

SAHAM TONEY SUSTAINABLE DRAINAGE SYSTEM (SuDS) DESIGN MANUAL



First Edition September 2020

This guide has been prepared for Saham Toney Parish Council by the Saham Toney Neighbourhood Plan Work Group

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1.0 INTRODUCTION

1.1 Saham Toney is a rural village and a civil parish in the Breckland District of Norfolk. The parish comprises not only the village of Saham Toney, but also Saham Hills, which has its own distinct history and character, together with a number of small hamlets. This guide applies to the whole parish and the words ‘village’ and ‘Saham Toney’ are used interchangeably with ‘parish’ throughout.

1.2 This guide is intended to be used by:

- Planners, as supplementary guidance and as a material consideration alongside the Saham Toney Neighbourhood Plan;
- Property developers and architects to guide them towards the type of design that will be seen as acceptable by the village; and
- Any other person or organisation involved in the development process;
- Householders affected by surface water flooding, with respect to retrofitting some of the measures described herein in order to reduce and mitigate flood risk to their properties.

1.3 The requirements herein are an expanded version of those that originally formed part of the Saham Toney Parish Design Guide.

1.4 Recognising the length and broad scope of this guide, throughout the document, each issue of critical importance is denoted as a “Key Point” and highlighted in a text box, thus:

* KEY POINT

1.5 A wealth of professional guidance on the design and implementation of SuDS is available in the public domain. It is not the intention of this document to duplicate such guidance in full, or attempt to reference it all, but salient points of particular relevance to Saham Toney have been summarised from such guidance. References to suggested and essential reading are highlighted in text boxes, thus:

USEFUL REFERENCE

1.6 This guide supports and complements the Saham Toney Neighbourhood Plan, and its implementation shall be in accordance with policies 8A-8H of that Plan. Cross-references to applicable policies are indicated thus:



1.7 Where applicable design parameters are to be applied in order to comply with the Neighbourhood Plan policies, they are highlighted in text boxes, thus:

DESIGN PARAMETERS

2.0 PURPOSE OF THIS GUIDE

2.1 The overall purpose of this document is to set out requirements for, and guidance on, the principles, design, construction and maintenance of sustainable underground drainage schemes (SuDS) in the Parish of Saham Toney, with the principle aim of ensuring such schemes are implemented in a way that avoids any increase in flood risk, both on and offsite, and wherever possible reduces it.

2.2 The more general purpose of this Guide is:

- a) To expand on the Policies 8A - 8H of the Saham Toney Neighbourhood Plan, which deal with surface water management, and to guide users in their application;
- b) To raise awareness of the surface water flooding issues in the Parish of Saham Toney, and to ensure they are robustly addressed when planning, designing and constructing SuDS, and when deciding planning applications;
- c) To attempt to allay the concerns of those villagers who worry that development will add to existing surface water flood issues;
- d) To promote environmental benefits to the greatest extent possible and practical through the implementation of SuDS;

*** KEY POINT 1: Neither this manual, nor the Neighbourhood Plan can solve existing flood problems, but if applied correctly, both will ensure new development does not add to those problems**

3.0 PLANNING STATUS OF THIS DOCUMENT

3.1 This document supports the Saham Toney Neighbourhood Plan, and shall be applied in conjunction with all relevant policies of that Plan, particularly Policies 8A - 8H, which deal with surface water management. It has been formally adopted by Saham Toney Parish Council and hence is to be used as a material consideration in planning decisions relating to development in the Parish.

3.2 Adherence to this Design Manual does not mean that development proposals will necessarily be approved, since other planning policy considerations may make a proposal unacceptable.

3.3 The guidance given is not intended to replace national or local strategic policy, planning practice guidance, non-statutory or Lead Local Flood Authority guidance or the wealth of specialist guidance available on the subject of SuDS, but instead to provide local context to ensure that the most appropriate measures are implemented to deal with site and parish-specific issues.

3.4 This Design Manual does not replace Building Regulations or other regulatory building codes.

4.0 NATIONAL & LOCAL STRATEGIC POLICY and GUIDANCE

4.1 In terms of surface water flood risk, the National Planning Policy Framework sets overarching policy requirements in paragraphs 155 – 165 (February 2019 version), and sets strict tests to protect people and property from flood risk. In summary its principal requirements are to:

- Avoid inappropriate development in areas at risk of flooding by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.

- Use opportunities provided by new development to reduce the causes and impacts of flooding (where appropriate through the use of natural flood management techniques).
- Ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment.
- Allow development only in areas at risk of flooding where (a) it is appropriately flood resistant and resilient; (b) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate; and (c) any residual risk can be safely managed.

4.2 Planning practice guidance on flood risk may be found at <https://www.gov.uk/guidance/flood-risk-and-coastal-change>.

4.3 Breckland Local Plan Policy ENV 09: Flood Risk & Surface Water Drainage sets local strategic policy and dictates that development:

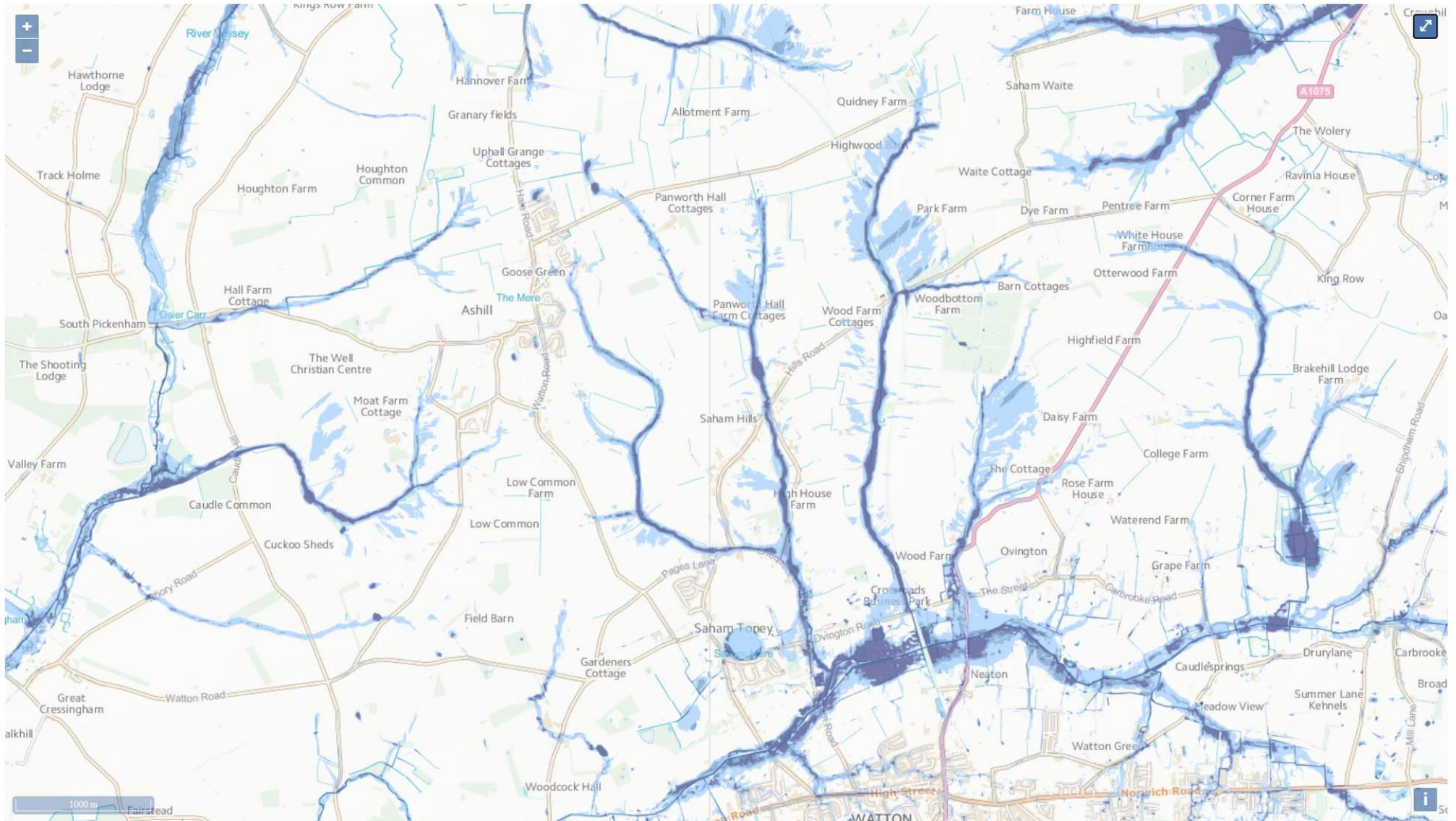
- Is located to minimise the risk of flooding, mitigating any such risk through design and implementing sustainable drainage (SuDS) principles.
- Incorporates appropriate surface water drainage mitigation measures to minimise its own risk of flooding and should not materially increase the flood risk to other areas.
- Will not increase green field run off rates and vulnerability of the site, or the wider catchment, to flooding from surface water run-off from existing or predicted water flows;
- Wherever practicable, have a positive impact on the risk of surface water flooding in the surrounding area adjacent to the development.

5.0 WHY SURFACE WATER DRAINAGE DESIGN & MANAGEMENT IS IMPORTANT IN SAHAM TONEY

5.1 Parts of Saham Toney are at significant risk of surface water flooding. This can be seen on the Environment Agency's flood risk maps, which can be found at <https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?easting=590341&northing=301270&address=100090791797&map=SurfaceWater>

While the online map must be referred to for detailed and up to date information, the screenshot taken from it on 17 August 2020, and given in Figure 1, gives an overview of the extent and level of surface water flood risk in the local area.

5.2 The extent of the problem is further illustrated in Figure 2, which shows the main Saham Toney watercourse and the main surface water flow paths, which are from higher ground to the north, via small streams and ditches. Ultimately water flows into Watton Brook, which forms much of the parish boundary between Saham Toney and Watton.



● High
 ● Medium
 ● Low
 Very low

Figure 1: Environment Agency Surface Water Flood Risk Map – Extent of Flooding

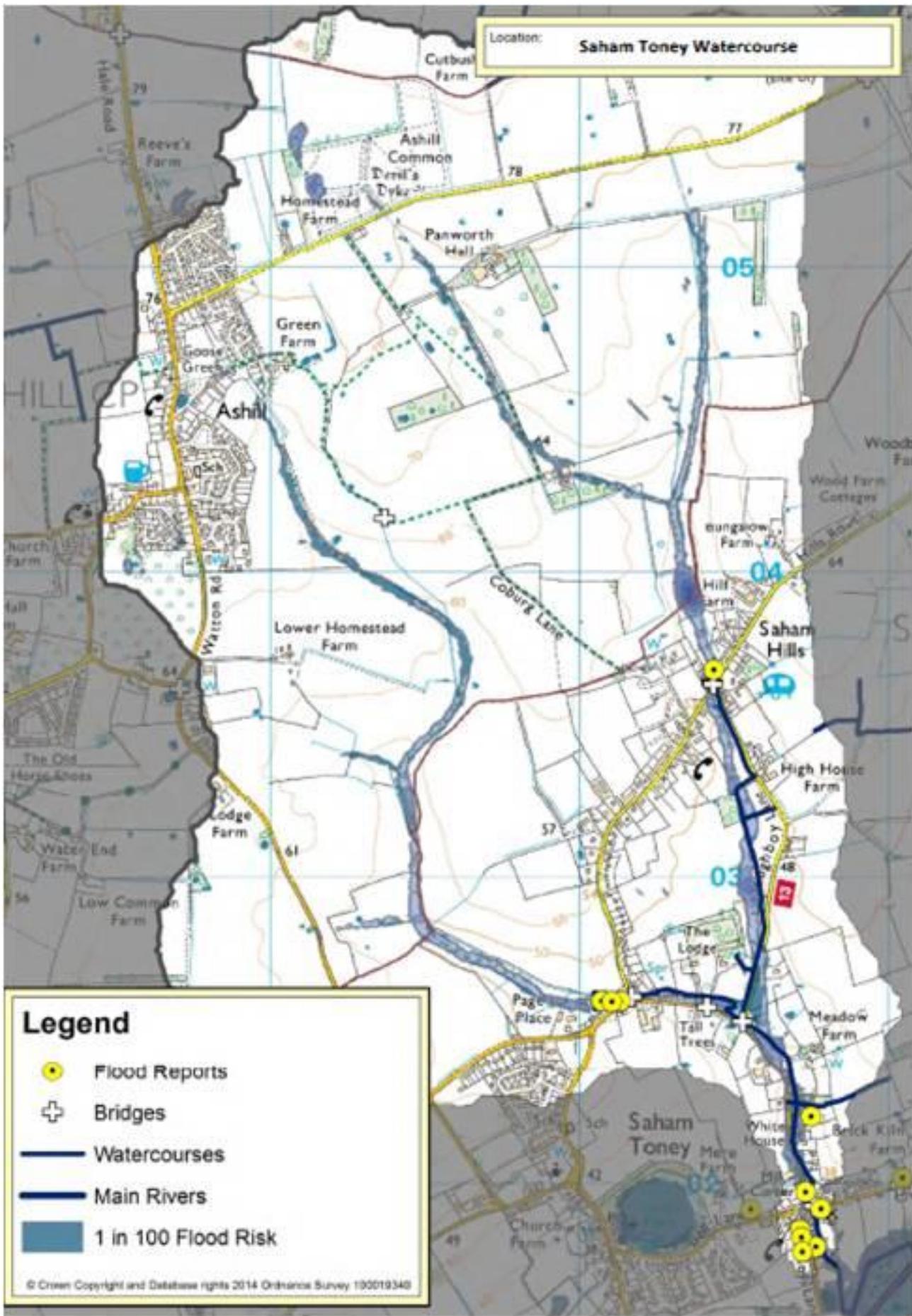


Figure 2: The Saham Toney Watercourse

5.3 Figure 2 is taken from Norfolk County Council's 2017 Flood Investigation Report into flooding in Watton and the surrounding area on 23 June 2016, which includes a specific section dealing with Saham Toney. Some photos of flooding on that date are given in Figure 3.

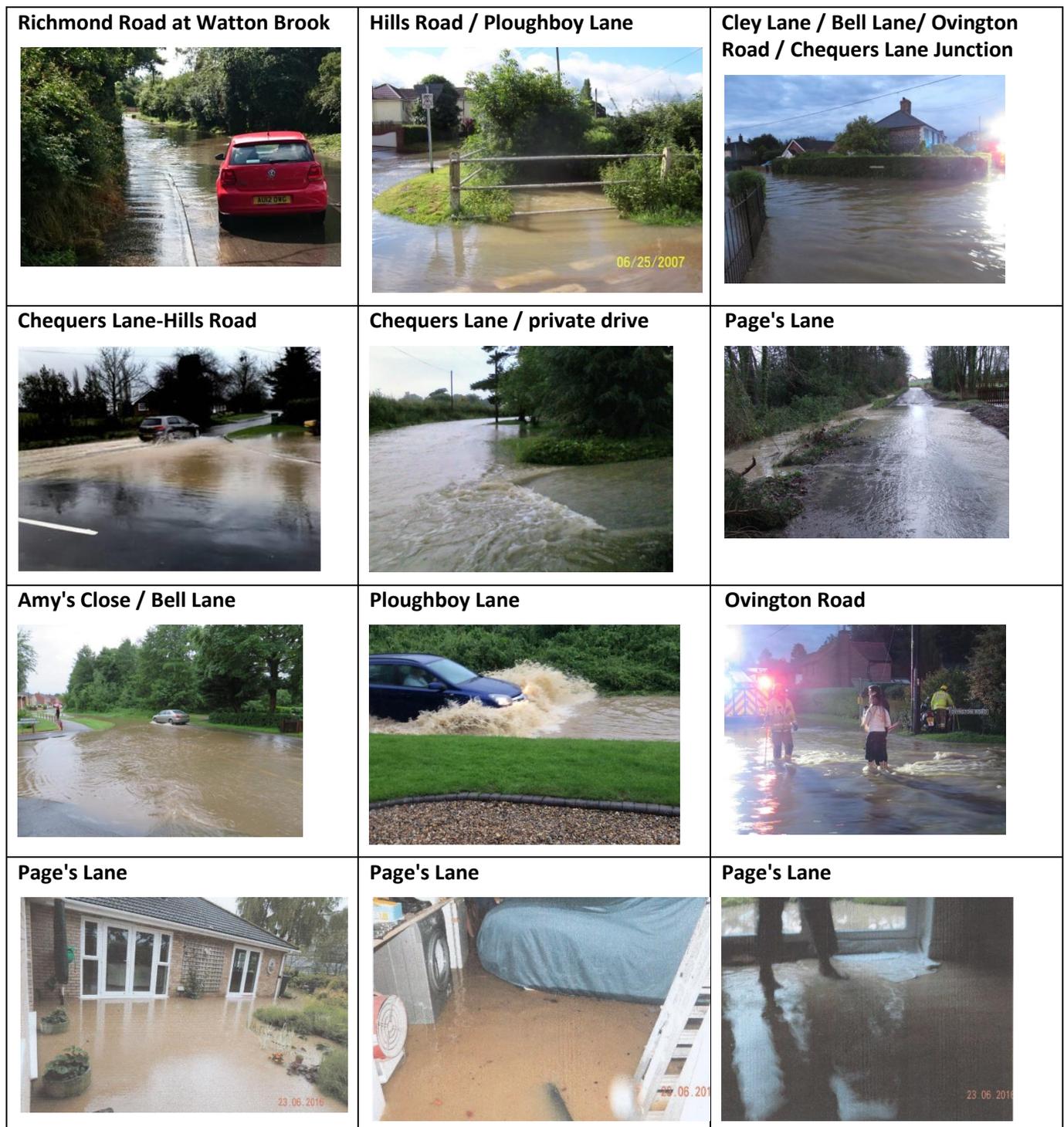


Figure 3: Photos of flooding on 23 June 2016

5.4 Homes and roads in the village were again flooded during a period of heavy rain during late December 2017. As a result of that event, some residents reported flooding to the Parish Council including as follows:

- a) At the Hills Road junction with Chequers Lane. The area flooded; water flowed as a continuous torrent down the road to join with an overflow from the culvert at the bottom of Hills Road.

- b) Swaffham / Richmond Road immediately south of the Watton Brook bridge. A build-up of surface water created a large ½ metre deep accumulation of water the full width of the road.
- c) Chequers Lane - Cley Lane junction. Large accumulations of surface water built up along the length of these lanes as ditches and road gullies overflowed.

5.5 Between 7 and 12 cm of rainfall in a period of approximately 5 hours on 16 August 2020, (data source: Saham Hills weather station, <https://www.wunderground.com/dashboard/pws/ISAHAMTO2/graph/2020-08-16/2020-08-16/daily>, and Saham Mere weather station, <https://www.wunderground.com/dashboard/pws/ITHETFOR7/graph/2020-08-16/2020-08-16/daily>) and again resulted in flooding in various parts of the village, as shown by the photos in Figure 4, and by videos available at <https://www.stnp2036.org/village-flood-event-photos--videos.html>.

<p>Chequers Lane / Hills Road junction</p> 	<p>Chequers Lane / Hills Road junction</p> 
<p>Overflowing manhole in Page's Lane</p> 	<p>Richmond Road at the Bell Lane junction</p> 
<p>"Nilefields" (off Swaffham Road / Richmond Road)</p> 	<p>Hills Road near the Ploughboy Lane junction</p> 

Figure 4: Photos of flooding on 16 August 2020

5.6 The fact that there have been three notable events in a four-year period, and that flooding has occurred not only in the at-risk areas identified by the Environment Agency’s maps, but elsewhere too, indicates the seriousness of the problem, and the reason that comprehensive and robust management of surface water is a fundamental requirement for development in many parts of the parish.

5.7 The extent of flood risk issues is further highlighted by a Norfolk County Council appraisal of flood risk in the village, which concluded that 37 properties are at risk from a 1 in 30-year flood event and a further 63 at risk from a 1 in 100-year flood event.

*** KEY POINT 2: About 14% of houses in the parish are at risk of surface water flooding**

5.8 As noted above, surface water flooding is not limited just to watercourses and the areas officially designated ‘at risk’. In Saham Toney, as elsewhere, in times of heavy or prolonged rainfall, surface water sewers often operate at or near their capacity and are sometimes insufficient to cope with peak events. As a result, during rainfall of the intensity experienced during the three events noted above, surface water running off fields onto local roads has nowhere to go other than to follow the path of least resistance along those roads to lower ground, and inevitably finds its way into residential gardens and properties. At the same time watercourses and drainage ditches, many of which are poorly maintained and partially blocked, overflow their banks and surface water runs over open fields, again finding its way into gardens and properties

5.9 At times of heavy or prolonged rainfall, flooding can and does occur along much of Page’s Lane, Chequers Lane, Cley Lane, Ploughboy Lane and parts of Bell Lane, Hills Road, Ovington Road and Richmond Road. Particular ‘wet-spots’ are the junctions of:

- a) Hills Road with Page’s Lane and Chequers Lane;
- b) Ploughboy Lane and Chequers Lane;
- c) Sections of Ploughboy Lane and Hills Road;
- d) At and near the junction of Bell Lane and Richmond Road;
- e) The Bell Lane / Cley Lane / Chequers Lane and/ Ovington Road crossroad and stretches of each road radiating from it.

5.10 Of the above, the first is of particular relevance to sites allocated in the Neighbourhood Plan, and therefore warrants more detailed examination.

5.11 Figure 5 illustrates the following:

Watercourse		Low point in the land	
Allocated site boundary		Flow of water along roads	
General runoff from fields			

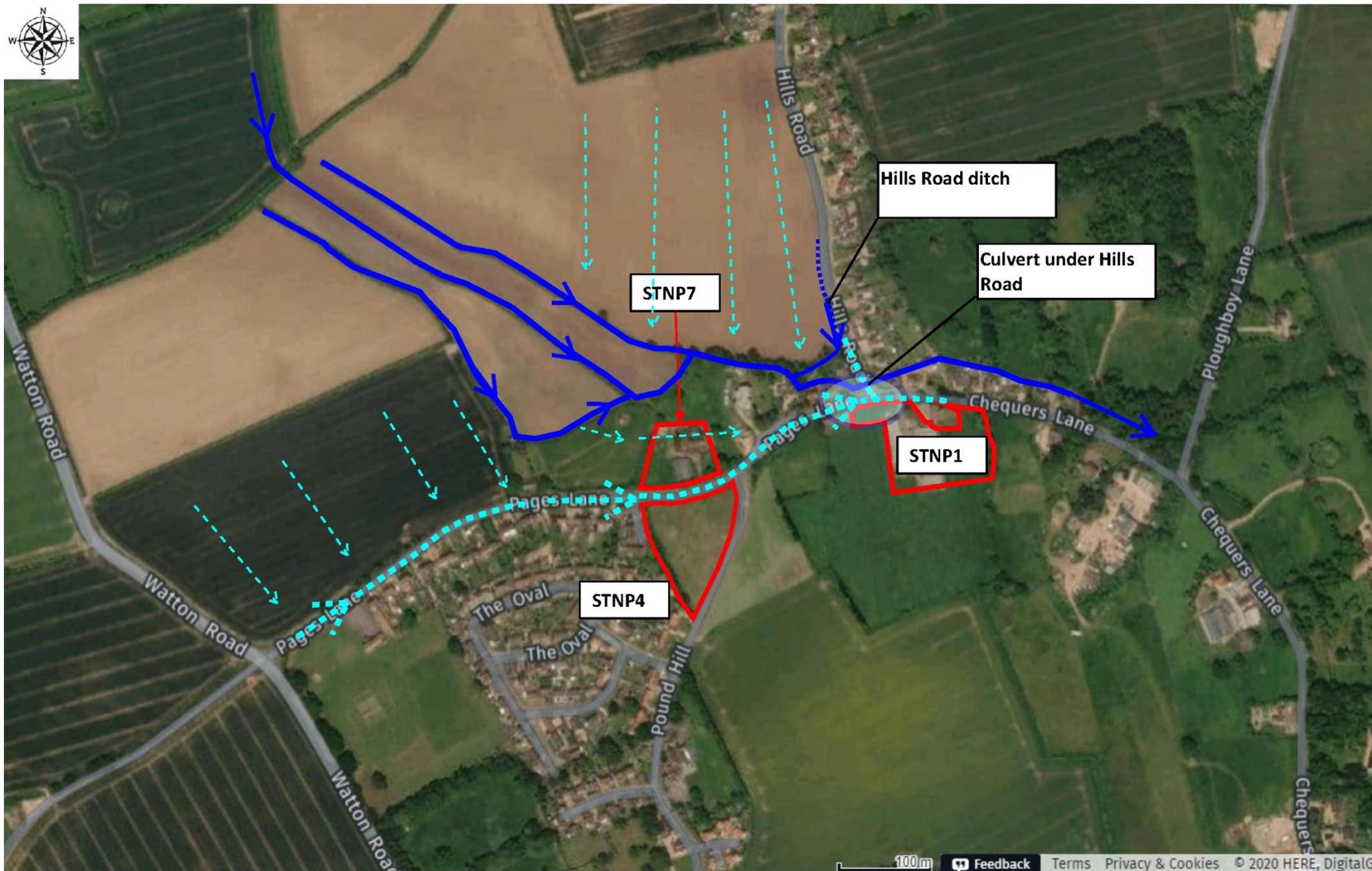


Figure 5: Surface water flood risk issues in the area of allocated sites STNP1, 4 & 7

5.12 The watercourses carry surface water from Ashill, which lies to the north-west. In part they are blocked or reduced in effectiveness due to poor maintenance, and in storm conditions debris carried downstream adds to blockages. The culvert under Hills Road is 600mm in diameter, less than other similar culverts in the village, and the fact that water backs up at that point is shown by the fact flooding issues are generally worse on its upstream side than downstream. The field to the north of the watercourse slopes steeply down from the north, and during heavy rainfall, there is insufficient time for it to soak into the ground, and instead it flows freely downhill, adding a large volume of water to a watercourse that is often already full to capacity from upstream flow during extreme events. South of the watercourse, surface water flows off other fields and the hard standings of older properties on the south side of Page's Lane, onto the highway, and during peak events what is effectively a shallow river flows east along Page's Lane (which has limited roadside ditches along its length on both sides), towards the low point at the junction of Hills Road with Page's Lane and Chequers Lane. At present as the water passes the entrance to the disused farm buildings on site STNP7, it flows freely along the derelict access road as the land slopes down away from the road, and thence onward to the east across neighbouring land. Similarly, water is channelled downhill south along Hills Road to the same low point.

*** KEY POINT 3: Existing surface water drainage infrastructure is sometimes inadequate and/or insufficiently well maintained to deal with extreme rainfall events**

5.13 Due to the failings of an inadequate existing system of draining surface water from surrounding fields and roads, parts of allocated site STNP7 experience flooding during extreme rainfall events. To a lesser extent, allocated site STNP1 also experiences problems, but those are limited to land along its northern boundary since most of the site comprises land sloping upwards away from the highway.

*** KEY POINT 4: In some cases, design of sites in areas at risk of surface water flooding needs to include measures to protect a site from surface water runoff from offsite, as well as ensuring runoff from the site itself is no greater than pre-development levels.**

5.14 Flood risk in affected areas is not just a hypothetical situation mapped by the Environment Agency, as villagers affected by it will attest, and as is demonstrated by the fact that more than 150 villagers identified flood risk resulting from new development as a concern in response to a Neighbourhood Plan consultation questionnaire. Hence design of developments in areas at risk shall demonstrate rigorous solutions that prevent surface water flooding both on the site itself and to surrounding properties, infrastructure and land.

*** KEY POINT 5: It is essential that design avoids adding to, or creating surface water flood risk, both onsite and offsite**

6.0 PREVENTING ADDITIONAL FLOOD RISK AS A RESULT OF NEW DEVELOPMENT



POLICY 8A

6.1 It is unrealistic to expect that existing sewers will be regularly upgraded to cope with additional runoff from new development and therefore an alternate solution is needed. The implementation of sustainable drainage systems (SuDS) will best satisfy the requirement for all proposals to have a neutral or positive impact on surface water drainage (i.e. to not add to flood risk, and where possible, to reduce it).

6.2 SuDS are an approach to managing surface water runoff which seek to mimic natural drainage systems and retain water on a site, and then allow it to slowly drain into the ground or off site, as opposed to traditional drainage approaches which involve piping water off site as quickly as possible.

*** KEY POINT 6: Drainage solutions shall avoid discharging into sewers in all but exceptional circumstances, where it is shown that no other solution is practical, and the agreement of Anglian Water has been obtained.**

6.3 To ensure that development deals with surface water flood risk in the most effective and realistically achievable manner, all development in Saham Toney shall incorporate a sustainable drainage system (SuDS), the use of which is the preference of the Lead Local Flood Authority and is supported by Local Plan Policy ENV 09 and the National Planning Policy Framework.

6.4 For the avoidance of doubt, drainage systems that incorporate sealed underground storage tanks and piped components are not deemed sustainable, and shall be avoided unless it can be shown that no other viable solution exists.

6.5 Some general conceptual ideas for addressing surface water flood risk for sites allocated in the Neighbourhood Area, and for the wider area generally, are given in Appendix A.

7.0 SUSTAINABLE DRAINAGE SYSTEMS (SuDS): THE BASICS EXPLAINED

7.1 When land is developed, impermeable surfaces are introduced and tend to increase surface water runoff, while decreasing evaporation (through a reduction in vegetation) and infiltration. This disrupts the natural water cycle, which is illustrated in Figure 6.

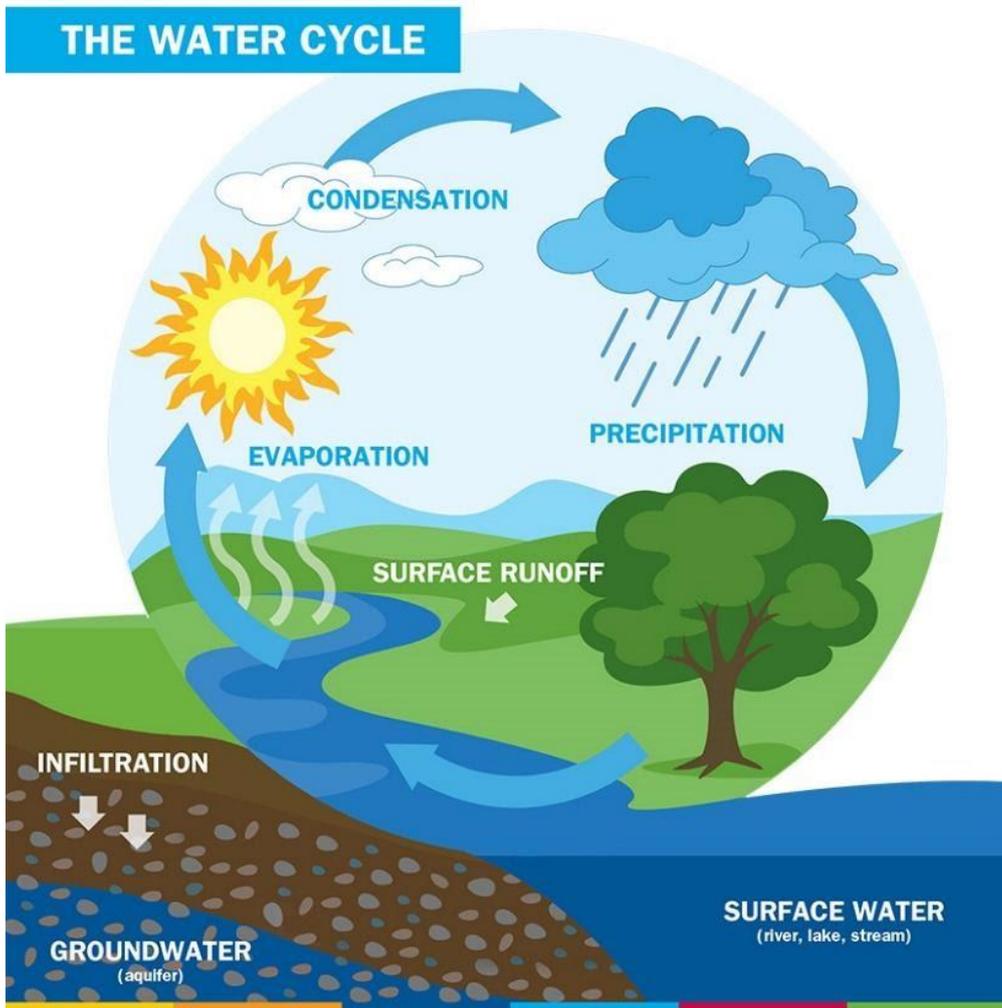


Figure 6: The Natural Water Cycle

7.2 An effective SuDS design will normally include three main components (or sets of components) that in combination provide surface water drainage that closely mimics natural processes:

- a) Infiltration into the soil. See section 10.
- b) Interception, to attenuate and temporarily store rainwater such that its rate and volume of discharge is within acceptable limits. See section 11.
- c) Evapotranspiration: the taking up of water by vegetation and evaporation from it. See section 12.

7.3 Sustainable drainage takes greater account of the long-term effects of development than traditional solutions. It takes into account social factors around drainage. Instead of just considering the quantity of water that needs to be removed from an area, as piped systems do, SuDS also takes account of water quality and how it may then be used to enhance an area, potentially improving the aesthetics of a development, and enhancing amenity and biodiversity. It also takes into account the wider challenges of

climate change and urbanisation, creating a long-term solution to water drainage, pollution, and environmental damage. This can be seen by the four pillars of SuDS, as shown in Figure 7.

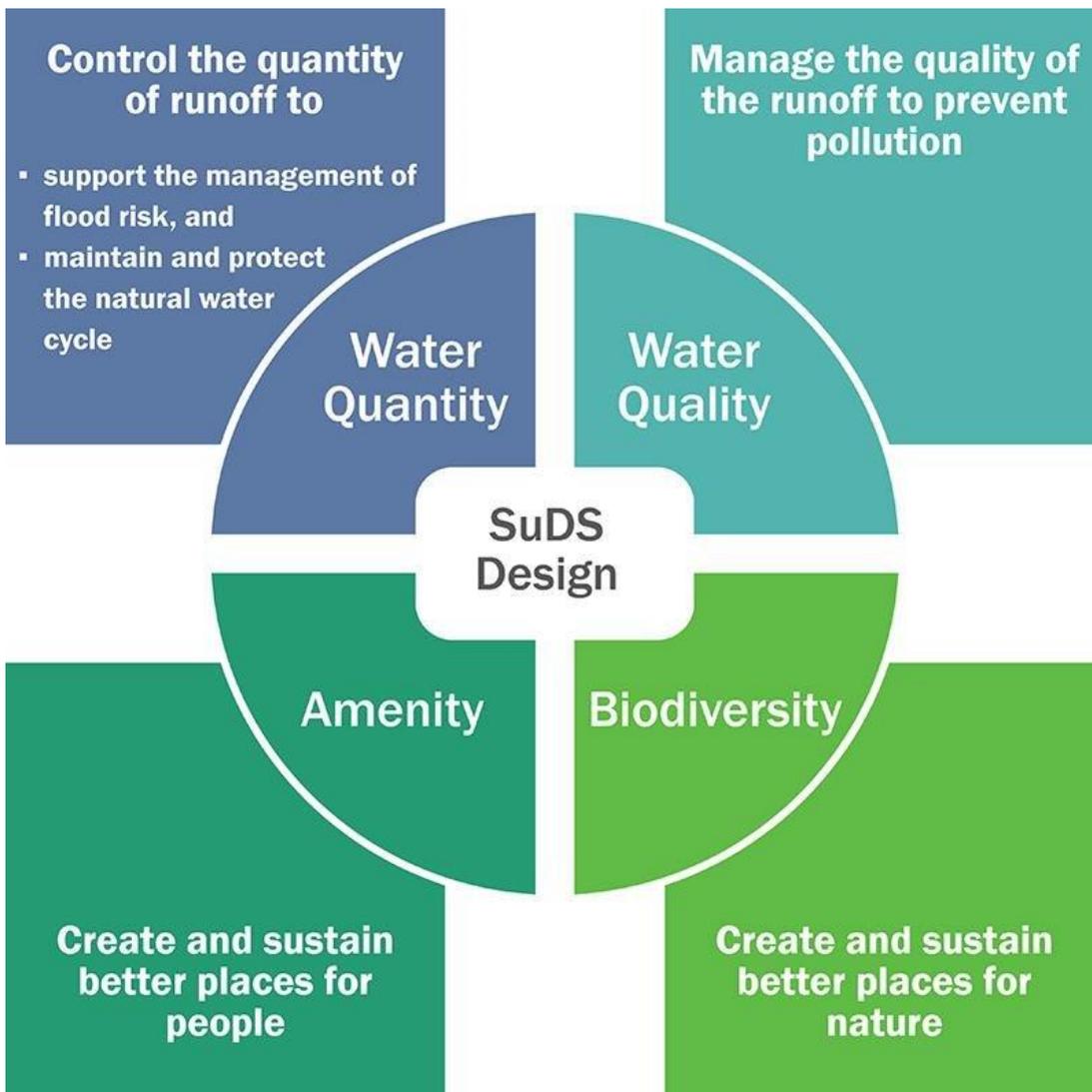


Figure 7: The four pillars of SuDS

7.4 Some key principles that influence the design process enabling SuDS to mimic natural drainage are:

- Allowing water to soak into the ground (infiltration);
- Harvesting the rain close to where it falls, and re-using it;
- Storing runoff and releasing it slowly (attenuation);
- Slowly transporting (conveying) water on the surface;
- Filtering out pollutants; and
- Allowing sediments to settle out by controlling the flow of the water

7.5 SuDS offer significant advantages over conventional piped drainage systems in reducing flood risk by attenuating the rate and quantity of surface water run-off from a site, promoting groundwater recharge, and improving water quality and amenity. The variety of SuDS techniques available means that virtually any development should be able to include a scheme based around these principles.

7.6 The CIRIA SuDS Manual confirms that "SuDS can be delivered on all sites". Challenges specific to particular sites, for example high groundwater levels, sloping sites, very flat sites, low infiltration capacity,

etc. will to an extent dictate the choice of SuDS components to ensure an effective system is implemented. The SuDS Manual should be referred to for guidance on how to overcome such challenges.

*** KEY POINT 7: SuDS can be adapted to suit virtually any situation**

USEFUL REFERENCES

❖ The CIRIA SuDS Manual

❖ 'Water. People. Places'; AECOM, September 2013

8.0 GENERAL SuDS DESIGN PRINCIPLES



POLICY 8A

8.1 In accordance with national and local strategic policy, the design of all new developments shall incorporate sustainable drainage systems (SuDS), as supported by the Lead Local Flood Authority and Anglian Water.

8.2 Some SuDS options could require use of open land areas, so it is essential that they are considered early on in the design process. It can be difficult to incorporate some options once the detailed development design is underway.

8.3 Adequate and satisfactory documentation shall be provided with a planning application to describe and explain the form of SuDS adopted, and to demonstrate with design calculations to a level of detail appropriate to the size, conditions and flood risk of a site, that the system will meet the requirements of national, local and neighbourhood plan policies.

8.4 Only if the water demonstrably cannot be managed on site should it be (slowly) conveyed elsewhere. This may be due to the water requiring additional treatment before disposal or the quantities of runoff generated being greater than the practically achievable capacity of the drainage system. This would be expected only in exceptional circumstances, and is not intended to sanction non-compliance with the policies of the Neighbourhood Plan. In such cases, excess flows will need to be routed offsite, but in all cases, that must be at a rate that will not add to offsite flood risk.

8.5 SuDS should not be thought of as individual components, but as an interconnected system, where water slowly flows from where it falls to a soakage area or discharge point through a series of carefully selected features that help to treat, store, re-use and convey it in a way that avoids flood risk. An important concept for the SuDS designer to follow is known as the 'treatment train', which is a term used for an integrated sequence of measures employed in a SuDS scheme, which, taken together, control volumes of runoff and reduce pollution before discharge. These measures are designed to emulate the natural catchment process, as illustrated in Figure 8.

*** KEY POINT 8: SuDS should be designed as a coherent system, rather than individual components**

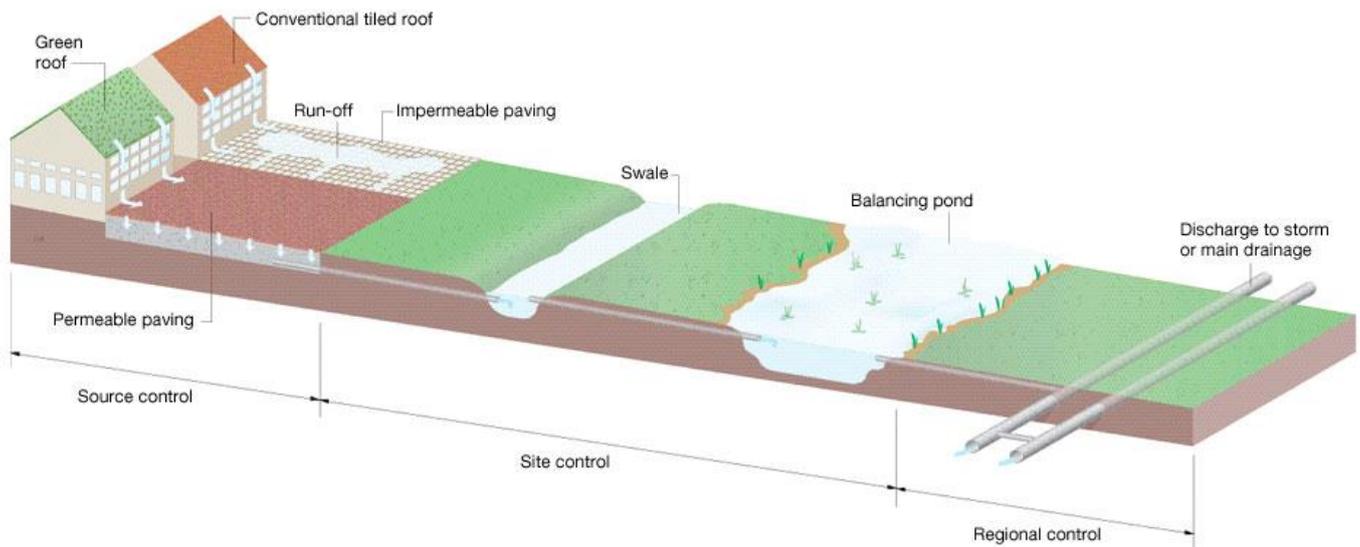


Figure 8: Example of a SuDS treatment train

- 8.6 Runoff need not pass through all the stages in the treatment train. It could flow straight to a site control for example, but as a general principle it is better to deal with runoff locally, returning the water to the natural drainage system as near to the source as possible.
- 8.6 By passing water through several stages of treatment, sediment and other pollutants will be removed more effectively, and maintenance costs will be reduced as this minimises the risk of downstream SuDS features becoming clogged or blocked.
- 8.7 Much of the parish has high seasonal groundwater levels, and this shall be taken into account when selecting the most appropriate SuDS components for a particular system and the depth at which they are installed.
- 8.8 The layout of a development site and its drainage system shall be designed so that surface water that enters the site from offsite sources is conveyed safely around or through the site, without compromising the level of service of the proposed drainage system or introducing unacceptable additional risk onsite or downstream.
- 8.9 The layout of a development site and the drainage system should be designed so that natural low-lying areas and overland conveyance pathways are used to manage surface runoff, where appropriate, providing they do not pose an unacceptable risk to the new development or downstream areas.
- 8.10 As well as managing surface water, wherever possible and practical, SuDS should be designed to enhance biodiversity. The amenity benefits achievable through the use of SuDS are described in section 20.
- 8.11 As well as managing surface water, wherever possible and practical, SuDS should be designed to enhance amenity, by enriching aesthetic and recreational value, promoting health and well-being and supporting green infrastructure. SuDS provides opportunities for water to be visible and audible, which many people value. The amenity benefits achievable through the use of SuDS are described in section 21.

USEFUL REFERENCES

Information on the benefits SuDS offers may be found in:

8.12 For the avoidance of doubt, drainage systems that incorporate sealed underground storage tanks and piped components are not deemed sustainable, and shall be avoided unless it can be shown that no other viable solution exists.

9.0 SURFACE WATER RUNOFF & SuDS



9.1 Runoff is the flow of water across the ground surface that occurs when excess rainwater, melt water or water from other sources cannot sufficiently quickly infiltrate into the soil or be evaporated by vegetation. It does occur in greenfield areas, for example when the soil is already saturated or if rainfall intensity is too high to allow it time to infiltrate, but is exacerbated by development, due to the introduction of impermeable surfaces.

9.2 When rain falls on roads, buildings, car parks, and other impermeable areas, the amount of surface water run-off that drains off these surfaces is much greater than that for the equivalent greenfield area. Using traditional drainage methods, the run-off from hard landscaped areas is collected by roof gutters, downpipes, and road gullies, and directed into a piped sewer network. In older systems, this collected water may be directed into the combined sewer network, thereby mixing the relatively clean surface water with the dirty foul water. Then when flash flooding happens, it often leads to both the foul and surface water spilling out of the drainage network, causing flooding to people and property. That said, more recently, separate foul and surface water drainage networks have been provided. But whether individual or combined, piped drainage systems have a limited capacity to accept extreme rainfalls. When their capacity is exceeded, flooding occurs as excess runoff has nowhere to drain to.

*** KEY POINT 9: Long-term management and control of surface water runoff is critical to the implementation of a successful drainage system**

9.3 It is unrealistic to expect that existing sewers will be regularly upgraded to cope with additional runoff from new development and therefore alternate solutions are needed. The implementation of SuDS solutions will best satisfy the requirement for all proposals to have a neutral or positive impact on surface water drainage (i.e. to not add to flood risk, and where possible, to reduce it).

9.4 SuDS are an approach to managing surface water run-off which seek to mimic natural drainage systems and retain water on a site, and then allow it to slowly drain off site, as opposed to traditional drainage approaches which involve piping water off site as quickly as possible.

*** KEY POINT 10: Drainage solutions shall avoid discharging into sewers in all but exceptional circumstances, where it is shown that no other solution is practical, and the agreement of Anglian Water has been obtained.**

9.5 In order to prevent any increase to offsite flood risk, Policy 8B of the Neighbourhood Plan sets requirements for surface water runoff rates and volumes, such that they do not exceed pre-development levels. Both peak rates and volumes require control, because although runoff rates may be restricted to equivalent pre-development greenfield rates, the duration over which the site could discharge at this rate is likely to increase after development. As noted in the CIRIA SuDS Manual, C753, “Peak rates of surface water runoff discharged from a development (i.e. relatively impermeable) site, if left uncontrolled, are normally significantly greater than from the site in its greenfield state.” This is because most of the runoff drains off the surfaces of the developed site much quicker than the greenfield site and there is much more runoff, as less water is able to penetrate the ground or be intercepted in other ways. This is illustrated in Figure 9.

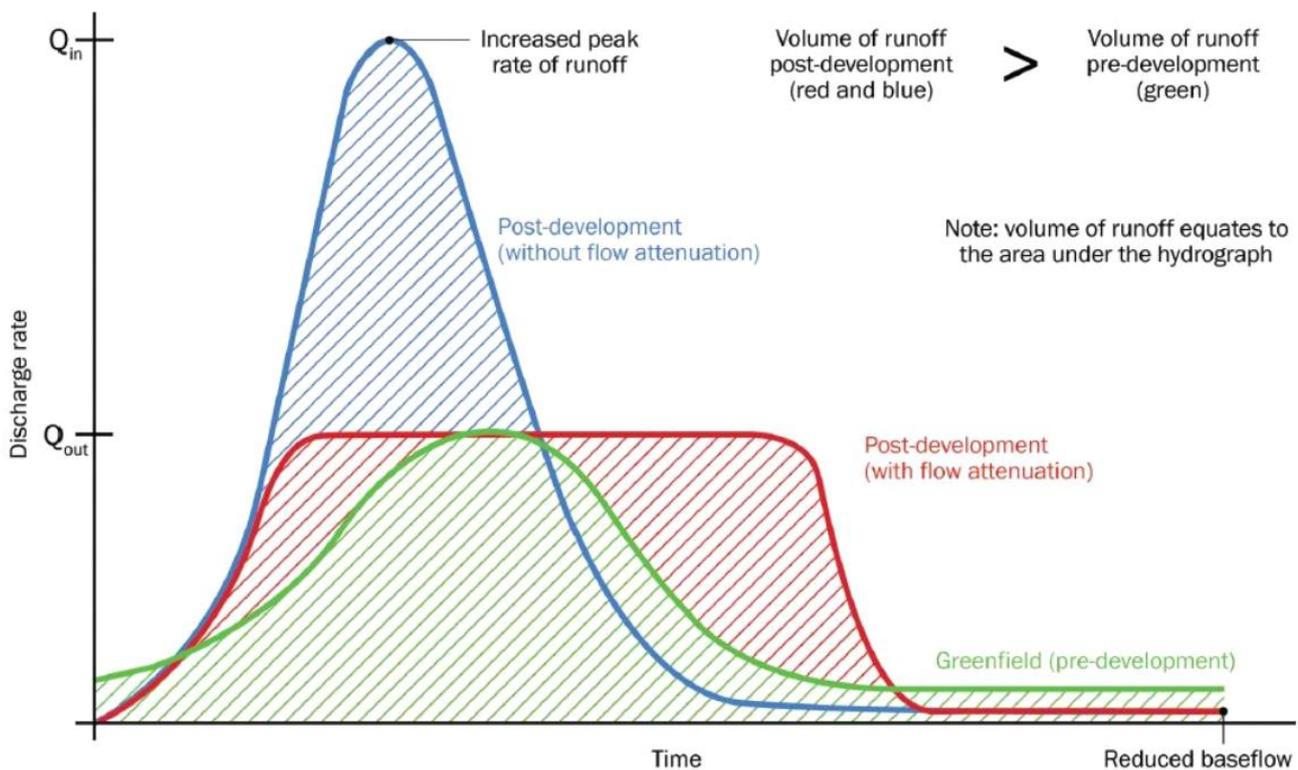


Figure 9: Example of a runoff hydrograph (Reproduced from C753 SuDS Manual Section 3.1.1 ©CIRIA 2015)

9.6 Calculations for greenfield runoff rates to watercourses should be based on the proposed area of impermeable land within the sub-catchment of the watercourse for the location of the proposed discharge. It may be possible to divert water to a different sub-catchment, only if the greenfield runoff rate for that watercourse is demonstrably not exceeded. Where there are large areas of open green space within a development, an allowance for the greenfield runoff rate and volume of the open space should be made. This is to account for water that naturally enters the watercourse prior to development, that would subsequently be intercepted by a SuDS feature, see Figure 10.

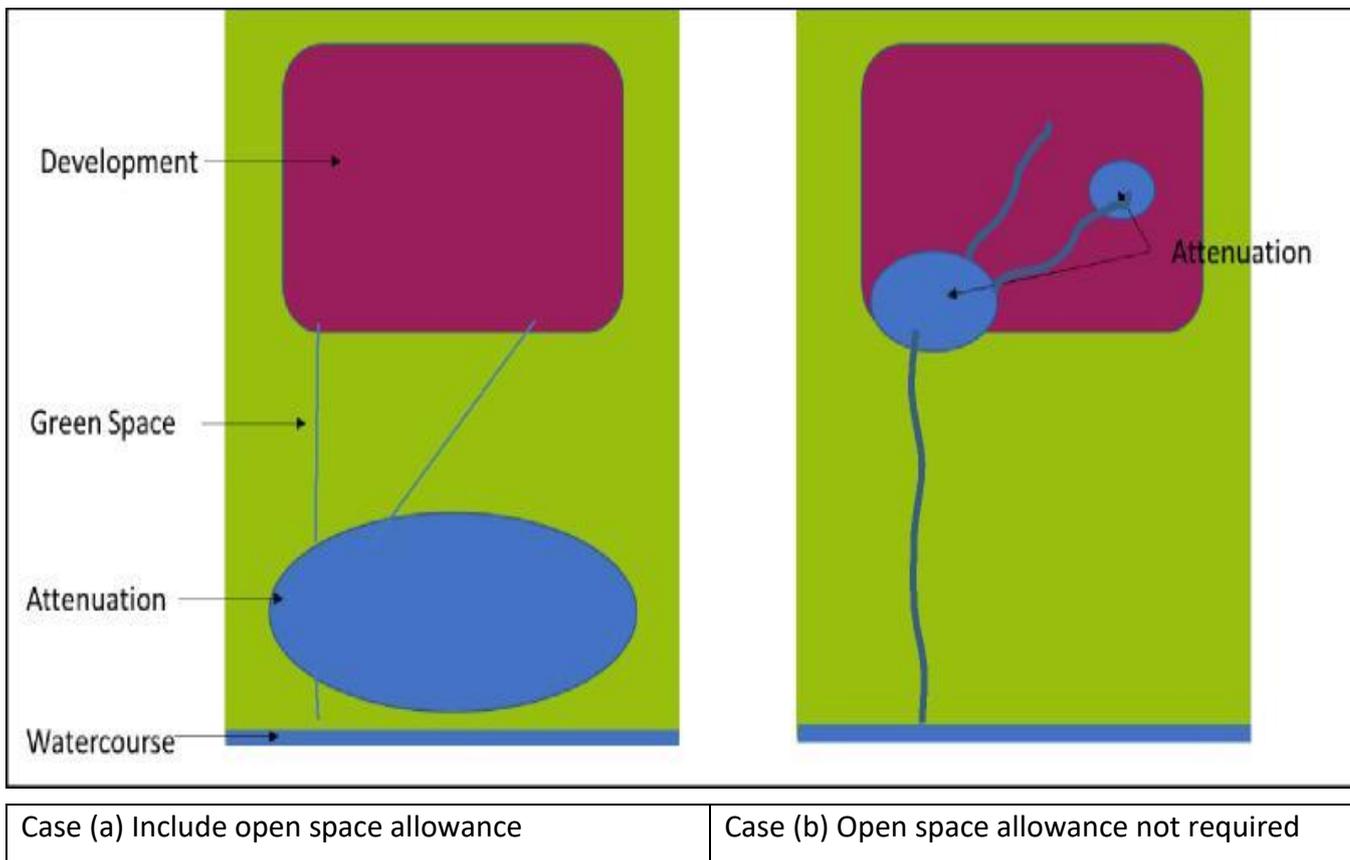


Figure 10: An indication of when to allow for open space with greenfield runoff calculations for a SuDS storage feature.

9.7 The CIRIA SuDS Manual presents two approaches for consideration of runoff volume from a development site (complex and simple). Although the simple approach will require a greater volume of storage than the complex approach, it is preferred by the Lead Local Flood Authority and should therefore normally be used in calculations.

DESIGN PARAMETERS: RUNOFF CALCULATIONS

Runoff calculations shall consider and account for the following:

- Where discharge is into an ordinary watercourse with known surface water flooding issues, a flood flow (i.e. surcharged outfall) shall be applied as a constraint in runoff calculations, using the 1% AEP event, plus relevant catchment specific, climate change fluvial flow;
- The potential increase in the volume of runoff from a development as a result of increases in the area of impermeable surfaces;
- Where runoff from off-site sources is drained together with the site runoff, the contributing catchment shall be modelled as part of the drainage system in order to take full account of the additional inflows to the site;
- For residential developments, an allowance based on development density for increases in impermeable surfaces throughout the lifetime of a development

shall be considered in runoff calculations, up to total impermeable surface percentage of 100%. The allowance shall be:

- 1) 10%, where density is less than or equal to 25 dwellings per hectare;
- 2) 8%, where density is greater than 25, but less than or equal to 30 dwellings per hectare;
- 3) 6%, where density is greater than 30, but less than or equal to 35 dwellings per hectare;
- 4) 4%, where density is greater than 35, but less than or equal to 45 dwellings per hectare;
- 5) 2%, where density is greater than 45 dwellings per hectare.

9.8 The principles of SuDS are explained in section 8, and information on SuDS components is given in sections 20 and 21.

10.0 INFILTRATION



POLICY 8C

10.1 Infiltration testing is required for all proposals, rather than just those proposing an infiltration drainage method. This is because for non-infiltration methods to be accepted, it must first be demonstrated that an infiltration method is not practical. Infiltration test results will be central to such a demonstration. Infiltration testing will be required to provide evidence that infiltration of surface water is or is not possible where such cases arise.

10.2 The scope for using infiltration may be reduced where soils have poor infiltration capacity, where groundwater levels are high, where there is a groundwater source protection zone (SPZ) constraint (particularly SPZ1), where there is ground contamination and infiltration would mobilise pollutants (refer to Environment Agency Groundwater Protection Policy statements G10, G12 and 13), or where ground conditions present particular risks of subsidence from voids and instability in the underlying geology.

USEFUL REFERENCE

Guidance on how to design SuDS in areas with infiltration constraints is given in CIRIA Report C753: The SuDS Manual

10.3 Where infiltration capacity of soils is low / inadequate, very low infiltration rates and/or low depths of soil storage may often be used for interception of rainwater, followed by conveyance to downstream attenuation / treatment components.

10.4 Permeable paving may also be used for all private drives and private roadways to encourage passive infiltration, with toe drains included to transfer water to basins if the ground begins to waterlog. The use

of permeable paving is another key measure for keeping water on site, although in line with Norfolk County Council design standards, adoptable roads are not permitted to be permeable.

DESIGN PARAMETERS

- ❖ **A design safety factor shall be applied to measured infiltration rates, guided by Table 25.2 of CIRIA Report C753: The SuDS Manual.**
- ❖ **Where the rate of infiltration established in accordance with Policy 8C is found to be less than 1×10^{-6} m/s or 0.0036 m/hour, only partial or no infiltration should be considered at a site, combined with on-site interception of run-off.**

11.0 INTERCEPTION & ATTENUATION

11.1 A key consideration in designing a SuDS treatment train should be the provision of rainwater interception for each impermeable area wherever possible, for example by using permeable pavements, green roofs and/or rainwater harvesting. Rainfall interception methods supplement natural infiltration in order to prevent an increase to runoff volumes in excess of greenfield levels.

11.2 Climate change projections suggest that water shortages will become more frequent, thereby increasing pressure on water supplies. Hence when designing a drainage scheme, every opportunity should be taken to incorporate efficient and creative methods of capturing, conserving and using rainwater.

11.3 If rainwater infiltration and/or interception cannot be used to the extent required to prevent excess surface water runoff from a site, excess runoff volumes must be attenuated and managed to avoid increased downstream or onsite flood risk. This may be achieved via separate long-term storage of rainwater that is released very slowly, or may be incorporated into a site's attenuation components (subject to achieving the overall storage volume required).

DESIGN PARAMETERS

- ❖ **Attenuation and runoff storage components and systems shall be designed in accordance with the most up-to-date guidance in CIRIA Report C753: The SuDS Manual**

11.4 Where open space on a site incorporates flood risk attenuation measures, in order for them to provide the maximum SuDS benefit, such open space should wherever practical be situated in the lowest parts of the site (so attenuation systems can be placed there) with green corridors running back through the site to allow for the placement of other SuDS components to transfer flows above ground to the final attenuation. prior to discharge offsite (should infiltration not be viable).

11.5 In terms of the best use of the use of green areas for flood risk attenuation, open SUDS features are always the most beneficial from all perspectives, including runoff rates/volumes, amenity, biodiversity and water quality. Therefore, as far as practical and necessary, green areas of a site should be used for the placement of infiltration (if viable) or attenuation basins with the use of below ground cellular / concrete

or similar underground tanks resisted. The use of open SuDS components, if designed online so water flows through them prior to outfall, will vastly reduce runoff volume from all sites through the slowing of water, uptake of water by plants, passive infiltration and evaporation.

*** KEY POINT 11: If infiltration is not practically possible, attenuation of runoff is the most critical measure that can be implemented to satisfactorily minimise the rate and volume of runoff from a site**

11.6 To best provide effective attenuation, the transmission of water to the SuDS attenuation components should be via open features (e.g. swales, filter strips etc.) to promote the loss of water by other means prior to outfall.

11.7 Figure 11 provides a brief summary of the most common attenuation options and how their cost compares to conventional below-ground attenuation and discharge offsite, which can be costed at circa £150 - £350 per m³ (source Saham Toney Parish Flood Risk Study, Create Consulting, May 2020), excluding VAT, or traditional pipe networks.

SuDS Measure	Benefits and Relative cost compared to below ground attenuation/pipe networks
Rainwater Harvesting	<ul style="list-style-type: none"> • Likely increases cost over a traditional attenuation system as the volume provided cannot be accounted as part of the attenuation. • If infiltration is not viable this can stop <i>some</i> water from leaving the site but does ultimately depend on how well used the system is (i.e. how empty it is at the time of rainfall).
Green/blue/brown roofs	<ul style="list-style-type: none"> • Likely increases cost over a traditional attenuation system as the construction build up for such a feature is more costly. • Only applicable for flat roofs. • Can reduce water leaving the site through promotion of storage and evaporation. • Provides treatment of water that does pass through and back into wider site drainage system.
Online Infiltration/attenuation basins (above ground storage)	<ul style="list-style-type: none"> • Vastly reduces costs over a traditional buried system as the only real cost is the excavation and installation of inlets/outlets. • Increases site amenity values, promotes evaporation (if basins online) and provides significant levels of treatment/settlement when designed correctly.
Swales	<ul style="list-style-type: none"> • Vastly reduces costs over a traditional piped system as the only real cost is the excavation and installation of inlets/outlets. • Increases site amenity values, promotes evaporation and provides significant levels of treatment/settlement when designed correctly. • Does have an impact on space as usually takes a 6.0 m corridor adjacent to roadways.

Filter Strips and Filter Drains	<ul style="list-style-type: none"> • Vastly reduces costs over a traditional piped system as the only real cost is the excavation and installation of inlets/outlets. • Increases site amenity values, promotes evaporation and provides significant levels of treatment/settlement when designed correctly.
Permeable Paving (tanked or infiltrating)	<ul style="list-style-type: none"> • Costs are broadly equivalent to traditional pipe networks when built with underdrains (where infiltration is poor). • Provide significant benefits in terms of water quality, slowing the flow from the site (due to percolation time through the sub base) and promote increased evaporation.

Figure 11: SuDS Measures Comparison with Non-SuDS

12.0 EVAPOTRANSPIRATION

12.1 Design of SuDS should include appropriate planting to promote evapotranspiration, which is an effective way to reduce requirements for infiltration and interception components. Proposals shall consider, and where possible make use of the contribution that trees and woodlands can provide to help resolve a range of water management issues.

12.2 Trees offer opportunities to make positive water use change, whilst also contributing to other SuDS objectives, such as biodiversity, as well as to green infrastructure

USEFUL REFERENCE

Stemming the Flow – the Role of Trees and Woods in Flood Protection. The Woodland Trust

<https://www.woodlandtrust.org.uk/publications/2014/05/stemming-the-flow/>

13.0 INCORPORATING EXISTING WATERCOURSES IN SuDS DESIGN

13.1 The retention and / or enhancement of traditional verges, streams, ditches and hedgerows adjacent to a highway is essential to surface water management, and so must be suitably addressed (on a local basis) where potentially affected by development.

13.2 Where a stream or ditch runs within a site or along all or part of its boundary, and will therefore fall into the responsibility of future residents as riparian owners, the stream or ditch shall be dredged or cleared during construction and necessary and appropriate measures taken to improve the way it functions in draining surface water.



Figure 12: Example of a well-maintained ditch

13.3 Consent from the Lead Local Flood Authority is required for any works that affect an ordinary watercourse, including, but not limited to culverting. Information can be found on the Norfolk County Council website at <https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-homeowners/consent-for-work-on-ordinary-watercourses>.

13.4 Culverting of existing watercourses shall be avoided wherever possible. If adopted, it shall be in accordance with the Lead Local Flood Authority's Standing Advice 1: Ordinary Watercourse Consenting.

13.5 Where used, careful attention to detailing is required when installing culverts. These shall:

- a) Be of adequate size to accommodate water flow in excess of that expected at peak (flood) flow rates;
- b) Be constructed in a way that prevents their blockage by debris; for example, by the use of metal grilles at each end of a culvert. At the culvert entry the grille should slope at around 45°, so that when a watercourse is in flood the forces involved will force the debris (particularly if it is buoyant) to the top of the grille, where it will be easier to rake clear. If entry grilles are vertical, flood forces will pin the debris to the vertical bars making it extremely difficult to rake clear and thus exacerbating the problem by backing up the flow. Vertical grilles at culvert exits are acceptable. See Figure 13 (a) and (b);
- c) Be adequately strong to bear the weight of heavy goods and emergency vehicles;
- d) Be readily maintainable.

13.6 Culverts are unlikely to be more than 6-8m wide (because if needed they will occur where site access roads cross a stream or ditch). The construction of an effective, long-lasting and easily maintainable culvert with grilles will cost little more than that of a poor example. The latter is a false economy, since the problems that will arise later when surface water flows are blocked or hindered will result in much greater costs, as evidenced at various locations around the village.



Figure 13: Good examples of culvert grilles (a) at entry; (b) at exit

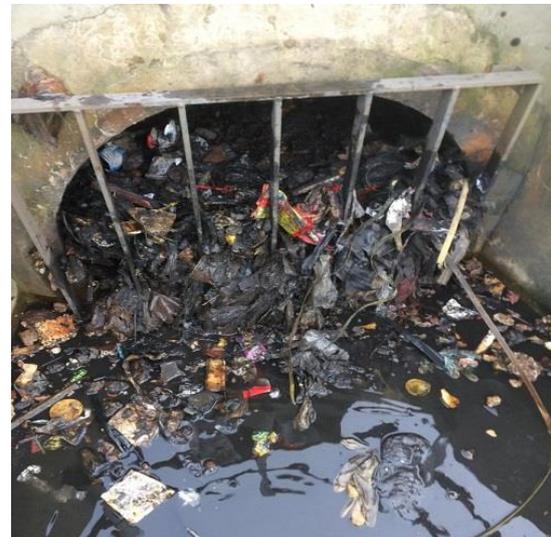


Figure 14: Poor examples of culverts (a) likely to be too small and lacks a grille; (b) grille blocked

14.0 OTHER SuDS DESIGN & CONSTRUCTION CONSIDERATIONS

14.1 On-site road drainage shall be designed in accordance with the most up to date guidance in the CIRIA SuDS Manual.

14.2 External ground levels should always slope away from any building, especially entrances, to avoid ponding of water against or within a structure.

14.3 Wherever possible clearing, grading and compaction of a site during construction should be limited as they have a negative effect on a site's natural runoff characteristics. Any areas compacted during construction should be returned to their pre-construction permeability levels.

15.0 SELECTING SuDS COMPONENTS

15.1 A SuDS treatment train should be implemented in the following order of priority:

- a) Prevention: Good housekeeping and site design to reduce and manage runoff and pollution.
- b) Source control: Runoff managed as close to its source as possible / practical.
- c) Site control: Runoff managed and slowed down over an entire site by using a series of SuDS measures in sequence
- d) Regional control: Downstream management of runoff. (Outside the scope of this guide).

15.2 The SuDS hierarchy is a useful tool when selecting SuDS components, and wherever practical, the use of the most sustainable solutions is strongly encouraged. The hierarchy is illustrated in Figure 15.

The SuDS Hierarchy

SuDS Technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
Living Roofs	✓	✓	✓
Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
Filter Strips and Swales	✓	✓	✓
Infiltration devices - Soakaways - Infiltration trenches and basins	✓	✓	✓
Permeable Surfaces and Filter Drains - Gravelled area - Solid paving blocks - Porous paviers	✓	✓	
Tanked Systems - Over-sized pipes/tanks - Storms cells	✓		

Figure 15: SuDS Hierarchy

15.3 At source SuDS control water run-off at the point where the rainfall lands on a surface, or very nearby. Source control is one of the most important principles of SuDS design. It can help provide interception storage and can handle and treat some pollutants.

15.4 Source control components should be upstream of any other SuDS components.

15.5 Source controls seek to maximise permeability within a site to promote attenuation, treatment and infiltration, thereby reducing or eliminating the need for offsite conveyance.

15.6 Site controls manage surface water runoff from an entire site. Depending on site size and conditions, surface water runoff may be dealt with directly by overall site control measures, or such measures may be incorporated to collect runoff after it has first passed through source control components and to provide final onsite mitigation, attenuation and treatment of runoff. Site control measures aim to restrict and manage the discharge from the whole or a significant part of a site at a single location and to temporarily

store any excess water. As well as attenuating the flow this may also improve the quality of the run-off from the site.

16.0 MANAGING THE FLOW OF WATER INTO & OUT OF SuDS

16.1 SuDS require inlets, outlets and control structures to manage the flow of water. Due to the nature of SuDS components and the need to manage flows throughout the SuDS treatment train, systems usually require a number of small, robust, cost-effective control structures. These structures are critical to the performance and maintenance of the system as a whole. In addition, SuDS may use low-flow channels, weirs, overflow structures and exceedance flood routes to augment SuDS techniques. Water is eventually released naturally into the ground wherever possible, to watercourses where the land is impermeable or as a last resort to the surface water sewer network. Inlets and outlets should be incorporated to have minimal visual impact.

17.0 DESIGN FOR RESILIENCE & RESISTANCE

17.1 The design of exceedance flow management system shall account for the location, intended normal use and capacity of residual flood pathways.

17.2 Residual flood pathways or storage zones should not detract from the drainage system's primary function, and shall be protected and maintained so as to be always available.

DESIGN PARAMETERS

- ❖ **The design of the drainage system for exceedance flow management shall take account of any residual flood risk for the site. An assessment shall also be made of the likely significance of risks associated with the following scenarios:**
 - a) **A blockage or failure of a drainage system component;**
 - b) **Failure of any embanked storage facility; and**
 - c) **Rainfall events that are larger than the storms used for the design of the drainage system.**
- ❖ **In all cases there shall be a minimum of at least 150mm freeboard between proposed external ground levels and property finished ground floor levels (FFL).**
- ❖ **Where there is a residual risk of flooding, as a minimum, property FFL throughout the development shall be set to a minimum of 300mm freeboard above the anticipated flood levels in a 1% AEP event plus 40% climate change from any source of flooding. This shall be increased to 600mm where there is uncertainty about flood levels.**
- ❖ **Where there is a residual risk of flooding, design shall be such that water on roads where speed limits do not exceed 30mph shall be no greater than 100 mm deep where there are kerb upstands.**

18.0 SuDS MANAGEMENT & MAINTENANCE

18.1 All SuDS management and maintenance proposals shall be guided by the most up to date version of CIRIA 753: The SuDS Manual.

18.2 It is strongly recommended that SuDS be designed to standards that will allow their adoption by the Local Highways Authority or Anglian Water as applicable, as that will provide the greatest certainty with regard to future management and maintenance.

18.3 Where SuDS are not intended to be adopted, it is essential to clearly communicate maintenance requirements to any future property owners, in accordance with section 12 and 11.4 of British Standard BS8582:2013. Such communication shall include clear explanation of the consequences of future property owners not carrying out the maintenance. Design and operation of SuDS should be easy to understand for those ultimately responsible for its maintenance.

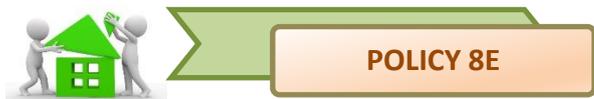
18.4 A maintenance buffer zone of 10m is advocated by British Standard BS 8533, but discussions should be held with the appropriate regulatory authority to agree specific requirements.

18.5 For maintenance of ordinary watercourses, it is recognised they can be relatively small in width and depth. If a watercourse is 2m wide by 1m deep the Lead Local Flood Authority recommends that a minimum buffer of 3.5m in width should be allocated to allow for access for maintenance. This should be provided from the top of both banks unless it can be shown that uninterrupted access along the length of the watercourse can be delivered. Locations of outfalls into the watercourse must be identified and plant not be placed directly above it to prevent damage to the structure.

18.6 The design of an exceedance flow management system shall account for the location, intended normal use and capacity of residual flood pathways.

18.7 Residual flood pathways or storage zones should not detract from the drainage system's primary function, and shall be protected and maintained so as to be always available.

19.0 WATER QUALITY



19.1 In general, the use of SuDS components, especially if a SuDS treatment train is used, can result in runoff water quality which is of a similar order to river water quality standards.

*** KEY POINT 12: The majority of sustainable drainage components also treat surface water runoff, often improving water quality as well as providing a drainage system. This is one of the main differences between traditional drainage systems based on the use of pipework and SuDS**

19.2 Water quality treatment requirements are considered not to be met by the Environment Agency if piped schemes are proposed.

19.3 Examples of SuDS components that may be used to treat water where a scheme includes piped components (for example pipes connecting to geo-cellular crates or attenuation tanks) include swales or filter strips.

19.4 An online tool is available to assist with assessment of risk to water quality at <http://www.uksuds.com/drainage-calculation-tools/water-quality-assessment-for-suds-developments>.

19.5 Where piped components are proposed as part of a surface water drainage scheme, non-piped SuDS components shall be used to treat water prior to final discharge.

19.6 Providing it is separated from other surface water runoff, residential roof water may be directly discharged to a watercourse or soakaway without treatment.

20.0 ACHIEVING BIODIVERSITY BENEFITS OF SuDS

20.1 Where potential exists, SuDS should be designed to restore or enhance existing habitats and create new ones. The water within a SuDS scheme is an essential resource for both flora and fauna. With good design SuDS can and should provide shelter, food and breeding opportunities for a wide variety of species.

20.2 Adopting a biodiversity-friendly approach to SuDS design will help developers meet the criteria of Neighbourhood Plan policies 7D and 7E.

20.3 Biodiversity will be able to become established if an appropriate water quality treatment train is implemented along with open shallow SuDS features.

20.4 Opportunities to achieve biodiversity benefits through SuDS design may depend on the size and nature of a development, but even small-scale features have benefit.

USEFUL REFERENCE

Information on SuDS design for biodiversity can be found in Chapter 6 of CIRIA Report C753: The SuDS Manual

21.0 ACHIEVING AMENITY BENEFITS OF SuDS

21.1 As well as managing surface water, wherever possible and practical, SuDS should be designed to enhance amenity, by enriching aesthetic and recreational value, promoting health and well-being and supporting green infrastructure. SuDS provides opportunities for water to be visible and audible, which many people value. Where possible, SuDS schemes should be designed in a way that both serves a practical drainage purpose and enhances site landscaping and appearance, as illustrated by the example in Figure 16.



Figure 16: Attractive incorporation of a SuDS feature

USEFUL REFERENCE 📖

Information on SuDS design for amenity can be found in Chapter 5 of CIRIA Report C753: The SuDS Manual

22.0 DOCUMENTATION REQUIRED WITH PLANNING APPLICATIONS

22.1 The importance of robust design of surface water drainage systems has been explained in section 5. The level and type of documentation to be submitted shall be proportionate to a site’s size and level of surface water flood risk, but all proposals are required to describe and justify the drainage system proposed, even those of the very simplest form. Minimum requirements are outlined in Figure 17.

Document	Major development in a surface water flood risk zone	Major development not in a surface water flood risk zone	Minor development in a surface water flood risk zone	Minor development not in a surface water flood risk zone
Surface water drainage strategy ¹	✓	✓	✗	✗
Description and justification of the proposed SuDS	2	2	✓	✓
Drawing(s) of the proposed SuDS	✓	✓	✓	✓

Calculations showing the pre-and post-development runoff rates and volumes	2	2	✓	✓
Details of the depth(s) at which any underground SuDS components will be installed	2	2	✓	✓
Infiltration test results	2	2	✓	✓
SuDS adoption and maintenance proposals	2	2	✓	✓
Evidence of compliance with the Lead Local Flood Authority's most up to date guidance on surface water management	2	2	✓	✓
Site-specific flood risk assessment ¹	✓	x	✓	x
Evidence of engagement with the Lead Local Flood Authority and/or Anglian Water	✓	x	✓	x
SuDS design statement ³	✓	✓	✓	✓
Drainage design data and calculations ⁴	✓	x	✓	x
Maintenance proposals	✓	✓	✓	✓
Resistance and resilience proposals, if applicable	✓	x	✓	x

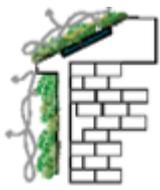
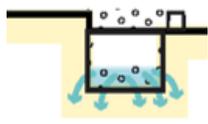
Figure 17: Minimum documentation requirements

Notes to Figure 17:

1. See supporting text to Neighbourhood Plan Policy 8A for the topics to be covered by these documents as a minimum;
2. To be presented with a surface water drainage strategy;
3. See supporting text to Neighbourhood Plan Policy 8H for the topics to be covered by this document;
4. To a satisfactory level of detail to demonstrate compliance with the policies of the Neighbourhood Plan and the requirements of this Design Manual.

23.0 AN OVERVIEW OF SuDS COMPONENTS

23.1 A variety of sustainable drainage components can be linked together in sequence, so that a designer is able to tailor surface water management to the local context and site-specific conditions. Figure 18 (taken from 'Water. People, Places', AECOM, September 2013) shows the most common SuDS components, their most suitable setting and their typical use of land. More detailed information on the various components is given in section 23.

SuDS component	Description	Setting	Required area
 <p>Green roofs</p>	A planted soil layer constructed on the roof of a building to create a living surface. Water is stored in the soil layer and absorbed by vegetation	 <p>Building</p>	Building integrated
 <p>Rainwater harvesting</p>	Rainwater is collected from the roof of a building and other paved surfaces, and stored in an underground or over ground tank for treatment and re-use locally. Such water may be used for toilet flushing and irrigation. On a smaller scale, water butts can also be used	 <p>Building</p>	Water storage
 <p>Soakaway</p>	Designed to allow water to quickly soak into permeable layers of soil. Constructed like a dry well, an underground pit is filled with gravel or rubble. Water is stored in the soakaway and from there allowed to gradually seep into the ground	 <p>Open space</p>	Dependant on runoff volumes and soil type
 <p>Filter strip</p>	A grassed or planted area that runoff is allowed to run across to promote infiltration and cleansing	 <p>Open space</p>	Minimum length required = 5m
<p>Filter drains</p>	Runoff is temporarily stored below the surface in a shallow trench filled with stone / gravel, providing attenuation, conveyance and treatment (via filtration)	 <p>Open space</p>	Minimum length required = 5m
 <p>Permeable paving</p>	Paving which allows water to soak through. It can be in the form of paving blocks or porous paving where water filters through the paving itself. Water can be stored in the sub-base beneath paving or allowed to infiltrate into the ground below	 <p>Street / open space</p>	Can typically drain double its area

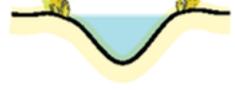
<p>Bioretention area</p> 	<p>A vegetated area with gravel and sand layers below, designed to channel, filter and cleanse water vertically. Water can infiltrate into the ground below or drain to a perforated pipe and conveyed elsewhere. Can be integrated with tree-pits of gardens</p>	<p>Street / open space</p> 	<p>Typical surface area is 5-10% of drained area with storage below</p>
<p>Swale</p> 	<p>A shallow, vegetated depression in the ground designed to convey and filter water. A swale can be 'wet', where water gathers above the surface before draining, or 'dry', where water collects in a gravel layer beneath. Can be lined or unlined to allow infiltration</p>	<p>Street / open space</p> 	<p>Account for width to allow safe, accessible maintenance: typically, 2-3 metres wide</p>
<p>Attenuation pond / basin</p> 	<p>Can be used to store and treat water. 'Wet' ponds have a constant body of water and runoff adds to that, while 'dry' ponds are empty during periods of little / no rainfall. Can be designed to allow infiltration into the ground or to store water for a period of time before discharge. May require an outlet that restricts/ controls outflow, to ensure adequate attenuation</p>	<p>Open space</p> 	<p>Dependant on runoff volumes and soil type</p>
<p>Wetland</p> 	<p>Shallow vegetated water bodies with a varying water level. Specially selected plant species are used to filter water. Water flows horizontally and is gradually treated before being discharged. Can be incorporated with a natural or hardscape environment</p>	<p>Open space</p> 	<p>Typically, 5-15% of drainage area to provide good treatment</p>
<p>Trees</p>	<p>Can be planted within a range of SuDS components to improve their performance, as root growth and decomposition increase soil infiltration capacity. Can also be incorporated as standalone features in soil-filled tree pits or tree planters</p>	<p>Open space</p> 	
<p>Underground storage</p> 	<p>Water can be stored in permeable crates beneath the ground to provide attenuation</p>	<p>Open space</p> 	<p>Dependent on runoff volume and soli type</p>

Figure 18: Typical SuDS Components

24.0 THE MAIN SuDS COMPONENTS IN MORE DETAIL

24.1 This section gives a brief outline of each main SuDS component that may be used as source and / or site controls in a treatment train. Illustrations given in various figures are examples only, and actual design should result in specific solutions that best suit a particular site.

24.2 Green roofs: See Figure 19. These provide vegetation cover on roofs, replacing some of that lost by development, and that increases storage, attenuation and evapotranspiration, thus helping manage flows as well as providing other benefits like thermal comfort and biodiversity gain.



Figure 19: Green roof construction

24.3 Permeable paving: See Figure 20. This allows water to soak into a gravel sub-base below, temporarily holding the water before it soaks into the ground, or passes to an outfall. During this process, there is also some water quality treatment. Such a solution may comprise porous pavers, porous concrete or porous asphalt, and may also consist of gravel or 'drivable grass', which is reinforced to take the weight of vehicles.

USEFUL REFERENCE  <https://www.pavingexpert.com/permeable03>

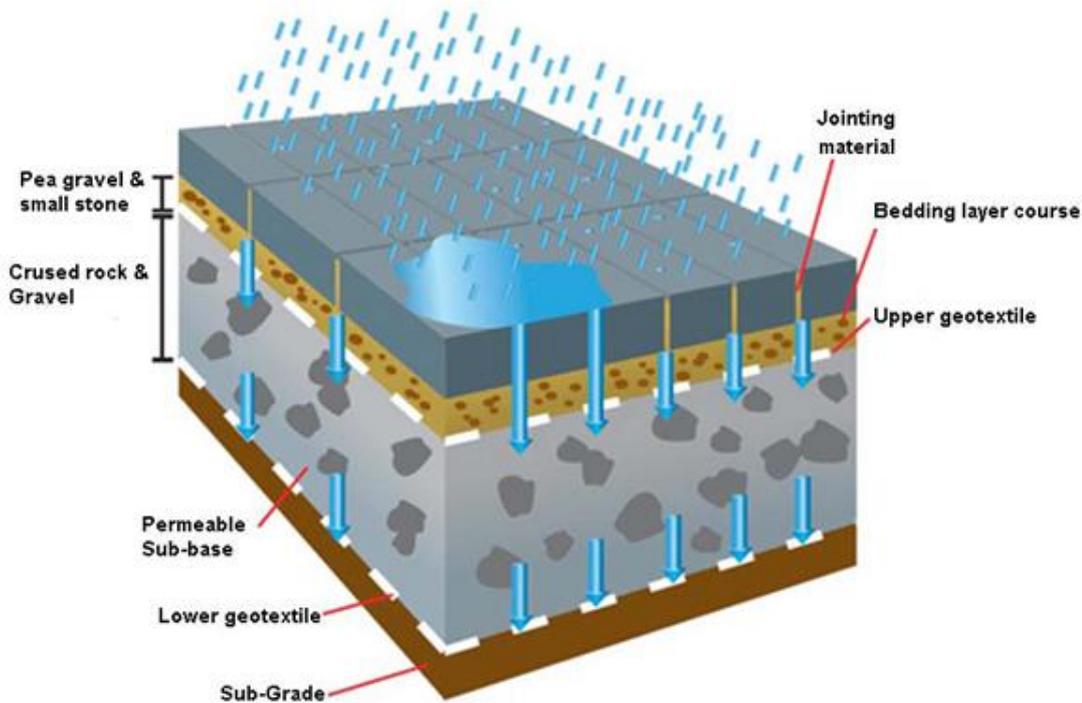


Figure 20: Permeable paving

24.4 Rainwater harvesting: This may take the simple form of rainwater butts (see Figure 21) or rain garden planters (see Figure 22), at each downpipe on a building, or may comprise large under or over-ground tanks to store rainwater for use around a garden and as domestic grey water (see Figures 23 and 24).

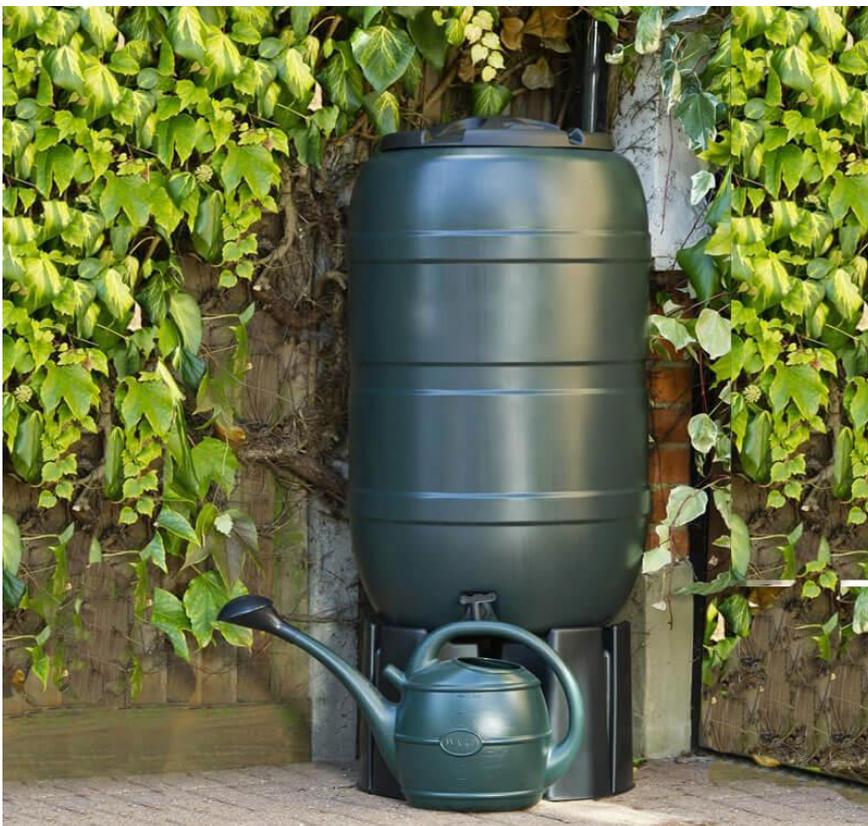


Figure 21: Typical water butt

Cross-section of a rain garden planter:

Raised planters are useful SuDS solutions if space is tight, or ground conditions don't allow water to soak away. They can be built over existing surfaces as long as there is a plan for any overflow, if necessary - excess water can continue into the existing system, as before.



Other materials can be used, or any suitable container could be converted - send us your DIY creations to feature on the website!

Figure 22: Cross-section of a rain garden planter

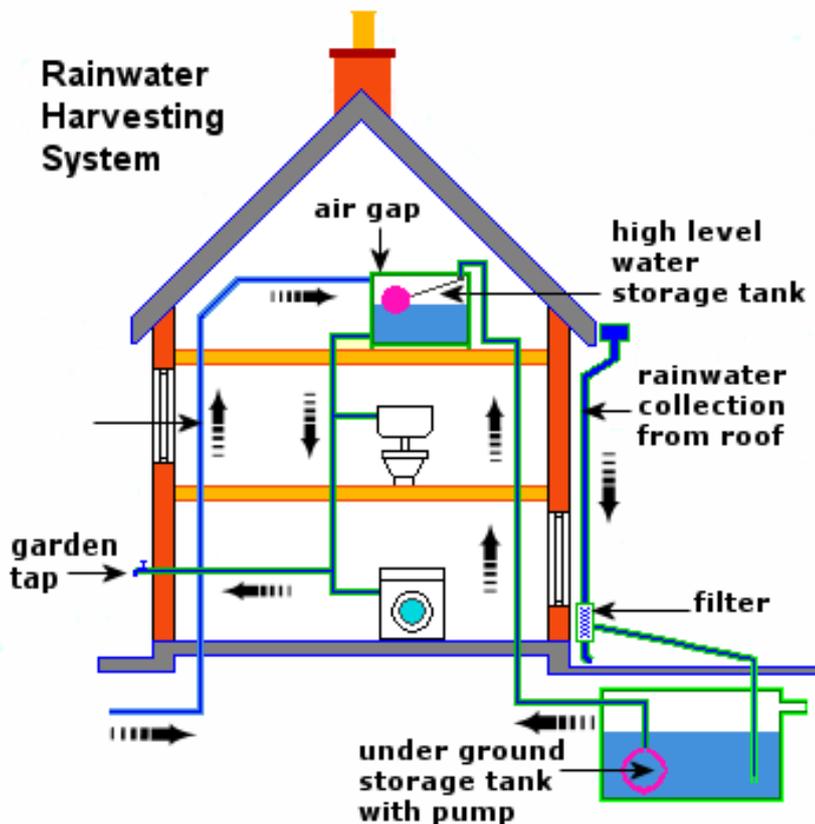


Figure 23: Schematic for a typical rainwater harvesting system



Figure 24: Typical underground rainwater harvesting system

24.5 Soakaways: These are ground excavations either filled with rubble or lined with brickwork, pre-cast concrete or polyethylene rings; or perforated storage structures surrounded by granular backfill (see Figure 25). They can be grouped and linked together to drain large areas including site access roads. The supporting structure and backfill may be substituted by modular or geocellular units (see Figure 26). Soakaways provide stormwater attenuation, stormwater treatment and groundwater recharge.

USEFUL REFERENCE 🍷 <https://www.pavingexpert.com/drain08>



Figure 25: Perforated structure / backfilled soakaway

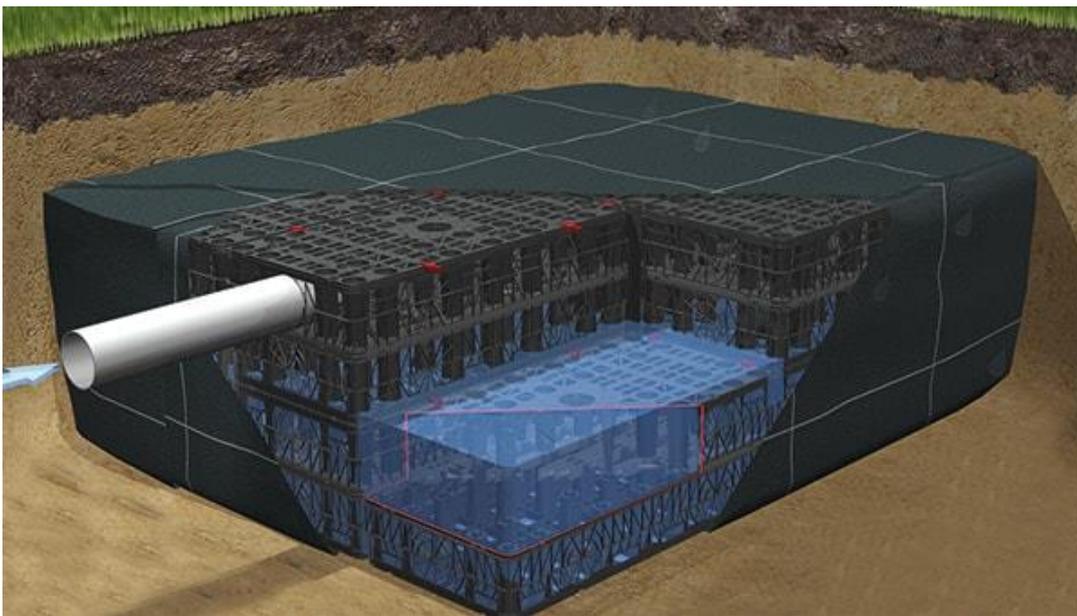


Figure 26: Geocellular soakaway

24.6 Filter strips: See Figure 27. These are gently sloping, vegetated strips of land that provide opportunities for slow conveyance and infiltration (where appropriate). They are designed to accept runoff as overland sheet flow from upstream development and often lie between a hard-surfaced area and a receiving stream, surface water collection, treatment or disposal system. They treat runoff by vegetative filtering, and promote settlement of particulate pollutants and infiltration.

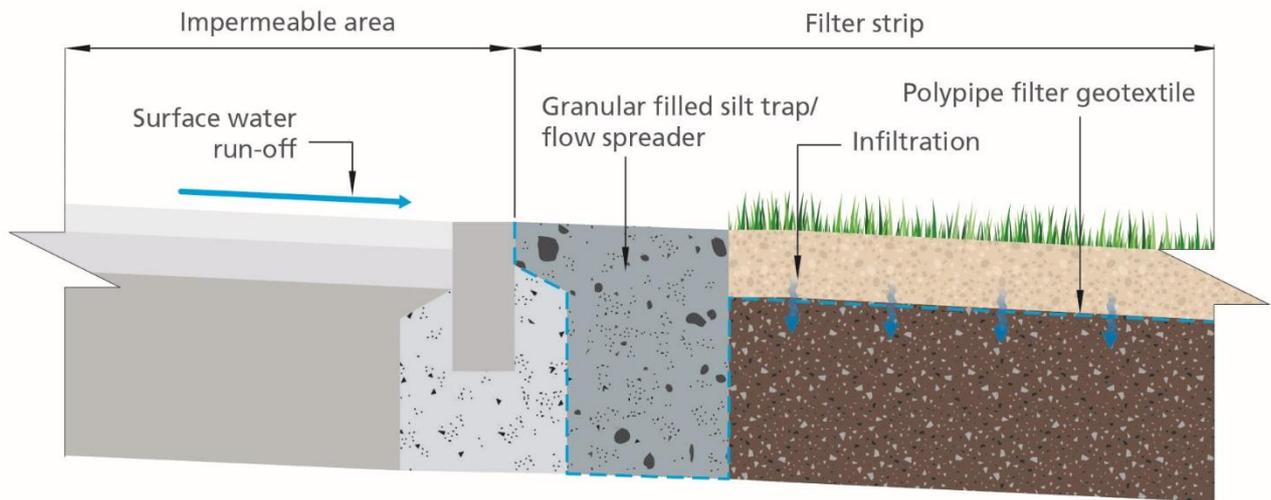


Figure 27: Cross-section through a typical filter strip

24.7 Filter drains. See Figure 28. These are gravel filled trenches that collect and move water. They also treat pollution. The trench is filled with free draining gravel and often has a perforated pipe in the bottom to collect the water. They are widely used to drain roads.

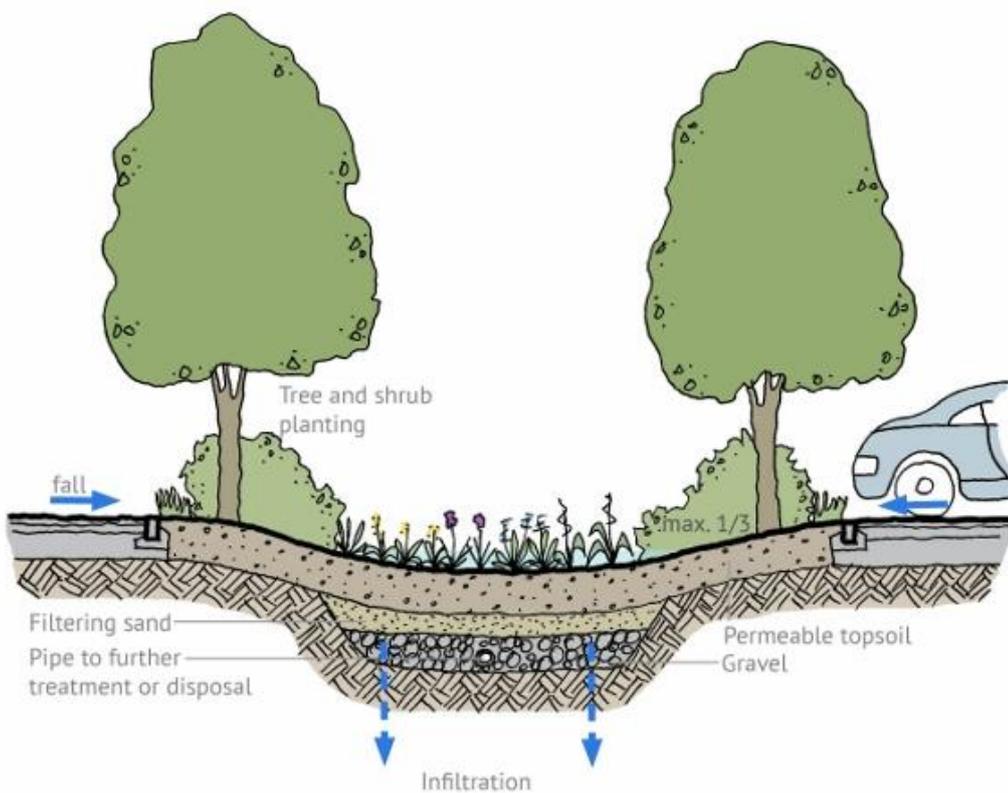


Figure 28: Cross-section through a typical filter drain

24.8 Bioretention Areas: See Figure 29. These are shallow landscaped depressions which are typically under drained and rely on engineered soils, enhanced vegetation and filtration to remove pollution and reduce runoff downstream. They are aimed at managing and treating runoff from frequent rainfall events. They may be implemented as rain gardens for individual housing plots and / or on a larger scale to serve an entire site.

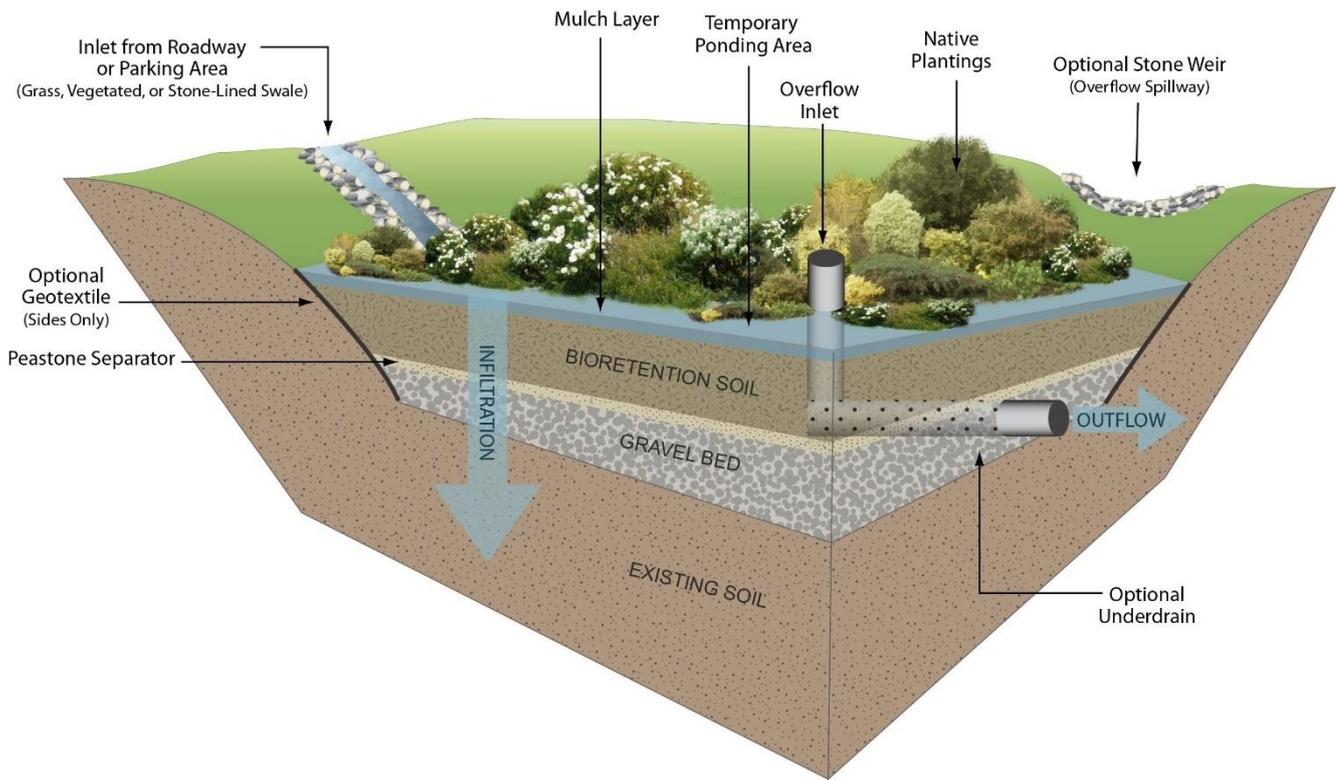


Figure 29: Bioretention area details

24.9 Swales: See Figure 30. These are shallow, broad and vegetated channels designed to store runoff and remove pollutants. They may also be used as conveyance structures to pass the runoff to the next stage of the treatment train and can be designed to promote infiltration where soil and groundwater conditions allow. Check dams and berms also can be installed across the flow path of a swale in order to promote settling and infiltration. Swale inlets can be used to drain roads or other hard standings. See Figure 31.



Figure 30: Typical swale



Figure 31: Example of a swale inlet

24.10 Attenuation ponds and basins. See Figure 32. These are surface storage basins or facilities that provide flow control through attenuation of stormwater runoff. They also facilitate some settling of particulate pollutants. They are normally dry and in certain situations the land may also function as a recreational facility. However, basins can also be mixed, including both a permanently

wet area for wildlife or treatment of the runoff and an area that is usually dry to cater for flood attenuation. They tend to be found towards the end of the SuDS treatment train, so are used if extended treatment of the runoff is required or if they are required for wildlife or landscape reasons.



Figure 32: An attenuation basin in a dry condition

24.11 Wetland: See Figure 33. These comprise shallow ponds and marshy areas, covered almost entirely in aquatic vegetation, which provide both stormwater attenuation and treatment. Wetlands detain flows for an extended period to allow sediments to settle, and to remove contaminants by facilitating adhesion to vegetation and aerobic decomposition. They also provide significant ecological benefits.



Figure 33: A SuDS wetland

24.12 Tree planting as a SuDS component: See Figure 34. Tree pits are designed to accept runoff and provide a level of treatment while attenuating its flow.

USEFUL REFERENCE 

Engaging with SuDS for Arboricultural Benefits, Robert Bray Associates

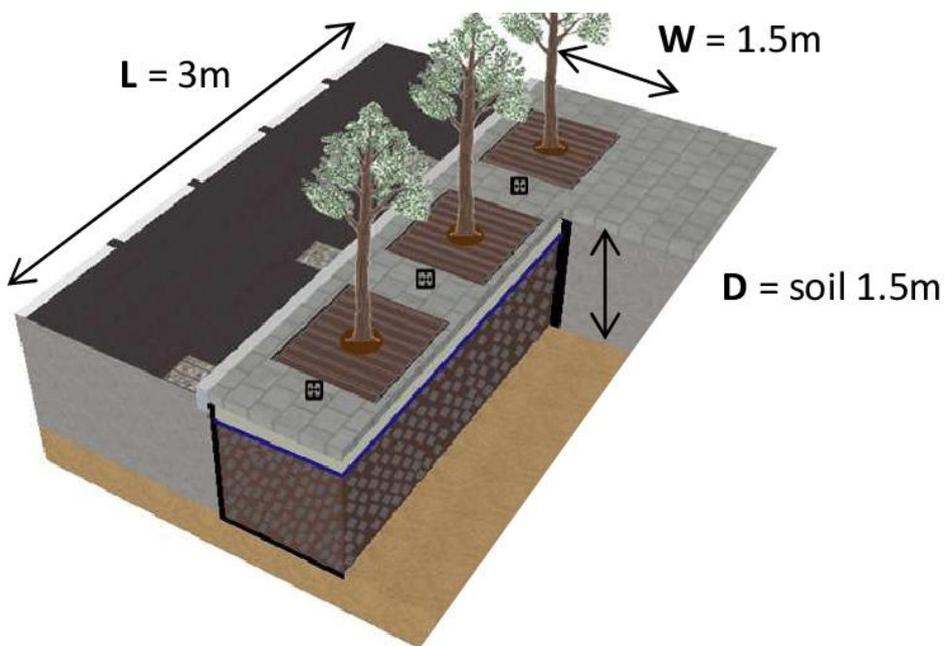


Figure 34: Tree pit details

25.0 GENERAL REFERENCES

ESSENTIAL READING

- ❖ **Guidance on Norfolk County Council's Lead Local Flood Authority Role as Statutory Consultee to Planning**

USEFUL REFERENCES

A wide range of guidance on SuDS design, construction and maintenance is available, to an extent that would be inappropriate to repeat in this Design Guide. Designers of SuDS are particularly referred to the latest available versions of the following:

- ❖ **CIRIA Report C753: The SuDS Manual**
- ❖ **CIRIA Report C768: Guidance on the Construction of SuDS**
- ❖ **Towards Sustainable Water Stewardship, Anglian Water's SuDS Adoption Manual**
- ❖ **Water. People. Places: A Guide for Master Planning Sustainable Drainage into Developments (AECOM)**
- ❖ **CIRIA Factsheet: SuDS Maintenance and Adoptions Options (England)**
- ❖ **Improving the Flood Performance of New Buildings (Communities and Local Government publication)**
- ❖ **Non-technical Standards for Sustainable Drainage: Practice Guidance (Defra)**
- ❖ **SuDS: Maximising the Potential for People and Wildlife (The RSPB and the Wildfowl and Wetlands Trust)**
- ❖ **Stemming the Flow - the Role of Trees and Woods in Flood Protection (The Woodland Trust)**

APPENDIX A: GENERAL IDEAS FOR DEALING WITH SURFACE WATER FLOOD RISK

A1. The information that follows is not intended to provide precise or even broadly indicative solutions to the management of surface water and has not been based on specific design. It remains fully the responsibility of developers to propose acceptable solutions that comply with Policies 8A – 8H of the Saham Toney Neighbourhood Plan and this Manual, together with local and national planning rules and guidance. That must be done with full considerations of a proposed site's particular and unique characteristics, conditions and location, and of how it fits into the drainage pattern for its surrounding area. Nevertheless, it is considered helpful to provide the information that follows with regard to very general design concepts that may be suitable for each of the sites allocated in the Neighbourhood Plan, and may serve as a starting point for more specific design by a developer; and where opportunities exist, to address existing surface water issues in the wider area,

A2. Allocated Site STNP1

A2.1 This site is located in the area described in paragraph 5.12 and Figure 5. The design of a surface water drainage solution for the site should take into account the flood risk issues of the immediately surrounding area along Chequers Lane, Page's Lane and Hills Road, and the land and property adjoining those roads. Key points relating to the site's drainage are:

- a) It lies on a slope that runs down from south to north;
- b) It is close to the junction of Hills Road, Chequers Lane and Page's Lane, that regularly experiences flooding;
- c) Surface water running west to east along Page's Lane flows onto the northern part of the site, which is defined as an area at low-to medium risk of surface water flooding by the online Environment Agency flood risk map, and regularly overflows the poorly-maintained ditch along the site frontage.

A2.2 Neighbourhood Plan Policy 2H sets aside an area in the north-western part of the site for flood risk attenuation measures, and includes additional open green space.

A2.3 Together with the wide range of measures in this manual to harvest, intercept and attenuate surface water runoff, it may be of particular use to direct flow from south to north by a swale leading to an attenuation pond in the north-west area of the site, with a swale replacing the existing ditch along the site's frontage. See Figure 33.

A3. Allocated Site STNP2

A3.1 This site lies in an area not defined by the Environment Agency as being at risk of surface water flooding and has no history of such flooding, and is a small-scale brownfield development. New development will replace existing areas of hard standing. Measures such as permeable paving, including for the site access road, which will be a private driveway; provision of rainwater butts and/ or rainwater harvesting for re-use; green roofs; filter strips / drains and soakaways are all likely to offer acceptable and appropriate drainage solutions.

A4. Allocated Site SNP4

A4.1 This site is located in the area described in paragraph 5.12 and Figure 5. The design of a surface water drainage solution for the site should take into account the flood risk issues of the immediately surrounding area along Chequers Lane, Page's Lane and Hills Road, and the land and property adjoining those roads. Key points relating to the site's drainage are:

- a) It lies on a slope that runs down from south to north;
- b) It is bordered to the north by Page's Lane, that regularly experiences flash flooding, with water flowing from west to east. Surface water also flows downhill along Pound Hill to the east of the site;
- c) A central strip of the site running south-north, and a small area at the western boundary of the site are defined as at low-to medium risk of surface water flooding by the online Environment Agency flood risk map;
- d) The ditch that runs along the northern boundary of the site is both blind (i.e. has no outlet) and poorly maintained;

A4.2 Neighbourhood Plan Policy 2J sets aside an area of green space in the central northern part of the site that may be used both for amenity and the preservation of landscape character, and for the implementation of flood risk attenuation measures.

A4.3 Together with the wide range of measures in this manual to harvest, intercept and attenuate surface water runoff, it may be of particular use to direct flow from south to north by a swale along the western boundary of the site; to replace the existing northern boundary ditch with a swale; and to include a 'wet and dry' balancing pond in the green space area to attenuate any extreme flows. See Figure 33.

A5. Allocated Site STNP7

A5.1 This site is located in the area described in paragraph 5.12 and Figure 5. The design of a surface water drainage solution for the site should take into account the flood risk issues of the immediately surrounding area along Chequers Lane, Page's Lane and Hills Road, and the land and property adjoining those roads. Key points relating to the site's drainage are:

- a) The site slopes gently down from south to north;
- b) It is bordered to the south by Page's Lane, that regularly experiences flash flooding, with water flowing from west to east. When such flooding occurs, water flows off the road onto the site via the access road serving the disused farm. Surface water also flows from open fields to the west, thence across the site to neighbouring property to the east, and in extreme conditions, surface water that overflows the watercourse to the north may reach the northern part of the site;
- c) Parts of the site are defined as at low risk of surface water flooding by the online Environment Agency flood risk map and almost immediately to the north of the site are areas at medium to high risk that form part of the main flow path from west to east;
- d) There is no ditch along the southern boundary of the site by the roadside and ditches to the west of the property that should intercept flows and direct them away from the site, are in poor condition;

A5.2 Neighbourhood Plan Policy 2K sets aside an area of green space along the eastern side of the site, both for the implementation of flood risk attenuation measures, and as a buffer with regard to heritage impact on the nearby listed building.

A5.3 Together with the wide range of measures in this manual to harvest, intercept and attenuate surface water runoff, it may be of particular use to both protect the site from offsite flows and to manage onsite surface water by providing a series of swales to direct excess surface water to an attenuation pond in the green space area, which would also help avoid creating offsite flood risk. See Figure 35.

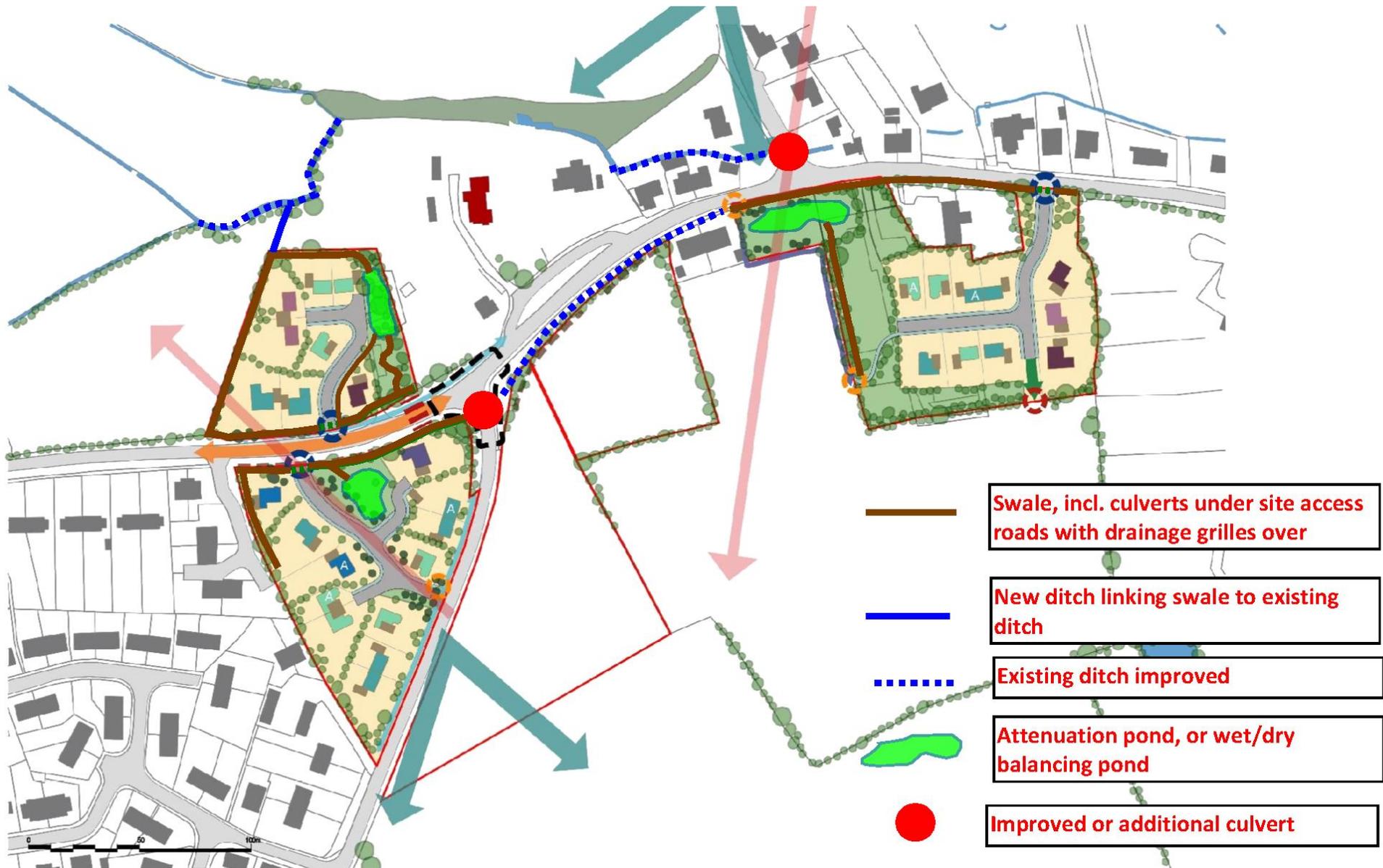


Figure 35: Ideas for Managing Surface Water on Allocated Sites STNP1, 4 and 7 and the Wider Area

A6. Allocated Site STNP9

A6.1 Key points relating to this site's drainage are:

- a) An area in the north-east corner of the site is defined as being at high risk of surface water flooding by the online Environment Agency map;
- b) Surface water flows in ditches along the northern and eastern boundaries of the site and leaves the site via a culvert that runs under Ovington Road;
- c) A new development to the north-west of the site may lead to an increase of surface water flow in the site's drainage ditches, since that other site was permitted prior to the Neighbourhood Plan's drainage policies coming into force.

A6.2 Together with the wide range of measures in this manual to harvest, intercept and attenuate surface water runoff, it may be of particular use to both protect the site from offsite flows and to manage onsite surface water by improving the existing ditches and providing an attenuation pond in the area of high flood risk. It may also be appropriate to increase the size of the culvert under Ovington Road. Since the site will be served by private driveways it would be acceptable and beneficial to construct those with permeable paving.

A7. Allocated Sites STNP13 and 14

A7.1 These sites lie in an area not defined by the Environment Agency as being at risk of surface water flooding and have no history of such flooding. Measures such as permeable paving, including for the site access road, which will be a private driveway; provision of rainwater butts and/ or rainwater harvesting for re-use; green roofs; filter strips / drains and soakaways are all likely to offer acceptable and appropriate drainage solutions.

A8. Allocated Site STNP15

A8.1 Key points relating to this site's drainage are:

- a) A small area located centrally towards the front (northern side) of the site is defined as being at low risk of surface water flooding by the online Environment Agency map;
- b) The site slopes down from its northern boundary with Richmond Road to its southern boundary. Although there is no record of surface water flowing offsite to the fields to the south, that possibility may arise after development if not addressed by design;
- c) The site includes an existing soakaway that drains a neighbouring property to the east and must be incorporated in the site's drainage scheme.

A8.2 Together with the wide range of measures in this manual to harvest, intercept and attenuate surface water runoff, attention is needed to the prevention of surface water flow off the site onto fields to the south. Measures such as permeable paving, including for the site access road, which will be a private driveway; provision of rainwater butts and/ or rainwater harvesting for re-use; green roofs; filter strips / drains and soakaways are all likely to offer acceptable and appropriate drainage solutions.

A9. Allocated Site STNP16

A9.1 This site lies in an area not defined by the Environment Agency as being at risk of surface water flooding and have no history of such flooding. Measures such as permeable paving, including for the site access road, which will be a private driveway; provision of rainwater butts and/ or rainwater harvesting for re-use; green roofs; filter strips / drains and soakaways are all likely to offer acceptable and

appropriate drainage solutions. Attention shall be paid to the prevention of excess surface water flowing offsite onto Richmond Road.

A10. Opportunities to Alleviate Existing Surface Water Flood Risk

A10.1 As noted in paragraph 5.9, certain areas of the Parish are at particular risk of surface water flooding and have experienced a number of flood events. While policies for the development of particular sites are unable to include measures to deal with such existing problems remote from the allocated sites, the development of some of the sites allocated in the Neighbourhood Plan may offer opportunities to implement measures local to those sites to alleviate existing problems to some extent, as follows, with reference to Figure 35:

- a) Policies for the development of allocated sites STNP1, 4 and 7 include measures to make improvements to the highway along the site frontages and to introduce footways. When such highway improvements are undertaken, that may present a cost-effective opportunity to improve and enlarge the existing culvert that forms part of a key watercourse under the lower end of Hills Road, and / or to introduce a culvert under the northern end of Pound Hill;
- b) When developing allocated site STNP7, the opportunity could be taken to improve the existing drainage ditch that runs from south-west to north-east, just to the north-west of the site, and to provide a new drainage ditch linking the site to that improved ditch and thereby offering an overflow route to the main watercourse that runs from west to east a little further to the north;
- c) Since surface water from allocated site STNP7 is in some part likely to flow into the main west to east watercourse just to the north, any opportunity to improve that watercourse should be taken, particularly to widen it where it currently narrows immediately to the west of where it flows under Hills Road;
- d) When implementing swales or other similar measures along the northern boundaries of allocated sites STNP1 and 4, the opportunity to improve the short length of drainage ditch along Page's Lane between the two sites should be taken;
- e) With the landowner's agreement, the introduction of 'wet-dry' attenuation ponds in farmland upstream of allocated site STNP7 to take excess flows from the main west to east watercourse that runs nearby to the north of the site would potentially reduce or eliminate the flood events experienced by residents immediately to the east of the allocated site.

A10.2 Although the Neighbourhood Plan cannot include policy measures to alleviate existing flood issues, well-considered application of the SuDS principles described in this manual offers potential for those problems to be addressed by implementing measures outside of the Plan. One of the main problems at present is the accumulation of surface water at certain points of the watercourse shown in Figure 2, and the consequent way in which it backs up and floods onto villagers' properties and land, and the public highway. Measures to unblock such bottlenecks in the system are likely to require significant engineering work and will likely be costly as a result, a fact that will hinder their delivery in practice. Additionally, resolving such problems at a particular point may simply move the problem downstream. A SuDS approach would seek to prevent the accumulation of surface water at locations where it leads to flooding of dwellings, gardens and roads, by attenuating its flow further upstream. Attenuation basins could be constructed to take excess flows when flash floods occur and hold them back until they can drain into the soil and/or be released at a rate slow enough to ensure floods do not occur downstream. Some potential locations are indicated on Figure 36, but it is stressed that these are conceptual ideas only, presented to promote discussion and more detailed assessment; and would require the agreement of landowners, the oversight of the Lead Local Flood Authority and detailed design before implementation.



Figure 36: Potential Locations for Surface Water Attenuation Basins