SuDS Guidance

London Borough of Tower Hamlets

TOWER HAMLETS

Introduction

This guidance note begins with the legislative and policy background information that serves to establish the legitimacy of Tower Hamlets requirement for the inclusion of sustainable drainage systems (SuDS) in developments across the borough.

It continues with some practicable examples of SuDS that are relevant to developments within the LB of Tower Hamlets. This is followed by an explanation of how to calculate water storage capacity of SuDS, together with worked examples. The document concludes with information about how to apply for approval of SuDS, the approval and adoption process, and concluding with contact details for further information.

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1.0 Legislative Context

1.1 Legislation

The Flood and Water Management Act was introduced in 2010. The Act defines the role of lead local flood authority (LLFA) for an area. All LLFA are required to develop, maintain, apply and monitor a strategy for local flood risk management in its area, called "local flood risk management strategy".

Alongside the Act, Flood Risk Regulations (2009) outline the roles and responsibilities of the various authorities, which include preparing Flood Risk Management Plans and identifying how significant flood risks are to be mitigated.

According to the Act, one of the major tasks that the LLFA is required to undertake is being a **SuDS Approving Body.**

As per Schedule 3 of the Act, LLFAs are designated the SuDS Approving Body (SAB) for any new sustainable drainage system. Therefore it must approve, adopt and maintain new sustainable drainage systems (SuDS) within its area. Highways authorities will continue to be responsible for maintaining SuDS in public roads. All SuDS must conform with the National Standards for SuDS.

1.1.1 National SuDS Standards

SuDS 1. Surface runoff not collected for use must be discharged to one or more of the following, listed in order of priority:

1) discharge into the ground (infiltration); or where not reasonably practicable,
2) discharge to a surface water body; or where not reasonably practicable,
3) discharge to a surface water sewer, highway drain, or another drainage system; or where not reasonably practicable,
4) discharge to a combined sewer.

SuDS 2. The design of the drainage system must mitigate any negative impact of surface runoff from the development on the flood risk outside the development boundary.

SuDS 3. Where the drainage system discharges to a surface water body that can accommodate uncontrolled surface water discharges without any impact on flood risk from that surface water body (e.g. the sea or a large estuary) the peak flow control Standards (SuDS 4 and SuDS 5) and volume control Standards (SuDS 6 to SuDS 8) do not apply.

SuDS 4. For greenfield sites, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must not exceed the peak greenfield runoff rate from the site for the same event.

SuDS 5. For previously developed sites, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the site for the same rainfall event, but must not exceed the rate of discharge for the predevelopment scenario for that event.

SuDS 6. Where reasonably practicable, for greenfield sites, the runoff volume from the developed site to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must not exceed the greenfield runoff volume for the same event.

SuDS 7. Where reasonably practicable, for previously developed sites, the runoff volume from the developed site to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but must not exceed the runoff volume for the predevelopment scenario for that event.

SuDS 8. Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with SuDS 5 or SuDS 6 above, the additional volume must be discharged at a rate that does not adversely affect flood risk.

SuDS 9. The drainage system must be designed so that, unless an area is designated to flood as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

SuDS 10. The drainage system must be designed so that flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement) or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

SuDS 11. The drainage system must be designed so that the capacity of the drainage system takes account of the likely impacts of climate change and likely changes in impermeable area within the development over the design life of the development.

SuDS 12. The design of the drainage system must ensure that so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in conveyance routes that minimise the risks to people and property.

SuDS 13. The drainage system must be designed to ensure that surface water discharged meets acceptable water quality standards to protect the ecology and morphology of receiving water bodies.

SuDS 13. The drainage system must be designed such that surface water discharged into receiving bodies does not lead to a contravention of water quality standards.

SuDS 14. The drainage system must be designed to intercept the surface water runoff as far as is reasonably practicable in order to reduce the number of potentially contaminated discharges to a drain, sewer or surface water body from small rainfall events.

SuDS 15. Water quality treatment components must be designed to ensure that they function effectively during rainfall events more frequent than the 1 in 1 year rainfall event.

SuDS 16. Surface runoff must be managed on the surface where it is reasonably practicable to do so and as close to its source as is reasonably practicable

SuDS 17. Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirement for reasonable levels of maintenance.

SuDS 18. The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use.

SuDS 19. The drainage system must be designed to take account of the construction, operation and maintenance requirements of both surface and subsurface components, allowing for any personnel, vehicle or machinery access required to undertake this work.

SuDS 20. The drainage system must be designed to ensure that the maintenance and operation requirements including design life costs are economically proportionate.

SuDS 21. Pumping must only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain water by gravity.

SuDS 23. The drainage system must be constructed in accordance with the approved design such that materials, including products, components, fittings or naturally occurring materials are adequately mixed or prepared and applied, used, or fixed so as to perform adequately the functions for which they are intended and constructed in a workmanlike manner.

SuDS 24. Damage to the drainage system resulting from construction activities must be minimised and must be rectified before the drainage system is considered to be completed.

SuDS 25. The mode of construction of any communication with an existing drainage system must be such that the making of the communication would not negatively impact the structural integrity and functionality of the drainage or sewerage system.

SuDS 26. Once constructed in accordance with the approved design, an approving body must presume that a drainage system is functioning in accordance with the approved design unless there is evidence to demonstrate that it is not.

SuDS 27. The drainage system must be maintained to ensure that it continues to function as designed.

SuDS 28. The drainage system must be operated to ensure that it continues to function as designed.

1.2 National Policies

The requirement for sustainable drainage is also enshrined within the planning policies listed as under:

1.2.1 National Planning Policy Framework (CLG, 2012)

99. Local Plans should take account of climate change over the longer term, including factors such as flood risk, water supply and changes to biodiversity and landscape. New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure.

100. Local Plans should take into account the impacts of climate change by using opportunities offered by new development to reduce the causes and impacts of flooding.

103. When determining planning applications, local planning authorities should ensure that flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where it can be demonstrated that development is appropriately flood resilient and resistant; and it gives priority to the use of sustainable drainage systems.

1.2.2 London Plan (GLA, 2011)

Policy 5.11A: Green roofs and development site environs: Major development proposals should be designed to include roof, wall and site planting, especially green roofs and walls where feasible, to deliver the following objectives:

a. adaptation to climate change
b. sustainable urban drainage

Policy 5.13A: Sustainable Drainage: Development should utilise sustainable urban drainage systems (SuDS) unless there are practical reasons for not doing so, and should aim to achieve Greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

1 store rainwater for later use

2 use infiltration techniques, such as porous surfaces in non-clay areas

3 attenuate rainwater in ponds or open water features for gradual release

4 attenuate rainwater by storing in tanks or sealed water features for gradual release

5 discharge rainwater direct to a watercourse

6 discharge rainwater to a surface water sewer/drain

7 discharge rainwater to the combined sewer.

Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation.

5.13B: Within LDFs boroughs should, in line with the Flood and Water Management Act 2010, utilise Surface Water Management Plans to identify areas where there are particular surface water management issues

and develop actions and policy approaches aimed at reducing these risks.

1.3 Tower Hamlets Policies

1.3.1 Tower Hamlets Core Strategy (2010)

Policy SPO4.5: Reduce the risk and impact of flooding through:

c. Ensuring that all new development across the borough does not increase the risk and impact of flooding.

d. Ensuring the application of flood-resilient design of all new developments in areas of Flood Risk 2 and 3a.

e. Protecting and where possible increasing the capacity of existing and new water spaces to retain water.

f. All new developments must aim to increase the amount of permeable surfaces, including SuDS, to improve drainage and reduce surface water run-off.'

1.3.2 TH Development Management DPD (2012)

Policy DM 13 (Sustainable Drainage): Development will be required to show how it reduces the amount of water usage, runoff and discharge from the site, through the use of appropriate water reuse and Sustainable Urban Drainage (SUD) techniques.

1.3.3 Surface Water Management Plan

Tower Hamlets has produced a Surface Water Management Plan to describe the issues of surface water flooding and how it will manage this. The plan has an action plan which includes the following actions that relate to SuDS.

14. In Local Flood Risk Zones use SWMP mapped outputs to require developers to ensure development will remain safe and will not increase risk to others, where necessary supported by more detailed integrated hydraulic modelling.

15. Developments in critical drainage areas (incl. new development in the Millennium Quarter Regeneration area and Lea Valley Regeneration areas) to contribute financially to measures to reduce surface water flood risk in the CDA.

16. Developments across the borough to include SUDS measures, resulting in a net improvement in water quantity or quality discharging to sewer compared to existing situation.

17. Developments across the borough greater than 0.5 hectares to reduce runoff from site to greenfield runoff rates.

18. Developments in Critical Drainage Areas to reduce runoff to predevelopment greenfield runoff rates

19. Seek to include SUDS retrofitting policies to enhance or replace conventional drainage systems in LFRZs, or elsewhere as opportunities arise e.g. refurbishment projects

20. Seek opportunities within all Masterplans and Area Action Plans to integrate fluvial and surface water flood risk reduction measures

21. Determine areas within the Borough which are appropriate for draining into green areas and treepits instead of main sewerage

22. Separation of combined sewers by riverside

2.0 SuDS Applicable to Tower Hamlets

2.1 What are SuDS?

Sustainable urban drainage systems are a modern way of dealing with surface water runoff, instead of directing the water to conventional underground sewerage systems that are already under pressure. SuDS aim to replicate natural drainage by storing flood water, consequently reducing surface water runoff. After the peak of flooding has passed, water retained by the SuDS is slowly released into the ground and directed to either a water course or to the sewerage system. Thus they mitigate the risk of flooding from surface water.

SUDS have wider benefits. In addition to mitigating the risk of local flooding they can also:

- Improve biodiversity
- Create green space
- Reduce urban heat
- Reduce air pollution
- Improvement in health and wellbeing
- Improve water quality
- Deliver CO_2 reductions
- Offer interest and education

The developer will propose SuDS of his/her choice and will demonstrate that the proposal meets our requirements.

2.2 Local conditions

SuDS are site specific therefore it is essential to design and install a sustainable drainage system that is appropriate for the specific development and location in question. In identifying a suitable sustainable drainage system, the following local conditions have to be identified:

- Land use characteristics
- Geology, hydrogeology and topography
- Contaminated ground
- Critical Drainage Areas
- Whether the sewers are combined or separate

Rainfall intensities for a 1in 30 and 1 in 100 return period have been analysed. The specific intensities for these events in Tower Hamlets, over a 2 hours rainfall period are as follows:

30 year storm: 9.47mm.hr

100 year storm: 13.98mm.hr

2.3 Practicable SuDS in Tower Hamlets

SuDS need to be appropriate not only for the type of site or development but also for the location. Some SuDS such as green roofs on top of buildings and porous paving are suitable for most locations and entirely applicable for anywhere in Tower Hamlets. Similarly, the harvesting of rainwater by water butt or larger tank, which can be on the surface or underground, and subsequent re-use as grey water for watering planters, cleaning or use within a building is generally good in all locations and sites.

The LB of Tower Hamlets is characterised as having contaminated land throughout the borough, because of this certain SuDS which rely on infiltration are not applicable anywhere within the borough, these being soakaways and borehole soakaways.

Being an inner-city borough, space is tight and so there is unlikely to be so much in the way of opportunity for expansive SuDS such as new ponds, larger swales and green verges. Notwithstanding, any green areas, however small, can be profiled into shallow basins so that they naturally store rather than discharge rainwater. Smaller scale measures such as green roofs on bike sheds and bin stores, rain gardens and tree pits, water butts feeding into planters would all be entirely suitable.

Any planting should be appropriate to the SuDS in question so that, for example, plants in a rain garden should be happy to be inundated for a few hours and those on a roof garden should be happy with the substrate within which they have been planted. Planting should also be indigenous to the area. LB of Tower Hamlets objective would be to create at roof level what would have been on the ground, had the building not been there. This practice supports the natural fauna of the area and the examples below give lists of suitable plans for a variety of situations.

Ideal SuDS are ground/shallow SuDS that can be inspected, maintained and repaired easily, thus increasing their longevity. Therefore tanked and underground systems, for example, are less desirable. The following examples describe SuDS that would be practicable to install in Tower Hamlets. Each SuDS is accompanied by a parameter of how much water it can absorb and thus how much it can contribute to the required reduction in runoff.

This should not be seen as an exhaustive list and applicants are welcome to propose different SuDS provided that they can demonstrate their suitability and viability.

2.3.1 Rain gardens

Rain gardens are simply shallow depressions in the ground, with a highly permeable soil base. They provide many of the benefits of a wetland system but on a smaller scale and are attractive as they can replace existing hard surfaced areas whilst taking up minimal additional space. They are flexible in design and are suitable for gardens, communal spaces and along the roadside.

Rain gardens are ideal for retrofit and new schemes alike, with well selected planting rain gardens can provide colourful planting for all seasons, whilst adding to the green infrastructure of the local environment.

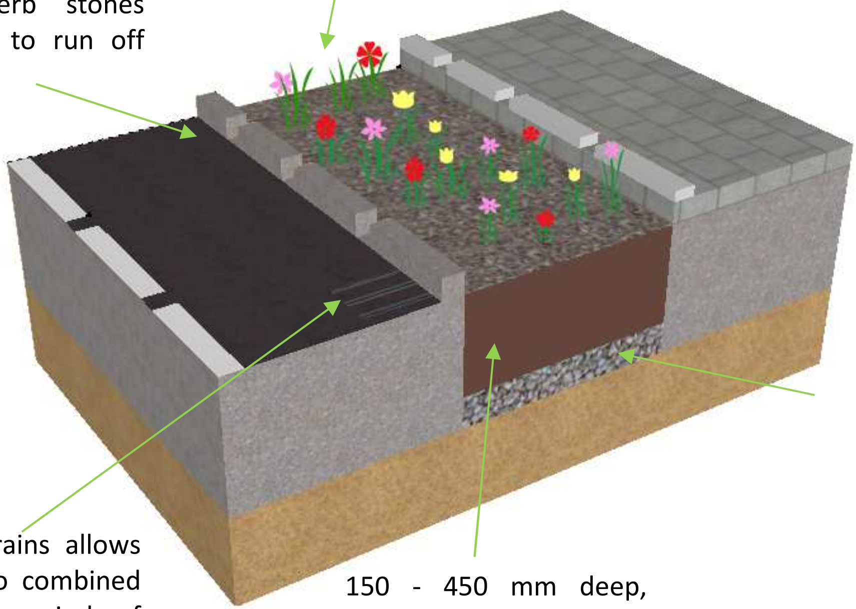

Figure 2.1 Rain garden diagram © University of East London

Table 2.1 Typical planting soil composition

Component	Percentage
Sand	35-60
Silt	30-50
Clay	10-25
Organic matter	0-4

<u>Maintenance</u>

Depending on location, rain gardens may require regular litter picking and inspection for pollution. Regular watering in the first year will aid in the establishment and survival of the rain garden. An annual weeding is essential in the two years until the ground cover has established.

Figure 2.2 Rain Garden, Derbyshire Street, Tower Hamlets

Rain gardens – species list

Suitable native/naturalised species include:

- Articulated rush *(Juncus articulatus)*
- Autumn crocus (*Colchium autumnale*)
- Bellflower (*Campanula glomerata*)
- Bog stitchwort *(Stellaria uliginosa)*
- Bog-myrtle *(Myrica gale)*
- Bottle sedge *(Carex rostrata)*
- British bluebell (*Hyacinthiodes non-scripta*)
- Broad buckler fern (*Dryopteris dilatata*)
- Bugle (*Ajuga reptans*)
- Bulbous rush *(Juncus bulbosus)*
- Common sedge *(Carex nigra)*
- Common spike-rush *(Eleocharis palustris)*
- Creeping forget-me-not *(Myosotis secunda)*
- Deergrass *(Trichophorum caespitosum)*
- Dogwood (*Cornus sanguine*)
- Floating sweet-grass *(Glyceria fluitans)*
- Flowering rush *(Butomus umbellatus)*
- Geulder rose (*Viburnum opulus*)
- Hard rush *(Juncus inflexus)*
- Alder buckthorn (*Frangula alnus)*
- Hemp agrimony (*Eupatorium cannabinum*)
- Lesser spearwort *(Ranunculus flammula)*
- Male fern (*Dryopteris felix-mas*
- Marsh speedwell *(Veronica scutellata)*
- Marsh thistle *(Cirsium palustre)*
- Marsh violet *(Viola palustris)*
- Marsh willowherb *(Epilobium palustre)*
- Pendulous sedge (*Carex pendula*)
- Ragged-robin *(Lychnis flos-cuculi)*
- Royal fern (*Osmunda regalis*)
- Sharp-flowered rush *(Juncus acutiflorus)*
- Silverweed (*Potentilla anserina*)
- Soft rush (*Juncus effusus*)
- Star sedge *(Carex echinata)*
- Stinking hellebore (*Helleborus foetidus*)
- Tormentil *(Potentilla erecta)*
- Tufted hair-grass *(Deschampsia caespitosa)*
- Wild daffodil (*Narcissus pseudonarcissus*)
- Wild tulip (*Tulipa sylvestris*)
- Yellow iris *(Iris pseudacorus)*

2.3.2 SuDS planters/Rain water harvesting systems

SuDS planters are an innovative way of increasing the water attenuation, additionally providing an opportunity to green areas where it is not practical to remove or break up permeable surfaces.

With excellent retro-fit potential SuDs planters can be designed to receive rain water from a drainpipe or other inlet or simply used to receive rainwater falling on them. SuDS planters are best placed where they can be used in conjunction with other SuDS.

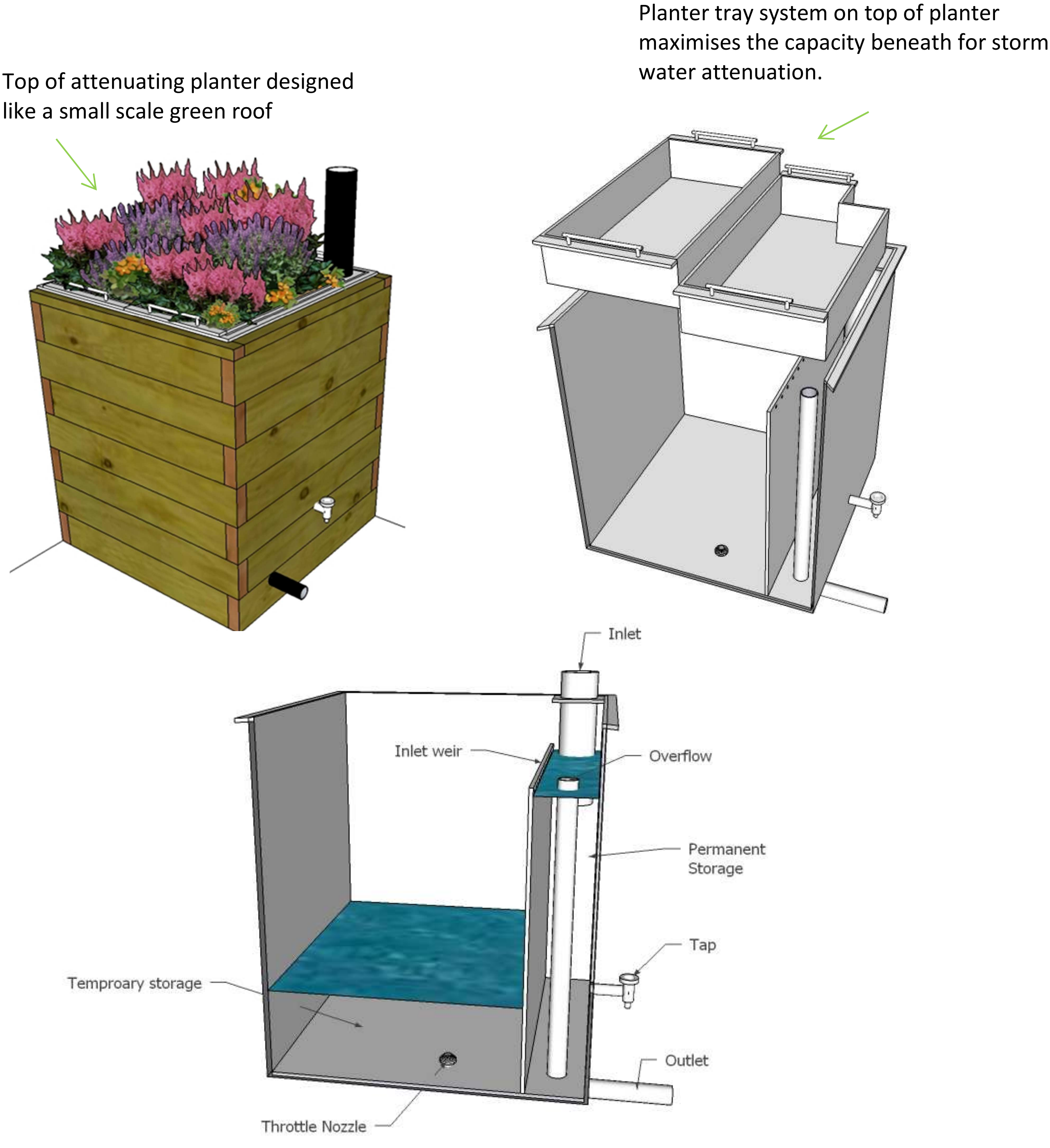

Figure 2.3 SuDS Planter with attenuating storage© Thames Water

They offer multi-use benefits such as aesthetic improvement and biodiversity potential. Furthermore with capacity for water storage, they are well suited in grow your own schemes, providing a substrate for plant growth and a water storage capacity, for use in watering other plants.

Maintenance

Regular inspection for pollution, vegetation health, litter and debris should be made. If planting as a small scale green roof, little to maintenance is required, for more aesthetic plants of food based planting, more maintenance is required.

Standard planter species list

- Articulated rush *(Juncus articulatus)*
- Autumn crocus (*Colchium autumnale*)
- Alder buckthorn (*Frangula alnus)*
- Bellflower (*Campanula glomerata*)
- Bog stitchwort *(Stellaria uliginosa)*
- Bog-myrtle *(Myrica gale)*
- Bottle sedge *(Carex rostrata)*
- British bluebell (*Hyacinthiodes non-scripta*)
- Broad buckler fern (*Dryopteris dilatata*)
- Bugle (*Ajuga reptans*)
- Bulbous rush *(Juncus bulbosus)*
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- Floating sweet-grass *(Glyceria fluitans)*
- Flowering rush *(Butomus umbellatus)*
- Geulder rose (*Viburnum opulus*)
- Hard rush *(Juncus inflexus)*
- Hemp agrimony (*Eupatorium cannabinum*)
- Lesser spearwort *(Ranunculus flammula)*
- Male fern (*Dryopteris felix-mas*
- Marsh speedwell *(Veronica scutellata)*
- Marsh thistle *(Cirsium palustre)*
- Marsh violet *(Viola palustris)*
- Marsh willowherb *(Epilobium palustre)*
- Pendulous sedge (*Carex pendula*)
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- Star sedge *(Carex echinata)*
- Stinking hellebore (*Helleborus foetidus*)
- Tormentil *(Potentilla erecta)*
- Tufted hair-grass *(Deschampsia caespitosa)*
- Wild daffodil (*Narcissus pseudonarcissus*)
- Wild tulip (*Tulipa sylvestris*)
- Yellow iris *(Iris pseudacorus)*

2.3.3 Tree pits

Engineered tree pits, such as Stockholm Tree Pits, serve as bioretention areas, they capture incoming run off from permeable surfaces, and remove it through transpiration, evaporation and infiltration.

Tree pits can be incorporated into residential and commercial areas and used in applications such as car parks, verges, landscaped areas and paving. In the urban environment they provide all the benefits of tree planting, with addition surface water mitigation.

Extras for use in the urban environment:

- An underdrain connected to the sewer system can be installed at the base of the structure to cope with extreme events.
- An aeration and irrigation tube can be installed to allow water and air to reach the tree roots in extreme weather events.
- Root director systems can also be used to divert the tree roots further below the adjacent paving to prevent future paving damage due to root growth.

Figure 2.4 Stockholm Tree Pits, Bethnal Green Road, LB Tower Hamlets

Choice of surface

A permeable solid covering can be placed around the tree and over the planting soil. This prevents compaction of the planting soil which will lead to poor tree growth and health, whilst also retaining the original amount of pedestrian footway.

Various surfacing options are available such as tree grates, permeable resin bound surfacing or creative edge planting.

Maintenance

Regular watering is required in first 2 years, to ensure tree survival. Depending on the location of planting regular litter picking and monitoring of pollution and hydraulic performance may also be required.

Tree species suitable for tree pits in Tower Hamlets

- Ash (*Fraxinus excelsior*)
- Aspen (*Populus tremula*)
- Beech (*Fagus sylvatica*)
- Black poplar (*Populus nigra subsp. Betulifolia*)
- Common alder (*Alnus glutinosa*)
- Common oak (*Quercus robur*)
- English elm (*Ulmus procera*)
- Hawthorn (*Crataegus monogyna*)
- Horse-chestnut (*Aesculus hippocastanum*)
- Large-leaved lime (*Tilia platyphyllos*)
- London Plane (*Platanus occidentalis x orientalis)*
- Scots pine (*Pinus sylvestris*)
- Sessile oak (*Quercus petraea*)
- Silver birch (*Betula pendula*)
- Small-leaved lime (*Tilia cordata*)
- Sweet chestnut (*Castanea sativa*)
- Sycamore (*Acer pseudoplantanus*)
- Walnut (*Juglans regia*)
- White willow (*Salix alba*)
- Wych elm (*Ulmus glabra*)

An aborist must be consulted when selecting a tree species for tree pit planting as the selection of a suitable species will be dependent on site and material specific factors such as soil pH, pollution and porosity.

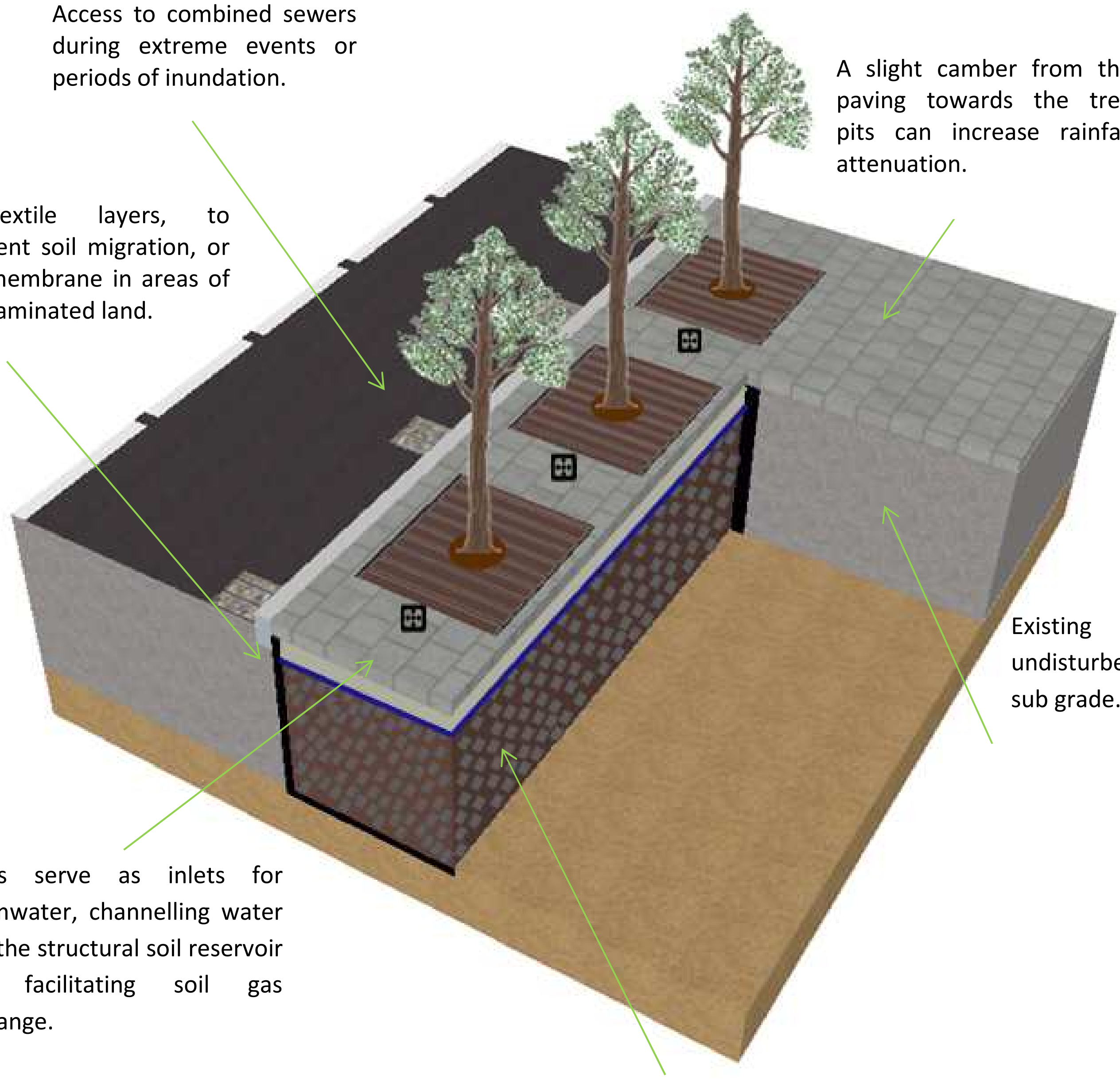


Figure 2.5 Soil corridor diagram© Environmental Research Group, University of East London

2.3.4 Green roofs

Green roofs are multi-layered vegetated systems, built on roof covers. These systems are designed to return the surface water runoff from a building to the sites pre-construction level, and can be built into new build or retrofitted and are suitable for any building with flat to gently sloping roofs providing the existing roof can take the required load.

Extensive green roofs also support a range of other ecosystem services such as thermal insulation, reduced air pollution, urban cooling, sound absorption and water quality improvement.

Figure 2.6 green roof at the Queen Elizabeth Olympic Park © University of East London

<u>Maintenance</u>

Extensive green roof systems covering entire roof areas comprised with fast growing, low maintenance plants (hardy, drought tolerant, etc) usually mosses, herbs and grasses. Vegetation growth is limited by substrate depth meaning that roofs are largely self-sustaining, lightweight and cost effective.

Maintenance comprises of inspections for litter and debris that block drainage outlets, annual vegetation checks to remove shrubs that may cause problems to the drainage and water proofing later (e.g. *buddleia*).

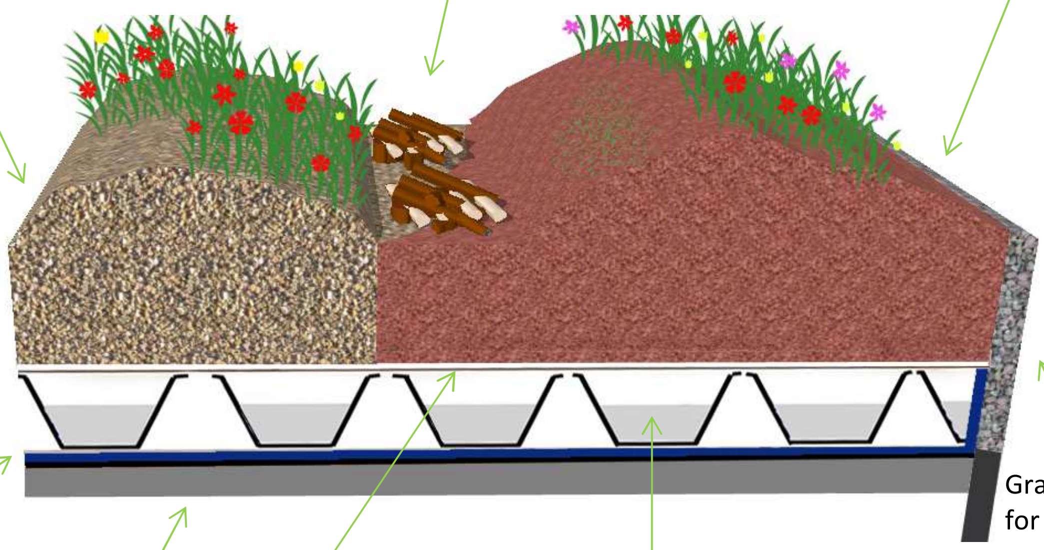


Figure 2.7 Biodiverse green roof diagram© Environmental Research Group, University of East London

<u>Planting</u>

Planting should comprise annuals and perennial native species of local importance to support Tower Hamlets Biodiversity Action Plan.

Green roofs – species list

Wildflowers for areas if roof with a substrate layer of 75mm +

- Agrimony (*Agrimonia eupatoria*)
- Autumn hawkbit (*Scorzoneroides autumnalis)*
- Birdsfoot trefoil (*Lotus corniculatus*)
- Black medick (*Medicago lupulina*)
- Bladder campion (*Silene vulgaris*)
- Bulbous buttercup (*Ranunculus bulbosus*)
- Clustered bellflower (*Campanula glomerata*)
- Common knapweed (*Centaurea nigra*)
- Common poppy (*Papaerva rhoeas*)
- Common spotted orchid (*Dactylorhiza fuchsia*)
- Common toadflax *(Linaria vulgaris*)
- Common vetch (*Vicia sativa*)
- Corncockle (*Agrostemma githago*)
- Cornflower (*Centaurea cyanus*)
- Cowslip (*Primula veris*)
- Crested dogstail (*Cynosurus cristatus*)
- Dog violet (Viola riviniana)
- Field scabious (*Knautia arvensis*)
- Vipers bugloss (*Echium vulgare*)
- Wild basil (*Clinopodium vulgare*)
- Wild marjoram (*Origanum vulgare*)
- Wild mignonette (*Reseda lutea*)
- Wild pansy (*Viola tricolor*)
- Wild red clover (*Trifolium pratense*)
- Wild thyme (*Thymus polytrichus*)
- Yarrow (*Achillea millefolium*)
- Yellow rattle (*Rhinanthus minor*)
- Hoary plantain (*Plantago media*)
- Kidney vetch (*Anthyllis vulneraria*)
- Lady's bedstraw (*Galium verum*)
- Lesser stitchwort (*Stellaria graminea*)
- London rocket (*Sisymbrium irio*)
- Maiden pink (*Dainthus deltoids)*
- Meadow buttercup (*Ranunculus acris*)
- Musk mallow (*Malva moschata*)
- Oxeye daisy (*Leucanthemum vulgare*)
- Perforate St John's-wort (*Hypericum perforatum*)
- Rough hawkbit (*Leontodon hispidus*)
- Salad burnet (*Sanguisorba minor*)
- Scarlet pimpernel (*Anagallis arvensis*)
- Self-heal (*Prunella vulgaris*)
- Sheep's fescue (*Festuca ovina*)
- Sheep's-bit (*Jasione montana*)
- Slender creeping red fescue (*Festuca rubra ssp. littoralis*)
- Small scabious (*Scabiosa columbaria*)
- Snapdragon (*Antirrhinum majus*)
- Thrift (*Armeria maritima*)

Native sedums for areas of roof with a substrate layer of 50-75mm

- Biting stonecrop (*Sedum acre*)
- English stonecrop (*Sedum anglicum*)
- Rock stonecrop (*Sedum forsterianum*)
- Roseroot (*Sedum rosea*)
- White stonecrop (*Sedum album*)

2.3.5 Small scale green roofs

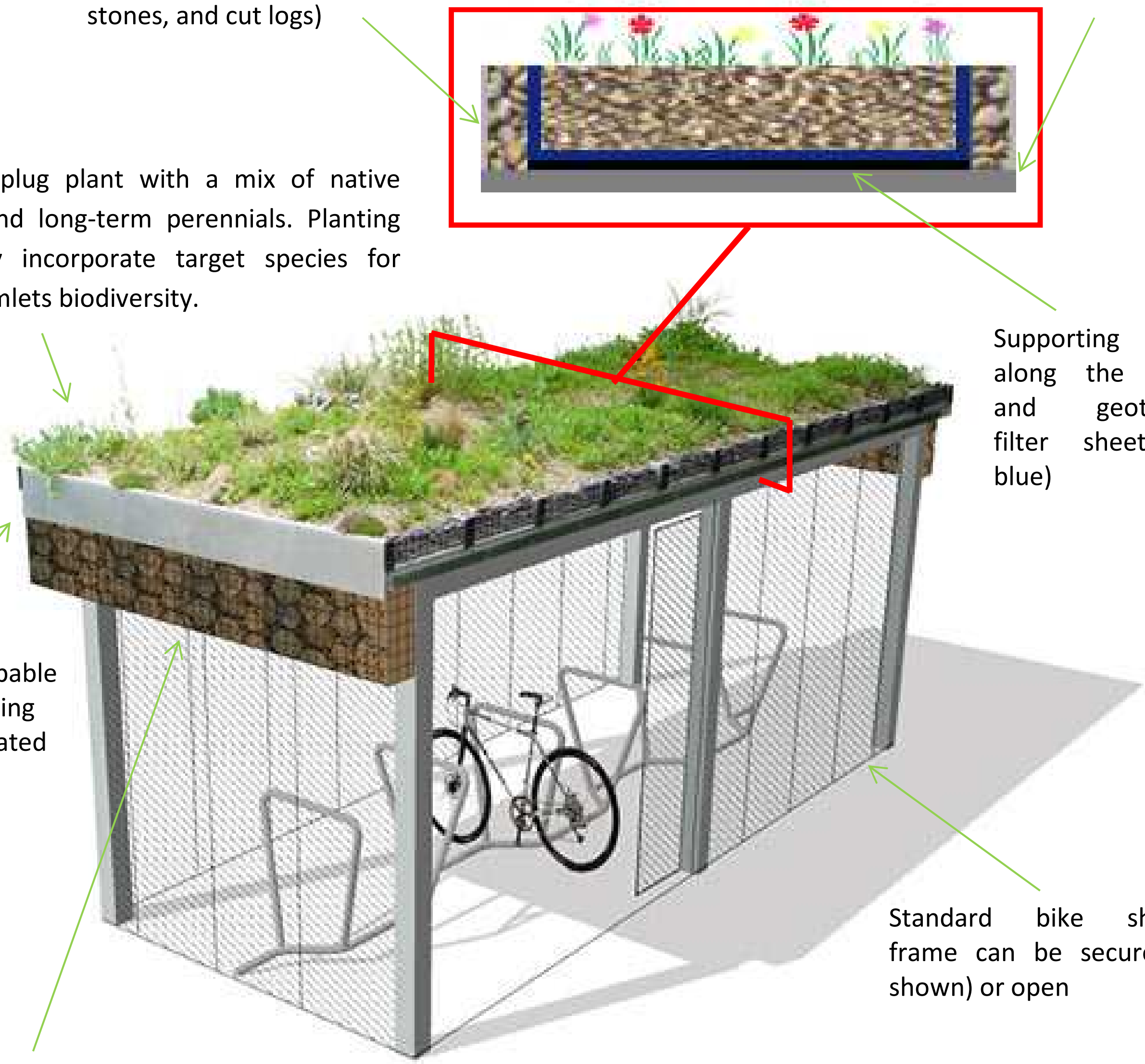
Small scale green roofs are an innovative way of increasing the use of SuDS in the urban environment. Offering all the benefits that regular green roofs do, but on a smaller scale. They can provide or enhance, existing essential utilities, offering an ideal multi-use opportunity, whilst taking up minimal additional space.

Figure 2.8 Green roof application on a bike shelter ©Green Roof Shelters

Figure 2.9 Pre-fabricated Green roof bin store ©Green Roof Shelters

<u>Maintenance</u>

Inspections for litter and debris blocking drainage outlets, and an annual vegetation check for plant health and to remove any shrubs that may cause problems to the drainage.



Habitat panels for insects:

- Cut bamboo canes or logs 10-20 cm long with holes drilled of varying diameters between 2mm and 10mm for nesting bees and wasps.
- Bark, piled loose stone or packed sand also make good habitat features for invertebrates.
- Bird boxes or bats boxes could also be incorporated

Figure 2.10 Green roof bike shelter, design by ©Green Roof Shelters

2.3.6 Swales

They are ideally suited for use along roadsides and industrial sites, but can be scaled appropriately and be successfully used in urban/ residential areas.

There are three main types of swale:

- Conveyance Swale carries run-off from one SuDS component to another, for instance conveying water from a disconnected down pipe to a rain garden.

- Dry Swale suitable for areas where occasional ponding of surface water is not appropriate, these swales are comprised of an under-drain system to provide extra storage capacity and water treatment.

- Wet Swale designed to encourage wet and marshy conditions, providing excellent biodiversity potential, however limiting the amount of water storage.

<u>Maintenance</u>

In the urban environment swales will require regular litter picking, which can be done in conjunction with existing routine cleansing.

Planted swales may require extra maintenance due to weeding (annually for the first two years until established) and possible watering depending on season planted. Turfed swales will require mowing on a routine basis, with an optimum height between 100-150mm.

Soil pollution should not be an issue, however if plant survival is low, the pollution levels of the swale soil should be analysed and remediated as necessary.

Figure 2.11 Swale, Derbyshire Street, Tower Hamlets

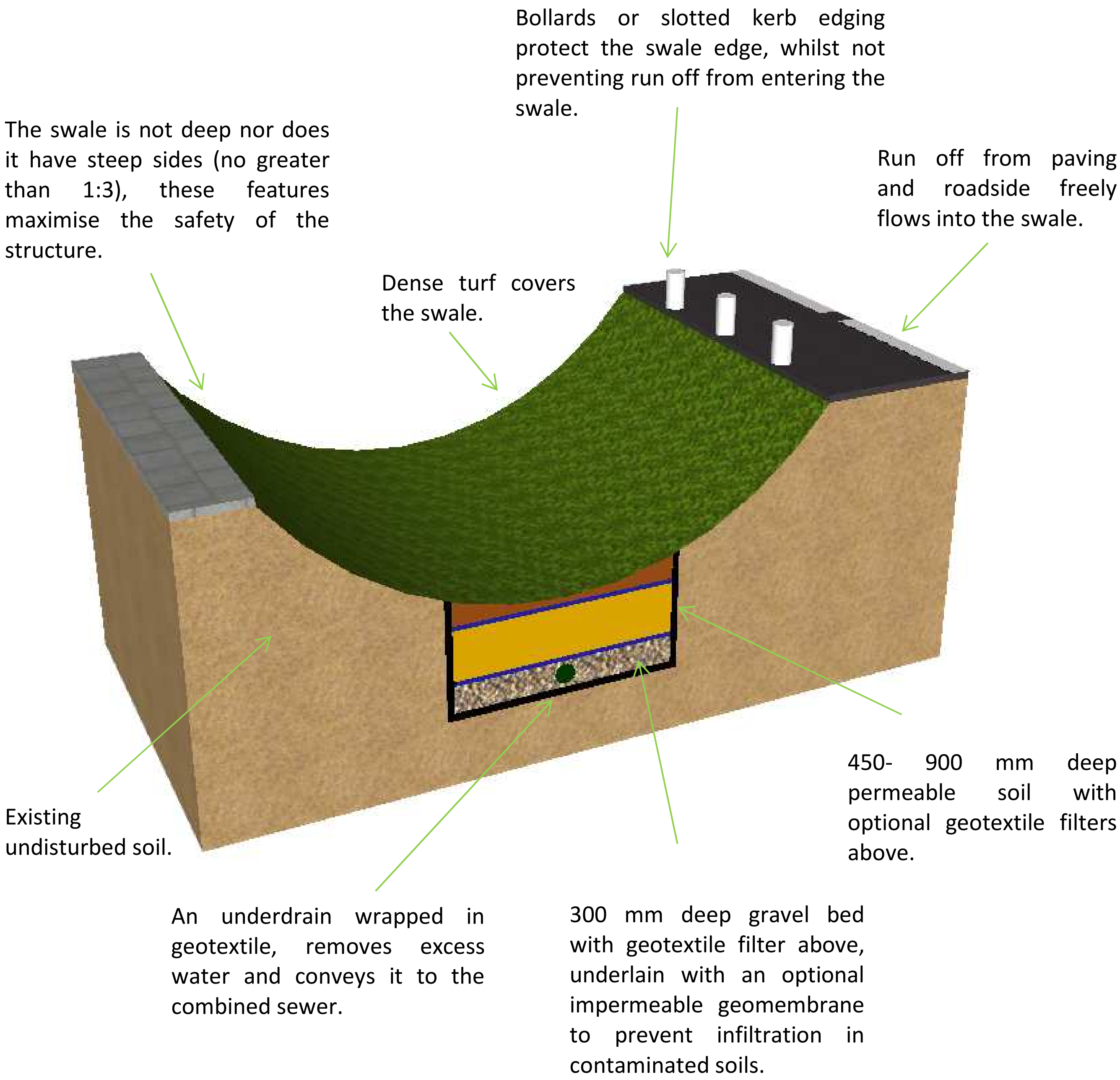


Figure 2.12 Urban swale diagram© University of East London

Planting

Optional planting soil mix will encourage natural colonisation by plants, and offer potential biodiversity improvements.

2.3.6 Porous and Permeable Paving

Pervious surfaces are multi-layered surfacing systems; they are designed to allow infiltration and subsequently retain or convey stormwater underground.

The design and materials required will vary with the intended load bearing and traffic, but generally continuously laid systems are suited to high load bearing and high frequencies whereas grid systems are suitable for a low loading and low frequency.

Additional strength and storage capacity can be provided through the incorporation of geocellular modules underneath the pervious surface structure. These modules allow great flexibility in design and can be tailored to almost any loading or traffic requirement. Geocellular modules also have the added advantage of reducing the amount of aggregate sub base required, thus keeping costs lower.

Permeable surfaces

The surface layer is constructed out of permeable material allowing infiltration of water through gaps along its surface. The options include:

1. Geo-synthetic paver grids suitable for light loadings and low frequency of use
2. Concrete grid paving: suitable for slightly heavier loading and higher frequency

Porous surface

The surface layer is constructed out of porous material allowing infiltration of water along its entire surface. Porous options include:

1. Continuous laid porous material, usually porous concrete or asphalt with a low fine particulate content, which is suitable for high loads and high frequency of use
2. Porous block paving, suitable for lighter loading and lower frequencies of use

Figure 2.13 Permeable Paving Derbyshire Street, Tower Hamlets

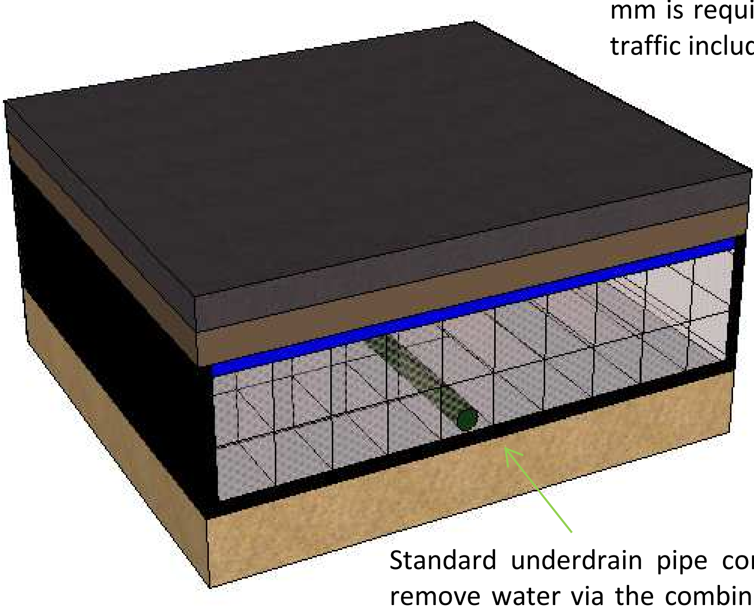
Porous asphalt, allows infiltration and storage of rainwater along its entire surface, providing a replacement for conventional impermeable tarmac.

Recommended product: Tarmac Dry porous asphalt, however other suppliers can be used.

Geocellular module stack to provide structural strength (up to 400kN/m^2) and high water storage capacity with void space of 95%+.

Designs based on the GEOlight™ modular system, but many other geocellular manufacturers exist (figures for other systems are manufacturer dependent).

A soil covering of 200 mm in areas with no vehicular traffic. Up to 2750 mm is required in areas of vehicular traffic including HGV's.



Geomembrane isolates stored water from the surrounding soil, especially in contaminated areas.

A geotextile layer prevents clogging and damage to the geocellular modules.

Standard underdrain pipe connected to the stack to remove water via the combined sewer. Easy to install and maintain. Throttle valve can be combined for controlled release.

Figure 2.14 Porous Tarmac and geocellular storage diagram© Environmental Research Group, University of East London

Maintenance

Regular surface cleaning and inspection for surface water ponding, sediment build up or pollution, with remediation taken as required.

Permeable block paving allows for infiltration through gaps in the surface. The addition of Geocellular module storage provides structural strength (up to 400kN/m^2) and high water storage capacity with void space of 95%+.

Designs based on the GEOlight™ modular system, but many other geocellular manufacturers exist (Figures for other systems are manufacturer dependent).

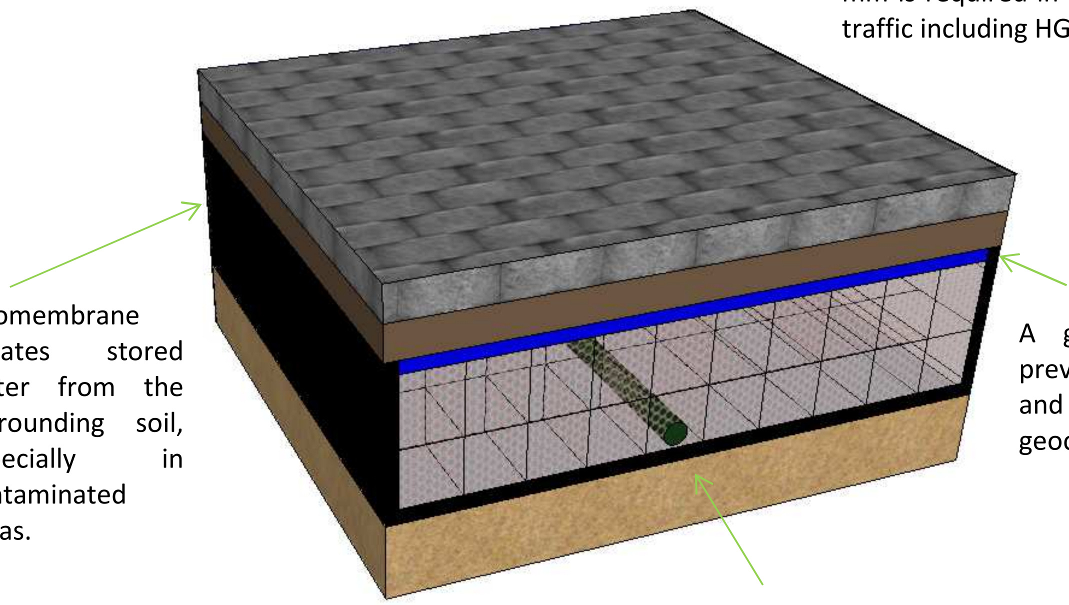


Figure 2.15 Porous block paving and geocellular storage diagram© Environmental Research Group, University of East London

Maintenance

Regular surface cleaning and inspection for surface water ponding, sediment build up or pollution, with remediation taken as required.

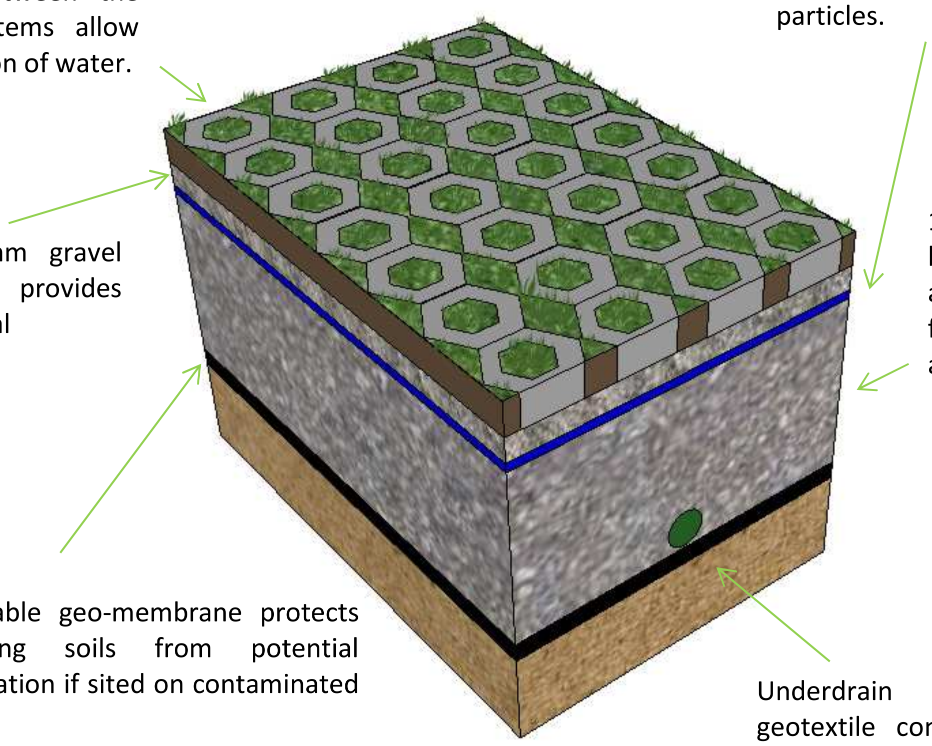


Figure 2.16 Permeable grid paving diagram© University of East London

Maintenance

Regular inspection for surface ponding, sediment build up, pollution and vegetation health - with remediation taken as required.

3.0 Water storage capacity of SuDS

3.1 Estimating SuDS water storage

This section provides the relevant calculations for estimating the minimum storage volume for SuDS elements. This has been done solely on the basis of quantifiable storage, and does not account for any highly variable factors such as infiltration or evapotranspiration.

Calculations for each SuDS element are performed using standard average values for soil void porosity by volume ratios, and the volume of water remaining in soils when at field capacity.

Soil void porosity by volume (SVP) represents the proportion of voids space that occupies a soil or other medium. This effectively establishes the upper limit for water storage, i.e. the maximum amount of water that a soil can retain before flooding. The calculations in this guidance have all used the minimum soil void porosity values to represent a conservative estimate.

The volumetric water content at field capacity (VFC) represents the proportion of the void space in a soil that is filled with water when free drainage has ceased. This provides a realistic value for the proportion of void space already occupied by water in the storage medium under normal conditions for each of the SuDS elements. The maximum value is used here to provide a conservative value.

Thus the volume of storage available for flood water in any particular SuDS element is the volume of voids in that element *less* the volume of those voids that is already occupied by water. This is represented by the Formula 3.1 as follows:

$V_s = V_{svp} – (V_{svp} \text{ x VFC})$ **Equation 3.1**

$= V_{svp}(1\text{-VFC})$

$= V \text{ x SVP}(1\text{-VFC})$

where,

V_s = water storage capacity(m^3)

V = volume of SuDS element (m^3)

V_{svp} = volume of void space in SuDS element (m^3)

where V_{svp} =V x SVP

SVP = soil void porosity

VFC = volumetric water content at field capacity

Values of SVP and VFC for different soils and other mediums are detailed in Table 3.1. SVP(1-VFC) is a constant for any particular medium and is also included in the table for convenience

Table 3.1 SVP, VFC and SVP(1-VFC) values

Media type	SVP	VFC	SVP(1-VFC)
Sand	0.30	0.25	0.225
Soil *	0.40	0.35	0.260
Gravel	0.30	0.15	0.255
ABG Green Roof Mix	0.23	0.35	0.150
Geocellular module	0.95	0.00	0.950
Sub-base	0.30	0.35	0.195
Geocomposite layer	0.50	0.00	0.500
Void	1.00	0.00	1.000
*based on the mean values for sand and loam			

Data from Geohring *et al*., 2009; ABG Ltd, 2013 and SDS Ltd, 2013

In turn, the volume of SuDS element can be calculated as follows:

For a layer of soil or other medium using Formula 3.2,

V = **L** x **W** x **D** **Equation 3.2**

where,

V = volume of SuDS element (m^3)

L = length of SuDS element (m)

W = width of SuDS element (m)

D =depth of SuDS element (m)

For a non-regular layer using Formula 3.3,

V = **A** x **L**

Where,

A = cross-sectional area of SuDS element (m^2)

L = length of SuDS element (m)

Where there are two or more elements in a SuDS, the storage volume can be calculated by adding together the storage volume of each individual element.

3.2 Rain garden storage volume: worked example:

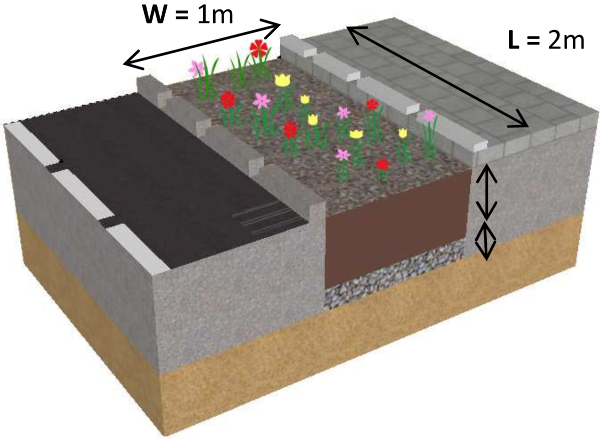


Figure 3.1 Design example of a rain garden

Calculation for estimating volume of **soil**:

V = **L** x **W** x **D1** Equation 3.2

= 2m x 1m x 0.45 m

=0.9m^3

Calculation for estimating storage, where the value for SVP(1-VFC) is found from Table 3.1:

V_s = V x SVP(1-VFC) Equation 3.1

= 0.9 x 0.260 m^3

= **0.234m^3**

Calculation for estimating volume of **gravel**:

V = **L** x **W** x **D2** Equation 3.2

= 2 x 1 x 0.1 m

= 0.2m^3

Calculation for estimating storage, where the value for SVP(1-VFC) is found from Table 3.1:

V_s = V x SVP(1-VFC) Equation 3.1

= 0.2 x 0.255 m^3

= **0.051m^3**

Estimate of total storage in the SuDS = 0.234m^3 + 0.051 m^3 = **0.285m^3**

3.3 SuDs planter storage volume: worked example

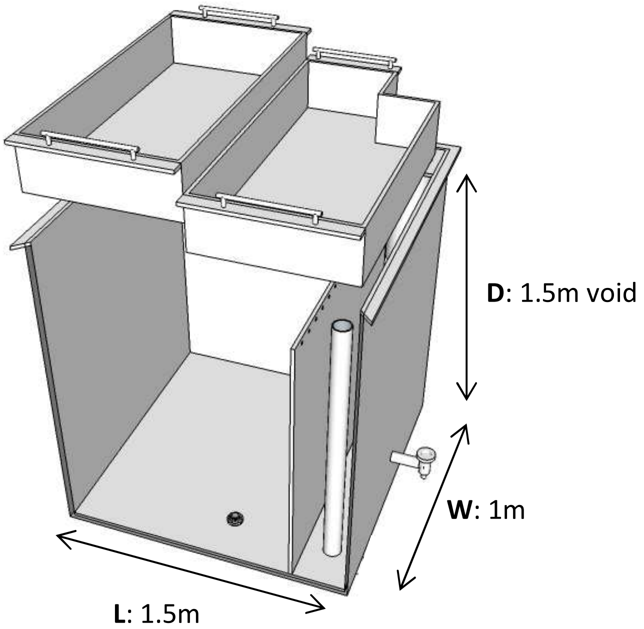


Figure 3.2 Design example of an attenuating planter

Calculation for estimating volume of **Void**:

V = **L** x **W** x **D** Equation 3.2

= 1.5 x 1 x 1.5m

= 2.25m^3

Calculation for estimating storage (where the value for SVP(1-VFC) is found from Table 3.1)

V_s = V x SVP(1-VFC) Equation 3.1

= 2.25 x 1 m^3

= 2.25m^3

3.4 Tree pit storage volume: worked example

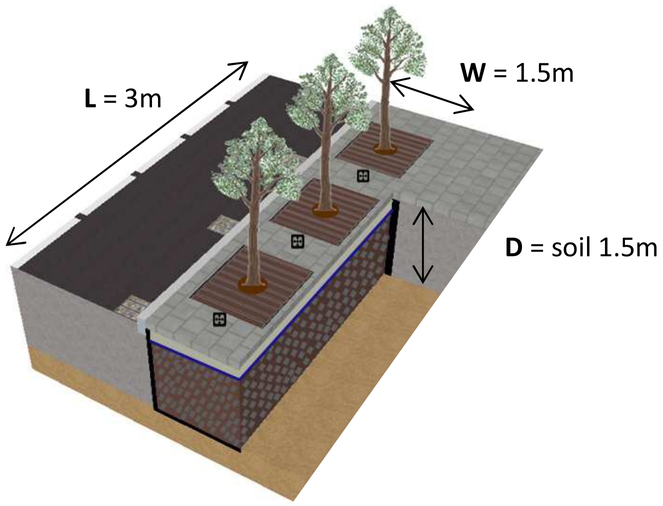


Figure 3.3 Design example of a tree pit

Calculation for estimating volume of **soil**:

V = **L** x **W** x **D** Equation 3.2

= 3m x 1.5m x 1.5 m

= **6.75m^3**

Calculation for estimating storage (where the value for SVP(1-VFC) is found from Table 3.1)

V_s = V x SVP(1-VFC) Equation 3.1

= 6.75 x 0.260 m^3

= **1.75m^3**

3.5 Green roof storage volume: worked example

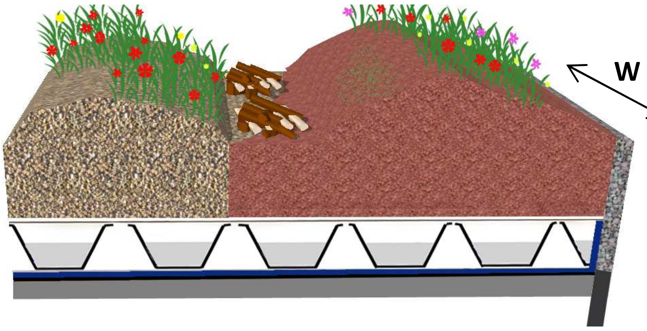


Figure 3.4 Design example of a green roof

Calculation for estimating volume of **ABG Green Roof Mix**:

V = **L** x **W** x **D1** Equation 3.2

= 10 x 5 x 0.2 m

= $10m^3$

Calculation for estimating storage (where the value for SVP(1-VFC) is found from Table 3.1)

V_s = V x SVP(1-VFC) Equation 3.1

= 10 x $0.15m^3$

= **$1.5m^3$**

Calculation for estimating volume of **Geocomposite layer**:

V = **L** x **W** x **D2** Equation 3.2

= 10 x 5 x 0.005 m

= $0.25m^3$

Calculation for estimating storage (where the value for SVP(1-VFC)is found from Table 3.1)

V_s = V x SVP(1-VFC) Equation 3.1

= 0.25 x $0.50m^3$

= **$0.125m^3$**

Estimated total Storage volume of the SuDS is: $1.5m^3$ + $0.125m^3$ = **$1.625m^3$**

3.6 Small scale green roof storage volume: worked example

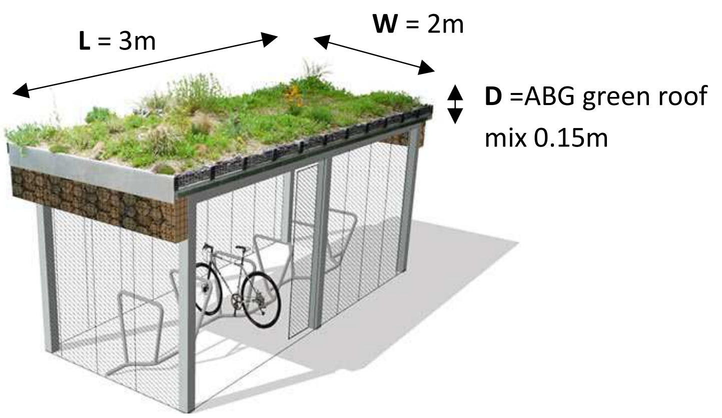


Figure 3.5 Design example of a small scale green roof

Calculation for estimating volume of **ABG Green Roof Mix**:

V = **L** x **W** x **D** Equation 3.2

= 3 x 2 x 0.15m

= **0.75m^3**

Calculation for estimating storage, where the value for SVP(1-VFC) is found from Table 3.1:

V_s = V x SVP(1-VFC) Equation 3.1

= 0.75 x 0.15 m^3

= **0.112 m^3**

3.7 Swale storage volume: worked example:

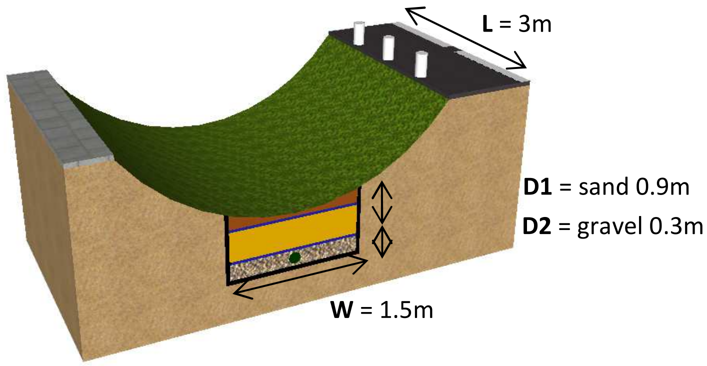


Figure 3.6 Design example of a swale

Calculation for estimating volume of **sand**:

V = **L** x **W** x **D1** Equation 3.2

= 3 x 1.5 x 0.9m

= 4.05m^3

Calculation for estimating storage, where the value for SVP(1-VFC) is found from Table 3.1:

V_s = V x SVP(1-VFC) Equation 3.1

= 0.911 x 0.225m^3

= **0.205m^3**

Calculation for estimating volume of **gravel**:

V = **L** x **W** x **D1** Equation 3.2

= 3 x 1.5 x 0.3m^3

= 1.35m^3

Calculation for estimating storage, where the value for SVP(1-VFC) is found from Table 3.1:

V_s = V x SVP(1-VFC) Equation 3.1

= 1.35 x 0.225m^3

= 0.304m^3

If the Swale is not free draining and the space within the swale is designed to fill with water, the volume of water storage in the swale can be calculated using equation 3.1, using the parameters for a void in Table 3.1. When calculating the volume, Equation 3.2 can be changed to reflect the shape of the swale. In Figure 3.7 the calculation for a trapezium is used to provide an estimate for volume. Where, W1 is the width of the swale at the surface, W2 the width of the swale at the base, D is the depth of the swale and L is the length of the swale.

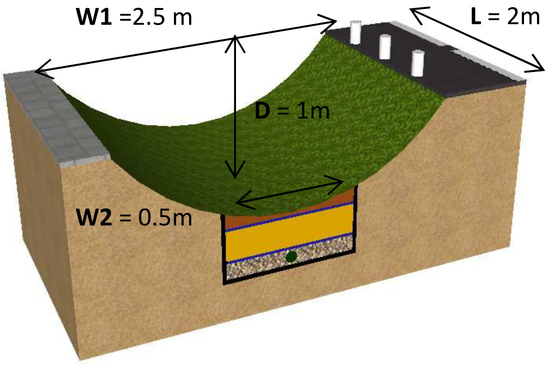


Figure 3.7 Design example of storage within a swale

Calculation for estimating volume of **void** (area in the swale):

V = **½ x D x (W1 + W2) x L** Equation 3.3

= 0.5 x 1x (2.5 + 0.5) x 2m

= **3m^3**

Calculation for estimating storage, where the value for SVP(1-VFC) is found from Table 3.1:

V_s = V x SVP(1-VFC) Equation 3.1

= 3 x 1m^3

= **3m^3**

Total Storage volume of the SuDS is: 0.205m^3 + 0.304m^3 + 3m3 = **3.51m^3**

3.8 Pervious surfaces with geocellular: worked example

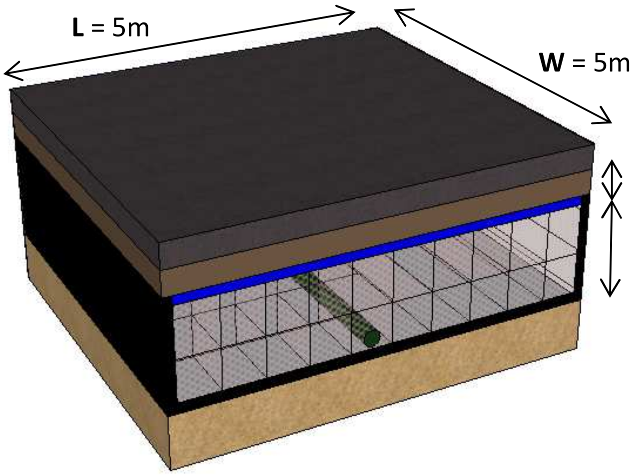


Figure 3.8 Design example of a porous surface

Calculation for estimating volume of **soil**:

V = **L** x **W** x **D1** Equation 3.2

= 5 x 5 x 0.275m

= 6.875m^3

Calculation for estimating storage, where the value for SVP(1-VFC) is found from Table 3.1:

V_s = V x SVP(1-VFC) Equation 3.1

= 6.875 x 0.260m^3

= 1.79**m^3**

Calculation for estimating volume of **Geocellular modules**:

V = **L** x **W** x **D2** Equation 3.2

= 5 x 5 x 0.5m

= 12.5m^3

Calculation for estimating storage, where the value for SVP(1-VFC) is found from Table 3.1:

V_s = V x SVP(1-VFC) Equation 3.1

= 12.5 x0.95m^3

= **11.88m^3**

Total Storage volume of the SuDS is: m^3 1.79 + 11.88m^3 **= 13.67m^3**

3.9 Pervious grid paving storage volume: worked example:

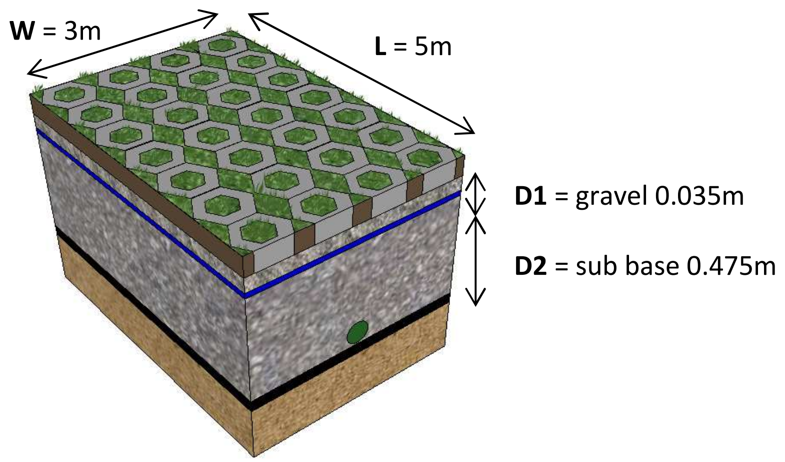


Figure 3.9 Design example of grid paving

Calculation for estimating volume of **gravel**:

V = **L** x **W** x **D1** Equation 3.2

= 5 x 3 x 0.035m

= 0.525m^3

Calculation for estimating storage, where the value for SVP(1-VFC) is found from Table 3.1:

V_s = V x SVP(1-VFC) Equation 3.1

= 0.525 x 0.255m^3

= **0.134m^3**

Calculation for estimating volume of **sub base**:

V = **L** x **W** x **D2** Equation 3.2

= 5 x 3 x 0.475m

= 7.125m^3

Calculation for estimating storage, where the value for SVP(1-VFC) is found from Table 3.1:

V_s = V x SVP(1-VFC) Equation 3.1

= 7.125 x 0.195m^3

= **1.389m^3**

Total Storage volume of the SuDS is: 0.134m^3 + 1.389m^3 = **1.52m^3**

4.0 SuDS Approval Body: application, approval and adoption

4.1 Application

4.1.1 Information required:

I. Detailed site layout at an identified scale, with North point;
II. Topographical survey of the site including cross-sections of any adjacent water courses for appropriate distance upstream and downstream of the discharge point if relevant
III. Plans, drawings and specification of SuDS proposals so that they are fully described. This should include detail of hard construction, soft landscaping and planting;
IV. Calculations of water storage capacity of the proposals and demonstration that they meet the requirements of the site;
V. Demonstration that the SuDS comply with SuDS 9 and 10 of the National Standards;
VI. Details of any offsite works required, together with necessary consents;
VII. Management and maintenance plan for all SuDS

4.1.2 Process

The process has been reconsidered by Central government and proposals are being consulted upon. This section will be completed when the process has been determined 041114.

4.1.3 Fees for application

This section will be completed when the SUDS application process has been determined 041114

4.2 Approval /Refusal

Consultation will take place with relevant parties on the application including Thames Water Utilities, Canal and Rivers Trust and the Environment Agency.

Tower Hamlets Council will determine whether the application is to be approved or refused within *x* weeks of the date of the valid application for a major development. Other applications will be similarly determined with *y* weeks. *This section will be completed when the SUDS application process has been determined 041114*

4.2.1 Appeal process

This section will be completed when the SUDS application process has been determined 041114

4.3 Adoption

This section will be completed when the SUDS application process has been determined 041114

LBTH would not normally adopt green roofs, porous paving, containers or rainwater harvesting systems.

4.4 Compliance

All SuDS must be constructed, managed and maintained in accordance with the information and plan that is approved. Enforcement action will be taken were necessary.

This section will be completed when the SUDS application process has been determined 041114

4.5 Contact information

For information on flooding issues in LBTH see the LBTH Flooding webpage http://www.towerhamlets.gov.uk/lgnl/environment_and_planning/flood_risk_management.aspxor contact the London Borough of Tower Hamlets Flood Team:

Paul Whitfield	Jessica Bastock
Team Leader (Flood and Structures)	Flood Engineer
6th Floor Mulberry Place	6th Floor Mulberry Place
5 Clove Crescent	5 Clove Crescent
London E14 2BG	London E14 2BG
020 7364 6866 paul.whitfield@towerhamlets.gov.uk	020 7364 3802 jessica.bastock@towerhamlets.gov.uk

For information on the planning process see the LBTH website www.towerhamlets.gov/lgnl/environment_and_planning/planning.aspx **or contact the London Borough of Tower Hamlets Planning Team:**

020 7364 5009

Email:planningandbuilding@towerhamlets.gov.uk

For further information on SUDS and suppliers contact the University of East London or log onto their website

Sustainability Research Institute University of East London

4-6 University Way

London E16 2RD

Tel: 0208 223 2508

www.uel.ac.uk/sri

5.0 References

Geohring, L.D., Duiker, W.S., Wolfe, D.W. & Ray, P.A., 2009. *NRCCA Soil and Water Management – Study Guide*. [pdf] New York: Cornell University. Available at: < http://www.northeastcropadvisers.org/files/Soil.pdf> [Accessed 1 December 2013].

SDS Limited, 2013. GEOlight Stormwater Management System product profile. [pdf] Somerset. Available at: < http://www.sdslimited.com/datasheets/GeolightDatasheets.pdf> [Accessed 1 December 2013]

ABG Limited, 2013., Geogreen Growing Media. [pdf] Holmfirth. Available at: <www.abgltd.com/request-file.act?target=262> [Accessed 1 December 2013]

5.1 Useful Documents and Guidance

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Woods-Ballard, B., Kellagher, R., Martin, P., Jefferies, C., Bray, R., & Shaffer, P. (2007) The SUDS manual. CIRIA Report C697. CIRIA, London UK.

Woods-Ballard, B., Kellagher, R., Martin, P., Jefferies, C., Bray, R., & Shaffer, P. (2007) Site handbook for the construction of SUDS. CIRIA Report C698. CIRIA, London UK.

6.0 Review and revisions

The LBTH SuDS Guidance will be reviewed annually and will be revised more often if there is a material change that should be recorded. Revisions to this document are recorded below in the revision table, Table6.1.

Table 6.1 Revisions to the document

Section	Revision	Date

TOWER HAMLETS

TURAS

UEL
University of
East London