# Sustainable Drainage Systems Design and Adoption Guide

Essex County Council July 2012



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# 1.0 INTRODUCTION

>>Wetlands, Frieberg, Germany

#### **1.0 INTRODUCTION**

#### 1.1 Surface water and urbanisation

Sustainable Drainage Systems (SuDS) are nothing new. They have been nature's way of dealing with rainfall, since time began. At its simplest, rain falling on the land may evaporate or be absorbed into the soil, nourishing our natural habitat, or else flows overland into ponds, ditches, watercourses and rivers, helping to sustain life by replenishing our precious water resource.

It is only recently that the balance of this natural water cycle has been disrupted. Modern urban development with its houses, roads and other impermeable surfaces has increasingly altered the way that rainwater finds its way into our soils, rivers and streams. Surface water has for many years been allowed to be collected and piped directly into our ditches and rivers. Conveying water away as quickly as possible from a development may adequately protect the immediate development from flooding but increases the risk of flooding occurring downstream. This unsustainable approach to surface water drainage, together with the potential effects of a changing climate, has contributed to some very serious consequences on life, property and the environment as evidenced by the disastrous flooding experienced throughout the UK during the summer of 2007.

#### 1.2 The Flood and Water Management Act

The Flood and Water Management Act 2010 was introduced in April 2010 to address the concerns and recommendations raised in the Pitt Report following the 2007 floods. The Act has and will have many implications for Essex County as a Local Lead Flood Authority. Amongst other things, it will make Essex County Council the SuDS Approving Body (SAB) responsible for ensuring that all drainage systems for new developments are designed and constructed to agreed standards.

These standards will strongly promote the use of Sustainable Drainage Systems which effectively reduce surface water run-off, mimicking the natural route that rainwater takes. This will ensure that developments and occupants are protected from flooding and that there are no increases, and wherever possible that there are reductions in off-site flood risk. Those SuDS which do not meet these standards will be refused permission to build.

The Act also provides for SuDS serving more than one property having been approved by the SAB and constructed in accordance with that approval, to be adopted by the SAB and

Bio-retention planters, Portland, Oregon



SuDS Wetlands, Wellesley College, USA

thereafter maintained.

A return to more natural, sustainable methods of dealing with surface water from development will also have additional benefits for:

- Water quality SuDS can help prevent and treat pollution in surface water runoff, protecting and enhancing the environment
- Amenity SuDS can have visual and community benefits for the community
- Ecology SuDS can provide the opportunity to create and improve habitats for wildlife, enhancing biodiversity



Essex County Council is committed to making our county a place which provides the best

possible quality of life for all who live and work here. Making it more sustainable is an important part of supporting this vision and it is therefore implicit that new development should incorporate sustainability measures that help achieve this goal.

Appropriately designed, constructed and maintained SuDS support the ideal of sustainable development. SuDS are more sustainable than conventional surface water drainage methods as they can mitigate many of the adverse effects that stormwater run-off has on the environment. This can be achieved by:

- Reducing run-off rates, thereby lessening the risk of flooding downstream
- Minimising additional run-off emanating from urban development, which could exacerbate the risk of flooding and impair water quality
- Encouraging natural groundwater recharge (as appropriate) and so reduce the impact on aquifers and rivers
- Reducing pollution risks associated with development
- Contributing to and enhancing the amenity and landscape of an area and so promoting community involvement and enjoyment
- Providing habitats for wildlife and

opportunities for biodiversity enrichment.

#### 1.4 The purpose of this guide

This guide is primarily intended for use by developers, designers and consultants who are seeking guidance on the County Council's requirements for the design of sustainable surface water drainage in Essex. It provides information on the planning, design and delivery of attractive and high quality SuDS schemes and should offer multiple benefits to the environment and community alike. It should also show that meeting these requirements need not be an onerous task and can help add to development.

Adherence to the principles set down in this guide will normally ensure that SuDS schemes are suitable for submission for approval by Essex County Council as the SAB. However it is important that the SuDS Approval Team is contacted at an early stage in development so that pre-application talks can take place. This guide provides a steer as to what is expected, including details of hydrological requirement, but detailed discussion of the proposal will also need to take place during the development, if an application is to be successfully approved. SuDS philosophy and concepts are based upon and derived from The SuDS Manual (CIRIA C697). It is not the intention that this guide reproduces or replaces The SuDS Manual; moreover it should be seen as complementing the source document and so users of this guide should familiarise themselves with The SuDS Manual and incorporate advice from both documents into their SuDS proposals.

#### 1.5 The structure of this guide

This guide aims to bring to life the expectations that Essex County Council has from SuDS

through case studies and worked examples. Chapter 2 provides an overview of the design considerations specific to the county such as topography. Chapter 3 provides a quick run down of the standards that are expected not just in terms of flood prevention but also amenity, ecology and water quality. It also provides an introduction to the main forms of SuDS features and when they are most suitable. Chapter 4 illustrates this information with a series of worked examples of major



Multi-functional open space, Rieselfeld, Frieberg, Germany

types of development. These show how SuDS could be fitted into real life situations. There are also case studies, showing how it has been achieved before. Chapters 5 and 6 look at the approval and adoption processes. These will be subject to revision as Defra releases further guidance but provide an understanding of what we are looking for and the service we're looking to provide.

#### 1.6 The SuDS Management Train

Sustainable drainage systems are now the preferred method for managing surface water run-off from a development area. In order to imitate the natural drainage of a site a series of drainage techniques (the "management train") should be employed to reduce flow rates and volumes, minimise pollution and so reduce the impact of the quantity of water emanating from a development. These techniques need to be applied progressively from prevention, source control, site control through to regional control.

Further information on the elements of the SuDS management train is set out in Section 1.3 of The SuDS Manual (CIRIA C697).



Figure 1.1 The SuDS Management Train, (CIRIA, 2010)

»18th-19th century duck decoy pond, Old Hall Marshes

# 2.0 Suds AND THE ESSEX ENVIRONMENT

#### 2.0 SUDS AND THE ESSEX ENVIRONMENT

This section provides an overview of design considerations specific to the county including topography, drainage patterns, rainfall, geology and soils, landscape and townscape character and nature conservation.

#### 2.1 Topography

Essex is a county of low hills and undulating valleys, with extensive areas of low flat land near to the coast. The altitude rises very gently from the coast towards the north-west. reaching about 30m around Chelmsford and just over 130m to the west of Saffron Walden. This gentle rise is interrupted by a series of low hills and ridges, the highest of which is Danbury Hill at 116m. The county has a large number of small rivers, largely as a consequence of the proportion of clay soils. These rivers are an important component of the county's topography, character and identity. The river corridors are frequently of value for landscape, nature conservation and heritage, as well as providing public access opportunities and the focus for recreation.

The low infiltration rate of many of Essex's soils lead historically to water features in the landscape – many ponds, open ditches, small streams, wetland and marsh. Many of these

have been drained or piped over the last few centuries, with few of these features surviving as part of a managed drainage system.

#### 2.2 Rainfall

Across most of East Anglia there are, on average, about 30 rain days (rainfall greater than 1 mm) in winter (December to February) and less than 25 days in summer (June to August) with the highest averages being at a higher altitude of the Wolds.

Climate changes already seen in the UK are consistent with the UKCPo2 scenarios. These suggested that winters would become wetter over the whole of the UK, by as much as 20% by the 2050's. A shift in the seasonal pattern of rainfall is also expected, with summers and autumns becoming much drier than at present, but the number of rain days and the average intensity of rainfall are overall expected to increase. The latest UK Climate Projections (UKCPo9) show that in the south east of England there is a 90% chance that winter mean precipitation will increase by 55%, and summer mean precipitation will increase by 7%, by the 2080's.



Coastal marshes, Colne Estuary

# 2.3 Geology

### **Underlying Geology:**

The solid geology of Essex forms part of the eastern sector of the London Basin chalk syncline. This dish-shaped formation underlies much of the county with chalk outcropping in the north west, near Saffron Walden. Tertiary deposits such as the Thanet Sands, Woolwich and Reading Beds and the Blackheath Beds (known as the Lambeth Group) are buried by Quaternary deposits. London Clay is the thickest Tertiary deposit, with an extensive outcrop across the centre of the county running east west, capped locally by the loamy Claygate and sandy Bagshot Beds. This is a stiff, dark, bluish-grey clay that weathers, on exposure, to brown and shrinks and cracks in dry weather.



Figure 2.1: Simplified section



Exposed glacial gravels, East Mersea (Geolocation, 2011)

#### Surface Geology:

The underlying geology of Essex has been dominated by the events over the last 2 million years - primarily by the Ice Age, but also by the climatic variations that have occurred before and since. These have generated vast deposits that have a strong influence on the landscape and overlie much of the area. Throughout the period Essex has been subjected to periodic ice advances and retreats as the climate has cooled and warmed. This has led to a complex mix of overlying deposits. Extensive sands and gravels were deposited in the Pleistocene ice age. Succeeding deposits have overlaid these, but exposures are common on the valley sides and on the Tendring plateau. Soil forming processes in the succeeding interglacial left the upper part of the sands and gravels reddened and clay enriched.

In the Anglian period, ice from the north



*Figure 2.2 Topography of Essex* 

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covered Essex to a line running from Brentwood to Billericay to Colchester. Upon melting the ice left the vast sheet of Boulder Clay, which contains clay, flints and chalk, over central and northern Essex. The climatic fluctuations that followed led to periods of vegetation establishment, first woodland and then heathland, interrupted by colder periods with sea level falling. The ground has been disturbed by solifluction and windblown silts accumulated to form the brickearths and loam deposits.

Following the periods of glacial advance and retreat there have been continuous periods of sea level rising, with the rate fluctuating. Extensive deposits of sand and gravel are known to have come from former courses of the Rivers Thames and Medway. There are eight terraces of these sand and gravel deposits known as the Kesgrave Formations. Three further diversions of these rivers left the high-level East Essex Gravels on the Dengie peninsula, the low-level East Essex Gravels at Rochford and Shoeburyness and the lower Thames Terraces at Orsett Heath, Little Thurrock and Mucking. It is thought that sea levels stabilised in the medieval period.

In general, it is the nature and the quality of the Essex soils that has contributed to the success of the county in agricultural terms. Over half of the agricultural land in Essex is of 'best and most versatile' quality (Grade 1, 2 or 3A). On the coastal marshes much of the land has been reclaimed. The soils are heavy gleys that undergo periodic waterlogging from fluctuations in the ground water table.

Inland from the marshes the soils that occur on the river terraces make up some of the best agricultural land in Essex. They are easy to work and naturally free draining brown soils, especially where Brickearth is present. Soils on the London Clay are seasonally waterlogged slowly permeable heavy clay soils. There are some lighter soils on foot slopes. The soils shrink and crack on drying, swelling on rewetting. When they are wet they are very sticky and plastic.

On the hills that rise above the London Clay the



Argricultural land, Little Waltham

fine sands of the Bagshot Beds are capped by the pebbly clay drifts. The soils on the boulder clay plateau to the north range from wet acidic clay soils to dry neutral/alkaline soils. All of these require under-draining for modern arable farming, making valuable corn land. The valley soils are complex but tend to be better drained and were popular with early settlers. Those soils that fall on the chalk in the north west of the county are alkaline and free draining.

In many development sites soils have been disturbed or removed. The natural drainage properties of soils on these sites can be severely affected by soil movement and compaction. Consequently following completion of a development it can take several years for soils to regain their ability to drain well naturally through gravity and capillary action.

#### 2.4 Historic Environment

Essex has a rich and varied historic environment that encompasses the physical legacy of thousands of years of human activity in the form of historic buildings and structures, archaeological sites and monuments, and historic landscapes. The historic environment makes a particular contribution to the character and value of the county's landscapes and provides a wide range of benefits, including contributing to local distinctiveness, and



Ramsey Creek, Tendring

people's sense of place and community. Essex County Council maintains the most complete record of the county's historic environment, comprised of around 38,000 known heritage assets, including 838 Scheduled Monuments, to help ensure that decisions which affect the historic environment are made from a sound knowledge base.

The impact of new developments, including SuDS, on heritage assets which are not subject to a statutory designation are considered and mitigated through the planning process. In this context, information and advice on the historic environment significance of areas affected by new SuDS, and of the mitigation that may be needed to reduce their impacts on the historic environment should be sought from Essex County Council's Historic Environment Branch, and where relevant, English Heritage.

#### 2.5 Landscape and Townscape Character

Planning policy requires developers to consider context carefully and to use documents for characterisation to inform their proposed layouts and detail design. A more detailed assessment of any proposed development site



*River Chelmer, Chelmer Conservation Area* 

is required to assess areas for conservation or protection and habitats which could be objectives for the development.

Essex broadly comprises seven landscape character types. These are Chalk Upland, Glacial Till Plateau, River Valley, Wooded Hill and Ridge, London Clay, Coastal and Urban. There is a further subdivision into 35 'character areas' with definition of what is distinctive about each. Most of the Districts have their own landscape character assessments and with areas further defined and looked at in even greater detail. There are also a number of townscape assessments which describe and analyse the pattern and history of development, and the style and quality of buildings. All these documents are valuable in understanding how to create a landscape with its proposed SuDS for a development so it fits into the landscape and townscape of the area.

#### 2.6 Nature Conservation

Although largely arable in character, Essex still supports a considerable variety of seminatural habitats many of which of are scarce or threatened nationally.

The Essex coast and its estuaries are recognised as one of the most important areas for wildlife in the UK, with a significant proportion protected by national and international designation primarily due to the large numbers of wildfowl and wading birds that visit the mudflats, saltmarshes and grazing marshes in winter.

Away from the coast, the most significant internationally and nationally important habitats are the wood-pastures of west Essex such as Epping Forest, Hatfield and Thorndon; and the wetlands of Abberton Reservoir, the Lee Valley and Hanningfield Reservoir.

Other valuable and characteristic Essex habitats include the oxlip woodlands on the chalky-boulder clays of the northwest, the ancient hornbeam and bluebell woodlands of the southern ridge-lines, and the unique invertebrate assemblages of the proto-Thames/ Medway terrace gravels and sands.

More information about statutory designated international and national areas can be found

at Nature on the Map. These are supported by a network of non-statutory designated sites of county value for nature conservation referred to as Local Wildlife Sites (LoWS). Details about the location and character of individual LoWS can be found on the Essex Local Wildlife Site Projects website.

# 3.0 DESIGN CRITERIA

Pond, Western Harbour, Malmo, Swe

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#### **3.0 DESIGN CRITERIA**

Design criteria provide a framework for designing a system to effectively drain the area to protect public health and safety and the environment, creating natural habitat where possible.

The National Standards for SuDS design set out the required design principles and standards, but also provide for Local Standards to be set to ensure SuDS design responds to local conditions and priorities. This guidance builds on the National Standards, by outlining local expectations within Essex. Local Planning Authorities will endorse this guidance and make reference to the local standards as the requirements for SuDS design within their Local Plans. This provides a consistent approach to dealing with surface water drainage across the County. Additional objectives and principles are set out in The SuDS Manual (CIRIA C697).

In the case of site redevelopments or SuDS retrofitting, some of the design criteria may not be appropriate and discussions should be had with the SAB to agree the specific criteria that are to be applied in that case.

This section sets out our Local Principles (Section 3.1) and Local Standards (Section 3.2) expected in Essex:



Wetlands store and treat run off at residential development in Denmark (Eos)

#### Local Principles:

- 1. Plan for SuDS
- Integrate with public spaces 2.
- Manage rainfall at the surface 3.
- Manage rainfall at the source 4.
- Mimic natural drainage 5.
- Design for amenity 6.
- Enhance biodiversity 7.
- 8. Link to wider landscape
- Design to be maintainable 9.
- Use a precautionary approach 10.
- Have regard to the historic 11. environment
- Show attention to detail 12.

#### Local Standards:

- Hydraulics 1.
- Water quality 2.
- Green roof design 3.
- Soakaway design 4.
- Filter strip design 5.
- Filter trenches and drain design 6.
- Swale design 7.
- **Bioretention design** 8.
- Pervious pavement design 9.
- Geocellular structures design 10.
- Infiltration basin design 11.
- Detention basin design 12.
- Pond design 13.
- Wetland design 14.
- Rainwater harvesting design 15.
- Greywater recycling design 16.

# 3.1 Local Principles

Our Local Principles are intended to supplement the National Standards and aid in the evaluation of SuDS proposals.

#### Local Principle 1: Plan for SuDS

# SuDS should be considered as early in the planning process as is feasible

As SuDS can impact far more visibly and dramatically on a development than conventional drainage, an integrated and multi-disciplinary approach to site planning and design is the key to a successful SuDS system.

Investing in good design and identifying the requirements, issues and opportunities for SuDS at the early stages of a project is very likely to be repaid in the long-term. The advantages include:

- Early consultation with risk management • authorities can prove extremely useful and save wasted time later on
- SuDS requirements will inform the layout • of buildings, roads and open spaces, which can reduce land-take and minimise



highways at Ravenswood in Ipswich. The scheme is estimated to have saved over £600.000 in the long *term (Ipswich Town Council, 2011)* 

potential conflicts later on

- Where soils vary across the site, SuDS features can be located on permeable soils to reduce the amount of storage required
- Existing landscape features can be • integrated in designs to reduce costs
- Water features can be designed and located • to enhance the desireability of a scheme

For more detail, see section 4.1 and Planning for SuDS (CIRIA, 2010).

### Local Principle 2: Integrate with public spaces

SuDS should be combined with public space to create multi-functional use areas.

The LifE Project (BRE, 2010) found that sustainable drainage could be integrated with open space provision and used for recreation. In fact, when other demands on the available land are taken into account, it becomes essential to consider SuDS as part of a broader green infrastructure than stand-alone features.

The Landscape Institute (2011) envision SuDS as one piece of a harder working landscape, which acts as an amenity space, stores and treats run off, alleviates flooding, enhances biodiversity and provides renewable energy sources.

Features such as ponds, detention basins and swales bring moving water, undulating landforms and nature to people's doorsteps. SuDS can be designed to accommodate large volumes of water during heavier events but remain dry the rest of the time to allow for recreation and events. Boardwalks, stepping stones and bridges can be provided to allow access across wetter areas. Shallow slopes, low water depths, strategically placed vegetation and stable ground around water margins help to create a safe environment for site users. Treatment and monitoring of pollutants upstream of accessible SuDS features must be carefully designed.



Basins and swales carved from the slopes at Manor Park in Sheffield store and treat run-off from residential areas (above) and are used for events space when dry (below) (Sheffield City Council, 2011)



The aim should be to create networks of high quality open space which adapt for attenuation of surface water, sports and play and enhancement of biodiversity (BRE, 2010).



Shallow slopes, low water depth and stable edges minimise the need for fences and illustrate a designled approach to health and safety

# Local Principle 3: Manage rainfall at the surface

Management and conveyance of surface runoff should be kept on the surface as far as possible.

There are several distinct advantages in using SuDS, which manage water at the surface in

the landscape:

- SuDS maintenance can be incorporated as part a typical landscape maintenance specification
- A range of habitats can be created
- Obstructions and blockages are more easily detected
- Creates visually complex and ever-changing landscape
- Potential to reduce construction costs
- Makes the water cycle visible and provides opportunities for contact with nature and education
- Can be designed as attractive features to enhance urban design

As detailed in Local Principle 6, careful risk assessment and a design-led approach to health and safety concerns is often an effective alternative to fencing around open water.

Local Principle 4: Manage rainfall at the source

# Surface runoff should be captured as close to where it falls as possible.

It is worth emphasising that SuDS planning and design should seek to control surface water as

close to the source as possible. Features such as green roofs, rain gardens, soakaways and permeable paving treat and store water where it falls. They reduce the storage volumes, flow



Moving surface water, lush vegetation and undulating landforms can enrich open spaces

rates and treatment stages of features further down the management train.

As well as considering health and safety and flooding issues, designers should bear in mind how vegetated SuDS features in close proximity to development will be perceived. In order to slow and treat run off effectively, the traditional neatly manicured landscape may need to give way to a more informal aesthetic. Colours, materials, height of vegetation and edges are some of the elements which can be manipulated to give the impression that a feature is intended and cared for.

Although it cannot (at present) be included in storage calculations, the role of mature leafy trees (albeit seasonally in deciduous species) in intercepting rainwater before it hits the ground should not be underestimated.

#### Local Principle 5: Mimic natural drainage

SuDS networks will be designed to match natural drainage routes, infiltration rates and discharges as far as possible



This raingarden controls surface water at source and provides habitat for wildlife. Strong landscape structure and ornamental pots help create the impression that this landscape is cared for.

Designs should work with natural gradients so as to avoid the use of energy consuming water pumps wherever possible, minimise use of man-made materials giving a softer and more natural feel to features and promote infiltration.

One of the main underlying principles of SuDS is that they should mimic natural processes and we would therefore favour systems that avoided the use of pipes or storage tanks. Vegetated SuDS should usually be given priority over pure engineering solutions as their operation is easier to observe and maintain. Below-ground features are not sustainable in the long term as they are not easily maintainable and have a limited life in comparison to grassed and more natural systems. We would discourage SuDS systems which were reliant on electricity or any kind of pumped system which require specialised maintenance.

## Local Principle 6: Design for amenity

Integrate water management with urban design to celebrate water and enhance the quality of places.

#### **Visual Impact and Amenity Benefit**

SuDS have the potential to be integrated into

public open spaces which can be both attractive to potential house buyers through the provision of areas for example for dog-walking and provide vital surface water drainage. SuDS that are designed with aesthetics in mind will ensure public acceptability and can be beneficial to the public realm. Key considerations to provide amenity benefit are the use of vegetation and landscaping techniques, linking open water areas to recreation sites, setting an appropriate maintenance programme to ensure areas are visually attractive throughout the year and informing and educating the public of the role of SuDS. Further advice on landscaping is provided in Chapter 20 of the SuDS Manual (CIRIA C697).

The main risks associated with SuDS are:

- Drowning
- Slips, trips and falls
- Waterborne disease
- Wildfowl strikes near airports

In the majority of situations these potential risks are removed though good site design and layout.

The risk of drowning and falls can be managed by installing gentle slopes, shallow ponds, safety benches and access points. However, there may be exceptions where it is appropriate to install avoidance measures, minimal fencing to protect small children for example.

The use of SuDS in School environments requires particular consideration with regard to health and safety. We will engage with Schools at an early stage to determine what is considered acceptable.

Systems should also avoid small stagnant pools which could lead to waterborne disease, and advice from the Civil Aviation Authority (CAA) is that SuDS should not attract large flocking birds near airports (The SuDS Manual C697 20.3.5).

SuDS that are well designed in line with C697 should not pose a significant health and safety risk. We will therefore expect SuDS features to be compliant with the design specifications in the SuDS Manual.

Early discussion with the SAB should be taken if proposals cannot meet with these standards, and evidence as to why this is the case should be provided.

#### **Health and Safety**

Ensuring that SuDS remain safe and accessible for the life-time of the developments they serve

is principal to their design. Along with other aspects, health and safety must first be considered at the pre-application stage. We will only approve and adopt SuDS where the risks have been formally assessed taking into account future amenity and maintenance requirements.



*Sutcliffe Park, London: A common sense approach to health and safety near water (lan Yarham)* 

The Construction, Design and Management Regulations 2007 (CDM) must be applied to the planning, design and construction, and long-term maintenance of SuDS. CDM regulations will apply to the majority of SuDS projects. The regulations ensure all foreseeable risks are assessed. Any risk should then be removed through design as a preference, before avoidance and mitigation measures need to be considered. A Health and Safety file must be produced and passed over to the SAB on completion of the adoption process.

Full details of the CDM regulation requirements and an example of a site-specific risk assessment can be found in Section 2.5.10 and Section 3.4.2 of The SuDS Manual C697.

#### **Community Engagement**

We encourage developers to produce a communications plan raising public awareness. This should address concerns around health and safety and encourage a sensible and responsible approach to living with SuDS.

Danger signs should not be necessary; however information boards which provide details of the type of SuDS features on site can be installed. This will further promote an understanding of how the system functions and the benefits of SuDS.

## Local Principle 7: Enhance Biodiversity

# SuDS should be designed to improve biodiversity whenever possible.

Section 3.5 of The SuDS Manual (CIRIA C697)

sets out ecological principles which should be followed. Maximising the ecological value of SuDS is consistent with national and local policies which aim to conserve and enhance biodiversity. This is underpinned by a variety of legislation including a biodiversity 'duty' for public bodies which is enshrined in the Natural Environment and Rural Communities (NERC) Act 2006.

This guidance strongly encourages developers to integrate biodiversity within SuDS and explore innovative ways to create new habitats where appropriate.

SuDS provide opportunities to create a variety of important habitats for wildlife due to the need to alter landform, provide open water and create associated terrestrial vegetation. All of which can provide new nesting and foraging or feeding opportunities for birds, amphibians, reptiles, mammals and invertebrates.

Furthermore, these features will often provide increased opportunities for people to experience wildlife in close proximity of their homes. For example, the pleasure in watching and listening to song birds is a very rich experience for residents in built-up areas adding quality to people's lives, and there is an increasing body of evidence which demonstrates the socio-economic value of wildlife collectively referred to as 'ecosystem services' (see Defra's website for further information).

To assist ECC and other partners with the delivery of its NERC Act duty, the Essex Biodiversity Project publishes an Essex Biodiversity Action Plan (EBAP) which sets-out those habitats considered a priority for nature conservation action. Developers are encouraged to reflect these priorities in the design of their SuDS, thereby maximising the contribution they can make to halting the loss of biodiversity in Essex.

The Essex Biodiversity Project can provide advice and information on BAP habitats, and further information can be found on their website.

Further detailed advice about integrating biodiversity in to SuDS can also be obtained from suitably qualified/experience consultant ecologists .

Finally, the following local projects may also be able to provide more general guidance:

- Water for Wildlife Project
- Essex Wildlife Sites Project

There is a considerable volume of published information and guidance available to

developers in relation to biodiversity and SuDS, this guide does not propose to replicate all of this information and we have signposted the reader to appropriate references throughout the document.

There are a number of simple principles to consider during the development and the implementation of SuDS to ensure existing wildlife is protected, and that biodiversity is integrated effectively in to the scheme design.

The wildlife value of existing wetland habitats and surrounding terrestrial areas should be surveyed by a suitably qualified/ experienced ecologist during the early planning stages:

- Particular attention should be given to protected species and sites; and 'habitats and species of principal importance'.
- Appropriate information is likely to have been generated as part of any associated planning application/permission.
- Hydrological surveys of the area should be undertaken to ensure natural waterflow, above and below the ground, will not be affected either by changes in water quantity or quality.

Where appropriate, the design should:

• Ensure adequate protection for existing

aquatic habitats from flooding events.

- Locate SuDS features close to, but not directly connected to, existing wetland areas, so plants and animals can naturally colonise the new SuDS ponds.
- Create well vegetated shallow bays and establish areas of marsh.
- Avoid smoothly finished surfaces; although they give the impression of tidiness, they provide less physical habitat diversity for plants and animals.
- If planting is essential ensure only native plants of local origin are used.



*SuDS at Wellesley College are connected to wetlands outsite the site boundary to create valuable green corridors for wildlife* 

#### General

- Ensure strong connections for wildlife between SuDS features themselves and existing habitat
- Low productivity soils will encourage more diverse vegetation and nutrient rich topsoil should be avoided where possible
- Aim for a succession of flowering and fruiting periods throughout the year and across the site



#### Outside the site

Larger SuDS features downstream of the site can be designed to include locally and nationally important habitat types such as fens, wet woodlands and reedbeds. Design considerations include:

- Scope for deeper water, ialsnds and mud for wildfowl and wading birds
- Design and zone to include areas for recreation and areas which are disturbance free for wildlife
- Avoid planting and allow to colonize naturally

#### At the source

Green and brown roofs can be designed to create disturbance free habitat for invertebrates and birds. Design considerations include:

- Design substrate and planting to increase diversity
- Brown roofs in South Essex could support ground-nesting birds such as the Black Redstart
- Sedum roofs have few benefits
- Where they hold water from March-May, rain gardens are excellent habitat for frogs, toads and newts and should feature a shallow profile and connections to other nearby habitat

#### Within the site

Swales, infiltration and detention basins can provide excellent habitat for invertebrates and birds. Key design considerations include:

- Can be sown with species rich grassland and wildflower mixes and cut for hay
- Combined with foraging and feeding opportunities, microtopography can be manipulated to create areas where wildlife can bask, dig holes, nest and shield themselves from winds
- South facing slopes and friable soils make excellent habitat and should be maximised
- Wooded areas and pockets of scrub can be included in the design of larger infiltration basins

Ponds can provide habitat for a vast array of life including amphibians and birds. Design considerations include:

- Complex, shallow, vegetated edges with large drawdown zones make the best habitat
- Amphibians require landscape features nearby which can be used for foraging and cover e.g hedges, rough grass, rocks
- Avoid planting and allow features to colonize naturally where this is acceptable to site users
- If planting is necessary, a list of suitable species for the area can be provided

*Opportunities for enhancing SuDS features for wildlife (Cambourne, Cambridgeshire)* 

### Local Principle 8: Link to wider landscape

### **Opportunities to link SuDS to existing or potential future blue and green infrastructure should be explored.**

The selection of SuDS types and the creation of the SuDS network should both respond to and inform the surrounding landscape. A landscape-led approach uses SuDS as a mechanism to create strong green and blue infrastructure networks and is important to increase connectivity to the wider ecosystem.

The linear nature of many SuDS can help create green corridors through developments, which is important for wildlife and ensures the associated development is connected with its surrounding environment.

Effective integration will also require carefully researched and selected plants, which work to improve the local green infrastructure.

#### Local Principle 9: Design to be maintainable

Consideration should be given to ease of access and waste generation when designing SuDS.

It is extremely important to bear maintenance requirements for SuDS in mind from the outset. Throughoutthe process, it should be considered how features can be accessed, who will be responsible for maintaining them and how much it is likely to cost. Good management and design go together.

SuDS must be designed to provide sufficient access for maintenance. In some instances, this will mean careful consideration to the extent of fencing, provision for gates, the location of drop kerbs to provide access for maintenance vehicles and the extent of which permanently wet features may limit crossing.

When undertaking the maintenance of SuDS, waste will be generated. This will be predominantly grass and other vegetation, and may be managed on site in wildlife piles. There is still a requirement to comply with all relevant waste management legislation. This is even more pertinent when waste is disposed off site.

SuDS on industrial sites will need to dispose of hazardous waste separately. It is also important to comply with the duty of care requirements of the waste management legislation. This means that silt should only be removed from site by authorised carriers and should be taken to authorised disposal locations.

## Local Principle 10: Use a precautionary approach

# Precautions should be taken in SuDS design to ensure their efficient functioning at all times.

The Environment Agency promotes SuDS but the natural floodplain must be protected and considered in design. Where SuDS are proposed in a fluvial floodplain the SuDS feature may fill up with river flood water when the area floods and will not have capacity to hold the rainfall runoff from the site as originally intended. Some areas of Essex, where land is low lying, are in the flood plain, and a pragmatic approach to SuDS design need to be taken where flood risk is carefully considered but the presence of a floodplain should not explicitly exclude the integration of SuDS features for day-to-day water management. SuDS should not be included in areas where water regularly flows or is stored. The following points should be considered:

- The consequences of failure or a blockage within the system must be considered before adoption.
- Once overland exceedance flow routes are identified, buildings should be positioned away or protected from potential flow paths.

- SuDS should be designed so that they can continue to operate during periods of high groundwater levels.
- Generally it is also considered that temporary storage provided by SuDS should empty from full within 24 to 48 hours, allowing for subsequent rainfall events.
- When considering the outfall from a site, if discharging into a watercourse, it should be designed to ensure that runoff from the site will not be influenced by high water levels.

Further principles of good drainage practice can be found in Section 3.2.4, and general guidance within Section 3.2, of The SuDS Manual (CIRIA C697). Please also refer to Designing for exceedance in urban drainage – good practice (CIRIA C635).

# Local Principle 11: Have regard to the historic environment

SuDS design and construction should be sensitive and complementary to Essex's heritage.

A number of principles can be followed when

designing SuDS in order to avoid negative impacts on the historic environment and, where possible, to enhance the contribution that SuDS make to the historic character of urban areas.

When creating new SuDS features, it is beneficial to design and place them with regard to both known and potential unrecorded archaeological remains. Provision may need to be made for archaeological desk based assessment and/or appropriate field investigations, the results of which can be used to assist in the design process, and to support the submission of any planning application. Consideration may also need to be given to the wider historic landscape character of the area.

When incorporating historic water bodies into a new SuDS care needs to be taken to reduce and mitigate any negative impacts and provision may also need to be made for appropriate assessments and specialist advice. Artificial water bodies such as moats and ponds are important features in the historic landscape of the county and may seem an attractive subject for restoration and ecological enhancement as part of a SuDS e.g. through the removal of vegetation and sediment to reveal open water. However, many of these water bodies possess deposits of important historical, archaeological and palaeoecological value and it is important to assess this potential prior to commencing any restoration works that may destroy these remains. If archaeologically significant deposits are present, then appropriate mitigation measures may need to be carried out.

Within designed landscapes, such as historic parks and open spaces, water can be a fundamental element, forming lakes. ornamental water features, ponds, rivers, streams, canals and ditches linked to the wider landscape. Such systems may have been in existence for centuries and be of considerable historic and ecological significance. Existing water bodies need to be conserved and repaired and where possible modifications (e.g. to original shape, form and profile) should be avoided that affect their historic character and ecological interest. When new SuDS features are introduced – for instance ponds. swales and infiltration basins – their positioning, scale and design, including any associated planting, should aim to be in keeping with the historic character of the designed landscape. Consideration needs to be given to the appearance of detention basins and infiltration basins when they are empty as well as full, and they should be positioned and detailed appropriately. Care needs be taken to ensure that the maintenance of new SuDS features conserves the character of the historic

designed landscape (e.g. regular cutting of bankside vegetation to avoid scrub growth).

#### Local Principle 12: Show attention to detail

# SuDS must be carefully designed using attention to detail to ensure they function as intended

SuDS should be designed to take account of current and possible future need for utilities. Underground ducting is a useful way of protecting SuDS features from potential future disruption and is particularly useful where nonstandard materials are used, such as permeable pavements.



SuDS Highway detail, Ashford, Kent

Utilities should be located either under shared service strips or the footway but never in the carriageway. Service or inspection points for utilities should be designed to be respective of SuDS features. In the example given in Chapter 4 for the Mews Courtyard, we have given an example of allowance for utilities by providing a 2m band of normal construction paving surrounding permeable paving to provide a conduit for services.

The careful design and construction of levels, selection of materials and design of inlets/ outlets is paramount to ensuring the SuDS function as intended. Investing in good design will also ensure that SuDS come together as a whole to deliver all of the desired objectives. If detail cannot be provided upfront it will be a condition of any SuDS permission which must be checked and approved by Essex County Development Management Council's Implementation team. Careful consideration to the placing of utilities around SuDS must also be considered to minimise potential disruption through any future upgrading of services. Attention to the detail of SuDS features can also contribute to a development's sense of place. Figures 1 and 2 show how the adoption of permeable paving can be integrated with utilities and conventional foul drainage to serve a development.







*Figure 2 Delineated Utility Road Crossing (plan)* 



Figure 3 Delineated Utility Road Crossing (section)



SuDS service crossing

Utilities within footways in dense urban settings allow the provision of SUDS within the road structure, as shown in Figure 1.

Where services crossings are required, particularly in shared surfaces, these may be provided and bounded using flush kerbs and, for example changing the pattern adopted in the block paving or colour of the surfacing to define the extent of the service crossing for future maintenance access, as Figure 2 and 3.

#### 3.2 Local Standards

Our Local Standards are also intended to supplement the National Standards through more aspirational criteria relating to Hydrology and Water Quality (LS1 & LS2). We have also set out some Local Standards relating to the design of individual SuDS features.

#### Local Standard: 1 Hydraulic

SuDS must be designed to ensure that development and occupants are protected from flooding, and that off-site flood risk is not increased. Where possible SuDS should aim to reduce the overall risk of flooding off-site and drain via infiltration as a preference.

#### Storage Volume

When planning the layout of SuDS, sites should take into account topography and make best use of low points for storage.

For rainfall events with a return-period up to and including the 1 in 100 year rainfall event with an allowance for climate change SuDS should be sized to contain all surface water volumes. Applications should demonstrate how this will be achieved, unless otherwise planned and approved by the SAB.

However, if this is not possible, drainage designers must demonstrate how additional flows will be managed.

Safe conveyance routes and overflow flood storage areas must be established and agreed with the SAB for the 1 in 100 year rainfall event

with 30% allowance for climate change before adoption.

## **Runoff Rate**

The storage volume required within SuDS on a site will depend on the allowable rate of runoff from the site.

Unlike developed areas, greenfield sites generally produce no measurable runoff during small rainfall events (up to 10mm). In order to replicate the natural situation, SuDS should therefore be designed so that rainfall runoff in events of 5-10mm does not leave the site. Source control techniques such as green roofs, permeablepavingand swales are recommended to achieve this.

In all cases, including on brownfield sites, runoff should where possible be restricted to the greenfield 1 in 1 year runoff rate during all events up to and including the 1 in 100 year rainfall event with climate change. If it is deemed that this is not achievable, evidence must be provided and developers should still seek to achieve no increase in runoff from greenfield sites and a 50% betterment of existing run off rates on brownfield sites (provided this does not result in a runoff rate less than greenfield).

#### Local Standard: 2 Water Quality

The level of pollution found within surface water runoff will depend on the nature of the development from which it arises, the time since the last rainfall event and the duration and intensity of rainfall.

An appropriate 'train' of SuDS components must be installed to reduce the risk of pollutants entering watercourses via runoff from developed sites. Following the SuDS Management Train hierarchy (Section 1.3.2 of C697), a series of drainage techniques should



Detention basin at Lambs Drove, Cambourne

be designed into the development layout. The design should achieve a system where pollution is incrementally reduced at each stage.

Treatment options to address pollution issues include:

- Infiltration
- Filtration
- Detention basins/ponds
- Permanent ponds

These options reduce pollution by either filtering out pollutants or reducing flow rates to encourage deposition of any contaminants. Polluted surface water runoff should not run directly into permanent ponds in order to protect biodiversity and amenity, and to prevent maintenance problems caused by heavy silts and oil.

Source of Runoff	Treatment Stages
Roofs, playing fields	1
Residential roads,parking areas, commerical zones	2
Waste and industrial sites, loadings bays and HGV parks	3 or more

The number of treatment stages required within the SuDS train will depend on the nature of the site.

Before adopting SuDS it must be demonstrated that the proposed scheme has followed the SuDS Management Train hierarchy and includes the appropriate number of treatment stages.

Detailed guidance on the SuDS Management Train is found in Section 1.3.2, and Water Quality and Treatment in Section 3.3, of The SuDS Manual (CIRIA C697)

### Local Standards (cont.)

SuDS Technique

#### Green Roofs



Soakaways



A multi-layered system that covers the roof of a building with vegetation/landscaping/permeable car Chapter 6 parking, over a drainage layer. These features will not be considered for adoption by the SAB.

#### Local Standard 3: Design of Green Roofs

**Description and Key Design Points** 

- Designed for Interception Storage
- Minimum roof pitch of 1 in 80, maximum 1 in 3
- Multiple outlets to reduce risk from blockages
- Lightweight soil and appropriate vegetation

Square or circular excavations, filled with aggregate or lined with brickwork, or pre-cast storage structures surrounded by granular backfill.

### Local Standard 4: Design of Soakaways

- Should be designed for the 1 in 30 year rainfall event as a minimum
- Infiltration testing carried out in accordance with BRE Digest 365
- Fill material should provide >30% void space
- Base of soakaway at least 1m from groundwater level
- Minimum of 5m away from foundations

Filter Strip



#### Chapter 8

#### Local Standard 5: Design of Filter Strips

- Recommended minimum width of 6m
- Runoff must be evenly distributed across the filter strip
- Slopes not exceeding 1 in 20, minimum of 1 in 50

#### **CIRIA SuDS Manual**

C697 Ref

SuDS Technique	Description and Key Design Points	C697 Ref
Filter trenches and drains	<ul> <li>Shallow excavations filled with stone to create temporary surface water attenuation.</li> <li>Local Standard 6: Design of Filter Trenches and Drains <ul> <li>Excavated trench 1-2m depth filled with stone aggregate</li> <li>Effective upstream pre-treatment to remove sediment and fine silts</li> <li>Infiltration should not be used where groundwater is vulnerable or to drain pollution hotspots</li> <li>Observation wells and/or access points for maintenance of perforated pipe components</li> </ul> </li> </ul>	Chapter 9
Swale	<ul> <li>Linear vegetated features in which surface water can be stored or conveyed. Can be designed to allow infiltration where appropriate.</li> <li>Local Standard 7: Design of Swales <ul> <li>Limit velocities during extreme events to 1-2 m/s</li> <li>Maximum side slopes of 1 in 3, where soil conditions allow</li> <li>Minimum base width of 0.5m</li> </ul> </li> </ul>	Chapter 10
<section-header></section-header>	<ul> <li>Shallow landscaped depressions or pre-cast units which rely on engineered soil and vegetation to remove pollution and reduce runoff.</li> <li>Local Standard 8: Design of Bioretention <ul> <li>Sufficient area to temporarily store the water quality treatment volume</li> <li>The water quality treatment event should half drain within 24 hrs to provide adequate capacity for multi-event scenarios.</li> <li>Minimum depth to groundwater of 1m, if unlined</li> <li>Overflow/bypass facilities for extreme events</li> </ul> </li> </ul>	Chapter 11

SuDS Technique	Description and Key Design Points	C697 Ref
Pervious pavement	<ul> <li>Permeable surface allowing rainwater to infiltrate through into underlying layer where it is temporarily stored.</li> <li>Local Standard 9: Design of Pervious Paving <ul> <li>Previous sub-base to be structurally designed for site purpose</li> <li>Temporary sub-surface storage must provide infiltration and/or controlled discharge for the 1 in 30 year rainfall event</li> <li>Geotextile may be specified to provide filtration treatment</li> </ul> </li> </ul>	Chapter 12
Geocellular structures	<ul> <li>Modular geocellular systems with a high void ratio that can be used to create below ground infiltration (soakaway) or storage device.</li> <li>Local Standard 10: Design of Geocellular structures <ul> <li>Standard storage design using limiting discharges to determine storage volume</li> <li>Structural design should be to relevent standards for appropriate surface loadings</li> <li>Use appropriate geotextile (for infiltration) or geomembrane (for storage)</li> </ul> </li> </ul>	Chapter 13
Infiltration basins	<ul> <li>Vegetated depressions designed to store runoff and infiltrate gradually into the ground.</li> <li>Local Standard 11: Design of Infiltration Basins</li> <li>Should be designed for the 1 in 30 year rainfall event as a minimum</li> <li>Pre-treatment is required to remove sediments and fine silts</li> <li>Infiltration should not be used where groundwater is vulnerable or to drain pollution hotspots</li> </ul>	Chapter 15

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SuDS Technique	Description and Key Design Points	C697 Ref
Detention basins	<ul> <li>Surface storage basins that provide attenuation of stormwater runoff and facilitate settling of particulate pollutants. They are normally dry and may also function as a recreational facility.</li> <li>Local Standard 12: Design of Detention Basins <ul> <li>Should be designed for the 1 in 30 year rainfall event via constrained outflow as a minimum</li> <li>Maximum side slopes of 1:4</li> <li>Bioretention and/or wetland/micropools at outlets for enhanced pollution control</li> </ul> </li> </ul>	Chapter 16
Ponds	<ul> <li>Provide stormwater attenuation and treatment. Permanent pools to support aquatic vegetation and retention time promotes sediment removal.</li> <li>Local Standard 13: Design of Ponds <ul> <li>Permanent pool for water quality treatment and temporary storage volume for flow attenuation</li> <li>Minimum depth for open water areas of 1.2m</li> <li>Maximum depth of permanent pool of 2m</li> <li>Maximum side slopes of 1:3</li> </ul> </li> </ul>	Chapter 17
Wetlands	<ul> <li>Shallow ponds and marshy areas for attenuation and water treatment. Aquatic vegetation and extended detention allow sediments to settle.</li> <li>Local Standard 11: Design of Wetlands <ul> <li>Shallow, temporary storage for attenuation</li> <li>Sediment forebay or equivalent upstream pre-treatment</li> <li>Combination of deep and shallow areas (maximum depth &lt;2m)</li> <li>Length:width ratio of greater than 3:1, shallow side slopes.</li> </ul> </li> </ul>	Chapter 18

SuDS Technique	Description and Key Design Points	C697 Ref
Rainwater Harvesting	<ul> <li>Rainwater harvesting is the process of collecting and using rainwater that would otherwise have gone into the drainage system or been lost through evaporation.</li> <li>Local Standard 12: Design of Rainwater Harvesting <ul> <li>Can range from complex district-wide systems to simple household systems linked to a water butt.</li> <li>Most simple rainwater harvesting systems are relatively easy to manage.</li> <li>Rainwater harvesting systems can be combined with grey water recycling systems to form an integrated process.</li> </ul> </li> </ul>	Chapter 6
Greywater Recycling GREYWATER IN USE	<ul> <li>Greywater recycling is the re-use of waste water collected from showers, baths, washbasins, washing machines and kitchen sinks.</li> <li>Local Standard13: Design of Greywater systems <ul> <li>Common features include a tank if storing water, a pump, a distribution system and, where it is needed, some sort of treatment.</li> <li>Greywater stored for any length of time has to be treated as otherwise it deteriorates rapidly. (For more information see Appendix 2)</li> </ul> </li> </ul>	

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## 4.0 DESIGNING SUDS

The purpose of this section is to focus upon the principles and processes of designing SuDS. Ideas, issues and opportunities are illustrated through a series of case studies and design examples.

#### Introduction

The SuDS ponds and wetlands at Augustenborg in Malmo have not only been designed to store and treat run-off but also to enhance the landscape setting of people's homes and provide habitat for wildlife. At Ravenswood in lpswich, the native vegetation and undulating topography of infiltration basins creates an exciting and dynamic network of open spaces for residents. The green roof at Sharrow School in Sheffield attenuates run off, provides an educational resource and was recently designated a Local Nature Reserve. These and an ever-growing number of other schemes demonstrate the multiple benefits a more sustainable approach to drainage can bring.

Unlike conventional piped drainage, SuDS store and treat large volumes of water within the site boundary and at the surface. As described above, this can enrich a development and reinforce the landscape character of the wider area as well as providing an effective and sustainable drainage mechanism. However, keeping water at the surface can potentially bring the drainage system into conflict with other requirements and site users.



*The SuDS ponds at Augustenborg in Malmo are integral features of the courtyards* 

SuDS features must be integrated with roads, parking areas, buildings, open spaces, urban design guidance and requirements for health and safety and utilities. The perceptions of site users should not be underestimated. SuDS make natural processes visible and, if not carefully designed, they can appear messy, uncared for and unsafe.

The characteristics of a site and nature of the

development must also be carefully assessed and will affect the complexity of designing a SuDS system. A low density residential scheme on a gently sloping greenfield site with sandy soils will pose less physical constraints to a SuDS scheme than a high density scheme on steep brownfield land with clay soils.



*Sheffield's latest Local Nature Reserve (Sheffield City Council, 2010)* 

In practice, reconciling these multiple considerations can be very challenging but the range of SuDS techniques (see section 3.0) is vast and solutions can be found. Permeable paving is traffickable and can be designed to manage run off from large areas. Rain gardens and ponds can be integrated and linked together to create a valuable series of open spaces. Larger wetland areas can be integrated within designated public open space.

The following sections explore the issues and opportunities for SuDS in Essex and how SuDS can be integrated with other requirements in pratice.

#### 4.1 The Planning and Design Process

A sustainable drainage solution must be tailored to the unique characteristics of the site, design criteria and the nature of the development. Topography, soil types, existing features and the specific requirements of the development are just some of the factors that will shape the final design.



Figure 4.1.1 Large stand-alone balancing ponds are not the only solution



Figure 4.1.2: An integrated approach to surface water management

The following series of diagrams have been adapted from section 4.0 of Planning for SuDS (CIRIA, 2010). They illustrate how SuDS design can be integrated within the planning process and influence the layout of developments.

#### Key to figures:





Figure 4.1.3 SUDS Planning Process (CIRIA, 2010)

# 1: Examine site topography and geology

- Aim to mimic the natural drainage systems and processes as far as possible
- Identify key natural flow paths and potential infiltration areas to understand opportunties and constraints.



Figure 4.1.4 SUDS Planning Process (CIRIA, 2010)

# 2: Create a spatial framework for SuDS

- Minimise run-off by rationalising large paved areas and maximising permeable surfaces
- Consider likely space needs for site control SuDS based on character of the development and the proposed degree of source control
- Use flow paths and possible infiltration or storage areas to inform development layout



Figure 4.1.5 SUDS Planning Process (CIRIA, 2010)

# 3: Look for multi-functional spaces

- Consider how SuDS features could be colocated with open space and public realm areas to create multi-functional spaces
- SuDS can be designed to be valuable amenity and ecological features



Figure 4.1.6 SUDS Planning Process (CIRIA, 2010)

# 4: Integrate with the street network with SuDS

- Structure the street network to complement and manage flow pathways
- Integrate SuDS features into street crosssections, ensuring street widths are adequate
- SuDS should be used to improve the streetscape providing amenity and multifunctionality by integrating with other street features including tree planting, traffic calming, parking bays, verges and central reservations



Figure 4.1.7 SUDS Planning Process (CIRIA, 2010)

# 5: Cluster land uses to manage pollution

- The number, size and type of SuDS will be affected by land uses and the corresponding pollution risk
- Potential polluters, e.g industrial developments, should have their own isolated SuDS network
- Integrate a series of SuDS features that will provide water treatment throughout the networks responding to the level of pollution risk
- Clustering should be considered alongside other mixed use ambitions

### 4.2 Design Examples

The following examples of possible SuDS schemes relate to actual places, (many of which are in Essex) and their design has therefore been influenced by local constraints and opportunities, which developers are likely to encounter. They are intended to illustrate some of the provisions of this guidance and demonstrate as many issues as possible.

Of course, each plan depicts just one possible solution for an individual site. There is no one size fits all with SUDS and the purpose of this section is to encourage an innovative and integrated approach to sustainable drainage, which is informed by site characteristics and development proposals. Rather than repeat existing guidance, the text includes references and electronic links for key sources of further details and information.

Conceptual design proposals for each scheme were developed by a multi-disciplinary team. The design process was adapted from The SuDS Manual by CIRIA and is illustrated by the adjacent flowchart (CIRIA C697)



Figure 4.2.1 SuDS Selection Flowchart (adapted from CIRIA, 2010)

## 4.2.1 Mews Courtyard

## Site Area: 0.2 Ha Net Density: 30+ dwellings per hectare

This example looks at how SuDS can be integrated within a mews courtyard. This type of development is typically a mix of two and three storey houses with private gardens, which face onto a central parking court.

The site slopes gently from the north east to the south west and overlays soils of very low permeability. The drainage system for the mews courtyard will need to manage run off from the following areas:

- Roofs
- Parking courts
- Access road
- Driveways

The opportunities and constraints for SuDS are detailed in the figure opposite. There is space for SuDS features to be incorporated within the design of the courtyard and parking areas as well as scope for green roofs on outbuildings.

## Site Characteristics:

Factor	Opportunity/Constraint
Use	Residential - low pollution risk
Soils	Low permeability in this location - no infiltration possible. No contamination
Topography	Gently sloping terrain to south west
Groundwater	Depth less than 1.om - not suitable for infiltration
Space	Limited space within parking courts due to vehicle movements and parking requirements
Catchment	Receiving watercourse is within a public open space
Maintenance	To be agreed with SAB, water company and Highways
Safety	Eliminate and mitigate residu- al risk of SuDS features to the health and safety of residents
Ecology	Limited scope for SuDS techniques which create opportunities for wildlife



Mews Development, Black Notley

## Site Analysis:



*Figure 4.2.1.1: Analysis of proposed development* 

Key

### **Design criteria and storage requirements:**

#### Storage

- Provide sufficient storage to cope with the 1 in 30 year rainfall event (Storage for the 1 in 100 year event plus 30% for climate change is provided downstream).
- Discharges from the site are to be limited to greenfield flow rates.
- The storage volume required for the 1 in 30 year event is in the region of 25m<sup>3</sup>.

## Quality

• The system must provide one level of treatment for roofs and two levels of treatment for the parking courts.

#### Amenity

• SuDS features must be integrated with the functional requirements of the courtyard and enhance its appearance.

#### Biodiversity

• SuDS features should be designed to maximise their value to wildlife.



*Figure 4.2.1.2: Initial assessment of flow routes and potential storage volumes* 

## **Case Study:**

**Scheme:** Augustenborg Courtyards **Location:** Malmo, Sweden **Techniques:** Ponds, channels and rills

Ekostaden Augustenborg is the collective name for a program to make Augustenborg into a more socially, economically and environmentallysustainableneighbourhood. The storm water system has gone through a major change. Green roofs and open storm water channels leading into ponds have stopped the flooding in the area and have created a beautiful environment and a richer biodiversity.

There are a total of 6 km canals and water channels in Augustenborg. 90 % of the storm water from roofs and hard surfaces is led into the open storm-water system in the housing area. The aim the project was that 70 % of all storm water should be taken care of for the whole of Augustenborg.



Ponds, channels and rills at Augustenborg, Malmo

- 1. Channel with notch for water to spill out into pond
- 2. No kerb to allow run off from adjacent paved surface to flow into channel
- 3. Permanent water body and storage volume
- 4. Play area forms part of integrated amenity space, in which the SuDS pond is a key feature
- 5. Outflow with flow control to larger SuDS features downstream
- 6. Overlooked space using natural surveillance as opposed to fencing off the site

#### **Concept Plan:**



Figure 4.2.1.3: Conceptual Drainage Solution

Key



Figure 4.2.1.4: Typical section through mewscourtyard

# 4.2.2 Informal Street

# Site Area: 1.25 Ha Net Density: 20+ dwellings per hectare

An informal street is proposed as part of a larger residential development on a greenfield site, which will drain to an integrated SuDS system. The drainage system for the site will need to manage run off from the following areas:

- Pitched roofs
- Parking courts
- Footpaths and driveways
- Highway

The soils on site are impermeable clays and there is a gentle slope from west to east. A large public open space lies to the east of the development.

The continuous frontage and dimensions of the street create a strong sense of enclosure. This is a defining principle of the Essex Design Guide. The drainage system should therefore be carefully designed to ensure that SuDS techniques proposed are compatible with this approach.

## Site characteristics:

Factor	Constraint/Opportunity
Use	Residential - low pollution risk
Soils	Mixed - infiltration possible in certain areas
Topography	Gently sloping terrain
Groundwater	Depth less than 2.0m
Space	Less public space than the mews courtyard. It will be necessary to consider how SuDS can be designed into the street
Catchment	Receiving watercourse is vul- nerable to pollution
Maintenance	To be agreed with SAB, water company and Highways
Safety	Health and safety of features in the street must be consid- ered
Ecology	Think about SuDS techniques which create opportunities for flora and fauna







*Figure 4.2.2.1: Analysis of proposed development* 

#### **Design criteria and storage requirements:**

#### Storage

- The design standard for the informal street is to provide sufficient storage to cope with the 1 in 30 year rainfall event.
- Discharges from the site are to be limited to greenfield flow rates.
- The storage volume required to provide sufficient attenuation of the 1 in 30 year event is in the region of 120m<sup>3</sup>.

## Quality

• The system must provide one level of treatment for roofs and two levels of treatment for the parking courts.

#### Amenity

• There is an opportunity to create attractive pocket park areas through creative design of SuDS features.

#### **Biodiversity**

• Best practice ecological design of SuDS features. Maximise biodiversity



*Figure 4.2.2.2: Initial assessment of flow routes and potential storage volumes* 

## **Case Study:**

Scheme: Ravenswood Location: Ipswich Techniques: Infiltration basin

The developers of this housing scheme designed the site so that all surface water run off is drained through a combination of soakaways and infiltration basins. using SuDS, there is no discharge from the site up to the 1 in 100 year storm - the equivalent of 6600m<sup>3</sup> storage.

The SuDS are managed by Ipswich Borough Council using commuted sums as public open space. Over its lifetime, the scheme has the potential to save £600,000 in construction compared to a traditional piped drainage system. Individual homeowners are also eligible for refunds of their sewerage charge.

Houses and driveways are connected to individual soakaways and roads are drained by a piped system that discharges to infiltration basins runing along the main boulevards.



Infiltration basin at Ravenswood

- 1. Grassed base of infiltration basin
- 2. Vegetated bank. opportunities for play whilst feature is dry
- 3. Native vegetation and naturalistic aesthetic creates exciting and dynamic landscape feature
- 4. Natural surveillance of amenity space as opposed to fencing off the facility





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Key



*Figure 4.2.2.4: Typical section through street* 

## 4.2.3 Mixed Use Street

## Density: 75+ dwellings per hectare

This example explores how sustainable drainage techniques can be accommodated within the streets of high density mixed use developments.

The street represents the major street within a mixed use residential development, which

The drainage system will need to manage run off from the following areas:

- Roofs
- Road
- Parking bays
- Pavement

The site is gently sloping. Although, it is challenging to integrate SuDS within this type of development, there are a number of SuDS techniques, which can be combined and designed to provide an effective drainage solution as well as enhancing the amenity of the street. Relevant schemes and techinques are highlighted throughout.

# Site characteristics:

Factor	Constraint/Opportunity
Use	Mixed - risk will vary according to land use
Soils	Low permeability - no infiltra- tion possible
Topography	Gently sloping valley
Groundwater	Depth greater than 4.om
Space	Land values are at a premium and pavements and roads
Catchment	A linear public open space is proposed to run through the centre of the development
Maintenance	To be agreed with SAB, water company and Highways
Safety	Eliminate and mitigate residual risk of SuDS features to the health and safety
Ecology	Limited scope for SuDS techniques which create opportunities for wildlife



Mixed Use Street, Brentwood

# Analysing the site:



*Figure 4.2.3.1: Analysis of proposed development* 

## Setting the design criteria:

#### Storage

- The design standard for the mixed use street is to provide sufficient storage to cope with frequent rainfall events.
- Discharges from the site are to be limited to greenfield flow rates.
- The storage volume required to provide sufficient attenuation of the 1 in 30 year event is in the region of 165m<sup>3</sup>. This increases to 320m<sup>3</sup> for the 1 in 100 year event plus 30% for climate change.

#### Quality

• One level of treatment is required for run off from roofs. Two levels of treatment are required for run off from the road and parking bays.

#### Amenity

• There is an opportunity to enhance the pedestrian environment through planting.

### Biodiversity

• Limited scope for biodiversity



*Figure 4.2.3.2: Initial assessment of flow routes and potential storage volumes* 

## **Case Study:**

Scheme: Portland Green Streets Location: Portland, Oregon Techniques: Bioretention planters

Bioretention planters are shallow landscaped depressions, which are typically underdrained and rely on engineered soils and enhanced vegetation to remove filtration and reduce run off downstream. They are aimed at managing and treating run off from frequent events.

The planters are very flexible and can be adapted to fit into the layout of most types of scheme. They are therefore ideal for the constraints posed by parking and access requirements of residential schemes.



Bioretention planter in Portland

- 1. Slot in kerb allows run off from adjacent paved surface
- 2. Inlet from road into forebay
- 3. Run-off is retained in the planter to a maximum depth of 15cm
- 4. Outlet to street
- 5. Footpath allows space for people to safely park and get out of their cars
- 6. Tree planting contributes to the amenity of the street



Figure 4.2.3.3: Conceptual Drainage Solution



## 4.2.4 High Density Neighbourhood

# Site Area: 1.5ha Net Density: 75+ dwellings per hectare

The development proposals include a variety of houses, apartments, business units and shops.

A small urban park is proposed at the centre of the development where children can play unsupervised. The drainage system will need to manage run off from the following areas:

- Pitched roofs
- Parking courts
- Footpaths
- Roads and shared space

The site lies at the centre of an established neighbourhood in Essex on a busy street corner.

Although the road to the west slopes quite steeply to the north, the site itself has been articially terraced and slopes gently down towards the River Colne in the east. The soils are thought to be low permeability.

# Site characteristics:

Factor	Constraint/Opportunity
Use	Residential - low pollution risk
Soils	Low permeability london clay - no infiltration possible
Topography	Gently sloping terrain
Groundwater	Depth greater than 4.om
Space	Drainage opportunities in courtyards and public open space
Catchment	River Colne lies to the east
Maintenance	To be agreed with SAB, water company and Highways
Safety	Health and safety of features in the street must be consid- ered
Ecology	Think about SuDS techniques which create opportunities for flora and fauna



High density development, Chelmsford



## **Design criteria and storage requirements:**

### Storage

- The design standard for the neighbourhood is to provide sufficient storage to cope with the 1 in 100 year rainfall event plus 30% for climate change.
- Discharges from the site are to be limited to greenfield flow rates of 5l/s/h.
- The storage volume required to provide sufficient attenuation of the 1 in 100 year event plus 30% is in the region of 470m<sup>3</sup>.

#### Quality

• One level of treatment is required for run off from roofs. Two levels of treatment are required for run off from the parking courts and road.

#### Amenity

• Opportunity to enhance development

#### Biodiversity

• There is significant scope to create SuDS features within provide habitat for a range of BAP species within the public open space and courtyards.



Figure 4.2.4.2: Initial assessment of flow routes and potential storage volumes

## **Case Study:**

Scheme: Upton Location: Northampton Techniques: Swales

A SuDS system is integrated within this major urban extension of 1382 homes. Dealing effectively with water was a key priority following the 1998 floods and SuDS provide the major structuring element.

Source control measures restrict discharge into the surface water drainage system. The pipe and swale system in the streets stores and conveys water downstream to larger retention ponds in the playing fields.

The 1 in 30 gradient presented a challenge in terms of creating and utilising storage volumes. Where possible, swales were arranged parallel to contour lines to maximise storage and potential for infiltration.

As none of the stakeholders would agree to adopt the surface water components, Upton Management Company, which has the backing of English Partnerships and Northampton Borough Council, undertakes necessary maintenance.



Site layout and design at Upton

- 1. Formal water feature near the school also provides storage volume in the event of intense rainfall events
- 2. Weirs at intervals in the swales increase the storage volume of the swales and mitigate for the effect of the gradient on site. Swales and ponds provide green fingers extending from the country park into the public realm, enhancing amenity and biodiveristy
- 3. Swale passes through and is integrated with amenity space adding visual and recreational interest
- 4. Storage swales and ponds at the end of the system allow for water to be treated, reatained and discharged to the drainage system in a controlled fashion



## 4.3 Schools

The following pages illustrate a number of case studies of SuDS, which have been designed into school grounds.

## **Case Study:**

Scheme: Sidwell Friends Middle School Location: US Techniques: Rain gardens

The masterplan and site design at Sidwell Friends School includes a central courtyard with a constructed wetland designed to utilize storm and wastewater for both ecological and educational purposes.

The plan integrated water management solutions into the landscape, inextricably linking the building to its site. The wetland becomes a "working landscape"; using biological processes to clean water while providing students with a vivid example of how such systems work in nature (Andropogon Associates, 2011).



Sidwell Friends Middle School (Andropogon Associates, 2011)

- 1. Surface water run off passes through a series of terraced rain gardens
- 2. Access and seating provided within the SuDS feature
- 3. A variety of vegetation types are planted within the terraced areas
- 4. Clean, treated water flows to a pond at the end of the system

## **Case Study:**

Scheme: Sharrow School Location: Sheffield Techniques: Green Roof

Sheffield's newest Local Nature Reserve is the first in the country to be located on top of a building. It has been designated due to its ecological importance and value to the local community.

The 2000 square metre roof was designed to represent the variety of habitats found in Sheffield – Peak District limestone grassland, wildflower meadows, urban brownfield and a wetland area with a small pond. Bird tables and insect feeders attract wildlife and a weather station and webcam have been installed to provide research opportunties.

The substrate consists of over 200 tonnes of crushed brick, organic greenwaste and limestone. Some areas were planted with shrubs and flowers while other areas were left to see what grew naturally.

Green roofs are a useful technique for providing above ground attenuation in the flood plain.



Green roof at Sharrow School

- 1. Access to the roof provided by designated and protected walkway
- 2. A range of habitats have been created by varying the type and depth of substrate across the roof
- 3. Habitats created include limestone grassland, urban brownfield and a small wetland area
- 4. Anchorage points at edge to allow safe maintenance

## **Case Study:**

Scheme: Mt Tabor School Location: Portland Techniques: Raingarden

In 2007, the Portland Bureau of Environmental Services implemented a stormwater retrofit at this middle school. It transformed an asphalt parking area into a rain garden, installed a vegetated swale within the main car park and planters along the building. A curb extension planter was also built out next to the school entrance along the streets.

The rain garden collects, stores and treats run off from the school roof and playgrounds. Water from the roof is conveyed directly to the rain garden through concrete guttering and water from the playground enters through a large trench drain.

The system is designed to have a ponding depth of 15-20cm with an infiltration of 4-6cm per hour, depending on the size of the rainfall event. Overflow is directed to the combined system.



Rain garden inundated during heavy downpour

- 1. Forebay treats run off from the playground before it drains into the rain garden
- 2. Gravel filter drain
- 3. Concrete rill conveys water from the roof

## 4.4 Roads

This section will illustrate the issues and opportunities for SuDS in roads.

## **Case Study:**

Scheme: Oxfordshire County Council Location: Oxfordshire (Various) Techniques: Swales, detention basins, peremable paving, soakaways

Oxfordshire County Council have been pioneering the design and adoption of SuDS in highways. SuDS is now an integral part of the planning process.

Developments in Oxfordshire have featured a range of alternatives to conventional drainage including swales, wetlands and balancing ponds.

In smaller developments, Oxfordshire County Council are insisting that all roads are built using porous surfacing, which they say is still performing well after ten years.



Swale

Permeable paving



Detention basin



#### 5.0 THE APPROVAL PROCESS

The number of applications we see as a SAB will be phased in over the next few years. Initially, SuDS applications will only be required for larger developments, but eventually SuDS approval will be compulsory for all planning applications with a drainage implication. It is anticipated that the SuDS application process will tie in with existing planning application arrangements and timescales. There will be a separate charge for SuDS applications in addition to the planning costs, and the fee will vary depending on the size of a development site. A key point to note is that the SuDS approval process is independent of the planning approval process. A SuDS refusal will mean that development cannot go ahead, even if planning permission is granted.

The SuDS Approval Body will take the role of regulating the way surface water is drained from developments. SuDS principles should be used where possible, and it will be for the developer to provide evidence to demonstrate that, where applicable, certain SuDS are not feasible for whichever reason. In these instances, we would still look for an agreed minimum extent of SuDS features to be incorporated into the surface water drainage system.

#### 5.1 Do I need SuDS approval?

SuDS approval is needed for any development that includes construction work that has drainage implications. Construction work means anything done in connection with the creation of a building or other structure and will have drainage implications if the building or structure will affect the ability of land to absorb water. A structure is anything that covers land and includes a patio or other surface. If you are unsure whether your development will require surface water drainage approval, you should contact the SAB for advice.

#### 5.2 SuDS approval and the planning process

The SAB should be involved in any preapplication discussions relating to a development as it is often recognised that the best and most viable SuDS outcomes are achieved if SuDS are considered early on in the formulation of the development design and layout. It would be beneficial for a range of people to be involved at the pre-application stage, including the Local Planning Authority (LPA), SuDS Approval Body, Environment Agency, Sewerage Undertakers, the developer, consultants, drainage engineers and master planners. This will enable different areas or features to be indicated for potential adoption

#### by different bodies.

If a development requires planning permission, the requirements of the SAB will depend on which type of planning permission is being applied for:

An outline planning application, made to the LPA, should include a minimum level of SuDS information, for the SAB to provide comments on. This stage will need to describe how SuDS have been accommodated in the concept design of the site and in agreement with National Standards. Required documentation includes:

• An examination of current and historical drainage patterns within and adjoining the site to ensure drainage proposals integrate with and do not compromise the function of natural drainage systems

• An assessment of suitability for infiltration, based on soil types and geology, which should account for: the presence of constraints that must be considered prior to planning infiltration SuDS; the drainage potential of the ground; potential for ground instability when water is infiltrated; and potential for deterioration in groundwater quality as a result of infiltration. This information is available via the British Geological Survey, by contacting digitaldata@

#### bgs.ac.uk.

- Concept surface water runoff management strategy
- Reasoning for inclusion of the selection of SuDS features
- SuDS layout and indicative sizing within overall site
- Indicative runoff rate calculations and attenuation volumes for the lifetime of the development
- Integration with landscape design
- Any phasing plan for development areas and associated SUDS for major sites must be submitted; or where minor development is not going to be built in a single phase
- Explanation of land use decision and how they impact drainage
- Expected source control measures
- Relationship with sustainability standards in buildings
- An application for full planning permission should be accompanied by a full SuDS



SuDS retention pond storing run off from residential development, Essex

Application which will be received by the Local Planning Authority and forwarded to the SAB for determination. The SAB is given 12 weeks to determine applications for major development and 7 weeks for all other applications. Following best practice guidance, in-line with the CIRIA SuDS Manual (2007), the following will be required for submission by the SAB as part of the drainage application:

• A method statement detailing how surface water arising during construction will be handled

• A statement of SuDS to be incorporated and final discharge points where relevant, including how the drainage design satisfies SuDS techniques, in terms of water quality and attenuation and discharge quantity for the lifetime of the development
• For full applications, a drainage plan identifying the types of SuDS to be incorporated and SuDS land take

• Proposals, where relevant, for integrating the drainage system into the landscape or required publicly accessible open space and providing habitat and social enhancement

• Evidence of soil porosity tests at the location of any intended infiltration device and the proximity of winter water table

• Calculations showing the pre- and post development peak runoff flow rate for the critical rainfall event

• Provision of drainage for large storm events, including protection for SuDS systems

• Indication of overland flow routes and safeguarding of properties from flooding

• Attenuation designed to contain the critical site design storm for the lifetime of the development.

• Details of which body will be responsible for vesting and maintenance for individual aspects of the drainage proposals

• Confirmation of land ownership of all land

required for drainage

• Foul drainage proposals

• SuDS Management Plan, which provides:

A management statement to outline the management goals for the site, and required maintenance;

Description of maintenance schedule, and materials and tools needed;

A maintenance schedule; and

A site plan, including access points and outfalls.

Where required for major developments or phasing of minor developments a plan showing each development plot (e.g. a development block of houses) which shows the allocation of volume storage and discharge rate given to that plot as part of a strategic plan.

For major developments or phasing of minor developments, a plan showing each development plot (e.g. a development block of houses) which shows the allocation of volume storage and discharge rate given to that plot as part of a wider SuDS strategy.

If a development is allowed under permitted development rights (as set out in the Town and Country Planning (General Permitted Development) Order 1995 available at www. legislation.gov.uk) but will have drainage implications, approval by the SAB is needed and a SuDS Application should be submitted directly to Essex County Council's SuDS Approval Body.

A SuDS Application will have to be accompanied by an Application Form. We will also require a number of plans to be submitted with a SuDS Application;

An application for SuDS approval is required to clearly show who is proposed to adopt certain parts of the system. We have provided an adoption model, see figure 5.1, to outline the likely bodies that may adopt and maintain SuDS elements. This includes arrangements for SuDS in multi-use spaces that would ordinarily be maintained by someone other than the SAB.

## **Need for Supporting Evidence**

Early pre-application discussion with the SuDS Approval Body is encouraged as there may be a requirement for a period of groundwater level monitoring or series of infiltration tests to be carried out to determine the suitability of proposed SuDS features. Evidence of drainage calculations should be provided in support of SuDS proposals, preferably using the WinDes software package Micro Drainage. Additional requirements that should be included where relevant at the applicant's discretion (and may be requested by the SAB following application if necessary):

- Demonstration of how future development has been taken into account
- Description of safety measures to render SuDS acceptably safe

• Calculations showing that the postdevelopment runoff volume does not exceed that for predevelopment for critical rainfall events or any more stringent requirements for the catchment specified by the Environment Agency or an Internal Drainage Board

- Assessment of flood risk including consideration of the flow route for the extreme period flood events showing detriment to land or property as a result of overland flow
- Calculation of the treatment volume and demonstration that the level of treatment and available treatment volume is adequate

• Consideration of the impact of development on pollution risk to groundwater, and/or mobilisation of groundwater contamination

• Possible additional level of treatment for

Scenario	Adoptable by SAB?	Possible alternate adopter
SuDS serving single property including schools, hospitals etc. Green roof Soakaways Swales Rain garden Rill Permeable paving Rainwater harvesting	No No No No No No	Landowner Landowner Landowner Landowner Landowner Landowner Landowner
SuDS in private roads Swales Rain garden Permeable paving Rainwater harvesting from road	Yes Yes Yes Consult	Landowner, District or Borough Council Landowner, District or Borough Council Landowner, District or Borough Council Landowner, District or Borough Council
SuDS in public adopted highway Swales Rain garden Permeable paving Rainwater harvesting from road	No No No No	Highways authority Highways authority Highways authority Highways authority or water company
SuDS in public open space Swales Rain garden Filter strips Filter drains Permeable paving Communal rainwater harvesting Rill Wetland Pond	Yes Yes Yes Yes Consult Yes Yes Yes	District or Borough Council District or Borough Council District or Borough Council District or Borough Council District or Borough Council or water company District or Borough Council District or Borough Council District or Borough Council District or Borough Council
SuDS in private property (serving more than one property) Swales Rain garden Permeable paving Communal rainwater harvesting Permeable paving Rill Wetland Pond	Yes Yes Consult Yes Yes Yes Yes Yes	Landowner Landowner Landowner Landowner Landowner Landowner Landowner Landowner

Figure 5.1: Adoption Model

Essex County Council

discharge to sensitive receiving water

- Survey habitats and species with reference to the Local Biodiversity Action Plans
- Demonstration of good ecological practice including habitat enhancement and deculverting
- Demonstration that surface water/ groundwater entering the development from adjacent land has been taken into account
- A site plan showing the phasing of development and associated SuDS

Figure 5.2 illustrates what we see as important stages and actions within the approval process. We see early pre-application discussion with developers and local planning authorities as vital to ensure that proposals take into account the need for SuDS in development design.



#### Notes

No response from consultees will be treated as nil return.

Figure 5.2: The Approval Process

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## **5.3 Determination of SuDS Applications**

Having received a SuDS Application, the SAB will review whether sufficient information has been provided to begin determining the application and may seek further information from the applicant. Only once all required information has been received by the SAB will the SuDS Application and planning application be registerable and the timescales for determination begin. The SAB will notify the Local Planning Authority of the acceptability of the submitted SuDS Application and the Planning Authority will, in their usual correspondence, notify the applicant that the applications have been registered.

Once a SuDS Application has been registered, the SAB will consult on the application with:

- Sewerage undertakers- to confirm any proposed discharges to surface water sewers owned by them or acceptability of features they are proposed to adopt
- Environment Agency- to determine any issues with the site such as groundwater protection or verify any proposed discharges to main rivers
- Highway Authority (Development Management) - to discuss agreements for adoption where highway and non-highway

drainage overlap

• Any other bodies who may be affected by or have an interest in the proposals.

The SAB will reserve the right to request further information from the applicant if required by a statutory consultee in order to determine the application, which it will endeavour to do as soon as possible to allow time to consider the further information and determine the application within the required timescale. The SAB is likely to arrange a site visit to inspect the site and assess the suitability of the proposals.

The SuDS Application will be determined in accordance with the National Standards and further advice provided in this guidance, also having regard to comments received in respect of the application. The SAB will notify the Local Planning Authority of its decision who will issue the decision notice(s) to the applicant. The SuDS Approval may contain conditions relating to:

- Construction of the drainage system must be in accordance with approved plans and any further details required to be submitted relating to construction including materials and specifications
- Approval subject to receipt of non-

performance bond to be received prior to commencement of construction

- Need to notify SAB of intention to commence construction including provision of Programme of Works to enable appropriate inspections to be arranged
- Requirement for fees to be paid in relation to work undertaken in connection with approval and construction.

There will be arrangements in place for an application for SuDS approval to be appealed, and further information on the appeal process will be provided in due course.

»Infiltration Basin at Ravenswood, Ipswich

# 6.0 THE ADOPTION PROCESS

## **6.0 THE ADOPTION PROCESS**

At this stage, we are awaiting national guidance from Defra on the specific details relating to the adoption process. Here we have outlined the way we see this process occurring. The duty of the SAB to adopt SuDS serving more than one property is conditional on obtaining SuDS Approval and:

- Provision of a non-performance bond
- Construction verification
- Performance verification

We may voluntarily adopt SuDS on smaller sites sooner than required as the SAB requirement to approve will be phased in and will only begin on larger sites.

## 6.1 Provision of a non-performance bond

It is likely that a SuDS Approval will be accompanied by a condition requiring a nonperformance bond to be provided to the SAB by the developer. If SuDS are not constructed to the appropriate standards, having given prior notification, the SAB may use the nonperformance bond to rectify works. The sum of this bond may have been pre-agreed in which case the developer can arrange for the deposit of the bond and commence construction arrangements. The sum of the bond may be required to be calculated in which case the developer should submit a request to the SAB for the value of the non-performance bond to be agreed. On agreement and receipt of the non-performance bond, the condition will be formally discharged in writing by the SAB and the developer can look to commence construction.

# 6.2 Construction verification

Work cannot start on site prior to formal SuDS Approval Body agreement to the submitted proposals. Prior to construction beginning on site, the SAB will require four weeks notice and should be provided with a Programme of Works. The Programme of Works should contain the following:

- The expected commencement and completion dates of works (including for different phases, to be indicated on a plan)
- Details of the Site Manager and any other technically competent persons who will oversee the construction of SuDS
- Details of the temporary drainage arrangements during ongoing construction including any mitigation measures e.g. to prevent silt overloading of constructed

## SuDS

- Details of suitable access arrangements and times for SAB inspections including who to report to or contact to arrange inspections
- Written evidence prior to construction will be required to demonstrate that all necessary health and safety risk assessments have been undertaken for all work phases

Any significant changes to this Programme of Works should be notified to the SAB at the earliest possible opportunity. During all stages of construction, SAB officers should be provided with access for inspection. Any work that cannot be inspected due to insufficient notice being provided will be required to be re-opened for inspection and reinstated at the Developer's expense. The impact of ongoing construction works on SuDS features should be minimised and advice is given in the Site Handbook on Construction of SuDS (CIRIA C698) on this.

Pre-excavation inspection will be carried out by the SAB to ensure that construction runoff will not have a detrimental effect on constructed SuDS features. Depending on the proposed phasing and timescales for construction, the SAB may carry out a number of on-site verification inspections. Following completion of construction, the developer's consultants will be required to produce a Verification Report

# covering the following:

- Excavations photos indicating soil conditions, levels, profiles, earthworks
- Inlets, outlets and control structuresphotographs and manufacturer's details (if appropriate)
- Topsoil sources- appropriate certificates
- Planting full planting list, plant sources, planting method statement, initial maintenance regime, photographs before and after planting
- Subsoil and topsoil- depths
- Gravel fill specification, sources, installation method statement of filter drains
- Membrane liners- source, test certificates. Should have welded joints which shall be inspected and tested, records of the tests to be provided
- Full as-built drawings and topographical survey of 'as constructed' feature
- Maintenance regimes- provide initial and proposed regimes.

Following completion of the whole development served by SuDS, the SAB will confirm in writing that it is satisfied that the SuDS have been constructed to appropriate standards. If SuDS are not constructed to the appropriate standards, having given prior notification the SAB may use the non-performance bond to rectify the works.

# **6.3 Performance verification**

Following completion of the whole development served by SuDS and confirmation from the SAB that SuDS are constructed to the correct standards, a maintenance period of one year will be required with all works to be carried out by the developer, including any remedial works. Following this period there will be a final inspection by the SAB when any accumulated silt or other defects will be rectified by the developer prior to consideration for adoption. The SAB will give confirmation in writing of the outcome of the final inspection.

If SuDS are found not to perform satisfactorily, the SAB may notify the developer and carry out remedial works using money contained within the non-performance bond if necessary.

# 6.4 Request for adoption

Having satisfactorily completed construction and after a period to test the systems correct performance, the developer may submit a request to the SAB for adoption. This request must include the following (if not previously provided):

- Final agreed adoption model- who is responsible for different elements of the system
- Confirmation of maintenance regime employed up to point of adoption
- Proposed future maintenance regime
- Any relevant manufacturer's guides/ manuals and warranty documents
- Plans showing the extent of the SuDS to be adopted by the SAB
- Final as built drawings and topographical survey of constructed SuDS
- Statement of arrangements for access
- Health and Safety file to include e.g handling arrangements and access

The division of responsibility between SuDS features in the highway and in Public Open Spaces will be determined between the SAB, and ECC Highways or the Local Authority as appropriate.

The figure on the following page outlines how we envisage the adoption process working, following a request by a developer for adoption.

The SAB will reserve the right to decline adoption of SuDS features that have not been approved. As with an application for approval,



### <u>Notes</u>

Single properties include:

- A residential building with multiple flats
- A single dwelling house (does not include a flat contained in a residential building with multiple flats)
- A retirement village
- An office or commercial building
- A school or university campus
- An industrial development or commercial estate
- A hospital or other medical facility

Within **28 days** of its adoption decision, the drainage system will be included in the asset register maintained by Essex County Council under section 21 of the Flood and Water Management Act.

Where eligible, single-property SuDS features will be designated under Schedule 1 of the Flood and Water Management Act.

Figure 6.1: The Adoption Process

Essex County Council

an applicant may appeal against a decision of the SAB in respect of adoption of features.

## 6.5 Post-adoption requirements

In some cases, the SAB can adopt a drainage system on its own initiative and must notify the developer as soon as is reasonably practicable. Notice of adoption (whether voluntary or following a request by a developer) must be given by the SAB to the sewerage undertaker, households on whose land the drainage system is or whose land will be drained by the system and other statutory consultees to the approval process such as the Environment Agency. The notice will specify the extent of the drainage system being adopted and will include details of any arrangements under the approved proposals for access and maintenance. Once adopted the SAB is responsible for maintenance and upkeep in perpetunity.

SuDS in public roads may be protected using a designation as 'streets with special engineering difficulties' or, alternatively, in private areas will be protected via registration on the local land charge register, which requires prior permission to be sought from the SAB for any works which may affect the SuDS features.

The figure on the following page is intended to give an overview of the approval and adoption



SuDS reed bed retention pond storing run off from residential development, Essex

processes, outlining what actions will be required of the developer and of the SAB at progressive development stages.

Development Stage	Developer Actions	SAB Actions	Outcomes
Site Purchase	Consider the space required for SuDS within the development area.	Provide advice on the area required by SuDS features and the overall costs involved.	Consideration to SuDS
Master Planning	Discussion with SAB and other consultees on their requirements for SuDS. Ensure master plans take into account the natural topography of a site for SuDS features.	Provide advisory comments on design requirements and initial feedback on SuDS concept design. Direct application to the relevant consultees.	Consideration to SuDS
Pre-application Enquiry	Drainage strategy and proposed SuDS elements for adoption should be discussed.	A formal response to any pre-application enquiry and recommendations on the initial design will be provided.	Principles established
Outline Planning Application	Outline planning permission can be granted without SuDS approval therefore developers must ensure that issues would not be encountered at the SuDS approval stage.	Review outline planning permission and provide comments. Highlight any potential issues with future SuDS applications on the site.	Principles established
Full Planning Application and SuDS Approval	SuDS approval can be sought prior to, or in conjunction with, a planning application being submitted. A detailed SuDS Application must be submitted to the SAB either directly where full planning permission is not required or via the LPA where it is.	SAB to review detailed design of SuDS proposals, make appropriate consultations, and either approve application with conditions or refuse within the appropriate time frame. The SuDS application will be determined independently of any planning application	Planning permission and SuDS permission granted
SuDS Construction	Must provide non-performance bond, give appropriate notice and submit Programme of Works to SAB prior to commencement of construction.	The SAB will carry out verification inspection(s) and give written confirmation of acceptability of construction.	Construction works verified
SuDS Adoption	Approved SuDS features which do not form part of a single- property development can be adopted by the SAB. Following approved construction must maintain for one year. Following SAB confirmation of satisfactory performance, submit adoption request.	Carry out final inspection and give written confirmation of acceptability of performance. SAB is required to determine a request for adoption within 8 weeks. Upon adoption must return any remaining non-performance bond.	Performance verified and SuDS adopted

Figure 6.2: Approval and Adoption Table

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# 7.0 APPENDICES

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# Appendix 1: Checklist for submission and summary of SuDS techniques

Item	Details to be submitted with SuDS Application
Hydraulic	
Protection against flooding	<ul> <li>1 in 30 year rainfall event – demonstrate that development and occupants are protected from flooding, and that off-site flood risk is not increased.</li> <li>1 in 100 year rainfall event inc. climate change– in situations where volumes cannot be stored, overland flow routes, depths and locations must be illustrated. It must be shown how surface water will be managed to control risk to people and property.</li> </ul>
Storage	<ul> <li>1 in 30 year rainfall event – permanent surface water storage areas should be sized to contain all surface volumes generated.</li> <li>1 in 100 year rainfall event inc. climate change– permanent storage areas should be shown to hold all volumes if possible, although alternative temporary above ground storage areas are acceptable if planned and agreed.</li> </ul>
Runoff	<ul> <li>Infiltration SuDS preventing any runoff from a site should be used as a preference.</li> <li>The first 5-10mm rainfall should be contained on site through source control.</li> <li>In all other rainfall events the runoff from a site should be restricted as near the 1 in 1 year greenfield runoff rate as possible.</li> </ul>
Precaution- ary approach	• The risk of blockage, failure and high ground water levels must be considered in the design of SuDS. A precautionary approach should be taken to ensure the risks are reduced.

Item	Details to be submitted with SuDS Application
Water Qualit	ty
Protect against pollution	<ul> <li>The first 5-10mm rainfall should be contained and treated on site through source control.</li> <li>A series of SuDS to provide treatment stages should be installed on the site. The number of treatment stages required will depend on the nature of the site and source of runoff.</li> </ul>
Amenity	
Health and safety	<ul> <li>CDM regulations will ensure all foreseeable risks are assessed. The Health and Safety file must be presented to the SAB.</li> <li>Risks to public safety should be managed through design before other measures are considered</li> </ul>
Community engagement	<ul> <li>Aesthetic appeal should be maximised.</li> <li>Education programmes and information boards may be used to promote understanding and encourage responsibility within communities using SuDS.</li> </ul>
Ecology	
Maximise ecological value	<ul> <li>Selected planting should be of a native variety and create varied habitat types.</li> <li>SuDS should be created to be as close a possible to natural ecosystems.</li> </ul>

## Appendix 2: Rainwater and Greywater Harvesting 7.1 Introduction

On average, every person in England and Wales uses around 150 litres\* of mains water per day (l/p/day), though there is potential for this to



be reduced through water reuse systems. \*Measured total England and Wales microcomponent use 2009-10 (%) Environment Agency

The most common systems used in the UK are rainwater harvesting and greywater recycling.

The main reasons for installing water reuse systems are potential environmental benefits, possible financial savings and to meet regulations and standards. This section explains what the different systems are, and highlights issues and opportunities.

# 7.2 Rainwater Recycling

Rainwater harvesting is the process of collecting and using rainwater that would otherwise have gone into the drainage system or been lost through evaporation. Once collected and stored it can be used for non-potable purposes, including toilet flushing, garden watering and, for higher quality harvested water, clothes washing using a washing machine.

Rainwater harvesting should be seen as both stand alone and an integral part of a wider strategy that includes SuDS, flood alleviation and water conservation, in response to changing climate and increased usage.

Possible benefits of rainwater harvesting

- It is estimated that domestic systems could reduce the mains water consumption by up to 50% rising to more than 80% in commercial applications. (UKRHA figures).
- Rainwater is a free resource that is naturally recycled through the water cycle.
- Part of a wider sustainable approach to the

management of water in the environment.

- Reduced utility bills and the reduction of running costs.
- Achievement of sustainability standards and help in achieving planning permission.
- Storing of source water for alternative use or as part of a SuDS system.

Evolving issues relating to rainwater recycling:

- Systems can be expensive to buy, though payback periods are improving as the market matures and water utility prices increase.
- Increasing water metering in 2011 only 37 per cent of homes were metered.
- Regulations and standards are emerging to reassure consumers.
- Population growth and lifestyle changes mean water supply is struggling to keep up with demand.
- Annual rainfall predicted to fall in the Eastern regions

# System Types and Design Considerations

To be economic and practical, the system design should consider roof area, roof connections, water demand, storage size required, location of facilities including whether storage will be above or below ground, potential pretreatment, design of collecting surfaces, appearance of facilities and any potential for combining facilities. Different rainwater harvesting measures should be considered according to the nature of the development and site. For example, it will nearly always be more economical to install harvesting below ground on new development whereas it will be more cost effective to install features above ground in existing development.

Rainwater harvesting is traditionally collected from roofs but can also be collected from ground surfaces. Rainwater from roofs does not require treatment if it is used for non-potable purposes, such as watering a garden, but pumping might be required if it is collected at a level below its intended end use. Rainwater collected from ground surfaces may be more polluted and require treatment before reuse, especially if it is stored in an above ground basin. Effective rainwater treatment should consider the materials coming into contact with the runoff, for example checking for chemicals and other pollutants.

Rainwater storage should be sized considering rainfall patterns and expected water demands using the BS 8515:2009 "intermediate approach". Optimising storage size for demand requirements can reduce land take needs. It is also important to take advantage of economies of scale. If underground storage can be used, land take can be reduced. Aboveground storage is preferable where geological conditions consist of shallow rock or a high water table. For communal rainwater harvesting, storage could take the form of either an above ground or below ground communal tank, or an above ground basin. With regard to design and layout, above ground water storage should consider visual impact and storage facilities must be accessible for easy maintenance.

Types of rainwater harvesting systems range in terms of complexity and size ranging from complex district-wide systems to simple household systems linked to a water butt. However, most share the same principles.

Once collected in storage tanks and treated the harvested water can reused using three types of distribution system:

- Pumped directly to points of use
- Fed by gravity to points of use
- Pumped to an elevated cistern and fed by gravity to the points of interest

Rainwater harvesting systems can be combined with grey water recycling systems to form an integrated process. However, given the issues and costs of mixing water, these should only generally be considered when either source would not provide sufficient water on its own.

Rainwater harvesting systems are relatively

easy to manage. For water collected from roofs, there will be a need to clean gutters. Each stage of treatment will require maintenance – pretreatment system performance, water quality in storage, and disinfection (second stage of treatment if required) infrastructure.



A typical passive rainwater collection system directly conveys rainwater into flushing tanks. (Pipex Flowstow system) 1-Rainwater outlet with filter, 2-Flushing tank 3-Mains water inlet, 4-Inspection cover 5-Overflow, 6-Full and half flush button, 7-Control system Appropriate maintenance access will need to be considered at all treatment stages. Metering and monitoring will also be required for communal systems.

A typical collection, treatment and storage system is shown and described as follows:

**1.** Rainwater is collected from the roof area or hard standing,

**2.** Filter system prevents solids from entering the holding tank,

**3.** Water enters tank through smoothing inlet which stops settled sediment from being disturbed,

**4.** A suction filter prevents the uptake of floating matter when water is drawn up,

5. A pump pressurises the water,

**6.** A control unit monitors water levels - if these drop too low mains water will top the system up,

**7.** An air gap installed in order to prevent back flow of rainwater into the mains,

**8.** An overflow trap allows floating material to be skimmed off into the storm drain,

**9.** Rainwater soaking through a permeable pavement can also be collected,

**10.** Oil trap fitted to prevent contamination entering the system from ground surfaces, though additional filtration and disinfectant might also be needed.



# 7.3 Greywater Recycling

### Introduction

Greywater is wastewater which can be collected from showers, baths, washbasins, washing machines and kitchen sinks, though this guidance focuses on the first three less contaminated sources. It gets its name from its cloudy appearance and from its status as being between fresh, potable water (known as "white water") and sewage water ("black water"). After treatment greywater can be recycled for use around the home for purposes which do not require drinking water quality.

Domestic systems, which this guidance focuses on, typically collect and store greywater before reusing it to flush the toilet. More advanced systems treat greywater to a standard that can be used in washing machines for example. The most basic systems simply divert cooled and untreated bath water to irrigate the garden. Greywater recycling can be installed in new or existing dwellings.

Possible benefits of greywater recycling:

• Reduced mains water usage, e.g. greywater toilet flushing should reduce home usage by over a quarter.

• Sourcing reliability compared to rainwater

harvesting.

- Reduced demand for water helps protect wetland habitats.
- Reduced water discharge into the sewerage system.
- Compliance with regulations and standards relating to water consumption
- А



typical short retention bathroom grey water recycling system for toilet flushing

Evolving issues relating to greywater recycling:

- Systems can be expensive to buy, maintain and run, though payback periods are improving as the market matures and water utility prices increase.
- Reliability has significantly improved with the

advancement of technologies.

- Increasing water metering in 2011 only 37 per cent of homes were metered.
- Increased embodied and operational energy use compared to mains water.
- Mixed public perceptions influenced by management systems, contamination levels, usage, potential contact and marketing.
- Regulations and standards are emerging to reassure consumers.



A typical biological soil box filter system

## System Types and Design Considerations

There are various greywater systems which might be considered, varying significantly in complexity and size. However, most have in common features such as a tank if storing water, a pump, a distribution system and, where it is needed, some sort of treatment.

Greywater stored for any length of time has to be treated as otherwise it deteriorates rapidly. This is because it is often warm and rich in organic matter, providing an ideal breeding ground for bacteria. A key consideration when choosing a greywater recycling system type should be the predicted water demand and supply for the user group over time.

The main types of greywater recycling systems are discussed as follows according to the type of treatment used:

Direct Reuse Systems (no treatment) - There is potential to very cheaply reuse untreated greywater if the water is not stored for long. Most commonly this involves less contaminated water simply being redirected for use in the garden, for example using a pump and hose for cooled bath or shower water.

Short Retention Systems – These take greywater from the bath or shower and apply a very basic treatment such as skimming debris off the surface and allowing particles to settle to the bottom of the tank. Potential reuse includes for toilet flushing. Unused water can be released after a certain time and the system is topped up with mains water. These systems are relatively cheap to buy and run, and can be located in the same room as the source of greywater.

Basic Physical and Chemical Systems – A number of systems filter to remove debris from greywater and use chemical disinfectants to prevent bacterial growth in storage. Water saving benefits should be considered against the environmental impact of disinfectants, maintenance requirements and possible odour issues.

Biological Systems – These vary in complexity, with systems available for groups of dwellings as well as individual homes. Active bacteria are used to remove organic material from wastewater using air-induced filtration and digestion principles. Biological systems generally use reed beds, with UV filters to kill remaining bacteria. Biological systems normally require a relatively large outside area, such as a roof or garden.

Bio-mechanical - The most advanced domestic systems combine biological and physical treatment to produce the highest quality water, but use significant amounts of energy and are more expensive to buy and install.

Integrated Greywater Recycling / Rainwater Harvesting Systems – Given the issues and

costs of mixing water, these should only generally be considered when either source would not provide sufficient water on its own.

**Regulations and Standards** 

• BS 8525-2:2011 Greywater Systems. Domestic Greywater Treatment Equipment. Requirements and Test Methods - embeds water quality parameters relating to greywater reuse applications.

• The Building Regulations (Part G) - requires the potential wholesome water consumption of new dwellings to not exceed 125 l/p/day.

• Code for Sustainable Homes - requires reduced mains water consumption, down to less than 80 l/p/day to meet the highest levels.

• The Water Supply (Water Fittings) Regulations 1999 – covers back flow prevention to avoid cross-contamination of mains water.

• Guidance on Marking and Identification of Pipe work for Reclaimed (Greywater) Systems (WRAS, 1999).

## **Further Guidance and References**

• Environment Agency (2011) Greywater for Domestic Users: An informative guide

• PUSH (2009) Draft PUSH Sustainable Development SPD Resource Document

• Anglian Water & CIPHE, Water Reuse Systems

• CIRIA (2001) Rainwater and Greywater Reuse in Buildings

• BSI (2010) BS 8525-1:2010 Greywater Systems. Code of practice

• Environment Agency, Conserving Water in Buildings

• WRAS (1999) Reclaimed Water Systems

• CIRIA (2010) Guidance on Water Cycle Management for New Developments (C690)

• UK Rainwater Harvesting Association at http://www.ukrha.org/

• Pipework for Reclaimed (Greywater) Systems (WRAS, 1999).

# 7.4.1 Rainwater Recycling case study

**Development:** Green Space project **Type:** Rainwater Recycling (residential) **Location:** Mendip Place, Chelmsford **Techniques:** Rainwater Harvesting

In 2010 Chelmer Housing Partnership completed 10 eco-houses on a former garage site in Chelmsford. A key objective of the scheme was to achieve Code for Sustainable Homes Level Sixusing innovative technologies.

Rain rainwater harvesting reduces water consumption, using relatively simple and inexpensive systems which utilises rainwater from roofs, redirecting it to individual water butts located in gardens. The primary purposes are to reduce water usage in the garden and costs in use. This forms part of a wider water management strategy for the scheme including reduced flow taps/ showers in each property.

The scheme includes a range of other sustainability features, such as electricity generating PV panels, a bio-mass heating and hot water system, high levels of thermal insulation and composting areas. Energy and water use are being monitored with results informing the association's long term development strategy. 



# 7.4.2 Rainwater Recycling case study

Development: Columbus School and College, Essex Building Schools for the Future Type: Rainwater Recycling (school) Location: Chelmsford Techniques: Rainwater Harvesting

Rainwater is harvested from the school and college to form a combined system with central storage and treatment. The water is then distributed for reuse in toilets.

Rainwater harvesting forms part of a wider water management strategy which includes water efficient fittings and fixtures, and a leak detection system. Drought resistant planting is also being used for landscaping to minimise the need for watering. The scheme also incorporates SuDS to attenuate water run off and mitigating against the risk of localised flooding.

The scheme forms part of a wider strategy by Essex County Council to improve sustainability standards and reduce costs. Other schools featuring rainwater harvesting include Hutton Willowbrook Primary School in Brentwood and Epping Primary School. Monitoring of different systems is helping inform future schemes.



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# 7.4.3 Greywater Recycling case study

Scheme: Affordable housing (Moat) Location: Heybridge, Essex Techniques: Greywater recycling (Basic physical and chemical system)

In 1997 when the technology was in its infancy, a housing association, in partnership with Essex and Suffolk Water and the BRE developed three homes in Heybridge incorporating individual greywater systems. The Water Dynamics Well Butt System takes water from the bath and hand basin, and filters and disinfects it before the water is reused to flush toilets.

Related findings:

- Unexpected failure of the system components reduced the water saved
- Lifestyle patterns significantly influenced water savings

• Testing of the greywater raised no health concerns, though water turbidity increased over time without regular upkeep.



Monitoring of the system produced varying results: Household Consumption:

Property	Occupancy	Time system worked	Potable water saved
3 bed house	3	63%	53%
3 bed house	3	83%	65%
4 bed house	7	39%	24%

# 7.4.4 Greywater Recycling case study

Scheme: Premier Inn hotels Location: Doncaster and others Techniques: Greywater recycling

In 2008 Premier Inn had an Aquacontrol greywater recycling system installed in their Doncaster Hotel. This was integral to owners Whitbread's ongoing strategy to tackle water consumption issues working closely with Waterscan their water management partners. The hotel is currently recycling 2,800 litres of water per day with a reduction in mains water consumption of 19%. In 2008 a combined rainwater and greywater recycling unit was also installed in Premier Inn's new green flagship Tamworth Hotel, with greywater recycling providing 100% of the hotel's toilet water use.



The Premier Inn greywater system collects greywater from baths and showers. In the collection tank aeration encourages natural biological cleansing of bio-degradable particles, before further filtration removes remaining particles. Filtered water then enters a clear water tank before being pumped to a water management system which supplies green water for flushing toilets, laundry, cleaning and irrigation. A Waterscan greywater system now goes into all new build Premier Inn's as standard with an option for a combined system incorporating rainwater harvesting. Waterscan also maintain the systems.

tion pond takes run off from roof at M42 Services, Hopwood (Robert Bray Associates)

# 8.0 GLOSSARY OF TERMS AND ACRONYMS

# 8.0 GLOSSARY OF TERMS AND ACRONYMS

Amenity	The quality of being pleasant or attractive; agreea- bleness.
Attenuation	Reduction of peak flow and increased duration of a flow event.
BAP	Biodiversity Action Plan
Basin	A ground depression acting as a flow control or wa- ter treatment structure that is normally dry and has a proper outfall, but is designed to detain stormwater temporarily.
Biodegradation	Decomposition of organic matter by micro-organ- isms and other living things.
Biodiversity	The diversity of plant and animal life in a particular habitat.
Bioretention area	A depressed landscaping area that is allowed to collect runoff so it percolates through the soil below the area into an underdrain, thereby promoting pollutant removal.
BRE	Building Research Establishment.
Catchment	The area contributing surface water flow to a point on a drainage or river system. Can be divided into sub-catchments.
CDM	Construction Design and Management Regulations 2007.
CIRIA	Construction Industry Research and Information As- sociation.

Conventional drainage	The traditional method of drainage surface water using subsurface pipes and storage tanks.
Conveyance	Movement or water from one location to another.
Defra	Department for Environment, Food and Rural Affairs.
Design criteria	A set of standards agreed by the developer, plan- ners, and regulators that the proposed system should satisfy.
Detention basin	A vegetated depression that is normally dry except following storm events. Constructed to store water temporarily to attenuate flows. May allow infiltration of water to the ground.
ECC	Essex County Council.
Exceedance flow route	Design and consideration of above-ground areas that act as pathways permitting water to run safely over land to minimise the adverse effect of flood- ing. This is required when the design capacity of the drainage system has been exceeded.
Filter drain	A linear drain consisting of a trench filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage.
Filter strip	A vegetated area of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
Filtration	The act of removing sediment or other particles from a fluid by passing it through a filter.
Flow control device	A device used for the control of surface water from an attenuation facility, e.g. a weir.

Geocellular structure	A plastic box structure used in the ground, often to attenuate runoff.
Geotextile	A plastic fabric that is permeable.
Green roof	A roof with plants growing on its surface, which con- tributes to local biodiversity. The vegetated surface provides a degree of retention, attenuation and treatment of rainwater, and promotes evapotranspi- ration.
Greenfield runoff	The surface water runoff regime from a site before development.
Groundwater	Water that is below the surface of ground in the saturation zone.
Habitat	The area or environment where an organism or eco- logical community normally lives or occurs.
Highway Author- ity	A local authority with responsibility for the main- tenance and drainage of highways maintainable at public expense e.g. Essex County Council.
Impermeable	Will not allow water to pass through it.
Impermeable surface	An artificial non-porous surface that generates sur- face water runoff after rainfall.
Infiltration	The passage of surface water into the ground.
Infiltration basin	A dry basin designed to promote infiltration of sur- face water into the ground.
Infiltration trench	A trench, usually filled with stone, designed to pro- mote infiltration of surface water to the ground.

Interception storage	The capture and infiltration of small rainfall events up to about 5mm.
Management train	The management of runoff in stages as it drains from a site.
Non-perform- ance bond	A written financial guarantee (usually a bank or insurance company) given by a developer underwrit- ing their agreement tto construct the works to an agreed standard.
Pavement	Technical name for the road or car park surface and underlying structure. N.B. the path next to the road for pedestrians is properly termed the footway.
Permeability	A measure of the ease with which a fluid can flow through a porous medium. It depends on the physi- cal properties of the medium, for example grain size, porosity and pore shape.
Permeable pave- ment	A permeable surface that is paved and drains through voids between solid parts of the pavement.
Piped system	Conduits generally located below ground to conduct water to a suitable location for treatment and/or disposal.
Pollution	A change in the physical, chemical, radiological or biological quality of a resource (air, water or land) caused by man or man's activities that is injurious to existing, intended or potential uses of the re- source.
Pond	Permanently wet basin designed to retain stormwa- ter and permit settlement of suspended solids and biological removal of pollutants.

Prevention	Site design and management to stop or reduce the occurrence of pollution and to reduce the volume of runoff.
POS	Public Open Space.
Rain Garden	A planted basin designed to collect and clean run- off.
Rainfall event	A single occurrence of rainfall before and after which there is a dry period sufficient to allow its effect on the drainage system to be defined.
Recharge	The addition of water to the groundwater system by natural or artificial processes.
Retention pond	A pond where runoff is detained for a sufficient time to allow settlement and biological treatment of some pollutants.
Return period	Refers to how often an event occurs. A 100-year storm refers to the storm that occurs on average once every hundred years. In other words, its annual probability of exceedance is 1% (1/100).
Rill	An open surface water channel with hard edges, used to collect and convey runoff. They can be planted to provide a cleaning function.
Runoff	Water flow over the ground surface to the drainage system. This occurs if the ground is impermeable, saturated or rainfall is particularly intense.
SAB	SuDS Approval Body.

Sediments	Sediments are the layers of particles that cover the bottom of waterbodies such as lakes, ponds, rivers and reservoirs.
Sewer	A pipe or channel taking domestic foul and/or surface water from buildings and associated paths and hard-standings from two or more cartilages and having a proper outfall.
Sewerage under- taker	Collective term relating to the statutory undertaking of water companies that are responsible for sewer- age and sewage disposal including surface water from roofs and gardens of premises.
Silt	The generic term for waterborne particles with a grain size of 4-63mm, ie. between clay and sand.
Site/regional control	Manage runoff drained from a sub-catchment or sev- eral sub-catchments. The controls deal with runoff at a catchment scale rather than at source.
Soakaway	A sub-surface structure into which surface water is conveyed, designed to promote infiltration.
Source control	The control of runoff at or near its source.
Sub-base	A layer of material on the sub-grade that provides a foundation for a pavement surface.
SuDS	Sustainable Drainage Systems. A sequence of man- agement practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques.
Surface water	Water that appears on the land surface ie. lakes, riv- ers, streams, standing water, and ponds.

Swale	A shallow vegetated channel designed to conduct and retain water, but may also permit infiltration. The vegetation filters particulate matter.
Treatment	Improving the quality of water by physical, chemical or biological means.
Watercourse	A term including all rivers, streams, ditches, drains, cuts, culverts, dykes, sluices, and passages through which water flows.
Water butt	Small scale garden water storage device which collects rainwater from the roof via the drainpipe.
Water quality treatment vol- ume	The proportion of total runoff from impermeable areas that is captured and treated to remove pollut- ants.
Wetland	Flooded area in which the water is shallow enough to enable the growth of bottom-rooted plants.

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By email: suds@essex.gov.uk

Visit our website: www.essex.gov.uk/flooding

By telephone: 01245 437062/437138

By post: Essex County Council, Environment, Sustainability & Highways, E3 County Hall, Market Road, Chelmsford, Essex CM1 1QH

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