1.0 Introduction

In the past year extreme weather events have let to devastating flash floods and forecasters are predicting more of the same. Runnymede Borough Council is committed to help reducing the risk of pluvial flooding within the Borough.

Achieving a sustainable way of managing water resources is one way of dealing with hazard and risk. The ability to provide sustainable drainage system is the key to the long-term stability of water resources.

2.0 Purpose of this Guidance

The purpose of this guidance document is to assist developers and their design team in the deliverance of sustainable drainage systems (SuDS). This guidance makes reference to existing guidance documents and standards.

Development within the flood plan and / or greater than 1ha in size should be accompanied by an adequate Flood Risk Assessment (FRA) based on the guidance provided in Section 10 of NPPF and its accompanying guidance. A site-specific FRA must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall.

Development at risk of flooding must also be accompanied with floodplain mitigation / compensation and safe means of Escape.

3.0 Types of Flooding

The flood risk elements that need to be considered for any site are defined in BS 8533 as the "Forms of Flooding" and are listed as:

- Flooding from Rivers (fluvial flood risk)
- Flooding from the Sea (tidal flood risk)
- Flooding from the Land (surface water)
- Flooding Groundwater
- Flooding from Sewers(sewer and drain exceedance, pumping station failure etc)
- Flooding from Reservoirs, Canal and other Artificial Structures.

4.0 Surface Water Drainage

Surface Water Drainage to be provided in accordance with Part H of the Building Regulation and the hierarchy of methods applied. It is expected that SuDS and source control solutions are implemented unless it can be demonstrated that these are not practical

The maximum allowable runoff for previously undeveloped sites will be limited to Greenfield runoff on a site specific basis. On large developments, runoff shall not exceed 5 litres per second per hectare.

For Brownfield developments, the developer will be expected to actively provide betterment to near Greenfield runoff values- like for like discharge will not be accepted under any circumstances.

4.1 Soakaway or other Infiltration Systems

Within the United Kingdom there are two widely accepted methods of designing Infiltration Systems, The Building Research Establishment' Digest 365 and CIRIA's C697 SuDS Manual. The main difference between the two methods is that BRE365 ignores the infiltration through the base of the infiltration system to account for the reduction in its efficiency over time whereas C697 utilises infiltration through both the base and sides of the infiltration system but applies a factor of safety to the infiltration rate to account for the loss of efficiency.

For both of these methods the design philosophy is that the amount of storage capacity provided is equal to or greater than the difference between the inflow volume and the outflow volume.

The design soil infiltration rate should be obtained using the method specified in BRE Digest 365.

Infiltration rates of substrata can vary significantly and can be very site specific. It is therefore not generally possible to assign typical values to the infiltration co-efficient and testing should be carried out.

Rainfall rates/depths are generally calculated using one of the two methods provided in HR Wallingford's Wallingford Procedure for design and analysis of urban storm drainage.

Amongst other factors the required volume of storage is a function of storm duration and severity. The principal of both BRE365 and C697 methods is to calculate the required storage for a range of different storm durations to establish what the maximum required storage is.

The National Planning Policy Framework requires that any development shall not increase flood risk beyond the boundaries of a development site for rainfall events not exceeding the severity of the 1 % annual exceedance probability (AEP) , which is also referred to as a 1 in 100 year return period. In calculating the rainfall rate/depth an allowance for climate change needs to be applied.

4.1.1 The soakaways should have a time of emptying such that it should discharge from full to half empty within 24 hours in readiness for subsequent storm inflow.

4.1.2 Soakaways or other infiltration devices should be designed so that they do not flood for rainfall events up to 10% annual probability (1 in 10 year return period) in accordance with Document H of the Building Regulations. Soakaways may be designed to drain all runoff from hard surfaces up to the 1% (I in 100 year return period) plus an allowance for climate change to satisfy the requirements in NPPF. In such cases the time to half empty must be within 24 hours.

4.1.3 In accordance with the requirements of the NPPF the surface water drainage system should be designed so that there is no building flooding for storms with annual probability up to 1% plus an allowance for climate change. Further, any flooding that does occur as the result of storms with annual probability up to 1% plus climate change should be retained within the site to ensure that flood risk to adjacent properties is not increased as the result of the development.

4.1.4 The allowance required to take climate change into account is dependent on the design life of the development. The relevant climate change factors are given in the NPPF Technical Guidance.

4.1.5 An appropriate water quality treatment train should be incorporated within the design of the surface water drainage to ensure that receiving waters are not polluted.

4.2 BRE DIGEST 365

S = I - O

Where:

I = the inflow from the impermeable area draining to the infiltration device.

O = the outflow infiltrating into the soil from the infiltration device.

S = the required temporary storage in the infiltration device needed to balance inflow and outflow.

I = A x R

where:

A = the impermeable area draining to the infiltration device

R = the depth of rain falling for a given storm duration and probability.

I = as50 x f x D

where :

as50 = the internal surface area of the soakaway to 50% effective depth: this excludes the base area which is assumed to clog with fine particles and become ineffective in the long term.

f = infiltration coefficient determined using the BRE365 method.

D = the duration of the rainstorm

This gives

S = (A x R) – (as50 x f x D)

For a rectangular pit:

$$a_{s50} = \frac{d}{2} * \ (l + w) * 2$$

where:

d = the depth of water

l = the length of the pit and

w = the width of the pit

The method given in BRE365 is specifically calculated on a 10% AEP (1 in 10 year return period).

Half Drain Time

$$t_{s50} = \frac{S * 0.5}{a_{s50*f}}$$

ts50 should be less than or equal to 24.

A copy of the BRE Digest 365 can b located at

www.ecomerchant.co.uk/productattachments/index/download?id=4074

4.3 CIRIAC697

For 3-D infiltration systems (infiltration through the base as well as the sides) the following formula apply:

$$h_{max} = a * (e^{(-bD)} - 1)$$

where

$$a = \frac{A_b}{P} - \frac{i * A_D}{P * q}$$

$$b = \frac{P * q}{A_b * n}$$

hmax = the maximum depth of water for a given configuration of infiltration system and storm duration and intensity.

e = the exponential function

D = the storm duration

Ab = the base area of the infiltration device

AD = the impermeable area draining to the infiltration device

i = the rainfall intensity for the storm of given duration and severity

P = the perimeter of the infiltration system. (For a rectangular pit P = (Length * Width) * 2

q = the infiltration rate measured by the percolation test adjusted by the factor of safety factor of safety

n = the porosity of fill material (voids volume/total volume).

Half Drain Time

$$t_{50} = \frac{n * A_b}{q * P} * log_e\left(\frac{h_{max} + \frac{A_b}{P}}{\frac{h_{max}}{2} + \frac{A_b}{P}}\right)$$

It is a requirement that the base of a infiltration device should be at least 1 metre above the level of the ground water table.

4.4 Rainfall Data

The methods for calculating rainfall intensity and depth given in the Wallingford Procedure for design and analysis of urban storm drainage require two factors to be obtained which are dependent on the geographical location of the site. These factors are:

M5-60 – the design depth of rain falling in 60 minutes for a 1 in 5 year return period (20%AEP)

r – the rainfall ratio

For Runnymede these factors are taken to be:

M5-60 = 20 mm

r = 0.4

from these the rainfall depths and intensities can be calculated for different storm durations and return periods.

The table below gives rainfall depths and intensities, appropriate for the Runnymede Area, for 1 in 10 year, 1in 30 year and 1 in 100 year storms with a range of storm durations. In calculating these figures an allowance of an increase 30% has been applied to take into account climate change.

Duration		**1 in 10 yr + cc**		**1 in 30 yr + cc**		**1 in 100 yr + cc**	
Minutes	**Hours**	**intensity m/hr**	**depth m**	**intensity m/hr**	**depth m**	**intensity m/hr**	**depth m**
10	0.167	0.098	0.016	0.123	0.021	0.159	0.027
15	0.25	0.078	0.019	0.099	0.025	0.128	0.032
30	0.5	0.050	0.025	0.064	0.032	0.084	0.042
60	1	0.031	0.031	0.040	0.040	0.053	0.053
90	1.5	0.023	0.035	0.030	0.045	0.039	0.059
120	2	0.019	0.038	0.024	0.048	0.032	0.064
180	3	0.014	0.042	0.018	0.053	0.023	0.070
240	4	0.011	0.045	0.014	0.057	0.019	0.075
360	6	0.008	0.049	0.010	0.063	0.014	0.081
480	8	0.007	0.053	0.008	0.067	0.011	0.086
600	10	0.006	0.056	0.007	0.070	0.009	0.090
840	14	0.004	0.060	0.005	0.076	0.007	0.097
960	16	0.004	0.062	0.005	0.078	0.006	0.099
1200	20	0.003	0.066	0.004	0.082	0.005	0.104
1440	24	0.003	0.068	0.004	0.085	0.004	0.108
1800	30	0.002	0.072	0.003	0.089	0.004	0.113
2160	36	0.002	0.075	0.003	0.093	0.003	0.117
2520	42	0.002	0.078	0.002	0.096	0.003	0.120
2880	48	0.002	0.080	0.002	0.098	0.003	0.123

4.5 Factor of Safety for Infiltration Rate

Size of Area to be Drained	Consequences of Failure		
	No Damage or Inconvenience	Minor Inconvenience (eg surface water on car parking)	Damage to buildings or structures or major inconvenience
<100 m^2	1.5	2	10
100 – 1000 m^2	1.5	3	10
>1000 m^2	1.5	5	10

In normal circumstances for domestic properties a factor of safety of 2 should be used. MicroDrainage (XP Solutions) recommend that the table above should be modified as shown below when designing soakaways with WinDes. (This accounts for the fact that the standard value for Cv in the software is 0.75)

Size of Area to be Drained	Consequences of Failure		
	No Damage or Inconvenience	Minor Inconvenience (eg surface water on car parking)	Damage to buildings or structures or major inconvenience
<100 m^2	2	3	13
100 – 1000 m^2	2	4	13
>1000 m^2	2	6.5	13

4.6 Porosity

Material	Porosity, n
Geocellular Systems	0.9 – 0.95
Clean Stone	0.4 – 0.5
Uniform Gravel	0.3 – 0.4
Graded sand or Gravel	0.2 – 0.3

A value of n = 0.3 is usually assumed for granular filled infiltration systems.

4.7 Ring Soakaways

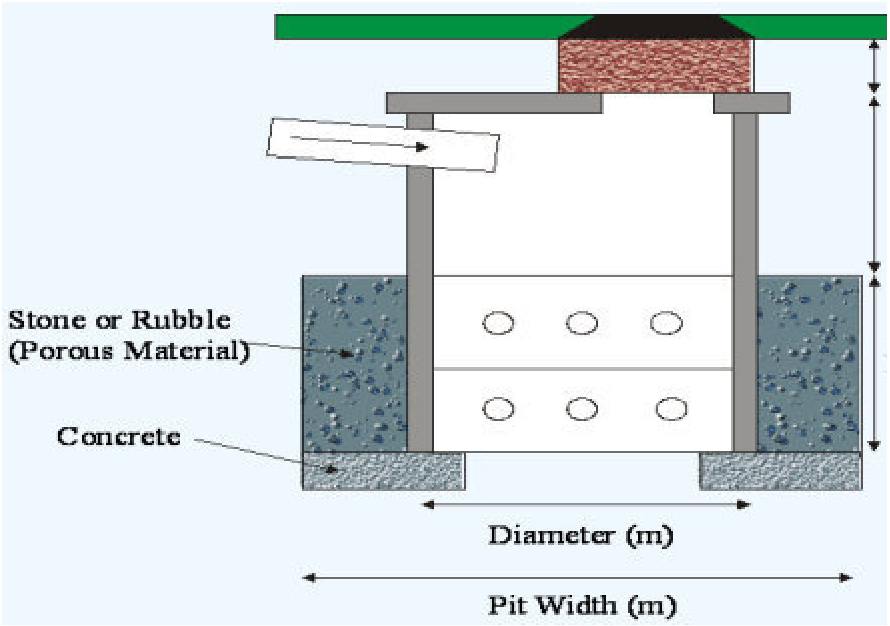
Where a ring soakaway is utilised it is acceptable to include the volume of the storage provided by the voids in the granular surround. In undertaking the soakaway design the effective porosity n' needs to be applied

$$n' = \frac{\pi r^2 * n * (w * l - \pi r^2)}{w * l}$$

n is the porosity of the granular material

l is the length of the excavation

w is the width of the excavation



BRE 365 recommends that pit for a ring soakaway should have sides in the region of twice the diameter of the concrete ring.

4.8 Other Drainage Solutions

Where infiltration is not feasible, developers will be allowed to discharge into the surface water sewers or adjoining watercourse with an allowable discharge as specified in section 4. The proposed system should provide storage facilities and control discharge for up to and including the 1 in 100 years storm with allowance to climate change.

4.9 Rainwater Harvesting Systems

Rainwater harvesting systems must be accompanied by an overflow system to cater for exceedance and can only be considered if the amount of water used daily is enough to create storage capacity throughout the year.

5.0 SuDS Management and Maintenance Regime

5.1 SuDS overview

5.2 A management statement to describe the SuDS scheme and set out the management aims for the site. It should consider how the SuDS will perform and develop over time anticipating any additional maintenance tasks to ensure the system continues to perform as designed.

5.3 Specification notes that describe how work is to be undertaken and the materials to be used

5.4 Proposed system layout

5.5 Maintenance checklist should include the maintenance schedule divided into regular maintenance, occasional maintenance, remedial actions and monitoring, the required action for each maintenance schedule and its frequency.

6.0 Notes

We strongly recommend that developers seek advice from professionally qualified engineers to determine the drainage requirements for their specific development.

For any site specific queries please contact the Engineering Services Team on 01932838383