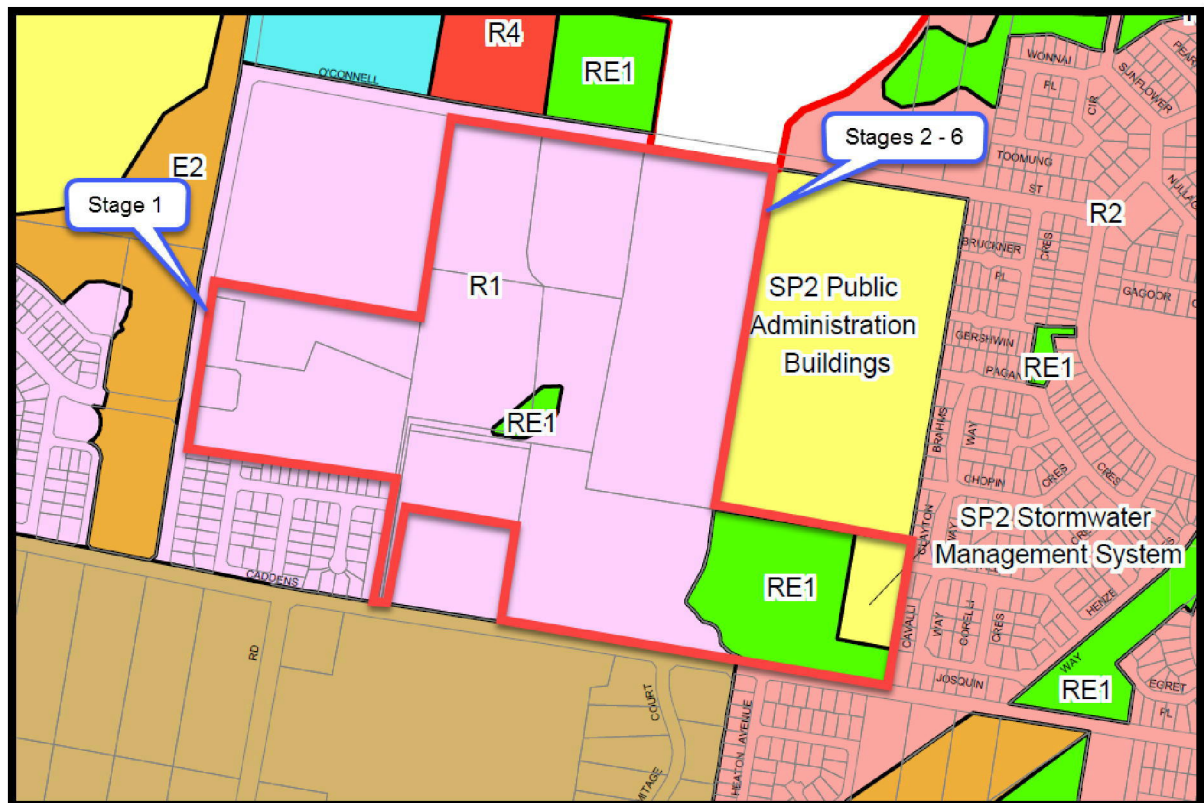
**Plate 2.1 - Existing Site**

Regional detention Basin 'A' shown in Plate 2.1 has been constructed as part of the adjacent Caddens development and also manages flows from Stage 1.

The other regional detention basins "D", "E" and "F" which were identified across the Caddens release area are shown on the Penrith Local Environmental Plan (Caddens) 2009 land-zoning map are also included on Plate 2.1.

Previous consultation with Penrith City Council has identified that there is no longer provision for delivery of stormwater infrastructure under the WELL section 94 contributions plan. J. Wyndham Prince understand that it is Council's desire that the regional basins still be constructed, however they require interim detention devices to be designed as permanent structures as the development of the Precinct proceeds.

The current Local Environment Plan from Council is shown on Plate 2.2 below. An “SP2 Stormwater System” land zoning is dedicated in the eastern portion of the site.



**Plate 2.2 – Local Environment Plan**  
(Source: Penrith City Council LEP 2010 dated 14 October 2016)

### 3 PROPOSED DEVELOPMENT

The overall development includes approximately 550 lots across a total of six (6) stages. In July, 2016, a Development Application (DA) was submitted to Penrith City Council (Council) and approved for 99 lots within Stage 1. A further DA submission for Stages 2 to 4 was then also submitted in October for an additional 257 lots. The current DA submission includes Stages 5 to 6 and includes the remaining 182 lots, whilst closely aligning with the previous development stages. Refer to Plate 3.1.

Stages 5 to 6 will include the creation of 182 residential lots, road network together with associated street drainage and stormwater management controls.

The proposed development will include a series of co-located raingarden / detention basins to manage stormwater quality and quantity. These include:

- **Basin "B"** - located within Stage 4, the basin (which will be constructed in Stage 4) will attenuate and treat runoff from Stage 6 prior to discharging overland to the adjacent property to the west (future subdivision). It is noted that this flowpath naturally occurs under existing catchments.
- **Basin "C"** – located within Stage 5, the basin will manage those catchments draining to the north prior to discharge to O'Connell Street.

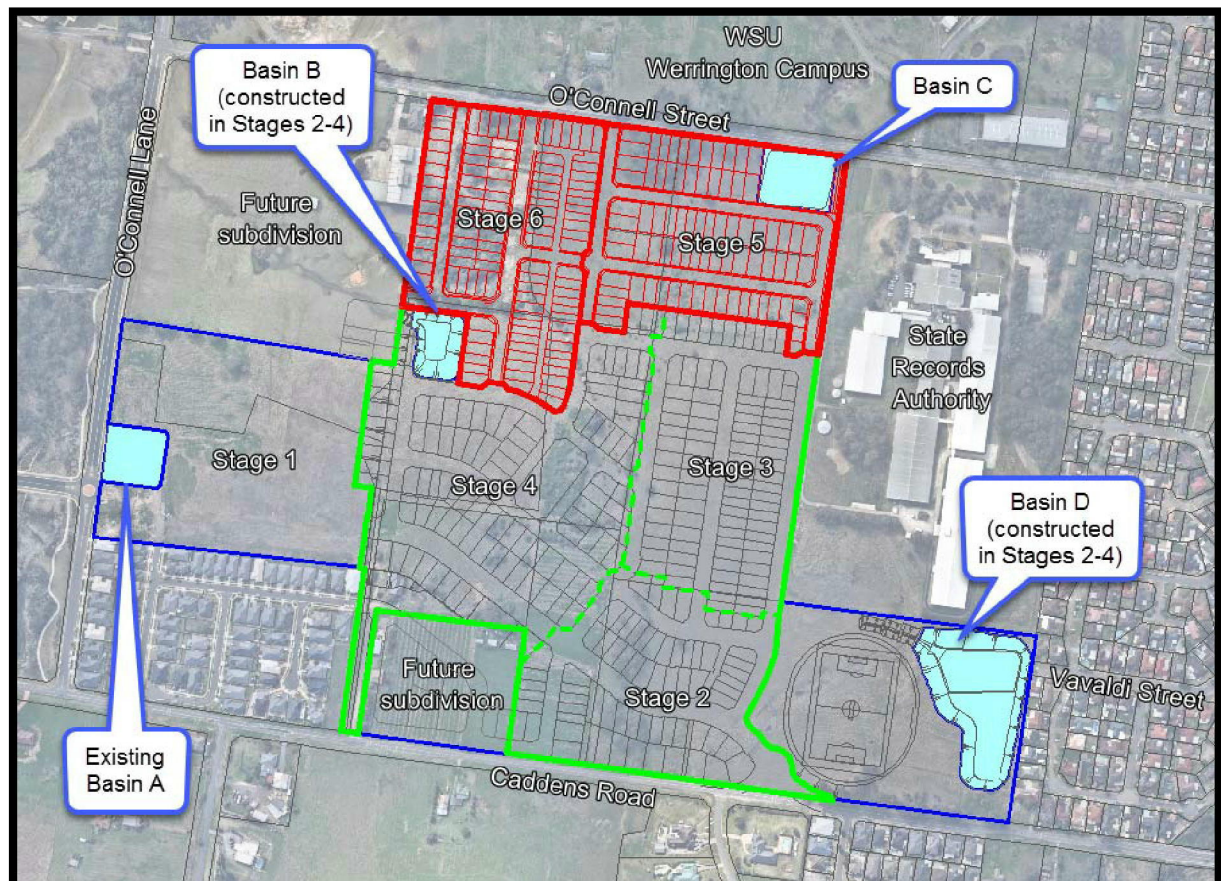


Plate 3.1 - Proposed Development

## **4 DEVELOPMENT CONTROLS AND GUIDELINES**

The following control documents have been considered in the development of the Stormwater management strategy for the Stages 5 to 6 of the O'Connell Street development:

- Penrith City Council DCP 2014
- Penrith City Council Engineering design guidelines for subdivisions
- Penrith City Council WSUD Policy (2013)
- Penrith City Council WSUD Technical Guidelines (2015)

## 5 WATER QUANTITY ANALYSIS

Two (2) detention basins (Basins “B” and “C”) are proposed to manage stormwater runoff from Stages 5 to 6 of the O’Connell Street development.

Existing and developed catchment plans are presented on Figures 1 and 2 in Appendix A. The total “developed” catchment area directed to Basin “C” includes 6.3 ha of proposed residential development.

The total “developed” catchment area being managed by Basin “B” includes 5.98 ha of proposed residential development area from Stage 4 (3.42 Ha)\_and Stage 6 (2.56 Ha including bypass).

A hydrological assessment has been undertaken using XP-RAFTS to determine the necessary detention volumes to ensure post development flows do not exceed existing condition flows exiting the subject site.

A water quality assessment was also undertaken to determine the treatment that is required to manage urban runoff from the O’Connell Street Stages 5 to 6 development, refer to Section 6 of this report for the water quality assessment.

Refer to XP-RAFTS layouts in Appendix B for further details of the hydrological modelling.

### 5.1 Discharge Estimates (Basin B)

Basin “B” is designed to manage stormwater runoff from Stage 4 and part of Stage 6. The basin is located adjacent to the western boundary and receives flows via the proposed pipe system and low points in the surrounding roads.

The outlet from Basin “B” will discharge to the west via a level spreader to ensure there is no concentration of flows. It is anticipated that when the future subdivision to the west is constructed, lots will be elevated up to the proposed road level, which will allow the emergency spillway to drain to the roadway. A raingarden is also located in the base for water quality treatment. Details of Basin B are included on drawing 110358/DA222.

Discharge estimates were derived for both the “existing” and “developed” catchments for the 1%, 20% and 50% AEP events. A range of storm durations from 10 minutes to 24 hours were analysed to determine the critical storm duration.

Table 5.1 to 5.3 below shows a comparison between pre and post development discharges at the Basin B outlet and just downstream (including a bypass catchment of 0.23 ha). Refer to Plate 5.1 for comparison location at “Dummy West”

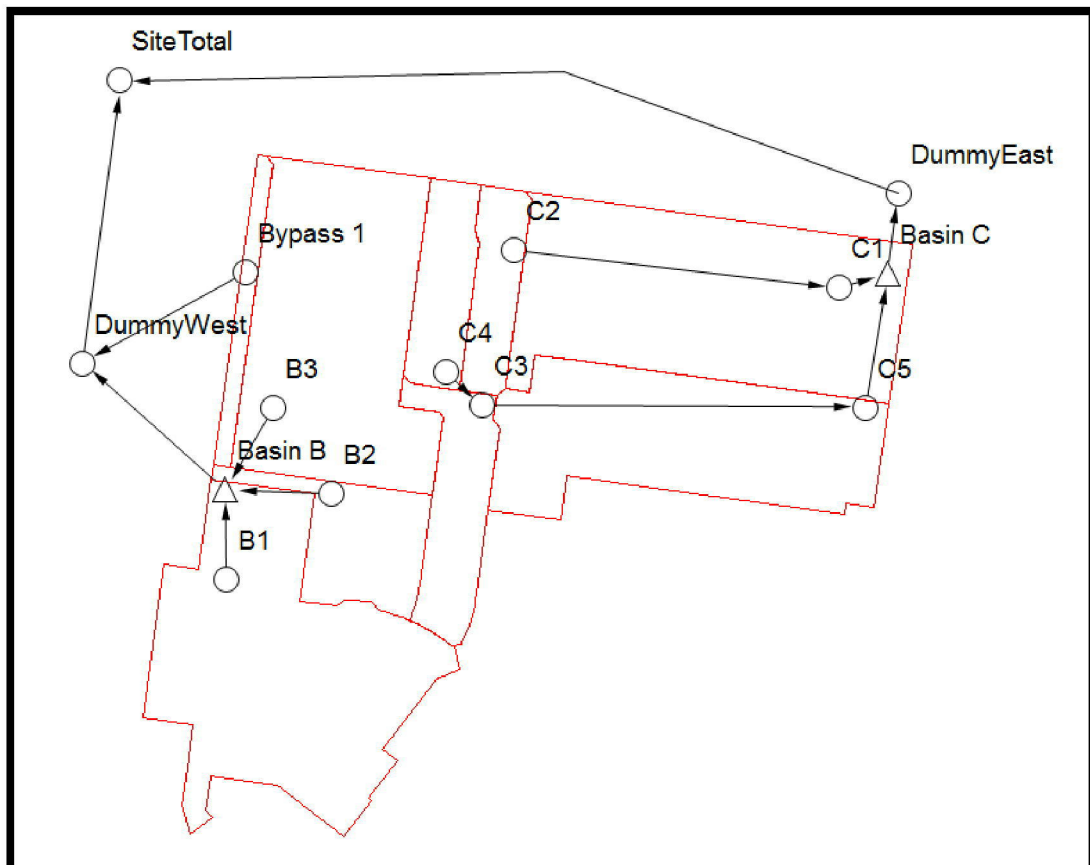


Plate 5.1 – XP-RAFTS Developed Layout (Northern)

Table 5.1 - Pre & Post Development Discharges at Basin B outlet

AEP	Existing (m <sup>3</sup> /s)	Post - Development (m <sup>3</sup> /s)	Post / Pre ratio
50%	0.57	0.50	0.88
20%	0.92	0.71	0.77
1%	2.00	1.79	0.90

Table 5.2 - Pre & Post Development Discharges at Dummy West  
 (including bypass catchment at western boundary)

AEP	Existing (m <sup>3</sup> /s)	Post - Development (m <sup>3</sup> /s)	Post / Pre ratio
50%	0.57	0.55	0.96
20%	0.92	0.74	0.80
1%	2.00	1.85	0.93

The performance of Basin B is also provided in Table 5.3 below.

**Table 5.3 - Basin "B" Performance**

Basin B Performance						
AEP	Peak Inflow	Storm Duration	Peak Outflow	Storm Duration	Storage Used	Top Water Level
	(m <sup>3</sup> /s)	(min)	(m <sup>3</sup> /s)	(min)	(m <sup>3</sup> )	RL (m)
50%	1.24	90	0.50	90	553	58.22
20%	1.67	90	0.71	90	782	58.37
1%	2.77	90	1.79	90	1287	58.66

Source: 110358\_RA1\_Dev (North).xp

## 5.2 Discharge Estimates (Basin C)

Basin "C" is designed to manage stormwater runoff from Stages 5 and 6. The basin is located in the eastern side of Stage 5 alongside proposed Road 12, with flows being attenuated and treated prior to discharge to the existing 600 mm dia pipe in O'Connell Street..

The basin design has considered freeboard to the proposed lots and the eastern boundary along with the existing pipe 600mm dia pipe crossing. The basin also includes a raingarden for water quality in the base. Details of Basin C are included on drawing 110358/DA511 and 110358/DA512.

Discharge estimates were derived for both the "existing" and "developed" catchments for the 1%, 20% and 50% AEP events. A range of storm durations from 10 minutes to 24 hours were analysed to determine the critical storm duration.

Tables 5.4 below shows a comparison between pre and post development discharge just downstream of the Basin C outlet (O'Connell Street). Table 5.5 also includes a comparison of the total northern portion of the site, which demonstrates how Basins "B" and "C" will function together to achieve the overall targets. Refer to Plate 5.1 for comparison locations at "Dummy East" (O'Connell Street) and "Site Total".

**Table 5.4 - Pre & Post Development Discharges at "Dummy East"**

AEP	Existing (m <sup>3</sup> /s)	Post - Development (m <sup>3</sup> /s)	Post / Pre ratio
50%	0.49	0.48	0.98
20%	0.82	0.62	0.76
1%	1.81	1.80	1.00

**Table 5.5 - Pre & Post Development Discharges at "Site Total"**

AEP	Existing (m <sup>3</sup> /s)	Post - Development (m <sup>3</sup> /s)	Post / Pre ratio
50%	1.04	1.01	0.98
20%	1.74	1.35	0.78
1%	3.83	3.65	0.95

The performance of Basin C is also provided in Table 5.6 below.

**Table 5.6 - Basin "C" Performance**

Basin C Performance						
AEP	Peak Inflow	Storm Duration	Peak Outflow	Storm Duration	Storage Used	Top Water Level
	(m <sup>3</sup> /s)	(min)	(m <sup>3</sup> /s)	(min)	(m <sup>3</sup> )	RL (m)
50%	1.40	90	0.48	120	665	45.00
20%	1.89	90	0.62	120	985	45.21
1%	3.07	90	1.80	90	1600	45.57

Source: 110358\_RA5\_Dev (North).xp

### 5.3 Discussion of Modelling Results

The results of the hydrological modelling show that the proposed detention basins "B" and "C" will ensure that post-development flows do not exceed pre-development flows at key comparison locations for the 1%, 20% and 50% AEP storm events.



## 6 WATER QUALITY ANALYSIS

### 6.1 Modelling Inputs and Assumptions

The MUSIC modelling for the Stage 4 to 6 development was undertaken using MUSIC Version 6.2 and in accordance with Penrith City Council's WSUD Design Policy (PCC, 2013a) and Technical Guidelines (PCC, 2015). This water quality modelling software was developed by the Cooperative Research Centre (CRC) for Catchment Hydrology, which is based at Monash University and was first released in July 2002.

In accordance with PCC's Water Sensitive Urban Design Technical Guidelines (2015), sub-catchments have been split into roof, road, urban pervious and urban impervious. The target pollutant removal rates for this development are 85% Suspended Solids (TSS), 60% Total Phosphorus (TP) and 45% Total Nitrogen (TN).

A proposed treatment train of water quality devices has been identified to achieve the target pollutant removals. This includes a combined system of rainwater tanks, Gross Pollutant Traps (GPT) and bio-retention raingardens.

The *MUSIC* Modelling has assumed the following in determination of results:

- Residential catchment 85% impervious overall;
- Roof area cover 75% of lots;
- Road reserve 95% impervious;
- Open Space 50% impervious;
- 3.0 kL rainwater tanks on each lot, 2.4 kL re-usable storage above top-up;
- Rainwater tank re-use has been assumed as follows:
  - 0.08 kL/day internal use per lot; and
  - 25 kL/year PET rain.

Further details on the MUSIC modelling parameters, Gross Pollutant Trap and the Bio-retention Rain garden are provided in Appendix C.

### 6.2 MUSIC Model Layout

The catchment plan for Stages 4 to 6 has been split into two (2) distinct sub-catchments, each being serviced by a treatment train that will incorporate gross pollutant traps upstream of a common bio-retention raingarden devices. A catchment plan is included in Appendix A.

There is a small portion of development in Stage 6 (rear of lots) which will bypass the Basin B. The strategy has overcompensated for this area.

The required device size parameters are summarised in Table 6.2, and the layout of the MUSIC model is shown in Appendix A. Further details are included in Appendix C.

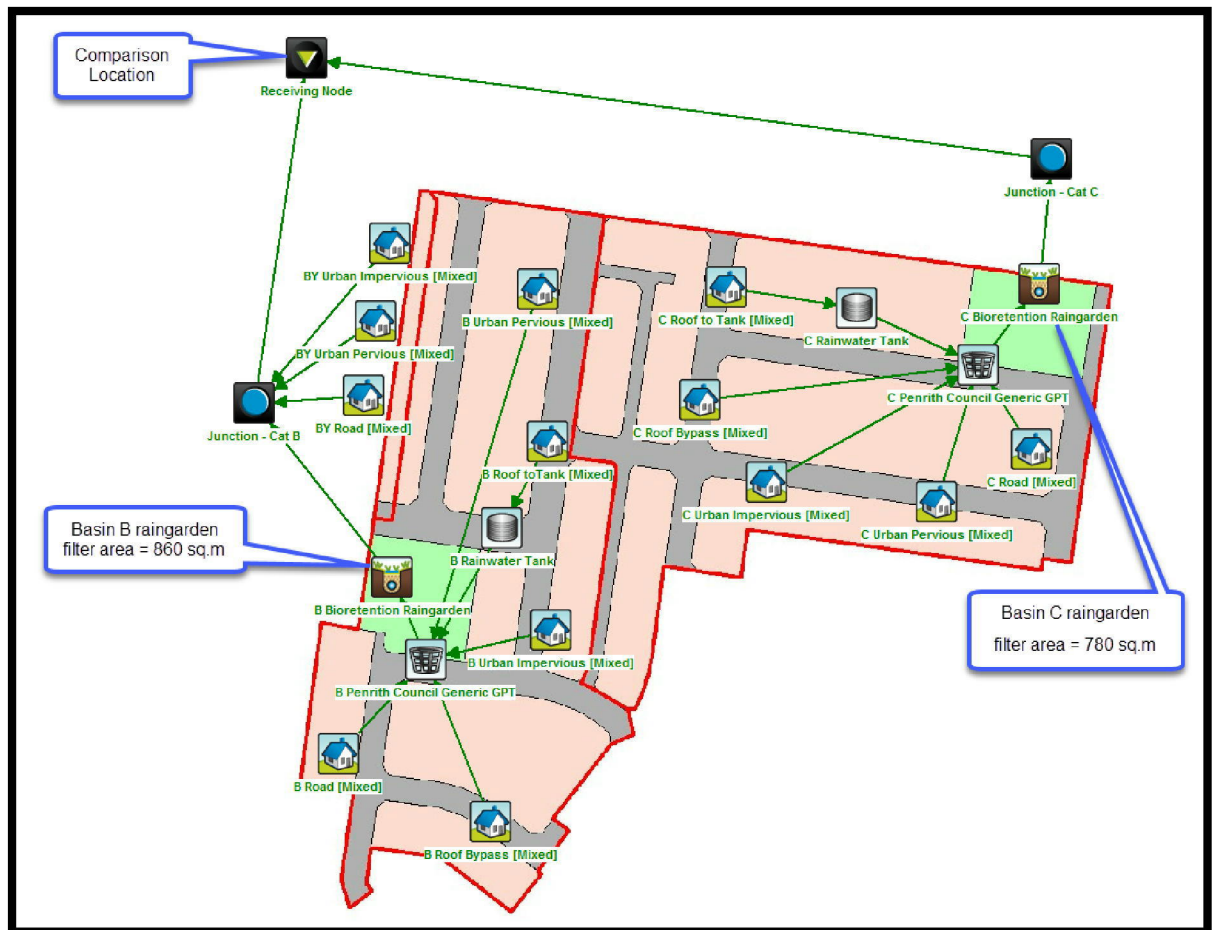


Plate 6.1 – MUSIC Model Layout (110358\_05 MU1.sqz)

6.3 Modelling Results

The combined performance of the proposed water quality management strategy for Stages 4 to 6 is summarised below in Table 6.1.

Table 6.1 - Summary of MUSIC Results (Stages 4 to 6)

Pollutant	Total Developed Source Nodes	Minimum Reduction Required	Total Residual Load from Site	Total Reduction Achieved	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)	(%)	(%)
TSS	9550	8118	1437	8113.0	85.0%	85.0%
TP	19.6	12.7	5.7	13.9	65.0%	71.1%
TN	144	64.8	56	88.3	45.0%	61.3%
Gross Pollutants	1750	1575	64	1686	90.0%	96.3%

The results indicate that the proposed treatment system that includes on-lot rainwater tanks, gross pollutant traps and bio-retention raingardens will provide adequate treatment removal in accordance with Council’s WSUD Policy (PCC, 2013a). Minimum raingarden sizes are summarised in Table 6.2.

**Table 6.2 - Summary of Minimum Raingarden Sizes**

Basin	Filter Area (m <sup>2</sup> )	Percentage of Catchment
B	860	1.5%
C	780	1.2%

A MUSIC-LINK report was generated which demonstrates that the MUSIC modelling achieves Penrith City Council's water quality targets. A copy of this report is provided in Appendix C.

## 7 SUMMARY

This report details the investigations and presents the results of the Stormwater Management Strategy to support the Stage 5 to 6 DA for the proposed subdivision at O'Connell Street, Caddens.

The proposed stormwater management strategy for the development of Stages 5 to 6 will consist of:

- Detention Basin "B" with a total active storage of approximately 1300 m<sup>3</sup>
- Detention Basin "C" with total active storage of 1600 m<sup>3</sup>
- Raingarden filter bed area within Basin "B" of 860 m<sup>2</sup>
- Raingarden filter bed area within Basin "C" of 780 m<sup>2</sup>

Results demonstrate that the proposed detention basins will ensure that peak post development discharges are restricted to less than the pre development levels at all key comparison locations. Water quality will be managed by on-lot rainwater tanks, gross pollutant trap and rain gardens co-located within detention basins. The proposed works are provided on engineering design drawing set 110358/DA511 to 110358/DA512.

The proposed Stormwater Management Strategy for Stages 5 to 6 of the O'Connell Street, Caddens development provides a basis for the detailed design and development of the Construction Certificate drawings to ensure that the environmental, urban amenity, engineering and economic objectives for stormwater management and site discharge are achieved.

We see that this stormwater strategy provides the necessary modelling to support approval for the Stage 5 to 6 DA. If you require any additional information, please do not hesitate to contact the undersigned on (02) 4720 3342.

Yours faithfully

**J. WYNDHAM PRINCE**



**CHRIS RANDALL**

Senior Water Resources Engineer

**8 REFERENCES**

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## APPENDIX A – Figures

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





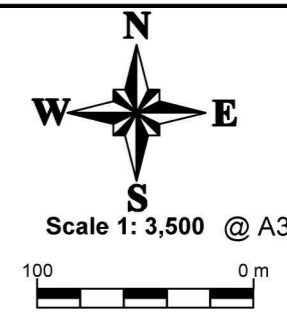
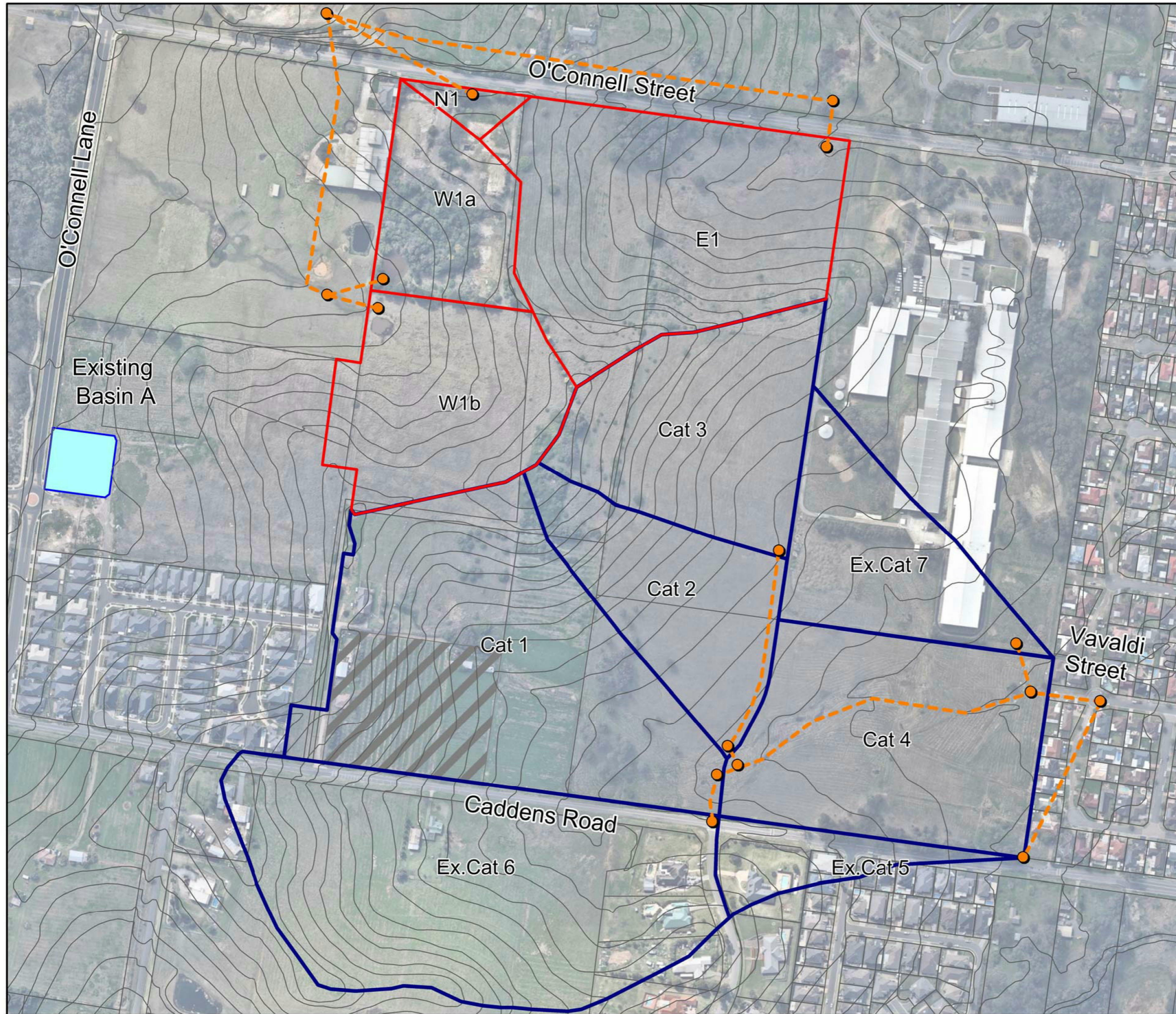
LEGACYPROPERTY

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#### LEGEND

-  XP-RAFTS Catchments (North)
-  XP-RAFTS Catchments (South)
-  Basin
-  Future Development
-  XP-RAFTS Node/Basin
-  XP-RAFTS Link
- Cat 1 XP-RAFTS Catchment Name



**Figure 1**  
**Stages 5 to 6**  
**O'Connell Street**  
**Caddens**

**Existing**  
**Catchment Plan**

File Name: 110358\_05 Figure 1  
 Date : 14/12/2016 Issue : A



LEGACYPROPERTY

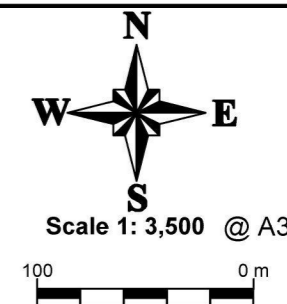
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#### LEGEND

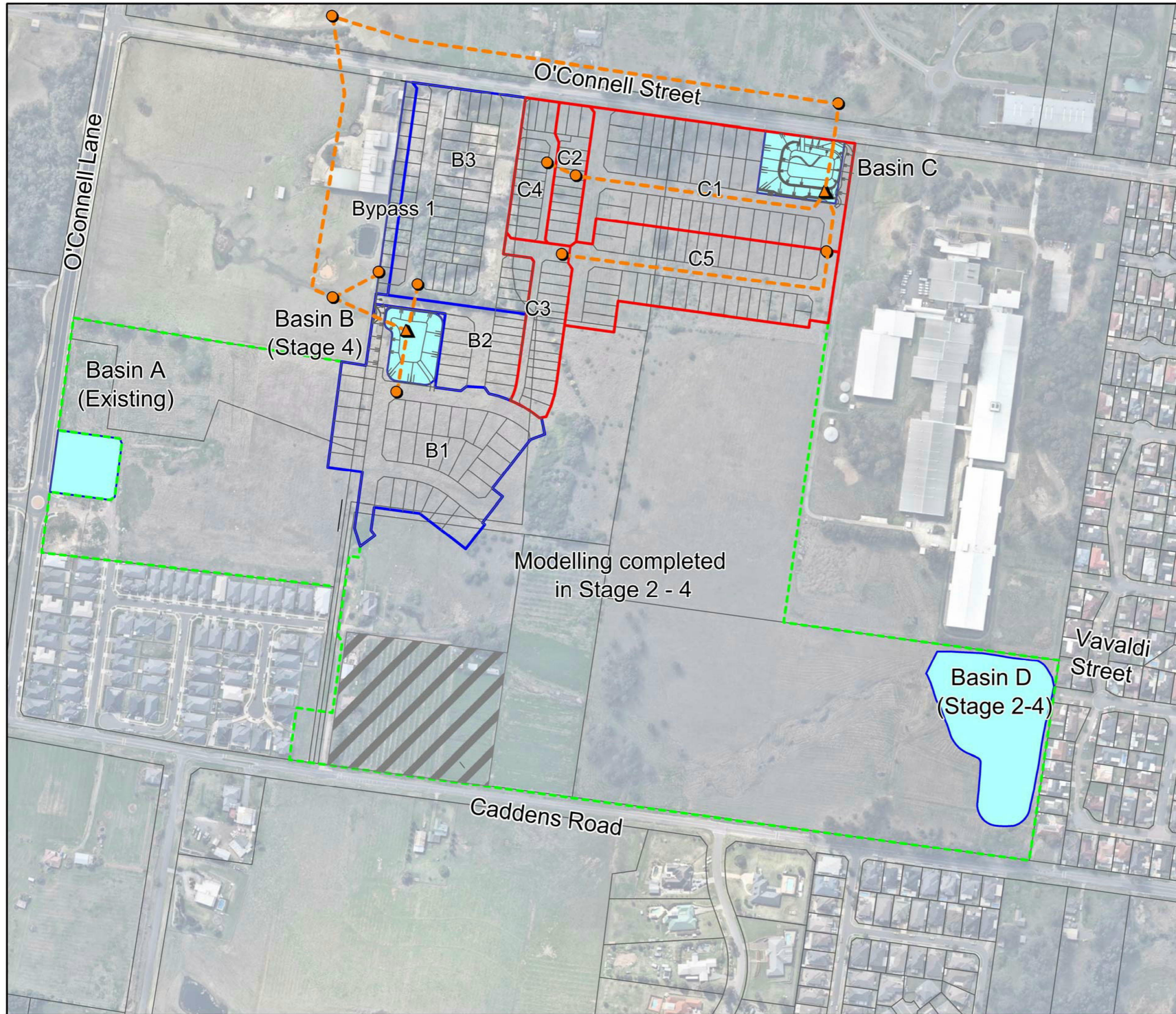
- XP-RAFTS Catchments (North)
- XP-RAFTS Catchments (North-West)
- XP-RAFTS Catchments (South)
- Basin
- Future Development
- XP-RAFTS Node/Basin
- XP-RAFTS Link
- Cat 1** XP-RAFTS Catchment Name
- Stages 1 - 4 Boundary



**Figure 2**  
**Stages 5 to 6**  
**O'Connell Street**  
**Caddens**

**Developed**  
**Catchment Plan**

File Name: 110358\_05\_Figure 2  
 Date : 14/12/2016 Issue : A







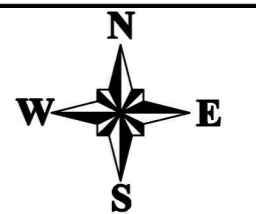
LEGACYPROPERTY

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#### LEGEND

-  MUSIC Catchment Boundary
-  Residential Lots
-  Road Reserve
-  Open Space
-  Future Development



Scale 1: 3,500 @ A3

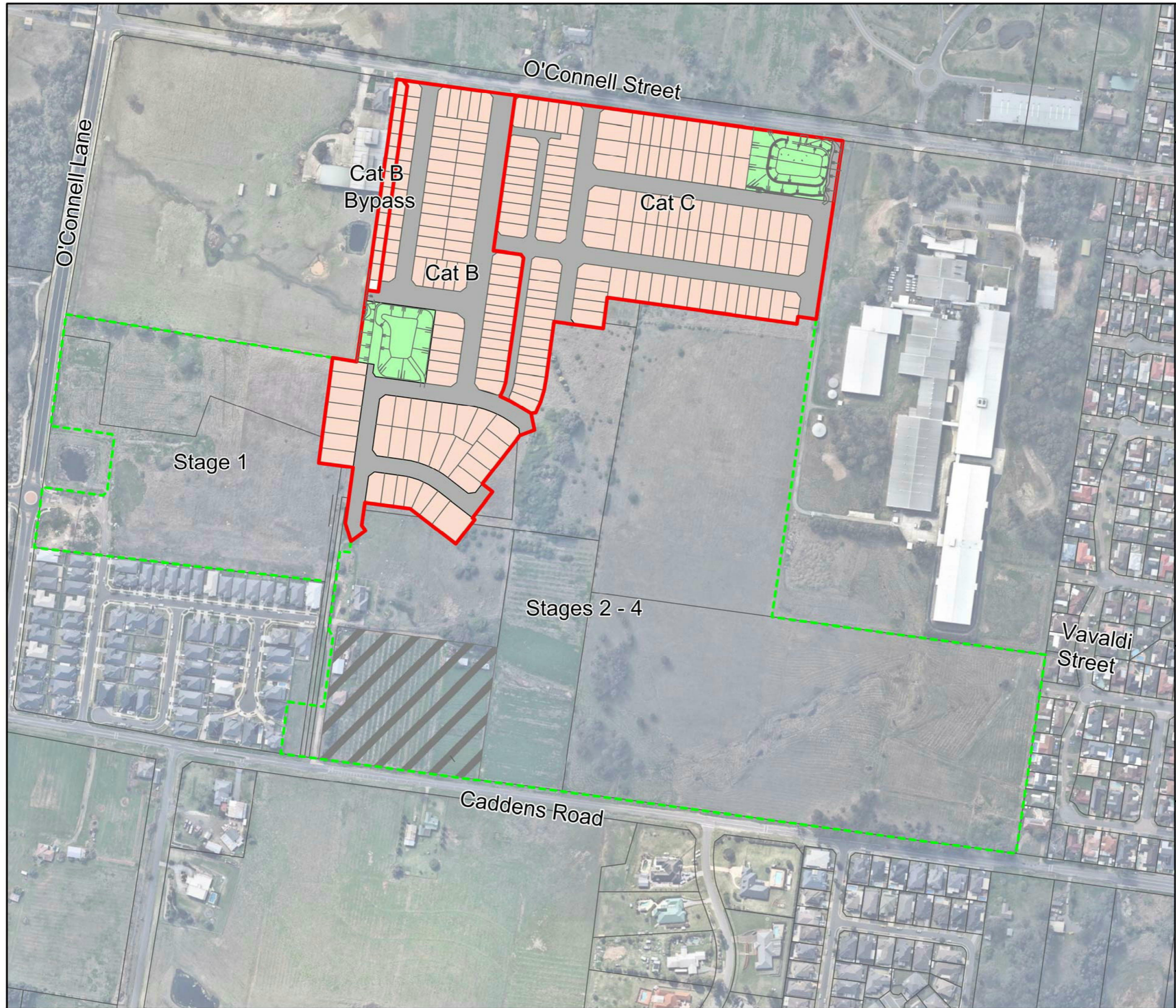


**Figure 3**  
**Stages 5 to 6**  
**O'Connell Street**  
**Caddens**

#### MUSIC Catchment Plan

File Name: 110358\_05 Figure 3  
Date : 14/12/2016

Issue : A



## **APPENDIX B – XP RAFTS Input Details**

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## RAFTS INPUT PARAMETERS

Table B 1 - Initial / Continuing Loss

Initial/ Continuing Losses		
Loss	Pervious Catchment	Impervious Catchment
Initial Loss	10.0	1.0
Continuing Loss	2.5	0.0

Table B 2 - Adopted PERNS

Catchment Condition	Adopted PERNS
Rural Pervious	0.05
Urban Pervious	0.025
Urban Impervious	0.015

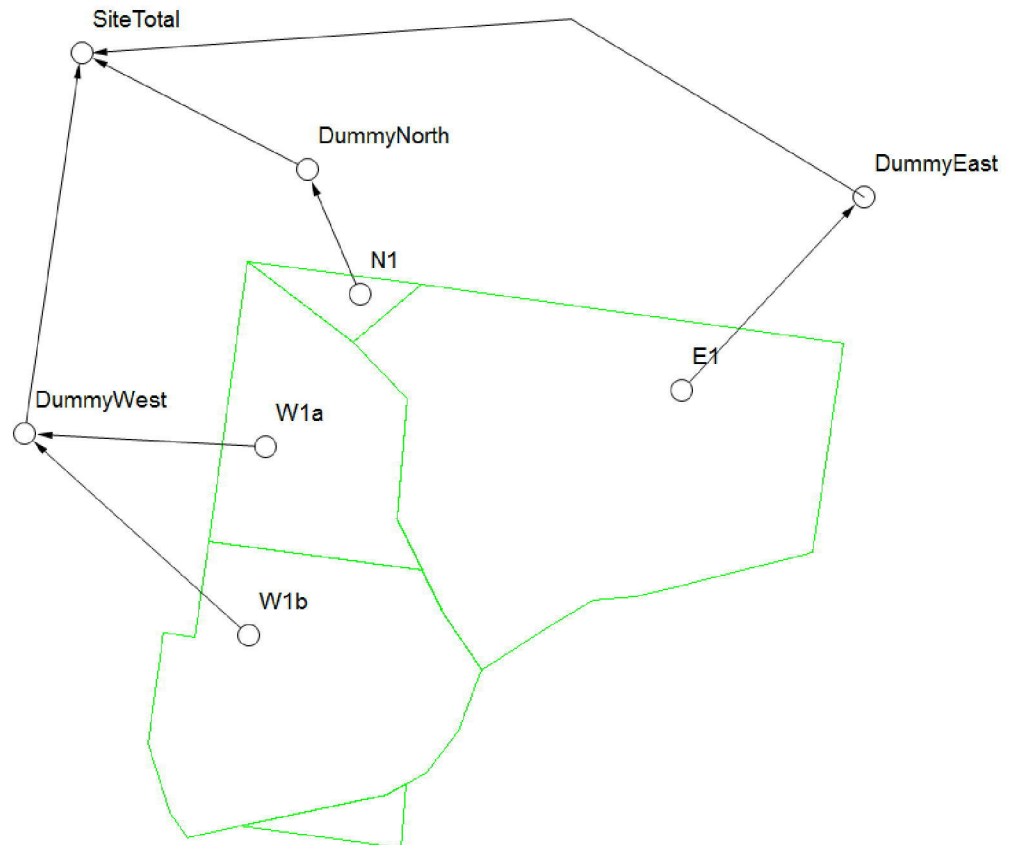


Plate B.1 – XP-RAFTS Layout Existing (Northern portion of site)

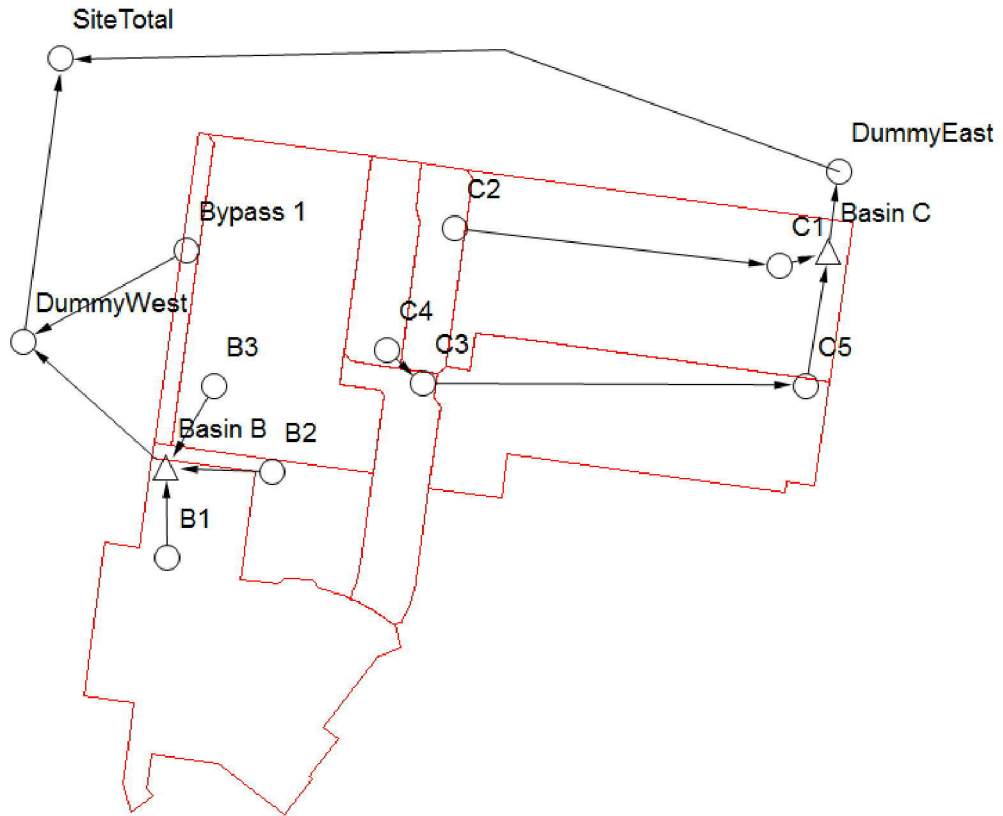


Plate B.2 – XP-RAFTS Layout Developed (Northern portion of site)

Table B 4 – NORTHERN PORTION OF SITE

XP-RAFTS Model - Northern Portion of Site												
Existing												
Catchment Name	Area (Ha)	Fraction Impervious	Slope				Area (Ha)		Links			
			U/S Level	D/ S Level	Length	Catchment Slope	Impervious	Pervious	Name	Length	Link time at 2m/s	
N1	0.30	40	68	64.94	50	6.1%	0.12	0.18	dmy 2 - out	300	2.5	
W1a	2.24	40	68	56.39	180	6.5%	0.89	1.34	dmy 1 - out	350	2.9	
W1b	3.74	5	73	56.05	218	7.8%	0.19	3.55				
E1	6.54	5	71.49	43.65	383	7.3%	0.33	6.21				
Total	12.8											
Developed												
Catchment Name	Area (Ha)	Fraction Impervious	Slope				Area (Ha)		Links			
			U/S Level	D/ S Level	Length	Catchment Slope	Impervious	Pervious	Name	Length	Link time (min) at 2m/s	
Bypass	0.23	85				4%	0.20	0.03				
B1	2.73	75	69.8	60.3	230	4%	2.05	0.68	C5-C1	49	0.4	
B2	0.69	85	66.2	58.1	180	5%	0.59	0.10				
B3	2.33	85	65.1	58.1	283	2%	1.98	0.35				
C1	2.71	75	61	50.3	255	4%	2.03	0.68				
C2	0.42	85	64.4	61.2	36	9%	0.36	0.06				
C3	0.66	85	66.2	62.4	176	2%	0.56	0.10				
C4	0.50	85	64.9	62.9	135	1%	0.43	0.08				
C5	2.01	85	64.7	51.8	334	4%	1.71	0.30				
Total	12.28											

## APPENDIX C – MUSIC Modelling Parameters and Report

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110358 - MUSIC MODELLING WORKSHEET

O'CONNELL LANE - STAGES 4 - 6

Catchment	Catchment Division				Node Inputs					
	Total Catchment Area (ha)	Residential Lot Area (ha)	Road (incl. Reserve) Area (ha)	Open Space	Road (ha)	Roof to Tank (ha)	Roof Bypass (ha)	Urban Impervious	Urban Pervious	Forest
Catchment B	5.75	3.460	1.822	0.471	1.822	1.298	1.298	0.582	0.755	0.000
Catchment C	6.31	4.188	1.659	0.460	1.659	1.571	1.571	0.649	0.858	0.000
Bypassing	0.23	0.216	0.012	0.000	0.012	0.000	0.000	0.184	0.032	0.000

RG Size (ha)	RG Size (% cat)
0.08630	1.50%
0.06307	1.00%
Assumed Not Treated	

O'Connell Lane bypassing - assumed not to be part of treatable flows

Flow to GPT/Raingarden

	Area (ha)	1yr Flow (m <sup>3</sup> /s)	3mth Flow (m <sup>3</sup> /s)
Catchment B	5.75	0.49	0.26
Catchment C	6.31	0.53	0.28
O'Connell Lane	Assumed Not Treated		

RAINWATER TANK

Catchment	Lots	Equivalent Pipe Area (m <sup>2</sup> )	Equivalent Pipe radius (m)	Equivalent Pipe dia (mm)	Total Area of Roof to Tank (Ha)	Overflow Pipe Dia	High Flow By-pass	Daily Demand	PET - RAIN	Tank Surface Area
						1yr flow on roof (m <sup>3</sup> /s)	Daily Demand (kL)	Annual Demand (kL/yr)	Total Tank Volume (m <sup>3</sup> )	Tank Surface Area (m <sup>2</sup> )
Catchment B	104	0.204	0.255	510	1.298	0.270	8.32	2600	249.6	195.00
Catchment C	121	0.237	0.275	550	1.571	0.327	9.68	3025	290.4	226.88
Bypassing	0	0.000	0.000	0	0.000	0.000	0	0	0.0	0.00

\*Backyard only

Basin 'A' Raingarden Design Parameters	Value
Catchment Area (ha)	10.37
High Flow Bypass (3 month ARI) (m <sup>3</sup> /s)	0.45
Extended Detention Depth (m)	0.3
Raingarden Storage Surface Area (m <sup>2</sup> )	1250
Filter Depth (m)	0.5

PET - Rain for landscape area	25 kL/year/dwel
Assumed Daily Demand	80 L/day
Adopted Tank Size	3 kL
Assumed 80% is useable (w/o topups)	80 %
Useable tank	2.4 kL
Assumed Tank height	1.6 m
15min/1yr	75 mm/hr

Input  
MUSIC Input

MUSIC-*link* Report

Project Details		Company Details	
<b>Project:</b>	110358 OConnell St - St 5-6 Caddens	<b>Company:</b>	J Wyndham Prince
<b>Report Export Date:</b>	1/12/2016	<b>Contact:</b>	Chris Randall
<b>Catchment Name:</b>	110358_05_MJ1	<b>Address:</b>	580 High Street, Penrith NSW2750
<b>Catchment Area:</b>	12.291ha	<b>Phone:</b>	47203342
<b>Impervious Area*:</b>	85.21%	<b>Email:</b>	crandall@jwprince.com.au
<b>Rainfall Station:</b>	67113 PENRITH		
<b>Modelling Time-step:</b>	6 Mminutes		
<b>Modelling Period:</b>	1/01/1999 - 31/12/2008 11:54:00 PM		
<b>Mean Annual Rainfall:</b>	691mm		
<b>Evapotranspiration:</b>	1158mm		
<b>MUSIC Version:</b>	6.1.0		
<b>MUSIC-link data Version:</b>	6.00		
<b>Study Area:</b>	Penrith		
<b>Scenario:</b>	Penrith Development		

\* takes into account area from all source nodes that link to the chosen reporting node, excluding Import Data Nodes

Treatment Train Effectiveness		Treatment Nodes		Source Nodes	
Node: Receiving Node	Reduction	Node Type	Number	Node Type	Number
Flow	17%	Bio Retention Node	2	Urban Source Node	13
TSS	85%	Rain Water Tank Node	2		
TP	71.1%	GPT Node	2		
TN	61.2%				
GP	96.3%				

**Comments**

GPT removal of TSS TP and TN is a modelling abnormality that is being investigated with ewater.

**Passing Parameters**

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	B Bioretention Raingarden	Hi-flow bypass rate (cum/sec)	None	99	0.26
Bio	B Bioretention Raingarden	PET Scaling Factor	2.1	2.1	2.1
Bio	C Bioretention Raingarden	Hi-flow bypass rate (cum/sec)	None	99	0.28
Bio	C Bioretention Raingarden	PET Scaling Factor	2.1	2.1	2.1
GPT	B Penrith Council Generic GPT	Hi-flow bypass rate (cum/sec)	None	99	0.26
GPT	C Penrith Council Generic GPT	Hi-flow bypass rate (cum/sec)	None	99	0.28
Receiving	Receiving Node	% Load Reduction	None	None	17
Receiving	Receiving Node	GP % Load Reduction	90	None	96.3
Receiving	Receiving Node	TN % Load Reduction	45	None	61.2
Receiving	Receiving Node	TP % Load Reduction	60	None	71.1
Receiving	Receiving Node	TSS % Load Reduction	85	None	85
Urban	B Road	Area Impervious (ha)	None	None	1.725
Urban	B Road	Area Pervious (ha)	None	None	0.096
Urban	B Road	Total Area (ha)	None	None	1.822
Urban	B Roof Bypass	Area Impervious (ha)	None	None	1.298
Urban	B Roof Bypass	Area Pervious (ha)	None	None	0
Urban	B Roof Bypass	Total Area (ha)	None	None	1.298
Urban	B Roof to Tank	Area Impervious (ha)	None	None	1.298
Urban	B Roof to Tank	Area Pervious (ha)	None	None	0
Urban	B Roof to Tank	Total Area (ha)	None	None	1.298
Urban	B Urban Impervious	Area Impervious (ha)	None	None	0.582
Urban	B Urban Impervious	Area Pervious (ha)	None	None	0
Urban	B Urban Impervious	Total Area (ha)	None	None	0.582
Urban	B Urban Pervious	Area Impervious (ha)	None	None	0
Urban	B Urban Pervious	Area Pervious (ha)	None	None	0.755
Urban	B Urban Pervious	Total Area (ha)	None	None	0.755
Urban	BY Road	Area Impervious (ha)	None	None	0.011
Urban	BY Road	Area Pervious (ha)	None	None	0.000
Urban	BY Road	Total Area (ha)	None	None	0.012
Urban	BY Urban Impervious	Area Impervious (ha)	None	None	0.184
Urban	BY Urban Impervious	Area Pervious (ha)	None	None	0
Urban	BY Urban Impervious	Total Area (ha)	None	None	0.184
Urban	BY Urban Pervious	Area Impervious (ha)	None	None	0
Urban	BY Urban Pervious	Area Pervious (ha)	None	None	0.032
Urban	BY Urban Pervious	Total Area (ha)	None	None	0.032
Urban	C Road	Area Impervious (ha)	None	None	1.583
Urban	C Road	Area Pervious (ha)	None	None	0.075
Urban	C Road	Total Area (ha)	None	None	1.659
Urban	C Roof Bypass	Area Impervious (ha)	None	None	1.571
Urban	C Roof Bypass	Area Pervious (ha)	None	None	0

Only certain parameters are reported when they pass validation

NOTE: A successful self-validation check of your model does not constitute an approved model by Penrith City Council  
MUSIC-*link* now in MUSIC by eWater – leading software for modelling stormwater solutions



Node Type	Node Name	Parameter	Min	Max	Actual
Urban	C Roof Bypass	Total Area (ha)	None	None	1.571
Urban	C Roof to Tank	Area Impervious (ha)	None	None	1.571
Urban	C Roof to Tank	Area Pervious (ha)	None	None	0
Urban	C Roof to Tank	Total Area (ha)	None	None	1.571
Urban	C Urban Impervious	Area Impervious (ha)	None	None	0.649
Urban	C Urban Impervious	Area Pervious (ha)	None	None	0
Urban	C Urban Impervious	Total Area (ha)	None	None	0.649
Urban	C Urban Pervious	Area Impervious (ha)	None	None	0
Urban	C Urban Pervious	Area Pervious (ha)	None	None	0.858
Urban	C Urban Pervious	Total Area (ha)	None	None	0.858

Only certain parameters are reported when they pass validation

**Failing Parameters**

Node Type	Node Name	Parameter	Min	Max	Actual
GPT	B Penrith Council Generic GPT	TN % Load Reduction	0	0	-0.00
GPT	B Penrith Council Generic GPT	TP % Load Reduction	0	0	-0.00
GPT	B Penrith Council Generic GPT	TSS % Load Reduction	0	0	-0.00
GPT	C Penrith Council Generic GPT	TN % Load Reduction	0	0	-0.01
GPT	C Penrith Council Generic GPT	TP % Load Reduction	0	0	-0.00
GPT	C Penrith Council Generic GPT	TSS % Load Reduction	0	0	-0.00

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