Greening and Nature-based SuDS for Active Travel Schemes

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Active Travel Advice Note:

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Key Points

This document has been developed to provide Design Engineers with advice on how Greening and Nature Based SuDS can be implemented and retrofitted into new and existing projects.

The goal is to provide inspiration on potential SuDS interventions, as well as practical information in relation to dimensions, planting, challenges, and potential solutions to the designer.

This advice not is not intended to replace existing guidance/legislation. It has been formulated to provide advice on what has worked well and not so well from lessons learned on other project experience.

Contents

1. Introduction

The Climate Action Plan 2023 (CAP23) is the second annual update to Ireland's Climate Action Plan 2019. It is the first plan to be prepared under the Climate Action & Low Carbon Development Act 2021 and sets out a road map to achieving net zero carbon by 2050.

Whilst reducing carbon and emissions is critical to reduce our future impact on the climate and our planet, the damage done to date means that we also need to design our villages, towns, cities and infrastructure to provide resilience against the impacts of climate change that are already occurring and to repair some of the damage that has already occurred as a result of human activity such as the loss of natural habitat and biodiversity.

One of the impacts of climate change is that we are experiencing wetter and hotter weather extremes, which can result in an increased risk of flooding and "urban heat island" effect. Urban heat islands occur when cities replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat. This urbanisation also means that less water is infiltrating into the ground and instead is being channelled into drainage networks that are already under pressure.

These increased volumes of rainwater wash over paved surfaces, especially roads, gathering up contamination, such as fuel residue, micro bead plastics, rubber crumb, amongst others and deposits them in our stressed drainage networks, which in turn often ends up in our rivers.

Additionally, these hard urban environments typically limit space available for natural habitat, fauna, and flora. This absence of space for nature has a negative impact on biodiversity, which in turn increases the pressure on our delicately balanced ecosystems.

All these impacts can be mitigated in some way by the introduction of nature-based Sustainable Drainage Systems (SuDS). Furthermore, reintroducing nature to our streets has a positive impact on how attractive our streets are, encouraging more people to spend time enjoying the outdoors, such as walking and cycling, all of which have a positive impact on our collective health and wellbeing.

This Advice Note has been produced to provide advice and guidance to those people that are responsible for the implementation and maintenance of, primarily, retrofit SuDS in existing streets and public realm.

There are numerous existing guides and manuals, including a very recent DMURS advise note on Road and Street Drainage using Nature Based Solutions. That set out the strategic benefit, policy positions, design guidance, construction details and guidance relating to maintenance. This advice note does not supersede those documents but is designed to provide more need-to-know advice in a compact and accessible format to enable the implementation of SuDS on NTA funded projects across Ireland.

2. What are Nature-based Sustainable Drainage Systems (SuDS)?

Sustainable Drainage Systems (SuDS) not only reduce the risk of flooding, but also improve the quality of water that enters our watercourses. SuDS is a broad term and there are numerous features that could be classed as SuDS from rainwater butts to large ponds. This advice note focuses on those elements that could be installed within an existing, constrained streetscape, and refers primarily to nature-based SuDS which also enhance biodiversity and amenity through the introduction of plants, making for more ecologically valuable and more attractive places.

The four "pillars" of SuDS: Water Quantity, Water Quality, Amenity and Biodiversity are illustrated in *Figure* 2 below.

Figure 1 Typical example of recently constructed SuDS features in the form of rain gardens Shoreditch Park, London UK

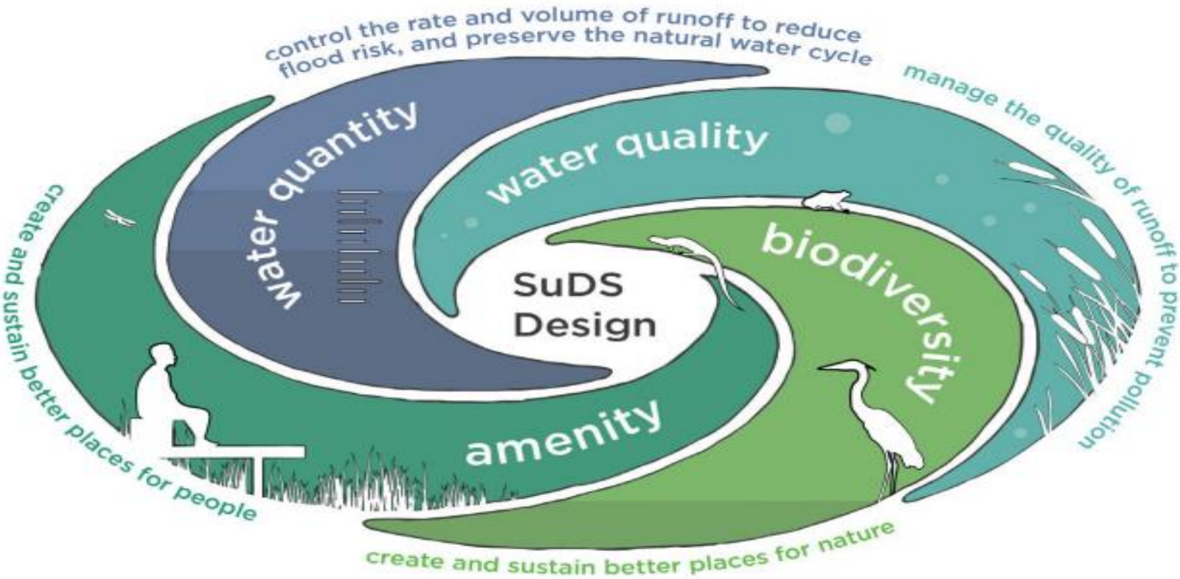


Figure 2 The Four Pillars of SuDS- illustration from the Dublin City Council Design and Evaluation Guide 2021 © 2021 McCloy Consulting and Robert Bray Associates

Nature-based SuDS features will generally rely on surface water flows being directed to areas of planting where the water is absorbed by soils, irrigating plants and dispersed back into the air through evapotranspiration. In suitable ground the water can also soak away, or infiltrate into the ground.

A basic building block of cost-effective SuDS is a rain garden, this is a shallow area of ground, such as a dip or low point in the landscape, which receives runoff from surrounding hard surfaces including roads and cycle tracks. It is sown with plants that can stand waterlogging for up to 48 hours at a time. More drought-tolerant plants are used towards the edges. Storm water fills the depression and then drains away in a controlled manner.

Where infiltration is not feasible then, typically, a perforated pipe, or an underdrain would be provided beneath the soils that would discharge the treated water back to the network, but at a much slower rate than a conventional system. The fact that the water is being directed to the planted area helps the right types of plants to thrive, providing the additional benefits in terms of biodiversity and amenity. There are a growing range of features and techniques that can be described as SuDS and that provide these benefits to varying degrees.

This advice note focuses primarily on opportunistic lower cost interventions as set out in *Table* 1 below, over page.

More complex SuDS systems can be utilised, which restrict surface water discharge to a specified rate and often require flow control devices along with deeper voided stone layers or supplementary, proprietary below-ground attenuation structures. These systems are referred to in Greening and SuDS Interventions but are not covered in detail within this Advice Note.

The interventions listed below range from the protection and retention of existing green space within new schemes, the introduction of new above ground planters which would provide amenity and biodiversity benefits but have a limited role in terms of surface water management, through to rain gardens that positively contribute to surface water management. Bioswales (rain gardens on a slope) and tree pits are included as part of the rain garden family in this advice note.

Table 1 Schedule of SuDS features considered in this Advice Note

Greening and SuDS Interventions		The Four Pillars of SuDS			
		Water Quality	Water Quantity	Amenity	Biodiversity
Above ground planters		No notable contribution	No notable contribution	Significant contribution	Significant contribution
Protecting existing green space and providing new		Some contribution	Some contribution	Significant contribution	Significant contribution
Rain garden		Significant contribution	Significant contribution	Significant contribution	Significant contribution
Bioswale		Significant contribution	Significant contribution	Significant contribution	Significant contribution
SuDS tree pit		Significant contribution	Significant contribution	Significant contribution	Significant contribution

3. Greening and SuDS Interventions

Delivering SuDS can be challenging. Currently our industry, our governing bodies, our supply chains, and our communities are learning and adapting to the changing pressures of urbanisation, introduction of active travel, digital innovation, shifting lifestyle choices and culture change. It can feel like everything is in a state of flux.

The SuDS features described here are intended to simplify the decision-making process, socialise, and demystify the language and methods, allowing our villages, towns, and cities transition across and learn, implement, and experience the benefits they bring, at a pace that suits the decision makers in these varied places, building consensus and confidence.

Whilst we are essentially talking about using nature to help provide climate resilience and add value to our streets, and the techniques proposed are very simple, the application of nature-based SuDS is only just becoming mainstream and as such each new feature that is introduced is slightly different from the last and the industry is constantly learning, innovating, and improving with each new project.

Because the features are at ground level there is the opportunity to observe and develop the features based on how they are performing, this might mean adjusting soil levels, changing the planting mix or varying the maintenance regime to achieve optimum results - In fact on-going monitoring of the performance of these features and sharing of knowledge is as important as installing them in the first place.

It is important to note that there will always be room for improvement, but the introduction of any features will provide a betterment over the existing condition, and this should provide confidence to anyone installing SuDS for the first time.

3.1 Above ground Planters

This is a familiar, tried, and tested technique which comes in many forms and has been employed and enjoyed by communities across the country, perhaps best recognised as a staple feature in the Tidy Towns tool kit.

Planters are essentially plant pots or containers. They typically sit, or are fixed, bolted down, on top of reallocated carriageway space/footpaths/any available permissible space. Planters are mobile and larger ones can be repositioned with lifting equipment to respond to the changing demands of a space over time. Planters can be used to delineate parklets to protect cycle facilities and can be used as modal filters, located in liveable neighbourhood type schemes.

They are often easier to replant and maintain as they sit taller in the streetscape and are readily accessible making litter picking or tending straightforward. They bring seasonal life and vitality to the spaces they occupy, offering a home for insects and small creatures.

For above ground planters for shrubs/flowers within the public realm, the preferred minimum planter depth should be 900mm to allow for:

- 100mm drainage layer to base,
- 750mm soil medium/compost (or 700mm medium + 50mm mulch),
- 50mm ‘freeboard’ to top of planter.

The preferred minimum width should be 900-1200mm or larger. The width can be reduced to 600mm where space is tight but maintain minimum 900-1200mm length. Lower than 600mm planters can also be utilised but will require more frequent irrigation and maintenance.

It is generally recommended to avoid trees in planters as they invariably die after a couple of years in planters. If trees in planters are a requirement, it is recommended to use the minimum size for above ground tree planters, which would be 1200mm x 1200mm x 900mm.

As with all above ground planters, it's worth including a water reservoir such as Mona Irrigation System (or equal approved) and incorporating a hydrogel such as Broadleaf P4 to the soil medium/compost.

While these attractive and versatile features add value to otherwise hard spaces, they contribute little meaningful benefit to rainwater management or control, leaving that work to conventional drainage systems along with their growing vulnerabilities and inherent limitations.

Planters are versatile and can be used to create parklets as shown in *Figure* 3 below, on Douglas St, Cork City, or to provide protection to Active Travel corridors such as at Inns Quay, Dublin City shown in *Figure 4* , or as modal filters, such as the example shown *Figure* 5 which is at Covent Road in Navan, Co.Meath.

Figure 3 Cork City Council miniature Parklet - Douglas St, Cork City

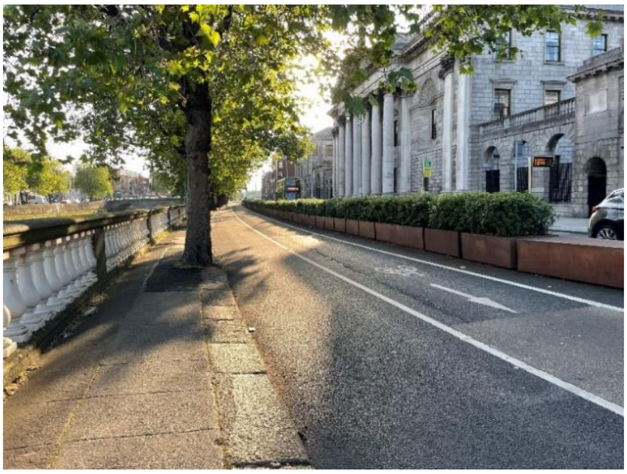


Figure 4 Planters provide protection to a cycle Lane at Inns Quay, Dublin

Figure 5 Modal filter at Convent Road, Co. Meath

Table 2 below summarises some of the more common challenges encountered when installing planters along with potential solutions to these challenges.

Table 2 Planters- Challenges and Solutions

Planters: Are decorative containers in which plants are grown and can include wooden, ceramic, terracotta, glass, or metal planters.	
Challenges	**Solutions**
Availability of space	Are relatively flexible and can be suited to fit in a range of spaces.
Anti-Social Behaviour	Planters should be too heavy to manually push over or should be bolted down. Heavy planting medium used to deter interference.
Impact on visibility splays	When placing near junctions and schools, road user visibility should be considered, and planters should be placed away from the road edge where possible. Visibility requirements should be calculated based on the guidance set out in Section 4.4 of the Design Manual for Urban Roads and Streets (DMURS) where appropriate.
Maintenance	Regular maintenance to include plant replacement, irrigation requirements, weeding, debris and litter control.

3.2 Protect and enhance existing green space and delivering new.

Existing green space should be protected where possible, or consideration should be made to provide more space when initially appraising options for the project. Protecting existing green space is a straightforward strategy and helps to reduce the amount of water entering the existing drainage network. This means that when a project is brought forward and proposals include changes to spaces, the changes include keeping as much of the existing natural permeable surface as possible or, better still, providing new.

Delivering new green space means removing areas of hard landscape and replacing them with natural permeable surfaces. This will contribute positively to biodiversity and amenity and have a beneficial impact in terms of surface water quality and quantity.

An example of where this approach has been successfully implemented is at Templeville Road (R112) carried out by South Dublin County Council. On this project new cycle infrastructure was provided within the carriageway and the existing verge was retained as green space. An image from Google Street View is shown in *Figure* 6. The design provided segregated cycling facilities while maintaining the existing grass verges. The existing concrete kerb was removed and replaced with timber edging along the existing edge of the grass verges, *Figure 8* below.

Figure 6 Image of recently implemented works at Templeville Road (R112), South Dublin

The images in *Figure 7* and *Figure 8* show the construction sequence where the existing grass verge was maintained.

Figure 7 Original kerb milled and removed off site.

Figure 8 Construction and installation stage of the new kerb maintaining greening.

A further example is shown in *Figure 9* where new planting has been added to [Sean MacDermott St](#) also in Dublin.

Figure 9 New Greening added on Sean MacDermott St Lower

It will not always be possible to retain existing green space or deliver new, but the opportunity should always be explored at options selection stage. *Table* 3 below summarises some of the more common challenges encountered when incorporating green space into the street along with potential solutions to these challenges.

Table 3 Green Space - Challenges and Solutions

<table>
<tr><th colspan="2">Protecting Existing Green Space and Delivering New:

Green space is defined as any vegetated land or water within an urban area, including parks, gardens, children’s play areas, woods, natural/grassed areas.</th></tr>
<tr><th>Challenges</th><th>Solutions</th></tr>
<tr><td>Availability of space</td><td>It will not always be possible to protect existing green space or provide new, but it should be prioritised wherever possible. Engagement with landscape architects at an early stage may identify opportunities that had not otherwise been considered.</td></tr>
<tr><td>Protecting Existing Trees</td><td>No dig solutions can be utilised to protect tree roots enabling delivery of hard surfaces within tree root zones without harming the tree.</td></tr>
</table>

Figure 10 Below shows a no dig solution under construction at Blackrock Park, Dublin. The no dig solution ensures that the loads are laterally dissipated rather than transferred to the soil and roots below. The walls of the system are perforated and when combined with the infill of clean angular stone, this enables free movement of water and oxygen, which ensures nutrients are supplied to the tree roots.

Figure 10 Shared path under construction using a no-dig solution, Blackrock Park, Dublin.

3.3 Rain Gardens

Rain gardens are areas of planting that sit slightly lower than the level of the adjacent ground. Rainwater is channelled overland to these features rather than directly to traditional road gullies or channels.

The principles of a rain garden are illustrated in *Figure 11* below.

1. Rainwater runs off hard surfaces into the rain garden.
2. The water filters through the soil and drainage layer.
3. Water infiltrates into the ground (where ground conditions permit); and
4. Water evaporates into the air from the soil or plants.

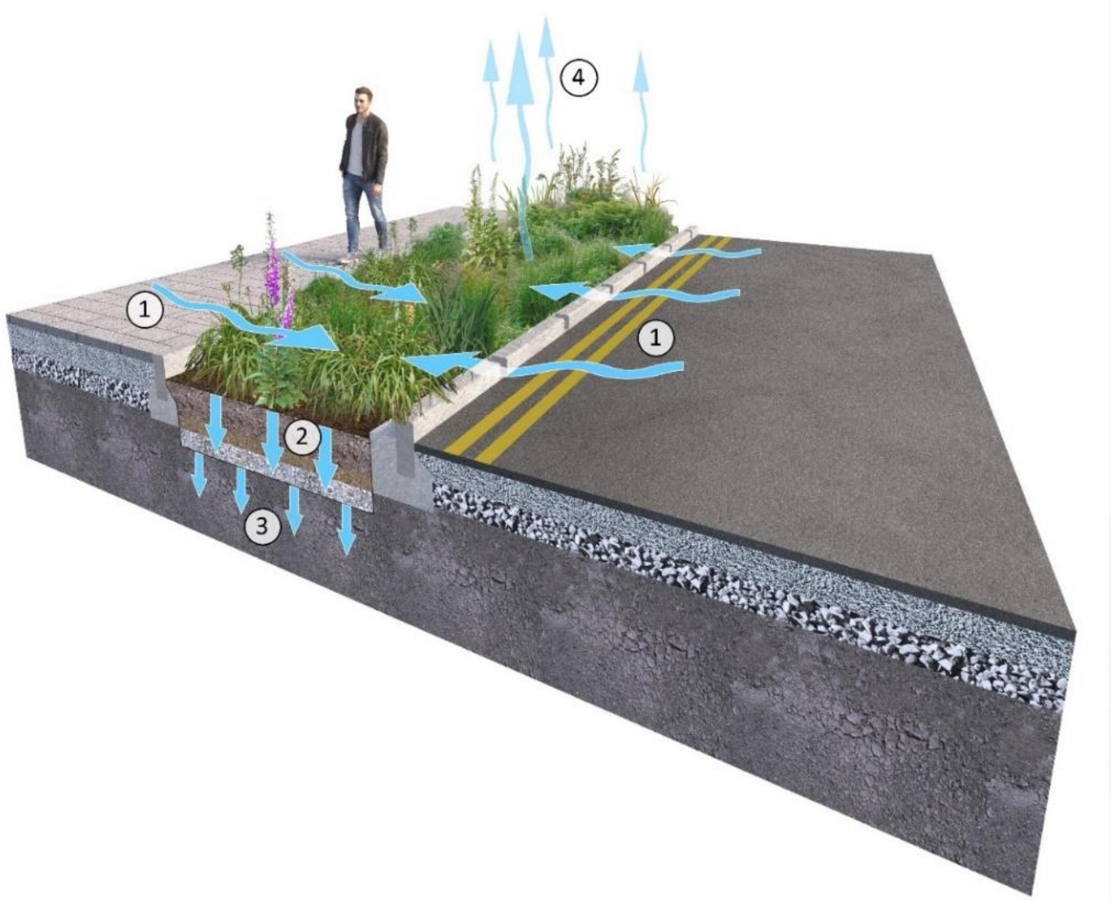


Figure 11 Illustration showing the principles of a rain garden.

Ideally rain gardens would collect run off from the carriageway as this often contains the most pollution, however even if only the footpath can drain to the rain garden this is a positive intervention.

Rain gardens should ideally be designed to maximise the amount of water that can infiltrate into the ground beneath the rain garden as this relieves pressure on the piped drainage network, replenishes groundwater and supports the baseflow in rivers.

The infiltration rate of the sub-soil can be estimated by digging a hole to the equivalent depth of the rain garden (approximately 500mm) and filling it with water and then recording the amount of time taken for the water to drain down. The approximate infiltration rate of the soil can be estimated by dividing the depth (mm) of water by the time taken to drain down (hrs). If 500mm of water soaks into the ground over a period of 6 hours, then the infiltration is good, and an underdrain should not be required. The test should be repeated 2-3 times to understand the infiltration in saturated conditions.

A more accurate method of measuring the infiltration rate of the soils is set out in BRE 365. BRE365 is the method of measuring the water absorption rate of the soil to determine if ground conditions are appropriate for infiltration/soakaways. Further factors should be considered when proposing infiltration such as:

- If there is any known contamination in the ground that the water might wash through the soils into nearby watercourses, then infiltration may not be suitable.
- Infiltration should not be permitted into existing road, and sub-base. Impermeable liners should be provided where the new rain garden edges do not provide a barrier between the rain garden and the sub-base or capping layer of the adjacent road pavement.

3.3.1 Key Design Components

The components of Rain Gardens where infiltration is feasible are shown in *Figure 12* below and over page.

Figure 12 Illustration showing the components of a rain garden.

a) ***Planting-*** certain types of planting are more appropriate as described in Section 4 of this advice note.

b) ***Soils***- Whilst greater depths of soil can be beneficial to optimise surface water management and provide a growing medium for plants, the focus of this document is on the delivery of cost effective, opportunistic SuDS interventions and as such in many instances it will be necessary to keep the overall depth of construction to a minimum. An absolute minimum of 300mm depth of soil should be provided for shrubs and 200mm minimum for wildflower or grasses. A 50mm depth of inorganic mulch should also be added to the top of the soil. The top of mulch should be set lower than the level that the water enters the rain garden (absolute minimum 50mm) so that water can sit on the surface of the rain garden without spilling on to the road. This gap between the top of mulch and the level of the road is referred to as "freeboard" and will provide a volume of attenuation in extreme events- the greater the freeboard the greater the volume of water that can be stored. Whilst standard topsoil could be used for rain gardens this will limit the performance of the system as the nature of the material generally would not allow water to soak through it very quickly, as such engineered soils would ideally be used. The specification of the soils is discussed in Section 4.

c) ***Transition Layer or geotextile separation laye***r- to reduce the migration of soils into the drainage layer and improve filtration of pollution's, a transition layer of 100mm coarse sand or grit should be provided above the drainage layer. Where it is necessary to minimise the depth of construction this layer could be replaced with a permeable geotextile.

d) ***Drainage layer***- a layer of free draining, voided stone should be provided beneath the soils. Where adjacent to a carriageway it is recommended that this material is a Type B Filter Material to TII Specification for Road Works Clause 505, that will provide structural support to the existing pavements and new edgings. This layer should be a minimum of 150mm deep.

e) ***Edgings***- the rain garden will require new edgings to support the existing pavement. Where next to a road a typical road kerb unit could be used, but next to a pavement a pin kerb could be suitable which could be installed flush. Kerbs should be installed with gaps between kerbstones to allow water to flow into the raingarden. The gaps could either be between every kerbstone with a minimum 100mm opening, or larger gaps can be provided with a larger spacing along the kerb line. Larger gaps reduce the risk of blockage, but increase the risk of erosion at the inlet as the flow of water is more concentrated.

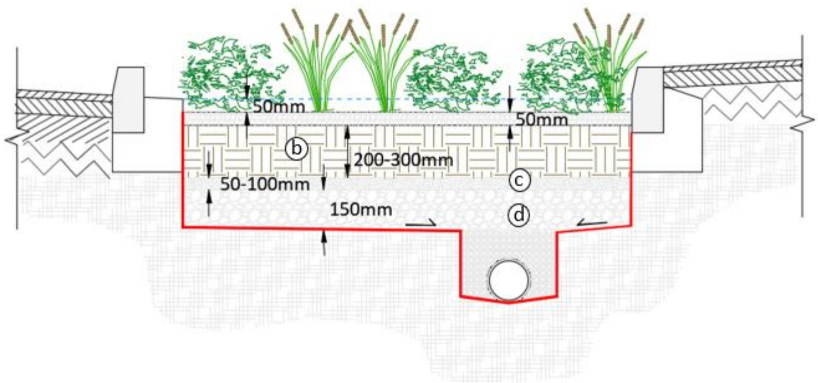
f) ***Inlets***- Where water enters the garden it is important to avoid the soil eroding. Erosion can be controlled by providing an area of gravels or pebbles embedded in concrete to "baffle" the flowing water as it enters the rain garden. Consistent gaps may negate the need for erosion control as run off entry would be more like sheet flow.

g) ***Overflow gully-*** an overflow gully should be provided such that it can provide an overflow in the event that the storm water exceeds the capacity of the rain garden. The top of the gully grating should sit a minimum of 50mm above the top of soil and be no higher than the level of the inlet. The existing kerbside gully could be repurposed to become this overflow gully, or a new overflow could be installed and connected to the existing road drainage network.

Where it is not feasible to infiltrate all runoff then the rain gardens should be lined with an impermeable liner and connected to the existing surface water drainage network via a permeable pipe that sits at the base of the rain garden, as illustrated in *Figure 13* below. This is to avoid water being held at the base of the rain garden and the soil being saturated for long periods which can cause problems for the soil and the plants.

Figure 13 Illustration showing the components of a rain garden including underdrain and impermeable liner which should be provided where infiltration is not feasible.

Technical details showing the components of a rain garden are included in the Appendix A to this report and an indicative typical section with dimensions is included *Figure 14* below.



b) Soils

c) Transition Layer/geotextile separation layer

d) Drainage layer

Figure 14 Typical section through a Lined/impermeable bioretention system (rain garden) (including underdrain) with key minimum dimensions.

3.3.2 Key Design Considerations

Key considerations to make when delivering rain gardens are listed below:

- It is very important to provide a level difference (freeboard) between the top of the mulch and the inlet level. Without this level difference the water will not be able to straightforwardly flow into the rain garden and there will be no capacity for the water to be held at the surface before it infiltrates. The soil and mulch should be set at the lower level across its surface as any mounds or humps will limit capacity.
- Equally important to setting the soil levels lower than the inlet is making sure that the level of the overflow gully is set above the soil level and no higher than the inlet level. This is to make sure that the water can be stored on top of the soil without entering the overflow and to make sure that the water flows into the overflow before spilling out on to the adjacent road surface.
- Inlets should be a minimum of 100mm wide. This is to make sure that they don't get blocked easily by leaves or litter.
- Where the raingarden is constructed along an existing kerb line then inlets should be provided at the ends of the rain garden adjacent to the existing kerb to make sure that any water flowing along the kerb line can enter the rain garden.
- Where the existing ground is not suitable for infiltration an underdrain should be provided which connects back to the existing drainage network.
- Any soils which are supporting adjacent pavements should be sufficient to provide structural support. Generally organic soils should not be placed lower than the bottom of the road build up or base of the edging. Where deeper soils are required then the kerb bed could be increased in depth.
- Provide an overflow gully connected to the existing drainage network or consider and manage overland flows should the capacity of the raingarden be exceeded.

3.3.3 Choosing locations for rain gardens.

In the context of existing streets, rain gardens are generally installed within the carriageway or to replace existing planted verges, this means that they don't take away space from footpaths and generally means that they are installed in areas which are less likely to contain buried utilities. Specific opportunities can arise where build outs or radius tightening are already proposed to provide traffic calming or create gateways or modal filters.

A further benefit to providing rain gardens in the carriageway is that they must be located in areas where surface water runoff from the hard surfaces is directed towards them- in particular from the carriageway, where possible, as this water will contain more pollutants that can be filtered out of the water by the rain garden. This will generally coincide with existing road gully positions and means that either the gully can be repurposed as an overflow to the rain garden, or a new gully can be installed with a connection to the existing gully pipe.

Where the intention is to repurpose an existing verge then consideration should be given to the location of existing gullies with a view to reusing the gully pipe to create an overflow connection where possible.

The illustrations below show typical locations of where rain gardens were retrofitted into an existing street.

Scenario 1 – Raingardens can be provided within the existing carriageway, ideally in the location of an existing gully that can be adapted to provide an overflow. Car parking spaces could potentially be repurposed into rain gardens. It is important to provide inlets along the existing kerb line to allow water running along the face of the existing kerb to enter the feature.

Before

After

Scenario 2– Existing verges can be repurposed as rain gardens. The existing gullies can be relocated to provide an overflow. Alternatively, the rain garden could be designed to overflow back into the carriageway gully.

Before

After

Scenario 3 – Rain gardens can be introduced at buildouts or radius tightening to form part of a traffic calming scheme or modal filter. These features are often hard paved, but would provide much more value if planted.

Before

After

As well as retrofitting into existing streets rain gardens could be installed as part of more linear Active Travel projects alongside new cycling infrastructure as shown in Scenarios 4a and 4b below.

Scenario 4a– Where new cycle tracks are installed on carriageway then the existing verge could be repurposed as a rain garden to collect run off from the footways.

Scenario 4b– If cycletracks can be constructed adjacent to the footpath then this could allow raingardens to collect surface water run off from the carraigeway as well as the footway. In this scenario the planting would also provide seperation between cyclists and motor vehicles.

3.3.4 Hydraulic Design Considerations

Provision of any rain garden will provide a betterment over the existing scenario. Making a rain garden bigger (and therefore storing more water) increases the flood risk management benefit, however this needs to be balanced against cost and availability of space.

Most of the pollutants are washed off roads and hard surfaces by the first 5mm of rainfall and as such the rain garden should ideally be designed to treat this run off before it enters any overflow structures. Typically, a road gully has a catchment of 200m² and as such 5mm of rain across that surface would result in 1m³ of water; in heavy rain this amount of water may fall over a 60-minute period. Soils are discussed in more detail in *Section 4,* but if it is assumed that the water soaks through the soil at a rate of 100mm/hr then this means that a 10m² rain garden (approximately the size of a car parking bay and equivalent to 5% of the catchment area) could treat the runoff from 200m² of road or hard surface. This is illustrated below in *Figure 15.*

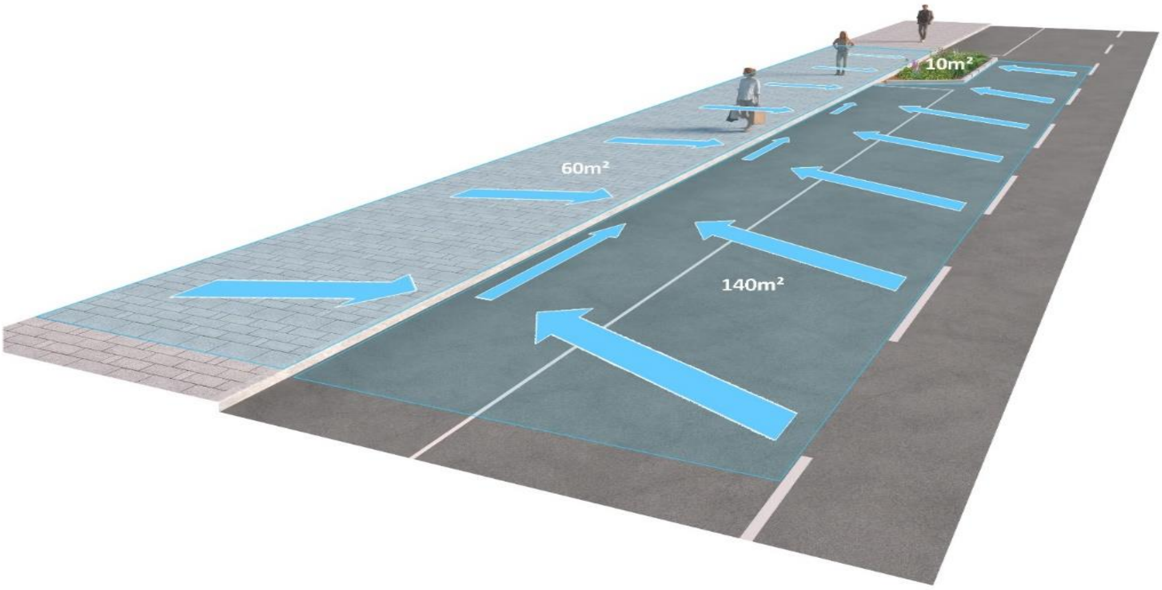


Figure 15 Typical Catchment area for a rain garden

If there is not sufficient space to provide a rain garden of this size that shouldn't mean that it is not installed, any size rain garden will provide a betterment of the exiting condition in terms of reducing flood risk, treating the water, increasing the attractiveness of the street, and improving biodiversity.

Further analysis could be undertaken to assess the catchment and discharge rates and the quantity of surface water that could be managed could be increased through introduction of deeper soils, and drainage layer, and/or the introduction of proprietary crates below the rain garden. In a scenario where an underdrain is required then the benefits could be optimised through introduction of flow control devices that restrict flows to a specific rate and the rain gardens and associated drainage layers could then be sized to provide a specific level of attenuation, but this is considered a more significant intervention than is covered by this advice note.

3.3.5 Working around utilities.

Rain gardens can be installed as relatively shallow features. Assuming a 50mm freeboard, 300mm of soil and 150mm of drainage layer this gives an overall depth of 500mm (excluding underdrain) which is little deeper than a standard pavement construction. Furthermore, as rain gardens will generally be located in areas that were previously carriageway or verge there is a reduced risk of encountering utilities infrastructure which is more often located within footpaths.

The usual measures should be taken to identify utilities when excavating within roads, including obtaining utility providers plans, undertaking the necessary scans, and adopting methods of safe excavation.

If utilities are encountered this does not mean that the rain garden cannot be installed. The depth of fill can be reduced locally to the duct or pipe such that the utilities are not affected, or the utilities can be threaded through the features, this approach is illustrated in *Figure 16* below. All of this work should be undertaken in consultation with the utility providers and early engagement is key, but in real terms there would be no detriment to the asset and as such there should be little resistance.

Utility providers may request a minimum easement for working around their asset and that it may be worth attempting to form some sort of agreement for reinstatement should the asset need to be accessed.

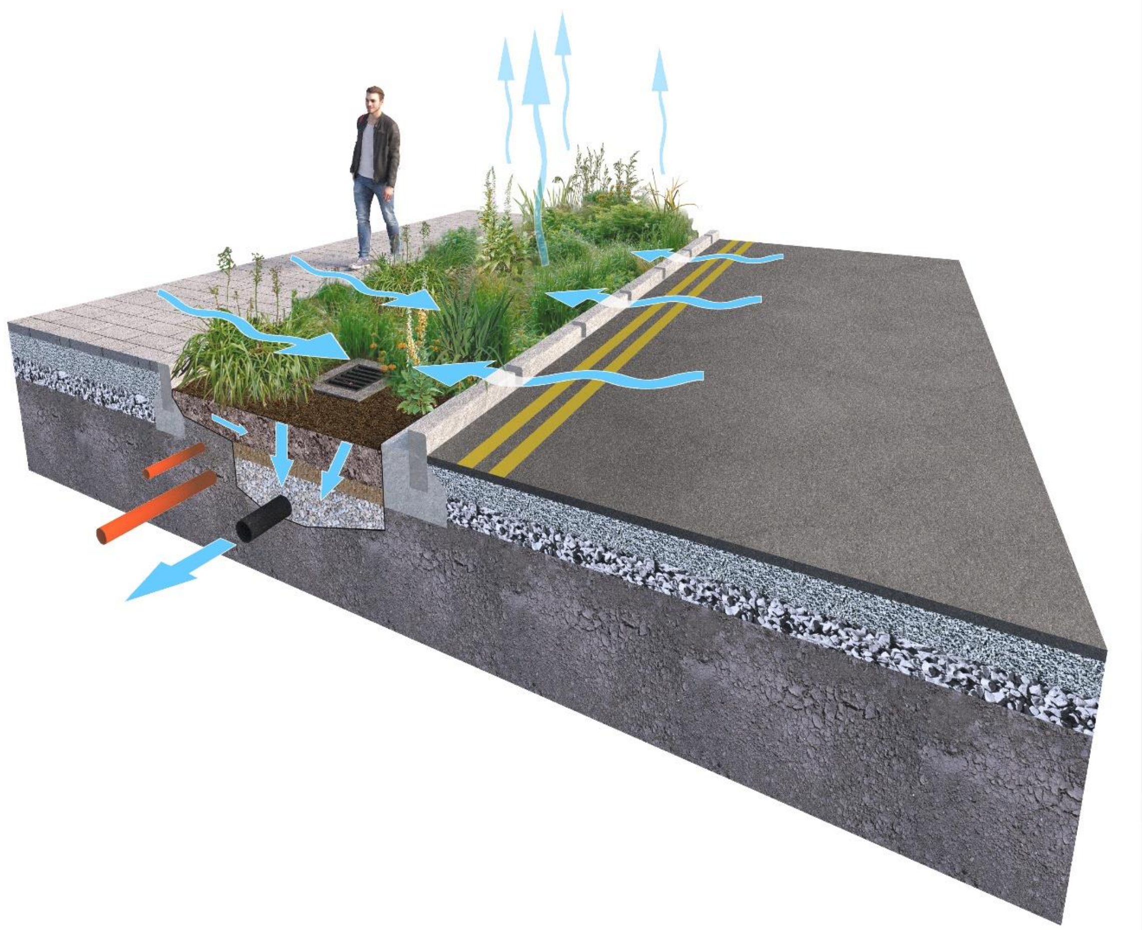


Figure 16 Illustration showing how rain gardens can be adjusted to work around utilities.

3.3.6 Case Studies

Some examples of where rain gardens have been installed on NTA funded projects in Mountview Road, Hartstown, Dublin 15 are shown in *Figure 17* and on Rock Road, Co. Dublin in *Figure 18.*

Figure 17 Rain gardens installed in existing verge, footpath widened - Mountview Road, Hartstown, Dublin 15

The introduction of rain gardens promoted sustainable drainage while also improving the aesthetics of the existing school zone space. Although each rain garden was small in footprint, their introduction reduced existing impermeable surfaces and in turn reduced the rate of rainfall entering the existing surface water network. As rain gardens can be flexible in shape and depth, they were easily incorporated into the existing environment with no requirement for utility diversion. The rain garden also served to discourage vehicle drop off in this critical area, requiring parents and caregivers to move their vehicles away from the school gate, reducing risk of injury to children and improving air quality at the front of school.

Figure 18 Rain gardens on [Rock Road, Co. Dublin]

The replacement of the existing paved separation island with a rain garden allowed for the introduction of sustainable drainage into the scheme design. To maximise the effectiveness of the rain garden a 'hit and miss' kerb was introduced to allow surface water enter the rain garden from the carriageway, while retaining the existing drainage infrastructure to manage extreme rainfall events. Minimal utilities were present in this area, which facilitated the introduction of an increased depth of engineered soil to ensure a good growing medium for plants, and allow for storage of surface water. The correct selection of plant species was also critical to encourage quick growth and coverage within the rain garden.

Table 4 below summarises some of the more common challenges encountered when installing rain gardens along with potential solutions to these challenges.

Table 4 Rain gardens- Challenges and Solutions

Rain gardens: Are engineered SuDS solutions. They are used to cleanse the rainwater through physical & biological processes. Rainwater filters through the soil media and collected in perforated sub-surface perforated drainage pipes. Water is then conveyed to the systems.	
Challenges	**Solutions**
Availability of space	Rain gardens of any size will have a positive impact in terms of the four pillars of SuDS. The bigger the feature the better and often reclaiming a parking space in an urban environment will achieve a really positive result. If it is not possible to reclaim large areas of road space, then a verge could be repurposed or traffic calming features such as build outs could be constructed as rain gardens rather than being hard surfaced.
Topography	Rain gardens should be located where rainwater will drain into them. This can be straightforwardly achieved in most instances by placing them at or around existing gullies. Where the streets are steeper then bioswales (refer to Section 3.4) with check dams (small weirs) can be used to manage flows.
Existing utilities	It is important to understand what is below the ground before designing the rain garden and certainly before building it. Simple investigations can be undertaken to identify whether there are utilities present for example and the rain garden can be adapted to avoid these below ground constraints, for example by making the rain garden construction locally shallower, as described earlier in this document. Rain gardens can be design/installed so that there is no impact to existing utilities. Early consultation with utility providers is important.
Ground Conditions	Where ground conditions are not suitable for infiltration then a liner and underdrain can straightforwardly be introduced.
Availability of products	Rain gardens can generally be constructed with a kit of parts that is not too dissimilar from that of a traditional highway, kerbs, edges, and gullies. Soils with a permeability of greater than 100mm/hr may not always be readily available and if necessary, a more standard soil can be used. This will impact on the hydraulic performance of the rain garden, but a betterment will still be achieved over the existing condition.

3.4 Bioswales (rain gardens on a slope)

Where there is a fall along the length of the street and there is sufficient space to create a longer feature, a valley can be created within the soil and planting which can channel water across the planted surface to a desired location. Where water is conveyed in such a way the feature is generally referred to as a swale.

As water will be encouraged to flow along the swale it is important to protect against erosion and as such an area of gravel could be provided along the base of the channel. Small check dams (or weirs) can also be provided, spaced out along the length of the bioswale to reduce the rate of flow along the channel, not only will this help with erosion control it will also retain water within the feature allowing sediment to settle and water to filter through the soils. Ideally the height of check dams should be limited to 100mm as such if the road has a fall along its length of 1in20 (for example) then the dams would be spaced at maximum 2m centres. The dams could be constructed from edging or pin kerbs and should be set slightly lower towards the centre of the swale to manage flows.

The principles of a bioswale are illustrated in *Figure 19* below.

Figure 19 Illustration showing the principles of a Bioswale- needs to focus on differences from rain garden.

An excellent example of a bioswale is the [Grey to Green]() project in Sheffield. Whilst this takes up significant space on plan the principles could be straightforwardly transferred to smaller features if necessary. Some of images of this project are shown below, before and after the planting established. The check dams can be clearly seen at regular centres along the length of the structure.

Figure 20 Grey to Green, West Bar Sheffield prior to established planting (image credit Nigel Dunnett)

Figure 21 Grey to Green with established planting (image credit Greenpeace)

Figure 22 Grey to Green, Sheffield (image credit Nigel Dunnett)

Bioswales are very similar to rain gardens, but *Table 5* below summarises some of the more common challenges encountered when installing bioswales along with potential solutions to these challenges.

Table 5 Bioswales- Challenges and Solutions

Bioswale (BS): Are vegetated shallow landscape depressions. They are designed to capture, treat, and infiltrate surface water runoff as it moves downstream	
Challenges	**Solutions**
Topography	Bioswales should be located where rainwater will drain into them, where there is a mild slope (no greater than 1:20). incorporating check dams can also help to slow the flow of water. Bioswales work best when installed in car parks, along roadways and footpaths or as an enhancement to the natural or existing drainage swales.
Ground Conditions	Where ground conditions are not suitable for infiltration then a liner and underdrain can be straightforwardly be introduced

3.5 SuDS Tree Pit

Rain gardens can be combined with street trees to create a SuDS tree pit. Introduction of a tree requires an increased depth of excavation and consideration as to the structural performance of the soils where they fall within the structural zone of influence of the road pavements. Tree pits can either be constructed using structural soils which would support the adjacent road pavement or deep concrete retaining features can be installed between the tree pit and the carriageway. *Figure 23* below illustrates the principles of a SuDS tree pit. Further product information can be sought from GreenBlue Urban - ArborFlow and TDAG-Trees in Hard Landscapes.

Figure 23 The principles of a SuDS tree pit

Some of the challenges associated with delivering SuDS tree pits are listed in *Table 6* below along with potential solutions.

Table 6 Tree pits- Challenges and Solutions

SuDS Tree Pits (TP): Tree pits are constructed to attenuate Surface Water runoff by exploiting the natural void within the tree soil rooting zone and is contained within an underground tree pit	
Challenges	**Solutions**
Availability of space	The ideal soil volume for a tree pit will be dependent on the species of tree as such it will often be possible to select trees to suit the specific conditions and below ground constraints. See [GreenBlueUrban - Soil Volume guide]
Structural Performance	As the tree pit and soils will need to be deeper than the adjacent pavement the structure consideration should be given to ensuring that the road is properly supported. Structural soils can be utilised which have low organic content or interlocking stone
Root protection	Root barrier systems should be utilised to control the direction of root growth and mitigate the risk of damage to adjacent structures and utilities. [GreenBlue Urban - Root Management]

3.6 Other SuDS Features

Whilst this advice note focuses on lower cost "opportunistic" SuDS interventions there are many more potential features that could be adopted which can provide enhanced benefits in terms of surface water management in particular. Some of these are summarised below:

3.6.1 Engineered bio-retention systems.

Rain gardens can be utilised in conjunction with flow controls to attenuate large volumes of water and significantly reduce the rate of surface water entering the drainage network.

This system requires an orifice plate or vortex flow control device to be provided prior to outfall which restricts flows to a specified rate. This leads to water backing up within the system which is then stored either within an increased depth of drainage layer, soils, and freeboard or in proprietary structures which can sit beneath the drainage layer. The typical detail below is taken from a project on which infiltration was not feasible and surface water discharge through the underdrains had to be restricted to greenfield run off rates. This resulted in the drainage layer being up to 1m deep in some instances to provide sufficient attenuation for the design storm event.

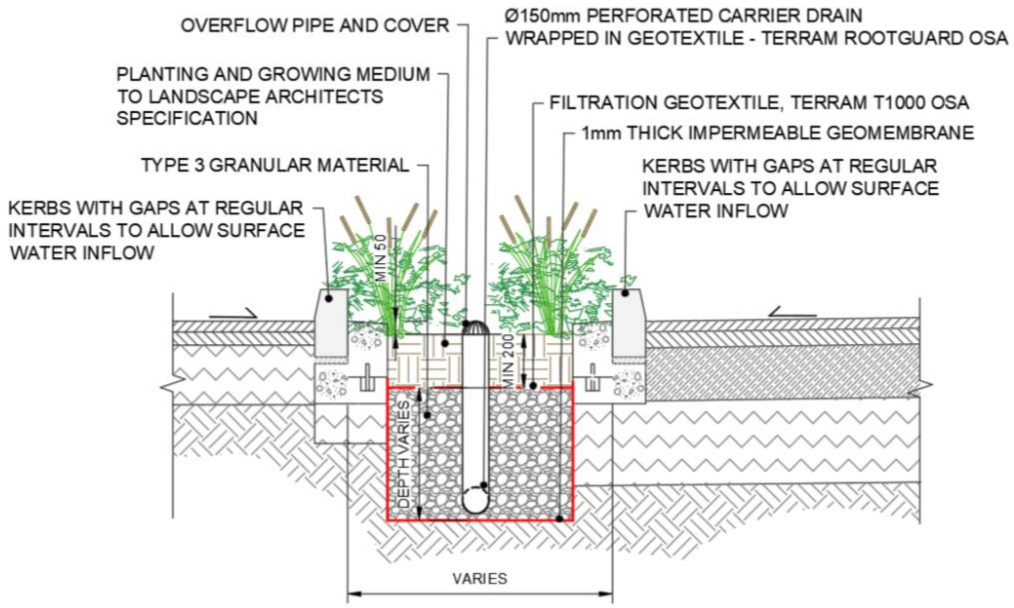


Figure 24 Typical Detail of an engineered bioretention system (Rain Garden with flow control)

3.6.2 Tree pit with Stockholm System

It is common to see trees in urban/hard landscaping struggling to thrive. There are several reasons for this, however the most common reason is because the tree does not have adequate access to rootable soils or don't receive enough water. If urban trees fail to reach maturity, the don't provide the full benefits they can potentially offer to the urban area.

The Stockholm System provides practical and effective solutions for planning trees in areas of hard landscape. When using the "Stockholm System" structural support is provided through large interlocking stones and the voids in the stone are filled with organic material. These solutions potentially provide the opportunity to extend the tree pit width into the footpath and carriageway due the stiffness/bearing capacity provided.

Further guidance on this approach can be found on the [Trees and Design Action Group website]() and the images below show the system being installed as part of the Luas works in O'Connell Street, Dublin.

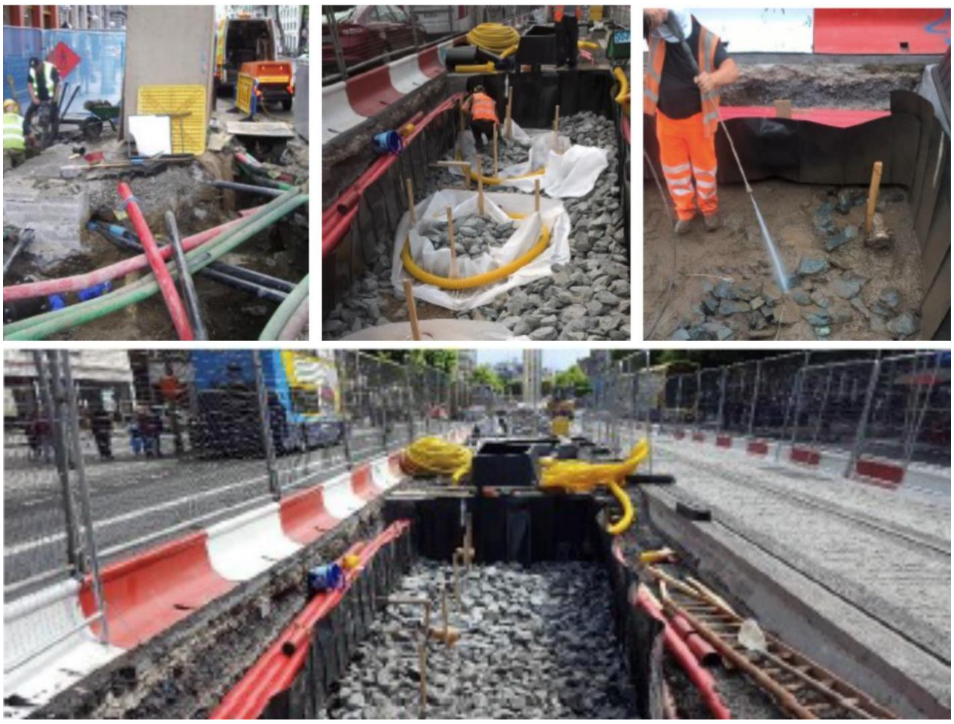


Figure 25 Stockholm tree pit system under construction in O'Connell Street Dublin.

Figure 26 Completed scheme for the Stockholm tree pit system in O'Connell Street Dublin

3.6.3 Tree pit with proprietary crate system

An alternative to structural soils within a tree pit is a proprietary crate system. The crates provide structural support and are filled with organic soils which can be specified to suit the species of tree. The crates are backfilled with structural soils to the landscape architect's specification or topped it 400mm type hardstanding (to be specified dependent on the location). The system can be designed to perform a SuDS function and store a predetermined volume of water.

There are numerous suppliers of such systems that can provide design support. An example of this approach is shown in *Figure 27* below.

Figure 27 Temple Bar Square improvement scheme - crate system

Figure 28 Temple Bar Square improvement scheme - crate system Work In Progres

3.6.4 Permeable paving

Permeable paving surfaces can help to collect and filter water at source as water filters through the paved surface into the permeable subbase before infiltrating into the ground or discharging to the sewer.

Reinforced grass

Whilst permeable pavements do not often contribute positively in terms of amenity and biodiversity reinforced grass systems consist of concrete or plastic grids filled with soil such that the planting can accommodate some vehicle loading. These systems are often used in car parks or emergency/occasional access tracks. *Figure 29* below shows car parking bays surfaced in reinforced grass.

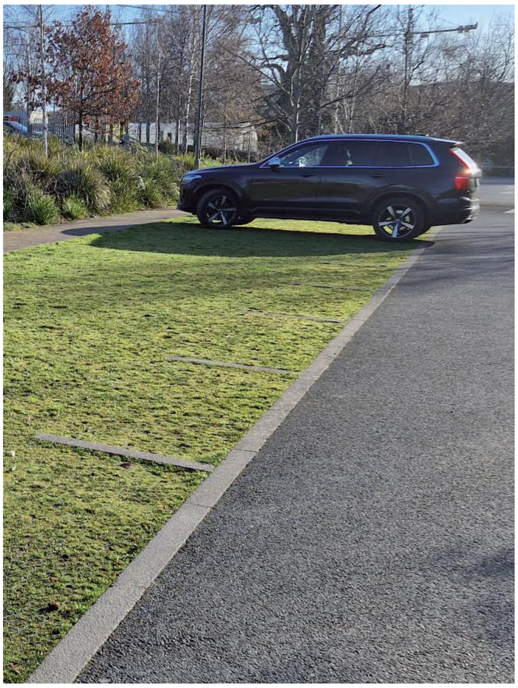


Figure 29 Car Parking using reinforced grass.

Figure 30 Permeable asphalt cycle path with raingarden

Permeable asphalt

Whilst permeable asphalt is generally not as smooth as traditional asphalt surfaces, it can be installed over a reduced fines sub-base to provide long continuous sections of SuDS attenuation.

Where budget permits then the cycle track could potentially be constructed along with rain gardens to create a continuous, composite feature with the reduced fines sub-base forming a continuation of the drainage layer beneath the raingarden. Any water that lands on the surface can pass through it and be stored within the sub-base before infiltrating into the ground or being discharged to the drainage network at a reduced rate. This approach is illustrated in *Figure 29* above.

4. Enabling SuDS to Thrive

4.1. Suitable Soils

Ideally a soil should be specified which has a minimum permeability of 100mm/hr. This provides an adequate drainage function. Engineered SuDS soils are available, or soils can be mixed on site. Generally, a mix of 50% sand, 30% topsoil and 20% compost can achieve sufficient permeability whilst providing sufficient nutrients for plant growth.

Standard topsoil can be used for rain gardens and will often provide a more nutrient rich medium for plant growth, however this will limit the amount of water that can be managed as the nature of the material generally would not allow water to soak through it very quickly.

The greater depth of soil that is provided the more beneficial it will be in terms of surface water management and providing a growing medium for planting. An absolute minimum of 300mm depth of soil should be provided for shrubs and 200mm minimum for wildflower or grasses.

A layer of inorganic mulch as an inorganic material, crushed rock, chippings, and decorative stone. Bark mulch should not be used as this leads to issues with the mulch floating in saturation events and carrying/holding debris and potentially clogging overflows or flowing back onto the public road.

4.2. Planting for successful SuDS

SuDS can be incorporated into urban, suburban, and rural design to collect and discharge surface water run-off and to enhance the environmental performance of the overall project. The optimum performance of SuDS infrastructure will be determined by the appropriate selection, specification, and maintenance of planting.

4.2.1 Suitable Planting Specification - General design criteria, planting design objectives

The planting and landscape design should increase the biodiversity and soften the existing built form.

Figure 31 Public Realm scheme benefitting from Innovative use of SuDS.

To create landscapes which provide an innovative use of SuDS and promotes an environmental approach to both design and use of the space.

- Create attractive, and where possible interactive schemes specific to each location.
- To provide year-round seasonal interest
- To meet the function of the enhancements as set out by the site-specific context.
- Plant selection will be compiled based on a right plant right place principle.
- Taking local area and national action plans on biodiversity and pollination into account.
- Plant characteristics height, growth and seasonality need also to be considered to ensure that safe line of sight for vehicles and pedestrian clear views will be maintained.

Figure 32 Examples of seasonality of a planting scheme in a SuDS scheme

It is important that the plant schedule for each project is considered in depth, and compiled on a site-specific bases, taking the context, existing soils, location, conditions, and function into account. Where possible ecological context, local biodiversity and enhancement plans should be referenced.

The plant characteristics should be suitable so as not to obstruct safe lines of sight for vehicles at gateways and junctions.
Form should follow function, shrub planting can be used to provide a colourful dynamic and naturalistic space in standard and SuDS planting beds, low to medium level ornamental grasses provide movement texture and seasonality suitable again for both SuDS and standard planting beds. Seasonal herbaceous plants will provide biodiversity, a rich source of pollen and nectar, colour seasonal interest and variety to planted spaces along with scent, texture and movement offer a wider sensory experience for pedestrians refer to *Figure 33.* Trees offer structure, scale, seasonal interest, and colour.

Figure 33 Miscanthus Grass with Hemerocallis

Ideally a planting schedule for each location will provide a year-round level of interest, utilising the seasonality of the selected planting mix.
It is then important that the seasonal nature of planting schemes is conveyed to and understood by the client and local community. Informative temporary signage explaining the planting mixes with graphics and seasonality can help to align perceived expectations with the natural cycle of planting schemes.

4.2.2 Plant typologies and uses.

The plant selection should consider the type of SuDS feature which has been implemented to enhance the activity and principal function of that feature. The structure, shape, and growth habits of the plants along with seasonality needs to be considered to ensure that the selected plants align with both the function and form of the planting bed.

As outlined above in Section 3 *Greening and SuDS Interventions* of this document and in the Ciria SuDS Manual 2015: Swales are principally designed or utilised to convey and treat surface run off. The planting should take account of this function. Grasses and herbaceous plants with soil binding root systems and dense habit should be utilised in the base of swales, as they will increase filtration, stabilise soils and retain and filter pollutants and suspended solids, thus helping to meet the functional requirement.

The plants on the base and on the sides of a swale will need to be capable of withstanding both drought and flood conditions, robust shrubs and finer ornamental grasses are suitable hear and will provide movement texture and seasonality. Native plants are best as they will be more suited to the local conditions and weather events.

Trees can also be included in a typical swale planting mix as long as the sunshade requirements for the selected ground cover planting are being met and the topsoil depths are adjusted to suit the selected tree. See 17.10 Landscape Design & Planting within CIRIA SuDS Manual 2015.

Figure 34 Grey to Green Phase 2 Sheffield

A rain garden bio retention system as outlined in Greening and SuDS Interventions of this document is primarily used to reduce run off rates and water volume taken in by positive surface drainage systems. Through their use of engineering soil or specified soils they can also be used to filter run off and pollutants. Along with the engineering soils within the vegetation selection will influence the performance of the system through the uptake of pollutants, protection from erosion to the surface

layer and maintaining permeability through the filtration layer. 'CIRIA SuDS Manual 2015' Trees can also be used in rain gardens systems if sufficient depth and volume of soil is used.
The criteria for plant selection for rain garden systems include:

- Surrounding landscape context.
- Whether native or introduced species are used.
- Tolerance for drought.
- Tolerance for short term/occasional inundation water events.
- Tolerance for expected pollution load.
- Spreading growth habit in light sanding free-draining soils.
- Plant structure, height/ shape to suit context.

For successful establishment of a planting scheme in a bioretention context the plants should be young and allowed to establish and mature in location. This can mean that in some instances, the site can look sparse when scheme is initially opened, but following the correct maintenance programme species should thrive in their allotted time.

A planting rate of 6 or 9/m² should be used to ensure a dense root structure zone to help maintain percolation in the soil.

Shrubs should be selected based on the function of the SuDS feature, the height and structure of certain shrubs can be used to deter from desire lines or pedestrian cutting through beds, a multi species mix of plant types should be used to prevent disease spread. On average 3-5 species of shrub and a mixed species of seasonal herbaceous.

Zoning of plants and species in larger schemes can also help to increase interest and allow for an increased species selection. Plants further away from inlet will be subject to different conditions than those close to inlets, likewise plants at the base or centre of the bio retention system or swale will be subject to different conditions than those on the slope or sides of the systems. Understanding this in plant layout and selection is imperative to a successful scheme.

4.2.3 Selecting suitable trees

Tree selection should be based on a site-specific basis, refer to

Table 7 below. The context and immediate vicinity will need to be considered, ensuring vehicle sight lines are not impacted and pedestrian and footpath visibility is maintained. Adequate space should be allowed to provide sufficient soil and air volume to the root, in cases where enhancement and regeneration are proposed. Where a new development is being proposed the root pit for the tree can be coordinated with the sub structural infrastructural works and both can be installed together. This is to ensure that the proposed tree, SuDS and green links are being considered and fully coordinated with any proposed utility service.

The options for tree pits, soil cell or structural soil systems will need to be assessed based on the above criteria. The required soil volume is directly related to the species growth and expected canopy size of the selected tree.

Table 7 below outlines the criterial to be considered and constraint to be reviewed on a site/location specific basis to help ensure correct species selection for the scheme and proposed tree planting locations.

Table 7 Tree Species Selection table

Tree Species Selection Criteria				
Site Constraints	**Aesthetic/Design Function**	**Tolerances**	**Hardiness**	**Ecosystem Services (and disservices)**
Space within built environment	Spatial Design - size, shape and form e.g., avenue, copse, specimen, screen etc.	Drainage / waterlogging	Resilience to climate change	Pollution
Local environmental conditions	Foliage	Drought	Exposure / wind / glare / heat	Biodiversity
Soil volume / type	Autumn colour	Salinity	Natural range	Shade
Soil PH	Flower	Pest / diseases	Built Environment	Rainwater interception
Soil compaction	Fruit	Local Availability - Consult with tree nurseries		C02 Sequestration

4.2.4 Tree Pit Sizes

The options for tree pits type, soil cell or structural soil system will also need to be assessed based on the above criteria. The required soil volume in the tree pit is directly related to the species mature growth and expected mature canopy size. Achieving the optimal soil volume in the tree pit is an integral part of ensuring long term mature tree growth.

The estimated soil volume needed for the trees, with soft landscaping should be based on the potential mature tree crown projections, i.e., the area inside the edge of the crown (or the dripline). This should be used as a guide only and used with particular caution if estimating soil volume requirements for the more upright, fastigiate tree cultivars.

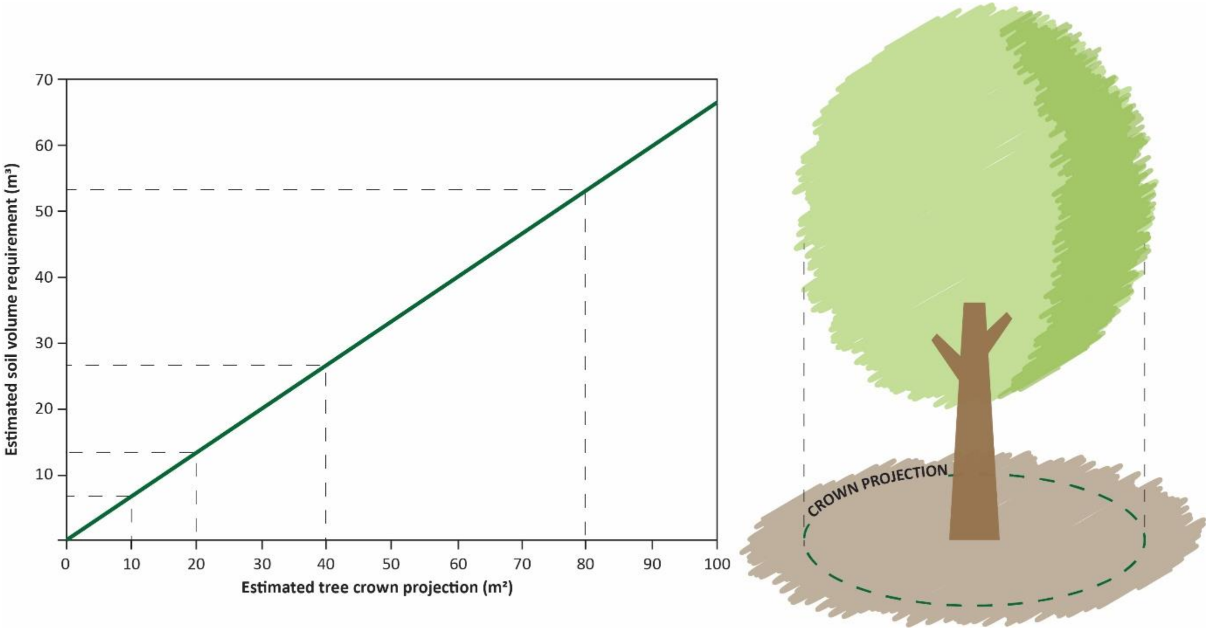


Figure 35 Tree pit size in verge and soft landscape Adapted from: Hirons, A. and Thomas, P.A. (2017) Applied Tree Biology.

https://doi.org/10.1002/9781118296387.

Using this information along with the information in *Table 8* will inform the size and type of tree pit.

For trees within hard landscape areas where loadbearing soils are required, *Table 8* provides a summary of the required soil volumes and air / water inlets in tree pits.

Table 8 Tree pit volume for load bearing soils within in paved/hard landscape areas

Mature size of trees (height)	Recommended minimum volume of **structural soil/modular soil cell system**	Recommended number of **air/water inlets with**
Very small (<5m)	**8 cu.m.** (6 cu.m. if shared)	**1** (0.5 if shared)
Small (5m-10m)	**15 cu.m.** (12 cu.m. if shared)	**1** (0.5 if shared)
Medium (10m-15m)	**26 cu.m.** (20 cu.m. if shared)	**1**
Large (15m-25m)	**36 cu.m.** (28 cu.m. if shared)	**1** (1.5 if shared)
Very Large (>25m)	**45 cu.m.** (35 cu.m. if shared)	**2**

A non-exhaustive, sample list of potential SuDS tolerant, urban street tree species is provided in *Table 9*.

Table 9 Example Species list and basic SuDS information

Example Species List			
Latin Name	**Common Name**	**Form**	**SuDS Tolerance**
Acer campestre 'Elsrijk'	Field Maple	Medium tree, Dense conical shaped crown	Good tolerance with drought and saturated conditions. Suitable for Paved and soft SuDS. Yellow leaves in autumn
Liquidambar styraciflua	Sweetgum	Large tree, Conical Shape, Standard or Feathered	Good to moderate tolerance with drought and saturated conditions. Tolerant of Light and shade conditions. Suitable for paved and soft SuDS.
Alnus x spaethii	Spaeth Alder	Large tree, Conical-Ovoid crown, standard or feathered,	Good tolerance with drought and saturated conditions. Tolerant of Light and low tolerance of shade conditions. Suitable for paved and soft SuDS.
Platanus x acerifolia	Fastigiate Plane	Large tree, Conical shape, large tree, Standard	Good tolerance with drought and saturated conditions. Tolerant of Light and low tolerance of shade conditions. Suitable for paved and soft SuDS.
Acer saccharinum	Silver Maple	Large tree, An open globe crown,	Good tolerance with drought and saturated conditions. Tolerant of Light, moderate tolerant of shade conditions. Suitable for paved and soft SuDS.
Malus (many cultivars)	Crab Apple	Small tree, Ovoid / open crown. Standard	Good Tolerance with drought and only short-lived saturated conditions. Tolerant of Light, moderately tolerant of shade conditions. Suitable for paved and soft SuDS.

Other elements of tree growth habits to be considered are:

- Canopy shape, Narrow /Columnar Fastigiate trees which may be better for narrow street scape or more confined amenity spaces.
- Standardise (Clear stem to a specified height, with branches and canopy starting at that height) or Feathered style trees, (wider at the base with a full branch structure from the ground up)
- Life expectancy
- Tolerance to summer drought
- Tolerance to saturated soils
- Root system type, fibrous or tap root. Will root barrier or direction be required?
- Is additional water attenuation required in the tree pit system?
- Leaf type, evergreen or deciduous. This will influence maintenance and seasonal cleaning of the area around the tree.
- Understory / ground level planting, Sun vs shade requirements
- Fruiting or flowering, again this will influence the level of maintenance required at certain times of the year.

4.2.5 Maintenance Requirements

Nature-based SuDS can be low maintenance features. The main activities that are required are trimming back of the planting, which is less onerous than the maintenance requirements for a traditional grass verge, along with weeding, litter picking and making sure the inlets are generally free from debris.

Utilisation of a traditional gully pot as the overflow means that desilting can occur as part of the regular maintenance of other gullies along the street. Desilting is the removal of the accumulation of silt and sediments to restore the capacity of the gully pot. A gully emptier is a specialised type of truck, which benefits from having a suction gear on board which has the capability to suck the debris, silt and sediments that can be causing blockages within the gully. This form of maintenance can prevent flooding from occurring. Once waste/debris has been removed most Contractors can jetwash the gully if required. This is usually conducted as part of the regular maintenance regime.

Table 10 below is an extract from 'Ciria SuDS Manual 2015' and sets out typical maintenance activities and anticipated frequencies.

Table 10 Representation of Table 18.3 of *'Ciria SuDS Manual 2015'*

Operation and maintenance requirements for bioretention systems		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular Inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain (if appropriate) to determine if maintenance is necessary.	Quarterly
	Check operation of underdrains by inspection of flows after rain.	Annually
	Assess plants for disease infection, poor growth, invasive species etc. and replace as necessary.	Quarterly
	Inspect inlets and outlets for blockage.	Quarterly
Regular maintenance	Remove litter and surface debris and weeds.	Quarterly (or more frequently for tidiness or aesthetic reasons)
	Replace any plants, to maintain planting density.	As required
	Remove sediment, litter, and debris build-up from around inlets or from forebays.	Quarterly or biannually
Occasional maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required	As required - (review biannually or after significant storm events)
	Repair minor accumulations of silt by raking away surface mulch, scarifying surface medium and replacing mulch	As required - (review biannually or after significant storm events)
Remedial actions	Remove and replace soils and vegetation above.	As required but likely to be > 20 years

4.3 Community Engagement

Introducing greening and SuDS features has many benefits for a Local Community, not least of which are climate resilience and a more attractive environment, and it is important to explain these benefits in advance of introducing rain gardens or other features into local streets.

With community support from the outset, it is more likely that the local community will feel a sense of ownership and in many locations, this has led to formal or informal community groups contributing to maintenance of the planting and undertaking more straightforward tasks like removing litter and weeds.

Discussion groups/workshops are a great way to involve the community and share proposals with them in this type of forum. This also provides them with an opportunity to share their feedback. This offers participants a sense of comfort and a feeling of being heard.

An excellent example of Community Engagement is on the Community Rain Gardens project in Waltham Forest, London by Meristem Design where, through early engagement local residents and schools contributed to the planting of the projects and members of the local community were assigned as gardening "stewards" to care for the rain gardens once constructed.

Figure 36 Community Rain Gardens project in Waltham Forest, UK - image © Meristem Design

5. Useful Resources

The following is a non-exhaustive list of useful resources that designers may wish to use when commencing work on a SuDS project.

Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas – Best Practice Interim Guidance Document. Department of Housing, Local Government and Heritage, 2022

Retrieved from: *https://www.gov.ie/en/publication/10d7c-nature-based-solutions-to-the-management-of-rainwater-and-surface-water-runoff-in-urban-areas-best-practice-interim-guidance-document/*

The SuDS Manual (C753F), CIRIA, 2015

Retrieved from *https://www.ciria.org/ItemDetail?iProductCode=C753F&Category=FREEPUBS*

The Susdrain Community website

Retrieved from: *https://www.susdrain.org/*

DMURS (Advice Note 5 – Road & Street Drainage using Nature Based Solutions)

Retrieved from:
https://www.dmurs.ie/_files/ugd/971679_d2678a1a617743d8b65436d6edef12be.pdf

Guidance on the construction of SuDS (C768), CIRIA, 2017

Retrieved from: *https://www.ciria.org/ItemDetail?iProductcode=C768&Category=BOOK*

Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas – Best Practice Interim Guidance Document,2022

Retrieved from: *Nature based solutions to the management of rainwater and surface water runoff in urban areas best practice interim guidance document*

Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas

Retrieved from: *Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas*

Sustainable Drainage Design & Evaluation Guide, 2021

Retrieved from: *DCC - Sustainable Drainage Design & Evaluation Guide 2021*

SDCC – Sustainable Drainage Explanatory Desing & Evaluation Guide 2022

Retrieved from: *Sustainable Drainage Explanatory Design & Evaluation Guide 2022*

FCC – Green/Blue Infrastructure for Development Guidance Note 2020

Retrieved from: Green/Blue Infrastructure for Development Guidance Note 2020

Example of a SuDS Maintenance Plan

Retrieved from: *Ciria RP992 the SuDS Manual update paper RP992/23*

Local Authority Waters Programme Publications

Retrieved from: *Publications - Local Authority Water Programme (lawaters.ie)*

Tree Council of Ireland

Retrieved from: *Tree Council*

Crann Trees for Ireland

Retrieved from: *Trees for Ireland*

Trees & Design Action Group

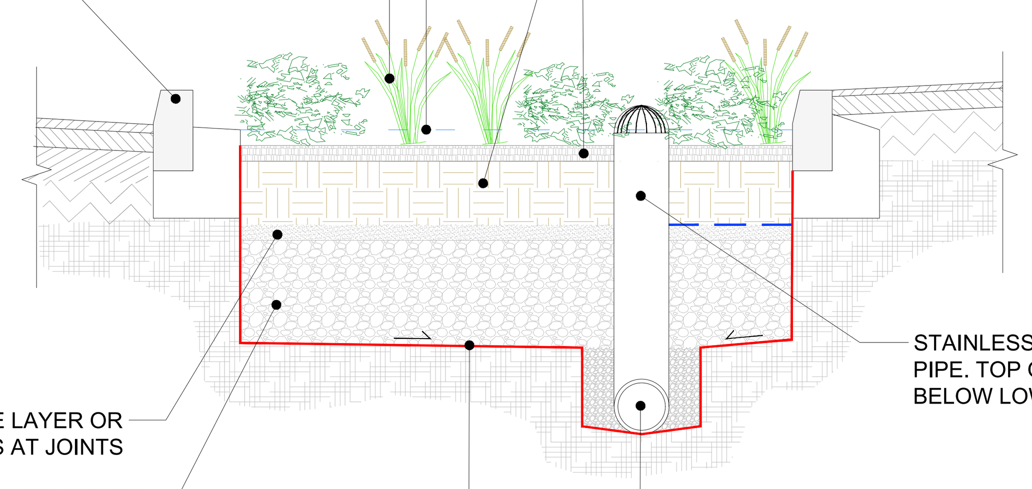
Retrieved from: *Tree and Design Action Group*

Sustrans Showcase – Case studies

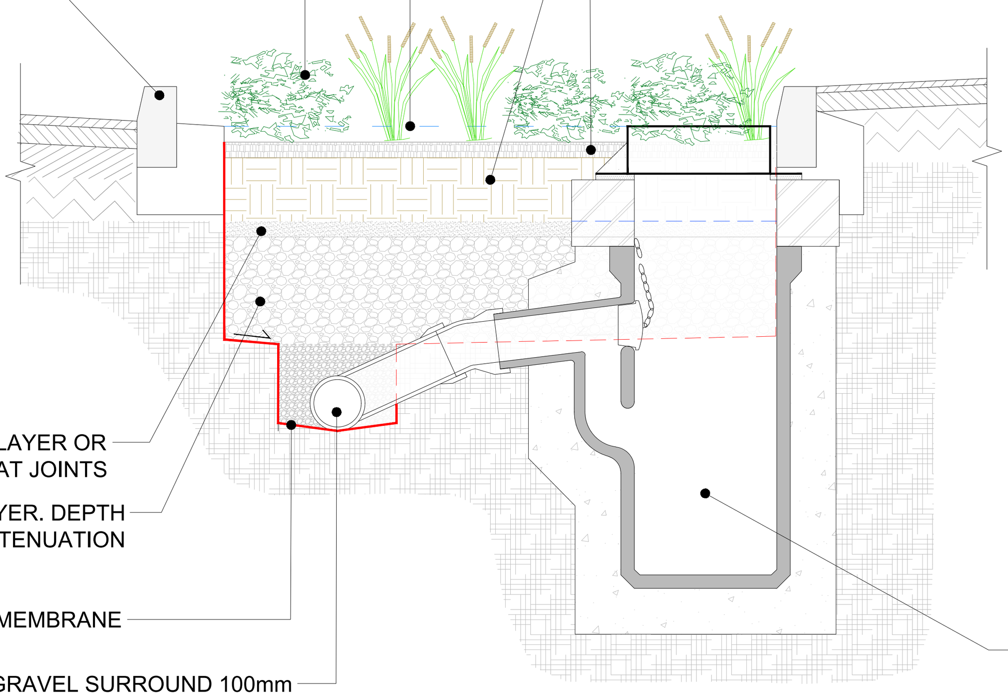
Retrieved from: *https://www.showcase-sustrans.org.uk/engage-inspire-learn/*

Appendices

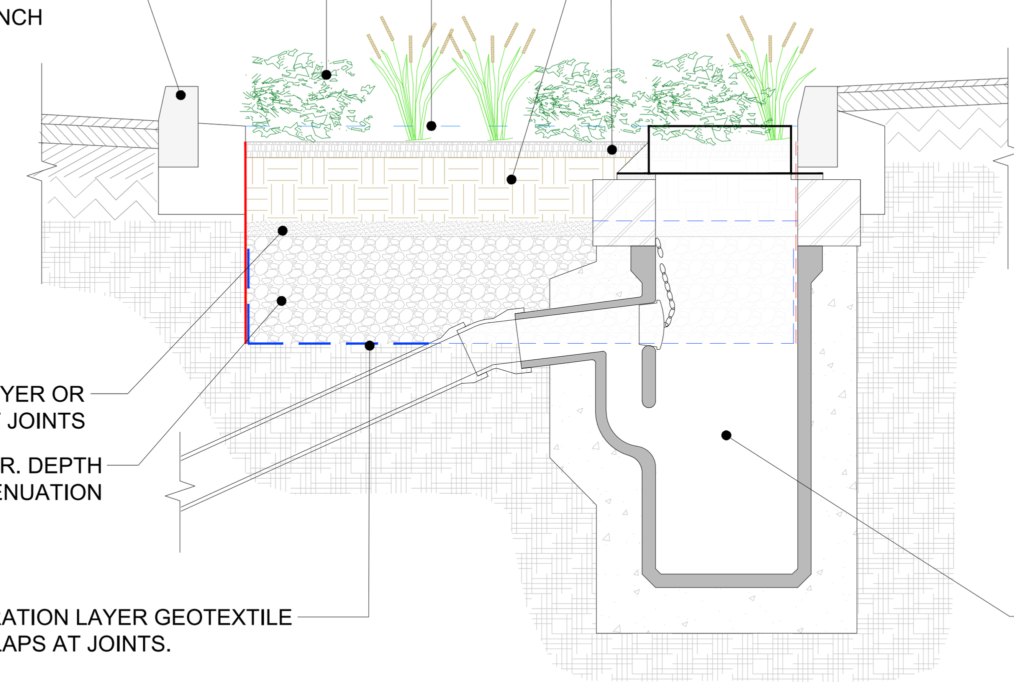
Appendix A Technical details for rain gardens



TYPICAL RAINGARDEN



TYPICAL RAINGARDEN NO INFILTRATION AND ROAD GULLY OVERFLOW



TYPICAL RAINGARDEN WITH INFILTRATION AND ROAD GULLY OVERFLOW

STANDARD NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECT'S AND ENGINEER'S DRAWINGS AND THE SPECIFICATIONS.
2. THIS DRAWING SHOULD NOT BE SCALED.
3. ALL DIMENSIONS ARE TO BE VERIFIED BY THE CONTRACTOR ON SITE.
4. ALL DISCREPANCIES SHOULD BE REPORTED TO C.A./E.A. PRIOR TO THE COMMENCEMENT OF WORKS.

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PROJECT

NTA SUSTAINABLE DRAINAGE SOLUTIONS

TITLE

RAINGARDEN DETAILS

DRAWING STATUS					STATUS CODE
INFORMATION					-
CE PROJECT No.	SCALE @ A1	DATE CREATED	DRAWN	CHECKED	
2858	1:20	09.06.23	CD	PM	
DRAWING No.					REV
2858-CIV-XX-XX-D-C-31001					P01

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Údarás Náisiúnta Iompair
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