the existing drainage system) is essential. Additionally, for infiltration SuDS it is imperative that the water table is low enough and a site specific infiltration test is undertaken. Where sites lie within or close to source protection zones further restrictions may be applicable, and guidance should be sought from the Environment Agency.

FRAs should consider the long-term maintenance and ownership of SuDS.

Gloucestershire County Council will become a SuDS Approval Body (SAB) by the enactment of Schedule 3 of the Flood and Water Management Act 2010, although a confirmed date for this enactment has yet to be announced. On enactment, all new development which has surface water drainage implications will potentially require SAB approval and need to conform to National and Local Standards.

Connection of surface water drainage to an existing surface water sewer should only be considered as a last resort. The sewerage undertaker should be consulted at an early stage to ensure that sufficient capacity is available in the existing drainage system.

6 Storage, volume and peak flow rate

Suggested minimum and aspirational storage requirements for an infiltration SuDS scheme for the development footprint are set out below, with more detail provided in subsequent sections.

Table 5. Storage requirements at the proposed development Site (Discharge runoff via infiltration)

Attenuation scenario		Attenuation required (m^3)	Explanation	
Discharge runoff via infiltration	1 in 30 year	134.74	Attenuation required to ensure surface water runoff is attenuated in all storm events up to and including the 1 in 30 year event*. Flooding of the Site of 40.96 m^3 should be contained within permeable landscaped areas within the Site to ensure no flooding of internal areas during the 1 in 100 year storm event.	A further 92.03 m^3 should be managed within overland flow routes to ensure there is no increase in flood risk in all events up to the 1 in 100 year including 40% allowance for climate change.
	1 in 100 year	175.70	Attenuation required to ensure surface water runoff is attenuated in all storm events up to and including the 1 in 100 year event*.	
	1 in 100 year including 40% CC	267.73	Attenuation required to ensure surface water runoff is attenuated in all storm events up to and including the 1 in 100 year event including a 40% allowance for climate change*.	

*Subject to confirmation through infiltration testing.

Surface water runoff

An increase in impermeable area on-Site will result in greater rainfall runoff. Reduction in runoff will help mitigate flood risk both on and off-Site. Further information on the surface water runoff calculations is provided in Section 12 'Background Information'.

Guidance

The Non-Statutory Technical Guidance for SuDS (Defra, March 2015) states:

"Where reasonably practicable, for Greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the Greenfield runoff volume for the same event. Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the Greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event."

Table 6. Change in impermeable area associated with the development

Total Site area	13,300 m^2
Impermeable area (and as a percentage of the total area of the proposed development footprint of 7,800 m^2)	
Pre-development	Post-development
2,245 m^2 (28.8%)	2,800 m^2 (35.9%)
Impermeable Land use: building footprints areas of hardstanding Permeable Land use: unmade ground, soil and areas of vegetation	New impermeable land use: building footprint, carparking spaces and access road New permeable land use: landscaped areas

Guidance

"The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event' and 'flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development"

(Defra, March 2015, non-statutory guidance).

Peak discharge rates

The table below presents peak discharge rates for a range of storm events used to assess the impact of the proposed development and select the maximum permitted discharge rate. Further information on the calculation and control of peak discharge rates is provided in Section 12 'Background Information'.

Table 7. Peak discharge rates associated with the development

Rainfall event	Greenfield runoff rates (l/s)	Existing runoff rates[1] (l/s)	Potential runoff rates without attenuation (l/s)	Potential minus existing (l/s)
QBAR	0.16	N/A	N/A	N/A
6 hour 1 in 1 year	0.14	3.28	3.87	0.59
6 hour 1 in 10 year	0.26	5.19	6.11	0.92
6 hour 1 in 30 year	0.36	6.93	8.17	1.24
6 hour 1 in 100 year	0.52	9.04	10.65	1.61
6 hour 1 in 100 year + 20% CC	N/A	N/A	12.78	3.74
6 hour 1 in 100 year + 40% CC	N/A	N/A	14.91	5.87

[1] Assumes 100% runoff from impermeable surfaces. Assumes Greenfield runoff from permeable surfaces calculated using the IoH124 method.

Relevant national, local and regional planning policy has been consulted in section 5 to determine restrictions on runoff from previously developed and greenfield sites. In some cases, greenfield rates may be requested, but in practice it is difficult to restrict discharge rates at any one control point to less than 2.0 l/s, without increasing the risk of any potential blockages occurring in the drainage network.

Total discharge volumes

The table overleaf presents discharge volumes for a range of storm events used to assess the impact of the proposed development and calculate the required storage volumes. Further information on the calculation of total discharge volumes is provided in Section 11 'Methodology and Limitations'. Total discharge volumes associated with the development.

Table 8. Total discharge volumes associated with the development

Rainfall event	Greenfield runoff volume (m^3)	Existing runoff volume[2] (m^3)	Potential runoff volume without attenuation (m^3)	Potential minus existing (m^3)
QBAR	20.90	N/A	N/A	N/A
6 hour 1 in 1 year	19.73	70.85	83.49	12.64
6 hour 1 in 10 year	32.19	112.21	131.99	19.78
6 hour 1 in 30 year	41.71	149.74	176.45	26.71
6 hour 1 in 100 year	54.38	195.25	230.08	34.83
6 hour 1 in 100 year + 20% CC	N/A	N/A	276.09	80.84
6 hour 1 in 100 year + 40% CC	N/A	N/A	322.11	126.86

[2] Assumes 100% runoff from impermeable surfaces. Assumes Greenfield runoff from permeable surfaces calculated using the IoH124 method.

7 Runoff destination

Options for the destination for the runoff generated on-Site have been assessed in line with the prioritisation set out in the Building Regulations Part H document (HM Government, published in 2010 and updated in 2015) and Defra's Non-statutory Technical Standards for SuDS (2015).

Flow attenuation using infiltration SuDS (discharge to ground) is generally the preferred option. If discharge to ground is not available, runoff discharge to surface water is the other preferred method. Only if these two options are impractical should discharge to the sewer network be considered.

Discharge to ground

The Site has high potential for infiltration, with anticipated permeable underlying bedrock. Based on the groundwater flood risk mapping high groundwater levels at the Site are unlikely to be an issue (See SuDS Infiltration Suitability Map (SD50)).

GeoSmart have prepared a separate Phase 1 Contaminated Land Assessment (ref: 74441) identifying a the potential for contamination to be present and recommending a proportionate programme of site investigation and monitoring to quantify the risk. Given that the Site is located within a Total SPZ any infiltrated water will require some level of treatment.

A site investigation comprising trial pits is recommended to confirm the depth to groundwater and allow infiltration tests to be undertaken to confirm the feasibility of an infiltration SuDS scheme.

Discharge to surface watercourse

According to data from the EA (2021) there are no surface water bodies within 100 m of the Site and therefore discharge to surface water is unfeasible.

Discharge to sewer

The regulated drainage and water search included in Appendix C confirms that there are no public surface water or combined sewers within 100 m of the Site and therefore discharge to sewer is considered unfeasible.

8 Water quality

A key requirement of any SuDS system is that it protects the receiving water body from the risk of pollution. This can be effectively managed by an appropriate "train" or sequence of SuDS components that are connected in series. The frequent and short duration rainfall events are those that are most loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5-10 mm of rainfall (first flush) should be adequately treated with SuDS.

The minimum number of treatment stages will depend on the sensitivity of the receiving water body and the potential hazard associated with the proposed development SuDS Manual (CIRIA, 2015). The proposed development is a combination of very low (roof water) to low hazard (runoff from car parking and road). The Site does lie within an SPZ and therefore additional treatment stages may be required.

Table 9. Level of hazard

Hazard	Source of hazard
Very Low	Residential roof drainage
Low	Residential, amenity uses including low usage car parking spaces and roads, other roof drainage.
Medium	Commercial, industrial uses including car parking spaces and roads (excluding low usage roads, trunk roads and motorways).
High	Areas used for handling and storage of chemicals and fuels, handling of storage and waste (incl. scrap-yards).

The recommended minimum number treatment stages suggested for the different runoff waters identified for the proposed development is highlighted in the table below.

Table 10. Minimum number of treatment stages for runoff

		Sensitivity of the receiving water body		
		Low	Medium	High
Hazard	Low	1	1	1
	Med	2	2	2
	High	3	3	3

Rainwater harvesting butts, permeable paving, swales and an infiltration basinwould offer sufficient treatment stages (storage/attenuation, filtration through the sub-base/unsaturated soil zone).

9 Proposed SuDS strategy

Sustainable drainage systems

DEFRA's non-statutory requirements for SuDS require the below ground drainage systems to have the capacity to accommodate at least the 1 in 30 year event and to manage the 1 in 100 year event without flooding of on-site buildings and substations. All runoff should be managed on-Site though for the 1 in 100 year event, accounting for the maximum impacts of climate change to ensure flood risk is not increased to third-parties.

It is assumed that drainage from areas outside the development footprint will continue to use existing drainage arrangements.

A surface water drainage strategy (summarised in Section 2 of this report) includes the following SuDS features to intercept, attenuate and treat surface water runoff.

SuDS Strategy:

Ground conditions at the Site are likely to be conducive to infiltration, surface water runoff will be managed within SuDS features and infiltrated to ground.

Table 11. Proposed SuDS type, features, discharge location and rate restriction

SuDS type	Source control (interception) and infiltration SuDS.
SuDS features	Rainwater harvesting butts, permeable paving, swales and an infiltration basin
Discharge location	Infiltrate to ground

Table 12. Proposed SuDS sizing (dimensions) and attenuation volumes

Rainwater harvesting	Rainwater harvesting butts should be established for each proposed development. In terms of attenuation storage within this SuDS scheme, the volume of run-off which could be attenuated by rainwater harvesting has not been considered within the Preliminary SuDS schematic.
Permeable paving	A 1,050 m^2 area of permeable paving (underlain with a Type 3 aggregate material) within the proposed access road and parking bays to a depth of 0.4 m, with a 30% porosity would result in c. 126 m^3 attenuation.
Swale	Two swales with a length of 40 m, width of 3.5 m, basal width of 0.5 m and depth of 0.5 m along the southern boundary of the proposed development would result in c. 80 m^3 attenuation.

Infiltration basin	An infiltration basin with a surface area of 65 m^2 and an average depth of 1m would provide c. 65 m^3 attenuation. The final sizing of the basin will be subject to the outcome of infiltration testing. Following the results of testing this should include a freeboard above the full level to allow for settlement.
Total Attenuation Provided	271.0 m^3
Total Attenuation Required	267.73 m^3
Freeboard Storage Provided	3.27 m^3

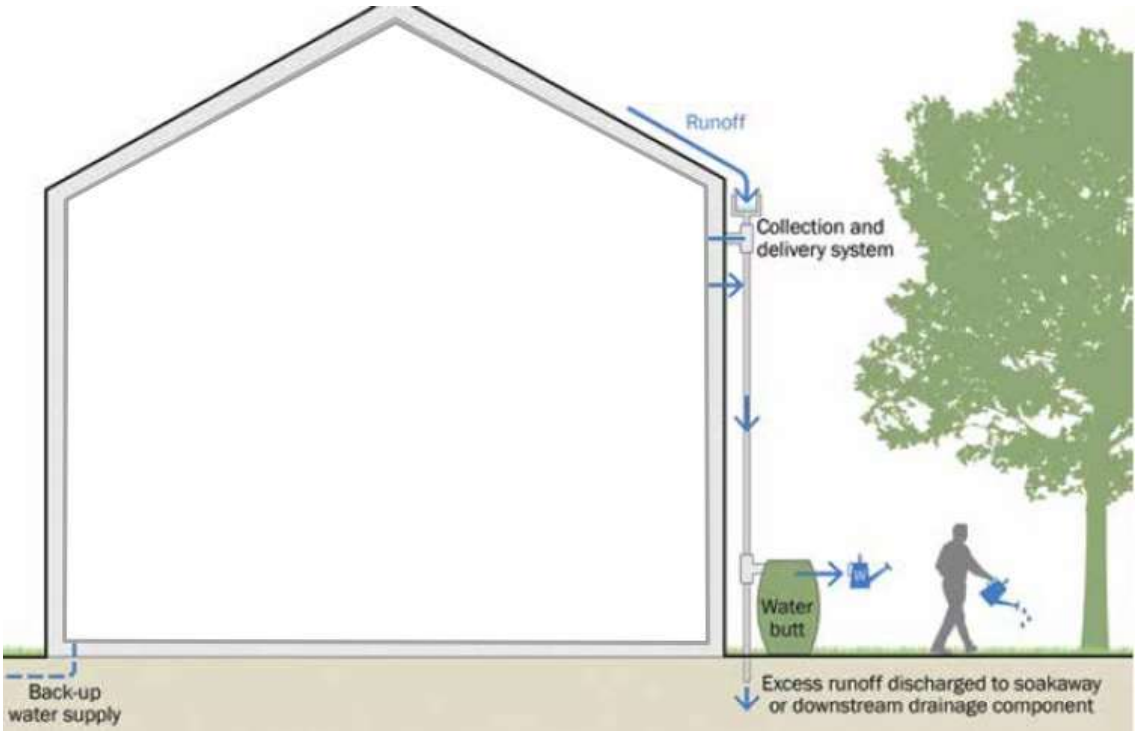
Rainwater harvesting

The run-off from the proposed development roof should be led into rainwater harvesting butts via rainwater downpipes and guttering to catch run-off from the extension roof. Overflow from the butts should be discharged into the storage system provided by the permeable paving.

Due to the relatively insignificant amounts of attenuation provided by rainwater harvesting tanks in this instance and the requirement to retain water for non-potable uses such garden maintenance, the volume of run-off which could be attenuated by rainwater harvesting has not been considered within the report.

As there is an issue with the storage capability of Rainwater Harvesting tanks, this method should have a fixed attenuation volume and a controlled outlet to discharge into the proposed SuDS feature. An overflow system will be required for implementation on the Site due to exceedance events (where the pumps fail or there is a blockage within the system / or the number of residents and subsequent water usage is reduced).

Roof run-off is generally less polluted than run-off from road surfaces but can still generate pollutants such as sediments. Pollutants would be captured by the collection and filtration system and, by reducing the volume of run-off generated from the Site. Primary screening devices are used to prevent leaves and other debris from entering the butt and first flush devises can be designed to divert the first part of the rainfall away from the main storage tank and can pick up most of the dirt, debris and contaminates that collect on a residential roof.



Modified from Figure 11.3 of the CIRIA SuDS Manual (C753) (2015)

Permeable paving

Permeable Paving is proposed for the access road and parking bays to intercept runoff. Suitable aggregate materials (angular gravels with suitable grading as per CIRIA, 2015) will improve water quality due to their filtration capacity and usually work to a 30% porosity. A geotextile layer will be required for paving underlain by aggregate material to intercept silt/particles. Permeable pavements are multi-layered surfacing systems. The surface layer is constructed out of permeable material allowing infiltration of water through gaps along its surface. A geomembrane isolates stored water from the surrounding soil, especially in contaminated areas and a geotextile layer prevents clogging and damage to the geo-cellular modules.

The geotextile layer works to intercept silt/particles flowing through the system via direct rainfall, or through vehicle use deposited onto the car park area and into the permeable paving. The majority of silt would be trapped within the top 30mm of the joining material between the paving blocks. Rainfall flowing into the permeable paving directly from the development roof/rainwater butts would not contain enough volumes of silt and or particles to cause blockage so will be fed directly into underlying porous substrate via rainwater pipes.

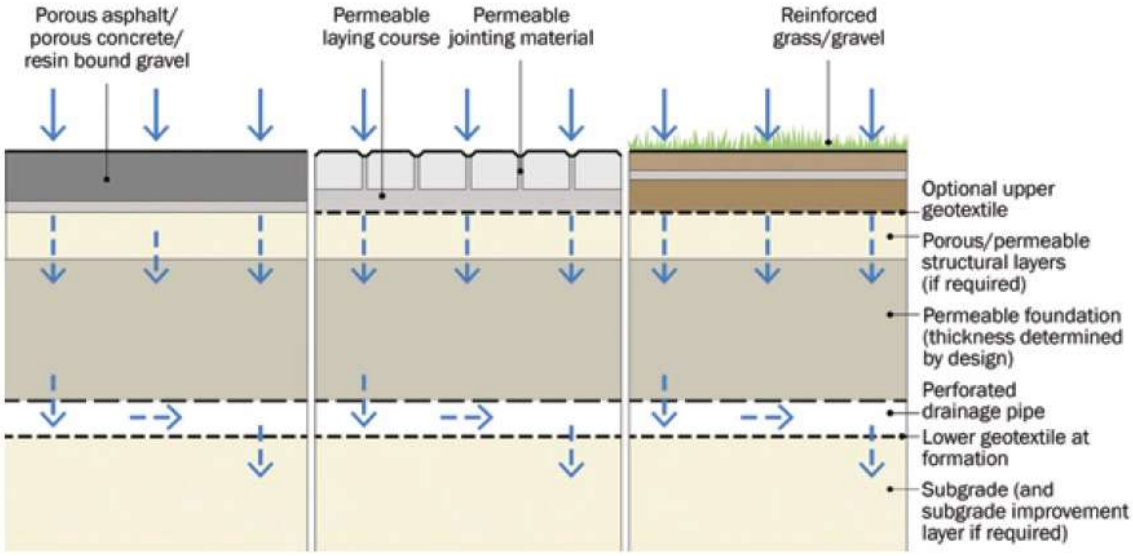


Figure 20.13 of the CIRIA SuDS Manual (C753) (2015)

Plastic geo-cellular systems could also be used, which can increase the void space and therefore storage but do not allow filtration unless they are combined with aggregate material and/or permeable geotextiles which could increase their storage potential by up to 20%. Geo-cellular modules also have the added advantage of reducing the amount of aggregate sub base required, thus keeping costs lower. Void systems, such as permavoids, have a void ratio of 95% (i.e. for every 1 m^3 there is 0.95 m^3 of space available for water storage), which has been factored into the storage capacity calculations.

Infiltration Basin

Infiltration basins are flat-bottomed, shallow landscape depressions that store runoff (allowing pollutants to settle and filter out) before infiltration into the subsurface soils.

Trees are beneficial in infiltration basins as they help maintain infiltration rates of the soil. However, the design should ensure the trees selected are capable of thriving in the conditions likely to be present in the basin.

The side slopes of infiltration basin should normally be no steeper than 1 in 3 to allow for vegetative stabilization, mowing, access and for public safety reasons. However, this requirement may be relaxed if a basin is very shallow (e.g. less than 500 mm deep). Stepped or benched slopes also offer a range of habitats that can survive fluctuating water levels and wet to dry soil conditions.

Inlet channels to infiltration basins should be stabilized using appropriate erosion control such as rip-rap although in a well-designed system, flows will be low and erosion protection requirements should be minimal. A level spreader should also be provided at the inlet to the basin from the pre-treatment system to promote shallow sheet flow into the basin, which will maximised pollutant removal opportunities, and reduce the risks of erosion.

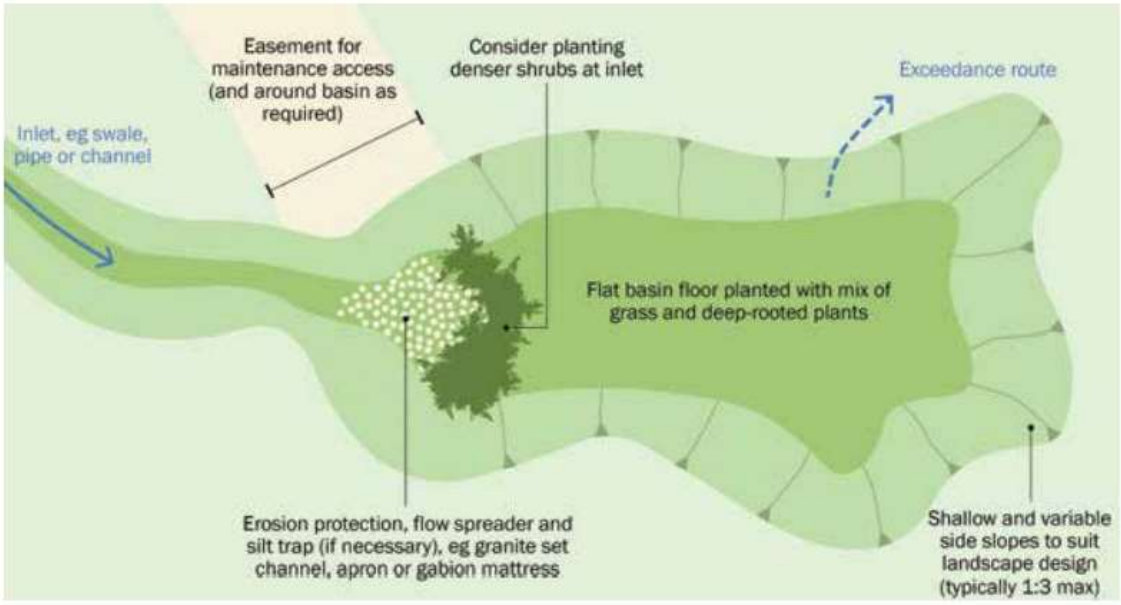
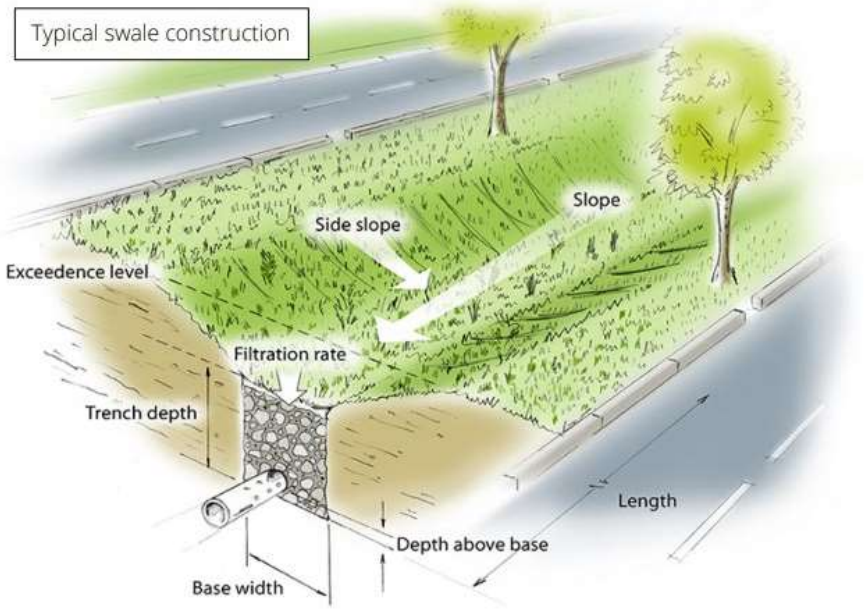


Figure 13.4 of the CIRIA SuDS Manual (C753) (2015)

Swales

Swales are flat bottomed, shallow open channels used to attenuate surface water which work to decrease flow velocity by ponding run-off temporarily. Longitudinal slopes should be between 0.5-6% with a maximum side slope of 1 in 3 (33%) with a depth of 0.4m-0.6m but can be slightly deeper if required. Lined swales are appropriate for areas where infiltration to ground is not possible and/or recommended.



The seasonal high groundwater level should be below the base level of the swale. The treatment process within SuDS features is linked to velocity and retention time of run-off.

Swales can offer primary and secondary treatment stages and can work to reduce sediment loads. As swales retain their vegetative state, the feature is able to remove coarse sediments through groundcover while the underlying soil can help to remove finer particles. The risk of swale erosion can be reduced with the implementation of inlets and flow spreaders (CIRIA, 2015).

The swale may also require a series of check dams to increase its capacity downslope, this should be a consideration of detailed design.

Exceedance Flows

Exceedance flow routes are included within the proposed SuDS drainage layout. Where possible, exceedance flows should be directed away from buildings and into non-essential areas of the Site such as the car park. The SuDS system recommended for the Site should provide enough storage that this method would only be utilized during a worst case scenario.

10 SuDS maintenance

Regular maintenance is essential to ensure effective operation of the SuDS features over the intended lifespan of the proposed development. The SuDS Manual (C753) (CIRIA, 2015) provides a maintenance schedule for SuDS with details of the necessary required actions as shown in the Table below.

Table 13. SuDS operation and recommended maintenance requirements

Asset type	Maintenance schedule (and frequency)
Infiltration basin	Regular maintenance: • Remove sediment and debris from pretreatment and inspection chamber. Clean gutters, filters, downpipes. Trim roots prevent blockages (annually). • Reconstruct/ clean if performance deteriorates, replace clogged geotextile (as required) Monitoring: • Inspect inlets/outlets, silt traps – note rate of accumulation (monthly). • Check water levels and emptying time (annually).
Permeable pavements	Regular maintenance: • Brushing and vacuuming (three times per year). • Trimming any roots and surrounding grass and weeds that may be causing blockages (annually or as required). Monitoring: • Initial inspection (monthly). • Inspect for poor performance and inspection chambers (annually).
Swales	Regular maintenance: • Remove litter and debris from basin (annually). • Trimming any roots and surrounding grass that may be causing blockages (annually or as required). Monitoring: • Inspect inlets, outlets and overflows for blockages (monthly). • Remove and replace mulching (annually). • Inspect and trim nearby trees
Underground drainage pipe network	Regular maintenance: • Remove sediment and debris from pre-treatment devices and floor of inspection tube or chamber (annually).

Asset type	Maintenance schedule (and frequency)
	• Cleaning of gutters and any filters on downpipes (annually). • Trimming any roots that may be causing blockages (annually or as required). Monitoring: • Inspect silt traps and note rate of sediment accumulation (monthly in the first year and then annually).
Rainwater Harvesting	Regular maintenance: • Inspection of tank for debris and sediment build up (annually and following poor performance). • Inspection of inlets, outlets, overflow areas, pumps and filters (annually and following poor performance). • Cleaning of tank, inlets, outlets, gutters, roof drain filters and withdrawal devices (annually or as required). Remedial actions: • Repair or overflow erosion damage or damage to tank and associated components (as required)

Client checklist

A drainage strategy has been recommended as suitable on the basis of the information provided. Prior to installation of the Site drainage system it is recommended that the client carries out the following checks to confirm the development proposals. GeoSmart would be able to support with any updates required to the drainage scheme, please contact us and we would be happy to provide you with a proposal to undertake the work.

Table 14. Potential SuDS limitations

Conditions in Non-Statutory Technical Standards (Defra, 2015), limitations to infiltration SuDS	Do these conditions arise at the Site?
Is the surface runoff greater than the rate at which water can infiltrate into the ground?	
Is there an unacceptable risk of ground instability?	
Is there an unacceptable risk of mobilising contaminants?	
Is there an unacceptable risk of pollution to groundwater?	
Is there an unacceptable risk of groundwater flooding?	
Is the infiltration system going to create a high risk of groundwater leakage to the combined sewer?	

Table 15. SuDS design considerations

Confirm that potential flooding on-Site in excess of the design storm event and exceedance flow routes have been considered.	
Review options for the control of discharge rates (e.g. hydrobrake).	
Confirm the owners/adopters of the drainage system. Consider management options for multiple owners.	
Is there an unacceptable risk of pollution to groundwater?	
Review access and way leave requirements.	
Review maintenance requirements.	

Health and safety considerations for SuDS

GeoSmart reports may include outline strategies or designs to support with development plans. Any drawings or advice provided do not comprise any form of detailed design. Implementation of any conceptual scheme options may constitute 'Construction Work' as defined by CDM Regulations (2015).

The CDM Regulations place specific Health and Safety duties on those commissioning, planning and undertaking construction works. If you are uncertain what this means you should seek the advice of your architect, builder or other competent professional.

GeoSmart does not provide health and safety advisory services but we are required to advise you of your general responsibilities under CDM (visit http://geosmartinfo.co.uk/knowledge-hub/cdm-2015/ for more information).

Please remember that detailed design work should be undertaken by a competent professional who might be your engineer, architect, builder or another competent party.

11 Methodology and limitations of study

This report assesses the feasibility of infiltration SuDS and alternative drainage strategies in support of the Site development process. From April 6th 2015 SuDS are regulated by Local Planning Authorities and will be required under law for major developments in all cases unless demonstrated to be inappropriate. What is considered appropriate in terms of costs and benefits by the Planning Authority will vary depending on local planning policy, and Site setting. The Lead Local Flood Authority will require information as a statutory consultee on major planning applications with surface water drainage implications. The National Planning Policy Framework requires that new developments in areas at risk of flooding should give priority to the use of SuDS and demonstrate that the proposed development does not increase flood risk downstream to third parties.

How was the suitability of SuDS estimated for the Site?

There are a range of SuDS options available to provide effective surface water management that intercept and store excess runoff. When considering these options, the destination of the runoff should be assessed using the order of preference outlined in the Building Regulations Part H document (HM Government, 2010) and Defra's National Standards for SuDS (2015):

1. Discharge to the ground;
2. Discharge to a surface water body;
3. Discharge to a surface water sewer;
4. Discharge to a local highway drain; and
5. Discharge to a combined sewer.

Data sets relating to each of the potential discharge options have been analysed to assess the feasibility of each option according to the hierarchy set out above. Hydrogeological characteristics for the Site are assessed in conjunction with the occurrence of SPZ's to assess infiltration suitability. The Site has been screened to determine whether flood risk from groundwater, surface water, fluvial or coastal sources may constrain SuDS. The distance to surface water bodies and sewers has been reviewed gauge whether these provide alternative options.

GeoSmart SuDS Infiltration Suitability Map (SD50)

The GeoSmart SuDS Infiltration Suitability Map (SD50) screens the suitability for infiltration drainage in different parts of the Site and indicates where further assessment is recommended. In producing the SuDS Infiltration Suitability Map (SD50), GeoSmart used data from the British Geological Survey on groundwater levels, geology and permeability to screen

for areas where infiltration SuDS may be suitable. The map classifies areas into 3 categories of High, Medium and Low suitability for infiltration SuDS. This can then be used in conjunction with additional data on Site constraints to give recommendations for SuDS design and further investigation.

The primary constraint on infiltration potential is the minimum permeability of the underlying material and in some cases the range in permeability may be considerable, ranging down to low. The map classifies these areas as moderate infiltration suitability requiring further investigation. In cases where the thickness of the receiving permeable horizon is less than 1.5 meters then additional Site investigation is recommended. If the Site is at risk of groundwater flooding for up to the 1% annual occurrence the map classifies these areas as moderate infiltration suitability requiring further investigation.

The GeoSmart SuDS Infiltration Suitability Map (SD50) is a national screening tool for infiltration SuDS techniques but a Site specific assessment should be used before final detailed design is undertaken. Further information on the GeoSmart SuDS Infiltration Suitability Map (SD50) is available at geosmartinfo.co.uk

How is the suitability to discharge to sewers and watercourses calculated?

The suitability to discharge to discharge to sewers and watercourses has been calculated using the distance from the Site to both. For example, where the Site is within 50m of a surface water body. Discharge to surface water is potentially appropriate subject to land access arrangements and a feasibility assessment. Where the Site is within 50m of a sewer, discharge to sewer is potentially appropriate subject to land access arrangements and a feasibility assessment. The utility company should be contacted to agree connection feasibility and sewer capacity.

Further information relating to sewers available in the area can be found in Appendix C.

What is a Source Protection Zone?

The Environment Agency have defined Source Protection Zones (SPZs) for 2000 groundwater sources such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater the risk. The maps show three main zones (inner, outer and total catchment) and a fourth zone of special interest, which is occasionally applied. The zones are used to set up pollution prevention measures in areas which are at a higher risk. The shape and size of a zone depends on the condition of the ground, how the groundwater is removed, and other environmental factors. Inner zone (Zone 1) is defined as the 50 day travel time from any point below the water table to the source (minimum radius of 50 metres). Outer zone (Zone 2) is defined by a 400 day travel time. Total catchment (Zone 3) is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

GeoSmart Information

How was surface water runoff estimated from the Site?

In accordance with The SuDS Manual (C753) (CIRIA, 2015), the Greenfield runoff from the Site has been calculated using the IoH124 method and is assumed representative of the runoff generated on the undeveloped surfaces that are affected by the proposed development. The method used for calculating the runoff complies with the NPPF (MHCLG, 2019). For the impermeable surfaces, it has been assumed that 100% runoff will occur (calculations provided in Appendix B). Rainfall data is derived from the Flood Estimation Handbook (FEH), developed by NERC (2009). Only areas affected by the proposed development are considered in the flow and volume calculations. Permeable areas that remain unchanged are not included in the calculations as it is assumed these will not be actively drained and attenuated.

What is the peak discharge rate?

An estimation of peak runoff flow rate and volume is required to calculate infiltration, storage and discharge requirements. The peak discharge rate is the maximum flow rate at which surface water runoff leaves the Site during a particular storm event, without considering the impact of any mitigation such as storage, infiltration or flow control. Proposed discharge rates (with mitigation) should be no greater than existing rates for all corresponding storm events. If all drainage is to infiltration there will be no discharge off-Site. Discharging all flow from Site at the existing 1 in 100 event would increase flood risk during smaller events. Flow restriction is generally required to limit the final discharge from Site during all events as a basic minimum to the green field QBAR rate. A more complex flow restriction which varies the final discharge rate from the Site depending on the storm event will reduce the volume of storage required on-Site. Drainage to infiltration SuDS is subtracted from the total discharge off-Site to achieve a beneficial net affect.

What is the total discharge volume?

The total discharge volume is calculated on the basis of the surface water runoff that has the potential to leave the Site as a result of the assumed 6 hour duration design storm event. The runoff is related to the underlying soil conditions, impermeable cover, rainfall intensity and duration of the storm event. The total volume generated by the current Site is compared to the potential total volume from the developed Site (not taking into consideration any mitigation). The difference provides the minimum total volume that will need to be stored and infiltrated on-Site or released at a controlled rate. Guidance indicates that the total discharge volume should never exceed the runoff volume from the development Site prior to redevelopment for that event and should be as close as is reasonably practicable to the Greenfield runoff volume.