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Stormwater Management Report

Emu Plains Industrial Estate Development

Prepared for: **Penrith City Council**

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Revisions

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A	Draft Issue	05/04/2022	Kundan P./ Harrison B. /Isaac K.	Kundan P.
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Review Panel

Division/ office	Name
Western Sydney	Stuart G. / Kundan P.

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1 Introduction

1.1 General

ACOR Consultants P/L has been engaged by Penrith City Council to undertake the civil engineering design to support the development application (DA) for the proposed subdivision of 158-164 Old Bathurst Road, Emu Plains. This stormwater management report presents the strategy adopted for the proposed development with respect to stormwater drainage, quantity, and quality management.

This report documents the methodology involved in determining the design of the proposed stormwater drainage system and is to be read in conjunction with drawings prepared by ACOR, NSW211637-SHT-DA-C1.001-C15.002. Engineering items addressed in this report include:

- Stormwater quantity
- Stormwater quality

Stormwater quantity items addressed in this report include:

- Stormwater conveyance/network
- Stormwater detention

Stormwater quality items to be addressed in this report include:

- Operational water quality management incorporating Water Sensitive Urban Design principles (WSUD)
- Construction water quality management incorporating soil and water management.

2 Site

2.1 Location

The site is located at the corner of Old Bathurst Road and David Road in the suburb of Emu Plains. The property is identified as Lot 1 DP588918 and Lot 2 in DP588919. The development is located to the South of Old Bathurst Road, and is bound by David Road to the west, Railway corridor and Lot 1 DP879523 to the east & Lot 12 DP881369 to the South. Refer to Figure 1 for showing the locality of the development.

Site measures approximately 16.3 Hectares in area stretching across the two lots mentioned above. The site was occupied by Rocla for pipe manufacturing and storage until the recent acquisition by Penrith City Council.

The adjoining site to the east, identified as Lot 1 DP879523, is currently under construction and will be finalised as a commuter car park to service the nearby Emu Plains train station. This carpark site is currently being managed by Transport for NSW (TfNSW); it will henceforth be referenced in this report as *the commuter carpark*.

2.1 Topography

This site is characterised by very flat grades, resulting in numerous areas of localised depression points spread throughout the site in its current condition There are two notable low points, one in the south-western corner, and the other in the north-eastern corner. These low points in the topography imply that historically there may have been more pronounced ridge line running north-south through the site, separating the site into two identifiable catchments. Significant stockpiling, earthworks, building and road works during Rocla’s tenure have rendered this natural ridge line indistinguishable in the current scenario

The low point in the southwestern portion of the site is of particular significance in the existing scenario, as it has been utilised by Rocla to control the chemical pollution and pH contamination emanating from the site. Two dams have been constructed in the area to control the drainage flow and allow for chemical dosing of the stormwater before it is discharged into the downstream system.

The existing site topography is very flat. The site generally falls from the North to the South and from the East to the West by approximately 250 mm over the length of approximately 300 m. Refer to Existing Topography Plan DA01-101.

Figure 1: Aerial Photograph of Site (Source: Nearmaps)

2.2 Existing/Previous Land Use and Vegetation

The site in its current condition is a Rocla pipe manufacturing and storage facility. Majority of the site area has been found as hard paved with the concrete surface. Thick vegetation can be seen at the southwestern corner of the site and along the eastern and the northern boundary lines of the site.

2.3 Existing Site Drainage

As the site is relatively flat in topography, several local land depressions were observed throughout the entire site accumulating drainage flow during and after the rain events. There is some underground drainage infrastructure present within the site collecting some of the surface runoff and routing them towards the pond area at the south-western corner of the site.

A closer analysis of the existing site reveals that the site can be broadly sub-divided into three sub-catchments that capture drainage runoff from the site prior to discharging them to their respective drainage outlet points. The sub-catchments along with their outlet points are shown below in Figure 2.

Figure 2: Existing sub-catchments

The north-western catchment is serviced by an 1800 x 600 RCBC box culvert and the south-western catchment outlet is 2 x 1800 x 600 RCBC box culverts across David Road. The north-eastern catchment outlet is serviced by 2 x 600 x 300 RCBC box culverts across Old Bathurst Road.

2.4 External Catchments

There are no external catchments that drain towards the site. However, there is an existing natural swale at the north-eastern corner of the site which acts as a passage for drainage runoff accumulated from the upstream catchment stretching towards the south-eastern direction into the adjoining property and across the railway corridor. The accumulated runoff within the swale gets drained across Old Bathurst Road via 2 x 600 x 300 RCBC box culverts and via sag point within the road pavement itself. The external catchments are further addressed in the accompanying flood report by ACOR Consultants.

3 Proposed Development

The proposed development will consist of subdivision of the site into 38 industrial lots, 1 lot for stormwater treatment infrastructure together with associated site works, roads, and street landscaping. The site will be accessible via Old Bathurst Road and David Road once subdivided.

In accordance with Australian Rainfall & Runoff 2019, the proposed stormwater management system will, in principle, consist of a major and minor stormwater runoff conveyance system and incorporate surface collection pits and underground pipes for minor flow. Major flows in excess of the capacity of the pipe system will be safely conveyed overland within the roadways.

The design proposes on-site stormwater treatment measures for each individual lot, as well as infrastructure to service the entire subdivision to meet council prescribed water quality treatment targets. It is proposed that the site wide infrastructure is constructed during the subdivision of the site, while the on-lot treatment measures are to be instated gradually as the lots are developed over time. There are also minor drainage works associated with the proposed widening of Old Bathurst Road along the site's northern boundary. These drainage lines have been designed in line with council guidelines to capture and convey the design runoff from Old Bathurst Road and connect them to the existing legal points of discharge.

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4 Stormwater Quantity

4.1 Standards

The stormwater quantity treatment strategy has been adopted for this development in accordance with the following relevant guidelines and policies:

- Penrith Development Control Plan 2014, parts:
  - C3 Water Management
  - D4 Industrial Development
- Penrith City Council WSUD Technical Guidelines, Version 3 – June 2015
- Penrith City Council Design Guidelines for Engineering Works or Subdivisions and Developments – November 2013
- Australian Rainfall and Runoff 2019
- AS/NZS 3500 (latest revisions)

4.2 Stormwater Conveyance

4.2.1 Minor Storm Event Conveyance

Minor system stormwater conveyance for the development will be a via a traditional pit and pipe system. The minor stormwater system will have the capacity to convey the peak flows from a 5% AEP storm event.

Refer to stormwater management plan NSW11637-SHT-DA-C7.001 for minor system layout.

4.2.2 Major Storm Event Conveyance

Major system stormwater conveyance for the proposed development will be via a traditional pit and pipe system and controlled overland flow. Overland flow will be via grassed drainage swales, and road carriage way and footpath. The major stormwater system will have the capacity to convey the peak flows from a 1% AEP storm event, containing flows within the road reserve.

To overcome the challenge of draining a flat site, a sag-crest approach has been adopted during the road design, that not only provide suitable slopes within the drainage infrastructure but also proved to be productive in optimising earthworks within the site. Sags throughout the site have been designed to allow emergency overflows in the event of a critical blockage to be directed towards the legal points of discharge and avoid any trap low points confined to the road network.

Refer to Road Design Plans NSW211637-SHT-DA-C5.201-C5.204 for the vertical design of roadways.

4.3 Legal Point of Discharge

There are three proposed legal points of discharge for the site in concurrence with the existing drainage outlets as discussed under section 2.3 above.

4.4 Downstream Tailwater conditions

The entire drainage network downstream of the site has been modelled in DRAINS coupled with the drainage design of the site for different storm events up to 1% AEP. The tailwater level generated from the downstream end were taken as the design constraint for further refinement of the site's drainage strategy.

Tail water conditions at the existing outlet beneath Old Bathurst Road to the northeast corner of the are unknown, however it is understood that the area downstream of the outlet is subject to minor flooding. Due to the uncertainty regarding the tailwater condition, the water level has been adopted as the obvert of the existing culvert in all events. This level is RL = 23.16m AHD.

The other two points of discharge in the west connect directly into the network for the downstream subdivision along David Road. Council have provided WAE plans for this drainage system. This system has been modelled in DRAINS as per the WAE plans, making account for tailwater condition imposed by the downstream site and simultaneously providing insight into the impact that the proposed development will have on the downstream system. Individual lot discharges in the downstream system have been specified as per a designed PSD for each lot. As such, they have been adopted as baseflows in the modelling of the downstream system. Two models have been developed to represent the downstream site, including the 1% and 5% AEP, the latter of which has been used in the models for the proposed 5% and 20% AEP design.

Refer to the following plans for the details of the downstream system:

- Proposed Industrial Subdivision of Lot 2 DP534504, David and Old Bathurst Rds., Emu Plains - Road & Drainage Plans D.A. 05/0375 (Rev F, 2006) (J. Wyndham Prince Pty. Ltd.)
- Industrial Subdivision of Lot 2, DP534504 Emu Plains, Stormwater Management for Paclib Industrial Pty. Ltd. (Rev F, 2006) (Patterson Britton & Partners Pty. Ltd.)

4.5 Wetlands

The primary purpose of the constructed wetlands designed for this site is to provide water quality treatment, as discussed in Section 5. Although they are not primarily intended to be used for flow attenuation or detention, the impact that they have on the site's hydraulic deign is not negligible and cannot be ignored in the modelling. It is for this reason that a simplified representation of the wetlands has been included in the DRAINS model.

Given the size of the pond structures proposed downstream of the sediment basin and wetland, some attenuation is provided. The main impact of the wetlands that the model intends to simulate is the tailwater effect that water levels in the sediment basins will have on the upstream stormwater networks. As such, the sediment basins have been modelled as their own node with low and high flow outlets as per the requirements of the water quality design. The storage provided downstream of the sediment basins by the ponds and wetlands has been combined into one node for the simplification of the model.

4.6 Stormwater Detention

4.6.1 General

Stormwater detention has been provided for the development, detaining flows from the proposed lots and roadways. DRAINS modelling was undertaken adopting the ILSAX modelling procedure to model the stormwater network, including detention structures.

4.6.2 Pre-Development

The site has three defined catchments in the predeveloped scenario based on the three points of discharge as seen in Figure 2. For post development stormwater catchment plans refer to NSW11637-SHT-DA-C7.111. The predeveloped catchment areas and fraction impervious taken in the predevelopment model are shown in Table 1. A more detailed analysis was undertaken for the south-western catchment due to its exceptionally flat grades and size.

Table 1 Predeveloped Catchments

Catchment	**Area (ha)**	**Predeveloped % Impervious**			**Pervious Time of Concentration (min)**		
North-western Catchment	4.985	63.6			10		
North-eastern Catchment	1.04	58.2			7		
	Area (ha)	**Predeveloped % Impervious**	**Flow path length (m)**	**Flow path slope (%)**	**Pervious Time of Concentration (min)**	**Impervious n***	**Pervious n***
South-western Catchment	10.27	84.4	500	0.2	20	0.04	0.06

4.6.3 Drains Catchment Modelling

DRAINS modelling was undertaken to determine the predeveloped and developed peak flows (combined flow to all outlet points) for a range of AEPs from 20% to 1%, for storm durations ranging from 5 minutes to 3 hours for the proposed development to confirm detention was required.

Table 2 Total Site Predeveloped vs Developed (without Detention) Peak Flows

Storm Event AEP	**Peak Discharge L/s:**			
	Pre-Development	**Post Development**	**Difference**	**Difference %**
20%	2134	4622	2488	116.56%
5%	3375	6935	3560	105.48%
1%	4914	9736	4822	98.13%

As can be seen from Table 2, generated stormwater discharge during the post developed condition is significant in comparison to the existing scenario which warrants a requirement of some detention system to reduce the peak flows from the development to the predeveloped levels.

4.6.4 On-site Detention Modelling

The stormwater quantity control has been achieved using the source control strategy. This means that each subdivided lot is proposed to be burdened with on-site detention (OSD) requirements in the form of a section 88(b) instrument. In order to determine the required sizing of the OSD for each lot, a prescriptive Permissible Site Discharge (PSD) value was obtained using an iterative approach in the DRAINS model to limit the total outflow to the pre-development levels. The PSD is the total discharge rate that a lot can drain from their site during the fully developed state. Similarly, based on the recommended PSD value for a generic 2000 sqm lot and 6000 sqm lot, design Site Storage Requirement (SSR) value was obtained. This indicates the total volume of the OSD required for every hectare of lot area. The PSD and SSR values are tailored to reduce the post development flow at each point of discharge. Given the post development catchment draining to the north-east is significantly larger than the pre-development catchment, this portion of the site is burdened with different PSD and SSR rates. Below are the recommended values of PSD and SSR prescribed for this development:

Table 3: Northwest and Southwest PSD & SSR Factors

	South-western & north-western Developments PSD Factor		
Storm Event AEP	20%	5%	1%
PSD (m^3/s)	0.103	0.155	0.2
SSR (m^3/ha)	340		

Table 4: North-eastern PSD & SSR Factors

	North-eastern developments PSD factor		
Storm Event AEP	20%	5%	1%
PSD (m^3/s)	0.035	0.065	0.097
SSR (m^3/ha)	450		

To simulate the fully developed subdivided lots, flows were determined for each lot based on their area and applicable PSD. These flows were applied to the interallotment pits as a baseflow within the post developed DRAINS model

Typical details for in-lot stormwater management strategy have been included in the drawing NSW211637-SHT-DA-C7.201.

4.6.5 DRAINS Result

A comparison of the predeveloped and the developed site peak flows with the in-lot OSD for each AEP from 20% through to 1% is shown in Table 5.

Table 5 Total Site Predeveloped vs Developed (with OSD) Peak Flows

Storm Event AEP	**Peak Discharge l/s:**			
	Pre-Development	**Post Development**	**Difference**	**Difference %**
20%	2134	1310	-843	-39%
5%	3375	2070	-1324	-39%
1%	4914	2650	-2273	-46%

In addition to the overall site meeting the post development flow requirement, the flows from each catchment and basin individually meet the requirement. A comparison of the predeveloped and the developed catchment peak flows with the basin for each AEP from 20% through to 1% is shown in Table 6, Table 7 and Table 8.

Table 6 North-western Predeveloped vs Developed (with Detention) Peak Flows

Storm Event AEP	**Peak Discharge l/s:**			
	Pre-Development	**Post Development**	**Difference**	**Difference %**
20%	1139	469	-670	-59%
5%	1727	700	-1027	-59%
1%	2429	831	-1598	-66%

Table 7 South-western Predeveloped vs Developed (with Detention) Peak Flows

Storm Event AEP	**Peak Discharge m^3/s:**			
	Pre-Development	**Post Development**	**Difference**	**Difference %**
20%	765	544	-221	-29%
5%	1270	892	-378	-30%
1%	1960	1200	-760	-39%

Table 8 North-eastern Predeveloped vs Developed (with Detention) Peak Flows

Storm Event AEP	**Peak Discharge m^3/s:**			
	Pre-Development	**Post Development**	**Difference**	**Difference %**
20%	247	247	0	0%
5%	399	389	-10	-3%
1%	535	499	-36	-7%

5 Stormwater Quality – Operational Phases

5.1 Standards

The stormwater quality measures implemented in this design have been designed in accordance with the following documents provided by council:

- Australian Runoff Quality (Engineers Australia 2005)
- Water Sensitive Urban Design Technical Guidelines for Western Sydney (NSW Government Stormwater Trust and UPRCT, May 2004)
- Design Guidelines for Engineering Works for Subdivisions and Developments (Penrith City Council, November 2013)
- WSUD Technical Guidelines (Penrith City Council, October 2020)

5.2 Objectives

The objectives of the stormwater quality management for the site are:

- Meet the water quality objectives of Penrith City Council for the operational phase of the site by using best practice stormwater treatment measures. The water quality reductions required by Penrith City Council are:
  - 90% reduction in total gross pollutants (GP),
  - 85% reduction in total suspended solids (TSS),
  - 60% reduction in total phosphorus (TP).
  - 45% reduction in total nitrogen (TN).

5.3 Stormwater Quality Modelling

5.3.1 Introduction

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) is used to assess the pollutant generation from the site in post-development conditions and to evaluate the proposed treatment train effectiveness.

Modelling has been undertaken in accordance with BMT WBM (2015) guidelines with the developed site based on conceptual lot layout with water quality treatment devices included to achieve councils' objectives.

5.3.2 Rainfall Data, Evaporation Data, and Soil Type

The rainfall data and evapotranspiration data for the project was adopted based on the available MUSIC link for Penrith City Council. For the proposed water quality modelling, the pluviography data from 67113 Penrith Lakes AWS rainfall station was utilised. The data spanned for the duration between 1990 to 2008. Similarly, an average Sydney potential evapotranspiration (PET) data was utilised for the modelling as available in MUSIC link for Penrith City Council.

5.3.3 MUSIC Model Source Inputs

The source data for the MUSIC model for the developed model were adopted from the Penrith City Council WSUD technical guidelines and NSW MUSIC Model Guideline values for urban residential. The tentative roof area of approximately 65% of the total site area has been assumed for each lot. An overall lot fraction impervious of 75% was adopted (including the roof area) for lots. A fraction impervious of 90% was adopted for the road catchments.

5.3.4 Catchments Pollutant Mean Concentrations

The pollutant Event Mean Concentration (EMC) values for the development were adopted from Penrith City Council WSUD technical Guidelines and NSW MUSIC Model Guideline values for urban residential for both base flows and storm flows. The catchments were divided into roofs, residential lots (remaining yards) and road areas.

5.3.5 MUSIC Model Treatment Train

To meet the water quality requirements of Penrith City Council a range of water quality improvement devices are proposed. The proposed water quality improvement devices for the site are:

- 100kL Rainwater tanks for each industrial lot
- 1 x Pit with ocean guard insert for each industrial lot
- 2 x Ocean Protect Ocean Save OS-1612-D GPT,1 x Ocean Protect Ocean Save OS-1618-D GPT
- 2 x Constructed Wetlands, consisting of:
  - 2 x Water Treatment Ponds
  - 2 x Sedimentation Basins
- Storm Filters (Detention Basins) for each industrial lot

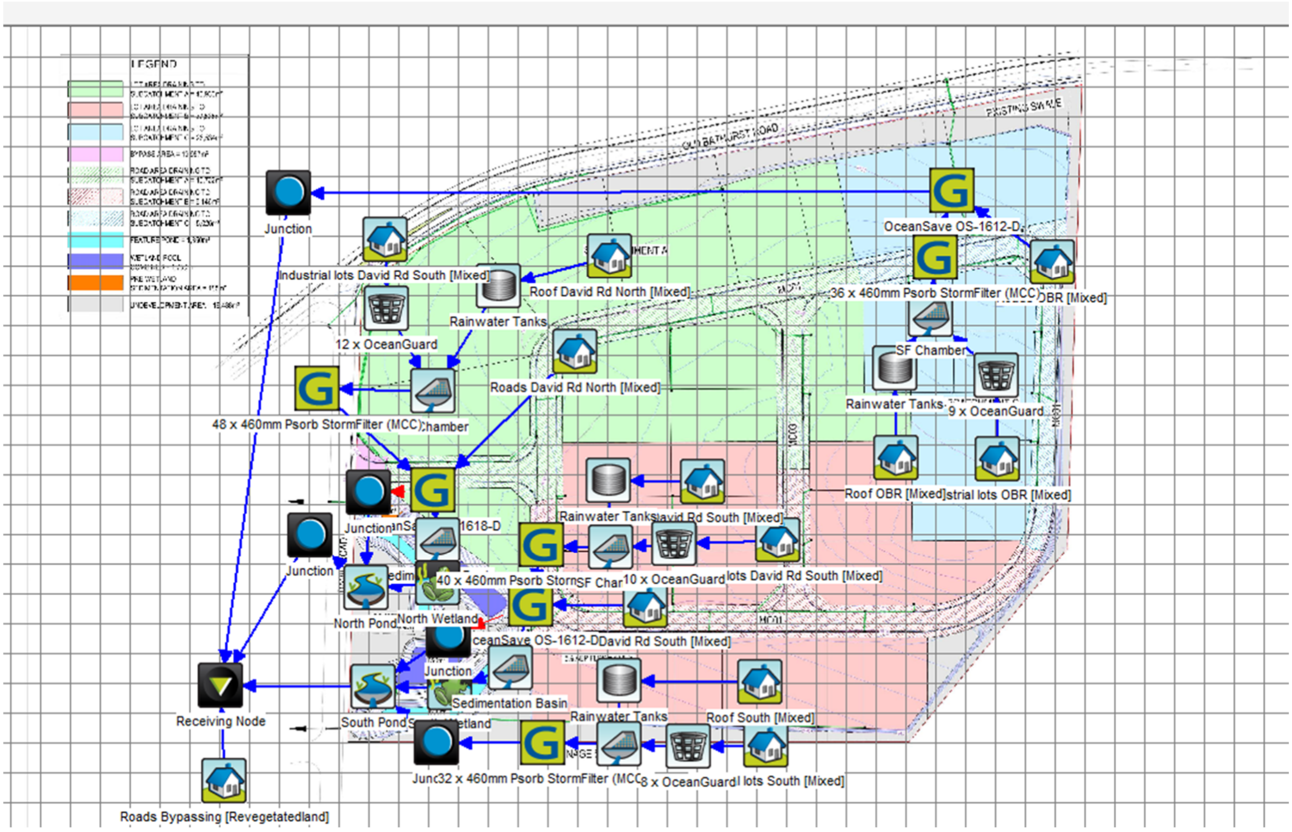


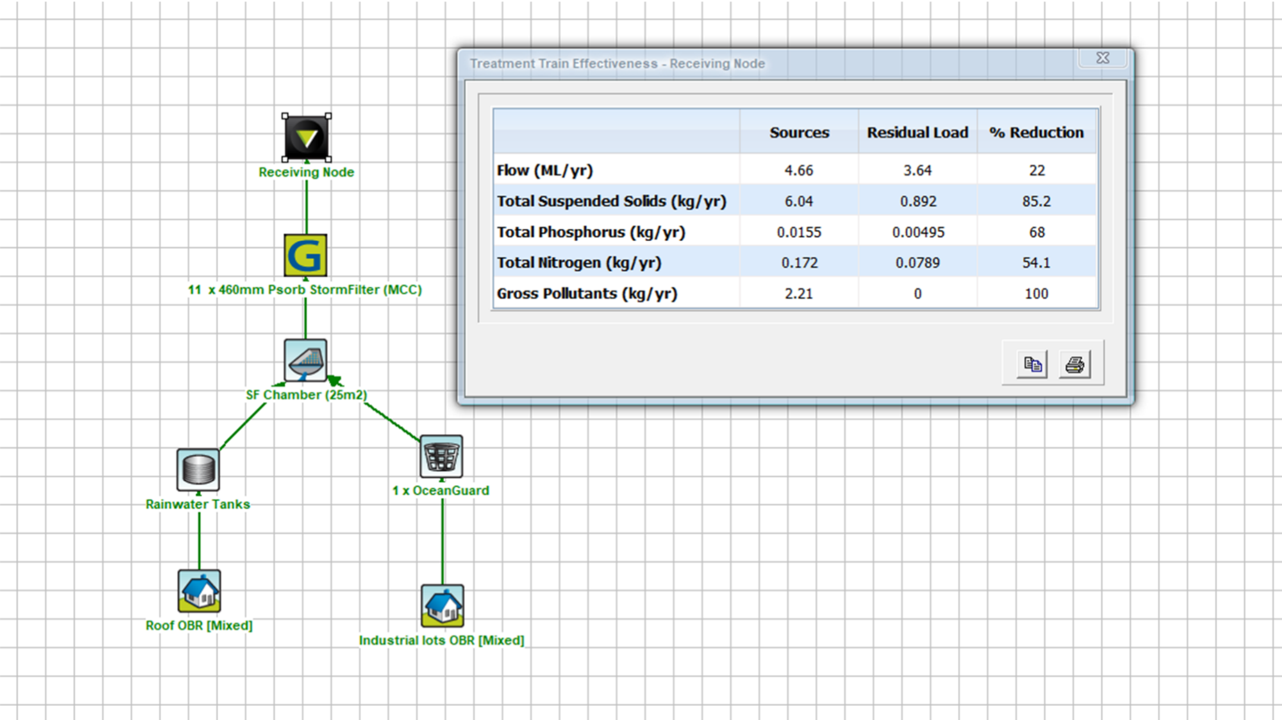
Figure 3 Screen shot of MUSIC treatment train

Similar to the stormwater strategy adopted for the quantity management, a source control approach has been adopted for the water quality management. Each lot will be self-sufficient to meet the pollutant control requirements within its site boundary. A typical MUSIC modelling has also been prepared to represent each standard subdivided lot and it demonstrates in the figure 4 below.

Due to grading constraints on site and the minimal pipe cover available over interallotment drainage lines, detention tanks with proprietary storm filters have been considered within each lot to reduce pollutants. Assuming 65% of the lot area will drain to rainwater tank and the remaining site with 10% pervious area will be collected and treated by a primary treatment prior to detention tank with the storm filters.

In order to determine the required number of storm filter cartridges for each lot, a prescriptive rate of one 460 mm high PSorb Storm filter by Ocean Protect per 240m^2 of non-roof site area is obtained from MUSIC model for the entire site (shown in Figure 3) to meet Penrith water quality targets for industrial developments. This design however is only preliminary and intends to demonstrate the efficacy of the at source treatment approach. During detailed design equivalent products with can also be used,

Lot number 34 with area of 8130 m^2 has been used as a typical example to show how to determine the number of the water quality devices required for each lot. The 35% of the area (2845.85m^2) bypassing the rainwater tank will be treated by storm filters. 11 x PSorb storm filters housed within a 25m^2 chamber will be required based on prescriptive rate mentioned above.



	Sources	Residual Load	% Reduction
Flow (ML/yr)	4.66	3.64	22
Total Suspended Solids (kg/yr)	6.04	0.892	85.2
Total Phosphorus (kg/yr)	0.0155	0.00495	68
Total Nitrogen (kg/yr)	0.172	0.0789	54.1
Gross Pollutants (kg/yr)	2.21	0	100

Figure 4 Screen shot of MUSIC treatment train for Lot 34

The above water quality improvement devices act as a treatment train, progressively reducing pollutants as they pass through each one.

Screenshots of the MUSIC models are shown in Figure 3 & 4 above. A brief discussion on each of the treatment train models is given below.

Rainwater Tanks

Rainwater tanks have been provided for each lot treating runoff from the roofs for all future industrial lots and buildings. A 100kL rainwater tank was assumed for each standard industrial lot as per control 3) a) in section 3.1.C of the Penrith DCP 2014 C3 Water Management. The re-use rates of the rainwater tanks have been estimated as per section 4.5 of the Penrith WSUD Technical Guidelines. Water captured in the rainwater tanks is expected to be reused for internal re-use and irrigation. Reuse demand for toilets flushing is 0.1 kL/day/per toilet for industrial developments and two toilets are assumed for each lot. For irrigation of landscaped areas purposes is 0.4 kL/year/m^2 as PET – Rain for sprinkler systems and 0.3 kL/year/m^2 for subsurface irrigation.

Pits with Ocean guard inserts

This measure installed within stormwater pits to capture gross pollutants and coarse sediments only before discharging to detention systems for each lot and has treatment flow rate is 0.02 cu.m/sec

Storm Filter

The detention basins with storm filters have been grouped and modelled in MUSIC to comply with Penrith's WSUD Technical Guidelines. The number of storm filter is based on a prescriptive rate of 240m^2/ per 460mm Psorb Storm filter of non-roof site area which has been calculated to meet the water quality objectives within the site itself.

Gross Pollutant Traps

Once the lot stormwater has been treated on the lots, it will be captured by the underground drainage infrastructure and flow towards the proposed constructed wetland system. Before entering the wetlands, the stormwater runoff from the road pavements is also captured in this drainage system. Therefore, the next treatment strategy adopted was the use of the Gross Pollutant Traps (GPT) as pre-treatment upstream of the wetlands. These products remove gross pollutants, sediment and attached nutrients. The MUSIC node for the GPT was provided by Ocean Protect, the manufacturer of the specified unit, who claim that the removal efficiencies used in MUSIC have been confirmed via independent testing. An equivalent product could be used if that specified is not deemed suitable. The GPT's have been designed in an offline configuration, with low flows being directed through the sediment basins and wetland nodes, and the high flow bypass (in excess of the 4EY) directed straight to the ponds.

Two Ocean Protect Ocean Save GPT devices have been used to treat the runoff from the private road noted as David Routh North and South as well as the industrial lots highlighted as Sub-Catchment A and partially Sub-Catchment B (Lots 10-11, 22-24, 29-31). A third Ocean Protect Ocean Save GPT is used to treat the runoff from the private road and industrial lot highlighted as Sub-Catchment C to the northeast of the site. A portion of Sub-Catchment B (Lots 14-21) does not get treated by an Ocean Protect Ocean Save GPT. Low flows of Sub-Catchment A and B passing through the Ocean Save GPTs will be subsequently treated by two separate sediment basins, then by two wetland macrophyte zones then two water treatment ponds.

Higher flows of Sub-Catchment A and B which bypass the Ocean Save GPTs will also bypass the two sedimentation basins and wetland areas. A portion of Sub-Catchment B (Lots 14-21) which bypasses the Ocean Save GPT will also bypass the sedimentation basin and wetland and will be treated by the water treatment ponds. Sub-Catchment C will not be treated by any wetlands or water treatment ponds.

Constructed Wetlands

The final treatment strategy proposed is a combination of 2 constructed wetlands and pond area. This treatment measure is discussed in further detail below in section 5.4.

5.4 Wetlands

5.4.1 Objectives

The objectives driving the design of the proposed wetlands area as follows:

- To improve water quality discharging from the site into Lapstone Creek downstream
- Enhance the ecological value of the area, replacing the existing dilapidated pond
- Provide amenity as a landscape feature in the industrial complex

The wetlands are not intended to act as flood mitigation and stormwater detention as a primary function, however due to their size and level they do provide some attenuation for stormwater flows.

5.4.2 Design

Constructed wetlands with a total treatment area of 1700 sqm have been proposed at the south-western corner of the site with sedimentation pools and active macrophyte zones which removes pollutants such as nutrients, heavy metals, and sediments. Furthermore, the wetlands will also promote water balance by promoting evapotranspiration and provide habitat for local flora and fauna.

Refer to Stormwater Management Plan NSW211637-SHT-DA-C7.001 for the locations of two constructed wetlands proposed on the site; namely Wetland A and Wetland B.

Refer to Stormwater Catchment Plan NSW211637-SHT-DA-C7.101 showing the catchment area being treated by each wetland.

5.4.2.1 Water Levels

In order to operate effectively, the proposed wetland systems have been designed to allow appropriate hydraulic function, with the design levels dictated by site constraints and design objectives.

The incoming pipes have an invert of RL 22.82 for Wetland A and 23.18 for Wetland B, to minimise the hydraulic impact of the wetland and the pipe under low flow conditions. Normal water levels are set below the inverts of the inlet pipes allowing incoming stormwater to be drawn down via gravity and avoiding drowned inlet pipes. The dry pipe inlet condition to the wetlands will provide ease for maintenance and regular inspection during the operation of the wetlands.

The downstream tailwater conditions in David Road is set as the minimum level for the wetlands. Wetland A is limited by the downstream connection pit which has an invert level of RL 22.49. Proposing a minimum 0.5% fall to this pit determines the outlet pipe from Wetland A to be at minimum RL 22.60. The water level for Wetland B is controlled by the downstream drainage culverts which have an invert of RL 23.13. Based on the site constraints of the downstream tailwater conditions, the NWL is at the same level of the receiving drainage. In this case, proposed pond A and B are designed to be receiving drainage systems. Therefor for plant establishment and maintenance of the wetlands pumping system will be required to maintain a lower water level. This will be designed and detailed at a later stage.

These wetland features are proposed to have the following arrangements:

- NWL was identified as at the invert level of the outlet pipe to allow permanent water body with a multiple level orifice outlet control structure set at the Normal Water Level (NWL) of RL 22.6 for Wetland A and RL 23.13 for Wetland B.
- Top Extended detention depth (TEDD) is the level above the NWL that will temporarily store water allowing stormwater to be treated. These levels are set at RL 22.85 for Wetland A and RL 23.38 for Wetland B.
- Maximum Water Levels are set to be at the 100-year ARI water level in the wetlands which are RL 23.2 for Wetland A and RL 23.47 for Wetland B.

The wetland schematic is shown in below Figure 5.

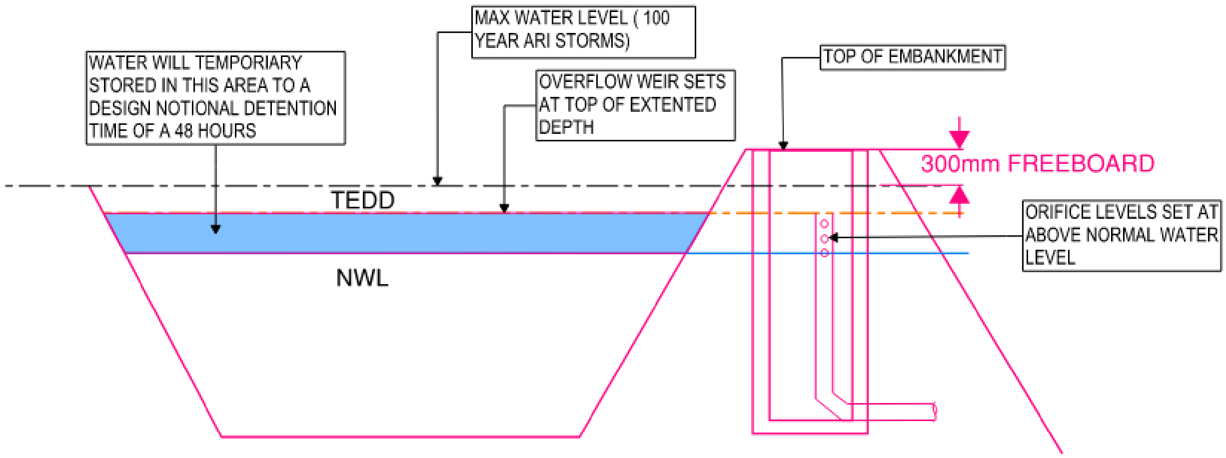


Figure 5 Wetland Schematic Diagram

5.4.2.2 Sediment ponds

At the inlet of each wetland is a sediment pond which is design to receive the stormwater inflow, dissipate its energy and act as a settling pond which will remove coarse sediments. In less frequent events, the sediment ponds also act as a high flow bypass structure, allowing incoming major flows to overtop a weir and flow directly into the downstream pond. This structure protects the macrophyte zone downstream by ensuring only flow flows pass through the wetland, avoiding scouring, and through sediment removal which prevents the vegetation from being smothered by coarse sediments.

The sediment ponds have been designed for a design flow of 1EY, with the target of removing 80% of sediment above 125μm in that event. The ponds have been designed with sufficient volume to store settled sediments for a maintenance period of up to 5 years. The estimated sediment volume accumulated in this interval is as follows:

- Sediment Pond A – 14 m^3
- Sediment Pond B – 11 m^3

The ponds have been positioned to ensure ease of access to carry out the required maintenance, with hardstand areas directly adjacent to both ponds.

5.4.2.3 Macrophyte marsh

The macrophyte zone is positioned within what is referred to on the plans was the “wetland” area. This is the area of the wetland system that performs the majority of the water treatment through biological, chemical, and physical processes. It consists of a number of deep and shallow marsh, and ephemeral zones featuring dense vegetation that filters out sediment and takes up nutrients.

The precise layout of the macrophyte zones has not been designed at this stage, however the MUSIC modelling indicates that the area allowed for their design is sufficient to achieve the treatment outcomes required by council. Upon further detailed design, it should be ensured that the macrophyte zone features a minimum vegetation coverage of 80% at a maximum of 0.4m below the NWL. The bathymetry of the zone is to be designed to pass incoming flows through deep water zones, followed by deep marsh, then shallow marsh, deep marsh and finally back out through deep water. The preliminary design presented in this report has taken the extended detention depth within the macrophyte zones as 250mm, with the outlet designed to release this water level over 48 hours. This slow release allows the water sufficient time to come into contact with the plants and for treatment to occur.

5.4.2.4 Flow control

Two overflow pits have been proposed with connection pipes to divert the low flows from sedimentation basins to the wetlands macrophyte zones. Flows bypass the wetland macrophyte during larger storm events when the sediment basins reach the extended detention depth. This occurs by introducing an overflow weir adjacent to the basins which convey flows to the receiving drainage systems in order to protect plants and prevent bed scouring in wetlands

Macrophyte Zone Outlet

Flows from the wetland will be controlled by the outlet control pits with a riser outlet pipe that consists of three orifices holes above the NWL (refer to Figure 5 above). The outlet structure has been designed to incorporate the following operational requirements:

- An extended detention time of 48 hours for water stored in the wetland to ensure that water receives treatment for a sufficient time period. This is achieved by introducing an outlet riser pipe with three orifices plates to control flow. The orifice details are summarised in the table below.
- 2.5m maintenance access road has been provided adjacent to the wetlands.

Orifice Positions (Centre line)	**Orifice 1**	**Orifice 2**	**Orifice 3**
Wetland A	30 DIA at CL=22.60	20 DIA at CL =22.725	15 DIA at CL =22.7875
Wetland B	30 DIA at CL =23.13	18 DIA at CL =23.255	10 DIA at CL =23.3175

The proposed configuration of the wetland high flow weir outlet has been designed direct the 1% AEP flow of 0.842 m^3/s and 1.2 m^3/s for Wetland A and B respectively. This provides the designed Maximum Water Level at RL 23.2 for Wetland A and RL 23.47 Wetland B.

5.4.3 Stormwater Treatment Modelling

A combination of sedimentation basins, macrophyte zones, and ponds have been modelled in series to represent a wetland design in accordance with recommendations in the NSW MUSIC Modelling Guidelines 2015, and the Blacktown Council WSUD Developer Handbook 2020. The input parameters are based on the guidelines in these documents; however, they also comply with the requirements in the Penrith WSUD Technical Guidelines – refer to the MUSIC Link report for verification. The specified size of these treatment nodes can be accommodated within Lot 32.

Refer to Figure 3 for MUSIC model configuration.

The design of these wetlands is still preliminary and shall be refined during the detailed design stage. The presented drawings and sketches are conceptual in nature to demonstrate the intent of overall design intent.

The catchment node areas for the model are based on two individual catchments draining to each wetland and the catchment areas and impervious fraction are shown in the below figure.

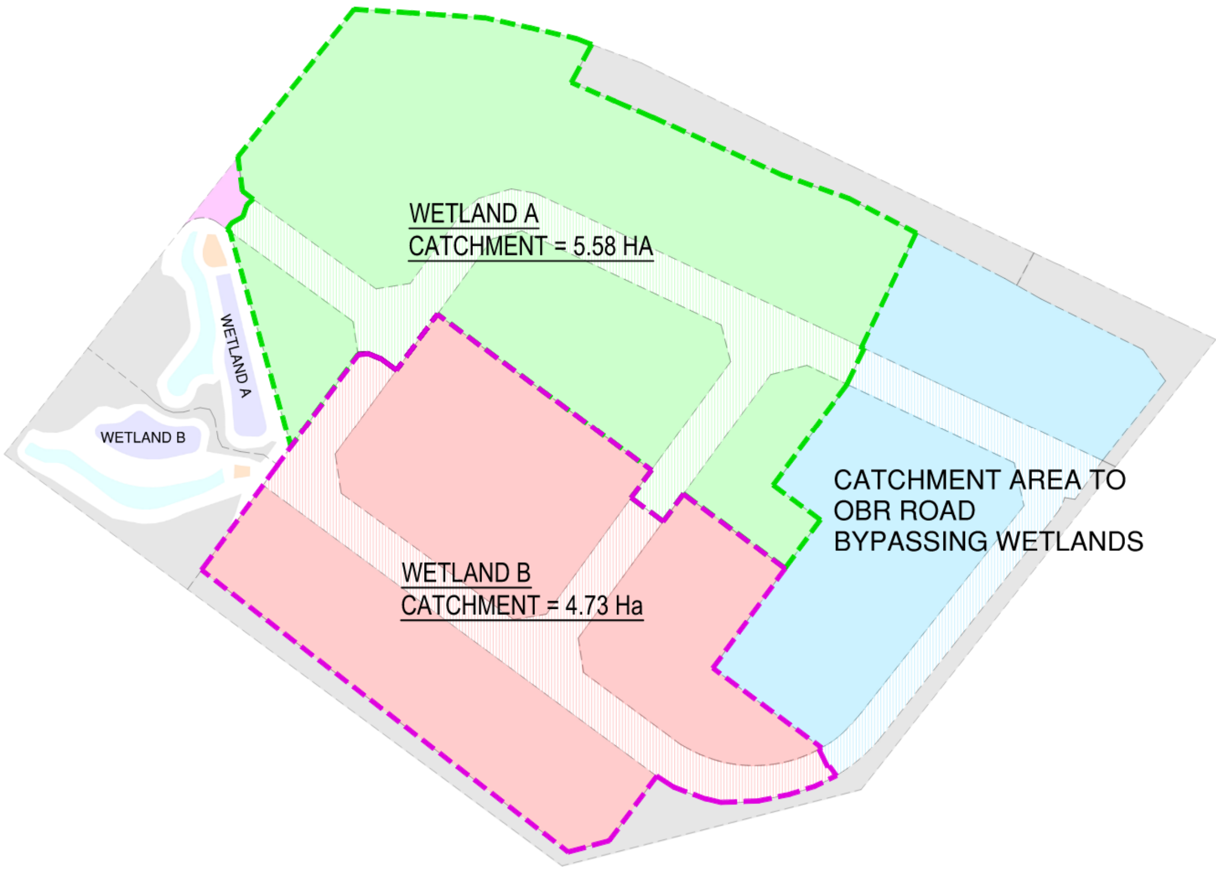


Figure 6 Wetland Catchment Plan

5.4.3.1 Treatment Node Parameters

Gross Pollutant Traps

Council has advised that an underground gross pollutant traps are to be used as part of the control to reduce pollutants targets before discharging to the wetlands. These GPTs have been discussed in detail in section 5.3.5 above and design parameters listed in table below.

Table 9 OceanSave OS - 1618 - D

Parameters	Values
High flow Bypass	0.35 m^3/s
Gross Pollutants	100%
Total Suspended Solids	70%
Total Phosphorus	30%
Total Nitrogen	100%

Table 10 OceanSave OS - 1612 - D

Parameters	Values
High flow Bypass	0.25 m^3/s
Gross Pollutants	100%
Total Suspended Solids	70%
Total Phosphorus	30%
Total Nitrogen	100%

Wetland Parameters

The parameters used for sedimentation basins and constructed wetlands are listed in tables below

Table 11 Sedimentation basins Design Parameters

Parameters	Values
Surface Area (m)	145 (A) & 47 (B)
Extended Detention Depth (m)	0.25
Permanent Pool Volume (cubic m)	215 (A) & 118 (B)
Initial Volume (cubic m)	215 (A) & 118 (B)
Equivalent pipe diameter (mm)	32
Overflow weir width (m)	20

Table 12 Constructed Wetland Design Parameters

Parameters	Values
High flow bypass (m^3/s)	0.842 (A) & 1.2 (B)
Extended Detention Depth (m)	0.25
Unlined Filter Material (m)	0.01
Saturated Hydraulic Conductivity (mm/hr)	100
Permanent Pool Volume (cubic m)	970 (A) & 730 (B)
Initial Volume (cubic m)	970 (A) & 730 (B)
Evaporation Loss as % PET	125
Equivalent pipe diameter (mm)	35 (A) & 30 (B)
Overflow weir width (m)	20
Notional Detention Time (hrs)	47.2 (A) & 48.3 (B)
Exfiltration Rate (mm/hr)	0
Base Lined	Yes

5.4.3.2 Stormwater Quality Modelling Results

Based on the proposed configuration of the water quality treatment modelling, the results of the overall site MUSIC model for the total catchment showing the mean annual pollutant loads for the existing and the developed catchment are shown in 11.

Table 13 Treatment Trains Results

	Source Load	**Residual Load**	**% Achieved Reduction**	**% Required Reduction**
TSS (kg/yr)	9980	1210	87.9	85
TP (kg/yr)	20.9	6.96	66.7	60
TN (kg/yr)	170	79.9	53.2	53.1
Gross Pollutants (kg/yr)	2160	0.0135	100	100

As can be seen from the results in Tables 11, the TSS, TN, TP and gross pollutants are reduced below the requirements of Penrith City Council. A copy of the MUSIC model and MUSIC link report will accompany this report as part of DA submission.

6 Stormwater Operation & Maintenance

6.1 Water Level Control and Maintenance

6.1.1.1 Wetland Maintenance

To plant out the wetland, the process will be to plant out the deeper areas first and manipulate the water levels upwards as the other planting bands are established. An outlet control pit is provided for both wetlands which can lower the NWL/TEDD to suit the initial planting depths. However due to the invert level of existing connecting points within David Road, it is practical to lower of the NWL to 300mm, which will be susceptible to water surcharging from David Road.

The following process to control the water levels for establishment and ongoing maintenance:

- Allow the wetland to fill above the normal water levels.
- Once achieved, pumping of the water from wetland down to the level required. A low flow pipe to be specified to allow low flows to drain to the deep-water area located at the outlet pits with the water discharged to existing connection points within David Road.
- To prevent backflows from existing downstream of Daivd Road, the existing culvert connected to David Road should be capped during maintenance occurring. This arrangement will maintain a low water during the establishment and maintenance period.

6.1.1.2 Sediment Pond & Pond Maintenance

Similar approach will apply to sediment ponds and storage ponds with the effluent pumped from the sedimentation ponds.

6.2 Ongoing Maintenance

A detailed operation and maintenance plan for the proposed stormwater structures will be prepared during detailed design. The maintenance requirements listed below give an indication of some of the maintenance tasks that will be required and their frequencies.

Table 14: Maintenance Requirements

Asset	**Maintenance Works**	**Maintenance Frequency**
Gross Pollutant Traps	Refer to Appendix C for detailed maintenance requirements for OceanSave GPT	Refer to Appendix C for detailed maintenance requirements for OceanSave GPT
Sediment Ponds	Litter removal	6 months minimum or as required following large rainfall events
	Weeding	3 months minimum
	Sediment removal	Every 5 years or as required. If sediment builds up to 0.5m below NWL then removal is required.
Wetlands	Litter removal	6 months minimum or as required following large rainfall events
	Weeding	3 months minimum
	Macrophyte harvesting	As required
Weir Structures	Litter removal	6 months minimum or as required following large rainfall events
	Weeding	3 months minimum
	Rock lining replacement	As required. Inspect every 5 years
Flow control structures	Clear blockages and sediment from sediment pond outlet pits	6 months minimum Inspect for obvious blockages monthly
	Clear blockages and sediment from wetland outlet pits and orifices	6 months minimum Inspect for obvious blockages monthly
	Clear blockages from outlet culverts under David Road	6 months minimum Inspect for obvious blockages monthly

7 Stormwater Quality - Construction Phase

7.1 General

During the construction phase of the development, an Erosion and Sediment Control Plan will be implemented to minimise the water quality impacts. The erosion and sediment controls will be in accordance with Landcom's Managing Urban Stormwater: Soils and Construction Volume 1, 4th Edition (Landcom, 2004) and the requirements of Penrith City Council. Erosion and sediment controls will be required preconstruction, during construction and post construction until the site is stabilized. The expected erosion and sediment control measures will include stabilized site access, sediment fence, gully pit sediment barriers, rock outlet scour protection and a temporary sediment basin.

Erosion and sediment control plans will be provided for the development at Detailed Design stage.

7.2 Pre-Construction Erosion and Sediment Control

Due to the topography of the site, the preconstruction erosion and sediment controls will be limited to stabilized site access, sediment fence and a temporary sediment basin until the initial bulk earthworks are undertaken. The proposed detention/water quality basin will be used as a sediment basin while construction is being undertaken. NSW211637-SHT-DA-C8.001 shows a concept erosion and sediment control plan for the development.

7.3 During Construction Erosion and Sediment Control

During the construction phase of the development, the erosion and sediment controls will consist of an installed sediment fence, a constructed sediment basin, gully pit sediment barriers and permanent rock outlet scour protection.

Regular inspection and maintenance of the erosion and sediment controls is required during the construction process.

Based upon the site soil-landscape or Fairy Meadow (fa) and utilising the Blue Book soil types, a sediment basin volume will be calculated using the Blue Book for type F soils. During construction, if the soils are found to be dispersive, the contractor will need to provide a flocculating agent to ensure discharge from the basin meets the requirements of the Blue Book. Design of sediment basins will be carried out as part of detailed design and subject to the staging of the development

7.4 Post Construction Erosion and Sediment Control

The contractor/developer will be responsible for the maintenance of the erosion and sediment control devices from the practical completion of the works for a minimum of 6 months or until stabilization has occurred to the satisfaction of Penrith City Council.

It is proposed to delay the construction of the bioretention filtration media in the basin until a significant proportion of the contributing lots are built on and established to avoid the system being filled with sediments and becoming ineffective.

8 Conclusion

Detention modelling for the site determined that the peak flows from AEPs for 20% to 1% AEP have been reduced to or below the predeveloped peak flows.

Water quality management for the site will consist of a treatment train to reduce the pollutant runoff from the site in accordance with the requirements of Penrith City Council.

Construction phase erosion and sediment control will be undertaken in accordance with Landcom's Managing Urban Stormwater and Penrith City Council.

If you have any questions regarding the information provided in this Civil Engineering DA Report, please c the undersigned to discuss

Yours faithfully,

ACOR Consultants (NSW) Pty Ltd

Kundan Pokharel
Senior Civil Engineer

Appendix A Civil Engineering Plans for DA Approval

Appendix B MUSIC Link Report

PENRITH
CITY COUNCIL

music link

MUSIC-*link* Report

Project Details		Company Details	
Project:	OBR_ DA	**Company:**	ACOR
Report Export Date:	23/09/2022	**Contact:**	STELLA HONG
Catchment Name:	NSW211637_MUSIC_Concept_DA_V3_220915	**Address:**	Unit 10, Level 1, 1 Maitland Place Norwest NSW 2153
Catchment Area:	15.311ha	**Phone:**	0404721196
Impervious Area*:	138.0%	**Email:**	SHong@acor.com.au
Rainfall Station:	67113 PENRITH		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1999 - 31/12/2008 11:54:00 PM		
Mean Annual Rainfall:	691mm		
Evapotranspiration:	1158mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.34		
Study Area:	Penrith		
Scenario:	Penrith Development		

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

Treatment Train Effectiveness		Treatment Nodes		Source Nodes	
Node: Receiving Node	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	12.6%	Rain Water Tank Node	5	Urban Source Node	14
TSS	88%	Wetland Node	2		
TP	66.8%	Sedimentation Basin Node	7		
TN	53.2%	Pond Node	2		
GP	100%	Generic Node	8		
		GPT Node	5		

Comments

CONCEPT DESIGN FOR DA

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
GPT	1 x OceanGuard	Hi-flow bypass rate (cum/sec)	None	99	0.02
GPT	10 x OceanGuard	Hi-flow bypass rate (cum/sec)	None	99	0.2
GPT	12 x OceanGuard	Hi-flow bypass rate (cum/sec)	None	99	0.24
GPT	8 x OceanGuard	Hi-flow bypass rate (cum/sec)	None	99	0.16
GPT	9 x OceanGuard	Hi-flow bypass rate (cum/sec)	None	99	0.18
Pond	North Pond	% Reuse Demand Met	None	None	0
Pond	South Pond	% Reuse Demand Met	None	None	0
Rain	Rainwater Tanks	% Reuse Demand Met	80	None	100
Rain	Rainwater Tanks	% Reuse Demand Met	80	None	100
Rain	Rainwater Tanks	% Reuse Demand Met	80	None	100
Rain	Rainwater Tanks	% Reuse Demand Met	80	None	100
Rain	Rainwater Tanks	% Reuse Demand Met	80	None	89.57
Receiving	Receiving Node	% Load Reduction	None	None	12.6
Receiving	Receiving Node	GP % Load Reduction	90	None	100
Receiving	Receiving Node	TN % Load Reduction	45	None	53.2
Receiving	Receiving Node	TP % Load Reduction	60	None	66.8
Receiving	Receiving Node	TSS % Load Reduction	85	None	88
Sedimentation	Sedimentation Basin	High Flow Bypass Out (ML/yr)	None	None	0
Sedimentation	Sedimentation Basin	High Flow Bypass Out (ML/yr)	None	None	0
Sedimentation	SF Chamber	High Flow Bypass Out (ML/yr)	None	None	0
Sedimentation	SF Chamber	High Flow Bypass Out (ML/yr)	None	None	0
Sedimentation	SF Chamber	High Flow Bypass Out (ML/yr)	None	None	0
Sedimentation	SF Chamber	High Flow Bypass Out (ML/yr)	None	None	0
Sedimentation	SF Chamber	High Flow Bypass Out (ML/yr)	None	None	0
Urban	Industrial lots David Rd South	Area Impervious (ha)	None	None	0.722
Urban	Industrial lots David Rd South	Area Impervious (ha)	None	None	1.416
Urban	Industrial lots David Rd South	Area Pervious (ha)	None	None	0.080
Urban	Industrial lots David Rd South	Area Pervious (ha)	None	None	0.164
Urban	Industrial lots David Rd South	Total Area (ha)	None	None	0.803
Urban	Industrial lots David Rd South	Total Area (ha)	None	None	1.581
Urban	Industrial lots OBR	Area Impervious (ha)	None	None	0.770
Urban	Industrial lots OBR	Area Impervious (ha)	None	None	0.681
Urban	Industrial lots OBR	Area Pervious (ha)	None	None	0.079
Urban	Industrial lots OBR	Area Pervious (ha)	None	None	0.168
Urban	Industrial lots OBR	Total Area (ha)	None	None	0.85
Urban	Industrial lots OBR	Total Area (ha)	None	None	0.85
Urban	Industrial lots South	Area Impervious (ha)	None	None	0.443
Urban	Industrial lots South	Area Pervious (ha)	None	None	0.049
Urban	Industrial lots South	Total Area (ha)	None	None	0.493
Urban	Roads Bypassing	Area Impervious (ha)	None	None	0

Only certain parameters are reported when they pass validation

PENRITH CITY COUNCIL

musiclink

Node Type	Node Name	Parameter	Min	Max	Actual
Urban	Roads Bypassing	Area Pervious (ha)	None	None	1.99
Urban	Roads Bypassing	Total Area (ha)	None	None	1.99
Urban	Roads David Rd North	Area Impervious (ha)	None	None	0.957
Urban	Roads David Rd North	Area Pervious (ha)	None	None	0.103
Urban	Roads David Rd North	Total Area (ha)	None	None	1.061
Urban	Roads David Rd South	Area Impervious (ha)	None	None	0.929
Urban	Roads David Rd South	Area Pervious (ha)	None	None	0.100
Urban	Roads David Rd South	Total Area (ha)	None	None	1.03
Urban	Roads OBR	Area Impervious (ha)	None	None	0.524
Urban	Roads OBR	Area Pervious (ha)	None	None	0.057
Urban	Roads OBR	Total Area (ha)	None	None	0.582
Urban	Roof David Rd North	Area Impervious (ha)	None	None	2.936
Urban	Roof David Rd North	Area Pervious (ha)	None	None	0
Urban	Roof David Rd North	Total Area (ha)	None	None	2.936
Urban	Roof David Rd South	Area Impervious (ha)	None	None	1.49
Urban	Roof David Rd South	Area Pervious (ha)	None	None	0
Urban	Roof David Rd South	Total Area (ha)	None	None	1.49
Urban	Roof OBR	Area Impervious (ha)	None	None	1.578
Urban	Roof OBR	Area Impervious (ha)	None	None	1.578
Urban	Roof OBR	Area Pervious (ha)	None	None	0
Urban	Roof OBR	Area Pervious (ha)	None	None	0
Urban	Roof OBR	Total Area (ha)	None	None	1.578
Urban	Roof OBR	Total Area (ha)	None	None	1.578
Urban	Roof South	Area Impervious (ha)	None	None	0.917
Urban	Roof South	Area Pervious (ha)	None	None	0
Urban	Roof South	Total Area (ha)	None	None	0.917

Only certain parameters are reported when they pass validation

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Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Sedimentation	Sedimentation Basin	Notional Detention Time (hrs)	8	12	43.8
Sedimentation	Sedimentation Basin	Notional Detention Time (hrs)	8	12	51.1
Sedimentation	SF Chamber	Notional Detention Time (hrs)	8	12	5.79
Sedimentation	SF Chamber	Notional Detention Time (hrs)	8	12	5.21
Sedimentation	SF Chamber	Notional Detention Time (hrs)	8	12	6.48
Sedimentation	SF Chamber	Notional Detention Time (hrs)	8	12	4.35
Sedimentation	SF Chamber	Notional Detention Time (hrs)	8	12	5.79
Sedimentation	SF Chamber	Total Nitrogen - k (m/yr)	500	500	1
Sedimentation	SF Chamber	Total Nitrogen - k (m/yr)	500	500	1
Sedimentation	SF Chamber	Total Nitrogen - k (m/yr)	500	500	1
Sedimentation	SF Chamber	Total Nitrogen - k (m/yr)	500	500	1
Sedimentation	SF Chamber	Total Nitrogen - k (m/yr)	500	500	1
Sedimentation	SF Chamber	Total Phosphorus - k (m/yr)	6000	6000	1
Sedimentation	SF Chamber	Total Phosphorus - k (m/yr)	6000	6000	1
Sedimentation	SF Chamber	Total Phosphorus - k (m/yr)	6000	6000	1
Sedimentation	SF Chamber	Total Phosphorus - k (m/yr)	6000	6000	1
Sedimentation	SF Chamber	Total Phosphorus - k (m/yr)	6000	6000	1
Sedimentation	SF Chamber	Total Suspended Solids - k (m/yr)	8000	8000	1
Sedimentation	SF Chamber	Total Suspended Solids - k (m/yr)	8000	8000	1
Sedimentation	SF Chamber	Total Suspended Solids - k (m/yr)	8000	8000	1
Sedimentation	SF Chamber	Total Suspended Solids - k (m/yr)	8000	8000	1
Sedimentation	SF Chamber	Total Suspended Solids - k (m/yr)	8000	8000	1
Urban	Roads Bypassing	Field Capacity (mm)	70	70	80
Urban	Roads Bypassing	Groundwater Daily Baseflow Rate (%)	10	10	5
Urban	Roads Bypassing	Impervious Area Rainfall Threshold (mm/day)	1.4	1.4	1
Urban	Roads Bypassing	Pervious Area Infiltration Capacity coefficient - a	150	150	200
Urban	Roads Bypassing	Pervious Area Infiltration Capacity exponent - b	3.5	3.5	1
Urban	Roads Bypassing	Pervious Area Soil Initial Storage (% of Capacity)	30	30	25
Urban	Roads Bypassing	Pervious Area Soil Storage Capacity (mm)	105	105	120
Wetland	North Wetland	Notional Detention Time (hrs)	48	72	47.2

Only certain parameters are reported when they pass validation

Appendix C OceanSave GPT O&M Manual

OCEAN PROTECT

OceanSave

Operations & Maintenance Manual

Table of Contents

Rev: *1* ***Last Updated:*** *Aug 2020*

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 OceanSave is a vortex type engineered stormwater management device designed to remove litter, gross pollutants, sediment and associated pollutants from stormwater runoff. It removes all particles 5 mm and greater from stormwater flows, including neutrally buoyant material. It also removes some suspended solids and free-floating oil and grease via the internal baffle.

The OceanSave is a system that effectively captures and retains a broad range of pollutants.

Why do I need to perform maintenance?

Adhering to the maintenance schedule of each stormwater treatment device is essential to ensuring that it works 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).

Health and Safety

Access to an OceanSave unit requires removing heavy access covers/grates, additionally it might become necessary to enter into a confined space. Pollutants collected by the OceanSave 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 objects such as broken glass and syringes. For these reasons, all aspects of maintaining and cleaning your OceanSave 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 OceanSave, 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:

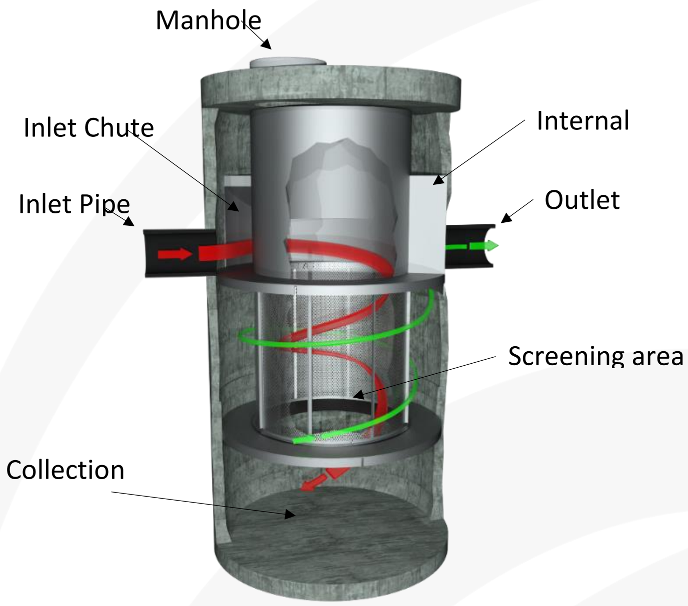
- Puncture resistant gloves
- Steel capped safety boots,
- Long sleeve clothing, overalls or similar skin protection
- Eye protection
- High visibility clothing or vest

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.

Whilst the minor maintenance for the OceanSave can be performed from surface level, there will be a need to enter the pit (confined space) during major services. 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 in confined space entry requirements.

How does it Work?

The OceanSave employs a unique screen design that maximizes hydraulic capacity and pollutant removal whilst simultaneously cleaning the screen surface. During operation, a tangential inlet causes stormwater to swirl in the circular treatment chamber. Buoyant materials migrate to the centre of the treatment chamber and rise above the screen while non-floating pollutants are trapped in the storage sump below.



During a storm, pipe flow enters the inlet structure where it is directed tangentially to the circular screen. The system builds driving head and forces water down into the screening area. This creates a vortex action with high tangential velocities across the face of the screen relative to the normal velocities through the screen. This indirect screening feature simultaneously cleans the screen surface whilst removing debris from stormwater. Floatable material is captured in the screening zone. There is also a baffle wall outside the screening zone that allows for the storage of hydrocarbons. Sediment and settable material fall into the sump below the screening area with treated stormwater exiting through the screen to the outlet pipe.

At higher flow rates, a portion of the runoff spills over the weirs located on either side of the inlet structure without affecting the treatable flow rate of the OceanSave. At the end of the storm water drains down to the pipe inverts further promoting the settling of fine suspended debris into the storage sump.

Given the unique component design the device can have multiple inlet/outlet pipes coming at a range of angles generally up to 270 degrees between inlet and outlet. Furthermore, any debris that accumulates behind the screen can be cleaned at time of routine maintenance without dismantling of the screen itself. The refined design of the OceanSave technology utilises the proven performance of the indirect vortex style gross pollutant traps whilst improving characteristics such as configuring and associated installation and maintenance.

Maintenance Procedures

To ensure optimal performance, it is advisable that regular maintenance is performed. Typically, the OceanSave requires a minor service every 6 months and a major service every 12 to 24 months.

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 OceanSave.

	Description of Typical Activities	Frequency
Minor Service	Visual inspection of inlet aperture Removal of large floatable pollutants Measuring of sediment depth	At 6 Months
Major Service	Removal of accumulated sediment and gross pollutants. Inspection of screening element and cleaning every 2 years	At 12 Months

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 assess the condition of the device and record necessary information that will inform the activities to be undertaken during a major service.

1. Establish a safe working area around the access point
2. Remove access cover
3. Visually inspect the inlet aperture
4. Remove large floatable pollutants with a net
5. Measure and record sediment depth
6. Replace access cover

Major Service

This service is designed to return the OceanSave device back to optimal operating performance.

1. Establish a safe working area around the access point
2. Remove access cover
3. Using a vacuum unit remove any floatable pollutants
4. Decant water until water level reaches accumulated sediment
5. Remove accumulated sediment and gross pollutants with vacuum unit (if required)
6. Enter the device to inspect the screening element (every 2 years on larger units)
7. Use high pressure water to clean screen and sump area (if required)
8. Replace access cover

When determining the need to remove accumulated sediment from the OceanSave unit, the specific sediment storage capacity for the size of unit should be considered (see table below).

OceanSave Model	Unit Diameter (m)	Total Capacity (m^3)	Sump Storage Capacity (m^3)
OS-0606	1.2	1.5	0.8
OS-0809	1.5	2.8	0.8
OS-1112	2.2	8.0	2.5
OS-1612	2.2	11.0	4.4
OS-2318	3.2	28.0	11.9
OS-2324	3.2	33.0	9.5

Additional Types of Maintenance

The standard maintenance approach is designed to work towards keeping the OceanSave system operational during normal conditions. From time to time 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, the OceanSave unit that potentially received flow should be inspected and cleaned. Specifically all captured pollutants from within the unit should be removed and disposed in accordance with any additional requirements that may relate to the type of spill event.

Blockages

The OceanSave internal high flow bypass functionality is designed to minimise the potential of blockages/flooding. In the unlikely event that flooding occurs around or upstream of the device location the following steps should be undertaken to assist in diagnosing the issue and determining the appropriate response.

1. Inspect the inlet aperture, ensuring that it is free of debris and pollutants
2. Decant water from OceanSave unit in preparation for confined space entry
3. Inspect the screen and flume as well as both inlet and outlet pipes for obstructions, if present remove any built up pollutants or blockages.

Major Storms and Flooding

In addition to the scheduled activities, it is important to inspect the condition of the OceanSave after a significant major storm event. The focus is to inspect for higher than normal sediment accumulation that may result from localised erosion, where necessary accumulated pollutants should be removed and disposed.

Disposal of Waste Materials

The accumulated pollutants found in the OceanSave 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 system has been exposed to any hazardous or 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 OceanSave system we offer long term pay-as-you-go contracts and pre-paid once off servicing.

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