the Kent design guide

making it happen – sustainability

(drainage systems)

Kent County Council
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Sustainable drainage - Making it Happen

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Terminology

Adopting authority – general term utilized in this guidance and relates to the authority that will ultimately manage the proposed drainage system and may be either:

Highway Authority – body responsible for the management and maintenance of public roads i.e. Kent County Council within Kent

Sewerage undertaker – water and sewerage service providers e.g. Southern Water or Thames Water, who operate under the provisions of the Water Industry Act 2003

Lead Local Flood Authority (LLFA) – under the terms of the Flood and Water Management Act 2010, LLFAs are responsible for developing, maintaining and applying a strategy for local flood risk management in their areas and for maintaining a register of flood risk assets. They also have lead responsibility for managing the risk of flooding from surface water, groundwater and ordinary watercourses. Kent County Council are the LLFA within Kent.

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Overview

This part of the sustainability section gives advice and guidance on the design and implementation of surface water drainage systems, including Sustainable Drainage Systems.

Kent County Council has statutory duties as both the Highway Authority and the Lead Local Flood Authority. As Highway Authority, Kent County Council may adopt drainage systems associated with highway drainage whilst as Lead Local Flood Authority, Kent County Council will be consulted on major development proposals in relation to local flood risk.

This document summarises:

- *Kent County Council's approach to drainage approval and adoption of drainage systems by Kent County Council, specifically those associated with highways; and,*
- *Kent County Council's requirements in how to approach drainage provision within new development.*

This guidance encapsulates the principles presented in the Non-Statutory Technical Standards for Sustainable Drainage, produced and issued by Government in 2015 and is further supported by KCC policy as defined in KCC's Drainage and Planning Policy Statement.

This document will be made available in alternative formats on request.

Chapter 1

INTRODUCTION

The extensive flooding that affected much of England in the summer of 2007 highlighted the unsustainable nature of traditional undergrounded drainage systems. With a changing climate and a growing population, it is becoming increasingly clear that draining developed areas through a 'traditional' piped system can have serious consequences and should be avoided wherever possible in the future. Sustainable Drainage Systems (SuDS) offer a sustainable alternative for controlling surface water runoff.

This was recognized in the Pitt Review: *'Lessons Learnt from the 2007 Floods'* which included a series of recommendations for improving flood risk management in England. Some of these recommendations led to the Flood and Water Management Act 2010.

This document should be used to assist in the preparation of drainage design for any new development in Kent. It sets out the procedures relating to the design and subsequent adoption of both SuDS and more traditional positive drainage systems and outlines the specific requirements of Kent County Council in their role as Highways Authority and LLFA.

Surface water management

Surface water runoff from both roofs and from impermeable paved surfaces is typically collected in a traditional piped drainage system. This water is then conveyed at a high velocity to a local watercourse where it discharges over a short period of time. This creates a 'surge' of water within the watercourse and these surges become more significant with continuing development and the associated increase in roofs and hard-paved areas. These larger surges can greatly exacerbate the localised risk of flooding from the receiving watercourse.

SuDS systems seek to mimic the natural environment and aim to discharge the surface water runoff from developments to receiving watercourses over a much longer period of time and at a much lower rate than from a traditional piped network, thereby reducing the risk of unnatural surges experienced from piped systems.

SuDS systems also protect or enhance river and groundwater quality and can provide a habitat for wildlife.

SuDS are therefore the preferred approach to managing rainfall from hard surfaces, especially as they can be used anywhere; it is just a case of choosing the right feature for the site.

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Determining the drainage solution

For approval, you must assess the site to determine a suitable drainage design early in the outline design process. The proposals should consider SuDS techniques which will retain surface water within the site and reduce the risk and impact of flooding during severe storms. It is especially important to identify and consider constraints which may affect the manner in which drainage is provided on site.

A whole-site proposal should be considered and early consultation with Kent County Council is recommended. Early discussions should also include the Local Planning Authority, the Environment Agency and any other relevant parties at an early stage, before submission of any planning application and/or drainage application.

It is essential that the drainage scheme proposed:

- Protects people and property and highway on the development site from flooding; and,
- Does not exacerbate flood risk outside of the development in any part of the catchment, either upstream or downstream.

Chapter 2

SUSTAINABLE DRAINAGE SYSTEMS (SUDs)

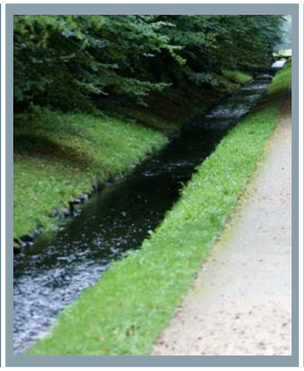
Sustainable drainage systems (SuDS) should mimic the natural surface water runoff processes at the site prior to development. This is achieved most effectively when a series of SuDS techniques are applied progressively as part of an interconnected system, referred to as a 'management train' or 'treatment train'.

The techniques that comprise the management train are prevention (preventing runoff by reducing impermeable areas), source control, site control and regional control. The application of these techniques allows for several stages at which the water can be treated and allowed to infiltrate into the ground.

Runoff does not need to pass through all stages of the train and it is usually best to deal with runoff locally as close to the source as possible. Water should only be conveyed elsewhere if it cannot be at source.

SuDS techniques include:

SOURCE CONTROL	AREA CONTROL	REGIONAL CONTROL
• Permeable pavements • Bioretention areas • Geocellular/modular systems • Trench soakaways	• Filter strips • Swales • Filter drains • Ring soakaway & Deep bore soakaway	• Ponds • Wetlands • Infiltration basins • Ciria SuDS Manual, C753, 2015



An overview of these features setting out where they are suitable for use and what their advantages and disadvantages are can be found on the following pages.

The technical specifications for drainage measures are included in the Appendices. Such measures include ring soakaways, deep bore soakaways, filter drains, filter strips, swales, trench soakaways, bioretention area, permeable pavements, geocellular systems and headwalls and outfalls.
An additional appendix is included for pipe design.

As the design of Ponds and of Wetlands is tailored to each individual site, no specifications are included within this guide. Developers wishing to make use of these measures must discuss specific proposals with the Local Planning Authority and Lead Local Flood Authority as early as possible in the design process.

Other widely available guidance is available for planning and design of sustainable drainage measures. It is recommended that the reader refers to the following for greater detail and support of this guidance:

- *Code of practice for surface water management for development sites, BS 8582:2013.*
- *Designing for exceedance in urban drainage – good practice, Ciria C635, 2006.*
- *Drainage of development sites – a guide, Ciria X108, 2004.*
- *Infiltration Drainage – manual of good practice, Ciria Report 156, 1996.*
- *National Planning Policy Framework (NPPF) and its associated Technical Guidance*
- *Site handbook for the construction of SuDS, Ciria C698, 2007.*
- *Soakaway design: Building Research Establishment (BRE) Digest 365, 1991.*
- *SuDS Manual, Ciria C753, 2015.*

Drainage element	Drainage element	Advantages	Disadvantages	Refer to Appendix
Ring soakaway	• Shallow sub-surface concrete structure to store water and promote the infiltration of surface water to ground.	• Conventional system	• Discharges may be closer to aquifer • Limited silt/ contaminant control	A
Deep bore soakaway	• Deep sub-surface structure to promote the infiltration of surface water to ground where near surface soils unsuitable	• Conventional system • Soils at greater depths may show better infiltration	• Deeper discharges inevitably closer to aquifer (EA prefer shallow soakage) • Limited silt/ contaminant control	B
Filter drains	• Linear drains consisting of trenches filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage (store/ conduct water)	• Storage below • Conventional system	• For storage not soakage • Overflow provision required • Stone scatter	C
Filter strips	• Vegetated areas of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.	• Sediment control • Some chemical de-contamination	• Soft verges and vehicular parking • Landtake • Unsightly sediment collection	D

Drainage element	Drainage element	Advantages	Disadvantages	Refer to Appendix
Swales	• Shallow vegetated channels that conduct and retain water and may also permit infiltration. The vegetation acts to filter particulate matter	• Sediment control • Some chemical de-contamination • Habitat provision • Added aesthetic value	• Litter and obstructions to flow • Unsightly sediment collection • Water access to subgrade/service trenches	E
Trench soakaways	• Linear trenches filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to promote infiltration of surface water	• Land strips available in highway verges • EA prefer near surface soakage	• Shallow soakage in variable surface deposits • Stone scatter • Interaction with service trenches	F
Bioretention areas	• Shallow landscaped depressions designed to control frequent rainfall events and provide water quality treatment through filtration and vegetation.	• Flexibility of design • Can be included within landscape features • Habitat provision	• Requires landscaping management • Not appropriate for steep slopes • Litter and obstructions to flow	G
Permeable surfaces	• Surfaces that allow inflow of rainwater into the underlying construction or soil.	• Contamination control • No additional landtake	• Difficult to inspect/maintain system • Risk of Softening subgrade • Risk of water flows via services	H

Drainage element	Drainage element	Advantages	Disadvantages	Refer to Appendix
Geocellular storage systems	• Shallow sub-surface plastic structure to store water; and promote the infiltration of surface water to ground.	• Large void space • Ease of placement • Can be used in trenches and wide areas • EA prefer near surface soakage	• Shallow soakage in variable surface soils • Difficulty in repairing if damaged • Design/ Construction details important	I
Ponds	• Areas that may be utilised for surface runoff storage including vegetated areas designed to collect and treat water before discharge via a piped system or infiltration to the ground.	• Sediment control • Some chemical de-contamination • Large capacity • Aesthetic features • Habitat provision	• Landtake • Sideslope stability • Vegetation control • Access to discharge provision • Access controls for safety	• Requires consultation with KCC, including biodiversity requirements.
Wetland Areas	• Shallow pond or marshy areas, supporting aquatic vegetation and detaining surface water for extended period.	• Ecological benefit • Water quality treatment capacity	• High land take • Requires baseflow • Minimal volume reduction	• Requires consultation with KCC, including biodiversity requirements.
Infiltration basins	• Sub-surface structure to promote the infiltration of surface water to ground.	• Sediment control • Some chemical de-contamination • Large capacity • Some infiltration	• Suitability of soils for infiltration • Landtake • Sideslope stability • Vegetation control • Access controls for safety	• Requires consultation with KCC.

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Chapter 3

PLANNING FOR SUDS

To ensure effective, beneficial drainage measures are successfully utilised, SuDS must be considered at the masterplanning stage of a development. A development masterplan is a strategic planning document which should show how the various elements of the development are to be fitted into the site layout. There are three key land use components that must be considered during the masterplanning stage: buildings and built form; the street network; and open spaces and landscape areas. The SuDS features which are best for each of these components should be considered from the outset.

Identifying the SuDS features which are most appropriate for the characteristics of the site will ensure that not only will the development priorities be achieved but that an integrated, efficient and cost-effective drainage strategy can be implemented. Consideration at the masterplanning stage is especially important for larger projects, where it is intended the development be split into a number of zones which will be constructed at different times and, potentially by different developers (i.e. 'phased' development).

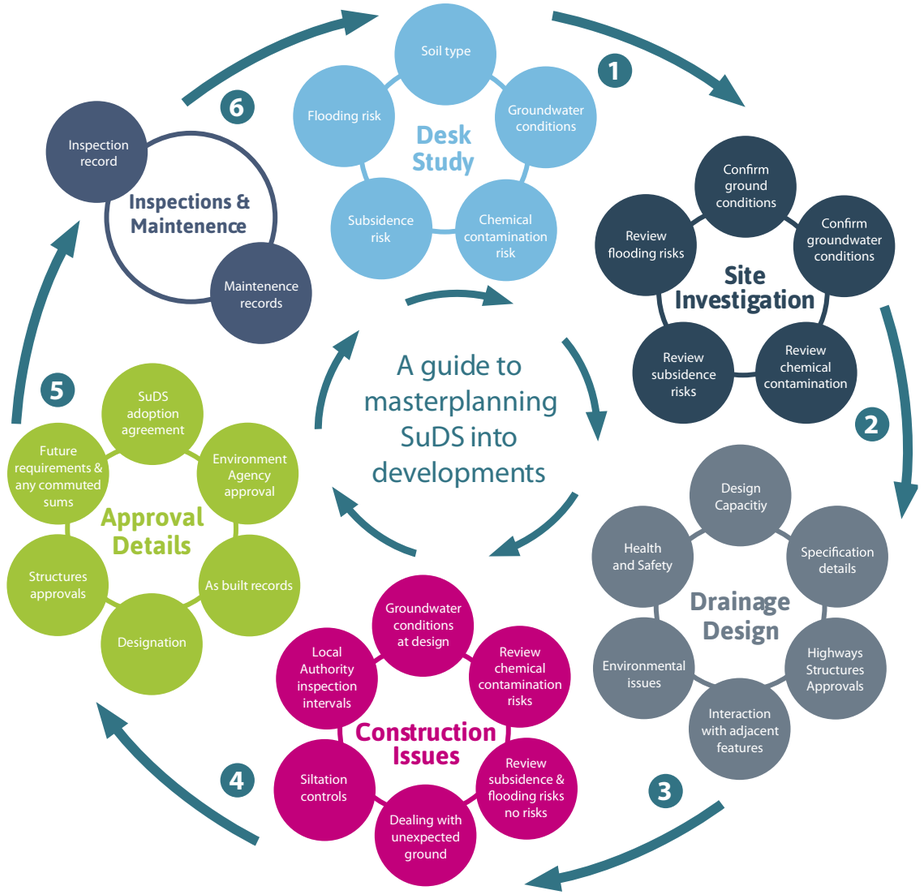
Further details on the key tasks that should be undertaken to develop conceptual SuDS designs at each stage of the masterplanning process can be found in the regional SuDS guidance for the South East:

Water I People I Places

A guide to masterplanning SuDS into developments.

Conceptual design then follows. A drainage strategy is developed through a process described in the following flow chart, following through: **Step 1:** Desk Study, **Step 2:** Site Investigation, **Step 3:** Drainage Design, **Step 4:** Construction Issues, **Step 5:** Approval Details and **Step 6:** Inspections and Maintenance.

It is expected that any drainage proposal submitted to Kent County Council for approval and adoption will include the identification, management, control and mitigation of risks through planning and would follow this detailed design process.



Drainage principles

A drainage system must be designed so that:

(a) impermeable areas are kept to a minimum;

(b) surface runoff is managed at its source, where practicable;

(c) surface runoff is managed on the surface, where practicable;

(d) public space is used and integrated with the drainage system, where it serves more than one property;

(e) design is cost-effective to operate and maintain over the design life of the development,

(f) design of the drainage system accounts for the likely impacts of: climate change and changes in impermeable area, over the design life of the development;

(g) the system is designed to have minimal on/offsite impact if the system's capacity is exceeded during extreme weather events; and,

(h) there is proper access for the maintenance of all elements of the system.

We also require that the surface water strategy for a new development should mimic, wherever possible, the natural existing runoff conditions and utilise, wherever feasible, the existing drainage channels and surface water pathways. Drainage measures should be at the surface where possible.

Discharge location

The drainage system must follow the drainage hierarchy of Building Regulations 2000 in H3: Rainwater Drainage, which states that rainwater shall be discharged to one of the following, listed in order of priority:

(a) an adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,

(b) a watercourse; or, where that is not reasonably practicable,

(c) a sewer.

With respect to the outfall or discharge location:

Any discharge or connection to the existing highway drainage system will require approval of the Highway Authority.

- Where it is proposed to outfall into a main river or where a main river is affected by the development proposals, it will be necessary to consult the Environment Agency for outline and detailed approval and agreement of discharge rates.
- Where it is proposed to utilise soakaways or infiltration trenches it will be necessary to provide geotechnical data i.e soil types and soakage tests and to consult the Environment Agency on any design restriction that may be imposed and obtain drainage consent.
- Where it is proposed to connect to an existing or proposed public sewer the consent of the appropriate adopting authority will be required.

We will require evidence that discussions with the appropriate consenting authority have commenced when we are reviewing the drainage strategy.

If the system is proposed for adoption by Kent County Council, approval to connect or discharge to another system will be required prior to approving the drainage design.

Drainage plans

Information of the local drainage system should be sought prior to any development.

Public sewer records can be requested but other asset mapping for highway drainage may be incomplete.

The County Council are under no statutory obligation to hold records of the highway drainage infrastructure. The information that we do have is largely historic.

Where more recent surveys have been completed for the purpose of highway drainage investigations, renewals and improvements, the findings are routinely recorded in the form of a sketch map which does not necessarily include invert depths or an accurate scale. Whilst these records meet with our requirements as the Highway Authority, they should not be used to inform third party designs or decisions.

A copy of any information we hold can be provided by contacting the "Highway Drainage Asset Team, Ashford Highway Depot, Javelin Way, Henwood, Ashford, Kent, TN24 8AD"enclosing a cheque made payable to Kent County Council for the sum of £90.00.

If development is planned that may impact upon or be affected by the highway drainage system, we would always recommend that a full drainage survey is carried out to inform design and construction.

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Ditches and watercourses

Ditches and watercourses comprise a substantial portion of Kent's drainage network. Different authorities have duties and responsibilities in relation to the designation these watercourses:

Major watercourses and rivers are designated as main rivers and are under the control of the Environment Agency.

All other watercourses, including streams, ditches (whether dry or not), culverts, drains, are defined as ordinary watercourses. These watercourses are overseen by either Kent County Council, the appropriate Internal Drainage Board (IDB) or local authority.

Approval and consents are required for certain works in watercourses under the Land Drainage Act 1991 and the Public Health Act 1936 (section 263), whether it is main river or ordinary watercourse.

More information can be found at http://www.kent.gov.uk/waste-planning-and-land/flooding-and-drainage/land-drainage-consent

Kent County Council generally opposes culverting of watercourses. Piecemeal losses of watercourses can create wider cumulative impacts on the water environment, including flooding, ecology, channel form, flow regime and chemistry.

If roads or footpaths are to cross a watercourse and cannot be avoided, the size of the bridge or culvert and construction details must be agreed with the appropriate authority managing the ordinary watercourse. If you are considering any development involving highway structures you must discuss the proposals with Kent County Council Highways.

If discharge of surface water is proposed into an existing watercourse, it is recommended that a condition survey of the receiving watercourse be undertaken to assess connectivity, capacity and maintenance needs. A consent may also be required and additional improvements undertaken to enable the watercourse to deal with any increased flow or to provide storage to control the rate of flow from the site.

Connections to sewers and drains

Before entering or breaking into an existing sewer or drain, notice must be given to the adopting authority responsible for the pipe to which the connection is to be made. Permission for the connection must be obtained from the relevant authority and any fees required must be paid.

To an existing public sewer system

A new surface water system may be connected to an existing surface water or to a combined public sewer or a sewer that is the subject of a Section 104 Agreement under the Water Industry Act 1991.

Any such agreement is subject to the approval of the adopting authority who will need to confirm the location of the connection and may wish to make the connection to the existing public sewer.

An existing highway drain

The highway drainage system is designed with the sole purpose of draining surface water from the highway.

A new surface water system, if serving the highway, may also be connected to an existing highway drain, subject to Kent County Council's approval.

With regards to new highway drainage connections, permission will only be granted if it can be demonstrated that there is no other practicable drainage solution. In these instances, it must also be demonstrated to the County Council's reasonable satisfaction that:

(a) there are no existing defects or blockages

(b) once the new connection is in place, there will be sufficient capacity in the drainage system to accommodate a 1 in 30-year storm without flooding. An additional 20% climate change is required for the 1 in 100 year storm and an additional 40% should be assessed. Some flooding may occur in this event subject to the approval of KCC.

Where (b) is not the case, permission will only be granted if the developer commits to upgrade the drainage system to the outfall point to ensure that this standard is met.

It should be noted that the County Council cannot commit to any ongoing maintenance over and above our statutory duty.

Connection will only be permitted where it can also be demonstrated that no increase of flood risk or drainage problems will be experienced within the system, whether downstream or upstream due to the additional surface water contribution.

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In all cases, existing sewers or drains must be properly extended, connected and jointed to new sewers, drains or chambers in accordance with Specification for Highway Works, Volume 1, Drainage and Service Ducts, Clause 560.

Where a new highway drainage system is connected to an existing piped system a temporary catchpit is required while the site is being developed. The temporary catchpit must be removed on completion of all works and the chamber to be made good with the necessary channels and benching.

To an existing private sewer or drain

A new surface water system may also be connected to an existing private sewer or drain. Connection will only be permitted where it can be demonstrated that:

- permission has been granted by the pipe's owner or owners to connect into the pipe; and
- calculations which demonstrate that the entire system, right down to its point of discharge, can safely accept the proposed flow in addition to the existing flow.

In some cases reinstatement of land drains may be required, but where they are to be connected to a sewer, a catchpit must be provided before the connection. The catchpit must have a silt trap 600mm below the lowest pipe invert. In the case of all other drains they must be connected in such a way that normal access for rodding and maintenance is achieved.

The removal of detritus from chambers, repairs to defects or re-cleaning of the whole or part of a section will be requested by us as additional works where necessary.

Designation

Drainage features may be specially designated under different authorities:

Critical structure in relation to type of construction

Special engineering difficulty (SED) designation can apply through the New Roads and Street Works Act 1991. Designation will reduce the risk that future services will damage any drainage feature within the highway but emergency powers for the Statutory Undertakers mean that this can be overlooked. The need for SED status and the implications of it being ignored need to be assessed.

Critical structure in relation to flood risk

Designation under Flood and Water Management Act 2010 section 10 may occur if the structure is critical to flood risk and is not adopted by Kent County Council or another Flood Risk Management Authority.

Critical structure due to size or proximity to the highway

A highway structure is any bridge, subway, culvert, pipe, tunnel, manhole, chamber, wall, reinforced soil embankment, piece of street furniture, building or other structure built in, over, under or adjacent to any part of a highway maintainable at public expense which materially affects the support of that highway and/or the safety of the travelling public.

Technical Approval Procedures apply to those structures as defined In accordance with the Design Manual for Roads and Bridges Part 1, BD2/12, Technical Approval of Highway Structures.

Other regulatory considerations

Approval for SuDS solutions or techniques will need to include the following:

correspondence – correspondence from other relevant authorities such as the Environment Agency to support the approval process;

access arrangements – details of gates, barriers, fences, padlocks, keys etc. for access and information pertaining to easements and agreements for access;

maintenance – assessment of the future regular maintenance liability made from published guidance, case histories, manufacturers guidance, ongoing research etc. The maintenance assessment will need to include easements, maintenance of any barriers and fencing, and maintenance of access routes; and

commuted sums – commuted sums will principally be linked to any measures which constitute part of the highway.

Final considerations for SUDs selection

Other matters related to the design of the surface water drainage system may have planning implications and must be discussed with the relevant planning authority, and resolved prior to submission for Highways adoption.

Features of sustainable drainage measures which need to be considered within design include:

- health and safety aspects of swales and of open waters;
- biodiversity aspects in relation to vegetation;
- landscape management; and,
- open space requirements.

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Chapter 4

DESIGN, SUBMISSION AND EVALUATION PROCESS

The evolution of sustainable drainage design will run in parallel with the planning process for any development site. The development layout, urban design approach, landscape provisions and open space allocations have direct impacts on the approach to surface water drainage.

It is anticipated that drainage design comprised three stages:

- **Conceptual drainage design**
- **Outline drainage proposals**
- **Detailed drainage design**

Conceptual drainage design

Conceptual drainage design is undertaken within preliminary planning phase for any site and should be tied to pre-application discussions with the Local Planning Authority, Highways Authority and the Lead Local Flood Authority.

It cannot be sufficiently emphasized the importance of pre-application discussions prior to any planning submission.

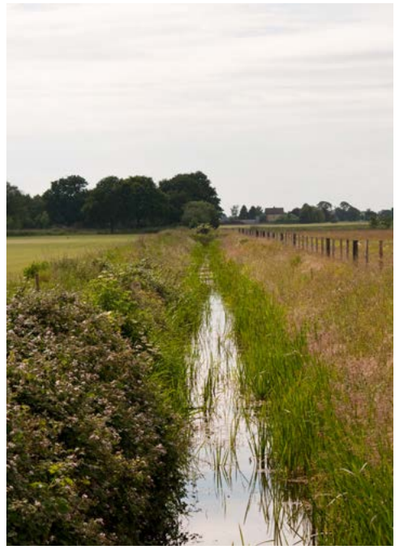
Early discussions have the potential to reduce unnecessary design and may identify other potential drainage solutions. Early discussions may also identify the extent of any adoption by Kent County Council.

At this stage, other parties which may have an involvement with the delivery of the drainage scheme should be consulted to assess any constraints. This may include sewerage undertaker, Internal Drainage Board or third party property owner.

Outline drainage proposals

For larger development proposals, an outline drainage strategy will be required to be submitted alongside any planning application, and fully described in KCC's Drainage and Planning Policy Statement.

This drainage strategy will need to be supported by appropriate information including but not limited to:



- Drainage system schematic with identification of main sustainable drainage measures
- Design calculations for peak flow, volume control and greenfield runoff, and/or brownfield runoff where appropriate, including allowances
- Impermeable and permeable areas
- Discharge location(s)
- Infiltration capacity
- Location of any ground investigations
- Topographical survey of the site
- Details of any adjacent water course
- Areas of flood risk
- Quantification of any surface water flows on-site from off-site locations
- Exceedance routes
- Offsite works
- Any constraints which affect the proposed development
- Locations of sensitive receptors, including groundwater protection zones, habitat designations or archaeological features
- Temporary drainage during construction
- Proposed extent of adoption
- Phasing
- Correspondence from any receiving authority or permitting authority

Detailed drainage proposals

Detailed drainage proposals may be submitted with a planning application but may also be subject to planning conditions for approval later in the development process.

The requirements for detailed drainage design are discussed in the following chapters specifically for any systems which may be proposed for adoption by Kent County Council.

Kent County Council will also refer to these requirements if consulted on drainage submissions by a Local Planning Authority.

Evaluation

Kent County Council as Lead Local Flood Authority and a statutory consultee of the planning process will evaluate major drainage scheme proposals. This evaluation is undertaken in relation to national policy as specified through **National Planning Policy Framework**[2] and **supported by the Non-Statutory Technical Standards for Sustainable Drainage**[3]**.**

The Non-statutory Technical Standards focus on the engineering design aspects of sustainable drainage provision to control surface water flows whilst the National Planning Policy Framework considers wider flood risk management, priority to the use of sustainable drainage as well as contributing and enhancing the natural and local environment.

If Kent County Council, as Highway Authority, is intending to adopt any or all of the drainage system, the evaluation as adopting authority will be more intensive. Matters which will need to be addressed in any design proposed for adoption are discussed in the chapter relating to "Design Considerations".

[2]National Planning Policy Framework paragraph 100, 103 and 109.

[3]The Non-Statutory Technical Standard for Sustainable Drainage are defined operational standards as referenced in NPPF paragraph 165.

Chapter 5

SUMMARY OF DRAINAGE STRATEGY REQUIREMENTS

A drainage strategy must include information supporting the selection of specific drainage measures, design arrangements with design calculations and construction aspects. The requirements are summarized below:

A. GROUND RELATED INFORMATION

Ground related information must include the following;

Site investigation data – adequate site investigation trial holes must be undertaken to supplement earlier desk study information. This is particularly important for near surface SuDS applications because of the likely variability of near surface soils. Particle size distribution tests are required to review the design of geotextile filter fabrics in addition to being helpful in general classification of the soils;

Soakage testing – adequate numbers of soakage tests will be required at appropriate depths and locations;

Risk assessment – near surface soil variability is common in Kent and the design submission must assess the ground related risks. This should include risks of washout/piping, subgrade softening, activation of solution features, collapse settlement, slope instability, impact on adjacent features; possible damage by future Statutory Undertakers' Plant excavations, chemical contamination and flooding.

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B. DRAINAGE DESIGN

Design calculations must include the following;

Catchment area – this will need to consider flows within defined catchments and may need to consider overflows from adjacent catchments;

Interaction with adjacent infiltration systems – reduced infiltration rates will need to consider interaction between adjacent systems;

System capacity – calculations will need to demonstrate that adequate capacity is available to cater for a 1 in 30 year storm return period with flows controlled on site for the critical, climate change adjusted 1 in 100 year storm return period with climate change allowance;

Overflow provision/design life/additional areas for replacement systems – the need for an overflow into additional infiltration systems, storage systems and/or positive outfalls must be based on the effects of more intense storm return periods than the minimum requirements for design; and

Design life of the proposed SuDS system – will need to be stated for specific elements and the difficulty in replacement may also require other areas of the site to be identified as areas where replacement systems can be installed.

C. CONSTRUCTION CONSIDERATIONS

Design must allow for construction phase implications including:

Monitoring systems – outline details of inspection access points that will be installed to allow inspection and maintenance of the SuDS once installed;

Risk minimization – proposals to minimise the risk of silt migration into SUDS during the construction phase; and

Temporary drainage proposals – outline details including use of the permanent SuDS.

D. OTHER APPROVAL DETAILS

The design must reflect any additional regulatory requirements.

The level of detail required to support any application for approval is dependent upon the complexity of the drainage scheme proposed. Items for consideration within a drainage application submission are shown on the following checklist. This list is not exhaustive.

Further detail is provided in the following chapters.

Approval checklist for consideration with detailed design

A. GROUND RELATED INFORMATION

DESK STUDY INFORMATION	
Topographical survey *	Aerial photographs
Ordnance survey maps	Environment Agency records
BGS Geological maps	Flood history
BGS borehole database	Flood risk zone
Wells records	Chelsea Speleological Society records
Landfill locations	Previous site investigation data
Infiltration strata	Aquifer protection maps
	Source protection zone

SITE INVESTIGATION	
Infiltration rate *	Engineering soil description
Testing methodology	Chemical contamination risk
Depth to groundwater	Identification of ground risks
Photographic evidence	Offset probes

*Indicates minimum requirements for a drainage strategy

B. DRAINAGE DESIGN

Location plan*	Site plan*
Discharge destination*	Highway Structure definition
Catchment area & sub-catchments	Number of measures
Pervious & impervious areas*	Drainage system design*, including • Development layout • Capacity and volume • Inverts and depth of cover • Depths • Unsaturated zone
Infiltration rate utilized in design	Pre-treatment • Oil/water separator • Sediment control devices
Infiltrating strata	Consideration of first flush
Hydraulic calculations*, including: • Pre & Post development flows • Range of storm events • Climate change incorporated • Draw-down time • Hydraulic control • Appropriate factor of safety • Computer modelling output	Separation distances • Adjacent structures • Highway carriageway • Services & other utilities • Other infiltration measures
Flood risk areas*	Design life of proposed system
Overland flow pathways	Any easement or rights of way
Points of exceedance	Maintenance plan
Inspection well or chamber(s)	
Maintenance access	
Plans and construction drawings*	

C. CONSTRUCTION ISSUES

DESK STUDY INFORMATION	
Inspection records	Photographic evidence
Construction testing	As-built drawings & drainage schedules
Sediment control	

D. OTHER APPROVAL DETAILS

DESK STUDY INFORMATION	
Evidence of any consenting requirements • EA consent • IDB consent • Sewerage undertaker consent • Land drainage consent	SED designation
	FWMA designation
	Structural approval
	Biodiversity plan
	Landscape plan

*Indicates minimum requirements for a drainage strategy

Chapter 6

GROUND RELATED INFORMATION

The desk study involves gathering as much relevant geo-environmental/geo-technical information about the site and its vicinity from publicly available sources and any previous studies (along with a site reconnaissance visit or walkover survey).

The desk study should begin to address questions including, but not limited to, the following:

- Are the characteristics and properties of the ground and geology at the site (principally the infiltration rate) likely to be such that infiltration drainage systems are feasible?
- Has the likelihood and risks of near surface variability in relation to ground conditions been assessed?
- Is there likely to be sufficient unsaturated ground above the groundwater, or might high groundwater levels at the site constrain the feasibility of some or all potential infiltration drainage systems?
- Does the site lie wholly or partly within one of the Environment Agency's Groundwater Protection Zones?
- Are there likely to be existing contaminants present in the ground (or groundwater) that might be mobilised by infiltrating drainage and hence pose a risk to controlled waters?
- Are the ground conditions such that drainage measures might cause softening, collapse or other forms of instability, including solution features, manmade caves, dene holes and washouts?
- Are there likely to be ground hazards, including made ground or contamination, present that might pose a risk to the successful construction and operation of the proposed drainage systems, to the proposed development and its users, or to the wider environment?

Site setting

A detailed description of the site includes:

- Topography
- Ground cover (permeable/impermeable)
- Existing drainage infrastructure on/near the site
- Details of known buried or overhead services (i.e. that may place constraints on subsequent site investigation)

Site history

A summary of the history of land use at the site should be provided to identify potential previous contaminative land uses, possible changes to the landscape/landform that may indicate made ground etc.

Reconnaissance site visit and walkover survey

A reconnaissance site visit or walkover survey should be conducted during the preparation of the desk study. This should include a visual inspection for the site for any evidence that may contribute to the sections described below. Key observations may be presented as a summary of field notes on the desk study report and may be augmented with photographs.

Geological setting

Information must be provided for the geological setting which:

- Defines known geological units (composition, thicknesses/depths) especially relative proportion of grain sizes, lateral consistency, fissures/fractures
- Evidences possible local variations e.g. made ground and/or contaminative land use etc.
- Identifies faults and other relevant structural geology.

Hydrogeological setting

Hydrogeological setting includes:

- EA aquifer classifications of known units, description as confined or unconfined, water strata
- Springs or artesian wells
- Groundwater levels
- Tidal influence
- Likely flow mechanism e.g. porous flow or fracture flow
- Abstractions or discharges from/to groundwater in the vicinity

It is recommended that reference be made to the River Basin District Management Plan (RBDMP) and to the relevant Catchment Abstraction Management Strategy (CAMS) for contextual information on the water resources management strategy/policy for the wider area of the proposed development.

If the site lies wholly or partly within a source protection zone, consultation with the Environment Agency would be required.

Surface water setting

Surface water setting includes:

- Identification and description of the surface water features in the vicinity of the site including identification of the river catchment(s) the site is within. This includes lakes, ponds, sea, estuaries, rivers, streams, wetlands, springs, drains, ditches, culverts, canals and harbours.
- Information on freshwater bodies including details, where known, of their dimensions, water depth and direction of flow
- Details of any licensed abstractions/discharges from/to nearby surface water features (can be obtained from the EA or appropriate IDBs)
- Details of any environmentally sensitive receptors identified in the surface water environment (e.g. wetlands classified SSSI)
- Identification of any off-site flows and/or overland flow paths which may cross the site.

Suitability for infiltration

The infiltration rate depends on the ability of the surrounding soil to absorb water; therefore, the more open the structure the greater the infiltration rate. There are only a few types of suitable strata into which deeper infiltration measures can be readily installed.

Deeper infiltration systems have been predominantly used in chalk and the Hythe Formation[4] throughout North and Central Kent. It is recognized that:

The soakage rate depends upon the frequency of the fissures and their degree of openness. In the case of chalk, zones of poor quality often have narrow spacings and wide gaps for the fissures which offers very good soakage qualities. The Middle Chalk and more notably in the Lower Chalk in Kent have significantly reduced permeabilities.

In the south of Kent the Lower Tunbridge Wells Sand tends to be fissured and has on occasion been used for soakaways; however, the silty nature of the deposit often makes it easily eroded and could lead to surface collapse particularly where open fissures are encountered at depth.

Zones of enhanced permeability may also be encountered adjacent to solution features in chalk, man-made underground chalk workings, gulls in cambered valleys in the Hythe Formation and in voided Made Ground; but infiltration discharges into such features should be avoided to manage the risk of collapse settlements occurring.

Sandy deposits such as the Thanet Sand Formation may be suitable for infiltration, but half drain times may be excessive if the soils are predominantly fine grained. Sand deposits can also be vulnerable to washout around soakaways and this risk will need to be mitigated through design.

Detailed descriptions of the geological strata are given in published geological memoirs and well records.

Geological mapping should only be utilised as a preliminary guide and it is recommended that advice be sought from a Geotechnical Specialist at an early stage of design.

[4]Hythe formation is geological strata which typically constitute layers of hard limestone (Ragstone) and weakly cemented calcareous sandstone (Hassock).

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Site investigation

Site investigation must be undertaken to support the choice of the correct infiltration method and enable appropriate design to be completed. Site appraisal by an experienced engineer will be needed to manage the risks.

Site investigation is crucial for the determination of an accurate estimate of the infiltration rate. This must be based on independently-observed testing carried out in accordance with a generally accepted procedure preferably BRE Digest 365 published by the Building Research Establishment for shallow testing (typically less than 3m depth) and falling head testing for other depths complaint to BS5930.

Any site investigation must also:

- correctly reflect the location of the proposed infiltration measure
- relate to the depth to be utilised for infiltration
- demonstrate the likelihood of any associated ground risks

Chapter 7

DRAINAGE DESIGN

Sizing of drainage systems

All hydrologic and hydraulic calculations shall be based on the design storm criteria provided within the National Planning Policy Framework Practice Guidance and the CIRIA SuDS Manual C753.

Storm return periods that shall be considered in design for sustainable drainage systems are:

1 year return period – aimed at morphological protection of receiving streams

30 year return period – the system may surcharge but should be designed not to flood any part of the site

100 year return period – no property damage and any temporary flooding is retained on site at appropriate locations, and does not restrict access and egress.

In all cases the drainage design must include an appropriate allowance for climate change to the runoff from the 100-year return period design rainstorm to allow for the predicted effects of climate change.

In the case of commercial development, it is open to the designer to add only a 20% increase for climate change but in order to claim the lower climate change adjustment the designer must also provide written justification to show that the building and its foundations are unlikely to exist after 60+ years.

Infiltration measures should be designed so as to avoid concentrating runoff from extensive impermeable areas into a small discharge area, therefore acting as large point infiltration devices.

No specific standards are set with respect to catchment areas for individual drainage measures, but consideration should be given to limiting the catchment area such that:

- An individual soakaway serves an impermeable area not greater than 1,000 m^2 (0.15 ha)
- If the runoff from an impermeable surface discharges to a permeable pavement then the surface area of the permeable pavement shall not be less than half that of the impermeable surface discharging to it.

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Discharge rates

The total discharge from the site should aim to mimic greenfield rates. The discharge from the site should be restricted to the theoretical greenfield runoff rates for each of the 1, 30 and 100 year return period storms.

The acceptable calculation methods are specified in Ciria SuDS Manual, Report C753 (2015) or as updated. When greenfield rates calculations result in a total discharge from the site of less than 5 litres/second, a rate of 2 litres/second may be used.

The discharge rate must be confirmed with the Kent County Council and/or the Local Planning Authority, as in particular circumstances a discharge rate other than greenfield rate may be required.

Where necessary, the proposed rate of discharge to a receiving watercourse may also need to be agreed in advance with the relevant Internal Drainage Board.

These local requirements for discharge may be specified within Local Planning Authority Local Plans or Supplementary Planning Documents, evidenced through assessment of flood risk for the specific locality.

Reference must also be made to any relevant Strategic Flood Risk Assessment, Surface Water Management Plan or other adopted flood risk document which may specify specific discharge rates or local requirements to manage flood risk within the locality.

In circumstances where the site runoff is to be discharged to a public surface water sewer or combined sewer, the sewerage undertaker should be consulted as to whether any additional or alternative discharge controls or connection points are required.

In circumstances where site runoff is to be discharged to a private sewer or to an unadopted sewer (either surface water or combined) then it will be the responsibility of the developer to demonstrate what additional or alternative discharge controls are required.

For previously developed sites, discharge rates should be reduced to the greenfield rates wherever possible. Any deviation from this principle will require full justification.

If the greenfield runoff rate cannot be achieved, full justification should be made by the applicant to KCC. The final discharge rate should seek to provide betterment from the existing rate but should not exceed 50% of the existing rate for each of the critical rainfall event.

1. the current discharge rate from the site at the time of the planning application; or

2. the capacity of the current connection to the surface water system.

Phased development or subdivision of a site should not lead to exceedance of the greenfield runoff rate from the original total site area as later areas of the site are developed.

Catchment area

The drainage system should be designed to reflect the natural catchment. This supposes that surface flows are not directed to other catchments and that means a pumping system is a last resort.

When calculating areas to be drained, allowance must be made for all parts of the highway, including footways, footpaths, paved areas and verges.

Where footpaths run remotely from the carriageways, gullies or channels connected to the highway drainage system must be provided to prevent surface water discharging into adjacent property or down steps/stairs.

Surface water within the highway boundary must be contained within the highway drainage system and not allowed to run onto adjacent property without our approval or that of the adjacent land owner.

In exceptional circumstances, Highway systems may be permitted to carry non-highway runoff i.e. roof runoff, but the system must predominantly operate as a highway drainage system and must be agreed with the Highway Authority.

Other impermeable areas not associated with the highway which lie within the curtilage of an individual property, with a total area of less than 5 m2 can be ignored. These include garden paths and other narrow paths with impermeable paving.

Sub-catchment area

The developable site area should be broken into smaller sub-catchments with controls to maximise treatment and storage capacity.

Large multi-phased developments are required to be designed on a sub-catchment basis with appropriate attenuation and discharge controls included within each phase.

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Attenuation

Underground attenuation and piped sections should be designed for a minimum of the 30-year rainfall event. Attenuation of events exceeding the capacity of the piped system may be achieved by temporary flooding of open spaces.

Flooding of the highway carriageway will generally not be accepted but may be permitted on agreement with the Highway Authority under special circumstances.

If surface flooding of open areas is not appropriate, the formal drainage system must be designed to accommodate the 100-year storm plus an allowance for climate change. In the case of below ground systems, consultation with the adopting authority will be required if volumes from storms greater than the 1 in 30-year storm are stored below ground.

For large sites, where infiltration is not used, long-term storage must be provided to store the additional volume of runoff caused by any increase in impermeable area. This is in addition to the attenuation storage required to address flow rates.

The long-term storage should discharge at a rate not exceeding 2 litres/second/hectare. The acceptable calculation methods are specified in the Defra/EA technical report *Preliminary rainfall runoff management for developments,* Report W5-074/A/TR/1, Revision E (2012) or as updated.

If the discharge is direct to coastal waters, attenuation may not be required. In this case the impact of the discharge on habitat, erosion and water quality should be assessed.

Draw down time

Any measure designed to manage the 1 in 10 year to 1 in 30 year rainfall event, should discharge from full to half-full within a reasonable time so as to manage risks associate with a follow on rainfall event.

Infiltration measures and attenuation systems with low discharge rates shall be designed to ensure that the storage volume of the device is half-empty within 24 hours up to and including the 1 in 30 year rainfall event, consistent with guidance provided by Ciria SuDS Manual. The 1 in 100 year rainfall event may exceed 24 hours but should not be excessive.

This is to ensure there will be adequate capacity within the system to reasonably accommodate any subsequent storm events. Where this is not achievable, additional storage capacity may have

to be provided, in agreement with Kent County Council.

Topography

Infiltration measures will be restricted by the allowable slope for that element. For example, a level or gently sloping area with gradients less than or equal to 3% is generally required for permeable pavements. However, steeper slopes can be used where check dams and vertical barriers to infiltrated flow paths are incorporated.

All other infiltration measures should be located in areas in which the slope does not exceed 20%.

Influence of groundwater table

An absolute minimum vertical distance of 1m must be provided between the bottom of the infiltration measure and the seasonal high ground water table or bedrock layer.

Infiltration measures, specifically deep bored soakaways should be located such that typically there is 10m of unsaturated zone below the bottom of the chamber.

Separation distances

Separation distances are required between the drainage measure and other drainage measures, building foundations and property boundaries. In all cases the design must show the impact of infiltration on any adjacent structures or features.

- For shallow infiltration measures the minimum separation or setback distance between any two infiltration measures less than 5m deep shall be equal to the maximum depth of the deepest.
- For infiltration measures with depths up to m, the separation distance from the edge of the chamber shall be a minimum of 5m.
- For infiltration measures with depths of greater than 5m, the separation distance from the edge of the chamber shall be a minimum of 10m.

Other considerations include:

- specific ground conditions, such as chalk or other soil and fill material subject to modification or instability where the advice of a geotechnical specialist should be sought as to the advisability and siting of any infiltration measure.
- public sewers, where 5m separation is required

Separation distances must also account for access and maintenance requirements or any future replacement (see below).

Zone of influence and interaction

If infiltration measures are sited closer than 10m to each other, an assessment of the reduced efficiency of each measure shall be undertaken and the estimated reduction resulting from interaction shall be used in the calculations of the size of the infiltration device.

Relation to highway

The minimum cover to pipes and other below ground structures shall be as follows:

- 1.2m in the carriageway and areas outside carriageway that are susceptible to overrunning
- 0.9m in footways, service strips or verges
- 0.5m in domestic driveways, parking areas and yards with restrictions to prevent entry by HGVs
- 0.35m in domestic gardens and pathways without any possibility of vehicular access

Reductions to depths within the highway boundary may be considered, subject to highway authority approval and the pipes being laid on a bed of, and surrounded by, 150mm of concrete.

Under no circumstances shall below ground infiltration measures be located within the adopted carriageway or junctions.

The edge of any excavation for below ground infiltration measures should not normally be closer than 600mm to the proposed kerb line or edge of carriageway.

Flow control devices

The use of flow control devices such as weirs, pumps, orifice plates (hydrobrakes), etc. within a system to be adopted by Kent County Council will require approval.

Minimum size of hydraulic devices for unprotected controls[5] shall usually be as follows:

- 100mm for orifice plates
- 75mm for vortex control devices (and in accordance with manufactures recommendations)
- 150mm for throttle pipes. Throttle pipes should be less than 15m in length.

The developer must demonstrate that he has chosen the flow control device which permits the lowest discharge rate.

Flow velocity at inlets and outlets shall be controlled to prevent erosion and scour in downstream vegetated areas.

[5]Protection against blockage may be provided by siting the control device downstream of permeable pavement or any other measure which filters large loose material.

Relaxation of these diameters requires consultation with the adopting authority. Flow control from upstream drainage measures such as permeable pavement may be further relaxed with consultation.

An assessment of the consequence of blockages must be carried out. Where it is deemed that the risk of failure would result in localised flooding that may affect properties or the operation of the highway then overflow devices must be provided.

Water quality

As there are a wide range of contaminants in surface runoff, it is preferred that a drainage system comprises a SuDS Management Train i.e. a number of components in series which provide a range of treatment processes.

Drainage design should be assessed for water quality benefits utilising the approach outlined in the Ciria *SuDS Manual,* Report C753 (2015) Chapter 26. The Simple Index Approach is usually sufficient.

This assessment should be included within any proposed drainage strategy for new development.

First flush

The principle of 'first flush' is set out in the SuDS Manual, whereby the first 5mm of any rainfall event usually flushes the vast majority of contaminants out of the system.

As runoff travels over a catchment it will pick up or dissolve pollutants; as a result, this 'first flush' portion of the flow may be the most contaminated.

Kent County Council would expect that developers demonstrate that the first 5mm of any rainfall event can be accommodated and disposed of on-site, rather than being discharged to any receiving watercourse or surface water sewer.

Where it proves exceptionally difficult to achieve this principle, it must be demonstrated that any water leaving the site has been appropriately treated to remove any potential pollutants.

Oil water separators

Oil water separators are required for impermeable surfaces which take vehicular traffic in locations as specified within Environment Agency advice notably where:

- Parking areas with a size of 800m^2 or greater; or,
- Areas where goods vehicles are parked or manoeuvred.

The decision to include an oil water separator should be made on a case-by-case basis in consultation with the Environment Agency and Kent County Council.

Oil water separators should be located off-line. The contributing drainage area should be completely impervious and as small as necessary to contain the sources of oil.

Oil Interceptors must be either full retention or bypass type to BS EN 858 and in accordance with pollution prevention guidelines issued by the Environment Agency in PPG3: "Use And Design Of Oil Separators In Surface Water Drainage Systems".

At most sites a Bypass Interceptor with Class 2 separation is appropriate subject to approval from both the Environment Agency and Kent County Council. The interceptors should be adequately ventilated.

Each device should have a site-specific maintenance plan (including guidelines on equipment to be used, health and safety procedures, and water disposal arrangements), providing guidance on a suitable inspection regime, maintenance practices and responsibilities that is held by the site operator or owner and be available for inspection.

Flow cut off valves to isolate the interceptor must be provided for use in an emergency and during site cleansing operation.

Interceptors must be fitted with oil level and silt level alarms. A marker post must be provided to clearly identify the location of a pollution interceptor or cut off valve.

Other pre-treatment measures

Wherever a soakaway, deep bore soakaway, trench soakaway, filter drain, filter strip, underground storage tank or attenuation tank is proposed, silt traps must be installed upstream of them to prevent and to reduce the possibility of solid material getting into the drainage apparatus.

Soakaways are particularly vulnerable to reduced performance or pollution if pre-treatment is inadequate.

Other pre-treatment options should be assessed, including but not limited to (lined) filter trenches, filter strips, grass swales and filter chambers, before discharge to the drainage system.

Access and maintenance

Below ground access

E=Each installed below ground drainage measure should include an observation well or inspection chamber(s) to facilitate periodic inspection and maintenance. The arrangement of any chamber must be positioned so that the discharge points of the individual drains into the drainage measure can be clearly seen.

General access arrangements

Access appropriate to the size of the drainage measure must be provided to allow personnel and heavy equipment to perform non-routine maintenance tasks, such as reconstruction or rehabilitation.

Access is easily provided for drainage measures if located within the highway boundary or within public open space. Appropriate easements will be required to allow access if located within private property. Implications of locating drainage measures within private property will need to be considered in the early stages of consultation with Kent County Council.

A minimum set back of 5 to 8m is required to be provided on any ditches or ordinary watercourses.

Maintenance requirements for access routes or pathways should be stated within a Maintenance Plan, clearly identifying responsible parties or bodies.

Access for Renovation or Replacement

Siltation of soakaways can overtime result in failure of the drainage measure and will require that the soakway is either emptied, replaced or re-bored. Separation distances between buildings and soakways may require additional approval to ensure adequate access is provided.

If minimum separation distances are provided, specific soakaway locations may attract additional commuted sums to account for increased renovation costs due to particular site arrangements.

Areas of flood risk

It is generally accepted that sustainable drainage measures, particularly infiltration devices would be ineffective in areas which may be inundated during a flood or impacted by high ground water levels associated with increased flood levels in the local vicinity.

The location of any sustainable drainage measure within Flood Zone 2 or 3 would require further consultation with the Environment Agency and the Lead Local Flood Authority.

Exceedance

Exceedance of the surface water system may occur for storms greater than 1 in 30. Safe ingress and egress should be provided by at minimum of one route. Sustained flooding should not occur within the highway. Flows should be directed to a safe attenuation area or return to the system relatively quickly.

Overland flood pathways should be assessed in the event of failure of the drainage measure. Kerb heights and property threshold levels in relation to the inlet or overflow point from each device should be considered in any design to prevent property flooding.

Safe and appropriate flow routes from blockage and exceedance of the drainage system must be evaluated. This must demonstrate no property flooding or increase in flood risk, either onsite or to third parties.

The layout of the development site and the drainage system should be designed so that any surface water that enters the site from off-site sources is conveyed safely around or across the site without compromising the level of service of the proposed drainage system or introducing unacceptable additional risks on-site or downstream.

A plan showing the anticipated course of the surface water together with the predicted depths and speeds of flow shall be supplied by the developer.

Pumping stations

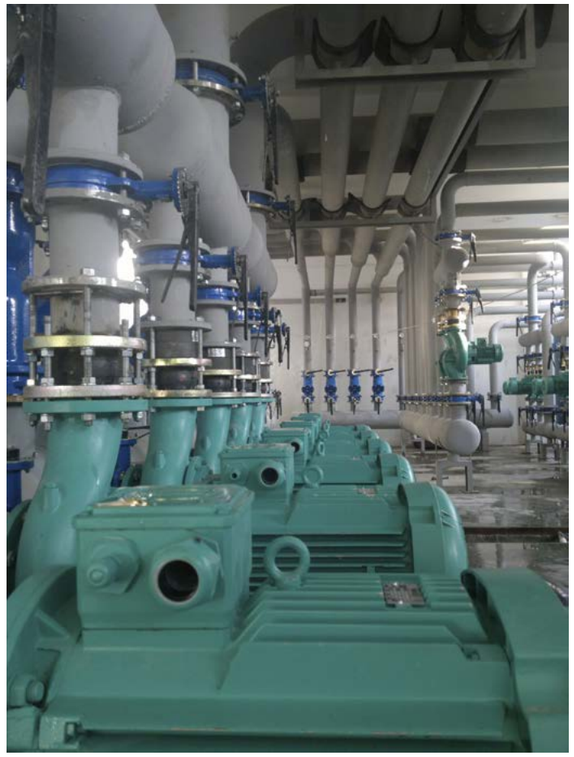
The use of pumping systems should be avoided; however, where it is not possible to provide a gravity drainage system to a watercourse a pumped system may be considered; however there are overarching issues in relation to reliability and sustainability.

The applicant should through pre-application discussion investigate other alternative arrangements to enable drainage.

The applicant should be aware that restrictions may occur on adoption of such measures. Kent County Council will not adopt the pumping system or associated equipment.

Factors of safety

Designs submitted for adoption must include a minimum Factor of Safety of 2, which is applied to calculations for design purposes where failure would result in minor inconvenience.
If failure would result in more severe damage, then a Factor of Safety of 10 should be applied to calculations for design purposes.



Chapter 8

CONSTRUCTION CONSIDERATIONS

Planning approval

The final development design, including highways and drainage measures will be approved under a specific planning reference, usually with further submissions for detailed design.
Any construction should be compliant with these agreed plans; however, on some occasions variations to the proposed design do occur for specific reasons. It should be noted that these variations may have planning implications and need planning approval.

Ground conditions

Unforeseen ground conditions, particularly in areas of ground instability, may cause a reconsideration of design and construction methods. If any previously unknown made ground is encountered the inspecting engineer from Kent County Council must be informed straight away if the system is to be adopted by Kent County Council.

Directed ground investigation such as dynamic probing may be necessary to support construction with particular areas of known ground risks (e.g. Hythe Formation gull features, Chalk dissolution features, washout of sandy soils), or areas of known man-made features (e.g. deneholes, caves and tunnels).

Other concerns may arise with seasonally high groundwater which may differ from original design assumptions. If groundwater is encountered within 1m of the work surface, construction work must cease, and consultation undertaken with the Lead Local Flood Authority and/or Highways Authority to assess the impact of the approved design.

Contamination

Work must be undertaken in such a way as to ensure that no significant impacts occur to the soil, the groundwater or to the surface waters throughout the construction period.

Attention must be paid to ensure the prevention of any accidental spillage of contaminants and to the prevention of soil or other material from entering any underground pipework, storage chamber, attenuation tank etc.

Sediment control

Drainage from the construction site area should not be permitted to discharge directly to any watercourse or drainage feature being constructed.

The greatest risk to any sustainable drainage system, particularly infiltration systems, is often from silt collecting in them during the construction phases. Precautionary measures during construction (regular road sweeping, wheel washes, geotextile filter fabrics on inlet systems, silt fences etc.) can help to manage this risk.

Rectification of siltation problems is very difficult and costly as often there are no readily available alternative sites for replacement soakaways.

The developer may decide to use the permanent drainage system during the construction phase and in such cases the infiltration systems should be tested prior to adoption to assess whether siltation has affected the anticipated soakage rates. Testing should be submitted to the Highways Authority for approval if adopted by Kent County Council or may require submission of evidence to the Local Planning Authority to demonstrate appropriate conditions.

Tracked equipment should be used where possible and traffic should be confined to designated routes to minimise soil compaction.

Phasing

Any major construction shall be accompanied by a phasing plan showing the location, size and anticipated start-date for each phase of the construction.

The plan must also show the location of haul roads and other designated routes. The lines of these haul roads and other designated routes must be agreed in advance with the Lead Local Flood Authority or Local Planning Authority and must avoid all areas where it is proposed to construct infiltration drainage features.

Strategic drainage features must be delivered in a timely manner to serve the development as required.

Sustainable drainage - Making it Happen

Inspection intervals

For adoption by the Highways Authority, inspection intervals will be agreed with Kent County Council at the approval stage. Inspections are anticipated at key construction intervals e.g. at foundation level, as below ground features are installed, etc.

Inspection may also be required by the Local Planning Authority as a condition of planning approval. This condition will specify the appropriate body or authority and other inspection requirements.

Photographic record

Digital photographs may be helpful for future maintenance inspections and should be encouraged during construction of all future systems, as they provide valuable information on ground conditions and installation details in any subsequent reviews of system performance.

Reinstatements of existing highways

It may be necessary to install a new drain within the existing adopted highway. Kent County Council must be consulted in respect of the construction details and all traffic management issues with respect to any works carried out within the highway boundary and requiring reinstatement of the existing highway.

Verification reports

As part of the planning process it is common practice now for a verification report condition to be attached to the permission so as to ensure that the drainage network has been installed in line with the approved design. Should the final as built system vary from that originally approved it will be necessary for it to demonstrated, as part of the verification report process, that it still complies with that originally approved (general principles, discharge rates, etc.)

Chapter 9

OTHER APPROVAL DETAILS

Consent to begin works

Written confirmation may be required from other authorities to verify their consent to the construction of a developer's drainage scheme. These authorities include, but are not limited to, the following:

- Environment Agency for discharge to ground or contaminated land, especially where the development site lies wholly or partly within a Groundwater Protection Zone
- Internal Drainage Board (IDB) for discharge to an IDB channel
- Sewerage undertaker for connection to an existing public sewer
- Kent County Council as Lead Local Flood Authority for construction within an ordinary water course
- Kent County Council as Highways Authority for discharge to a highway drain
- Kent County Council for highways structural approval

The drainage design must respond to details required by these other authorities and must be evidenced prior to commencement of work. This may be a condition of the planning approval.

Sustainable drainage - Making it Happen

Third party land

Information shall be submitted that demonstrates that off-site surface water drainage works or drainage measures located within private land are appropriately secured and protected.

Any section or component of the drainage system which is located on private third-party land or within land managed by another authority or organisation shall be protected by the granting of an easement or right of way for purposes of maintenance. The easement shall be included as a covenant on the respective land title and may be a condition of planning.

The developer will be required to provide evidence from the third party, whether a private individual, local authority or management company, that this person, authority or company will take responsibility for the maintenance of any areas for which they are responsible for outside of the highway boundary and which contains any section or component of the drainage system.

This maintenance for which they are to be responsible includes the maintenance of all gates, fences etc. which define and control the maintenance access.

Where any pipes or other drainage measures cross third party land as a component of the drainage system to be adopted, a protected strip width shall be provided:

- A clear strip, a minimum of 3m wide on both sides of a pipe measured from the pipe exterior, for pipes up to 3m deep. This minimum distance increases for deeper or larger diameter pipes.
- A clear space for maintenance access must be provided and maintained around the entire surface water drainage system. For apparatus other than pipes (for which, see above) the maintenance access strip must be a minimum of 5m wide measured from the exterior of the drainage measure itself.

There is a prohibition on substantial construction or building over this protected width where the drainage system serves more than one property. This prohibition should be noted within any legal document on sale of the land.

As-built drawings & records

If the drainage system is to be adopted by the Highways Authority, a record of the as-constructed drainage networks must be provided. This will include:

- GPS Location of chambers, interceptors, soakaways, outfalls, shut off valves and pipe runs etc.
- dimensions of chambers, interceptors pipes etc
- invert levels, diameter, direct of flow and depths of pipework
- clearly identify pipework used for storage
- maintenance regime for the Pollution interceptors.

Chapter 10:

INSPECTIONS AND MAINTENANCE

Inspections will be undertaken by the Highways Authority for those systems adopted as a highway drainage system and by the sewerage undertaker for those adopted as public drainage systems. Inspections for other systems may be specified through a planning condition attached to the planning approval.

Inspection

Inspection forms a vital element of future maintenance and as-constructed details and associated construction records will enable a more comprehensive gathering of data notably in relation to ground conditions.

A global review of the system environment should be undertaken to assess the performance of the systems and where possible an internal inspection should also be undertaken, although for many SuDS solutions and techniques internal inspection may not be possible.

General details from inspections

Typical details that should be recorded are as follows:

- site name
- grid reference
- ground level (mAOD)
- description of drainage solution or technique
- weather conditions
- date of inspection

The expected ground conditions should also be stated and ideally this would relate to site specific ground investigation data associated with the installation recorded during the construction phase, although retrospective assessments will have to rely on geological maps, nearby exposures and local knowledge.

External inspection

External inspections should consider the following:

- evidence of subsidence
- location/height/type of any nearby trees
- offset to nearby buildings/walls
- any noted catchpits/other statutory undertakers plant
- any evidence of surface/standing water
- effects evident in vegetation

Internal inspection

Internal inspections should consider the following:

- water level
- system dimensions
- inlet pipes
- any collected silt
- evidence of contamination
- any distortion/tilting of chambers;
- open joints/perforations/lifting hook eyes
- warning signs
- depth of access shaft below manhole cover
- overflow provision.

The design calculations and verifications tests should be collated with the installation records and subsequent inspection records, although the extent of such record keeping depends on the size and sensitivity of the systems.

Appendix A

Ring soakaway

A.1 Description

TThe ring soakaways are commonly used due to their simplicity of installation and ready availability of their components. Ring soakaways basically comprise a cylindrical chamber into which the surface run-off from the catchment area is collected (Photos A.1 and A.2). The chamber is formed from precast perforated cylindrical rings each approximately 1m high which are stacked upon each other to produce sufficient height to achieve the required effective storage volume. The space between the rings and the excavation is backfilled with coarse aggregate.

Photos A.1 and A.2 – typical examples of ring soakaways

Soakaways are generally accepted to depths of 4m below ground level, but greater depths may be approved dependent upon locations and site conditions. Typical diameters of soakaway rings are 1.2 m, 1.5 m, 1.8 m, 2.1 m, 2.4m and 2.7m.

Ring soakaways can also be installed as linked measures. It must be noted that this places a greater burden on the initial chamber in the sequence and its associated inlet pipe both of which will require a greater frequency of maintenance compared to an isolated ring soakaway. Banks of soakaways and their connecting pipes will effectively sterilise a large area.

Existing, but failed, soakaways either in the sense of ineffective soakage or structural damage tend to be caused by constructing them in the adverse conditions outlined in the previous sections. It should be noted that failures occur usually if they are either wholly located in the overlying sand or close to the interface with the chalk or Hythe Formation.

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A.2 Design requirements

Soil suitability: Infiltration testing must support the design and site selection. A minimum infiltration rate of 1 x 10^{-5} m/s is required for measures which are to be adopted and must be demonstrated through appropriate ground investigation. If less favourable conditions are present, consultation with Kent County Council must be undertaken prior to progressing the design.

Sizing: Soakaways must be designed to meet the surface runoff management requirements as specified within the Kent Design Guide. The storage volume of device is required to be half-empty within 24 hours.

Catchment area: The maximum impervious area to be served by a soakaway shall be limited where possible to 1,000m^2. Consultation should be undertaken with Kent County Council when smaller catchments are not possible.

Dimensions: Diameters greater than 0.9m are acceptable up to 2.7 m, with appropriate Kent County Council Structural approval where required. Depths should be limited to 4 m, excepting with consultation and approval of the adopting authority.

Groundwater: A minimum vertical distance of 1m must be provided below the bottom of the chamber to the seasonally high groundwater table.

Separation distances: Infiltration measures must be separated by 5m from the edge of the chamber with depths up to 5m and separated by a minimum of 10m for infiltration measures with depths greater than 5m.

Location: No soakaway may be constructed wholly or partly within made or contaminated ground.

Pre-treatment measure: Silt traps are mandatory upstream of any soakaway. Other pre-treatment measures such as filter trenches, filter strips or grass swales may be considered.

Aggregate: approved 40mm one size flint or gravel.

Non-Woven Geotextile: Where used, this shall consist of needled nonwoven polypropylene fibres and meet the following properties:

Thickness at 2kPA – ≥ 1mm
Tensile Strength (longitudinal/transverse) – ≥ 8.0 kN/ m^2
CBR puncture resistance – ≥ 1500 N
Cone drop test – ≤ 40mm
Opening size – ≤ 90 µm
Water permeability – ≥ 90 l/m^2/s

A.3 Mandatory submittal requirements

Infiltration test at specific site location and depth as specified by design in general accordance with BRE Digest 365.

Highways Structural response/approval for soakaways located in or within 3.66m of the highway carriageway or having an internal span exceeding 900mm .

Environment Agency response/approval for soakaways located within a source protection zone.

A.4 Specifications and standard details

1. These notes shall be read in conjunction with drawing KCC/HTW/500/003.*

2. Where the cover slab needs to be at a greater depth than shown on KCC/HTW/500/003 resulting in a brickwork shaft, the opening in the slab shall be 675 x 675mm with the top 2 courses of brickwork corbelled in to give adequate bearing to the manhole cover and frame.

3. Chamber walls and cover slab to be constructed in precast concrete to **BS EN 1917:2002** Concrete manholes and inspection chambers, unreinforced, steel fibre and reinforced and **BS 5911-3:2010** Concrete pipes and ancillary concrete products.

4. Tapers and reduced diameter shafts shall not be used unless absolutely unavoidable and agreed with the adopting authority.

5. In situ concrete finish to base slab shall be Class U3.

6. Soakaways greater than 1500mm internal diameter and located within the highway boundary will require Technical Approval by Kent County Highway Structures. The design and detailing shall be in accordance with the Approval in Principle (AIP) submitted to Kent County Council for each chamber. The use of precast concrete products to BS EN 1917 and BS 5911-3 will not necessarily be accepted. Type approval is available for the design of some precast concrete supplier's products. The following additional requirements are required for adoption by Kent County Council:

   a) The chamber cover slab shall be set to a minimum 450mm below the finished surface level.

   b) The buried surfaces of the cover slab shall receive two coats of cut back bitumen.

   c) Non perforated shaft rings shall receive a minimum 150mm ST2 concrete surround.

*The KCC standard drawings are available in pdf. format which can be purchased for £108 (inc. VAT), To purchase a copy of the drawings please make a cheque for this amount payable to Kent County Council and send to the Agreements Team, Ashford Highway Depot, Javelin Way, Ashford, Kent, TN24 8AD. Please provide your contact details including email, with the cheque so the drawings can be swiftly sent to you.

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A.5 Construction considerations

Special attention should be paid to the management of silt and sediment during the construction period. The soakaway should be kept off-line until construction is complete.

The location of the soakaway should not be subject to compaction prior to, during and after the construction of the facility.

A.6 Maintenance and inspection issues

Check inlets and pre-treatment measures for sediment buildup and structural damage.
Note if any sediment needs to be removed. Undertake jetting and cleaning prior to adoption.

Adequate access should be provided to an infiltration trench facility for inspection and maintenance.

In the case of soakaway failure: it is normally essential to cast a concrete base to the soakaway, seal all the joints and holes and line the lower portion of the chamber with a 'bituthene' coating protected by some form of dwarf wall. Soakage should then be effected by a deep bored liner.

A.7 References

1. BS EN 1917:2002 Concrete manholes and inspection chambers, unreinforced, steel fibre and reinforced

2. BS 5911-3:2010 Concrete pipes and ancillary concrete products Part 3: specification for unreinforced and reinforced concrete manholes and soakaways (complementary to BS EN 1917:2002)

3. Building Research Establishment, BRE Digest 365, Soakaway Design, September 1991

4. CIRIA C753 'The SuDS Manual', 2015 or as updated.

5. Design Manual for Roads and Bridges Design Manual for Roads and Bridges Volume 2 Section 2 Part 8 Design of Soakaways, 2006

Appendix B

Deep bore soakaway

B.1 Description

Where infiltration must take place at depths greater than can be readily reached by ring soakaways then a deep bore soakaway liner through a sealed soakaway chamber may be considered. Here the water is transported from a sealed storage chamber to the infiltration medium down a small diameter plastic or steel pipe, perforated in part. In exceptional circumstances the lower part of the chamber may also be perforated provided the perforations commence a minimum of 1m into suitable permeable strata.

Photo B.1 Typical examples of deep bored soakaways

The plastic or steel liner which passes through the base is usually 100mm to 150mm in diameter. The plastic or steel liner is perforated to allow water to pass into the infiltration medium but there must be a minimum of 2m of unperforated liner below the interface between the suitable and the unsuitable strata. As the diameter of the borehole is more controlled than the dimensions of the ring soakaway chamber excavation, for calculation purposes the soakage area of the liner is taken as the borehole diameter.

A syphon head caps the liner which protrudes 1m above the base of the chamber to prevent the blockage of the deep bore. This also helps to inhibit the ingress of silt into the liner.

On brownfield sites the liners themselves may be in suitable strata but the chambers and/or inlet pipes may be in loose Made Ground. This may result in surface settlements and/or washouts. It is therefore important to consider the need for ground improvement in the vicinity of the soakaway chamber, for a reinforced connection between the lowest soakaway ring and the base of the soakaway and for greater flexibility in the inlet pipes.

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B.2 Design requirements

Soil suitability: Infiltration testing must support the design and site selection. A minimum infiltration rate of 1 x 10^{-5} m/s is required for measures which are to be adopted and must be demonstrated through appropriate ground investigation. If less favourable conditions are present, consultation with Kent County Council must be undertaken prior to progressing the design.

Sizing: Soakaways must be designed to meet the surface runoff management requirements as specified within the Kent Design Guide. The storage volume of device is required to be half-empty within 24 hours.

Catchment area: The maximum impervious area to be served by a soakaway shall be limited to 1,000m^2, excepting with consultation and approval of the adopting authority. Consultation should be undertaken with Kent County Council when smaller catchments are not possible.

Dimensions: Diameters greater than 0.9m are acceptable up to 2.7m, with appropriate Highway Structural approval where required as specified within Section 1.4.4. Depths should be limited to 4 m, excepting with consultation and approval of the adopting authority.

Groundwater: No direct discharge to groundwater should occur and an unsaturated zone of 10m minimum should be provided below the soakage zone.

Separation distances: Infiltration measures must be separated by 5m from the edge of the chamber with depths up to 5m and separated by a minimum of 10m for infiltration measures with depths greater than 5m.

Pre-treatment measure: Silt raps are mandatory upstream of any soakaway. Other pre-treatment measures such as filter trenches, filter strips or grass swales may be considered.

Aggregate: approved 40mm one size flint or gravel.

B.3 Mandatory submission requirements

Infiltration test at specific site location and depth as specified by design

Highways Structural response/approval for soakaways located in or within 3.66m of the highway boundary or having an internal span exceeding 900mm

Environment Agency response/approval for soakaways located within a source protection zone

B.4 Specifications and standard details

1. These notes should be read in conjunction with drawing KCC/HTW/500/004.*

2. Where the cover slab needs to be at a greater depth than shown in KCC/HTW/500/004 resulting in a brickwork shaft, the opening in the slab shall be 675 x 675mm with the top 2 courses of brickwork corbelled in to give adequate bearing to the manhole cover and frame.

3. Chamber walls and cover slab to be constructed in precast concrete to **BS EN 1917:2002** Concrete manholes and inspection chambers, unreinforced, steel fibre and reinforced and **BS 5911-3:2010** Concrete pipes and ancillary concrete products.

4. Tapers and reduced diameter shafts shall not be used unless absolutely unavoidable and agreed with the adopting authority.

5. When placing the bentonite seal on top of the aggregate, care shall be taken to prevent contamination of the aggregate.

6. The syphon head shall be in any approved non-rusting material and shall be removable from the ground surface.

7. Concrete collar to borehole liner to be constructed if borehole installed after construction of chamber slab.

8. Smaller diameter rotary drilled boreholes and associated liners may be accepted in hard rock strata subject to the approval of the adopting authority.

9. Steel reinforcement in base to be provided if specified in the Works Order.

10. In situ concrete finish to base slab shall be Class U3.

11. Soakways greater than 1500mm internal diameter and located within the highway boundary will require Technical Approval by Kent County Council Highway Structures. The design and detailing shall be in accordance with the Approval in Principle (AIP) submitted to Kent County Council for each chamber. The use of precast concrete products to BS EN 1917 and BS 5911-3 will not necessarily be accepted. Type approval is available for the design of some precast concrete supplier's products. The following additional requirements are required for adopting authority approval:-

    a) The chamber cover slab shall be set to a minimum 450mm below the finished surface level.
    b) The buried surfaces of the cover slab shall receive two coats of cut back bitumen.
    c) Non perforated shaft rings shall receive a minimum 150mm ST2 concrete surround.
    d) The base slab thickness and steel reinforcement shall be determined/confirmed by the design criteria contained in the AIP.

*The KCC standard drawings are available in pdf. format which can be purchased for £108 (inc. VAT), To purchase a copy of the drawings please make a cheque for this amount payable to Kent County Council and send to the Agreements Team, Ashford Highway Depot, Javelin Way, Ashford, Kent, TN24 8AD. Please provide your contact details including email, with the cheque so the drawings can be swiftly sent to you.

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B.5 Construction sequence

1. Where the chamber acts purely as a storage chamber, it shall be fully sealed.

2. In all new soakaway installations the borehole liner shall be located close to the edge of the chamber and the inspection cover sited on the opposite side of the chamber to the borehole liner This may require rotation of the soakaway cover slab following placement of the siphon head on the borehole liner if the borehole soakaway is drilled through the cover slab opening. This will enable ready access should a replacement borehole liner be required to provide additional capacity as a replacement for a liner that has become damaged or silted up following installation.

3. It is usual practice to construct the borehole liner first to confirm that suitable ground conditions are actually present before deciding if it is appropriate to construct a ring chamber around it.

4. Each location considered for the installation of a soakaway should be investigated by means of a constant or falling head soakage test. These tests should be carried out in the deposits considered suitable and at vertical intervals as agreed with the Overseeing Authority. Alternatively a proof test may be undertaken on the installed liner.

5. The borehole liner shall have an internal diameter of at least 100mm but normally not more than 250mm. It may be UPVC or other durable material agreed with Kent County Council. It must be capable of insertion in the borehole without risk of breakage, or damage to the joints.

6. Perforated slotted or screened pipe shall only be used in that section where infiltration is intended. The apertures in such a pipe shall be smaller than any aggregate placed between the liner and the borehole wall. The perforated pipe shall commence a minimum of 2 metres below the interface with the overlying unsuitable strata.

7. After installation of the lining tube, rounded 5mm to 10mm pea gravel shall be placed in the annulus between the borehole wall and the lining tube to a level 1 metre above the perforated pipe as the casing is withdrawn. Care must be taken to ensure that the level of the aggregate is maintained just above the bottom of the casing to prevent collapse of the borehole. In addition excessive heights of aggregate above the bottom of the casing could jam the casing during withdrawal and which could make the liner lift or even fracture. In that event Kent County Council must be informed immediately and no further action taken without their written approval.

8. A bentonite seal shall be placed on top of the aggregate to extend nominally 1m above and below the interface with the overlying unsuitable material. Care should be taken to prevent contamination of the gravel.

9. As the casing is withdrawn the remaining annulus shall be filled with suitable backfill material or grout as directed by Kent County Council.

10. The removable syphon head shall be in any approved non-rusting material. It shall have a 10mm diameter air vent at its highest point. It shall be fixed to the liner in a manner agreed by Kent County Council. Correctly fitted push fitting syphon heads may be acceptable with the approval of Kent County Council to remove the need for entry into a confined space.

11. On completion, if requested, the soakaway shall be tested to the satisfaction of the Overseeing Authority.

12. Where the deep bored liner has to be installed within an existing chamber without a concrete foundation, a Class ST4 concrete floor, 225mm thick, shall be cast to avoid any necessary erosion of the soil at the base of the chamber.

13. Where the deep bored liner has to be installed within a chamber in which a hole has been made during drilling, or preformed in the base, the annulus remaining after completion of the installation shall be filled with a 225mm thick Class ST4 concrete plug.

14. Where the deep bored liner has to be installed within an existing chamber which does not have a concrete base and which is showing signs of instability then the bottom rings should be underpinned and a concrete floor (Class ST4), 225mm thick be cast beneath them. More serious instability will require additional ground improvement and/or relocation of the soakaway.

15. All ring joints, soakaway holes, lifting hook eye holes and inlet pipes in the precast concrete rings should be sealed with mortar or other sealing materials approved by Kent County Council. This shall prevent seepage of water by any other means than through the deep bored liner.

16. Where an existing soakaway shows signs of instability it is recommended that after the remedial measures have been completed the bottom two metres of the chamber be sealed with a bituthene coating protected by a 150mm thick dwarf wall formed from Class ST4 concrete. More serious instability may require additional ground improvement and/or relocation of the soakaway.

B.6 Construction considerations

Zones of enhanced permeability may be encountered adjacent to solution features in chalk, man-made underground chalk workings, gulls in cambered valleys in the Hythe Beds and in voided Made Ground but infiltration discharges into such features should be avoided to manage the risk of collapse settlements occurring. Site appraisal by an experienced geotechnical engineer will be needed in the management of such risks.

Some geological strata, e.g. Lower Tunbridge Wells Sand, with a silty nature can be easily eroded and lead to surface collapse particularly where open fissures are encountered at depth. Seepages have also reduced the suitability of the stratum in some locations. A suitably designed non-woven geotextile filter fabric is required for these soil types.

Special attention should be paid to the management of silt and sediment during the construction period. The soakaway should be kept off-line until construction is complete.

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B.7 Maintenance and inspection issues

Check inlets and pre-treatment measures for sediment buildup and structural damage. Note if any sediment needs to be removed. Undertake jetting and cleaning prior to adoption.

Adequate access should be provided to an infiltration trench facility for inspection and maintenance.

In the case of soakaway failure:

a) **Rebore existing liner –** a larger diameter borehole will normally be required and problems may occur if the original or new borehole is not drilled vertically. Visual inspection of soil samples and further soakage tests will be required to assess soakage capacity of the strata. The stability of the area local to the chamber and the risk of leakage from the chamber must also be assessed.

a) **Install replacement borehole soakaway elsewhere in the chamber –** This will either require the cover of the chamber to be rotated or a core hole through the soakaway cover to provide access to the new borehole location. Coring through the cover will require approvals from the soakaway manufacturer and the adopting authority. Decommissioning of the failed deep bored liner may also be required.

a) **Reconstruction of the chamber and deep bore at a new location –** this may be required if the damage is severe. Decommissioning of the failed deep bored liner may also be required.

B.8 References

1. BS EN 1917:2002 Concrete manholes and inspection chambers, unreinforced, steel fibre and reinforced

2. BS 5911-3:2010 Concrete pipes and ancillary concrete products Part 3: specification for unreinforced and reinforced concrete manholes and soakaways (complementary to BS EN 1917:2002)

3. Building Research Establishment, BRE Digest 365, Soakaway Design, September 1991

4. Ciria C753 'The SUDS Manual', 2015 or as updated

5. Design Manual for Roads and Bridges Design Manual for Roads and Bridges Volume 2 Section 2 Part 8 Design of Soakaways, 2006

Appendix C

Filter drains

C.1 Description

Filter drains (also sometimes referred to as filter trenches) are shallow linear excavations filled with granular material or stone that creates temporary subsurface storage for filtration. (Photos C.1 and C.2).

Filter drains treat runoff by filtration through its stone/granular matrix before discharge into the surrounding soil thereby reducing runoff rates and volumes, and helping preserve the natural water balance, replenish groundwater and preserve baseflow. Water exfiltrates into the surrounding soils from the bottom and sides of the trench.

In addition to stone, a turf or seeded surface treatment to the filter drain may be utilized. Choice of surface treatment is to suit the surrounding environment.

Photos C.1 and C.2 – typical examples of filter drains, filter drain (left) Filter trench (Source: Susdrain) (right)

Filter drains can be used to filter and convey storm water to downstream drainage measures. They can also be used to capture sheet or point flow from a drainage area or can function as an off-line device.

Filter drains are suitable for use within residential, commercial/industrial, high density and retrofit sites. They are also suitable, where lined, for contaminated sites and sites above vulnerable groundwater; however infiltration trenches are not suitable for these conditions.

They should generally not be used as end-of-pipe systems due to the high flows that can occur and work best when used in conjunction with other sustainable drainage measures. Filter drains are best located adjacent to impermeable surfaces such as car parks or roads/highways to intercept sheet flows.

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Unless very effective pre-treatment of sediments is included within the design, they are applicable primarily to impervious areas where there are no high levels of particulates in the runoff and should be considered for sites only where the sediment load is low.

C.2 Description Design requirements

Soil suitability: Infiltration testing must support the design and site selection for infiltration trenches. Infiltration rates must be demonstrated through appropriate ground investigation.

Sizing: Filter drains/trenches must be designed to meet the surface runoff management requirements as specified within the design guide.

Dimensions: Depths usually between 1 to 2m. Width varies to suit site conditions.

Topography: Filter drains are typically unsuitable for sites with significant slopes, unless they can be placed parallel to contours. The longitudinal slope should not exceed 2% as low velocities are required for pollutant removal and to promote infiltration

Groundwater: A minimum vertical distance of 1m must be provided below the bottom of the trench to the seasonally high groundwater table.

Location: Filter drains should not be constructed wholly or partly within made grade and located to receive lateral inflow from the adjacent impermeable surface.

Pre-treatment measure: Filter drains not intended to function as sediment traps and should always be designed with an effective pre-treatment system in order to prevent clogging and failure.

Aggregate: Aggregates used within the filter drain shall be Type B filter drain material, as described in Table 5/5 and Clause 505 of the Specification of Highway Works (Manual of Contract Documents for Highway Works).

Non-Woven Geotextile: This shall consist of needled nonwoven polypropylene fibres and meet the following properties:

Thickness at 2kPA – ≥ 1mm
Tensile Strength (longitudinal/transverse) – ≥ 8.0 kN/ m^2
CBR puncture resistance – ≥ 1500 N
Cone drop test – ≤ 40mm
Opening size – ≤ 90 µm
Water permeability – ≥ 90 l/m^2/s

Impermeable Liner: this shall meet the following minimum specification (ASTM):

Thickness – ≥ 1mm
Density – 0.9 g/cm^3
Tensile stress at yield – 16 N/mm^2
Elongation at break – > 500%
Puncture resistance – 170N

C.3 Description Mandatory submittal requirements

Infiltration test at specific site location and depth as specified by design.

Environment Agency response/approval for infiltration within a source protection zone.

C.4 Description Specifications and standard details

1. These notes shall be read in conjunction with drawing KCC/SD/IDG/C01.*

2. Vitrified clay pipes and fittings must comply with the relevant requirements of BS 65 and be of 'normal' type and flexible mechanical joints.

3. Unreinforced and reinforced concrete pipes and fittings with flexible joints must comply with the relevant provisions of BS 5911.

4. Unplasticized PVC pipes, joints and fittings must comply with the relevant provisions of BS 4660.

5. The granular filter material, including the bed and surround to perforated distributer pipes where used, shall be wrapped in a geotextile filter fabric, or an impermeable geomembrane where infiltration is not acceptable and the filter drain is to be used as a conveyance feature.

6. Geotextile / geomembranes must be lapped by a minimum of 300mm.

C.5 Description Construction considerations

Special attention should be paid to the management of silt and sediment during the construction period.

Areas close to the location of the filter drains/trenches should not be subject to compaction prior to, during and after the construction of the facility particularly where infiltration is to be promoted.

*The KCC standard drawings are available in pdf. format which can be purchased for £108 (inc. VAT), To purchase a copy of the drawings please make a cheque for this amount payable to Kent County Council and send to the Agreements Team, Ashford Highway Depot, Javelin Way, Ashford, Kent, TN24 8AD. Please provide your contact details including email, with the cheque so the drawings can be swiftly sent to you.

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C.6 Description Maintenance and inspection issues

Litter and debris removal from trench surface, access chambers and pre-treatment devices on a monthly basis or as required.

Inspect inlets, outlets and inspection points for blockages, clogging, standing water and structural damage on a monthly basis.

Inspect pre-treatment systems, inlets, trench surfaces and perforated pipework for silt accumulation every six months. Establish appropriate silt removal frequencies as required.

Removal of sediment from pre-treatment devices every six months.

Removal and washing of exposed stones on the trench surface on an annual basis (bi-annual for the first year) or when silt is evident on the surface.

At locations with high pollution loads, remove surface geotextile and replace, and wash or replace filter media as required.

Rehabilitate infiltration or filtration surfaces as required.

Excavate trench walls to expose clean soils if infiltration performance reduces to unacceptable levels as required.

Clear perforated pipework of blockages as required.

Trimming of any roots that may be causing blockages on an annual basis (semi-annual for the first year).

Remove weeds on the trench surface initially on a monthly basis at start, then as required.

Remove tree roots or trees that grow close to the trench as required.

Replace geotextiles and clean and replace filter media, if clogging occurs as required.

C.7 Description References

1. BS 65:1991 Specification for Vitrified clay pipes, fittings and ducts, also flexible mechanical joints for use solely with surface water pipes and fittings
2. BS 4660:2000 Thermoplastics ancillary fittings of nominal sizes 110 and 160 for below gravity drainage and sewerage
3. BS 5911 Precast concrete pipes, fittings and ancillary concrete products
4. BS EN 1916:2002 Concrete pipes and fitting, unreinforced, steel fibre and reinforced
5. BS EN 13285:2010 Unbound Mixtures – Specifications
6. BS EN 13242:2002 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction
7. CIRIA C753 'The SUDS Manual,' 2015 or as updated.
8. Design Manual for Roads and Bridges HD 233/06 Volume 4 Section 2 Part 3 Surface and Sub-Surface Drainage Systems for Highways
9. Design Manual for Roads and Bridges HD 217/08 Volume 4 Section 2 Part 4 Alternative filter media and surface stabilization techniques for combined surface and sub-surface drains
10. Manual of Contract Documents for Highway Works Volume 1 Specification of Highway Works Series 500, Drainage and Service Ducts

Appendix D

Filter strips

D.1 Description

A filter strip is a gently sloping area of grass or vegetation with a uniform gradient. Surface water runoff flows as a sheet across the filter strip at a sufficiently low velocity to ensure sediments are filtered out along with associated pollutants.

Filter strips are often used as pre-treatment technique before other SuDS techniques to extend the life of downstream components. The extent of infiltration during intense storms tends to be limited as only a small proportion of the runoff is dealt with by the filter strip.

Filter strips are suitable for residential, commercial/industrial, high density and retrofit sites. They are not suitable for steep sites, contaminated sites and above vulnerable groundwater which do not have sub-surface liners or a suitable topsoil mix.

Filter strips are best suited to treating runoff from relatively small drainage areas or as a buffer between incompatible land uses and can provide locations for groundwater recharge in areas with pervious soils. They are also suitable for use adjacent to large impervious areas.

Photos D.1 – filter strip leading to a filter drain to the right (Source: Susdrain)

Filter strips encourage evaporation and are easily integrated into landscaping.

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D.2 Design requirements

Soil suitability: Topsoil on which the filter strip is built should drain well and must be suitable for supporting the growth of dense vegetation, preferably grass with a minimum depth of 150mm.

Sizing: Filter strips are typically 6m to 15m wide to provide sufficient water quality treatment; a reduced width may be provided for filter strips intended solely for pre-treatment. In these cases and with approval of Kent County Council, a minimum width of 3m would be acceptable for slopes of 2% and 5m for slopes greater than 2%.

Catchment area: The maximum 'length' of impervious area draining to filter strips should be controlled and should be no more than 25m to reduce the risk of sheet flows changing to concentrated flows and leading to erosion of the strip.

Topography: A minimum longitudinal slopes (i.e. in direction of flow) of 1% should be provided with a maximum slope of 5%. Level spreaders can be utilised on steeper slopes.

Location: Filter strips should be sited along the drainage area. Planting of trees with shrubs within filter strips should generally be avoided.

D.3 Environmental considerations in design

The use of filter strips and their location should be considered in conjunction with other landscaping and environmental measures which enhance biodiversity and amenity.

Filter strips have potential for wildlife pollinators or biodiversity mitigation measures if specified and managed effectively by:

- Seeding specification
- Vegetation cutting regime
- Inclusion of hibernacula e.g. log piles

For potential linkages to environmental projects with the site area contact KCC at biodiversity@Kent.gov.uk

A management plan for the filter strip shall be created which take account of any biodiversity management requirements and/or mitigation. This plan would be consulted with the Kent County Council Natural Environment team.

D.4 Mandatory submittal requirements

Environment Agency response/approval in areas where the soil beneath the filter strip is or may be potentially polluted.

D.5 Specifications and standard details

1. These notes shall be read in conjunction with drawing KCC/SD/IDG/D01 with all dimensions in millimetres.*

2. The filter strip surface should be planted with an appropriate grass mixture, or turfed. The grass or other planting specification used within the filter strip shall be submitted and agreed with Local Planning Authority or Kent County Council prior to construction.

3. Trees and dense scrub should generally be avoided on the filter strip, as this will make it difficult to maintain a vegetated surface and uniform slope required for a well-functioning filter strip.

D.6 Construction considerations

Care should be taken not to compact the soil below the filter strip during construction as this will reduce its capacity for infiltration.

It a large area of the filter strip is bare after four weeks, reseeding or replanting is required to achieve at least 90% coverage.

Special attention should be paid to the management of silt and sediment during the construction period.

If sediment from construction work accumulates on a filter strip, it should be cleared and the strip fully rehabilitated before the drainage system is adopted by the organisation carrying out the maintenance.

Vehicles should be prevented from trafficking the filter strip surface as this may cause rutting and changes to the profile.

*The KCC standard drawings are available in pdf. format which can be purchased for £108 (inc. VAT), To purchase a copy of the drawings please make a cheque for this amount payable to Kent County Council and send to the Agreements Team, Ashford Highway Depot, Javelin Way, Ashford, Kent, TN24 8AD. Please provide your contact details including email, with the cheque so the drawings can be swiftly sent to you.

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D.7 Maintenance and inspection issues

Litter and debris removal from filter strip surface on a monthly basis or as required.

Grass cutting to retain grass height within specified design range on a monthly basis during growing season, or as required.

Manage other vegetation and remove nuisance plants initially on a monthly basis at start, then as required.

Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where possible on an annual basis.

Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, if required. These should be done annually, or if bare soil is exposed over 10% or more of the filter strip area.

Repair erosion or other damage by re-turfing or reseeding as required.

Re-level uneven surfaces and reinstate design levels as required.

Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface as required.

Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip as required.

Remove and dispose of oils or petrol residues using safe standard practices as required.

Inspect filter strip surface to identify evidence of erosion, compaction, ponding, sedimentation and contamination (e.g. oils) on a six monthly basis.

Check flow spreader and filter strip surfaces for even gradients on a six monthly basis.

Inspect silt accumulation rates on a six monthly basis and establish appropriate removal frequencies.

D.8 References

1. CIRIA C753 'The SUDS Manual', 2015 or as updated.
2. NHBC Foundation, A simple guide to Sustainable Drainage Systems for housing, July 2010

Appendix E

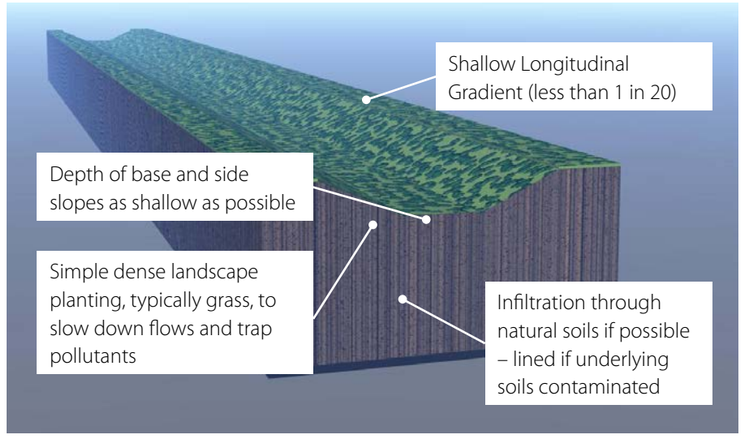
Swales

E.1 Description

A swale is a shallow vegetated linear depression with a flat base in which water can be stored or conveyed and pollutants can be removed. Water is conveyed at low flow velocities to allow a considerable amount of the suspended particulate load to settle out and provide effective pollutant removal. Swales also offer some attenuation and can be designed to allow infiltration where soil and groundwater conditions are appropriate. The dense vegetation slows flow velocities enabling some water to infiltrate into the ground. The vegetation also allows some water to evaporate and helps filter out pollution.

Photos E.1 and E.2 – example of a large scale swale (left) and small scale swale (right)

Swales are suitable for residential, commercial/industrial and contaminated sites/sites above vulnerable groundwater (so long as a liner is used). Swales have a limited use in retrofit or high density sites due to the space required.



Photos E.4 – typical swale (Source: WSP)

Swales are typically located next to roads but can also be located in landscaped areas, adjacent to car parks and in other open spaces. They are ideal for use on industrial sites because any pollution that occurs is visible and can therefore be dealt with before it causes damage to the receiving watercourse. Where adjacent to roads, protective measures should be considered to prevent vehicles overrunning into swales in key or sensitive locations.

Swales may be used for solely conveyance, include a filter bed or be designed to provide wet marshy conditions. Enhanced drainage beneath a swale will provide increased conveyance and infiltration capacity (infiltration where ground conditions allow), and will reduce the risk of localized ponding and marshy areas developing. The installation of drainage beneath swales can facilitate the construction of crossing points for footways/footpaths, driveways and utilities while maintaining the swale's conveyance capacity.

E.2 Design requirements

Soil suitability: Should not be sited on unstable or made ground.

Sizing: Velocities should be limited during extreme events to 1-2m/s (depending on soil type) to prevent erosion. Maximum depths should be between 400mm and 600mm. Depths may be increased if accompanied by a health and risk assessment.

Dimensions:

- The side slopes should normally be 1 in 4 or no more than 1 in 3 where soil conditions allow. Non-standard side slopes may be acceptable dependent on particular site application; these are to be agreed with Kent County Council prior to construction.
- Longitudinal gradients should not be greater than 4% (or 10% with check dams) as low velocities are required for pollutant removal and to prevent erosion.
- The base of the swale should not be less than 0.5m wide.
- A minimum swale length of 5m is recommended.

Topography: Usually restricted to sites without significant slopes, though careful planning should enable their use in steeper areas by considering contours of the site. The longitudinal slope should not exceed 4% (10% with check dams) as low runoff velocities are required for pollutant removal and to prevent erosion.

Groundwater: Where designed for infiltration the seasonably high groundwater table must be more than 1m below the base of the swale. Where infiltration is not required, the seasonally high groundwater level should be below the base of the swale.

Location: Swales are applicable to many situations. Locations immediately adjacent to carriageways must be agreed with Kent County Council.

Pre-treatment measure: Lateral inflow is preferred into swales; however entry into swales via a gully or pipe should include a flow spreader and erosion control at the inlet.

Topsoil and subsoil: Topsoil is to be a well-structured, clay loam "as dug" soil in conformity with BS 3882. To ensure successful planting operations and establishment, topsoil should be specified at a depth of 100mm for grass areas and minimum of 300mm for planted areas. The subsoil or filter media must be sufficiently permeable between 100mm/h and 300mm/h.

Underdrain: If utilised, underdrains should be a minimum diameter 100mm PVC perforated pipe with 150mm clean gravel above the pipe.

Planting: Swales may be grassed or have a greater vegetative complexity. The vegetation specification should reflect surrounding habitats, maintenance obligations and biodiversity requirements.

- The vegetation specification will need to withstand both wet and dry conditions.
- Planting should ideally provide a vegetation height approximately twice the depth of the water to be treated and ideally be 100mm to 200mm in height.
- Seeding to establish vegetation should be uniform and carried out early in the construction process as soon as soils are ready, and in the appropriate seasons, ideally late summer (August to September).
- Planting should not be provided in systems which are lined and in the vicinity of inspection chambers, sediment and debris traps.

Non-Woven Geotextile: these shall consist of needled nonwoven polypropylene fibres and meet the following properties:

Thickness at 2kPA – ≥ 1mm
Tensile Strength (longitudinal/transverse) – ≥ 8.0 kN/m^2
CBR puncture resistance – ≥ 1500 N
Cone drop test – ≤ 40mm
Opening size – ≤ 90 µm
Water permeability – ≥ 90 l/m^2/s

Impermeable Liner:, these shall meet the following minimum specification (ASTM):

Thickness – ≥ 1mm
Density – 0.9 g/cm^3
Tensile stress at yield – 16 N/mm^2
Elongation at break – > 500%
Puncture resistance – 170N

E.3 Environmental considerations in design

The use of swales and their location should be considered in conjunction with other landscaping and environmental measures which enhance biodiversity and amenity.

Swales have potential for use as connectors between high quality biodiversity areas. Their use should be assessed in relation to adjacent land uses. For potential linkages to environmental projects with the site area contact KCC at biodiversity@Kent.gov.uk.

A management plan for the filter strip shall be created which takes into account any biodiversity management requirements and/or mitigation. The management plan must be agreed with Kent County Council.

E.4 Mandatory submittal requirements

Infiltration test at specific site location as specified by design

Environment Agency response/approval

E.5 Specifications and standard details

1. These notes shall be read in conjunction with drawing KCC/SD/IDG/E01.*
2. Lining of swales adjacent to residential roads with an impermeable geomembrane is not generally considered necessary unless the site lies above a sensitive groundwater zone or within sites where there is an unacceptable risk posed by leaching of contaminants and groundwater pollution.
3. Check dams can be used for a variety of reasons including reducing flow velocities on steeper sloping swales or to demarcate re-treatment areas. Materials used for check dams can vary e.g. coarse aggregate, wooden boards, gabions or earth etc. Details of the ones proposed for use in a scheme must be agreed with the Local Planning Authority or the adopting authority prior to construction.
4. Vitrified clay pipes and fittings must comply with the relevant requirements of BS65 and be of 'normal' type and flexible mechanical joints.

*The KCC standard drawings are available in pdf. format which can be purchased for £108 (inc. VAT), To purchase a copy of the drawings please make a cheque for this amount payable to Kent County Council and send to the Agreements Team, Ashford Highway Depot, Javelin Way, Ashford, Kent, TN24 8AD. Please provide your contact details including email, with the cheque so the drawings can be swiftly sent to you.

5. Unreinforced and reinforced concrete pipes and fittings with flexible joints must comply with the relevant provisions of BS 5911.

6. Unplasticized PVC pipes, joints and fittings must comply with the relevant provisions of BS 4660.

7. The granular filter material, including the bed and surround to perforated distributer pipes (where used), shall be wrapped in a geotextile filter fabric or in an impermeable geomembrane where infiltration is not acceptable and the filter drain is to be used as a conveyance feature.

8. Geotextile / geomembranes must be lapped by a minimum of 300mm.

E.6 Construction considerations

Special attention should be paid to the management of silt and sediment during the construction period.

Stockpiling of soil for use within the vegetated feature shall be avoided whenever possible to minimise loss of physical quality, diffusion of oxygen and biological activity.

Soil shall not be handled in inappropriate conditions of weather and soil moisture i.e. during or shortly after heavy precipitation; when soil is in a waterlogged condition; when the ground is frozen or covered by snow; or, when there are pools of water on the grounds surface.

If sediment from construction work accumulates on a swale it should be cleared and the swale fully rehabilitated before the drainage system is adopted by the organisation carrying out the maintenance.

Vehicles should be prevented from running over the swale.

E.7 Maintenance and inspection issues

Litter and debris removal from swales on a monthly basis or as required.

Grass cutting to retain grass height within specified design range on a monthly basis during growing season, or as required.

Manage other vegetation and remove nuisance plants initially on a monthly basis on completion for 12 months, then as required.

Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where possible on an annual basis.

Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, if required. These should be done annually, or if bare soil is exposed over 10% or more of the filter strip area.

Repair erosion or other damage by re-turfing or reseeding as required.

Re-level uneven surfaces and reinstate design levels as required.

Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface as required.

Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip as required.

Remove and dispose of oils or petrol residues using safe standard practices as required.

Inspect filter strip surface to identify evidence of erosion, compaction, ponding, sedimentation and contamination (e.g. oils) on a six monthly basis.

Inspect inlets, outlets and overflows for blockages on a monthly basis, and clear if required.

Inspect infiltration surfaces for ponding, compaction and silt accumulation on a monthly basis or as required. Record areas where water is ponding for >48hrs.

Inspect inlets and facility surface for silt accumulation on a six monthly basis and establish appropriate removal frequencies.

E.8 References

1. BS 65:1991 Specification for Vitrified clay pipes, fittings and ducts, also flexible mechanical joints for use solely with surface water pipes and fittings

2. BS 3882:2007 Specification for topsoil and requirements for use

3. BS 4660:2000 Thermoplastics ancillary fittings of nominal sizes 110 and 160 for below gravity drainage and sewerage

4. BS 5911 Precast concrete pipes, fittings and ancillary concrete products

5. CIRIA C753 'The SUDS Manual', 2015

6. DMRB Volume 4 Section 2 Part 1 HA103/06 Vegetated drainage systems

7. Kent Design Guide, making it happen – landscaping

Appendix F

Trench soakaways

F.1 Description

A trench soakaway is an approved granular and/or modular cell filled trench and is typically a shallow feature.

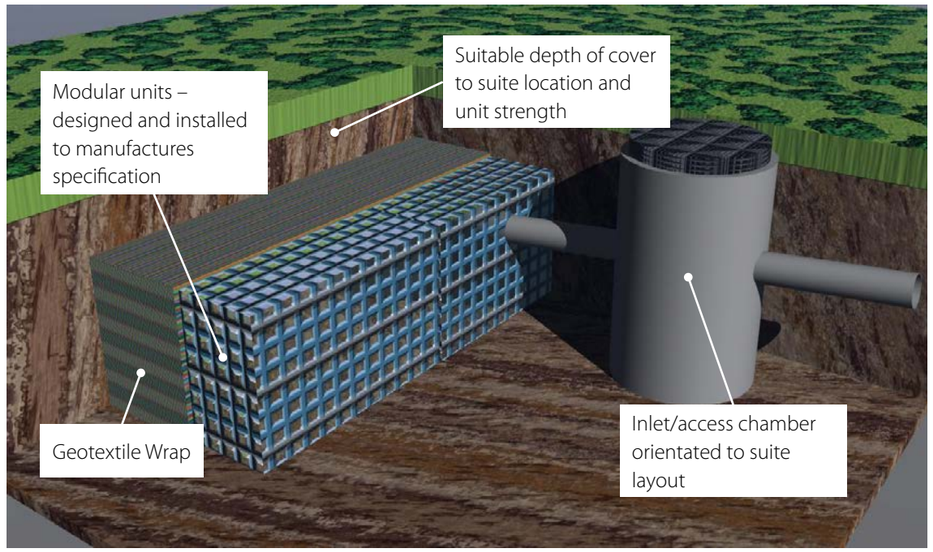


Image F.1 – example of a modular cell filled trench soakaway (WSP)

Trench soakaways can also be installed as linked measures. It must be noted that this places a greater burden on the initial soakaway in the sequence and its associated inlet pipe. The initial chamber in the series will consequently require a greater frequency of maintenance compared to a series of isolated trench soakaways. Banks of soakaways and their connecting pipes will effectively sterilise a large area.

F.2 Design requirements

Soil suitability: Infiltration testing must support the design and site selection. A minimum infiltration rate of 1 x 10^{-5} m/s is required for measures which are to be adopted and must be demonstrated through appropriate ground investigation. If less favourable conditions are present, consultation with Kent County Council must be undertaken prior to progressing the design.

Sizing: Soakaways must be designed to meet the surface runoff management requirements as specified within the design guide. The storage volume of device is required to be half-empty within 24 hours.

Catchment area: The maximum impervious area to be served by a soakaway shall be limited to 1,500m^2, excepting with consultation and approval of Kent County Council.

Dimensions: Depths to invert level of distributor pipes should be limited to 4 m, excepting with consultation and approval of Kent County Council. The minimum width of a trench soakaway shall be 300mm.

Inspection: Inspection chambers or observation wells will be provided at regular intervals. The distribution pipework is to run through the entire length of the trench soakaway with its extreme ends identified by inspection chambers or other access covers.

Groundwater: A minimum vertical distance of 1m must be provided below the bottom of the trench to the seasonally high groundwater table.

Separation distances: The outside of the trench soakaway must be setback 5m from the edge of the nearest building and should not be nearer than 10m to the nearest soakaway /soakaway trench.

Location: No trench soakaway may be constructed wholly or partly in made ground.

Pre-treatment measure: Pre-treatment is not required for roof drainage. If used for draining other surfaces then consultation with Kent County Council is required.

Underdrain: If utilised, underdrains should be a minimum diameter 100mm PVC perforated pipe with 150mm clean gravel above the pipe.

Aggregate: Aggregates used within the trench soakaway shall be Type B filter drain material, as described in Table 5/5 and Clause 505 of the Specification of Highway Works (Manual of Contract Documents for Highway Works).

Non-Woven Geotextile: these shall consist of needled nonwoven polypropylene fibres and meet the following properties:

Thickness at 2kPA – ≥ 1mm
Tensile Strength (longitudinal/transverse) – ≥ 8.0 kN/m^2
CBR puncture resistance – ≥ 1500 N
Cone drop test – ≤ 40mm
Opening size – ≤ 90 µm
Water permeability – ≥ 90 l/m^2/s

F.3 Mandatory submittal requirements

Infiltration rates at specific site locations and depths in general accordance with BRE Digest 365.

Highways Structural response/approval for soakaways located in or within 3.66m of the highway carriageway or having an internal span exceeding 900mm .

Environment Agency response/approval for soakaways located within a source protection zone.

F.4 Specifications and standard details

1. These notes shall be read in conjunction with drawing KCC/SD/IDG/F01.*
2. Vitrified clay pipes and fittings must comply with the relevant requirements of BS65 and be of 'normal' type and flexible mechanical joints.
3. Unreinforced and reinforced concrete pipes and fittings with flexible joints must comply with the relevant provisions of BS 5911.
4. Unplasticized PVC pipes, joints and fittings must comply with the relevant provisions of BS 4660.
5. The granular filter material, including the bed and surround to perforated distributer pipes (where used), shall be wrapped in a geotextile filter fabric or in an impermeable geomembrane where infiltration is not acceptable and the filter drain is to be used as a conveyance feature.
6. Geotextile / geomembranes must be lapped by a minimum of 300mm.

F.5 Construction considerations

Special attention should be paid to the management of silt and sediment during the construction period.

Areas close to the location of the trench soakaways should not be subject to compaction prior to, during and after the construction of the facility.

F.6 Maintenance and inspection issues

Check inlets and pre-treatment measures for sediment buildup and structural damage. Note if any sediment needs to be removed. Undertake cleaning prior to adoption.

Adequate access should be provided to an infiltration trench facility for inspection and maintenance.

* The KCC standard drawings are available in pdf. format which can be purchased for £108 (inc. VAT), To purchase a copy of the drawings please make a cheque for this amount payable to Kent County Council and send to the Agreements Team, Ashford Highway Depot, Javelin Way, Ashford, Kent, TN24 8AD. Please provide your contact details including email, with the cheque so the drawings can be swiftly sent to you.

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F.7 References

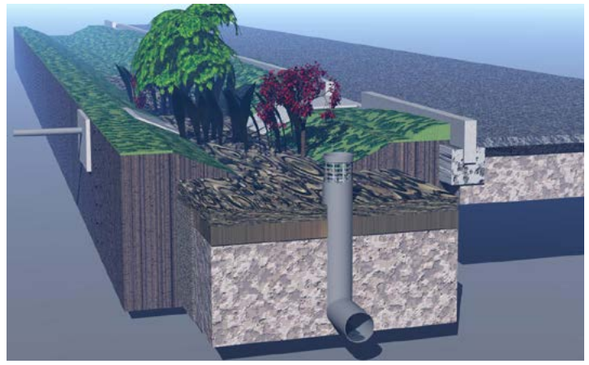
1. BS 65:1991 Specification for Vitrified clay pipes, fittings and ducts, also flexible mechanical joints for use solely with surface water pipes and fittings
2. BS 4660:2000 Thermoplastics ancillary fittings of nominal sizes 110 and 160 for below gravity drainage and sewerage
3. BS 5911 Precast concrete pipes, fittings and ancillary concrete products
4. BS EN 13285:2010 Unbound Mixtures – Specifications
5. BS EN 13242:2002 Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction
6. Building Research Establishment, BRE Digest 365, Soakaway Design, September 1991
7. CIRIA C753 'The SUDS Manual', 2015
8. DMRB Volume 2 Section 2 Part 8 Design of Soakaways HA118/06, 2006

Appendix G

Bioretention areas

G.1 Description

Bioretention areas are shallow, landscaped depressions or enclosures which are typically under-drained. They rely on engineered soils, enhanced vegetation and filtration to remove pollution and reduce runoff downstream. Bioretention areas typically receive road or hard surface runoff. Features that are normally designed to receive relatively clean roofwater are usually referred to as **raingardens**. Both features are aimed at managing and treating runoff from frequent rainfall events.



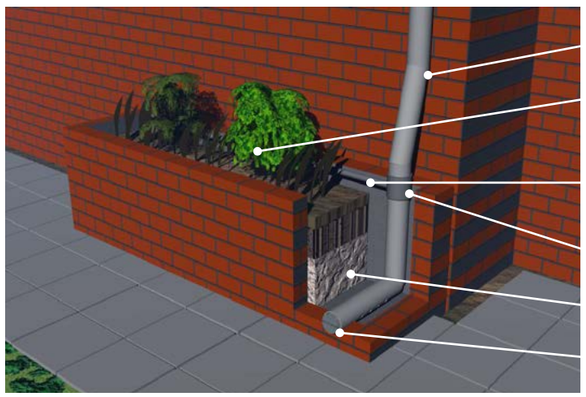


Image G.1 and G.2 – typical examples of Bioretention area (top) (Source: WSP), and Raingarden (bottom) (Source: WSP) (bottom).

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Photo G.3 – typical example of Bioretention area (Source: Susdrain)

Bioretention areas are suitable for residential, commercial/industrial, retrofit and contaminated sites/sites above vulnerable groundwater (so long as a liner is used). Raingardens and bioretention areas may not be suitable for high density sites.

G.2 Design requirements

Soil suitability: The bioretention volume normally includes free draining topsoil between 750mm and 1000mm deep but is dependent upon the planting regime.

Sizing / water quality: The bioretention system should have sufficient area to temporarily store the Water Quality Treatment Volume (Vt) at a maximum depth of 150mm on the surface. The water quality treatment should half drain within 24 hours to provide adequate capacity for multi-event scenarios. They should also have overflow/bypass facilities for extreme events.

Catchment area: The maximum area of 800m^2 is recommended for an individual bioretention system. Consultation should be undertaken with Kent County Council when smaller catchments are not possible.

Groundwater: If unlined, a minimum vertical distance of 1m must be provided below the bottom of the facility to the seasonally high groundwater table.

Topsoil and subsoil: Any source of top soil will be a well-structured, clay loam, "as dug" soil in conformity with BS 3882. To ensure successful planting operations and establishment, topsoil should be specified at a depth of 100mm for grass areas and minimum of 300mm for planted areas as a guide after settlement. The subsoil or filter media must be sufficiently permeable between 100mm/h and 300mm/h.

Planting: Bioretention areas generally have a greater vegetative complexity and should be planted with a wide range of species.

- Planting schemes should include about 10 species planted in 2 to 3 clumps per m^2. The usual planting density is 6 to 10 plants per m^2.
- Plant species should be able to withstand flooding. Plants to be avoided include those usually associated with dry/Mediterranean climates, e.g. Lavender, Azalea, Juniper and Chinese privet.
- Careful consideration should be given to any planting schemes within visibility splays with associated height restrictions.

Underdrain: If utilised, underdrains should be a minimum diameter 100mm PVC perforated pipe with 150mm clean gravel above the pipe.

Non-Woven Geotextile: for infiltration bioretention areas, these shall consist of needled nonwoven polypropylene fibres and meet the following properties:

Thickness at 2kPA – ≥ 1mm
Tensile Strength (longitudinal/transverse) – ≥ 8.0 kN/m^2
CBR puncture resistance – ≥ 1500 N
Cone drop test – ≤ 40mm
Opening size – ≤ 90 µm
Water permeability – ≥ 90 l/m^2/s

Impermeable Liner: for lined systems, these shall meet the following minimum specification (ASTM):

Thickness – 1mm
Density – 0.9 g/cm^3
Tensile stress at yield – 16 N/mm^2
Elongation at break – > 500%
Puncture resistance – 170N

G.3 Mandatory submittal requirements

Infiltration test at specific site location and depth as specified by design if used for infiltration.

Environment Agency response/approval if used for infiltration

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G.4 Specifications and standard details

1. These notes shall be read in conjunction with drawing KCC/SD/IDG/G01 and drawing KCC/SD/IDG/G02.*
2. A maximum 75mm mulch layer is to be spread over the bioretention area. Alternatively, a layer of pea shingle may be provided.
3. The sand filter should have a minimum thickness of 300mm and consist of sand with a grain size of 0.5 to 1mm.
4. The gravel around the underdrain should comprise 20mm to 5mm aggregate.
5. Plants to be used within bioretention areas shall be robust enough to withstand the pollution from the areas drained. The grass and other planting specification used within the bioretention areas shall be submitted and agreed with Local Planning Authority or the adopting authority prior to construction.
6. Lining of bioretention areas with an impermeable geomembrane is not generally considered necessary unless the site lies above a sensitive groundwater zone or within sites where there is an unacceptable risk posed by leaching of contaminants and groundwater pollution.
7. Vitrified clay pipes and fittings must comply with the relevant requirements of BS65 and be of 'normal' type and flexible mechanical joints.
8. Unreinforced and reinforced concrete pipes and fittings with flexible joints must comply with the relevant provisions of BS 5911.
9. Unplasticized PVC pipes, joints and fittings must comply with the relevant provisions of BS 4660.
10. The granular filter material, including the bed and surround to perforated distributer pipes where used, shall be wrapped in a geotextile filter fabric, or an impermeable geomembrane where infiltration is not acceptable and the bioretention system is to be used as a conveyance feature.
11. Geotextile / geomembranes must be lapped by a minimum of 300mm.

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G.5 Construction considerations

Special attention should be paid to the management of silt and sediment during the construction period.

Stockpiling of soil for use within the vegetated feature shall be avoided whenever possible to minimise loss of physical quality, diffusion of oxygen and biological activity.

Soil shall not be handled in inappropriate conditions of weather and soil moisture i.e. during or shortly after heavy precipitation; when soil is in a waterlogged condition; when the ground is frozen or covered by snow; or, when there are pools of water on the grounds surface.

Areas close to the location of the bioretention area should not be subject to compaction prior to, during and after the construction of the facility.

Bioretention areas should be constructed at the end of development, to minimize erosion and sediment generation.

G.6 Maintenance and inspection issues

Litter and debris removal from bioretention areas on a monthly basis or as required

Mulching – remove and replace on an annual basis.

Pruning and trimming of trees and vegetation – recycle back into mulch. Activity to be carried out every two years.

Scarify and spike topsoil layer to improve infiltration performance, and remove any thatch build-up. Activity to be carried out every three years and when mulching.

Water plants as required.

Weed areas as required, particularly during the first two years of establishment.

Removal of damaged or silt covered vegetation to a depth of 50mm below original design level as required.

Treatment of diseased planting as required.

Treatment and restoration of eroded areas as required.

Returf as required.

Reinstatement of design levels, restoration or improvement of infiltration and silt removal as required.

Inspect inlets, outlets and overflows for blockages, clogging, and clear if required on a monthly basis and after large storm events.

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Inspect infiltration surfaces for ponding on a monthly basis or when required. Record dewatering time of the facility to determine if maintenance is necessary.

Inspect inlets and facility surface for silt accumulation every six months. Establish appropriate silt removal frequencies as required.

Test planting soil for pH on an annual basis – if adjustment is necessary, amalgamate with appropriate substances.

G.7 References

1. Bray, B., Gedge, D., Grant, G. and Leuthvilay, L., Rain Garden Guide, 2012.

2. BS 65:1991 Specification for Vitrified clay pipes, fittings and ducts, also flexible mechanical joints for use solely with surface water pipes and fittings

3. BS 4660:2000 Thermoplastics ancillary fittings of nominal sizes 110 and 160 for below gravity drainage and sewerage

4. BS 5911 Precast concrete pipes, fittings and ancillary concrete products

5. Building Research Establishment, BRE Digest 365, Soakaway Design, September 1991

6. CIRIA C753 'The SUDS Manual', 2015

7. CIRIA C698 Site handbook for the construction of SuDS. London, 2007.

8. Graham, A., Day, J., Bray, B., and Mackenzie, S., Sustainable drainage systems – maximising the potential for people and wildlife. A guide for local authorities and developers. Prepared for RSPB and WWT. 2012.

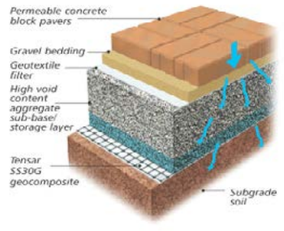
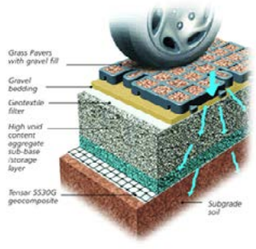
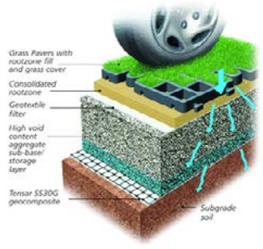
Appendix H

Permeable pavements

H.1 Description

Permeable pavements are pavements suitable for pedestrians and/or vehicular traffic which allow rainwater to pass through the entire pavement via gaps/joints on the pavement surface. They comprise a structural element for loading and a hydraulic element for water storage. Water is temporarily stored before infiltration to the ground, reuse, or discharge to a watercourse or other drainage system.

There are three main types of permeable pavements:

Paved surfaces	Gravel	Grass
Water either passes through the entire pavement via gaps/joints or through the pavement elements (blocks are porous)	Water passes through the pavement (voids in aggregate/ structure)	Water passes through the entire pavement via gaps/joints
		

Photos H.1, H.2 and H.3 – Permeable Paved Surface (left), Gravel Surface (middle), and Grass Surface (right) (Source: Interpave)

Surface water runoff passes through the pavement structure, leaving behind silt on or just below the surface. Oils and other pollutants are trapped on geotextiles or in the stone construction below the pavement surface. Pavements with aggregate sub-bases can provide good water quality treatment. Pollutants are then biodegraded by bacteria. Surface water runoff is stored in the structure before infiltrating or discharging to the management train.

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Photos H.3 and H.4 – Permeable paving in a residential development

Permeable paved surfaces are usually used within adoptable estate roads, parking bays and parking courts. Gravel and grassed permeable pavements are usually used within less formal parking and access ways within public open space.

This guide will focus on permeable paved surfaces, although a number of requirements contained in this guide are applicable to gravel and grassed permeable pavements.

There are three permeable paving systems:

System A total infiltration	Water passes through the entire pavement before infiltrating into the ground; there is no other sub-surface discharge from this system.
System B partial infiltration	Some water infiltrates into the ground whilst the remainder is drained by either perforated pipes or fin drains to swales, drainage systems, etc. This type of system can be used to control the areas where only limited infiltration is possible. There is some discharge from this system into another drainage network.
System C no infiltration	Water is contained and prevented from infiltrating due to the use of an impermeable membrane at formation level. This system is typically used within areas with high ground water, areas with very poor infiltration or areas with underlying contamination. The water is removed from the system by fin drains, perforated pipes, swales etc. All water is discharged from this system

The choice of pavement system depends upon the underlying geology and site conditions. Permeable pavements are suitable for residential, commercial/industrial, high density, retrofit and contaminated sites/sites above vulnerable groundwater with the use of a liner.

H.2 Design requirements

Adoptable highway: Permeable pavements may form part of the adoptable highway. In these instances the carriageway must comply with adoptable highway standards and must be approved by Kent County Council. Adoption of permeable pavements will only be considered where road speeds are less than 30 mph, on roads which are not designated bus routes, and on roads which carry less than 1,000 vehicles per day. Other sub-base approaches e.g. geocellular storage below permeable pavement will not be acceptable within a carriageway to be adopted.

Soil suitability: The permeability of the underlying soil together with the general ground conditions, especially the presence of contamination, will determine which paving system is to be designed. If infiltration is to be utilised, infiltration testing must support the design and site selection. A minimum infiltration rate of 1 x 10^{-5} m/s is required for measures which are to be adopted and must be demonstrated through appropriate ground investigation. If less favourable conditions are present, consultation with Kent County Council must be undertaken prior to progressing the design.

Catchment area: Permeable pavements may manage runoff from adjacent impermeable areas. The impermeable catchment area should not be greater than twice the area of the permeable pavement area. If a greater catchment area is proposed, then information should be submitted to demonstrate the management of risks associated with blockage and soil stability.

Topography: Permeable pavement is typically unsuitable for sites with significant slopes. Systems B and C should have a sub-surface gradient of about 1 in 200 towards the drainage outlets. For steeper slopes where the subgrade gradient exceeds 1 in 20, terraced areas of paving should be separated below the surface by compartmental walls.

Groundwater: If a permeable pavement is unlined, a minimum vertical distance of 1m must be provided below the bottom of the permeable pavement's sub-base and to the seasonally high groundwater table.

Location: Where any part of a permeable pavement conforming to either System A or System B is less than 5m from a building, measures must be taken to ensure that no infiltration is possible into the ground within the 5m zone. For instance by installing a sufficiently large impermeable membrane beneath the sub-base and lapping it vertically up at the edges of the permeable pavement.

Sub-base layer storage: The sub-base layer is specified as coarse graded aggregate in compliance with BS 7533-13 or Type 3 sub-base in accordance with of the Specification of Highway Works (Manual of Contract Documents for Highway Works). Design calculations should utilise a void ratio of 30% unless otherwise evidenced and tested to conform compliance on site for pavement suitability.

Non-Woven Geotextile: this shall consist of needled nonwoven polypropylene fibres and meet the following properties:

Thickness at 2kPA – ≥ 1mm
Tensile Strength (longitudinal/transverse) – ≥ 8.0 kN/m^2
CBR puncture resistance – ≥ 1500 N
Cone drop test – ≤ 40mm
Opening size – ≤ 90 µm
Water permeability – ≥ 90 l/m^2/s

Impermeable Liner: this shall meet the following minimum specification (ASTM):

Thickness – ≥ 1mm
Density – 0.9 g/cm^3
Tensile stress at yield – 16 N/mm^2
Elongation at break – > 500%
Puncture resistance – 170N

Outflow control: Storage within any extended pavement areas should be effectively management by compartmentalisation and inclusion of flow controls. Small orifice plates i.e. less than 100mm may be considered in these cases.

Kerb delineation: A concrete footing must be provided to delineate the edge of the permeable pavement.

Service Corridors: These should be considered early in the design process. Service corridors should be rationalised and delineated through varied surface finish e.g. asphalt/non-permeable pavement or changes to block paving arrangements or colour.

H.3 Mandatory submittal requirements

Infiltration test at specific site location and depth as specified by design.

Pavement design calculations.

H.4 Specifications and standard details

1. These notes shall be read in conjunction with drawing KCC/IDG/H01 and drawing KCC/SD/IDG/G02.*
2. Permeable pavements and sub-base construction are to be structurally designed for the vehicles to be used on site as well as the worst-case loading from the vehicles that can reasonably be expected to use the paved area.

*The KCC standard drawings are available in pdf. format which can be purchased for £108 (inc. VAT), To purchase a copy of the drawings please make a cheque for this amount payable to Kent County Council and send to the Agreements Team, Ashford Highway Depot, Javelin Way, Ashford, Kent, TN24 8AD. Please provide your contact details including email, with the cheque so the drawings can be swiftly sent to you.

H.5 Construction considerations

Special attention should be paid to the management of silt and sediment during the construction period.

Soil and other material must be prevented from contaminating the pavement surface and sub-structure.

Areas close to the location of the permeable pavements, especially Systems A and B, should not be subject to compaction prior to, during and after their construction.

Permeable paving that is to be subject to temporary loading or construction should use an additional flexible running course during the construction phase. This running course can be broken through once the construction phase is complete to allow infiltration to the protected sub-base.

H.6 Maintenance and inspection issues

Surfaces are to be brushed at least twice a year: end of winter and after autumn leaf fall, or as required based on site specific observations or paving manufacturer's recommendations.

Where grass is located adjacent to permeable pavements, the vegetated surface must be more than 50mm from the level of the paving; remediation steps must be taken if this distance has reduced.

Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users as required.

Rehabilitation of surface and upper sub-structure as required especially if infiltration performance is reduced as a result of significant clogging.

Installation shall be inspected on completion and monthly for first three month after completion.

Inspect for evidence of poor operation and/or weed growth on a three monthly basis and after large storm events. If required take remedial action.

Inspect surface and any inspection chambers for silt accumulation rates and establish appropriate brushing frequencies on an annual basis.

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H.7 References

1. BS 7533-13: 2009, Guide for the Design of Permeable pavements Constructed with Concrete Paving Blocks and Flags, Natural Stone Slabs and Setts and Clay Pavers.
2. Building Research Establishment, BRE Digest 365, Soakaway Design, September 1991
3. CIRIA C582 Source control using constructed pervious surfaces: hydraulic, structural and water quality performance issues. Pratt, C., Wilson, S., and Cooper, P. London, 2002.
4. CIRIA C753 'The SUDS Manual' or as updated.
5. Interpave, Permeable Pavements: Guide to the design, construction and maintenance of concrete block permeable Pavements. Edition 6, 2010.

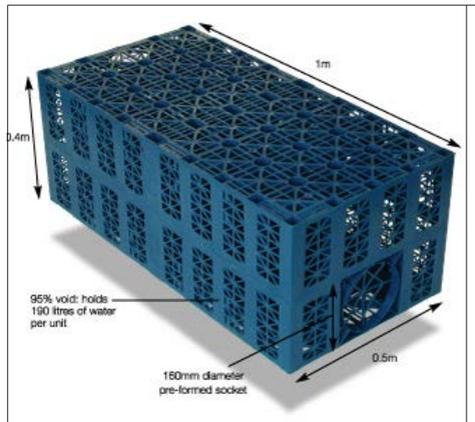
Appendix I

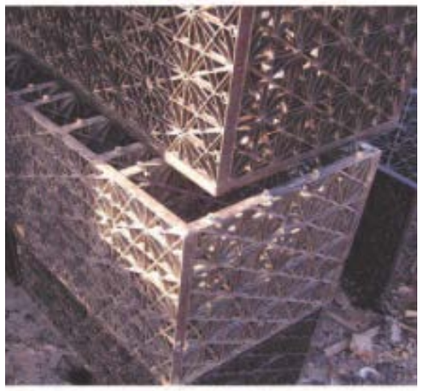
Geocellular systems

I.1 Description

Geocellular systems are below-ground structures which can be used for both infiltration and storage. They are unable to treat water so therefore surface water runoff must be treated before entering any such geocellular system. They are all fitted with a control structure to limit the discharge rate and the volume of water they can attenuate is dependent on their individual configurations.Geocellular/modular structures are suitable for residential, commercial/industrial, high density and retrofit schemes. They can also be used for contaminated sites/sites above vulnerable groundwater if they use a suitable impermeable liner.

A variety of geocellular unit types and configurations are available, such as shallow sub-base replacement infiltration systems for use within parking areas, deep large attenuation tanked systems for use in open fields, and relatively small soakaway installations to serve a small number of dwellings, etc.





Photos I.1 and I.2 – Examples of different types of Geocellular Units

Photos I.3 and I.4 – Examples of different types of Geocellular Unit Installations

I.2 Design requirements

GENERAL

Design Guide: Geocellular systems are underground structures and their design should be considered as such. Due to the different types of geocellular systems available and their different ground–structure interactions, consideration should be given to detail in the current CIRIA report C680 'Structural Design of Modular Geocellular Drainage Tanks'.

Soil suitability: The underlying permeability and ground conditions (contamination etc.) will determine the geocellular system to be designed. If ground conditions are suitable for infiltration then a geotextile protective layer will be required or if low infiltration or contamination is present them attenuation with an impermeable geomembrane liner will be required.

Pre-treatment measure: Catchpits, separators, and other pre-treatment features must be used upstream of inlets to geocellular systems to control siltation and blockage.

Structural stability: The structural specification consists of the unit's structural properties, the geotextile and/or membrane utlised and the backfill material. Information will be required to demonstrate the suitability of the units and materials selected.

Flow distribution: Manifolds may be necessary to split flows entering any tanked system to ensure the system operates efficiently within the cellular internal structure.

Venting: Sufficient venting is necessary in any system which has symphonic roof drainage discharging into the tank to prevent uplift pressures.

Access: Designs should cater for adequate access to permit easy internal inspection and any long term maintenance.

In addition to the above, the following should also be considered for both infiltration and attenuation systems:

INFILTRATION SYSTEMS

Groundwater: A minimum vertical distance of 1m must be provided between the base of the geocellular structure andthe seasonally high groundwater table.

Non-Woven Geotextile: for infiltration systems this shall consist of needled nonwoven polypropylene fibres and meet the following properties:

Thickness at 2kPA – ≥ 1mm
Tensile Strength (longitudinal/transverse) – ≥ 8.0 kN/m^2
CBR puncture resistance – ≥ 1500 N
Cone drop test – ≤ 40mm
Opening size – ≤ 90 µm
Water permeability – ≥ 90 l/m^2/s

ATTENUATION SYSTEMS

Groundwater: Flotation can occur if tanked attenuation systems are located below the water table. This should be considered in the design.

Impermeable Liner: for lined systems, these shall meet the following minimum specification (ASTM):

Thickness – ≥ 1mm
Density – 0.9 g/cm^3
Tensile stress at yield – 16 N/mm^2
Elongation at break – > 500%
Puncture resistance – 170N

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I.3 Mandatory submittal requirements

Infiltration test at specific site location and depth as specified by design in general accordance with BRE Digest 365.

Test results of geocellular units appropriate to the geotechnical category classification.

Provision of a geotechnical statement or report to include description of the ground conditions, standards or design guides applied, any design calculations, recommendations for construction, supervision, monitoring and maintenance.

Details of geocellular tanks (including details such as venting arrangements) must be agreed with Kent County Council prior to construction.

Environment Agency response/approval for soakaways located within a source protection zone.

I.4 Specifications and standard details

1. These notes shall be read in conjunction with drawings KCC/IDG/I01 and KCC/IDG/I02* showing a typical geocellular tank arrangement. Please note that as there are several acceptable arrangements of geocellular tanks, these drawings are provided for guidance only.

I.5 Construction considerations

Special attention should be paid to the management of silt and sediment during the construction period. Runoff should be prevented from entering the geocellular system during construction.

Where geocellular structures are constructed in places which have received little vehicle traffic their excavations can generally be backfilled with selected, as-dug material that does not contain large particles or sharp materials. It should then be well compacted.

- In tracked areas the choice of the material to be used as backfill and cover is particularly important. Back fill material should be selected to ensure structural support and integrity and to ensure that the structural frame is not overstressed or moves excessively, which could then lead to structural failure.

If a geomembrane is to be used it may need protection from the backfill by a geotextile fleece.

The installation area should be protected from construction traffic. Areas close to or within the location of the geocellular tanks should not be subject to compaction prior to, during and after the construction of the facility.

*The KCC standard drawings are available in pdf. format which can be purchased for £108 (inc. VAT), To purchase a copy of the drawings please make a cheque for this amount payable to Kent County Council and send to the Agreements Team, Ashford Highway Depot, Javelin Way, Ashford, Kent, TN24 8AD. Please provide your contact details including email, with the cheque so the drawings can be swiftly sent to you.

Where geocellular systems are to be subject to temporary or construction vehicle traffic loading, an adequate assessment shall be made available to Kent County Council to confirm they are able to withstand these loadings. Running heavy plant over constructed tanks or stockpiling material over them during construction when such loads have not been included within design calculations may cause collapse.

All storage tanks should be fully sealed in accordance with waterproofing standards (i.e. welded joints rather than adhesive taped) and the integrity of the seal checked through the use of non-destructive testing to ensure it is leak proof.

I.6 Maintenance and inspection issues

Inspect and identify any areas that are not operating correctly monthly for the initial three months, thereafter on an annual basis.

Debris removal from catchment surface (where debris may cause risks to performance) on a monthly basis.

Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter on a monthly basis and after large storm events. Remove and replace surface infiltration medium as necessary.

Repair/rehabilitation of inlets, outlet, overflows and vents as required.

Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed on an annual basis and after large storm events.

I.7 References

1. Building Research Establishment, BRE Digest 365, Soakaway Design, September 1991

2. CIRIA C753 'The SUDS Manual', or as updated.

3. CIRIA C698 Site handbook for the construction of SuDS. London, 2007.

4. CIRIA report C680 'Structural Design of Modular Geocellular Drainage Tanks'.

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Appendix J

Headwalls and outfalls

J.1 Description

Headwalls and outfalls form the physical connection between piped system into a ditch or watercourse. These can also form the connection from a SuDS feature into a culvert under a road or embankment. Different types and configurations of headwalls and outfalls can be used, but owing to the large number of them, only the following types are shown in these standard drawings* for guidance:

KCC/HTW/500/039 – Headwall Type 1 (Concrete)

KCC/HTW/500/040 – Headwall Type 2 (Brickwork)

KCC/HTW/500/041 – Headwall Type 3 (Stepped Brickwork)

Photo J.1 – Example of a brick headwall

*The KCC standard drawings are available in pdf. format which can be purchased for £108 (inc. VAT), To purchase a copy of the drawings please make a cheque for this amount payable to Kent County Council and send to the Agreements Team, Ashford Highway Depot, Javelin Way, Ashford, Kent, TN24 8AD. Please provide your contact details including email, with the cheque so the drawings can be swiftly sent to you.

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Trash racks and security screens are in general only applicable for large inlets and outlets. Security screens should be provided where there is a significant risk to the general public. Hazards with potentially high risk include:

Long culverts (greater than 50m)

Culverts that have potential of flowing full

Culverts with steep gradients with swift flow velocities

Culverts with internal hazards such as steps in a bed or a hydraulic jump

Designs should avoid the need for a screen and alternative approaches should be considered before a decision to provide a trash or security screen is made (see guidance contained in the EA's 'Trash and Security Screen Guide 2009'.

J.2 Design requirements

Direction: Discharge should be directed in the general direction of flow in the receiving water course. Direction at right angles should be avoided if at all possible and should never discharge against the oncoming flow.

Bank protection: If the outfall is at an angle greater than 45o to the direction of flow then scour protection should be provided on the opposite bank of the receiving water course.

Headwall: The headwall should be keyed into the banks and bed to prevent erosion. The angle of inlet/outlet header walls should follow the profile of the ground to reduce their visual prominence where possible.

Outlet velocity: Where the velocity of the peak outflow exceed 1m/s then some form of energy dissipation will be required. If outlet pipe velocities exceed 1.4m/s and cannot be reduced through design, advice of the adoption authority and/or consenting authority should be sought. See J3 below for a list of those authorities.

Flap valves: Flap valves may required by the Highway Authority to protect operation of the highway systems. This may have adverse effects on the capacity of the drainage system which should be allowed for within design.

Invert: Where a piped system discharges into an existing ditch or watercourse the pipe invert must not be lower than the level of the average flow in the ditch or watercourse and under no circumstances less than 150mm above the ditch or watercourse invert.

J.3 Mandatory submittal requirements

All headwall and outfall details must be agreed with KCC prior to construction.

Structural approval is required from Kent County Council Highways Structures where the retained height of the construction is equal to or greater than 1.4m.

Structural approval is required from KCC Highways where the pipe diameter exceeds 900mm and is located beneath a highway.

Environment Agency response/approval is required for outfalls into main rivers.

Land drainage consent may be required from either Kent County Council or the appropriate IDB for outfalls into an ordinary watercourse.

The written consent of the owner of the land where the headwall or outfall is to be constructed will be required. If the developer is himself the landowner then written confirmation of that fact will be required

J.4 Specifications and standard details

1. These notes shall be read in conjunction with drawings KCC/SD/IDG/J01 to J06*.

2. The standard details accompanying these notes are applicable to headwalls and outfalls where the ground level difference either side of the structure is 1400mm or less; where the ground level difference is greater than 1400mm, structural approval is required from Kent County Council Highway Structures.

3. Trash screens and security grilles are applicable only for large headwalls and outfalls. Further guidance on the assessing the need for and design of these features can be found in the Environment Agency Trash and Security Screen Guide 2009.

4. Energy dissipation measures at outfalls are required where outfall velocities are high (see J2). Examples include rip-rap aprons, stone pitching, use of gabion blankets, use of granite sets, etc. A stilling basin can, if necessary, be provided to reduce the velocity" after "use of granite setts, etc.

*The KCC standard drawings are available in pdf. format which can be purchased for £108 (inc. VAT), To purchase a copy of the drawings please make a cheque for this amount payable to Kent County Council and send to the Agreements Team, Ashford Highway Depot, Javelin Way, Ashford, Kent, TN24 8AD. Please provide your contact details including email, with the cheque so the drawings can be swiftly sent to you.

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J.5 Construction considerations

Special attention should be paid to the management of silt and sediment during the construction period.

Dewatering and settlement lagoons or tanks may be required to retain contaminated water when constructing the headwall or outfall within the receiving watercourse. The Environment Agency's PPG5 provides guidance in relation to its requirements for settlement lagoons or tanks.

J.6 Maintenance and inspection issues

Litter and debris removal from headwalls and outfalls on a monthly basis or as required.

Grass cutting to retain grass height within specified design range on a monthly basis during growing season, or as required.

Manage other vegetation and remove nuisance plants initially on a monthly basis at start, then as required.

Inspect inlets and facility surface for silt accumulation on a six monthly basis and establish appropriate removal frequencies after major storms.

Repair erosion and other damage as required.

J.7 References

1. CIRIA C753, 'The SUDS Manual', 2015.

2. CIRIA C689 'Culvert design and operation guide', 2010.

3. DMRB Volume 4 Section 2 Part 1 HA78/96 Design of outfalls for surface water channels.

4. DMRB Volume 4 Section 2 Part 7 HA107/04 Design of outfall and culvert details.

5. Environment Agency, 'Trash and Security Screen Guide', 2009.

6. Environment Agency, Pollution Prevention Guidelines – Works and maintenance in or near water: PPG5, October 2007.

Appendix K

Carriageway inlets

K.1 Description

Carriageway inlets are features which allow surface water runoff directly from roads and carriageways into adjacent SuDS features.

There are a large number of arrangements and propriety types available. As a result, those shown in the standard drawings* KCC/SD/IDC/K01 are for guidance only.

K.2 Design requirements

Design arrangements:

- Provided with suitable spacing and falls to adequately drain the carriageway.
- Should minimize hazard to people and road users.
- Should prevent erosion to the downstream drainage feature.
- should be designed so as not to be too visually intrusive

Grass surface: the receiving grass surface should be 20mm to 30mm below the kerb edge.

Kerb openings: should be sufficient to prevent channelling and blockage and minimise erosion; normally widths of 300mm to 400mm, increasing to 600mm if flow direction is at an angle.

Energy dissipation: gravel strips, tactile pacing blocks or other appropriate measures should be utilised to spread the flow downstream of kerb edges.

Maintenance: Inlets should be simple, robust and easily maintainable. They should be easy to inspect, clean and repair.

K.3 Mandatory submittal requirements

All inlet details must be agreed with Kent County Council prior to construction.

K.4 Specifications and standard details

These notes shall be read in conjunction with drawings KCC/SD/IDG/K01.*

K.5 Construction considerations

Special attention should be paid to the management of silt and sediment during the construction period.

K.6 Maintenance and inspection issues

Litter and debris removal from carriageway inlets on a monthly basis or as required.

Inspect inlets and facility surface for silt accumulation on a six monthly basis and establish appropriate removal frequencies.

K.7 References

1. CIRIA C753 'The SUDS Manual', 2015.

*The KCC standard drawings are available in pdf. format which can be purchased for £108 (inc. VAT), To purchase a copy of the drawings please make a cheque for this amount payable to Kent County Council and send to the Agreements Team, Ashford Highway Depot, Javelin Way, Ashford, Kent, TN24 8AD. Please provide your contact details including email, with the cheque so the drawings can be swiftly sent to you.

Appendix L

Piped drainage

A.1 General

Surface water from the highway may be collected by means of gullies and gully connections, channel and grating systems or combined drainage and kerb systems and must be discharged through pipes of not less than 150mm diameter to an adequate sewer, drain, ditch, swale, watercourse, wetland or lagoon or, where sufficient permeability is obtainable, to soakaways. Please note where a system is to be adopted a 150mm diameter pipe is only acceptable for gully connections, a pipe diameter of 225mm minimum should be provided between chambers.

A.2 Design of Highway Drainage Networks

Small catchments up to 1000m^2:

- An assessment will be required to verify compliance with the above and that there are no flooding issues arising from this simple design.

- An assessment will be required to verify that there are no flooding issues arising from this simple design.

Larger catchments between 1000m^2 and 1ha:

- Calculations must be submitted to Kent County Council.

- The 'Rational (Lloyd Davies)' method must be used for the design as set out in Road Note 35 'A guide for engineers to the design of storm sewer systems' published by HMSO and used in conjunction with the 'Tables for the Hydraulic Design of Pipes, Sewers and Channels (7th edition)', published for hydraulics research by Thomas Telford Ltd.

- To assist in the checking of the drainage calculations, a design sheet based on Table 1 of Road Note 35 should be used and submitted to us on A4 paper for approval.

- An assessment will be required to verify that there are no flooding issues arising from this simple design.

Catchments over 1ha or any site where there is risk of flooding of the highway or adjacent properties:

- These will need to be modelled using a computerised drainage package such as Windes by Microdrainage.

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A.3 Design Parameters for Pipe Networks and Gully Spacing

The following parameters must be used for pipe network and gully spacing designs:

- Time of entry – normally 2 minutes.
- Minimum self-cleansing velocity in pipework – 0.75 m/sec.
- Full bore velocity should generally be limited to 3m/sec by use of back drop manholes or cascades where necessary, but only with our approval.
- Impermeability factor – 1.0 over whole width of highway (including footways and verges).

A.4 Highway Drainage Systems - Specification

- Highway drains must be laid in straight lengths and within the existing or proposed highway, unless it is impracticable to do so. The edge of the excavation should not normally be closer than 600mm to the proposed kerb line or edge of carriageway. Where it is necessary to lay pipes through areas of fill, special precautions must be taken and our approval sought.

- Chambers must be provided at all changes of direction and grade, at the head of all drains and branches, at every junction of two or more drains, except gully connections, and where there is a change of size of pipe. The spacing of chambers should not in any case exceed 100m. Chambers must not be located within the carriageway at junctions or roundabouts without our prior approval. At difficult sites where approval is given they must not be sited at or near the centre of the carriageway or within the wheel track.

- Chambers must be positioned so maintenance vehicles have easy access that causes the minimum disruption to highway users.

- Chambers must have a minimum diameter of 1200mm. Access shafts must be a minimum internal clearance of 600mm square. Safety chains must be provided across pipes in chambers where pipes are 600mm or greater. Step irons must be provided for chambers up to 3.0m deep. Step irons are not permitted for chambers greater than 3.0m deep andladders must be provided for chambers greater than 3.0m deep.

- Minimum clearance of 300mm should be maintained where a pipe crosses any other piped or ducted service and care should be taken to avoid differential settlement. If it should be necessary to lay two pipes, drains or sewers in the same trench the clear horizontal distance between the barrels must be 450mm, and the proposed chamber details must be submitted for approval to us and the appropriate Drainage Undertaker.

- The basis for design of highway drains up to and including 900mm diameter, including gully connections and sewers must be BS EN 752. The type and class of both pipe and bedding, which must be determined by the ground conditions, the proposed cover to the pipe, the design loading and the trench width, must be shown on the drawings.

- Calculation of design loads and bedding factors must be in accordance with the Simplified Table of External Loads on Buried Pipelines, issued by the Building Research Station and published by HMSO. All calculations for design loads must be submitted to us for approval.

- Highway drains and sewers greater than 900mm diameter are classified as highway structures and must be approved by Kent County Council Highways Structures team.

- As far as possible, the pipe cover must be at least 1.2m within the highway or wherever it may be subject to heavy wheel loads. Elsewhere the minimum cover must be 0.9m. If it should be impossible to provide the cover specified above, the pipe must be of extra strength and surrounded by 150mm thick ST2 concrete and provided with flexible joints at no more than 5m centres.

- Gullies should preferably connect directly into chambers, but if this is not possible they must be connected to the main pipe by means of 45º oblique angled junctions or be saddled at an oblique angle and surrounded by ST2 concrete. Gully connections must not be longer than 20m and a separate connection provided for each gully. Alternatively carrier drains may run directly between gullies with gully connections serving no more than two gullies.

- In normal circumstances each gully must not drain more than 200m^2 of catchment area and gullies must not be spaced at intervals greater than 45m, except at summits where the first gully should not be more than 45m from the high point. Double gullies must always be provided at sag points, low points, entrances to shared surfaces and before traffic calming features, each with its individual connection to the main sewer.

- Gullies should be sited upstream of the tangent point at road junctions so that surface water in the channel does not flow across the junction. Care should be taken to avoid ponding in the vicinity of the mid-point of the radius kerbs.

- Where super-elevation is provided, a gully should be sited just short of the point where adverse camber is removed to prevent water in the upstream channel flowing across the carriageway. Care should be taken to avoid ponding in the transition length when the longitudinal gradient is flat or where there are traffic islands, central reserves or traffic calming measures.

- Gullies must not be sited directly within pedestrian crossing points or driveways, and wherever practically possible, must be located directly upstream of the crossing point.

A.5 Catchpits

- Catchpits must be provided before each soakaway or outfall. Catchpits must have a minimum sump depth of 600mm below the invert of the outlet pipe. Catchpits must be sealed unless there is no subsidence or contamination risks in allowing leakage from the catchpit. The Environment Agency may also require the inclusion of oil interceptors and must be consulted in all cases concerning such requirements.

A.6 Pipes, Pipe Trenches, Laying and Jointing Pipes

- Vitrified clay pipes and pipeline fittings for highway drains must comply with the relevant requirements of BS 65 and be of 'normal' type with flexible mechanical joints. Extra chemically resistant pipes and fittings must comply with the relevant provision of BS 65.
- Unreinforced and reinforced concrete pipes and fittings with flexible joints must comply with the relevant provisions of BS 5911: Part 100.
- Ductile iron pipes, fittings and joints must comply with the relevant provisions of BS EN 545.
- Unplasticized PVC pipes, joints and fittings must comply with the relevant provisions of BS 4660 or BS 5481. Solid wall concentric external rib-reinforced unplasticized PVC sewer pipes must comply with the relevant provisions of Water Industry Specification No. 4-31-05 (published by the Water Research Council).
- Concrete pipes must be spigot and socket. Ogee joints must not be used. Where necessitated by sulphates in the soil, sulphate resistant pipes with concrete bed and surrounds must be used. The concrete must be compacted to give a dense mix, using suitable vibration methods for all concrete in surrounds to gullies, chambers and the like and in all other cases where practicable. The type and class of both the pipe and bedding are to be stated on the drawings.
- The open end of the last pipe must be sealed whenever work is suspended using an approved plug to prevent the entry of harmful material. The end of any pipe to receive a future connection or extension must be fitted with an approved stopper or seal. Its position must be recorded with details handed to us and wherever possible the position must be suitably marked on the ground.
- The pipe must not be covered or backfilled until it has our approval. All drains and gully leads must pass an air test in accordance with Clause 509 of the Specification.

- In addition to the requirements of Clause 509 all highway drains, gully connections, and road gullies must be completely cleaned of all detritus and foreign matter both at the beginning and end of the maintenance period. If any extraneous matter from the development site enters an existing road drain or public sewer, you will be responsible for its removal.
- Granular bed and surrounds to pipes need to be wrapped in a geotextile filter fabric in ground conditions susceptible to piping

A.7 Gullies

Gully pots must accord with Clause 508 of the Specification and the following:

- Gully pots must be 450mm internal diameter and 900mm deep with 150mm diameter outlet and manufactured in accordance with BS 5911 Part 230 or BS EN 295. The outlet must be fitted with an appropriate trap and rodding eye unless agreed otherwise by us. Alternatively plastic gully pots of approved manufacture, or brick or precast concrete sectional catchpits may be used subject to our approval. Gully pots and sectional catchpits must be bedded on ST4 concrete and surrounded with 150mm thickness of ST2 concrete and must be connected to the main sewer by means of 150mm diameter clay, concrete or UPVC pipes, bedded and surrounded by 150mm thick ST2 concrete, whenever the cover to the pipe is less than 1.2 m, and provided with flexible joints at no more than 5m centres.

- All gully gratings and frames must be non-rocking and cast iron, to BS EN 124, Class D400 with a 900 cm^2 minimum area of waterway, and a minimum frame depth of 150mm. The gratings must not have longitudinal slots capable of arresting a cycle wheel.

- Gully frames must be set on a minimum of 2 and maximum of 4 courses of Class B Engineering bricks. Engineering bricks must be to BS 3921.

- Gratings and frames to gully pots must be fixed so that the top of the frame is set, initially, slightly below the binder course of the carriageway. They must be re-set 6mm below the level of the surfacing layer and the other ironwork flush with the surfacing layer. Tile slips and the like must not be used for adjustment of levels. Gully gratings and frames must be raised on epoxy mortar.

A.8 Chambers

- Chambers will either be Manholes, Catchpits or Inspection Chambers and must be in accordance with Clause 507 of the Specification and the DTp Highway Construction Details Drawing Nos F3 and F12 or Sewers for Adoption Fig 1-7.

- Chambers must also accord with the following:
  – All chamber, taper and shaft sections are to be surrounded with 150mm of ST2 concrete
  – All covers and frames must be cast iron, non-rocking, to BS EN 124, Class D400 with a 600mm diameter clear opening and a minimum frame depth of 150mm.

- In some urban areas and in areas liable to flooding we may require a larger opening and may have a preference for a different type of cover. In such situations you must consult with us.

- As far as possible, the necessity for backdrop connections should be avoided by lowering the pipe approaching the chamber, but where this is impractical or where it would result in a velocity of flow exceeding 3.0 m/sec, either a properly constructed backdrop connection or some suitable arrangement to reduce the velocity will be required. In cases of difficulty we must be consulted.

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- In a chamber at a change of size of pipe, the soffit or crown levels of the two pipes, where conditions permit, must be the same. The soffit level of a smaller pipe must not be below that of a larger pipe.

- Chambers in fields must be to the general requirements of the landowner and will generally require easements for access purposes. Although buried chambers are not normally acceptable, where these are necessary, approved location marker posts must be provided in agreed positions.

- Chamber covers, frames and other ironwork must be fixed so that the top of the frame is set at the level of the binder course of the carriageway. They must be set or re-set to the final level prior to the laying of the surfacing course.

- Where chambers are classified as structures, structural approval is required.

A.9 Channel and Grating Systems and Combined Drainage and Kerb Systems

- In some situations it may be more appropriate to provide channel and grating systems or combined drainage and kerb systems such as 'Beany Blocks' or similar. Such systems may be preferable where the longitudinal gradient is flat and/or at locations where Statutory Undertakers' apparatus is situated.

- It will be necessary to determine the amount of discharge in order to establish whether the outfall drain has sufficient capacity. These systems are to be sealed to prevent egress of water to the adjacent subgrade.

- Access covers must be provided at either end of each run and at a maximum spacing of 50m to enable ease of maintenance.

- Silt traps must be provided immediately prior to an outfall and at low points in the run. It is recommended that the silt traps drain up to a maximum of 200m2. All silt traps must have an access cover. Additional silt traps may be required at locations where significant leaf fall is anticipated.

- Joints in kerb drain systems must be sealed using a proprietary sealant.

- Wildlife friendly drainage measures must ensure appropriate collection of surface water. Commercial products are available and should be considered as appropriate.