BIRZULIS ASSOCIATES Pty Ltd
Consulting Structural + Civil Engineers
ACN 003 797 911 ABN 99 003 797 911

583 Darling Street, Rozelle NSW 2039
Telephone: 9555 7230 Facsimile: 9555 7239
Email: office@birzulisassociates.com

STORMWATER MANAGEMENT REPORT

ARMIDALE SECONDARY COLLEGE
ARMIDALE NSW

Prepared For:
Armidale Secondary College
c/- NBRS Architecture Pty Ltd
Level 3, 4 Glen Street
MILSONS POINT NSW 2061

Prepared by:
Birzulis Associates Pty Ltd
583 Darling Street
ROZELLE NSW 2039

***Rev*: D**

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	Name	**Signature**
Prepared by	Steven Luu	Steven Luu
Checked by	Michael Grogan	
Issued by	Michael Grogan	
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1 INTRODUCTION

Birzulis Associates Pty Ltd has been commissioned by NBRS Architecture Pty Ltd on behalf of Schools Infrastructure to prepare this Stormwater Management Report in support of a proposed development application to be lodged over the site.

The site is located on the southern side of Mann Street between Butler Street and Barry Street, Armidale, NSW. The proposed development is for a co-educational public secondary school consisting of numerous multi storey classroom buildings and car parks.

This report provides a summary of the stormwater management design principles and planning objectives for the management of stormwater quality and quantity. The objectives for the development are to provide an appropriate and economical stormwater management system which incorporates best practice in water sensitive urban design consistent with the requirements of Armidale Regional Council's (ARC) water quality objectives.

A set of drawings have been prepared to show that the proposed stormwater quantity and quality requirements for the development can be met. These drawings cover stormwater management elements which cover surface levels and drainage layouts.

The consent authority is Armidale Regional Council. The engineering and policy requirements of ARC have also been considered in the design. The stormwater management design had been discussed with the Stormwater Engineer at ARC throughout the design stages of this project. It was agreed that the use of rainwater tanks for water re-use and agricultural purposes would benefit the site, in conjunction with the use of an on-site detention tank.

2 SITE CHARACTERISTICS

2.1 Site Description

The proposed development is located in the suburb of Armidale on Butler Street with an area of approximately 18.3 hectares in area, as shown in **Figure 2.1.**

The site is bounded by Mann Street to the north, arboretorium to the south and low density residential land to the east and west.

Figure 2.1 Locality Plan

2.2 Proposed Development

The proposed development is for the construction of a new secondary college.

An indicative layout of the development has been produced by NBRS Architecture and can be seen in **Figure 2.2**.

The development will include the following engineering components:

- Earthworks to provide foundation support for the classroom buildings including the excavation for underground on-site detention tanks;
- Construction of an access driveway off Butler Street;
- Maintaining the natural gradient of the site and overland flow path through the development site;

- Stormwater drainage system based on a major/ minor design philosophy;
- Management of stormwater quality using a treatment train approach to pollutant loads on a developed catchment in accordance with ARC's recommendations; and
- Management of stormwater quantity by reducing post developed flow to pre-developed over the range of storms between the 1 in 5 year Average Recurrence Interval (ARI) to the 1 in 20 year ARI as per council policy and recommendations.

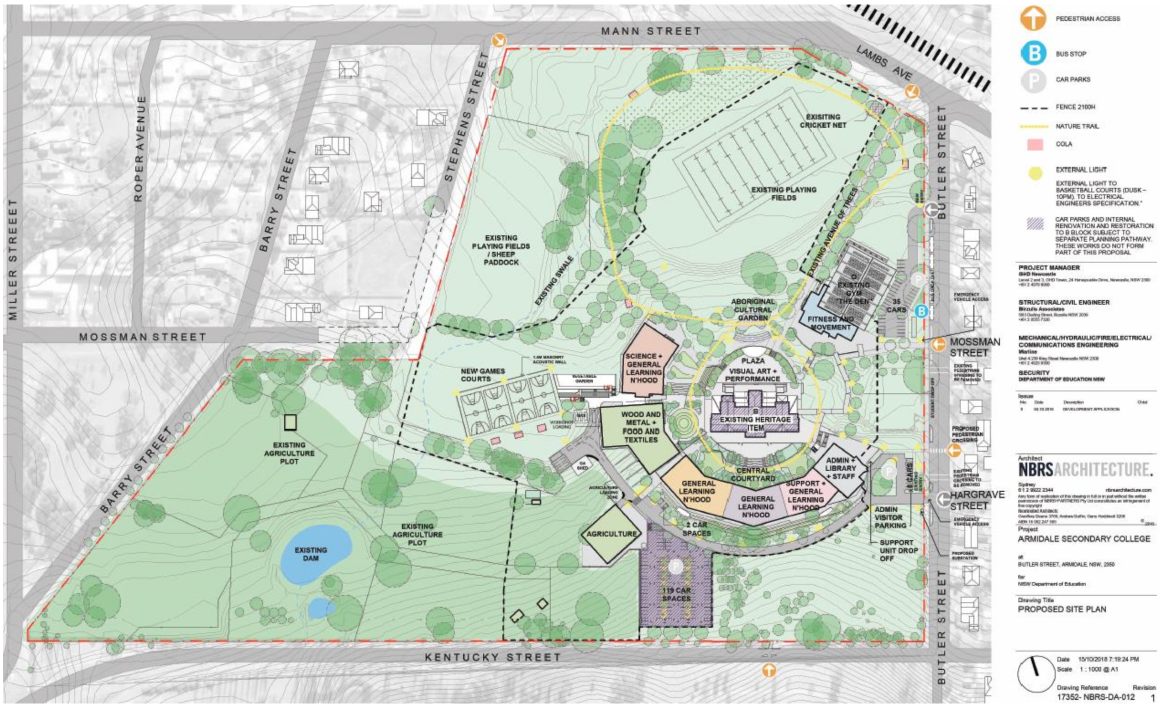


Figure 2.2 Architectural Plan

3 STORMWATER DRAINAGE

3.1 Site Drainage

3.1.1 Existing Site Drainage

The property is currently developed as public high school with a large portion of the property utilized for agricultural purposes. All current overland flows travel towards the north of the site via a grassed channel and then into a headwall that drains under Mann Street into an underground reinforced concrete pipe approximately 1200mm diameter, travelling in a northerly direction. An additional stormwater outlet is to be proposed on Butler Street.

3.1.2 Proposed Site Drainage

The proposed system to be completed generally in accordance with the following general engineering practice, the guidelines of ARC and the following regime:

- The proposed stormwater drainage system for the development will comprise a minor and major system to safely and efficiently convey collected stormwater runoff from the development to the legal point of discharge

- The minor system is to consist of a piped drainage system which has been designed to accommodate the 1 in 5-year ARI storm event. This results in the piped system being able to convey all stormwater runoff up to and including the Q5 event. This meets the requirements of ARC stormwater criteria.

- The major system will be designed to cater for storms up to and including the 1 in 20-year ARI storm event. The major system will employ the use of defined overland flow paths, such as roads and open channels, to safely convey excess run-off from the site. Discussions were held with ARC stormwater engineer and a 1 in 20-year ARI storm event was deemed to be satisfactory due to the semi-rural nature of the site.

- The design of the stormwater system for this site will be based on relevant national design guidelines, Australian Standard Codes of Practice, the standards of ARC and accepted engineering practice. Runoff from buildings will generally be designed in accordance with AS 3500.3 National Plumbing and Drainage Code Part 3 – Stormwater Drainage. Overall site runoff and stormwater management will generally be designed in accordance with the Institution of Engineers, Australia publication “Australian Rainfall and Runoff” (1988 Edition), Volumes 1 and 2 (AR&R).

- The site area taken into consideration for stormwater design is shown in **Figure 3.1**.

Stormwater Management is required to be provided for water quantity and quality in accordance with the requirements of ARC DCP. Allowance for conveyance of the existing overland flow through the site will be required as discussed in **Section 5.2** of the report.

Further discussion on the Stormwater Management Strategy is provided in **Section 4** and **5** of this report.

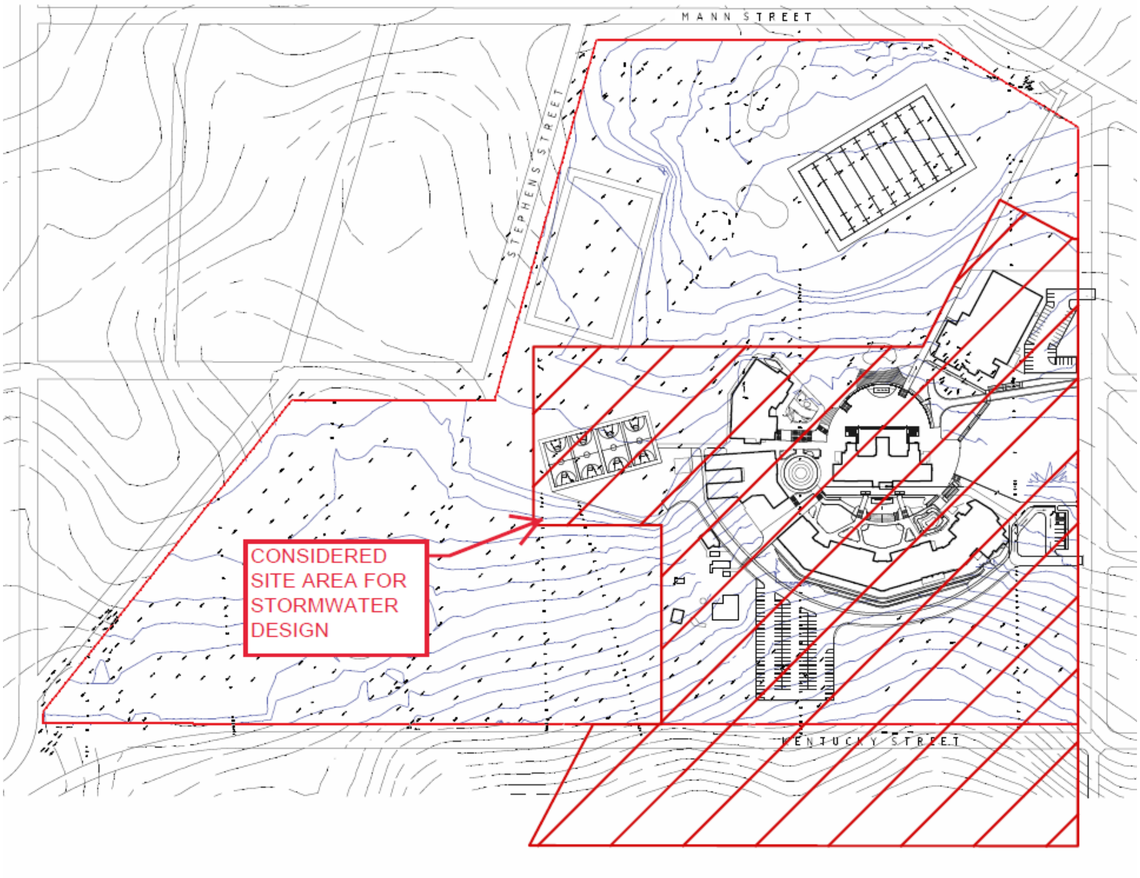


Figure 3.1. Site area taken for stormwater design.

4 INTEGRATED WATER MANAGEMENT PLAN

Armidale Regional Council requires water quantity management, or stormwater detention and/or retention to be provided to limit the runoff discharged from private property into the underground piped drainage system to pre-developed flow and to assist in mitigating the increased stormwater runoff generated by development.

Attenuation of stormwater runoff from the development is proposed to be managed via a number of detention tanks provided in strategic locations for the developed site. As discussed with Armidale Regional Council the objective is to attenuate stormwater flow from the development to pre-developed flows.

Sizing of the basin systems has been completed using DRAINS modelling software in accordance with Armidale Regional Council's stormwater policy for the 1 in 5 year ARI to 1 in 20 year ARI storms for various durations. The modelling accounts for the proposed developed catchment relating to the current site layout. In lieu of the sole use of on-site detention tanks, we believe it is more efficient and economical for the developed site to adopt rainwater tanks for water re-use and agricultural purposes to minimise the size of the on-site detention tank.

Table 4.1 provides details for the pre-development and post-development flows and storage for the total detention system.

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Pre-developed	Post-developed	
		Site	Site (no atten.)	Site (+ atten.)
5	5	0.280	0.397	**0.121**
	30	0.596	0.803	**0.215**
	60	0.561	0.755	**0.210**
	120	0.484	0.693	**0.208**
20	5	0.549	0.763	**0.212**
	30	1.150	1.340	**0.302**
	60	1.090	1.270	**0.298**
	120	0.977	1.170	**0.284**

Table 4.1. Site and Detention Hydrology

Indicative location of the stormwater detention/retention system can be found on stormwater drawings **7070-BIRZ-SW-01 to SW-08**. The final arrangement of the tanks would be confirmed in the detailed-design stage, ensuring the flow arrangements of **Table 4.2** are achieved. Indicative hydrological and storage arrangements are shown below.

ARI	Post Developed Flow (m^3/s)				Storage (m^3)
	Un-attenuated	Attenuated			
		Att. Flow	Overflow	Total	
5	0.596	0.215	0	0.215	240
20	1.150	0.302	0	0.302	

Table 4.2. Detention/Retention Tank Hydraulics and Storage Requirements

The modelling has shown that, with the provision of a total storage volume of $240m^3$ contained in one modelled system, stormwater flows from the development will be attenuated to predevelopment flows. Detention storage will be fully active and will be provided as by underground tanks. The proposed detention system meets the policy requirements of Armidale Regional Council. As discussed with the Stormwater Engineer at ARC, it was agreed that the use of rainwater tanks for water re-use and agricultural purposes would benefit the site, in conjunction with the use of an on-site detention tank.

4.1 Non-Potable Water – Rainwater Reuse

The rainwater harvesting system will include a booster pump assembly, stormwater filters all associated valves and pipe work in accordance with NSW Health Guidelines and AS3500 requirements. The harvested water service shall be used for toilet flushing and irrigation purposes (hose taps).

The rainwater harvesting system will incorporate an in-line pumping assembly located directly after the rainwater tank. The pump and associated equipment shall be capable of delivering non-potable water to the fixtures at the required pressures and on demand.

The rainwater harvesting system will have an automatic potable cold water air gap make-up supply complete with associated valves and equipment in accordance with all relevant standards and AS3500 requirements.

At the completion of works, the tank should be filled to a certain level as required with potable water, tested, commissioned and handed over fully operational.

5 STORMWATER QUALITY CONTROLS

5.1 Regional Parameters

There is a need to provide a preliminary design which incorporates the principles of Water Sensitive Urban Design (WSUD) and to target pollutants that are present in the stormwater so as to minimise the adverse impact these pollutants could have on receiving waters and to also meet the requirements specified by Armidale Regional Council.

5.2 Proposed Stormwater Treatment System

Developed impervious areas including roof, hardstand, car parking, roads and other extensive impervious areas are required to be treated by the Stormwater Treatment Measures (STM's). The STM's shall be sized according to the whole catchment area of the development. As a preliminary design input, we have allowed for a stormfilter filtration chamber to be installed at the first inlet point in the tank prior to stormwater runoff entering the rainwater tank. STM's for the development shall be based on a treatment train approach to ensure that ARC's objectives are met.

Components of the treatment train for the development are as follows:

. Treatment of stormwater on the development is to be performed via the provision of a treatment train of proprietary systems;

- Primary treatment to the paved areas and car parks is via Enviropod pit inserts; and
- Secondary treatment of all site water will be treated via stormwater filters by Stormwater 360 (SW360).

5.3 Maintenance and Monitoring

It is important that each component of the water quality treatment train is properly operated and maintained. In order to achieve the design treatment objectives, an indicative maintenance schedule has been prepared (refer to **Table 5.1**) to assist in the effective operation and maintenance of the various water quality components.

In addition to the below nominated frequency it is recommended that inspections are made following large storm events.

Table 5.1 Indicative Maintenance Schedule

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
LANDSCAPED AREAS			
Check density of vegetation and ensure minimum height of 150mm is maintained. Check for any evidence of weed infestation	Six monthly	Maintenance Contractor	Replant and/or fertilise, weed and water in accordance with landscape consultant specifications
Inspect swale for excessive litter and sediment build up	Six monthly	Maintenance Contractor	Remove sediment and litter and dispose in accordance with local authorities' requirements.
Check for any evidence of channelisation and erosion	Six monthly/ After Major Storm	Maintenance Contractor	Reinstate eroded areas so that original, designed swale profile is maintained
Weed Infestation	Three Monthly	Maintenance Contractor	Remove any weed infestation ensuring all root ball of weed is removed. Replace with vegetation where required.
Inspect swale surface for erosion	Six Monthly	Maintenance Contractor	Replace top soil in eroded area and cover and secure with biodegradable fabric. Cut hole in fabric and revegetate.
RAINWATER TANK			
Check for any clogging and blockage of the first flush device	Monthly	Maintenance Contractor	First flush device to be cleaned out

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
Check for any clogging and blockage of the tank inlet - leaf/litter screen	Six monthly	Maintenance Contractor	Leaves and debris to be removed from the inlet leaf/litter screen
Check the level of sediment within the tank	Every two years	Maintenance Contractor	Sediment and debris to be removed from rainwater tank floor if sediment level is greater than the maximum allowable depth as specified by the hydraulic consultant
INLET & JUNCTION PITS			
Inside of pits	Six Monthly	Maintenance Contractor	Remove grate and inspect internal walls and base, repair where required. Remove any collected sediment, debris, litter.
Outside of pits	Four Monthly/ After Major Storm	Maintenance Contractor	Clean grate of collected sediment, debris, litter and vegetation.
STORMWATER SYSTEM			
General Inspection of complete stormwater drainage system	Bi-annually	Maintenance Contractor	Inspect all drainage structures noting any dilapidation in structures and carry out required repairs.
STORMWATER360 ENVIROPOD SYSTEM			
Refer Manufacturers Operation and Maintenance Manual for Enviropod maintenance	Refer Manufacturers Operation and Maintenance Manual	Maintenance Contractor	Refer Manufacturers Operation and Maintenance Manual

6 FLOODING & OVERLAND FLOW

The assessed site has been identified by Armidale Regional Council as being unaffected by overland flow from an external catchment. Refer to the flood map in **Appendix C** (1 in 100 year Annual Exceedance Probability, based on Armidale Flood Study 2004 and Martins Gully Update 2011) provided by Armidale Regional Council.

A flood risk assessment for this site has been prepared by Eco Logical Australia. Please refer to report 'Eco Logical Australia 2018. *Armidale Future Secondary School Redevelopment Project, Flood Risk Assessment*. Prepared for NBRS Architecture' for further information.

7 CONCLUSION

This Civil Engineering Details Report has been prepared to support the application for a proposed development at Armidale High School, Butler Street, Armidale.

A Stormwater Management strategy for the site has been developed which provides a best practice solution within the constraints of the existing landform and proposed development layout. The strategy for stormwater quantity and quality management has been developed to reduce both peak flows and pollutant loads in stormwater leaving this site. The stormwater management for the development has been designed in accordance with Armidale Regional Council's Engineering Code Design Specification D5 - Stormwater Drainage Design (Dated September 2016).

The stormwater layout for the development maintains the existing catchment breakdown and a proposed two discharge points. A hydrological assessment has been undertaken which confirms local post development flows from the site will be less than pre-development flows and demonstrates that the site discharge would not adversely affect any land, drainage system or watercourse as a result of the development. A stormwater retention system comprising an active storage of 240m^3 is proposed to attenuate developed stormwater flows to pre-developed flows. This will be provided by an underground retention tank.

During the construction phase, an erosion and sediment control plan will be in place to ensure the downstream drainage system and receiving waters are protected from sediment laden runoff.

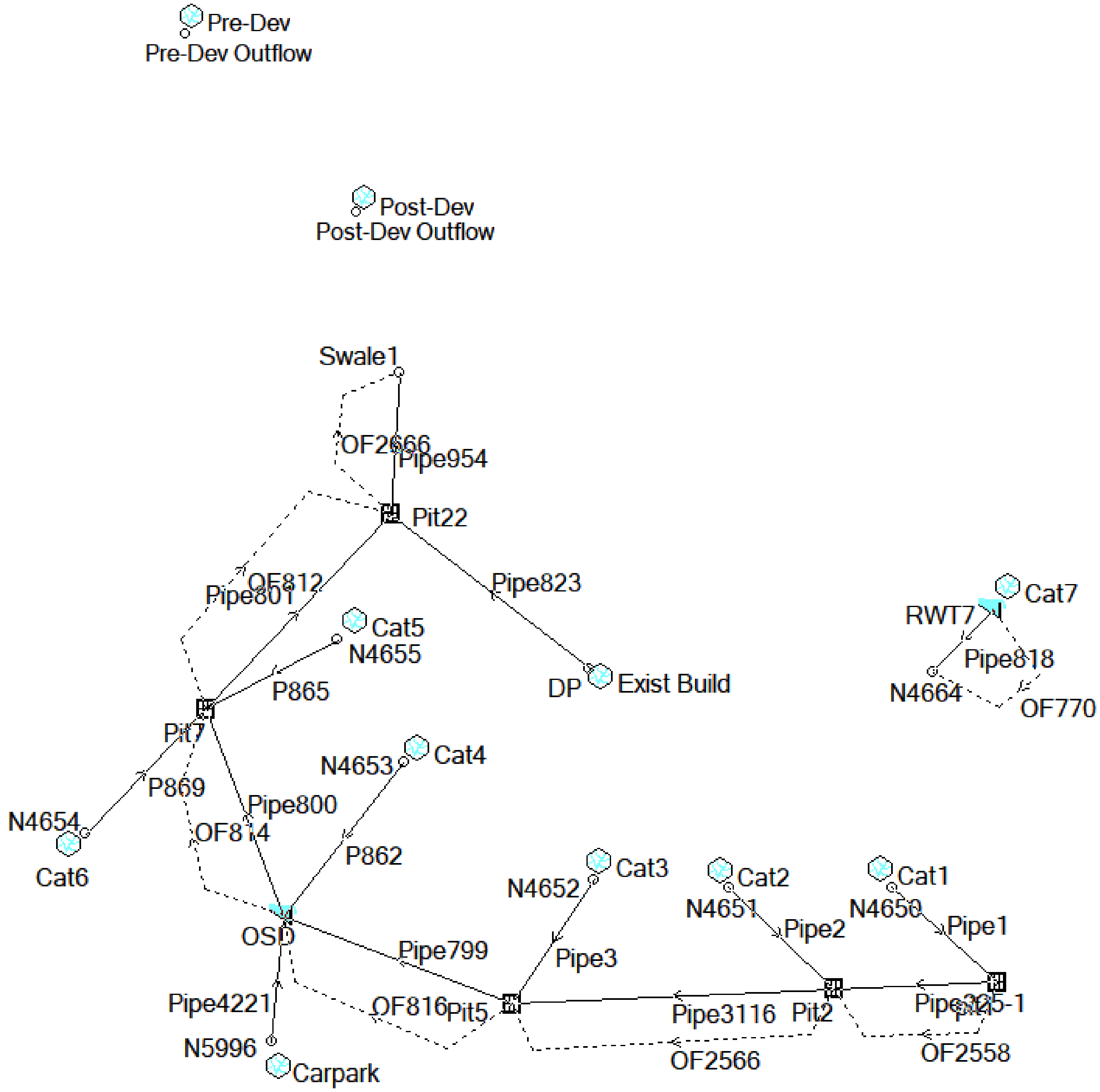
During the operational phase of the development, a treatment train incorporating the use Stormwater Treatment Measures (STM's) comprising a proprietary treatment train of Enviropod pit inserts, retention tanks and SW360 stormfilters been proposed to mitigate the increase in stormwater pollutant loads generated by the development. Best management practices have been applied to the development to ensure that the quality of stormwater runoff is not detrimental to the receiving environment.

It is recommended the management strategies in this report be approved and incorporated into the future detailed design.

8 REFERENCES

- Managing Urban Stormwater: Harvesting and Reuse – 2006 (NSW DEC);
- Managing Urban Stormwater: Source Control – 1998 (NSW EPA);
- Managing Urban Stormwater: Treatment Techniques – 1997 (NSW EPA);
- Managing Urban Stormwater: Soils & Construction – 2004(LANDCOM); and
- Armidale Regional Council's Engineering Code Design Specification D5 - Stormwater Drainage Design (Dated September 2016).

APPENDIX A - DRAINS MODEL



DRAINS results prepared from Version

PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N4664	98.23		0				
DP	98.12		0.126				
Pit22	97.55		0		0.49	0	None
Swale1	96.29		0				
N4650	100.97		0.022				
pit1	100.82		0		0.93	0	None
Pit2	100.78		0		0.92	0	None
Pit5	100.48		0		0.82	0	None
Pit7	98.15		0		0.39	0	None
N4651	101.01		0.027				
N4652	101.01		0.041				
N4653	99.12		0.037				
N4654	98.78		0.023				
N4655	98.8		0.035				
N5996	100.65		0.098				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Pre-Dev	0.596	0.519	0.17	5	10	5	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Cat7	0.047	0.047	0	5	10	5	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Exist Build	0.126	0.119	0.013	5	10	5	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Post-Dev	0.803	0.736	0.143	5	10	5	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Cat1	0.022	0.022	0	5	10	5	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Cat2	0.027	0.027	0	5	10	5	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Cat3	0.041	0.041	0	5	10	5	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Cat4	0.037	0.037	0	5	10	5	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Cat6	0.023	0.023	0	5	10	5	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Cat5	0.035	0.035	0	5	10	5	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Carpark	0.098	0.094	0.005	5	10	5	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2

Outflow Volumes for Total Catchment (7.09

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 5 year, 5 minutes storm, average 111	1197.05	275.87 (23.0%)	275.87 (42.0%)	0.00 (0.0%)
AR&R 5 year, 30 minutes storm, average	3086.45	1439.47 (46.6%)	1223.57 (72.3%)	215.89 (15.5%)
AR&R 5 year, 1 hour storm, average 31.5	4076.45	2128.30 (52.2%)	1720.14 (77.0%)	408.16 (22.2%)
AR&R 5 year, 2 hours storm, average 20.2	5228.1	2854.31 (54.6%)	2297.79 (80.2%)	556.52 (23.6%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Pipe818	0.009	3.23	101.231	98.231	AR&R 5 year, 2 hours storm, average 20.2 mm/h, Zone 2
Pipe823	0.125	1.93	98.119	97.557	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Pipe954	0.215	3.85	97.289	96.293	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Pipe1	0.022	1.18	100.975	100.823	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Pipe225-1	0.022	0.48	100.806	100.778	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Pipe3116	0.049	1.07	100.691	100.484	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Pipe799	0.09	2	100.192	99.728	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Pipe800	0.041	1.27	98.26	98.15	AR&R 5 year, 1 hour storm, average 31.5 mm/h, Zone 2
Pipe801	0.09	2.42	98.047	97.588	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Pipe2	0.027	1.46	101.009	100.778	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Pipe3	0.041	2.2	101.009	100.484	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
P862	0.037	2	99.122	98.999	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
P869	0.023	2.59	98.775	98.15	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
P865	0.035	2.85	98.797	98.15	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2
Pipe4221	0.098	4.15	100.653	99.623	AR&R 5 year, 30 minutes storm, average 47.7 mm/h, Zone 2

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Stor
OF770	0	0	0.007	0	0	0	0	
OF2666	0	0	0.908	0	0	0	0	
OF2558	0	0	0.908	0	0	0	0	
OF2566	0	0	0.908	0	0	0	0	
OF816	0	0	0	0	0	0	0	
OF814	0	0	0.018	0	0	0	0	
OF812	0	0	0.007	0	0	0	0	

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
RWT7	104.11	46.6	0.009	0.009	0
OSD	99	134	0.041	0.041	0

CONTINUITY CHECK for AR&R 5 year, 30

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Pre-Dev Outflow	482.71	482.71	0	0
RWT7	34.12	0	34.12	0
N4664	0	0	0	0
DP	94.5	94.41	0	0.1
Pit22	229.19	227.86	0	0.6
Swale1	227.86	227.86	0	0
Post-Dev Outflow	622.46	622.46	0	0
N4650	15.85	15.84	0	0.1
pit1	15.84	15.77	0	0.4
Pit2	35.29	35.3	0	0
Pit5	64.76	64.7	0	0.1
OSD	163.16	93.94	69.21	0
Pit7	136.13	134.78	0	1
N4651	19.59	19.52	0	0.4
N4652	29.42	29.45	0	-0.1
N4653	26.79	26.57	0	0.8
N4654	16.8	16.79	0	0.1
N4655	25.41	25.4	0	0.1
N5996	71.82	71.88	0	-0.1

Run Log for Armidale_OSD_v4.drn run at
No water upwelling from any pit. Freeboard
Flows were safe in all overflow routes.

DRAINS results prepared from Version 2018.05

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N4664	98.25		0				
DP	98.19		0.188				
Pit22	97.8		0		0.24	0	None
Swale1	96.33		0				
N4650	102		0.03				
pit1	101.73		0		0.02	0	None
Pit2	101.64		0		0.06	0	None
Pit5	101.11		0		0.19	0	None
Pit7	98.18		0		0.36	0	None
N4651	102.07		0.037				
N4652	102.07		0.056				
N4653	99.65		0.051				
N4654	98.79		0.032				
N4655	98.83		0.048				
N5996	100.68		0.135				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Pre-Dev	1.147	0.706	0.55	5	10	5	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Cat7	0.065	0.065	0	5	10	5	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Exist Build	0.188	0.162	0.034	5	10	5	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Post-Dev	1.345	1	0.433	5	10	5	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Cat1	0.03	0.03	0	5	10	5	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Cat2	0.037	0.037	0	5	10	5	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Cat3	0.056	0.056	0	5	10	5	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Cat4	0.051	0.051	0	5	10	5	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Cat6	0.032	0.032	0	5	10	5	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Cat5	0.048	0.048	0	5	10	5	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Carpark	0.135	0.128	0.009	5	10	5	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2

Outflow Volumes for Total Catchment (7.09 impervious + 5.85 pervious = 12.9 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 20 year, 5 minutes storm, average 155 mm/h, Zone 2	1671.56	517.82 (31.0%)	513.88 (56.1%)	3.95 (0.5%)
AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2	4192.92	2531.36 (60.4%)	1778.56 (77.4%)	752.79 (39.7%)
AR&R 20 year, 1 hour storm, average 42.3 mm/h, Zone 2	5474.08	3494.28 (63.8%)	2421.18 (80.7%)	1073.10 (43.4%)
AR&R 20 year, 2 hours storm, average 26.8 mm/h, Zone 2	6936.43	4535.00 (65.4%)	3154.67 (83.0%)	1380.33 (44.0%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Pipe818	0.02	4.08	101.247	98.247	AR&R 20 year, 1 hour storm, average 42.3 mm/h, Zone 2
Pipe823	0.182	1.95	98.194	97.8	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Pipe954	0.291	4.14	97.327	96.33	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Pipe1	0.03	1.61	102.002	101.726	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Pipe225-1	0.03	0.65	101.694	101.644	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Pipe3116	0.067	1.45	101.485	101.11	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Pipe799	0.122	2.65	100.574	99.742	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Pipe800	0.048	1.3	98.282	98.181	AR&R 20 year, 1 hour storm, average 42.3 mm/h, Zone 2
Pipe801	0.114	2.66	98.062	97.8	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Pipe2	0.037	1.99	102.065	101.644	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Pipe3	0.056	2.99	102.067	101.11	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
P862	0.051	2.72	99.651	99.31	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
P869	0.032	2.79	98.791	98.181	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
P865	0.048	2.85	98.831	98.181	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2
Pipe4221	0.135	4.48	100.681	99.651	AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V
OF770	0	0	0.206	0	0	0	0
OF2666	0	0	1.479	0	0	0	0
OF2558	0	0	1.479	0	0	0	0
OF2566	0	0	1.479	0	0	0	0
OF816	0	0	0.288	0	0	0	0
OF814	0	0	0.362	0	0	0	0
OF812	0	0	0.206	0	0	0	0

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
RWT7	104.19	47.9	0.02	0.02	0
OSD	99.31	208.6	0.048	0.048	0

CONTINUITY CHECK for AR&R 20 year, 30 minutes storm, average 64.8 mm/h, Zone 2

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Pre-Dev Outflow	944.82	944.82	0	0
RWT7	49.59	4.16	45.43	0
N4664	4.16	4.16	0	0
DP	149.68	149.56	0	0.1
Pit22	321.15	319.41	0	0.5
Swale1	319.41	319.41	0	0
Post-Dev Outflow	1086.7	1086.7	0	0
N4650	23.04	23.04	0	0
pit1	23.04	22.96	0	0.3
Pit2	51.36	51.37	0	0
Pit5	94.17	94.02	0	0.2
OSD	238.83	111.82	127.01	0
Pit7	173.14	171.59	0	0.9
N4651	28.47	28.4	0	0.3
N4652	42.77	42.81	0	-0.1
N4653	38.94	38.72	0	0.6
N4654	24.41	24.4	0	0
N4655	36.94	36.92	0	0
N5996	105.99	106.09	0	-0.1

Run Log for Armidale_OSD_v4.drn run at 14:56:27 on 12/6/2018
No water upwelling from any pit.
Freeboard was less than 0.15m at Pit2, pit1

Flows were safe in all overflow routes.

APPENDIX B

MANUFACTURER'S SPECIFICATIONS & INSTALLATION

(STORMWATER 360)

EnviroPod®

Cost-effective, easily maintained gullypit insert

The EnviroPod is a proven gullypit insert that's been designed for easy retrofitting into new and existing stormwater gullypits, requiring no construction or land take. It removes a significant portion of sediment, litter, debris and other pollutants from water entering the stormwater system, and can be installed in either kerb inlet, standard pre-cast gullypits or manhole gullypits. Using low-cost passive screening and optional oil-adsorbent media, the EnviroPod can be customised to meet site-specific requirements with interchangeable polyester mesh screens ranging from 200 to 1600 micron pore size. Unless specified otherwise, 1600 micron filter mesh screening bags are supplied as standard.

> "Designed for easy fit into new or existing gully pits, the EviroPod® is a simple and effective solution for preventing gross pollutants from entering the stormwater system.

The EnviroPod is also effective as a pre-treatment device for use in a treatment train with hydrodynamic separators, filtration devices, ponds and wetlands. In many cases, it is often the most practical solution for retrofits.

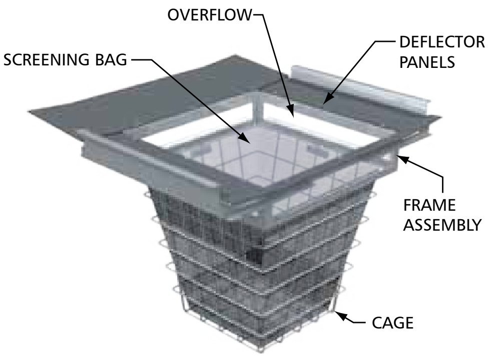
Independently trialled and tested by city councils throughout Australia and New Zealand, and with installation of over 15,000 units including North America, the EnviroPod filter is the premier gully pit insert.

How does it work?

As stormwater enters a storm grate or gullypit, it passes over the oil adsorbent pillows (optional) and into the screening bag. Litter, debris, and other pollutants larger than the screening bag aperture are captured and retained, while the oil adsorbent pillows reduce oil and grease. If the screening bag is full, or during high flows, overflow is released through the overflow apertures in the frame assembly.

Design and operation

The EnviroPod consists of a screening bag supported by a filter box and structural cage. Modular plastic deflector panels attach to the filter box and guide the flow of water to the screening bag. The screening bag captures pollutants and allows the water to pass through to the outlet pipe. Optional absorbent material inside the screening bag captures oil and grease. Openings in the filter box allow water to bypass the screening bag during high flow conditions to prevent surface flooding.



Capabilities

- Captures sediment, litter, debris and other pollutants before they enter the drainage system
- Fits a range of gullypit sizes – ideal for retrofits
- Easy access – maintenance friendly design, generally no confined space entry required
- Bypasses high flows with no moveable parts
- Adjustable panels allow fine-tuning during installation for a perfect fit

Configurations

The kerb entry EnviroPod is inserted through the pit access cover and is supported by aluminium arms fixed to the kerb channel/pit wall.

The Drop-In EnviroPod is designed to simply insert into the gullypit below the grate, again supported by aluminium arms fixed to the kerb channel/wall pit. Plastic deflector panels seal against the pit walls and direct flow into the filter box and through the mesh screens. There are two standard sizes to fit most pre-cast regular and kerb entry gullypits. Custom designs can be fabricated for non-standard pits.

Installation, inspection and maintenance

Traffic control must be well planned when installing, inspecting or maintaining EnviroPod Filters. All standard rules and regulations governing traffic control and safety while working on the road must be rigidly followed at all times. All potential hazards must be identified and control methods put in place prior to installing, inspecting or maintaining filters.

StormFilter®

Cartridge Installation Procedure

Stormwater360
AUSTRALIA

Contents

Section 1

—

1.1 DESCRIPTION

StormFilter is a passive, flow-through stormwater filtration system. It consists of vaults that house rechargeable cartridges filled with a variety of filter media. The filter systems are installed in-line with storm drains. The StormFilter works by passing stormwater through media-filled cartridges, which trap particulates and adsorb materials such as dissolved metals and hydrocarbons. After being filtered through the media, the treated stormwater flows into a collection pipe or discharges into an open channel drainage way. StormFilter is offered in three different configurations: cast-in-place, precast and linear. The precast and linear models utilize pre-manufactured vaults. The cast-in-place units are customized for larger flows and may be either covered or uncovered underground units.

1.2 OPERATIONS

1.2.1 Purpose

The StormFilter is a passive stormwater filtration system designed to improve the quality of stormwater runoff from the urban environment before it enters receiving waterways.

Through independent third party studies, it has been demonstrated that the StormFilter is highly effective for treatment of first flush flows and flow-paced flows during the latter part of a storm. In general, StormFilter's efficiency is highest when pollutant concentrations are highest. The primary target pollutants for removal are: sediments (TSS), soluble metals, soluble phosphorus, nitrates, and oil and grease.

1.2.2 Sizing

The StormFilter is typically sized to treat the peak flow of a water quality design storm as it passes through the filter. The peak flow is determined by calculations based on the contributing watershed hydrology and using a design storm magnitude. The design storm is usually based on the regulatory requirements set by the local stormwater management agency. The particular size of a StormFilter is determined by the number of filter cartridges (see Figure 1) required to treat the peak stormwater flow. Each cartridge is designed to treat a peak flow up to 1.6 liter/second.

Because of the highly porous nature of the granular filter media, the flow through a newly installed cartridge is restricted to 1L/s, using a restrictor disc, to ensure adequate pollutant-media contact time.

1.2.3 Basic Function

The StormFilter is designed to siphon stormwater runoff through a filter cartridge containing media. The variety of media available can be designed to act as a mechanical filter to remove sediments, as an ion exchanger to remove dissolved heavy metals, and as an absorber to remove oils and greases.

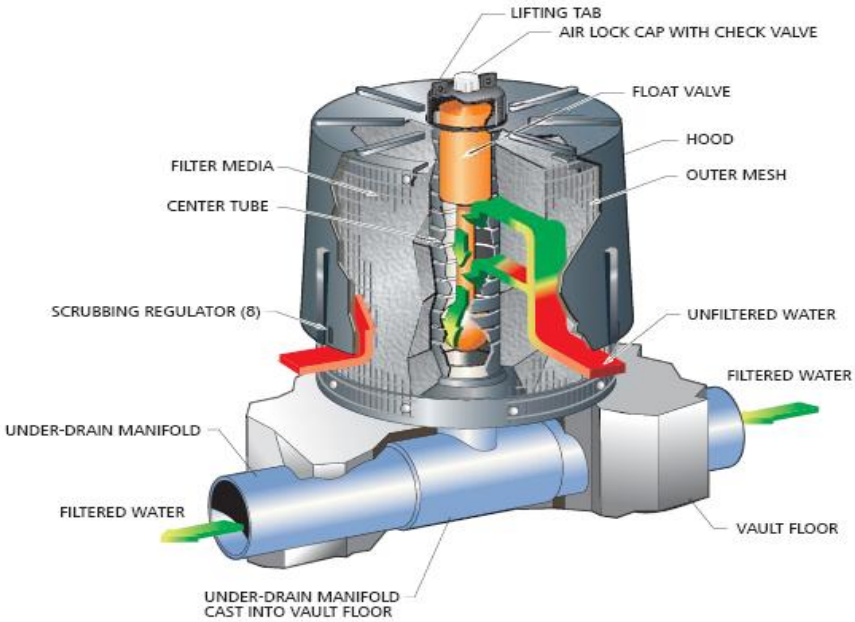


Figure1. Filter Cartridge

1.2.4 Priming System Function

The treated stormwater collects in the center tube of the cartridge, which is equipped with a self-priming siphon system. Figure 1 illustrates this system. The key component of the system is the plastic float. The float consists of a ball located at the base leading up to a larger portion, which provides increased buoyancy. Initially the ball rests in a seat effectively closing off the port to the drainage manifold.

As a result, the filter fills the center drainage tube until the water level has risen high enough to purge the air from the filter cartridges and displaces the float. At a water depth of 22 inches the float pulls loose and allows the filtered water to drain out through the manifold. This effectively "primes" a siphon within the drainage tube and greatly increases the potential across the filter. The priming system increases StormFilter's ability to be loaded with sediment. A related feature is the cartridge "hood". This hood maintains the siphon effect by preventing air from being drawn into the cartridge until the external water level drops below the bottom of the hood.

Cartridges are connected to the manifold with a plastic connector. Since some media used is potentially buoyant, a threaded connector affixed to the manifold with compression bolts is necessary to ensure the cartridge isn't lifted out of place. For the heavier leaf media, a slip connector is used.

StormFilter is also equipped with flow spreaders that trap floating debris and surface films, even during overflow conditions. Depending on individual site characteristics, some systems are equipped with high and/or low flow bypasses. High flow bypasses are installed when the calculated peak storm event generates a flow that overcomes the overflow capacity of the system. This is especially important for precast systems. Low flow bypasses are sometimes installed to bypass continuous inflows caused by ground water seepage, which usually do not require treatment. All StormFilter units are designed with an overflow. The overflow operates when the inflow rate is greater than the infiltration capacity of the filter media.

Section 2

—

2.1 OVERVIEW

The procedure described below details the fit-out or installation of the Stormwater Management StormFilter Cartridge (1/4 turn connector) within a concrete vault.

2.2 MATERIALS REQUIRED

The following parts, supplied by Stormwater360, are required for the successful installation of the filter cartridges.

Figure 2. Flow Disc

Figure 3. Cartridge Connector

Figure 4. Solvent Cement

Figure 5. Cartridge

2.3 FIT-OUT PROCEDURE

Cartridge installation typically involves the steps below. However, if it appears that a spill of some type has occurred, the local hazard control agency and Stormwater360 should be notified immediately. In the case of a spill, the worker should abort activities until the proper guidance has been obtained. Depending on the configuration of the particular system, a worker may be required to enter the vault to perform some tasks. If vault entry is required, OH & S rules for general confined space entry must be strictly adhered to and are not detailed in the steps below. Filter cartridge installation should occur during dry weather and it may be necessary to plug the filter inlet pipe if base flows exist.

Steps For Cartridge Installation:

1. Depending on the particular unit, one or two utility workers and a hauling truck operator will deliver the replacement cartridges to the site. Information concerning how to obtain the replacement cartridges is available from Stormwater360.

2. If applicable, set up safety equipment to protect pedestrians from fall hazards presented by open doors. Also, set up appropriate safety equipment for work near roadways.

3. Inspect the external condition of the unit and take notes concerning defects/problems.

4. Open the doors to the vault and allow the system to air out for 5-10 minutes.

5. Without entering the vault, give the inside of the unit, including components, a general condition inspection.

6. Ensuring safe working procedures are met, off load the replacement cartridges (16-39kgs each) and set aside.

7. Providing all OH&S Safe Work practices have been met, enter the StormFilter Vault chamber, leaving one workman at the top of the pit and another at the base of the pit.

8. Pass down through opening the opening a shovel and a bucket to remove any accumulated debris from the vault floor.

9. The cartridges are typically on PVC fitting cast in the concrete like the one shown below. Follow the drawing provided by Stormwater360 for the location of the holes.

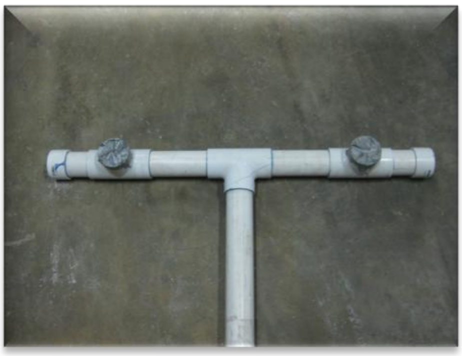


Figure 6. PVC Under Concrete Slab.

10. Pass down a hammer and/or small bar and locate and expose all cartridge connections holes. Only a thin layer of concrete existing over the 50mm diameter openings. Remove all tape from all holes and dry with a rag. Ensure all waste tape is removed from vault during clean up. Please note that any standing water inside the chamber will now pass through these holes and out of the system.

Figure 7. Exposing Holes in PVC Fittings.

11. Pass down all small materials required to complete the task. These include PVC cement, Flow restrictor discs & cartridge connectors and small piece of timber.

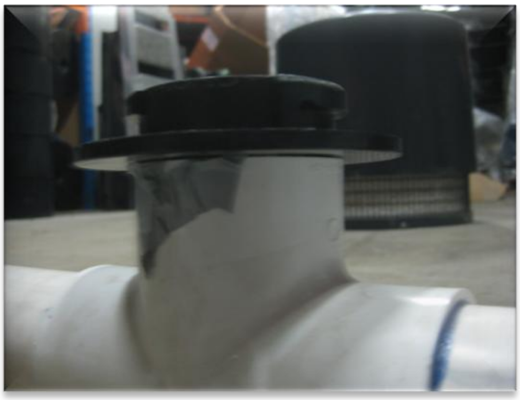
12. Install Flow restrictor discs into PVC fittings as shown below.

Figure 8. Install Flow Discs.

Figure 9. Install Flow Discs

13. Apply PVC solvent cement to PVC floor connectors at connection points and then insert connectors into pre-formed drainage holes. Place timber over connector and lightly tap with a hammer to ensure connectors are flush with the floor. Allow time for PVC glue to set. Repeat step until all connectors are installed.


Figures 10 & 11. Applying Cement.

Figures 12 & 13. Affixing Connectors.

14. Lower pre-filled cartridges into vault, one at a time through opening using tripod with winch or rope pulley system.

15. Place centre of cartridge over floor connector, attach cartridge to connector and rotate cartridge 180 degrees until cartridge locks into floor connector. Repeat process for all cartridges.

Figure 14. Centre of Cartridge Base Connected.

Figure 15. Cartridge Connection Completed.

16. Once Completed remove all tools & equipment and waste materials from vault. All personnel to exit vault. Replace all lids / close all access covers. Pack up, put away all tools & equipment.

2.4 TYPICAL EQUIPMENT REQUIRED FOR CARTRIDGE INSTALLATION

Typical equipment & labor required for conducting cartridge installation is shown in Table 1. Some of the materials listed are suggestions rather than requirements. It should be noted that there is more than one way to accomplish some tasks. Owners with available labor and equipment resources may desire to use alternative methods. However, it is advisable that guidance from Stormwater360 be obtained prior to using alternative techniques.

Table 1 : Typical Equipment Requirements

Cartridge Installation General Equipment Guide
Personnel: 1 x Laborer, 1 x Skilled Worker
Safety Equipment*: First aid, cones, barricades, flagging, flares, tape, vests, hard hats.
Work Clothes: Rubber boots, overalls, and gloves.
Gatic Lifters and 1.2m Water Pipe & Miscellaneous Tools.
Tape Measure
Flashlight
Craft Knife
Hammer
Bar
Crane, Tripod and Hoist, or Other Lifting Device (150kg capacity)
Shovels
Trash/Debris Container
Ladder

*** Confined space equipment may be required for vault entry. This equipment must be used by personnel with the appropriate OH & S training. This equipment typically includes: Atmospheric testing devices, atmospheric purging and ventilating devices, and entry, exit, and rescue assisting devices.**

StormFilter®

Operation, Design, Maintenance & Performance Manual

Stormwater360
AUSTRALIA

Contents

1. INTRODUCTION

Stormwater360 has adopted a comprehensive research and design program, which is unparalleled by any manufacturer in Australasia, to strategically provide our clients, both consulting engineers and regulators alike, the reassurance of our products in-field performance, validity and longevity.

This document has been produced as a guideline to assist engineers and designers with the development application process when utilizing Stormwater360's Stormwater Management StormFilter.

The StormFilter, a passive, flow-through, stormwater filtration system, improves the quality of stormwater runoff from the urban environment before it enters receiving waterways by removing non-point source pollutants, including sediment (TSS), oil and grease, soluble metals, nutrients, organics, and trash and debris. The StormFilter is used in a wide variety of applications to treat runoff from various sites including: retail and commercial developments, residential streets, urban roadways, freeways, and industrial sites such as shipyards, foundries, and high tech developments. For developers and contractors, the StormFilter is cost-effective, easy to install, and uses no additional land (completely underground). For engineers, full design support is provided by Stormwater360. Finally for local government authorities (LGA's), Stormwater360 offers flexible maintenance options ensuring units are operating at their optimal efficiency thereby protecting LGA's downstream assets.

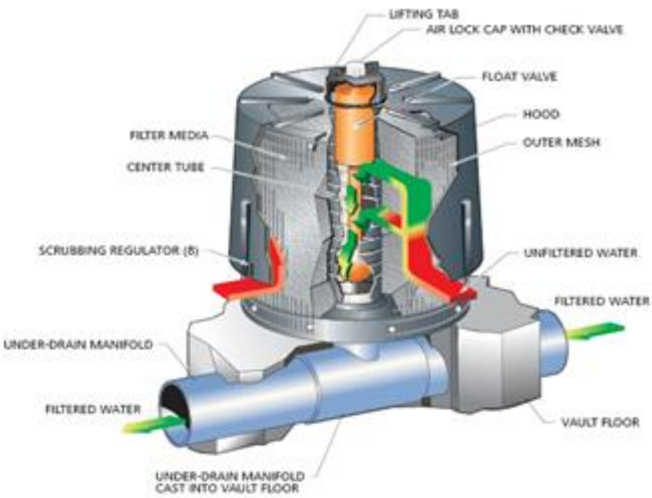


Figure 1. Filter Cartridge

Operation

The StormFilter system is typically comprised of a vault that houses the rechargeable, media-filled, filter cartridges (Figure 3). Stormwater from storm drains is percolated through these media-filled cartridges, which trap particulates and remove pollutants such as dissolved metals, nutrients, and hydrocarbons. During the filtering process, the StormFilter system also removes surface scums and floating oil and grease. Once filtered through the media, the treated stormwater is directed to a collection pipe or discharged to an open channel drainage way.

Priming System Function

The treated stormwater collects in the centre tube of the cartridge, which is equipped with a self-priming siphon system. Figure 1 illustrates this system. The key component of the system is the plastic float. The float consists of a ball located at the base leading up to a larger portion, which provides increased buoyancy. Initially the ball rests in a seat effectively closing off the port to the drainage manifold.

As a result, the filter fills the centre drainage tube until the water level has raised high enough to purge the air from the filter cartridges and displaces the float. For the standard cartridges, at water depth of 460mm the float pulls loose and allows the filtered water to drain out through the manifold. This effectively "primes" a siphon within the drainage tube and greatly increases the potential across the filter. The priming system increases StormFilter's ability to be loaded with sediment. A related feature is the cartridge "hood". This hood maintains the siphon effect by preventing air from being drawn into the cartridge until the external water level drops below the bottom of the hood.

Figure 2. Cartridge Operation from left to right: Priming – Filtering – Surface Cleaning & Dewatering

Cartridges are connected to the manifold with a plastic connector.

Depending on individual site characteristics, some systems are equipped with high and/or low flow bypasses. High flow bypasses are installed when the calculated peak storm event generates a flow that overcomes the overflow capacity of the system. This is especially important for precast systems. Low flow bypasses are sometimes installed to bypass continuous inflows caused by ground water seepage, which usually do not require treatment. All StormFilter units are designed with an overflow and operate when the inflow rate is greater than the infiltration capacity of the filter media.

2. DESIGN

The first step when designing your StormFilter is to calculate the treatable flow rate required to meet the stormwater quality targets for your site. There are several methods for determining the flow rate required, however, the most common is by using software packages. The Model for Conceptual MUSIC is the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) is available from eWater Limited. MUSIC is now the industry standard aiding the design of various Water Sensitive Urban Design treatment measures in demonstrating compliance with regulator's water quality objectives. In this section you will find step-by-step instructions on how to determine the number of filter cartridges required for your StormFilter.

Once you have determined the treatable flow rate of your StormFilter system required to treat the runoff from your site, the next step when designing your system is to select the StormFilter cartridge and configuration that will best handle the runoff water quality flow rate or volume at your site. The StormFilter is offered in several configurations: manhole, detention, vault, cast in place or panel.

After selecting one of these StormFilter configurations, you can size the selected configuration using the data tables that we have provided for you in this section of the manual.

Using the cartridge number and the system size that you calculated in the first two design steps, the final step in the design process is to integrate the StormFilter into your site plans.

In this section you will find information on factors that you must consider when integrating the StormFilter into your site plans. Factors discussed in this section include: selecting a site location, evaluating system depth and maintenance access requirements, determining pretreatment and bypassing needs, evaluating system hydraulics, and selecting a cartridge media type.

<u>Determining the treatable flow rate of your StormFilter - MUSIC Modelling</u>

Modeling the StormFilter within MUSIC should be undertaken by people who are familiar with MUSIC's functions and limitations. Should you require further information, or to make use of Stormwater360's design services, please contact Stormwater360's Engineering Services & Support.

The StormFilter technology is usually placed downstream of any pre-treatment devices such as gully pit inserts, gross pollutant traps, porous paving etc, and consequently the node is simply placed in-line or end-of-pipe near the outlet of the catchment model.

Given below is a simplified procedure for modeling the StormFilter technology.

1. Setup a MUSIC model utilizing the desired meteorological data and source nodes applicable for the site to be modeled.

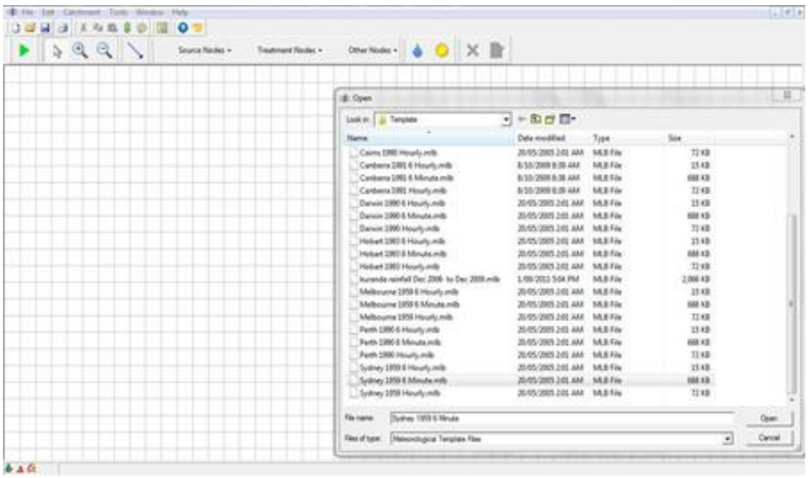


Figure 3. Rainfall setup

2. Construct or copy source nodes for your site and modify by using the edit properties dialogue box.

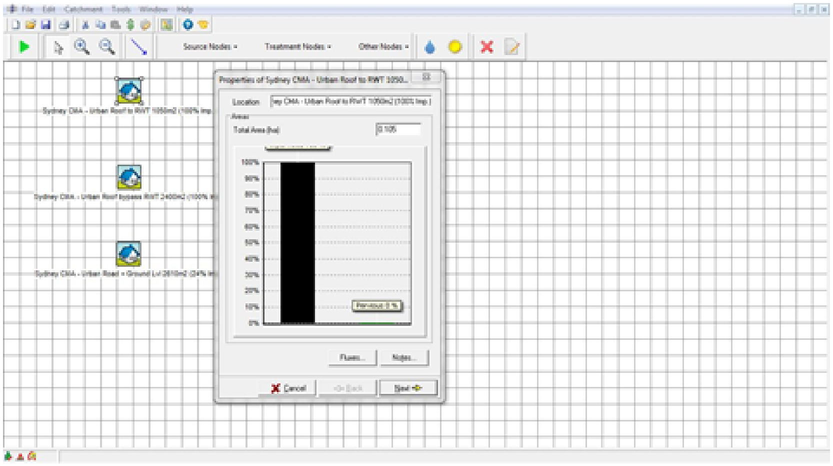


Figure 4. Source Node setup

3. Create copy and edit ALL pre-treatment after perusing all known information from the site plans etc. Details on the Stormwater360 treatment nodes are available upon request. Modify the Stormwater360 pre-treatment nodes by changing the high flow bypass only. As a starting point for StormFilter, modify the high-flow bypass and initially estimate 1L/s of treatment per 250m2 of upstream catchment area.

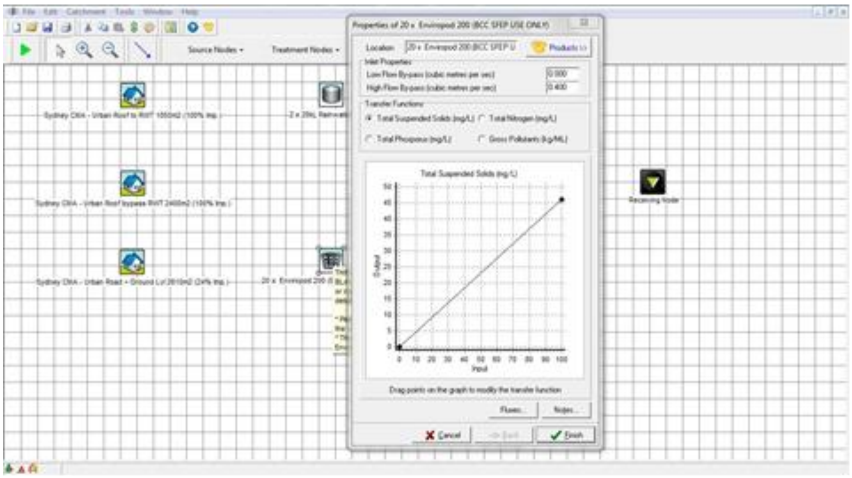


Figure 5. Create, Copy and Edit Treatment Nodes

4. Link all nodes and then run the model. After the model has finished, check the results obtained and compare them to the water quality targets. Adjust the high-flow bypass to refine the design and re-run the model.

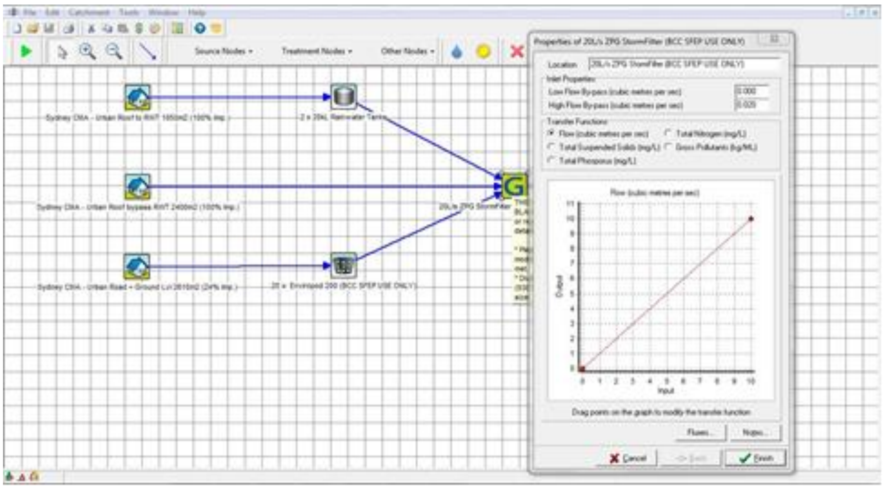


Figure 6. First Model Simulation

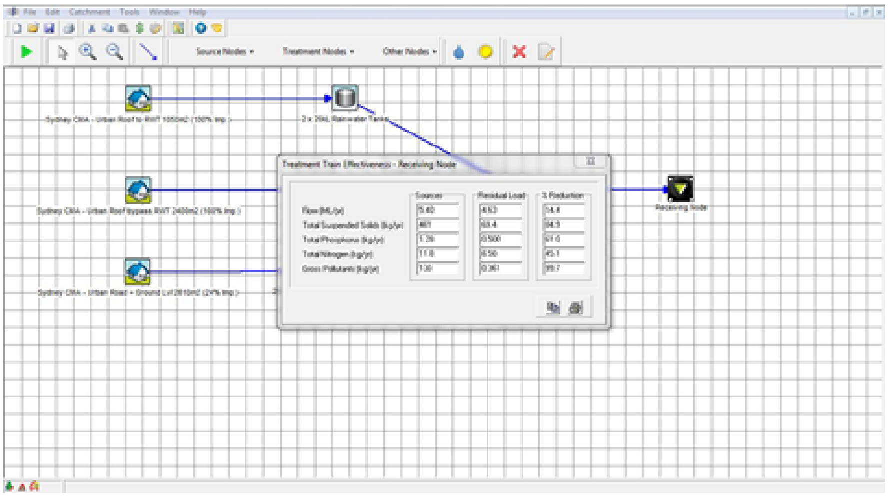
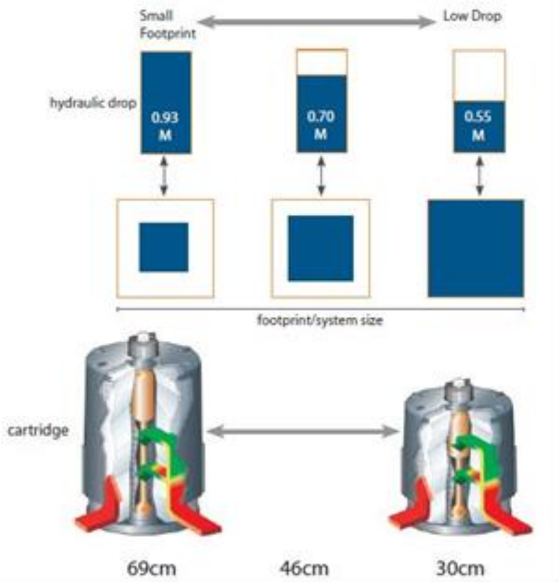


Figure 7. Results

Selecting and sizing your StormFilter

Peruse you site plans and determine the amount of fall or hydraulic loss that is available for your site. Once determined, select the most appropriate StormFilter cartridge that best suits your needs from the table below.



1.6 L/s **1.1 L/s** **0.68 L/s**

Figure 8. Filter Cartridge height options

The peak flow rates for each cartridge immeadiately prior to bypass are shown above in red. Simply divide the high flow bypass from your MUSIC modelling results to determine the number of cartridges required. You will need to record the cartridge height used in each design.

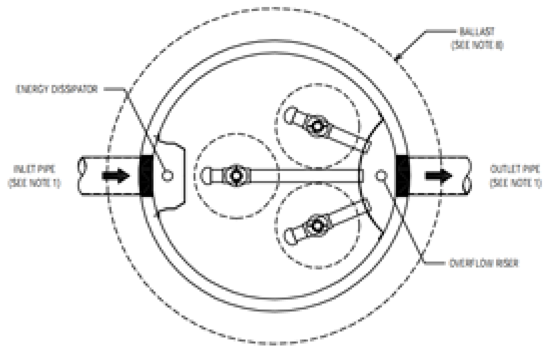
Please note that Stormwater360 prefers to drop the hydraulic loss across the unit (head drop). If this cannot be achieved, the StormFilter CAN be configured for a zero drop system. Please contact Stormwater360 for more details.

After the number of cartridges have been selected, determine the system size from the table below and contact Stormwater360, or go online and register at www.stormwater360.com.au to download the applicable drawing for your site. For more configurations contact Stormwater360.

Configuration	System Cartridge Capacity	System Footprint
Manhole	1 – 2 3 – 4 5 – 7 8 – 22	1200mm dia 1500mm dia 1800mm dia 3100mm dia
Vault	23 – 44	5.4 x2.4m
Large Vault	45 – 70 71 - 140	10.8m x 2.4m 10.8m x 4.9m
Cast In-Place or Panel	140+	Contact Stormwater360

Table 1. System Configurations

Manhole StormFilter



MANHOLE STORMFILTER
PLAN

The Manhole StormFilter™ consists of a 1200mm dia to 3100mm concrete manhole that can contain up to twenty-two StormFilter cartridges. The Manhole StormFilter can be installed flush with the finished grade. The top of the unit has an either 600mm sq or 900mm sq, Class D rated traffic-bearing access cover (or grate) that allows the filter to be installed in paved areas and, for all practical purposes, takes up no land area.

The Manhole StormFilter unit treats peak water quality design flows up to 35L/s and has an internal bypass capability of 80L/s.

Design Operation

The Manhole StormFilter is installed online with the stormwater drainage system, typically downstream of an existing catch basin or of a detention system. Runoff enters the Manhole StormFilter through an inlet pipe discharging directly to the unit and, therefore, may require an additional upstream pretreatment system depending on local agency requirements.

An inherent benefit of the manhole design is the flexibility in piping orientation. The inlet pipe may be placed in the manhole at any angle relative to the outlet pipe. Access to the cartridges is provided by manhole opening. Installation of the Manhole StormFilter is identical to that of a typical manhole.

Applications

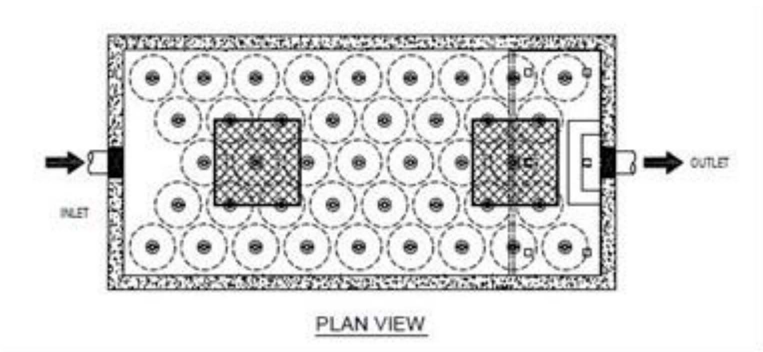
The Manhole StormFilter is particularly useful where small flows are being treated.

Special Considerations

When designing the Manhole StormFilter into your system, you should consider the following:

- The unit should maintain sufficient drop from the invert of the inlet to the invert of the outlet.
- For depths with cover greater than 2.0m, contact Stormwater360 for information on additional requirements.

Vault StormFilter



Overview

The Vault (and large vault) StormFilter can consist of one or more precast concrete structures 5.4 x 2.4m (ID). These units treat peak water quality design flows up to 70L/s. StormFilter vaults can be placed in series or in parallel to treat higher flows if needed (Large Vault type). A Vault StormFilter can be installed online or offline with the stormwater drainage system. It is installed with 900mm sq Class D traffic-bearing lids for parking lot applications, and it takes up no land area.

Design Operation

The typical Vault StormFilter is composed of a filtration bay, with inlet energy dissipation and an outlet baffled overflow riser. Stormwater first enters the StormFilter vault through the inlet pipe. The stormwater is then directed over an energy dissipater into the filtration bay for full treatment. The outlet overflow riser acts as a baffle, trapping some floatables, oils, and surface scum as the stormwater is filtered through the filtration bay.

Once in the filtration bay, the stormwater begins to pond and percolate horizontally through the media contained in the filter cartridges. After passing through the media, treated water that has collected in the cartridge center tube is directed into the outlet bay by an under-drain manifold. The treated water in the outlet bay is then discharged through the single outlet pipe. The Vault StormFilter has an internal bypass capability of 80L/s. If peak flows to the system exceed 50L/s, a high flow bypass is needed. See Stormwater360 for more information.

Applications

The Vault StormFilter can be used for the following applications:

- Parking lots
- Roadways
- Residential developments
- Retail/commercial developments
- Business/industrial sites
- Maintenance facilities

Special Considerations

When designing the Vault StormFilter into your system, you should consider the following:

- Stormwater360 recommends a minimum of 1500m of head room inside the vault for maintenance access.
- For depths with cover greater than 2.0m, contact Stormwater360 for information on additional requirements.

3. MAINTENANCE

Overview

The primary purpose of the StormFilter is to filter out and prevent pollutants from entering our waterways. Like any effective filtration system, periodically these pollutants must be removed to restore the StormFilter to its full efficiency and effectiveness. Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site. To assist the owner with maintenance issues, Stormwater360 provides detailed Operation & Maintenance Guidelines with each unit.

Stormwater360 can provide maintenance services completely, or in part. Available services include tracking of installed systems, advising the system's owner of maintenance needs, and notification of the regulatory agency once the system has been maintained.

Maintenance is usually performed in the dryer periods to rejuvenate the filter media and prepare the system for the next rainy period. Maintenance activities can also be required in the event of a chemical spill or excessive sediment loading due to site erosion or extreme storms. It is good practice to inspect the system after severe storm events.

Types of Maintenance

Presently, procedures have been developed for two levels of maintenance: Inspection/minor maintenance and major maintenance. Inspection/minor maintenance activities are combined since the minor maintenance does not require special equipment and typically little or no materials are in need of disposal. Inspection/minor maintenance typically involves a visual inspection and cleanup of vegetation and debris should it be required. Major maintenance typically includes cartridge recharging. Major maintenance may involve disposal of materials that require consideration of regulatory guidelines.

Maintenance Frequency

The primary factor controlling timing of maintenance for the StormFilter is sedimentation. A properly functioning system will remove solids from water by trapping these particulates within the porous structure of the media. The flow through the system will naturally decrease as more and more solids are trapped. Eventually the flow through a system will be low enough to require replacement of the cartridges. Sediment should be removed from upstream trapping devices on an as needed basis to prevent material from being re-suspended and discharged to the system.

Site conditions greatly influence maintenance requirements. StormFilter units located in areas with erosion or active construction should be inspected and maintained more often than those in fully established areas. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that develop known problems should be inspected more frequently than areas that demonstrate no problems, particularly after large storms. Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual filter. It is recommended that the maintenance agency develop a database to properly manage StormFilter maintenance programs.

Prior to the development of the maintenance database, maintenance frequencies shown in Table 2 should be followed as a minimum.

	INSPECTION/MINOR MAINTENANCE (TIMES/YEAR)	MAJOR MAINTENANCE (TIMES/YEAR)
StormFilter	2 (and after major storms)	1 (except in case of a spill)

Table 2. Frequency of Maintenance (typ.)

Determining Maintenance Frequency from Modelling Design

The procedure below however provides a method to estimate the cartridge replacement frequency.

1. Using the results obtained from the modeling in figure 7 earlier; determine the mass of TSS removed by the StormFilter technology itself. This usually involves deducting the quantity removed by the pre-treatment devices upstream. This can is done by determining the residual load from each immediate upstream node(s) only and then subtracting the residual load at the StormFilter node.

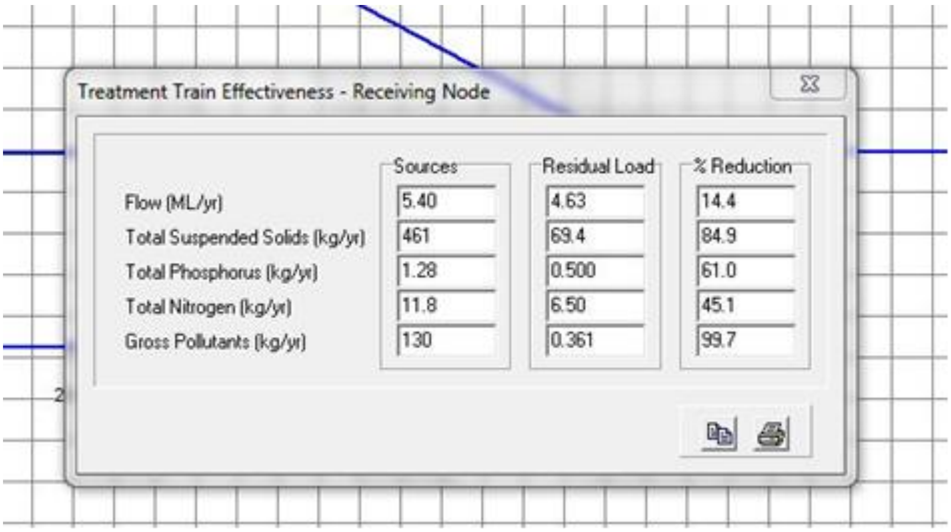


Figure 9. Results

2. Open the StormFilter Maintenance Frequency Calculator spreadsheet (shown below) and enter the load removed by the filter into cell C8. Also enter the number of cartridges from the previous design section into cell C13.

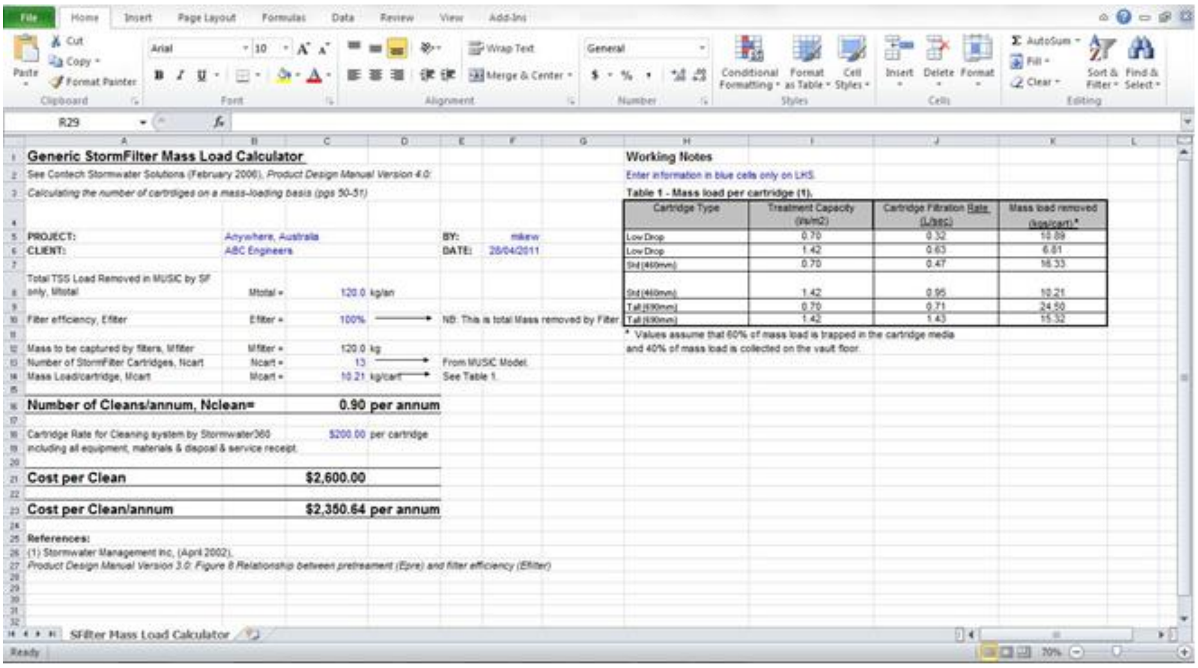


Figure 10. StormFilter Maintenance Frequency Spreadsheet

3. See table 1 on the spreadsheet. For each given cartridge height (column h) find the corresponding mass load per cartridge (column k) removed by the filter and enter into cell into cell C14.

Figure 11. StormFilter Maintenance Frequency Spreadsheet

Once complete see cell C16 to determine the maintenance frequency of the cartridge replacement. Always check that the cartridge replacement period is no less than 12months. Contact Stormwater360 for further information.

4. PERFORMANCE DATA

Suspended Solids

The transfer function for suspended solids for the StormFilter node has been derived from the results of the "The Portland Submittal". This paper details the results from 5 separate StormFilter's. Figure 12 shows the influent / effluent relationship developed in the paper.

Influent vs. Effluent Plot for the 5 Sites

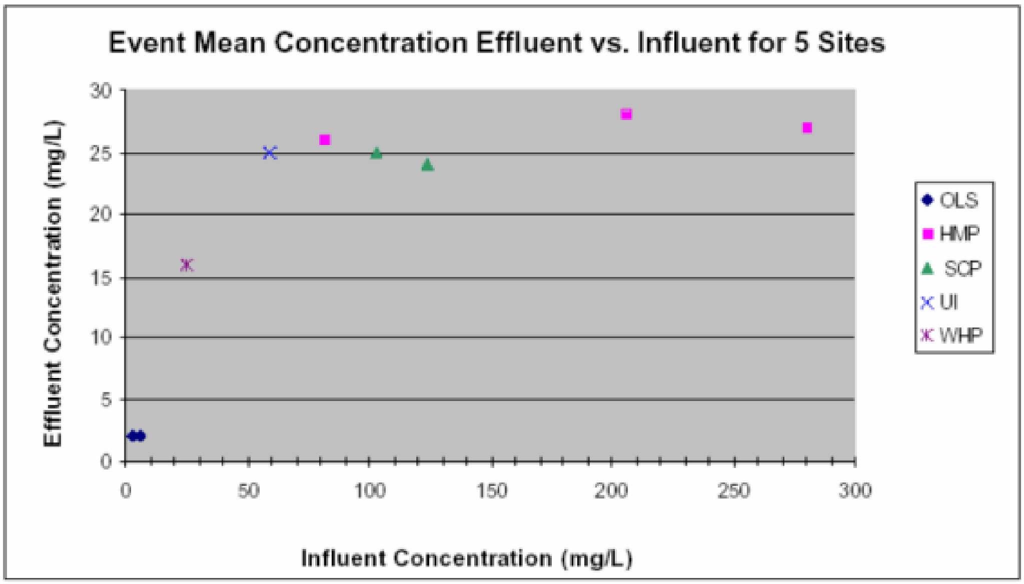


Figure 12. Portland Submittal Influent/Effluent Relationship

Source: City of Portland Submittal 2002

Also attached as supporting information is the paper; "Total Suspended Solids (TSS) Removal Using Different Particle Size Distributions with the Stormwater Management StormFilter". The particle size distribution in Stormwater is highly variable and greatly affects the performance of the treatment device. This paper details Laboratory testing of the StormFilter with different particle size distributions of synthetic sediment.

NJCAT Technology Verification Stormwater Management StormFilter. Portland, OR (USA).

NJCAT is a not-for-profit corporation to promote in New Jersey the retention and growth of Technology-based businesses in emerging fields such as environmental and energy technologies. NJCAT provides innovators with the regulatory, commercial, technological and financial assistance required to bring their ideas to market successfully.

The technology verification program specifically encourages collaboration between vendors and users of technology. Through this program, teams of academic and business professionals are formed to implement a comprehensive evaluation of vendor specific performance claims. Thus, suppliers have the competitive edge of an independent third party confirmation of claims.

A major condition of Conditional Interim Certification by the NJDEP is the execution of a subsequent field trial conducted in accordance with TARP (2003) and NJDEP (2006) to verify performance relative to the certified claims. Accordingly, a Project Plan for field verification testing was completed in accordance with the applicable protocols and accepted in June 2004, resulting in the commencement of monitoring activities. In December 2004, Conditional Interim Certification was extended based upon demonstrable project progress.

As part of a performance assessment of the StormFilter® in the State of New Jersey, a system using perlite media, installed at Greenville Yards, Jersey City, NJ, was evaluated. This StormFilter system treats stormwater runoff draining from a parking lot and commercial loading dock area.

This project was managed by CONTECH Stormwater Solutions Inc. (CONTECH) in Co-operation with the site owner and the New Jersey Department of Environmental Protection (NJDEP). Independent oversight of all aspects of the project was provided by Dr. Qizhong Guo of Rutgers University. Sample handling services were provided by Sovereign Consulting Inc. of Parsippany, NJ, and analytical work was conducted by Chemtech of Mountainside, NJ, and North Creek Analytical of Beaverton, OR.

Flow, level, and precipitation measurement equipment collected continuous data. Samplers were programmed to enable the sampling program after a minimum flow rate condition of >5 gpm (0.3L/s) was met. Once enabled, the equipment collected samples on a volume-paced basis allowing the specified pacing volume to pass before taking a sample.

The sample collection program input into each automated sampler was a two-part program developed to: 1) maximize the number of discrete samples (aliquots); 2) maximize the coverage of the precipitation event while at the same time maximizing aliquot volume.

Upon collection of samples following a precipitation event, CONTECH personnel communicated remotely with the automated sampling equipment to confirm sample collection and dispatch personnel from Sovereign to retrieve the samples and reset the automated sampling equipment. Samples were delivered to the Analytical Laboratory by Sovereign using cold transport and accompanied by chain-of-custody documentation. Discrete composite sample bottles were combined by the Analytical Laboratory to create bulk influent and effluent composite samples through identification of those bottles best representing the precipitation event based upon the hydrograph. Subsamples of the bulk influent and effluent composite samples to be used for analysis were created using an 8-L or 14-L.

Assessment of the mass of materials captured by the StormFilter as a whole over the course of the monitoring period revealed a net capture and retention of 2750 lbs (1248 kg) of material.11% of this material was found inside of the cartridges and 89% was found outside of the cartridges in the inlet bay and on the floor of the cartridge bay.

The results of the Coulter Counter influent PSD analysis revealed an average d50 of 13um. The average particle size distribution was comprised of 15% sand, 68% silt and 18% clay.

As per NJDEP (2006) both TSS and SSC demonstrate a linear relationship between influent and influent suspended solids EMCs that is significant at the >99.9% confidence level, indicating that the regression statistics can be used for the direct comparison of the field test observations to the performance claim.

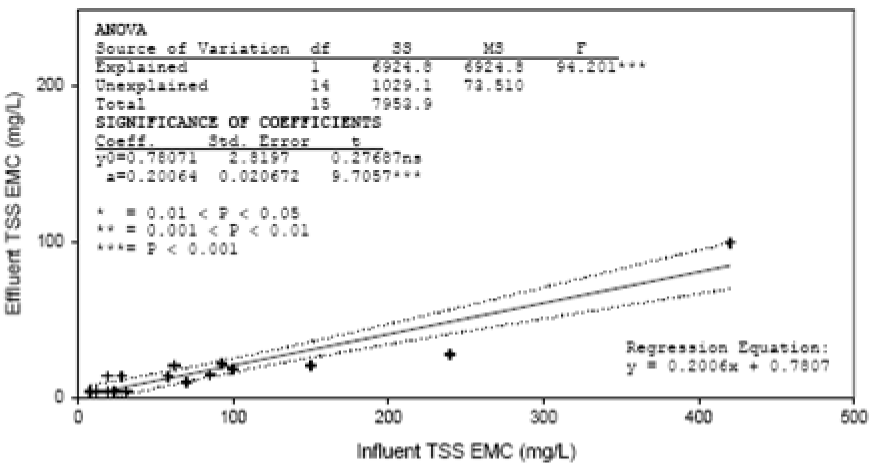


Figure 13. Regression of EMC for TSS Removal.

The regression statistics suggest a mean TSS removal efficiency of 80% with a standard error of 2.1% and a mean SSC removal efficiency of 84% with a standard error of 1.9%.

Analyte				Regression of EMC				Aggregate Load Reduction	
	n	Range of Influent EMCs (mg/L)	Median Influent EMC (mg/L)	Mean Removal Efficiency Estimate (%)	95% Confidence Interval for the Mean Removal Efficiency Estimate (%)	Median Effluent EMC Estimate (mg/L)	95% Confidence Interval for the Median Effluent EMC Estimate (mg/L)	Mean Removal Efficiency Estimate (%)	One-Tailed Sign Test* (H0=H1=0.5)
SSC	16	11.0 to 462	56.0	84***	80 to 88	10.7	5.60 to 15.9	80	R
TVSS	10	10.0 to 420	31.0	93**	89 to 96	9.20	4.19 to 14.2	78	R
SSC<500-um	13	6.00 to 170	26.0	89***	84 to 94	9.55	6.76 to 12.3	68	R
TVSS<500-um	7	12.0 to 130	29.0	---	--- to ---	---	--- to ---	76	R
TSS	16	8.00 to 420	60.0	80***	76 to 84	12.8	8.05 to 17.6	77	R

*** = P < 0.001
** = 0.01 > P > 0.001
* = 0.05 > P > 0.01
bold = equivalent to non-detect
--- = undeterminable due to insufficient data quantity
R = removal is significant at the 5% level or less
~ = no significant difference
A = addition is significant at the 5% level or less

Table 2. Total Suspended Solids (SSC in this case) Reduction for StormFilter.

In conclusion NJCAT verified that the claim that the Greenville Yards StormFilter system field test has demonstrated:

The Stormwater Management StormFilter® system operating at a specific flow rate of 2.05 gpm/ft2 per cartridge (15 gpm, 57 l/m) using perlite media has demonstrated a TSS (EPA Method 160.2) removal efficiency of 80% with 95% confidence limits of 76% and 84% for a sandy loam texture sediment (or finer) in the field using the NJDEP TARP/Tier II Protocol.

Total Phosphorous

The transfer function for total phosphorus has been developed from sampling 9 different StormFilters over 55 storms. The results are detailed and discussed in the paper "The Stormwater Management StormFilter Performance for Removal of Total Phosphorus". The Influent / Effluent relationship was developed through liner regression of the 55 storms as shown in figure 14 below.

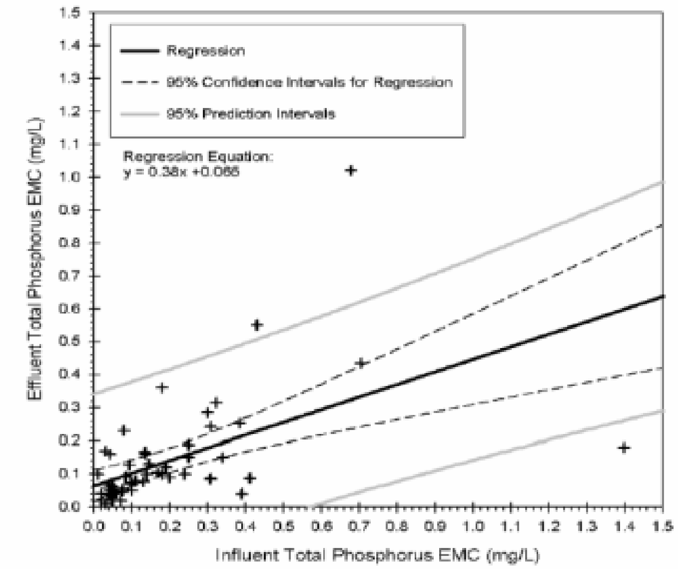


Figure 14. Influent TP vs. Effluent TP Linear Regression

Source: The Stormwater Management StormFilter Performance for Removal of Total Phosphorus

Total Nitrogen

A StormFilter system was installed in the Ski Run Marina parking lot by the City of South Lake Tahoe (CA, USA) in 2001. The City of South Lake Tahoe established automated storm water monitoring equipment at the inlet and outlet of the StormFilter system to quantitatively evaluate the in-situ ability of the StormFilter to reduce nutrient and fine sediment loads from stormwater runoff at Ski Run Marina in South Lake Tahoe. A total of 2.5 years of storm water quality monitoring (10 events) was completed at the site (2nd Nature Consulting, 2004).

The City of South Lake Tahoe (CSLT) installed two Sigma 900 MAX automated water samplers with area velocity flow meters at both the inlet (Site Sin) and the outlet (Site Sout) of the StormFilter vault to collect flow weighted stormwater samples during a variety of runoff events. Both sampling units were equipped with 24 sample bottles (1L) and flow pacing was adjusted to collect a number of samples during each individual event that provided a representative selection of the entire storm hydrograph at both the inlet and outlet. The instruments were well maintained and serviced prior to each anticipated runoff event. The two monitoring systems and the associated data were installed, maintained and managed primarily by Russ Wigart, an engineer with CSLT. A total of 10 events were successfully monitored at both the inlet and outlet for flow and water sample collection. All samples were placed on ice and submitted to WetLab Analytical and processed for the constituents listed in Table 3 within 48 hours of collection by the auto samplers. Analysis of pollutants, including nitrate, nitrite, ammonium and orthophosphate, phosphorus and suspended solids was untaken (2nd Nature Consulting, 2004).

		volume reductions	REMOVAL EFFICIENCIES					BLACK VALUE INDICATES REDUCTION IN POLLUTANT RED VALUE INDICATED INCREASE IN POLLUTANT				
EVENT	EVENT TYPE		NO3-N	NO2-N	NH3-N	TKN	TN	OP	DP	PP	TP	TSS
11/22/01	rain	11%	-3%	-17%	46%	-22%	-18%	0%	16%		23%	-80%
11/24/01	rain	23%	15%	1%	38%	31%	28%	2%	10%		59%	-28%
12/2/01	snow melt	22%	42%	16%	68%	47%	46%	18%	64%	5%	43%	88%
4/30/02	snow melt	23%	21%	-92%	61%	32%	24%	-57%	0%		-26%	96%
7/18/02	thunderstorm	82%	-94%	84%	96%	95%	86%	96%	95%	97%	97%	99%
11/8/02	rain	21%	-6%	-45%	10%	17%	9%	17%	16%	39%	26%	44%
11/10/02	rain	24%	39%	24%	30%	56%	51%	-75%	-33%	89%	65%	97%
3/15/03	rain on snow	14%	32%	14%	11%	37%	37%	20%	18%	65%	55%	57%
6/21/03	thunderstorm	16%	69%	7%	46%	19%	32%	73%	61%	23%	35%	69%
1/8/04	rain	11%	-86%	11%	11%	55%	47%	49%	-47%	66%	56%	63%
			NO3-N	NO2-N	NH3-N	TKN	TN	OP	DP	PP	TP	TSS
STORMFILTER PERFORMANCE	average removal		5 ± 57 %	0 ± 46%	42 ± 28%	37 ± 30 %	34 ± 28 %	14 ± 52 %	22 ± 46 %	55 ± 34 %	43 ± 32 %	52 ± 60 %
	PROJECT EFFICIENCY		14%	-12%	36%	34%	29%	23%	6%	70%	50%	63%
Project Efficiency: treatment efficiency for sum of all inflow and outflow loads over monitoring duration												
[2] with first 2 events removed	PROJECT EFFICIENCY [2]		15%	-36%	35%	39%	32%	7%	5%	70%	51%	79%

Table 3. Performance Summary for StormFilter.

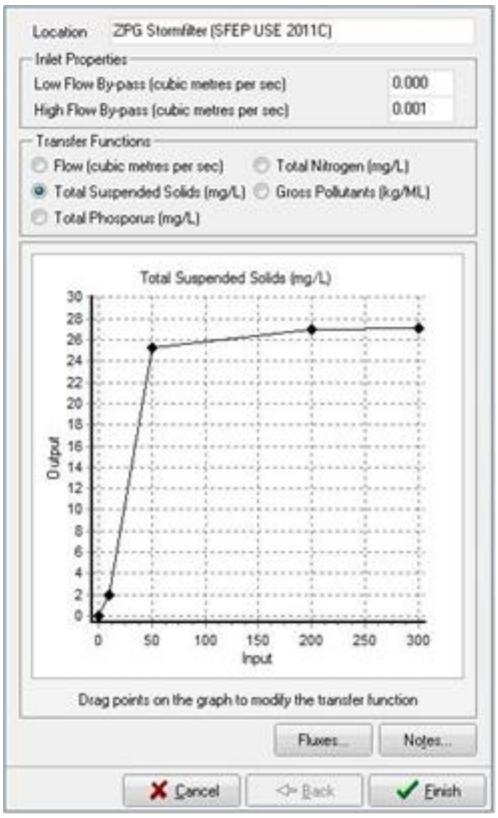
The project efficiency of the system with the anomalies removed indicated a removal efficiency of 79% for Suspended Solids, 51% Total Phosphorus & 32% for Total Nitrogen.

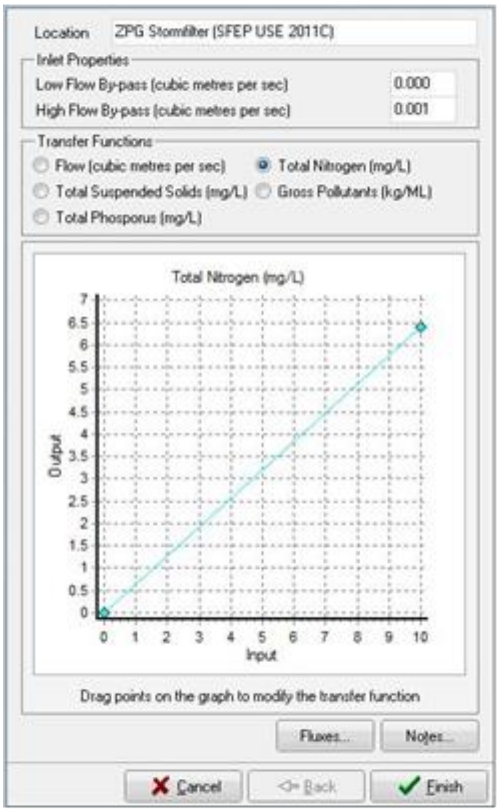
There has been various studies relating to nutrient reduction of the StormFilter technology. A summary of these studies of the StormFilter technology in the United States, the system has achieved 60% TP reduction (across 9 different sites & 55 storms) and 36% TN reduction (older style wet sump fore bay StormFilter across 3 sites & 33 storms) as a standalone technology which has been used in modeling the StormFilter technology.

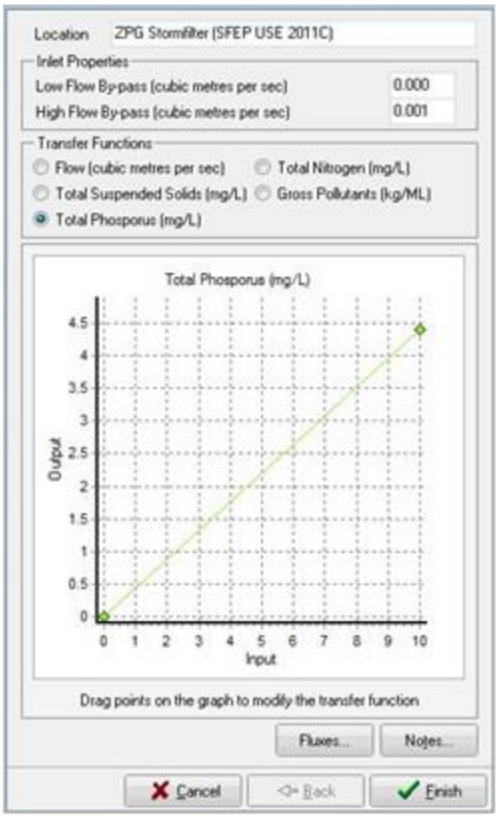
Please note the data used above is for the standalone StormFilter treatment system. For modelling the SFEP treatment train consult the SFEP MUSIC Modelling Guidelines for details and published performance data.

Appendix A – Transform Functions

StormFilter







<u>APPENDIX C</u>

FLOOD PLANNING LEVEL MAP

ARMIDALE REGIONAL COUNCIL

Armidale Flood Planning Level Map

(Based on Armidale Flood Study 2004 and Martins Gully Update 2011)

- Flood Planning Level (1Percent AEP + 0.5m)
- Watercourse
- Parcel Boundary
- Roads
- Railway Line

DISCLAIMER:

- The extent of flooding depicted on these maps is approximate as ground levels used are sourced from aerial photography. For a more accurate assessment of the extent of flooding, actual ground levels must be obtained and compared to predicted flood levels.
- The map depicts flooding from rising water from natural watercourses only.
- The map does not indicate possible extents of flooding from flash flooding - local high intensity storms and associated run-off.
- Information is a pictorial representation only.
- Ground truthing is required.
- Contours are a general indication of ground shape only.
- Provided for intended purpose only.
- Should not be used for any other purpose.

New flood studies have recently been completed by BMT WBM for Council. It is anticipated that these will go on display, as part of a public consultation process, at the end of January 2015. In the meantime the forecast flood planning limits shown on this map should treated with caution. For more accurate information contact Mike Brooks, Senior Engineer Utilities, on 6770 3894.

AUTHOR: ADC GIS OFFICER

DATE : APRIL 2011