Advice Note on contents of a Surface Water Drainage Statement

London Borough of Camden

1. Introduction

1.1 The Government has strengthened planning policy on the provision of sustainable drainage and new consultation arrangements for 'major' planning applications will come into force from 6 April 2015 as defined in the Written Ministerial Statement (18th Dec 2014).

1.2 The new requirements make Lead Local Flood Authorises statutory consultees with respect to flood risk and SuDS for all major applications. Previously the Environment Agency had that statutory responsibility for sites above 1ha in flood zone 1.

1.3 Therefore all 'major' planning applications submitted from 6 April 2015 are required demonstrate compliance with this policy and we'd encourage this is shown in a **Surface Water Drainage Statement**.

1.4 The purpose of this advice note is to set out what information should be included in such statements.

2. Requirements

2.1 It is essential that the type of Sustainable Drainage System (SuDS) for a site, along with **details of its extent and position**, is identified within the planning application to clearly demonstrate that the proposed SuDS can be accommodated within the development.

2.2 It will now not be acceptable to leave the design of SuDs to a later stage to be dealt with by planning conditions.

2.3 The NPPF paragraph 103 requires that developments do not increase flood risk elsewhere, and gives priority to the use of SuDS. Major developments must include SuDS for the management of run-off, unless demonstrated to be inappropriate. The proposed minimum standards of operation must be appropriate and as such, a **maintenance plan** should be included within the Surface Water Drainage Statement,clearly demonstrating that the SuDS have been designed to ensure that the maintenance and operation requirements are economically proportionate Planning Practice Guidance suggests that this should be considered by reference to the costs that would be incurred by consumers for the use of an effective drainage system connecting directly to a public sewer.

2.4 Camden Council will use planning conditions or obligations to ensure that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

2.5 Within Camden, SuDS systems must be designed in accordance with London Plan policy 5.13. This requires that developments should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve **greenfield run-off rates** and ensure that surface water run-off is managed as close to its source as possible in line with the following **drainage hierarchy**:

1 store rainwater for later use
2 use infiltration techniques, such as porous surfaces in non-clay areas
3 attenuate rainwater in ponds or open water features for gradual release
4 attenuate rainwater by storing in tanks or sealed water features for gradual release
5 discharge rainwater direct to a watercourse
6 discharge rainwater to a surface water sewer/drain
7 discharge rainwater to the combined sewer.

2.6 The hierarchy above seeks to ensure that surface water run-off is controlled as near to its source as possible to mimic natural drainage systems and retain water on or near to the site, in contrast to traditional drainage approaches, which tend to pipe water off-site as quickly as possible.

2.7 Before disposal of surface water to the public sewer is considered all other options set out in the drainage hierarchy should be exhausted. When no other practicable alternative exists to dispose of surface water other than the public sewer, the Water Company or its agents should confirm that there is adequate spare capacity in the existing system taking future development requirements into account.

2.8 Best practice guidance within the non-statutory technical standards for the design, maintenance and operation of sustainable drainage systems will also need to be followed. Runoff volumes from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the **greenfield runoff volume** for the same event.

2.9 Camden Development Policy 23 (Water) requires developments to reduce pressure on combined sewer network and the risk of flooding by limiting the rate of run-off through sustainable urban drainage systems. This policy also requires that developments in areas known to be at risk of surface water flooding are designed to cope with being flooded. Camden's SFRA surface water flood maps, updated SFRA figures 6 (LFRZs), and 4e (increased susceptibility to elevated groundwater) , as well as the Environment Agency updated flood maps for surface water (ufmfsw), should be referred to when determining whether developments are in an area at risk of flooding.

2.10 Camden Planning Guidance 3 (CPG3) requires developments to achieve a greenfield run off rate once SuDS have been installed. Where it can be demonstrated that this is not feasible, a minimum 50% reduction in run off rate across the development is required. Further guidance on how to reduce the risk of flooding can be found in CPG3 paragraphs 11.4-11.8.

2.11 Where an application is part of a larger site which already has planning permission it is essential that the new proposal does not compromise the drainage scheme already approved.

3. Further information and guidance

3.1 Applicants are strongly advised to discuss their proposals with the Lead Local Flood Authority at the pre-application stage to ensure that an acceptable SuDS scheme is submitted.

3.2 For general clarification of these requirements please Camden's Local Planning Authority or Lead Local Flood Authority

Surface Water Drainage Pro-forma for new developments

This pro-forma accompanies our advice note on surface water drainage. Developers should complete this form and submit it to the Local Planning Authority, referencing from where in their submission documents this information is taken. The pro-forma is supported by the Defra/EA guidance on Rainfall Runoff Management and uses the storage calculator on www.UKsuds.com. This pro-forma is based on current industry best practice and focuses on ensuring surface water drainage proposals meet national and local policy requirements. The pro-forma should be considered alongside other supporting SuDS Guidance.

1. Site Details

Site	MOUNT PLEASANT CIRCUS
Address & post code or LPA reference	WC1X 0AY
Grid reference	531003,182209
Is the existing site developed or Greenfield?	DEVELOPED
Is the development in a LFRZ or in an area known to be at risk of surface or ground water flooding? If yes, please demonstrate how this is managed, in line with DP23?	NO
Total Site Area served by drainage system (excluding open space) (Ha)*	0.855

***** The Greenfield runoff off rate from the development which is to be used for assessing the requirements for limiting discharge flow rates and attenuation storage from a site should be calculated for the area that forms the drainage network for the site whatever size of site and type of drainage technique. Please refer to the Rainfall Runoff Management document or CIRIA manual for detail on this.

2. Impermeable Area

	Existing	Proposed	Difference (Proposed-Existing)	Notes for developers
Impermeable area (ha)	0.855	0.805	-0.05	If the proposed amount of impermeable surface is greater, then runoff rates and volumes will increase. Section 6 must be filled in. If proposed impermeability is equal or less than existing, then section 6 can be skipped and section 7 filled in.
Drainage Method (infiltration/sewer/watercourse)	SEWER	SEWER	N/A	If different from the existing, please fill in section 3. If existing drainage is by infiltration and the proposed is not, discharge volumes may increase. Fill in section 6.

3. Proposing to Discharge Surface Water via

	Yes	No	Evidence that this is possible	Notes for developers
Existing and proposed MicroDrainage calculations	X		MD ANALYSIS	Please provide MicroDrainage calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology or the results of a full infiltration test (see line below) if infiltration is proposed.
Infiltration		x		e.g. soakage tests. Section 6 (infiltration) must be filled in if infiltration is proposed.
To watercourse		x		e.g. Is there a watercourse nearby?
To surface water sewer	x			Confirmation from sewer provider that sufficient capacity exists for this connection.
Combination of above		x		e.g. part infiltration part discharge to sewer or watercourse. Provide evidence above.
Has the drainage proposal had regard to the SuDS hierarchy?	X			Evidence must be provided to demonstrate that the proposed Sustainable Drainage strategy has had regard to the SuDS hierarchy as outlined in Section 2.5 above.
Layout plan showing where the sustainable drainage infrastructure will be located on site.	X		K16 0639/C/Sk001	Please provide plan reference numbers showing the details of the site layout showing where the sustainable drainage infrastructure will be located on the site. If the development is to be constructed in phases this should be shown on a separate plan and confirmation should be provided that the sustainable drainage proposal for each phase can be constructed and can operate independently and is not reliant on any later phase of development.

4. Peak Discharge Rates – This is the maximum flow rate at which storm water runoff leaves the site during a particular storm event.

	Existing Rates (l/s)	Proposed Rates (l/s)	Difference (l/s) (Proposed-Existing)	% Difference (difference /existing x 100)	Notes for developers
Greenfield QBAR	3.1	N/A	N/A	N/A	QBAR is approx. 1 in 2 storm event. Provide this if Section 6 (QBAR) is proposed.
1 in 1	110	55	-55	-50%	Proposed discharge rates (with mitigation) should aim to be equivalent to greenfield rates for all corresponding storm events. As a minimum, peak discharge rates must be reduced by 50% from the existing sites for all corresponding rainfall events.
1 in 30	142	55	-87	-61%	
1in 100	306	55	-251	-82	
1 in 100 plus climate change	N/A	55	N/A	N/A	The proposed 1 in 100 +CC peak discharge rate (with mitigation) should aim to be equivalent to greenfield rates. As a minimum, proposed 1 in 100 +CC peak discharge rate must be reduced by 50% from the existing 1 in 100 runoff rate sites.

5. Calculate additional volumes for storage –The total volume of water leaving the development site. New hard surfaces potentially restrict the amount of stormwater that can go to the ground, so this needs to be controlled so not to make flood risk worse to properties downstream.

	Greenfield runoff volume (m^3)	Existing Volume (m^3)	Proposed Volume (m^3)	Difference (m^3) (Proposed-Existing)	Notes for developers
1 in 1	27	60	79	+19	Proposed discharge volumes (with mitigation) should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable and as a minimum should be no greater than existing volumes for all corresponding storm events. Any increase in volume increases flood risk elsewhere. Where volumes are increased section 6 must be filled in.
1 in 30	65	147	180	+33	
1in 100 6 hour	220	444	N/A	N/A	
1 in 100 6 hour plus climate change	308	622	578	-44	The proposed 1 in 100 +CC discharge volume should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable. As a minimum, to mitigate for climate change the proposed 1 in 100 +CC volume discharge from site must be no greater than the existing 1 in 100 storm event. If not, flood risk increases under climate change.

6. Calculate attenuation storage – Attenuation storage is provided to enable the rate of runoff from the site into the receiving watercourse to be limited to an acceptable rate to protect against erosion and flooding downstream. The attenuation storage volume is a function of the degree of development relative to the greenfield discharge rate.

		Notes for developers
Storage Attenuation volume (Flow rate control) required to meet greenfield run off rates (m^3)	471	Volume of water to attenuate on site if discharging at a greenfield run off rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to reduce rates by 50% (m^3)	135	Volume of water to attenuate on site if discharging at a 50% reduction from existing rates. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to meet [OTHER RUN OFF RATE (as close to greenfield rate as possible] (m^3)	285 [Restricted outflow = 55l/s]	Volume of water to attenuate on site if discharging at a rate different from the above – please state in 1st column what rate this volume corresponds to. On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to retain rates as existing (m^3)	65.5	Volume of water to attenuate on site if discharging at existing rates. Can't be used where discharge volumes are increasing
Percentage of attenuation volume stored above ground,	10	Percentage of attenuation volume which will be held above ground in swales/ponds/basins/green roofs etc. If 0, please demonstrate why.

7. How is Storm Water stored on site?

Storage is required for the additional volume from site but also for holding back water to slow down the rate from the site. This is known as attenuation storage and long term storage. The idea is that the additional volume does not get into the watercourses, or if it does it is at an exceptionally low rate. You can either infiltrate the stored water back to ground, or if this isn't possible hold it back with on site storage. Firstly, can infiltration work on site?

			Notes for developers
Infiltration	**State the Site's Geology and known Source Protection Zones (SPZ)**	LONDON CLAY FORMATION	Avoid infiltrating in made ground. Infiltration rates are highly variable and refer to Environment Agency website to identify and source protection zones (SPZ)
	Are infiltration rates suitable?	NO	Infiltration rates should be no lower than $1x10^{-6}$ m/s.
	State the distance between a proposed infiltration device base and the ground water (GW) level	N/A	Need 1m (min) between the base of the infiltration device & the water table to protect Groundwater quality & ensure GW doesn't enter infiltration devices. Avoid infiltration where this isn't possible.

	Were infiltration rates obtained by desk study or infiltration test?	N/A	Infiltration rates can be estimated from desk studies at most stages of the planning system if a back up attenuation scheme is provided..
	Is the site contaminated? If yes, consider advice from others on whether infiltration can happen.	NO	Advice on contaminated Land in Camden can be found on our supporting documents webpage Water should not be infiltrated through land that is contaminated. The Environment Agency may provide bespoke advice in planning consultations for contaminated sites that should be considered.
In light of the above, is infiltration feasible?	**Yes/No? If the answer is No, please identify how the storm water will be stored prior to release**	NO - attenuate within geocellular sub-surface storage structures.	If infiltration is not feasible how will the additional volume be stored?. The applicant should then consider the following options in the next section.

Storage requirements

The developer must confirm that either of the two methods for dealing with the amount of water that needs to be stored on site.

Option 1 Simple – Store both the additional volume and attenuation volume in order to make a final discharge from site at the greenfield run off rate. This is preferred if no infiltration can be made on site. This very simply satisfies the runoff rates and volume criteria.

Option 2 Complex – If some of the additional volume of water can be infiltrated back into the ground, the remainder can be discharged at a very low rate of 2 l/sec/hectare. A combined storage calculation using the partial permissible rate of 2 l/sec/hectare and the attenuation rate used to slow the runoff from site.

		Notes for developers
Please confirm what option has been chosen and how much storage is required on site.	SIMPLE	The developer at this stage should have an idea of the site characteristics and be able to explain what the storage requirements are on site and how it will be achieved.

8. Please confirm

		Notes for developers
Which Drainage Systems measures have been used, including green roofs?	GREEN ROOFS/NO INFILTRATION POROUS PAVEING & SUB SURFACE STORAGE	SUDS can be adapted for most situations even where infiltration isn't feasible e.g. impermeable liners beneath some SUDS devices allows treatment but not infiltration. See CIRIA SUDS Manual C697.
Drainage system can contain in the 1 in 30 storm event without flooding	YES	This a requirement for sewers for adoption & is good practice even where drainage system is not adopted.
Will the drainage system contain the 1 in 100 +CC storm event? If no please demonstrate how buildings and utility plants will be protected.	YES	National standards require that the drainage system is designed so that flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.
Any flooding between the 1 in 30 & 1 in 100 plus climate change storm events will be safely contained on site.	YES	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased.
How will exceedance events be catered on site without increasing flood risks (both on site and outside the development)?	EXCEEDANCE FLOWS TO BE CONTAINED WITHIN THE DEVELOPMENT BOUNDARY.	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased. Exceedance events are defined as those larger than the 1 in 100 +CC event.
How are rates being restricted (vortex control, orifice etc)	VORTEX FLOW CONTROL	Detail of how the flow control systems have been designed to avoid pipe blockages and ease of maintenance should be provided.
Please confirm the owners/adopters of the entire drainage systems throughout the development. Please list all the owners.	THAMES WATER AUTHORITY/MANAGEMENT COMPANY	If these are multiple owners then a drawing illustrating exactly what features will be within each owner's remit must be submitted with this Proforma.
How is the entire drainage system to be maintained?	REFER TO SuDS MAINTEANCE DETAILS ATTACHED	If the features are to be maintained directly by the owners as stated in answer to the above question please answer yes to this question and submit the relevant maintenance schedule for each feature. If it is to be maintained by others than above please give details of each feature and the maintenance schedule. Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided. Details must demonstrate that maintenance and operation requirements are economically proportionate. Poorly maintained drainage can lead to increased flooding problems in the future.

9. Evidence Please identify where the details quoted in the sections above were taken from. i.e. Plans, reports etc. Please also provide relevant drawings that need to accompany your proforma, in particular exceedance routes and ownership and location of SuDS (maintenance access strips etc

Pro-forma Section	Document reference where details quoted above are taken from	Page Number
Section 2	DRAWING NO. SK110 REV G	
Section 3	MICRODRAINAGE ANALYSIS RESULTS/SK??? CONCEPTUAL DRAINAGE LAUOUT	
Section 4	MICRODRAINAGE ANALYSIS RESULTS	
Section 5	MICRODRAINAGE ANALYSIS RESULTS	
Section 6	MICRODRAINAGE ANALYSIS RESULTS	
Section 7	K16 0639/C/Sk001 - CONCEPTUAL DRAINAGE LAYOUT	
Section 8	MICRODRAINAGE ANALYSIS RESULTS	

The above form should be completed using evidence from the Flood Risk Assessment and site plans. It should serve as a summary sheet of the drainage proposals and should clearly show that the proposed rate and volume as a result of development will not be increasing. If there is an increase in rate or volume, the rate or volume section should be completed to set out how the additional rate/volume is being dealt with.

This form is completed using factual information from the Flood Risk Assessment and Site Plans and can be used as a summary of the surface water drainage strategy on this site.

Form Completed By C J MELLETT……………………………………………………………………………………………….......................

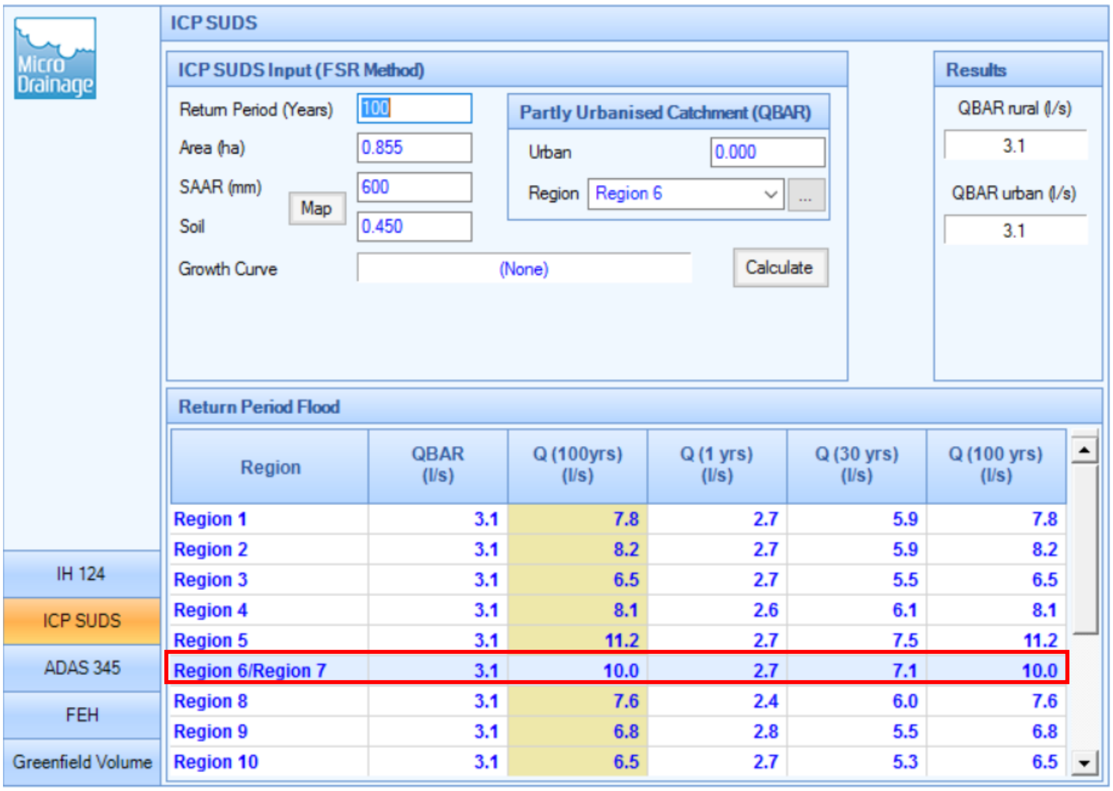
Qualification of person responsible for signing off this pro-forma IENG AMICE...

Company CALFORDSEADEN…………………………………………………………………………,...

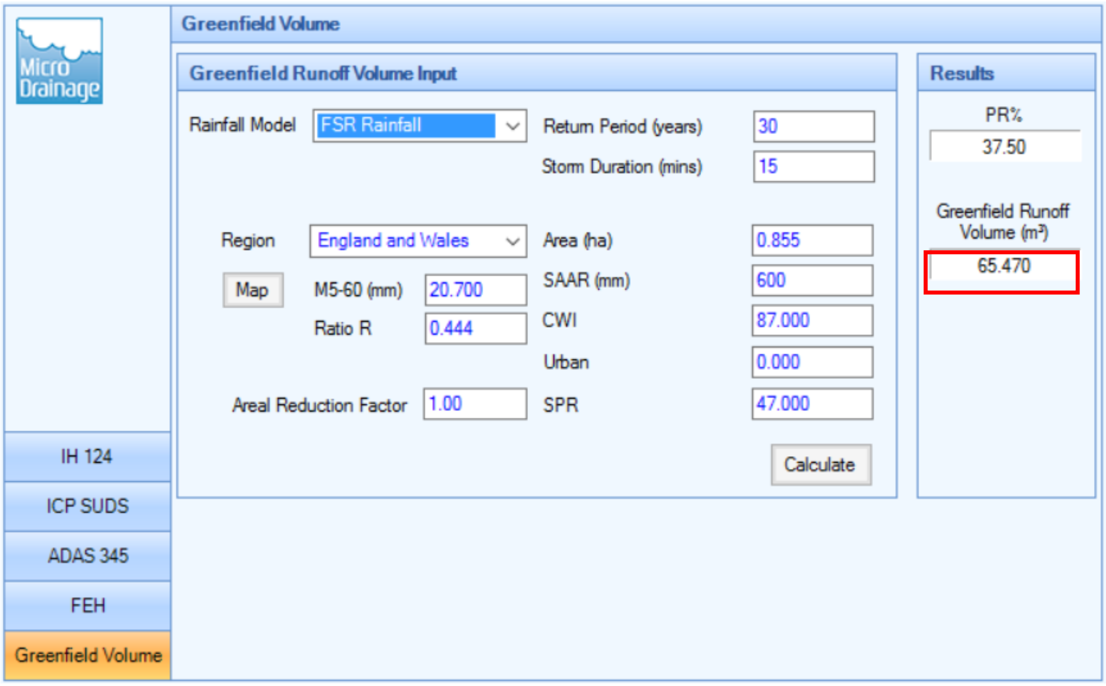
On behalf of (Client's details) CREATE STREETS LTD..

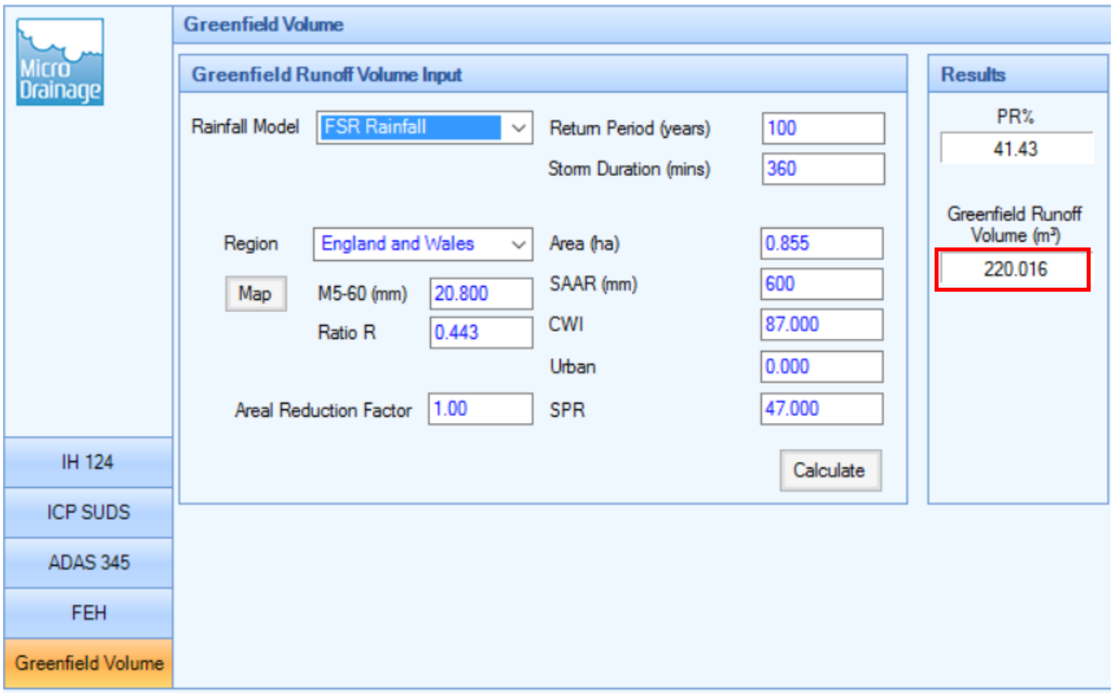
Date: 17/08/16……………………….........................

SECTION 4 & 5
PRE-DEVELOPMENT RUNOFF [GREENFIELD]



Region	QBAR (l/s)	Q (100yrs) (l/s)	Q (1 yrs) (l/s)	Q (30 yrs) (l/s)	Q (100 yrs) (l/s)
Region 1	3.1	7.8	2.7	5.9	7.8
Region 2	3.1	8.2	2.7	5.9	8.2
Region 3	3.1	6.5	2.7	5.5	6.5
Region 4	3.1	8.1	2.6	6.1	8.1
Region 5	3.1	11.2	2.7	7.5	11.2
Region 6/Region 7	3.1	10.0	2.7	7.1	10.0
Region 8	3.1	7.6	2.4	6.0	7.6
Region 9	3.1	6.8	2.8	5.5	6.8
Region 10	3.1	6.5	2.7	5.3	6.5

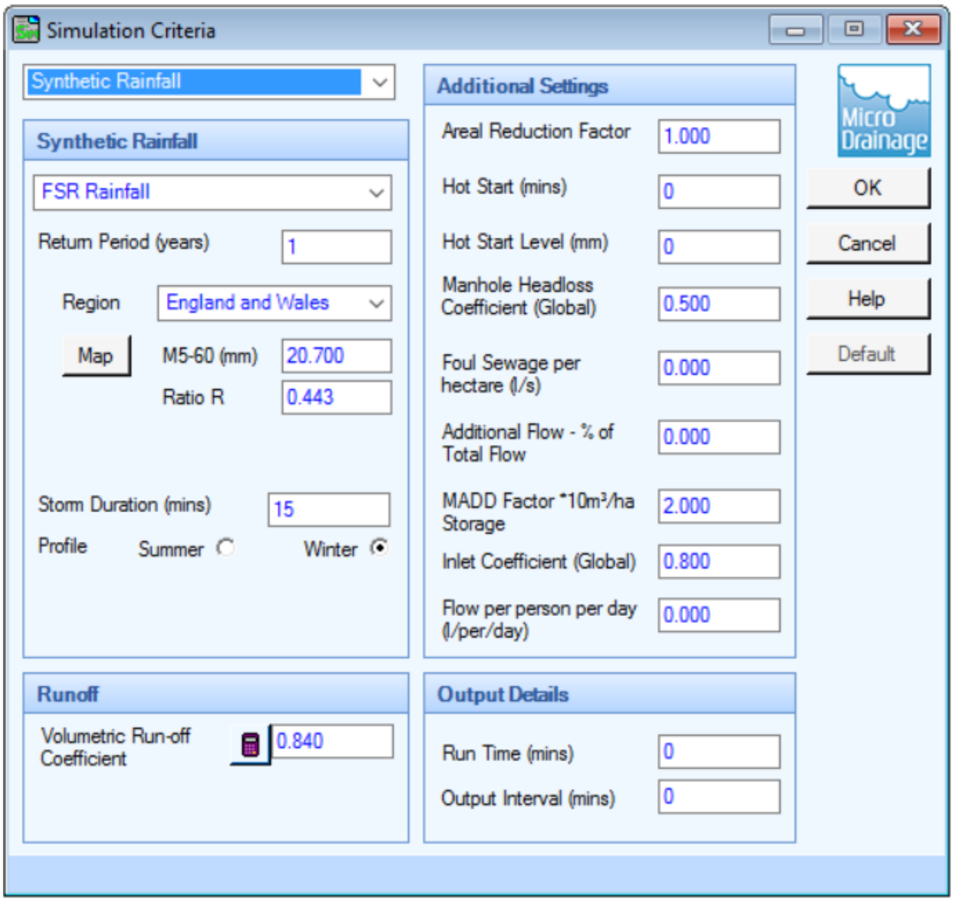

Micro Drainage
Greenfield Volume
Greenfield Runoff Volume Input
Rainfall Model
FSR Rainfall
Return Period (years)
30
Storm Duration (mins)
15
Region
England and Wales
Map
M5-60 (mm)
20.700
Ratio R
0.444
Areal Reduction Factor
1.00
Area (ha)
0.855
SAAR (mm)
600
CWI
87.000
Urban
0.000
SPR
47.000
Calculate
Results
PR%
37.50
Greenfield Runoff Volume (m³)
65.470
IH 124
ICP SUDS
ADAS 345
FEH
Greenfield Volume


Micro Drainage
Greenfield Volume
Greenfield Runoff Volume Input
Rainfall Model
FSR Rainfall
Return Period (years)
100
Storm Duration (mins)
360
Region
England and Wales
Map
M5-60 (mm)
20.800
Ratio R
0.443
Areal Reduction Factor
1.00
Area (ha)
0.855
SAAR (mm)
600
CWI
87.000
Urban
0.000
SPR
47.000
Calculate
Results
PR%
41.43
Greenfield Runoff Volume (m³)
220.016
IH 124
ICP SUDS
ADAS 345
FEH
Greenfield Volume

PRE-DEVELOPMENT RUNOFF [BROWNFIELD]

Pipe Number	Pipe Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Time of Entry (mins)	Base Flow (l/s)	Pipe Rough. (mm)	US/IL (m)	US/CL (m)	Pipe DIA (mm)	Auto Design
1.000	20.000	0.067	298.5	0.285	4.00		0.600	99.000	100.000	525	
1.001	20.000	0.067	298.5	0.285			0.600	98.933	100.000	525	
1.002	20.000	0.067	298.5	0.285			0.600	98.866	100.000	525	

Pipe Number	Rain (mm/hr)	TC (mins)	DS/IL (m)	Σ Imp. Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Pro. Vel (m/s)	Pro. Depth (mm)	Velocity (m/s)	Cap (l/s)	Flow (l/s)	Rain No.
1.000	82.02	4.26	98.933	0.285	0.0	0.0	0.0	1.05	169	1.29	279.5	63.3	1
1.001	80.05	4.52	98.866	0.570	0.0	0.0	0.0	1.25	244	1.29	279.5	123.6	1
1.002	78.19	4.77	98.799	0.855	0.0	0.0	0.0	1.37	308	1.29	279.5	181.1	1



Summary of Results for 15 minute 1 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	99.202	-0.323	0.000	0.20	19.896	43.5	OK
1.001	2	100.000	99.174	-0.284	0.000	0.35	39.786	76.8	OK
1.002	3	100.000	99.132	-0.259	0.000	0.50	59.680	109.9	OK

Summary of Results for 15 minute 2 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	99.242	-0.283	0.000	0.26	25.702	56.1	OK
1.001	2	100.000	99.218	-0.240	0.000	0.45	51.396	99.1	OK
1.002	3	100.000	99.178	-0.213	0.000	0.65	77.093	142.0	OK

Summary of Results for 15 minute 30 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	99.557	0.032	0.000	0.47	48.856	102.1	SURCHARGED
1.001	2	100.000	99.528	0.070	0.000	0.94	97.708	205.4	SURCHARGED
1.002	3	100.000	99.465	0.074	0.000	1.40	146.585	306.0	SURCHARGED

Summary of Results for 15 minute 100 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	99.756	0.231	0.000	0.62	63.547	134.7	FLOOD RISK
1.001	2	100.000	99.719	0.261	0.000	1.24	127.098	269.6	FLOOD RISK
1.002	3	100.000	99.588	0.197	0.000	1.84	190.662	402.3	SURCHARGED

Summary of Results for 360 minute 100 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	99.118	-0.407	0.000	0.08	148.051	17.2	OK
1.001	2	100.000	99.086	-0.372	0.000	0.16	296.168	34.5	OK
1.002	3	100.000	99.038	-0.353	0.000	0.24	444.403	51.7	OK

POST-DEVELOPMENT RUNOFF [NO MITIGATION]

Pipe Number	Pipe Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Time of Entry (mins)	Base Flow (l/s)	Pipe Rough. (mm)	US/IL (m)	US/CL (m)	Pipe DIA (mm)	Auto Design
1.000	20.000	0.067	298.5	0.268	4.00		0.600	99.000	100.000	525	
1.001	20.000	0.067	298.5	0.268			0.600	98.933	100.000	525	
1.002	20.000	0.067	298.5	0.268			0.600	98.866	100.000	525	

Pipe Number	Rain (mm/hr)	TC (mins)	DS/IL (m)	Σ Imp. Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Pro. Vel (m/s)	Pro. Depth (mm)	Velocity (m/s)	Cap (l/s)	Flow (l/s)	Rain No.
1.000	82.02	4.26	98.933	0.268	0.0	0.0	0.0	1.03	163	1.29	279.5	59.5	1
1.001	80.05	4.52	98.866	0.536	0.0	0.0	0.0	1.23	236	1.29	279.5	116.2	1
1.002	78.19	4.77	98.799	0.804	0.0	0.0	0.0	1.35	296	1.29	279.5	170.3	1

Simulation Criteria

Synthetic Rainfall

Synthetic Rainfall

FSR Rainfall

Return Period (years)	1
Region	England and Wales
M5-60 (mm)	20.700
Ratio R	0.443
Storm Duration (mins)	15
Profile	Summer ○ Winter ◉

Runoff

Volumetric Run-off Coefficient	0.840

Additional Settings

Areal Reduction Factor	1.000
Hot Start (mins)	0
Hot Start Level (mm)	0
Manhole Headloss Coefficient (Global)	0.500
Foul Sewage per hectare (l/s)	0.000
Additional Flow - % of Total Flow	40.000
MADD Factor *10m³/ha Storage	2.000
Inlet Coefficient (Global)	0.800
Flow per person per day (l/per/day)	0.000

Output Details

Run Time (mins)	0
Output Interval (mins)	0

Micro Drainage

OK | Cancel | Help | Default | Map

Summary of Results for 15 minute 1 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	99.246	-0.279	0.000	0.26	26.195	57.3	OK
1.001	2	100.000	99.222	-0.236	0.000	0.46	52.380	101.2	OK
1.002	3	100.000	99.182	-0.209	0.000	0.67	78.570	145.2	OK

Summary of Results for 15 minute 2 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	99.301	-0.224	0.000	0.34	33.839	73.7	OK
1.001	2	100.000	99.282	-0.176	0.000	0.59	67.662	129.7	OK
1.002	3	100.000	99.244	-0.147	0.000	0.86	101.488	186.6	OK

Summary of Results for 15 minute 30 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	99.770	0.245	0.000	0.63	64.302	136.7	FLOOD RISK
1.001	2	100.000	99.733	0.275	0.000	1.26	128.615	273.7	FLOOD RISK
1.002	3	100.000	99.598	0.207	0.000	1.87	192.937	408.6	SURCHARGED

Summary of Results for 15 minute 100 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	100.002	0.477	2.518	0.84	83.598	183.3	FLOOD
1.001	2	100.000	99.964	0.506	0.000	1.57	167.249	342.6	FLOOD RISK
1.002	3	100.000	99.774	0.383	0.000	2.36	250.917	515.2	FLOOD RISK

Summary of Results for 360 minute 100 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	99.140	-0.385	0.000	0.10	194.912	22.7	OK
1.001	2	100.000	99.111	-0.347	0.000	0.21	389.905	45.4	OK
1.002	3	100.000	99.066	-0.325	0.000	0.31	585.064	68.1	OK

POST-DEVELOPMENT RUNOFF [WITH MITIGATION]

Summary of Results for 15 minute 1 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	100.001	0.476	1.324	0.21	26.211	45.9	FLOOD
1.001	2	100.000	100.001	0.543	0.762	0.28	52.438	60.5	FLOOD
1.002	3	100.000	100.000	0.609	0.285	0.33	78.607	72.2	FLOOD
1.003	4	100.000	100.000	0.676	0.003	0.25	78.606	55.2	FLOOD

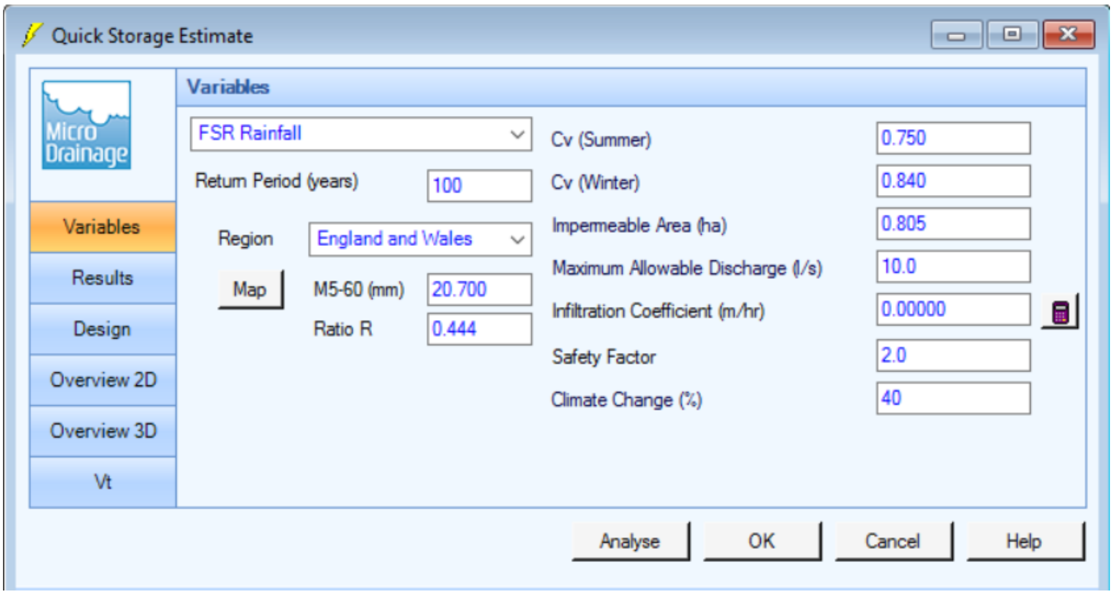
Summary of Results for 15 minute 30 year Winter

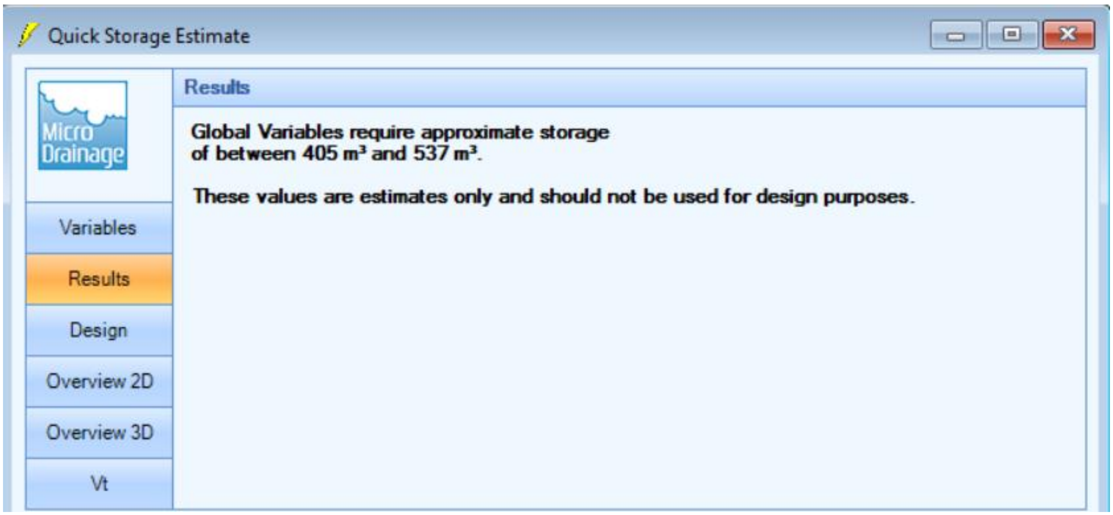
Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	100.040	0.515	39.882	0.27	62.487	59.4	FLOOD
1.001	2	100.000	100.035	0.577	35.360	0.30	123.834	65.3	FLOOD
1.002	3	100.000	100.025	0.634	24.513	0.37	182.797	79.7	FLOOD
1.003	4	100.000	100.007	0.683	7.406	0.25	180.071	55.1	FLOOD

Summary of Results for 360 minute 100 year Winter

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	100.000	100.005	0.480	4.838	0.13	196.667	28.5	FLOOD
1.001	2	100.000	100.002	0.544	2.917	0.21	388.708	45.6	FLOOD
1.002	3	100.000	100.002	0.611	2.744	0.29	589.856	62.2	FLOOD
1.003	4	100.000	100.001	0.677	1.455	0.25	577.594	54.0	FLOOD

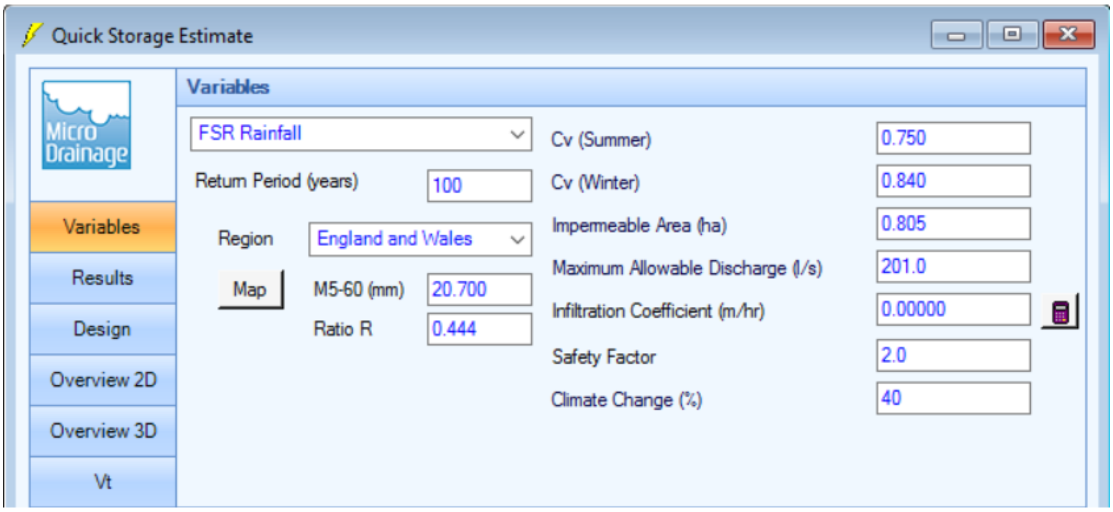
QUICK STORAGE CALCULATIONS [RUNOFF RESTRICTED TO GREENFIELD RUNOFF RATE]

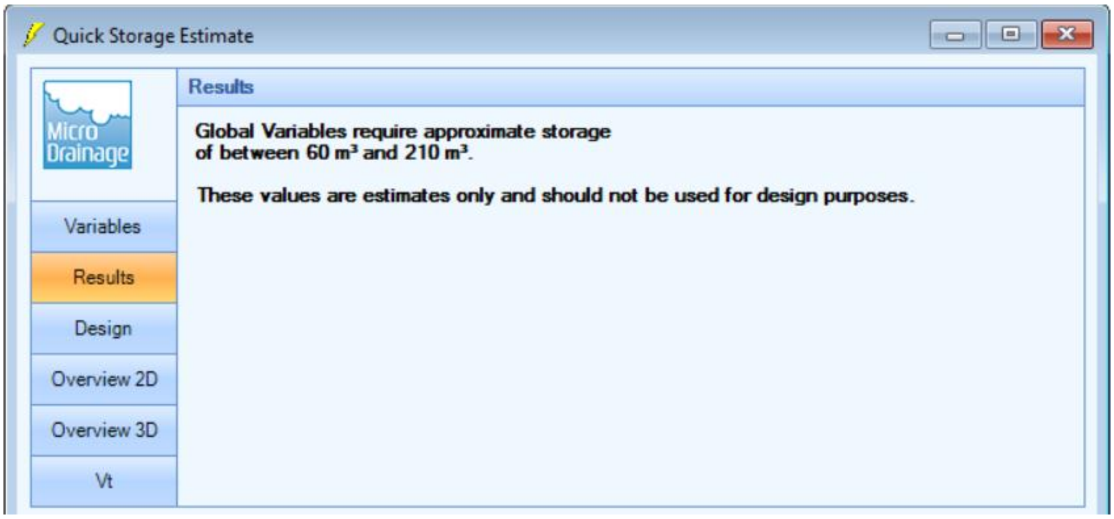




Average volume = 471m^3

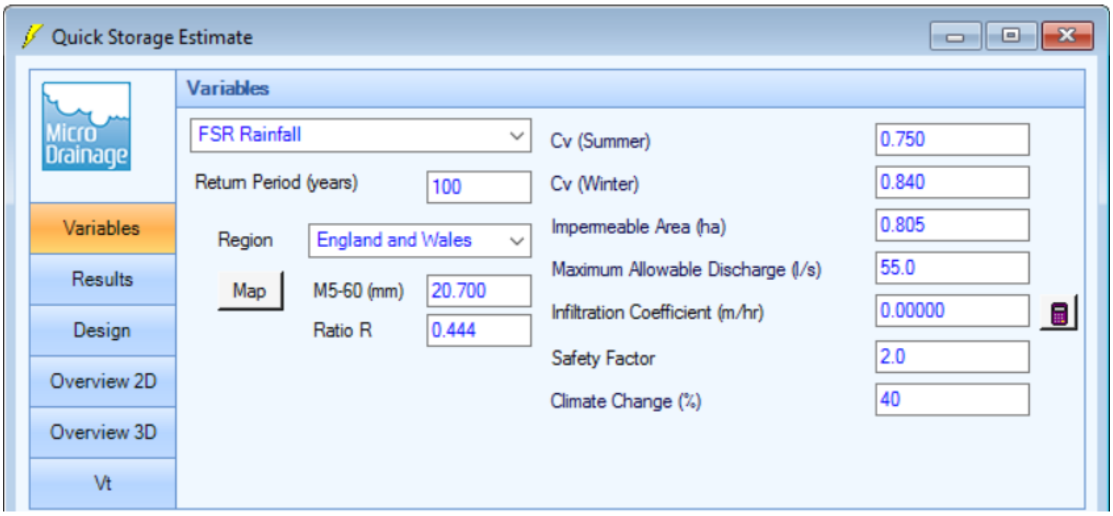
QUICK STORAGE CALCULATIONS [RUNOFF RESTRICTED TO 50% OF THE 100 YEAR 15 MIN BROWNFIELD RUNOFF RATE]

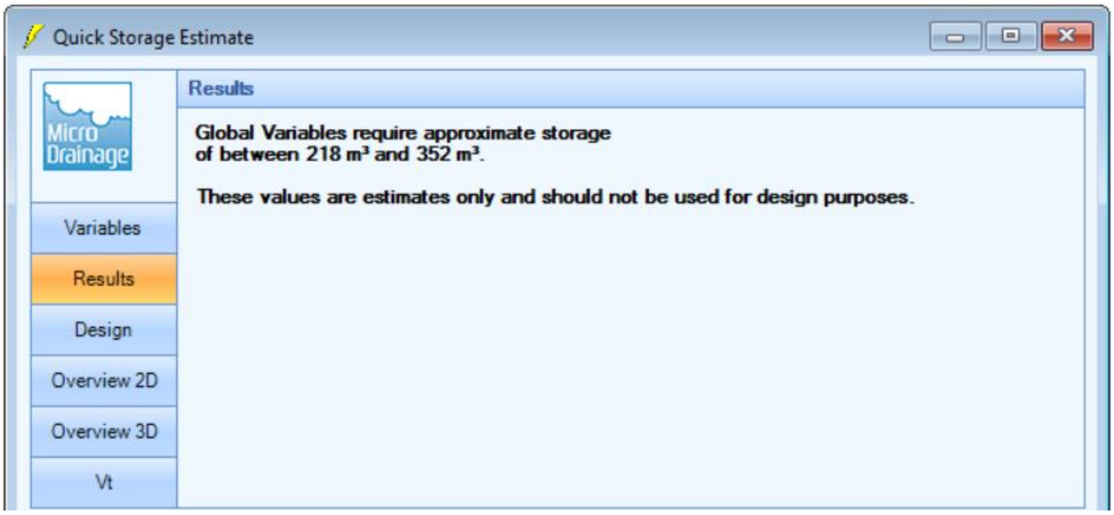




Average volume = 135m^3

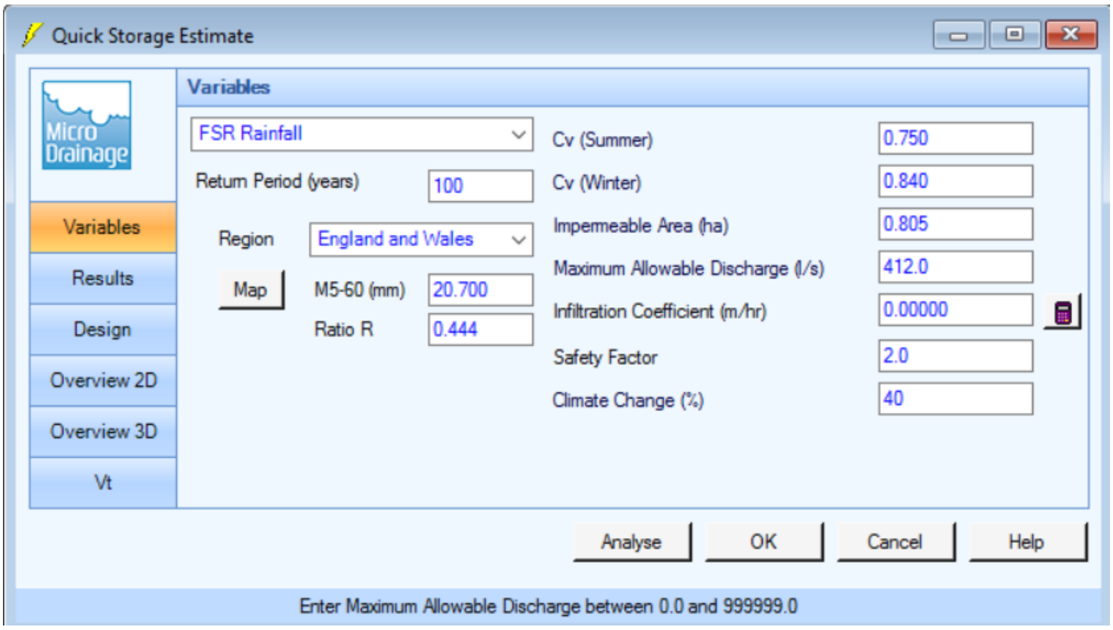
QUICK STORAGE CALCULATIONS [RUNOFF RESTRICTED TO 50% OF THE 1 YEAR 15 MIN BROWNFIELD RUNOFF RATE]

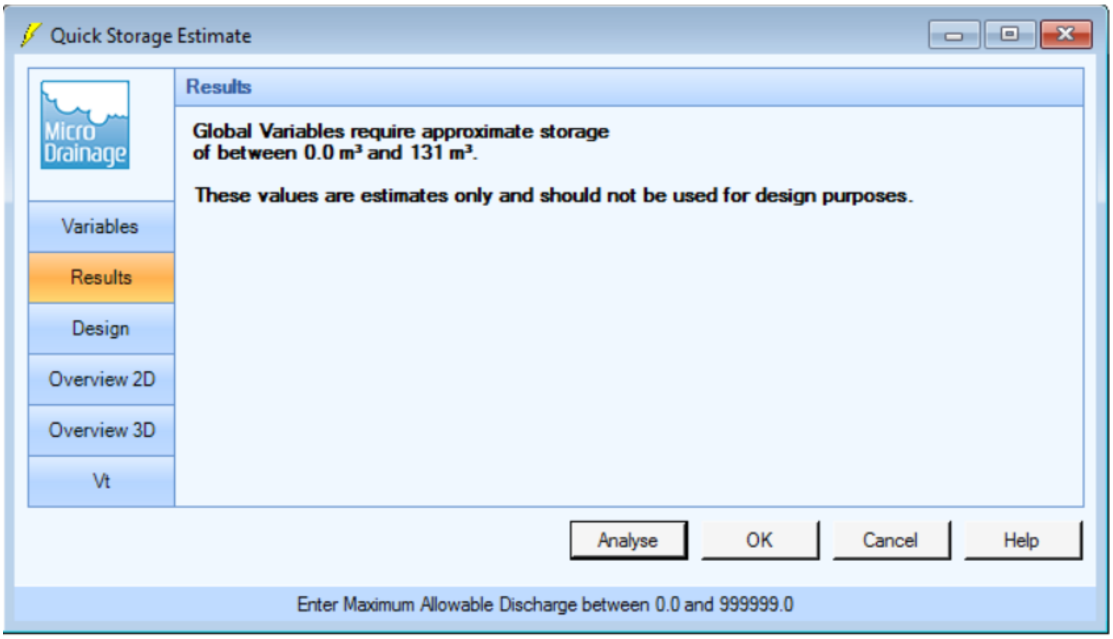




Average volume = 285m^3

QUICK STORAGE CALCULATIONS [RUNOFF RESTRICTED TO 100 YEAR 15 MIN BROWNFIELD RUNOFF RATE]





Average volume = 65.5m^3

Green roofs

Description

Green roofs comprise a multi-layered system that covers the roof of a building or podium structure with vegetation cover/landscaping/ permeable car parking, over a drainage layer. They are designed to intercept and retain precipitation, reducing the volume of runoff and attenuating peak flows.

Key design criteria

- design for interception storage
- minimum roof pitch of 1 in 80, maximum 1 in 3 (unless specific design features are included).
- structural roof strength must provide for the full additional load of saturated green roof elements.
- hydraulic design should follow guidance in BSEN 12056-3 (BSI 2000)
- multiple outlets to reduce risk from blockages
- lightweight soil medium and appropriate vegetation

Advantages

- mimic predevelopment state of building footprint
- good removal capability of atmospherically deposited urban pollutants
- Can be applied in high density developments
- Can sometimes be retrofitted
- Ecological, aesthetic and amenity benefits
- no additional land take
- Improve air quality
- help retain higher humidity levels in city areas
- insulates buildings against temperature extremes
- reduces the expansion and contraction of roof members
- sound absorption

Disadvantages

- cost (compared to conventional runoff)
- not appropriate for steep roofs
- opportunities for retrofitting may be limited by roof structure (strength, pitch etc)
- maintenance of roof vegetation
- any damage to waterproof membrane likely to be more critical since water is encouraged to remain on the roof

Performance

peak flow reduction	medium
volume reduction	medium
water quality treatment	good
amenity potential	good
ecology potential	good

Treatment Train Suitability

source control	yes
conveyance	no
site control	no
regional control	no

Site Suitability

residential	yes
commercial/industrial	yes
high density	yes
retrofit	yes
contaminated sites/sites above vulnerable ground water	yes

Cost implications

land take	none
capital cost (depending on roof type and capacity)	low-high
maintenance burden	medium

Pollutant removal

total suspended solids	high
nutrients	low
heavy metals	medium

Key maintenance requirements

- irrigation during establishment of vegetation
- inspection for bare patches and replacement of plants
- litter removal (depending on setting and use

SUDS Operational & Maintenance Requirements
Green roofs

Maintenance schedule	Required action	Frequency
Regular maintenance	Remove debris and litter to prevent clogging of inlet drains and interface with plant growth	Six monthly/annually or as required.
	During establishment (i.e year one), replace dead plants as required.	Monthly (but usually responsibility of manufacturer.
	Post establishment, replace dead plants as required	Six monthly or as required.
	Remove fallen leaves and debris from deciduous plant foliage.	Six monthly or as required.
	Remove nuisance and invasive vegetation, including weeds.	Six monthly or as required.
	Mow grasses (if appropriate) as required. Clippings must be removed and not allowed to accumulate.	Six monthly or as required.
Occasional maintenance	-	-
Remedial actions	If erosion channels are evident, these should be stabilised with additional soil substrate similar to the original material. Sources of erosion damage must be identified and controlled.	As required.
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate.	As required.
Monitoring	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability.	Annually/after severe storms.
	Inspect soil substrate for evidence of erosion channels and identify and sediment sources.	Annually/after severe storms.
	Inspect drain inlets to ensure unrestricted runoff from drainage layer to the conveyance or roof drain system.	Annually/after severe storms.
	Inspect underside of roof for evidence of leakage.	Annually/after severe storms.

Note:
If mechanical systems are located on the roof, then spill prevention measures must be exercised to ensure that roof runoff is not contaminated. The mechanical system area should be bunded and provided with separate drainage.

Training and guidance information on operating and maintaining the roof should be provided to all property owners and tenants, Safety fastenings will be required for personnel working on the roof.

Water butts

Description

Water butts are the most common means of harvesting rainwater for garden use. They are small, off-line storage devices that are designed to capture and store roof runoff. If stormwater management benefits are to be obtained. specific modification of these units is required. This

Key design criteria

- Overflow provision

Advantages

- easy to construct, install and operate
- easy to retrofit
- inexpensive
- marginal stormwater management benefits
- provides water for non potable water uses, eg garden watering

Disadvantages

- high risk of blockage of small throttles
- very limited water quality treatment
- property owner responsible for operation and maintenance, therefore cannot be guaranteed

Performance

peak flow reduction	low
volume reduction	low
water quality treatment	low
amenity potential	poor
ecology potential	poor

Treatment Train Suitability

source control	yes
conveyance	no
site control	no
regional control	no

Site Suitability

residential	yes
commercial/industrial	yes
high density	yes
retrofit	yes
contaminated site/sites above vulnerable ground water	yes

Cost implications

land take	none
capital cost	low
maintenance burden	low

Pollutant removal

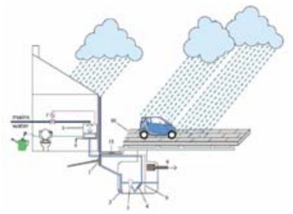
total suspended solids	low
nutrients	low
heavy metals	low

Key maintenance requirements

- inspection of inlet and outlet for blockages
- silt and debris removal
-

Maintenance schedule	Required action	Frequency
Regular maintenance	Cleaning of tank, inlets, outlets, gutters, withdrawal devices and roof drain filters of silts and other debris	Annually (or following poor performance).
Occasional maintenance	Replacement of any filters	As required
Remedial actions	Repair of erosion damage, or damage to tank	As required.
Monitoring	Inspection of the tank for debris and sediment build up	Annually (or following poor performance).
	Inspection of areas receiving overflow, for evidence of erosion	After extreme storms
	Inspection of roof drain filters	Annually (or following poor performance).

Rainwater harvesting



Description

Rainwater from roofs and hard surfaces can be stored and used. If designed appropriately, the systems can also be used to reduce the rates and volumes of runoff.

Key design criteria

- design dependant on demand requirements, contributing surface area, stormwater management requirements and seasonal rainfall characteristics
- first flush often diverted away from tank

Advantages

- with careful design, can provide source control of stormwater runoff
- Reduces demand on mains water

Disadvantages

- potential risks to public health
- systems can be complex and costly to install
- above ground tanks can be unsightly

Performance

peak flow reduction	high
volume reduction	high
water quality treatment	poor
amenity potential	poor
ecology potential	poor

Treatment Train Suitability

source control	yes
conveyance	no
site control	no
regional control	no

Site Suitability

residential	yes
commercial/industrial	yes
high density	yes
retrofit	yes
contaminated site/sites above vulnerable ground water	yes

Cost implications

land take	none
capital cost	high
maintenance burden	medium

Pollutant removal

total suspended solids	high
nutrients	low
heavy metals	medium

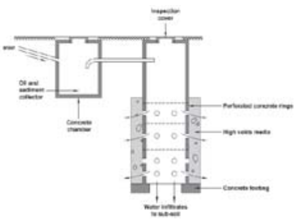
Key maintenance requirements

- inspection and cleaning of collection systems, filters, throttles and valves, pumps

Maintenance schedule	Required action	Frequency
Regular maintenance	Cleaning of tank, inlets, outlets, gutters, withdrawal devices and roof drain filters of silts and other debris.	Annually (or following poor performance).
Occasional maintenance	Replacement of any filters.	Three monthly.
Remedial actions	Repair of erosion damage, or damage to tank.	As required.
Monitoring	Inspection of the tank for debris and sediment build up.	Annually (or following poor performance).
	Inspection of inlets, outlets and withdrawal devices.	Annually (or following poor performance).
	Inspection of areas receiving overflow, for evidence of erosion.	Annually (or following poor performance).
	Inspection of any pumps – check function and wiring.	Annually (or following poor performance).
	Inspection of roof drain filters.	Annually (or following poor performance).

Note:
When buying a property, purchasers should be made aware that a rainwater harvesting system is installed. Maintenance and operational requirements must be made clear. This should preferably be in the form of a manual and system logbook, with initial instruction carried out in person. Such a manual and logbook should be incorporated into the literature given to the new owner.

Soakaways



Description

Soakaways are square or circular excavations, either filled with rubble or lined with brickwork, precast concrete or polyethylene rings/perforated storage structures surrounded by granular backfill. They can be grouped and linked together to drain large areas including highways. The supporting structure and backfill can be substituted by modular, geocellular units. Soakaways provide stormwater attenuation, stormwater treatment and groundwater recharge

Key design criteria

- design to meet site drainage standards – generally 1 in 10 or 1 in 30 year design event
- site infiltration rate assumed for design should be based on appropriate site investigations and should include an appropriate factor of safety
- appropriate pre-treatment is required
- if used, fill material should provide >30 per cent void space
- minimum distance of 1m from base to the seasonally high groundwater table
- minimum distance of 5m from foundations

Advantages

- minimal net land take
- provides groundwater recharge
- good volume reduction and peak flow attenuation
- good community acceptability
- easy to construct and operate
- can be retrofitted

Disadvantages

- not suitable for poor draining soils
- field investigations required to confirm infiltration rates
- not suitable for locations where infiltrating water may put structural foundations at risk, or where infiltrating water may adversely affect existing drainage patterns
- not appropriate for draining polluted runoff
- increased risk of groundwater pollution
- some uncertainty over long-term performance
- possible reduced performance during long wet periods
- where property owner responsible for operation and maintenance, performance difficult to guarantee

Performance

peak flow reduction	good
volume reduction	good
water quality treatment	good
amenity potential	poor
ecology potential	poor

Treatment Train Suitability

source control	yes
conveyance	no
site control	yes
regional control	no

Site Suitability

residential	yes
commercial/industrial	yes
high density	yes
retrofit	yes
contaminated sites/ sites above vulnerable ground water	no

Cost implications

land take	low
capital cost	low
maintenance burden	low

Pollutant removal

total suspended solids	medium
nutrients	low
heavy metals	medium

Key maintenance requirements

- removal of sediments/debris from pre-treatment device
- monitoring performance (using observation well)

Maintenance schedule	Required action	Frequency
Regular maintenance	Remove sediment and debris from pre-treatment devices and floor of inspection tube or chamber.	Annually.
	Cleaning of gutters and any filters on downpipes	Annually
Occasional maintenance	Trimming any roots that may be causing blockages	As required (unlikely)
Remedial actions	Reconstruct soakaway and /or replace or clean void fill, if performance deteriorates or failure occurs.	As required.
Monitoring	Inspect silt traps and note rate of sediment accumulation.	Monthly in the first year then annually.
	Check soakaway to check emptying is occurring	Annually.

Note:
Some, otherwise permeable soils and soft rocks (eg chalk) can have their permeability significantly reduced by smearing of the surface during excavation, especially by mechanical diggers. It is recommended that the exposed surface of the soil is manually cleaned of any smearing before the geotextile and granular fill surrounding the chamber are installed.

Pervious pavements

Description

Pervious pavements provide a pavement suitable for pedestrian and /or vehicular traffic, while allowing rainwater to infiltrate through the surface and into the underlying layers. The water is temporarily stored before infiltration to the ground, reuse, or discharged to a watercourse or other drainage system. Pavements with aggregate sub-bases can provide good water quality treatment.

Key design criteria

- pervious surfaces and sub-base to be structurally designed for site purpose and design vehicular loading
- surface infiltration rate should normally be an order of magnitude greater then design rainfall intensity
- temporary subsurface storage volume to meet requirements for infiltration and /or controlled discharge
- geotextile may be specified as a filtration treatment component near the top of the structure
- soil and other material must be prevented from contaminating the pavement surface and sub-structure

Advantages

- effective in removing urban runoff pollutants
- lined systems can be used where infiltration is not desirable, or where soil integrity would be compromised
- significant reduction in volume and rate of surface runoff
- suitable for installation in high density development
- good retrofit capability
- no additional land take, allows dual use of space
- low maintenance
- removes need for gully pots and manholes
- eliminates surface ponding and surface ice
- good community acceptability

Disadvantages

- cannot be used where large sediment loads may be washed/carried onto the surface
- in the UK, current practice is to use on highways with low traffic volumes, low axle loads and speeds of less than 30mph
- risk of long-term clogging and weed growth if poorly maintained

Performance

peak flow reduction	good
volume reduction	good
water quality treatment	good
amenity potential	poor
ecology potential	poor

Treatment Train Suitability

source control	yes
conveyance	no
site control	yes
regional control	no

Site Suitability

residential	yes
commercial/industrial	yes
high density	yes
retrofit	yes
contaminated site/sites above vulnerable ground water (with liner)	yes

Cost implications

land take	low
capital cost	medium
net capital cost	low
maintenance cost	low

Pollutant removal

Total suspended solids	high
Nutrients	high
Heavy metals	high

Key maintenance requirements

- sweeping
- regular brushing and vacuuming

SUDS Operational & Maintenance Requirements
Pervious pavements

Maintenance schedule	Required action	Frequency
Regular maintenance	Jet wash & suction sweeper.	twice per year at beginning of Spring and end of Autumn leaf fall or as required based on site-specific observations of clogging.
Occasional maintenance	Removal of weeds.	As required.
	Jet wash & suction sweeper where silt has accumulated in joints or voids. Replace grit and vibrate surface.	As required.
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip has been raised to within 50mm of the level of the paving or adjacent kerbing.	As required.
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or hazard to users	As required.
	Rehabilitation of surface and upper sub-structure.	As required (if infiltration performance is reduced as a result of significant clogging).
Monitoring	Initial inspection.	Monthly for 3 months after installation.
	Inspect for evidence of poor operation and/or weed growth. If required take remedial action.	3-monthly, 48 hrs after large storm
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually
	Monitor inspection chambers	Annually

Note:
Preventing impermeable contaminants such as soil and mud from entering the pavement surface and sub-base both during and after construction is imperative to ensure that the pavement remains permeable throughout its design life. Construction equipment should be kept away from the area and silt fences, staged excavation works and temporary drainage swales which divert runoff away from the area should all be considered to manage these risks. Landscaping activities should be carefully designed and carried out to prevent deposition of topsoil, turf and other materials on the surface of the pavement. Infiltration surfaces must not be compacted and should be protected at all times.

Geocellular/modular systems

Description

Modular plastic geocellular systems with high void ratio that can be used to create a below ground infiltration (soakaway) or storage structure.

Key design criteria

- standard storage design using limiting discharges to determine storage volumes
- structural design to relevant standards for appropriate surface loadings
- appropriate geotextile/geomembrane for wrapping

Advantages

- modular and flexible
- dual usage ie infiltration and /or storage
- high void ratios (up to 96%) providing high storage volume capacity
- lightweight, easy to install and robust
- capable of managing high flow events
- can be installed beneath trafficked or non-trafficked areas (providing structural performance is proven to be sufficient)
- long-term physical and chemical stability
- can be installed beneath public open spaces, eg play areas

Disadvantages

- no water quality treatment

Performance

peak flow reduction	good
volume reduction (storage only)	poor
volume reduction (with infiltration)	good
water quality treatment	poor
amenity potential	poor
ecology potential	poor

Treatment Train Suitability

source control	yes
conveyance	possible
site control	yes
regional control	yes

Site Suitability

residential	yes
commercial/industrial	yes
high density	yes
retrofit	yes
contaminated site/sites above vulnerable ground water (with liner)	yes

Cost implications

land take	low
capital cost	low
maintenance burden	low

Pollutant removal

Total suspended solids	low
Nutrients	none
Heavy metals	low

Key maintenance requirements

- regular inspection of silt traps, manholes, pipework and pre-treatment devices, with removal of sediment and debris as required

Maintenance schedule	Required action	Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then six monthly.
	Debris removal from catchment surface (where may cause risks to performance)	Monthly
	Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary.	Monthly (and after large storms)
	Remove sediment from pre-treatment structures i.e catchpits	Annually, or as required
Remedial actions	Repair/rehabilitation of inlets, outlets, overflows and vents.	As required.
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually or after large storms.

Note:
Runoff should be prevented from entering the modular blocks during construction. Alternatively and only if the design allows, a flushing operation may be required prior to commissioning to ensure all sediments have been removed from the system.

All storage tanks should be sealed in accordance with waterproofing standards (i.e welded joints rather than adhesive taped) and the integrity of the seal checked through the use of non-destructive testing, to ensure it is leak-proof. Care needs to be taken during installation against damage of both the modular structure and the geotextile and /or geomembrane wrapping.

A1 SHEET

REV	DESCRIPTION	DATE	INIT	CHKD
A	ISSUED FOR COMMENT	24.08.16	GRC	CJM

FOR COMMENT

calfordseaden

Client
CREATE STREETS LTD
Project
MOUNT PLEASANT CIRCUS
Title
Conceptual SW Drainage Layout - Non-Infiltration

Scale	Date	Drawn By	Checked By	Project No:	Drawing No:	Revision
1:200@A1	AUG 16	GRC	CJM	K150248	SK1000	A

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