CMA CORPORATION Pty Ltd.
MATERIALS RECYCLING FACILITY

FIRST FLUSH STUDY

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Introduction

CMA Corporation proposes to develop a materials recycling facility on part of their 6.54ha site at 191 Miller Rd, Chester Hill. Refer drawing 0600/002-P01 for the existing site layout.

The site was previously owned by Incitec Ltd and used primarily in the production of and distribution of fertiliser products. Site operations included the production and storage of sulphuric acid and its by-products such as oleum and battery acid. Other activities on site included soil testing and the storage of liquid chemicals.

The main entry and exit is from Miller Road, located at the western side of the site.

Purpose of Report

This report accompanies an application made under Part 3A of the Environmental Planning and Assessment Act 1979 for approval to a Major Project comprising the construction and use of a portion of No. 191 Miller Road, Chester Hill as a materials recycling facility. Refer Doerfler Borg Architects Drawing 0605-SK01 for the proposed site plan.

The report details items specifically relating to:-

- Stormwater quality and quantity issues;
- Storage capacity and catchment size for the on-site detention system;
- Assessment of the likely frequency of off-site release from the on-site detention system;
- Assessment of Erosion and Sediment control requirements.

Background

The site has had various uses resulting in various levels of soil contamination.

The soil contamination, including Asbestos sheet fragments, results in a ground condition that requires soils to be contained and prevented from being transported or otherwise disturbed. It further indicates that infiltration methods cannot be employed to treat stormwater runoff. Refer drawing 0600/002-P02 for the location of contaminated land.

Site photographs are included in Appendix E for reference.

Based on past use, the planning of the site therefore requires that limited earthworks be undertaken for construction and drainage purposes, and that activities requiring the excavation and removal of material from the site be limited.

Methodology

1. Site assessment

a) Existing Drainage System

The site is paved with concrete or asphaltic concrete with the exception of the existing concrete rubble and earth stockpile areas and various grassed areas, these areas range from bare earth to dense grass. These areas , excluding roofs have a fraction impervious value of 75% .Some paved areas are in adequate condition where as others, namely asphalt areas have failed and need replacing.

There is an existing piped drainage system that flows generally west with the fall of the land and discharges into Councils stormwater system in Miller Rd. The condition of this system is assessed as fair to poor and may require upgrading in sections for both maintenance and capacity purposes.

Refer drawing 0600/002-P01 for the existing site layout and drainage schematic.

b) Existing Treatment of Stormwater Runoff

No treatment is provided for the site in its current condition.

c) Catchment Areas

Areas of all sub catchments are given below in Table 1. Refer drawing 0600/002-P03.

Table 1

CATCHMENT	DESCRIPTION	AREA
A	Balance site	4.126 ha
B	Auto Dismantling	0.169 ha
C	Shearing and Storage – Non Ferrous	0.335 ha
D	Shearing and Storage – Ferrous	0.57 ha
E	Existing Building	0.335 ha
F	Existing Building	0.059 ha
G	Existing Building	0.057 ha
H	Existing Building	0.047 ha
I	Existing Building	0.028 ha
J	Future Building	0.5 ha
K	Future Building	0.315 ha
	TOTAL	**6.5446ha**

Note: The building sizes indicated for catchments J and K are nominal only and subject to further investigation.
Figure 1 shows the site plan

Figure 1

d) Constraints

1. Area constraints.: Existing Buildings and Roadways
2. Contaminated soil (Asbestos) that should not be disturbed. Existence of these constraints prevents the treatment infiltration of stormwater using devices, earth detention basin, and wet lands.
    - The contaminated soil would add to pollutant discharge should infiltration or earth walled devices were used.
    - The limitation of area makes it impossible to have any kind of basins or treatments that require large spaces.

e) Opportunities

According to the constraints of the site and the nature of the pollutants, a storage treatment system was chosen.

The system consists of First Flush pit + GPT + Filternator™.
This type of treatment can benefit both quantity and quality control.

More details about the treatments are in the paragraphs below.

2. Impact of Development

Pollutants generated from each catchment

Table 2

CATCHMENT	SPECIAL POTENTIAL POLLUTANT	COMMENTS
A	Metal, leachates from the scrap yards + TSS, N, P	
B	Metals, leachates from the yard, Oil Grease + TSS, N, P	
C	Metals, Oil Grease + TSS, N, P	
D	Metals+ TSS, N, P	
E	TSS, N, P	Roof area
F	TSS, N, P	Roof area
G	TSS, N, P	Roof area
H	TSS, N, P	Roof area
I	TSS, N, P	Roof area
J	TSS, N, P	Future Roof area
K	TSS, N, P	Future Roof area

3. Objectives

The following table of treatment objectives has been extracted from Table 2 of the Bankstown City Council's Engineering and Drainage Standards Policy (page 49) (December 2005) for the Past Construction Phase. The objectives for the construction phase are general standards currently used in construction sites.

Table 3

Pollutant:	**ESD Treatment Objective:**
Post construction phase:	
Suspended solids (SS)	50% retention of the average annual load
Total phosphorus (TP)	45% retention of the average annual load
Total nitrogen (TN)	45% retention of the average annual load
Litter	Retention of litter greater than 50 mm and 70 % of litter greater than 5mm for flows up to25% of the 1 year ARI peak flow
Coarse sediment	Retention of sediment coarser than 0.1 mm for flows up to 25% of the 1 year ARI peak flow
Oil and grease (hydrocarbons)	In areas with concentrated hydrocarbon deposition, no visible oils for flows up to 25% of the 1 year ARI peak flow and 90% reduction of average annual load of hydrocarbons
Construction phase:	
Suspended solids	Effective treatment of 90% of daily runoff events. Effective treatment equates to a 50%ile SS concentration of 50 mg/L.
Other pollutants	Limit the application, generation and migration of toxic substances to the maximum extent practicable

4. Evaluate Options

Prevention practices:

Bunding to be provided as shown in the diagram below

The aim of the bunded area is to contain the runoff from larger and longer events to enable operation of the site during periods of wet weather.

The bunded area shall contain at least the volume of runoff from a 20 year, 24 hour event, excluding the volume occupied by the product.

Figure 2

Treatment practices:

Proposed treatment train was chosen to relying on the site's conditions and constraints as the contaminated soil in the site doesn't allow infiltration system, and the lack of space is not suitable for big detention basin.

Proposed treatment devices ware figure 3& 4 shows the treatment train

1. Pollutant Trap(GPT)/ Copa Water Model 0305 Filternator
2. CDS P1012L GPT / Copa Water Model 2025 Filternator
3. First Flush pit

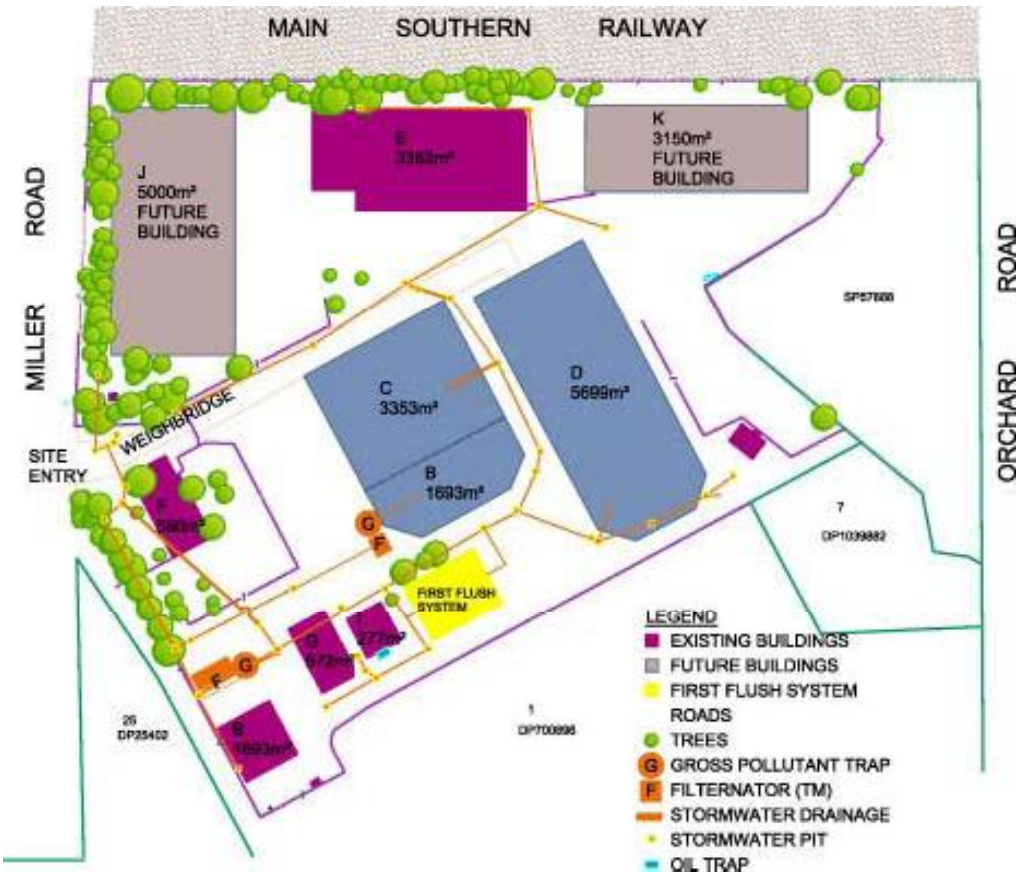


Figure 3

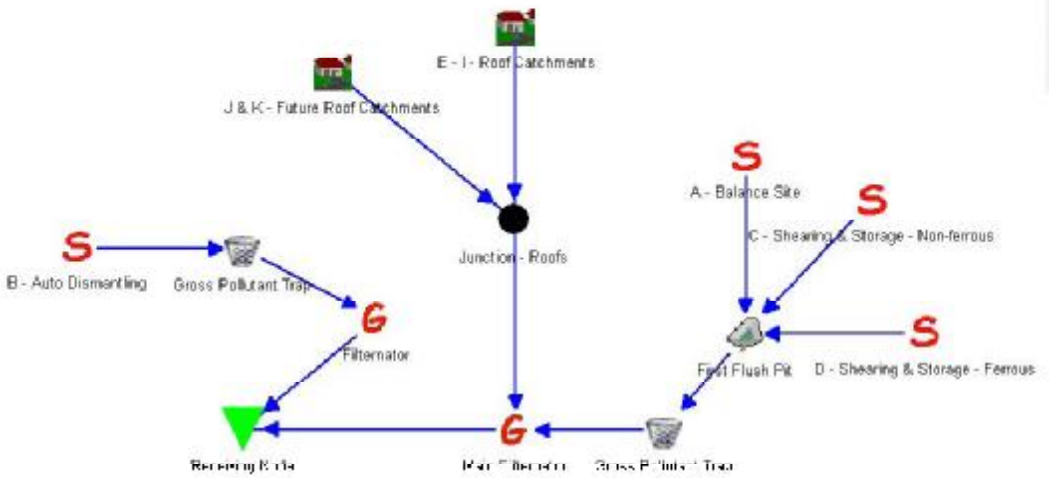
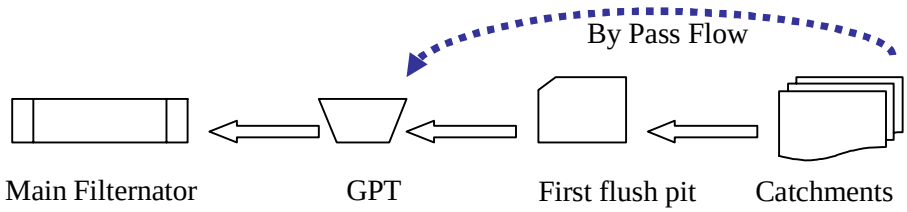


Figure 4

Overview of the Treatment Trains

An indicative treatment train has been developed in Conjunction with Copa Water to manage the specific discharges from the site. Refer drawing 0600/002-P04 for an indicative layout.

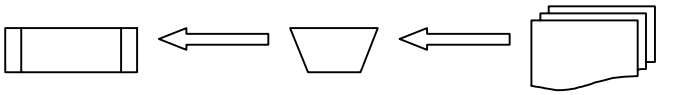
- Unit 1: Stormwater is collected from the catchments A (site balance), C (shearing & storage area, non ferrous) and D (shearing & storage area, ferrous). These catchments are the main source of pollutants generated by the site, and area directed firstly to the flush pit, then through a GPT device and subsequently through the main Filternator™ before discharge to the external stormwater network.



Unit 1

- Stormwater from the Buildings E,F,G,H,I and the future Buildings k, j is collected and passed through the main Filternator™ and discharge to the external stormwater network. it is optional to install roof water tanks for each building to collect rain water for reuse onsite)

- Unit 2: Stormwater from the catchment B (auto dismantling) is collected and passed through a GPT to remove the oil and grease and then through a filternator prior to discharge to the external stormwater network.



Unit 2

The proposed device specifications:

The treatment trains for the catchments are specified above constructed as follows.

Unit 1: A CDS P1012L GPT / Copa Water Model 2025 Filternator ™ combination is being utilised to achieve a satisfactory removal rate for the balance of the pollutants being generated on-site.

The arrangement of these devices allows the initial GPT stage to remove litter and suspended solids. The balance of pollutants passing through the GPT is treated to a high standard by the Filternator. Refer Appendix B for a Copa Water performance review summary for the Filternator system.

The Filternator is a cartridge filtration unit configured with varying filtration media housed in individual units in a concrete vault. The main unit is sized based on a treatment flow rate of 22l/s and a retention time from the first flush pit of 10 hours. This sizing is designed to minimise the construction cost and maintenance requirements of the CDS unit.

Capturing the entire 3 month flow volume for treatment is critical as this allows for the treatment of greater than 95% of the annual discharge.

Unit 2: A CDS P0708 Gross Pollutant Trap(GPT) / Copa Water Model 0305 Filternator ™ is proposed to be located at the vehicle dismantling area to enable efficient removal of oils, greases and metal matter at source.

Roofwater from the site is to undergo basic treatment as the Total Phosphorus and Total Nitrogen content of the water is low compared to the surface water discharge

. Refer Appendix B for Copa Water product review and sample drawings.

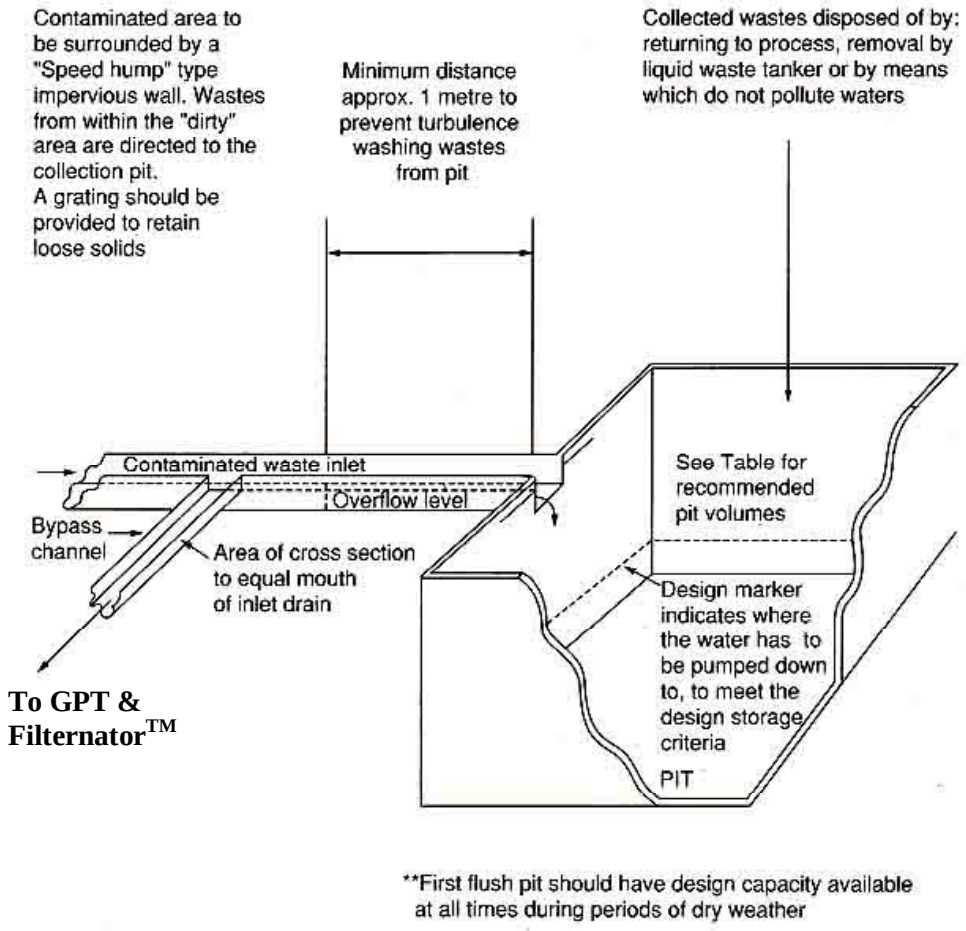


Figure 5 -Typical First Flush Pit
http://www.epa.nsw.gov.au/mao/stormwater.htm

5. Operational Phase

- **Efficiency**

0 **WATER QUALITY**

Analysis of the proposed treatment train has been carried out using Music Version 3.01.

The Media Filtration Summary included in Appendix B provides observed data for the pollutant removal efficiencies of a Filternator installation.
Use of these values in a generic treatment node provides satisfactory analysis of the discharge.

Total Nitrogen is not included in the Copa Water performance review as the treatment media, Zeolite, is yet to be performance tested in the Filternator units. The Music analysis has allowed an expected removal rate of 32% utilising Zeolite in the filter cartridges, combined with the 13% reduction in the CDS GPT units.

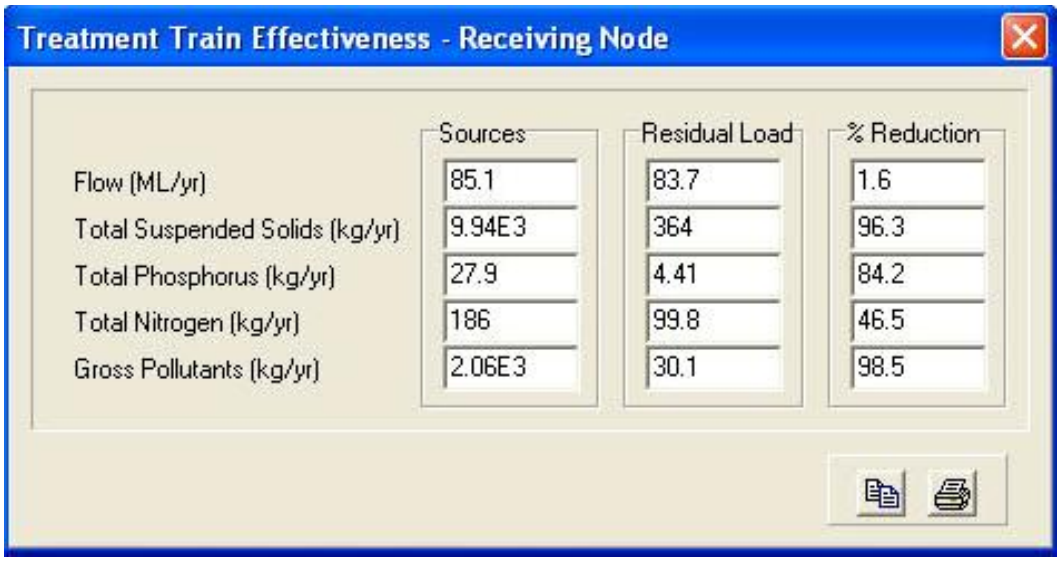


Figure 6 treatment train effectiveness according to MUSIC

0 WATER QUANTITY

The critical storm for increase in peak discharges is the 2 year event, being for an average 25 minute storm at the site. The discharge in this storm shows an increase of 326.18m^3 from the present condition.
In this case the unmitigated peak discharge increases by 0.514 m^3/s to 1.861m^3/s and the total volume discharged is increased to 2158.99m^3.

Tables 7.1 and 7.2 shows flowrates and discharge quantity for the site. These tables indicate the effect of the proposed system in controlling flows and discharge quantity to approximate the undeveloped case.
In all cases the mitigated flows and discharge quantities are reduced below the current condition.

A DRAINS analysis has been undertaken to assess the impact of roofwater tanks on the discharge from the site. It was determined that tanks utilised on the smaller, existing buildings on the site have little effect in reducing discharge quantity. Larger tanks were assessed for the existing building I and the future buildings J and K. It was determined that tanks in the order of 30 – 50 kl for these three buildings do little in terms of overall discharge control but may be useful for site supply purposes. Tanks are therefore an optional item only and are not required for mandatory detention requirements.

*In addition the proposed bund mentioned previously in Paragraph **Prevention practices,** enhance the collection of storm water and provide a detention area during periods of wet weather.*

Table 4

Condition	Flow	m^3/second						
	Q3month	Q1	Q2	Q5	Q10	Q20	Q50	Q100
Undeveloped	0.165	0.329	0.633	1.046	1.339	1.706	2.145	2.480
Existing	0.455	0.909	1.346	1.985	2.318	2.733	3.007	3.422
Future - Unmitigated	0.706	1.411	1.860	2.422	2.754	3.152	3.452	3.836
Future - Mitigated	0.138	0.275	0.515	1.170	1.569	2.018	2.385	2.784
Change Mitigated - Existing Development	-0.317	-0.634	-0.831	-0.815	-0.749	-0.715	-0.622	-0.638
Change Mitigated - Undeveloped	-0.027	-0.054	-0.118	0.124	0.230	0.312	0.240	0.304

Table 5

Condition Quantity m^3

	Q3Month	Q1	Q2	Q5	Q10	Q20	Q50	Q
Undeveloped	216.975	433.950	840.680	879.570	1102.170	1370.220	1537.090	1789.220
Existing	654.755	1309.510	1832.810	1629.740	1901.980	2228.810	2380.650	2686.500
Future - Unmitigated	815.520	1631.040	2158.990	1881.600	2153.930	2480.790	2617.410	2922.430
Future - Mitigated	282.135	564.270	1090.660	814.050	1084.900	1410.920	1548.660	1845.250
Change Mitigated - Existing Development	-372.620	-745.240	-742.150	-815.690	-817.080	-817.890	-831.990	-841.250
Change Mitigated - Undeveloped	65.160	130.320	249.980	-65.520	-17.270	40.700	11.570	56.030

Maintenance

The treatment train outlined above optimizes treatment to maximise pollutant removal efficiency and provide a reasonable maintenance schedule that can be maintained by the owners.

According to Copa Water performance review summary -Refer Appendix B in point 4 of Paragraph ADVANCES & BENEFITS COMPARED TO OTHER MEDIA SYSTEMS in

"Maintenance of the CDS MFS does not require special equipment or proprietary media. CDS™ Technologies Inc. will provide media manufacturers and exact gradation of filter media to municipalities who wish to perform their own maintenance or contract with readily available commercial maintenance services. Contracts for service from CDS will always be available if desired.**"**

First Flush tank can be cleared using a standard vacuum truck. Should there be a need to cover the First Flush with a concrete slab revision should be made for access entry and step irons.

Calculation

Table 6: Design criteria for first flush containment systems

http://www.epa.nsw.gov.au/mao/stormwater.htm

Pollutants	Catchment surface	Examples of industries	Rainfall level to be contained
Substances easily mobilised, such as soluble materials, fine dusts and silts	Impervious: concrete, cement, bitumen	Concrete batching plants	10 mm
Substances that are more difficult to mobilise, such as oil, grease and other non-volatile hydrocarbons	Impervious: concrete, cement, bitumen	Petrochemical plants, motor vehicle courtyards, chemical manufacturers, hot mix bitumen emulsion plants, roadways	15 mm
All types of pollutant	Pervious surfaces (including natural ground surface) that are not as easily cleansed of deposited pollutants	Market gardens, nurseries	20 mm

To enable the runoff to be treated effectively, a first flush pit is required to capture the first 15mm of runoff from the site. The first flush pit will then be used to control flow through a series of treatment devices to enable the runoff to be treated to an acceptable standard. Refer section 8 for treatment train details.

A table of worst case storms giving peak flows and runoff volume is shown below for each recurrence interval. Refer appendix A for DRAINS data and results.

The table shows the discharge volume for the 3 month event for the entire site in the developed condition as being 815 m^3. This equates to 12.5mm runoff from the site. Note this area includes the less polluted roof areas.
The discharge volume for the 3 month event from the polluted areas only is 638.5 m^3.

A first flush storage tank is proposed with sufficient storage (1,500m^3) to store theQ_{3month} flows from the site (6.554ha) when storage in pipes and pits is taken into account. This volume provides for the first 15mm of flow from the polluted areas (638.5m^3) plus the balance of the Q3month flows and additional storage volume for quantity purposes in other storm events.

Comparing this volume to the increase in discharge volume, the first flush pit will detain the increase in discharge volume for all storms from the site. This will enable the first flush pit to be utilised to treat the runoff to the required standard and be used to limit peak discharges to approximate the undeveloped condition. It should be noted that the discharges proposed under this study will approximate the discharge from the site in the undeveloped condition and effectively reduce the flows to below the current discharge flowrates experienced at the site from development undertaken prior to CMA Corporation taking possession of the site.

Refer Appendix A for drains calculation

EROSION AND SEDIMENT CONTROL

The site requires the configuration of erosion and sediment control measures for the construction and operational phases of development. Refer drawing 0600/002-P05.

Establishment of the first flush pit is proposed early in the construction phase to enable configuration of the site for efficient erosion and sediment control during construction. During the construction phase the site shall utilise sediment control fencing around all earthworks and inlet protection measures to all stormwater inlets where sediment transport issues exist.

Operational erosion and sediment control shall occur through the configuration of the operations areas and the treatment devices to effectively limit the discharge of sediment laden water outside the boundary

of the property. The first 15mm of surface runoff passes through the GPT/Filternator process via the first flush tank. This allows the first flush tank to act as a permanent sediment basin, requiring regular maintenance in accordance with the design maintenance schedule.

Generation of suspended materials during the operational phase is expected as the nature of materials recycling typically involves fine materials present on scrap being deposited in the working areas and flushed to the stormwater system during rain events. Allowing for these materials to be collected in a gross pollutant trap is the most effective method of discharge prevention. In addition, the acoustic/visual fencing proposed will assist in containing particulate matter that is subject to airborne transportation.

CONCLUSION

This report has defined measures required to satisfy the requirements of the NSW Government Department of Planning.

The requirements addressed in this report encompass erosion and sediment controls and the operational stormwater management system for water quality and quantity.

APPENDIX A
DRAINS DATA

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N105	19.91		0				
N99	19.91		0				
N14	19.91		0				
N104	22.09		0				
N103	19.91		0				
N100	22.31		0				
N9	10.22		0				
UndevOut	9.22		0				
N17	19.91		0				
N18	19.91		0				
N19	10.36		0				
DevOut	9.36		0				

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
B Auto	0.041	0.041	0	5	1	1	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
D Ferrous	0.136	0.136	0	5	1	1	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
C Non Ferrous	0.08	0.08	0	5	1	1	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
A Balance Site	0.833	0.751	0.088	8	7	1	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
Undeveloped	0.398	0.055	0.376	8.89	18.49	16.68	AR&R 1 year, 1 hour storm, average 27.4 mm/h, Zone 1
Developed	0.909	0.751	0.26	9.2	9.75	13.95	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
K	0.075	0.075	0	5	1	1	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
E	0.08	0.08	0	5	1	1	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
J	0.12	0.12	0	5	1	1	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
F	0.014	0.014	0	5	1	1	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
G	0.014	0.014	0	5	1	1	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
H	0.011	0.011	0	5	1	1	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
I	0.007	0.007	0	5	1	1	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1

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
Pipe156	0.041	0.2	19.913	19.913	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
Pipe10	1.09	2.2	19.913	19.912	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
P50	1.09	2.5	19.912	19.911	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
Pipe155	0.136	5.5	22.086	19.913	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
Pipe154	0.08	0.3	19.913	19.913	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
Pipe153	0.833	4.8	22.312	19.913	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
Pipe5	0.398	2.8	10.222	9.222	AR&R 1 year, 1 hour storm, average 27.4 mm/h, Zone 1
P14	0	0	19.911	19.911	AR&R 1 year, 5 minutes storm, average 88 mm/h, Zone 1
Pipe46	0	0	19.911	19.911	AR&R 1 year, 5 minutes storm, average 88 mm/h, Zone 1
P17	0.909	3.2	10.36	9.36	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	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 Storm
DetentionOF	0.133	0.133	0.381	0.112	0.08	4.72	0.72	AR&R 1 year, 1.5 hours storm, average 21.5 mm/h, Zone 1
Ult Flow	0.314	0.314	0.81	0.035	0.05	10.91	1.59	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
OF K	0.075	0.075	0.256	0.032	0.01	10.38	0.44	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
OF E	0.08	0.08	0.256	0.032	0.02	10.38	0.47	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
OF J	0.116	0.116	0.256	0.036	0.02	11.27	0.53	AR&R 1 year, 25 minutes storm, average 44.2 mm/h, Zone 1
OF81	0.014	0.014	0.256	0.017	0.01	5.54	0.31	AR&R 1 year, 10 minutes storm, average 68 mm/h, Zone 1
OF G	0.017	0.017	0.256	0.018	0.01	6.14	0.3	AR&R 1 year, 5 minutes storm, average 88 mm/h, Zone 1
OF H	0.013	0.013	0.256	0.017	0	5.54	0.29	AR&R 1 year, 10 minutes storm, average 68 mm/h, Zone 1
OF I	0.007	0.007	0.256	0.013	0	4.34	0.26	AR&R 1 year, 5 minutes storm, average 88 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin20	19.91	1311.9	0.133	0	0.133
Tank K	27.16	30.8	0.075	0	0.075
Tank E	27.16	30.9	0.08	0	0.08
Tank J	27.18	51.9	0.116	0	0.116
Tank F	22.62	1	0.014	0	0.014
Tank G	22.62	1	0.017	0	0.017
Tank H	22.62	1	0.013	0	0.013
Tank I	22.61	1	0.007	0	0.007

CONTINUITY CHECK for AR&R 1 year, 1 hour storm, average 27.4 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Cl (cu.m)	Difference %
N105	44.72	44.72	0	0
N99	1277.02	1277.01	0	0
N14	1277.01	1277.01	0	0
Basin20	1277.01	1277.01	1272.63	-99.7
N104	150.45	150.45	0	0
N103	88.52	88.52	0	0
N100	993.32	993.32	0	0
N9	524.28	524.28	0	0
UndevOut	524.28	524.28	0	0
N17	0	0	0	0
N18	0	0	0	0
N19	1309.51	1309.51	0	0
DevOut	1309.51	1309.51	0	0
UltOut	240	240	0	0
Tank K	83.16	83.16	30	-36.1
Tank E	88.44	88.44	30	-33.9
Tank J	132	132	50	-37.9
Tank F	15.58	15.58	1	-6.4
Tank G	15.05	15.05	1	-6.6
Tank H	12.41	12.41	1	-8.1
Tank I	7.39	7.39	1	-13.5
N175	239.99	239.99	0	0

Run Log for 2006 run at 14:57:54 on 11/10/2006

The following detention basins have little effect (less than 2%) in reducing peak discharge: Tank I, Tank H, Tank G, Tank F, Tank E, Tank K You might consider upsizing these, or removing them from the model.

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N105	19.98		0				
N99	19.98		0				
N14	19.97		0				
N104	22.1		0				
N103	19.98		0				
N100	22.37		0				
N9	10.29		0				
UndevOut	9.29		0				
N17	19.97		0				
N18	19.97		0				
N19	10.45		0				
DevOut	9.45		0				

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
B Auto	0.052	0.052	0	5	1	1	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
D Ferrous	0.176	0.176	0	5	1	1	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
C Non Ferrous	0.104	0.104	0	5	1	1	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
A Balance Site	1.114	0.968	0.146	8	7	1	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
Undeveloped	0.633	0.06	0.603	8.11	16.77	15.14	AR&R 2 year, 1 hour storm, average 35.5 mm/h, Zone 1
Developed	1.346	0.984	0.448	8.4	8.9	12.7	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
K	0.097	0.097	0	5	1	1	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
E	0.103	0.103	0	5	1	1	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
J	0.154	0.154	0	5	1	1	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
F	0.018	0.018	0	5	1	1	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
G	0.018	0.018	0	5	1	1	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
H	0.015	0.015	0	5	1	1	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
I	0.009	0.009	0	5	1	1	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1

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
Pipe156	0.052	0.2	19.979	19.979	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
Pipe10	1.446	2.8	19.979	19.975	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
P50	1.446	3.3	19.975	19.971	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
Pipe155	0.176	5.9	22.097	19.979	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
Pipe154	0.104	0.3	19.979	19.979	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
Pipe153	1.114	5.2	22.367	19.979	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
Pipe5	0.633	3	10.287	9.287	AR&R 2 year, 1 hour storm, average 35.5 mm/h, Zone 1
P14	0	0	19.971	19.971	AR&R 2 year, 5 minutes storm, average 114 mm/h, Zone 1
Pipe46	0	0	19.971	19.971	AR&R 2 year, 5 minutes storm, average 114 mm/h, Zone 1
P17	1.346	3.4	10.452	9.452	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	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 Storm
DetentionOF	0.364	0.364	0.256	0.058	0.04	15.58	0.72	AR&R 2 year, 1 hour storm, average 35.5 mm/h, Zone 1
Ult Flow	0.451	0.451	0.81	0.04	0.07	11.99	1.74	AR&R 2 year, 1 hour storm, average 35.5 mm/h, Zone 1
OF K	0.097	0.097	0.256	0.035	0.02	10.91	0.49	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
OF E	0.103	0.103	0.256	0.035	0.02	11.09	0.5	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
OF J	0.154	0.154	0.256	0.041	0.02	12.17	0.57	AR&R 2 year, 25 minutes storm, average 57 mm/h, Zone 1
OF81	0.017	0.017	0.256	0.018	0.01	6.14	0.3	AR&R 2 year, 1.5 hours storm, average 27.8 mm/h, Zone 1
OF G	0.017	0.017	0.256	0.018	0.01	5.84	0.32	AR&R 2 year, 1.5 hours storm, average 27.8 mm/h, Zone 1
OF H	0.013	0.013	0.256	0.017	0	5.54	0.28	AR&R 2 year, 1.5 hours storm, average 27.8 mm/h, Zone 1
OF I	0.001	0.001	0.256	0.007	0	2.25	0.15	AR&R 2 year, 1.5 hours storm, average 27.8 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin20	19.97	1344.8	0.364	0	0.364
Tank K	27.17	10.3	0.097	0	0.097
Tank E	27.17	10.3	0.103	0	0.103
Tank J	27.2	10.4	0.154	0	0.154
Tank F	22.62	10.1	0.017	0	0.017
Tank G	22.62	10.1	0.017	0	0.017
Tank H	22.62	10.1	0.013	0	0.013
Tank I	22.6	10	0.001	0	0.001

CONTINUITY CHECK for AR&R 2 year, 1 hour storm, average 35.5 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Cl (cu.m)	Difference %
N105	58.44	58.44	0	0
N99	1696.37	1696.37	0	0
N14	1696.37	1696.37	0	0
Basin20	1696.37	1696.37	1278.88	-75.4
N104	196.62	196.62	0	0
N103	115.68	115.68	0	0
N100	1325.63	1325.63	0	0
N9	840.68	840.68	0	0
UndevOut	840.68	840.68	0	0
N17	0	0	0	0
N18	0	0	0	0
N19	1832.81	1832.81	0	0
DevOut	1832.81	1832.81	0	0
UltOut	811.68	811.68	0	0
Tank K	108.67	108.67	10	-9.2
Tank E	115.57	115.57	10	-8.7
Tank J	172.5	172.5	10	-5.8
Tank F	20.35	20.35	10	-49.1
Tank G	19.66	19.66	10	-50.9
Tank H	16.21	16.21	10	-61.7
Tank I	9.66	9.66	9.63	-99.7
N175	811.65	811.65	0	0

Run Log for 2006 run at 14:56:05 on 11/10/2006
The maximum flow exceeded the safe value in the following overflow routes: DetentionOF

The following detention basins have little effect (less than 2%) in reducing peak discharge: Tank J, Tank E, Tank K You might consider upsizing these, or removing them from the model.

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N105	20.21		0.052				
N99	20.21		0				
N14	20.15		0				
N104	22.11		0				
N103	20.21		0				
N100	22.43		0				
N9	10.39		0				
UndevOut	9.39		0				
N17	20.11		0				
N18	20.11		0				
N19	10.55		0				
DevOut	9.55		0				

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
B Auto	0.068	0.068	0	5	1	1	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
D Ferrous	0.228	0.228	0	5	1	1	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
C Non Ferrous	0.134	0.134	0	5	1	1	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
A Balance Site	1.455	1.257	0.198	8	7	1	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
Undeveloped	1.046	0.102	1	6.3	12.76	11.54	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
Developed	1.985	1.301	0.687	7.67	8.12	11.54	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
K	0.126	0.126	0	5	1	1	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
E	0.134	0.134	0	5	1	1	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
J	0.2	0.2	0	5	1	1	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
F	0.024	0.024	0	5	1	1	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
G	0.023	0.023	0	5	1	1	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
H	0.019	0.019	0	5	1	1	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
I	0.011	0.011	0	5	1	1	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1

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
Pipe156	0.068	0.2	20.209	20.209	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
Pipe10	1.885	3.5	20.209	20.151	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
P50	1.885	4.3	20.151	20.111	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
Pipe155	0.228	6.3	22.112	20.209	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
Pipe154	0.134	0.3	20.209	20.209	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
Pipe153	1.455	5.6	22.425	20.209	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
Pipe5	1.046	3.3	10.389	9.389	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
P14	0	0	20.111	20.111	AR&R 5 year, 5 minutes storm, average 145 mm/h, Zone 1
Pipe46	0	0	20.111	20.111	AR&R 5 year, 5 minutes storm, average 145 mm/h, Zone 1
P17	1.985	3.9	10.555	9.555	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	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 Storm
DetentionOF	1.16	1.16	7.665	0.093	0.09	22.59	0.99	AR&R 5 year, 1.5 hours storm, average 36.2 mm/h, Zone 1
Ult Flow	1.416	1.416	11.007	0.062	0.15	16.48	2.45	AR&R 5 year, 1.5 hours storm, average 36.2 mm/h, Zone 1
OF K	0.126	0.126	7.665	0.038	0.02	11.63	0.53	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
OF E	0.134	0.134	7.665	0.039	0.02	11.81	0.54	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
OF J	0.2	0.2	7.665	0.045	0.03	13.07	0.61	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
OF81	0.024	0.024	7.665	0.02	0.01	6.74	0.35	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
OF G	0.023	0.023	7.665	0.02	0.01	6.74	0.33	AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1
OF H	0.018	0.018	7.665	0.018	0.01	6.14	0.31	AR&R 5 year, 1.5 hours storm, average 36.2 mm/h, Zone 1
OF I	0.003	0.003	7.665	0.009	0	3.14	0.23	AR&R 5 year, 1 hour storm, average 46.3 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin20	20.11	1422.8	1.16	0	1.16
Tank K	27.18	10.4	0.126	0	0.126
Tank E	27.19	10.4	0.134	0	0.134
Tank J	27.22	10.5	0.2	0	0.2
Tank F	22.63	10.1	0.024	0	0.024
Tank G	22.63	10.1	0.023	0	0.023
Tank H	22.63	10.1	0.018	0	0.018
Tank I	22.61	10	0.003	0	0.003

CONTINUITY CHECK for AR&R 5 year, 25 minutes storm, average 74 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
N105	50.54	50.54	0	0
N99	1481.54	1481.54	0	0
N14	1481.54	1481.54	0	0
Basin20	1481.54	1481.54	1278.83	-86.3
N104	170.02	170.02	0	0
N103	100.03	100.03	0	0
N100	1160.95	1160.95	0	0
N9	879.57	879.57	0	0
UndevOut	879.57	879.57	0	0
N17	0	0	0	0
N18	0	0	0	0
N19	1629.74	1629.74	0	0
DevOut	1629.74	1629.74	0	0
UltOut	535.84	535.84	0	0
Tank K	93.98	93.98	10	-10.6
Tank E	99.94	99.94	10	-10
Tank J	149.17	149.17	10	-6.7
Tank F	17.6	17.6	10	-56.8
Tank G	17	17	10	-58.8
Tank H	14.02	14.02	10	-71.3
Tank I	8.35	8.35	8.34	-99.8
N175	535.81	535.81	0	0

Run Log for 2006 run at 14:55:01 on 11/10/2006

The following detention basins have little effect (less than 2%) in reducing peak discharge: Tank G, Tank F, Tank J, Tank E, Tank K You might consider upsizing these, or removing them from the model.

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N105	20.34		0.073				
N99	20.34		0				
N14	20.24		0				
N104	22.12		0				
N103	20.34		0.145				
N100	22.47		0				
N9	10.5		0				
UndevOut	9.5		0				
N17	20.17		0				
N18	20.17		0				
N19	10.61		0				
DevOut	9.61		0				

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
B Auto	0.077	0.077	0	5	1	1	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
D Ferrous	0.259	0.259	0	5	1	1	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
C Non Ferrous	0.153	0.153	0	5	1	1	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
A Balance Site	1.655	1.427	0.228	8	7	1	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
Undeveloped	1.618	0.141	1.535	6.04	12.17	11.02	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
Developed	2.318	1.49	0.831	7.34	7.77	11.02	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
K	0.143	0.143	0	5	1	1	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
E	0.152	0.152	0	5	1	1	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
J	0.228	0.228	0	5	1	1	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
F	0.027	0.027	0	5	1	1	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
G	0.026	0.026	0	5	1	1	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
H	0.021	0.021	0	5	1	1	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
I	0.013	0.013	0	5	1	1	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1

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
Pipe156	0.077	0.3	20.34	20.338	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
Pipe10	2.144	4	20.338	20.242	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
P50	2.144	4.9	20.242	20.17	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
Pipe155	0.259	6.4	22.12	20.338	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
Pipe154	0.153	0.3	20.34	20.338	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
Pipe153	1.655	5.7	22.466	20.338	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
Pipe5	1.618	3.7	10.497	9.497	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
P14	0	0	20.17	20.17	AR&R 10 year, 5 minutes storm, average 163 mm/h, Zone 1
Pipe46	0	0	20.17	20.17	AR&R 10 year, 5 minutes storm, average 163 mm/h, Zone 1
P17	2.318	4	10.606	9.606	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	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 Storm
DetentionOF	1.576	1.576	0.381	0.221	0.29	12.79	1.31	AR&R 10 year, 1.5 hours storm, average 41.2 mm/h, Zone 1
Ult Flow	1.948	1.948	0.81	0.071	0.19	18.28	2.65	AR&R 10 year, 1.5 hours storm, average 41.2 mm/h, Zone 1
OF K	0.143	0.143	0.256	0.04	0.02	11.99	0.55	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
OF E	0.152	0.152	0.256	0.041	0.02	12.17	0.56	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
OF J	0.226	0.226	0.256	0.047	0.03	13.43	0.64	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
OF81	0.027	0.027	0.256	0.021	0.01	7.03	0.36	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
OF G	0.026	0.026	0.256	0.021	0.01	7.03	0.35	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
OF H	0.021	0.021	0.256	0.019	0.01	6.44	0.34	AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1
OF I	0.016	0.016	0.256	0.018	0.01	5.84	0.32	AR&R 10 year, 5 minutes storm, average 163 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin20	20.17	1455.6	1.576	0	1.576
Tank K	27.19	31.3	0.143	0	0.143
Tank E	27.2	31.3	0.152	0	0.152
Tank J	27.23	52.9	0.226	0	0.226
Tank F	22.63	1	0.027	0	0.027
Tank G	22.63	1	0.026	0	0.026
Tank H	22.63	1	0.021	0	0.021
Tank I	22.62	1	0.016	0	0.016

CONTINUITY CHECK for AR&R 10 year, 25 minutes storm, average 84 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
N105	57.6	57.6	0	0
N99	1697.99	1697.99	0	0
N14	1697.99	1690.02	0	0.5
Basin20	1690.02	1690.02	1278.84	-75.7
N104	193.77	193.77	0	0
N103	114	114	0	0
N100	1332.62	1332.62	0	0
N9	1331.58	1331.58	0	0
UndevOut	1331.58	1331.58	0	0
N17	0	0	0	0
N18	0	0	0	0
N19	1901.98	1901.98	0	0
DevOut	1901.98	1901.98	0	0
UltOut	754.9	754.9	0	0
Tank K	107.1	107.1	30	-28
Tank E	113.9	113.9	30	-26.3
Tank J	170	170	50	-29.4
Tank F	20.06	20.06	1	-5
Tank G	19.38	19.38	1	-5.2
Tank H	15.98	15.98	1	-6.3
Tank I	9.52	9.52	1	-10.5
N175	754.86	754.86	0	0

Run Log for 2006 run at 14:53:09 on 11/10/2006
The maximum flow exceeded the safe value in the following overflow routes: Ult Flow, DetentionOF

The following detention basins have little effect (less than 2%) in reducing peak discharge: Tank I, Tank H, Tank G, Tank F, Tank J, Tank E, Tank K You might consider upsizing these, or removing them from the model.

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N105	20.5		0.085				
N99	20.5		0				
N14	20.34		0				
N104	22.13		0				
N103	20.5		0.168				
N100	22.52		0				
N9	10.57		0				
UndevOut	9.57		0				
N17	20.23		0				
N18	20.23		0				
N19	10.66		0				
DevOut	9.66		0				

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
B Auto	0.088	0.088	0	5	1	1	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
D Ferrous	0.296	0.296	0	5	1	1	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
C Non Ferrous	0.174	0.174	0	5	1	1	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
A Balance Site	1.896	1.631	0.265	8	7	1	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
Undeveloped	2.061	0.163	1.94	5.78	11.59	10.5	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
Developed	2.733	1.72	1.014	7.01	7.41	10.5	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
K	0.164	0.164	0	5	1	1	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
E	0.174	0.174	0	5	1	1	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
J	0.26	0.26	0	5	1	1	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
F	0.031	0.031	0	5	1	1	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
G	0.03	0.03	0	5	1	1	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
H	0.024	0.024	0	5	1	1	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
I	0.015	0.015	0	5	1	1	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1

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
Pipe156	0.088	0.3	20.5	20.497	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
Pipe10	2.454	4.6	20.497	20.342	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
P50	2.454	5.6	20.342	20.226	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
Pipe155	0.296	6.7	22.129	20.497	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
Pipe154	0.174	0.4	20.501	20.497	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
Pipe153	1.896	5.8	22.52	20.497	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
Pipe5	2.061	3.9	10.567	9.567	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
P14	0	0	20.226	20.226	AR&R 20 year, 5 minutes storm, average 187 mm/h, Zone 1
Pipe46	0	0	20.226	20.226	AR&R 20 year, 5 minutes storm, average 187 mm/h, Zone 1
P17	2.733	4.3	10.661	9.661	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	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 Storm
DetentionOF	2.004	2.004	2.207	0.236	0.34	12.79	1.44	AR&R 20 year, 1.5 hours storm, average 47.7 mm/h, Zone 1
Ult Flow	2.55	2.55	11.007	0.079	0.23	19.9	2.87	AR&R 20 year, 1.5 hours storm, average 47.7 mm/h, Zone 1
OF K	0.163	0.163	7.665	0.042	0.02	12.35	0.58	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
OF E	0.173	0.173	7.665	0.043	0.03	12.53	0.59	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
OF J	0.258	0.258	7.665	0.05	0.03	13.97	0.67	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
OF81	0.031	0.031	7.665	0.023	0.01	7.63	0.35	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
OF G	0.03	0.03	7.665	0.022	0.01	7.33	0.37	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
OF H	0.024	0.024	7.665	0.021	0.01	7.03	0.33	AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1
OF I	0.017	0.017	7.665	0.018	0.01	6.14	0.3	AR&R 20 year, 5 minutes storm, average 187 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin20	20.23	1486.5	2.004	0	2.004
Tank K	27.2	31.4	0.163	0	0.163
Tank E	27.21	31.5	0.173	0	0.173
Tank J	27.24	53.2	0.258	0	0.258
Tank F	22.64	1	0.031	0	0.031
Tank G	22.64	1	0.03	0	0.03
Tank H	22.63	1	0.024	0	0.024
Tank I	22.62	1	0.017	0	0.017

CONTINUITY CHECK for AR&R 20 year, 25 minutes storm, average 96 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Cl (cu.m)	Difference %
N105	66.07	66.07	0	0
N99	1957.8	1957.03	0	0
N14	1957.03	1941.91	0	0.8
Basin20	1941.91	1941.91	1278.85	-65.9
N104	222.26	222.26	0	0
N103	130.77	130.77	0	0
N100	1538.7	1538.7	0	0
N9	1655.43	1655.43	0	0
UndevOut	1655.43	1655.43	0	0
N17	0	0	0	0
N18	0	0	0	0
N19	2228.81	2228.81	0	0
DevOut	2228.81	2228.81	0	0
UltOut	1073.9	1073.9	0	0
Tank K	122.85	122.85	30	-24.4
Tank E	130.65	130.65	30	-23
Tank J	195	195	50	-25.6
Tank F	23.01	23.01	1	-4.3
Tank G	22.23	22.23	1	-4.5
Tank H	18.33	18.33	1	-5.5
Tank I	10.92	10.92	1	-9.2
N175	1073.85	1073.85	0	0

Run Log for 2006 run at 14:51:50 on 11/10/2006

The following detention basins have little effect (less than 2%) in reducing peak discharge: Tank I, Tank H, Tank G, Tank F, Tank J, Tank E, Tank K You might consider upsizing these, or removing them from the model.

PIT / NODE DETAILS

Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N105	20.61		0.092				
N99	20.6		0				
N14	20.41		0				
N104	22.14		0				
N103	20.61		0.183				
N100	22.56		0				
N9	10.64		0				
UndevOut	9.64		0				
N17	20.26		0				
N18	20.26		0				
N19	10.7		0				
DevOut	9.7		0				

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
B Auto	0.097	0.097	0	5	1	1	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
D Ferrous	0.328	0.328	0	5	1	1	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
C Non Ferrous	0.193	0.193	0	5	1	1	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
A Balance Site	2.062	1.78	0.289	8	7	1	AR&R 50 year, 20 minutes storm, average 126 mm/h, Zone 1
Undeveloped	2.592	0.18	2.452	5.28	10.5	9.52	AR&R 50 year, 20 minutes storm, average 126 mm/h, Zone 1
Developed	3.007	1.852	1.157	6.63	7.01	9.9	AR&R 50 year, 25 minutes storm, average 113 mm/h, Zone 1
K	0.181	0.181	0	5	1	1	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
E	0.193	0.193	0	5	1	1	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
J	0.288	0.288	0	5	1	1	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
F	0.034	0.034	0	5	1	1	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
G	0.033	0.033	0	5	1	1	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
H	0.027	0.027	0	5	1	1	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
I	0.016	0.016	0	5	1	1	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1

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
Pipe156	0.097	0.3	20.606	20.602	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
Pipe10	2.647	5	20.602	20.406	AR&R 50 year, 15 minutes storm, average 144 mm/h, Zone 1
P50	2.647	6	20.406	20.258	AR&R 50 year, 15 minutes storm, average 144 mm/h, Zone 1
Pipe155	0.328	6.8	22.136	20.602	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
Pipe154	0.193	0.4	20.607	20.602	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
Pipe153	2.062	5.9	22.558	20.602	AR&R 50 year, 20 minutes storm, average 126 mm/h, Zone 1
Pipe5	2.592	4.2	10.642	9.642	AR&R 50 year, 20 minutes storm, average 126 mm/h, Zone 1
P14	0	0	20.258	20.258	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
Pipe46	0	0	20.258	20.258	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
P17	3.007	4.4	10.705	9.705	AR&R 50 year, 25 minutes storm, average 113 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	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 Storm
DetentionOF	2.263	2.263	0.381	0.244	0.37	12.79	1.51	AR&R 50 year, 1.5 hours storm, average 56 mm/h, Zone 1
Ult Flow	2.901	2.901	0.81	0.084	0.25	20.79	2.96	AR&R 50 year, 1.5 hours storm, average 56 mm/h, Zone 1
OF K	0.177	0.177	0.256	0.044	0.03	12.71	0.58	AR&R 50 year, 15 minutes storm, average 144 mm/h, Zone 1
OF E	0.188	0.188	0.256	0.044	0.03	12.89	0.6	AR&R 50 year, 15 minutes storm, average 144 mm/h, Zone 1
OF J	0.28	0.28	0.256	0.052	0.03	14.33	0.68	AR&R 50 year, 15 minutes storm, average 144 mm/h, Zone 1
OF81	0.035	0.035	0.256	0.024	0.01	7.93	0.37	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
OF G	0.033	0.033	0.256	0.023	0.01	7.63	0.38	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
OF H	0.028	0.028	0.256	0.022	0.01	7.33	0.34	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1
OF I	0.017	0.017	0.256	0.018	0.01	6.14	0.3	AR&R 50 year, 5 minutes storm, average 219 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin20	20.26	1504.2	2.263	0	2.263
Tank K	27.21	31.5	0.177	0	0.177
Tank E	27.21	31.5	0.188	0	0.188
Tank J	27.25	53.3	0.28	0	0.28
Tank F	22.64	1	0.035	0	0.035
Tank G	22.64	1	0.033	0	0.033
Tank H	22.63	1	0.028	0	0.028
Tank I	22.62	1	0.017	0	0.017

CONTINUITY CHECK for AR&R 50 year, 20 minutes storm, average 126 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
N105	69.45	69.45	0	0
N99	2067.61	2066.33	0	0.1
N14	2066.33	2047.91	0	0.9
Basin20	2047.91	2047.91	1278.76	-62.4
N104	233.66	233.66	0	0
N103	137.47	137.47	0	0
N100	1627.02	1627.02	0	0
N9	1857.04	1857.04	0	0
UndevOut	1857.04	1857.04	0	0
N17	0	0	0	0
N18	0	0	0	0
N19	2380.65	2380.65	0	0
DevOut	2380.65	2380.65	0	0
UltOut	1207.01	1207.01	0	0
Tank K	129.15	129.15	30	-23.2
Tank E	137.35	137.35	30	-21.8
Tank J	205	205	50	-24.4
Tank F	24.19	24.19	1	-4.1
Tank G	23.37	23.37	1	-4.3
Tank H	19.27	19.27	1	-5.2
Tank I	11.48	11.48	1	-8.7
N175	1206.97	1206.97	0	0

Run Log for 2006 run at 14:49:51 on 11/10/2006
The maximum flow exceeded the safe value in the following overflow routes: Ult Flow, OF J, DetentionOF

The following detention basins have little effect (less than 2%) in reducing peak discharge: Tank I, Tank H, Tank G, Tank F You might consider upsizing these, or removing them from the model.

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N105	20.74		0.106				
N99	20.73		0				
N14	20.48		0				
N104	22.14		0				
N103	20.74		0.206				
N100	23.28		2.294				
N9	10.7		0				
UndevOut	9.7		0				
N17	20.29		0				
N18	20.29		0				
N19	10.78		0				
DevOut	9.78		0				

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
B Auto	0.108	0.108	0	5	1	1	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
D Ferrous	0.364	0.364	0	5	1	1	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
C Non Ferrous	0.214	0.214	0	5	1	1	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
A Balance Site	2.294	1.978	0.324	8	7	1	AR&R 100 year, 20 minutes storm, average 140 mm/h, Zone 1
Undeveloped	2.996	0.202	2.842	5.11	10.11	9.17	AR&R 100 year, 20 minutes storm, average 140 mm/h, Zone 1
Developed	3.422	2.081	1.341	6.39	6.75	9.52	AR&R 100 year, 25 minutes storm, average 126 mm/h, Zone 1
K	0.201	0.201	0	5	1	1	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
E	0.214	0.214	0	5	1	1	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
J	0.319	0.319	0	5	1	1	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
F	0.038	0.038	0	5	1	1	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
G	0.036	0.036	0	5	1	1	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
H	0.03	0.03	0	5	1	1	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
I	0.018	0.018	0	5	1	1	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1

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
Pipe156	0.108	0.4	20.74	20.735	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
Pipe10	2.94	5.5	20.735	20.485	AR&R 100 year, 15 minutes storm, average 160 mm/h, Zone 1
P50	2.94	6.7	20.485	20.293	AR&R 100 year, 15 minutes storm, average 160 mm/h, Zone 1
Pipe155	0.364	7	22.144	20.735	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
Pipe154	0.214	0.5	20.741	20.735	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
Pipe153	2.294	5.2	23.281	20.735	AR&R 100 year, 20 minutes storm, average 140 mm/h, Zone 1
Pipe5	2.996	4.4	10.703	9.703	AR&R 100 year, 20 minutes storm, average 140 mm/h, Zone 1
P14	0	0	20.293	20.293	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
Pipe46	0	0	20.293	20.293	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
P17	3.422	4.4	10.777	9.777	AR&R 100 year, 25 minutes storm, average 126 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	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 Storm
DetentionOF	2.564	2.564	2.207	0.253	0.4	12.79	1.59	AR&R 100 year, 1.5 hours storm, average 63 mm/h, Zone 1
Ult Flow	3.29	3.29	11.007	0.088	0.27	21.69	3.06	AR&R 100 year, 1.5 hours storm, average 63 mm/h, Zone 1
OF K	0.196	0.196	7.665	0.045	0.03	13.07	0.6	AR&R 100 year, 15 minutes storm, average 160 mm/h, Zone 1
OF E	0.209	0.209	7.665	0.046	0.03	13.25	0.62	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
OF J	0.311	0.311	7.665	0.054	0.04	14.87	0.69	AR&R 100 year, 15 minutes storm, average 160 mm/h, Zone 1
OF81	0.038	0.038	7.665	0.025	0.01	8.23	0.38	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
OF G	0.037	0.037	7.665	0.024	0.01	7.93	0.39	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
OF H	0.031	0.031	7.665	0.023	0.01	7.63	0.35	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1
OF I	0.018	0.018	7.665	0.018	0.01	6.14	0.32	AR&R 100 year, 5 minutes storm, average 242 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin20	20.29	1523.8	2.564	0	2.564
Tank K	27.22	31.6	0.196	0	0.196
Tank E	27.22	31.7	0.209	0	0.209
Tank J	27.26	53.6	0.311	0	0.311
Tank F	22.64	1	0.038	0	0.038
Tank G	22.64	1	0.037	0	0.037
Tank H	22.64	1	0.031	0	0.031
Tank I	22.63	1	0.018	0	0.018

CONTINUITY CHECK for AR&R 100 year, 20 minutes storm, average 140 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
N105	77.36	77.36	0	0
N99	2310.17	2306.27	0	0.2
N14	2306.27	2284.68	0	0.9
Basin20	2284.68	2284.68	1278.76	-56
N104	260.25	260.25	0	0
N103	153.12	153.12	0	0
N100	1819.44	1819.44	0	0
N9	2161.64	2161.64	0	0
UndevOut	2161.64	2161.64	0	0
N17	0	0	0	0
N18	0	0	0	0
N19	2686.5	2686.5	0	0
DevOut	2686.5	2686.5	0	0
UltOut	1506.35	1506.35	0	0
Tank K	143.85	143.85	30	-20.9
Tank E	152.98	152.98	30	-19.6
Tank J	228.33	228.33	50	-21.9
Tank F	26.94	26.94	1	-3.7
Tank G	26.03	26.03	1	-3.8
Tank H	21.46	21.46	1	-4.7
Tank I	12.79	12.79	1	-7.8
N175	1506.32	1506.32	0	0

Run Log for 2006 run at 14:48:51 on 11/10/2006
The maximum flow exceeded the safe value in the following overflow routes: DetentionOF

The following detention basins have little effect (less than 2%) in reducing peak discharge: Tank I, Tank H, Tank G, Tank F You might consider upsizing these, or removing them from the model.

APPENDIX B

COPA WATER REPORT AND DRAWINGS

CDS MEDIA FILTRATION SYSTEM
PERFORMANCE REVIEW SUMMARY

CDS Technologies, Inc.

CDS Technologies, Inc. developed the Media Filtration System in Early 2003 and immediately embarked upon laboratory and field verification of the system. Field verification was performed according to the Washington State Department of Ecology's Technology Assessment Protocol – Ecology (TAPE) program and the New Jersey Corporation for Advanced Technology (NJCAT) program. These two programs have been developed with rigorous testing protocols and are recognized as national programs which provide equivalent testing environments for various storm water Best Management Practices, such as the CDS Media Filtration System. The WSDOE field program was completed in May 2006, while sampling is still under way to fulfill the requirements of the NJCAT program.

CDS Technologies, Inc. has prepared this summary of the results of the successful monitoring effort as a submittal document for jurisdictions throughout the US and Australia. This document provides the laboratory and field performance data in the interest of obtaining approval of the CDS Media Filtration System (MFS) from regulators and engineers interested in treating storm water through media filtration. The laboratory and third-party verified field data confirm removal rates of better than 80% for typical concentration of TSS through the CDS MFS.

Sediment is a surrogate for pollutants such as oil and grease, nutrients, Total Phosphorus and heavy metals in storm water. Pollutants such as these attach to sediments and are typically removed in greater quantities with the high removals of TSS. To verify this relationship, CDS collected and engaged Test America Laboratory, of Beaverton, OR in analyzing, samples from the two Pacific Northwest field test sites for reductions in Total Phosphorous and Heavy Metals form the two field test sites. Field and laboratory testing verified 65% removal of Total Phosphorous. Field testing verified average removals of Total Metals (Chromium, CR; Zinc, Zn; Copper, Cu; and Lead, Pb) ranging from 51.9% - 70.9%.

The full laboratory and field performance results are reported first in this document followed by a description of the Media Filter Systems including function, operation, installation and benefits and advances of the CDS MFS compared to other cartridge systems.

PERFORMANCE

Laboratory Testing – Sediment

The CDS Media filter cartridge when tested using Perlite as the filter media achieved >80% removal of suspended solids measured by the TSS/SSC method of analysis at flow rates ranging from 50 to 125% of the design hydraulic loading rate. Laboratory testing of the CDS MFS confirmed that 80% removal of particles with a mean particle size of 19 µm and single grain specific gravity of 2.65, was achieved at 15-gpm per 18"-diameter by 22" tall cartridge.

Sil-Co-Sil 106 silica sediment was used in these laboratory evaluations per the Technology Assessment Protocol – Ecology (TAPE) as defined by the Washington State Department of Ecology's Guidance for Evaluating Emerging Stormwater Treatment. This Sil-Co-Sil 106 evaluation test material consists of a much finer Particle Size Distribution (PSD) than the suspended solid and sediment material typically found in storm water or deposited in urban areas throughout the United States and the rest of the world, see Table 1 below.

Particle Size Distribution microns (µm)	Percent Finer
< 150	100%
106 - 150	99.90%
75 - 106	98%
50 - 75	93%
10 - 50	80%
10	30%

Table 1
Sil-Co-Sil 106 silica Particle Size Distribution

In an effort to confirm the U.S. Silica Company's particle size distribution, an independent analysis was performed by Louisiana State University. This analysis confirms that the particles tested in the CDS lab match the sizes as documented from U.S. Silica company, within the accuracy normally found for this work.

Particles smaller than 50-µm constitute above 80% of this material and 50% of the material is smaller than 25-µm. Figure 1 shows the PSD of the Sil-Co-Sil 106 silica TSS / Sediment plotted along with 23 field evaluations of Particle Size Distributions of Suspended Solids and sediment found in urban and road storm water runoff or deposited on the streets, Walker, et al.

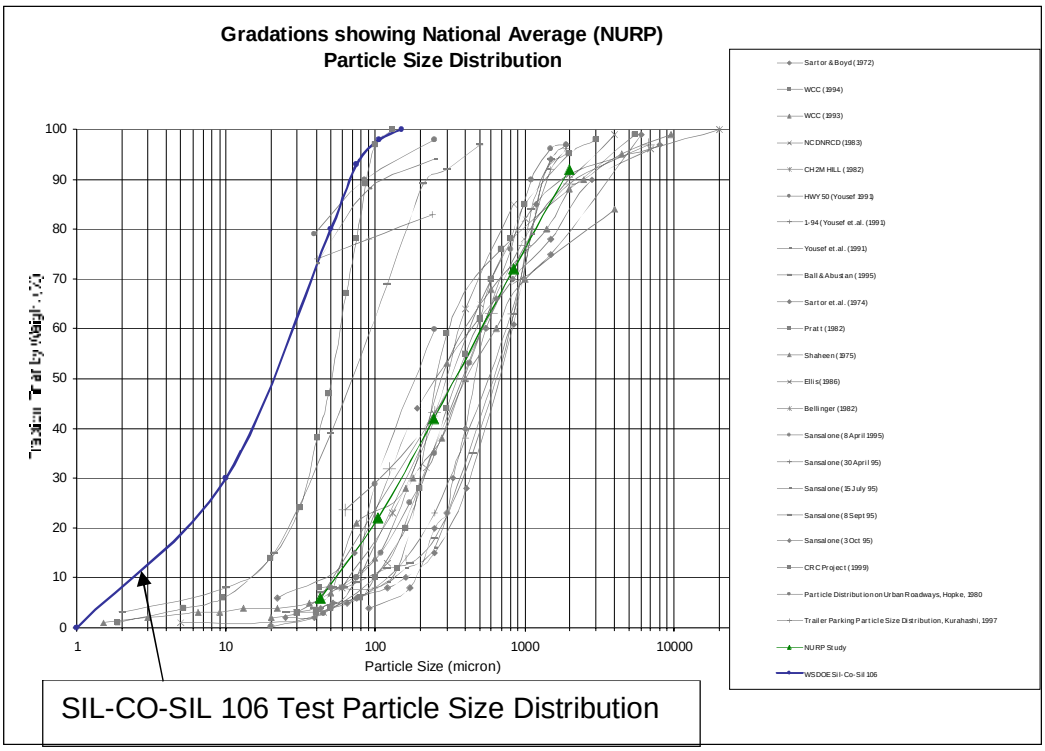


Figure 1. Particle Size Distribution of Solids Found on Street and Suspended in Road Runoff

Cursory review for the PSD curve plots on Figure 1 readily shows that the Sil-Co-Sil 106 silica PSD used in the WASDOE evaluation protocol is a conservative PSD.

The laboratory tests were run using a cartridge filter 18-inches in diameter and 21-inches in height, influent TSS concentrations ranging from 110–184 milligrams per liter (mg/l) and at flow rates in the range of 7.29-gpm to 18.45-gpm. A total of twenty three (23) laboratory test run data are shown in Figure 3. Six (6) of these tests were conducted using the solid materials collected from a CDS unit positioned upstream of the Media Filtration System. The sediment

PSD analysis showed that CDS upstream manhole materials are even finer particles compared to Sil-Col-Sil 106 (Figure 2).

From the 23 laboratory results, a regression curve was developed for the TSS removal as a function of flow rate, shown in Figure 3. A good regression correlation coefficient of 0.80 was obtained. The removal efficiency at any flow rate conditions in the range of 7.29-gpm to 18.45-gpm could be interpolated using the equation derived from these data. The average TSS removal at flow rate of 15-gpm for solids with a gradation ranging in size from 1-micron to 106-microns, for the PERLITE media filter is 80%. Testing results also show that the cartridge height should be established at 75% of the available head, with cartridge heights varying from 12 to 22-inches.

Figure 2. Tested Material PSD comparison
Sil-Col-Sil 106 & CDS upstream manhole material

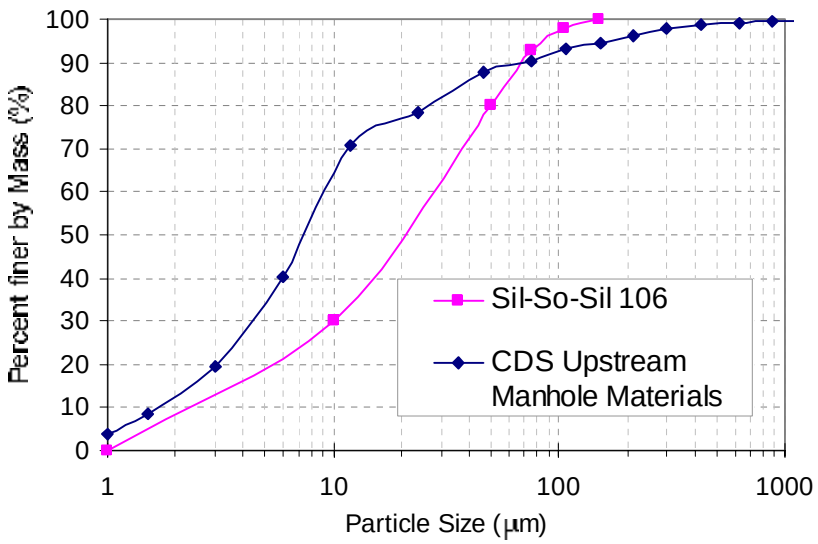
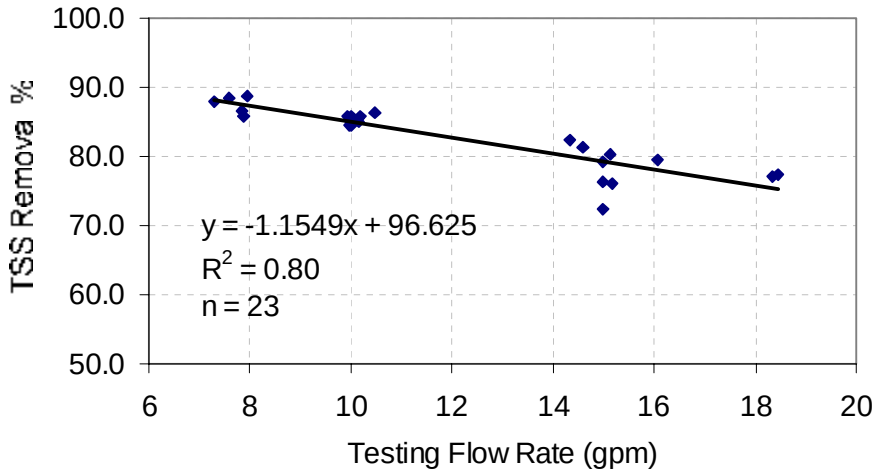


Figure 3. Media Filtration System Laboratory Data
Total Suspended Solids (TSS) Removal
Standard Cartridge (18" Diameter 22" Depth)



The laboratory testing program confirmed the cartridge filter's effectiveness to achieve removal of very fine particles. The PSD data found:

- 50% of the particles in the effluent were < 3.67 µm (microns) and 80% < 7.11-µm when the system operated at 50% (7.5-gpm) of the design capacity
- 50% of the particles in the effluent were < 5.11 µm and 80% < 11.7-µm when operated at 67% (10-gpm) of the design capacity
- 50% of the particles in the effluent were < 7.11 µm and 80% < 22.7-µm when operated at the design capacity of 15-gpm
- 50% of the particles in the effluent were < 6.03-µm and 80% < 19.2-µm when operated at 125% of the design capacity

For reference, Bacteria ranges in size from 0.4 µm – 25 µm; silt size particles range from 25 µm – 75 µm; Medium sands range from 75 µm – 425 µm, with coarse sediment above this range.

Laboratory Testing - Phosphorous

The test material selected for the Phosphorous testing portion of the laboratory program is sediment gathered from Hanson Concrete products in Portland, Oregon. Wet samples of the sediment were dried and processed at Portland State University to obtain a uniform particle gradation. Analysis of the dry sediment by Test America (formerly North Creek Analytical, Inc.) of Beaverton, Oregon found Total Phosphorous concentrations of 1090 and 1080 mg/kg. Analysis of this material by Soil Control Lab of Watsonville, California for particle size confirmed that it was comparable to Sil-Co-Sil 106 specified by the State of Washington Department of Ecology (WSDOE) for full–scale laboratory studies for evaluating emerging storm water treatment technologies. The gradation of this material is extremely fine, with 87.4% silt size (31-62 microns) and smaller and single grain specific gravity of 2.34. The full distribution is shown in Table 2 below.

Table 2
Particle Size Distribution
Of Total Solids Used for CDS Phosphorous Removal Tests

Particle Size Distribution microns (µm)	Percentage of Total
< 1000	99%
< 500	97%
< 180	93%
< 62	74%
< 37	16%
< 4	8%

The testing program was performed in a laboratory setting having a water delivery capability to fully test and evaluate the hydraulic characteristics of the cartridge filter system.

The testing program conducted in February of 2004, followed the protocol set forth in the Washington Department of Ecology Technology Assessment Protocol – Ecology (TAPE). In addition to the required testing and analysis, particle size analysis on the effluent was performed. Testing TSS and Total Phosphorus removal results from the Hanson solids are summarized in Table 3.

Table 3

Total Suspended Solids and Total Phosphorous Removal Efficiencies

Flow Rate gpm	TSS Feed Rate mg/l	TSS Removal Efficiency, %	TP Feed Rate mg/l	**TP Removal Efficiency, %**
7.5	100.4	85.5	0.109	**72.2**
	310.4	91.7	0.338	**84.2**
	533.2	87.1	0.581	**81.1**
10	108.9	84.5	0.118	**79.4**
	320.0	85.8	0.349	**81.7**
	498.4	84.9	0.543	**81.1**
15	111.5	79.1	0.122	**82.4**
	321.3	80.3	0.350	**75.0**
	539.6	76.0	0.588	**72.8**

PERFORMANCE RESULTS – FIELD EVALUATION

Field Results– Sediment

Field testing of the CDS MFS in accordance with a Quality Assurance Project Plan (QAPP) approved by WSDOE, was conducted at two sites starting December 2005. This field testing was performed to substantiate the removals observed in the laboratory setting. The carefully planned and executed monitoring program demonstrated that CDS MFS performance in the field operation satisfied the Ecology specified treatment performance goals for basic (TSS) treatment, which are:

- *80% removal of total suspended solids for influent concentrations that are greater than 100 mg/L, but less than 300 mg/L;*
- *and/or an effluent of less than 20 mg/L total suspended solids for influent concentrations less than 100 mg/L.*

This performance data typically allows for approval of the CDS MFS at flow rates ranging from 9-gpm per cartridge to 20-gpm cartridge depending upon the Hydrology model specified by the jurisdiction.

The field monitoring and sampling was conducted using advanced monitoring and data logging equipment to measure and record;

- Rainfall
- Runoff flow rates
- Water depth in the system to determine the hydraulic profile in the system.

Laboratory analyses of collected flow weighted samples were performed for:

- Total suspended solids (TSS)
- Total Chromium (Cr)
- Total Cadmium (Cd)
- Total Copper (Cu)
- Total Lead (Pb)
- Total Zinc (Zn)
- Total Phosphorous (TP) and,
- Particle Size Distribution (PSD)

In addition to basic treatment removal of TSS, the system definitively demonstrated a capacity to remove quantifiable amounts total phosphorous and total metal (Cr, Cu, Pb and Zn), water quality constituents associated with solid mass. The field monitoring of the MFS confirmed the reliability and robustness of the system.

It should be noted, that the CDS Technologies, Inc. funded field monitoring effort is independent third-party verified. The Portland, OR office of Herrera Environmental was involved in every step of the monitoring program. Mr. Matt Brennan, PE, Project Manager for Herrera Environmental, participated in preparing the Quality Assurance Project Plan and equipment verification at the beginning of the monitoring program. Additionally, Herrera Environmental retrieved and split each sample using a Dekaport Cone sample splitter.

Herrera Environmental prepared flow weighted samples and transported the samples to Test America (formerly North Creek Analytical) in Beaverton, OR. Herrera received all results from Test America and downloaded all flow, rainfall and vault depth data from the data logger monitoring equipment installed at each site. The results from these field evaluations were reported to CDS in detailed tabular format from Herrera Environmental and directly used in the full field report submitted to WSDOE and presented here. Each of the over 97 samples

transported to Test America was analyzed using the SSC (suspended sediment concentration) method of analysis.

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The field evaluations were conducted on two separate (2) Media Filtration Systems. One of these MFS units was in installed in Hillsboro, Oregon on the Hillsboro-Silverton Highway. This highway is owned by the Oregon Department of Transportation and is a high traffic road serving industrial and commercial businesses. The second unit was installed in Zigzag, Oregon on Lolo Pass Road, at the foothills of Mt. Hood. Lolo Pass road sees light to medium traffic and serves residential housing. These field tests evaluated the treatment performance and confirmed the functionality of the Media Filtration System. Both systems were designed as in-line bypass systems. Throughout this report the two sites will be referred to as the Silverton Highway, Hillsboro and the Lolo Pass, Zigzag sites respectively.

At the Silverton Highway, Hillsboro site, water quality monitoring was initiated in late December 2005. This Silverton Highway site flows ranged from 19% - 300% of the design treatment flow rate. At the Lolo Pass, Zigzag site, the monitoring program was started February 2006 and the flow rates challenged the systems with maximum influent flows up to 150% of the systems capacity. Sizing of the CDS MFS should range from 9-gpm to 20-gpm per cartridge, depending upon the jurisdiction and the Hydrology sizing methodology. Storm runoff samples from both sites have been collected and analyzed for water quality parameters in accordance with the Quality Assurance Project Plan (QAPP) and Ecology's TAPE protocol.

97 total storms were captured and analyzed from both sites. 29 storms met the criteria as defined by WSDOE. The criteria for inclusion of a storm event in the table shown on page 9, as the Qualified Storm events, are as follows:

- **Minimum Storm Depth:** 0.15 inches or intensity > 0.03 inch/ hour for influent TSS concentrations > 50 mg/**l**
- **Antecedent Dry Period:** 6-hours
- **Storm Duration:** 1 hour minimum
- **Sample Aliquots:** Five aliquots minimum with coverage of 50% of the storm volume
- **Influent TSS Concentration:** 33 – 300 mg/l

A summary table of TSS treatment performance for the "qualified" monitoring events is presented in Table 4, on the following page.

Table 4: CDS MFS Treatment Performance - Individual Event TSS Concentrations (Qualified Storm Events from Both Monitoring Sites Influent TSS<300-mg/L)

Event ID	Influent EMC > 100 mg/L			Influent EMC < 100 mg/L		
	IN TSS (mg/L)	EFF TSS (mg/L)	Re%	IN TSS (mg/L)	EFF TSS (mg/L)	Re%
H002				78.8	26	67.0
H003	124.0	11.7	90.6			
H007				41.9	15.3	63.5
H008	100.0	28.0	72.0			
H009				95.9	10.4	89.2
H012	107.0	36.0	66.4			
H013				54.7	12.5	77.1
H015				85.8	11.7	86.4
H016				49.6	7.8	84.4
H018	131.0	23.1	82.4			
H022				91.0	69.5	23.6
H024				34.1	15.9	53.4
H025				45.8	8.94	80.5
H026	205.0	29.3	85.7			
H027				60.7	33.7	44.5
H028				79.5	23.2	70.8
H030				52.8	24.9	52.8
H035	141.0	61.2	56.6			
H040				96.5	19.7	79.6
H043				60.6	26.8	55.8
H044				56.4	8.3	85.2
H047				49.0	14.0	71.4
H049	140.0	10.5	92.5			
H050	117.0	8.9	92.4			
H051				35.2	10.7	69.6
H052				34.4	12	65.1
L034	178	24	86.8			
L040-L042				64.3	11.4	84.9
L044	274	15.9	94.2			
	Average EMC (mg/L)			Average EMC (mg/L)		
	IN	EFF		IN	EFF	
	151.70	24.81		61.42	19.09	
	Reduction %	83.6		Reduction %	68.9	

As shown in Table 4, for a total of 29 qualified events from both monitoring sites, the CDS MFS achieved 83.6% TSS removal for the 10 monitored storm events having influent TSS concentrations greater than 100-mg/L but less than 300-mg/L. The average influent TSS concentration for the 10 events was 151.70-

mg/L. For the 19 monitored storm events that had influent TSS concentrations less than 100-mg/L, the average effluent TSS concentration was 19.09-mg/L, less than 20-mg/L. The ≥ 80% average percent TSS removal efficiencies and TSS effluent concentrations ≤ 20-mg/L demonstrate the ability of the MFS unit to achievement Ecology specified basic treatment goals. The particle size gradation of the influent and effluent sediments is still under analysis. Each of the 97 flow weighted samples was analyzed using a Laser In-Situ Scattering and Transmissometry (LISST) particle size analyzer manufactured by Sequoia Scientific, Inc., Bellevue, WA. The D_{20}, D_{50} and D_{80} for each sample will be determined and the results available soon.

Field Results – Phosphorous and Heavy Metals

Studies showed that Phosphorous is partitioned on the solid fraction in the urban rainfall runoff. CDS media filtration system has proved to achieve desired solid removal efficiencies. The following analysis and results show that the particulate bound portion of phosphorous can be efficiently removed from runoff flows through the removal of captured solids with the MFS unit.

Table 5 shows the Total Phosphorous (TP) removal for the events monitored at both sites.

Table 5: Monitored Storm Events TP Removal

Silverton Highway, Hillsboro & Lolo Pass, Zigzag Sites

Event ID	TP		
	Influent mg/L	Effluent mg/L	Re%
L001	0.168	0.062	63.1
L002	0.100	0.057	43.2
L003	0.126	0.072	43.0
L004	0.105	0.033	68.4
L005	0.086	ND	76.7
L006	0.068	0.029	57.6
L007	0.302	0.034	88.8
L008	1.590	ND	93.7
L009	0.378	ND	73.5
L010	0.294	0.137	53.4
L011	0.186	ND	89.2
L012	1.020	ND	90.2
L013	0.324	ND	69.1
L014	0.397	ND	74.8
L015	2.340	ND	95.7
L016	1.140	0.522	54.2
L017	0.870	0.109	87.5
H025	0.037	0.023	37.1
H034	0.248	ND	59.7
H036	0.212	0.039	81.8
H037	0.250	ND	60.0
H038	0.114	ND	82.5
H039	0.242	ND	58.7
H040	0.24	ND	58.3
H041	0.259	ND	61.4
H042	0.568	ND	82.4
H043	0.174	0.118	42.5
H044	0.142	ND	29.6
Avg	*0.43*		*67.0*
std	*0.52*		
cov	*0.82*		

ND – Non detectable, if the concentration is ND, the removal efficiency is calculated using the detection limit reported (0.02-mg/L or 0.1-mg/L).

As demonstrated in Table 5, coefficient of variance of influent TP was 0.82 for a total of 28 events. The averaged removal of TP is 67.0%.

Total Metal Removal

Cr, Cu, Pb and Zn are the most common metal elements identified in urban storm water runoff. Consistent with research findings, the metals are primarily associated with particulate fraction for the analyzed events at the monitoring sites, therefore, by removing the solid particles (TSS), a significant reduction of total metals for these four metal elements (Cr, Cu, Pb and Zn) were achieved in the CDS media filtration system.

Total metal concentration for Cd, Cr, Cu, Pb and Zn were analyzed for the second portion of the monitored events to evaluate MFS treatment performance of metals. Cd concentrations in all the analyzed events were under the detection limit of 0.001-mg/L (1-µg/L) for both influent and effluent samples and were therefore omitted from the results table. The analytical results for the other four metals (Cr, Cu, Pb and Zn) were summarized in Tables 6 and 7.

Table 6: Monitored Storm Event Total Metals Removal

Silverton Highway, Hillsboro Site

Event ID	Cr			Zn			Cu			Pb		
	IN µg/L	EFF µg/L	Re %	IN µg/L	EFF µg/L	Re %	IN µg/L	EFF µg/L	Re %	IN µg/L	EFF µg/L	Re %
H025	1.66	ND	39.76	33.1	21.9	33.84	8.38	3.74	55.37	3.63	1.41	61.16
H034	19	1.12	94.11	107	47.3	55.79	20.3	6.78	66.60	8.77	ND	88.60
H036	5.01	1.87	62.67	84.8	41.7	50.83	17.4	8.96	48.51	8.26	2.43	70.58
H037	7.75	2.27	70.71	126	47.7	62.14	22.7	8.4	63.00	11.9	3.89	67.31
H038	3.23	3.37		50.4	56.4		10.3	11.7		5.04	4.78	
H039	5.65	2.55	54.87	89.8	44.4	50.56	18.9	7.63	59.63	10.1	3.76	62.77
H040	7.65	2.74	64.18	106	45.6	56.98	21.4	9.76	54.39	11.2	3.38	69.82
H041	5.78	1.32	77.16	103	48.2	53.20	20.1	3.51	82.54	9.08	2.36	74.01
H042	12.3	ND	91.87	260	50.4	80.62	37.9	2.94	92.24	19.8	ND	94.95
H043	4.06	3.28	19.21	91.9	112		16.4	13.9	15.24	6.72	4.09	39.14
H044	4.1	2.2	46.34	78.1	59.8	23.43	14.2	9.26	34.79	6.24	2.15	65.54
Avg	***6.9***	***2.3***	***62.1***	***102.7***	***52.3***	***51.9***	***18.9***	***7.9***	***57.2***	***9.2***	***3.1***	***69.4***
Min	*1.7*	*1.1*	*19.2*	*33.1*	*21.9*	*23.4*	*8.4*	*2.9*	*15.2*	*3.6*	*1.4*	*39.1*
Max	*19.0*	*3.4*	*94.1*	*260.0*	*112.0*	*80.6*	*37.9*	*13.9*	*92.2*	*19.8*	*4.8*	*94.9*
std	*4.90*			*58.40*			*7.75*			*4.34*		
cov	*0.71*			*0.57*			*0.41*			*0.47*		

Table 7: Monitored Storm Event Total Metals removal

Lolo Pass, Zigzag Site

Event ID	Cr			Zn			Cu			Pb		
	IN µg/L	EFF µg/L	Re %	IN µg/L	EFF µg/L	Re %	IN µg/L	EFF µg/L	Re %	IN µg/L	EFF µg/L	Re %
L001	ND	ND		71.4	43.7	38.80	15.8	10.4	34.18	7.61	5.07	33.38
L002	4.12	ND	75.73	86.1	43.5	49.48	17.5	9.01	48.51	9.8	3.99	59.29
L003	2.77	1.91	31.05	69	41.7	39.57	16.6	8.6	48.19	8.59	5.01	41.68
L004	1.4	ND	28.57	30.2	20.9	30.79	8.7	3.95	54.44	3.71	1.9	48.79
L005	5.18	1.12	78.38	122	20.9	82.87	24.2	2.52	89.59	16.5	1.56	90.55
L006	1.45	ND	31.03	143	23.7	83.43				35.6	1.9	94.66
L007	2.31	ND	56.71	65.2	23	64.72	16.8	6.53	61.13	6.76	ND	85.21
L008	11.6	ND	91.38	258	37	85.66	50.2	3.17	93.69	68.1	ND	98.53
L009	4.32	ND	76.85	102	25	75.49	20.0	4.18	79.10	11.3	2.07	81.68
L010	3.01	1.87	37.87	67.2	42.7	36.46	13.5	9.65	28.52	8.27	4.98	39.78
L011	2.02	ND	50.50	48.5	2.48	94.89	11.8	8.36	29.15	5.75	3.56	38.09
L012	16.5	ND	93.94	331	52	84.29	59.3	4.29	92.77	40.6	2.08	94.88
L013	6.39	ND	84.35	148	51.7	65.07	28.1	4.54	83.84	14.5	1.25	91.38
L014	7.29	2.26	69.00	118	60.4	48.81	27.0	11.4	57.78	17.2	5.36	68.84
L015	ND	ND		536	62.5	88.34	87.9	7.95	90.96	61.9	1.44	97.67
L016	ND	ND		291	106	63.57	53.9	19	64.75	38.6	14.5	62.44
L017	14.3	ND	93.01	253	59.1	76.64	44.7	11.6	74.05	34.1	3.1	90.91
L022	5.89	2.3	60.95	105	50.8	51.62	19.4	8.46	56.39	15.2	4.47	70.59
L030	7.31	2.2	69.90	156	46.9	69.94	30.6	12.6	58.82	21.6	5.97	72.36
L040	1.66	ND	39.76	40.6	24.3	40.15	10.2	8.26	19.02	5.05	2.18	56.83
Avg	***5.7***	***1.9***	***62.9***	***152.1***	***41.9***	***63.5***	***29.3***	***8.1***	***61.3***	***21.5***	***3.9***	***70.9***
Min	*1.4*	*1.1*	*28.6*	*30.2*	*2.5*	*30.8*	*8.7*	*2.5*	*19.0*	*3.7*	*1.3*	*33.4*
Max	*16.5*	*2.3*	*93.9*	*536.0*	*106.0*	*94.9*	*87.9*	*19.0*	*93.7*	*68.1*	*14.5*	*98.5*
std	*4.54*			*125.14*			*20.84*			*18.89*		
cov	*0.79*			*0.82*			*0.71*			*0.88*		