Report

HOUT BAY CEMETERY EXTENSION

STORMWATER MANAGEMENT PLAN

Prepared for:

ZUTARI
IMPACT. ENGINEERED.

Prepared by:

Graeme McGill consulting

Tel: 021 976 0386
Mobile: 082 550 9108
graeme@mcgillconsulting.co.za

Report No.: MC425-01
Revision: 0
Date: 2024-03-05

CONTENTS

DRAWINGS

MC425-C400	EXISTING CONDITIONS
MC425-C401	STORMWATER MANAGEMENT PLAN
MC425-C420	POND STORMWATER DETAILS

HOUT BAY CEMETERY EXTENSION – STORMWATER MANAGEMENT PLAN

EXECUTIVE SUMMARY

It is proposed to extend the Hout Bay Cemetery on erven RE/1460, RE/1461 and RE/1462 onto the adjacent erf 2596 (area: 0,824 ha).

Earthworks have been carried out on the site so as to create 2 platforms. These have recently been used for temporary housing which has since been removed.

There are no detailed site development plans at this stage, therefore for this stormwater management plan (SMP) it has been assumed that a certain amount of surface hardening will take place and that the platforms will remain.

The proposed SMP has been formulated to meet the objectives of the City of Cape Town stormwater policy "Management of Urban Stormwater Impacts". This will require that the majority of the runoff is directed to the low point of the erf in the north-east corner where the runoff will be treated and attenuated in a 141m^3 pond, and to release pre-development peak flows. The pond outfall pipe will be constructed to cross Hughenden Road and connect to an existing stormwater manhole.

The proposed SMP is also shown on the accompanying drawings:

MC425-C401 SMP Layout

MC425-C420 Stormwater infrastructure details

HOUT BAY CEMETERY EXTENSION – STORMWATER MANAGEMENT PLAN

1. EXISTING AND PROPOSED DEVELOPMENT

The existing Hout Bay cemetery is located on erven RE/1460, RE/1461 and RE/1462. It is proposed to extend the cemetery onto the adjacent erf 2596.

The existing condition on the erf is that level platforms have been created, as shown in Figures 2 and 3.

There are no detailed site development plans at this stage. Therefore, for the purpose of preparing this stormwater management plan conservative assumptions of hardening of surfaces due to the construction of paved access roads have been made.

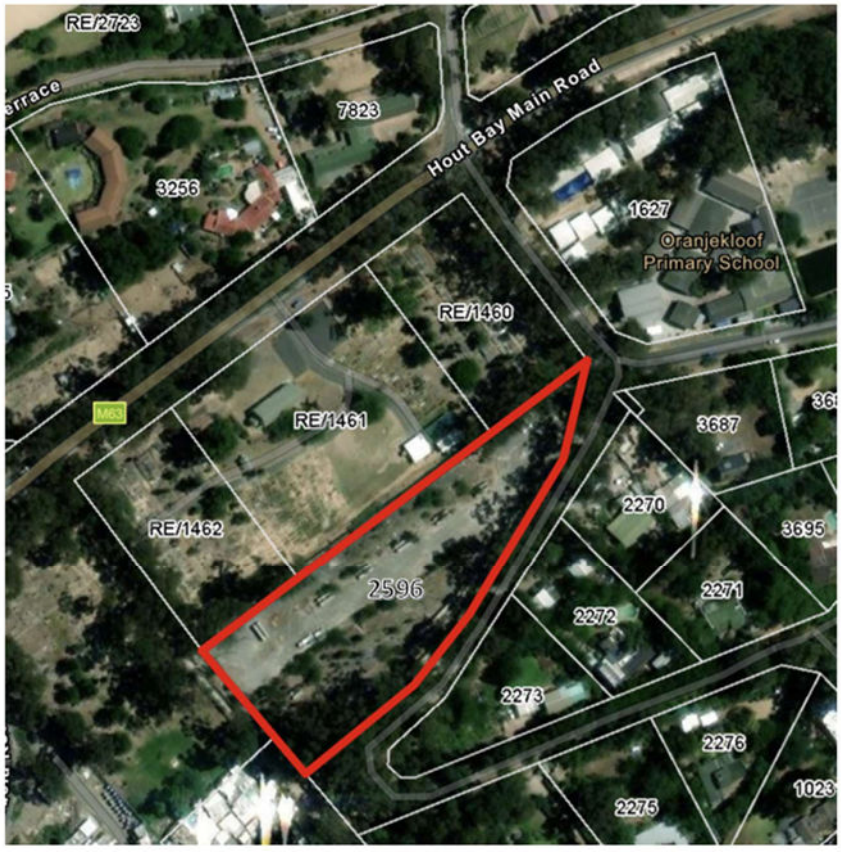

FIGURE 1: SITE LOCATION ERF 2596, HOUT BAY

FIGURE 2: EXISTING ERF 2596 – VIEW TOWARDS NORTH-EAST CORNER

FIGURE 3: EXISTING ERF 2596 – VIEW TOWARDS SOUTH-WEST CORNER

FIGURE 4: HUGHENDEN ROAD ABOVE ERF 2596 SHOWING STORMWATER INFRASTRUCTURE WHICH INTERCEPTS RUNOFF FROM ABOVE THE SITE

2. APPLICABLE CONDITIONS

2.1 MANAGEMENT OF URBAN STORMWATER IMPACTS POLICY

The goal of the City of Cape Town's Management of Urban Stormwater Impacts Policy (City of Cape Town, 2009a) is to implement Sustainable Drainage Systems (SuDS). These systems attempt to maintain or mimic the natural flow systems as well as prevent the wash-off of urban pollutants to receiving waters.

The stormwater policy objectives to be satisfied in the stormwater management plan are listed in Table 1.

In this case the site is undeveloped and is thus deemed to be a Greenfield Development.

TABLE 1: STORMWATER POLICY OBJECTIVES TO BE SATISFIED IN THE STORMWATER MANAGEMENT PLAN WITH RELEVANT PORTIONS MARKED IN RED

ANNEXURE: INTERIM CRITERIA FOR ACHIEVING SUSTAINABLE URBAN DRAINAGE SYSTEM OBJECTIVES IN VARIOUS DEVELOPMENT SCENARIOS

SUDS OBJECTIVES		Greenfield Developments *and* Brownfield and Existing Development Sites located in catchments of sensitive receiving water systems	Brownfield and Existing Development Sites > 50 000 m²	Brownfield and Existing Development Sites 4000 m² – 50 000 m² *and* Total impervious area (exist & new) > 15% of site	Brownfield and Existing Development Sites < 4000 m² *and* Total impervious area (exist and new) > 600m²
		Design storm event for water quality treatment: 1/2-year RI, 24 h storm			
IMPROVE QUALITY OF RUNOFF *Remove pollutants through combination of reducing and/or disconnecting impervious areas, and the use of BMPs which infiltrate or capture and treat stormwater runoff*		Pollutant removal target: Reduction of post-development annual stormwater pollutant load discharged from dev. site: SS & TP - reduce to undeveloped catchment levels, *or* SS - 80% reduction TP - 45% reduction *whichever requires higher level of treatment*	Pollutant removal target: On-site reduction of post-development annual stormwater pollutant load discharged from developmenrt site: SS - 80% reduction TP - 45% reduction	Pollutant removal target: Combination of on-site and regional off-site measures to achieve target reductions: SS - 80% reduction TP - 45% reduction	On-site stormwater treatment not required but encouraged where practicable. Regional off-site treatment measures to achieve target reductions: SS - 80% reduction TP - 45% reduction
		All developments are required to trap litter, oil, grease at source			
CONTROL QUANTITY AND RATE OF RUNOFF	*Protect the stability of downstream channels*	24 hour extended detention of the1-year RI, 24h storm event	24 hour extended detention of the1-year RI, 24h storm event	Combination of on-site and regional off-site measures to achieve requirements as for development sites >50 000m²	On-site runoff control measures not required but encouraged where practicable Regional off-site runoff control measures to be provided to achieve requirements as for development sites > 50 000m²
	Protect downstream properties from fairly frequent nuisance floods	Up to 10-year RI peak flow reduced to pre-development level	Up to 10-year RI peak flow reduced to pre-development level		
	Protect floodplain developments and floodplains from adverse impacts of extreme floods	Up to 50-year RI peak flow reduced to existing development levels. Evaluate the effects of the 100-year RI storm event on the stormwater management system, adjacent property, and downstream facilities and property. Manage the impacts through detention controls and / or floodplain management	Up to 50-year RI peak flow reduced to existing development levels. Evaluate the effects of the 100-year RI storm event on the stormwater management system, adjacent property, and downstream facilities and property. Manage the impacts through detention controls and / or floodplain management		
		Developments adjacent to floodplains must adhere to the requirements of the Floodplain and River Corridor Management Policy			
ENCOURAGE NATURAL GROUNDWATER RECHARGE		Where appropriate, site specific requirements to be considered in consultation with Council			

2.2 FLOODPLAIN AND RIVER CORRIDOR MANAGEMENT POLICY

The goal of this policy is balancing flood risk, ecological and socio-economic considerations in developments near watercourses and wetlands.

The policy provides guidelines for various land uses.

In this case the proposed cemetery extension lies outside of any floodplain. Therefore, the policy need not be applied in this case.

3. PRE-DEVELOPMENT ANALYSIS

3.1 STORM RUNOFF MODEL

3.1.1 METHODOLOGY

The pre-development and post-development runoffs were calculated using the Storm and Sanitary Analysis (SSA) package using the EPA SWMM hydrology method.

SWMM is a dynamic hydrology-hydraulic-water quality simulation model. It is used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. The runoff component operates on a collection of sub-catchment areas that receive precipitation and generate runoff and pollutant loads. The routing portion transports this runoff through a system of pipes, channels, storage/treatment devices, pumps, and regulators.

SWMM tracks the quantity and quality of runoff made within each sub catchment. It tracks the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period made up of multiple time steps. SWMM 5.1 used for the development can also model the hydrologic performance of specific types of low impact development (LID) controls. The LID controls that the user can choose include the following: Permeable pavement, Vegetative swales, Infiltration trenches.

3.1.2 STORM RAINFALL

The City of Cape Town commissioned the University of Kwa-Zulu Natal to investigate the likely effect of climate change on storm intensities in the Western Cape. The recommendation from this investigation was that an increase of approximately 15% over the existing IDF curves be allowed for. This was accepted by the City and a set of point storm rainfall depths has been prepared for a one minute by one-minute grid covering the Western Cape.

The point rainfall figures applicable to the development site have been extracted from the Western Cape design rainfall database. The development site is located near grid points 34°1'S 18°22'E and 34°2'S 18°22'E. The rainfall figures used for the design is given in Table 2.

TABLE 2: FINAL SELECTED GRID POINT STORM RAINFALL DEPTHS FOR THE DEVELOPMENT SITE EXTRACTED FROM THE CITY OF CAPE TOWN DESIGN GRID INCORPORATING A CLIMATE CHANGE FACTOR

RI (yr)	POINT STORM RAINFALL DEPTHS (mm) FOR EVENT DURATIONS (minutes) OF:							
	10	**30**	**60**	**120**	**240**	**360**	**720**	**1440**
0.5	4.4	7.3	10.0	13.8	17.5	20.2	25.7	32.7
1	6.2	10.5	14.4	19.7	25.1	28.9	36.8	46.8
2	8.1	13.6	18.6	25.5	32.4	37.3	47.5	60.4
5	10.7	18.0	24.7	33.8	43.0	49.5	63.0	80.2
10	12.5	21.1	28.9	39.6	50.4	58.0	73.8	93.9
20	14.3	24.2	33.1	45.4	57.7	66.5	84.5	107.5
50	16.8	28.4	38.9	53.2	67.6	77.9	99.1	126.1
100	18.7	31.6	43.4	59.3	75.4	86.9	110.5	140.6

NOTES:
1. These data are the storm depths from grid points 34°1'S 18°22'E and 34°2'S 18°22'E.
2. The 1:0.5 year and 1:1 year return period rainfall depths have been extrapolated.

3.2 EXISTING SITE CONDITIONS AND STORMWATER INFRASTRUCTURE

3.2.1 EXISTING SITE CONDITIONS

Erf 2596 was previously covered in pine forest and had a natural slope of 13%. It was subsequently cleared, and two platforms were formed on the site in a cut and fill exercise. A ramp was created from the lower platform (which covers most of the site) to the smaller, higher platform. The fill and cut faces of the embankment have been stabilised with concrete retaining blocks.

In 2017 basic services were installed to enable the property to be used to temporarily house 228 dwellings. These dwellings have now been removed but the installed services remain.

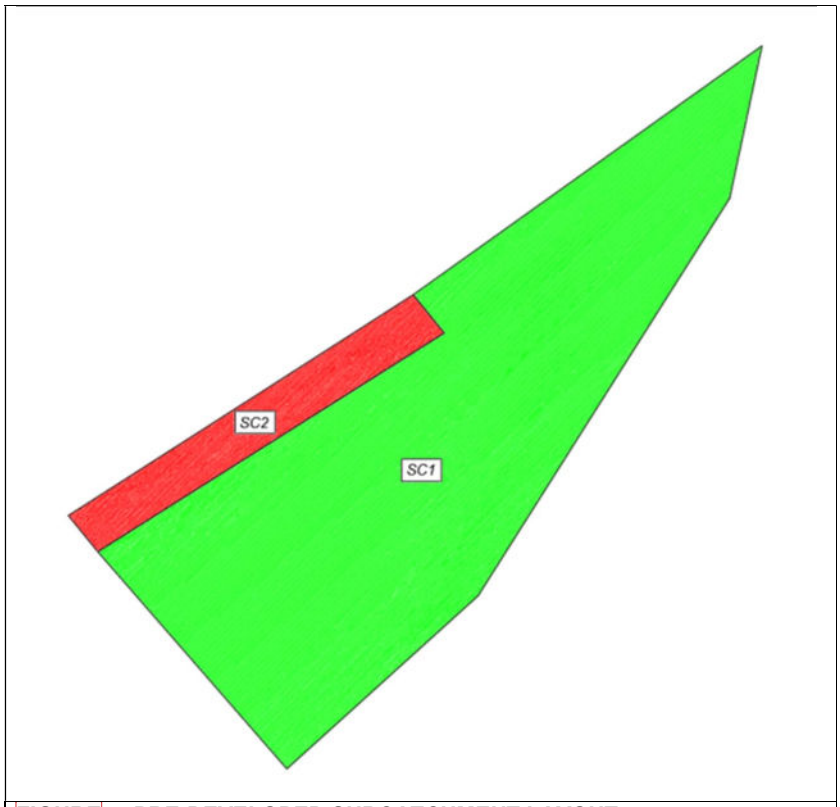

FIGURE 5: PRE-DEVELOPED SUBCATCHMENT LAYOUT

Commented [Jd1]: Numbering

3.2.2 EXISTING STORMWATER INFRASTRUCTURE AT THE DEVELOPMENT SITE

The site, erf 2596, is abutted by Hughenden Road to the south and east. The existing stormwater system in Hughenden Road (Figure 4) will intercept runoff from above the site and also provides a pipe into which the attenuated runoff from the site may be discharged.

Although certain services, installed for temporary housing, remain on site, these do not include stormwater.

Presently the site slopes to the north-east so that a portion of the site drains to the existing cemetery (SC2 as shown in figure 5) and the bulk of the site drains to Hughenden Road on the north-east side (SC1 as shown in figure 5).

3.2.3 ADJACENT CATCHMENT RUN-ON

As noted above the stormwater system is Hughenden Road and the crossfall on this road intercept catchment run-on onto erf 2596.

3.3 PRE-DEVELOPMENT RUNOFF PEAKS

The pre-development runoff peaks have been calculated using the SSA modelling method. The SAA pre-development model layout is shown in figure 5 and Annexure A. The pre-development parameters and CN values are shown in Table 5.

The total development site pre-development peak runoff flows for both sections are given in Table 6.

TABLE 5: PRE-DEVELOPMENT SSA MODEL PARAMETERS

Sub-Catchment	Area (ha)	Width (m)	% Slope	n-Imperv	n-Perv	D-store Imp	D-store Perv	% Zero Imp	SOIL	Infil CN
SC1	0.773	41	1.00%	0	0.020	0.15	2	8	C	74
SC2	0.052	261	1.00%	0	0.020	0.15	2	8	C	74

Notes:

1). "Width" is a SSA catchment parameter computed as Area/Longest Collector.

3). Parameter % Imperv was set to 0.

4). Infiltration is controlled by the SCS runoff factor CN, which was set to 74 – representative of the current greenfield condition.

TABLE 6: PEAK PRE-DEVELOPMENT RUNOFF SUMMARY

SUB CATCHMENT	Q_{PEAK} (l/s)							
	0.5y	1y	2y	5y	10y	20y	50y	100y
SC1	0.15	1.41	4.04	11.5	18.74	27.88	43.65	56.76
SC2	0.04	0.32	2.69	5.12	6.53	7.96	10	11.65
TOTAL (SUM OF SC1 & SC2)	0.19	1.73	6.73	16.62	25.27	35.84	53.65	68.41

4. POST-DEVELOPMENT STORMWATER MANAGEMENT – QUANTITY AND RATE OF RUNOFF

4.1 REQUIREMENTS

In Section 2 the conditions for the greenfield development, which are to be applied to quantity and rate of runoff, are contained in the City of Cape Town stormwater policies for which it is necessary to:

- Provide 24-hr extended detention for the 1:0.5 year 24-hour duration storm.
- Provide post-development attenuation to pre-development peaks for storm events ranging from 1:5-year to the 1:50-year storm events.
- Provide controlled discharge of the 1:100-year storm event so as to not cause downstream damage.

4.2 RUNOFF ANALYSIS

4.2.1 PROPOSED ON-SITE STORMWATER CONFIGURATION

The development site will be divided into two separate areas. As shown in figure 5, the development has two pre-development subcatchments, SC1 and SC2 respectively. SC2 consists of a small area between the property boundary and an existing concrete block retaining wall. This area will not be attenuated by the proposed pond and will act as adjacent run-on to the existing cemetery (RE/1462, RE/1461, and RE/1460) north-west of the development. The remainder of the property is divided into five sub-catchments which will be attenuated via an attenuation pond. Refer to drawing MC425-C401 for the post-development subcatchment layout.

To achieve the attenuation at the development site for the five subcatchments, all runoff will be collected and conveyed by underground pipes and discharge into the attenuation and treatment pond located in the north-east corner of the development site.

Any sediment or litter which enters the stormwater system will be trapped in the attenuation and treatment pond forebay after which it will be collected and removed as part of the pond maintenance.

The roadway and parking bays runoff will be collected by catchpits along the roads and conveyed by underground stormwater pipes towards the attenuation pond.

The flow entering the attenuation pond will be attenuated via an outlet structure with two orifices and a spillway. The attenuated and treated flow will be discharged into the existing manhole located in Hughenden Street which discharges into the Disa river. Refer to MC425-C401.

4.3 MODEL LAYOUT AND PARAMETERS

The SSA model layout shown in Annexure B corresponds to the post-development scenario. A summary of the parameters used to model the post-development scenario is shown in Table 7. The model consists of 6 post development sub-catchments as shown in Figure 6 below.

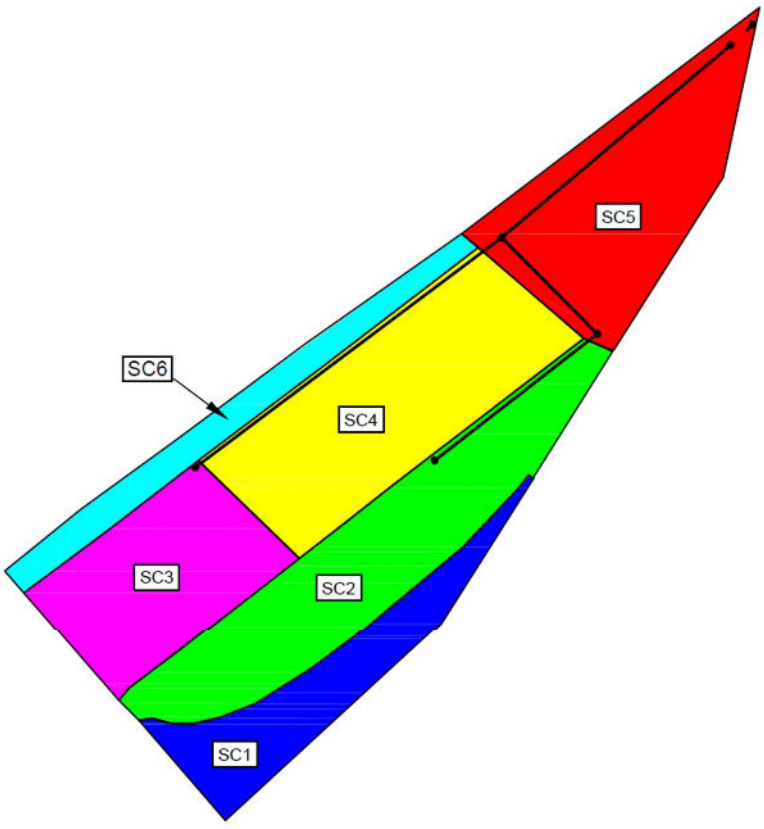

FIGURE 6: SITE POST DEVELOPMENT SUB-CATCHMENTS

The attenuation pond is located in by SC5 with an area of 161.93m², with vertical side walls. The side walls of the pond consist out of 1.00m x 1.00m gabion boxes which adds an additional 55.48m² effective area to the attenuation pond. Only one layer of gabion boxes is used thus the depth of the attenuation pond is 1.00m. The pos-development subcatchment properties of the SSA model is shown in Table 7 below.

TABLE 7: POST-DEVELOPMENT SUBCATCHEMNT PARAMETERS

SUB-CATCHMENT	AREA (ha)	WIDTH (m)	% SLOPE	n-IMPERV	n-PERV	D-STORE IMP	D-STORE PERV	% ZERO IMP	SOIL	LAND USE	INFIL CN
SC1	0.087	58	1.00%	0	0.020	0.15	2	8	C	CEMENTED OPEN SPACE	74
SC2	0.196	16	1.00%	0	0.020	0.15	2	8	C	OPEN SPACE/LANDSCAPE	79
SC3	0.135	29	1.00%	0	0.020	0.15	2	8	C	OPEN SPACE/LANDSCAPE	79
SC4	0.200	29	1.00%	0	0.020	0.15	2	8	C	OPEN SPACE/LANDSCAPE	79
SC5	0.156	21	1.00%	0	0.020	0.15	2	8	C	OPEN SPACE/LANDSCAPE	79
SC6	0.052	261	1.00%	0	0.020	0.15	2	8	C	OPEN SPACE/LANDSCAPE	74

Notes:
"WIDTH" is a SSA catchment parameter computed as Area/Longest Collector
The %imperv parameter was set to “0”.

4.4 POND OUTLET STRUCTURES AND SITE OUTFALL

The attenuation pond will have an outlet structure with 2 orifices and a spillway. The dimensions and elevations of the orifices, spillway, and the attenuation pond are listed in Tables 8

The orifices and spillway have been sized to achieve the required attenuation to pre-development peaks or less and to minimise the peak water levels in the pond.

The performance of the attenuation pond under a range of storm conditions is summarised in Tables 8.

4.5 EMERGENCY OVERLAND ESCAPE ROUTES

In the event that the outlet structure and outlet pipe of the attenuation pond becomes blocked, the spillway will safely discharge the attenuated flow to Hughenden Road.

4.6 ATTENUATION POND PERFORMANCE

The attenuation performances of the attenuation pond is set out in detail in Table 8.

These figures show that the post-development runoff will not exceed the pre-development peak flows (section 4.7)

TABLE 8: POND ATTENUATION PERFORMANCE								
PEAKS FOR VARIOUS RECURRENCE INTERVALS								
RECURRENCE INTERVAL (1: _year)	0.5	1	2	5	10	20	50	100
INFLOW (l/s)	0.56	2.92	9.15	27.53	43.80	60.48	83.03	101.39
VOLUME (m3)	5	14	32	79	100	114	132	141
WATER SURFACE AREA (m2)	179	179	179	179	179	179	179	179
WATER DEPTH (m)	0.03	0.08	0.18	0.44	0.56	0.64	0.74	0.79
WATER SURFACE ELEVATION (RLm)	44.03	44.08	44.18	44.44	44.56	44.64	44.74	44.79
OUTFLOW (l/s)	0.50	2.21	4.85	8.29	16.80	26.64	41.81	61.88

POND, ORIFICE, AND SPILLWAY SUMMARY				
OUTLET TYPE	POND	ORIFICE1	ORIFICE2	SPILLWAY
INVERT LEVEL (RLm)	44.00	44.00	44.44	44.74
DIA / HEIGHT (m)		0.10	0.30	0.283
WIDTH (m)		0.05	0.10	0.8
COEFFICIENT		0.60	0.60	1.8

4.7 POST-DEVELOPMENT RUNOFF PEAKS

The resulting peak pre- and post-development flows for the development are listed in Table 9. The post-development peaks represent the unattenuated peak discharge from the 5 catchments.

TABLE 9: PEAK FLOW SUMMARY PRE- AND -POST DEVELOPMENT FOR THE

	FLOW PEAKS (l/s) FOR RECURRANCE INTERVAL, YEARS							
	1:0.5y	**1:1y**	**1:2y**	**1:5y**	**1:10y**	**1:20y**	**1:50y**	**1:100y**
PRE-DEVELOPMENT	0.2	1.4	4.0	11.5	18.7	27.9	43.7	56.8
POST-DEVELOPMENT	0.5	2.2	4.9	8.3	16.8	26.6	41.8	61.9

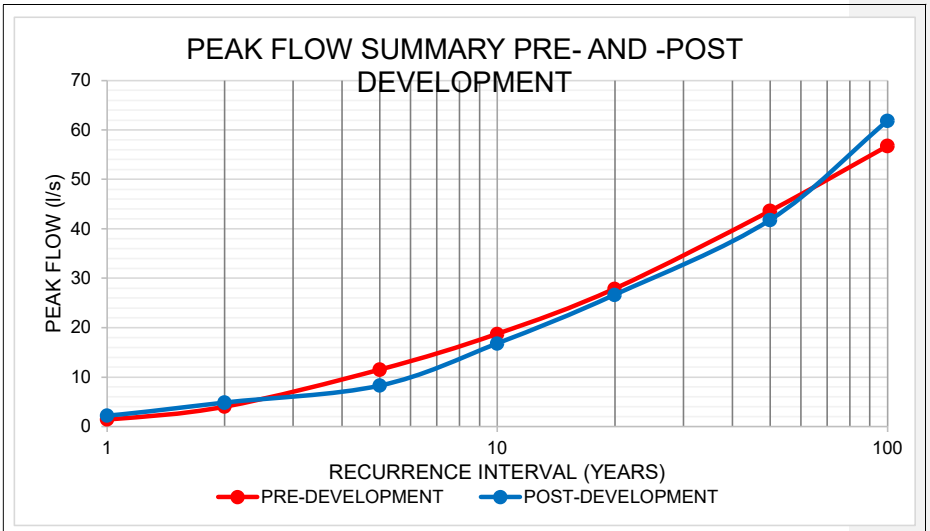

FIGURE 7: ATTENUATED POST-DEVELOPMENT PEAKS COMPARED TO PRE-DEVELOPMENT PEAKS

The attenuation of post-development peak flows is compared with the pre-development peak flows in Figure 7 above. The post development peak flows were found to be less than the pre-development peak flows for the recurrence intervals 1:5 year to 1:50 year for the 5 subcatchments. Only the 1:0.5 to 1:2-year and the 1:100-year recurrence intervals post development peak flows where slightly above the pre-development peak flows.

4.8 REQUIRED STORMWATER INFRASTRUCTURE

The internal stormwater reticulation should be sized so that a minimum of the 1:5-year peak flows are accommodated in an underground piped system.

The balance of the peak flow up to 1:100 year should be safely conveyed through the development and through the outfall to Hughenden Road. Table 10 lists the proposed pipes to be used with the minimum required provision for flow in the road prism.

TABLE 10: PROPOSED PIPE DIAMETER AND ROAD PRISM FLOW CAPACITY									
FROM	IL (RLm)	TO	IL (RLm)	5YR	100YR	PIPE DIA (mm)	SLOPE (%)	PIPE CAPACITY (l/s)	MINIMUM REQUIRED ROAD PRISM CAPACITY (l/s)
SWMH2	45.3	SWMH1	44.8	21.45	79.59	375	1.6%	211.2	0
SWMH3	46.8	SWMH2	45.3	7.18	22.38	375	2.0%	236.7	0
SWMH4	46.3	SWMH2	45.3	7.26	29.26	375	3.5%	316.2	0
SWMH5	48.8	SWMH4	46.3	7.26	29.29	375	6.2%	418.3	0
SWMH6	43.086	EX_SWMH3A	42.904	8.29	63.39	375	1.0%	167.9	0
SWMH1	44.8	POND	44	21.5	79.84	375	13.3%	613.3	0
Outlet Chamber	44	SWMH6	43.086	8.29	61.88	375	10.3%	538.5	0

5. POST-DEVELOPMENT STORMWATER MANAGEMENT - QUALITY TREATMENT

5.1 OBJECTIVES

In order to design the quality treatment component of the stormwater system according to SuDS principles the following standards have been applied:

- The 24h duration 1:0.5-year storm Water Quality Volume (WQv) is to be treated.
- Suspended solids (SS): 80% reduction
- Total phosphorous concentration (TP): 45% reduction

Table 11 is the summary of the WQv of the contributing sub-catchments to the attenuation pond.

TABLE 11: WATER QUALITY VOLUME SUMMARY

WQv INFILTRATION BED			
SUB-CATCHMENT	AREA (m²)	RUNOFF (mm)	WQv (m³)
SC_1	867.42	0.55	0
SC_2	1956.40	2.01	4
SC_3	1349.00	2.20	3
SC_4	1998.00	2.06	4
SC_5	1562.00	2.04	3
SC_6	521.00	0.72	0
TOTAL	**8253.8**	**9.58**	**15**

5.2 IMPLEMENTATION OF TREATMENT AT THE POND

5.2.1 FOREBAY

The forebay is located in the attenuation pond.

The forebay sides will be constructed with gabions. The base of the forebays will be concrete for ease of maintenance. A geotextile fabric is to be placed within the gabion which forms the barrier between the forebay and the remainder of the pond. This will allow water to seep through while trapping litter and sediment in the forebay. An access ramp is to be provided for routine maintenance accessibility.

The forebay has been sized according to the guidelines in the Georgia Stormwater Management Manual (Atlanta Regional Commission, 2016)

Refer to section A-A on drawing MC425-C420.

5.2.2 BIOLOGICAL FILTERBED

A 1.0m deep biological filtration bed will be provided at the attenuation pond. The biological filtration bed will have a surface area sized for the incoming WQv, as per the Georgia Stormwater Management Manual Volume 2 Technical Handbook, Section 3.2.3 (Atlanta Regional Commission, 2016). A geotextile layer is placed between the filterbed sand and the in-situ material to prevent material loss. The filterbed sand will drain naturally into the in-situ soil through the geotextile. Refer to section A-A on drawing MC425-C420.

The WQv represents the runoff from the 24-hour duration, 1:0.5-year storm.

The remaining area of the pond base will be in-situ sandy soil.

Table 12 below contains the soil grading summary required for the biological filter beds and in Table 13 the parameters of the water quality treatment components.

TABLE 12: BIOLOGICAL FILTERBED SPECIFICATIONS

Sieve size (mm)	Soil Type	% Passing
6	Fine Gravel	100
2	Coarse sand	90-100
0.6	Medium sand	40-70
0.2	Fine Sand	5-20
0.063	Clay/silt	<5

Notes:
1. Depth as per stormwater management plan.
2. Add 3-5% organic material by weight.
3. Ph 5.5-8.5
4. Underdrain porosity >30%
5. Electrical Conductivity, Salinity <3300 µS/cm
6. Minimum infiltration rate: 600mm/day

References:
- CIRIA Report C753 The SuDS Manual
- Georgia Stormwater Management Manual. Vol 2 Technical Manual

TABLE 13: ATTENUATION POND WATER QUALITY TREATMENT COMPONENTS

DESCRIPTION	**POND**
Contributing Area	SC1, SC2, SC3, SC4, and SC5
TOB (RLm)	45.00
IL (RLm)	44.00
Total Depth (m)	1.00
Top Area (m²)	161.93
Base Area (m²)	161.93
Forebay Depth (m)	0.50
Forebay (m²)	42
Filterbed Sand (m²)	60
In-situ Sand (m²)	-
Internal Side Slope (1:V)	0

6. MAINTENANCE OF THE STORMWATER SYSTEM

6.1 SCOPE OF MAINTENANCE

The ongoing sustainability of the stormwater system is linked to the effective maintenance of all its components. These include the attenuation ponds, the outlet structures, manholes, pipes, spillways, and channels.

6.2 RESPONSIBILITY FOR MAINTENANCE

The registered owners of the property will be solely responsible for the stormwater management, operation and maintenance of each stormwater component proposed in this stormwater management plan. The owners of will be required to ensure that the stormwater system is in good repair, in a healthy state and regularly serviced as described in this section of the report. Records should be kept of these maintenance activities.

A maintenance schedule is included as Annexure C. This should be used as a checklist and for record purposes.

7. SEDIMENT, LITTER AND DEBRIS CONTROL: OPERATIONS AND SERVICES

Addressing sediment, litter, and debris control during construction for the development of this size requires that the construction work, operational activities and transportation activities work in unison to achieve a successful reduction in all three pollutant types.

8. DETAILED DESIGN NOTES

The following points are to be taken note of during the detailed design phase:

1. All dimensions and components given in this stormwater management plan are conceptual only and not for construction purposes.
2. The design engineer must design all load bearing and retaining structures.
3. The attenuation pond area is not final. If alterations to shapes are required, it must be ensured that the total proposed volumes are achieved.

9. ADJACENT CATCHMENT RUN-ON

There is no adjacent catchment run-on as Hughenden Road intercept run-on from the south and east respectively.

10. PHASING

Phasing of the extension of the Hout Bay Cemetery on erf 2596 should not be a factor in stormwater management. The proposed stormwater management system should be fully implemented when the extension is undertaken

11. CONCLUSIONS

11.1 PROPOSED DEVELOPMENT

The proposed development is to be located on site (Erf-2596), which is located south-east of the existing Hout Bay cemetery (RE-1460, RE-1461, and RE-1462).

The site is to be developed as an extension of the existing cemetery.

11.2 APPLICABLE CONDITIONS

The sustainable drainage systems (SuDS) methodology as required by the City of Cape Town stormwater policies, has been applied to the sub-catchments of the development site. The objectives include attenuation of peak runoff and water quality treatment. The objectives to be met by this stormwater management plan are listed in section 5.1.

11.3 EXISTING CONDITIONS

The site is undeveloped but has been formed into platforms inaccessible cut and fill exercise. It has concrete retaining block supporting the cut and fill slopes. Certain basic services such as sewer and water have been installed for the site's recent use for temporary housing.

11.4 RUNOFF PEAK ATTENUATION

Estimates of the pre-development runoff have been computed for a range of recurrence intervals.

The permitted peak outflow from the site is limited to these of the pre-development peaks.

The runoff is to be attenuated with the attenuation pond and is to be discharged into the existing stormwater system via an existing manhole located in Hughenden Road. The attenuation objectives are achieved as is summarised in Section 4.7.

11.5 RUNOFF WATER QUALITY TREATMENT

The runoff water quality objective (80% reduction of TSS and 45% reduction in TP for the WQv) is achieved with the use of forebays and filter beds in the attenuation ponds. The runoff water quality objectives are achieved as summarised in section 5.

11.6 OPERATION AND MAINTENANCE

Maintenance forms an integral part of the sustainability of the stormwater management plan. A plan is presented in Section 6 and Annexure C. The implementation of the plan will be the responsibility of the owners of the property as described in section 6.

REFERENCES

ATLANTA REGIONAL COMMISSION, 2016: Georgia Stormwater Management Manual, Vol. 2 Technical Handbook, 2016 edition.

CITY OF CAPE TOWN 2009a: *Management of Urban Stormwater Impacts Policy,* Roads and Stormwater Department, Catchment, Stormwater and River Management Branch, Ver 1.1 Approved by Council 27 May 2009 C 58/05/09.

CITY OF CAPE TOWN 2009b: *Floodplain and River Corridor Management Policy,* Roads and Stormwater Department, Catchment, Stormwater and River Management Branch, Ver 2.1 Approved by Council 27 May 2009 C 58/05/09.

ANNEXURE A: PRE-DEVELOPMENT RUNOFF

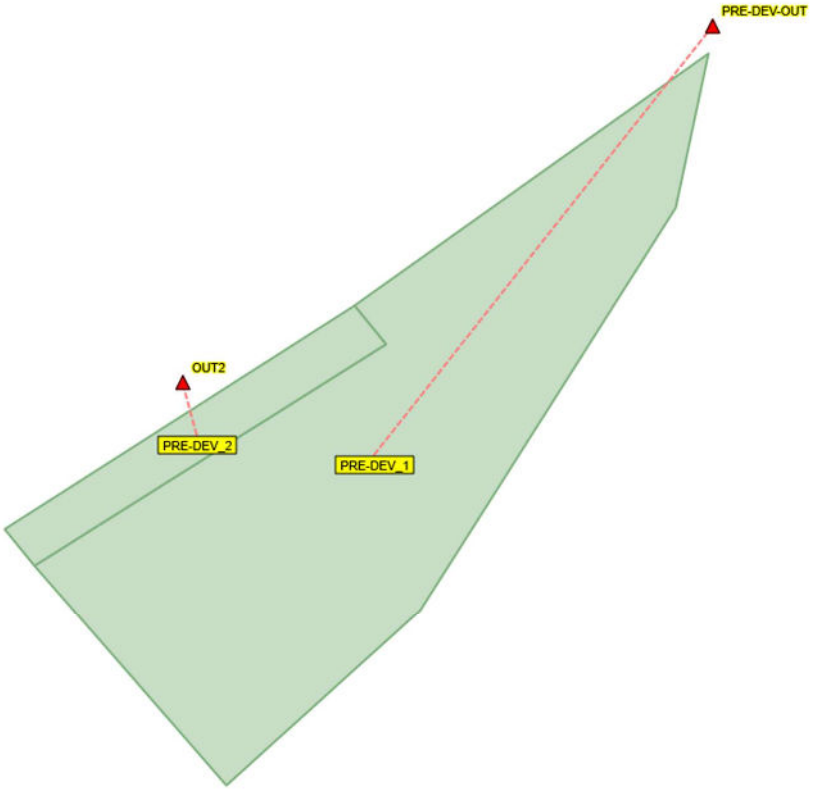

FIGURE B1: PCSWMM PRE-DEVELOPMENT MODEL LAYOUT

1:0.5 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
PRE-DEV_1	32.74	0.00	0.00	31.34	0.00	0.16	0.16	0.00	0.15	0.005
PRE-DEV_2	32.74	0.00	0.00	30.77	0.00	0.72	0.72	0.00	0.04	0.022

1:1 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
PRE-DEV_1	46.84	0.00	0.00	38.93	0.00	6.65	6.65	0.05	1.41	0.142
PRE-DEV_2	46.84	0.00	0.00	37.54	0.00	8.05	8.05	0.00	0.32	0.172

1:2 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
PRE-DEV_1	60.43	0.00	0.00	44.47	0.00	14.71	14.71	0.11	4.04	0.243
PRE-DEV_2	60.43	0.00	0.00	42.89	0.00	16.47	16.47	0.01	2.69	0.273

1:5 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
PRE-DEV_1	80.21	0.00	0.00	50.88	0.00	28.08	28.08	0.22	11.50	0.350
PRE-DEV_2	80.21	0.00	0.00	49.11	0.00	30.01	30.01	0.02	5.12	0.374

1:10 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
PRE-DEV_1	93.90	0.00	0.00	54.49	0.00	38.16	38.16	0.30	18.74	0.406
PRE-DEV_2	93.90	0.00	0.00	52.62	0.00	40.15	40.15	0.02	6.53	0.428

1:20 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
PRE-DEV_1	107.52	0.00	0.00	57.57	0.00	48.71	48.71	0.38	27.88	0.453
PRE-DEV_2	107.52	0.00	0.00	55.65	0.00	50.78	50.78	0.03	7.96	0.472

1:50 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
PRE-DEV_1	126.10	0.00	0.00	61.14	0.00	63.72	63.72	0.49	43.65	0.505
PRE-DEV_2	126.10	0.00	0.00	59.14	0.00	65.86	65.86	0.03	10.00	0.522

1:100 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
PRE-DEV_1	140.59	0.00	0.00	63.51	0.00	75.85	75.85	0.59	56.76	0.540
PRE-DEV_2	140.59	0.00	0.00	61.48	0.00	78.03	78.03	0.04	11.65	0.555

ANNEXURE B: POST-DEVELOPMENT RUNOFF

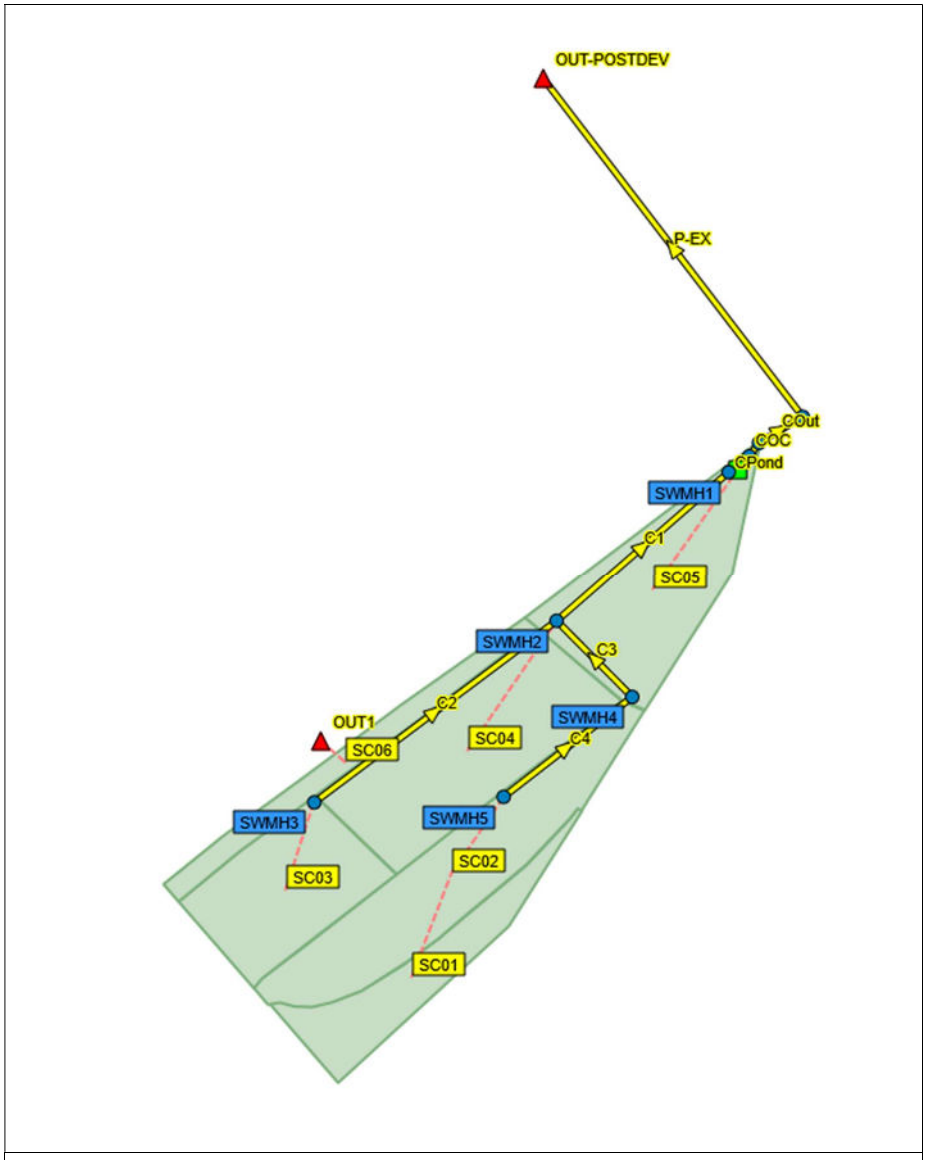

FIGURE B2: PCSWMM POST-DEVELOPMENT MODEL LAYOUT

1:0.5 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
SC01	32.74	0.00	0.00	30.94	0.00	0.55	0.55	0.00	0.05	0.017
SC02	32.74	0.24	0.00	29.73	0.00	2.01	2.01	0.00	0.18	0.061
SC03	32.74	0.00	0.00	29.28	0.00	2.20	2.20	0.00	0.12	0.067
SC04	32.74	0.00	0.00	29.42	0.00	2.06	2.06	0.00	0.16	0.063
SC05	32.74	0.00	0.00	29.44	0.00	2.04	2.04	0.00	0.13	0.062
SC06	32.74	0.00	0.00	30.77	0.00	0.72	0.72	0.00	0.04	0.022

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
EX_SWMH3A	JUNCTION	0.00	0.01	42.92	1 00:10	0.01
Outlet_Chamber	JUNCTION	0.00	0.01	44.01	1 00:09	0.01
SWMH1	JUNCTION	0.00	0.01	44.81	0 23:31	0.01
SWMH2	JUNCTION	0.00	0.01	45.31	0 23:30	0.01
SWMH3	JUNCTION	0.00	0.01	46.81	0 20:20	0.01
SWMH4	JUNCTION	0.00	0.01	46.31	1 00:01	0.01
SWMH5	JUNCTION	0.00	0.01	48.81	1 00:00	0.01
SWMH6	JUNCTION	0.63	0.64	43.72	1 00:09	0.64
OUT1	OUTFALL	0.00	0.00	44.00	0 00:00	0.00
OUT-POSTDEV	OUTFALL	0.00	0.01	34.01	1 00:11	0.01
POND	STORAGE	0.00	0.03	44.03	1 00:09	0.03

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
EX_SWMH3A	JUNCTION	0.00	0.50	1 00:10	0	0.0141	0.000
Outlet_Chamber	JUNCTION	0.00	0.50	1 00:09	0	0.0141	0.000
SWMH1	JUNCTION	0.00	0.44	0 23:31	0	0.011	0.000
SWMH2	JUNCTION	0.16	0.44	0 23:30	0.00412	0.011	0.000
SWMH3	JUNCTION	0.12	0.12	0 20:20	0.00297	0.00297	0.000
SWMH4	JUNCTION	0.00	0.18	1 00:01	0	0.00393	0.000
SWMH5	JUNCTION	0.18	0.18	1 00:00	0.00393	0.00393	0.000
SWMH6	JUNCTION	0.00	0.50	1 00:09	0	0.0141	0.000
OUT1	OUTFALL	0.04	0.04	0 22:00	0.000375	0.000375	0.000
OUT-POSTDEV	OUTFALL	0.00	0.50	1 00:11	0	0.0141	0.000
POND	STORAGE	0.13	0.56	0 23:13	0.00318	0.0142	-0.000

****
Node Flooding Summary
****
No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
POND	0.001	0.5	0.0	0.0	0.005	3.1	1 00:09	0.50

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
OUT1	3.86	0.03	0.04	0.000
OUT-POSTDEV	23.85	0.22	0.50	0.014
System	13.86	0.25	0.53	0.014

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	0.44	0	23:31	0.39	0.00	0.03
C2	CONDUIT	0.12	0	20:22	0.29	0.00	0.02
C3	CONDUIT	0.18	1	00:01	0.40	0.00	0.02
C4	CONDUIT	0.18	1	00:01	0.47	0.00	0.02
COC	CONDUIT	0.50	1	00:09	0.53	0.00	0.03
COut	CONDUIT	0.50	1	00:10	0.35	0.00	0.04
CPond	CONDUIT	0.44	0	23:31	0.83	0.00	0.02
P-EX	CONDUIT	0.50	1	00:11	0.73	0.00	0.02
01	ORIFICE	0.50	1	00:09			0.00
02	ORIFICE	0.00	0	00:00			0.00
03	WEIR	0.00	0	00:00			0.00

1:1 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
SC01	46.84	0.00	0.00	37.76	0.00	7.82	7.82	0.01	0.33	0.167
SC02	46.84	3.47	0.00	35.59	0.00	13.45	13.45	0.03	0.86	0.267
SC03	46.84	0.00	0.00	34.99	0.00	10.59	10.59	0.01	0.69	0.226
SC04	46.84	0.00	0.00	35.17	0.00	10.41	10.41	0.02	0.86	0.222
SC05	46.84	0.00	0.00	35.21	0.00	10.37	10.37	0.02	0.65	0.221
SC06	46.84	0.00	0.00	37.54	0.00	8.05	8.05	0.00	0.32	0.172

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
EX_SWMH3A	JUNCTION	0.01	0.03	42.93	0 15:53	0.03
Outlet_Chamber	JUNCTION	0.00	0.02	44.02	0 15:53	0.02
SWMH1	JUNCTION	0.00	0.03	44.83	0 13:41	0.03
SWMH2	JUNCTION	0.00	0.03	45.33	0 13:40	0.03
SWMH3	JUNCTION	0.00	0.01	46.81	0 13:10	0.01
SWMH4	JUNCTION	0.00	0.01	46.31	0 14:31	0.01
SWMH5	JUNCTION	0.00	0.01	48.81	0 14:30	0.01
SWMH6	JUNCTION	0.63	0.65	43.73	0 15:53	0.65
OUT1	OUTFALL	0.00	0.00	44.00	0 00:00	0.00
OUT-POSTDEV	OUTFALL	0.00	0.02	34.02	0 15:54	0.02
POND	STORAGE	0.01	0.08	44.08	0 15:53	0.08

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
EX_SWMH3A	JUNCTION	0.00	2.21	0 15:53	0	0.0775	0.000
Outlet_Chamber	JUNCTION	0.00	2.21	0 15:53	0	0.0775	0.000
SWMH1	JUNCTION	0.00	2.27	0 13:41	0	0.0614	0.000
SWMH2	JUNCTION	0.86	2.27	0 13:40	0.0208	0.0614	0.000
SWMH3	JUNCTION	0.69	0.69	0 13:10	0.0143	0.0143	0.000
SWMH4	JUNCTION	0.00	0.86	0 14:31	0	0.0263	0.000
SWMH5	JUNCTION	0.86	0.86	0 14:30	0.0263	0.0263	-0.000
SWMH6	JUNCTION	0.00	2.21	0 15:53	0	0.0775	0.000
OUT1	OUTFALL	0.32	0.32	0 13:00	0.00419	0.00419	0.000
OUT-POSTDEV	OUTFALL	0.00	2.21	0 15:54	0	0.0775	0.000
POND	STORAGE	0.65	2.92	0 13:33	0.0162	0.0776	-0.000

****
Node Flooding Summary
****
No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
POND	0.003	1.4	0.0	0.0	0.015	8.2	0 15:53	2.21

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
OUT1	15.97	0.10	0.32	0.004
OUT-POSTDEV	33.21	0.89	2.21	0.078
System	24.59	1.00	2.32	0.082

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	2.27	0	13:41	0.65	0.01	0.07
C2	CONDUIT	0.69	0	13:12	0.49	0.00	0.04
C3	CONDUIT	0.86	0	14:31	0.64	0.00	0.04
C4	CONDUIT	0.86	0	14:31	0.78	0.00	0.03
COC	CONDUIT	2.21	0	15:53	0.83	0.01	0.06
COut	CONDUIT	2.21	0	15:53	0.55	0.01	0.08
CPond	CONDUIT	2.27	0	13:41	1.35	0.00	0.04
P-EX	CONDUIT	2.21	0	15:54	1.13	0.00	0.05
01	ORIFICE	2.21	0	15:53			0.00
02	ORIFICE	0.00	0	00:00			0.00
03	WEIR	0.00	0	00:00			0.00

1:2 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
SC01	60.43	0.00	0.00	43.12	0.00	16.09	16.09	0.01	1.27	0.266
SC02	60.43	7.13	0.00	39.96	0.00	26.36	26.36	0.05	2.71	0.390
SC03	60.43	0.00	0.00	39.30	0.00	19.90	19.90	0.03	2.11	0.329
SC04	60.43	0.00	0.00	39.50	0.00	19.69	19.69	0.04	2.63	0.326
SC05	60.43	0.00	0.00	39.54	0.00	19.66	19.66	0.03	1.99	0.325
SC06	60.43	0.00	0.00	42.89	0.00	16.47	16.47	0.01	2.69	0.273

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days	Time of Max Occurrence hr:min	Reported Max Depth Meters
EX_SWMH3A	JUNCTION	0.01	0.04	42.95	0	14:30	0.04
Outlet_Chamber	JUNCTION	0.01	0.03	44.03	0	14:29	0.03
SWMH1	JUNCTION	0.01	0.05	44.85	0	12:42	0.05
SWMH2	JUNCTION	0.01	0.05	45.35	0	12:41	0.05
SWMH3	JUNCTION	0.00	0.02	46.82	0	12:30	0.02
SWMH4	JUNCTION	0.00	0.02	46.32	0	13:01	0.02
SWMH5	JUNCTION	0.00	0.02	48.82	0	13:00	0.02
SWMH6	JUNCTION	0.63	0.66	43.74	0	14:29	0.66
OUT1	OUTFALL	0.00	0.00	44.00	0	00:00	0.00
OUT-POSTDEV	OUTFALL	0.01	0.03	34.03	0	14:31	0.03
POND	STORAGE	0.02	0.18	44.18	0	14:29	0.18

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
EX_SWMH3A	JUNCTION	0.00	4.85	0	14:30	0	0.148	0.000
Outlet_Chamber	JUNCTION	0.00	4.85	0	14:29	0	0.148	0.000
SWMH1	JUNCTION	0.00	7.17	0	12:42	0	0.118	0.000
SWMH2	JUNCTION	2.63	7.17	0	12:41	0.0393	0.118	0.000
SWMH3	JUNCTION	2.11	2.11	0	12:30	0.0268	0.0268	0.000
SWMH4	JUNCTION	0.00	2.71	0	13:01	0	0.0516	0.000
SWMH5	JUNCTION	2.71	2.71	0	13:00	0.0516	0.0516	0.000
SWMH6	JUNCTION	0.00	4.85	0	14:29	0	0.148	0.000
OUT1	OUTFALL	2.69	2.69	0	12:10	0.00858	0.00858	0.000
OUT-POSTDEV	OUTFALL	0.00	4.85	0	14:31	0	0.148	0.000
POND	STORAGE	1.99	9.15	0	12:41	0.0307	0.148	-0.000

****
Node Flooding Summary
****
No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days	Time of Max Occurrence hr:min	Maximum Outflow LPS
POND	0.004	2.3	0.0	0.0	0.033	18.3	0	14:29	4.85

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
OUT1	16.86	0.20	2.69	0.009
OUT-POSTDEV	34.69	1.65	4.85	0.148
System	25.77	1.84	5.06	0.157

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	7.17	0	12:42	0.92	0.03	0.13
C2	CONDUIT	2.11	0	12:31	0.68	0.01	0.07
C3	CONDUIT	2.71	0	13:01	0.90	0.01	0.07
C4	CONDUIT	2.71	0	13:01	1.10	0.01	0.06
COC	CONDUIT	4.85	0	14:29	1.05	0.02	0.09
COut	CONDUIT	4.85	0	14:30	0.70	0.03	0.12
CPond	CONDUIT	7.17	0	12:42	1.93	0.01	0.08
P-EX	CONDUIT	4.85	0	14:31	1.44	0.01	0.07
01	ORIFICE	4.85	0	14:29			0.00
02	ORIFICE	0.00	0	00:00			0.00
03	WEIR	0.00	0	00:00			0.00

1:5 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
SC01	80.21	0.00	0.00	49.40	0.00	29.65	29.65	0.03	6.16	0.370
SC02	80.21	13.14	0.00	44.84	0.00	47.28	47.28	0.09	7.26	0.506
SC03	80.21	0.00	0.00	44.14	0.00	34.86	34.86	0.05	7.31	0.435
SC04	80.21	0.00	0.00	44.36	0.00	34.63	34.63	0.07	8.21	0.432
SC05	80.21	0.00	0.00	44.40	0.00	34.59	34.59	0.05	6.11	0.431
SC06	80.21	0.00	0.00	49.11	0.00	30.01	30.01	0.02	5.12	0.374

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
EX_SWMH3A	JUNCTION	0.01	0.06	42.96	0 14:09	0.06
Outlet_Chamber	JUNCTION	0.01	0.04	44.04	0 14:09	0.04
SWMH1	JUNCTION	0.01	0.08	44.88	0 12:12	0.08
SWMH2	JUNCTION	0.01	0.08	45.38	0 12:11	0.08
SWMH3	JUNCTION	0.00	0.04	46.84	0 12:10	0.04
SWMH4	JUNCTION	0.00	0.04	46.34	0 12:30	0.04
SWMH5	JUNCTION	0.00	0.03	48.83	0 12:30	0.03
SWMH6	JUNCTION	0.63	0.67	43.75	0 14:09	0.67
OUT1	OUTFALL	0.00	0.00	44.00	0 00:00	0.00
OUT-POSTDEV	OUTFALL	0.01	0.03	34.03	0 14:10	0.03
POND	STORAGE	0.05	0.44	44.44	0 14:09	0.44

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
EX_SWMH3A	JUNCTION	0.00	8.29	0 14:09	0	0.263	0.000
Outlet_Chamber	JUNCTION	0.00	8.29	0 14:09	0	0.263	0.000
SWMH1	JUNCTION	0.00	21.45	0 12:12	0	0.209	0.000
SWMH2	JUNCTION	8.21	21.46	0 12:11	0.0692	0.209	0.000
SWMH3	JUNCTION	7.31	7.31	0 12:10	0.047	0.047	0.000
SWMH4	JUNCTION	0.00	7.26	0 12:30	0	0.0925	0.000
SWMH5	JUNCTION	7.26	7.26	0 12:30	0.0925	0.0925	-0.000
SWMH6	JUNCTION	0.00	8.29	0 14:09	0	0.263	0.000
OUT1	OUTFALL	5.12	5.12	0 12:10	0.0156	0.0156	0.000
OUT-POSTDEV	OUTFALL	0.00	8.29	0 14:10	0	0.263	0.000
POND	STORAGE	6.11	27.53	0 12:11	0.054	0.263	0.029

****
Node Flooding Summary
****
No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
POND	0.008	4.6	0.0	0.0	0.078	43.9	0 14:09	8.29

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
OUT1	17.25	0.35	5.12	0.016
OUT-POSTDEV	35.88	2.82	8.29	0.263
System	26.57	3.17	8.64	0.278

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	21.45	0	12:12	1.27	0.10	0.22
C2	CONDUIT	7.18	0	12:11	1.00	0.03	0.12
C3	CONDUIT	7.26	0	12:31	1.23	0.02	0.10
C4	CONDUIT	7.26	0	12:30	1.50	0.02	0.09
COC	CONDUIT	8.29	0	14:09	1.23	0.03	0.11
COut	CONDUIT	8.29	0	14:09	0.82	0.05	0.15
CPond	CONDUIT	21.50	0	12:11	2.71	0.03	0.13
P-EX	CONDUIT	8.29	0	14:10	1.72	0.02	0.09
01	ORIFICE	8.29	0	14:09			0.00
02	ORIFICE	0.00	0	00:00			0.00
03	WEIR	0.00	0	00:00			0.00

1:10 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
SC01	93.90	0.00	0.00	52.93	0.00	39.80	39.80	0.03	8.79	0.424
SC02	93.90	17.64	0.00	47.49	0.00	62.82	62.82	0.12	11.69	0.563
SC03	93.90	0.00	0.00	46.78	0.00	45.91	45.91	0.06	10.92	0.489
SC04	93.90	0.00	0.00	46.99	0.00	45.68	45.68	0.09	12.93	0.486
SC05	93.90	0.00	0.00	47.05	0.00	45.63	45.63	0.07	9.70	0.486
SC06	93.90	0.00	0.00	52.62	0.00	40.15	40.15	0.02	6.53	0.428

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
EX_SWMH3A	JUNCTION	0.01	0.08	42.98	0 13:21	0.08
Outlet_Chamber	JUNCTION	0.01	0.06	44.06	0 13:20	0.06
SWMH1	JUNCTION	0.01	0.10	44.90	0 12:11	0.10
SWMH2	JUNCTION	0.01	0.10	45.40	0 12:11	0.10
SWMH3	JUNCTION	0.00	0.05	46.85	0 12:10	0.05
SWMH4	JUNCTION	0.00	0.05	46.35	0 12:20	0.05
SWMH5	JUNCTION	0.00	0.04	48.84	0 12:20	0.04
SWMH6	JUNCTION	0.63	0.68	43.77	0 13:20	0.68
OUT1	OUTFALL	0.00	0.00	44.00	0 00:00	0.00
OUT-POSTDEV	OUTFALL	0.01	0.05	34.05	0 13:21	0.05
POND	STORAGE	0.06	0.56	44.56	0 13:20	0.56

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
EX_SWMH3A	JUNCTION	0.00	16.80	0 13:21	0	0.347	0.000
Outlet_Chamber	JUNCTION	0.00	16.80	0 13:20	0	0.347	0.000
SWMH1	JUNCTION	0.00	34.29	0 12:11	0	0.276	0.000
SWMH2	JUNCTION	12.93	34.29	0 12:11	0.0913	0.276	0.000
SWMH3	JUNCTION	10.92	10.92	0 12:10	0.0619	0.0619	0.000
SWMH4	JUNCTION	0.00	11.69	0 12:20	0	0.123	0.000
SWMH5	JUNCTION	11.69	11.69	0 12:20	0.123	0.123	0.000
SWMH6	JUNCTION	0.00	16.80	0 13:20	0	0.347	0.000
OUT1	OUTFALL	6.53	6.53	0 12:10	0.0209	0.0209	0.000
OUT-POSTDEV	OUTFALL	0.00	16.80	0 13:21	0	0.347	0.000
POND	STORAGE	9.70	43.80	0 12:11	0.0713	0.347	0.036

****
Node Flooding Summary
****
No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
POND	0.010	5.8	0.0	0.0	0.099	55.5	0 13:20	16.80

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
OUT1	17.76	0.46	6.53	0.021
OUT-POSTDEV	36.89	3.63	16.80	0.347
System	27.33	4.08	17.44	0.368

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	34.29	0	12:11	1.45	0.16	0.27
C2	CONDUIT	10.69	0	12:11	1.13	0.05	0.14
C3	CONDUIT	11.69	0	12:20	1.41	0.04	0.13
C4	CONDUIT	11.69	0	12:20	1.72	0.03	0.11
COC	CONDUIT	16.80	0	13:20	1.52	0.06	0.16
COut	CONDUIT	16.80	0	13:21	1.00	0.10	0.21
CPond	CONDUIT	34.30	0	12:11	3.11	0.06	0.16
P-EX	CONDUIT	16.80	0	13:21	2.12	0.03	0.13
01	ORIFICE	9.45	0	13:20			0.00
02	ORIFICE	7.35	0	13:20			0.00
03	WEIR	0.00	0	00:00			0.00

1:20 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
SC01	107.52	0.00	0.00	55.96	0.00	50.41	50.41	0.04	11.15	0.469
SC02	107.52	22.35	0.00	49.70	0.00	78.94	78.94	0.15	16.72	0.608
SC03	107.53	0.00	0.00	48.99	0.00	57.33	57.33	0.08	14.31	0.533
SC04	107.53	0.00	0.00	49.21	0.00	57.09	57.09	0.11	17.52	0.531
SC05	107.52	0.00	0.00	49.25	0.00	57.05	57.05	0.09	13.23	0.531
SC06	107.52	0.00	0.00	55.65	0.00	50.78	50.78	0.03	7.96	0.472

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
EX_SWMH3A	JUNCTION	0.01	0.10	43.00	0 13:00	0.10
Outlet_Chamber	JUNCTION	0.01	0.07	44.07	0 13:00	0.07
SWMH1	JUNCTION	0.01	0.12	44.92	0 12:11	0.11
SWMH2	JUNCTION	0.01	0.12	45.42	0 12:11	0.12
SWMH3	JUNCTION	0.00	0.06	46.86	0 12:10	0.06
SWMH4	JUNCTION	0.00	0.06	46.36	0 12:16	0.06
SWMH5	JUNCTION	0.00	0.05	48.85	0 12:15	0.05
SWMH6	JUNCTION	0.63	0.70	43.78	0 13:00	0.70
OUT1	OUTFALL	0.00	0.00	44.00	0 00:00	0.00
OUT-POSTDEV	OUTFALL	0.01	0.06	34.06	0 13:01	0.06
POND	STORAGE	0.07	0.64	44.64	0 13:00	0.64

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
EX_SWMH3A	JUNCTION	0.00	26.64	0 13:00	0	0.434	0.000
Outlet_Chamber	JUNCTION	0.00	26.64	0 13:00	0	0.434	0.000
SWMH1	JUNCTION	0.00	47.57	0 12:11	0	0.345	0.000
SWMH2	JUNCTION	17.52	47.57	0 12:11	0.114	0.346	0.000
SWMH3	JUNCTION	14.31	14.31	0 12:10	0.0773	0.0773	0.000
SWMH4	JUNCTION	0.00	16.70	0 12:16	0	0.154	0.000
SWMH5	JUNCTION	16.72	16.72	0 12:15	0.154	0.154	0.000
SWMH6	JUNCTION	0.00	26.64	0 13:00	0	0.434	0.000
OUT1	OUTFALL	7.96	7.96	0 12:10	0.0265	0.0265	0.000
OUT-POSTDEV	OUTFALL	0.00	26.64	0 13:01	0	0.434	0.000
POND	STORAGE	13.23	60.48	0 12:11	0.0891	0.435	0.060

****
Node Flooding Summary
****
No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
POND	0.012	6.7	0.0	0.0	0.114	63.7	0 13:00	26.64

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
OUT1	18.34	0.56	7.96	0.026
OUT-POSTDEV	37.92	4.42	26.64	0.434
System	28.13	4.98	27.76	0.460

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	47.57	0	12:11	1.60	0.23	0.32
C2	CONDUIT	14.05	0	12:11	1.23	0.06	0.16
C3	CONDUIT	16.71	0	12:16	1.57	0.05	0.16
C4	CONDUIT	16.70	0	12:16	1.91	0.04	0.14
COC	CONDUIT	26.64	0	13:00	1.75	0.09	0.20
COut	CONDUIT	26.64	0	13:00	1.15	0.16	0.27
CPond	CONDUIT	47.59	0	12:11	3.42	0.08	0.19
P-EX	CONDUIT	26.64	0	13:01	2.42	0.06	0.16
01	ORIFICE	10.18	0	13:00			0.00
02	ORIFICE	16.45	0	13:00			0.00
03	WEIR	0.00	0	00:00			0.00

1:50 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
SC01	126.10	0.00	0.00	59.45	0.00	65.50	65.50	0.06	14.48	0.519
SC02	126.10	29.03	0.00	52.23	0.00	101.69	101.69	0.20	23.60	0.655
SC03	126.10	0.00	0.00	51.50	0.00	73.40	73.40	0.10	18.99	0.582
SC04	126.10	0.00	0.00	51.74	0.00	73.16	73.16	0.15	23.82	0.580
SC05	126.10	0.00	0.00	51.77	0.00	73.11	73.11	0.11	18.06	0.580
SC06	126.10	0.00	0.00	59.14	0.00	65.86	65.86	0.03	10.00	0.522

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
EX_SWMH3A	JUNCTION	0.01	0.13	43.03	0 12:44	0.13
Outlet_Chamber	JUNCTION	0.01	0.09	44.09	0 12:44	0.09
SWMH1	JUNCTION	0.01	0.14	44.94	0 12:11	0.14
SWMH2	JUNCTION	0.01	0.14	45.44	0 12:11	0.14
SWMH3	JUNCTION	0.00	0.07	46.87	0 12:10	0.07
SWMH4	JUNCTION	0.01	0.07	46.37	0 12:11	0.07
SWMH5	JUNCTION	0.00	0.06	48.86	0 12:15	0.06
SWMH6	JUNCTION	0.64	0.72	43.80	0 12:44	0.72
OUT1	OUTFALL	0.00	0.00	44.00	0 00:00	0.00
OUT-POSTDEV	OUTFALL	0.01	0.07	34.07	0 12:44	0.07
POND	STORAGE	0.08	0.74	44.74	0 12:44	0.74

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
EX_SWMH3A	JUNCTION	0.00	41.81	0 12:44	0	0.557	0.000
Outlet_Chamber	JUNCTION	0.00	41.81	0 12:44	0	0.557	0.000
SWMH1	JUNCTION	0.00	65.51	0 12:11	0	0.444	0.000
SWMH2	JUNCTION	23.82	65.66	0 12:11	0.146	0.444	0.000
SWMH3	JUNCTION	18.99	18.99	0 12:10	0.099	0.099	0.000
SWMH4	JUNCTION	0.00	23.60	0 12:11	0	0.199	0.000
SWMH5	JUNCTION	23.60	23.60	0 12:15	0.199	0.199	0.000
SWMH6	JUNCTION	0.00	41.81	0 12:44	0	0.557	0.000
OUT1	OUTFALL	10.00	10.00	0 12:10	0.0343	0.0343	0.000
OUT-POSTDEV	OUTFALL	0.00	41.80	0 12:44	0	0.557	0.000
POND	STORAGE	18.06	83.03	0 12:11	0.114	0.558	0.086

****
Node Flooding Summary
****
No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
POND	0.014	7.8	0.0	0.0	0.132	73.9	0 12:44	41.81

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
OUT1	19.28	0.69	10.00	0.034
OUT-POSTDEV	39.54	5.44	41.80	0.557
System	29.41	6.13	43.46	0.591

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	65.51	0	12:11	1.74	0.31	0.38
C2	CONDUIT	18.74	0	12:11	1.33	0.08	0.19
C3	CONDUIT	23.59	0	12:15	1.74	0.07	0.18
C4	CONDUIT	23.60	0	12:11	2.12	0.06	0.16
COC	CONDUIT	41.81	0	12:44	1.99	0.14	0.25
COut	CONDUIT	41.81	0	12:44	1.30	0.25	0.34
CPond	CONDUIT	65.52	0	12:11	3.75	0.11	0.22
P-EX	CONDUIT	41.80	0	12:44	2.77	0.09	0.20
01	ORIFICE	11.03	0	12:44			0.00
02	ORIFICE	30.77	0	12:44			0.00
03	WEIR	0.00	0	00:00			0.00

1:100 YEAR

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
SC01	140.59	0.00	0.00	61.80	0.00	77.67	77.67	0.07	17.19	0.553
SC02	140.59	34.43	0.00	53.87	0.00	119.94	119.94	0.23	29.30	0.685
SC03	140.59	0.00	0.00	53.15	0.00	86.26	86.26	0.12	22.76	0.614
SC04	140.59	0.00	0.00	53.38	0.00	86.01	86.01	0.17	28.86	0.612
SC05	140.59	0.00	0.00	53.41	0.00	85.97	85.97	0.13	21.92	0.611
SC06	140.59	0.00	0.00	61.48	0.00	78.03	78.03	0.04	11.65	0.555

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
EX_SWMH3A	JUNCTION	0.02	0.16	43.06	0 12:30	0.16
Outlet_Chamber	JUNCTION	0.01	0.11	44.11	0 12:30	0.11
SWMH1	JUNCTION	0.01	0.16	44.96	0 12:11	0.15
SWMH2	JUNCTION	0.01	0.16	45.46	0 12:11	0.15
SWMH3	JUNCTION	0.00	0.08	46.88	0 12:10	0.08
SWMH4	JUNCTION	0.01	0.08	46.38	0 12:11	0.08
SWMH5	JUNCTION	0.01	0.07	48.87	0 12:10	0.07
SWMH6	JUNCTION	0.64	0.74	43.82	0 12:30	0.74
OUT1	OUTFALL	0.00	0.00	44.00	0 00:00	0.00
OUT-POSTDEV	OUTFALL	0.01	0.09	34.09	0 12:31	0.09
POND	STORAGE	0.09	0.79	44.79	0 12:30	0.79

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
EX_SWMH3A	JUNCTION	0.00	61.88	0 12:30	0	0.655	0.000
Outlet_Chamber	JUNCTION	0.00	61.88	0 12:30	0	0.656	0.000
SWMH1	JUNCTION	0.00	79.59	0 12:11	0	0.522	0.000
SWMH2	JUNCTION	28.86	79.67	0 12:11	0.172	0.522	0.000
SWMH3	JUNCTION	22.76	22.76	0 12:10	0.116	0.116	0.000
SWMH4	JUNCTION	0.00	29.29	0 12:11	0	0.234	0.000
SWMH5	JUNCTION	29.30	29.30	0 12:10	0.235	0.235	0.000
SWMH6	JUNCTION	0.00	61.89	0 12:30	0	0.655	0.000
OUT1	OUTFALL	11.65	11.65	0 12:10	0.0407	0.0407	0.000
OUT-POSTDEV	OUTFALL	0.00	61.87	0 12:31	0	0.655	0.000
POND	STORAGE	21.92	101.39	0 12:11	0.134	0.656	0.115

****
Node Flooding Summary
****
No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow LPS
POND	0.015	8.6	0.0	0.0	0.141	78.8	0 12:30	61.88

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
OUT1	20.05	0.78	11.65	0.041
OUT-POSTDEV	40.74	6.21	61.87	0.655
System	30.39	7.00	64.32	0.696

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	79.59	0	12:11	1.84	0.38	0.43
C2	CONDUIT	22.38	0	12:11	1.40	0.09	0.21
C3	CONDUIT	29.26	0	12:12	1.85	0.09	0.21
C4	CONDUIT	29.29	0	12:11	2.26	0.07	0.18
COC	CONDUIT	61.89	0	12:30	2.22	0.20	0.31
COut	CONDUIT	61.88	0	12:30	1.45	0.37	0.42
CPond	CONDUIT	79.84	0	12:11	3.98	0.13	0.24
P-EX	CONDUIT	61.87	0	12:31	3.10	0.13	0.24
01	ORIFICE	11.42	0	12:30			0.00
02	ORIFICE	35.46	0	12:30			0.00
03	WEIR	15.01	0	12:30			0.00

ANNEXURE C: OPERATION AND MAINTENANCE MANUAL

Graeme McGill Consulting

TABLE C1: STORMWATER MAINTENANCE SCHEDULE

COMPONENT	INSPECTIONS [I]			ROUTINE MAINTENANCE [R]			CORRECTIVE AND IRREGULAR MAINTENANCE [C]			ANNUAL SPREAD OF MAINTENANCE ACTIVITIES (I=INSPECTION; R=ROUTINE; OTHER AS SPECIFIED)											
		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)	J	F	M	A	M	J	J	A	S	O	N	D
Attenuation pond overland inlet strip	1.1	Inspect inlet strip for any obstructions	3	1.1	Remove obstructions	3	1.1	Inspect for damage and repair or replace.	As required	I, R			I, R			I, R			I, R		
Attenuation Pond Forebay	2.1	Inspect forebays for sediment, litter and weeds	3	2.1	Remove sediment, litter and weeds and dispose off site.	3	2.1	Inspect for damage to base or gabion wall and repair.	As required	I, R			I, R			I, R			I, R		
Attenuation Pond Filterbed	3.1	Inspect infiltration bed surfaces for silting and ponding, record dewatering timeof the facility and assess, stating water levels in underdrain (if applicable) to determine if immediate maintenance is required.	3	3.1	Remove silt, litter, surface debris and weeds.	3	3.1	Infill holes and depressions. Replace portions of filterbed which is noted to be non-functioning.	As required	I, R			I, R			I, R			I, R		
	3.2	Check operation of underdrains by inspection of flows after rain.	3	3.2	Rod underdrains to remove sediment and other blockages.	3	3.2	Replace damaged underdrains including stone/geotextile surround.	As required	I, R			I, R			I, R			I, R		
	3.3	Assess plants for diseases, infection, poor growth, invasive species.	3	3.3	Replace diseased, infected and invasive plants. Add plants to maintain coverage.	As required	3.3	As for routine maintenance.	As required	I, R			I, R			I, R			I, R		
	3.4	Inspect inlets and outlets for any blockages	3	3.4	Remove litter, debris and weeds.	3	3.4	Repair structural damage.	As required	I, R			I, R			I, R			I, R		
Attenuation pond grassblock access for vehicles	4.1	Inspect for functionality	3	4.1	Remove surface debris and weeds.	3	4.1	Repair structural damage.	As required	I, R			I, R			I, R			I, R		
Attenuation pond Gabion walls	5.1	Inspect gabion perimeter & forebay walls	3	5.1	Check integrity of wall and repair damage or sagging.		5.1	Repair structural damage.	As required	I, R			I, R			I, R			I, R		
Attenuation pond Outlet structure	6.1	Inspect for blockages of the 3 orifices.	3	6.1	Remove any obstructions. Repair wear and tear.	3	6.1	Repair structural damage.	As required	I, R			I, R			I, R			I, R		
	6.2	Inspect for blockages in the 300dia outlet pipe.	3	6.2	Remove any obstructions. Repair wear and tear.	3	6.2	Repair structural damage.	As required	I, R			I, R			I, R			I, R		
	6.3	Ensure that the steel hinged grid can open and close.	3	6.3	Attend to access problems.	3	6.3	Repair structural damage.	As required	I, R			I, R			I, R			I, R		

TABLE C1 (continued): STORMWATER MAINTENANCE SCHEDULE

COMPONENT	INSPECTIONS [I]			ROUTINE MAINTENANCE [R]			CORRECTIVE AND IRREGULAR MAINTENANCE [C]			ANNUAL SPREAD OF MAINTENANCE ACTIVITIES (I=INSPECTION; R=ROUTINE; OTHER AS SPECIFIED)											
		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)	J	F	M	A	M	J	J	A	S	O	N	D
Attenuation Pond Embankment	7.1	Take note of depressions, subsidence or erosion.	3	7.1	Check that embankment dimensions and elevations comply with original design.	6	7.1	Assess routine maintenance report and storm damage and repair to original specifications.	As required	I, R			I			I, R			I		
	7.2	Take note of vegetative cover on inside and outslopes	3	7.2	Replace diseased, infected and invasive plants. Add plants to maintain coverage.	6	7.2	Assess routine maintenance report and storm damage and repair to original specifications.	As required	I, R			I			I, R			I		
Attenuation pond outfall culvert over SWMH6	8.1	Inspect for functionality & buildup of sediment	3	8.1	Note condition of culvert and patch any defects.	6	8.1	Repair structural damage.	As required	I, R			I			I, R			I		
Stormwater system in internal roads (applies to all sections of development)	9.1	Remove manhole covers and note condition.	3	9.1	Ensure that covers fit well and that manholes are in good condition. Repair if damage is serious.	6	9.1	Repair or replace damaged manholes and covers	As required	I, R			I			I, R			I		
	9.2	Note condition of kerb inlets	3	9.2	Ensure that covers fit well and that manholes are in good condition. Repair if damage is serious.	6	9.2	Repair or replace damaged kerb inlets.	As required	I, R			I			I, R			I		
	9.3	Note condition of	3	9.3	Ensure that covers fit	6	9.3	Repair or replace	As required	I, R			I			I, R			I		