KILGALLEN & PARTNERS
CONSULTING ENGINEERS

John Flanagan Developments Ltd.

Proposed Residential Development at Puttaghan Lands, Tullamore

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Report on Surface Water Drainage

DMS-23 & DMS-24

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REVISION HISTORY

Client	John Flanagan Developments Ltd.
Project	Proposed Residential Development at Puttaghan Lands, Tullamore
Title	Report on Surface Water Drainage

Date	**Detail of Issue**	**Issue No.**	**Origin**	**Checked**	**Approved**
06/10/22	Pre-planning consultation	PL1	SC	PB	PB
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1. Introduction

John Flanagan Developments Ltd ['the Applicant'] is applying to Offaly County Council [the "Planning Authority"] for planning permission for a residential development at Puttaghan Lands, Tullamore, Co. Offaly ['the Site'].

The purpose of this report is to describe the surface water drainage infrastructure that will serve the proposed development. This report has been prepared for planning purposes only.

The following drawings and reports should be read in conjunction with this report:

Type	Ref. No.	Title
Drawing	22009-C-DR-201	Surface Water Drainage – General Layout
Drawing	22009-C-DR-203	Surface Water Sewers - Longitudinal Sections
Drawing	22009-C-DR-205	Surface Water Infrastructure – Standard Details

2. Collection and disposal of surface water run-off

Ground investigation found in-situ soils to be of relatively low permeability and therefore unsuited to point infiltration of surface water run-off from roofs and large paved areas.

Accordingly, paved areas will typically be impermeable and run-off from these areas and from roofs will be collected at surface level (i.e. gullies, channels, downpipes, swales adjoining paved areas, etc) and discharged to an underground drainage network. This network is described in Section 3.

The only exception will be paved areas within the curtilage of houses (i.e. driveways and surrounds), which will be permeable.

Notwithstanding the relatively low permeability, the underground drainage system will include SUDS measures to facilitate the infiltration of surface water run-off to ground. Run-off that does not infiltrate to ground will be carried in the drainage system and ultimately discharged to an open drain immediately upstream of Tinnycross Road, the rate of this discharge being restricted to ensure there will be no impact on the floor regime in the receiving environment. These SUDS measures are described in Section 4.

3. Design of Surface Water Drainage Network

The surface water drainage network comprises gullies, channels and downpipes at surface level collecting run-off and discharging it via collector drains to piped sewers.

The network was designed in accordance with the Greater Dublin Strategic Drainage Study (GDSDS) and using the industry-standard software package 'Storm and Sanitary Analysis'.

In accordance with the above standard, pipes in surface water sewers have been designed using the Modified Rational Method (Wallingford method) to calculate the volume of surface water run-off under storm conditions.

Site-specific rainfall data provided by Met Eireann was used to calculate run-off, after first being factored up by 20% to allow for climate change.

The volume of run-off from a particular surface is affected by the nature of that surface; i.e. permeable surfaces will generate lower run-off then impermeable surfaces. The run-off coefficients given in Table 2-1 show the run-off coefficients applied to arrive at the equivalent impermeable area for each surface type within the proposed development.

Surface Type	Run-off Coefficient
Carriageway, Homezone, Footway, Paved Areas	1.00
Carriageway with Tree Pits one side	0.75
Carriageway with Tree Pits both sides	0.50
Homezone with Roadside Dry Swale	0.70
Roofs	1.00
Permeable Paved Areas, Roofs and Grassed Areas within the curtilage of private houses	0.80
Grassed Area	0.00

Table 2-1 Run-off Coefficients

The volume of run-off for any given rainfall event is arrived at by applying the rainfall depth for that event provided by Met Eireann (factored as described above) to the equivalent impermeable area.

Pipes in the network are designed so that:

- there will be no overflow during rainfall events of 30-year return period with durations between 30 minutes and 1440 minutes;
- only localised overflow occurs during rainfall events of 100-year return period with durations between 30 minutes and 1440 minutes (localised overflow is regarded as an event that that does not threaten water vulnerable areas of the proposed development and does not affect emergency access).

Typically, self-cleansing flows of greater than 0.75m/s are provided; however, this is not always possible at upstream pipe-runs where contributing areas are low. In these cases, minimum gradients of 1:DN or greater are provided, thus meeting the recommendations of IS EN 752-4 for ensuring self-cleansing flow velocities.

4. SUDS Strategy

A SuDS strategy was prepared for the proposed development in accordance with the recommendations of the Greater Dublin Strategic Drainage Study (GDSDS) and CIRIA - The SuDS Manual.

4.1 Measures to facilitate infiltration

<u>Permeable Driveways</u>

Driveways and paved areas within the curtilage of private houses will be of permeable surfacing. During intense rainfall events, run-off infiltrating through the permeable surface will exceed the infiltration capacity of the sub-soil. This excess water will be stored in a porous sub-base under the driveways. All driveways will slope away from houses and towards streets and Homezones so that if rainfall is unable to infiltrate through the driveway during intense rainfall events, it can flow towards the surface water drainage collection network for Streets and Homezones.

<u>Swales</u>

Swales are shallow, vegetated open channels designed to convey and treat surface water run-off. Swales can include a variety of planting that will help to make a positive contribution to urban biodiversity – providing habitat and food for insects, invertebrates and birds. Incorporating swales into the site design enhances the natural landscape while providing aesthetic and biodiversity benefits.

Typically, swales will comprise a shallow grassed channel over a piped drain that is part of the surface water drainage network. The piped drain will be surrounded by a free-draining stone that will facilitate the infiltration of water that has soaked through the grass surface of the swale. The pipe will be perforated to allow the ingress of water from the backfill when run-off entering the backfill exceeds the infiltration capacity of the surrounding soils.

Swales will be placed at roadside edges in the large open space area at the west of the Site; surface water run-off from these roads will flow across the edge and into the swale (thereby removing the need for gullies and collector pipes at these locations). Swales are designed as 'Dry Swales' and so will contain water under normal conditions.

<u>Tree Pits</u>

Tree pits will be used at the roadside edge where perpendicular parking is proposed. Tree pits will collect surface water runoff, removing the need for gullies.

Tree pits and their planting structures provide benefits to surface water collection in the following ways:

- Transpiration – Water is taken from the soil and evaporated through the pores / stomata on the surface of leaves;
- Interception – Trees absorb rainfall, storing and allowing water to evaporate;
- Increased infiltration – Root growth and decomposition increase soil infiltration.

4.2 Restriction of discharge to receiving drainage environment

The maximum permissible discharge rate from the proposed development to the receiving drainage system is calculated in accordance with the GDSDS.

Table 4-1 reproduces the various criteria defined in GDSDS for restricting the rate of discharge. The most onerous of these relates to river flood protection (Criterion No. 4) which ensures development will not lead to an increase in flood risk in receiving watercourses. Long-term storage cannot be provided within the proposed development and so sub-criterion 4.3 will be applied.

Sub-criterion 4.3 restricts permissible discharge to the greater of 2.0 li/sec/hectare or Q_{BAR}.

Calculation of Q_{BAR}

Q_{BAR} is calculated using *Report No. 124 – Flood Estimation for Small Catchments,* published by the Institute of Hydrology, as applied to site-specific catchment characteristics taken from the Flood Studies Report (FSR).

The FSR defines a soil index value of 0.4 for the area in which the Site is located. Figure 4-1 shows the calculation of a Q_{BAR} rate of 39.6 lit/sec using this soil index value. This value of QBAR is considered high and so, applying the precautionary principle, a lower soil index value of 0.2 is used. Figure 4-2 shows the calculation of a Q_{BAR} rate of 16.5 lit/sec using the lower soil index value.

Permissible rate of discharge

From above, Q_{BAR} is calculated as 16.5 lit/sec.

The Site Area is 4hectares which, at 2 lit/sec/ha, gives an equivalent rate of discharge of 8.0 lit /sec.

Accordingly, the permissible rate of discharge is taken as 16.5 lit/sec.

IH124 Estimation of Q_{100} and Q_{1000}			
$Q_{BAR\ RURAL} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$			
Characteristic	**Value**	**Unit**	**Source**
Area (A)	0.040	km²	FSU
Average Annual Rainfall (SAAR)	1105	mm	FSU
G1 % =	0	%	Fig I 4.18
G2 % =	0	%	Fig I 4.18
G3 % =	0%	%	Fig I 4.18
G4 % =	100%	%	Fig I 4.18
G5 % =	0%	%	Fig I 4.18
Soil index (G) =	0.45	%	
$Q_{BAR\ RURAL}$ =	0.04	m3/sec	
CWI =	121		Fig I 6.62
CIND =	44.96		Eqn 7.2
NC =	0.65		Eqn 7.3
URBAN =	0%		FSU
$Q_{BAR\ URBAN} / Q_{BAR\ RURAL}$ =	1.000		Eqn 7.4
Q_{BAR} =	39.8	lit/sec	

Fig 4-1 Calculation of Q_{BAR} for Soil Index Value of 0.4

IH124 Estimation of Q_{100} and Q_{1000}			
$Q_{BAR\ RURAL} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$			
Characteristic	**Value**	**Unit**	**Source**
Area (A)	0.040	km^2	FSU
Average Annual Rainfall (SAAR)	1105	mm	FSU
G1 % =	0	%	Fig I 4.18
G2 % =	100	%	Fig I 4.18
G3 % =	0%	%	Fig I 4.18
G4 % =	0%	%	Fig I 4.18
G5 % =	0%	%	Fig I 4.18
Soil index (G) =	0.30	%	
$Q_{BAR\ RURAL}$ =	0.02	m3/sec	
CWI =	121		Fig I 6.62
CIND =	29.60		Eqn 7.2
NC =	0.65		Eqn 7.3
URBAN =	0%		FSU
$Q_{BAR\ URBAN} / Q_{BAR\ RURAL}$ =	1.000		Eqn 7.4
Q_{BAR} =	16.5	lit/sec	

Fig 4-2 Calculation of Q_{BAR} for Soil Index Value of 0.2

Restriction of discharge

Discharge to the receiving culvert will be restricted to 16.5 lit/sec by installing a constant head / variable discharge flow-control valve at manhole S30, immediately downstream from Storage Area 01.

Storage of attenuated surface water

Restricting the rate of discharge from the proposed development will result in water being attenuated within the Site during intense rainfall events. This attenuated water must be stored temporarily in the Site.

Two underground storage areas are proposed; both using Stormtech chambers (or equivalent) to provide the required storage.

The first storage area is in the large open space towards the west of the Site. The manhole immediately downstream of this storage area (MH S100) will be fitted with a flow control valve that will restrict the rate of discharge to 6 lit/sec. Surface water attenuated by this valve will be stored in the chambers and in the porous stone surround to the chambers.

The second storage area is in the smaller open space towards the east of the Site and close to the receiving culvert. The manhole immediately downstream of this storage area (MH S30) will be fitted with a flow control valve that will restrict the rate of discharge to 0.5 maximum permissible, i.e. 16.5 lit/sec. Surface water attenuated by this valve will be stored in the chambers and in the porous stone surround to the chambers.

Determination of Storage Requirement

The criterion for determining the storage requirement was that sufficient capacity must be provided to store attenuated run-off during rainfall events of 100-year return period with durations between 30 minutes and 1440 minutes.

A model of the surface water network, complete with flow restrictions and storage areas, was prepared in Autodesk Storm and Sanitary Analysis. Performance of the network was modelled for all rainfall events within the range of durations; the critical rainfall events, i.e., the events that generated the greatest storage requirement, was found to be 180 minutes in duration.

Appendix II contains details of the model and the results of the simulation for the critical rainfall event, i.e. 100-year return period and 180-minute duration.

Criteria		Sub-Criterion	Return Period (yrs)	Design Objective	Design Proposal
1	River Quality Protection	1.1	< 1	Interception Storage of at least 5mm, and preferably 10mm, of rainfall where run-off to the receiving water can be prevented	In-situ soils are of low permeability and so the use of infiltration to provide interception storage is not feasible. Notwithstanding this, the drainage system includes chambers to store attenuated surface water. The construction of a drainage layer under these chambers will allow the limited potential for infiltration to be maximised before discharge from the Site.
		1.2	< 1	Where initial runoff from at least 5mm cannot be intercepted, treatment of runoff is required. Retention Pond (if used) to have minimum pool volume equivalent to 15mm rainfall.	A Class 1 discharge bypass separator in accordance with IS EN 858, will be installed on the outfall pipe.
2	River Regime Protection	2.1	1	Discharge rate equal to 1-year greenfield site peak runoff rate or 2l/s/ha, whichever is the greater. Site critical duration storm to be used to assess attenuation storage volume	The surface water system is designed to comply with this sub-criterion.
		2.2	100	Discharge rate equal to 1 in 100-year greenfield site peak runoff rate. Site critical duration storm to be used to assess attenuation storage volume.	The surface water system initially designed to comply with this sub-criterion. The discharge rate was subsequently reduced in order to comply with Criterion 4.
3	Level of Service (flooding) for the Site	3.1	30	No flooding on site except where specifically planned flooding is approved. Summer design storm of 15 or 30 minutes are normally critical.	Flooding does not occur during rainfall events ranging from 30 minutes to 1440 minutes in duration.
		3.2	100	No internal property flooding. Planned flood routing and temporary flood storage accommodated on site for short high intensity storms. Site critical duration events.	Localised overtopping of manholes does not occur during rainfall events ranging from 30 minutes to 1440 minutes.
		3.3	100	No internal property flooding. Floor levels at least 500mm above maximum river level and adjacent onsite storage retention.	Floor levels upstream of the storage areas are at least 500mm above the top water level in the hydrochambers and associated stone surround for the 100-year event. Floor levels throughout are at least 500mm above the top water level at the inlet to the culvert during the 100-year storm.
		3.4	100	No flooding of adjacent urban areas. Overland flooding managed within the development.	Overtopping does not occur during rainfall events ranging from 30 minutes to 1440 minutes. No risk of flooding of adjacent areas.
4	River Flood Protection (Sub-criterion 4.1, 4.2 or 4.3 to be applied)	4.1	100	"Long-term" floodwater accommodated on site for development runoff volume which is in excess of the greenfield runoff volume. Temporary flood storage drained by infiltration on a designated flooding area brought into operation by extreme events only. 100-year, 6-hour duration storm to be used for assessment of the additional volume of runoff.	It is not possible to meet either sub-criterion 4.1 or 4.2; accordingly, the surface water drainage network has been designed to meet sub-criterion 4.3. The rate of discharge will be set at 16.5 lit/sec.
		4.2	100	Infiltration storage provided equal in volume to "long term" storage. Usually designed to operate for all events. 100year, 6-hour duration storm to be used for assessment of the additional volume of runoff.	
		4.3	100	Maximum discharge rate of QBAR or 2 l/s/ha, whichever is the greater, for all attenuation storage where separate "long term" storage cannot be provided	

Table 4-1 SUDS STRATEGY

4.3 Treatment

The infiltration measures described in Section 4.1 and storage measures described in Section 4.3 will provide the following treatments to surface water run-off.

Storage

- the Stormtech storage areas include isolator rows which will trap silts; access chambers to these rows will allow access for inspection, maintenance and silt removal;
- the Stormtech storage areas are surrounded by porous stone which will allow run-off to infiltrate to the surrounding ground insofar as possible, thus facilitating the infiltration of first-flush run-off to ground;
- a Class 1 discharge bypass hydrocarbon separator will be installed downstream of each storage area.

Swales and Tree Pits

- Swales and tree pits will facilitate the infiltration and treatment of first-flush surface water run-off.
- Tree pits will facilitate phytoremediation, by which trace amounts of harmful chemicals are transformed into less harmful substances, used as nutrients and/or stored in roots, stems and leaves.

Permeable Pavements

- permeable pavements will facilitate the infiltration and treatment of first-flush surface water run-off.

5. Maintenance

The surface water drainage system operates entirely under force of gravity.

Drains and gullies in public areas should be inspected on an annual basis, with covers lifted to ensure that manholes remain accessible. Where the inspection reveals evidence of silt or other deposits, these should be sucked out and disposed of appropriately. However, given the nature of the development and the traffic flows that it will generate, it is not anticipated that significant maintenance measures will be required for this infrastructure.

Swales should be inspected half yearly. Inspect infiltration surfaces for ponding, compaction, silt accumulation. Record areas where water is ponding for > 48 hours. Vegetation coverage should be inspected monthly for 6 months, quarterly for 2 years and half yearly thereafter. Areas of poor vegetation growth should be reseeded if bare soil is exposed for over 10% of the swale treatment area. Plant types should be altered to suit conditions if required.

Tree pits should be inspected regularly for litter and debris as well as nuisance plants and vegetation. Inspection of tree health as well as inspection of inlets and outlets is required annually. Any silt build up should be removed and the surface material shall be reinstated. Silt accumulation rates should be monitored to establish appropriate removal frequencies.

Flow control valves, hydrocarbon separators and silt chambers should be inspected and maintained in accordance with manufacturer's recommendations.

Maintenance of electrical infrastructure will not be required.

A Safety File for the infrastructure in public areas will be prepared in accordance with the Safety, Health and Welfare at Work (Construction) Regulations. In terms of the operation and maintenance of the surface water drainage system, the Safety File should set out:

- Drawings and details of the surface water drainage system together with a description of how the system operates and how damage or failures of the system will manifest themselves;
- The maintenance regime to be applied, based on the designer's assessment of maintenance requirements and manufacturer's recommendations;
- Designer's assessment of risks in maintenance or repair that may not be obvious to a competent caretaker of remedial works contractor.

Appendix I

Hydrology

RAINFALL DATA

Return Period	Event Duration													
	5	10	15	30	60	120	180	240	360	540	720	1080	1440	2880
1	4.00	5.60	6.60	8.30	10.60	13.50	15.50	17.10	19.70	22.70	25.10	28.80	31.90	39.20
2	4.60	6.50	7.60	9.60	12.00	15.10	17.30	19.00	21.70	24.80	27.30	31.20	34.30	41.90
5	6.80	9.40	11.10	13.50	16.50	20.20	22.70	24.60	27.70	31.10	33.80	38.00	41.30	49.50
30	11.60	16.10	19.00	22.20	26.10	30.50	33.50	35.80	39.30	43.10	46.00	50.50	54.00	62.90
100	16.20	22.50	26.50	30.30	34.60	39.50	42.70	45.10	48.80	52.70	55.70	60.20	63.70	73.00

FROM MET ERIEANN

Total Rainfall (mm)

Return Period	Event Duration													
	5	10	15	30	60	120	180	240	360	540	720	1080	1440	2880
1	48.00	33.60	26.40	16.60	10.60	6.75	5.17	4.28	3.28	2.52	2.09	1.60	1.33	0.82
2	55.20	39.00	30.40	19.20	12.00	7.55	5.77	4.75	3.62	2.76	2.28	1.73	1.43	0.87
5	81.60	56.40	44.40	27.00	16.50	10.10	7.57	6.15	4.62	3.46	2.82	2.11	1.72	1.03
30	139.20	96.60	76.00	44.40	26.10	15.25	11.17	8.95	6.55	4.79	3.83	2.81	2.25	1.31
100	194.40	135.00	106.00	60.60	34.60	19.75	14.23	11.28	8.13	5.86	4.64	3.34	2.65	1.52

mm / hr

Rainfall Intensity (mm/hr)

Return Period	Event Duration													
	5	10	15	30	60	120	180	240	360	540	720	1080	1440	2880
1	57.60	40.32	31.68	19.92	12.72	8.10	6.20	5.13	3.94	3.03	2.51	1.92	1.60	0.98
2	66.24	46.80	36.48	23.04	14.40	9.06	6.92	5.70	4.34	3.31	2.73	2.08	1.72	1.05
5	97.92	67.68	53.28	32.40	19.80	12.12	9.08	7.38	5.54	4.15	3.38	2.53	2.07	1.24
30	167.04	115.92	91.20	53.28	31.32	18.30	13.40	10.74	7.86	5.75	4.60	3.37	2.70	1.57
100	233.28	162.00	127.20	72.72	41.52	23.70	17.08	13.53	9.76	7.03	5.57	4.01	3.19	1.83

with 20% climate change

Rainfall Intensity (mm/hr) with 20% Climate Change factor

SITE-SPECIFIC RAINFALL DATA *(Source: Met Eireann)*

Appendix II

SURFACE WATER DRAINAGE CALCULATIONS

SUMMARY OF RESULTS FOR RAINFALL EVENTS OF 30-MINUTE AND 180-MINUTE DURATION FOR 1 YEAR, 30 YEAR AND 100 YEAR RETURN PERIOD

Project Description

File Name	22009 Surface Water.SPF

Project Options

Flow Units	LPS
Elevation Type	Elevation
Hydrology Method	Modified Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Rainfall Details

Return Period..	1	years
Event Duration ………………………………………………..	30	minutes

Run-off Coefficients

Carriageway, Homezone, Footway, Paved Areas	1
Carriageway with Tree Pits one side...	0.75
Carriageway with Tree Pits both sides..	0.5
Homezone with Roadside Dry Swale..	0.7
Roofs, Permeable Paving, Grassed areas within the curtilage of private houses.........	0.8
Roofs...	1
Other Grassed Areas	0

Ref.	Area	Run-off Coefficient	Rainfall During Event	Run-off volume
	(sq.m)		(mm)	(m^3)
Sub-01	800	0.8	9.96	6.4
Sub-02	200	0.7	9.96	1.4
Sub-03	300	0.7	9.96	2.1
Sub-04	200	1.0	9.96	2.0
Sub-05	0	1.0	9.96	0.0
Sub-06	200	0.7	9.96	1.4
Sub-07	200	0.8	9.96	1.6
Sub-08	500	0.8	9.96	4.0
Sub-09	700	0.8	9.96	5.6
Sub-10	200	0.7	9.96	1.4
Sub-11	600	0.7	9.96	4.2
Sub-12	200	0.8	9.96	1.6
Sub-13	100	0.8	9.96	0.8
Sub-14	0	0.7	9.96	0.0
Sub-15	100	0.7	9.96	0.7
Sub-16	1300	0.8	9.96	10.4
Sub-17	300	0.7	9.96	2.1
Sub-18	500	0.8	9.96	4.0
Sub-19	200	1.0	9.96	2.0
Sub-20	1200	0.5	9.96	6.0
Sub-21	600	0.8	9.96	4.5
Sub-22	100	0.5	9.96	0.5
Sub-23	800	1.0	9.96	8.0
Sub-24	1100	1.0	9.96	11.0
Sub-25	400	1.0	9.96	4.0
Sub-26	100	1.0	9.96	1.0
Sub-27	400	1.0	9.96	4.0
Sub-28	500	1.0	9.96	5.0
Sub-29	300	1.0	9.96	3.0
Sub-30	200	1.0	9.96	2.0
Sub-31	700	0.8	9.96	5.6
Sub-32	500	0.8	9.96	4.0
Sub-33	1100	0.8	9.96	8.8
Sub-34	300	0.8	9.96	2.4
Sub-35	400	1.0	9.96	4.0
Sub-36	200	0.8	9.96	1.6
Sub-37	200	1.0	9.96	2.0
Sub-38	600	0.8	9.96	4.8
Sub-39	100	0.8	9.96	0.8
Sub-40	200	0.8	9.96	1.6
Sub-41	1000	0.8	9.96	8.0
Sub-42	600	0.8	9.96	4.8
Sub-43	400	0.8	9.96	3.2
Sub-44	700	0.8	9.96	5.6
Sub-45	700	0.8	9.96	5.6
Sub-46	200	0.8	9.96	1.6
			TOTAL RUN-OFF	**100.3**

CONTRIBUTING AREAS

Upstream manhole	Downstream manhole	Length	Invert level		Gradient	Diameter	Peak Flow	Capacity	Peak Flow / Capacity	Peak Flow Velocity	Total Time Surcharged	Status
			Inlet	Outlet								
		(m)	(m)	(m)	(%)	(mm)	(lps)	(lps)		(m/sec)	(min)	
S106	S105	56.90	61.81	61.45	0.62	225	4.1	30.7	0.13	0.51	0.00	Calculated
S105	S104	60.19	61.45	59.80	2.74	225	10.8	64.5	0.17	1.19	0.00	Calculated
S140	S130	40.22	60.78	59.71	2.65	225	3.8	61.1	0.06	0.58	0.00	Calculated
S132	S131	25.67	60.54	60.03	2.01	225	3.9	55.1	0.07	0.82	0.00	Calculated
S130	S120	36.18	59.78	59.49	0.82	225	12.4	35.2	0.35	0.80	0.00	Calculated
S30	S20	9.63	57.80	57.76	0.48	225	**16.5**	31.1	0.53	0.72	0.00	Calculated
S20	S10	44.64	57.76	57.54	0.48	225	16.6	31.1	0.53	0.73	0.00	Calculated
S10	S0 - Outfall	9.13	57.54	57.50	0.48	225	16.5	31.2	0.53	0.77	0.00	Calculated
S52	S51	53.92	58.44	58.15	0.54	225	7.9	32.9	0.24	0.68	0.00	Calculated
S51	S50	9.40	58.08	58.02	0.68	300	11.8	79.5	0.15	0.72	0.00	Calculated
S50	S40	5.02	57.92	57.89	0.52	375	58.6	126.9	0.46	0.86	0.00	Calculated
S53	S52	12.29	58.53	58.44	0.67	225	2.4	36.8	0.06	0.37	0.00	Calculated
S83	S82	71.09	59.80	59.22	0.81	225	3.4	40.2	0.08	0.39	0.00	Calculated
S82	S81	47.02	59.22	58.91	0.66	225	9.1	37.0	0.25	0.76	0.00	Calculated
S81	S80	11.38	58.91	58.80	1.01	225	9.4	45.1	0.21	0.84	0.00	Calculated
S80	S70	39.72	58.66	58.45	0.51	375	26.3	124.9	0.21	0.77	0.00	Calculated
S70	S60	57.88	58.45	58.13	0.57	375	38.4	131.9	0.29	0.95	0.00	Calculated
S60	S50	40.06	58.13	57.92	0.51	375	43.9	125.6	0.35	0.75	0.00	Calculated
S131	S130	12.03	60.03	59.78	2.11	225	4.2	64.0	0.06	0.50	0.00	Calculated
S120	S110	12.50	59.41	59.29	0.97	300	14.7	95.2	0.15	0.74	0.00	Calculated
S100	S90	19.91	59.25	59.14	0.57	150	**6.0**	11.5	0.52	0.74	0.00	Calculated
S90	S80	40.74	59.14	58.80	0.85	225	11.0	41.4	0.26	0.86	0.00	Calculated
S104	S103	10.41	59.73	59.64	0.86	300	10.8	89.8	0.12	0.64	0.00	Calculated
S103	S102	29.37	59.64	59.42	0.72	300	18.5	82.2	0.23	0.72	0.00	Calculated
S102	S101	20.89	59.42	59.32	0.48	300	24.6	67.0	0.37	0.80	0.00	Calculated
S103a	S103	29.73	59.99	59.75	0.80	225	3.6	40.1	0.09	0.61	0.00	Calculated
S40	S30	17.62	57.89	57.80	0.53	375	58.6	127.5	0.46	1.04	0.00	Calculated
S101	S100	9.57	59.32	59.25	0.72	300	24.6	82.3	0.30	0.92	0.00	Calculated
S110	S100	18.40	59.29	59.25	0.20	300	14.7	43.6	0.34	0.63	0.00	Calculated
S511	S51	27.05	58.54	58.15	1.45	230	3.9	54.0	0.07	0.78	0.00	Calculated
S122	S121	25.23	60.00	59.85	0.59	150	1.3	11.7	0.11	0.44	0.00	Calculated
S121	S120	28.44	59.78	59.50	0.96	225	2.3	43.9	0.05	0.57	0.00	Calculated

NETWORK CALCULATIONS

Storage Area 1

Invert level of Sub-base Layer	58.855	m
Invert level of Storage Chamber	59.255	m
Max. Water Level during Critical Storm	59.41	m
Storage Provided at Max. Water level	146.5	m3

Depth above IL (m)	**IL** (m OD)	**Storage Volume (cumulative)** (m^3)	***Storage Type***
0	58.855	0.0	Sub-base Layer
0.025	58.880	5.1	
0.051	58.906	10.4	
0.076	58.931	15.5	
0.102	58.957	20.8	
0.127	58.982	25.9	
0.152	59.007	31.0	
0.178	59.033	36.3	
0.203	59.058	41.4	
0.229	59.084	46.7	
0.254	59.109	51.7	
0.305	59.160	62.1	
0.33	59.185	67.2	
0.356	59.211	72.5	
0.381	59.236	77.6	
0.406	59.261	87.4	Hydrochamber and Stone Surround
0.432	59.287	97.5	
0.483	59.338	117.4	
0.508	59.363	127.0	
0.533	59.388	136.6	
0.559	59.414	146.5	
0.584	59.439	156.0	
0.61	59.465	165.8	
0.635	59.490	175.1	
0.66	59.515	184.4	
0.686	59.541	193.9	
0.711	59.566	203.0	
0.737	59.592	212.4	
0.762	59.617	221.3	
0.787	59.642	230.0	
0.813	59.668	239.0	
0.838	59.693	247.6	
0.864	59.719	256.3	
0.889	59.744	264.6	
0.914	59.769	272.7	
0.94	59.795	281.0	
0.965	59.820	288.7	
0.991	59.846	296.6	
1.016	59.871	303.9	
1.041	59.896	310.9	
1.067	59.922	317.8	
1.092	59.947	324.0	
1.118	59.973	329.9	
1.143	59.998	335.3	
1.168	60.023	340.4	
1.194	60.049	345.7	
1.219	60.074	350.8	
1.245	60.100	356.1	
1.27	60.125	361.1	
1.295	60.150	366.2	

Network Summary for Critical Event 30 minutes

A	Peak Outflow (lps)	6
B	Max Water Level (m)	59.41
C	Storage Provided	366.24
D	Total exfiltration volume (1000-m³)	0.000
E	Total discharge to outfall (m3)	10.8
F	Total amount discharged during event (m3) [= D + E]	10.8
G	Total run-off during event (m3)	100.3
H	Newtork Storage (m3) [= G - (F + C)]	-276.7
	Total Flooded Volume (ha-mm)	0

Storage Area 2

Invert level of Sub-base Layer	57.401	m
Invert level of Storage Chamber	57.801	m
Max. Water Level during Critical Storm	57.99	m
Storage Provided at Max. Water level	190.4	m3

Depth above IL (m)	**IL** (m OD)	**Storage Volume (cumulative)** (m^3)	***Storage Type***
0	57.401	0.0	Sub-base Layer
0.025	57.426	6.6	
0.051	57.452	13.5	
0.076	57.477	20.1	
0.102	57.503	27.0	
0.127	57.528	33.7	
0.152	57.553	40.3	
0.178	57.579	47.2	
0.203	57.604	53.8	
0.229	57.630	60.7	
0.254	57.655	67.3	
0.305	57.706	80.8	
0.33	57.731	87.5	
0.356	57.757	94.4	
0.381	57.782	101.0	
0.406	57.807	111.8	Hydrochamber and Stone Surround
0.432	57.833	123.1	
0.483	57.884	145.2	
0.508	57.909	156.0	
0.533	57.934	166.7	
0.559	57.960	177.7	
0.584	57.985	188.3	
0.61	58.011	199.3	
0.635	58.036	209.8	
0.66	58.061	220.2	
0.686	58.087	230.9	
0.711	58.112	241.1	
0.737	58.138	251.7	
0.762	58.163	261.8	
0.787	58.188	271.7	
0.813	58.214	282.0	
0.838	58.239	291.7	
0.864	58.265	301.8	
0.889	58.290	311.3	
0.914	58.315	320.7	
0.94	58.341	330.2	
0.965	58.366	339.2	
0.991	58.392	348.4	
1.016	58.417	357.0	
1.041	58.442	365.4	
1.067	58.468	373.8	
1.092	58.493	381.5	
1.118	58.519	388.8	
1.143	58.544	395.7	
1.168	58.569	402.4	
1.194	58.595	409.2	
1.219	58.620	415.9	
1.245	58.646	422.8	
1.27	58.671	429.4	
1.295	58.696	436.0	
1.321	58.722	442.9	
1.346	58.747	449.5	
1.372	58.773	456.4	
1.397	58.798	463.0	

Network Summary for Critical Event 30 minutes

A	Peak Outflow (lps)	16.5
B	Max Water Level (m)	57.99
C	Storage Provided	463.05
D	Total exfiltration volume (1000-m³)	0.000
E	Total discharge to outfall (m3)	29.7
F	Total amount discharged during event (m3) [= D + E]	29.7
G	Total run-off during event (m3)	100.3
H	Newtork Storage (m3) [= G - (F + C)]	-392.5
	Total Flooded Volume (ha-mm)	0

Project Description

File Name .... 22009 Surface Water.SPF

Project Options

Flow Units .... LPS
Elevation Type .... Elevation
Hydrology Method .... Modified Rational
Time of Concentration (TOC) Method .... User-Defined
Link Routing Method .... Hydrodynamic
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods .... YES

Rainfall Details

Return Period...	1	years
Event Duration ………………………………………………..	180	minutes

Run-off Coefficients

Carriageway, Homezone, Footway, Paved Areas 1
Carriageway with Tree Pits one side.. 0.75
Carriageway with Tree Pits both sides... 0.5
Homezone with Roadside Dry Swale.. 0.7
Roofs, Permeable Paving, Grassed areas within the curtilage of private houses...... 0.8
Roofs.. 1
Other Grassed Areas 0

Ref.	Area	Run-off Coefficient	Rainfall During Event	Run-off volume
	(sq.m)		(mm)	(m^3)
Sub-01	800	0.8	18.60	11.9
Sub-02	200	0.7	18.60	2.6
Sub-03	300	0.7	18.60	3.9
Sub-04	200	1.0	18.60	3.7
Sub-05	0	1.0	18.60	0.0
Sub-06	200	0.7	18.60	2.6
Sub-07	200	0.8	18.60	3.0
Sub-08	500	0.8	18.60	7.4
Sub-09	700	0.8	18.60	10.4
Sub-10	200	0.7	18.60	2.6
Sub-11	600	0.7	18.60	7.8
Sub-12	200	0.8	18.60	3.0
Sub-13	100	0.8	18.60	1.5
Sub-14	0	0.7	18.60	0.0
Sub-15	100	0.7	18.60	1.3
Sub-16	1300	0.8	18.60	19.3
Sub-17	300	0.7	18.60	3.9
Sub-18	500	0.8	18.60	7.4
Sub-19	200	1.0	18.60	3.7
Sub-20	1200	0.5	18.60	11.2
Sub-21	600	0.8	18.60	8.4
Sub-22	100	0.5	18.60	0.9
Sub-23	800	1.0	18.60	14.9
Sub-24	1100	1.0	18.60	20.5
Sub-25	400	1.0	18.60	7.4
Sub-26	100	1.0	18.60	1.9
Sub-27	400	1.0	18.60	7.4
Sub-28	500	1.0	18.60	9.3
Sub-29	300	1.0	18.60	5.6
Sub-30	200	1.0	18.60	3.7
Sub-31	700	0.8	18.60	10.4
Sub-32	500	0.8	18.60	7.4
Sub-33	1100	0.8	18.60	16.4
Sub-34	300	0.8	18.60	4.5
Sub-35	400	1.0	18.60	7.4
Sub-36	200	0.8	18.60	3.0
Sub-37	200	1.0	18.60	3.7
Sub-38	600	0.8	18.60	8.9
Sub-39	100	0.8	18.60	1.5
Sub-40	200	0.8	18.60	3.0
Sub-41	1000	0.8	18.60	14.9
Sub-42	600	0.8	18.60	8.9
Sub-43	400	0.8	18.60	6.0
Sub-44	700	0.8	18.60	10.4
Sub-45	700	0.8	18.60	10.4
Sub-46	200	0.8	18.60	3.0
			TOTAL RUN-OFF	**187.3**

CONTRIBUTING AREAS

Upstream manhole	Downstream manhole	Length	Invert level		Gradient	Diameter	Peak Flow	Capacity	Peak Flow / Capacity	Peak Flow Velocity	Total Time Surcharged	Status
			Inlet	Outlet								
		(m)	(m)	(m)	(%)	(mm)	(lps)	(lps)		(m/sec)	(min)	
S106	S105	56.90	61.81	61.45	0.62	225	1.3	30.7	0.04	0.37	0.00	Calculated
S105	S104	60.19	61.45	59.80	2.74	225	3.4	64.5	0.05	0.85	0.00	Calculated
S140	S130	40.22	60.78	59.71	2.65	225	1.2	61.1	0.02	0.44	0.00	Calculated
S132	S131	25.67	60.54	60.03	2.01	225	1.2	55.1	0.02	0.59	0.00	Calculated
S130	S120	36.18	59.78	59.49	0.82	225	3.9	35.2	0.11	0.58	0.00	Calculated
S30	S20	9.63	57.80	57.76	0.48	225	**16.5**	31.1	0.53	0.71	0.00	Calculated
S20	S10	44.64	57.76	57.54	0.48	225	16.5	31.1	0.53	0.72	0.00	Calculated
S10	S0 - Outfall	9.13	57.54	57.50	0.48	225	16.5	31.2	0.53	0.77	0.00	Calculated
S52	S51	53.92	58.44	58.15	0.54	225	2.5	32.9	0.07	0.50	0.00	Calculated
S51	S50	9.40	58.08	58.02	0.68	300	3.7	79.5	0.05	0.55	0.00	Calculated
S50	S40	5.02	57.92	57.89	0.52	375	22.4	126.9	0.18	0.72	0.00	Calculated
S53	S52	12.29	58.53	58.44	0.67	225	0.7	36.8	0.02	0.27	0.00	Calculated
S83	S82	71.09	59.80	59.22	0.81	225	1.1	40.2	0.03	0.28	0.00	Calculated
S82	S81	47.02	59.22	58.91	0.66	225	2.8	37.0	0.08	0.56	0.00	Calculated
S81	S80	11.38	58.91	58.80	1.01	225	2.9	45.1	0.07	0.61	0.00	Calculated
S80	S70	39.72	58.66	58.45	0.51	375	12.3	124.9	0.10	0.65	0.00	Calculated
S70	S60	57.88	58.45	58.13	0.57	375	16.1	131.9	0.12	0.76	0.00	Calculated
S60	S50	40.06	58.13	57.92	0.51	375	17.8	125.6	0.14	0.63	0.00	Calculated
S131	S130	12.03	60.03	59.78	2.11	225	1.3	64.0	0.02	0.38	0.00	Calculated
S120	S110	12.50	59.41	59.29	0.97	300	4.6	95.2	0.05	0.59	0.00	Calculated
S100	S90	19.91	59.25	59.14	0.57	150	**6.0**	11.5	0.52	0.74	0.00	Calculated
S90	S80	40.74	59.14	58.80	0.85	225	7.5	41.4	0.18	0.78	0.00	Calculated
S104	S103	10.41	59.73	59.64	0.86	300	3.4	89.8	0.04	0.48	0.00	Calculated
S103	S102	29.37	59.64	59.42	0.72	300	5.8	82.2	0.07	0.56	0.00	Calculated
S102	S101	20.89	59.42	59.32	0.48	300	7.7	67.0	0.11	0.65	0.00	Calculated
S103a	S103	29.73	59.99	59.75	0.80	225	1.1	40.1	0.03	0.44	0.00	Calculated
S40	S30	17.62	57.89	57.80	0.53	375	22.4	127.5	0.18	0.81	0.00	Calculated
S101	S100	9.57	59.32	59.25	0.72	300	7.7	82.3	0.09	0.68	0.00	Calculated
S110	S100	18.40	59.29	59.25	0.20	300	4.6	43.6	0.11	0.45	0.00	Calculated
S511	S51	27.05	58.54	58.15	1.45	230	1.2	54.0	0.02	0.54	0.00	Calculated
S122	S121	25.23	60.00	59.85	0.59	150	0.4	11.7	0.03	0.32	0.00	Calculated
S121	S120	28.44	59.78	59.50	0.96	225	0.7	43.9	0.02	0.40	0.00	Calculated

NETWORK CALCULATIONS

Storage Area 1

Invert level of Sub-base Layer	58.855	m
Invert level of Storage Chamber	59.255	m
Max. Water Level during Critical Storm	59.45	m
Storage Provided at Max. Water level	160.2	m3

Depth above IL (m)	IL (m OD)	Storage Volume (cumulative) (m^3)	*Storage Type*
0	58.855	0.0	Sub-base Layer
0.025	58.880	5.1	
0.051	58.906	10.4	
0.076	58.931	15.5	
0.102	58.957	20.8	
0.127	58.982	25.9	
0.152	59.007	31.0	
0.178	59.033	36.3	
0.203	59.058	41.4	
0.229	59.084	46.7	
0.254	59.109	51.7	
0.279	59.134	56.8	
0.305	59.160	62.1	
0.33	59.185	67.2	
0.356	59.211	72.5	
0.381	59.236	77.6	
0.406	59.261	87.4	Hydrochamber and Stone Surround
0.432	59.287	97.5	
0.457	59.312	107.3	
0.483	59.338	117.4	
0.508	59.363	127.0	
0.533	59.388	136.6	
0.559	59.414	146.5	
0.584	59.439	156.0	
0.61	59.465	165.8	
0.635	59.490	175.1	
0.66	59.515	184.4	
0.686	59.541	193.9	
0.711	59.566	203.0	
0.737	59.592	212.4	
0.762	59.617	221.3	
0.787	59.642	230.0	
0.813	59.668	239.0	
0.838	59.693	247.6	
0.864	59.719	256.3	
0.889	59.744	264.6	
0.914	59.769	272.7	
0.94	59.795	281.0	
0.965	59.820	288.7	
0.991	59.846	296.6	
1.016	59.871	303.9	
1.041	59.896	310.9	
1.067	59.922	317.8	
1.092	59.947	324.0	
1.118	59.973	329.9	
1.143	59.998	335.3	
1.168	60.023	340.4	
1.194	60.049	345.7	
1.219	60.074	350.8	
1.245	60.100	356.1	
1.295	60.150	366.2	

Network Summary for Critical Event 180 minutes

A	Peak Outflow (lps)	6
B	Max Water Level (m)	59.45
C	Storage Provided	366.24
D	Total exfiltration volume (1000-m³)	0.000
E	Total discharge to outfall (m3)	64.8
F	Total amount discharged during event (m3) [= D + E]	64.8
G	Total run-off during event (m3)	516.0
H	Newtork Storage (m3) [= G - (F + C)]	85.0
	Total Flooded Volume (ha-mm)	0

Storage Area 2

Invert level of Sub-base Layer	57.401	m
Invert level of Storage Chamber	57.801	m
Max. Water Level during Critical Storm	58.02	m
Storage Provided at Max. Water level	203.1	m3

Depth above IL (m)	**IL (m OD)**	**Storage Volume (cumulative) (m^3)**	***Storage Type***
0	57.401	0.0	Sub-base Layer
0.025	57.426	6.6	
0.051	57.452	13.5	
0.076	57.477	20.1	
0.102	57.503	27.0	
0.127	57.528	33.7	
0.152	57.553	40.3	
0.178	57.579	47.2	
0.203	57.604	53.8	
0.229	57.630	60.7	
0.254	57.655	67.3	
0.279	57.680	73.9	
0.305	57.706	80.8	
0.33	57.731	87.5	
0.356	57.757	94.4	
0.381	57.782	101.0	
0.406	57.807	111.8	Hydrochamber and Stone Surround
0.432	57.833	123.1	
0.457	57.858	134.0	
0.483	57.884	145.2	
0.508	57.909	156.0	
0.533	57.934	166.7	
0.559	57.960	177.7	
0.584	57.985	188.3	
0.61	58.011	199.3	
0.635	58.036	209.8	
0.66	58.061	220.2	
0.686	58.087	230.9	
0.711	58.112	241.1	
0.737	58.138	251.7	
0.762	58.163	261.8	
0.787	58.188	271.7	
0.813	58.214	282.0	
0.838	58.239	291.7	
0.864	58.265	301.8	
0.889	58.290	311.3	
0.914	58.315	320.7	
0.94	58.341	330.2	
0.965	58.366	339.2	
0.991	58.392	348.4	
1.016	58.417	357.0	
1.041	58.442	365.4	
1.067	58.468	373.8	
1.092	58.493	381.5	
1.118	58.519	388.8	
1.143	58.544	395.7	
1.168	58.569	402.4	
1.194	58.595	409.2	
1.219	58.620	415.9	
1.245	58.646	422.8	
1.27	58.671	429.4	
1.295	58.696	436.0	
1.321	58.722	442.9	
1.346	58.747	449.5	
1.372	58.773	456.4	
1.397	58.798	463.0	

Network Summary for Critical Event 180 minutes

A	Peak Outflow (lps)	16.5
B	Max Water Level (m)	58.02
C	Storage Provided	463.05
D	Total exfiltration volume (1000-m³)	0.000
E	Total discharge to outfall (m3)	178.2
F	Total amount discharged during event (m3) [= D + E]	178.2
G	Total run-off during event (m3)	516.0
H	Newtork Storage (m3) [= G - (F + C)]	-125.3
	Total Flooded Volume (ha-mm)	0

Project Description

File Name .... 22009 Surface Water.SPF

Project Options

Flow Units .... LPS
Elevation Type .... Elevation
Hydrology Method .... Modified Rational
Time of Concentration (TOC) Method .... User-Defined
Link Routing Method .... Hydrodynamic
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods .... YES

Rainfall Details

Return Period...	30	years
Event Duration …………………………………………………..	30	minutes

Run-off Coefficients

Carriageway, Homezone, Footway, Paved Areas 1
Carriageway with Tree Pits one side... 0.75
Carriageway with Tree Pits both sides... 0.5
Homezone with Roadside Dry Swale... 0.7
Roofs, Permeable Paving, Grassed areas within the curtilage of private houses....... 0.8
Roofs.. 1
Other Grassed Areas 0

Ref.	Area	Run-off Coefficient	Rainfall During Event	Run-off volume
	(sq.m)		(mm)	(m^3)
Sub-01	800	0.8	26.64	17.0
Sub-02	200	0.7	26.64	3.7
Sub-03	300	0.7	26.64	5.6
Sub-04	200	1.0	26.64	5.3
Sub-05	0	1.0	26.64	0.0
Sub-06	200	0.7	26.64	3.7
Sub-07	200	0.8	26.64	4.3
Sub-08	500	0.8	26.64	10.7
Sub-09	700	0.8	26.64	14.9
Sub-10	200	0.7	26.64	3.7
Sub-11	600	0.7	26.64	11.2
Sub-12	200	0.8	26.64	4.3
Sub-13	100	0.8	26.64	2.1
Sub-14	0	0.7	26.64	0.0
Sub-15	100	0.7	26.64	1.9
Sub-16	1300	0.8	26.64	27.7
Sub-17	300	0.7	26.64	5.6
Sub-18	500	0.8	26.64	10.7
Sub-19	200	1.0	26.64	5.3
Sub-20	1200	0.5	26.64	16.0
Sub-21	600	0.8	26.64	12.0
Sub-22	100	0.5	26.64	1.3
Sub-23	800	1.0	26.64	21.3
Sub-24	1100	1.0	26.64	29.3
Sub-25	400	1.0	26.64	10.7
Sub-26	100	1.0	26.64	2.7
Sub-27	400	1.0	26.64	10.7
Sub-28	500	1.0	26.64	13.3
Sub-29	300	1.0	26.64	8.0
Sub-30	200	1.0	26.64	5.3
Sub-31	700	0.8	26.64	14.9
Sub-32	500	0.8	26.64	10.7
Sub-33	1100	0.8	26.64	23.4
Sub-34	300	0.8	26.64	6.4
Sub-35	400	1.0	26.64	10.7
Sub-36	200	0.8	26.64	4.3
Sub-37	200	1.0	26.64	5.3
Sub-38	600	0.8	26.64	12.8
Sub-39	100	0.8	26.64	2.1
Sub-40	200	0.8	26.64	4.3
Sub-41	1000	0.8	26.64	21.3
Sub-42	600	0.8	26.64	12.8
Sub-43	400	0.8	26.64	8.5
Sub-44	700	0.8	26.64	14.9
Sub-45	700	0.8	26.64	14.9
Sub-46	200	0.8	26.64	4.3
			TOTAL RUN-OFF	**268.3**

CONTRIBUTING AREAS

Upstream manhole	Downstream manhole	Length	Invert level		Gradient	Diameter	Peak Flow	Capacity	Peak Flow / Capacity	Peak Flow Velocity	Total Time Surcharged	Status
			Inlet	Outlet								
		(m)	(m)	(m)	(%)	(mm)	(lps)	(lps)		(m/sec)	(min)	
S106	S105	56.90	61.81	61.45	0.62	225	10.9	30.7	0.36	0.66	0.00	Calculated
S105	S104	60.19	61.45	59.80	2.74	225	29.3	64.5	0.46	1.55	0.00	Calculated
S140	S130	40.22	60.78	59.71	2.65	225	10.2	61.1	0.17	0.73	0.00	Calculated
S132	S131	25.67	60.54	60.03	2.01	225	10.4	55.1	0.19	1.07	0.00	Calculated
S130	S120	36.18	59.78	59.49	0.82	225	33.7	35.2	0.95	1.00	0.00	Calculated
S30	S20	9.63	57.80	57.76	0.48	225	**16.5**	31.1	0.53	0.72	0.00	Calculated
S20	S10	44.64	57.76	57.54	0.48	225	16.7	31.1	0.54	0.74	0.00	Calculated
S10	S0 - Outfall	9.13	57.54	57.50	0.48	225	16.6	31.2	0.53	0.77	0.00	Calculated
S52	S51	53.92	58.44	58.15	0.54	225	22.0	32.9	0.67	0.86	3.00	SURCHARGED
S51	S50	9.40	58.08	58.02	0.68	300	32.5	79.5	0.41	0.81	27.00	SURCHARGED
S50	S40	5.02	57.92	57.89	0.52	375	145.8	126.9	1.15	1.32	61.00	SURCHARGED
S53	S52	12.29	58.53	58.44	0.67	225	7.3	36.8	0.20	0.46	0.00	Calculated
S83	S82	71.09	59.80	59.22	0.81	225	9.1	40.2	0.23	0.51	0.00	Calculated
S82	S81	47.02	59.22	58.91	0.66	225	24.5	37.0	0.66	0.95	0.00	Calculated
S81	S80	11.38	58.91	58.80	1.01	225	25.2	45.1	0.56	1.06	0.00	Calculated
S80	S70	39.72	58.66	58.45	0.51	375	65.8	124.9	0.53	0.91	0.00	Calculated
S70	S60	57.88	58.45	58.13	0.57	375	91.9	131.9	0.70	1.09	14.00	SURCHARGED
S60	S50	40.06	58.13	57.92	0.51	375	106.6	125.6	0.85	0.97	26.00	SURCHARGED
S131	S130	12.03	60.03	59.78	2.11	225	11.1	64.0	0.17	0.62	0.00	Calculated
S120	S110	12.50	59.41	59.29	0.97	300	39.3	95.2	0.41	0.89	4.00	SURCHARGED
S100	S90	19.91	59.25	59.14	0.57	150	**6.0**	11.5	0.52	0.74	0.00	Calculated
S90	S80	40.74	59.14	58.80	0.85	225	19.6	41.4	0.47	0.99	0.00	Calculated
S104	S103	10.41	59.73	59.64	0.86	300	28.8	89.8	0.32	0.76	0.00	Calculated
S103	S102	29.37	59.64	59.42	0.72	300	49.5	82.2	0.60	0.86	2.00	SURCHARGED
S102	S101	20.89	59.42	59.32	0.48	300	65.7	67.0	0.98	0.96	11.00	SURCHARGED
S103a	S103	29.73	59.99	59.75	0.80	225	9.8	40.1	0.24	0.80	0.00	Calculated
S40	S30	17.62	57.89	57.80	0.53	375	145.8	127.5	1.14	1.42	61.00	SURCHARGED
S101	S100	9.57	59.32	59.25	0.72	300	65.7	82.3	0.80	1.14	102.00	SURCHARGED
S110	S100	18.40	59.29	59.25	0.20	300	39.3	43.6	0.90	0.84	136.00	SURCHARGED
S511	S51	27.05	58.54	58.15	1.45	230	10.9	54.0	0.20	0.99	0.00	Calculated
S122	S121	25.23	60.00	59.85	0.59	150	3.5	11.7	0.30	0.58	0.00	Calculated
S121	S120	28.44	59.78	59.50	0.96	225	6.1	43.9	0.14	0.74	0.00	Calculated

NETWORK CALCULATIONS

Storage Area 1

Invert level of Sub-base Layer	58.855	m
Invert level of Storage Chamber	59.255	m
Max. Water Level during Critical Storm	59.71	m
Storage Provided at Max. Water level	253.3	m3

Depth above IL (m)	IL (m OD)	Storage Volume (cumulative) (m^3)	*Storage Type*
0	58.855	0.0	Sub-base Layer
0.025	58.880	5.1	
0.051	58.906	10.4	
0.076	58.931	15.5	
0.102	58.957	20.8	
0.127	58.982	25.9	
0.152	59.007	31.0	
0.178	59.033	36.3	
0.203	59.058	41.4	
0.229	59.084	46.7	
0.254	59.109	51.7	
0.305	59.160	62.1	
0.33	59.185	67.2	
0.356	59.211	72.5	
0.381	59.236	77.6	
0.406	59.261	87.4	Hydrochamber and Stone Surround
0.432	59.287	97.5	
0.483	59.338	117.4	
0.508	59.363	127.0	
0.533	59.388	136.6	
0.559	59.414	146.5	
0.584	59.439	156.0	
0.61	59.465	165.8	
0.635	59.490	175.1	
0.66	59.515	184.4	
0.686	59.541	193.9	
0.711	59.566	203.0	
0.737	59.592	212.4	
0.762	59.617	221.3	
0.787	59.642	230.0	
0.813	59.668	239.0	
0.838	59.693	247.6	
0.864	59.719	256.3	
0.889	59.744	264.6	
0.914	59.769	272.7	
0.94	59.795	281.0	
0.965	59.820	288.7	
0.991	59.846	296.6	
1.016	59.871	303.9	
1.041	59.896	310.9	
1.067	59.922	317.8	
1.092	59.947	324.0	
1.118	59.973	329.9	
1.143	59.998	335.3	
1.168	60.023	340.4	
1.194	60.049	345.7	
1.219	60.074	350.8	
1.245	60.100	356.1	
1.27	60.125	361.1	
1.295	60.150	366.2	

Network Summary for Critical Event 30 minutes

A	Peak Outflow (lps)	6
B	Max Water Level (m)	59.71
C	Storage Provided	366.24
D	Total exfiltration volume (1000-m³)	0.000
E	Total discharge to outfall (m3)	10.8
F	Total amount discharged during event (m3) [= D + E]	10.8
G	Total run-off during event (m3)	268.3
H	Newtork Storage (m3) [= G - (F + C)]	-108.8
	Total Flooded Volume (ha-mm)	0

Storage Area 2

Invert level of Sub-base Layer	57.401	m
Invert level of Storage Chamber	57.801	m
Max. Water Level during Critical Storm	58.34	m
Storage Provided at Max. Water level	329.8	m3

Depth above IL (m)	IL (m OD)	Storage Volume (cumulative) (m^3)	*Storage Type*
0	57.401	0.0	Sub-base Layer
0.025	57.426	6.6	
0.051	57.452	13.5	
0.076	57.477	20.1	
0.102	57.503	27.0	
0.127	57.528	33.7	
0.152	57.553	40.3	
0.178	57.579	47.2	
0.203	57.604	53.8	
0.229	57.630	60.7	
0.254	57.655	67.3	
0.305	57.706	80.8	
0.33	57.731	87.5	
0.356	57.757	94.4	
0.381	57.782	101.0	
0.406	57.807	111.8	Hydrochamber and Stone Surround
0.432	57.833	123.1	
0.483	57.884	145.2	
0.508	57.909	156.0	
0.533	57.934	166.7	
0.559	57.960	177.7	
0.584	57.985	188.3	
0.61	58.011	199.3	
0.635	58.036	209.8	
0.66	58.061	220.2	
0.686	58.087	230.9	
0.711	58.112	241.1	
0.737	58.138	251.7	
0.762	58.163	261.8	
0.787	58.188	271.7	
0.813	58.214	282.0	
0.838	58.239	291.7	
0.864	58.265	301.8	
0.889	58.290	311.3	
0.914	58.315	320.7	
0.94	58.341	330.2	
0.965	58.366	339.2	
0.991	58.392	348.4	
1.016	58.417	357.0	
1.041	58.442	365.4	
1.067	58.468	373.8	
1.092	58.493	381.5	
1.118	58.519	388.8	
1.143	58.544	395.7	
1.168	58.569	402.4	
1.194	58.595	409.2	
1.219	58.620	415.9	
1.245	58.646	422.8	
1.27	58.671	429.4	
1.295	58.696	436.0	
1.321	58.722	442.9	
1.346	58.747	449.5	
1.372	58.773	456.4	
1.397	58.798	463.0	

Network Summary for Critical Event 30 minutes

A	Peak Outflow (lps)	16.5
B	Max Water Level (m)	58.34
C	Storage Provided	463.05
D	Total exfiltration volume (1000-m³)	0.000
E	Total discharge to outfall (m3)	29.7
F	Total amount discharged during event (m3) [= D + E]	29.7
G	Total run-off during event (m3)	268.3
H	Newtork Storage (m3) [= G - (F + C)]	-224.5
	Total Flooded Volume (ha-mm)	0

Project Description

File Name .... 22009 Surface Water.SPF

Project Options

Flow Units .... LPS
Elevation Type .... Elevation
Hydrology Method .... Modified Rational
Time of Concentration (TOC) Method .... User-Defined
Link Routing Method .... Hydrodynamic
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods .... YES

Rainfall Details

Return Period...	30	years
Event Duration …………………………………………………..	180	minutes

Run-off Coefficients

Carriageway, Homezone, Footway, Paved Areas 1
Carriageway with Tree Pits one side.. 0.75
Carriageway with Tree Pits both sides... 0.5
Homezone with Roadside Dry Swale.. 0.7
Roofs, Permeable Paving, Grassed areas within the curtilage of private houses...... 0.8
Roofs... 1
Other Grassed Areas 0

Ref.	Area (sq.m)	Run-off Coefficient	Rainfall During Event (mm)	Run-off volume (m³)
Sub-01	800	0.8	40.20	25.7
Sub-02	200	0.7	40.20	5.6
Sub-03	300	0.7	40.20	8.4
Sub-04	200	1.0	40.20	8.0
Sub-05	0	1.0	40.20	0.0
Sub-06	200	0.7	40.20	5.6
Sub-07	200	0.8	40.20	6.4
Sub-08	500	0.8	40.20	16.1
Sub-09	700	0.8	40.20	22.5
Sub-10	200	0.7	40.20	5.6
Sub-11	600	0.7	40.20	16.9
Sub-12	200	0.8	40.20	6.4
Sub-13	100	0.8	40.20	3.2
Sub-14	0	0.7	40.20	0.0
Sub-15	100	0.7	40.20	2.8
Sub-16	1300	0.8	40.20	41.8
Sub-17	300	0.7	40.20	8.4
Sub-18	500	0.8	40.20	16.1
Sub-19	200	1.0	40.20	8.0
Sub-20	1200	0.5	40.20	24.1
Sub-21	600	0.8	40.20	18.1
Sub-22	100	0.5	40.20	2.0
Sub-23	800	1.0	40.20	32.2
Sub-24	1100	1.0	40.20	44.2
Sub-25	400	1.0	40.20	16.1
Sub-26	100	1.0	40.20	4.0
Sub-27	400	1.0	40.20	16.1
Sub-28	500	1.0	40.20	20.1
Sub-29	300	1.0	40.20	12.1
Sub-30	200	1.0	40.20	8.0
Sub-31	700	0.8	40.20	22.5
Sub-32	500	0.8	40.20	16.1
Sub-33	1100	0.8	40.20	35.4
Sub-34	300	0.8	40.20	9.6
Sub-35	400	1.0	40.20	16.1
Sub-36	200	0.8	40.20	6.4
Sub-37	200	1.0	40.20	8.0
Sub-38	600	0.8	40.20	19.3
Sub-39	100	0.8	40.20	3.2
Sub-40	200	0.8	40.20	6.4
Sub-41	1000	0.8	40.20	32.2
Sub-42	600	0.8	40.20	19.3
Sub-43	400	0.8	40.20	12.9
Sub-44	700	0.8	40.20	22.5
Sub-45	700	0.8	40.20	22.5
Sub-46	200	0.8	40.20	6.4
			TOTAL RUN-OFF	**404.8**

CONTRIBUTING AREAS

Upstream manhole	Downstream manhole	Length	Invert level		Gradient	Diameter	Peak Flow	Capacity	Peak Flow / Capacity	Peak Flow Velocity	Total Time Surcharged	Status
			Inlet	Outlet								
		(m)	(m)	(m)	(%)	(mm)	(lps)	(lps)		(m/sec)	(min)	
S106	S105	56.90	61.81	61.45	0.62	225	2.7	30.7	0.09	0.46	0.00	Calculated
S105	S104	60.19	61.45	59.80	2.74	225	7.3	64.5	0.11	1.06	0.00	Calculated
S140	S130	40.22	60.78	59.71	2.65	225	2.6	61.1	0.04	0.53	0.00	Calculated
S132	S131	25.67	60.54	60.03	2.01	225	2.6	55.1	0.05	0.73	0.00	Calculated
S130	S120	36.18	59.78	59.49	0.82	225	8.5	35.2	0.24	0.71	0.00	Calculated
S30	S20	9.63	57.80	57.76	0.48	225	**16.5**	31.1	0.53	0.72	0.00	Calculated
S20	S10	44.64	57.76	57.54	0.48	225	16.5	31.1	0.53	0.73	0.00	Calculated
S10	S0 - Outfall	9.13	57.54	57.50	0.48	225	16.5	31.2	0.53	0.77	0.00	Calculated
S52	S51	53.92	58.44	58.15	0.54	225	5.4	32.9	0.16	0.61	0.00	Calculated
S51	S50	9.40	58.08	58.02	0.68	300	8.0	79.5	0.10	0.67	84.00	SURCHARGED
S50	S40	5.02	57.92	57.89	0.52	375	41.4	126.9	0.33	0.80	159.00	SURCHARGED
S53	S52	12.29	58.53	58.44	0.67	225	1.6	36.8	0.04	0.33	0.00	Calculated
S83	S82	71.09	59.80	59.22	0.81	225	2.3	40.2	0.06	0.35	0.00	Calculated
S82	S81	47.02	59.22	58.91	0.66	225	6.1	37.0	0.17	0.69	0.00	Calculated
S81	S80	11.38	58.91	58.80	1.01	225	6.3	45.1	0.14	0.76	0.00	Calculated
S80	S70	39.72	58.66	58.45	0.51	375	19.7	124.9	0.16	0.73	0.00	Calculated
S70	S60	57.88	58.45	58.13	0.57	375	28.0	131.9	0.21	0.87	0.00	Calculated
S60	S50	40.06	58.13	57.92	0.51	375	31.5	125.6	0.25	0.70	0.00	Calculated
S131	S130	12.03	60.03	59.78	2.11	225	2.8	64.0	0.04	0.45	0.00	Calculated
S120	S110	12.50	59.41	59.29	0.97	300	9.9	95.2	0.10	0.68	168.00	SURCHARGED
S100	S90	19.91	59.25	59.14	0.57	150	**6.0**	11.5	0.52	0.74	0.00	Calculated
S90	S80	40.74	59.14	58.80	0.85	225	9.3	41.4	0.23	0.82	0.00	Calculated
S104	S103	10.41	59.73	59.64	0.86	300	7.3	89.8	0.08	0.59	0.00	Calculated
S103	S102	29.37	59.64	59.42	0.72	300	12.5	82.2	0.15	0.69	0.00	Calculated
S102	S101	20.89	59.42	59.32	0.48	300	16.6	67.0	0.25	0.74	156.00	SURCHARGED
S103a	S103	29.73	59.99	59.75	0.80	225	2.4	40.1	0.06	0.55	0.00	Calculated
S40	S30	17.62	57.89	57.80	0.53	375	41.4	127.5	0.32	0.95	181.00	SURCHARGED
S101	S100	9.57	59.32	59.25	0.72	300	16.5	82.3	0.20	0.84	286.00	SURCHARGED
S110	S100	18.40	59.29	59.25	0.20	300	9.9	43.6	0.23	0.56	330.00	SURCHARGED
S511	S51	27.05	58.54	58.15	1.45	230	2.7	54.0	0.05	0.69	0.00	Calculated
S122	S121	25.23	60.00	59.85	0.59	150	0.9	11.7	0.07	0.40	0.00	Calculated
S121	S120	28.44	59.78	59.50	0.96	225	1.5	43.9	0.04	0.51	0.00	Calculated

NETWORK CALCULATIONS

Storage Area 1

Invert level of Sub-base Layer	58.855	m
Invert level of Storage Chamber	59.255	m
Max. Water Level during Critical Storm	59.85	m
Storage Provided at Max. Water level	297.7	m3

Depth above IL (m)	IL (m OD)	Storage Volume (cumulative) (m^3)	*Storage Type*
0	58.855	0.0	Sub-base Layer
0.025	58.880	5.1	
0.051	58.906	10.4	
0.076	58.931	15.5	
0.102	58.957	20.8	
0.127	58.982	25.9	
0.152	59.007	31.0	
0.178	59.033	36.3	
0.203	59.058	41.4	
0.229	59.084	46.7	
0.254	59.109	51.7	
0.279	59.134	56.8	
0.305	59.160	62.1	
0.33	59.185	67.2	
0.356	59.211	72.5	
0.381	59.236	77.6	
0.406	59.261	87.4	Hydrochamber and Stone Surround
0.432	59.287	97.5	
0.457	59.312	107.3	
0.483	59.338	117.4	
0.508	59.363	127.0	
0.533	59.388	136.6	
0.559	59.414	146.5	
0.584	59.439	156.0	
0.61	59.465	165.8	
0.635	59.490	175.1	
0.66	59.515	184.4	
0.686	59.541	193.9	
0.711	59.566	203.0	
0.737	59.592	212.4	
0.762	59.617	221.3	
0.787	59.642	230.0	
0.813	59.668	239.0	
0.838	59.693	247.6	
0.864	59.719	256.3	
0.889	59.744	264.6	
0.914	59.769	272.7	
0.94	59.795	281.0	
0.965	59.820	288.7	
0.991	59.846	296.6	
1.016	59.871	303.9	
1.041	59.896	310.9	
1.067	59.922	317.8	
1.092	59.947	324.0	
1.118	59.973	329.9	
1.143	59.998	335.3	
1.168	60.023	340.4	
1.194	60.049	345.7	
1.219	60.074	350.8	
1.245	60.100	356.1	
1.295	60.150	366.2	

Network Summary for Critical Event 180 minutes

A	Peak Outflow (lps)	6
B	Max Water Level (m)	59.85
C	Storage Provided	366.24
D	Total exfiltration volume (1000-m³)	0.000
E	Total discharge to outfall (m3)	64.8
F	Total amount discharged during event (m3) [= D + E]	64.8
G	Total run-off during event (m3)	516.0
H	Newtork Storage (m3) [= G - (F + C)]	85.0
	Total Flooded Volume (ha-mm)	0

Storage Area 2

Invert level of Sub-base Layer	57.401	m
Invert level of Storage Chamber	57.801	m
Max. Water Level during Critical Storm	58.47	m
Storage Provided at Max. Water level	374.4	m3

Depth above IL (m)	IL (m OD)	Storage Volume (cumulative) (m^3)	***Storage Type***
0	57.401	0.0	Sub-base Layer
0.025	57.426	6.6	
0.051	57.452	13.5	
0.076	57.477	20.1	
0.102	57.503	27.0	
0.127	57.528	33.7	
0.152	57.553	40.3	
0.178	57.579	47.2	
0.203	57.604	53.8	
0.229	57.630	60.7	
0.254	57.655	67.3	
0.279	57.680	73.9	
0.305	57.706	80.8	
0.33	57.731	87.5	
0.356	57.757	94.4	
0.381	57.782	101.0	
0.406	57.807	111.8	Hydrochamber and Stone Surround
0.432	57.833	123.1	
0.457	57.858	134.0	
0.483	57.884	145.2	
0.508	57.909	156.0	
0.533	57.934	166.7	
0.559	57.960	177.7	
0.584	57.985	188.3	
0.61	58.011	199.3	
0.635	58.036	209.8	
0.66	58.061	220.2	
0.686	58.087	230.9	
0.711	58.112	241.1	
0.737	58.138	251.7	
0.762	58.163	261.8	
0.787	58.188	271.7	
0.813	58.214	282.0	
0.838	58.239	291.7	
0.864	58.265	301.8	
0.889	58.290	311.3	
0.914	58.315	320.7	
0.94	58.341	330.2	
0.965	58.366	339.2	
0.991	58.392	348.4	
1.016	58.417	357.0	
1.041	58.442	365.4	
1.067	58.468	373.8	
1.092	58.493	381.5	
1.118	58.519	388.8	
1.143	58.544	395.7	
1.168	58.569	402.4	
1.194	58.595	409.2	
1.219	58.620	415.9	
1.245	58.646	422.8	
1.27	58.671	429.4	
1.295	58.696	436.0	
1.321	58.722	442.9	
1.346	58.747	449.5	
1.372	58.773	456.4	
1.397	58.798	463.0	

Network Summary for Critical Event 180 minutes

A	Peak Outflow (lps)	16.5
B	Max Water Level (m)	58.47
C	Storage Provided	463.05
D	Total exfiltration volume (1000-m³)	0.000
E	Total discharge to outfall (m3)	178.2
F	Total amount discharged during event (m3) [= D + E]	178.2
G	Total run-off during event (m3)	516.0
H	Newtork Storage (m3) [= G - (F + C)]	-125.3
	Total Flooded Volume (ha-mm)	0

Project Description

File Name .... 22009 Surface Water.SPF

Project Options

Flow Units .... LPS
Elevation Type .... Elevation
Hydrology Method .... Modified Rational
Time of Concentration (TOC) Method .... User-Defined
Link Routing Method .... Hydrodynamic
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods .... YES

Rainfall Details

Return Period...	100	years
Event Duration ………………………………………………..	30	minutes

Run-off Coefficients

Carriageway, Homezone, Footway, Paved Areas 1
Carriageway with Tree Pits one side... 0.75
Carriageway with Tree Pits both sides... 0.5
Homezone with Roadside Dry Swale... 0.7
Roofs, Permeable Paving, Grassed areas within the curtilage of private houses....... 0.8
Roofs.. 1
Other Grassed Areas 0

Ref.	Area	Run-off Coefficient	Rainfall During Event	Run-off volume
	(sq.m)		(mm)	(m^3)
Sub-01	800	0.8	36.36	23.3
Sub-02	200	0.7	36.36	5.1
Sub-03	300	0.7	36.36	7.6
Sub-04	200	1.0	36.36	7.3
Sub-05	0	1.0	36.36	0.0
Sub-06	200	0.7	36.36	5.1
Sub-07	200	0.8	36.36	5.8
Sub-08	500	0.8	36.36	14.5
Sub-09	700	0.8	36.36	20.4
Sub-10	200	0.7	36.36	5.1
Sub-11	600	0.7	36.36	15.3
Sub-12	200	0.8	36.36	5.8
Sub-13	100	0.8	36.36	2.9
Sub-14	0	0.7	36.36	0.0
Sub-15	100	0.7	36.36	2.5
Sub-16	1300	0.8	36.36	37.8
Sub-17	300	0.7	36.36	7.6
Sub-18	500	0.8	36.36	14.5
Sub-19	200	1.0	36.36	7.3
Sub-20	1200	0.5	36.36	21.8
Sub-21	600	0.8	36.36	16.4
Sub-22	100	0.5	36.36	1.8
Sub-23	800	1.0	36.36	29.1
Sub-24	1100	1.0	36.36	40.0
Sub-25	400	1.0	36.36	14.5
Sub-26	100	1.0	36.36	3.6
Sub-27	400	1.0	36.36	14.5
Sub-28	500	1.0	36.36	18.2
Sub-29	300	1.0	36.36	10.9
Sub-30	200	1.0	36.36	7.3
Sub-31	700	0.8	36.36	20.4
Sub-32	500	0.8	36.36	14.5
Sub-33	1100	0.8	36.36	32.0
Sub-34	300	0.8	36.36	8.7
Sub-35	400	1.0	36.36	14.5
Sub-36	200	0.8	36.36	5.8
Sub-37	200	1.0	36.36	7.3
Sub-38	600	0.8	36.36	17.5
Sub-39	100	0.8	36.36	2.9
Sub-40	200	0.8	36.36	5.8
Sub-41	1000	0.8	36.36	29.1
Sub-42	600	0.8	36.36	17.5
Sub-43	400	0.8	36.36	11.6
Sub-44	700	0.8	36.36	20.4
Sub-45	700	0.8	36.36	20.4
Sub-46	200	0.8	36.36	5.8
			TOTAL RUN-OFF	**366.1**

CONTRIBUTING AREAS

Upstream manhole	Downstream manhole	Length	Invert level		Gradient	Diameter	Peak Flow	Capacity	Peak Flow / Capacity	Peak Flow Velocity	Total Time Surcharged	Status
			Inlet	Outlet								
		(m)	(m)	(m)	(%)	(mm)	(lps)	(lps)		(m/sec)	(min)	
S106	S105	56.90	61.81	61.45	0.62	225	14.9	30.7	0.49	0.71	0.00	Calculated
S105	S104	60.19	61.45	59.80	2.74	225	40.3	64.5	0.63	1.65	0.00	Calculated
S140	S130	40.22	60.78	59.71	2.65	225	14.0	61.1	0.23	0.78	0.00	Calculated
S132	S131	25.67	60.54	60.03	2.01	225	14.7	55.1	0.27	1.16	0.00	Calculated
S130	S120	36.18	59.78	59.49	0.82	225	46.1	35.2	1.31	1.21	15.00	SURCHARGED
S30	S20	9.63	57.80	57.76	0.48	225	**16.5**	31.1	0.53	0.73	0.00	Calculated
S20	S10	44.64	57.76	57.54	0.48	225	16.7	31.1	0.54	0.75	0.00	Calculated
S10	S0 - Outfall	9.13	57.54	57.50	0.48	225	16.6	31.2	0.53	0.77	0.00	Calculated
S52	S51	53.92	58.44	58.15	0.54	225	31.3	32.9	0.95	0.89	27.00	SURCHARGED
S51	S50	9.40	58.08	58.02	0.68	300	43.5	79.5	0.55	0.84	143.00	SURCHARGED
S50	S40	5.02	57.92	57.89	0.52	375	193.8	126.9	1.53	1.75	196.00	SURCHARGED
S53	S52	12.29	58.53	58.44	0.67	225	10.2	36.8	0.28	0.49	26.00	SURCHARGED
S83	S82	71.09	59.80	59.22	0.81	225	22.7	40.2	0.56	0.69	5.00	SURCHARGED
S82	S81	47.02	59.22	58.91	0.66	225	35.2	37.0	0.95	1.00	24.00	SURCHARGED
S81	S80	11.38	58.91	58.80	1.01	225	36.3	45.1	0.81	1.11	25.00	SURCHARGED
S80	S70	39.72	58.66	58.45	0.51	375	75.3	124.9	0.60	0.89	26.00	SURCHARGED
S70	S60	57.88	58.45	58.13	0.57	375	119.6	131.9	0.91	1.13	28.00	SURCHARGED
S60	S50	40.06	58.13	57.92	0.51	375	139.8	125.6	1.11	1.27	74.00	SURCHARGED
S131	S130	12.03	60.03	59.78	2.11	225	15.8	64.0	0.25	0.66	12.00	SURCHARGED
S120	S110	12.50	59.41	59.29	0.97	300	55.1	95.2	0.58	0.94	230.00	SURCHARGED
S100	S90	19.91	59.25	59.14	0.57	150	**6.0**	11.5	0.52	0.74	21.00	SURCHARGED
S90	S80	40.74	59.14	58.80	0.85	225	26.5	41.4	0.64	0.99	23.00	SURCHARGED
S104	S103	10.41	59.73	59.64	0.86	300	40.2	89.8	0.45	0.75	26.00	SURCHARGED
S103	S102	29.37	59.64	59.42	0.72	300	67.9	82.2	0.83	0.96	34.00	SURCHARGED
S102	S101	20.89	59.42	59.32	0.48	300	90.0	67.0	1.34	1.27	231.00	SURCHARGED
S103a	S103	29.73	59.99	59.75	0.80	225	13.8	40.1	0.34	0.86	12.00	SURCHARGED
S40	S30	17.62	57.89	57.80	0.53	375	194.1	127.5	1.52	1.80	199.00	SURCHARGED
S101	S100	9.57	59.32	59.25	0.72	300	90.0	82.3	1.09	1.35	322.00	SURCHARGED
S110	S100	18.40	59.29	59.25	0.20	300	55.0	43.6	1.26	0.93	356.00	SURCHARGED
S511	S51	27.05	58.54	58.15	1.45	230	15.1	54.0	0.28	1.02	20.00	SURCHARGED
S122	S121	25.23	60.00	59.85	0.59	150	5.0	11.7	0.42	0.63	0.00	Calculated
S121	S120	28.44	59.78	59.50	0.96	225	8.5	43.9	0.19	0.75	1.00	SURCHARGED

NETWORK CALCULATIONS

Storage Area 1

Invert level of Sub-base Layer	58.855	m
Invert level of Storage Chamber	59.255	m
Max. Water Level during Critical Storm	59.94	m
Storage Provided at Max. Water level	322.3	m3

Depth above IL (m)	**IL** (m OD)	**Storage Volume (cumulative)** (m^3)	***Storage Type***
0	58.855	0.0	Sub-base Layer
0.025	58.880	5.1	
0.051	58.906	10.4	
0.076	58.931	15.5	
0.102	58.957	20.8	
0.127	58.982	25.9	
0.152	59.007	31.0	
0.178	59.033	36.3	
0.203	59.058	41.4	
0.229	59.084	46.7	
0.254	59.109	51.7	
0.305	59.160	62.1	
0.33	59.185	67.2	
0.356	59.211	72.5	
0.381	59.236	77.6	
0.406	59.261	87.4	Hydrochamber and Stone Surround
0.432	59.287	97.5	
0.483	59.338	117.4	
0.508	59.363	127.0	
0.533	59.388	136.6	
0.559	59.414	146.5	
0.584	59.439	156.0	
0.61	59.465	165.8	
0.635	59.490	175.1	
0.66	59.515	184.4	
0.686	59.541	193.9	
0.711	59.566	203.0	
0.737	59.592	212.4	
0.762	59.617	221.3	
0.787	59.642	230.0	
0.813	59.668	239.0	
0.838	59.693	247.6	
0.864	59.719	256.3	
0.889	59.744	264.6	
0.914	59.769	272.7	
0.94	59.795	281.0	
0.965	59.820	288.7	
0.991	59.846	296.6	
1.016	59.871	303.9	
1.041	59.896	310.9	
1.067	59.922	317.8	
1.092	59.947	324.0	
1.118	59.973	329.9	
1.143	59.998	335.3	
1.168	60.023	340.4	
1.194	60.049	345.7	
1.219	60.074	350.8	
1.245	60.100	356.1	
1.27	60.125	361.1	
1.295	60.150	366.2	

Network Summary for Critical Event 30 minutes

A	Peak Outflow (lps)	6
B	Max Water Level (m)	59.94
C	Storage Provided	366.24
D	Total exfiltration volume (1000-m³)	0.000
E	Total discharge to outfall (m3)	10.8
F	Total amount discharged during event (m3) [= D + E]	10.8
G	Total run-off during event (m3)	366.1
H	Newtork Storage (m3) [= G - (F + C)]	-10.9
	Total Flooded Volume (ha-mm)	0

Storage Area 2

Invert level of Sub-base Layer	57.401	m
Invert level of Storage Chamber	57.801	m
Max. Water Level during Critical Storm	58.59	m
Storage Provided at Max. Water level	407.9	m3

Depth above IL (m)	**IL (m OD)**	**Storage Volume (cumulative) (m^3)**	***Storage Type***
0	57.401	0.0	Sub-base Layer
0.025	57.426	6.6	
0.051	57.452	13.5	
0.076	57.477	20.1	
0.102	57.503	27.0	
0.127	57.528	33.7	
0.152	57.553	40.3	
0.178	57.579	47.2	
0.203	57.604	53.8	
0.229	57.630	60.7	
0.254	57.655	67.3	
0.305	57.706	80.8	
0.33	57.731	87.5	
0.356	57.757	94.4	
0.381	57.782	101.0	
0.406	57.807	111.8	Hydrochamber and Stone Surround
0.432	57.833	123.1	
0.483	57.884	145.2	
0.508	57.909	156.0	
0.533	57.934	166.7	
0.559	57.960	177.7	
0.584	57.985	188.3	
0.61	58.011	199.3	
0.635	58.036	209.8	
0.66	58.061	220.2	
0.686	58.087	230.9	
0.711	58.112	241.1	
0.737	58.138	251.7	
0.762	58.163	261.8	
0.787	58.188	271.7	
0.813	58.214	282.0	
0.838	58.239	291.7	
0.864	58.265	301.8	
0.889	58.290	311.3	
0.914	58.315	320.7	
0.94	58.341	330.2	
0.965	58.366	339.2	
0.991	58.392	348.4	
1.016	58.417	357.0	
1.041	58.442	365.4	
1.067	58.468	373.8	
1.092	58.493	381.5	
1.118	58.519	388.8	
1.143	58.544	395.7	
1.168	58.569	402.4	
1.194	58.595	409.2	
1.219	58.620	415.9	
1.245	58.646	422.8	
1.27	58.671	429.4	
1.295	58.696	436.0	
1.321	58.722	442.9	
1.346	58.747	449.5	
1.372	58.773	456.4	
1.397	58.798	463.0	

Network Summary for Critical Event 30 minutes

A	Peak Outflow (lps)	16.5
B	Max Water Level (m)	58.59
C	Storage Provided	463.05
D	Total exfiltration volume (1000-m³)	0.000
E	Total discharge to outfall (m3)	29.7
F	Total amount discharged during event (m3) [= D + E]	29.7
G	Total run-off during event (m3)	366.1
H	Newtork Storage (m3) [= G - (F + C)]	-126.6
	Total Flooded Volume (ha-mm)	0

Project Description

File Name .... 22009 Surface Water.SPF

Project Options

Flow Units .... LPS
Elevation Type .... Elevation
Hydrology Method .... Modified Rational
Time of Concentration (TOC) Method .... User-Defined
Link Routing Method .... Hydrodynamic
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods .... YES

Rainfall Details

Return Period..	100	years
Event Duration …………………………………………………..	180	minutes

Run-off Coefficients

Carriageway, Homezone, Footway, Paved Areas 1
Carriageway with Tree Pits one side.. 0.75
Carriageway with Tree Pits both sides... 0.5
Homezone with Roadside Dry Swale.. 0.7
Roofs, Permeable Paving, Grassed areas within the curtilage of private houses...... 0.8
Roofs... 1
Other Grassed Areas 0

Ref.	Area (sq.m)	Run-off Coefficient	Rainfall During Event (mm)	Run-off volume (m^3)
Sub-01	800	0.8	51.24	32.8
Sub-02	200	0.7	51.24	7.2
Sub-03	300	0.7	51.24	10.8
Sub-04	200	1.0	51.24	10.2
Sub-05	0	1.0	51.24	0.0
Sub-06	200	0.7	51.24	7.2
Sub-07	200	0.8	51.24	8.2
Sub-08	500	0.8	51.24	20.5
Sub-09	700	0.8	51.24	28.7
Sub-10	200	0.7	51.24	7.2
Sub-11	600	0.7	51.24	21.5
Sub-12	200	0.8	51.24	8.2
Sub-13	100	0.8	51.24	4.1
Sub-14	0	0.7	51.24	0.0
Sub-15	100	0.7	51.24	3.6
Sub-16	1300	0.8	51.24	53.3
Sub-17	300	0.7	51.24	10.8
Sub-18	500	0.8	51.24	20.5
Sub-19	200	1.0	51.24	10.2
Sub-20	1200	0.5	51.24	30.7
Sub-21	600	0.8	51.24	23.1
Sub-22	100	0.5	51.24	2.6
Sub-23	800	1.0	51.24	41.0
Sub-24	1100	1.0	51.24	56.4
Sub-25	400	1.0	51.24	20.5
Sub-26	100	1.0	51.24	5.1
Sub-27	400	1.0	51.24	20.5
Sub-28	500	1.0	51.24	25.6
Sub-29	300	1.0	51.24	15.4
Sub-30	200	1.0	51.24	10.2
Sub-31	700	0.8	51.24	28.7
Sub-32	500	0.8	51.24	20.5
Sub-33	1100	0.8	51.24	45.1
Sub-34	300	0.8	51.24	12.3
Sub-35	400	1.0	51.24	20.5
Sub-36	200	0.8	51.24	8.2
Sub-37	200	1.0	51.24	10.2
Sub-38	600	0.8	51.24	24.6
Sub-39	100	0.8	51.24	4.1
Sub-40	200	0.8	51.24	8.2
Sub-41	1000	0.8	51.24	41.0
Sub-42	600	0.8	51.24	24.6
Sub-43	400	0.8	51.24	16.4
Sub-44	700	0.8	51.24	28.7
Sub-45	700	0.8	51.24	28.7
Sub-46	200	0.8	51.24	8.2
			TOTAL RUN-OFF	**516.0**

CONTRIBUTING AREAS

Upstream manhole	Downstream manhole	Length	Invert level		Gradient	Diameter	Peak Flow	Capacity	Peak Flow / Capacity	Peak Flow Velocity	Total Time Surcharged	Status
			Inlet	Outlet								
		(m)	(m)	(m)	(%)	(mm)	(lps)	(lps)		(m/sec)	(min)	
S106	S105	56.90	61.81	61.45	0.62	225	3.5	30.7	0.11	0.49	0.00	Calculated
S105	S104	60.19	61.45	59.80	2.74	225	9.4	64.5	0.15	1.14	0.00	Calculated
S140	S130	40.22	60.78	59.71	2.65	225	3.3	61.1	0.05	0.56	0.00	Calculated
S132	S131	25.67	60.54	60.03	2.01	225	3.4	55.1	0.06	0.78	0.00	Calculated
S130	S120	36.18	59.78	59.49	0.82	225	10.9	35.2	0.31	0.76	108.00	SURCHARGED
S30	S20	9.63	57.80	57.76	0.48	225	**16.5**	31.1	0.53	0.72	0.00	Calculated
S20	S10	44.64	57.76	57.54	0.48	225	16.5	31.1	0.53	0.73	0.00	Calculated
S10	S0 - Outfall	9.13	57.54	57.50	0.48	225	16.5	31.2	0.53	0.77	0.00	Calculated
S52	S51	53.92	58.44	58.15	0.54	225	6.9	32.9	0.21	0.66	94.00	SURCHARGED
S51	S50	9.40	58.08	58.02	0.68	300	10.2	79.5	0.13	0.70	289.00	SURCHARGED
S50	S40	5.02	57.92	57.89	0.52	375	51.1	126.9	0.40	0.83	357.00	SURCHARGED
S53	S52	12.29	58.53	58.44	0.67	225	2.0	36.8	0.06	0.35	44.00	SURCHARGED
S83	S82	71.09	59.80	59.22	0.81	225	2.9	40.2	0.07	0.38	0.00	Calculated
S82	S81	47.02	59.22	58.91	0.66	225	7.8	37.0	0.21	0.74	0.00	Calculated
S81	S80	11.38	58.91	58.80	1.01	225	8.9	45.1	0.20	0.81	0.00	Calculated
S80	S70	39.72	58.66	58.45	0.51	375	24.4	124.9	0.20	0.76	0.00	Calculated
S70	S60	57.88	58.45	58.13	0.57	375	34.1	131.9	0.26	0.92	14.00	SURCHARGED
S60	S50	40.06	58.13	57.92	0.51	375	38.5	125.6	0.31	0.73	202.00	SURCHARGED
S131	S130	12.03	60.03	59.78	2.11	225	3.7	64.0	0.06	0.48	0.00	Calculated
S120	S110	12.50	59.41	59.29	0.97	300	12.6	95.2	0.13	0.72	419.00	SURCHARGED
S100	S90	19.91	59.25	59.14	0.57	150	**6.0**	11.5	0.52	0.74	0.00	Calculated
S90	S80	40.74	59.14	58.80	0.85	225	10.4	41.4	0.25	0.84	0.00	Calculated
S104	S103	10.41	59.73	59.64	0.86	300	9.3	89.8	0.10	0.62	95.00	SURCHARGED
S103	S102	29.37	59.64	59.42	0.72	300	15.9	82.2	0.19	0.71	173.00	SURCHARGED
S102	S101	20.89	59.42	59.32	0.48	300	21.1	67.0	0.32	0.78	409.00	SURCHARGED
S103a	S103	29.73	59.99	59.75	0.80	225	3.1	40.1	0.08	0.59	0.00	Calculated
S40	S30	17.62	57.89	57.80	0.53	375	51.1	127.5	0.40	1.00	378.00	SURCHARGED
S101	S100	9.57	59.32	59.25	0.72	300	21.1	82.3	0.26	0.89	531.00	SURCHARGED
S110	S100	18.40	59.29	59.25	0.20	300	12.6	43.6	0.29	0.60	571.00	SURCHARGED
S511	S51	27.05	58.54	58.15	1.45	230	3.4	54.0	0.06	0.74	35.00	SURCHARGED
S122	S121	25.23	60.00	59.85	0.59	150	1.2	11.7	0.10	0.42	0.00	Calculated
S121	S120	28.44	59.78	59.50	0.96	225	2.0	43.9	0.04	0.55	112.00	SURCHARGED

NETWORK CALCULATIONS

Storage Area 1

Invert level of Sub-base Layer	58.855	m
Invert level of Storage Chamber	59.255	m
Max. Water Level during Critical Storm	60.15	m
Storage Provided at Max. Water level	366.2	m3

Depth above IL (m)	IL (m OD)	Storage Volume (cumulative) (m^3)	*Storage Type*
0	58.855	0.0	Sub-base Layer
0.025	58.880	5.1	
0.051	58.906	10.4	
0.076	58.931	15.5	
0.102	58.957	20.8	
0.127	58.982	25.9	
0.152	59.007	31.0	
0.178	59.033	36.3	
0.203	59.058	41.4	
0.229	59.084	46.7	
0.254	59.109	51.7	
0.279	59.134	56.8	
0.305	59.160	62.1	
0.33	59.185	67.2	
0.356	59.211	72.5	
0.381	59.236	77.6	
0.406	59.261	87.4	Hydrochamber and Stone Surround
0.432	59.287	97.5	
0.457	59.312	107.3	
0.483	59.338	117.4	
0.508	59.363	127.0	
0.533	59.388	136.6	
0.559	59.414	146.5	
0.584	59.439	156.0	
0.61	59.465	165.8	
0.635	59.490	175.1	
0.66	59.515	184.4	
0.686	59.541	193.9	
0.711	59.566	203.0	
0.737	59.592	212.4	
0.762	59.617	221.3	
0.787	59.642	230.0	
0.813	59.668	239.0	
0.838	59.693	247.6	
0.864	59.719	256.3	
0.889	59.744	264.6	
0.914	59.769	272.7	
0.94	59.795	281.0	
0.965	59.820	288.7	
0.991	59.846	296.6	
1.016	59.871	303.9	
1.041	59.896	310.9	
1.067	59.922	317.8	
1.092	59.947	324.0	
1.118	59.973	329.9	
1.143	59.998	335.3	
1.168	60.023	340.4	
1.194	60.049	345.7	
1.219	60.074	350.8	
1.245	60.100	356.1	
1.295	60.150	366.2	

Network Summary for Critical Event 180 minutes

A	Peak Outflow (lps)	6
B	Max Water Level (m)	60.15
C	Storage Provided	366.24
D	Total exfiltration volume (1000-m³)	0.000
E	Total discharge to outfall (m3)	64.8
F	Total amount discharged during event (m3) [= D + E]	64.8
G	Total run-off during event (m3)	516.0
H	Newtork Storage (m3) [= G - (F + C)]	85.0
	Total Flooded Volume (ha-mm)	0

Storage Area 2

Invert level of Sub-base Layer	57.401	m
Invert level of Storage Chamber	57.801	m
Max. Water Level during Critical Storm	59	m
Storage Provided at Max. Water level	463.0	m3

Depth above IL (m)	**IL (m OD)**	**Storage Volume (cumulative) (m^3)**	***Storage Type***
0	57.401	0.0	Sub-base Layer
0.025	57.426	6.6	
0.051	57.452	13.5	
0.076	57.477	20.1	
0.102	57.503	27.0	
0.127	57.528	33.7	
0.152	57.553	40.3	
0.178	57.579	47.2	
0.203	57.604	53.8	
0.229	57.630	60.7	
0.254	57.655	67.3	
0.279	57.680	73.9	
0.305	57.706	80.8	
0.33	57.731	87.5	
0.356	57.757	94.4	
0.381	57.782	101.0	
0.406	57.807	111.8	Hydrochamber and Stone Surround
0.432	57.833	123.1	
0.457	57.858	134.0	
0.483	57.884	145.2	
0.508	57.909	156.0	
0.533	57.934	166.7	
0.559	57.960	177.7	
0.584	57.985	188.3	
0.61	58.011	199.3	
0.635	58.036	209.8	
0.66	58.061	220.2	
0.686	58.087	230.9	
0.711	58.112	241.1	
0.737	58.138	251.7	
0.762	58.163	261.8	
0.787	58.188	271.7	
0.813	58.214	282.0	
0.838	58.239	291.7	
0.864	58.265	301.8	
0.889	58.290	311.3	
0.914	58.315	320.7	
0.94	58.341	330.2	
0.965	58.366	339.2	
0.991	58.392	348.4	
1.016	58.417	357.0	
1.041	58.442	365.4	
1.067	58.468	373.8	
1.092	58.493	381.5	
1.118	58.519	388.8	
1.143	58.544	395.7	
1.168	58.569	402.4	
1.194	58.595	409.2	
1.219	58.620	415.9	
1.245	58.646	422.8	
1.27	58.671	429.4	
1.295	58.696	436.0	
1.321	58.722	442.9	
1.346	58.747	449.5	
1.372	58.773	456.4	
1.397	58.798	463.0	

Network Summary for Critical Event 180 minutes

A Peak Outflow (lps) 16.5

B Max Water Level (m) 59

C Storage Provided 463.05

D Total exfiltration volume (1000-m³) 0.000

E Total discharge to outfall (m3) 178.2

F Total amount discharged during event (m3) [= D + E] 178.2

G Total run-off during event (m3) 516.0

H Newtork Storage (m3) [= G - (F + C)] .... -125.3

Total Flooded Volume (ha-mm) 0

Appendix III

Stormtech Chambers

StormTech®
a product of ADS® Europe

Product Catalogue

Not intended for design layouts; refer to the appropriate "StormTech Design Manual" for specific chamber design information.

StormTech Subsurface Stomwater Management

Table of Contents

StormTech has well over ten thousand chamber systems in service throughout the world. All StormTech chambers are designed to meet the most stringent industry performance standards for superior structural integrity. The StormTech system is designed primarily to be used under car parks, roadways and heavy earth loads saving valuable land and protecting water resources for commercial and municipal applications. In our continuing desire to answer designers' challenges, StormTech has expanded the family of products providing engineers, developers, regulators and contractors with additional site specific flexibility.

Advanced Structural Performance for Greater Long-Term Reliability

StormTech developed a state of the art chamber design through:

- Collaboration with world-renowned experts of buried drainage structures to develop and evaluate the structural testing program and product design
- Designing chambers to meet and exceed various European standards for both dynamic and long-term static loads.
- Subjecting the chambers to rigorous full-scale, third party testing, under severe loading conditions to verify their performance both under dynamic loads as well as long term static loads.

Our Chambers Provide...

- Extremely *efficient transportation.* Stacking of the chambers results in lower cost per m³ installed volume while being more eco-friendly.
- A *remarkably quick installation.* For example: Ten of the MC-3500 chambers, providing a total installed storage of over 55 m³, can be easily installed in 10 minutes. When installing the same 55 m³ using box type systems you would need to install 125 to 250 boxes, taking significantly more time!
- The *strength* of concrete tanks, but at a very competitive price.
- A robust, *continuous, true elliptical arch design* which effectively transfers loads into the surrounding backfill providing the long-term safety factor required by various local standards. This offers developers a cost-effective underground system that will perform as designed for decades.
- A *design in accordance with various local European design specifications* providing engineers with a structural performance standard for live and long-term dead loads.
- Innovative *polypropylene and polyethylene* resins which have been tested using international standards to ensure long and short-term structural properties.
- Uniform wall thickness and repeatable quality due to *injection mold production.*
- Third party *tested and patented Isolator® Row* for less frequent maintenance, water quality, and long-term performance.
- *Traditional manifold/header designs* using conventional hydraulic equations that can easily verify flow equalization and scour velocity.
- *Open chamber design* requiring only one chamber model to construct each row assuring ease of construction and no repeating end walls to obstruct access or flow.

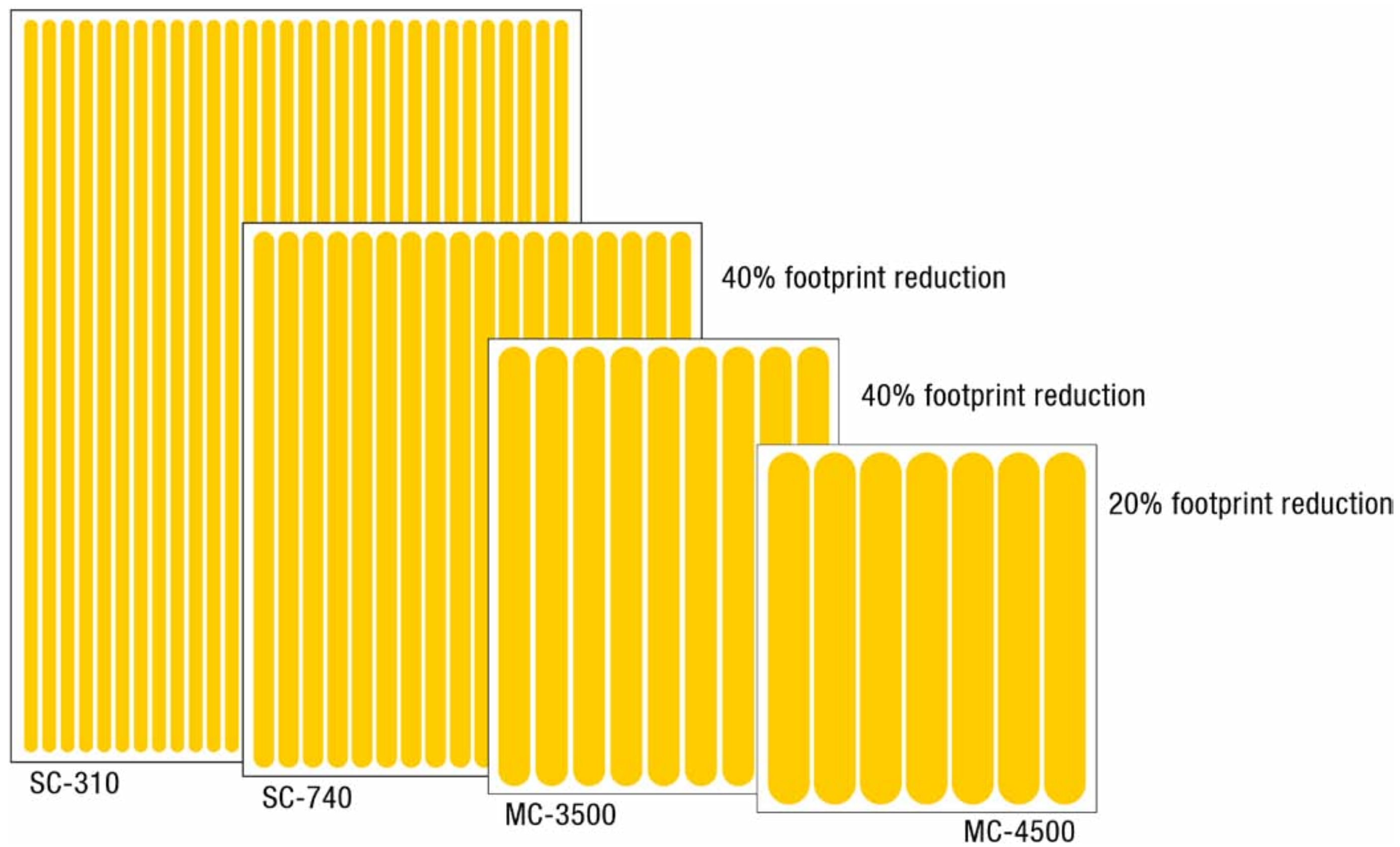
StormTech offers a variety of chamber sizes (SC-310, SC-740, DC-780, MC-3500 and MC-4500) so the consulting design engineer can choose the chamber that is best suited for the site conditions and regulatory requirements. StormTech has well over ten thousand chamber systems in service worldwide. We provide plan layout and cost estimate services at no charge for consulting engineers and developers.

StormTech Specifications and Product Comparison

PRODUCT SPECIFICATIONS	SC-310	SC-740	DC-780	MC-3500	MC-4500
Height, mm	405	760	760	1140	1525
Width, mm	865	1295	1295	1955	2540
Length, mm	2300	2300	2300	2285	1320
Installed Length, mm	2170	2170	2170	2185	1230
Bare Chamber Storage, m³	0.42	1.30	1.30	3.11	3.01
Stone above, mm	150	150	150	300	300
Foundation Stone, mm*	150	150	230	230	230
Row Spacing, mm	150	150	150	150	230
Minimum Installed Storage, m³	**0.88**	**2.12**	**2.22**	**5.06**	**4.60**
Storage Per Unit Area, m³	0.39	0.67	0.70	1.06	1.35

**Please refer to the design manual.*

Example: Footprint Comparison - 1000m³ Project



StormTech LEED® Credits

List of LEED Credits that StormTech may contribute toward:

SUSTAINABLE SITES

- **SS Credit 5.1 Site Development: Protect or Restore Habitat**
  Utilizing StormTech System beneath roadways, surface parking, walkways, etc. may reduce overall site disturbance.
- **SS Credit 5.2 Site Development: Maximize Open Space**
  Utilizing StormTech System can increase overall open space and may reduce overall site disturbance.
- **SS Credit 6.1 Stormwater Design: Quantity Control**
  Design StormTech System per local or LEED stormwater quantity requirements, whichever is more stringent.
- **SS Credit 6.2 Stormwater Design: Quality Control**
  Use of Isolator Row provides sediment removal, and can also promote infiltration and groundwater recharge.
- **SS Credit 7.1 Heat Island Effect: Non-Roof**
  Use of StormTech System may eliminate need for above ground detention ponds, thus reducing thermal impacts of stormwater runoff.

WATER EFFICIENCY

- **WE Credit 1 Water Efficient Landscaping**
  Utilize StormTech System to store captured rainwater for landscape irrigation.
- **WE Credit 2 Innovative Water Technologies**
  Utilize StormTech System to store captured rainwater to reduce potable water demand.
- **WE Credit 3 Water Use Reduction**
  Utilize StormTech System to store captured rainwater and allow reuse for non-potable applications.

MATERIALS

- **MR Credit 4 Recycled Content**
  Utilize recycled concrete as the backfill material for the StormTech System.
- **MR Credit 5 Regional Materials**
  Stone backfill material for the StormTech System will apply if extracted within 500 miles of project site.

INNOVATION & DESIGN

- **ID Credit 1 Innovation in Design**
  Utilize StormTech System to substantially exceed a performance credit.

StormTech SC-310 Chamber Specifications

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech SC-310 system is designed primarily to be used under car parks thus maximizing land usage for commercial and municipal applications.

StormTech SC-310 Chamber (not to scale)

Nominal Chamber Specifications

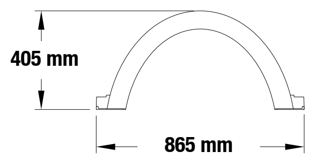
Size (L x W x H)	2170 x 865 x 405 mm
Chamber Storage	0.42 m³
Min. Installed Storage*	0.88 m³
Weight	17.5 kg

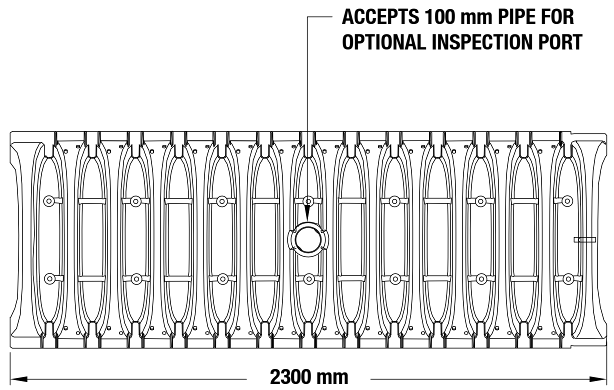
**Assumes 150 mm stone above, below and between chambers and 40% stone porosity.*

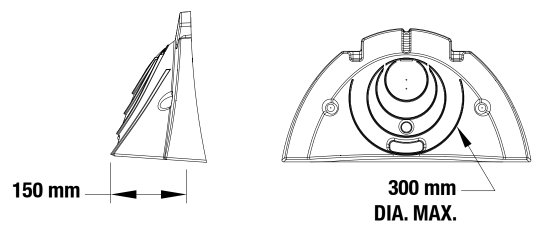
Transportation:

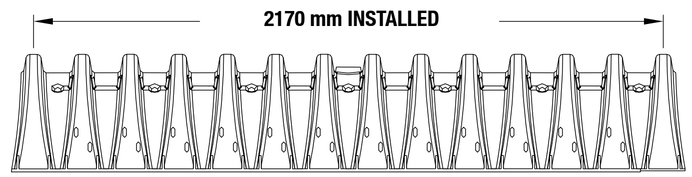
656 chambers per truck

(over 580 m³ storage per truck)









StormTech SC-310 Chamber Specifications

CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F 2922 (POLYETHYLENE CHAMBERS) OR ASTM F2418 (POLYPROPYLENE CHAMBERS)

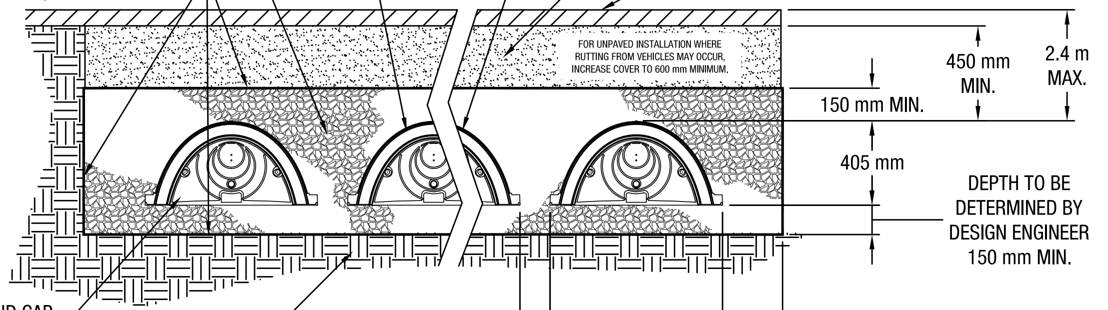
NOMINAL 20 mm - 50 mm CLEAN, CRUSHED, ANGULAR STONE (AASHTO M43 #3 THROUGH #57 STONE SIZES ALLOWED)

ADS 601T NON-WOVEN GEOTEXTILE ALL AROUND CLEAN, CRUSHED, ANGULAR STONE

CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH THE REQUIREMENTS OF ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".

GRANULAR WELL GRADED SOIL/AGGREGATE MIXTURES, <35% FINES. COMPACT IN 150 mm LIFTS TO 95% STANDARD PROCTOR DENSITY. SEE THE TABLE OF ACCEPTABLE FILL MATERIALS

PAVEMENT



SC-310 END CAP

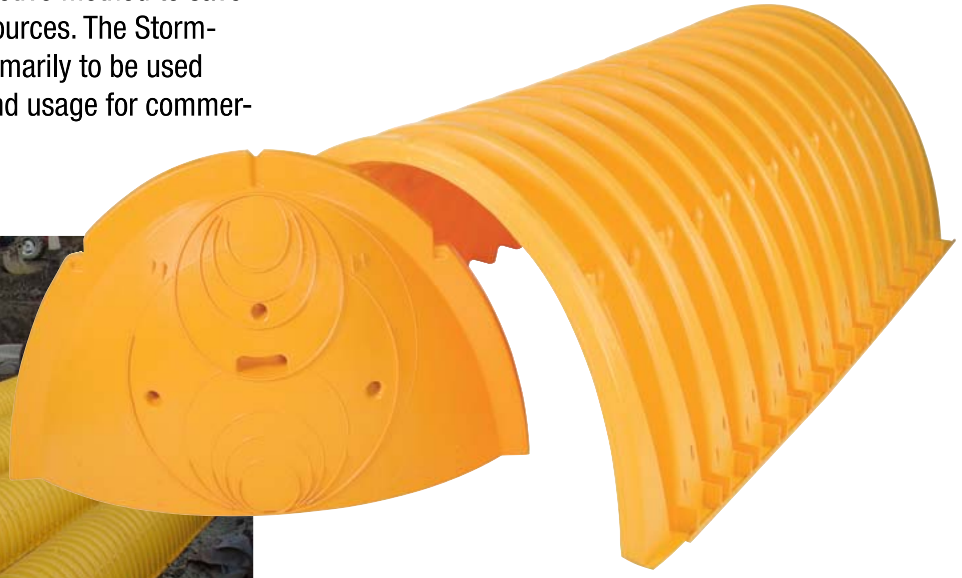
DESIGN ENGINEER RESPONSIBLE FOR ENSURING THE REQUIRED BEARING CAPACITY OF SUBGRADE SOILS

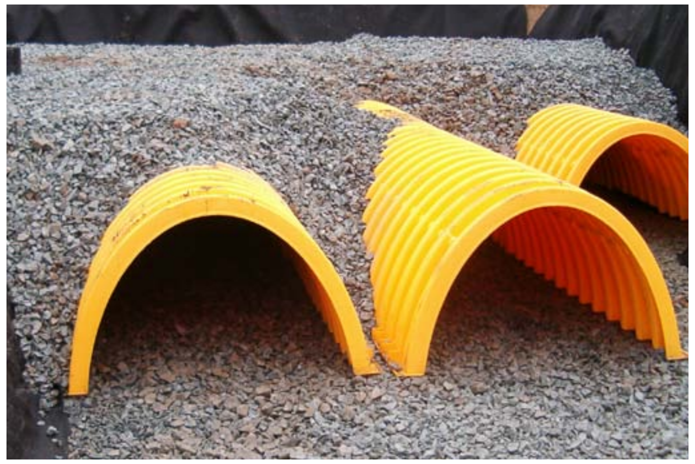
150 mm MIN. — 865 mm — 300 mm MIN.

THIS CROSS SECTION DETAILS THE REQUIREMENTS NECESSARY TO SATISFY THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS FOR EARTH AND LIVE LOADS USING STORMTECH CHAMBERS.

StormTech SC-740 Chamber Specifications

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech SC-740 system is designed primarily to be used under car parks thus maximizing land usage for commercial and municipal applications.





StormTech SC-740 Chamber (not to scale)

Nominal Chamber Specifications

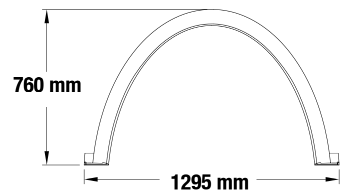
Size (L x W x H)	2170 x 1295 x 760 mm
Chamber Storage	1.30 m³
Min. Installed Storage*	2.12 m³
Weight	35.5 kg

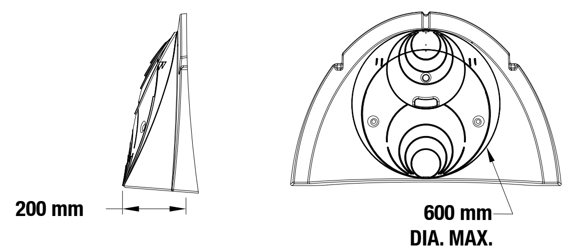
**Assumes 150 mm stone above, below and between chambers and 40% stone porosity.*

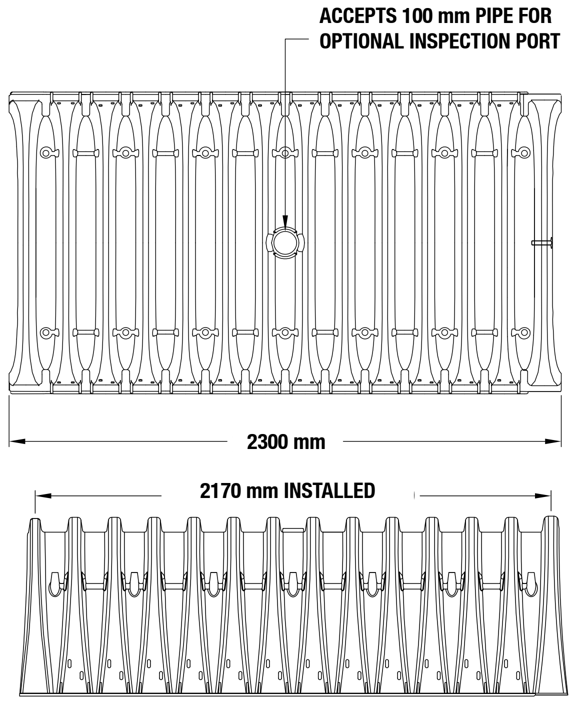
Transportation:

300 chambers per truck

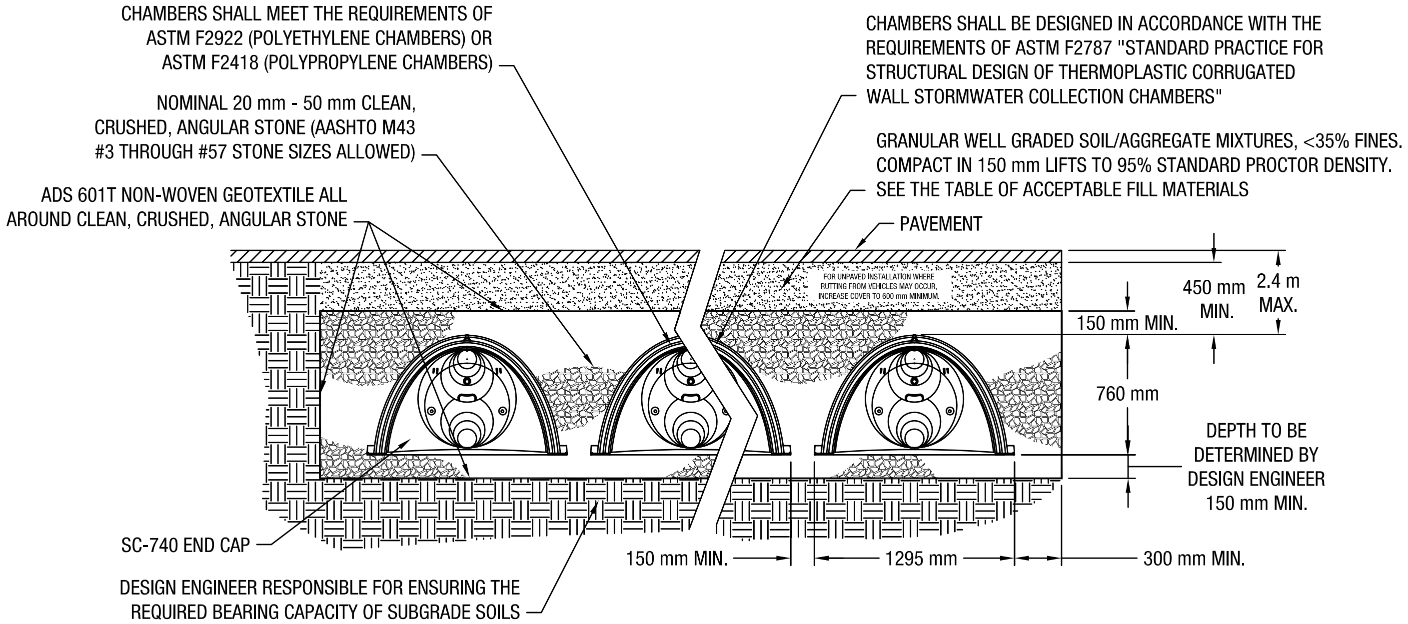
(635 m³ storage per truck)







StormTech SC-740 Chamber Specifications

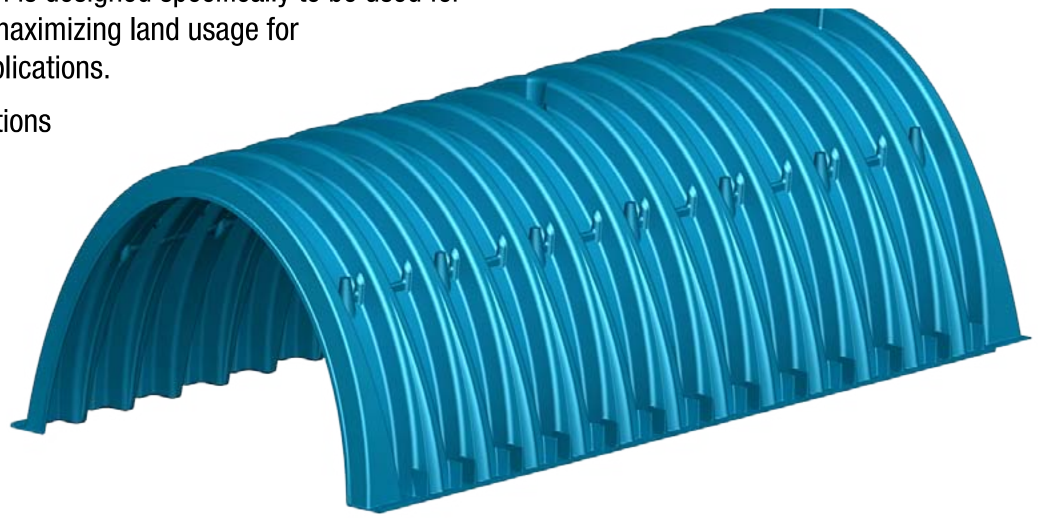


THIS CROSS SECTION DETAILS THE REQUIREMENTS NECESSARY TO SATISFY THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS USING STORMTECH CHAMBERS

StormTech DC-780 Chamber Specifications

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech DC-780 system is designed specifically to be used for deep cover applications thus maximizing land usage for commercial and municipal applications.

- 3.7 m Deep Cover applications



StormTech DC-780 Chamber (not to scale)

Nominal Chamber Specifications

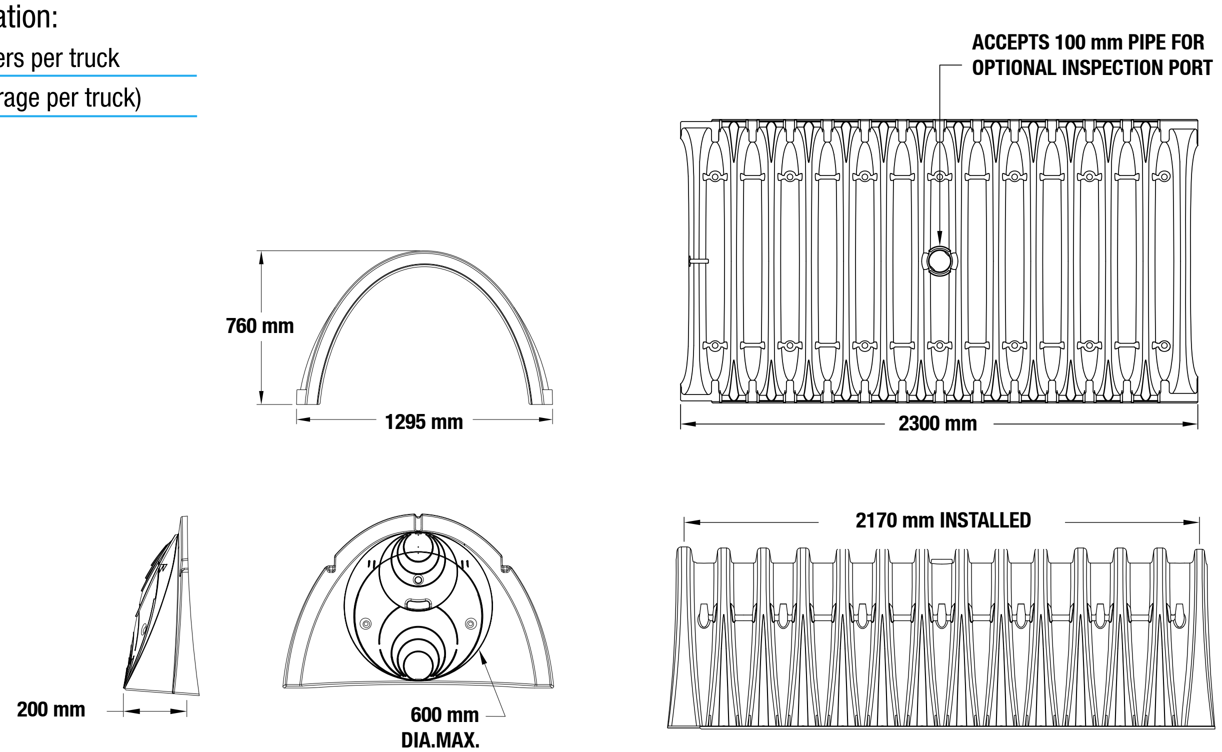
Size (L x W x H)	2170 x 1295 x 760 mm
Chamber Storage	1.30 m^3
Min. Installed Storage*	2.20 m^3

**Assumes 230 mm stone below, 150 mm stone above, and 150 mm row-spacing chambers and 40% stone porosity.*

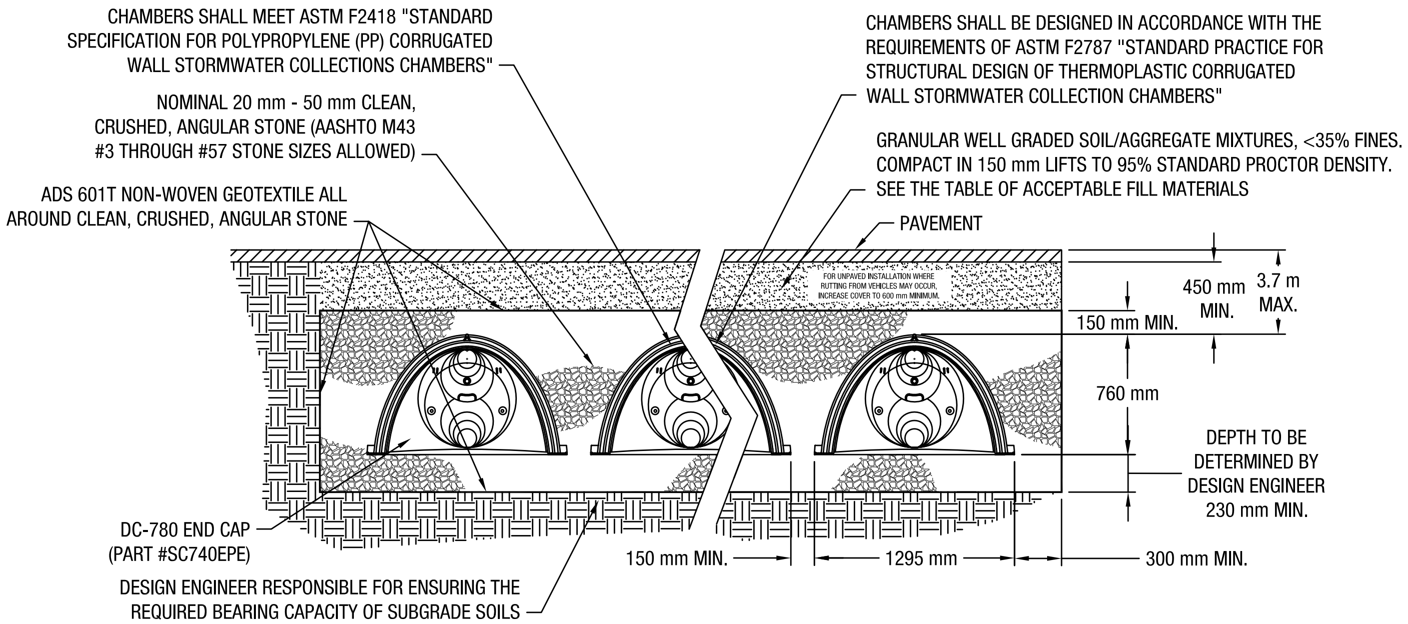
Transportation:

240 chambers per truck

(530 m^3 storage per truck)



StormTech DC-780 Chamber Specifications



THIS CROSS SECTION DETAILS THE REQUIREMENTS NECESSARY TO SATISFY THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS USING STORMTECH CHAMBERS

StormTech MC-3500 Chamber Specifications

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech MC-3500 system is designed primarily to be used under car parks thus maximizing land usage for commercial and municipal applications.

StormTech MC-3500 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	2285 x 1955 x 1145 mm
Chamber Storage	3.11 m³
Min. Installed Storage*	5.06 m³
Weight	56.5 kg

**Assumes a minimum of 305 mm of stone above, 230 mm of stone below, chambers, 230 mm of stone between chambers/end caps, and 40% stone porosity.*

StormTech MC-3500 End Cap (not to scale)

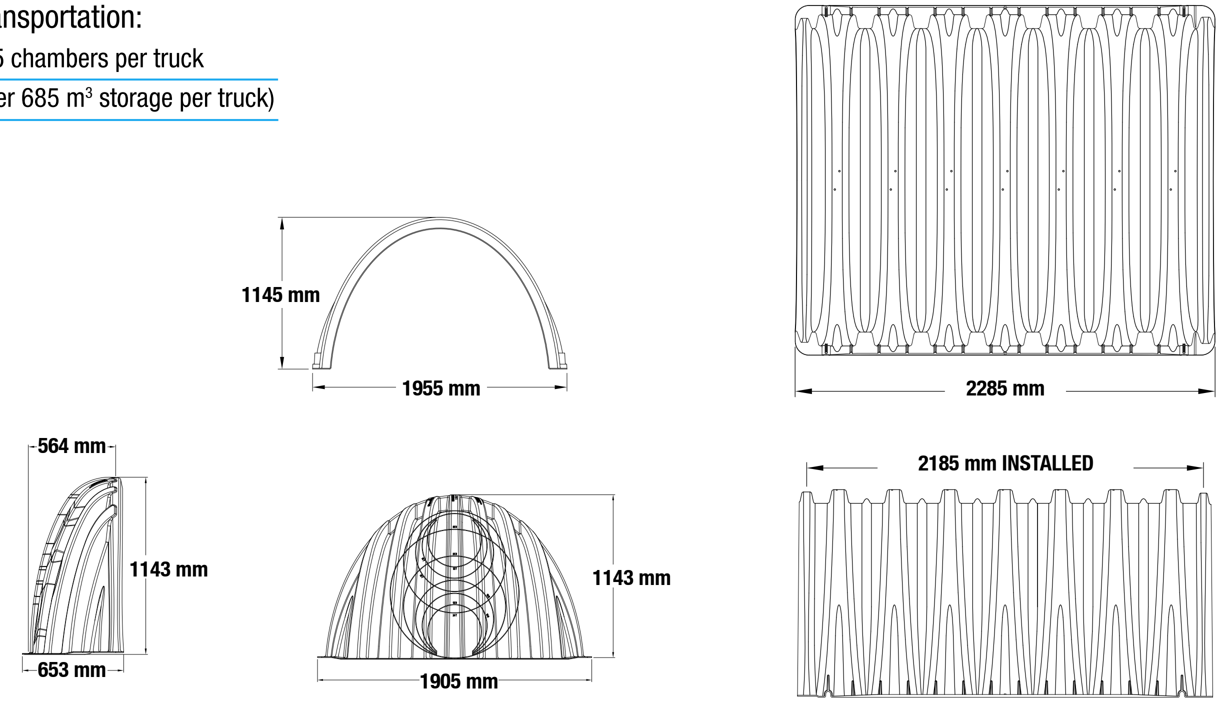
Nominal End Cap Specifications

Size (L x W x H)	675 x 1805 x 1145 mm
End Cap Storage	0.44 m³
Min. Installed Storage*	1.33 m³
Weight	19.5 kg

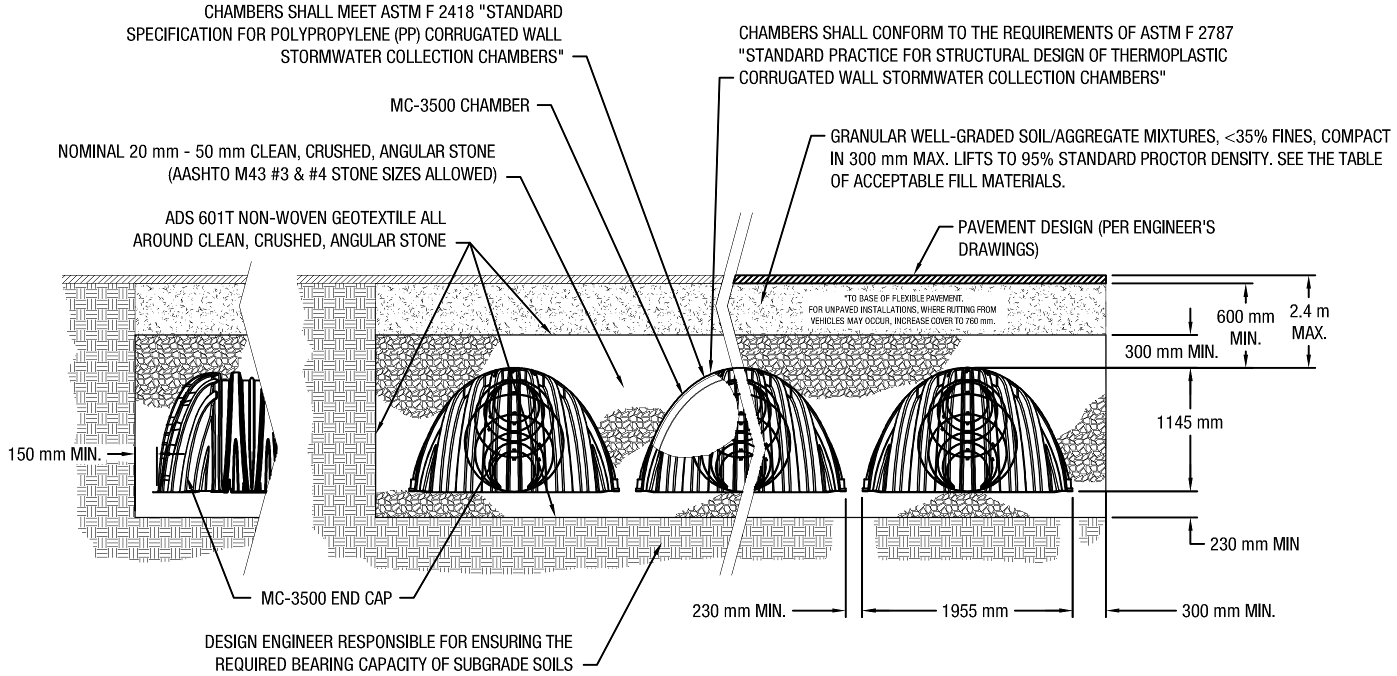
**Assumes a minimum of 305 mm stone above, 230 mm stone below, 150 mm stone perimeter, 230 mm of stone between chambers/end caps, and 40% stone porosity.*

Transportation:

135 chambers per truck
(over 685 m³ storage per truck)

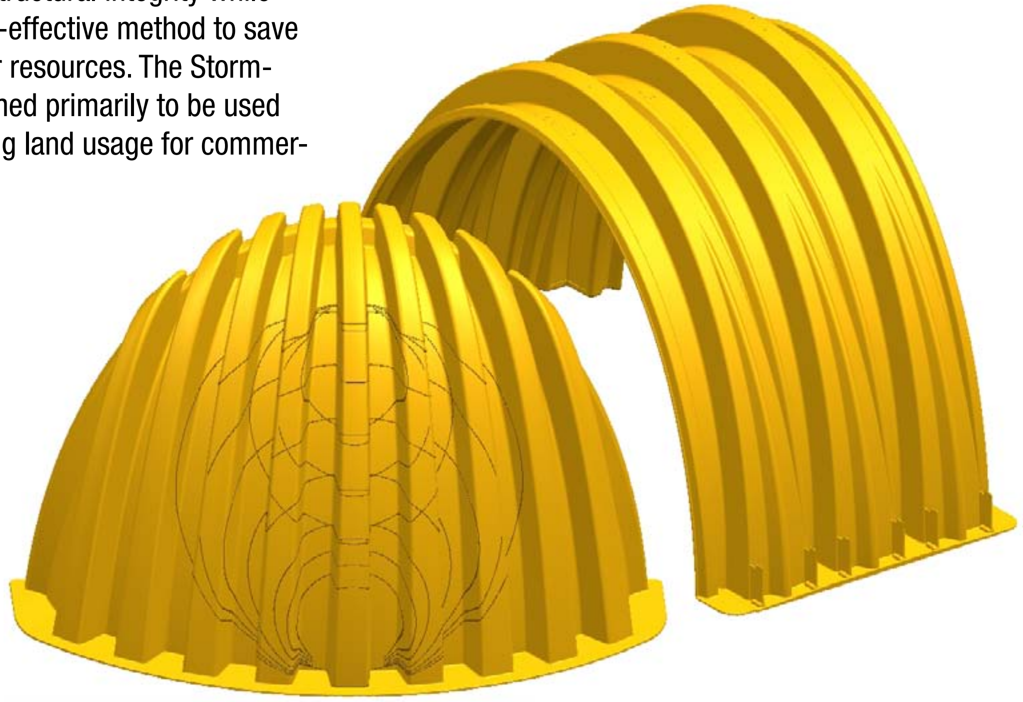


StormTech MC-3500 Chamber Specifications



StormTech MC-4500 Chamber Specifications

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech MC-4500 system is designed primarily to be used under car parks thus maximizing land usage for commercial and municipal applications.



StormTech MC-4500 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	1320 x 2540 x 1525 mm
Chamber Storage	3.01 m³
Min. Installed Storage*	4.60 m³
Nominal Weight	53.5 kg

Assumes a minimum of 300 mm of stone above, 230 mm of stone below chambers, 230 mm of stone between chambers/end caps, and 40% stone porosity.

StormTech MC-4500 End Cap (not to scale)

Nominal End Cap Specifications

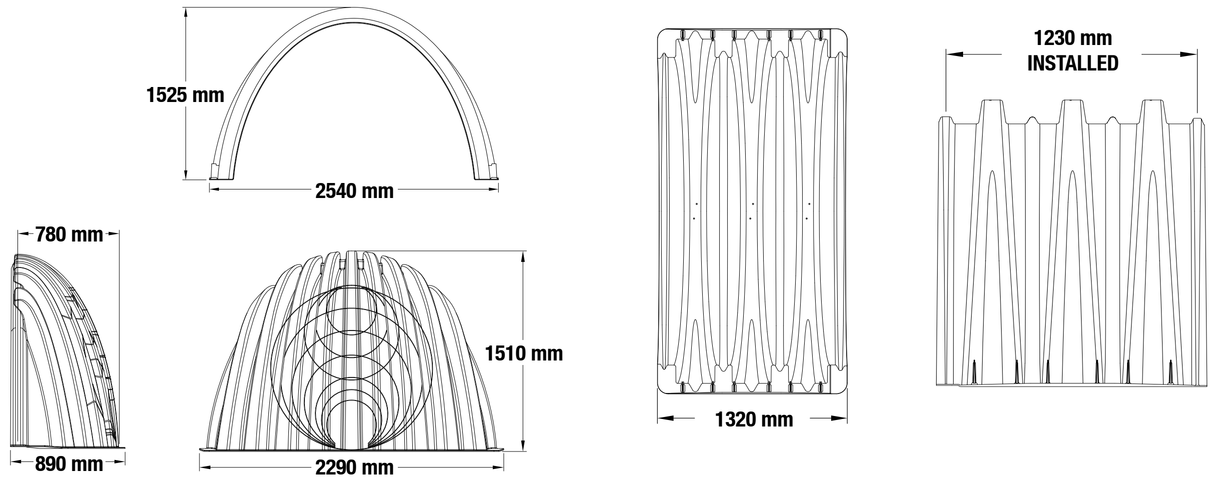
Size (L x W x H)	890 x 2290 x 1510 mm
End Cap Storage	1.01 m³
Min. Installed Storage*	3.08 m³
Nominal Weight	53.5 kg

Assumes a minimum of 300 mm of stone above, 230 mm of stone below, 305 mm of stone perimeter, 230 mm of stone between chambers/end caps, and 40% stone porosity.

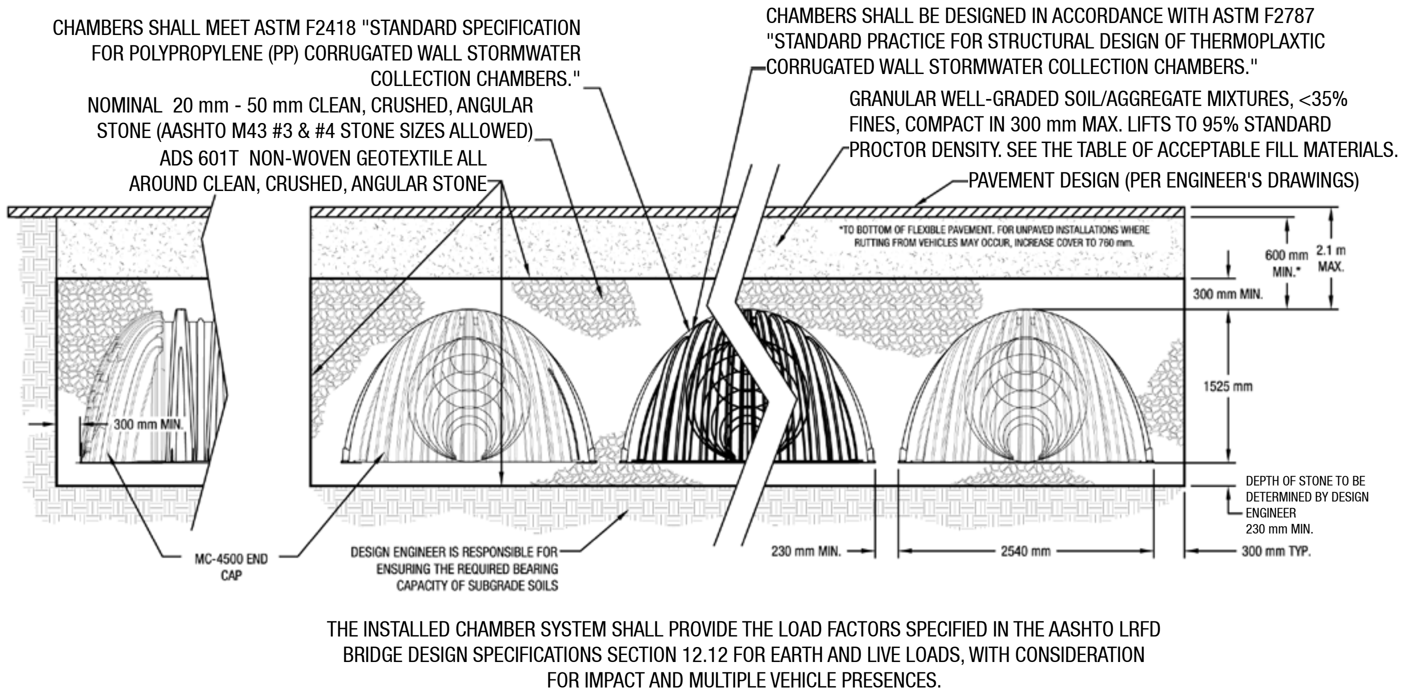
Transportation:

84 chambers per truck

(over 385 m³ storage per truck)



StormTech MC-4500 Chamber Specifications



StormTech Isolator® Row

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patented technique to inexpensively improve stormwater quality and provide easy access for inspection and maintenance. By using the StormTech Isolator Row a TSS removal of 80%, a hydrocarbon (diesel) removal of 90%, a total Zinc removal of 53% and a total Phosphorus removal of 49% can be achieved.*

The Isolator Row is a row of StormTech chambers that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as stormwater rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310 and SC-740 models) allow stormwater to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row, protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for stormwater filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

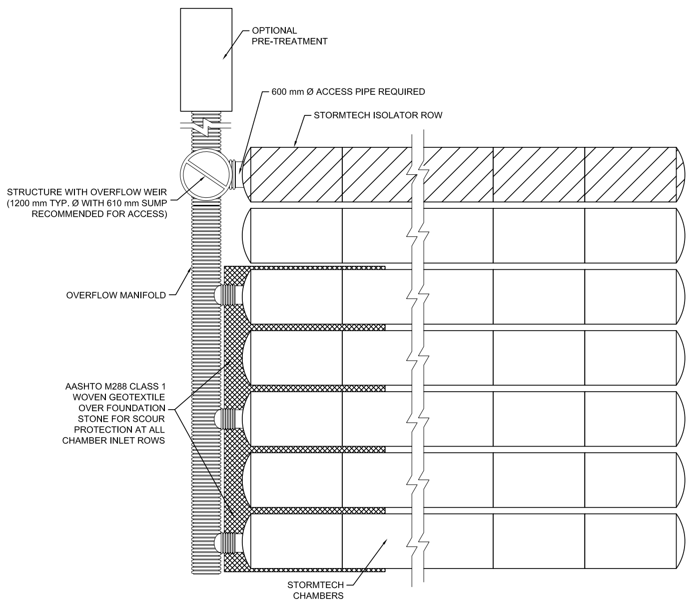
The Isolator Row is typically designed to capture the “first flush” and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row, but typically includes a high flow weir such that stormwater flow rates or volumes that exceed the capacity of the Isolator Row crest the weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating stormwater prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins and oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

*Based on independent university testing.

StormTech Isolator Row with Overflow Spillway (not to scale)



StormTech Isolator Row

Inspection
The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

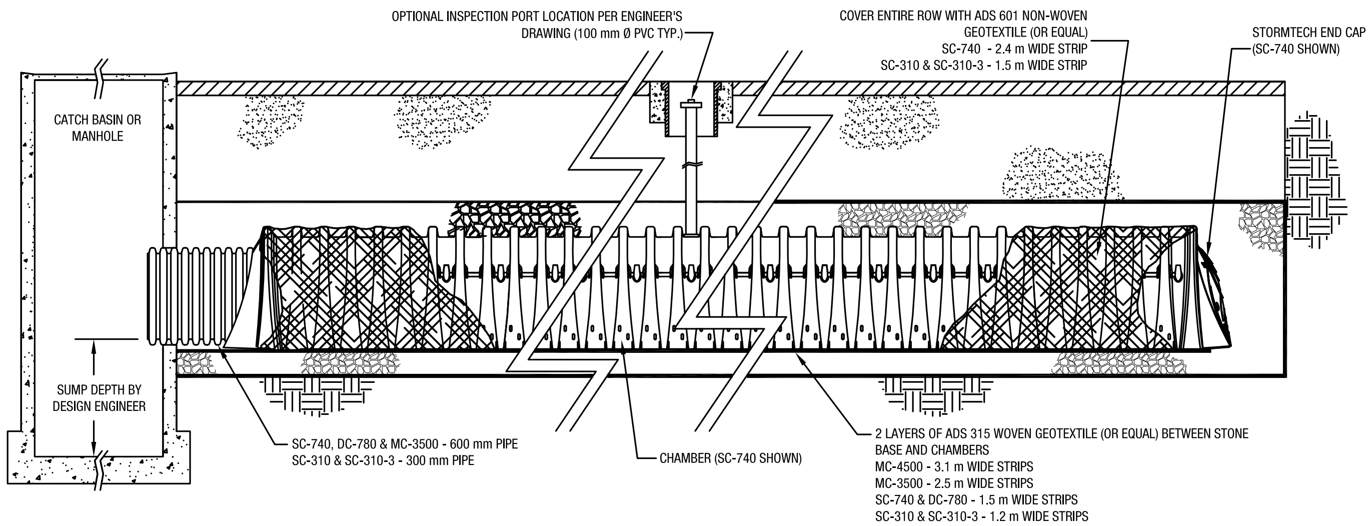
The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If, upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 8 cm throughout the length of the Isolator Row, clean-out should be performed.

Maintenance
The Isolator Row was designed to reduce the cost of periodic maintenance. By “isolating” sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow the applicable rules and regulations for a confined space entries.

Maintenance is accomplished by jetting the Isolator Row. The jetting process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/jetting combination vehicles. Selection of an appropriate jetting nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45° are best. Most jetting reels have 120 meters of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The jetting process shall only be performed on StormTech Isolator Rows that have the correct woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)

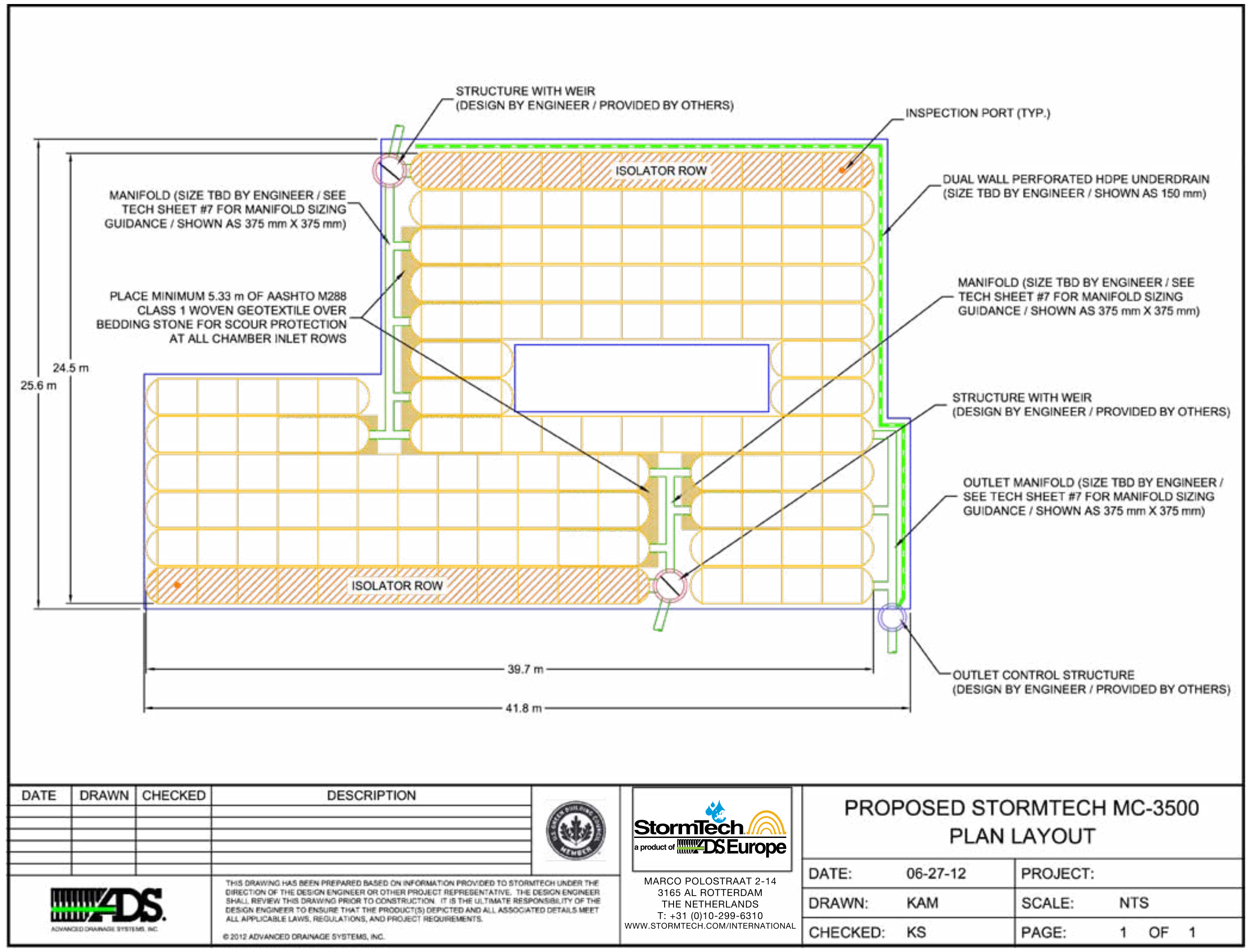


NOTE: NON-WOVEN FABRIC IS ONLY REQUIRED OVER THE INLET PIPE CONNECTION INTO THE END CAP FOR DC-780, MC-3500 AND MC-4500 CHAMBER MODELS AND IS NOT REQUIRED OVER THE ENTIRE ISOLATOR ROW.

A Family of Products and Services

- SC-310 Chambers and End Caps
- SC-740 Chambers and End Caps
- DC-780 Chambers and End Caps
- MC-3500 Chambers and End Caps
- MC-4500 Chambers and End Caps
- SC, DC and MC Fabricated End Caps
- Fabricated Manifold Fittings
- Patented Isolator Row for Maintenance and Water Quality
- In-House System Layout Assistance
- On-Site Educational Seminars
- Worldwide Technical Sales Group
- Centralized Product Applications Department
- Research and Development Team
- Technical Literature, O&M Manuals and Detailed CAD drawings all downloadable via our website at **www.stormtech.com/international**

"Interested in using StormTech products in your design? We would be glad to help you. StormTech provides plan layout and cost estimate services <u>at no additional charge</u> for consulting engineers and developers."



StormTech Customer Support

Please contact one of our inside Technical Service professionals or Engineered Product Managers (EPMs) to discuss your particular application. A wide variety of technical support material is available from our website at **www.stormtech.com/international.** For any questions, please call StormTech at **+31 (0)10 2996410.**

- SC-310, SC-740, and DC-780 Design Manual
- MC-3500 and MC-4500 Design Manual
- SC-310, SC740, and DC-780 Installation Instructions
- MC-3500 and MC-4500 Installation Videos
- Infiltrator Row Informational Video
- CAD Drawings
- Technical Sheets
- Site Calculator Spreadsheets
- Installation Guidelines and Industry Standards
- Industry Links
- Free Layout Assistance
- Pre-construction Meetings
- Case Studies

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www.stormtech.com/international

Appendix IV

Hydroslide Flow Control Valves

Surface Water Management Solutions

ELIQUO | HYDROK

HydroSlide®

Flow control regulators – for controlling surface water flows

HydroSlide®

WITH THE NEED TO OPTIMISE STORAGE AND ATTENUATION NEEDS WITHIN RESTRICTED DEVELOPMENT SITES, THE HYDROSLIDE CAN PROVIDE A COST EFFECTIVE SOLUTION.

THE HYDROSLIDE IS A CONSTANT FLOW REGULATOR WHICH OPTIMISES THE PERMITTED DOWNSTREAM FLOW, THIS REDUCES THE REQUIRED UPSTREAM STORAGE VOLUME AND THUS SAVING COST AND 'LAND TAKE'.

Varaiable orifice provides a constant discharge throughout the units head range.

Flow regulation from as little as 2 l/s

HOW IT WORKS

The maintenance of such units from ground level is becoming a standard requirement along with the ability to retrofit into existing manholes.

The **HydroSlide** flow regulator provides a proven cost effective technique for regulating flows from as little as 2 l/s. The float activated mechanism of the **HydroSlide** is designed to maintain a constant discharge without the use of external energy sources. The flow area is adjusted to perfectly match any increase or decrease in the upstream water level providing a constant discharge throughout the head range. These units can also be provided to control varying flows at varying upstream head levels to provide a discharge solution in line with Environmental Agency requirements particularly related to surface water discharges.

ADVANTAGES AND BENEFITS

- Accurate, cost effective flow control
- Surface water flow control within SUDS systems
- Controlled discharge of storm retention tanks
- Prevention of downstream flooding
- Utilisation of the upstream storage volumes within the pipe work system

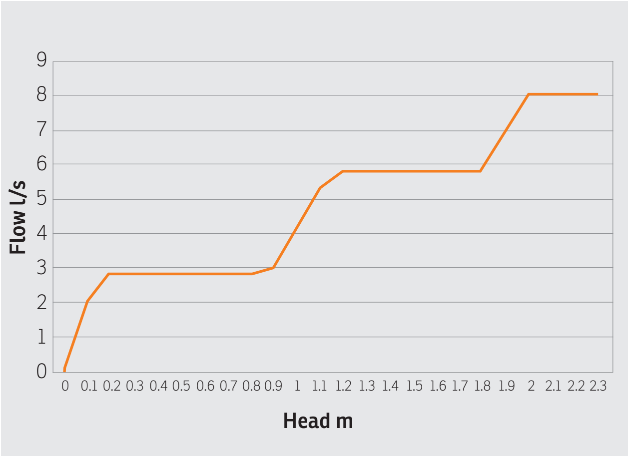
OPERATING PRINCIPLES

The **HydroSlide** remains in the open position during dry weather. As the inflow within the flow control chamber increases during the storm event and exceeds the capacity of the fully opened unit, the increasing water level causes the float to rise, this in turn causes the variable orifice of the **HydroSlide** to be adjusted so that a constant discharge is maintained throughout the head range.

The **HydroSlide** is able to accurately regulate the flow by the use of a designed control cam. This can be designed to provide a constant Pass Forward Flow (PFF), or a stepped flow pattern, in line with the storm return periods, as shown below. This example is based upon providing the following flow pattern:

- 10 l/s up to 0.3 m
- 20 l/s from 0.3 to 1.0 m
- 30 l/s from 1.5 to 2.5 m

TYPICAL STEPPED HYDROSLIDE FLOW CONTROL



It can be an advantage for a developer to design a storage system to be deeper, to avoid too much of the development site being taken up with attenuation provision. ELIQUO HYDROK can provide a solution to the high head / low flow rate problem. The **HydroSlide** can be used with any attenuation / storage / pipe system or within attenuation lagoons / dams.

The **HydroSlide** flow passage area is largest at the most critical time during dry weather flow e.g. at the beginning of a storm event when the pipes are being flushed and at the end of a storm event when the pipes are emptying, thereby reducing the chances and frequency of potential blockage.

Designed to maintain a constant discharge flow control
without the use of external energy sources.

Version 001

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MEMBER OF **ELIQUO WATER GROUP**