WATER CYCLE MANAGEMENT STRATEGY

FOR

13L NARROMINE ROAD & LOT 7 JANNALI ROAD, DUBBO

STAGE 6

REF: MKR00357-16

VERSION 02 | AUGUST 2022

Prepared For:

The Bathla Group

MAKER ENG

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Approved: Angus Dyson Date: 19 August 2022

Version Amendment Record

Document	Outline of Amendments	Amended By	Date Amended
Version 1	Issue for DA	LH	19 August 2022
Version 2	Issue for DA	LH	25 August 2022

1 INTRODUCTION AND BACKGROUND

MakerENG Pty Ltd ('Maker') has been engaged by The Bathla Group to prepare a Water Cycle Management Strategy (WCMS) to assist in the preparation of a development application for Stage 6 of the subdivision of Lot 22 DP1038924 (13L Narromine Road, Dubbo) and Lot 7 DP223428 (Jannali Road, Dubbo).

Stage 6 is a part of a proposed masterplan and covers developing the northern portion of the site including the Narromine Road intersection into an industrial Business Park area.

Stormwater management considerations have been conducted based on:

- Dubbo Regional Council Local Environment Plan 2022
- Dubbo Regional Council Development Control Plan 2013
- Dubbo Regional Council Draft Clearmont Rise Development Control Plan X

Future development of the site is to be consistent with the aims of the Dubbo Regional Local Environment Plan 2022, particularly:

- To manage urban stormwater to prevent damage to downstream development
- To implement ecologically sustainable development to conserve environmental resources for the benefit of current and future generations

1.1 SITE DESCRIPTION

The total site area is 273.4ha, a crest splits the site into two major catchments however it predominantly grades to the northwest with a typical grade of 1-3%. The site is located south of Narromine Road, and to the east of Jannali Road. It is bounded to the south by the Main Western Railway, and by large rural residential lots accessed by Rosedale Road to the west. To the central east there is the TAFE NSW Dubbo campus and to the North across Narromine Road is the Dubbo City Regional Airport.

Stage 6 is 67ha and located within the north most portion of the site along Narromine Road. Stage 1 is to the south of the proposed Stage 6 area. Runoff from Stage 1 is conveyed through Stage 6. Both Stage 6 and Stage 1 discharge to the existing box culverts beneath Narromine Road.

The site is currently maintained as a grass paddock with several outbuildings and sheds. The Stage 6 extents are shown over a recent aerial image in **Figure 1**.

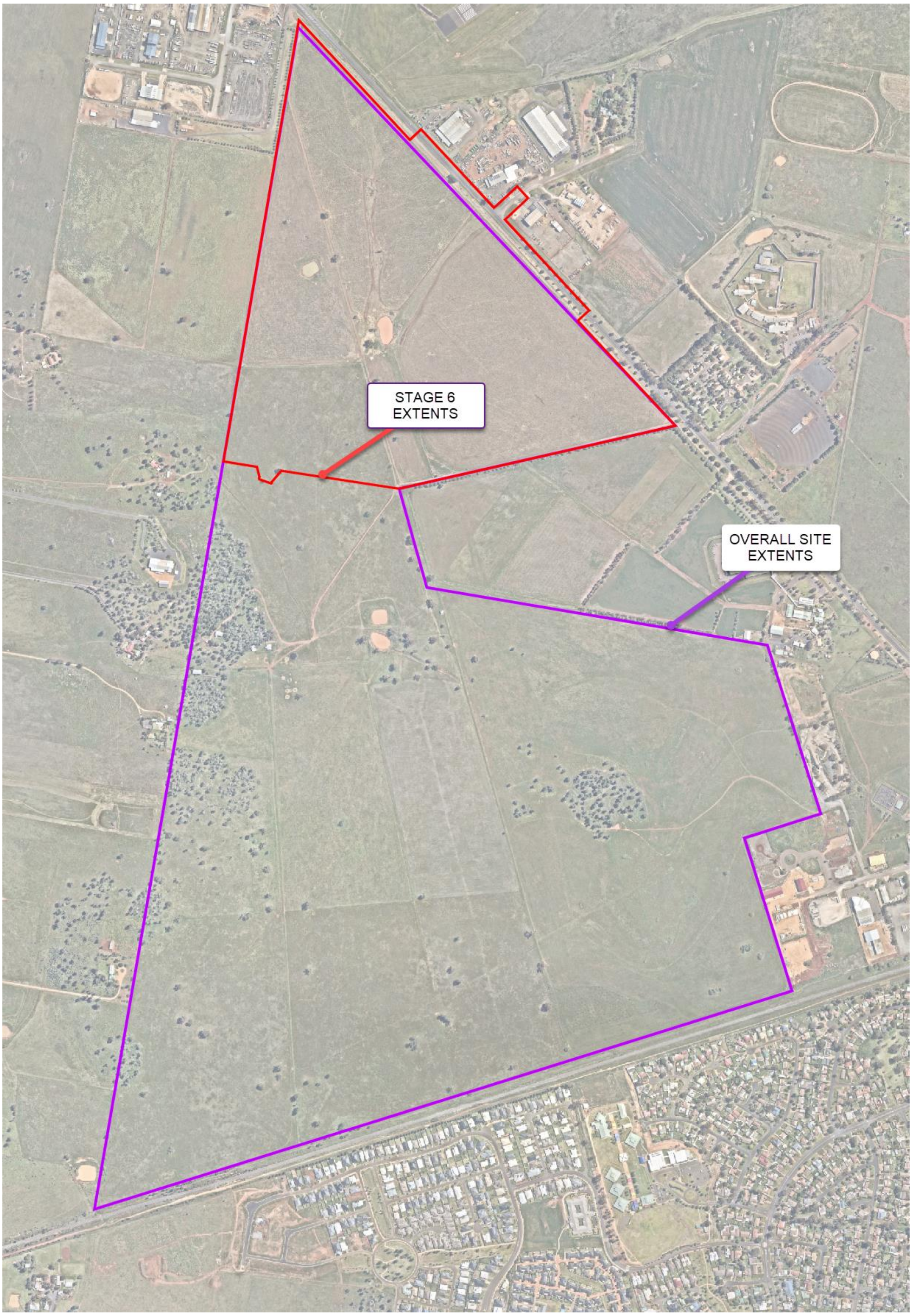


Figure 1 – Aerial image of site and Stage 6 extents (Nearmap, 2022)

1.2 PROPOSED DEVELOPMENT

1.2.1 Master Plan

It is proposed to subdivide the site into a 181ha residential area (generally the southern two thirds of the site) consisting of approximately 1650 residential lots and a 66ha Business Park (generally the northern third of the site) consisting of 10 super lots. The proposal also includes approximately 86 new public roads, with access provided via a new arterial road which will connect to Narromine Road.

A master plan has been developed to convey, treat the quality of, and provide detention for stormwater from the proposed developed site to meet the requirements of the Clearmont Rise DCP. Large conveyance channels will transport stormwater from the northern and central residential areas to a central On-Site Detention [OSD] basin. A second OSD basin is proposed in the northern corner of the site and has inflow from the Business Park, central OSD and TAFE site. The northern OSD basin discharges to existing box culverts crossing Narromine Road and is adequately sized to ensure the fully developed site will not exceed predeveloped peak outflow rates.

Flows are conveyed between the central and northwest basins via an under-road trunk drainage pipe network consisting of triple Reinforced Concrete Pipes.

The remaining residential area in the southern portion of the site is managed via conveyance swales and by another OSD basin, which discharges to the existing stormwater channel within the Main Western Railway corridor.

Stormwater quality for the overall central and northern areas of the site is managed with a treatment train consisting of the following:

- Vegetated conveyance swales through the central and northern residential areas
- Bioretention basin within the central OSD area – it is proposed that three 800m^2 basins will be installed
- Small trash racks and bioretention basins on Business Park super lots
- Trash racks within all OSD basins
- Connection to the downstream swale external to site within the airport precinct

The proposed overall site treatment train has been designed in MUSIC considering a complete developed site and achieves the pollutant reduction targets of the Clearmont Rise Area Specific DCP discussed within section 3 of this report.

A separate treatment train will treat the southern area of the site consisting of:

- Vegetated conveyance swales through the southern residential areas
- Bioretention basin within the southern OSD area
- Trash racks within the OSD basin

For further details of the treatment train refer to section 3 of this report and the Water Cycle Management Strategy for Stage 6. These 2 reports cover the majority of the proposed treatment devices, with exception of the expansion of the central OSD bioretention basins which will be completed alongside Stages 2 and 3.

Overall catchments for the master plan are shown below in **Figure 2** and in Appendix C.

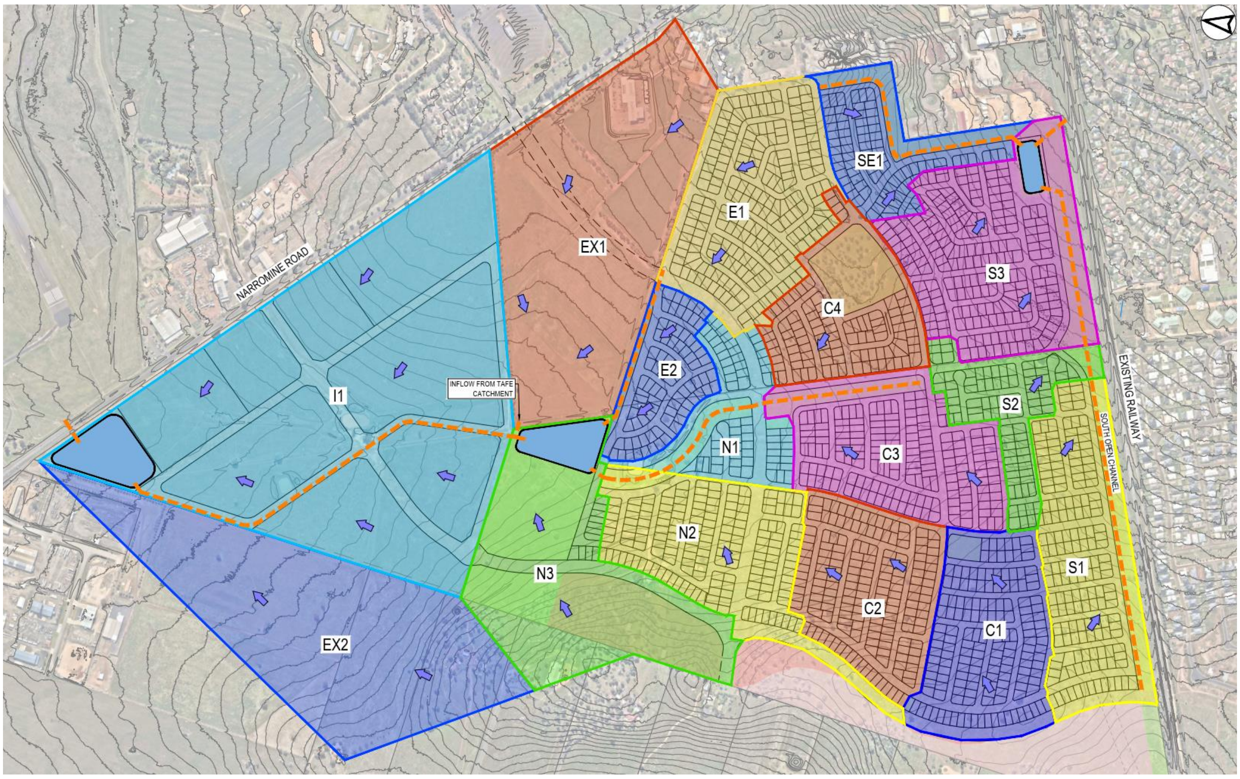


Figure 2 – Master catchment plan with trunk conveyance marked in orange and basins marked in blue

1.2.2 Stage 6

Stage 6 proposes to subdivide the northern most portion of the site into 9 industrial lots. Refer to Stage 6 development application drawings, MKR00357-16, for further details.

The proposed development will alter the hydrology of the site. There will be a significant increase in impervious area. The current open paddock rural area with scattered sheds and access tracks is considered 5% impervious.. The existing dams onsite are proposed to be decommissioned and filled in. Flows from undeveloped areas will remain unchanged, flowing overland to their existing discharge location at Narromine Road.

OSD and stormwater quality improvements devices are proposed within Stage 6 to appropriately manage the stormwater runoff from the proposed development.

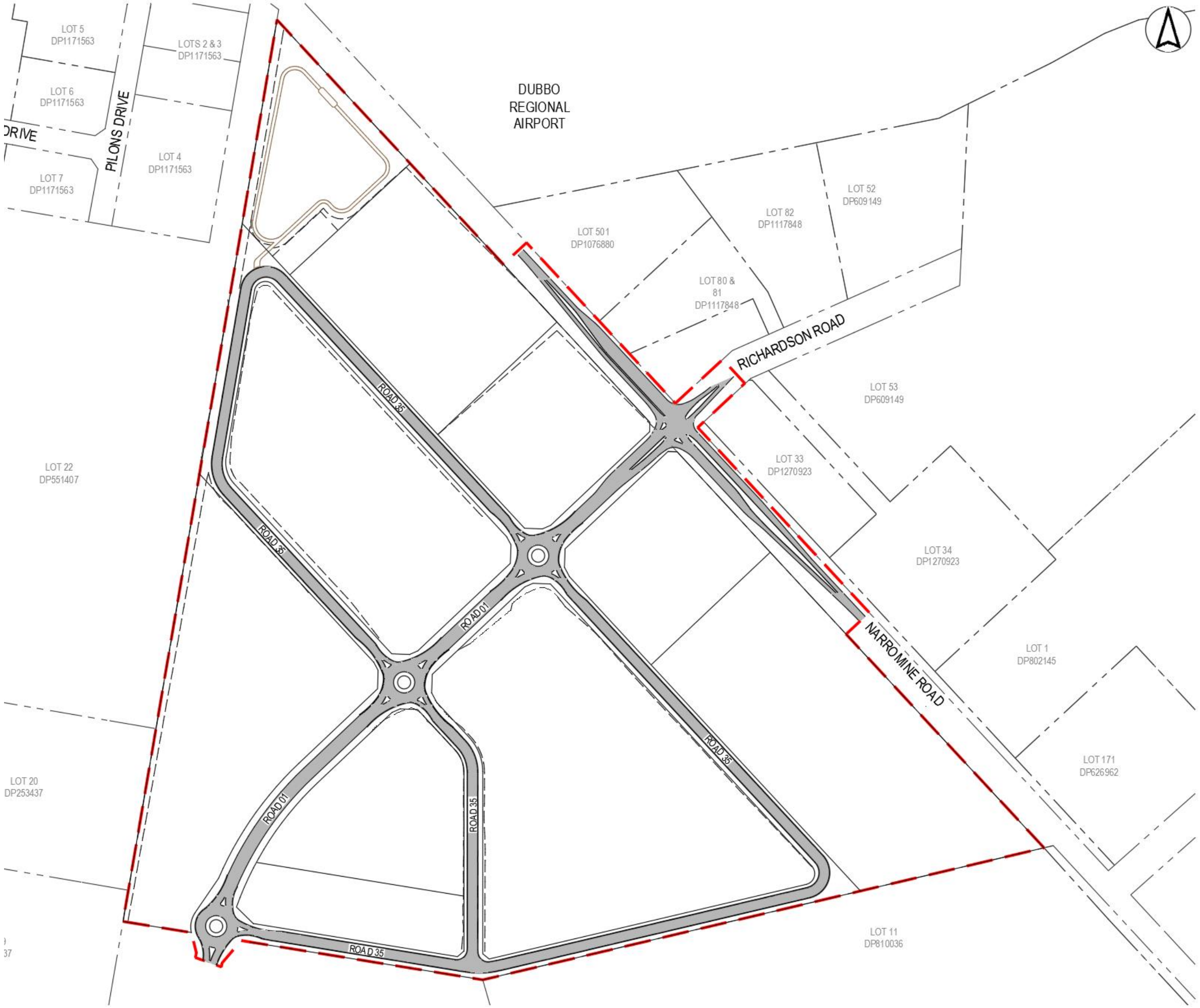


Figure 3 – Proposed Stage 6 work extents

2 STORMWATER QUANTITY MANAGEMENT

2.1 ONSITE STORMWATER DETENTION (OSD)

The DCP for Industrial development includes a performance criteria that "Drainage from development sites is not larger than the pre-development stormwater patterns" and suggests "providing onsite stormwater detention typically will be required to meet that criteria".

Onsite stormwater detention is to be provided to ensure peak flows do not increase due to the development. Watershed Bounded Network Model (WBNM) was utilized to determine peak flows and design adequately sized OSD basins for the development. ARR2019 rainfall data used within the model was taken from the ARR Datahub (Lat: -32.220000, Long: 148.580000). The flow rate for the critical burst duration for the 20, 10, 2 and 1% AEP storm events were determined.

2.1.1 Stage 6 OSD

To reduce the size of the proposed OSD basin within the Business Park the masterplan strategy involved over attenuation of flows discharging from the residential area. This is achieved by providing an oversized central OSD basin within the Public Open Space, located between the Business Park and residential zones. Due to this the northern (Stage 6) OSD basin alone is insufficient in attenuating site discharge to predeveloped rates. Therefore, the central interim (Stage 1) OSD basin is required to be constructed as part of or concurrently with Stage 6 works. Refer to the Stage 1 Water Cycle Management Strategy for full details relating to this basin.

The Stage 6 OSD basin requires a storage volume of 15000m^3 (including freeboard allowance) and will manage the flows from the Business Park, and upstream areas of the site. It is to be located in the north west corner of the property, adjacent to Narromine Road and outlets directly to the northern discharge point, at the Narromine Road culverts. Note that these existing culverts are proposed to be upgraded as part of the Stage 6 works, see Section 2.3 of this report. The total catchment area considered for the Stage 6 OSD design was 235.98Ha which includes the undeveloped upstream areas (future residential area), the existing TAFE site, and the proposed Stage 6 Business Park area.

The predevelopment impervious area was set at 5% considering the scattered sheds and access tracks on the existing site. The post-developed impervious area was set at 13% for the TAFE site (based on the aerial image), 70% for proposed roads (based on the proposed cross section) and 90% for proposed Business Park lots. The interim central OSD basin proposed as a part of Stage 1 drains to the northern OSD basin, prior to its discharge at the existing Narromine Road culvert crossing. The flow from the central basin is conveyed through the Business Park via the trunk drainage detailed in Section 2.2 of this report. Stormwater from most of the Business Park area will enter the trunk drainage to be conveyed to the northern OSD. The northern most lots will be conveyed separately via a street drainage network. The outlet configuration of the northern OSD basin includes a 4500mm wide x 1000mm tall headwall outlet at RL 284.0mAHD, and a high flow weir of length 25m.

The OSD is effective at ensuring peak flows do not increase due to the Stage 6 development, as shown below in Table 1. See Appendix A for complete WBNM results.

Table 1 – Stage 6 – Pre and post developed peak flows

Scenario/ Discharge	20% AEP peak flows (m^3/s)	10% AEP peak flows (m^3/s)	2% AEP peak flows (m^3/s)	1% AEP peak flows (m^3/s)
Predevelopment	7.94	10.269	15.528	17.998
Post development	6.956	8.372	13.186	16.488

2.2 TRUNK DRAINAGE

Trunk drainage is proposed under portions of Road 35 throughout the Business Park area. This drainage is designed to convey the flows from the Stage 1 OSD and TAFE site to the Stage 6 OSD basin. Additionally local flows from Lots B5, B6, B7 and B8, and Roads R1, R5, R5, R7 and R8 1 will enter the drainage to be conveyed to the basin. Refer to Appendix B: catchment plan.

The trunk drainage has been proposed as pipes which will be installed under the road. Three pipes are proposed along the whole length of the drainage with two increases in pipe diameter. The pipe sizing was completed in DRAINS with an inflow hydrograph representing the flows from the Central OSD basin and the TAFE site, and sub catchments at each inlet point reflecting the local flows. The pipes were sized to contain the 1% AEP fully. The pipes leaving the central OSD are sized at 3 x DN1050, upsizing to 3 x DN1500 at the first local inlet point, and once again to 3 x DN1650 at the final local inlet point before prior to the northern OSD basin. See Appendix B: Stage 6 catchment plan for pipe size locations.

2.2.1 Additional Drainage

The flows from the northern lots, B1, B2, B3, B4 and roads R3 and R4 will be conveyed to the OSD basin via a pipe network in the road.

External flows from the farm catchment to the west of the development area are to be diverted around the site to the existing Narromine Road culverts via a cut-off drain. These flows do not enter any of the proposed OSD basins.

The run-off from road section R2 flows towards Narromine Road and will enter the existing roadside swale on the southern side of the road.

2.3 NARROMINE ROAD CULVERT

The existing culverts under Narromine Road will not be upgraded as part of Stage 6 works. The current culvert configuration is 4 x 1800mm W x 600mm H box culverts with total length 16m. The upstream invert level is RL 283.74mAHD, and downstream invert level RL 283.59mAHD. The road currently overtops at RL 284.89mAHD. The existing culverts have capacity for approximately 10.5m^3/s before overtopping the road and therefore are insufficient to cater for both the existing and proposed 1% AEP peak flows.

At a height of 600mm an additional flow width of 4800mm is required to convey the 1% AEP flow of 18.1 m^3/s without the road overtopping. This is to be achieved with provision of an additional 2 x 1800mm W x 600mm H box culverts with a link slab achieving the remaining 1200mm width.

The development has been designed to ensure existing flows are not increased for all events up to the 1% AEP, therefore, upgrades to the existing Narromine Road culverts are the responsibility of the Road Authorities.

3 STORMWATER QUALITY AND WATERWAY PROTECTION

3.1 STORMWATER RETENTION AND REUSE

Rainwater tanks are proposed on each industrial lot, sized at a conservative ratio of approximately 1kL per 550m^2 roof area and rounded to the nearest 10kL. Re-use on the tanks was set in line with the Using MUSIC in the Sydney Drinking Water Catchment Guidelines indicative suggestions for industrial use. They are: 0.1kL/day/1000m^2 of roof area for internal use and 20kL/yr/1000m^2 of roof area for external use. Suitability of these values will need to be assessed by Council during the assessment of future development applications for building on the individual lots.

3.2 POLLUTANT REDUCTION

The Clearmont Rise DCP Draft development control number 4), states that the stormwater management regime should achieve the following reduction targets shown in **Table 2**, as per the Clearmont Rise Area Specific DCP.

Table 2 Target pollutant reductions

Pollutant	Target % reduction
Total suspended solids	80
Total phosphorus	40
Total nitrogen	45

Development control number 3) states that "the water cycle management strategy is to achieve the reduction of stormwater discharge and pollutants by including the following elements: rainwater tanks on each lot, gross pollutant traps, bioretention areas and detention basins".

3.3 MASTERPLAN

The proposed stormwater quality master plan for all water discharging to the north has been modelled in MUSIC and represented in the conceptual schematic **Figure 4**. Refer to Stage 1 Water Cycle Management Report for details on proposed residential treatment train devices. During discussion with Council on 4th August 2022, it was suggested that the existing external swale through the airport site be considered in the overall treatment train from the site. The swale begins on the north side of Narromine Road, immediately after the discharge culverts.

The treatment train effectiveness of the proposed masterplan is presented in **Figure 5**. These results comply with the targets in **Table 2**.

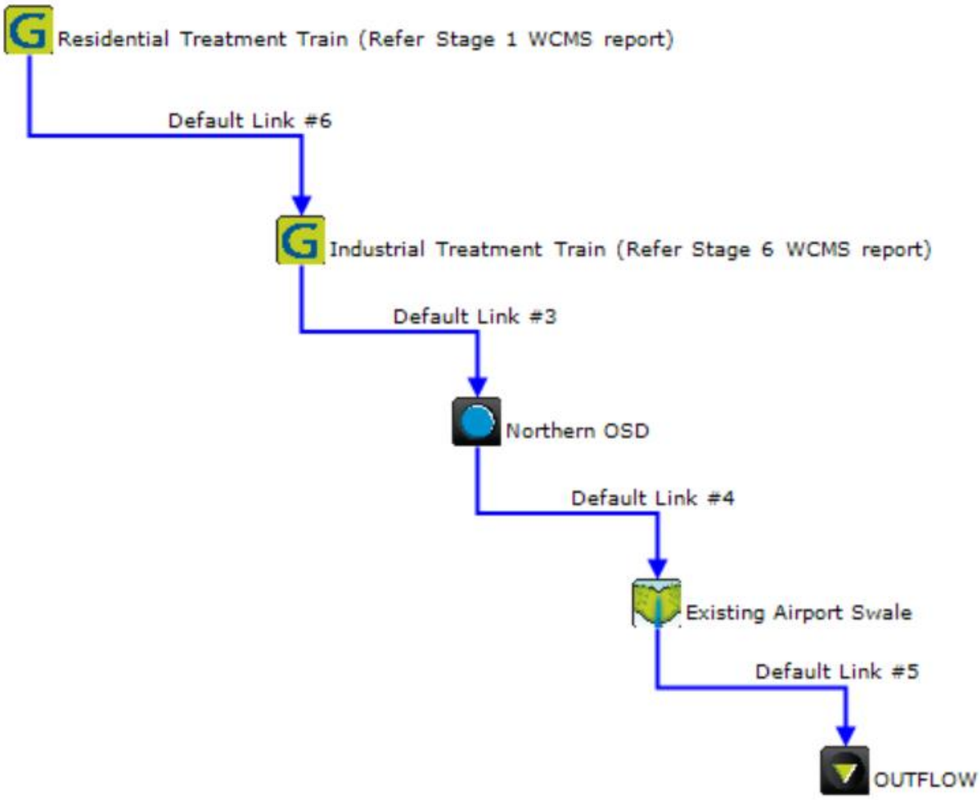


Figure 4 Conceptual masterplan schematic

	Sources	Residual Load	% Reduction
Flow (ML/yr)	441.9	382.2	13.5
Total Suspended Solids (kg/yr)	5.877E+04	8132	86.16
Total Phosphorus (kg/yr)	128.1	53.53	58.21
Total Nitrogen (kg/yr)	1065	584.5	45.12
Gross Pollutants (kg/yr)	1.479E+04	0	100

Figure 5 Masterplan treatment train effectiveness

3.4 MUSIC

3.4.1 Data

The data used within MUSIC is the 6min Rainfall and monthly areal PET collected from Dubbo Airport. The period selected was a 3-year range from July 2006 to July 2009, due to incomplete records. This time period includes a particularly wet period during the summer of 07-08, and a drier period during the summer from 06-07. Mean annual rainfall over the model period is 580 mm, compared to a long-term average of 570 mm.

3.4.2 Treatment Train

A treatment train is proposed to reduce runoff and remove pollutants. This is composed of rainwater tanks, trash racks, bioretention basins and swales. The treatment nodes were included in the model as outlined below. A diagram of the treatment train is shown in **Figure 6**.

It is proposed to treat stormwater on lots with a treatment train of rainwater tanks, litter baskets and small bioretention filters.

Source nodes for proposed lots within MUSIC were split into roof area going to a tank and additional area. this was completed by assigning 60% of the lot area to be roof, and the remaining 40% to be carpark/open space with an impervious percentage of 90%. The impervious area for the roof was set to 100% with a rainfall threshold value of 0.3. The remaining (non-roof) area of the lots is modelled as Urban – Industrial with a rainfall threshold value of 1.0. The road source nodes are modelled as Urban – Sealed Roads with an impervious fraction of 70% and a rainfall threshold value of 1.5.

<u>Rainwater tanks:</u>

It is assumed that 100% of the roof area will flow to the rainwater tank. Overflow from the tank will be treated within the bioretention basin. The tanks were sized at a minimum consideration and can be increased as the lot owner desires to capture and reuse more water. This may decrease the required size of bioretention basin on the lots. Decreasing the size of any water quality treatment device requires detailed water quality modelling and assessment and approval from Council. Refer to Section 3.1 for reuse assumptions and Table 4 for the required Tank sizes for each lot. Note that the rainwater tank volume was determined as a minimum as different industrial lots may have vastly differing capture and re-use goals based on the industrial uses on that specific lot. The same ratio was used on each lot as a general base.

<u>Litter baskets</u>

Overflow from the rainwater tank and other areas of the site are modelled to enter an OceanGuard (pit inset litter bag) from Ocean Protect. The litter basket acts to capture gross pollutants prior to the bioretention basin. The Ocean Protect OceanGuard was modelled using the NSW node set provided by Ocean Protect. See Appendix D for technical guidelines and maintenance documentation for the OceanGuard. Alternative devices may be used with Council approval and following verification of the equivalent water quality results.

On-lot bioretention

A bioretention basin was modelled on each industrial lot with the properties presented in **Table 3**. The bioretention basin will discharge to the respective water conveyance network. The bioretention system may be replaced with another stormwater quality improvement device of the same reduction capacity or greater and subject to approval from Council.

Table 3 Bioretention properties

Bioretention Node Parameter	Value
Area	0.8% of super lot size
Plant type	Effective nutrient removal
Extended detention depth	200mm
Filter media depth	500mm
TN content of filter media	400mg/kg
Orthophosphate content of filter media	40mg/kg

Roadside swales

Swales are proposed along Roads 2, 3, 5 and 7, refer to Appendix B Catchment Plan. These are located within the road reserve and provide localized treatment for the road flows themselves. The swales are proposed with a base width of 0.6m, top width of 1.5m and depth of 0.5m.

Basin trash rack

An end of line trash rack is included in the model to prevent gross pollutants from entering the OSD basin. The Urban Asset Solutions Trash Rack was modelled for this purpose which has a gross pollutant removal efficiency of 97%. Any trash rack with a similar performance may be utilised in place of this particular device, subject to Council approval.

The treatment train schematic within MUSIC and pollutant reduction results are presented in Figures 6 & 7.

Table 4 specifies each lot and the water quality treatment device size included in the MUSIC model. **Table 4** does not include the proposed litter basket.

Table 4 Lot specific treatment device sizing

Lot Number	Stormwater Improvement Device	Required Size
1	Rainwater tank	60kL
	Bioretention basin	423.2m^2
2	Rainwater tank	40kL
	Bioretention basin	278.4m^2
3	Rainwater tank	40kL
	Bioretention basin	278.4m^2
4	Rainwater tank	90kL
	Bioretention basin	694.4m^2
5	Rainwater tank	100kL
	Bioretention basin	918.4m^2
6	Rainwater tank	60kL
	Bioretention basin	452.82m^2
7	Rainwater tank	90kL
	Bioretention basin	659.2m^2
8	Rainwater tank	90kL
	Bioretention basin	642.4m^2

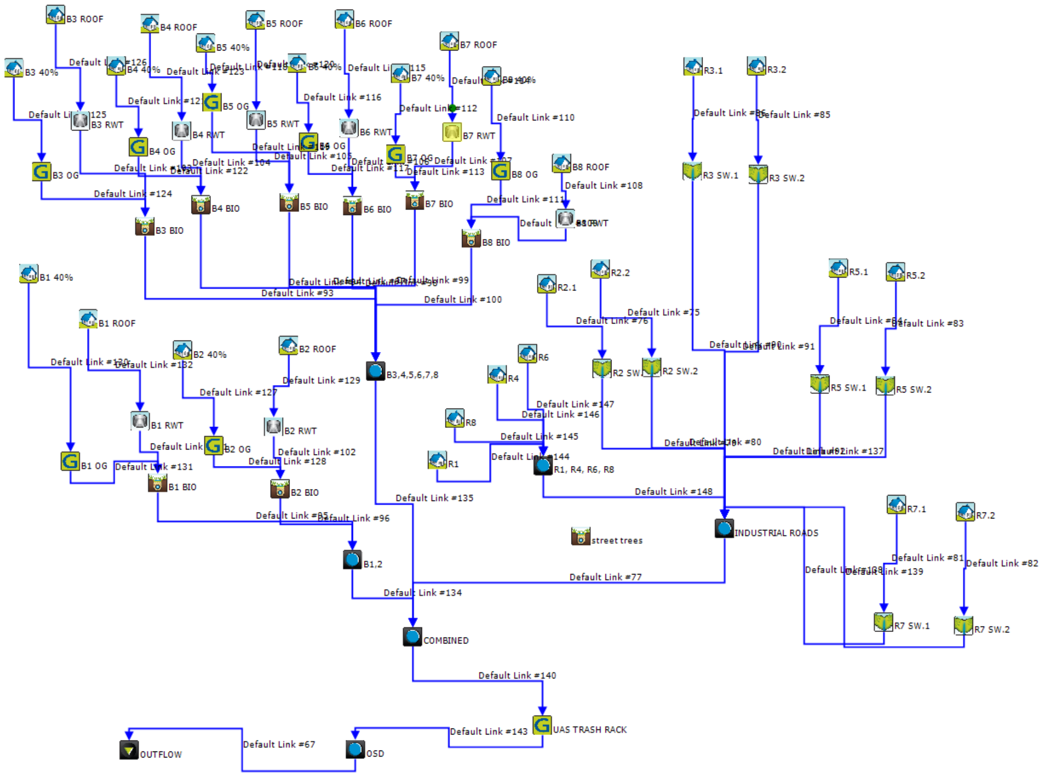


Figure 6: MUSIC treatment train

	Sources	Residual Load	% Reduction
Flow (ML/yr)	248.3	231.3	6.823
Total Suspended Solids (kg/yr)	2.838E+04	4814	83.03
Total Phosphorus (kg/yr)	61.82	32.31	47.74
Total Nitrogen (kg/yr)	550.8	360.9	34.47
Gross Pollutants (kg/yr)	8171	0	100

Figure 7: Receiving node treatment train effectiveness

3.5 TARGET POLLUTANT REDUCTION

The proposed treatment train meets the required pollutant reduction targets for TSS and TP, however under performs for nitrogen removal. In order to achieve this required target additional stormwater quality improvement devices would be required to be installed. The site grade and shallow existing outfall does not allow for provision of a bioretention basin within the Northern OSD area unless excessive filling were to occur.

Further to this the proposed OSD area is directly beneath the Dubbo Airport landing/take off path which discourages the possibility of a wetland for stormwater treatment as it would increase the bird habitat in the area and thus have negative effect on the airport due to increased bird strike risk. Communication with Council has indicated that additional roadside devices such as bioretention swales dedicated to council are also undesired due to maintenance and safety requirements.

Stormwater from the overall site strategy meets the required pollutant reduction targets, see Section 3.3. Stage 1 of the development ultimately overtreats the required targets which facilitates the overall site discharge at the Narromine Road culverts to achieve all pollutant reduction targets in line with the DCP. Refer to Stage 1 Water Cycle Management Strategy for further details of the proposed treatment train devices and results.

3.6 MAINTENANCE OF TREATMENT DEVICES

The treatment train proposed has been designed to not unduly increase the maintenance requirements to Council or lot owners. Lot owners will be responsible for the maintenance of rainwater tanks., trash racks and bioretention basins. The roadside swales, and end of line infrastructure located within lot 10 will be dedicated to council.

Rainwater tank maintenance will include cleaning gutters, maintaining first-flush devices, clearing inlet screens, and occasional desludging.

The on-lot trash racks will require maintenance by the lot owners at a frequency which is determined by the pollutant load of the catchment, indicatively every quarter, and after each major rain event. See Appendix C for the operations and maintenance manual provided by Ocean Protect. The end of line trash rack will be dedicated to Council and will require maintenance which can be completed alongside the regular required maintenance of the OSD basin. This includes regular inspection and removal of gross pollutants.

The bioretention basins will require maintenance from the lot owners at a frequency which is determined by the pollutant load of the catchment. It is suggested that quarterly checks are required to ensure that the bioretention is functioning as designed and to complete any required maintenance. This may include removal of dead plants, replanting of vegetation, inlet and outlet blockage checks and remediation of any scour damage. Suitably designed access tracks and points will be provided to ensure ease and safety of maintenance.

The roadside swales will require maintenance by Council at a frequency determined by the pollutant loading of the catchment. Maintenance activities should be completed alike with existing roadside swales within the Dubbo Regional Council area, including removal of gross pollutants and routine mowing. Observation of the condition of the swale surface should be completed during these routine actions to ensure the swale is conveying flows as per design.

4 CONCLUSION

A water cycle management strategy has been proposed following best practise to support the proposed Stage 6 subdivision plan at 13L Narromine Road & Lot 7 Jannali Road.

OSD has been proposed through WBNM to ensure the post developed peak flows do not exceed the predeveloped scenarios. A site-wide stormwater treatment train has been modelled using MUSIC to achieve the target pollutant reductions.

APPENDIX A

WBNM & RESULTS

Catchments, Lags, Losses, Flowpaths **Location:**

Catchment Details								Lag		Losses								Flowpaths				
	SORT		MID/MIF					FILL		FILL	LOSSRATES							FILL				
Subarea Name	D/S Subarea	Area [ha]	CGE	CGN	Out E	Out N	Imp Fraction	C	Imp Lag	Type	IL	CLR	ImpIL	N/A	N/A	N/A	N/A	Type	Stream Lag Factor	Delay (mins)	Musk K	Musk X (mins)
PREnorth	node	235.98	0.000	0.000	0.000	0.000	5	1.6	0.1	LOSSRATES	0	2	0					ROUTING	1.00	0		
C14N12E12post	C1	134.1	0.000	0.000	0.000	0.000	5	1.6	0.1	LOSSRATES	0	2	0					ROUTING	1.00	0		
EX1post	C1	34.94	0.000	0.000	0.000	0.000	13	1.6	0.1	LOSSRATES	0	2	0					ROUTING	1.00	0		
R8	C1	1.83	0.000	0.000	0.000	0.000	70	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
C1	C2	0	0.000	0.000	0.000	0.000	0	1.6	0.1	LOSSRATES	0	2	0					ROUTING	1.00	0		
B6	C2	5.66	0.000	0.000	0.000	0.000	90	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
B5	C2	11.48	0.000	0.000	0.000	0.000	90	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
R7	C2	1.1	0.000	0.000	0.000	0.000	70	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
R6.1	C2	0.75	0.000	0.000	0.000	0.000	70	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
C2	C3	0	0.000	0.000	0.000	0.000	0	1.6	0.1	LOSSRATES	0	2	0					ROUTING	1.00	0		
R6.2	C3	1.45	0.000	0.000	0.000	0.000	70	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
B7	C3	8.24	0.000	0.000	0.000	0.000	90	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
C3	C4	0	0.000	0.000	0.000	0.000	0	1.6	0.1	LOSSRATES	0	2	0					ROUTING	1.00	0		
R1	C4	0.59	0.000	0.000	0.000	0.000	70	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
B8	C4	7.88	0.000	0.000	0.000	0.000	90	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
C4	B1OSD	0	0.000	0.000	0.000	0.000	0	1.6	0.1	LOSSRATES	0	2	0					ROUTING	1.00	0		
B1	B1OSD	5.29	0.000	0.000	0.000	0.000	90	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
R3R4R5B2B3B4	B1OSD	19.24	0.000	0.000	0.000	0.000	80	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
B1OSD	POSTnorth	0	0.000	0.000	0.000	0.000	0	1.6	0.1	LOSSRATES	0	2	0					ROUTING	1.00	0		
EX2	POSTnorth	21.68	0.000	0.000	0.000	0.000	5	1.6	0.1	LOSSRATES	0	2	0					ROUTING	1.00	0		
R2	POSTnorth	0.21	0.000	0.000	0.000	0.000	70	1.6	0.1	LOSSRATES	0	2	0					ROUTING	0.33	0		
POSTnorth	node	0	0.000	0.000	0.000	0.000	0	1.6	0.1	LOSSRATES	0	2	0					ROUTING	1.00	0		
node	SINK	0	0.000	0.000	0.000	0.000	0	1.6	0.1	LOSSRATES	0	2	0					ROUTING	1.00	0		

Structure Summary

						Local		Basin Details			Tailwater_Details						Directed Subareas	
Lock	ID	Subarea	Type	Description of Structure	Local / Out	%Per to LS	%Imp to LS	IWL	Surf_Area	Stor_Fac	TW_ELEV	CHNL_BED_WIDTH	CHNL_S_SLOPE	CHNL_BED_SLOPE%	CHNL_n	CHNL_BED_	1	2
	1	**C14N12E12po**	**HS**	**OSD**	**OUTLET**			**0**	**0**	**1**							**C1**	
	2	**B1OSD**	**HS**	**OSD**	**OUTLET**			**284**	**0**	**1**							**POSTnorth**	

Databases -->

Outlet Database

STRUCTU	OUTLETS	STRUCTURE_TYPE	SUBAREA_NAME	DISCHARG	BLOCKAGE_TIME	DELAY_TIN	DIRECT_TO_T	INVERT_EL	WEIR_LEN	WEIR_COE	NUMBER_	ENTRANCE	BOX_CULVERT_WIDTH	BOX_CULVERT_DEI	ENTRANCE
1		BOX	C1	1	0	0	TOP	0			1	1	1500	1200	
1		WEIR	C1	1	0	0	TOP	1.25	10	1.7					
2		BOX	POSTnorth	1	0	0	TOP	284			1	1	4500	1000	
2		WEIR	POSTnorth	1	0	0	TOP	285.05	25	1.7					

Basins

STRUCTURE_ID	H	S	Q1	Q2
1	**0**	**0**		
1	**1.5**	**15000**		
2	283	0		
2	284	0		
2	284.1	187.015		
2	284.2	689.678		
2	284.3	1473.398		
2	284.4	2493.756		
2	284.5	3675.857		
2	284.6	4983.633		
2	284.7	6387.901		
2	284.8	7849.745		
2	284.9	9344.653		
2	285	10872.335		
2	285.1	12433.018		
2	285.2	14026.928		
2	285.3	15654.289		

Results | Local-Perv | PEAK_Flows | VOLUMES | TIMES | Structures | CLEAR

AEP / ARI	20	10	5	2	1
Dura	15	15	15	15	15
DESCRIPTION	*20 %AEP 15mins Duratic*	*10 %AEP 15mins*	*5 %AEP 15mins Dui*	*2 %AEP 15mins D*	*1 %AEP 15mins Duration Pattern A*
	::1-20.00-15-7(DES)	:2-10.00-15-7(DE!	::3-5.00-15-7(DES)	::4-2.00-15-7(DES	::5-1.00-15-7(DES)
Catch_area_ha	490.42	490.42	490.42	490.42	490.42
Impervious%	15.98	15.98	15.98	15.98	15.98
Rainfall_depth_mm	17.61	20.83	24.13	28.74	32.44
Excess_depth_mm	17.19	20.41	23.71	28.32	32.02
Calc_runoff_mm	14.72	17.61	20.61	24.81	28.25
VOLUMES_Outlet_m3					
PREnorth	34301	41140	48252	58258	66377
C14N12E12pos	18172	21843	25676	31057	35511
EX1post	5838	6957	8105	9711	11003
R8	318	377	437	522	589
C1	24328	29177	34218	41289	47103
B6	992	1175	1361	1622	1832
B5	2013	2384	2762	3291	3716
R7	191	226	263	313	354
R6.1	130	154	179	213	241
C2	27654	33116	38783	46729	53247
R6.2	252	299	346	413	467
B7	1445	1710	1982	2362	2667
C3	29351	35125	41112	49505	56381
R1	102	121	141	168	190
B8	1382	1636	1896	2259	2550
C4	30835	36882	43148	51931	59121
B1	927	1098	1272	1516	1712
R3R4R5B2B3B4	3365	3986	4620	5507	6220
B1OSD	34215	40843	47709	57315	65228
EX2	3647	4344	5059	6060	6864
R2	36	43	50	60	67
POSTnorth	37898	45230	52818	63434	72159
node	72199	86370	101070	121692	138536
PEAK_FLOWRATES_m3/s					
PEAK_Stream-Top					
PREnorth	0	0	0	0	0
C14N12E12pos	0	0	0	0	0
EX1post	0	0	0	0	0
R8	0	0	0	0	0
C1	3.508	4.545	5.399	6.784	7.814
B6	0	0	0	0	0
B5	0	0	0	0	0
R7	0	0	0	0	0
R6.1	0	0	0	0	0
C2	6.766	9.158	10.752	13.621	15.545
R6.2	0	0	0	0	0
B7	0	0	0	0	0
C3	8.435	11.53	13.505	17.143	19.528
R1	0	0	0	0	0
B8	0	0	0	0	0
C4	9.897	13.607	15.916	20.224	23.012
B1	0	0	0	0	0
R3R4R5B2B3B4	0	0	0	0	0

B1OSD	13.867	19.088	22.287	28.307	32.162
EX2	0	0	0	0	0
R2	0	0	0	0	0
POSTnorth	6.956	8.372	9.709	13.186	16.488
node	14.382	17.688	21.026	25.993	31.111
PEAK_Stream-Bottom					
PREnorth	0	0	0	0	0
C14N12E12pos	0	0	0	0	0
EX1post	0	0	0	0	0
R8	0	0	0	0	0
C1	3.508	4.545	5.399	6.784	7.814
B6	0	0	0	0	0
B5	0	0	0	0	0
R7	0	0	0	0	0
R6.1	0	0	0	0	0
C2	6.766	9.158	10.752	13.621	15.545
R6.2	0	0	0	0	0
B7	0	0	0	0	0
C3	8.435	11.53	13.505	17.143	19.528
R1	0	0	0	0	0
B8	0	0	0	0	0
C4	9.897	13.607	15.916	20.224	23.012
B1	0	0	0	0	0
R3R4R5B2B3B4	0	0	0	0	0
B1OSD	13.867	19.088	22.287	28.307	32.162
EX2	0	0	0	0	0
R2	0	0	0	0	0
POSTnorth	6.956	8.372	9.709	13.186	16.488
node	14.382	17.688	21.026	25.993	31.111
PEAK_Local-Perv					
PREnorth	5.901	7.442	9.014	11.38	13.315
C14N12E12pos	4.202	5.311	6.427	8.118	9.491
EX1post	1.719	2.194	2.645	3.348	3.903
R8	0.085	0.118	0.14	0.181	0.207
C1	0	0	0	0	0
B6	0.087	0.122	0.143	0.185	0.212
B5	0.16	0.217	0.257	0.33	0.38
R7	0.054	0.076	0.09	0.117	0.134
R6.1	0.039	0.054	0.064	0.083	0.095
C2	0	0	0	0	0
R6.2	0.069	0.097	0.114	0.148	0.17
B7	0.121	0.166	0.196	0.253	0.29
C3	0	0	0	0	0
R1	0.032	0.044	0.051	0.067	0.077
B8	0.116	0.16	0.189	0.244	0.28
C4	0	0	0	0	0
B1	0.082	0.115	0.135	0.175	0.201
R3R4R5B2B3B4	0.413	0.543	0.649	0.827	0.957
B1OSD	0	0	0	0	0
EX2	1.334	1.708	2.057	2.607	3.035
R2	0.013	0.017	0.02	0.026	0.029
POSTnorth	0	0	0	0	0
node	0	0	0	0	0
PEAK_Local-Imp					
PREnorth	2.116	2.827	3.274	4.148	4.683
C14N12E12pos	1.265	1.668	1.932	2.464	2.782

EX1post	0.884	1.156	1.339	1.715	1.936
R8	0.268	0.345	0.399	0.519	0.586
C1	0	0	0	0	0
B6	0.983	1.288	1.492	1.909	2.155
B5	1.876	2.499	2.894	3.673	4.146
R7	0.165	0.211	0.244	0.319	0.36
R6.1	0.114	0.145	0.168	0.22	0.249
C2	0	0	0	0	0
R6.2	0.215	0.275	0.319	0.415	0.469
B7	1.388	1.834	2.124	2.705	3.054
C3	0	0	0	0	0
R1	0.09	0.115	0.133	0.175	0.197
B8	1.332	1.758	2.037	2.596	2.93
C4	0	0	0	0	0
B1	0.923	1.208	1.4	1.792	2.023
R3R4R5B2B3B4	2.688	3.615	4.187	5.288	5.97
B1OSD	0	0	0	0	0
EX2	0.229	0.293	0.34	0.442	0.499
R2	0.033	0.042	0.048	0.064	0.072
POSTnorth	0	0	0	0	0
node	0	0	0	0	0
PEAK_Directed-to-Btm					
PREnorth	0	0	0	0	0
C14N12E12pos	0	0	0	0	0
EX1post	0	0	0	0	0
R8	0	0	0	0	0
C1	0	0	0	0	0
B6	0	0	0	0	0
B5	0	0	0	0	0
R7	0	0	0	0	0
R6.1	0	0	0	0	0
C2	0	0	0	0	0
R6.2	0	0	0	0	0
B7	0	0	0	0	0
C3	0	0	0	0	0
R1	0	0	0	0	0
B8	0	0	0	0	0
C4	0	0	0	0	0
B1	0	0	0	0	0
R3R4R5B2B3B4	0	0	0	0	0
B1OSD	0	0	0	0	0
EX2	0	0	0	0	0
R2	0	0	0	0	0
POSTnorth	0	0	0	0	0
node	0	0	0	0	0
PEAK_OUTLET-Inflow					
PREnorth	7.94	10.269	12.288	15.528	17.998
C14N12E12pos	5.379	6.979	8.359	10.582	12.273
EX1post	2.522	3.349	3.984	5.063	5.839
R8	0.349	0.463	0.539	0.7	0.793
C1	3.508	4.545	5.399	6.784	7.814
B6	1.065	1.41	1.635	2.094	2.367
B5	2.017	2.716	3.152	4.003	4.526
R7	0.218	0.287	0.334	0.436	0.493
R6.1	0.153	0.2	0.232	0.304	0.344
C2	6.766	9.158	10.752	13.621	15.545

R6.2	0.282	0.372	0.433	0.564	0.639
B7	1.497	2	2.32	2.958	3.344
C3	8.435	11.53	13.505	17.143	19.528
R1	0.122	0.159	0.184	0.242	0.274
B8	1.438	1.918	2.226	2.84	3.21
C4	9.897	13.607	15.916	20.224	23.012
B1	1.001	1.323	1.535	1.967	2.224
R3R4R5B2B3B4	3.046	4.158	4.836	6.116	6.927
B1OSD	13.867	19.088	22.287	28.307	32.162
EX2	1.526	2.002	2.397	3.049	3.535
R2	0.045	0.058	0.068	0.09	0.102
POSTnorth	6.956	8.372	9.709	13.186	16.488
node	14.382	17.688	21.026	25.993	31.111
PEAK_OUTLET-Outflow					
PREnorth	7.94	10.269	12.288	15.528	17.998
C14N12E12pos	1.92	2.342	2.785	3.418	4.552
EX1post	2.522	3.349	3.984	5.063	5.839
R8	0.349	0.463	0.539	0.7	0.793
C1	3.508	4.545	5.399	6.784	7.814
B6	1.065	1.41	1.635	2.094	2.367
B5	2.017	2.716	3.152	4.003	4.526
R7	0.218	0.287	0.334	0.436	0.493
R6.1	0.153	0.2	0.232	0.304	0.344
C2	6.766	9.158	10.752	13.621	15.545
R6.2	0.282	0.372	0.433	0.564	0.639
B7	1.497	2	2.32	2.958	3.344
C3	8.435	11.53	13.505	17.143	19.528
R1	0.122	0.159	0.184	0.242	0.274
B8	1.438	1.918	2.226	2.84	3.21
C4	9.897	13.607	15.916	20.224	23.012
B1	1.001	1.323	1.535	1.967	2.224
R3R4R5B2B3B4	3.046	4.158	4.836	6.116	6.927
B1OSD	5.829	6.992	8.045	11.108	14.008
EX2	1.526	2.002	2.397	3.049	3.535
R2	0.045	0.058	0.068	0.09	0.102
POSTnorth	6.956	8.372	9.709	13.186	16.488
node	14.382	17.688	21.026	25.993	31.111

TIME_to_PEAK_mins					
TIME_Stream-Top					
PREnorth	0	0	0	0	0
C14N12E12pos	0	0	0	0	0
EX1post	0	0	0	0	0
R8	0	0	0	0	0
C1	15	15	15	15	15
B6	0	0	0	0	0
B5	0	0	0	0	0
R7	0	0	0	0	0
R6.1	0	0	0	0	0
C2	15	15	15	15	15
R6.2	0	0	0	0	0
B7	0	0	0	0	0
C3	15	15	15	15	15
R1	0	0	0	0	0
B8	0	0	0	0	0
C4	15	15	15	15	15

B1	0	0	0	0	0
R3R4R5B2B3B4	0	0	0	0	0
B1OSD	15	15	15	15	15
EX2	0	0	0	0	0
R2	0	0	0	0	0
POSTnorth	20	21	20	21	20
node	15	15	15	15	18
TIME_Stream-Bottom					
PREnorth	0	0	0	0	0
C14N12E12pos	0	0	0	0	0
EX1post	0	0	0	0	0
R8	0	0	0	0	0
C1	15	15	15	15	15
B6	0	0	0	0	0
B5	0	0	0	0	0
R7	0	0	0	0	0
R6.1	0	0	0	0	0
C2	15	15	15	15	15
R6.2	0	0	0	0	0
B7	0	0	0	0	0
C3	15	15	15	15	15
R1	0	0	0	0	0
B8	0	0	0	0	0
C4	15	15	15	15	15
B1	0	0	0	0	0
R3R4R5B2B3B4	0	0	0	0	0
B1OSD	15	15	15	15	15
EX2	0	0	0	0	0
R2	0	0	0	0	0
POSTnorth	20	21	20	21	20
node	15	15	15	15	18
TIME_Local-Perv					
PREnorth	15	15	15	15	15
C14N12E12pos	15	15	15	15	15
EX1post	15	15	15	15	15
R8	15	15	15	15	15
C1	0	0	0	0	0
B6	15	15	15	15	15
B5	15	15	15	15	15
R7	15	15	15	15	15
R6.1	10	15	15	15	15
C2	0	0	0	0	0
R6.2	15	15	15	15	15
B7	15	15	15	15	15
C3	0	0	0	0	0
R1	10	15	15	15	15
B8	15	15	15	15	15
C4	0	0	0	0	0
B1	15	15	15	15	15
R3R4R5B2B3B4	15	15	15	15	15
B1OSD	0	0	0	0	0
EX2	15	15	15	15	15
R2	10	15	15	15	15
POSTnorth	0	0	0	0	0
node	0	0	0	0	0
TIME_Local-Imp					

PREnorth	10	15	15	15	15
C14N12E12pos	10	15	15	15	15
EX1post	10	15	15	15	15
R8	10	15	15	15	15
C1	0	0	0	0	0
B6	10	15	15	15	15
B5	10	15	15	15	15
R7	10	15	15	15	15
R6.1	10	15	15	15	15
C2	0	0	0	0	0
R6.2	10	15	15	15	15
B7	10	15	15	15	15
C3	0	0	0	0	0
R1	10	15	15	15	15
B8	10	15	15	15	15
C4	0	0	0	0	0
B1	10	15	15	15	15
R3R4R5B2B3B4	10	15	15	15	15
B1OSD	0	0	0	0	0
EX2	10	15	15	15	15
R2	10	15	15	15	15
POSTnorth	0	0	0	0	0
node	0	0	0	0	0
TIME_Directed-to-Btm					
PREnorth	0	0	0	0	0
C14N12E12pos	0	0	0	0	0
EX1post	0	0	0	0	0
R8	0	0	0	0	0
C1	0	0	0	0	0
B6	0	0	0	0	0
B5	0	0	0	0	0
R7	0	0	0	0	0
R6.1	0	0	0	0	0
C2	0	0	0	0	0
R6.2	0	0	0	0	0
B7	0	0	0	0	0
C3	0	0	0	0	0
R1	0	0	0	0	0
B8	0	0	0	0	0
C4	0	0	0	0	0
B1	0	0	0	0	0
R3R4R5B2B3B4	0	0	0	0	0
B1OSD	0	0	0	0	0
EX2	0	0	0	0	0
R2	0	0	0	0	0
POSTnorth	0	0	0	0	0
node	0	0	0	0	0
TIME_OUTLET-Inflow					
PREnorth	15	15	15	15	15
C14N12E12pos	15	15	15	15	15
EX1post	15	15	15	15	15
R8	10	15	15	15	15
C1	15	15	15	15	15
B6	10	15	15	15	15
B5	10	15	15	15	15
R7	10	15	15	15	15

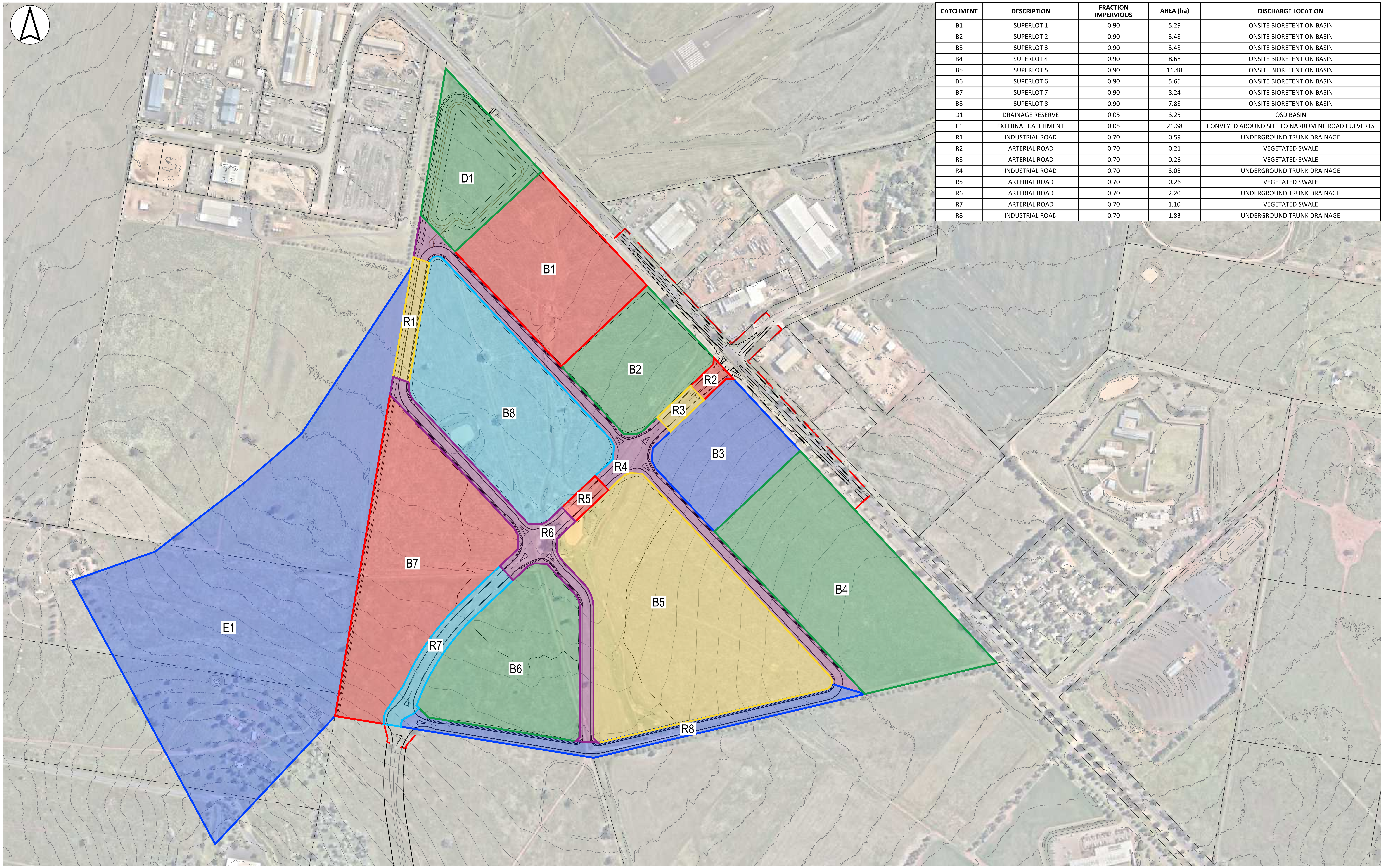
R6.1	10	15	15	15	15
C2	15	15	15	15	15
R6.2	10	15	15	15	15
B7	10	15	15	15	15
C3	15	15	15	15	15
R1	10	15	15	15	15
B8	10	15	15	15	15
C4	15	15	15	15	15
B1	10	15	15	15	15
R3R4R5B2B3B4	15	15	15	15	15
B1OSD	15	15	15	15	15
EX2	15	15	15	15	15
R2	10	15	15	15	15
POSTnorth	20	21	20	21	20
node	15	15	15	15	18
TIME_OUTLET-Outflow					
PREnorth	15	15	15	15	15
C14N12E12pos	68	68	67	66	56
EX1post	15	15	15	15	15
R8	10	15	15	15	15
C1	15	15	15	15	15
B6	10	15	15	15	15
B5	10	15	15	15	15
R7	10	15	15	15	15
R6.1	10	15	15	15	15
C2	15	15	15	15	15
R6.2	10	15	15	15	15
B7	10	15	15	15	15
C3	15	15	15	15	15
R1	10	15	15	15	15
B8	10	15	15	15	15
C4	15	15	15	15	15
B1	10	15	15	15	15
R3R4R5B2B3B4	15	15	15	15	15
B1OSD	22	23	23	22	21
EX2	15	15	15	15	15
R2	10	15	15	15	15
POSTnorth	20	21	20	21	20
node	15	15	15	15	18

OUTLET_STRC_on: C14N12E12pos					
PEAK_Inflow_m3/s	5.379	6.979	8.359	10.582	12.273
PEAK_Outflow_m3/s	1.92	2.342	2.785	3.418	4.552
VOLUME_Inflow_m3	0	0	0	0	0
VOLUME_Max_m3	6874	8385	9969	12235	13439
WATER-ELEVATION_Max_m	0.687	0.839	0.997	1.223	1.344
OUTLET_STRC_on: B1OSD					
PEAK_Inflow_m3/s	13.867	19.088	22.287	28.307	32.162
PEAK_Outflow_m3/s	5.829	6.992	8.045	11.108	14.008
VOLUME_Inflow_m3	35127	41966	49041	58954	67052
VOLUME_Max_m3	8333	9952	11663	13714	15091
WATER-ELEVATION_Max_m	284.832	284.94	285.051	285.18	285.265

APPENDIX B

CATCHMENT PLAN

CATCHMENT	DESCRIPTION	FRACTION IMPERVIOUS	AREA (ha)	DISCHARGE LOCATION
B1	SUPERLOT 1	0.90	5.29	ONSITE BIORETENTION BASIN
B2	SUPERLOT 2	0.90	3.48	ONSITE BIORETENTION BASIN
B3	SUPERLOT 3	0.90	3.48	ONSITE BIORETENTION BASIN
B4	SUPERLOT 4	0.90	8.68	ONSITE BIORETENTION BASIN
B5	SUPERLOT 5	0.90	11.48	ONSITE BIORETENTION BASIN
B6	SUPERLOT 6	0.90	5.66	ONSITE BIORETENTION BASIN
B7	SUPERLOT 7	0.90	8.24	ONSITE BIORETENTION BASIN
B8	SUPERLOT 8	0.90	7.88	ONSITE BIORETENTION BASIN
D1	DRAINAGE RESERVE	0.05	3.25	OSD BASIN
E1	EXTERNAL CATCHMENT	0.05	21.68	CONVEYED AROUND SITE TO NARROMINE ROAD CULVERTS
R1	INDUSTRIAL ROAD	0.70	0.59	UNDERGROUND TRUNK DRAINAGE
R2	ARTERIAL ROAD	0.70	0.21	VEGETATED SWALE
R3	ARTERIAL ROAD	0.70	0.26	VEGETATED SWALE
R4	INDUSTRIAL ROAD	0.70	3.08	UNDERGROUND TRUNK DRAINAGE
R5	ARTERIAL ROAD	0.70	0.26	VEGETATED SWALE
R6	ARTERIAL ROAD	0.70	2.20	UNDERGROUND TRUNK DRAINAGE
R7	ARTERIAL ROAD	0.70	1.10	VEGETATED SWALE
R8	INDUSTRIAL ROAD	0.70	1.83	UNDERGROUND TRUNK DRAINAGE



0 25 50 75 100 125m
SCALE 1:2500 AT ORIGINAL SIZE

REV	DATE	DESCRIPTION	AMD BY	APP BY
2	12.08.22	ISSUED FOR APPROVAL	JMN	RXT
1	27.07.22	DRAFT ISSUE	JMN	RXT

James Agustin, 11/11/2020 4:38 PM

The Bathla Group

MAKER ENG
SURVEY DESIGN DELIVER

DRAWN: J.NEWELL
DESIGNED: H.SMITH
DRAFT CHECK: J.AGUSTIN
DESIGN CHECK: J.AGUSTIN
APPROVED: R.THOMSON

NOT FOR CONSTRUCTION

CLEARMONT RISE DUBBO - STAGE 6
INDUSTRIAL SUBDIVISION
STORMWATER MANAGEMENT STRATEGY
CATCHMENT PLAN

DRAWING NUMBER	SHEET No.	ORIG. SIZE	REVISION
MKR00357-16-C060		A1	2

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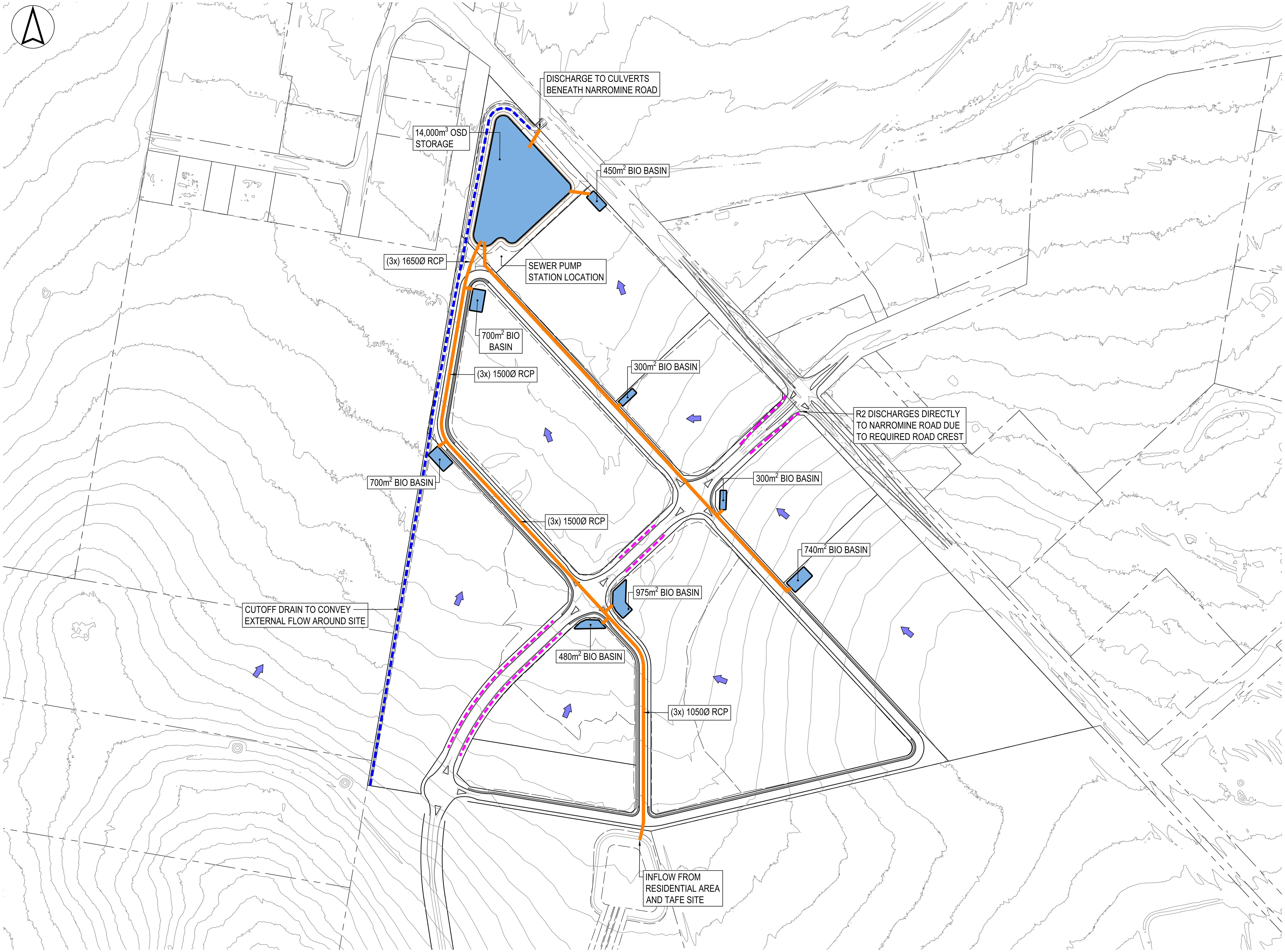

LEGEND

PROPOSED

- CUT OFF DRAIN
- VEGETATED SWALE
- TRUNK DRAINAGE
- BASIN

EXISTING

- LOT BOUNDARY
- CONTOURS (1.0m)

NOTES:

1. BASIN LOCATIONS AND SIZES ARE INDICATIVE ONLY AND WILL CHANGE WITH DETAIL DESIGN AND FUTURE BUILT FORM LAYOUTS

James Agustin, 11/11/2020 4:38 PM

REV	DATE	DESCRIPTION	AMD BY	APP BY
2	12.08.22	ISSUED FOR APPROVAL	JMN	RXT
1	27.07.22	DRAFT ISSUE	JMN	RXT

0 25 50 75 100 125m

SCALE 1:2500 AT ORIGINAL SIZE

The Bathla Group

MAKER ENG
SURVEY DESIGN DELIVER

DRAWN: J.NEWELL	DESIGNED: H.SMITH
DRAFT CHECK: J.AGUSTIN	DESIGN CHECK: J.AGUSTIN
APPROVED:	R.THOMSON

NOT FOR CONSTRUCTION

CLEARMONT RISE DUBBO - STAGE 6
INDUSTRIAL SUBDIVISION
STORMWATER MANAGEMENT STRATEGY
OVERALL PLAN

DRAWING NUMBER	SHEET No.	ORIG. SIZE	REVISION
MKR00357-16-C061		A1	2

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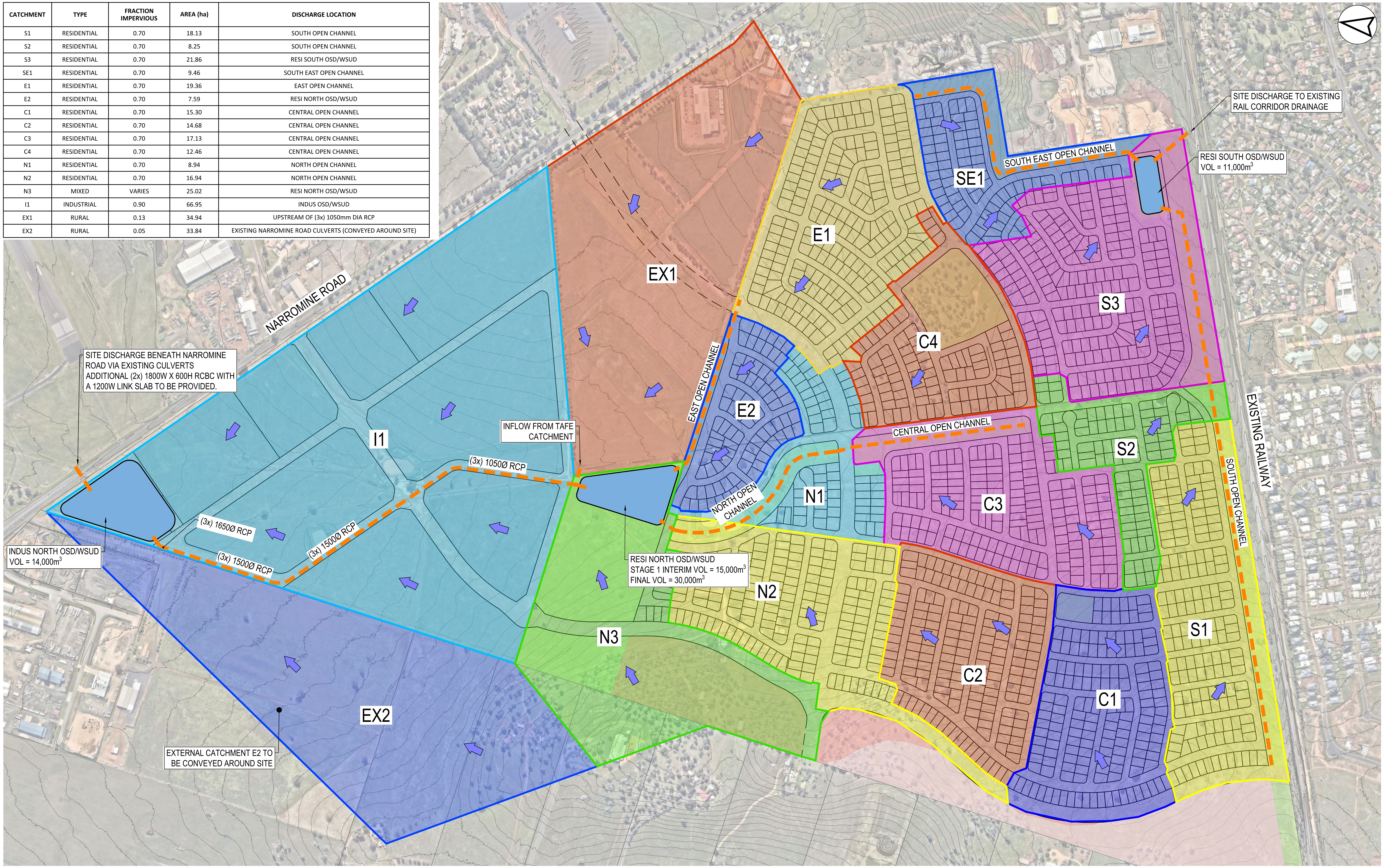
APPENDIX C

OVERALL CATCHMENT PLAN

CATCHMENT	TYPE	FRACTION IMPERVIOUS	AREA (ha)	DISCHARGE LOCATION
S1	RESIDENTIAL	0.70	18.13	SOUTH OPEN CHANNEL
S2	RESIDENTIAL	0.70	8.25	SOUTH OPEN CHANNEL
S3	RESIDENTIAL	0.70	21.86	RESI SOUTH OSD/WSUD
SE1	RESIDENTIAL	0.70	9.46	SOUTH EAST OPEN CHANNEL
E1	RESIDENTIAL	0.70	19.36	EAST OPEN CHANNEL
E2	RESIDENTIAL	0.70	7.59	RESI NORTH OSD/WSUD
C1	RESIDENTIAL	0.70	15.30	CENTRAL OPEN CHANNEL
C2	RESIDENTIAL	0.70	14.68	CENTRAL OPEN CHANNEL
C3	RESIDENTIAL	0.70	17.13	CENTRAL OPEN CHANNEL
C4	RESIDENTIAL	0.70	12.46	CENTRAL OPEN CHANNEL
N1	RESIDENTIAL	0.70	8.94	NORTH OPEN CHANNEL
N2	RESIDENTIAL	0.70	16.94	NORTH OPEN CHANNEL
N3	MIXED	VARIES	25.02	RESI NORTH OSD/WSUD
I1	INDUSTRIAL	0.90	66.95	INDUS OSD/WSUD
EX1	RURAL	0.13	34.94	UPSTREAM OF (3x) 1050mm DIA RCP
EX2	RURAL	0.05	33.84	EXISTING NARROMINE ROAD CULVERTS (CONVEYED AROUND SITE)



REV	DATE	DESCRIPTION	AMD BY	APP BY
P6	16.08.22	ISSUED FOR INFORMATION	HRS	JMA
P5	09.08.22	ISSUED FOR INFORMATION	HRS	JMA
P4	30.06.22	ISSUED FOR INFORMATION	HRS	JMA
P3	21.06.22	ISSUED FOR INFORMATION	HRS	JMA
P2	14.06.22	ISSUED FOR INFORMATION	HRS	JMA
P1	10.06.22	ISSUED FOR INFORMATION	HRS	JMA

Harry Smith, 8/16/2022 1:54 PM

0 40 80 120 160 200m
SCALE 1:4000 AT ORIGINAL SIZE

MAKER ENG
SURVEY DESIGN DELIVER

DRAWN: H.SMITH
DESIGNED:
DRAFT CHECK:
DESIGN CHECK:
APPROVED:
NOT FOR CONSTRUCTION

13L NARROMINE ROAD DUBBO
STORMWATER MANAGEMENT STRATEGY
OVERALL CONCEPT PLAN

DRAWING NUMBER	SHEET No.	ORIG. SIZE	REVISION
MKR00357-00-SK037		A1	P6

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APPENDIX D

OCEANGUARD TECHNICAL & MAINTENANCE GUIDELINES

OceanGuard

Technical Design Guide

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Rev: *1* ***Last Updated:*** *March 2019*

Introduction

The OceanGuard technology is a gully pit basket designed to fit within new and existing stormwater pits targeting pollution in stormwater runoff. The system is offered with a choice of filtration bag liners, designed to remove gross pollutants, total suspended solids and attached pollutants. It can be adopter as a stand-alone technology or as part of a treatment train with our StormFilter or Jellyfish filtration products.

The filtration bag, filtration cage and flow diverter work together to maximise the flow treated, pollutant capture, hydraulic efficiency and ultimately retaining captured pollutants dry. OceanGuard pit inserts are highly effective, easy to install and simple to maintain.

Operational Overview

The OceanGuard is installed into field or kerb inlet gully pits. The flow diverter at top of the unit has a rigid recycled plastic HDPE skirt that is installed against the walls directing all incoming stormwater flows into the filtration bag.

The stormwater is then filtered via direct screening through the filtration bag liner ensuring that any debris larger than the openings in the filtration bag are captured and retained.

During large storm events the water elevation in the filtration bag can rise and peak flows are internally bypassed through slots created in the flow diverter which has no moving parts that may prematurely fail.

At the end of the storm event debris and stormwater rest at the base of the filtration bag where the stored material will start to dry until the next storm event.

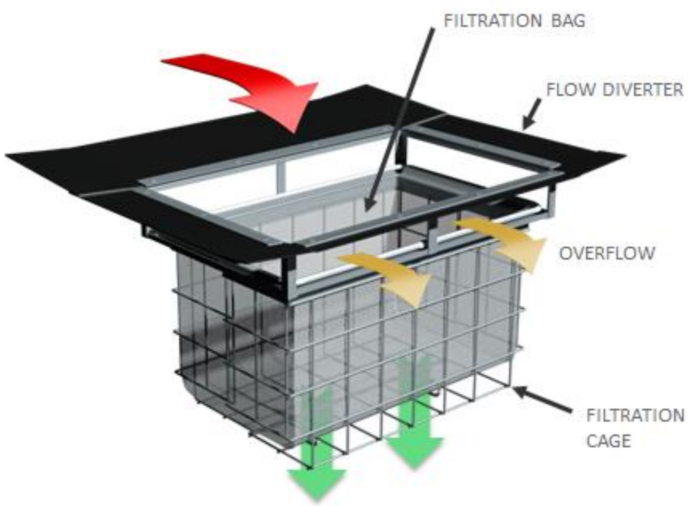

Figure 1: OceanGuard components

Features

The OceanGuard technology has the following features:

- Flow Diverter
  Directs flow into the unit for filtration of stormwater flows and includes an in-built rigid bypass to divert stormwater overflows in high-intensity and peak storm flows.
- Filtration Bag
  Removable coarse (gross pollutant removal) and fine grade (200micron) filtration bags.
- Filtration Cage
  The supporting cage that allows for the use of larger filtration bags.

The OceanGuard can also be fitted with an oil/hydrocarbon adsorbent material (optional) to capture and retain oil and grease. The adsorbent material is contained in socks that are designed to ensure maximum contact with stormwater as it enters the gully pit.

The OceanGuard is designed to be easily retrofitted into new and existing stormwater pits, requiring no construction or land take. The OceanGuard is often the most practical solution and reduces the pollutant load and maintenance burden on downstream infrastructure.

Configurations

The OceanGuard can fit a range of pits typically found in Australia including, kerb entry, rear entry with grated drain entry as well as field gully pits. There are multiple sizes to suit pits ranging in plan dimensions of *450 x 450mm – 1200 x 1200mm*. Additional custom sizes are available to suit circular and non-standard pits.

The standard OceanGuard configuration treats surface flow only, see figure 2. In some instances, it may be necessary to treat pipe flow, see figure 3. Remember to limit the upstream catchment to the basket to no more than 1000m^2 (or DN300mm pipe) otherwise the peak flows may cause structural damage to the OceanGuard. Furthermore, to assist design checks by a suitable qualified engineer need to be undertaken to ensure the upstream catchment is not excessively large. Please note that the OceanGuard technology is not a replacement for an in-line gross pollutant trap.

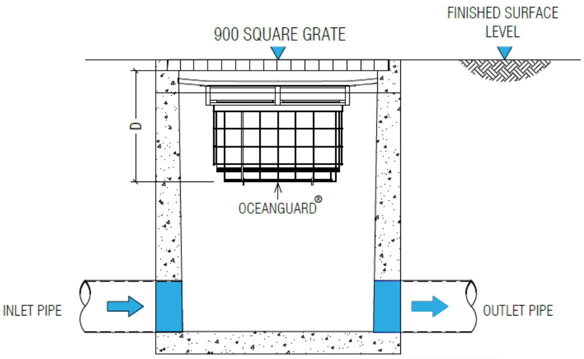

Figure 2: Standard configuration – surface flow

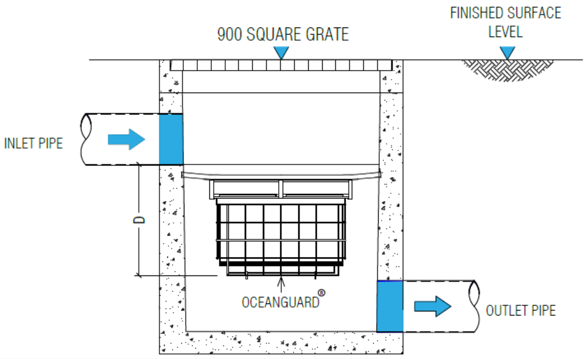

Figure 3: Example configuration – pipe flow

Another typical configuration required, is where the runoff collected by grated strip or trench drains needs to be treated, see figure 4.

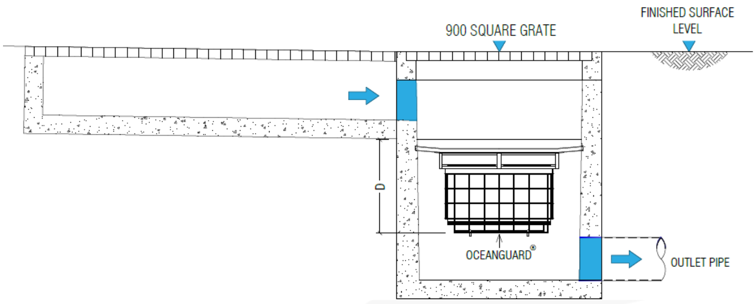

Figure 4: Example configuration – Grated strip/trench drain

Performance

Typically, laboratory testing provides a means to generate hydraulic and basic performance data, but it should also be complemented with long-term field data. Gully pit baskets that operate under unrestricted flows require both a combination lab and field studies to accurately understand performance.

Ocean Protect has and is undertaking field testing locally in Australia and copies of the supporting articles are available upon request from Ocean Protect.

Gully pit baskets and associated technology have been available in Australia and overseas for more than 20 years. The OceanGuard technology has design elements and removal performance that are the same as some off-patent technologies, such as the previous generation EnviroPod previously sold by Stormwater360 Australia (Now Ocean Protect) under licence.

The OceanGuard meets all previous performance data and current approvals across Australia in terms of pollutant removal, flow rate and head loss. Please contact your Ocean Protect representative for more information.

Please contact your Ocean Protect representative to obtain the StormFilter approval status in your area.

Maintenance

Maintenance of the OceanGuard is simple effective and seldom requires confined space entry or specialised equipment, often being completed by hand without the need of vacuum equipment. Simply remove the OceanGuard from the pit with the tags provided and invert the bag into a waste bin. Inspect the liner and brush by hand or spray with a pressure washer if required to rejuvenate the filtration bag. Record the information and replace the filtration bag.

Inspection & Cleaning

The Ocean Guard® system should be inspected at regular intervals from 1-2 months during the first year of installation to ensure optimum performance. The frequency at which the OceanGuard will need to be maintained will depend on site activities, land uses, catchment area and this size of OceanGuard installed, 1-6 times annually (3-4 typ.).

For further information please refer to the OceanGuard Operations and Maintenance Manual.

Design Basics

The design requirements of any OceanGuard system is detailed in 3 typical steps.

1. Hydraulic Design & Configuration
2. Water Quality Design
3. Mass Load Design

1. Hydraulic Design & Configuration

All OceanGuard inserts must be designed to ensure that the hydraulic requirements of the system are met without adversely impacting the upstream hydraulics (limiting the likelihood of localised flooding).

2. Water Quality Design

Ocean Protect recommends and uses the widely endorsed Model for Urban Stormwater Improvement Conceptualisation (MUSIC), which makes it easy to correctly sizing an appropriate StormFilter system for your site.

A complimentary design service which includes MUSIC modelling is provided by the Ocean Protect engineering team. Simply email your project details to design@oceanprotect.com.au or alternatively you can always call one of our engineers for a discussion or to arrange a meeting in your office. The team will provide you with an efficient design containing details of the devices required to meet your water quality objectives together with budget estimates, product drawings and the MUSIC (.sqz) file.

Alternatively, you can download the MUSIC treatment nodes for the Ocean Protect products from our website (www.oceanprotect.com.au).

When designing/modelling an OceanGuard system for water quality purposes in MUSIC, a single GPT node is utilised. The GPT node is utilised with relevant removal efficiencies inserted. These parameters can vary based on the jurisdiction (authority) of your project, relevant details can be obtained from Ocean Protect. When modelling, the high-flow bypass is modified in node by adding the total number of Ocean Guards installed and multiplying this number by 20L/s, eg 10 x Ocean Guards = $0.2m^3/s$.

All details such as drawings, specifications and maintenance manuals can also be downloaded for integration into your project's documentation. Additionally the Ocean Protect team is available to review your model and provide additional assistance and guidance on the configuration of the OceanGuard system(s) for your project.

3. Mass Load Design

Always be mindful of the magnitude of upstream catchment areas pay particular attention to perceived dirty or high loading sites. The Ocean Protect team can provide assistance and details on this process.

OceanGuard™

Operations & Maintenance Manual

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Rev: *1* ***Last Updated:*** *March 2019*

Introduction

The primary purpose of stormwater treatment devices is to capture and prevent pollutants from entering waterways, maintenance is a critical component of ensuring the ongoing effectiveness of this process. The specific requirements and frequency for maintenance depends on the treatment device and pollutant load characteristics of each site. This manual has been designed to provide details on the cleaning and maintenance processes as recommended by the manufacturer.

The OceanGuard technology is a gully pit basket designed to fit within new and existing gully pits to remove pollution from stormwater runoff. The system has a choice of Filtration liners, designed to remove gross pollutants, total suspended solids and attached pollutants as either a standalone technology or as part of a treatment train with our StormFilter or Jellyfish Filtration products. OceanGuard pit baskets are highly effective, easy to install and simple to maintain.

Why do I need to perform maintenance?

Adhering to the maintenance schedule of each stormwater treatment device is essential to ensuring that it functions properly throughout its design life.

During each inspection and clean, details of the mass, volume and type of material that has been collected by the device should be recorded. This data will assist with the revision of future management plans and help determine maintenance interval frequency. It is also essential that qualified and experienced personnel carry out all maintenance (including inspections, recording and reporting) in a systematic manner.

Maintenance of your stormwater management system is essential to ensuring ongoing at-source control of stormwater pollution. Maintenance also helps prevent structural failures (e.g. prevents blocked outlets) and aesthetic failures (e.g. debris build up), but most of all ensures the long term effective operation of the OceanGuard.

Health and Safety

Access to pits containing an OceanGuard typically requires removing (heavy) access covers/grates, but typically it is not necessary to enter into a confined space. Pollutants collected by the OceanGuard will vary depending on the nature of your site. There is potential for these materials to be harmful. For example, sediments may contain heavy metals, carcinogenic substances or sharp objects such as broken glass and syringes. For these reasons, there should be no primary contact with the waste collect and all aspects of maintaining and cleaning your OceanGuard require careful adherence to Occupational Health and Safety (OH&S) guidelines.

It is important to note that the same level of care needs to be taken to ensure the safety of non-work personnel, as a result it may be necessary to employ traffic/pedestrian control measures when the device is situated in, or near areas with high vehicular/pedestrian activity.

Personnel health and safety

Whilst performing maintenance on the OceanGuard pit insert, precautions should be taken in order to minimise (or when possible prevent) contact with sediment and other captured pollutants by maintenance personnel. In order to achieve this the following personal protective equipment (PPE) is recommended:

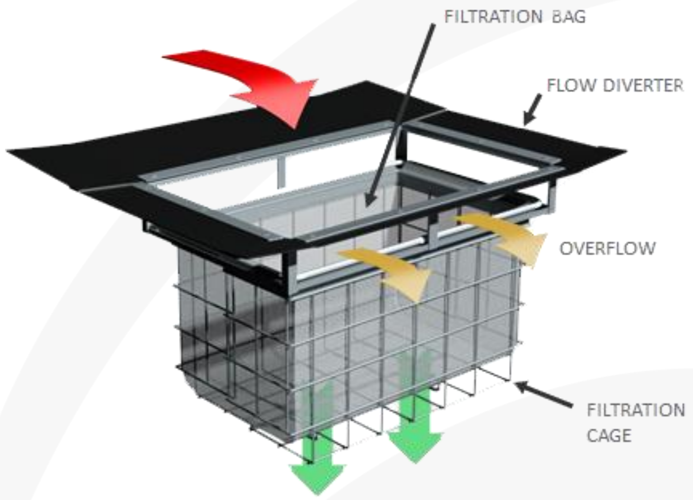
- Puncture resistant gloves
- Steel capped safety boots,
- Long sleeve clothing, overalls or similar skin protection
- Eye protection
- High visibility clothing or vest

During maintenance activities it may be necessary to implement traffic control measures. Ocean Protect recommend that a separate site specific traffic control plan is implemented as required to meet the relevant governing authority guidelines.

The OceanGuard pit insert is designed to be maintained from surface level, without the need to enter the pit. However depending on the installation configuration, location and site specific maintenance requirements it may be necessary to enter a confined space occasionally. It is recommended that all maintenance personnel evaluate their own needs for confined space entry and compliance with relevant industry regulations and guidelines. Ocean Protect maintenance personnel are fully trained and carry certification for confined space entry.

How does it Work?

OceanGuard is designed to intercept stormwater as it enters the stormwater pits throughout a site. The OceanGuard has diversion panels that sit flush with the pit walls, this ensures that as stormwater enters at the top of the pit it is directed to the middle of the insert where the Filtration bag is situated. The filtration bag allows for screening to occur removing 100% of pollutants greater than the opening of the filtration material (200micron, 1600micron bags available).



During larger rain events the large flows overflow slots in the flow diverter of the OceanGuard ensure that the conveyance of stormwater is not impeded thus eliminating the potential for surface flooding. As the flow subsides, the captured pollutants are held in the OceanGuard Filtration bag dry. The waste then starts to dry which reduces the magnitude of organic material decomposition transitioning between maintenance intervals.

Maintenance Procedures

To ensure that each OceanGuard pit insert achieves optimal performance, it is advisable that regular maintenance is performed. Typically the OceanGuard requires 2-4 minor services annually, pending the outcome of these inspections additional maintenance servicing may be required.

Primary Types of Maintenance

The table below outlines the primary types of maintenance activities that typically take place as part of an ongoing maintenance schedule for the OceanGuard.

	Description of Typical Activities	Frequency
Minor Service	Filter bag inspection and evaluation Removal of capture pollutants Disposal of material	2-4 Times Annually
Major Service	Filter Bag Replacement Support frame rectification	As required

Maintenance requirements and frequencies are dependent on the pollutant load characteristics of each site. The frequencies provided in this document represent what the manufacturer considers to be best practice to ensure the continuing operation of the device is in line with the original design specification.

Minor Service

This service is designed to return the OceanGuard device back to optimal operating performance. This type of service can be undertaken either by hand or with the assistance of a Vacuum unit.

Hand Maintenance

1. Establish a safe working area around the pit insert
2. Remove access cover/grate
3. Use two lifting hooks to remove the filtration bag
4. Empty the contents of the filtration bag into a disposal container
5. Inspect and evaluate the filtration bag
6. Inspect and evaluate remaining OceanGuard components (i.e. flow diverter, filtration cage and supporting frame)
7. Rejuvenate filtration bag by removing pollutant build up with a stiff brush, additionally the filtration bag can be washed using high pressure water
8. Re-install filtration bag and replace access cover/grate

Vacuum Maintenance

1. Establish a safe working area around the pit insert
2. Remove access cover/grate
3. Vacuum captured pollutants from the filtration bag
4. Remove filtration bag
5. Inspect and evaluate the filtration bag
6. Inspect and evaluate remaining OceanGuard components (i.e. flow diverter, filtration cage and supporting frame)
7. Rejuvenate filtration bag by removing pollutant build up with a stiff brush, additionally the filtration bag can be washed using high pressure water
8. Re-install filtration bag and replace access cover/grate

Major Service (Filter Bag Replacement)

For the OceanGuard system, a major service is a reactionary process based on the outcomes from the minor service.

Trigger Event from Minor Service	Maintenance Action
Filtration bag inspection reveals damage	Replace the filtration bag[1]
Component inspection reveals damage	Perform rectification works and if necessary replace components[1]

[1] Replacement filtration bags and components are available for purchase from Ocean Protect.

Additional Reasons of Maintenance

Occasionally, events on site can make it necessary to perform additional maintenance to ensure the continuing performance of the device.

Hazardous Material Spill

If there is a spill event on site, all OceanGuard pits that potentially received flow should be inspected and cleaned. Specifically all captured pollutants from within the filtration bag should be removed and disposed in accordance with any additional requirements that may relate to the type of spill event. All filtration bags should be rejuvenated (replaced if required) and re-installed.

Blockages

The OceanGuards internal high flow bypass functionality is designed to minimise the potential of blockages/flooding. In the unlikely event that flooding occurs around the stormwater pit the following steps should be undertaken to assist in diagnosing the issue and implementing the appropriate response.

1. Inspect the OceanGuard flow diverter, ensuring that they are free of debris and pollutants
2. Perform a minor service on the OceanGuard
3. Remove the OceanGuard insert to access the pit and inspect both the inlet and outlet pipes, ensuring they are free of debris and pollutants

Major Storms and Flooding

In addition to the scheduled activities, it is important to inspect the condition of the OceanGuard pit insert after a major storm event. The inspection should focus on checking for damage and higher than normal sediment accumulation that may result from localised erosion. Where necessary damaged components should be replaced and accumulated pollutants disposed.

Disposal of Waste Materials

The accumulated pollutants found in the OceanGuard must be handled and disposed of in a manner that is in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. If the filtration bag has been contaminated with any unusual substance, there may be additional special handling and disposal methods required to comply with relevant government/authority/industry regulations.

Maintenance Services

With over a decade and a half of maintenance experience Ocean Protect has developed a systematic approach to inspecting, cleaning and maintaining a wide variety of stormwater treatment devices. Our fully trained and professional staff are familiar with the characteristics of each type of system, and the processes required to ensure its optimal performance.

Ocean Protect has several stormwater maintenance service options available to help ensure that your stormwater device functions properly throughout its design life. In the case of our OceanGuard system we offer long term pay-as-you-go contracts, pre-paid once off servicing and replacement filter bags.

For more information please visit www.OceanProtect.com.au

OCEAN PROTECT

OceanGuard

Installation Guide

***Rev:** 1 **Last Updated:** March 2019*

Introduction

The purpose of this manual is to indicate the safest and most efficient method in installing the Ocean Protect OceanGuard.

Equipment

The following personal protective equipment is required by staff for installation activities:

- Puncture resistant gloves
- Steel capped safety boots,
- Long sleeve clothing, overalls or similar skin protection
- Eye protection
- Hearing protection
- High visibility clothing or vest

Note: The above list is a guide only, all individuals performing installation should evaluate their own OH&S requirements as required by law or site specific safety requirements.

Typical tools required for installation include the following

- Tape measure
- Marking Template
- Marking spray paint
- 8mm masonry drill
- 5 mm steel drill
- Pop Riveter for 4.8mm rivets
- Hammer
- Stanley knife
- Straight edge
- 10mm socket and ratchet
- Hacksaw

Components

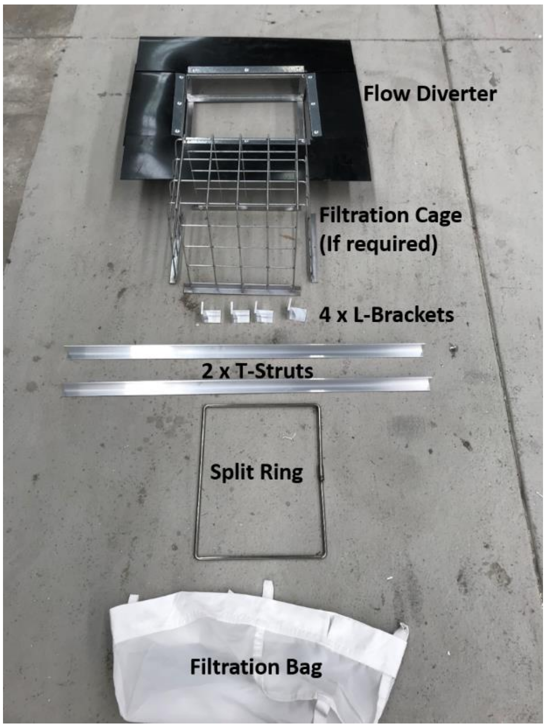


Figure 1: OceanGuard components

Configurations

The OceanGuard can fit a range of pits typically found in Australia including, kerb entry, rear entry with grated drain entry as well as field gully pits.

There are multiple sizes to suit pits ranging in plan dimensions of *450 x 450mm – 1200 x 1200mm*. Additional custom sizes are available to suit circular and non-standard pits.

The standard OceanGuard installation treats surface flow only, see figure 2.

In some instances, it may be necessary to perform an installation that treats pipe flow, see figure 3.

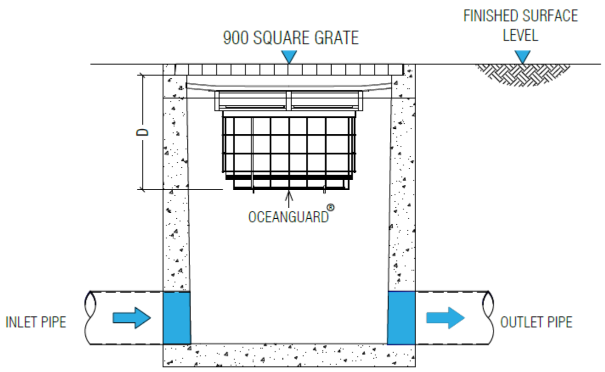


Figure 2: Standard configuration – surface flow

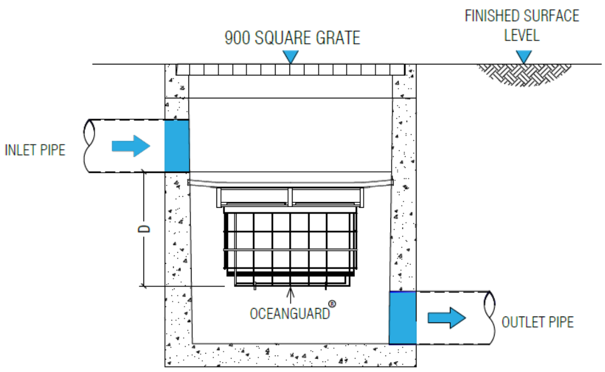


Figure 3: Example configuration – pipe flow

Another typical configuration required, is where the runoff collected by grated strip or trench drains needs to be treated, see figure 4.

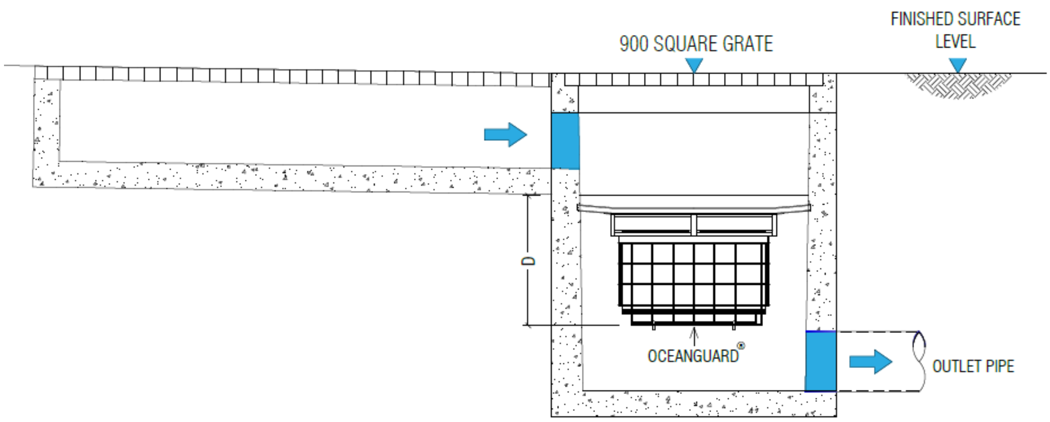


Figure 4: Example configuration – strip/trench drain

Installation Procedure

The aim of all pit insert installations is to install the largest unit into each pit, without influencing the hydraulic performance of the pit or drainage system.

Strut Install

1. Measure the internal dimensions of the pit while marking the center of the pit length, at 150mm down from entry of pit (the height where the struts are to be secured).

2. Mark the position of the holes for the L-brackets, based on the center mark

3. Using an 8mm masonry drill bit drill holes for the insertion of the Dyna Bolts (4 holes total, 2 per strut)

4. Attached L-brackets with dyna bolts to the pit wall (4 locations)

5. Align T-strut onto L-brackets and secure with pop rivets, repeat for second strut


Flow Diverter Install

1. Measure the internal dimensions of the pit at the height at which the plastic is to sit. If necessary trim flow diverter panels to fit internal dimensions (add an additional 20mm each side to ensure tight pressure fit)

2. With the plastic bent slightly upwards, lower the Top Section into the pit, guiding the unit so that it locates on the T Sections struts.

3. Drill a 5mm hole through the flow diverter and into the strut for each T-strut, and secure the flow diverter to the T-strut with a pop rivet. **NOTE: if you OceanGuard requires a Filtration Cage this step can be skipped and addressed as part of the Filtration Cage Installation.**

Filtration Cage Install (if required)

1. Lower the filtration cage through the flow diverter until the lip of the cage sits on the internal lip


2. Drill a 5mm hole through the flow diverter, filtration cage lip and into the strut for each T-strut, and secure the flow diverter to the T-strut with a pop rivet.

Filtration Bag Install

1. Open the split ring by pulling apart at the connection point and thread the filtration bag onto the stainless steel split ring.


2. Lower the bag into the pit ensuring and pull the internal filter mesh downwards to ensure a secure fit with the top section.


Office Locations

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Torquay VIC 3228

www.makereng.com.au

Management Systems

Quality and safety are extremely important to Maker ENG and as such we are certified to the following Australian Standards:

- ISO 9001:2015 Quality Management Systems
- ISO 45001:2018 Occupational Health and Safety Management Systems
- ISO 14001:2015 Environmental Management Systems