ADW JOHNSON PTY LIMITED
ABN 62 129 445 398

Sydney
Level 35 One International Towers
100 Barangaroo Avenue
Sydney NSW 2000
02 8046 7411
sydney@adwjohnson.com.au

Central Coast
5 Pioneer Avenue
Tuggerah NSW 2259
02 4305 4300
coast@adwjohnson.com.au

Hunter Region
7/335 Hillsborough Road,
Warners Bay NSW 2282
02 4978 5100
hunter@adwjohnson.com.au

Engineering

Working Beyond Expectations

Stormwater Management Report

Rezoning for 65 & 80-120 Pacific Highway Doyalson (Doyalson Wyee RSL Club) Stormwater Management Report

Property:
Pacific Highway, Doyalson

Applicant:
Doyalson Wyee RSL Club

Date:
March 2019

Document Control Sheet

Issue No.	Amendment	Date	Prepared By	Checked By
A	Preliminary Issue	December 2018	JB	ML
B	Client Comments	11th December 2018	JB	ML
C	Final	18th December 2018	JB	ML
D	Council Comments	12th March 2019	JB	ML
E	Council Comments	2nd May 2019	JB	ML
F	Masterplan Changes	25th June 2019	JB	ML
G	Urbis Comments	27th June 2019	JB	ML

Executive Summary

ADW Johnson has been engaged by Urbis to complete a Stormwater Management Report for the rezoning of current RE2 and RU6 zoned land adjacent to the existing Doyalson RSL on the Pacific Highway. The request for rezoning comes as a result of the proposed relocation of the existing RSL and associated development of five (5) different precincts of which include accommodation, food stores, a medical centre, childcare, a seniors living and residential development and more.

The strategy requires the assessment of the potential impacts on water quality, quantity, effects to downstream wetlands and assessment of flooding for local overland flows and accessibility during flood events.

The object of this report is to take a holistic approach to the treatment of stormwater runoff from any residential development for both quality and quantity purposes.

The methodology employed was to treat all stormwater within the limits of the development in order to maintain receiving waters in their current state. Due to only an indicative masterplan being available, catchments and their associated parameters were decided upon based on similar land usage types.

Modelling indicated that stormwater detention basins will be required to attenuate storm flows to pre-development conditions. The detention basins were sized to give indicative volumes of stormwater to be detained. The proposed location and footprint for these basins has also been identified based on the requirements but may be subject to change in the Development Application stage.

An analysis of the Central Coast Council Wyong Shire flood map showed no potential risk of flooding to the development given the RL's of the existing and potential future site. An analysis of the NSW Department of Planning and Environment – Coastal Management map showed the development poses no impact on coastal wetlands in the nearby area as it does not drain directly towards these areas.

The stormwater quality model utilised a treatment train approach which included rainwater tanks, biofiltration swales, gross pollutant traps and constructed quality treatment ponds. The results of the modelling indicated the reduction in pollutant loads and peak discharge entering receiving waters meet their target objectives.

The study has concluded that with appropriate controls stormwater can be adequately managed for the site. Hence, stormwater management does not prevent the rezoning of the site.

Table of Contents

1.0 Introduction

ADW Johnson has been engaged by Urbis to complete a Stormwater Management Report for the rezoning of current RE2 and RU6 zoned land adjacent to the existing Doyalson RSL on the Pacific Highway. The request for rezoning comes as a result of the proposed relocation of the existing RSL and associated development of five (5) different precincts of which include accommodation, food stores, a medical centre, childcare, a seniors living and residential development and other associated buildings. The full extent of the development can be seen in the attached masterplan Exhibit 001.

The site location is shown below in Figure 1 and can be identified generally as various properties along the Pacific Highway, Doyalson, situated to the north of the existing RSL and within the current area of the Raw Challenge course.

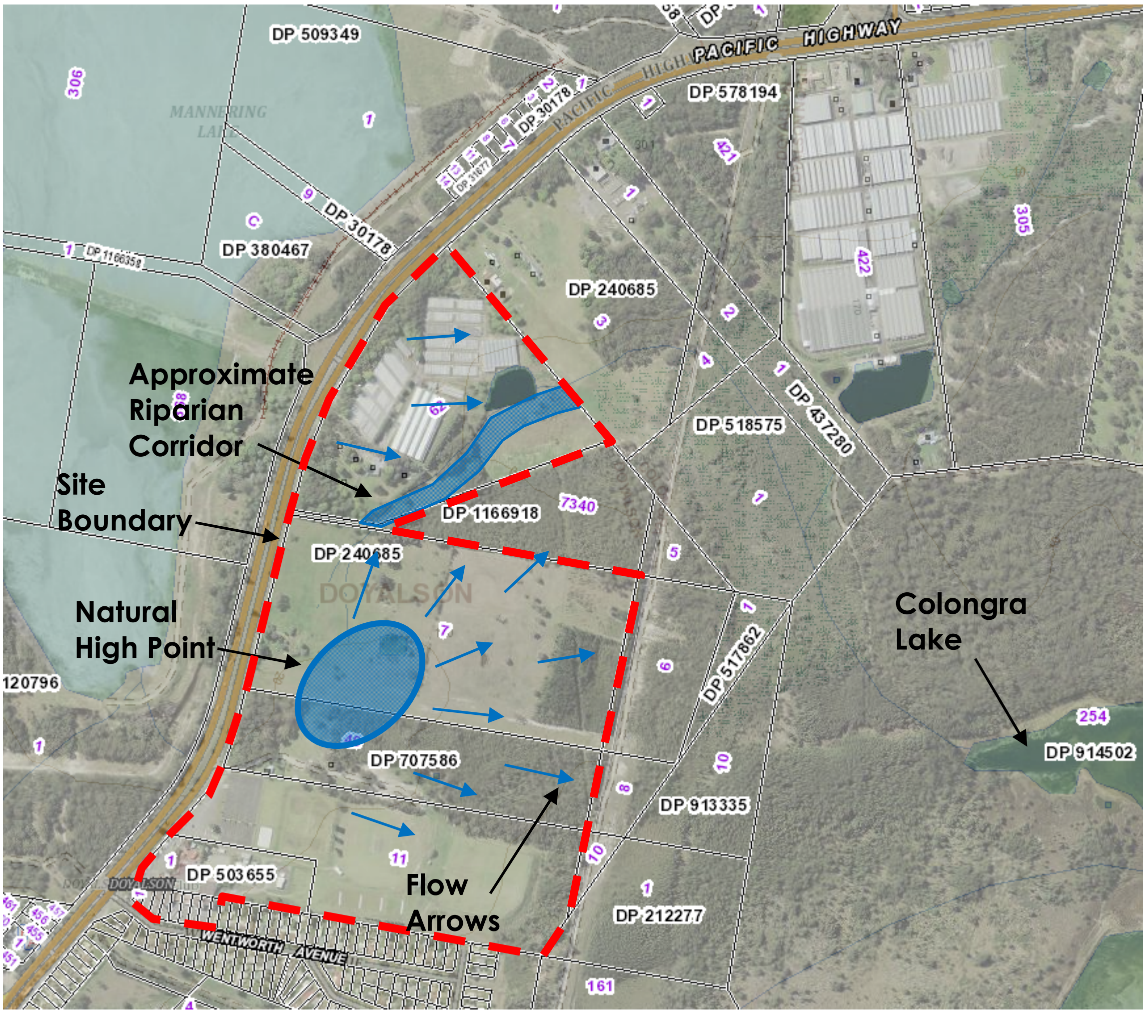


Figure 1: Site Location
(Source: SIX Maps)

This Stormwater Management Report is concerned with the first four (4) precincts of the proposed development. This report will cover localised flooding, water quality, stormwater detention, total water management and hydrological considerations in relation to the wetland downstream.

1.1 EXISTING SITE

The overall site has an approximate area of 40ha and consists of the existing Raw Challenge, existing sheds and existing dams. The total preliminary development area, which is the focus of this stormwater report as outlined in Section 1.0, is 41ha and consists of the Raw Challenge area and the adjoining land to the north. The site is bounded by bushland to the east and the Pacific Highway to the west.

Towards the northern end of the site, there are a number of existing dams, the majority of which are relatively small. There are also a few existing sheds and a residential dwelling adjacent to these dams. The majority of the preliminary development area can be classified as fully pervious, with the exception of these few buildings.

Site slopes are generally flat, in the range of 1-3%, typically the flatter areas are located throughout the middle of the site where there is an existing high point as shown in Figure 1. There is an existing watercourse running through the northern end of the site which drains water towards the nearby Colongra Lake to the east. This watercourse is a riparian corridor and consists of a few first order stems with a main second order branch leaving the site. The general location can be seen on Figure 1 and Exhibit 001.

The site consists of a mix of clear open plains and dense tree/bush areas. There is high probability for the occurrence of acid sulphate soils along the eastern edge of the site.

1.2 PROPOSED DEVELOPMENT AND ASSOCIATED CATCHMENTS

An Indicative Concept Plan (Concept Plan) has been developed for the site to demonstrate the potential developments that is likely to occur if the Planning Proposal was gazetted. The Concept Plan includes the following land uses:

1. RSL Club;
2. Health and Wellness Precinct – Fitness Centre, Swimming Pool and Allied Health Facilities;
3. Tourist Accommodation – Hotel and Villa;
4. Medical Clinic;
5. Child Care Centre;
6. Service Station;
7. Fast Food Outlets;
8. Indoor and Outdoor Recreational Uses – Raw Challenge Outdoor Course, Go-Kart, Paintball, Indoor Recreational Warehouse and Arrival Centre;
9. Seniors Living and Residential Development.

Figure 2: Proposed Development
(Source: Exhibit 001)

The site can be broken down into three (3) main catchments given the natural topography:

- Southern Catchment – drains to the south east and includes the food, medical and childcare buildings, residential and seniors housing, as well as adjacent carparks and roads shown in yellow, orange and light blue in Exhibit 003;
- Northern Catchment – drains directly into the riparian corridor and includes the RSL, hotel, go kart track, warehouse and all roads and carparks shown by blue hatching;
- Eastern Catchment – drains to the east and is comprised of the pink hatching in Exhibit 003 which includes smaller resort buildings, a single road and carpark.

These three (3) catchments will have three (3) separate discharge locations from the site given the topography, however they all share the common downstream waterway, Colongra Lake. The predeveloped catchment plan can be found in Exhibit 002.

3.0 Requirements

Stormwater management within the proposed rezoning is to comply with Central Coast Council (CCC) documents including but not limited to:

- CCC Civil Works Specification – Design Guideline;
- Wyong Development Control Plan (WDCP) 2013 – Chapter 3.3 – Floodplain Management;
- WDCP 2013 – Chapter 3.10 Wetland Management;
- WDCP 2013 – Chapter 4 Subdivision.

The CCC Civil Works Specification – Design Guideline outlines the specific requirements for catchment related parameters and assumptions used in the modelling of the proposed rezoning. Additionally, the Design Guideline outlines the various requirements for the design of the stormwater for the proposed development.

3.1 HYDROLOGY

Impervious fractions have been determined based on the proposed land usage. These impervious percentages can be found in Table 1 below.

Table 1: Recommended Impervious Fractions

LAND USE	PERCENTAGE IMPERVIOUS (%)
Future Buildings (roof areas)	100
Carparks	100
Roadways	100
Miscellaneous outdoor areas	80
Planted areas/Gardens	20

3.2 CONCEPT STORMWATER DESIGN

A concept stormwater design is required to demonstrate that stormwater runoff can be effectively conveyed from the proposed development to the existing receiving waters. The stormwater design is required to consider adjacent properties and ensure no nuisance runoff occurs onto these properties. The concept stormwater layout can be found in the concept engineering plans.

3.3 STORMWATER DETENTION

The stormwater system designed for the proposed development is to limit changes in flow rate, flow duration and overland flowpath areas downstream. It is required that the post-development peak flow from the proposed development shall not exceed the pre-development peak flow for all design storm events ranging from the 63% AEP storm event to the major system 1% AEP storm event.

3.4 STORMWATER QUALITY / WATER SENSITIVE URBAN DESIGN

The stormwater drainage system must effectively remove the nutrients and gross pollutants from the site prior to the runoff entering the existing downstream waterways.

The stormwater design for the proposed subdivision is to adopt Water Sensitive Urban Design (WSUD) principles throughout the development to promote sustainable and integrated land and water resource management.

The guidelines for stormwater quality treatment objectives are expressed as mean annual reductions of pollutant loads. The target objectives were obtained from the CCC Design Guideline and can be found in Table 2.

Table 2 - Stormwater Treatment Objectives

Pollutant	Stormwater Treatment Objectives
Gross Pollutants	90% retention of the average annual load
Suspended Solids	80% retention of the average annual load
Total Phosphorus	45% retention of the average annual load
Total Nitrogen	45% retention of the average annual load

The objective of this report is to demonstrate that the water quality objectives for the proposed development comply with the requirements of CCC/Engineers Australia as outlined above in Table 2.

3.5 ASSESSMENT OF POTENTIAL IMPACTS/WATER BALANCE

CCC objectives from Chapter 3.10 Wetlands Management of Development Control Plan 2013 aim to protect wetlands from impacts. An initial assessment of the proximity of the site to any wetlands will be done, and if any wetlands are deemed as affected by the development, water balance assessment will be completed to verify any potential indirect impacts related to hydrology.

3.6 TOTAL WATER MANAGEMENT

The development is to incorporate water retention or reuse measures to reduce the demand on potable water.

3.7 EROSION AND SEDIMENTATION CONTROL

Erosion and sedimentation control measures need to be implemented during any construction activities on the proposed subdivision to minimise the risk of erosion to disturbed areas and limit the transport of sediments from the construction site to downstream drainage. Due to this report pertaining to a rezoning, erosion and sediment control will not be covered in detail and will be further investigated at the Development Application (DA) and Construction Certificate (CC) stage.

4.0 Constraints and Opportunities

As described in Section 2.0, the site comprises generally moderate grades. This provides an opportunity for selection from a wide range of water quality treatment devices within the overall treatment train.

There is no current recycled water strategy for the site and therefore rainwater tanks will be critical in reducing potable water demand. Rainwater tanks also have additional benefits in terms of reducing the volume of flow as well as pollutant loads being directed towards the downstream wetland.

The watercourses and tributaries to be maintained are a constraint to potential future development extents. Setbacks are required for the core riparian zone and any vegetated buffers. The proposed riparian zone widths are to be in accordance with the Guidelines for Controlled Activities under the Water Management Act (2000) and are as follows:

- First order classification = 10m setback;
- Second order classification = 20m setback;
- Third order classification = 20m-40m setback;
- Vegetated Buffer = 10m setback from Core Riparian Zone.

The development layout is able to comply with the riparian zone setbacks. The riparian corridor is retained to provide detention storage. There is potential to improve the ecological value of the riparian corridor by planting as specified within Office of Water Guidelines.

Mining subsidence is of importance to the development, as it lies within the Great Northern Seam workings area. This will need to be taken into consideration when designing stormwater and may affect minimum pipe grades and classes.

Due to the overall layout and implied self-maintenance of the site (as it is privately owned), there is opportunity for the use of swales as a part of the drainage system for the edges of roads and carparks. These swales can be utilised as a quality control measure for stormwater and will convey flows to the designated discharge point. The proposed lake within the masterplan (Exhibit 001) will also create an opportunity to incorporate further stormwater quality treatment and detention measures whilst providing a visual water feature for guests of the RSL.

5.0 Stormwater Management Strategy

The stormwater management controls for the proposed development have been determined in accordance with the constraints and opportunities discussed in Section 4.0.

The proposed stormwater management strategy can be summarised as the following:

- The existing defined riparian corridor running through the site will remain as a drainage corridor and will be revegetated. Detention storage will be incorporated into this natural drainage corridor by construction of embankments and utilisation of the natural terrain to form a basin for the northern catchment;
- Water quality controls at source, street level and precinct level for the proposed development including rainwater tanks, biofiltration swales, gross pollutant traps and constructed treatment ponds as necessary which can also be utilised as a visual feature.

Parameters, modelling and methodology for stormwater management is described below in Sections 5.1-5.5.

5.1 CATCHMENTS

The catchment areas for the site was determined from the architectural masterplan (found in Exhibit 001) and site contours obtained from a detailed topographical and cadastral survey. The total catchment size of the developed is approximately 22ha.

The overall site catchments were divided into subcatchments for modelling purposes based on their land usage type as per the masterplan. Similar surface types were grouped together for simplification of the model (for instance a single node was used to portray a group of buildings within a catchment). The post-development catchment plan can be found in Exhibit 003. The catchments and respective subcatchments can be found in Table 3. Mannings 'n' roughness parameters were determined based on typical values for the surface type.

Table 3: Post Development Catchment Details

Catchment	Sub Catchment	Area (Ha)	Impervious Area (Ha)	Pervious Area (Ha)	Percentage Impervious (%)	Slope (%)	Mannings n	
							Perv.	Imperv.
Southern Catchment	Buildings	0.664	0.664	0	100	25	-	0.014
	Carparks	0.683	0.683	0	100	1	-	0.016
	Roads	0.985	0.985	0	100	3	-	0.016
	Gardens	1.313	0.263	1.050	20	2	0.04	0.016
	Childcare Outdoor	0.308	0.246	0.062	80	1	0.016	0.035
	MHE	14.666	12.467	2.200	85	4	0.016	0.035
Total		**18.619**	**15.308**	**3.312**				
Northern Catchment	Buildings	1.459	1.459	0	100	25	-	0.014
	Carparks	1.839	1.839	0	100	1	-	0.016
	Roads	1.485	1.485	0	100	3	-	0.016
	Gardens	1.778	0.356	1.422	20	2	0.04	0.016
	Warehouse	0.586	0.586	0	100	25	-	0.014

	Go Kart Track	0.694	0.694	0	100	2	-	0.016
	Undeveloped	11.973	0	11.973	0	3	0.075	-
Total		**19.814**	**6.419**	**13.395**				
Easter Catchment	Buildings	0.234	0.234	0	100	25	-	0.014
	Carparks	0.244	0.244	0	100	1	-	0.016
	Roads	0.424	0.424	0	100	3	-	0.016
	Gardens	0.928	0.186	0.743	20	2	0.04	0.016
Total		**1.831**	**1.088**	**0.743**				

The impervious percentage for the predeveloped catchments has been based on the existing site conditions as outlined in Section 2.0. Predeveloped catchment data is shown in Table 4.

Table 4: Pre-Development Subcatchment Details

Subcatchment Name	Area (Ha)	Impervious Area (Ha)	Pervious Area (Ha)	Percentage Impervious (%)	Slope (%)	Mannings n	
						Perv.	Imperv.
Southern Predeveloped	18.740	1.874	16.866	10	3	0.075	0.016
Northern Predeveloped	21.977	0	21.977	0	3	0.075	-
Eastern Predeveloped	3.005	0	3.005	0	3	0.075	-
Total	31.582	0	31.582				

5.2 HYDROLOGICAL MODEL

Hydrological assessment was undertaken to determine peak flows over the site during the 63% to the 1% AEP storm event. The XP-RAFTS program was used to carry out this assessment. The RAFTS model uses rainfall data to simulate each subcatchment's response to storm events to generate hydrographs and predict an estimate of peak discharges.

Design rainfall intensity-frequency-duration (IFD) data for the site was obtained using methods set out in Australian Rainfall and Runoff (ARR) 2016. The RAFTS model was calibrated using the Rational Method calculated separately.

RAFTS results are shown in Section 6.1. It was anticipated that due to the large increase in percentage imperviousness following development, that stormwater detention would be required. Stormwater detention is described in Section 5.3.

5.3 STORMWATER DETENTION

As described in Section 3.0 and Section 5.2, stormwater detention is required for the attenuation of post development peak flows to predevelopment peak flow levels to meet Council's requirements.

RAFTS modelling was used for the prediction of the attenuation storage requirements for the 63% up to the 1% AEP storm events.

The flow leaving the site is proposed to be controlled through three (3) detention basins located near the discharge point for the three (3) catchments (see Exhibit 003).

The final location and detailed design of the detention facilities shall be determined in conjunction with future development application and engineering works. The stormwater detention modelling results are shown in Section 6.2.

5.4 FLOOD MODELLING

Central Coast Council's flood mapping has been assessed for the site. Based on the location of the site relative to the zone of influence of the local flooding area of Colongra Lake, it has been determined that the site is not flood affected. A screenshot of the flood map for the area is shown in Figure 3 below.

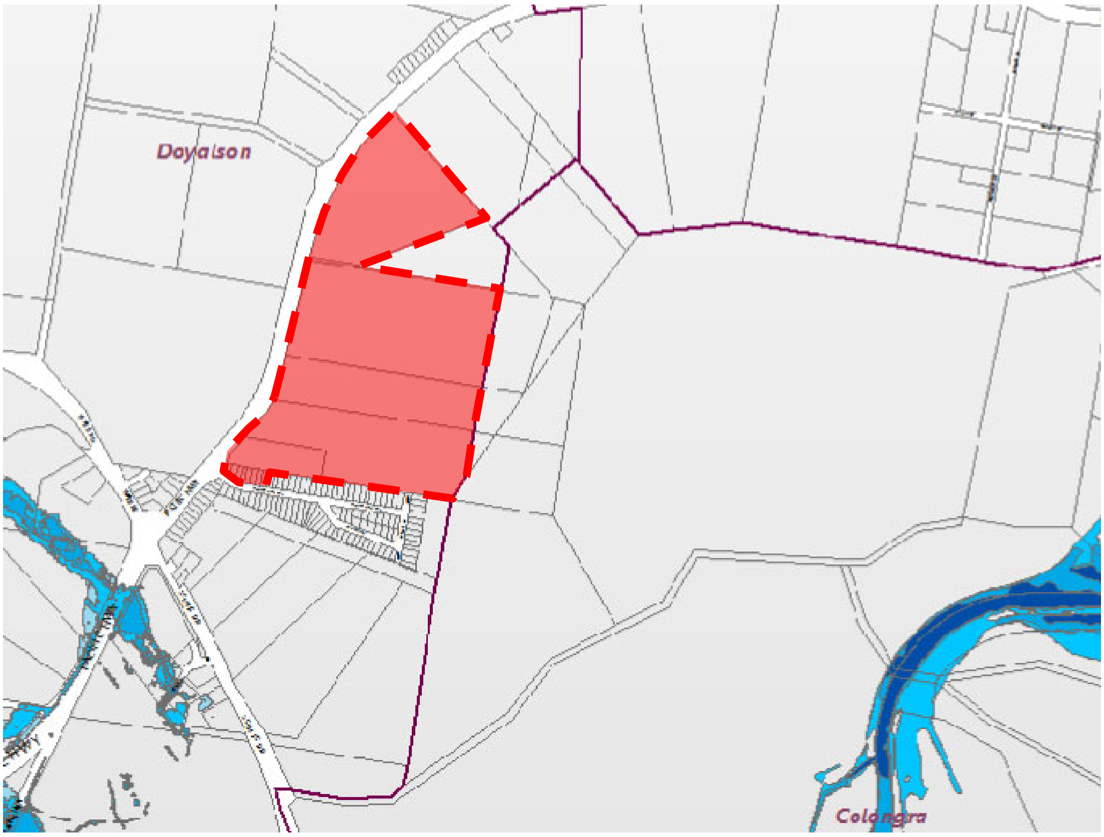


Figure 3: Screenshot of the Local Flood Map
(Source: CCC - Wyong Shire Mapping)

5.5 WATER QUALITY

A treatment train strategy of permanent stormwater quality controls is proposed for the development of the site for compliance with the water quality objectives.

MUSIC (Model for Urban Stormwater Improvement Conceptualisation) is the industry standard model for prediction of stormwater quality outcomes from proposed development. The modelling approach is based on continuous simulation, operating at time steps to match the scale of the catchment.

Central Cost Council (Wyong Area) have adopted MUSICLink. MUSICLink streamlines the process for assessing the compliance of Water Sensitive Urban Designs (WSUD) submitted by the development sector against guidelines from a specific Council or other Local Government Authority.

It generates efficiencies in the development process by not only providing very specific modelling parameters to designers but also speeding up the assessment process, thus saving valuable time.

As described in Section 4.0, there are several alternatives for stormwater treatment for the development of this site.

The strategy for water quality is shown below:

- Rainwater tanks for each building within the release area;
- Biofiltration swales where applicable for road and carpark drainage;
- Provide Gross Pollutant Traps at all street drainage outlet points;
- Constructed ponds at the proposed discharge locations as per Exhibits 004 and 005.

The catchments and associated parameters used for the model were based on the same node points as detailed in Table 3.

Biofiltration swales will be used for both its conveyance function and water quality treatability. These swales will be provided where possible alongside roads or between carriageways where dual roads exist. Incorporating swales into the design can form appealing streetscapes, giving landscape features to the development. The layout of a typical biofiltration swale can be seen below in Figure 4.

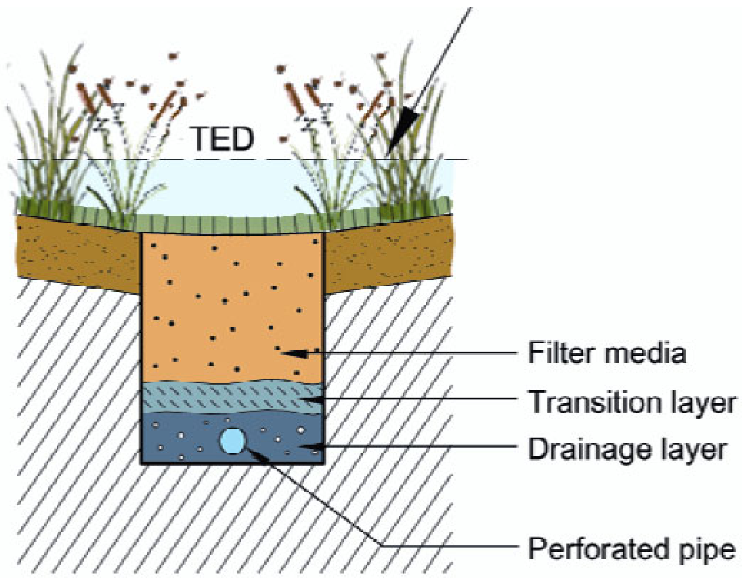


Figure 4: Typical Biofiltration Swale Detail
(Source: WSUD Engineering Procedures for Stormwater Management in Southern Tasmania 2005)

Gross pollutant traps (GPT) will be incorporated at the end of all street networks before water is discharged into ponds for further quality treatment. GPT's are designed to capture and retain gross pollutants, litter, grit and sediments from stormwater. Figure 5 depicts the process of litter filtering through a centrifugal type GPT.

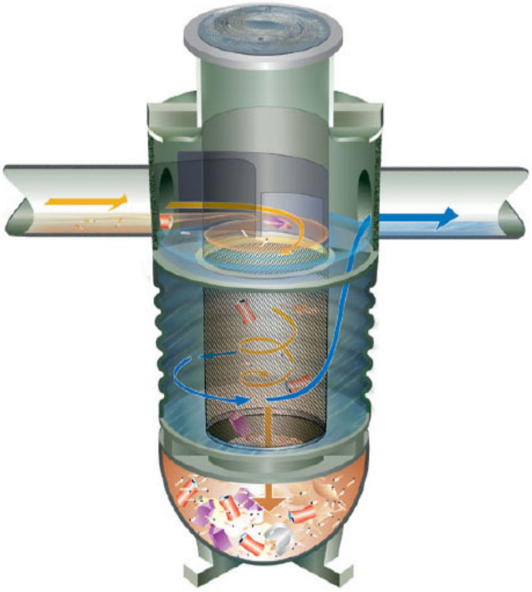


Figure 5: Litter Filtration Process of a Rocla CDS GPT
(Source: Rocla CDS Separator Product Brochure)

Constructed ponds will be utilised as a final treatment measure for stormwater quality before discharge from the site. Naturally, rainwater accumulates nutrients such as nitrogen and phosphorus as it falls. These nutrients are usually not an issue when rain falls onto undeveloped land as plants can absorb the nutrients before the water reaches the main waterways. However, when a site is developed and impervious surfaces are introduced, these nutrients can build up in stormwater and negatively affect downstream ecosystems when discharged. Incorporating constructed ponds into the development will provide nutrient control as various plants within ponds absorb nutrients. These ponds can also be used as a visual feature for guests as seen in Figure 6.

Figure 6: A Boardwalk across a Constructed Wetland
(Source: Wetland Technical Design Guidelines, May 2017)

6.0 Results and Discussion

The modelling results of hydrology, stormwater detention and water quality are shown below in Sections 6.1 – 6.3.

6.1 HYDROLOGY

6.1.1 Mannings 'n'

Mannings 'n' is the catchment roughness factor; this value is adjusted to represent the different response of rural and urbanised catchments, impervious and pervious surfaces. Values of Mannings 'n' used are as per Table 3.

6.1.2 Rainfall Data

Rainfall data was received from the BOM website in accordance with ARR 2016. The site used IFD data for Wyong as this IFD data corresponded best with the IFD data for Wadalba as determined by the Bureau of Meteorology.

The peak discharges from RAFTS for the 63% up to the 1% AEP storm events for the subcatchments in pre and post development conditions are presented below in Table 6. Storm durations of 10 minutes up to 48 hours were used in the modelling.

6.1.3 Catchment Data

An analysis of the subcatchments described above in Section 5 was undertaken and it was determined that due to the location of the proposed recreational warehouse and go-kart track, these areas will not drain to the proposed detention area. Over-detention will as such, be utilised in order to meet pre to post flow requirements.

Catchment data for each node was used as per Table 3.

6.2 STORMWATER DETENTION

The proposed location and footprint for the basin listed above can be seen in Exhibits 003, 004 and 005. The results of the XPRAFTS modelling can be found in Tables 5, 6 and 7.

Table 5: XPRAFTS Peak Flow Pre and Post Development for Northern Catchment

AEP	Peak Discharge Pre-Development (m^3/s)	Critical Storm	Peak Discharge Post-Development Undetained (m^3/s)	Peak Discharge Post-Development Detained (m^3/s)	Critical Storm
63% (1-yr ARI)	1.146	1yr 720min	1.751	0.708	1yr 720min
40% (2-yr ARI)	1.625	2yr 720min	2.486	1.177	2yr 720min
20%	2.2	5yr 720min	3.335	1.672	5yr 720min
10%	2.638	10yr 120min	3.806	1.941	10yr 720min
5%	3.292	20yr 120min	4.434	2.272	20yr 120min
2%	4.008	50yr 120min	4.937	2.561	50yr 120min
1%	4.756	100yr 120min	5.657	2.957	100yr 120min

Table 6: XPRAFTS Peak Flow Pre and Post Development for Southern Catchment

AEP	Peak Discharge Pre-Development (m^3/s)	Critical Storm	Peak Discharge Post-Development Undetained (m^3/s)	Peak Discharge Post-Development Detained (m^3/s)	Critical Storm
63% (1-yr ARI)	0.898	1yr 720min	1.709	0.564	1yr 120min
40% (2-yr ARI)	1.342	2yr 720min	2.442	0.79	2yr 120min
20%	1.816	5yr 120min	3.579	1.285	5yr 360min
10%	2.112	10yr 120min	4.325	1.648	10yr 360min
5%	2.566	20yr 120min	5.202	2.14	20yr 120min
2%	3.064	50yr 120min	5.939	2.537	50yr 120min
1%	3.542	100yr 120min	6.860	2.938	100yr 120min

Table 7: XPRAFTS Peak Flow Pre and Post Development for Eastern Catchment

AEP	Peak Discharge Pre-Development (m^3/s)	Critical Storm	Peak Discharge Post-Development Undetained (m^3/s)	Peak Discharge Post-Development Detained (m^3/s)	Critical Storm
63% (1-yr ARI)	0.149	1yr 720min	0.314	0.125	1yr 120min
40% (2-yr ARI)	0.213	2yr 720min	0.417	0.17	2yr 120min
20%	0.286	5yr 720min	0.585	0.249	5yr 120min
10%	0.333	10yr 120min	0.674	0.312	10yr 120min
5%	0.414	20yr 120min	0.783	0.39	20yr 120min
2%	0.521	50yr 120min	0.87	0.44	50yr 120min
1%	0.62	100yr 120min	0.981	0.489	100yr 120min

RAFTS modelling results shown in Tables 5, 6 and 7 confirm that stormwater detention is required with development of the site. Refer to Section 6.2.

A number of outlet controls were used on the respective basins in order to safely convey the 63% up to the 1% AEP storm events. The general principle of basin design for the study was to provide a low flow pipe to convey 63 % AEP storm flow, high level culvert to convey 10% AEP storm flow and a weir providing control of 1% AEP storm flow.

The RAFTS modelling completed was based on the proposed detention basins. Required detention storage volumes are as follows (approximations):

- Northern Basin: 5,000m^3;
- Southern Basin: 9060m^3;
- Eastern Basin: 750m^3.

It is possible that this volume will be distributed over a number of smaller basins/detention devices, sized and located to suit the development layout when it is completed.

6.3 STORMWATER QUALITY

Urban areas have expanses of constructed hard and impervious surfaces like roads, driveways, carparks, roofs and paving. When stormwater run-off flows over these hard surfaces, it readily accumulates pollutants. Stormwater pollutants originate from many different sources including fuel and oil on our roads, excess fertilisers, litter dropped on streets and parks and sediment from building sites.

Improving stormwater quality in the long term required effective prevention and management of these pollutants at their sources, as well as treatment of stormwater before it enters our waterways. The proposed strategy to mitigate the effects of urban stormwater runoff for the site is summarised below.

6.3.1 Treatment Train

The following treatment controls were utilised to improve the water quality of runoff over the developed catchment:

- **Rainwater Tanks** – 10kL rainwater tanks are proposed to be installed with each building. The tanks should be fitted with first flush devices and be fitted to have indoor use of the rainwater collected. This is an at source treatment control;
- **Biofiltration Swales** – The development will utilise biofiltration swales as a means of conveying stormwater where applicable from roads and carparks to the discharge location. These swales have been designed to have a filtration layer which will capture TSS, TN and TP. This is a conveyance treatment control;
- **Gross Pollutant Trap** – As part of the development, it is proposed to use underground proprietary gross pollutant traps;
- **Constructed Ponds** – Constructed ponds will serve as a physical and biological treatment process to improve the quality of the water being discharged from the wetland. The second is it can be easily be utilised as a visual feature for guests.

6.3.2 Modelling

The software used for the water quality modelling is MUSIC. This program is well regarded as industry best practice for analysis of the effectiveness of treatment mechanisms on the quality of stormwater runoff from a development site of this size.

MUSIC-link for Council has been used for the modeling for this site. Using Council's MUSIC-link enables the simplification of the development and assessment of MUSIC models.

Council's MUSIC-link enables the model to adopt all of Council's preferred parameters such as rainfall, evapotranspiration data, lowland soil characteristics and pollutant generation rates. The "Forest" type node has been chosen for catchments in the pre-development scenario as this most closely resembles the existing site.

The parameters used for the WSUD devices can be found in the attached MUSIC-Link Report in Appendix B. Comments in relation to where the adopted parameters differ from Council's parameters are also contained within the report.

The MUSIC modelling results of water quality prediction post development are shown below in Tables 8, 9 and 10.

Table 8: MUSIC Model Pollutant Reduction Prediction Northern Catchment

Pollutant	Pre Developed (No Treatment)	Post Development (No Treatment)	Post Development (with Treatment)	Post Development Reduction (%)	Required Reduction (%)
Gross Pollutants (kg/year)	0	1930	0	100	90
Total Suspended Solids (kg/year)	2790	17700	1760	90.1	80
Total Phosphorus (kg/year)	5.72	32.4	7.29	77.5	45
Total Nitrogen (kg/year)	65.4	175	89.8	48.8	45

Table 9: MUSIC Model Pollutant Reduction Prediction Southern Catchment

Pollutant	Pre Developed (No Treatment)	Post Development (No Treatment)	Post Development (with Treatment)	Post Development Reduction (%)	Required Reduction (%)
Gross Pollutants (kg/year)	1110	4710	0	100	90
Total Suspended Solids (kg/year)	3140	35500	3340	90.6	80
Total Phosphorus (kg/year)	6.41	58.9	15.7	73.4	45
Total Nitrogen (kg/year)	73.5	408	224	45	45

Table 10: MUSIC Model Pollutant Reduction Prediction Eastern Catchment

Pollutant	Pre Developed (No Treatment)	Post Development (No Treatment)	Post Development (with Treatment)	Post Development Reduction (%)	Required Reduction (%)
Gross Pollutants (kg/year)	0	400	0	100	90
Total Suspended Solids (kg/year)	389	3080	273	91.1	80
Total Phosphorus (kg/year)	0.788	5.7	1.35	76.2	45
Total Nitrogen (kg/year)	9.15	33	18	45.4	45

The use of a combination of some of the above permanent devices will ensure the best solution for the development. This may also reduce the required footprint for end of line devices. Some of these features can be incorporated into streetscape design, and should form part of the development application. Investigation of Integrated Water Cycle Management will then be appropriate.

6.3.3 Preliminary Basin Details

It is understood that more defined detention basin designs will need to be detailed at a later stage of the process. The general footprints that have been provided are indicative only. The overall layout and location of the detention basin can be changed if needed given the overall volume requirements are met. Preliminary gradings have been undertaken to ensure areas are appropriate as well as identifying that adequate compensatory storage can be provided. Once post developed catchments are defined, the basins can be designed in their final form to the satisfaction of Council, most likely at the Development Application Stage.

7.0 Total Water Management

The proposed future subdivision is to incorporate water retention or reuse measures to reduce the demand on potable water.

As part of the stormwater management for the future development, there will be a requirement to install rainwater tanks to BASIX requirements to capture roof runoff. These tanks will be connected to toilet cisterns and be used for landscaping to minimise the demand on potable water supply. In addition, future dwellings are to have AAA+ fixtures and appliances, dual flush toilets, water efficient gardens and rainwater tanks where appropriate. These are BASIX requirements, imposed upon the proponent of the new dwellings on the lots.

8.0 Wetland Management Considerations

NSW Department of Planning and Environment's wetlands map has been assessed for the site. Based on the location of the site relative to the proximity area for coastal wetlands (shown in Figure 7 as blue), there is no direct impact to the wetland from the development.

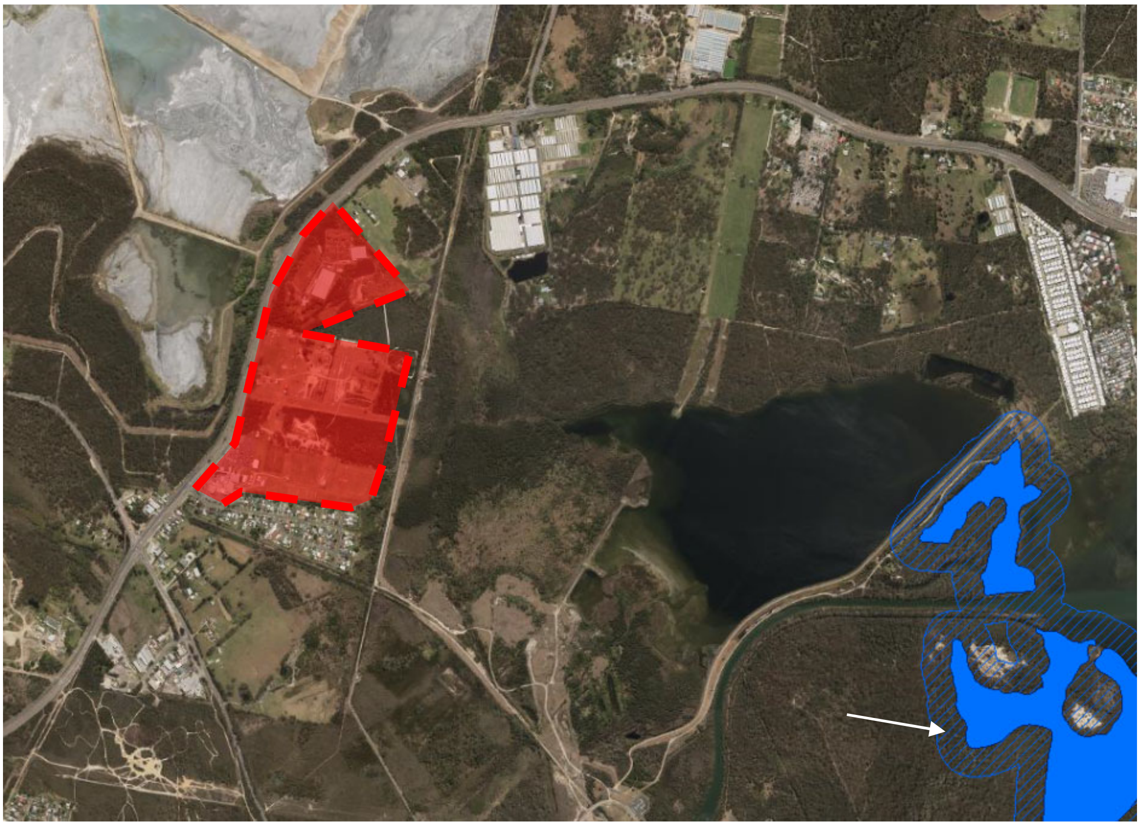


Figure 7: Screenshot of the Coastal Wetlands Extents
(Source: State Environment Planning Policy (Coastal Management) 2018 - Maps)

It can be seen that any increase in surface flows caused by increasing the impervious area will discharge directly to Colongra Lake. The potential effect on any downstream wetland including "Colongra Swamp" is insignificant. The critical element is ensuring flows discharged from the site are clear of any gross pollutants and achieve the target reductions as previously set out within this report.

9.0 Erosion and Sedimentation Control

Erosion and sedimentation control measures need to be implemented during any construction on the proposed subdivision to minimise the risk of erosion to disturbed areas and limit the transport of sediments from the construction site to downstream waterways. Plans for erosion and sediment control will be further detailed at the Development Application stage.

During the construction period, it is recommended that the detention basins and wetlands are constructed early and used as a temporary sediment basin. It is recommended that initially all water runoff from the site is diverted to the wetland prior to the wetland being planted out. When the wetland is being utilised as a temporary sediment basin the sediment basin can be constructed and fully established. Once the sediment basin is fully established, the stormwater runoff can be diverted to the sediment basin which can be used as a temporary sediment basin. Whilst the sediment basin is being used as a temporary sediment basin the wetland can be fully established. The stormwater runoff is not to be discharged to the wetland until the upstream catchment has been completely stabilised. The temporary sediment basins required during construction will be sized at the detailed design stage to ensure they comply with the proposed sediment basin and wetland.

It is also recommended that an appropriate Erosion and Sedimentation Control Plan is implemented throughout the entire construction period to minimise the quantity of sediments being conveyed to the temporary sediment basin. A preliminary Erosion and Sediment Control Plan can be found within the concept engineering drawings.

10.0 Conclusion

The Stormwater Management Strategy has been prepared to support the application for rezoning of the proposed area to a RE2 Private Recreation. The strategy has been undertaken to meet Central Coast Council requirements as well as industry best practice management and environmental constraints. Hydrology, flooding, water quality and detention has been investigated in this Stormwater Management Report.

The development layout is able to comply with the riparian zone setbacks. The riparian corridor is retained to provide detention storage. There is potential to improve the ecological value of the riparian corridor by planting as specified within Office of Water Guidelines.

Hydrology modelling indicated that post development peak flows are attenuated within the site to pre-development peak flow levels after provision is made for detention storage for stormwater up to the 1% AEP storm event.

Water quality treatment has been modelled and utilising the adopted treatment meets Council target pollutant removal objectives prior to discharge of stormwater from the site. This was achieved by a treatment train approach utilising rainwater tanks, biofiltration swales, gross pollutant traps and constructed ponds.

The development is not subject to flooding risk and also will have no impact on any nearby wetlands due to the location of the site.

The outcomes of the Stormwater Management Report indicate compliance with requirements for estimated post development conditions. Mitigate stormwater controls for stormwater detention and quality are presented for site rezoning and hence, future master planning of the development layouts of the site. Detailed assessment of water quality and detention will be completed once a final masterplan layout is available and will accompany any subsequent development application for the site.

Exhibits

EXHIBIT 002 - PREDEVELOPED CATCHMENT PLAN

drawing title:

EXHIBIT 002 - PRE-DEVELOPMENT CATCHMENT PLAN

location: DOYALSON RSL REZONING

council: CENTRAL COAST COUNCIL

dwg ref: 190526-RPT-002

client:

adw johnson

central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100
sydney office ph: (02) 8046 7411
www.adwjohnson.com.au

working beyond expectations

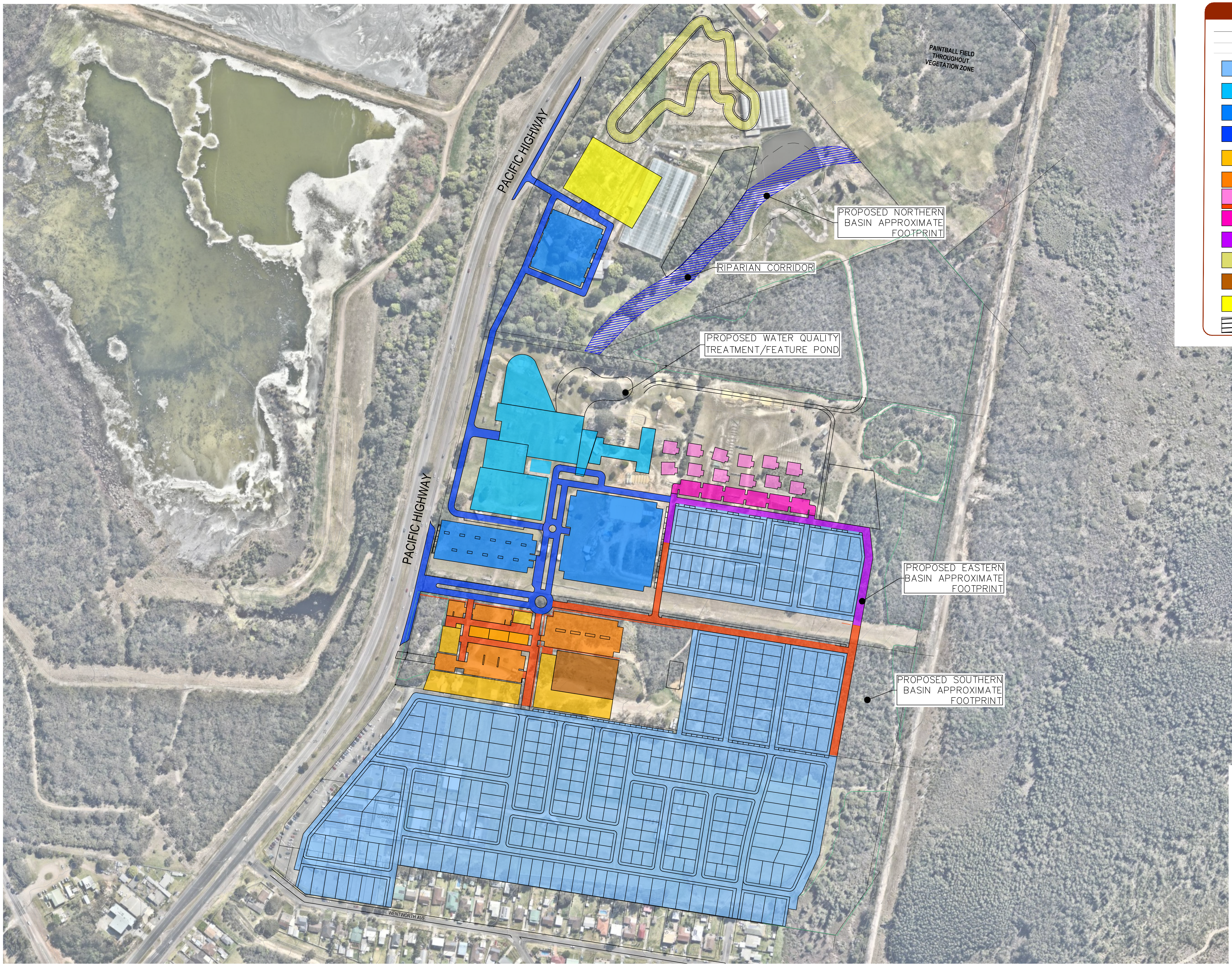
ver.	date	comment	drawn	pm	level information	scale (A1 original size)	notes
A	05/10/18	INITIAL ISSUE	J.B.	M.K.	DATUM: A.H.D. CONTOUR INTERVAL: 0.5m	0 50 100m SCALE: 1:2000 (FULL)	

• project management • civil engineering • infrastructure • superintendency • economic analysis • social impact • town planning • surveying • development feasibility • visualisation • urban design

Plotted By: Joshua Bagus Plot Date: 24/04/19 3:59:29PM Cad File: S:\190526\DESIGN\SWMP\EXHIBIT 002 - PREDEVELOPED CATCHMENT PLAN.DWG

This plan includes coloured information. If you have a black and white copy you do not have all of the information. This note is coloured RED.

EXHIBIT 003 - CATCHMENT PLAN - REV B



LEGEND

- EXISTING LOT BOUNDARY
- MAJOR CONTOUR
- MINOR CONTOUR
- RESIDENTIAL/MHE CATCHMENT
- BUILDINGS NORTH CATCHMENT
- CARPARKS NORTH CATCHMENT
- ROADS NORTH CATCHMENT
- BUILDINGS SOUTH CATCHMENT
- CARPARKS SOUTH CATCHMENT
- BUILDINGS EAST CATCHMENT
- ROADS SOUTH CATCHMENT
- CARPARKS EAST CATCHMENT
- ROADS EAST CATCHMENT
- GO KART TRACK CATCHMENT
- CHILDCARE OUTDOOR CATCHMENT
- WAREHOUSE CATCHMENT
- BASIN AREA

CONTOUR INTERVAL = 0.5m

ver.	date	comment	drawn	pm	level information	scale (A1 original size)	notes
A	05/10/18	INITIAL ISSUE	J.B.	M.K.	DATUM: A.H.D. CONTOUR INTERVAL: 0.5m	0 50 100m SCALE: 1:2000 (FULL)	

drawing title: EXHIBIT 003 - CATCHMENT PLAN

location: DOYALSON RSL REZONING

council: CENTRAL COAST COUNCIL

dwg ref: 190526-RPT-003

client:

adw johnson

central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100
sydney office ph: (02) 8046 7411

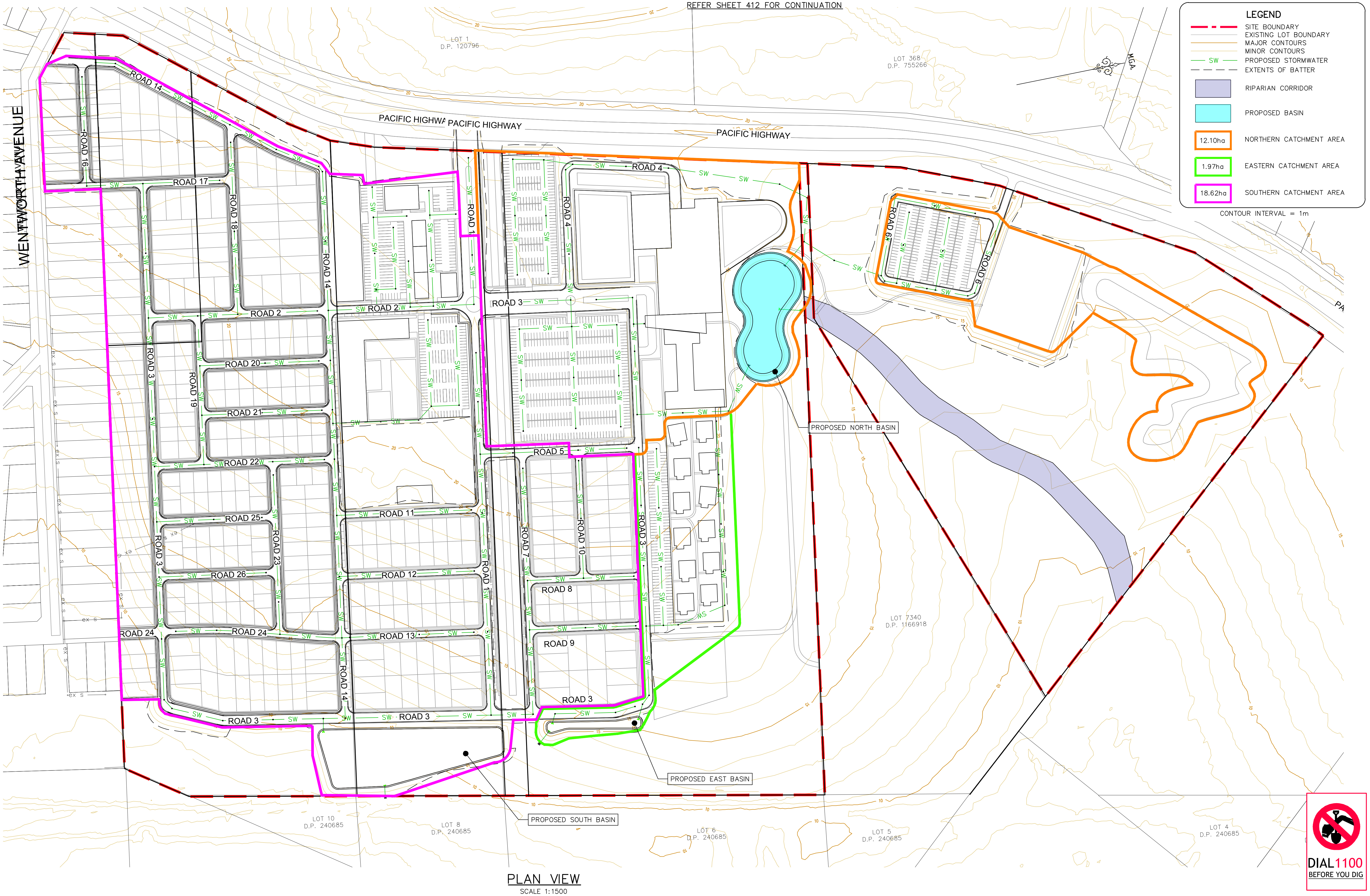
www.adwjohnson.com.au

Plotted By: Joshua Bagus Plot Date: 24/06/19 3:58:37 PM Cad File: S:\190526\DESIGN\SWMP\EXHIBIT 003 - CATCHMENT PLAN - REV B.DWG

This plan includes coloured information. If you have a black and white copy you do not have all of the information. This note is coloured RED.

190526-CENG-411

REFER SHEET 412 FOR CONTINUATION



PLAN VIEW

SCALE 1:1500

100mm AT FULL SIZE

REV.	DATE	AMENDMENT	DESIGN	DRAWN	CHECKED	APPROVED
A	06.11.2018	PRELIMINARY ISSUE	J.B.	J.J.	M.L.	M.L.
B	25.06.2019	ADDITIONAL INFORMATION	J.B.	G.H.	M.L.	M.L.

DRAFT

SCALES
0 30 60 75m
SCALE: 1:1500 (FULL)

DESIGN FILE S:\190526\Design\12D\DOYALSON WYEE RSL

ALL DIMENSIONS ARE IN METRES. DO NOT SCALE

adw johnson

Central Coast
5 Pioneer Avenue,
P.O. Box 3717,
Tuggerah N.S.W. 2259
Phone: (02) 4305 4300
Fax: (02) 4305 4399
email: coast@adwjohnson.com.au
www.adwjohnson.com.au
ABN 62 129 445 398

CLIENT

URBIS

PROPERTY DESCRIPTION

PACIFIC HIGHWAY,
DOYALSON

PROJECT

PROPOSED DEVELOPMENT

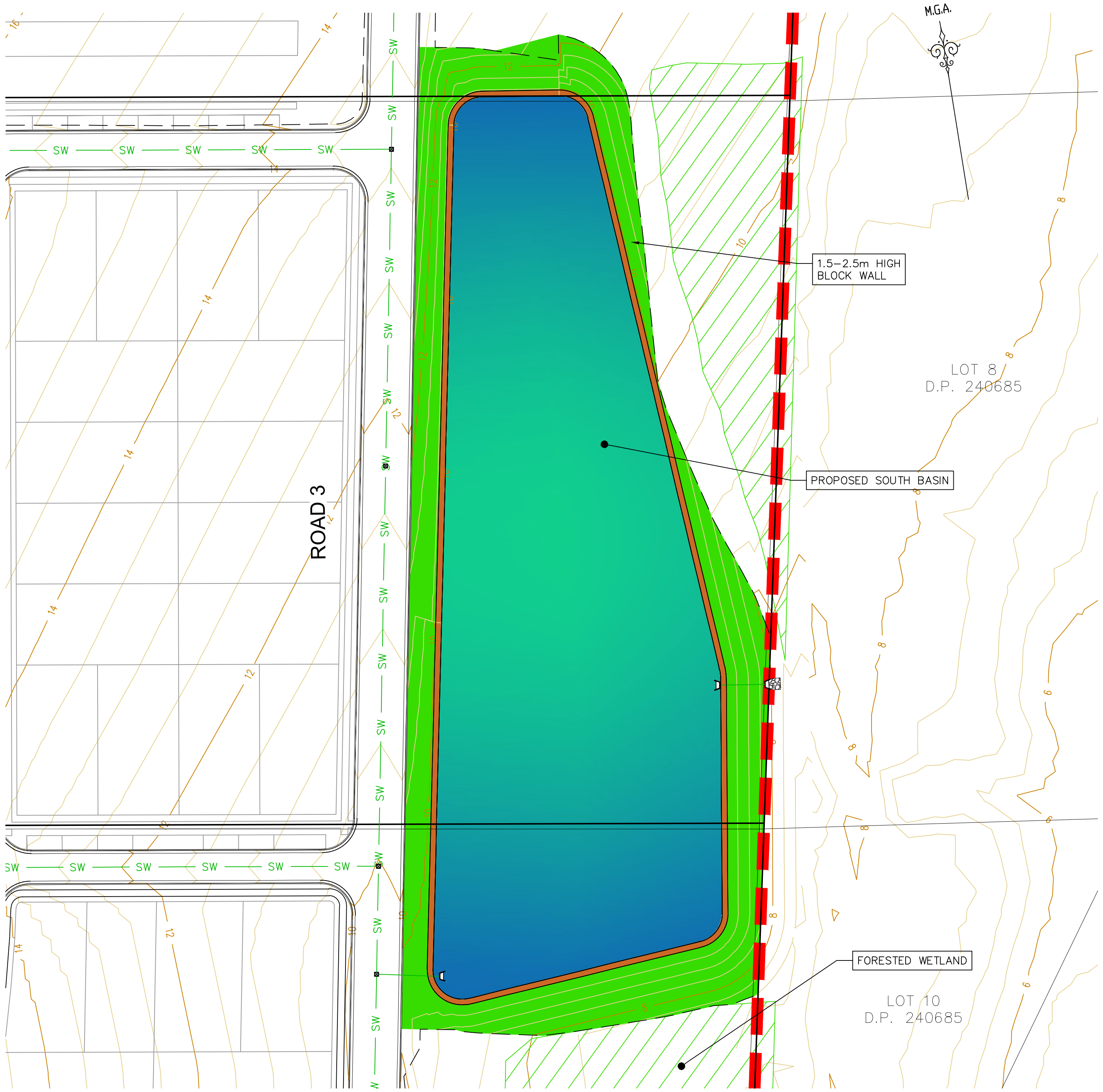
PLAN TITLE

CATCHMENT PLAN
SHEET 1 OF 1

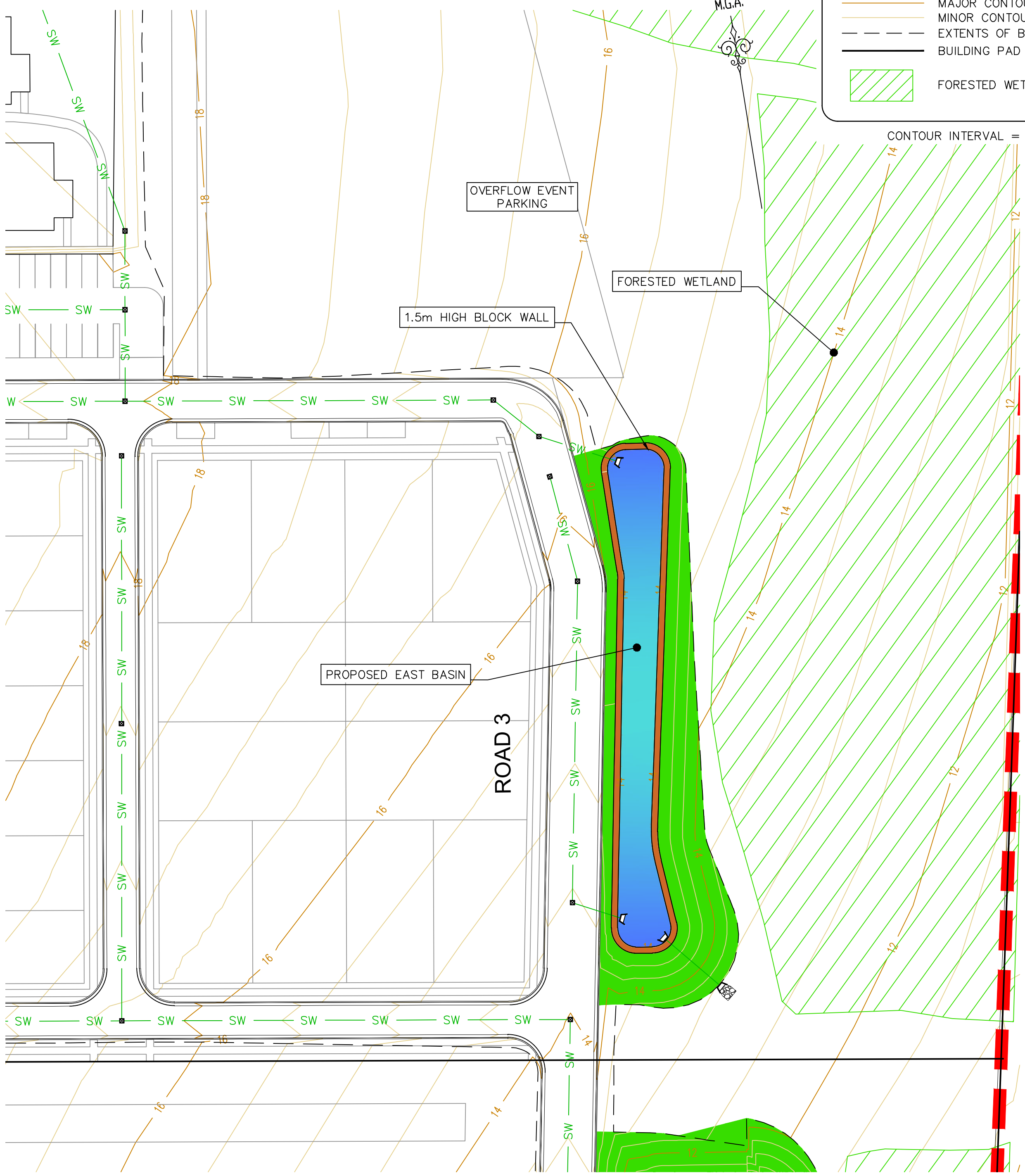
SURVEYED	DATUM	PROJECT No.	DISCIPLINE	NUMBER	REV.
ADWJ	A.H.D.	190526 –	CENG –	411	B

Plotted By: Gail Hall Plot Date: 25/06/19 3:48:05PM Cad File: S:\190526\DWG'S\ENGINEERING\CIVIL\CENG\190526–CENG–411.DWG

190526-CENG-421



DETAIL PLAN
SCALE 1:500



DETAIL PLAN
SCALE 1:500

LEGEND
- STAGE BOUNDARY
- EXISTING LOT BOUNDARY
- MAJOR CONTOURS
- MINOR CONTOURS
- EXTENTS OF BATTER
- BUILDING PAD
- FORESTED WETLANDS

CONTOUR INTERVAL = 0.5m

Southern Basin	
Parameter	Details
Levels	Basin floor at RL 8.45m
	Top of wall at RL 9.95m to 10.95m
Batters	None, 1.5-2.5m block wall
Approximate Base Area	6000m^2
Required Detention Storage	9061m^3

Eastern Basin	
Parameter	Details
Levels	Basin floor at RL 14.0m
	Top of wall at RL 15.5m
Batters	None, 1.5m block wall
Approximate Base Area	500m^2
Required Detention Storage	750m^3

DIAL 1100 BEFORE YOU DIG

100mm AT FULL SIZE

REV.	DATE	AMENDMENT	DESIGN	DRAWN	CHECKED	APPROVED
A	06.11.2018	PRELIMINARY ISSUE	J.B.	J.J.	M.L.	M.L.
B	25.06.2019	ADDITIONAL INFORMATION	J.B.	G.H.	M.L.	M.L.

DRAFT

SCALES: 0 12.5 25.0m SCALE 1:500 (FULL)

DESIGN FILE S:\190526\Design\12D\DOYALSON WYEE RSL
ALL DIMENSIONS ARE IN METRES. DO NOT SCALE

adw johnson
Central Coast
5 Pioneer Avenue,
P.O. Box 3717,
Tuggerah N.S.W. 2259
Phone: (02) 4305 4300
Fax: (02) 4305 4399
email: coast@adwjohnson.com.au
www.adwjohnson.com.au
ABN 62 129 445 398

CLIENT: URBIS

PROPERTY DESCRIPTION: PACIFIC HIGHWAY, DOYALSON

SURVEYED: ADWJ
DATUM: A.H.D.

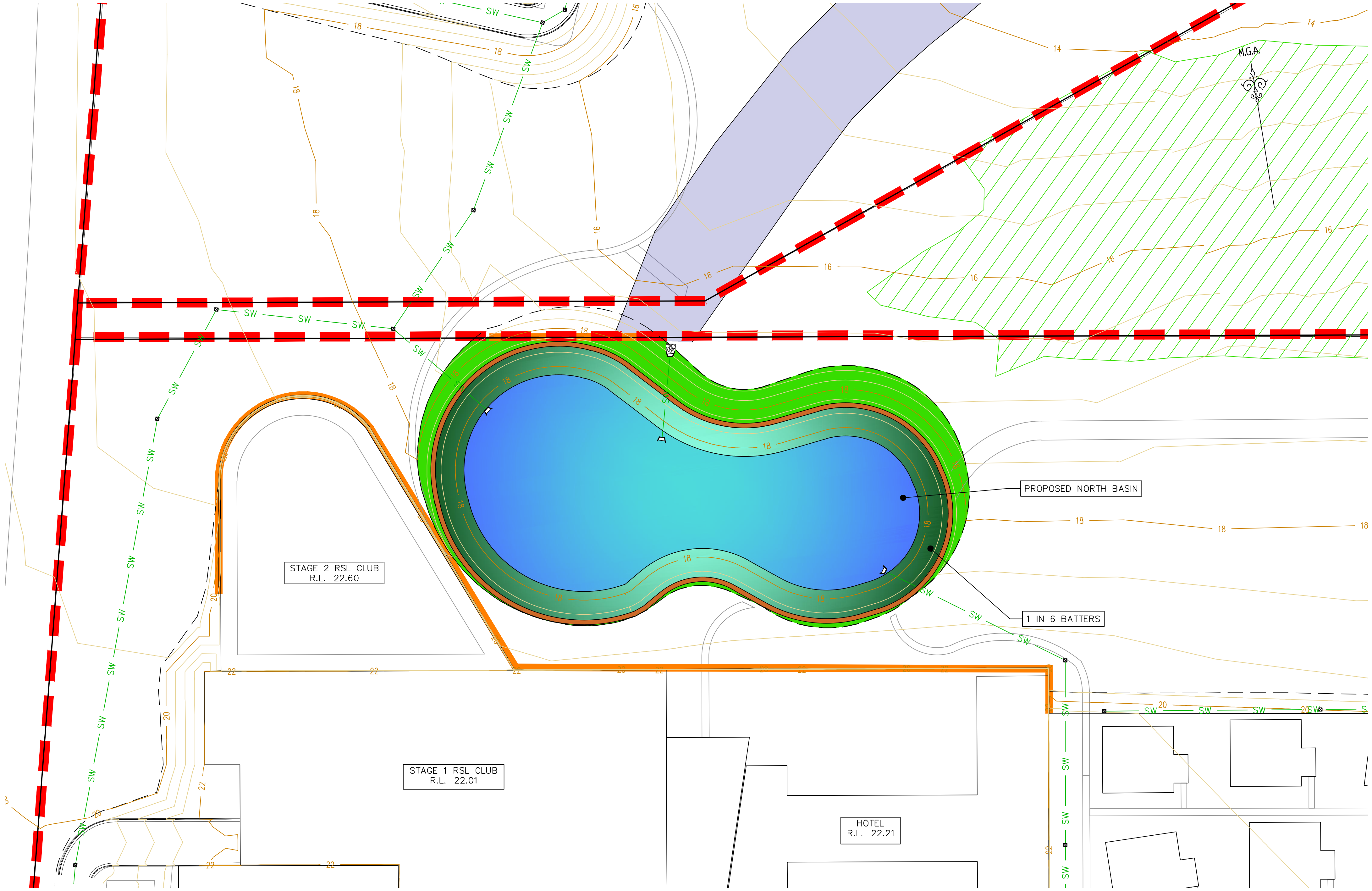
PROJECT: PROPOSED DEVELOPMENT

PLAN TITLE: BASIN PLAN SHEET 1

PROJECT No.	DISCIPLINE	NUMBER	REV.
190526	CENG	421	B

Plotted By: Gail Hall Plot Date: 25/06/19 3:48:11PM Cad File: S:\190526\DWG'S\ENGINEERING\CIVIL\CENG\190526-CENG-421.DWG

190526-CENG-422



LEGEND

- STAGE BOUNDARY
- EXISTING LOT BOUNDARY
- MAJOR CONTOURS
- MINOR CONTOURS
- PROPOSED RETAINING WALL
- EXTENTS OF BATTER
- BUILDING PAD
- FORESTED WETLANDS
- RIPARIAN CORRIDOR

CONTOUR INTERVAL = 0.5m

DETAIL PLAN

SCALE 1:500

Northern Basin	
Parameter	Details
Levels	Basin floor at RL 17.7m
	Top of wall at RL 18.7m
Batters	1V:6H
Approximate Base Area	$2900m^2$
Required Detention Storage	$5000m^3$

DIAL 1100 BEFORE YOU DIG

100mm AT FULL SIZE

REV.	DATE	AMENDMENT	DESIGN	DRAWN	CHECKED	APPROVED
A	06.11.2018	PRELIMINARY ISSUE	J.B.	J.J.	M.L.	M.L.
B	25.06.2019	ADDITIONAL INFORMATION	J.B.	G.H.	M.L.	M.L.

DRAFT

SCALES: 0 12.5 25.0m SCALE: 1:500 (FULL)

DESIGN FILE S:\190526\Design\12D\DOYALSON WYEE RSL

ALL DIMENSIONS ARE IN METRES. DO NOT SCALE

adw johnson

Central Coast
5 Pioneer Avenue,
P.O. Box 3717,
Tuggerah N.S.W. 2259
Phone: (02) 4305 4300
Fax: (02) 4305 4399
email: coast@adwjohnson.com.au
www.adwjohnson.com.au
ABN 62 129 445 398

CLIENT: URBIS

PROPERTY DESCRIPTION: PACIFIC HIGHWAY, DOYALSON

SURVEYED: ADWJ

DATUM: A.H.D.

PROJECT: PROPOSED DEVELOPMENT

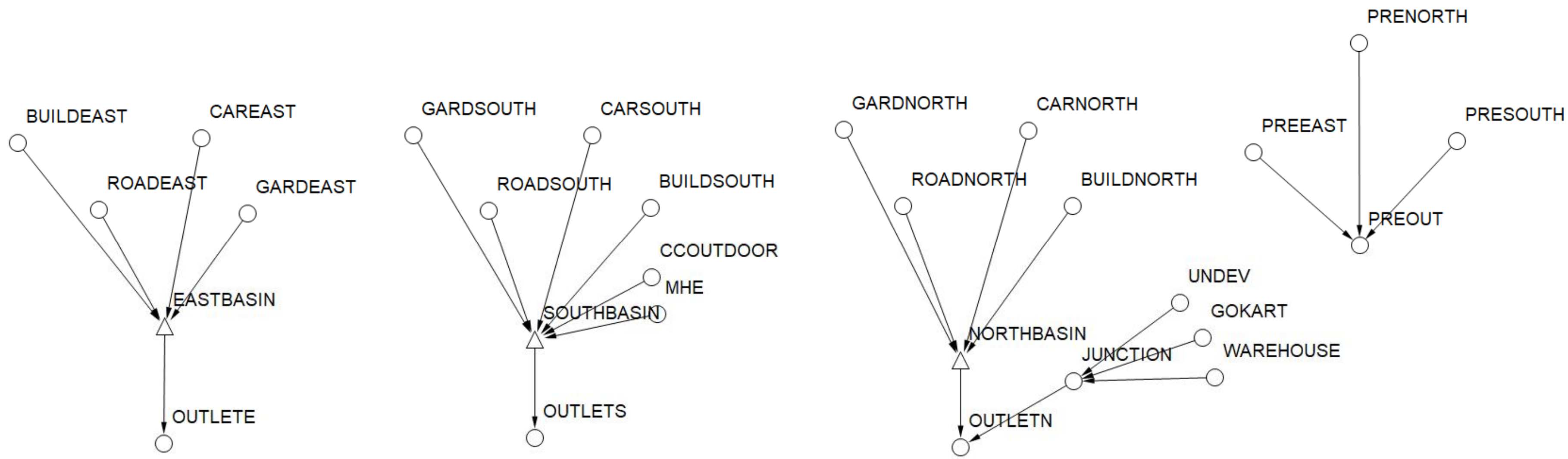
PLAN TITLE: BASIN PLAN SHEET 2

PROJECT No. 190526 – DISCIPLINE CENG – NUMBER 422 REV. B

Plotted By: Gail Hall Plot Date: 25/06/19 3:48:13PM Cad File: S:\190526\DWG'S\ENGINEERING\CIVIL\CENG\190526-CENG-422.DWG

Appendix A

XP RAFTS DETAILS



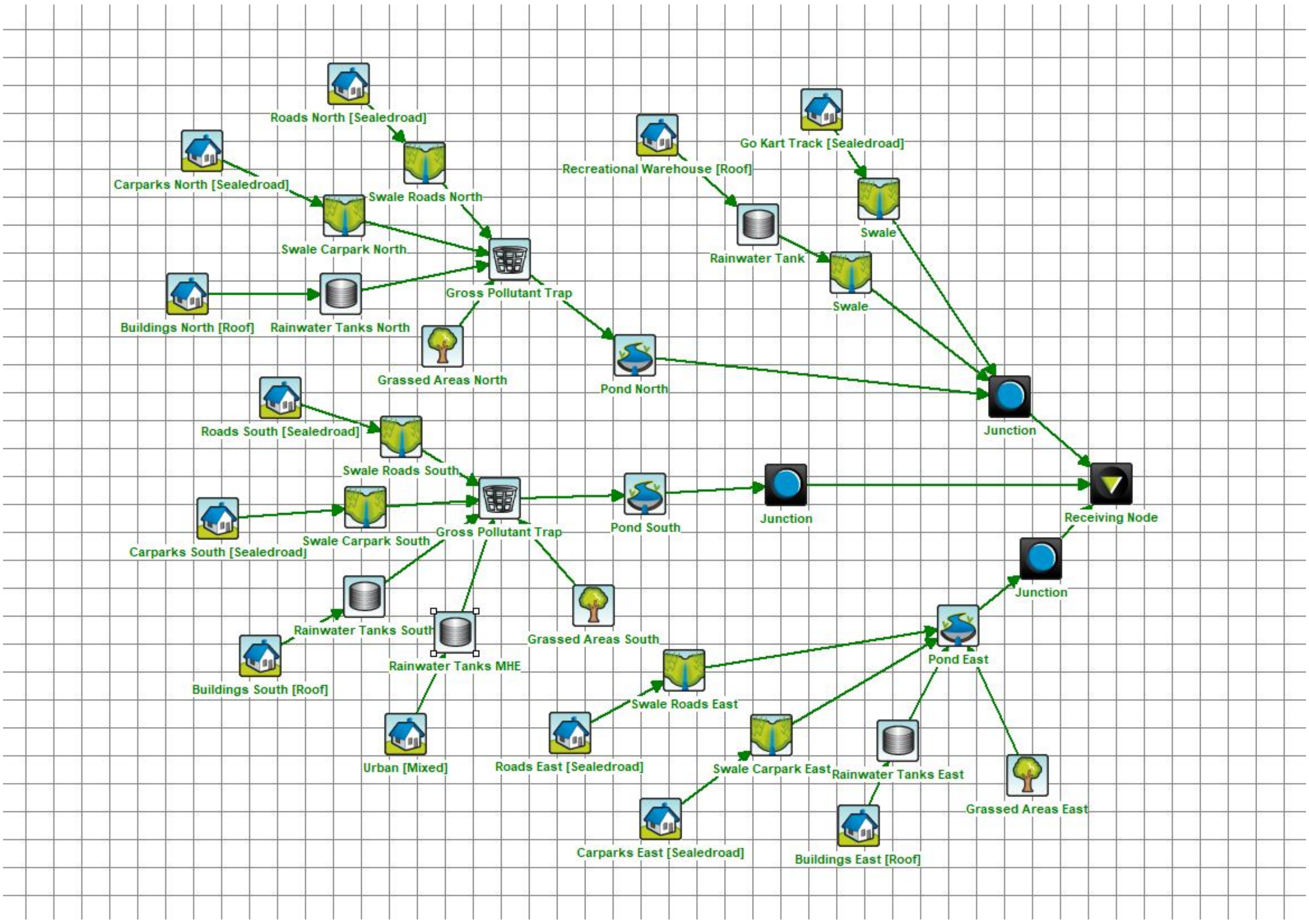
IFD COEFFICIENTS		
DURATION	**2yr**	**50yr**
1 hour	35.13	70.66
12 hour	8.02	16.42
72 hour	2.52	5.39

Geographical Factors:

- F2 = 4.31
- F50 = 15.93
- Skew = 0

Appendix B

MUSIC DETAILS & MUSIC-LINK REPORT



MUSIC-*link* Report

Project Details		Company Details	
Project:	Doylo RSL Rezoning	**Company:**	ADW Johnson
Report Export Date:	26/06/2019	**Contact:**	
Catchment Name:	DOYALSON-WYEE RSL REV B	**Address:**	
Catchment Area:	28.137ha	**Phone:**	
Impervious Area*:	80.76%	**Email:**	
Rainfall Station:	66062 SYDNEY		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1974 - 31/12/1993 11:54:00 PM		
Mean Annual Rainfall:	1297mm		
Evapotranspiration:	1261mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.31		
Study Area:	Upland		
Scenario:	Central Coast 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	33.8%	Rain Water Tank Node	5	Urban Source Node	12
TSS	91.9%	Swale Node	8	Forest Source Node	6
TP	76.2%	Pond Node	3		
TN	46.2%	GPT Node	3		
GP	100%				

Comments

Swale bed slopes are typical of the general slopes of roads designed.

Swale exfiltration rates are typical of a lower bound value for sand.

Central Coast Council

music link

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Forest	East Predev	Baseflow Total Nitrogen Mean (log mg/L)	-0.52	-0.52	-0.52
Forest	East Predev	Baseflow Total Phosphorus Mean (log mg/L)	-1.52	-1.52	-1.52
Forest	East Predev	Baseflow Total Suspended Solids Mean (log mg/L)	0.78	0.78	0.78
Forest	East Predev	Stormflow Total Nitrogen Mean (log mg/L)	-0.05	-0.05	-0.05
Forest	East Predev	Stormflow Total Phosphorus Mean (log mg/L)	-1.1	-1.1	-1.1
Forest	East Predev	Stormflow Total Suspended Solids Mean (log mg/L)	1.6	1.6	1.6
Forest	Grassed Areas East	Baseflow Total Nitrogen Mean (log mg/L)	-0.52	-0.52	-0.52
Forest	Grassed Areas East	Baseflow Total Phosphorus Mean (log mg/L)	-1.52	-1.52	-1.52
Forest	Grassed Areas East	Baseflow Total Suspended Solids Mean (log mg/L)	0.78	0.78	0.78
Forest	Grassed Areas East	Stormflow Total Nitrogen Mean (log mg/L)	-0.05	-0.05	-0.05
Forest	Grassed Areas East	Stormflow Total Phosphorus Mean (log mg/L)	-1.1	-1.1	-1.1
Forest	Grassed Areas East	Stormflow Total Suspended Solids Mean (log mg/L)	1.6	1.6	1.6
Forest	Grassed Areas North	Baseflow Total Nitrogen Mean (log mg/L)	-0.52	-0.52	-0.52
Forest	Grassed Areas North	Baseflow Total Phosphorus Mean (log mg/L)	-1.52	-1.52	-1.52
Forest	Grassed Areas North	Baseflow Total Suspended Solids Mean (log mg/L)	0.78	0.78	0.78
Forest	Grassed Areas North	Stormflow Total Nitrogen Mean (log mg/L)	-0.05	-0.05	-0.05
Forest	Grassed Areas North	Stormflow Total Phosphorus Mean (log mg/L)	-1.1	-1.1	-1.1
Forest	Grassed Areas North	Stormflow Total Suspended Solids Mean (log mg/L)	1.6	1.6	1.6
Forest	Grassed Areas South	Baseflow Total Nitrogen Mean (log mg/L)	-0.52	-0.52	-0.52
Forest	Grassed Areas South	Baseflow Total Phosphorus Mean (log mg/L)	-1.52	-1.52	-1.52
Forest	Grassed Areas South	Baseflow Total Suspended Solids Mean (log mg/L)	0.78	0.78	0.78
Forest	Grassed Areas South	Stormflow Total Nitrogen Mean (log mg/L)	-0.05	-0.05	-0.05
Forest	Grassed Areas South	Stormflow Total Phosphorus Mean (log mg/L)	-1.1	-1.1	-1.1
Forest	Grassed Areas South	Stormflow Total Suspended Solids Mean (log mg/L)	1.6	1.6	1.6
Forest	North Predev	Baseflow Total Nitrogen Mean (log mg/L)	-0.52	-0.52	-0.52
Forest	North Predev	Baseflow Total Phosphorus Mean (log mg/L)	-1.52	-1.52	-1.52
Forest	North Predev	Baseflow Total Suspended Solids Mean (log mg/L)	0.78	0.78	0.78
Forest	North Predev	Stormflow Total Nitrogen Mean (log mg/L)	-0.05	-0.05	-0.05
Forest	North Predev	Stormflow Total Phosphorus Mean (log mg/L)	-1.1	-1.1	-1.1
Forest	North Predev	Stormflow Total Suspended Solids Mean (log mg/L)	1.6	1.6	1.6
Forest	South Predev	Baseflow Total Nitrogen Mean (log mg/L)	-0.52	-0.52	-0.52
Forest	South Predev	Baseflow Total Phosphorus Mean (log mg/L)	-1.52	-1.52	-1.52
Forest	South Predev	Baseflow Total Suspended Solids Mean (log mg/L)	0.78	0.78	0.78
Forest	South Predev	Stormflow Total Nitrogen Mean (log mg/L)	-0.05	-0.05	-0.05
Forest	South Predev	Stormflow Total Phosphorus Mean (log mg/L)	-1.1	-1.1	-1.1
Forest	South Predev	Stormflow Total Suspended Solids Mean (log mg/L)	1.6	1.6	1.6
GPT	Gross Pollutant Trap	Hi-flow bypass rate (cum/sec)	None	99	99
GPT	Gross Pollutant Trap	Hi-flow bypass rate (cum/sec)	None	99	99
GPT	Gross Pollutant Trap	Hi-flow bypass rate (cum/sec)	None	99	99
Pond	Pond East	Evaporative Loss as % of PET	100	100	100

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Pond	Pond East	Extended detention depth (m)	0.25	1	0.7
Pond	Pond North	Evaporative Loss as % of PET	100	100	100
Pond	Pond North	Extended detention depth (m)	0.25	1	0.7
Pond	Pond South	Evaporative Loss as % of PET	100	100	100
Pond	Pond South	Extended detention depth (m)	0.25	1	1
Receiving	Receiving Node	% Load Reduction	None	None	33.8
Receiving	Receiving Node	GP % Load Reduction	90	None	100
Receiving	Receiving Node	TN % Load Reduction	45	None	46.2
Receiving	Receiving Node	TP % Load Reduction	45	None	76.2
Receiving	Receiving Node	TSS % Load Reduction	80	None	91.9
Swale	Swale	Bed slope	0.02	0.05	0.02
Swale	Swale	Bed slope	0.02	0.05	0.02
Urban	Buildings East	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.32
Urban	Buildings East	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.82
Urban	Buildings East	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.1
Urban	Buildings East	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.3	0.3
Urban	Buildings East	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.89	-0.89
Urban	Buildings East	Stormflow Total Suspended Solids Mean (log mg/L)	1.3	1.3	1.3
Urban	Buildings North	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.32
Urban	Buildings North	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.82
Urban	Buildings North	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.1
Urban	Buildings North	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.3	0.3
Urban	Buildings North	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.89	-0.89
Urban	Buildings North	Stormflow Total Suspended Solids Mean (log mg/L)	1.3	1.3	1.3
Urban	Buildings South	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.32
Urban	Buildings South	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.82
Urban	Buildings South	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.1
Urban	Buildings South	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.3	0.3
Urban	Buildings South	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.89	-0.89
Urban	Buildings South	Stormflow Total Suspended Solids Mean (log mg/L)	1.3	1.3	1.3
Urban	Carparks East	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Carparks East	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	Carparks East	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Carparks East	Stormflow Total Nitrogen Mean (log mg/L)	0.34	0.34	0.34
Urban	Carparks East	Stormflow Total Phosphorus Mean (log mg/L)	-0.3	-0.3	-0.3
Urban	Carparks East	Stormflow Total Suspended Solids Mean (log mg/L)	2.43	2.43	2.43
Urban	Carparks North	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Carparks North	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	Carparks North	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Carparks North	Stormflow Total Nitrogen Mean (log mg/L)	0.34	0.34	0.34

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Carparks North	Stormflow Total Phosphorus Mean (log mg/L)	-0.3	-0.3	-0.3
Urban	Carparks North	Stormflow Total Suspended Solids Mean (log mg/L)	2.43	2.43	2.43
Urban	Carparks South	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Carparks South	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	Carparks South	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Carparks South	Stormflow Total Nitrogen Mean (log mg/L)	0.34	0.34	0.34
Urban	Carparks South	Stormflow Total Phosphorus Mean (log mg/L)	-0.3	-0.3	-0.3
Urban	Carparks South	Stormflow Total Suspended Solids Mean (log mg/L)	2.43	2.43	2.43
Urban	Go Kart Track	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Go Kart Track	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	Go Kart Track	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Go Kart Track	Stormflow Total Nitrogen Mean (log mg/L)	0.34	0.34	0.34
Urban	Go Kart Track	Stormflow Total Phosphorus Mean (log mg/L)	-0.3	-0.3	-0.3
Urban	Go Kart Track	Stormflow Total Suspended Solids Mean (log mg/L)	2.43	2.43	2.43
Urban	MHE	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	MHE	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	MHE	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	MHE	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.3	0.3
Urban	MHE	Stormflow Total Phosphorus Mean (log mg/L)	-0.6	-0.6	-0.6
Urban	MHE	Stormflow Total Suspended Solids Mean (log mg/L)	2.15	2.15	2.15
Urban	Recreational Warehouse	Baseflow Total Nitrogen Mean (log mg/L)	0.32	0.32	0.32
Urban	Recreational Warehouse	Baseflow Total Phosphorus Mean (log mg/L)	-0.82	-0.82	-0.82
Urban	Recreational Warehouse	Baseflow Total Suspended Solids Mean (log mg/L)	1.1	1.1	1.1
Urban	Recreational Warehouse	Stormflow Total Nitrogen Mean (log mg/L)	0.3	0.3	0.3
Urban	Recreational Warehouse	Stormflow Total Phosphorus Mean (log mg/L)	-0.89	-0.89	-0.89
Urban	Recreational Warehouse	Stormflow Total Suspended Solids Mean (log mg/L)	1.3	1.3	1.3
Urban	Roads East	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Roads East	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	Roads East	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Roads East	Stormflow Total Nitrogen Mean (log mg/L)	0.34	0.34	0.34
Urban	Roads East	Stormflow Total Phosphorus Mean (log mg/L)	-0.3	-0.3	-0.3
Urban	Roads East	Stormflow Total Suspended Solids Mean (log mg/L)	2.43	2.43	2.43
Urban	Roads North	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Roads North	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85
Urban	Roads North	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Roads North	Stormflow Total Nitrogen Mean (log mg/L)	0.34	0.34	0.34
Urban	Roads North	Stormflow Total Phosphorus Mean (log mg/L)	-0.3	-0.3	-0.3
Urban	Roads North	Stormflow Total Suspended Solids Mean (log mg/L)	2.43	2.43	2.43
Urban	Roads South	Baseflow Total Nitrogen Mean (log mg/L)	0.11	0.11	0.11
Urban	Roads South	Baseflow Total Phosphorus Mean (log mg/L)	-0.85	-0.85	-0.85

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Roads South	Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.2	1.2
Urban	Roads South	Stormflow Total Nitrogen Mean (log mg/L)	0.34	0.34	0.34
Urban	Roads South	Stormflow Total Phosphorus Mean (log mg/L)	-0.3	-0.3	-0.3
Urban	Roads South	Stormflow Total Suspended Solids Mean (log mg/L)	2.43	2.43	2.43

Only certain parameters are reported when they pass validation

Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Swale	Swale	Exfiltration Rate (mm/hr)	0	0	36
Swale	Swale	Exfiltration Rate (mm/hr)	0	0	36
Swale	Swale Carpark East	Bed slope	0.02	0.05	0.01
Swale	Swale Carpark East	Exfiltration Rate (mm/hr)	0	0	36
Swale	Swale Carpark North	Bed slope	0.02	0.05	0.01
Swale	Swale Carpark North	Exfiltration Rate (mm/hr)	0	0	36
Swale	Swale Carpark South	Bed slope	0.02	0.05	0.01
Swale	Swale Carpark South	Exfiltration Rate (mm/hr)	0	0	36
Swale	Swale Roads East	Bed slope	0.02	0.05	0.01
Swale	Swale Roads East	Exfiltration Rate (mm/hr)	0	0	36
Swale	Swale Roads North	Bed slope	0.02	0.05	0.01
Swale	Swale Roads North	Exfiltration Rate (mm/hr)	0	0	36
Swale	Swale Roads South	Bed slope	0.02	0.05	0.01
Swale	Swale Roads South	Exfiltration Rate (mm/hr)	0	0	36

Only certain parameters are reported when they pass validation