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Urban Green Infrastructure Technical Guide

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Authors

Urban Green Infrastructure Technical Guide

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Consultees:

Introduction

This technical guide continues from the best practice guidance set out in 'Using Urban Green Infrastructure to Achieve Biodiversity Net Gain', with the purpose to provide technical detail and guidance on implementing the GI systems covered to ensure a long-term environmental asset. This guide is based on our own research and experience designing, installing and maintaining green infrastructure systems over the last 15 years, and is not representative of all available GI systems, but rather systems and methods we've tested and currently use and therefore recommend due to their proven durability, effectiveness and ability to provide for biodiversity.

This guide details the technical specifics and practical installation of systems that can be used in urban locations to help new development projects and refurbishments achieve biodiversity net gain (BNG), and more generally provide for local ecology. Instead of a prescriptive document, the following is rather to aid building and landscape architects and consultants in applying the correct solutions in the most effective way, including advice on planting design, build-up options and maintenance guidance of the following habitats, in order to ensure product longevity. This document also provides indicative species lists for each urban green infrastructure habitat which are likely to contribute to the solution achieving a 'Good' habitat condition score.

Whilst the information in this document provides guidance on GI systems which can be used by practitioners whilst designing urban green infrastructure, more generally, references are made throughout the document in regard to BNG and specifically how design of these habitats influences BNG assessments.

The current version of Metric 2.0 includes several urban GI habitats types, taken from the UK Habitat Classification[1], and eight of these are explored in this guide, namely:

1. **Living roofs:**
   a. Extensive green roof;
   b. Intensive green roof; and,
   c. Brown roof.
2. **Living walls:**
   a. Ground based green wall; and,
   b. Façade bound green wall.
3. **Vegetated Drainage Features:**
   a. Sustainable urban drainage feature (SuDS);
   b. Bioswale; and,
   c. Rain garden.

[1]The UK Classification Working Group (2020). The UK Habitat Classification Habitat Definitions Version 1.1. September 2020.

Using Urban Green Infrastructure to Achieve Biodiversity Net Gain

For descriptions and detailed information on these habitats and advice on incorporating GI within developments, refer to the guidance set out in 'Using Urban Green Infrastructure to Achieve Biodiversity Net Gain'[3]. This recommends best practice use of Natural England's Metric 2.0 when assessing how urban GI contributes to achieving BNG, and gives definitions to the terms used within the metric.

A key component of BNG assessments is habitat condition. To achieve the target condition set out within a BNG assessment, there is one key element that is essential for the success of these habitats: soil. Opening up an array of biodiverse benefits that only natural substrate can achieve, soil is more than just a growing medium. Soil is in itself an eco-system, which not only provides for native plants but also for biodiversity and ecosystem services more widely. As Chartered Environmentalist and Fellow of CIEEM, Gary Grant, states when speaking about soil in urban greening systems, "there are many things we don't know about soil but one thing we do know is that without soil, there wouldn't be any civilisation. It's that important."

The use of soil not only allows for burrowing insects and solitary bees but provides a variety of regulating ecosystem services. For example, it provides a water storage buffer useful in hardstanding urban areas, sequesters carbon and fixes nitrogen. Fungal diversity is an important component of soil; soil fungi are typically supported by soil microbes and help to create healthy soils which contribute to biodiversity[2]. Soil fungi is present in systems based on a natural organic substrate.

Soil is key

To boost biodiversity on a local or larger scale, soil is a key component[4] in the creation of a successful long-term green infrastructure solution, and will help ensure that the targeted habitat condition can be achieved, particularly for living roofs and walls.

[2] Fungal Biodiversity and Their Role in Soil Health. Available at: www.frontiersin.org

[3] ANS, AECOM, BREEAM (2021). Using Urban Green Infastructure to Achieve Biodiversity Net Gain

[4] Soil Biodiversity. Available at: www.environment.nsw.gov.au

Longevity

In order to ensure living walls, green roofs, rain gardens and other SuDS schemes are designed as long-term sustainable solutions, there are four key points to be considered that are applicable across all solutions:

1. **Natural organic substrate that is suited to the plant's pH requirement**

2. **Plant species selection**

3. **Water management**

100% of stormwater can be captured and used in the maintenance regime of a living wall or a green roof, creating a closed loop environmental solution. Rainwater harvesting is also a more cost-effective maintenance strategy for a façade-bound living wall.

4. **Maintenance and forward planning**

Maintenance

It is essential that solutions are designed and built to last in order for the benefits assumed in BNG approaches to be realised in practice.

Maintaining and securing habitat for a minimum period of 30 years will become a mandatory requirement of biodiversity net gain under the Environment Bill, once enshrined in law. Ensuring solutions are designed for the long-term and devising a green infrastructure management plan which outlines maintenance and monitoring across this period will help support planning applications.

Maintenance and forward planning are key for product longevity for any urban greening system, ensuring it remains an environmental asset. Details of maintenance should be included within the specifications, O&M manuals, and on-going management plans for the building. The maintenance costs should be calculated at the design stage to become part of the management costs of the building and reflected in the service charge within the cost consultants' reports.

It should be noted that ongoing maintenance and warranties should be subject to a renewable annual contract, ensuring healthy planting and operational irrigation.

Section 1

Living Roofs

There are several systems to choose from when creating a living roof, including component and modular systems. When examining the difference between the systems, there are clear contrasts. These are discussed below.

Section contents

8 Component Systems

9 Modular Systems

10 Brown Roof

12 Extensive Green Roof

15 Plant Species

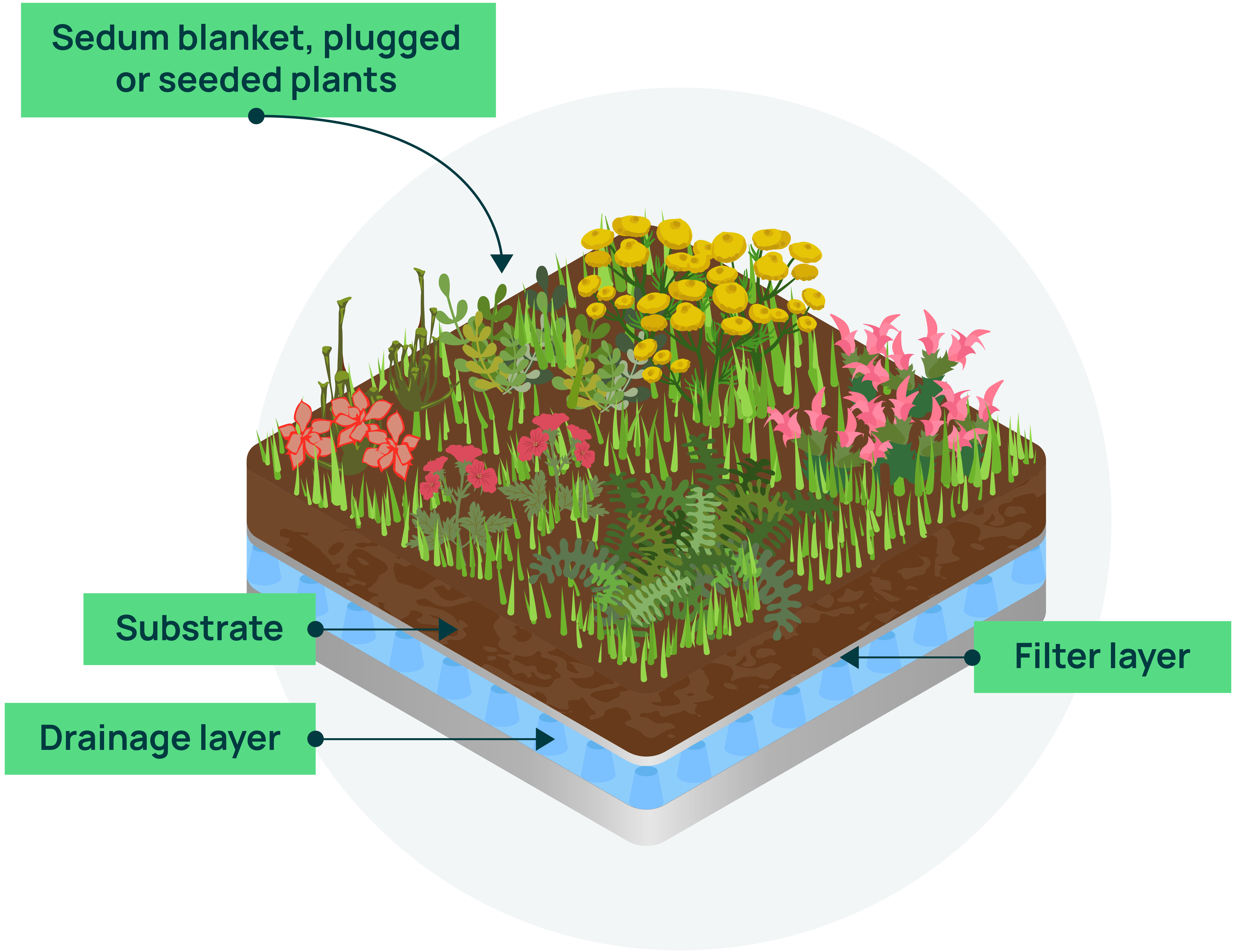
15 Intensive Green Roof

18 Living Roof Comparison

Component Systems

Component green roofs consist of a drainage layer (usually between 20-30mm), filter layer (a geo-textile fabric), substrate (60-90mm deep) and sedum blankets (with 8-12 sedum varieties) or plugs, all installed separately. With component brown roofs, the substrate contains an organic matter and can vary between 80mm-150mm deep and either oversewn with wildflower seeds or left to naturally colonise.

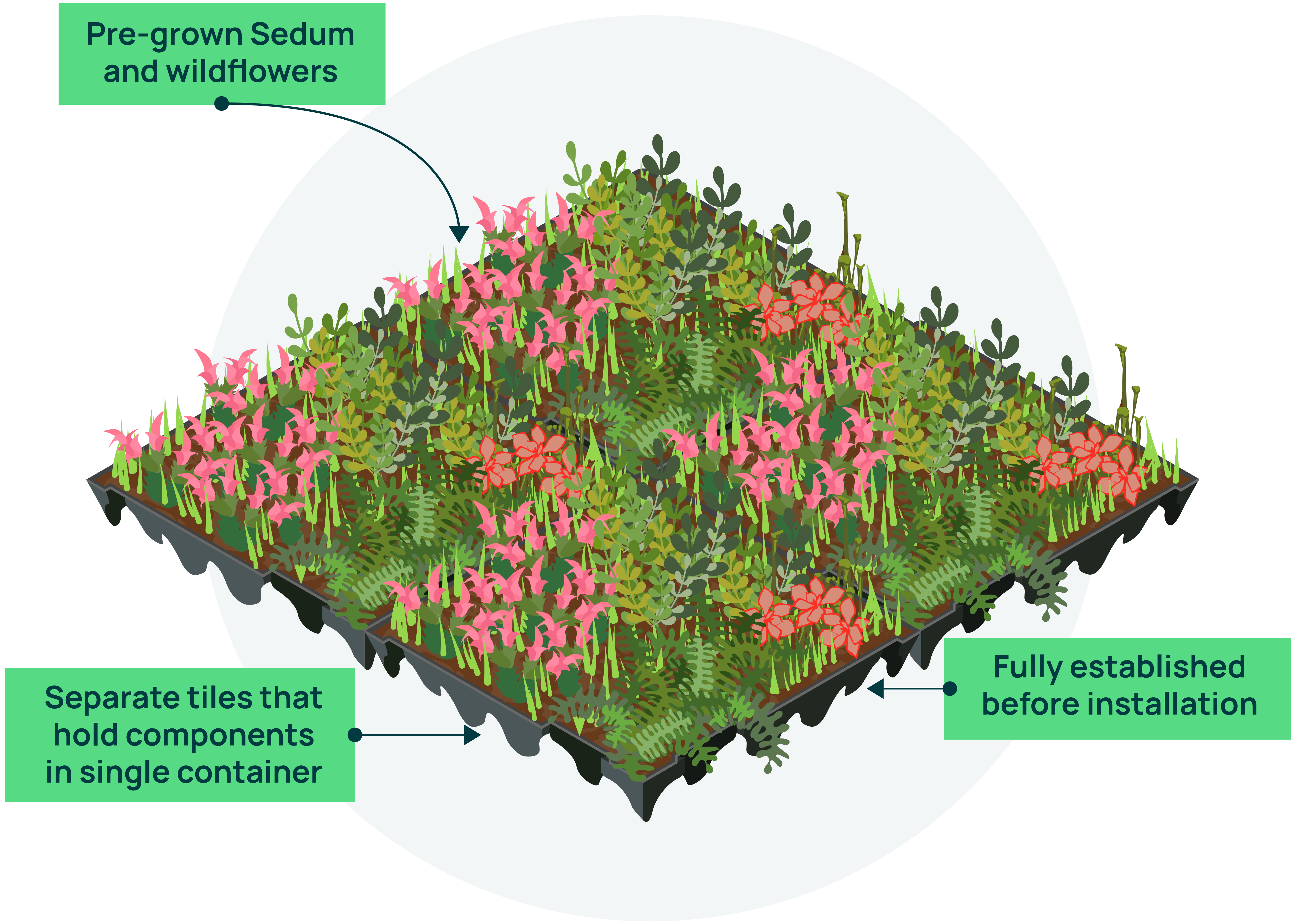
Once installed the green roofs need irrigation and regular maintenance to aid establishment for 6-9 months after installation, requiring access and a permanent water supply to the roof. After the 6-9-month period of establishment, the roof will then require annual maintenance and become an environmental asset. However, we do highlight the importance of ensuring there is a water supply to establish the roof in its early months.



Modular Systems

Modular systems comprise of separate tiles that hold all the components of a traditional green roof system in one container. These are usually fully established and acclimatised before ready for installation, which mitigates the risk of failure. This is because extensive sedum or brown modular roofs are pre-grown for 12-16 months prior to installation, and therefore do not require intensive aftercare or irrigation in order to establish once installed. Sedum modules contain a mixture of sedum varieties (approximately 8-12 varieties) grown randomly and can also be combined with wildflower species. Brown roofs can be pre-grown with native grasses and wildflowers or can be left to naturally colonise.

In the following sections, we demonstrate the technical specifications of a modular system. Ensuring the success of establishment and longevity of each system will mean that the habitat condition selected within a development project's BNG assessment can be achieved with ease.



Brown Roof

Part 1 of 2

Table 1:

Technical specification details for a typical modular brown roof.

Module

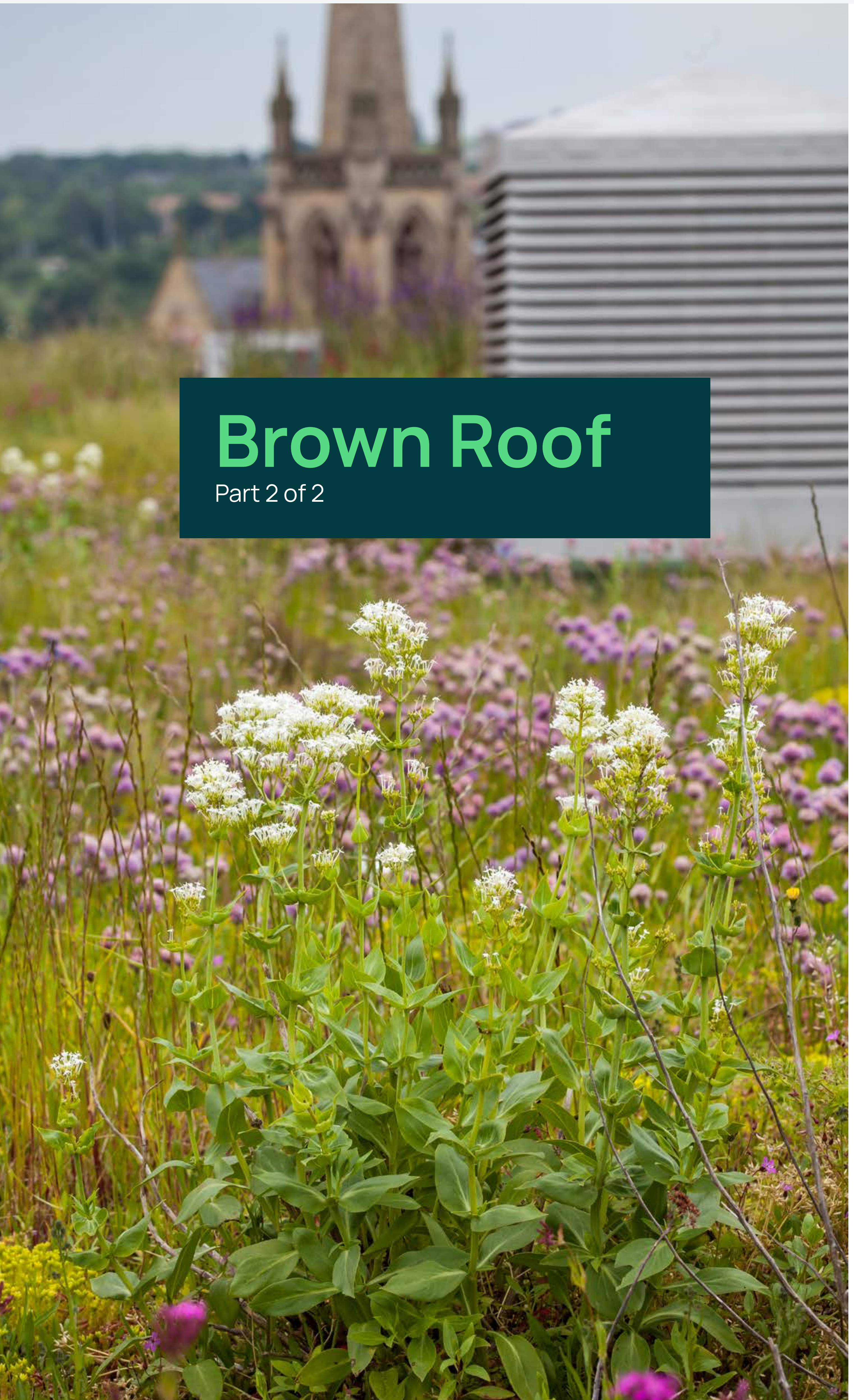
Length	540mm
Width	540mm
Depth	90mm
Material	Polypropylene (PP)
Recycled	True

Substrate

Depth	60mm
Material	Natural soil mix

Overall

Length	540mm
Width	540mm
Depth	60mm
Weight	75kg per m^2 (fully saturated weight)
Compressive strength	2.000kg per m^2
UV Resistant	True
Temperature	-50◦C - 80◦C
Drainage surface	318cm^2 per m^2
Outflow volume	40 litres per m^2
Water holding capacity	20 litres per m^2
Irrigation	No
Maintenance	Low



Brown Roof

Part 2 of 2

Design: Installation

A brown roof is installed at the stage of completion of the structure and waterproofing of the roof. It does not replace the roof structure or act as technical waterproofing layer (although it does significantly mitigate water run-off). With most vegetated roof systems, the roof needs to be completed and waterproofed before installation.

The build-up details are applicable for a modular system, due to its ease of installation and the fact it does not require an irrigation system.

Order of build-up:

1. Waterproofed roof membrane

2. Protection fleece

3. Modules clipped together via a double-action coupling system. The tabs on the side of each part engage the edge in the gaps between tabs of the facing part.

4. Edge guard (if no upstand) and stone borders installed (aesthetic or sometimes required by local authorities)

Design: Plant Selection

Founded on an intensive substrate, a brown roof can be left to be naturally germinated with local seeds carried by the wind or can be pre-sown with wildflower seeds to encourage biodiversity. As with a brownfield site, building rubble and materials can be recycled. For example features like log piles or small sand dunes can provide an alternative habitat for a variety of insects and even birds. Where such materials may be produced from site excavation, these materials can be used as the brown roof's substrate, instead of bringing in new materials. However, variation in substrates and aggregates is key for allowing a diverse plant community to establish.

Maintenance

A brown roof typically requires one annual visit to remove pernicious weeds and strim colonised wildflowers.

Extensive Green Roof

Part 1 of 3

Table 2:

Technical specification details for a typical modular extensive green roof.

Module

Length	540mm
Width	540mm
Depth	90mm
Material	Polypropylene (PP)
Recycled	True

Substrate

Depth	60mm
Material	Natural soil mix

Vegetation

Height	30 - 40mm
Material	Bespoke. Usually a variety of sedum, wildflowers and meadow grasses.

Overall

Length	540mm
Width	540mm
Depth	120 – 130mm
Weight	65 – 75kg per m^2 (fully saturated weight)
Compressive strength	2.000kg per m^2
UV Resistant	True
Temperature	-50°C - 80°C
Drainage surface	318cm^2 per m^2
Outflow volume	40 litres per m^2
Water holding capacity	20 litres per m^2
Irrigation	No
Maintenance	Low

Extensive Green Roof

Part 2 of 3

Design: Installation

An extensive green roof is installed at the stage of completion of structure and waterproofing of the roof. It does not replace the roof structure or act as technical waterproofing layer (although it does significantly mitigate water run-off). With most green roof systems, the roof needs to be completed and waterproofed before installation of the green roof commences.

Compared to sedum blankets or mat solutions, a modular system is one of the simplest solutions for covering areas in green roof without installation expertise required. The substrate and vegetation are already placed and established in the module, and no irrigation system is required.

Order of build-up:

1. Waterproofed roof membrane

2. Protection fleece

3. Modules clipped together via a double-action coupling system. The tabs on the side of each part engage the edge in the gaps between tabs of the facing part.

4. Edge guard (if no upstand) and stone borders installed (aesthetic or sometimes required by local authorities)

Extensive Green Roof

Part 3 of 3

Design: Plant Selection

Extensive green roofs are covered with low growing plants. Whilst extensive green roofs which resemble meadows or grasslands typically provide the greatest value to biodiversity, many extensive green roofs - typically include sedum (*Sedum* spp.), small, evergreen, stress and drought tolerant succulents. This evergreen plant family is naturally hardy and requires limited maintenance; however, planted alone sedum has limited value to biodiversity. Besides the visual impact, an extensive green roof also provides a natural habitat for birds and insects. If sedum is to be planted within the roof's planting specification, consider planting a large variety of wildflowers and meadow grasses amongst the sedum. No more than 20-30% of the planting palette should consist of sedum to ensure the roof provides greater value to invertebrates and birds, avoiding non-native invasive species.

Many modular systems are pre-grown, which not only means the plants are established and acclimatised but allows for maximum biodiverse value from the first day; currently, there is no direct way of reflecting instant results in Metric 2.0. Despite this, such systems are more likely to ensure the predicted habitat condition is achieved within under the stated time to target condition.

Maintenance

Extensive green roofs require one annual visit in the Autumn to remove any pernicious weeds and if a sedum roof, a top dress with an organic fertiliser. Fertilisers typically contain minimal nitrates, so foliage growth is not encouraged, and with phosphates and potassium to strengthen the root systems. (Please note: this is a general horticultural recommendation. Organic fertiliser should be avoided if creating living roofs which contain grassland or meadow plant communities, as this can encourage growth of undesirable species). Where breeding birds are expected, maintenance should be carried out once nesting season has ended. Sedum becomes red in colour when 'stressed' which is due to cold or dry weather or when it is low on organic nutrients. This does not mean the sedum have died. You can either wait for rain or irrigate the roof once a week for approximately 1 hour.

Key maintenance checks:

- Weed and remove unwanted seedlings
- Clear gutters or drainage outlets
- Feed the roof with organic phosphate and potassium
- Ensure stone perimeters are clear of dead and live plants
- Clear any leaves that have fallen from deciduous trees

Table 3:

Example of plant species suitable for planting or seeding in brown and extensive green roofs

Wildflowers

Common Name	Latin Plant Name
Yarrow	*Achillea millefolium*
Kidney vetch	*Anthyllis vulneraria*
Common knapweed	*Centaurea nigra*
Greater knapweed	*Centaurea scabiosa*
Wild carrot	*Daucus carota*
Dropwort	*Filipendula vulgaris*
Lady's bedstraw	*Galium verum*
Field scabious	*Knautia arvensis*
Rough hawkbit	*Leontodon hispidus*
Oxeye daisy	*Leucanthemum vulgare*
Birdsfoot trefoil	*Lotus corniculatus*
Wild marjoram	*Origanum vulgare*
Burnet saxifrage	*Pimpinella saxifrage*
Hoary plantain	*Plantago media*
Salad burnet	*Sanguisorba minor*
Cowslip	*Primula veris*
Selfheal	*Prunella vulgaris*
Meadow buttercup	*Ranunculus acris*
Wild mignonette	*Reseda lutea*
Small scabious	*Scabiosa columbaria*
Yellow rattle	*Rhinanthus minor*

Grasses

Common Name	Latin Plant Name
Quaking grass	*Briza media*
Crested dog'stail	*Cynosurus cristatus*
Sheep's fescue	*Festuca ovina*
Slender creeping red fescue	*Festuca rubra*
Crested hair-grass	*Koeleria macrantha*
Smaller cat's – tail	*Phleum bertolonii*
Yellow oat-grass	*Trisetum flavescens*

Intensive Green Roof

Part 1 of 2

Table 4:

Technical specification details for a typical modular intensive green roof.

Substrate	
Depth	150 - 800mm
Material	Natural soil mix
Vegetation	
Height	Varied.
Material	Bespoke.
Module	
Weight	180 - 500kg per m²
Height	150 – 1000mm
Irrigation	Yes
Maintenance	Yes

Intensive Green Roof

Part 2 of 2

Design: Installation

The planting medium in intensive green roofs starts at 150mm and if trees are included, this can increase to 800mm. Where this is the vision the substrate will be architecturally contoured. Once the soil and the plants are installed, the irrigation is fitted, meaning an increased saturated weight, which will require a structural consultant. The irrigation and drainage systems have to operate effectively to reduce the possibility of overloading the roof's structure.

Design: Plant Selection

Intensive green roofs are widely used on buildings to create large roof top areas that can incorporate all sizes and types of plants, including grasses, ground covers, flowers, shrubs and trees, and will often have paths or walkways. This wide variety of species, including large plants and plant groupings, is supported by deeper planting mediums.
In turn, this allows for the opportunity of vegetable and herb gardens.

Maintenance

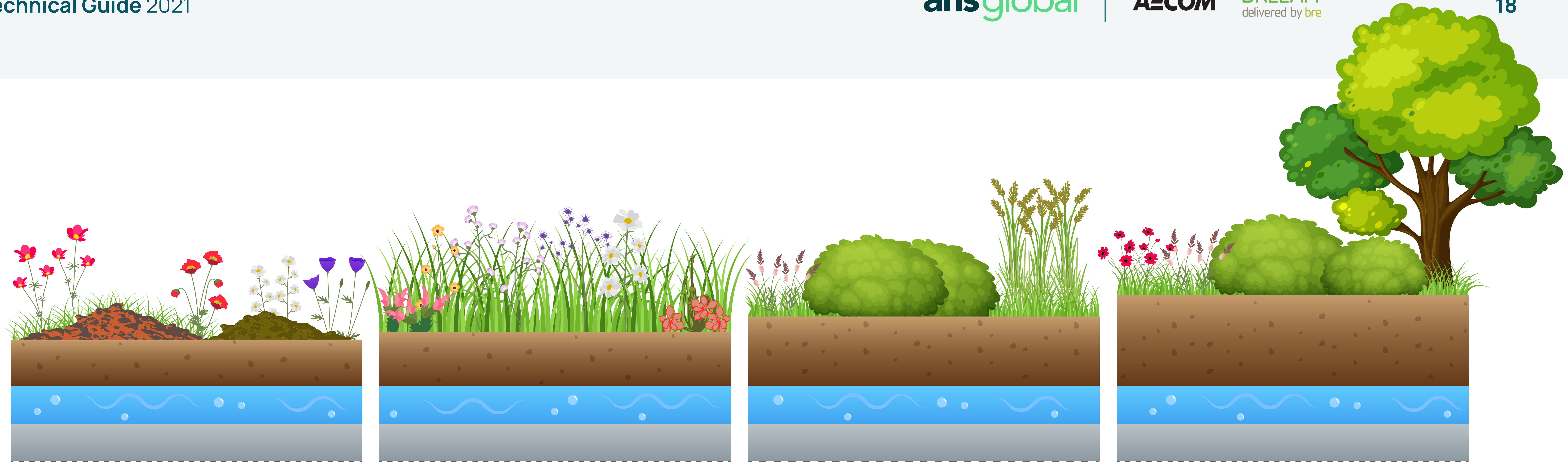
Due to the plant varieties supported, intensive green roofs require a maintenance schedule which involves essential pruning, regular maintenance checks, application of organic fertiliser and an irrigation system.

Semi-intensive Green Roof

Semi-intensive green roofs are typically used to improve the aesthetics of a rooftop and can be used recreationally, although as with intensive green roofs, this reduces their value to biodiversity.

These green roofs can be viewed as a 'compromise solution', whereby you can have similar aesthetic appeal to an intensive green roof but without the weight loading and with greater biodiverse value. As the substrate depth is greater than with extensive green roofs, there is more scope for different plant species. This means that if plants are selected with biodiversity in mind, a semi-intensive green roof could hold more biodiverse value than an extensive green roof, however it does depend on plant selection.

Maintenance for these is very similar to intensive, especially if you have a diverse mix of plants growing, which will require regular maintenance visits (typically monthly). Installation would involve build-up on-site, like a component system.



	Brown roof	Extensive green roof	Semi-intensive green roof	Intensive green roof
Maintenance	Low	Low	Periodically	High
Irrigation	No	No	Periodically	Regularly
Plant communities	Wildflowers	Moss, sedum, herbs & grasses	Grass, herbs, shrubs, sedum & wildflowers	Lawn or perennials, shrubs & trees
System build-up height	60 - 100 mm	60 - 100 mm	100 - 150 mm	150-400 mm on underground garages > 1000 mm
Weight	75 - 150 kg/m^2	60 - 150 kg/m^2	120 - 200 kg/m^2	180 - 500 kg/m^2
Costs	Low	Low	Middle	High
Use	Ecological protection layer	Ecological protection layer	Designed green roof	Park like garden

Section 2

Living Walls

Section contents

20 Ground-based green wall

24 Façade-based green wall

Ground-based green wall

Part 1 of 4

Technical System Details

Ground-based green wall systems offer many options from wire poles to mesh panels which provide a frame for climbing plants to grow up; many contemporary examples are designed to fit bespoke artistic and architectural concepts. The weight loading for wires and mesh panels is significantly lower than a modular façade-based system. However, this does vary depending on the growth height, foliage, fruit and wood weight (subject to species). Natural elements such as dew, rain, ice, snow and wind speeds also need to be taken into account when selecting a system.

Correct selection of the grid structure, distance of the grid from the walls and spacing of the mesh are all factors that should be designed by an industry specialist to ensure long-term sustainability. Longevity is also affected by the substrate, which needs to be selected to suit the location and the net gain targets.

If the planting is directly into the ground, ensuring the topsoil or organic content is as per BS 3882:2015 and the selected plant species grow in that particular location and soil structure is essential. In contrast, if the planting is based in planters then the eventual height of the climbing plants needs to be considered.

As there is a proposed industry standard planter of 400mm deep, realistically the plants will not achieve much more than a 6-8m height on the elevation. Therefore, if an elevation greater than 8m is present within the design, structural loadings and installation troughs must be considered.

Design: Installation

Wires and mesh panels are fixed back to the facades using mechanical fixings. The plants then grow up and across the elevations, directed by the wires and the mesh. When specifying, consideration of the natural elements will influence the type of fixing that is used and we advise employing a structural consultant to ensure the correct fixings are used for the location.

Design: Planting

Most climbing plants will work on a wire or mesh system, for example the species listed in Table 5 (shown on next page), however plant selection is dependent on the substrate's content, quality, and depth. Table 5 provides examples of species which can contribute to a ground-based green wall achieving 'good condition' in BNG terms. Whilst native species are preferable, there are many non-native plant species which can provide refuge, nectar and pollen for a range of wildlife; using a combination of natives and non-natives of value to biodiversity within urban areas is therefore appropriate, providing the non-native species has no invasive properties.

Ground-based green wall Part 2 of 4

Table 5:

Example species of known value to biodiversity which can be planted within a ground-based green wall.

Common Name	Latin Name	Flower/Foliage Colour	Growth Cycle	Season of Interest	Native/Introduced	Value to Biodiversity
Honeysuckle	*Lonicera periclymenum*	Cream, yellow to red or pink flush flower / deep green leaves /red berries	Hardy perennial	June - September	Native	Very valuable to wildlife, supporting several rare species including the white admiral butterfly (*Limenitis camilla*)[5]. Bumblebees and pollinating moths are attracted by the sweet scent and several species of birds eat the berries in the late summer – autumn. In addition, some ornamental varieties of Lonicera also provide value to urban pollinators[6].
Birthwort	*Aristolochia clematitis*	Yellow, green / dark green	Evergreen foliage/ Perennial	June - September	Introduced	Research has shown that the flower structure of this species is adapted to cross-pollination. The species is of known value to pollinating flies of the Anthomyiidae family[7].
Common Jasmine	*Jasminum officinale*	White / green	Deciduous/evergreen	May - August	Introduced	Fragrant flowers provide nectar and pollen for insects and birds, before producing black fruits in the autumn[8].
Ivy	*Hedera helix*	Long lasting evergreen coverage	Evergreen	All Seasons	Native	It provides shelter for nesting birds and hibernating insects, nectar for pollinators, berries for birds and leaves for caterpillars (including the holly blue butterfly, *Celastrina argiolus*)[9].

[5]Henwood, B. P., Walters, J. M. (2019). The extraordinary larva of the White Admiral butterfly, Limenitis camilla (Linnaeus, 1764). Entomologist's gazette. 70:2. Available at: www.ingentaconnect.com

[6]Jachula, J., Denisow, B., Strzalkowska-Abramek, M. (2019). Floral reward and insect visitors in six ornamental Lonicera species – Plants suitable for urban bee-friendly gardens. Urban Forestry & Urban Greening. 44: 126390. Available at: www.sciencedirect.com

[7]Nakonechnaya, O.V., Sidorenko, V.S., Koren, O.G., Nesterova, S.V., Zhuravlev, Y.N. (2008). Specific features of pollination in Manchurian birthwort, Aristolochia clematitis. Biol Bull Russ Acad: Sci 35, 459. Available at: www.doi.org

[8]RHS Plants for Pollinators: garden plants. Available at: www.rhs.org.uk

[9]Jacobs, J.H., Clark, Z. J., Denholm, I., Goulson, D., Stoate, C., Osborne, J.L. (2010). Pollinator effectiveness and fruit set in common ivy, Hedera helix (Araliaceae). Arthropod-Plant Interactions. 4: 19-28. Available at: www.link.springer.com

Ground-based green wall Part 3 of 4

Common Name	Latin Name	Flower/Foliage Colour	Growth Cycle	Season of Interest	Native/Introduced	Value to Biodiversity
Hop	*Humulus lupulus*	Green-yellow / green / light green to brown fruit	Perennial	July – September	Native	Hop is pollinated by wind but can be attractive to insects. The flower provides nectar for insects as well as a valuable refuge[10].
Wisteria	*Wisteria sinensis*	Woody climber with clusters of lightly fragrant	Deciduous	May - June	Introduced	Provides shelter for nesting birds and insects. Recommended by the Goulson Lab at Surrey University[11].
Tube flowered clematis	*Clematis heracleifolia*	Blue-purple / green	Deciduous	June - August	Introduced	The flower provides nectar for insects as well as a valuable refuge[12].
Traveller's-joy	*Clematis vitalba*	White / green / white-grey feather-like fruit	Perennial	July – September	Native	Visited by pollinating insects such as bees and hoverflies, whilst being a food plant for moth species[13]. The seedheads also provide a food source for birds such as goldfinches.
Passion flower	*Passiflora caerulea*	Dark evergreen leaves with exotic looking flowers	Evergreen	July - October	Introduced	Provides general shelter for insects and birds, and nectar for some pollinators. Pollinated by bees (e.g. carpenter bees, *Xylocopa* spp.)[14], which have recently colonised Britain from mainland Europe.

[10] www.woodlandtrust.org.uk
[11] www.sussex.ac.uk
[12] RHS Plants for Pollinators: garden plants. Available at: www.rhs.org.uk
[13] RHS Plants for Pollinators: garden plants. Available at: www.rhs.org.uk

[14] Aguino D. S., Garcia, M.T.A. (2019). Pollen dispersal in a population of Passiflora caerulea: spatial components and ecological implications. Plant Ecology. 220: 845-860. Available at: www.link.springer.com

Ground-based green wall

Part 4 of 4

Maintenace

As with any green infrastructure system, the planting on a ground-based green wall will require maintenance, involving regular pruning and fertilisation, and an irrigation system. This is usually once every three months for a general health check and once a year for a full trim and prune of the façade. Maintenance should be carried out by trained horticultural technicians, and often the installer will have trained maintenance teams and contract options. It is worth considering on-going maintenance during design stage to ensure there is an access plan, a feasible long-term plant palette and also the opportunity to involve other interested parties which contributes to a greener community, such as in the 'Green Capital' initiative in London[15], and other local BID initiatives.

[15]www.london.gov.uk

Façade-based green wall

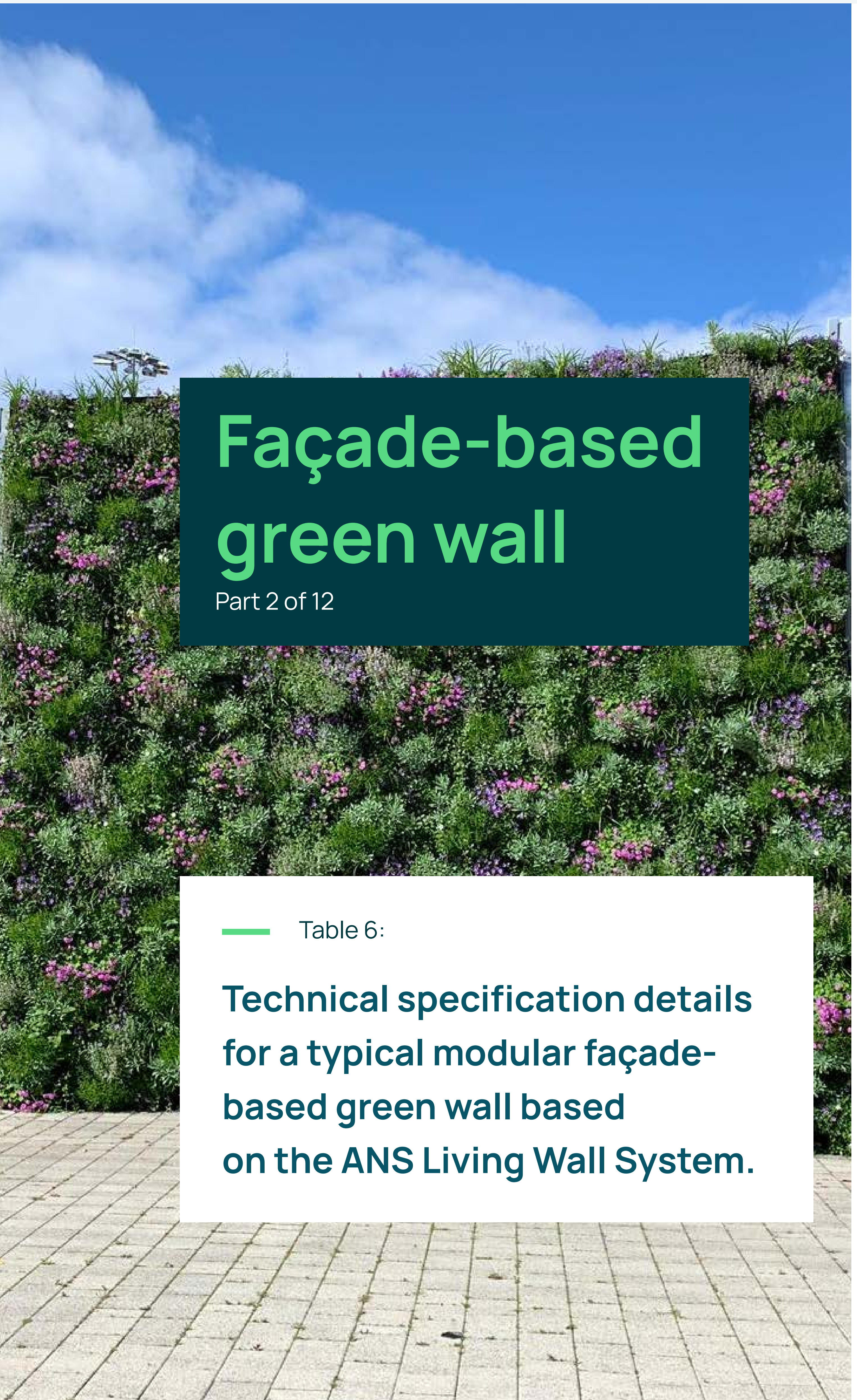
Part 1 of 12

Technical System Details

The following technical details provide a good practice example of how a façade-based (living) green wall can be integrated into a variety of structures. These are not the only ways to produce a finished green wall at a good quality but apply details and methods that have been researched and evidenced by successful projects ANS have worked on.

From a broader perspective, these are the key principles of a good façade-based green (living) wall system:

- **Root migration system**
- **Integrated drainage**
- **Angled to prevent soil erosion**
- **Integration of an automated irrigation system**
- **Ability to connect to a rainwater harvesting system (further sustainability)**
- **Even calibration of water over the façade**
- **Proven durability of the module or plant holder**



Façade-based green wall

Part 2 of 12

Table 6:

Technical specification details for a typical modular façade-based green wall based on the ANS Living Wall System.

Table 6 shows technical specification details for a modular façade-based green (living) wall system. It is split according to the build-up materials of the system, before showing the overall details such as weight, acoustic values and plant density. The diagrams help to illustrate how these components work together to create the final living wall. This is a typical example of a modular façade-based green (living) wall system that ensures a long-term asset.

Module

Length	500mm
Width	250mm
Depth	100mm
Material	Polypropylene (PP)
Standards	BS 476 Part 7: 1997
Recycled	Class 1 80% post-industrial recycled material
UV Resistant	True
Temperature	-40°C to 80°C
Fire Rated	True

Fixing Rails

Width	48mm
Depth	12mm
Fixing	500mm centres with countersunk screws (size of which is site specific)
Material	Low-density polyethylene (LDPE)
Standard	BS 476 Part 7: 1997
Recycled	100% post-industrial recycled material
UV Resistant	True
Temperature	-40°C to 80°C

Irrigation

Tank	Required if wall is over 30m^2
Drainage	Required. See details below.
Power	13A single socket
Control	Automated
Irrigation pipe	16mm
Average water usage	1-1.5 litres per m^2 per application. 3-4 applications per week.

Drainage Channel

Width	107mm
Depth	51mm
Material	PVC-U
UV resistant	True
Water run-off	Minimum. Not toxic.

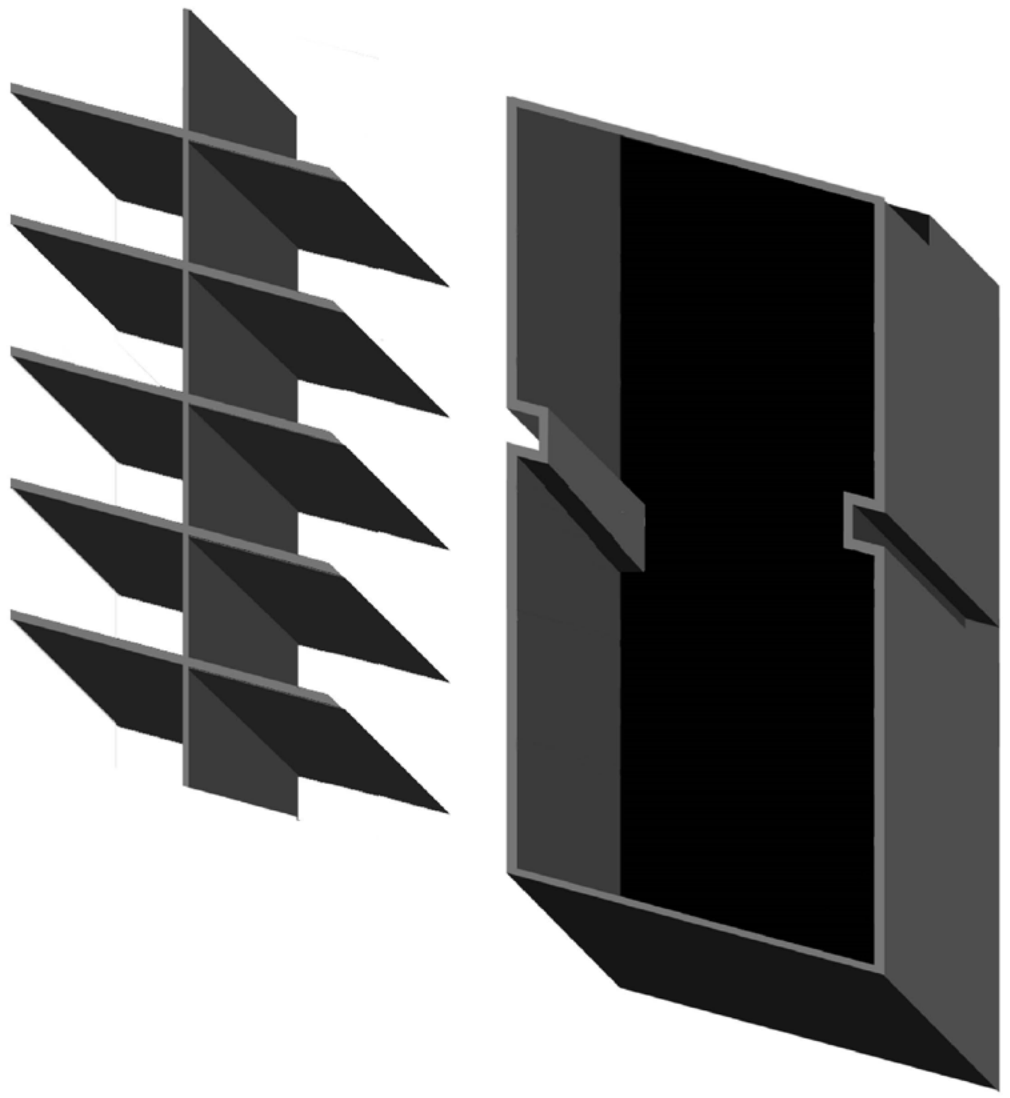
Overall

Weight	72kg per m^2 (fully saturated weight)
Plant density	96 plants per m^2
Wind resistant	140mph
Acoustics	10dB - 15dB absorbed
Temperature	30% reflected. 50% absorbed

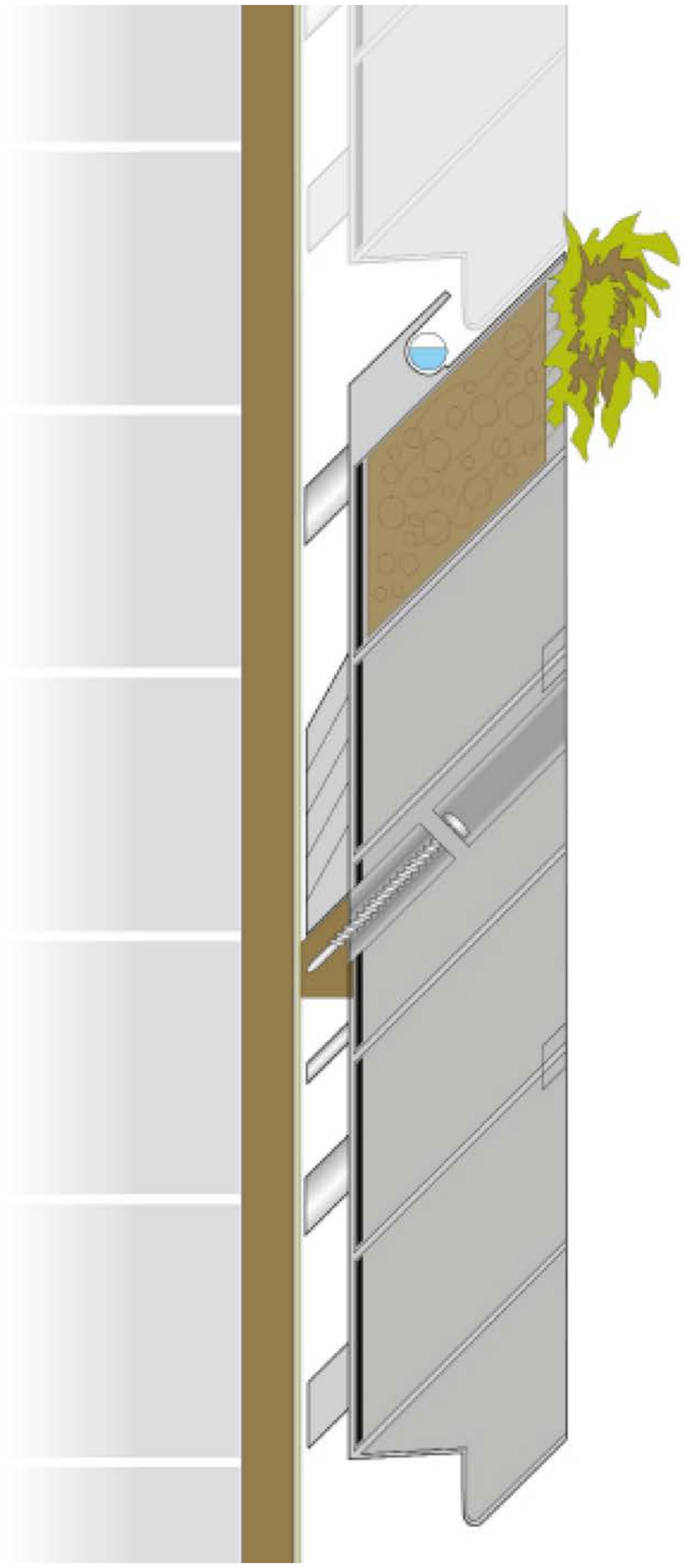
Façade-based green wall

Part 3 of 12

ANS Global module example



Side profile of module build-up



Façade-based green wall

Part 4 of 12

Design: Installation

It's worthwhile noting that designing and selecting a living wall system in the early stages of a scheme allows for configuration of the build-up system details into the building structure. This reduces unnecessary costs from doubling up on façade materials, and also means the feature forms the final façade of the building and acts as sustainable rainscreen cladding with not only added biodiversity benefits, but well-being benefits too (the science of biophilia). Having discussed the relationship between soil and an impactful biodiverse solution, there are several build-up options for a soil-based façade system depending on the design constraints, application, and purpose.

The following four examples are fixing systems used and proven by ANS. These are not prescriptive build-up options for successful façade-bound green (living) walls, but rather to provide guidance as to how these GI systems can be integrated on different facades.

[16]www.bregroup.com

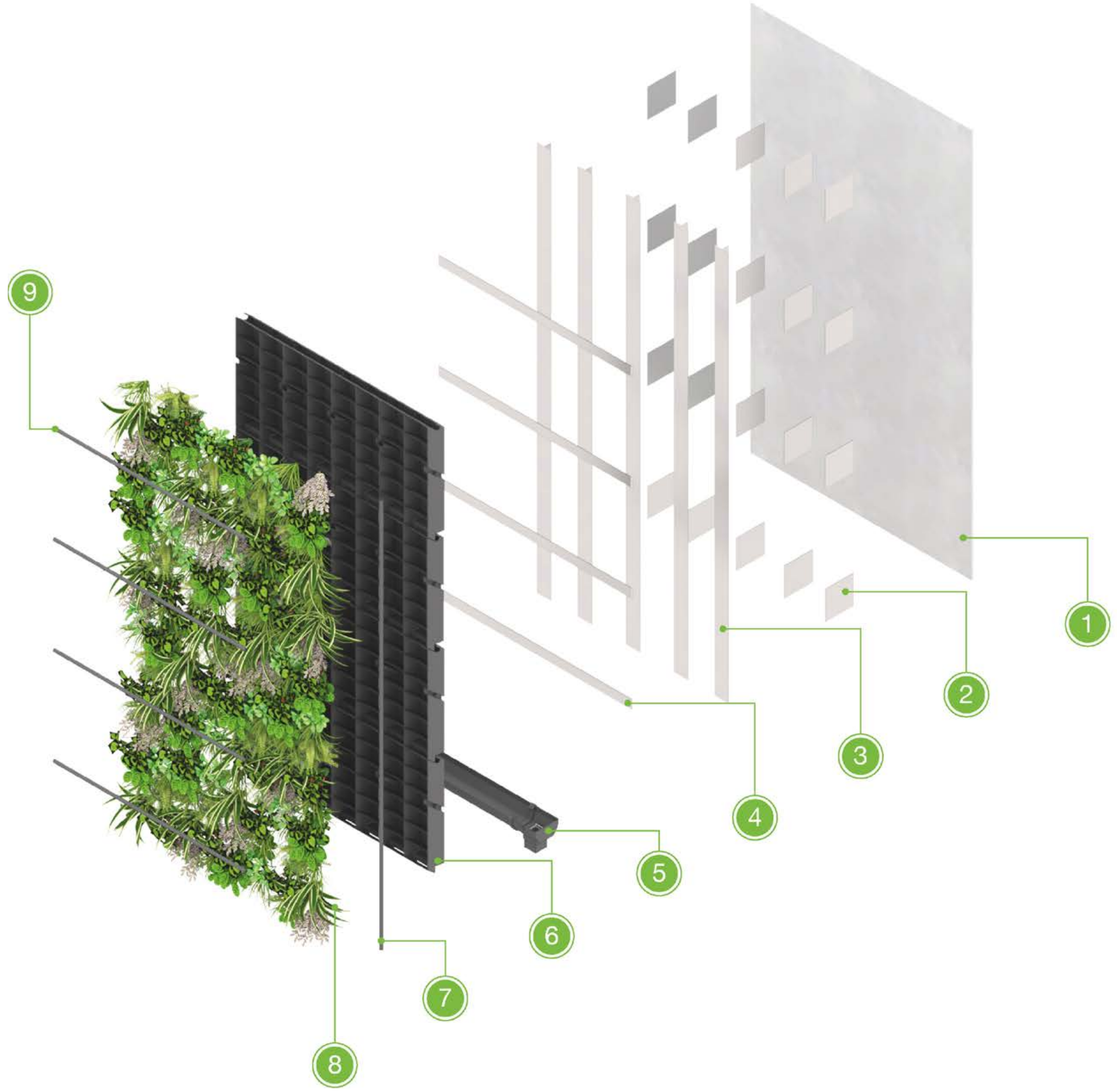
Façade-based green wall Part 5 of 12

Rainscreen Cladding Construction Detail

Suitable for a façade-bound living wall that is to be applied as rainscreen cladding.

Order of build-up:

1. Insulation or cladding
2. Helping hand 'L' bracket
3. Vertical 'T' rail
4. Fixing rail
5. Gutter
6. Module (ANS Living Wall Module)
7. Irrigation pipe
8. Planting
9. Inline emitter pressure regulated irrigation pipe



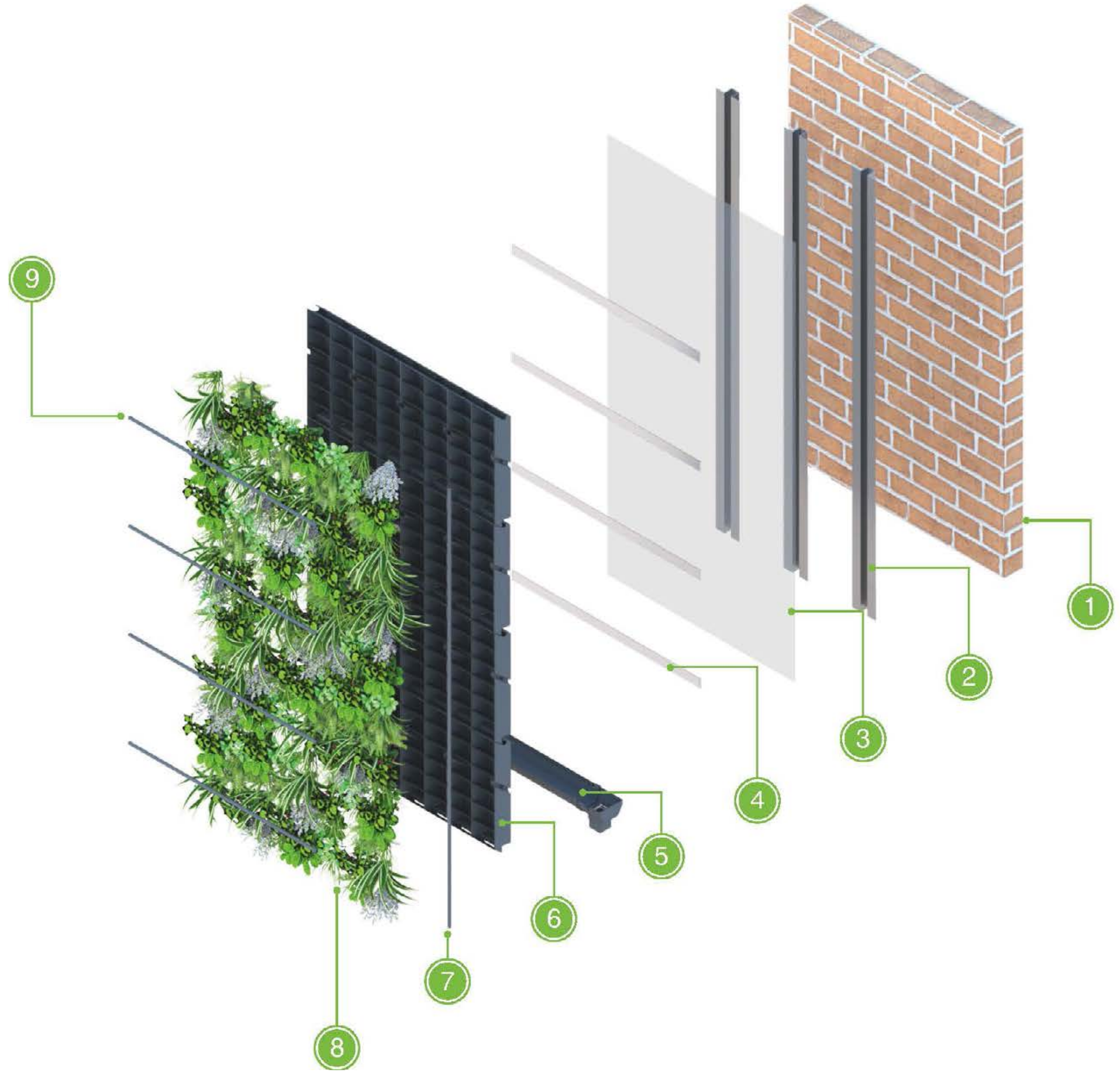
Façade-based green wall

Aluminium Standard Construction Detail

The aluminium baton build-up can be used to retrofit a living wall onto new brick work and masonry façade. This option is suitable for any application where there is a solid brick or concrete surface to fix back to.

Order of build-up:

1. Indicative brick or concrete surface
2. Vertical carrier rail
3. Waterproof membrane
4. Fixing rail
5. Gutter
6. Module (ANS Living Wall Module)
7. Vertical irrigation pipe
8. Planting
9. Inline emitter pressure regulated irrigation pipe



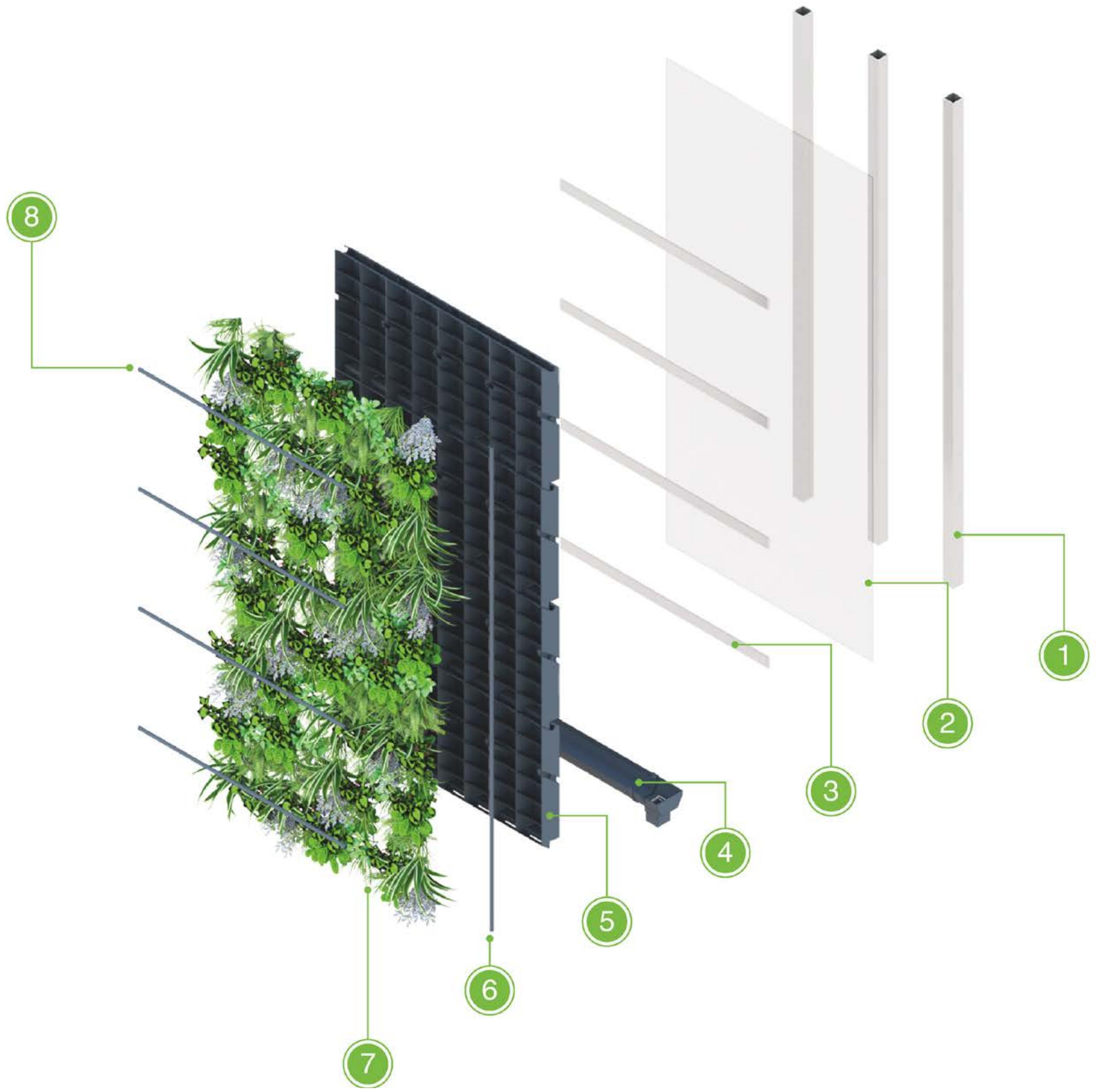
Façade-based green wall Part 7 of 12

Steel Frame Construction Detail

A purpose-built steel frame can be used to serve as a biodiverse sound barrier or site divider, such as at The NEC, Birmingham (pictured).

Order of build-up:

1. Existing steel frame – maximum 600mm horizontal centres
2. Waterproof membrane
3. Fixing rail
4. Gutter
5. Module (ANS Living Wall Module)
6. Vertical irrigation pipe
7. Planting
8. Inline emitter pressure regulated irrigation pipe



Design: Plant Species Selection

Whilst the build-up forms the foundation of successful installation, the plant selection is crucial for long-term sustainability.

During specification and design, seeking horticultural and ecological advice is important to ensure correct plant selection for the appropriate location. This means factors such as the physical elements, local ecology and presence of other structures that would reflect light on the elevations on which greening is proposed, are considered. These features should ideally be designed and considered as part of wider design and project planning activities, as early as possible (for example, at concept design stage). This should involve input from the project team including the ecologist and landscape architect where they are appointed. This helps to ensure systems are considered early enough to complement wider goals for the project and maximise their value for biodiversity and other ecosystem service benefits. BREEAM UK New Construction 2018 and HQM ONE provide a pathway towards biodiversity net-gain that recognises good practice including collaborative working and early planning.

Ecological properties of plants

Plant species should be analysed for their particular properties and ecological values, for example native species are more likely to flower and provide for pollinators, becoming important sources of nectar, offering berries, seeds and fodder.

Using soil as the foundation allows for a wider range of species including bulbs which can be of value to native pollinating insects. For example, when a bumblebee emerges in early Spring, crocuses may be the sole source of food. If the primary purpose of the living wall is to provide for biodiversity, such things should be considered within the planting specification.

Plants from just one growth cycle category can range from having poor to significant biodiverse value. It is important to understand that whilst, for example, there are many evergreens, they do not all hold equal value to native biodiversity. Some evergreen species like common thyme (*Thymus vulgaris*) (see table 7 on the next page) have value for invertebrates, providing a source of nectar and supporting a number of native bee species (*Apis* spp.); these plant species, whilst not always native, can be suitable for planting in urban areas for this reason. On the other hand, many evergreen species are largely to maintain the aesthetic and have limited biodiversity value.

If you are designing a planting specification for biodiversity, these should be limited within the planting specification; Japanese pachysandra (Pachysandra terminalis) being an example (see table 7). However, if biodiversity is not the primary purpose of the living wall, but aesthetics or a certain ecosystem service is, then such species may be deemed suitable; the species selected as part of a living wall will, to some extent, dictate the 'habitat condition' the solution can achieve. It is therefore worthwhile, considering all points before committing to a design. Table 7 provides examples of species which can contribute to a ground-based green wall achieving 'good condition' in BNG terms.

Façade-based green wall

Table 7:

An indicative range of plant species, with varying value to biodiversity, which can be planted within a façade-bound living wall.

Common Name	Latin Name	Flower/Foliage Colour	Growth Cycle	Season of Interest	Native/Introduced	Value to Biodiversity
Sea thrift	*Armeria maritima*	Pink/Green	Evergreen	Spring Summer	Native	Pollinator plant for various insects including bees, flies, beetles and *Lepidoptera* (family of butterflies and moths)[17].
Garden thyme	*Thymus vulgaris*	Purple/Green-glaucous	Evergreen	Spring Summer	Introduced	Natural plant, source of nectar for butterflies and bees, particularly beneficial for the common carder bee (*Bombus pascorum*), red mason bee (*Osmia bicornis*) and white tail bumblebee (*Bombus lucorum*)[18].
Wild strawberry	*Fragaria vesca*	White + Green	Deciduous	Spring Early Summer	Native	Leaves are important for grizilled skipper (*Pyrgus malvae*) eggs and larvae, flat-backed millipede (*Polydesmus angustus*) and honeybee[19].
Common bluebell	*Hyacinthoides non-scripta*	Blue/Green	Deciduous	Late Winter Early Spring	Native	Flowers are pollinated by the first bees to emerge on warm days[20].

[17] Plants for a Future. Armeria maritima. Available at: www.pfaf.org
[18] RHS Plants for Pollinators: garden plants. Available at: www.rhs.org.uk
[19] Brereton, T.M., Bourne, N.A.D., Warren, M. S. (1998). Species Action Plan. Grizzle Skipper Pyrgus malvae. Butterfly Conservation.Available at: www.researchgate.net
[20] RHS Plants for Pollinators: garden plants. Available at: www.rhs.org.uk

Façade-based green wall Part 10 of 12

Cowslip	*Primula veris*	Yellow/Green	Semi-Evergreen	Spring	Native	Provides a valuable source of nectar for bees early in the season[21].
Japanese pachysandra	*Pachysandra terminalis*	Green	Evergreen	All year	Introduced	Limited value to biodiversity. However, the evergreen nature of the plant provides refuge for insects and aesthetic appeal over winter months.

The plant selection within urban greening systems like a living wall or an intensive green roof would typically be densely planted with a combination of supportive evergreens and deciduous species, and designed with particular percentages of each variety to provide for biodiversity whilst reaching a compromise on aesthetics. Evergreen species with greater value for biodiversity, such as thrift (*Armeria maritima*), provide refuge and protection for invertebrates during the colder months. Therefore, integrating a balance of evergreen and deciduous plants into the planting design is important to ensure sources of nectar, pollen and refuge is available for wildlife all year round.

In the case of vertical greening, to implement an effective system that ensures a habitat of high ecological value without compromising on aesthetics, the following simplistic guide can be used. This is the 'compromise solution' which whilst providing value to biodiversity, provides aesthetic value with evergreen winter cover.

- **Planting percentages:** approximately 75-80% of the species selected in the planting palette should hold significant ecological value against 20-25% of evergreens to give year-round colour and interest.
- **Bulbs and perennials:** should be regarded as a significant part of any plant palette when designing a solution that successfully brings biodiverse value. By using an organic natural soil substrate, you are able to utilise the power of species like snowdrops, English bluebells (Hyacinthoides non-scripta), geraniums (Geranium spp.), crocuses (Crocus spp.) and other plants that provide seasonal interest (discovery plants). These few examples provide early sources of nectar and pollination, providing for invertebrates at a local level. Bulbs such as daffodils (Narcissus pseudonarcissus) and bluebells naturally multiply over a three-to-five-year period. This not only reduces the need for plant replacement but can add to the ecological value of the habitat, as the number of pollinator-friendly plants increases over a short period of time.
- **Habitat boxes:** habitat boxes can be included within soil-based modular green wall systems wall systems to provide refuge habitat for a range of animals. Insect hotels, bird and bat boxes are just some examples of what can be incorporated. It's important that these types of features are installed in line with manufacturers and good practice guidance, and features are chosen based on local priority species, strategies and any nearby habitats (for example within the zone of influence), and input from an ecologist where available. These features also need to be included in the maintenance schedules. Without this wider consideration, features such as this can be at risk of being token efforts. Whilst habitat boxes provide refuge for a range of species and are encouraged alongside habitat creation, they should not be counted within Metric 2.0.

If providing for biodiversity is the key driver behind the scheme, the GI features can be designed with a plant selection that is solely focused on providing ecological value, with 100% of the plants holding significant biodiverse properties. This would mostly consist of native planting and wildflower varieties.

[21]RHS Plants for Pollinators: garden plants. Available at: www.rhs.org.uk

Façade-based green wall

Part 11 of 12

Maintenance

Maintenance for a façade-bound green wall is usually once a month for a visual, irrigation and plant health inspection, and twice a year for a full horticultural husbandry visit. This involves a trim, prune, and replacement of any aged or failing plants. Table 8 shows an example of an ANS specific maintenance schedule for the UK for a façade-bound living wall (flexibility should be allowed for in each maintenance package).

Table 8:

Example of an ANS maintenance schedule for a façade-bound living wall in the UK

	January	February	March	April	May	June	July	August	September	October	November	December
Visually inspect the living wall	√	√	√	√	√	√	√	√	√	√	√	√
Check the moisture levels			√	√	√	√	√	√	√	√	√	√
Re-calibrate irrigation zones		√	√	√	√	√	√	√	√	√	√	√
Check the health of plants		√	√	√	√	√	√	√	√	√	√	√
Remedial work if necessary		√		√		√		√		√		√
Remove weeds		√		√		√		√		√		√
Prune in accordance with season			√							√		
Dead head seasonal plants			√	√	√							
Treat for pest and disease						√	√		√			
Apply feed and nutrient as necessary							√					
Service irrigation system	√	√	√	√	√	√	√	√	√	√	√	√
Check run off outlets for blockage	√	√	√	√	√	√	√	√	√	√	√	√
Replace any plants that have failed		√	√							√		
Sweep and tidy below wall	√	√	√	√	√	√	√	√	√	√	√	√

An indication of maintenance costs would be between 7.5% and 12% of the installation costs subject to size, location, and accessibility.

Section 3

Vegetated Drainage Features

Sustainable Drainage System (SuDS) is an umbrella term used to describe for various vegetated infiltration systems which allow the storage of water and removal of pollutants including infiltration trenches and basins, and soakaways. By definition, SuDS are systems that provide a solution to urban drainage in a sustainable way, and therefore also cover living roofs and walls that have clear run-off mitigation benefits (examples of this are shown in the image of the University of Leicester). For example, 25 hectares of green roofs can deal with 80,000m3 of rainwater per year: a successful example of these principles in action. Despite this, in relation to BNG and use of Metric 2.0, living roofs and walls should be categorised as such despite technically acting as part of a SuDS feature. The SuDS habitat categories in Metric 2.0 therefore refer to ground level SuDS. These are discussed in further detail on the next page.

Section contents

37 Sustainable Urban Drainage Systems

38 Bioswale

40 Rain Gardens

Sustainable Urban Drainage Systems

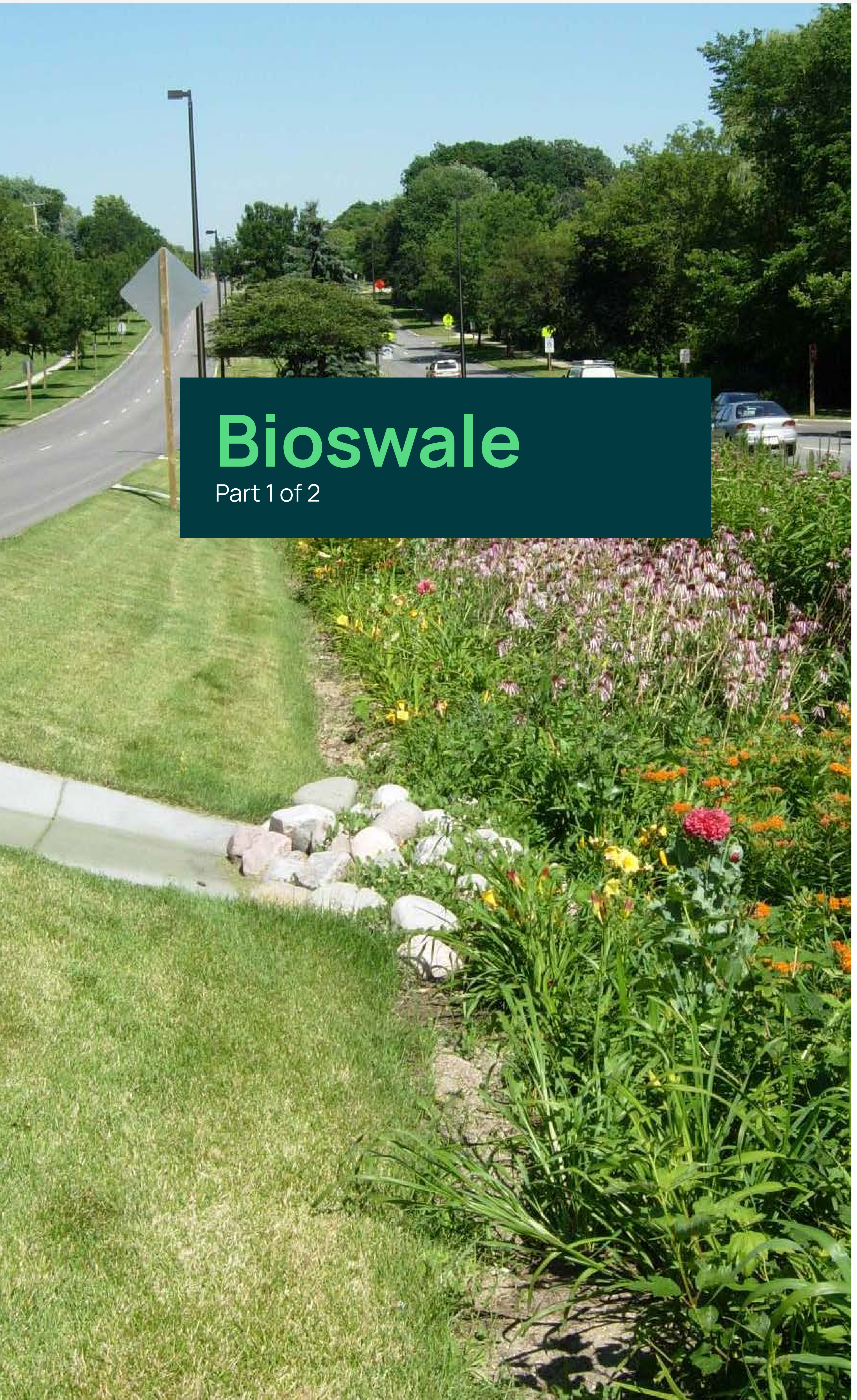
'Sustainable Urban Drainage Systems' is a term used within the UK Habitat Classification and Natural England's Biodiversity Metric 2.0 which describes a particular type of SuDS habitat. Sustainable urban drainage systems differ from bioswales or rain gardens as they typically comprise semi-natural habitats such as grasslands which can take longer to establish.

Sustainable Urban Drainage Systems should be a part of an integrated strategy when considering how our landscape is designed and managed. Designed to both manage the pollution and flood risks caused by urban run-off, and contribute where possible to environmental enhancement, the multi-functionality of SuDS allows for multiple benefits. This is particularly true of systems designed to integrate seamlessly with the landscape in which they're installed.

The key challenge is to adopt an effective SuDS strategy in the first stages of designing a landscape and ensure responsibility for maintenance and management at the outset.

The appropriate solutions should be selected for the benefits to biodiversity, health and wellbeing, safety and with the users of the space in mind.

CIRIA offer detailed advice on integrating SuDS into a variety of applications, including counsel on design, planning for construction, considerations for maintenance and other technical details.



Bioswale

Part 1 of 2

Technical system details

Bioswales are one of the most effective type of green infrastructure system in slowing run-off velocity and cleansing water while recharging the underlying groundwater table.

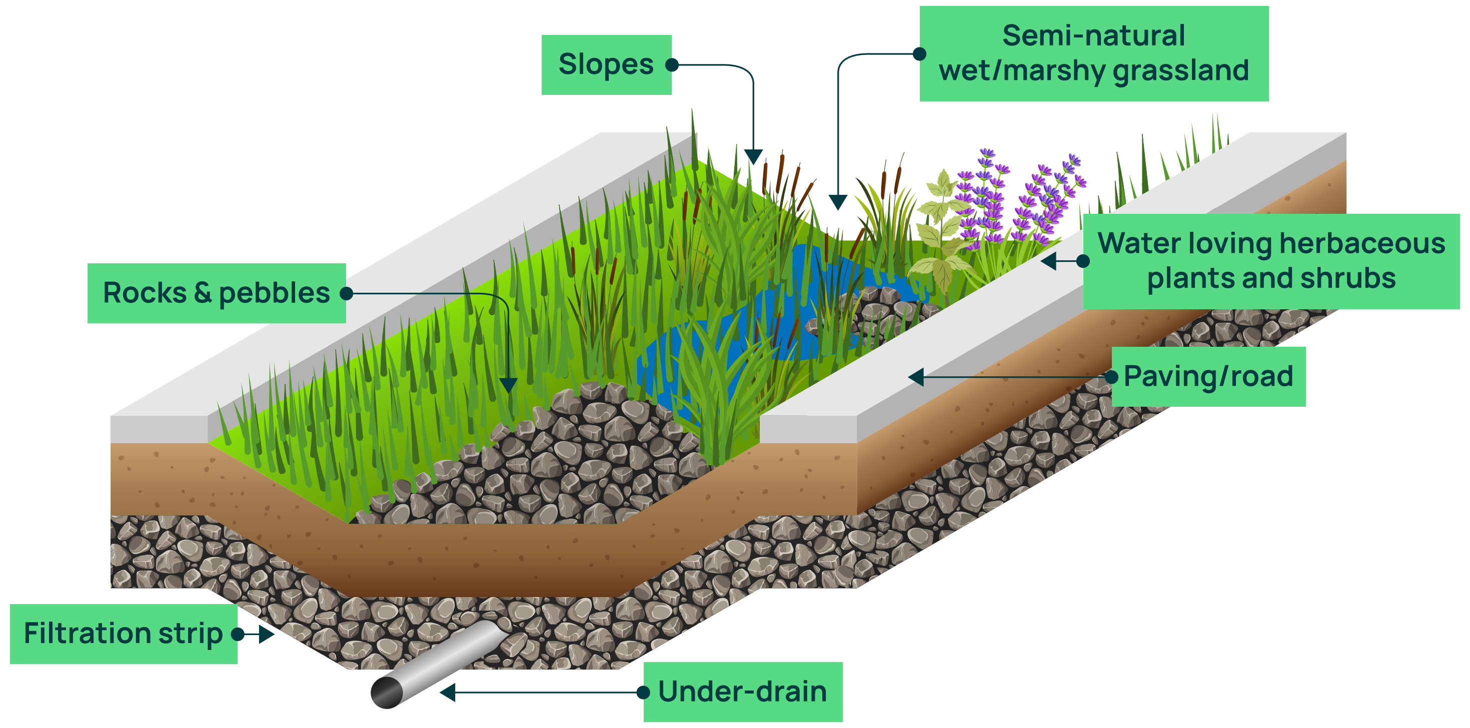
Requiring the correct planting media composition, the engineered soil mixture should consist of 5% maximum clay content, must be designed to pass 150-300mm inches of rainwater per hour and the infiltration facilities should only be in Type A or Type B soils.

It is necessary that underlying native soils are not contaminated before implementation as this can undermine the purpose of the installation. Allowing pollutants and sediments to settle out, bioswales have a slight longitudinal slope that moves water along the surface. The ideal side slopes are 4:1, with a maximum slope of 3:1. The in-place infiltration then allows localised groundwater to re-charge.

Design: Installation

Waterproof liners or a deep curb should be constructed during installation to maintain the minimum clearances, and a 1.20m minimum clearance should be maintained from the bottom of the bioswale to the high groundwater table.

In order to manage larger storms, the overflow or bypass drain system can be raised approximately 150mm above the soil surface. Runoff that enters the bioswale in a sheet flow fashion requires that the edge of the bioswale is flush with the main surface. Where curbs are necessary, intermittently spaced curb cuts allow runoff to enter and be treated within the swale. Both sheet flow and curb cut systems must allow for a minimum 51mm drop in grade between the street grade and the finished grade of the facility, and curb cuts should be at least 450mm wide and spaced from 0.9-1.20 m apart.



Design: Plant selection

Bioswales should be composed of diverse, native vegetation. Vegetation selection should consider species compatibility, minimum irrigation requirements, and the potential for wildlife habitat creation.

Maintenance

Whilst bioswales do not require excessive maintenance, annual checks as well as after major storms should be carried out to ensure the feature continues to operate effectively. Inspections should involve looking for erosion, debris, bare soil or sediment and ensure there is no woody plant encroachment. Vegetation should not be mowed below the design flow depth. It is therefore important that 'do not mow' signage is displayed, or property owners or maintenance personnel are educated to ensure a long-term solution. Correct maintenance will allow the bioswale to function properly whilst preventing overgrowth that could have a negative visual impact.[22]

[22]www.nrcsolutions.org

Rain Gardens

Part 1 of 3

Technical system details

Also known as 'bio-infiltration basins', these are shallow planted depressions designed to hold water until it soaks into the soil. Whilst rain gardens work in most climates, they are most effective in areas with a natural groundwater hydrology. These are areas with greater soil depth that soak up water, rather than rocky areas where stormwater is forced over land.

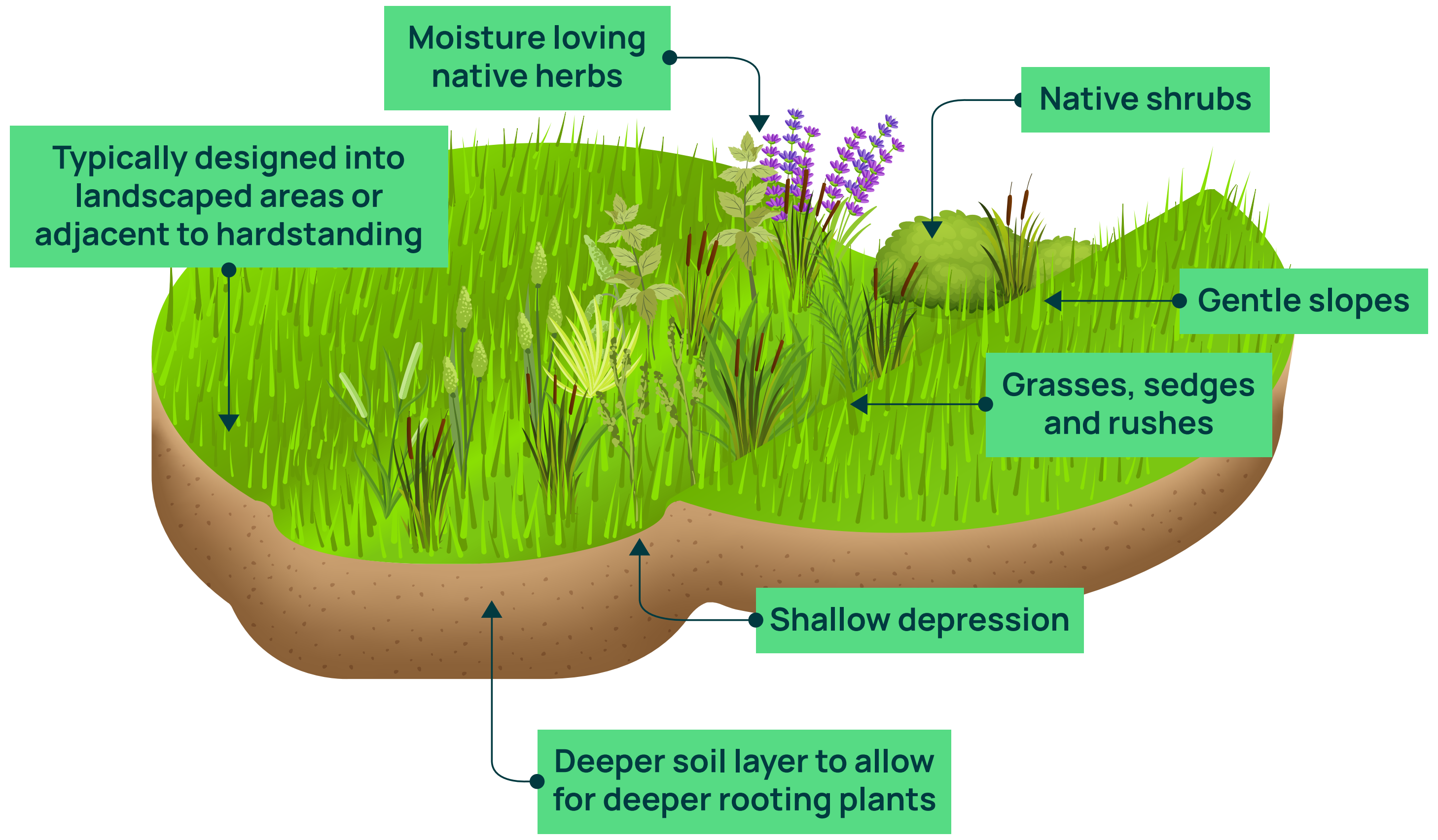
A rain garden should be a part of a greater rain-water management system, and it does not need to be a specific shape to function properly. This means the design can be as formal or relaxed as you wish – the key factor is the plant selection. Surrounding the rain garden with shrubs or creating the basin in a perennial bed are options to firmly integrate the feature into the landscape design.

Design: Installation

Whilst they can work in almost any soil type, rain gardens work best in light, sandy soil compared to a denser clay composition. A simple percolation test can be undertaken before a decision: water needs to drain away at the rate of 50mm per hour or more.

The base of the excavation is usually between 150mm – 450mm below the original ground level, and the substrate dug up from creating the basin can be placed at the edge to create a lip. This will need to be firmly compacted and around 100mm high to provide adequate protection to the surrounding area from storm water. These can be tapered to ensure they blend in with the surroundings.

The basin is then filled with the excavated soil which can be improved by adding organic matter or, if heavy clay, gravel, stones or sand, before planting commences. If a downpipe empties into the rain garden, the energy of the water needs to be dissipated before it hits the soil, which can be done by placing stones under the pipe. This prevents the soil from being washed away.



Rain Gardens Part 2 of 3

Design: Plant selection

Plant selection is dependent on the depth and media composition of the rain garden, for example larger plants with greater root depths will work better in rain gardens with deeper basins.

Table 9:

An indicative range of plant species for a rain garden.

Common Name	Latin Name	Flower/Foliage Colour	Growth Cycle	Season of Interest	Native/Introduced	Value to Biodiversity
Coneflowers	*Rudbeckia spp.*	Yellow / Green	Perennial – annual	July – October	Introduced	A source of nectar for butterflies, moths and bees[23].
Common bistort	*Persicaria spp.*	Light pink / Green	Perennial – annual	June – October	Native	It's ideal for using as ground cover in sun or partial shade, and its blooms are loved by bees and other pollinators[24].
Gravel root	*Eupatorium purpureum*	Purple / Green	Perennial	July – October	Introduced	A source of nectar for butterflies, moths and bees[25].
Bee balm	*Monarda spp.*	Bright red – lilac – pink and white	Perennial	July – October	Introduced	Often used in bee and butterfly gardens, the fragrant blossoms attract pollinating insects such as bees and butterflies[26].
Sea aster	*Aster tripolium*	Purple	Perennial	July – September	Native	Aster species are used as food plants by the larvae of a number of Lepidoptera species[27].

[23] RHS Plants for Pollinators: garden plants. Available at: www.rhs.org.uk
[24] RHS Plants for Pollinators: garden plants. Available at: www.rhs.org.uk
[25] Welsh Government. The Action Plan for Pollinators. Suggest Plant List for Pollinators. Available at: www.gov.wales
[26] RHS Plants for Pollinators: garden plants. Available at: www.rhs.org.uk
[27] Plant Life. Sea Aster. Available at: www.plantlife.org.uk

Rain Gardens

Part 3 of 3

Maintenance

Rain gardens are typically low maintenance although regular inspections and weeding is likely to be required within the first two years.
As the feature matures, the plants will supress weed growth which will limit the necessity of regular maintenance, although once every 3-4 months for a visual inspection is advised.

Conclusion

Under the Environment Bill, BNG is due to become a mandatory requirement for all developments through the planning system in England in 2021. BNG is an approach to development that leaves biodiversity in a measurably better state than it was before (Baker et al., 2016), with the aim to minimise the losses of biodiversity and help restore ecological networks from construction and development. Urban green infrastructure habitats (i.e. GI systems) can be used to help urban developments, particularly those with limited ground space, achieve favourable BNG targets, providing that the design, planning and maintenance is considered at the earliest possible design stage. As nature based solutions, GI systems should be designed to integrate with the surrounding environment, enhancing habitat connectivity and where possible, contributing to ecosystem services. Designing to complement local priorities or strategies for GI, biodiversity or ecosystem services is also recommended.

When designing such systems, the primary focus should be defined at the earliest stage (e.g. biodiversity, stormwater drainage, air pollution amelioration etc.), as this will drive the direction of design. Whilst many primary design considerations (e.g. storm water drainage) may not provide the best option for biodiversity, each system should be designed to maximise the biodiversity value under the constraints provided by the primary consideration. Where possible, resilience to climate change should also be factored into the design, to ensure long-term climate resilience and to provide refuge, nectar and pollen sources for urban invertebrate communities which are also adapting to climatic changes.

Climate change will always be a risk to plants and the effectiveness of GI systems. The changing conditions will, over time, affect the suitability of the plants chosen when the GI system was designed and implemented. Where this occurs, it may be worthwhile changing the species within a GI system. Providing a maintenance schedule is in place and the contract covers plant replacement (this is often the case), more resilient species can be planted i.e. species that are not able to adapt to changes in local climatic conditions, due to climate change can be replaced with more suitable species. Within most GI systems, plant health and climate adaptation are monitored under a maintenance schedule typically provided by the supplier of the GI system. Monitoring of plant establishment, health and adaptability is essential in the habitat developing in line with its BNG 'time to target condition'.

Furthermore, the following should be considered when designing a GI system:

- **Soil:** is one of four key factors which help ensure the success of GI systems. When designing a planting specification, the soil type and pH should always be considered to ensure success.
- **Plant selection:** will allow a system to boast plants that flourish in their environment, support the local ecosystem, and successfully provide for local biodiversity. A natural substrate with the correct plant palette ensures a solid foundation for a green infrastructure system to be an effective long-term feature.
- **Water management and maintenance:** provide opportunities to give further sustainable benefits with rainwater harvesting, and guidance on managing the maintenance costs.

Together, these four key points ensure integration of a green infrastructure system that remains an environmental asset as a long-term sustainable solution that effectively supports BNG.

[29]Baker, J., Hoskin. R., Butterworth, T. (2019). Biodiversity net gain. Good practice principals for development. CIRIA, CIEEM, IEMA. Available at: www.cieem.net

[30] www.thelandmarkpractice.com

Definitions

Term	Definition
Acclimatised	When an organism is adjusted to a change in its environment, allowing it to maintain performance across a range of environmental conditions.
Biodiversity	The number and types of plants and animals that exist in a particular area. Biodiversity forms the foundation of the vast array of ecosystem services that contribute to human and environmental well-being. The number and types of plants and animals that exist in a particular area. Biodiversity forms the foundation of the vast array of ecosystem services that contribute to human and environmental well-being.
Brownfield site	Previously developed land which is or was occupied by a permanent structure.
Biodiversity Net Gain (BNG)	Biodiversity Net Gain (BNG) is defined as "development that leaves biodiversity in a measurably better state than before"[31] and involves an approach where developers work with local governments, wildlife groups, landowners, and other stakeholders in order to support their priorities for nature conservation.

Term	Definition
Colonised wildflowers	Wildflower seedlings that have spread to new areas and settled.
Condition	The ecological condition of a particular habitat parcel. Condition relates to the standard of a habitat parcel relative to other parcels of that particular habitat type. Habitat condition relates to Natural England's Biodiversity Metric 2.0's habitat condition scores which range from 'Poor' to 'Good'[32].
Connectivity	The relationship of a habitat in a defined place to its immediate surroundings in respect of biological and ecosystem flows. Habitat connectivity relates to Natural England's Biodiversity Metric 2.0's connectivity scores[33].
Deciduous	Species that completely lose their foliage during winter.
Distinctiveness	"includes parameters such as species richness, diversity, rarity (at local, regional, national and international scales) and the degree to which a habitat supports species rarely found in other habitats"[34].

[31] CIEEM, CIRIA, IEMA (2016) Biodiversity Net Gain: Good practice principles for development
[32] Natural England Joint Publication, The Biodiversity Metric 2.0 Tech Supplement Beta Edition, 2019
[33] Ibid
[34] Biodiversity Offsetting Pilots, Technical Paper: the metric for the biodiversity offsetting pilot in England, March 2012

Term	Definition
Discovery plants	Species that provide seasonal interest, for example bulbs like daffodils, or wildflowers that blossom in the spring. They are a 'discovery' when sighted.
Evergreen	Species that remain green and functional through the year – the opposite of deciduous.
Fungal diversity	The number and types of fungi that exist in a certain environment which contribute to improved health and for example in soil, a regulation of carbon and nutrients[35].
Façade	Side of a building.
Green infrastructure (GI)	A network of multi-functional green and blue spaces and other natural features, urban and rural, which is capable of delivering a wide range of environmental, economic, health and wellbeing benefits for nature, climate, local and wider communities and prosperity[36].
Intensive substrate	A natural substrate like soil with a minimum of 80% organic matter.

Term	Definition
Invasive non-native species	Species which colonised or have been introduced into an environment where they are not native, which cause ecological or environmental harm.
Lepidoptera	An order of insects that includes butterflies and moths where mostly all have some form of membranous wings.
Native species	Also known as indigenous species, these are species that are naturally occurring within a location i.e. a species which living within its natural range, opposed to a species which has been introduced into a location outside of its natural range.
Perennial	A species that lives for several years, goes into dormancy during the winter and re- grows in the spring.
Pernicious weeds	Plants that are destructive to other plants in their midst.
Planting medium	The material that plants grow in.

[35] www.frontiersin.org
[36] National Planning Policy Framework 2021: Draft text for consultation.
Available at: www.assets.publishing.service.gov.uk

Term	Definition
Strategic significance	Strategic significance is a parameter of Metric 2.0 which utilises published local plans and objectives to identify local priorities for targeting biodiversity and nature improvement, such Nature Recovery Areas, local biodiversity plans, National Character Area14 objectives and green infrastructure strategies.
Substrate	The layer underneath or the surface where an organism grows, for example, soil.
Type A soil	Cohesive and has a high unconfined compressive strength, for example, clay, silty clay, sandy clay and clay loam.
Type B soil	Medium unconfined compressive strength, for example, angular gravel, silt, silt loam, and soils that are fissured or near sources of vibration but could otherwise be classed as Type A soils.
Urban green infrastructure (GI) habitats	Infrastructure within the urban environment that form a network of semi-natural features and provide biodiversity value to an urban area.
Urban greening systems	Urban greening systemsSystems that are designed with natural elements like soil and vegetation to restore nature and natural processes to urban environments.
Zone of influence	The areas or resources that may be affected by the biophysical changes caused through activities associated with a project during or after its completion

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About ANS Global

A heritage in horticulture and original design with global reach, we're on a mission to re-introduce biodiversity and biophilia to our urban spaces, improve air quality and wellbeing and make the process of meeting environmental regulation simple with soil-based green infrastructure systems, creating long-term environmental assets.

Supporting architects in achieving the ecological and regulatory requirements surrounding green infrastructure, we also consult on and help to establish schemes that are environmentally high performing, providing you with a consolidated view of the opportunities there are in urban greening.

Keep up to date on where we're heading @ANSGlobal on LinkedIn or @ans_global on Instagram, or for more in depth resources, head over to our website (linked opposite).

About AECOM

AECOM is the world's premier infrastructure consulting firm, delivering professional services throughout the project lifecycle – from planning, design and engineering to program and construction management.

On projects spanning transportation, buildings, water, energy and the environment, our public- and private-sector clients trust us to solve their most complex challenges. Our teams are driven by a common purpose to deliver a better world through our unrivalled technical expertise and innovation, a culture of equity, diversity and inclusion, and a commitment to environmental, social and governance priorities.

AECOM is a Fortune 500 firm and its Professional Services business had revenue of $13.2 billion in fiscal year 2020. See how we deliver what others can only imagine at aecom.com and @AECOM.