

Briefing Paper

Greening the Built Environment

The Benefits of Selecting Ecological Options

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Introduction

This briefing paper has been primarily written to support clients, developers and project teams making design and specification decisions for building or infrastructure developments as well as landlords, facilities management teams and asset managers making maintenance, refurbishment or retrofitting decisions relating to existing buildings and their surroundings.

It highlights the role and benefits that the natural environment and the green and blue (water-based) spaces within it can have in the built environment beyond landscape and nature. As such it aims to overcome the widely held practice of considering ecological factors where there are statutory requirements or where narrowly defined and often short-term feasibility and viability considerations permit.

BREEAM (Building Research Establishment Environmental Assessment Method) is the world's most long-lived sustainability rating scheme for the built environment with nearly 3 decades of working with industry to recognise and encourage practical and viable actions to enhance the sustainability of the built environment.

All schemes within the BREEAM family (which includes those operated under the BREEAM Brand itself as well as the Home Quality Mark (HQM) and CEEQUAL (the Civil Engineering Environmental Quality certification scheme) seek to ensure quality by providing an accessible, holistic and balanced measure of social, economic-related and environmental impacts. It helps to ensure that decisions are not made in isolation without considering all potential impacts and benefits.

BREEAM helps to measure and reduce the impacts of the communities, buildings and infrastructure projects that make up our built environment and in doing so, create higher value, lower risk assets that are better for people and the planet. See the Ecology in BREEAM section of this paper for more information about BREEAM approach in this area.



Ecology, Sustainability and the Built Environment

Integrating green space and biodiversity into the built environment is an important part of sustainable design and management. The structure of the built environment plays a major role in shaping the sustainability benefits obtained from the natural environment, by influencing the functioning of the ecosystems around it, and by serving as an interface between people and the natural world. Increasingly policy guidance is directing statutory bodies such as planning authorities to drive and therefore expect biodiversity benefit in developments. This can result in the additional benefit of making a valuable contribution to people's quality of life.

Societal benefits

Developments, large and small, can have a significant effect on the ability of people to experience and enjoy nature. Enhancement of biodiversity and habitat creation can range from small measures such as the installation of a nest box or 'bug hotel' to more comprehensive ones that result in the creation of an integrated ecological landscape linked to surrounding areas. The fabric of the built environment itself can be used to cost-effectively support the integration of green space, so enhancing biodiversity in dense, urban areas with wider benefits for individuals, society and business.

- Those who live and work around nature have been shown to experience lower rates of mental and physical disorders, rate their general health more highly, report feeling happier and more satisfied with life, and are more resilient to stressful life circumstances.
 - Green and blue (water-based) landscape features can provide areas for socialising, exercise, recreation and relaxation, which are valuable in promoting physical health.
 - Direct contact with nature is widely accepted to have a positive impact on our emotional state, reducing stress and bolstering cognitive functioning. This makes it a valuable tool in improving mental health, which is increasingly recognised as creating a significant financial burden on business and society more generally.
- Urban neighbourhoods and developments with a greater quantity and quality of natural features have been shown to have lower rates of violence and crime and greater community cohesion.



Environmental benefits

Urban sprawl and the dominance of man-made surfaces (buildings, infrastructure) often results in habitats becoming fragmented and can significantly lower their value to wildlife:

- Even relatively minor inclusion of soft landscaping features on a site, such as grass, planting beds, water features, hedges and trees can help to improve the biodiversity and support a balanced ecosystem if carried out appropriately.
- Green walls and roofs can also be effective in reducing or preventing this fragmentation effect by enhancing habitat connectivity in locations where space is limited.
- These features can be used to mitigate unavoidable impacts arising from pressures to increase development densities.
- In urban areas, green and blue (water-based) spaces can enhance the environment by helping to improve air quality, reduce the urban heat island effect, reduce pollution, store carbon, and even mitigate noise and visual disturbance.

See the 'Built Environment Elements, Ecological Options, Benefits' part of this paper for an overview of these benefits.



Financial benefits

There are many tangible financial incentives and associated benefits that can be realised by carefully adopting more ecologically based solutions to meet functional requirements.

- They can contribute to increased rental and real estate values by providing green biodiverse spaces that convey vibrancy and make for a more pleasant and healthy environment than areas with little or no nature and biodiversity.
 - This is often an important factor for organisations looking for new premises and intending to relocate staff, as well as for new and existing employees increasingly aware of their own physical and mental health.

- These characteristics may also help to draw in more customers for leisure, commerce and tourism-based developments providing indirect economic benefits.
- Financial benefits may also be realised by using methods such as soft landscaping and green roofs to enhance resilience to flooding, helping to avoid substantial costs from flood damage and disruption.
- Some measures that enhance ecology, such as green walls, green roofs, and green and blue space, can also help to reduce demands for artificial heating and cooling by contributing to insulation performance and reducing demands through solar gain and wind generated heat loss. This both helps to reduce energy demand and its associated costs as well as conveying resilience to future climate change in a visible manner, thus assisting in demonstrating corporate social responsibility (see the 'Built Environment Elements, Ecological Options, Benefits' part of this paper).
- Significant savings may be achieved by individuals, their employers, and the wider economy through reductions in healthcare costs and absenteeism given the impact on health and wellbeing. Moreover, workplace performance can be enhanced (and profit margins increased) through greater willingness to cooperate with others, higher productivity, and job satisfaction that can be reinforced by increased interaction with the natural environment. These are increasingly being referred to as biophilic benefits.



Economics, feasibility and viability

It is important to recognise that the benefits of integrating biodiverse green space into the built environment can only be realised in practice and maintained over time where specification, installation, management and maintenance processes and costs are both practical and economically viable. Long term achievement of positive outcomes are impacted by the context and limitations of a development. More resilient solutions typically provide a range of experience/opportunities.

Considerations should include:

- Appropriateness - are the measures selected suitable for the development over the long term?
- Technological change – do the measures avoid over-dependence on the availability and cost effectiveness of specific systems and suppliers /contractors that may change over time?
- The dependence on specific champions /drivers being present in relation to ongoing management and delivery over time. Are there clearly defined ownership and responsibilities?

- Does the measure selected support a sense of engagement, participation and / or ownership by the workforce / local community?
- Does it meet the needs of the local community, and where possible is this accessible?
- Does it allow for security and safety demands over time bearing in mind that these may change and can often be impacted by changes in needs over time?
- Can the measure be dynamic enough to develop with social needs as aspirations change over time?

Careful consideration of these factors can result in robust and resilient solutions being identified which will maximise the value of the benefits achieved.

Built Environment Elements, Ecological Options, Benefits

This section of the paper focuses on some of the key built environment elements where more ecology-based options are increasingly being considered in building and infrastructure contexts. It outlines some of the key options and provides a wide range of associated benefits. The key built environment elements considered are:

- Boundary Protection
- Walls
- Roofs
- Drainage Systems

In addition, short discussions are included on hard and soft landscaping.

The section begins with a summary of the general benefits of selecting ecological options for the key built environment elements listed. The 'Further Information' section of the paper provides sources of more detailed information about ecological options or related aspects.

General Benefits of Selecting Ecological Options Relevant for all Key Elements

This section of the briefing paper summarises benefits that can be achieved for all the built environment elements relevant to this document.

People and Community	
Health, Wellbeing, Comfort Heritage and Local Character	• Can contribute to creating attractive and accessible places for people to enjoy contact with the natural environment. • Can support and in cases improve community connectedness by providing places for people to meet. • Can help to develop a sense of local ownership which can lead to reduced anti-social behaviour, such as graffiti and vandalism, creating a safer environment to live in. • Strengthens links between urban areas and their surrounding countryside and brings the natural world into every neighbourhood with benefits for individual and community health and wellbeing. • Providing visual connection with external vegetation creates positive emotions. Visual and physical contacts with plants can result in direct health benefits. Plants can have restorative effects leading to improved mental health, including positive effects on concentration, productivity rates and decreased stress levels, improved patient recovery and resistance to illness. • Promotes a positive image of the surrounding area, which can encourage economic activity and investment, and can increase local land values, residential property prices and rental values for commercial property. The development and management of greenspaces can also create jobs and training opportunities.
Reducing Construction and Operational Impacts	
Surface Water Runoff and Flood Management	• Multifunctional green and blue space can support the management of water resources e.g. by storing water runoff in the substrate or acting as flood storage areas and providing drainage and flood protection. • Vegetation cover intercepts rainwater and helps reduce water quantities through evapotranspiration.
Air Quality	• Vegetation and soft landscaping can help to provide local shelter from and in some cases even absorb pollution arising from road traffic, industrial exhaust flues and improve air quality in urban residential areas. • Urban vegetation has the potential to filter out fine and ultra-fine particles (PM less than 10 microns in diameter) by encouraging deposition on the leaf surfaces which is then either absorbed or washed off in rain to be infiltrated or removed via drainage systems.
Water Quality	• Absorption and binding of contaminants so avoiding pollution in surface runoff.
Noise Mitigation	• Well-designed urban green space can help to moderate actual and perceived noise levels in and around buildings and open spaces.

Climate Change	
Adaptation Mitigation	• Vegetation can promote natural means of managing rainwater runoff levels through increasing infiltration opportunities and through direct absorption and evaporation (evapotranspiration) by plants. • Can help to reduce external temperatures by helping to moderate the urban heat island effect. This can lower health risks associated with high temperatures and air quality impacts of atmospheric stratification which can have significant economic consequences. • Carefully planned use of vegetation can result in lower cooling demands and associated costs in buildings by providing shading and local shelter from prevailing wind directions. All plants act as a carbon sink as they remove carbon dioxide from the atmosphere during photosynthesis and store it in the plant itself, its root system and the soil. The denser the vegetation and the larger the surface area, the higher the rate of carbon capture that will occur. Its impact is likely to be small on an individual site but significant if added together at a broader urban level. The scale of impact will vary with the type of vegetation.
Habitat and Biodiversity	• Design and management that supports habitat connectivity and biodiversity can also lead to the provision of more beneficial ecosystem services. • Green space can act as a 'bridge' promoting the connectivity of natural habitats to address the effects of biodiversity isolation. • Plants on buildings and infrastructure installations can provide a valuable food source for birds and invertebrates, which will result in benefits across the natural food chain. They can also provide breeding and nesting habitat for invertebrates, birds and mammals such as bats and are ideal for including artificial animal breeding structures such as nest or bat roosting boxes. • Soft boundaries can provide ecological corridors and permeability of boundaries that allow wildlife to freely move between habitats in safety. These can play a part in creating an extensive network of green corridors and natural habitats throughout a development and its surroundings connecting larger or more expansive open spaces for both wildlife and people.



Boundary Protection

The primary function of boundary protection is to act as a protective barrier or delineation marker identifying ownership or responsibilities of a site, property or land. Common types of boundary protection include walls, fencing, railings and posts. While these tend to be constructed out of impermeable materials (metal, stone, wood etc), more nature-based options can meet the same functional needs while also providing a range of other sustainability benefits as well as being less visually intrusive.

Options

There are multiple proven ways to integrate multi-functional, 'green' solutions which can act as boundary protection. Natural forms of boundary protection can take the form of shrubs, bushes, hedges and trees, as well as softer landscape boundaries such as water, banks, slopes, mounds, soil / flower beds and traditional landscape features such as a ha-ha and moats. Benefits that are specific to boundary protection options are summarised in the table below.



Benefits	
People and Community - Health, Wellbeing, Comfort - Heritage and Local Character	• Natural forms of boundary protection can blend in with the natural environment, be more aesthetically pleasing, create an impression of landscape quality and provide a feeling of privacy and shelter. This can help in negotiations with planners, local communities etc.
Reducing Construction and Operational Impacts - Surface Water Runoff and Flood Management - Air Quality - Water Quality - Light Pollution - Glare control / shading - Noise Mitigation - Resilience	• Trees and shrubs increase the amount of green space, cooling urban environments and reducing surface water run-off. • Hedge networks can assist in reducing peak flows to nearby water courses and local drainage systems following heavy rainfall. This can be an effective means of limiting nutrients and other pollutants that run-off to water bodies. • Hedges, trees and shrubs can reduce and control the impact of air pollution. • Planting in relative proximity to buildings can help reduce dazzling sunlight and solar gain in buildings, therefore reducing operation demands, as well as being used as natural screens to reduce disturbance to occupants and/or neighbours from night time light pollution.
Climate Change - Mitigation - Adaption	• Hedges, trees and shrubs provide a degree of carbon sequestration by accumulating and storing significant amounts of carbon both above and below ground. • Trees, larger shrubs, and climbers can provide cooling summer shade as well as insulation against heat loss during the heating season through the shelter that they provide from prevailing winds. Carefully sited, they can act as effective but attractive windbreaks.
Habitat and Biodiversity	• Hard boundaries can act as a barrier to wildlife corridors and so contribute to habitat fragmentation. Careful design can reduce this effect by incorporating transit routes for wildlife as well as shelter and in some cases food sources such as insect supporting habitats.

A Selection of Practical Considerations

Functionality, appropriateness and ability to sustain biodiverse green space

- Effectiveness of benefits dependent on size of space, planning, installation considerations e.g. ground conditions etc.
- Time to maturity of planting
- Shading and other benefits may vary in their effectiveness depending on the seasons e.g. deciduous planting, angle of the sun etc.
- Balancing soft landscaping against security and safety considerations

Cost

- Balancing costs relating to landscaping and planting, maintenance and

- management needs with the need for specialist input or arrangements
- Ongoing management and maintenance budgets will be dependent on the type of boundary protection selected.

Management and maintenance

- Careful planning needed to take account of long term management commitment
- Appropriate actions are taken at the right time of year i.e. tree pruning, bird nesting etc

Walls

The provision of green space in compact developed areas can be a challenge as land can be scarce and expensive. Adapting wall space in buildings and / or infrastructure installations to incorporate vegetation has the potential to allow substantial green space and effective green corridors to be created without the need for extra land take. They can also help achieve a wide range of additional economic, social and health benefits to society. In addition to these general benefits associated benefits specific to walls are summarised in the table below.

Options

Three options are summarised. The first, green walls, (also known as green façades, living walls, or vertical gardens) are partially or completely covered with greenery / vegetation. These can be split broadly into three types:

- Climbing facades: Plants are established in the ground or in suitable troughs at the base of the wall to be covered. A framework is then attached to the wall for the plants to 'climb-up' to provide the wall with its green covering.
- Hydroponic (soil-less): Generally grown on pre-constructed panels prior to vertical installation using a growing medium as root support. Once installed plants will continue to grow and further cover the structure.
- Substrate / soil-based: Use moulded troughs or containers that are built on or attached to existing walls (or similar structures). Planting is supported by soil-based substrates similar to those used in green roof installations utilising a lightweight combination of materials containing the right balance of nutrients with a free-draining medium.



Another option are wildlife friendly installations and designs that permit the transition of wildlife such as kerbs which contain recesses allowing animals to follow the lower edge of the kerb while keeping them clear of the drains, wildlife crossings integrated into bridges, roads tunnels, bird and bat boxes, insect hotels etc.

Wall materials and textures can also have a significant impact on wildlife by providing opportunities for climbing and food collection whilst creating risks, as is the case with larger areas of glazing and other highly reflective materials which frequently result in bird strikes.

Benefits	
People and Community - Health, Wellbeing, Comfort - Heritage and Local Character	• Can help create attractive and accessible places for people to enjoy direct and regular contact with the natural environment. • Can provide an opportunity for education. Examples include: ecological observations, growing plants and vegetables. • Can be used as growing space for food supporting local sourcing of food. • Can provide an instant impact and can be very varied in their look, therefore capable of being designed to suit the local character. • Use is not limited by densely populated areas. As such they do not limit the level of development that can take place around them.
Reducing Construction and Operational Impacts - Surface Water Runoff and Flood Management - Air Quality - Water Quality - Light Pollution - Glare control / shading - Noise Mitigation - Resilience	• Can provide good sound absorption capacities, unlike other hard surfaces in urban areas which only reflect it. • Can reduce night-time light pollution for occupants from streetlights and other external lighting sources by reducing light entering the building and internal light exiting the building. This can control excessive light spill and upward reflections to the sky and buildings.
Climate Change - Mitigation - Adaption	• Can reduce surface temperatures through shading and evaporative cooling so providing significant reduction in the Urban Heat Island effect. • Absorbing the heat above street level, preventing pavements and associated social spaces from heating up and can offer an evaporative cooling affect for users of these spaces.
Habitat and Biodiversity	See general benefits table

A Selection of Practical Considerations

Functionality, appropriateness and ability to sustain biodiverse green space

- Vertical greenery needs correct environmental conditions to be successful. This will be determined by the plant species and the system installed. Factors to consider include provision of the correct climatic conditions (e.g. temperature, sunlight, orientation and humidity/irrigation needs) as well as the support and substrate system and the level of management required.
- The level of light pollution control may vary seasonally, as particular plants may die back or drop leaves seasonally, resulting in varying levels of light blocking.
- Depending on the solution specified, it can take several years for vegetation to fully establish and mature sufficiently to provide the benefits intended (e.g. light control/screening etc.).

Cost

- Costs associated with installation and maintenance can vary significantly between climbing facades and green walls where plants are container based or hydroponically fed and irrigated.
- Ongoing management and maintenance budgets will be required dependent on the type of solution selected.

Management and maintenance

- Maintenance requirements can be intensive and can include preventative maintenance and replacement regimes. Green walls will typically require specialist management skills and planning throughout the life of the installation to ensure plant survival and maintain aesthetic and biodiversity benefits are realised in practice.

A Note on Hard Landscaping

Predominantly, hard landscaping is constructed using hard materials like stone, concrete and asphalt. Hard landscaping is predominantly used where there is likely to be significant foot fall or vehicle use, although in some instances it may be required for occasional use such as for fire brigade access around a building.

Urban sprawl and the associated need for car parking space has increased in recent years and with it the area of impermeable surfaces. This contributes massively to an increase in runoff due to the lack of permeable surfaces. Though not necessarily directly linked to biodiversity benefits some of the benefits of using alternative options to typical hard landscaping materials and solutions are highlighted below. Some of the general benefits in the 'Built Environment Elements, Ecological Options, Benefits' section are also relevant for Hard Landscaping.

Options

Cellular or open-block pavers (also known as turf block pavers, grow-through pavers) and plastic grid paving solutions provide a credible and cost-effective alternative to asphalt, concrete, and traditional paving in areas of lower intensity use such as car parks, drives, lower intensity access roads, pedestrian areas and paths. They can be made of concrete or recycled plastic with open cells that allow for a gravel or other permeable infill to allow for infiltration. Some insects will be able to make use of the gravel substrate resulting in an



La Caserne de Bonne, Grenoble

increase in food source for other ground feeding wildlife. Alternatively, in areas of light use and generally where vehicular use is very limited, grass or other smaller plant species can be sown to grow through them combining many of the practical benefits of a light use hard surface whilst retaining something of a garden/green look.

Porous asphalt: A type of porous pavement material specifically designed to allow rainfall and runoff to flow into and through the pavement structure. Porous pavement offers the potential to collect and/or slow the rate of run-off from other impervious surfaces. It can maintain water levels for adjacent planting such as urban trees and permit lighter traffic such as walking, cycling or even occasional vehicular use.

Benefits

- *Surface water runoff, flood risk management, water quality:* Permeable paving (porous pavements, gravelled areas etc) can help to improve water quality by removing pollutants through infiltration and helping to manage flooding. Paving systems can be designed to retain silts and retain/degrade oils and so can reduce watercourse pollution.
- *Climate change adaptation / mitigation:* Using precast concrete paving with high albedo (i.e. a lighter colour) can reduce the contribution of a development on the urban heat island effect.
- *Habitat and Biodiversity:* Depending on the site and situation cellular pavers can allow grass and plants to grow which support the surrounding ecosystem and natural environment in a limited way.



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Roofs

Most roofs are constructed with a view to removing rainfall as rapidly as possible however some roof constructions can provide a range of other benefits including water retention and ecological value. Well-designed green and brown roofs provide one way of achieving this especially where space is limited. Their potential to generate sustainability benefits are significant. In addition to these general benefits associated benefits specific to roofs are summarised in the table below.

Options

Green or brown roofs comprise a multi-layered system that covers the roof of a building or podium structure with vegetation cover / landscaping. In addition to structural and insulation elements, the roof will consist of an impermeable layer, a substrate or growing medium and a drainage layer (although not all green roofs require the latter).

- A green or living roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It typically also includes additional layers such as a root barrier and drainage and irrigation systems.
- A brown roof is similar to a green roof, but the overall aim is to increase biodiversity, and often aims to provide a home for local plants that may have been displaced by the build. A brown roof often has a more complex structure than a green roof to provide a more diverse range of habitats. There are many different types of vegetation that can be applied to roofs, and the final decision depends on the individual characteristics of each roof/building and the benefits that are required especially when it is being designed to provide ecological benefits.



These roofs can be split generally into two types:

- Extensive (drought tolerant, self-seeding vegetated roof, light weight thin substrate layers requiring minimal maintenance and management requirements).
- Intensive (an area with a deep substrate, load bearing capacity which can provides roof gardens, ponds, bushes, meadows trees etc. More complex and heavy than extensive roofs requiring more maintenance).

Benefits	
People and Community - Health, Wellbeing, Comfort - Heritage and Local Character	• Can improve the roofscape and overlook from other buildings as it is often more aesthetically pleasing than many conventional roofing solutions. • Can reduce the visual impact of development for both buildings and infrastructure especially in more rural or aesthetically sensitive locations. • Can make outdoor activities on the roof more pleasant and encourage people to go outside. • Can contribute to a reduction in the urban heat island effect by absorbing heat into the plants and substrate rather than reflecting it to the local environment. This can have a significant impact by lowering the health risks associated with high temperatures e.g. heat stroke and economic consequences that result. • Can become a focus of community life, where people are willing to get involved with local activities. For example, this can include retrofitting and creation of rain gardens, seeding of community meadows or planting of wetlands.
Reducing Construction and Operational Impacts - Surface Water Runoff and Flood Management - Air Quality - Water Quality - Noise Mitigation - Resilience	• Can act as a natural buffer helping to prevent flash flooding. Both the time to onset and the time to peak flow of stormwater entry are delayed, and the overall time taken to drain the roof is increased. The overall volume of stormwater is also reduced because of the retention by the substrate and other layers of the green roof. Can contribute to less frequent and less dramatic flood events for urban areas, thereby reducing costs to business and residents. • Can enhance the attenuation of diffracted sound and reduce the transmission of sound through a buildings' roof, particularly in buildings without additional ceiling insulation. Can also help to reduce road traffic and other external noise.

Climate Change - Mitigation - Adaption	• Can offer extra thermal performance by increasing insulation levels and so allow buildings to adapt better to the effects of climate change over time contributing to a reduction in energy consumption and lowering the cost of heating in winter and cooling in summer. • Can reduce surface temperatures and so reduce the long-term problems arising as a result of the urban heat island effect. • Can contribute to a reduction in the urban heat island effect by absorbing heat into the plants and substrate rather than re-emitting it to the local environment. • Can reduce roof surface temperatures and surround air through shading and remove heat from the air through evapotranspiration.
Habitat and Biodiversity	See general benefits table

A Selection of Practical Considerations

Functionality, appropriateness and ability to sustain biodiverse green space

- Additional structure may be necessary to support more complex roof construction (Intensive roofs are typically heavier than extensive ones)
- Where retrofitted, strengthening may be required to provide appropriate structural support and stability.
- Balance to be achieved between increasing the depth of substrate for stormwater management and the effect this will have on other aspects such as the need for increased structural support, biodiversity value and irrigation requirements

Cost

- Additional structural requirements may increase upfront costs although they may present opportunities to reduce some ongoing costs

- Ongoing management and maintenance budgets will be required dependent on the type of roof construction and planting.

Management and maintenance

- Management and maintenance requirements will depend on the type of planting and roof construction.
- With no ground water reserves and exposure to high winds and sunlight, the roofs can tend to dry out in drought conditions. Irrigation may be required for some types of planting during periods of low precipitation.
- If used for urban agriculture, the farming can be labour intensive and requires continual attention to manage crop production and distribution. This may raise safety and liability issues as compared with a low maintenance green roof.

A Note on Soft Landscaping

For the purposes of this document, soft landscaping is used as a term to describe landscapes that provide permeable surfaces for surface water and often contain significant planting. Soft landscaping can be made up of grass, shrubs, hedges, trees, flower beds and planters etc. As well as connecting green spaces through ecological corridors, street trees can line roads and pavements, providing ecosystem services in heavily urbanised areas. These green spaces can incorporate recreation, relaxation, transport, and biodiversity. They can provide economic, social and environmental benefits to developers and users. The best results achieved from soft landscaping solutions come when they are considered throughout the design process and are fully integrated into the development. Soft landscaping in a development can be managed or left to its natural processes. The benefits of soft landscaping are summarised in the 'Built Environment Elements, Ecological Options, Benefits' section.



Drainable Systems

There are two distinct requirements for drainage systems relating to foul and surface water. Black (sewage) and grey water treatment can be provided through the use of more natural installations such as reedbeds where space, regulation and acceptability allow. Surface water drainage manages the surface water run-off due to impermeable surfaces (roof, walls, driveway etc) in urban areas.

Sustainable drainage systems (SuDS) are designed to manage surface water runoff, in a more sustainable, natural way than by conventional drainage which can perform the same, or better, than more conventional systems. Surface water can be a major source of pollution especially from hard surfaces such as carparks, roads and landscaped areas unless steps are taken to remove or treat the pollution before discharge. Benefits specific to SuDS are summarised in the table below.

Options

Sustainable Urban Drainage Systems

Approaches to managing surface water that take account of water quantity (flooding), water quality (pollution) biodiversity (wildlife and plants) and amenity are collectively referred to as Sustainable Drainage Systems (SuDS).

SuDS mimic natural processes and typically manage rainfall close to where it falls. SuDS can be designed to convey surface water, slow down runoff rates (attenuation) before it enters watercourses to reduce the impact of flash runoff at peak rainfall times. They provide areas to store water in natural contours and can be used to encourage the absorption of rainwater into the ground (infiltration) or evaporation to the atmosphere from surface water bodies and from vegetation (known as evapotranspiration). The former helps to ensure that ground water



levels are maintained with major benefits in terms of maintaining water supplies from aquifers, natural water courses and avoiding ground shrinkage leading to subsidence and other soil stability problems.

SuDS can be used to incorporate ecology and social well being aspects into local drainage systems and reduce the broader environmental and social impacts of remote management and treatment in centralised drainage systems. They can include filter strips and filter drains, attenuation basins, swales, sacrificial landscaped retention areas, infiltration trenches, infiltration basins (rain gardens) and open spaces. Recreational areas can also be incorporated into the design of SuDS.

Benefits	
People and Community - Health, Wellbeing, Comfort - Heritage and Local Character	• Encourages the resilience of green space in urban areas by controlling the water at the source and offers a whole landscape approach to the management of surface water. • Combining water management with green spaces can provide more recreational space for the benefit of users and the wider community as appropriate. • Can provide many opportunities for learning, informal recreation, supported play and other community programmes. Retention area, swales, and detention basins can provide teaching spaces for tactile learning. • SuDS design features can take into consideration the character of the landscape, allowing for better integration and acceptance as well as maximising ecological and biodiversity benefits.

Reducing Construction and Operational Impacts - Surface Water Runoff and Flood Management - Air Quality - Water Quality - Glare control / shading - Resilience	• Offers an opportunity to combine the necessary drainage required with natural elements that can benefit ecosystems. • Filter strips, filter drains, detention basins, swales, retention areas, detention basins (sacrificial areas to allow for temporary flooding to attenuate runoff and encourage infiltration), infiltration trenches, and infiltration basins can all be used together to form a network. Drainage systems for buildings could be interconnected to form a SuDs network. This could be on housing developments, industrial sites, retail parks, etc. • Vegetated filter strips also reduce runoff velocities, surface erosion and increase the time of concentration as compared to channelized flow, resulting in a reduction of peak discharge rates. • Can absorb or remove certain pollutants, including nitrogen dioxide (NO₂), sulphur dioxide (SO₂), particulates (PM10) and ozone (O₃), so providing benefits to people that live, visit or pass through the area. • Preventing contamination of natural rainwater with untreated sewage. • Improve water quality where the water passes through green planted systems. • Reduces the flood risk to buildings, infrastructure and other assets which can lower the cost of repairs to the asset itself, more widely in a community and to the local environment more generally.
Climate Change - Mitigation - Adaption	• Can impact surrounding microclimates by reducing temperatures and improving comfort, contributing to global climate change mitigation. • Can replace some of the evaporative cooling lost through urbanisation providing climate change adaption against urban heat island effects. • Can support runoff management (see previous section). • Filter strips can serve as a location for snow storage during winter months and will also help to trap and treat the salt and sand in snow when it melts.
Habitat and Biodiversity	• Can increase the diversity of habitat to increase food resources for local wildlife through the promotion of amphibians and insects. • Provides habitats for wildlife in urban watercourses.

A Selection of Practical Considerations

Functionality, appropriateness and ability to sustain biodiverse green (and blue) space

- The design of SuDS installations selected must consider local soil type, groundwater table, size of area serviced, imperviousness and slope of swale system. Swales are impractical for areas with very flat or very steep slopes (no more than 5%).
- Retrofitting/regeneration opportunities will often exist for the use of SuDS solutions within an existing development context, however, this is likely to be more challenging than on an open or undeveloped site to avoid unintended impacts and ensure that benefits are achieved in practice.
- Plants used within drainage solutions should be selected specifically for their nutrient uptake ability and site opportunities/restrictions as well as their appropriateness to the local ecosystem.
- Seasonality must be considered when developing and maintaining SuDS to ensure the system operates properly.

Cost

- SuDS basins and other solutions can be relatively expensive in some instances. Variables influencing cost effectiveness include landscape and soil type, land prices, permit cost and design and construction costs.

- Ongoing management and maintenance budgets will be required dependent on the type of solution selected.

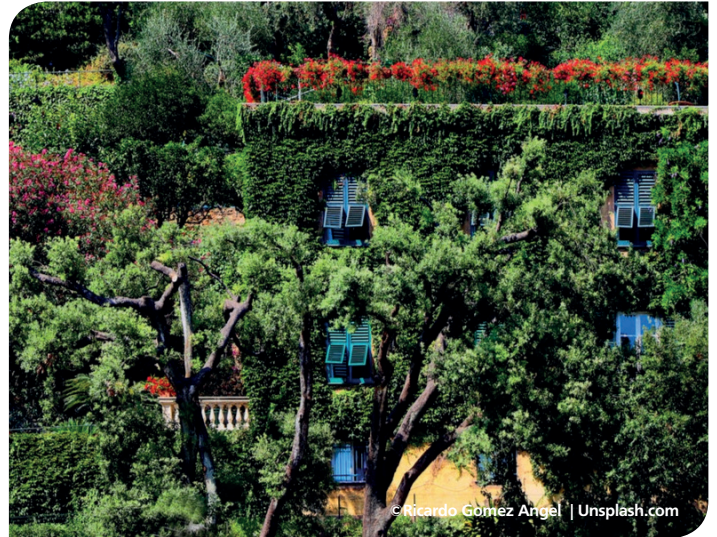
Management and maintenance

- SuDS require maintenance to ensure that they continue to operate effectively. Potential issues arise as a result of sediment collection in substrates that impact on infiltration levels, blocked overflows and overgrown plants etc.
- Performance of SuDS should be monitored on a regular basis as maintenance needs will depend on climatic and other factors.
- In some instances it is unclear who is responsible for ensuring that SuDS continue to operate effectively once they are built. This may often be assumed to be covered by landscape contractors but specialist skills are required. Responsibilities should, therefore, be clear and help support management and maintenance plans and performance should be monitored on a regular basis.
- A strong commitment to maintenance is required to ensure continued function of the drainage basin. Annual inspections and necessary repairs can include: removal of built up sediments, gullies etc formed in the vegetation mat and replanting any bare soil patches.

In summary

This paper has summarised a variety of ecology-focused alternatives to standard commonly specified built environment solutions and their potential associated sustainability benefits. The hope is that the content will help inform clients, developers and project teams making design and specification decisions for building or infrastructure developments, as well as landlords and facilities / asset managers making management, maintenance, refurbishment or retrofitting decisions.

It aims to highlight the relevance and availability of more ecologically sensitive options to standard specification solutions and so encourage the investigation of viable alternatives for projects, developments or assets. It also highlights the additional benefits that can be achieved by enhancing ecological value in the built environment. These benefits will have an impact on the level of recognition in BREEAM and other schemes that measure and certify the sustainability performance of the built environment that is additional to the ecological benefits themselves and as such boosts the business case for taking ecology seriously when decisions are being made.



Appendix A

Ecology in BREEAM

Ecology is one of a series of key sections included across the BREEAM family of schemes as it relates to decisions made in relation to

opportunities and solutions at a district, neighbourhood, building and infrastructure level (See Figure 1).

Figure 1 – Relationship



The Ecology section encourages project teams and facilities managers to identify ecologically valuable features and opportunities to protect and enhance habitats and local ecosystems, and to mitigate unavoidable impacts. It also seeks to improve long term biodiversity management practices and strategies for assessed sites and associated areas through careful consideration of future management, maintenance and adaptability requirements to ensure that long term objectives are both achievable and viable.

Having successfully driven consideration of ecological impacts of the built environment across many projects, BREEAM's approach to assessing ecological impacts had remained largely unchanged since 1998. Recognising that there have been significant developments over the last decade in knowledge, understanding and best practice around the evaluation, protection and enhancement of ecological features and in evolving several related key policy areas (biodiversity metrics, ecosystem services and natural capital), BREEAM has worked with a wide range of stakeholders to understand how to move forward development of the Ecology assessment issues. Stakeholders included the UK Green Building Council, professional bodies such as Chartered

Institute of Ecology and Environmental Management (CIEEM) and the Landscape Institute, as well as a range of consultants, developers, designers, constructors, landscape contractors, managers and policy makers and more. The aim has been to better reflect current best practice and respond to developing policy concerns and opportunities including consideration of natural capital and ecosystem services. The output was a Strategic Ecology Framework to establish a robust and forward-looking strategy for BREEAM that is supportive of the forward direction in this important area and to guide development of BREEAM schemes. This was published in 2016 and is available as a free download from the BREEAM Website.

The Strategic Ecology Framework is intended to provide a consistent and holistic framework within which BREEAM schemes will set criteria appropriate to the sector and/or life cycle stage that they relate to. It is used to guide alignment of the ecological criteria, maximising synergies between schemes and efficiencies in assessment through the transfer of assessment results where appropriate. Its aims are summarised in Figure 2.

Figure 2 – Hierarchy of evaluation and recognition within BREEAM Schemes



Appendix B

Acknowledgements and Glossary

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Glossary

Biophilia: (meaning love of nature) focuses on humans' innate connection to nature and natural processes.

Biophilic design: design which integrates nature and natural elements, materials and forms into architecture and interiors. Biophilic Design uses these ideas as principles to create a human centred approach that when applied improves many of the spaces that we live and work in today, with numerous benefits to our health and well-being.

Carbon sequestration: the act of absorbing and storing atmospheric carbon dioxide.

Ecosystem services: the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; economic value such as tourism and cultural/social services such as health and wellbeing, recreational, spiritual, religious and other non-material benefits.

Evapotranspiration: the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.

Ha-ha: a traditional form of landscape boundary in the UK and some other parts of Europe, comprising a ditch with a retaining wall on its inner side usually constructed to form a boundary between a park or garden for the purpose of excluding animals from the later without interrupting the view.

Hydroponic: the process of growing plants without using soil by instead using nutrients in sand or liquids.

Micro-climate: the distinctive climate of a local area, whose weather variables, such as temperature, rainfall, wind or humidity, may be subtly different to the conditions prevailing over the area. Micro-climate will be influenced by environmental variables such as vegetation cover, aspect and proximity to water.

Sustainable urban drainage systems (SuDS): systems designed to slow down and reduce the amount of surface water runoff within developed areas to manage flood risk, through harvesting, infiltrating, storing and treating runoff. SuDS can take the form of rainwater harvesting systems, green roofs, pervious pavements swales and soakways.

Urban heat island effect: an area or locality which has a higher temperature than its surroundings; especially an urban area having a sustained higher temperature, owing to heat generation by vehicles and energy consumption, and to the absorption of sunlight by roads and buildings.

Appendix C

Further Information and References

Further Information

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