APPENDIX 6.6
GREENFIELD RUNOFF RATES

Preliminary rainfall runoff management for developments
(EA/DEFRA W5-074/A)

Summary information

Interim procedure for rainfall runoff management for developments

This interim procedure is expected to be revised as improved tools are developed. It uses well-recognised existing methods, but revision is anticipated to provide a more consistent approach as and when Flood Estimation Handbook (FEH) procedures can be extended to catchments at development scale.

The objective of this procedure is to assist developers and their designers to conform to Planning Policy Guidance Note 25 (PPG25) and applies to both greenfield and brownfield sites.

In the case of brownfield sites, drainage proposals will be measured against the existing performance of the site (although it is preferable for solutions to provide runoff characteristics, which are similar to greenfield behaviour).

Sites with polluted land will have particular consent requirements and affect the drainage techniques that can be used.

Part H of the Building Regulations requires that the first choice of surface water disposal should be to discharge to infiltration systems where practicable. Infiltration techniques should therefore be applied wherever they are appropriate.

Drainage calculations and criteria, where appropriate, should comply with *Sewers for Adoption* (5th edition).

The objectives of this procedure are:

- For stormwater runoff discharged from urban developments to replicate or achieve a reduction from the greenfield response of the site over an extended range of storm probabilities (return periods)
- To manage runoff on site for extreme events.

This requires:

- the **peak rate** of stormwater run-off to be controlled
- the **volume** of run-off to be reduced
- the **pollution** load to receiving waters from stormwater runoff to be minimised
- the assessment of **overland flows and temporary flood storage** across the site.

The Environment Agency will normally require that, for the range of annual flow rate probabilities, up to and including the 1% annual probability (1 in 100 year event) the developed rate of runoff into a watercourse should be no greater than the undeveloped rate of runoff for the same event. Exceptions only apply where it is not practical to achieve this due to the size of the hydraulic control unit. The purpose of this is to retain a natural flow regime in the receiving watercourse and not increase peak rates of flow for events of an annual probability greater than 1%. Three annual probabilities merit specific consideration; 100%, 3.33% and 1%.

The 100% annual probability (once in one-year event) is the highest probability event to be specifically considered to ensure that flows to the watercourse are tightly controlled for these more frequent events.

The 3.33% annual probability (1 in 30 years event) is of importance because of its linkage with the level of service requirement of *Sewers for Adoption* (5th edition). *Sewers for Adoption* requires that surface water sewers should be capable of carrying the 3.33% annual probability event within the system without causing flooding to any part of the site.

The 1% annual probability (1 in 100 years event) has been selected since it represents the boundary between high and medium risks of fluvial flooding defined by PPG25 and also recognises it is not practicable to fully limit flows for the most extreme events. Also *Sewers for Adoption* recognises that, during extreme wet weather, the capacity of surface water sewers may be inadequate. *Sewers for Adoption* requires that the site layout should be such that internal property flooding does not result, by demonstrating safe above ground flow paths. The return period for this analysis is not specified, but it is recommended that 1% annual probability event (ie an event with a return period of 100 years) is used.

Flood flows up to the 1% annual probability event should preferably be contained within the site at designated temporary storage locations unless it can be shown to have no material impact in terms of nuisance or damage, or increase river flows during periods of river flooding. Analysis for overland flood flows within the site will need to use short high intensity rainfall events of between 15 minutes and 1 hour duration.

The calculation of peak rates of runoff from greenfield sites is related to catchment size. The values derived should be regarded as indicative due to the limitations of the existing tools. The table below summarises the techniques to be used.

Development size	Method
0 – 50 ha	The Institute of Hydrology Report 124 Flood Estimation for Small Catchments (1994) is to be used to determine peak green field run-off rates. Where developments are smaller than 50 ha, the analysis for determining the peak greenfield discharge rate should use 50 ha in the formula and linearly interpolate the flow rate value based on the ratio of the development to 50 ha. FSSR 2 and 14 regional growth curve factors are to be used to calculate the greenfield peak flow rates for 1, 30 and 100 year return periods.
50 ha – 200 ha	IH Report 124 will be used to calculate greenfield peak flow rates. Regional growth factors to be applied.
Above 200 ha	IH Report 124 can be used for catchments that are much larger than 200 ha. However, for schemes of this size it is recommended that the Flood Estimation Handbook (FEH) should be applied. Both the statistical approach and the unit hydrograph approach should be used to calculate peak flow rates. The unit hydrograph method will also provide the volume of greenfield run-off. However, where FEH is not considered appropriate for the calculation of greenfield run-off for the development site, for whatever reasons, IH 124 should be used.

The stormwater runoff volume from a site should be limited to the greenfield runoff volume wherever possible. The additional runoff volume caused by urbanisation should be controlled using two criteria.

Where possible, infiltration or other techniques are to be used to ensure minimal discharge to receiving waters for rainfall depths up to 5mm.

The difference in runoff volume pre- and post-development for the 100 year 6 hour event, (the additional runoff generated) should be disposed of by way of infiltration, or if this is not feasible due to soil type, discharged from the site at flow rates below 2l/s/ha.

Where compliance to 100 year volumetric criterion, as defined above, is not provided, the limiting discharge for the 30 and 100 year return periods will be constrained to the mean annual peak rate of runoff for the greenfield site (Referred to as Q_{BAR} in IH Report 124).

The percentage runoff of the rainfall on a greenfield site can be assumed to be approximately equal to the SPR value of the soil type of the site. The SPR value can be used from either the Flood Studies Report (FSR) or the Flood Estimation Handbook (FEH).

Calculation of the run-off volume from the developed site for preliminary assessment and design of drainage facilities will assume 100% run-off from paved areas and 0% run-off from pervious areas. Runoff from impermeable surfaces served by effective infiltration systems can be assumed to contribute no runoff for storage volumes assessment.

All network design for stormwater runoff and proof of compliance in meeting peak flow rate discharge criteria, using computer simulation, should use the standard Wallingford Procedure variable UK runoff model using appropriate parameters or similar software.

SUDS units should be used to achieve water quality improvements and amenity benefits as well as achieving compliance to these hydraulic criteria. Best practice in achieving water quality protection should be used.

At present, certain SUDS units are considered to have some degree of risk of medium term hydraulic failure, due to either maintenance or possible change of status. In these situations, to ensure compliance with pipe capacity criteria, they will be deemed not to be effective when calculating pipe sizes and storage requirements. For pipe sizing the current view of the Water Undertakers should be sought. For storage sizing of all structures which are not to be adopted by Water Undertakers, the view of the Environment Agency should normally apply.

Climate change will be taken into account in hydrological regions by increasing the rainfall depth by 10% for computing storage volumes. The official advice by Defra on river flows is that a 20% increase should be added for climate change. Due to the relationship between rainfall and runoff being non-linear, the use of 10% additional rainfall is considered to approximate to a 20% increase in runoff for larger events. No allowance for climate change should be applied to calculated greenfield peak rates of runoff from the site for any hydrological region. It should be recognised that although climate change is acknowledged as taking place, certainty regarding the hydrological changes, particularly of extreme short duration events, is very low.

The minimum size of throttle serving the outfall of a pond is to be 150mm in diameter. Similarly the minimum pipe size is to be 150mm diameter and laid at a minimum gradient of 1:150. This defines the minimum limiting discharge from a site pond based upon the use of a hydraulic throttle, which is 13l/s. This criteria meets the requirements of *Sewers for Adoption*. Lower outflow rates may be achievable using other SUDS or mechanical techniques where technically appropriate. Use of smaller throttles and pipe sizes within, or as part of, SUDS units should be avoided unless specifically defined in best practice guidance.

Catchment Flood Management Plans (CFMPs), consider the impact of development on flood risk in the catchment based on existing land use plans contained in the local plan published by the Local Planning Authority and projections of development beyond the periods covered by the land use plans. Strategy Plans identified in the CFMPs each cover part of the catchment and may consider the local impact of these developments in more detail. Where these exist for an area proposed for development, their findings must be taken into account in the development proposal.

Further information on the calculation of Greenfield runoff can be found in CIRIA publication C609 and *Preliminary rainfall runoff management for developments* EA/Defra Technical Report W5-074/A (HR Wallingford 2004).

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