Stormwater Management Plan

Williams Road Staged Residential Subdivision

Williams Road
Lots 301 & 302 DP1202877 , Lot 2 DP1189190
Table Top

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1. INTRODUCTION

This report accompanies the Development Consent Application to Albury City Council seeking consent for the proposed development of land identified as Williams Road Staged Residential Subdivision, Lots 301 & 302 DP1202877, Lot 2 DP1189190, 507 Table Top Road, 65 Williams Road Thurgoona.

This report has been prepared to document and make an assessment of the required works to ensure:

1. Habitat outcomes - Sloane's froglet breeding habitat requirements are incorporated into all new stormwater wetlands irrespective of the presence of existing habitat.

2. Stormwater quality outcomes - Stormwater design delivers water quality outcomes in accordance with current state regulations.

We have made an assessment of previous reports prepared for Williams Road Development and surrounding including:

Eslers Land Consulting, Sloane's Froglet Habitat Management Plan 16918 V1 dated 1/11/2022

Spiire prepared for AlburyCity Council, Thurgoona/Wirlinga Drainage Strategy, November 2020

2. SUBJECT LAND

For the purposes of this SWMP the subject land comprises three parcels being Lots 301 & 302 DP1202877, Lot 2 DP1189190 and currently known as Williams Road Stage Residential Subdivision.

The subject land total is approx. 77.29ha in area, however the study area is approx. 127.4 ha including the subject land and two upstream catchment area's known as Thurgoona Training Academy and partially part of an undeveloped parcel of land to the north of the site that we have identified as Lot 22 DP1191688 Catchment.

Williams Road Stage Residential Subdivision is located approximately 10km northeast of the Albury City Centre. The land currently has one planning zone across it (General Residential Zone - R1).

There are four outlet points where the drainage currently leaves the subject site. They include;

- South West of Eight Mile Creek (South East section of the proposed development)

- North West Eight Mile Creek (North East section of the proposed development)

- Unnamed Watercourse (Western section of the proposed development)

- East Eight Mile Creek (Eastern most parcel of the proposed development)

3. OBJECTIVES

3.1 Sloane's Froglet Breeding Habitat Creation

The development falls within the Sloane's Froglet Local Area Management Plan, which requires wetland breeding habitat to be designed in accordance with Sloane's Froglet Stormwater Wetland Design Guidelines (Spiire, 2017).

Sloane's froglet breeding habitat requirements are to be incorporated into combined stormwater quality treatment wetlands and flood retarding basins by ensuring that wetland construction adheres to the following key habitat design principles:

Habitat water depth	Calling male Sloane's froglets are typically found in areas of shallow water ranging from depths of 10 to 310 mm
Habitat hydrology - length and season of inundation	Waterbodies need to contain water from mid- to late-autumn, and for at least 3 months after the winter breeding period finishes (i.e., at least until the end of October).
Habitat accessibility	Movement of Sloane's froglet into and out of wetlands can be helped by ensuring that batter slopes to water level are typically 1 to 4%, with a maximum acceptable slope of 18%.
Habitat size	Large robust colonies of Sloane's froglet are typically found in wetlands greater than 3000 m2 in area.
Habitat vegetation	Ideal Sloane's froglet breeding habitat includes emergent wetland species that have a stem diameter of less than 5 mm (e.g., common spike rush, Eleocharis acuta). Plant species with a larger stem diameter (e.g., Typha and Phragmites species) should not be planted.

Each of these habitat characteristics have been considered.

3.2 Major/Minor Stormwater Conveyance

Albury Council requires an approach consistent with Australian Rainfall and Runoff to the provision of major stormwater 1% AEP conveyance paths that control flows and protect dwellings and assets from inundation.

This is generally achieved within the actual estate by providing sufficient area in the road cross sections to convey and control such flows within maximum velocity and depth constraints.

A minor underground stormwater system is required to prevent damage to property in smaller rainfall events and to contain nuisance flows underground to a level that is acceptable to the community. For residential estates in Albury, Council requires the minor design to be a 10% AEP rainfall event.

Preliminary modelling of the site indicates detention will be required up to the 1% AEP storm event on the site. This is proposed to be accomplished by strategically located detention basins, upgrading an existing dam, ponds and wetlands systems within the development.

3.3 Water Quality Protection

Albury Council's Development Standards require consideration and inclusion of the principles of Water Sensitive Urban Design (WSUD) in order to manage urban stormwater as both a resource and to protect the water quality parameters of receiving waters. Stormwater systems need to be designed and managed to minimise the impacts on surface waters.

Increased impervious areas associated with urbanisation of catchments result in increased stormwater peak flows and volumes and corresponding damage to instream ecosystems from increased and more frequent flows and from pollutants delivered directly to the streams by piped stormwater systems.

Council requires WSUD to be undertaken in accordance with the general principles provided in *"The Urban Stormwater Best Practice Environmental Management Guidelines"* (BPEMG), (CSIRO 1999). The BPEMG are a toolbox designed to meet the needs of people involved in the planning, design and/or management of urban land uses or stormwater systems.

The principles articulated in the BPEMG require an integrated approach to managing the volume and rate of catchment runoff, the quality of the runoff and the protection of in-stream environmental values.

Flood protection and public safety remain as fundamental objectives of stormwater system planning and design.

Urban Stormwater, BPEMG suggests that stormwater management should be based on the following three principles:

- Preservation: preserve existing valuable elements of the stormwater system, such as natural channels, wetlands and streamside vegetation.
- Source Control: limit changes to the quantity and quality of stormwater at or near the source; and
- Structural Control: use structural measures, such as treatment techniques or detention basins to improve water quality and control streamflow discharges.

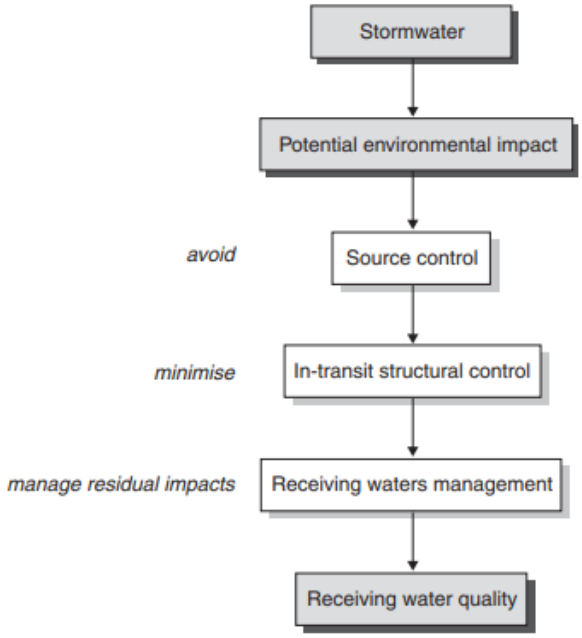

Figure 1: **Stormwater management framework (Urban Stormwater: Best Practice Environmental Management Guideline, CSIRO PUBLISHING, 2006)**

Table 2.1 of Urban Water BMPG documents the performance objectives for the environmental management of stormwater.

Pollutant	Current best practice objective
Post Construction Phase	
Suspended solids (SS)	80% detention of typical urban load
Total phosphorus (TP)	45% detention of typical urban load
Total nitrogen (TN)	45% detention of typical urban load
Litter	70% reduction of typical urban load
Construction Phase	
Suspended Solids	Effective treatment of daily runoff events (eg. <4mths ARI). Effective treatment equates to a 50%tile SS concentration of 50mg/L.
Litter	Prevent litter from entering the stormwater system.
Other Pollutants	Limit the application, generation and migration of toxic substances to the maximum extent possible.

Table 1: **Objectives for environmental management of stormwater (Urban Stormwater: Best Practice Environmental Management Guideline, CSIRO PUBLISHING, 2006)**

Measures to meet ACC and WSUD requirements within the development are listed as follows:

Rainwater Tanks

Rainwater tanks collect rainwater from rooftops in order to be used either for irrigation or indoor uses. Rainwater tanks help to protect the urban streams by reducing the total volume of stormwater runoff (and associated pollutants) from a site from reaching the downstream waterways.

A rainwater tank system typically includes:

- an inlet filter providing a primary treatment by removing the leaf litter and some sediments;
- a first flush diverter (optional) removing fine particle, animal faeces and other contaminants;
- a maintenance drain/sludge valve for removal of excess build-up, sludge layer and biofilm developing inside the tank;
- a mains top-up (optional) ensuring automatic top-up to ensure uninterrupted supply to the household;
- an overflow pipe connected to the drainage network; and
- a pump to supply the household demands.

By storing rainwater runoff from rooftops and gutters, rainwater tanks provide an ideal substitute for potable water in a household. Uses can include irrigation of gardens, car washing, toilets, laundry, and within the hot water service. There are a variety of commercial rainwater tank products available, but all essentially provide the same function. Rainwater tanks can be above or below ground, circular or slimline.

Advantages of rainwater tanks are that they:

- minimise water usage when used in the toilet, laundry or garden (reduction in potable water use leads to reducing the need for new dams or desalination plants and provide economic benefits to the end user on water bills)
- reduce strain on the stormwater drainage system
- retain water close to the source
- reduce site run-off and flood peaks
- assist in meeting the building energy rating requirements

Rainwater tanks should be inspected after a significant rainfall event, to check whether cleaning out is necessary and to ensure no damage has occurred.

Treatment of Gross Pollutants

Treatment of gross pollutants will be via GPT's located at the outlets of the underground stormwater drainage systems to the existing watercourse.

Gross pollutants traps are structures that use physical processes to trap solid waste such as litter and coarse sediment. They are commonly used as the primary treatment because they mostly remove large, non-biodegradable pollutants

Primary treatment includes:

- physical screening
- rapid sedimentation
- separation processes

Typical retained contaminants include:

- gross pollutants
- coarse sediments

Advantages of gross pollutant traps are that they:

- have a relatively small lateral footprint
- are hidden from view

Limitations of gross pollutant traps are that they:

- provide limited removal of fine sediment and dissolved pollutants
- have a high cost of build
- are complex to install
- require regular cleaning

Treatment of Impervious Runoff

Treatment of impervious runoff will be via detention basins including inlet sediment pond located at the lower areas of the development. Impervious runoff from the road will discharge into the roadside pipes which will inturn discharge into detention basins or sediment ponds areas which will then discharge into the outlets described in Section 2.

Detention basins contain stormwater and release it slowly to prevent flooding, contamination, erosion, and more.

Stormwater is caused by excess rain that the ground cannot absorb quickly enough to prevent flooding. Stormwater runoff occurs when roads, sidewalks, and other developments cannot absorb water like the natural ground can, causing the water to

start flowing. Even minor precipitation can quickly turn into stormwater runoff in urban or developed areas.

A detention basin, also known as a detention pond, holds excess water generated by storms to prevent flooding. The land is designed to slope down into a basin, creating the perfect spot for water to run during a storm.

Tertiary Treatment of Runoff

Treatment via Wetland basins including inlet sediment pond will provide water treatment requirements. The basins are proposed to be located in reserves situated at the lowest point of the development. By using two smaller basins it increases the treatment effectiveness.

Sediment basins are used to retain coarse sediments from runoff and are typically the first element in a treatment train. They are important in protecting downstream elements from becoming overloaded or smothered with sediments. They operate by reducing flow velocities and encouraging sediments to settle out of the water column.

They are frequently used for trapping sediment in runoff from construction sites and as pretreatments for elements such as wetlands (e.g. an inlet pond). They can be designed to drain during periods without rainfall and then fill during runoff events or to have a permanent pool.

Sediment basins can have various configurations including hard edges and base (e.g. concrete) or a more natural form with edge vegetation creating an attractive urban landscape element. They are, however, typically turbid and maintenance usually requires significant disturbance of the system.

Constructed wetland systems are shallow, extensively vegetated water bodies that use enhanced sedimentation, fine filtration and pollutant uptake processes to remove pollutants from stormwater. Water levels rise during rainfall events and outlets are configured to slowly release flows, typically over three days, back to the water levels of dry weather.

Wetlands generally consist of an inlet zone (sediment basin to remove coarse sediments), a macrophyte zone (a shallow heavily vegetated area to remove fine particulates and uptake of soluble pollutants) and a high flow bypass channel (to protect the macrophyte zone).

Wetland processes are engaged by slowly passing runoff through heavily vegetated areas. Plants filter sediments and pollutants from the water and biofilms that grow on the plants can absorb nutrients and other associated contaminants. In addition to being important in stormwater treatment, wetlands can also have significant community benefits. They provide habitat for wildlife and a focus for recreation, such as walking paths and resting areas. They can also improve the aesthetics of a development and be a central feature in a landscape.

4. EXISTING CATCHMENT

We have obtained the rainfall intensity data from the Bureau of Meteorology (BOM) for the Thurgoona area and have calculated the frequency factors for the 10% AEP to the 1% AEP found in Appendix 3.

4.1 Pre-development Catchment Area – Area No.1

This catchment relates predominantly to the majority of the proposed development area. The land is mostly undeveloped with only with the Thurgoona Training Academy located centrally. The majority of land has been cleared for agricultural purposes with tree scatter generally throughout the site. The catchment area is approx. 80.55ha total, with multiple sub catchments converging to the south east section of the site, towards Eight Mile Creek.

There is flood overlay over this section of the site from flows from Seven Mile Creek (1% AEP flood depth +300mm). As documented by Eslers Land Consulting, the assessed flood water to not enter the site.

There are currently 6 dams within this catchment. For this report we have considered that all these dams would be either full, or removed, and no upstream detention would be available. This adds a safety factor to the calculations.

Estimated pre-development flow calculations:

Catchment 1.1	10% AEP	= 0.56 m^3/s
Catchment 1.1	1% AEP	= 0.68 m^3/s
Catchment 1.2	10% AEP	= 0.40 m^3/s
Catchment 1.2	1% AEP	= 0.48 m^3/s
Catchment 1.3	10% AEP	= 0.41 m^3/s
Catchment 1.3	1% AEP	= 0.49 m^3/s
Catchment 1.4	10% AEP	= 0.59 m^3/s
Catchment 1.4	1% AEP	= 0.70 m^3/s
Catchment 1.5	10% AEP	= 1.70 m^3/s
Catchment 1.5	1% AEP	= 4.38 m^3/s

Catchment 1	10% AEP	= 3.65 m^3/s
Catchment 1	1% AEP	= 4.38 m^3/s

4.2 Pre-development Catchment Area – Area No.2

This catchment relates the western part of the majority of the proposed development area. The land is mostly undeveloped and has been cleared for agricultural purposes with tree scatter generally throughout the site. The catchment area is approx. 44.28ha total, with multiple sub catchments converging to the south west section of the site, towards Seven Mile Creek.

There are currently 6 dams within this catchment. For this report we have considered that all these dams would be either full and no upstream detention would be available. This adds a safety factor to the calculations.

Estimated pre-development flow calculations:

Catchment 2.1	10% AEP	= 0.43 m^3/s
Catchment 2.1	1% AEP	= 0.51 m^3/s
Catchment 2.2	10% AEP	= 0.79 m^3/s
Catchment 2.2	1% AEP	= 0.95 m^3/s
Catchment 2.3	10% AEP	= 0.93 m^3/s
Catchment 2.3	1% AEP	= 1.11 m^3/s

Catchment 2	10% AEP	= 2.14 m^3/s
Catchment 2	1% AEP	= 2.57 m^3/s

4.3 Pre-development Catchment Area – Area No.3

This catchment relates the most eastern parcel part of the proposed development area. The land is mostly undeveloped and has been cleared for agricultural purposes with tree scatter generally throughout the site. The catchment area is approx. 1.91ha total, which flow towards Eight Mile Creek.

Estimated pre-development flow calculations:

Catchment 3	10% AEP	= 0.14 m^3/s
Catchment 3	1% AEP	= 0.16 m^3/s

4.4 Pre-development Catchment Area – Area No.4

This catchment relates the north eastern part of the proposed development area. The land is mostly undeveloped and has been cleared for agricultural purposes. The catchment area is approx. 6.85ha total, which flows towards Eight Mile Creek.

Estimated pre-development flow calculations:

Catchment 4	10% AEP	= 0.40 m^3/s
Catchment 4	1% AEP	= 0.48 m^3/s

4 POST DEVELOPMENT CATCHMENT

The proposal is to develop the Williams Road Development in multiple stages. The development will provide sufficient detention capacity within the development to cater for the site. Refer to Appendix 2 for the post development catchment areas.

It is desirable that the 10% AEP storm event is conveyed by the underground stormwater system and the 1% AEP storm event is contained wholly within the Road Reserves and Drainage Reserves.

5.1 Post-development Catchment Area – Area No.1

The proposal is to pipe the design flows from the Estate into proposed sediment basins and wetlands located on the south eastern side of the site, and provide controlled outlet structure which will pipe the controlled flows towards Eight Mile Creek.

We have calculated the post development flows from post-development catchment No.1 and included them in the table below.

Sub-Catchment	Minor Flow – 10% AEP (m^3/s)	Major Flow – 1% AEP (m^3/s)
Catchment 1.1	1.86	2.24
Catchment 1.2	1.06	1.27
Catchment 1.3	0.58	0.70
Catchment 1.4*	1.96*	2.35*
Catchment 1.5	6.90	8.28
Catchment 1 Total	8.82	10.58

Table 2: Post development discharge flows

*Land not a part of application – For information purposes only

We have calculated the onsite detention required to limit the post development flows, this includes Lot 21 DP1034326 (Thurgoona Training Academy - Master Plan Flows), for the 10% AEP storm event and the 1% AEP storm event to the pre development flows and included the results in the table below. See Appendix 4 for post development discharge and detention calculations.

Sub-Catchment	10% AEP detention volume required (m^3)	1% AEP detention volume required (m^3)
Catchment 1.1	885	1062
Catchment 1.2	422	506
Catchment 1.3	104	125
Catchment 1.4*	1,298*	1,557*
Catchment 1.5	9,512	11,415

Table 3: Detention volumes required

*Land not a part of application – For information purposes only

The proposed development includes detention basins, wetlands and ponds throughout the catchment to detain flows and provide a habitat connection corridor. This will reduce the impact upon the drainage system with large events and to limit flows prior to discharging into neighbouring properties (Thurgoona Training Academy) and Eight Mile Creek.

No further external catchment enters the development in peak storm events. The proposed flood mitigations by Eslers Land Consulting (ref: 16918 Williams Road Subdivision Development – Flood Report) provides protection to the proposed lots with a fill increase over the southern section of the site for risk mitigation.

5.2 Post-development Catchment Area – Area No.2

The proposal is to pipe the design flows from the Estate into detention located on the north west section of the site, and provide controlled outlet structure.

We have calculated the post development flows from post-development catchment No.2 and included them in the table below.

Sub-Catchment	Minor Flow – 10% AEP (m^3/s)	Major Flow – 1% AEP (m^3/s)
Catchment 2.1	0.43	0.51
Catchment 2.2	1.01	1.22
Catchment 2.3	0.93	1.11
Catchment 2 Total	2.37	2.84

Table 4: Post development discharge flows

We have calculated the onsite detention required to limit the post development flows for the 10% AEP storm event and the 1% AEP storm event to the pre development flows and included the results in the table below. See Appendix 4 for post development discharge and detention calculations.

Sub-Catchment	10% AEP detention volume required (m^3)	1% AEP detention volume required (m^3)
Catchment 2.2	400	480

Table 5: Detention volumes required

The required volume can be achieved in the proposed location, with detailed design to be provided as part of the Subdivision Works Application.

5.3 Post-development Catchment Area – Area No.3

The proposal is to pipe the design flows from the Estate into detention located on the eastern parcel of the site, and provide controlled outlet structure.

We have calculated the post development flows from post-development catchment No.3 and included them in the table below.

Minor Flow – 10% AEP (m3/s)	Major Flow – 1% AEP (m3/s)
0.48	0.57

Table 6: Post development discharge flows

We have calculated the onsite detention required to limit the post development flows for the 10% AEP storm event and the 1% AEP storm event to the pre development flows and included the results in the table below. See Appendix 4 for post development discharge and detention calculations.

10% AEP detention volume required (m^3)	1% AEP detention volume required (m^3)
151	182

Table 7: Detention volumes required

The required volume can be achieved in the proposed location, with detailed design to be provided as part of the Subdivision Works Application.

5.4 Post-development Catchment Area – Area No.4

The proposal is to pipe the design flows from the Estate into detention located on the north east section of the site, and provide controlled outlet structure.

We have calculated the post development flows from post-development catchment No.4 and included them in the table below.

Minor Flow – 10% AEP (m3/s)	Major Flow – 1% AEP (m3/s)
1.26	1.51

Table 8: Post development discharge flows

We have calculated the onsite detention required to limit the post development flows for the 10% AEP storm event and the 1% AEP storm event to the pre development

flows and included the results in the table below. See Appendix 4 for post development discharge and detention calculations.

10% AEP detention volume required (m^3)	1% AEP detention volume required (m^3)
569	683

Table 9: Detention volumes required

The required volume can be achieved in the proposed location, with detailed design to be provided as part of the Subdivision Works Application.

5 DESIGN RESPONSE

6.1 Sloane's Froglet Breeding Habitat Creation

Step One

To satisfy Step 1 of the Sloane's Froglet Stormwater Wetland Design Guidelines (Spiire, 2017), a site visit was completed between AlburyCity Council, DPE-BCD, Eslers Land Consulting and Blueprint Planning on 26/5/2022, where the proposed location of the wetlands was considered to be appropriate to all parties.

Step Two

The following key habitat design principles are summarized as:

Habitat water depth	Shallow water ranging from depths of 10 to 300 mm
Habitat hydrology - length and season of inundation	Refer to Water Depth Flux below
Habitat accessibility	Batter slopes to water level are typically 10%
Habitat size	A total wetland habitat area of 22,409m^2 is required for the 74.70Ha of developable area (full master area*). A total wetland habitat area of 22,440m^2 is proposed.
Habitat vegetation	Landscaping to be in accordance with Sloane's Froglet Stormwater Wetland Design Guidelines Appendix G – Plant List

Full master area includes Lot 21 DP1034326 – land not included as part of application.

Water Depth Flux

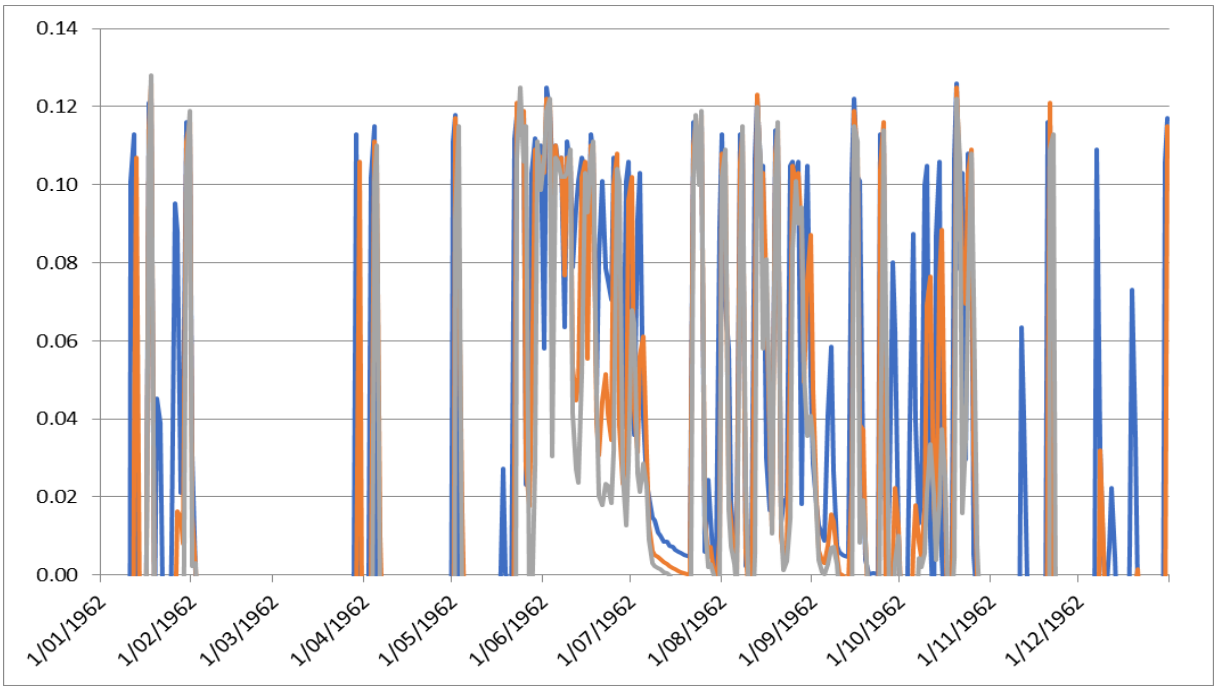

Figure 2: Wetlands EDD Levels – Wetlands Cells No.1 (Grey), 2 (Blue), 3 (Orange)

Proposed wetland cells are able to maintain the required 300mm water depth in at least one cell from mid- to late-autumn, and for at least 3 months after the winter breeding period finishes (i.e., at least until the end of October).

Each of these habitat characteristics have been considered and achieve the key habitat design principals.

Albury City Council required a connectivity corridor be added to provide a linkage east-west for Sloane's movement. A pond corridor has been added to the estate which will contain shallow depth permanent water and provide stormwater management prior to the proposed key wetland habitat.

Habitat characteristics (150mm permanent water, vegetation plantings etc) have also been added to the other stormwater management basins.

The NSW Department of Climate Change, Energy, the Environment and Water required Semi-Mountable Kerb and Gutter (sometime known as Roll Kerb and Gutter or SM2 Kerb) be incorporated on all roads in lieu of Barrier Kerb and Gutter to prevent a barrier for Sloane's movement between habitat areas.

As of 30th October 2025, NSW Department of Climate Change, Energy, the Environment and Water advised that Step 2 of the Sloane's Froglet Management Guidelines have been satisfied subject to minor amendments being included. Minor amendments have been incorporated into Version 4 of EDM Group's Stormwater Management Plan.

6.2 Major/Minor Stormwater Conveyance

The objective of providing safe overland major storm flood flow paths has been borne in mind in developing the roads and lot layouts documented in the Estate Plan.

In line with AlburyCity Council's requirements the minor stormwater system is to be designed to convey the 10% AEP peak design flows. The street network is also designed to provide cross sections of sufficient capacity to convey a 1% AEP design storm event without significant damage to property.

Preliminary storage calculations for the site are provided at Appendix 5. The proposal is to utilise an integrated system to store the 1% AEP storm event.

6.3 Water Quality Protection

Urban Stormwater: BPEMG lists five key objectives of WSUD for application to urban stormwater planning and design:

i). Protect natural systems; *protect and enhance natural waterway systems within urban developments*

ii). Integrate stormwater treatment into the landscape; *use stormwater in the landscape by incorporating multiple use corridors that maximise the visual and recreational amenity of developments*

iii). Protect water quality; *protect the water quality draining from urban development*

iv). Reduce runoff and peak flows; *reduce peak flows from urban developments by local detention measures and minimising impervious areas*

v). Add value while minimising development costs; *minimise the drainage infrastructure cost of development*

WSUD is implemented through a *treatment train* of Best Management Practices (BMP) integrated into the streetscape and landscape. Techniques include wetlands, ponds and detention basins to lower peak flows, water treatment options to facilitate water infiltration and pollutant filtration and fauna connection ways.

We have provided MUSIC modelling calculations on the development site which shows the measures proposed as part of the subdivision works meets the requirements of the AlburyCity Council Engineering Guidelines. This detail is included in Appendix 6.

6 SUMMARY AND CONLUSIONS

In conclusion, it is proposed to utilise an integrated stormwater system design to meet the stormwater requirement of AlburyCity Council for both detention and water quality treatment as well as incorporating Sloane's froglet breeding habitat requirements.

<u>Legal Points of Discharge</u>

The legal points of discharge for this development align with natural drainage paths that flow through the development.

On Site Catchment Detention Williams Road Development

- Total Williams Road Development required storage volume 16,011m^3
- Storage Volume available basins, wetlands, ponds +16,500m^3

Water Quality

Water quality measures have exceeded the minimum requirements as set out by the development consent. The proposed treatment train includes GPT's, sediment basins, ponds and detention basins / wetlands are consistent with Council requirements.

Music modelling has been relied upon to calculate the effectiveness of the proposed treatment train that includes GPT's, sediment basins, ponds and detention basins / wetlands, rainwater tanks, overland flow paths & swale drains. The results are as shown below in Table 10. (See Appendix 6 for further details).

Treatment Train Effectiveness (MUSIC)

Water Treatment Requirements	Detention Objective	Reduction
Total Suspended Solids	80%	90.8%
Total Phosphorus	45%	73.5%
Total Nitrogen	45%	46.3%
Gross Pollutant Removal	70%	100%

Table 10: MUSIC Modelling results

APPENDIX 1

Estate Plans

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OVERALL LAYOUT PLAN AND STAGING PLAN LOT 2 DP1189190 AND LOTS 301 & 302 DP1124543 WILLIAMS ROAD TABLE TOP 2640

APPROX TRUE NORTH

NOTE:
The cadastre has been laid over an aerial image f presentation purposes only.
The aerial image is intended as a visual aid only and may not be an accurate representation of ground conditions. Title survey must be undertake to accurately verify the location of any boundary shown hereon.

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Drawing No. 24123 Model
Scale 1:2500

SHEET
5 OF27

Original Sheet
A1

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APPENDIX 2

Catchment and Arrangement Plans

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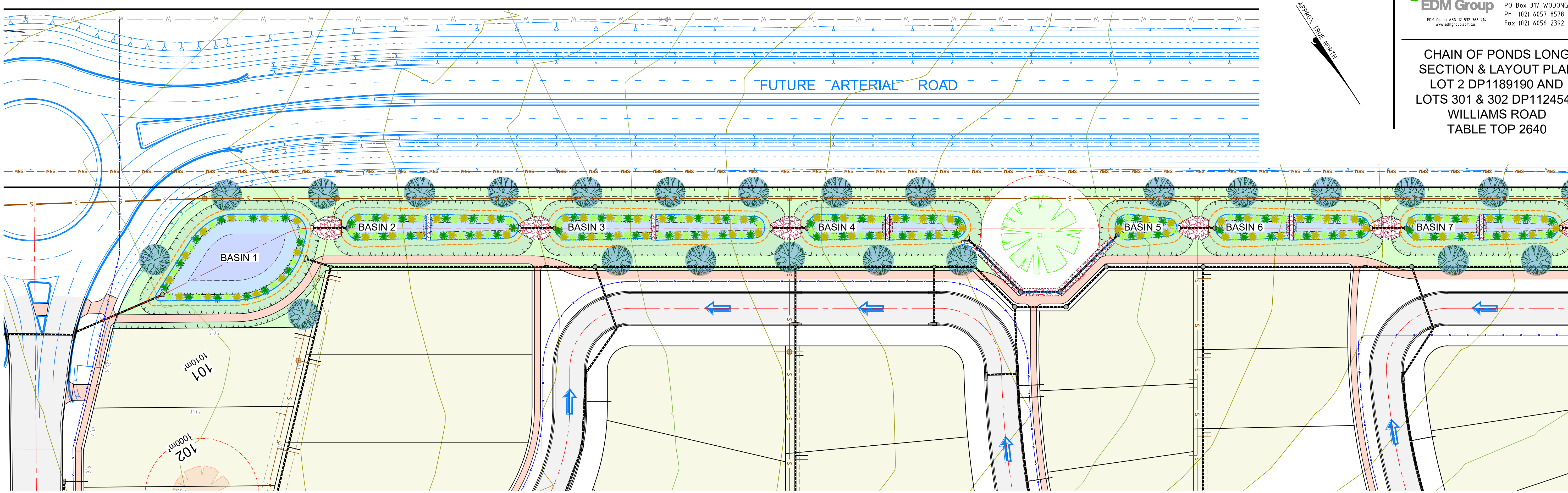
CHAIN OF PONDS LONG SECTION & LAYOUT PLAN LOT 2 DP1189190 AND LOTS 301 & 302 DP1124543 WILLIAMS ROAD TABLE TOP 2640



CHAIN OF PONDS LAYOUT

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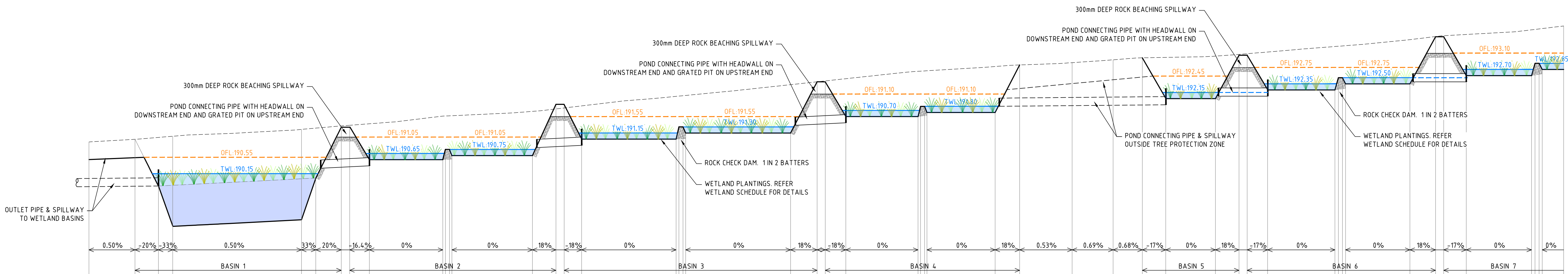

R.L. 187.300

CHAINAGE	EXISTING SURFACE	DESIGN SURFACE	CUT/FILL
0.000	190.93	190.480	-0.450
11.247	191.00	190.550	-0.450
16.950	191.04	189.850	-1.194
20.450	191.10	188.850	-1.194
51.884	191.20	189.050	-1.194
55.384	191.27	190.050	-1.220
61.600	191.32	191.293	-0.031
63.600	191.34	191.293	-0.046
68.442	191.38	190.500	-0.875
86.379	191.56	190.500	-1.061
87.000	191.57	190.750	-0.815
88.000	191.57	190.750	-0.820
88.596	191.57	190.600	-0.973
108.250	191.68	190.600	-1.079
114.000	191.74	191.850	0.120
116.000	191.76	191.850	0.090
120.250	191.81	191.000	-0.812
143.331	192.05	191.000	-1.044
144.000	192.05	191.300	-0.752
145.000	192.06	191.300	-0.761
145.649	192.07	191.150	-0.918
171.263	192.33	191.150	-1.181
177.744	192.40	192.400	-0.001
179.744	192.42	192.400	-0.022
184.744	192.48	190.550	-0.924
202.376	192.66	190.550	-1.105
203.000	192.66	191.800	-0.861
204.000	192.67	191.800	-0.867
204.566	192.67	191.650	-1.017
221.200	192.77	191.650	-1.121
227.200	192.81	192.800	-0.012
240.000	192.87	192.868	+0.000
250.000	192.94	192.937	+0.000
257.139	192.99	192.985	-0.001
262.869	193.00	192.000	-1.005
274.990	193.03	192.000	-1.036
280.740	193.07	193.050	-0.020
282.740	193.09	193.050	-0.036
287.740	193.13	192.200	-0.926
304.164	193.26	192.200	-1.060
305.000	193.27	192.500	-0.678
306.000	193.28	192.500	-0.676
306.757	193.28	192.350	-0.930
322.474	193.43	192.350	-1.077
328.724	193.51	193.500	-0.005
330.724	193.53	193.500	-0.025
336.223	193.56	192.550	-1.003
352.160	193.67	192.550	-1.117
353.000	193.68	192.850	-0.729
354.000	193.69	192.850	-0.721
354.755	193.70	192.700	-0.998
360.000	193.76	192.700	-1.061

CHAIN OF PONDS LONGITUDINAL SECTION

Ch 63.633 to Ch 360.00

SCALES: HORIZONTAL 1:500 VERTICAL 1:50

0 5 10 15 20 25m

NOTE:
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Drawing No. 24123 Model
Scale 1:500 (H) & 1:50 (V)

SHEET 12 OF 27

Original Sheet A1

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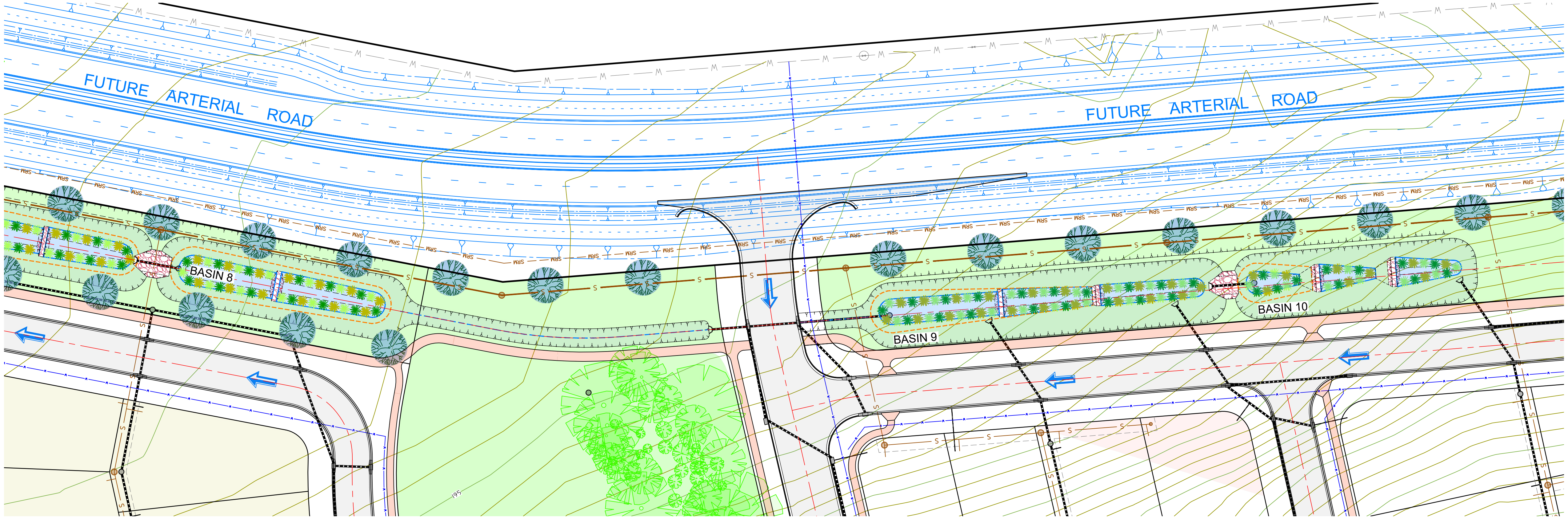
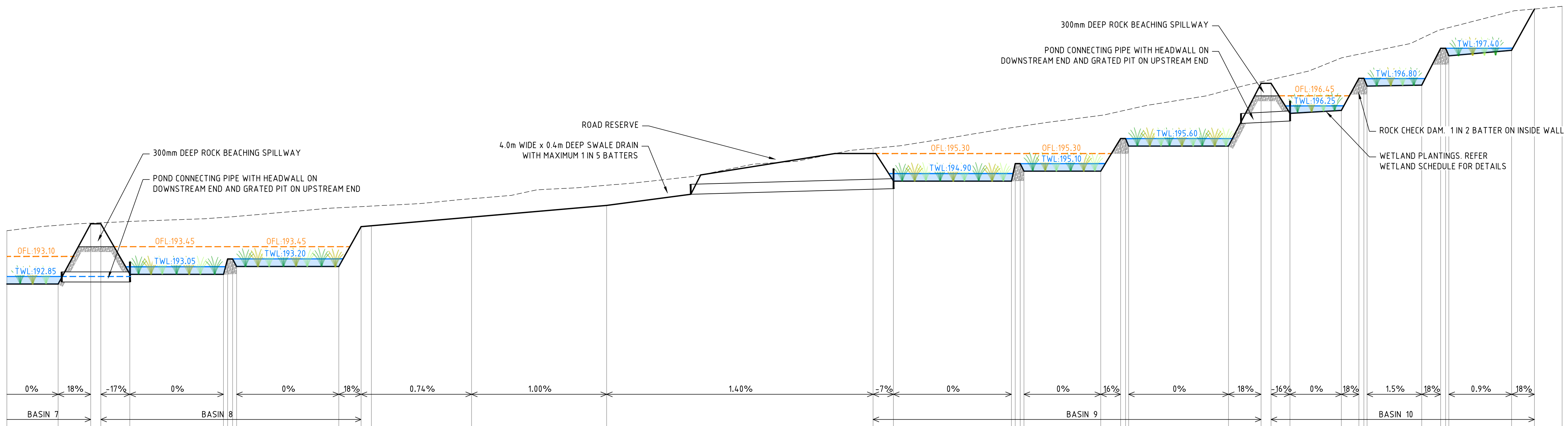
CHAIN OF PONDS LONG SECTION & LAYOUT PLAN LOT 2 DP1189190 AND LOTS 301 & 302 DP1124543 WILLIAMS ROAD TABLE TOP 2640

APPROX. TRUE NORTH



CHAIN OF PONDS LAYOUT

SCALE: 1:500



R.L. 189.500

CHAINAGE	CUT/FILL	DESIGN SURFACE	EXISTING SURFACE
360.000	-1.063	192.700	193.76
370.223	-1.171	192.700	193.87
376.724	-0.012	193.900	193.91
378.724	-0.021	193.900	193.92
384.515	-1.054	192.900	193.95
403.170	-1.134	192.900	194.03
404.000	-0.733	193.200	194.03
405.000	-0.741	193.200	194.04
405.804	-0.998	193.050	194.05
426.158	-1.170	193.050	194.22
430.619	-0.420	193.863	194.24
432.674	-0.400	193.853	194.25
452.617	-0.400	194.000	194.40
479.549	-0.400	194.268	194.67
532.667	-0.400	195.010	195.41
536.719	-0.691	194.750	195.44
560.235	-1.064	194.750	195.82
561.000	-0.727	195.100	195.83
562.000	-0.742	195.100	195.84
562.739	-0.903	194.950	195.85
578.035	-1.111	194.950	196.06
582.000	-0.544	195.600	196.14
583.000	-0.567	195.600	196.17
583.599	-0.730	195.450	196.18
603.500	-1.120	195.450	196.57
610.000	-0.030	196.700	196.73
612.000	-0.075	196.700	196.78
615.748	-0.759	196.100	196.86
626.006	-1.044	196.162	197.21
629.485	-0.481	196.800	197.28
630.485	-0.502	196.800	197.30
631.117	-0.670	196.650	197.31
642.021	-0.934	196.667	197.60
645.784	-0.369	197.400	197.77
646.784	-0.395	197.400	197.80
647.425	-0.562	197.250	197.81
659.933	-0.776	197.358	198.13
664.489	-0.003	198.178	198.18
670.000	+0.000	198.236	198.24

CHAIN OF PONDS LONGITUDINAL SECTION

Ch 360.000 to Ch 720.00

SCALES: HORIZONTAL 1:500 VERTICAL 1:50

NOTE:
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0 5 10 15 20 25m

Drawing No. 24123 Model
Scale 1:500 (H) & 1:50 (V)

SHEET 13 OF 27

Original Sheet A1

P:\2400\24123 - Diocese of Wagga Wagga - Williams Road Subdivision\Eng Design\Dwg\24123 Model.dwg

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WETLANDS LAYOUT PLAN
LOT 2 DP1189190 AND LOTS 301 & 302 DP1124543
WILLIAMS ROAD
TABLE TOP 2640

APPROX TRUE NORTH

NOTE:
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0 5 10 15 20 25m

DISTRIBUTOR ROAD

POSSIBLE FUTURE
PRIVATE SCHOOL SITE
121,065m²

(FILL)

STUB FOR SCHOOL CATCHMENT

3.0m WIDE ACCESS TRACK

GROSS POLLUTANT TRAPS

SEDIMENT DRY OUT AREA

SEDIMENT BASIN 1
NORMAL WATER LEVEL 189.3
CELL NWL AREA = 392m²
WETLAND FLOOR LEVEL 187.9

WEIR LEVEL 188.51

HEADWALL WITH ROCKED OUTLET

WETLAND - CELL 1
SHALLOW MARSH
CELL NWL AREA = 7,687m²

ROCK WALL

WETLAND - CELL 2
SHALLOW MARSH
MIN. TRACK/WALL LEVEL 188.895
(300mm FREEBOARD)
Q100 LEVEL 188.595
EXTEND DETENTION LEVEL 188.20
NORMAL WATER LEVEL 188.10
CELL NWL AREA = 7,698m²
WETLAND FLOOR LEVEL 187.80

ROCK WALL

WETLAND - CELL 3
SHALLOW MARSH
CELL NWL AREA = 7,055m²

SEDIMENT DRY OUT AREA

GROSS POLLUTANT TRAP

SEWER PUMP STATION SITE
4192m²

FUTURE ARTERIAL ROAD

Drawing No. 24123 Model
Scale 1:500

SHEET
14 OF 27

Original Sheet
A1

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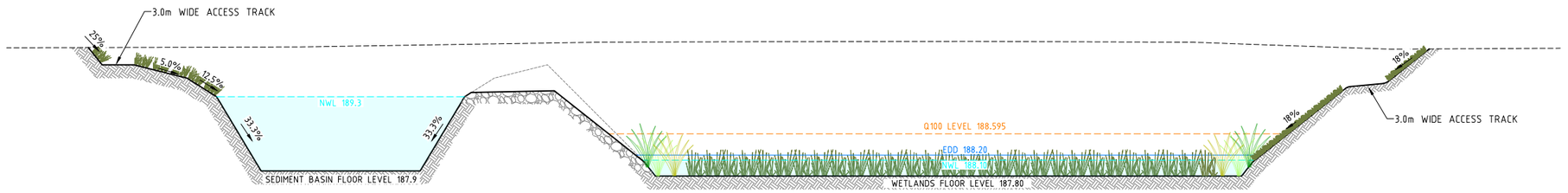
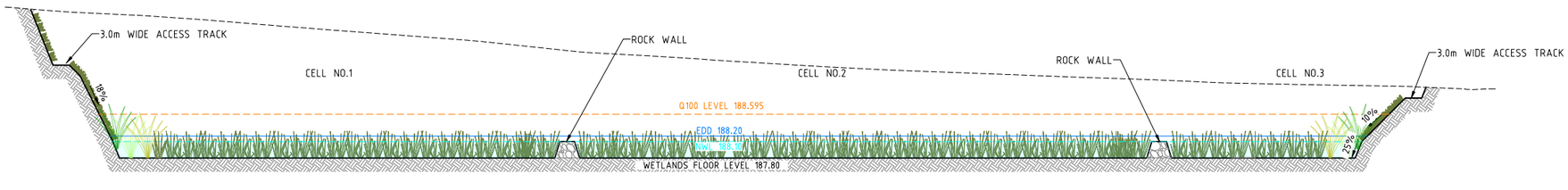
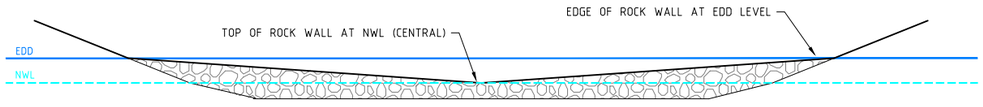


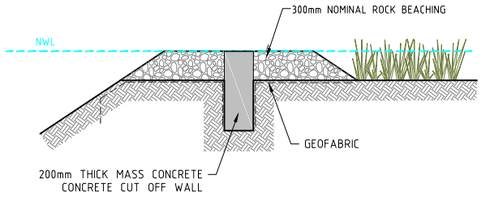
TYPICAL CROSS SECTION
SECTION A-A
SCALES: HORIZONTAL 1:250 VERTICAL 1:50



TYPICAL CROSS SECTION
SECTION B-B
SCALES: HORIZONTAL 1:500 VERTICAL 1:50



TYYPCIAL ROCK WALL ELEVATION
SCALES: NTS



TYPICAL ROCK WALL SECTION
SCALES: NTS

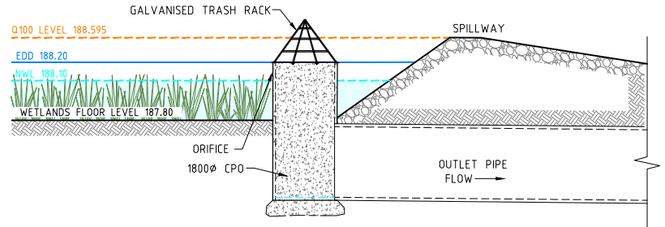
PLANT LIST

Emergent vegetation zone:
- Eleocharis acuta (common spike rush); six to eight tubes per m^2
- Potamogeton ochreatus (blunt pondweed); two per m^2
- Myriophyllum papillosum (common water-milfoil); four to six tubes per m^2

Fringing vegetation zone:
- Poa labillardieri (snow grass); four tubes per m^2
- Carex appressa (tall sedge); four tubes per m^2
- Juncus usitatus (common rush); one to two for every $1m^2$
- Cynodon dactylon (common couch); three tubes per m^2
- Paspalum distichum (water couch); two to three per m^2

Barrier shrubs zone:
- Medium Shrubs – greater than 1m high (but not shading the breeding habitat)
- Fan Grevillea – Grevillea ramosissima subsp. ramosissima
- Urn Heath – Melichrus urceolatus

Small Shrubs – less than 1m high
- Heathy Bush-pea – Pultenaea procumbens
- Crimson Grevillea – Grevillea polybractea



TYPICAL OUTLET DETAIL
WETLAND
SCALES: NTS

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WETLANDS CROSS SECTIONS
LOT 2 DP1189190 AND
LOTS 301 & 302 DP1124543
WILLIAMS ROAD
TABLE TOP 2640

NOTE:
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0 5 10 15 20 25m

Drawing No. 24123 Model
Scale 1:500 (H) & 1:50 (V)

SHEET
15 OF 27

Original Sheet
A1

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PRE DEVELOPMENT CATCHMENT PLAN
LOT 2 DP1189190 AND LOTS 301 & 302 DP1124543
WILLIAMS ROAD
TABLE TOP 2640

PRE CATCHMENT No2.1
PRE CATCHMENT No2.2
PRE CATCHMENT No1.1
PRE CATCHMENT No1.2
PRE CATCHMENT No1.3
PRE CATCHMENT No1.4
PRE CATCHMENT No1.5
PRE CATCHMENT No2.3
PRE CATCHMENT No4
PRE CATCHMENT No3
EX.BUILDINGS
ARTERIAL ROAD
FUTURE ARTERIAL ROAD
WIGNELL ROAD
WILLIAMS ROAD
SEVEN MILE CREEK
EIGHT MILE CREEK
TABLE TOP ROAD
CAMBRIDGE DRIVE
OXFORD DRIVE
SRM

APPROX. TRUE NORTH

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0 25 50 75 100 125m

Drawing No. 24123_DA03_4Mar25
Scale 1:2500

SHEET
21 OF 27

Original Sheet
A1

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POST DEVELOPMENT CATCHMENT PLAN
LOT 2 DP1189190 AND LOTS 301 & 302 DP1124543
WILLIAMS ROAD
TABLE TOP 2640

POST CATCHMENT No2.1
POST CATCHMENT No2.2
POST CATCHMENT No1.1
POST CATCHMENT No1.2
POST CATCHMENT No1.3
POST CATCHMENT No4
POST CATCHMENT No2.3
POST CATCHMENT No1.4
POST CATCHMENT No1.5
POST CATCHMENT No3

DETENTION BASIN 2.0
480m³ STORAGE REQUIRED

DETENTION BASIN 1.1
1062m³ STORAGE REQUIRED

DETENTION BASIN 1.2
506m³ STORAGE REQUIRED

DETENTION BASIN 4.0
683m³ STORAGE REQUIRED

MODIFIED DAM 1.3
125m³ STORAGE REQUIRED

DETENTION BASIN 3.0
182m³ STORAGE REQUIRED

WETLANDS 1.5
11,415m³ STORAGE REQUIRED

EX.BUILDINGS

WIGNELL ROAD
FUTURE ARTERIAL ROAD
WILLIAMS ROAD
SEVEN MILE CREEK
FUTURE ARTERIAL ROAD
EIGHT MILE CREEK
TABLE TOP ROAD
CAMBRIDGE DRIVE
OXFORD DRIVE

SRM

APPROX TRUE NORTH

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0 25 50 75 100 125m

Drawing No. 24123_DA03_4Mar25
Scale 1:2500

SHEET
22 OF 27

Original Sheet
A1

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MASTER POST DEVELOPMENT CATCHMENT PLAN
LOT 2 DP1189190 AND LOTS 301 & 302 DP1124543
WILLIAMS ROAD
TABLE TOP 2640

POST CATCHMENT No2.1
POST CATCHMENT No2.2
POST CATCHMENT No1.1
POST CATCHMENT No1.2
POST CATCHMENT No1.3
POST CATCHMENT No4
POST CATCHMENT No2.3
POST CATCHMENT No1.5
POST CATCHMENT No3

DETENTION BASIN 2.0
480m³ STORAGE REQUIRED

DETENTION BASIN 1.1
1062m³ STORAGE REQUIRED

DETENTION BASIN 1.2
506m³ STORAGE REQUIRED

DETENTION BASIN 4.0
683m³ STORAGE REQUIRED

DETENTION BASIN 3.0
182m³ STORAGE REQUIRED

MODIFIED DAM 1.3
125m³ STORAGE REQUIRED

WETLANDS 1.5
11,415m³ STORAGE REQUIRED

MASTER CATCHMENT No1.4*
SUBJECT TO DA APPLICATION

EX.BUILDINGS

ARTERIAL ROAD
FUTURE ARTERIAL ROAD
WIGNELL ROAD
WILLIAMS ROAD
TABLE TOP ROAD
CAMBRIDGE DRIVE
OXFORD DRIVE
SEVEN MILE CREEK
EIGHT MILE CREEK
SRM

APPROX TRUE NORTH

NOTE:
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0 25 50 75 100 125m

Drawing No. 24123_DA03_4Mar25
Scale 1:2500
SHEET 23 OF 27

Original Sheet A1

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APPENDIX 3

Pre-Development Catchment Data Sheet

Project Number:	24123	Project Title: Williams Road Staged Residential Development

Location	Thurgoona
Latitude	-36.015
Longitude	147.003

Annual Exceedance Probability (AEP)

Duration	Duration in min	63.2%	50%	20%	10%	5%	2%	1%
1 min	1	102	115	157	185	213	251	280
2 min	2	86.7	97.5	132	156	178	207	228
3 min	3	78.6	88.4	120	141	162	188	208
4 min	4	72.5	81.6	110	130	149	174	193
5 min	5	67.5	76	103	121	139	163	181
10 min	10	51	57.5	78.1	92.3	106	126	141
15 min	15	41.6	46.9	63.8	75.5	87.2	103	116
20 min	20	35.4	39.9	54.3	64.3	74.2	87.8	98.4
25 min	25	31	34.9	47.5	56.2	64.9	76.7	86
30 min	30	27.7	31.2	42.4	50.1	57.8	68.3	76.5
45 min	45	21.2	23.9	32.3	38.2	44	51.8	57.9
1 hour	60	17.4	19.6	26.4	31.2	35.9	42.1	46.9
1.5 hour	90	13.2	14.7	19.7	23.2	26.6	31.1	34.5
2 hour	120	10.7	12	16	18.7	21.4	24.9	27.7
3 hour	180	8.05	8.96	11.8	13.8	15.7	18.3	20.2
4.5 hour	270	6.05	6.71	8.79	10.2	11.6	13.4	14.9
6 hour	360	4.95	5.48	7.14	8.26	9.38	10.9	12
9 hour	540	3.74	4.13	5.35	6.17	6.99	8.11	8.98
12 hour	720	3.07	3.39	4.37	5.04	5.71	6.64	7.36
18 hour	1080	2.32	2.56	3.31	3.82	4.32	5.04	5.6
24 hour	1440	1.9	2.1	2.72	3.14	3.55	4.16	4.64
30 hour	1800	1.62	1.8	2.33	2.7	3.05	3.58	4
36 hour	2160	1.43	1.58	2.05	2.38	2.69	3.17	3.55
48 hour	2880	1.16	1.28	1.68	1.95	2.21	2.6	2.92
72 hour	4320	0.85	0.944	1.24	1.44	1.64	1.94	2.19
96 hour	5760	0.676	0.752	0.989	1.15	1.3	1.55	1.75
120 hour	7200	0.563	0.626	0.82	0.949	1.08	1.28	1.44
144 hour	8640	0.483	0.536	0.697	0.803	0.911	1.08	1.22
168 hour	10080	0.423	0.468	0.604	0.69	0.783	0.929	1.05

Project Number: 24123 **Project Title: Williams Road Staged Residential Development**

ENGINEERING DEVELOPMENT STANDARDS PART 3 – STORMWATER DRAINAGE DESIGN
4.14 FRACTION IMPERVIOUS
Typical fractions for impervious areas are:

Land	Type	f
Park/Open Space	1	0.00
Residential Area	2	0.42
Road and Reserve	3	0.85

BOM Design Rainfall Data System
Rainfall Data and Coordinates

Location	**Thurgoona**
Latitude	-36.015
Longitude	147.003

Catchment - 10% AEP

Pre Development Flow

CATCHMENT ID	Area(m2)	Area Description	Type	f	$C_{10\%}$	Fy	Area (Ha)	Tc (min)	Total Time (min)	I(mm/h)	$Q_{1\%}$(m3/s)	Cumulative $Q_{1\%}$(m3/s)	Notes
1.1	113062	OPEN SPACE	1	0	0.18	1.00	11.31	19.9	20	98.40	0.56	-	
1.2	68280	OPEN SPACE	1	0	0.18	1.00	6.83	16.4	17	116.00	0.40	-	
1.3	68937	OPEN SPACE	1	0	0.18	1.00	6.89	16.5	17	116.00	0.41	-	
1.4	117493	OPEN SPACE	1	0	0.18	1.00	11.75	20.2	21	98.40	0.59	1.15	Pre1.4 + Pre1.1
1.5	437509	OPEN SPACE	1	0	0.18	1.00	43.75	33.3	34	76.50	1.70	3.65	Pre1.5 + Pre1.4 + Pre1.3 + Pre1.2 + Pre1.1
2.1	72621	OPEN SPACE	1	0	0.18	1.00	7.26	16.8	17	116.00	0.43	-	
2.2	157914	OPEN SPACE	1	0	0.18	1.00	15.79	22.6	23	98.40	0.79	1.21	Pre2.2 + Pre2.1
2.3	212444	OPEN SPACE	1	0	0.18	1.00	21.24	25.3	26	86.00	0.93	2.14	Pre2.3 + Pre2.2 + Pre2.1
3	19070	OPEN SPACE	1	0	0.18	1.00	1.91	10.1	11	141.00	0.14	-	
4	68493	OPEN SPACE	1	0	0.18	1.00	6.85	16.5	17	116.00	0.40	-	
											6.33		

Project Number: 24123 **Project Title: Williams Road Staged Residential Development**

ENGINEERING DEVELOPMENT STANDARDS PART 3 – STORMWATER DRAINAGE DESIGN
4.14 FRACTION IMPERVIOUS
Typical fractions for impervious areas are:

Land	Type	f
Park/Open Space	1	0.00
Residential Area	2	0.42
Road and Reserve	3	0.85

BOM Design Rainfall Data System
Rainfall Data and Coordinates

Location	**Thurgoona**
Latitude	-36.015
Longitude	147.003

Catchment - 1% AEP

Pre Development Flow

CATCHMENT ID	Area(m2)	Area Description	Type	f	$C_{10\%}$	Fy	Area (Ha)	Tc (min)	Total Time (min)	I(mm/h)	$Q_{1\%}$(m3/s)	Cumulative $Q_{1\%}$(m3/s)	Notes
1.1	113062	OPEN SPACE	1	0	0.18	1.20	11.31	19.9	20	98.40	0.68	-	
1.2	68280	OPEN SPACE	1	0	0.18	1.20	6.83	16.4	17	116.00	0.48	-	
1.3	68937	OPEN SPACE	1	0	0.18	1.20	6.89	16.5	17	116.00	0.49	-	
1.4	117493	OPEN SPACE	1	0	0.18	1.20	11.75	20.2	21	98.40	0.70	1.38	Pre1.4 + Pre1.1
1.5	437509	OPEN SPACE	1	0	0.18	1.20	43.75	33.3	34	76.50	2.04	4.38	Pre1.5 + Pre1.4 + Pre1.3 + Pre1.2 + Pre1.1
2.1	72621	OPEN SPACE	1	0	0.18	1.20	7.26	16.8	17	116.00	0.51	-	
2.2	157914	OPEN SPACE	1	0	0.18	1.20	15.79	22.6	23	98.40	0.95	1.46	Pre2.2 + Pre2.1
2.3	212444	OPEN SPACE	1	0	0.18	1.20	21.24	25.3	26	86.00	1.11	2.57	Pre2.3 + Pre2.2 + Pre2.1
3	19070	OPEN SPACE	1	0	0.18	1.20	1.91	10.1	11	141.00	0.16	-	
4	68493	OPEN SPACE	1	0	0.18	1.20	6.85	16.5	17	116.00	0.48	-	
											7.60		

APPENDIX 4

Post-Development Catchment Data Sheet

Project Number: 24123 **Project Title: Williams Road Staged Residential Development**

ENGINEERING DEVELOPMENT STANDARDS PART 3 – STORMWATER DRAINAGE DESIGN
4.14 FRACTION IMPERVIOUS
Typical fractions for impervious areas are:

Land	Type	f
Park/Open Space	1	0.00
Residential Area	2	0.42
Road and Reserve	3	0.85

BOM Design Rainfall Data System
Rainfall Data and Coordinates

Location	Thurgoona
Latitude	-36.015
Longitude	147.003

Catchment - 10% AEP

Post Development Flow

CATCHMENT ID	Area(m2)	Area Description	Type	f	$C_{10\%}$	Fy	Area (Ha)	Tc (min)	Total Time (min)	I(mm/h)	C_1xA	ΣCA	$Q_{1\%}$(m3/s)	Cumulative $Q_{1\%}$(m3/s)	Notes
1.1	20209	ROAD	3	0.85	0.95		2.02	10.4			1.91				
1.1	36676	RESIDENTIAL	2	0.42	0.56	1.0	3.67	13.0	14	141.00	2.05	4.76	1.86	-	
1.1	43800	OPEN	1	0	0.18		4.38	13.9			0.80				
1.2	13037	ROAD	3	0.85	0.95		1.30	8.8			1.23				
1.2	25085	RESIDENTIAL	2	0.42	0.56	1.0	2.51	11.2	12	141.00	1.40	2.70	1.06	-	
1.2	3568	OPEN	1	0	0.18		0.36	5.4			0.07				
1.3	4193	ROAD	3	0.85	0.95		0.42	5.7			0.40				
1.3	19356	RESIDENTIAL	2	0.42	0.56	1.0	1.94	10.2	11	141.00	1.08	1.48	0.58	-	
1.3	0	OPEN	1	0	0.18		0.00	0.0			0.00				
1.4	0	ROAD	3	0.85	0.95		0.00	0.0			0.00				
1.4	0	RESIDENTIAL	2	0.42	0.56	1.0	0.00	0.0	20	98.40	0.00	2.02	0.55	1.12	Post1.4 + Pre1.1
1.4	110603	OPEN	1	0	0.18		11.06	19.8			2.02				
1.5	117519	ROAD	3	0.85	0.95		11.75	20.2			11.11				
1.5	355759	RESIDENTIAL	2	0.42	0.56	1.0	35.58	30.8	31	76.50	19.90	32.45	6.90	8.82	Pre1.1 + Pre1.2 + Pre1.3 + Post1.4 + Post1.5 + Post1.6
1.5	78942	OPEN	1	0	0.18		7.89	17.4			1.44				
2.2	6973	ROAD	3	0.85	0.95		0.70	6.9			0.66				
2.2	6827	RESIDENTIAL	2	0.42	0.56	1.0	0.68	6.9	22	98.40	0.38	3.71	1.01	2.37	Pre2.3 + Post2.2 + Pre2.1
2.2	146451	OPEN	1	0	0.18		14.65	22.0			2.67				

Project Number: 24123 **Project Title: Williams Road Staged Residential Development**

ENGINEERING DEVELOPMENT STANDARDS PART 3 – STORMWATER DRAINAGE DESIGN
4.14 FRACTION IMPERVIOUS
Typical fractions for impervious areas are:

Land	Type	f
Park/Open Space	1	0.00
Residential Area	2	0.42
Road and Reserve	3	0.85

BOM Design Rainfall Data System
Rainfall Data and Coordinates

Location	**Thurgoona**
Latitude	-36.015
Longitude	147.003

3	2666	ROAD	**3**	**0.85**	**0.95**		**0.27**	**4.8**			**0.25**				
3	10433	RESIDENTIAL	**2**	**0.42**	**0.56**	**1.0**	**1.04**	**8.1**	**9**	**181.00**	**0.58**	**0.94**	**0.48**		
3	5985	OPEN	**1**	**0**	**0.18**		**0.60**	**6.5**			**0.11**				
4	11755	ROAD	**3**	**0.85**	**0.95**		**1.18**	**8.4**			**1.11**				
4	31949	RESIDENTIAL	**2**	**0.42**	**0.56**	**1.0**	**3.19**	**12.3**	**13**	**141.00**	**1.79**	**3.21**	**1.26**		
4	16972	OPEN	**1**	**0**	**0.18**		**1.70**	**9.7**			**0.31**				
													13.70		

Project Number: 24123 **Project Title: Williams Road Staged Residential Development**

ENGINEERING DEVELOPMENT STANDARDS PART 3 – STORMWATER DRAINAGE DESIGN
4.14 FRACTION IMPERVIOUS
Typical fractions for impervious areas are:

Land	Type	f
Park/Open Space	1	0.00
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Road and Reserve	3	0.85

BOM Design Rainfall Data System
Rainfall Data and Coordinates

Location	**Thurgoona**
Latitude	-36.015
Longitude	147.003

Catchment - 10% AEP
Master Planned Flows

CATCHMENT ID	Area(m2)	Area Description	Type	f	$C_{10\%}$	Fy	Area (Ha)	Tc (min)	Total Time (min)	I(mm/h)	C_1xA	ΣCA	$Q_{1\%}$(m3/s)	Cumulative $Q_{1\%}$(m3/s)	Notes
1.4	21439	ROAD	3	0.85	0.95		2.14	10.6			2.03				
1.4	63077	RESIDENTIAL	2	0.42	0.56	1.0	6.31	16.0	16	116.00	3.53	6.07	1.96	2.52	MPF1.4 + Pre1.1
1.4	28467	OPEN	1	0	0.18		2.85	11.8			0.52				
													1.96		

Project Number: 24123 **Project Title: Williams Road Staged Residential Development**

ENGINEERING DEVELOPMENT STANDARDS PART 3 – STORMWATER DRAINAGE DESIGN
4.14 FRACTION IMPERVIOUS
Typical fractions for impervious areas are:

Land	Type	f
Park/Open Space	1	0.00
Residential Area	2	0.42
Road and Reserve	3	0.85

BOM Design Rainfall Data System
Rainfall Data and Coordinates

Location	Thurgoona
Latitude	-36.015
Longitude	147.003

Catchment - 1% AEP

Post Development Flow

CATCHMENT ID	Area(m2)	Area Description	Type	f	$C_{10\%}$	Fy	Area (Ha)	Tc (min)	Total Time (min)	I(mm/h)	C_1xA	ΣCA	$Q_{1\%}$(m3/s)	Cumulative $Q_{1\%}$(m3/s)	Notes
1.1	20209	ROAD	3	0.85	0.95		2.02	10.4			2.29				
1.1	36676	RESIDENTIAL	2	0.42	0.56	1.2	3.67	13.0	14	141.00	2.46	5.71	2.24	-	
1.1	43800	OPEN	1	0	0.18		4.38	13.9			0.96				
1.2	13037	ROAD	3	0.85	0.95		1.30	8.8			1.48				
1.2	25085	RESIDENTIAL	2	0.42	0.56	1.2	2.51	11.2	12	141.00	1.68	3.24	1.27	-	
1.2	3568	OPEN	1	0	0.18		0.36	5.4			0.08				
1.3	4193	ROAD	3	0.85	0.95		0.42	5.7			0.48				
1.3	19356	RESIDENTIAL	2	0.42	0.56	1.2	1.94	10.2	11	141.00	1.30	1.78	0.70	-	
1.3	0	OPEN	1	0	0.18		0.00	0.0			0.00				
1.4	0	ROAD	3	0.85	0.95		0.00	0.0			0.00				
1.4	0	RESIDENTIAL	2	0.42	0.56	1.2	0.00	0.0	20	98.40	0.00	2.42	0.66	1.34	Post1.4 + Pre1.1
1.4	110603	OPEN	1	0	0.18		11.06	19.8			2.42				
1.5	117519	ROAD	3	0.85	0.95		11.75	20.2			13.33				
1.5	355759	RESIDENTIAL	2	0.42	0.56	1.2	35.58	30.8	31	76.50	23.88	38.94	8.28	10.58	Pre1.1 + Pre1.2 + Pre1.3 + Post1.4 + Post1.5
1.5	78942	OPEN	1	0	0.18		7.89	17.4			1.73				
2.2	6973	ROAD	3	0.85	0.95		0.70	6.9			0.79				
2.2	6827	RESIDENTIAL	2	0.42	0.56	1.2	0.68	6.9	22	98.40	0.46	4.46	1.22	2.84	Pre2.3 + Post2.2 + Pre2.1
2.2	146451	OPEN	1	0	0.18		14.65	22.0			3.21				

Project Number: 24123 **Project Title: Williams Road Staged Residential Development**

ENGINEERING DEVELOPMENT STANDARDS PART 3 – STORMWATER DRAINAGE DESIGN
4.14 FRACTION IMPERVIOUS
Typical fractions for impervious areas are:

Land	Type	f
Park/Open Space	1	0.00
Residential Area	2	0.42
Road and Reserve	3	0.85

BOM Design Rainfall Data System
Rainfall Data and Coordinates

Location	**Thurgoona**
Latitude	-36.015
Longitude	147.003

3	2666	ROAD	**3**	**0.85**	**0.95**		**0.27**	**4.8**			**0.30**				
3	10433	RESIDENTIAL	**2**	**0.42**	**0.56**	**1.2**	**1.04**	**8.1**	**9**	**181.00**	**0.70**	**1.13**	**0.57**		
3	5985	OPEN	**1**	**0**	**0.18**		**0.60**	**6.5**			**0.13**				
4	11755	ROAD	**3**	**0.85**	**0.95**		**1.18**	**8.4**			**1.33**				
4	31949	RESIDENTIAL	**2**	**0.42**	**0.56**	**1.2**	**3.19**	**12.3**	**13**	**141.00**	**2.14**	**3.85**	**1.51**		
4	16972	OPEN	**1**	**0**	**0.18**		**1.70**	**9.7**			**0.37**				
													16.44		

Project Number: 24123 **Project Title: Williams Road Staged Residential Development**

ENGINEERING DEVELOPMENT STANDARDS PART 3 – STORMWATER DRAINAGE DESIGN
4.14 FRACTION IMPERVIOUS
Typical fractions for impervious areas are:

Land	Type	f
Park/Open Space	1	0.00
Residential Area	2	0.42
Road and Reserve	3	0.85

BOM Design Rainfall Data System
Rainfall Data and Coordinates

Location	**Thurgoona**
Latitude	-36.015
Longitude	147.003

Catchment - 1% AEP
Master Planned Flows

CATCHMENT ID	Area(m2)	Area Description	Type	f	$C_{10\%}$	Fy	Area (Ha)	Tc (min)	Total Time (min)	I(mm/h)	C_1xA	ΣCA	$Q_{1\%}$(m3/s)	Cumulative $Q_{1\%}$(m3/s)	Notes
1.4	21439	ROAD	3	0.85	0.95		2.14	10.6			2.43				
1.4	63077	RESIDENTIAL	2	0.42	0.56	1.2	6.31	16.0	16	116.00	4.23	7.29	2.35	3.03	MPF1.4 + Pre1.1
1.4	28467	OPEN	1	0	0.18		2.85	11.8			0.62				
													2.35		

APPENDIX 5

Storage Volumes

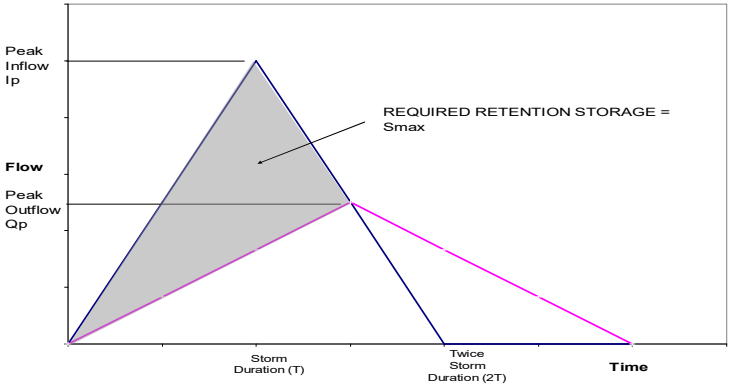
Project Number: 24123 **Project Title: Williams Road Staged Residential Development**

ENGINEERING DEVELOPMENT STANDARDS PART 3 – STORMWATER DRAINAGE DESIGN
4.14 FRACTION IMPERVIOUS
Typical fractions for impervious areas are:

Land	Type	f
Park/Open Space	1	0.00
Residential Area	2	0.42
Road and Reserve	3	0.85

BOM Design Rainfall Data System
Rainfall Data and Coordinates

Location	**Thurgoona**
Latitude	-36.015
Longitude	147.003



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

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

Catchment - 10% AEP
Storage

CATCHMENT ID	Area(m2)	Runoff Coefficient	ΣCA	Outflow Requirement - Pre $Q_{1\%}$(m3/s)	Critical Storm Duration (mins)	I(mm/h)	Ip (m^3/s)	V_1 (m^3)	Critical Storage S_{max} (m^3)	Notes
1.1	100685	0.47	4.76	0.56	20	98.40	1.3	1562	885	Detention Basin
1.2	41690	0.65	2.70	0.40	15	116.00	0.9	783	422	Detention Basin
1.3	23549	0.63	1.48	0.41	10	141.00	0.6	348	104	Existing Dam with Controlled Outlet
1.4 (MPF)	112983	0.54	6.07	0.59	25	86.00	1.5	530	1298	Not Part of Application - Information Purposes Only
1.5	552220	0.59	32.45	1.70	45	57.90	5.2	14092	9512	Wetlands
2.2	160251	0.23	4.46	0.43	10	141.00	1.5	873	400	Detention Basin
3	19084	0.50	1.13	0.14	15	116.00	0.3	274.02	151	Detention Basin
4	60676	0.53	3.85	0.40	20	98.40	0.9	1052	569	Detention Basin
									13342	

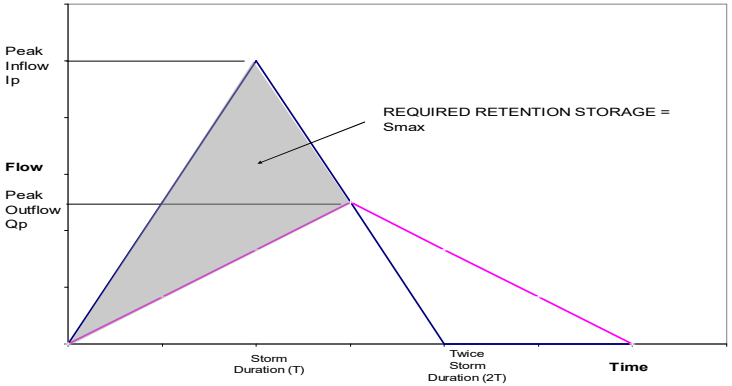
Project Number: 24123 **Project Title: Williams Road Staged Residential Development**

ENGINEERING DEVELOPMENT STANDARDS PART 3 – STORMWATER DRAINAGE DESIGN
4.14 FRACTION IMPERVIOUS
Typical fractions for impervious areas are:

Land	Type	f
Park/Open Space	1	0.00
Residential Area	2	0.42
Road and Reserve	3	0.85

BOM Design Rainfall Data System
Rainfall Data and Coordinates

Location	**Thurgoona**
Latitude	-36.015
Longitude	147.003



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

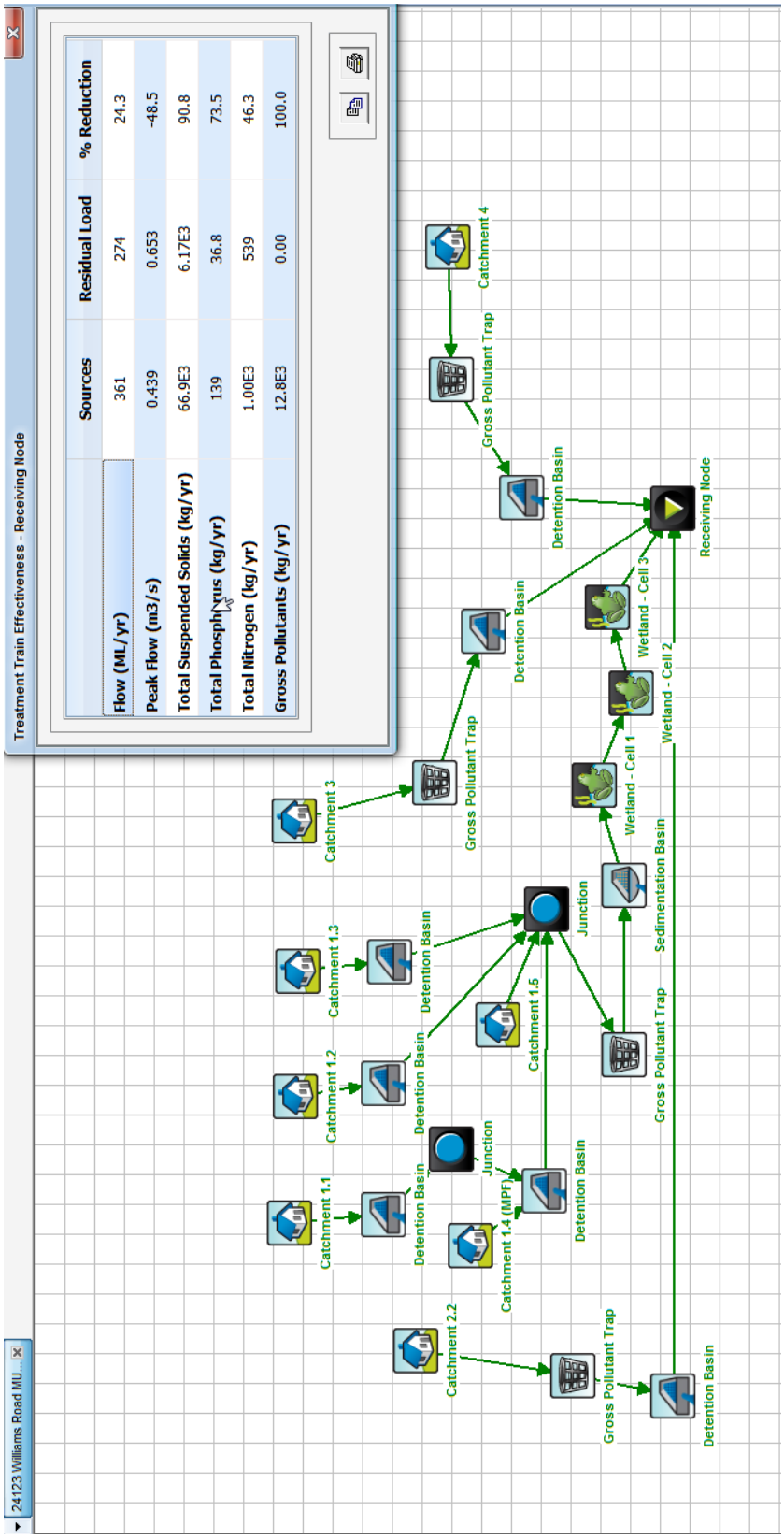
S_{max} = Maximum Volume of temporary Storage (m^3)
V_1 = Volume of inflow flood (m^3)
I_p = Peak discharge of inflow hydrograph (m^3/s)
Q_p = Peak discharge of outflow hydrograph (m^3/s)

Catchment - 1% AEP
Storage

CATCHMENT ID	Area(m2)	Runoff Coefficient	ΣCA	Outflow Requirement - Pre $Q_{1\%}$(m3/s)	Critical Storm Duration (mins)	I(mm/h)	Ip (m^3/s)	V_1 (m^3)	Critical Storage S_{max} (m^3)	Notes
1.1	100685	0.57	5.71	0.68	20	98.40	1.6	1874	1062	Detention Basin
1.2	41690	0.78	3.24	0.48	15	116.00	1.0	940	506	Detention Basin
1.3	23549	0.75	1.78	0.49	10	141.00	0.7	417	125	Existing Dam with Controlled Outlet
1.4 (MPF)	112983	0.65	7.29	0.70	25	86.00	1.7	636	1557	Not Part of Application - Information Purposes Only
1.5	552220	0.71	38.94	2.04	45	57.90	6.3	16911	11415	Wetlands
2.2	160251	0.28	4.46	0.51	10	141.00	1.7	1047	480	Detention Basin
3	19084	0.59	1.13	0.16	15	116.00	0.4	328.82	182	Detention Basin
4	60676	0.63	3.85	0.48	20	98.40	1.1	1263	683	Detention Basin
									16011	

APPENDIX 7

MUSIC Model


Treatment Train Effectiveness - Receiving Node
24123 Williams Road MU...
Sources
Residual Load
% Reduction
Flow (ML/yr) 361 274 24.3
Peak Flow (m3/s) 0.439 0.653 -48.5
Total Suspended Solids (kg/yr) 66.9E3 6.17E3 90.8
Total Phosphorus (kg/yr) 139 36.8 73.5
Total Nitrogen (kg/yr) 1.00E3 539 46.3
Gross Pollutants (kg/yr) 12.8E3 0.00 100.0
Catchment 1.1
Catchment 1.2
Catchment 1.3
Catchment 1.4 (MPF)
Catchment 1.5
Catchment 2.2
Catchment 3
Catchment 4
Detention Basin
Detention Basin
Detention Basin
Detention Basin
Detention Basin
Detention Basin
Junction
Junction
Gross Pollutant Trap
Gross Pollutant Trap
Gross Pollutant Trap
Gross Pollutant Trap
Sedimentation Basin
Wetland - Cell 1
Wetland - Cell 2
Wetland - Cell 3
Receiving Node