Green Infrastructure Planning and Design Guide

Designing nature-rich, healthy, climate-resilient, and thriving places

NATURAL ENGLAND

Contents

Front cover: natural play, RHS Wisley (credit: RHS/Davies White); Elephant Park, London (credit: Lendlease); pond, Stratford (credit: Biodiversity by Design); remaining images/photos (credit: Jacobs Consulting)

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Foreword

Now more than ever we need to place Nature at the heart of making and regenerating attractive, investable places that are good for people, climate, and the economy. Good design that integrates green infrastructure from the outset is essential if we are to deliver the Nature recovery, climate change adaptation, net zero targets, health and wellbeing benefits and the economic prosperity that we need. Examples of green infrastructure design features include pocket parks, green roofs, street trees and 'rain gardens', which can all play a role in supporting and enhancing Nature in urban areas, as well as delivering benefits for people.

For me the greenspace close to where I live is a vitally important place that contributes hugely to quality of life, through being an attractive place for exercise, a daily dose of green and casual encounters with Nature, such as the mature deciduous trees that chart the changing seasons, the summer visiting common terns flying along the river, small tortoiseshell caterpillars growing bigger by the day on the nettles in the un-mowed areas or simply having enough open space to create a horizon that reveals the sight of dramatic clouds and the ever changing sky. Even though we live in the centre of the city of Cambridge, having that daily connection with Nature and its cycles is an essential part of what makes our neighbourhood so liveable and popular.

People often feel passionate about their local greenspace because it's a place where they experience and connect with Nature. Green and blue spaces provide the places we meet, socialise, relax, exercise, and connect with Nature on a day-to-day basis. They provide an estimated £25.6bn of 'recreational welfare value' every year and do so in a very cost effective manner, considering how only a fraction of that value is needed to maintain them. The cost effectiveness point is demonstrated in how for every £1 spent on parks in England an estimated £7 in additional value for health and wellbeing and the environment is generated. Green infrastructure provides other important services for society, trees for example, can help store carbon, provide valuable shade, and, when positioned appropriately, help reduce flooding and buffer noise and air pollution. Other green and blue spaces bring a range of benefits including for food, biodiversity, and pollination.

However, inequalities in access to greenspace were brought into sharp focus during the coronavirus pandemic. So, in this design guide we set out how good planning and design can help to address these inequalities by supporting the ambition that:

Everyone has access to and benefit from good quality green and blue spaces within 15 minutes' walk from home.

Good design can help to make towns and cities greener and more beautiful, attracting inward investment, retaining skilled staff, and increasing productivity. Greener high streets can encourage people to visit them and stay longer, becoming more economically successful and resilient. Green roofs and walls can insulate buildings, helping to reduce energy use, whilst also generating energy when designed as biosolar roofs. In this design guide we set out how good design can:

Support an uplift in the greening of residential urban neighbourhoods to at least 40% (or UGF 0.4) average green cover (in areas that don't meet this baseline) and support an uplift in urban woodland canopy cover.

The Green Infrastructure Planning and Design Guide provides evidence based practical guidance on how to plan and design good green infrastructure. It complements the National Model Design Code[1] and National Design Guide[1] and can be used to help planners and designers develop local design guides and codes with multifunctional green infrastructure at the heart. It will also be useful to landscape architects, urban designers, parks and greenspace managers and neighbourhood planning bodies.

Restoring Nature is one of the most important things we can do for the long-term health and prosperity of people, wildlife, and our economy. Using the Green Infrastructure Planning and Design Guide can support Government's 25 Year Environment Plan commitment to leave the environment in a better state than it was before and to making greener, healthier, climate resilient, distinctive, and thriving places to live learn work and play.

Dr Tony Juniper CBE, Chair of Natural England

[1] Department for Levelling Up, Housing and Communities, and Ministry of Housing, Communities & Local Government

Chapter 1: Introduction

Introduction

1.1 Purpose of the Design Guide

This guide aims to provide practical, evidence-based advice on how to plan, design, deliver and manage good quality green infrastructure that helps to create beautiful nature-rich places that support people's health and wellbeing, make places more resilient to climate change, and create attractive investable places that are good for the economy.

It is aimed primarily at local authorities, particularly those officers within local authorities who are responsible for generating design codes, but it is also intended to be of value to a wider readership that includes planners, developers, urban designers, engineers, landscape architects, ecologists, and neighbourhood planning bodies, as well as anyone responsible for the development and management of accessible natural green space and other green infrastructure. It also aims to help other sectors, including health, transport, energy, education, heritage, and regeneration, to identify opportunities to deliver their policies. The aim is to integrate and mainstream good green infrastructure solutions.

The guide is part of Natural England's National Green Infrastructure Framework (see Chapter 2) and complements the National Model Design Code and National Design Guide[2] (see Chapter 3).

The guide advises on:

- How to apply the National Green Infrastructure Framework, including Principles and Standards to good design.
- How to design green infrastructure features as the building blocks of a larger interconnected network.
- How to combine green infrastructure features within different area types to create multifunctional and connected networks at different scales.
- How to design green infrastructure to meet identified needs; in particular - nature, health, wellbeing, climate change adaptation and mitigation, water management, and economic prosperity.
- How to develop landscape led green infrastructure with a focus on landscape character and local distinctiveness.
- The application of tools and strategies such as Biodiversity Net Gain, Urban Greening Factors and Local Nature Recovery Strategies, in the context of green infrastructure design.

[2] Ministry of Housing, Communities and Local Government, 2021 (Department for Levelling Up, Housing and Communities)

- Relevant case studies that illustrate the design principles and sources of further information.

1.2 What is Green Infrastructure?

The National Planning Policy Framework 2021 defines green infrastructure 'as a network of multifunctional 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.'

A green infrastructure network includes street trees, green roofs, green walls, parks, private gardens, allotments, sustainable drainage systems, through to wildlife areas, woodlands, rock outcrops, wetlands, and natural flood management functioning at local and landscape scale. Linear green infrastructure includes roadside verges, green bridges, field margins, rights of way, access routes, and canals and rivers.

Green infrastructure is also described by the JNCC as blue green infrastructure. Blue Infrastructure is the term used to refer to the water elements of green infrastructure, including watercourses, waterbodies, and wetlands. Nature-based Solutions (N-bS) is a term used to describe many of the elements of green infrastructure. The IUCN uses the term Nature-based Solutions to describe 'natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.'

Good quality green infrastructure is a vital component of both urban and rural environments. Well-designed and managed green infrastructure generates multiple benefits for people and nature; it creates greener, healthier, more climate resilient and more equitable places to live that in turn support a more productive and sustainable economy.

Green infrastructure plays a big role in climate change mitigation by sequestering carbon and to climate change adaptation through urban cooling and reducing flood risk.

Improvements to green infrastructure can be delivered as part of new development through the planning process, better management and upgrading of existing green infrastructure, and retrofitting of new green infrastructure, wherever opportunities arise, but particularly in areas where provision is poor.

Chapter 2: How can the National Green Infrastructure Framework Support Good Design?

How can the National Green Infrastructure Framework Support Good Design?

2.1 Green Infrastructure Framework

The Green Infrastructure Framework: Principles and Standards for England is a commitment to the Government's 25 Year Environment Plan. The aim is to green our towns and cities and improve existing green infrastructure. The components of the Green Infrastructure Framework are set out in Figure 1.

Further Information on the Framework, including the green infrastructure mapping database can be found here. Of particular importance for the planning, design and nurture of green infrastructure are the **Green Infrastructure Principles,** which set out:

- **Why** green infrastructure is important for nature, physical and mental health and wellbeing, prosperity, water, and climate.
- **What** good green infrastructure looks like - multi-functional and varied, connected, accessible and responsive to landscape (including historic) character.
- **How** to plan, design and nurture green infrastructure, namely:
  - ➢ Partnership working with a shared vision
  - ➢ Evidence-based
  - ➢ Strategically planned
  - ➢ Beautiful design from the outset
  - ➢ Good management, monitoring, and evaluation, supported by good governance and adequate funding

Green Infrastructure Principles and Standards	Green Infrastructure Guidance	Green Infrastructure Mapping and other Evidence
GI Principles: • 'Why' do GI • 'What' good GI is • 'How' to do GI **Headline GI Standards** • GI Standards Summary • Greening Factor Reports and Case Studies	**GI Planning and Design Guide** **Process Journeys** Step-by-step guides for: • Local planning authorities • Neighbourhood Planning Groups • Developers	**GI Mapping Database for England** **GI Mapping User Guide** **Health and Wellbeing Evidence Review** **Glossary**

Figure 1: Structure of the Green Infrastructure (GI) Framework

2.2 Green Infrastructure Principles

When designing green infrastructure, it is important to consider how it is planned and designed strategically from the outset, the key characteristics or attributes of a green infrastructure network and the outcomes required. Thinking about these principles from the outset can inform good design. A summary of the Green Infrastructure Principles is given below. More detailed guidance on the Green Infrastructure Principles can be found on the Natural England Green Infrastructure website.

Providing multi-functionality and designing with management and maintenance in mind can be particularly problematic, because of divisions in responsibility, which means that special consideration should be given to these principles.

WHY Green Infrastructure is important (its benefits/ outcomes)

Why 1: Nature-Rich Beautiful Places - Green infrastructure supports nature to recover and thrive everywhere, in towns, cities and countryside, conserving and enhancing natural beauty, wildlife and habitats, geology and soils, and our cultural and personal connections with nature.

Why 2: Active and Healthy Places - Green neighbourhoods, green/blue spaces and green routes support active lifestyles, sense of place, community cohesion and nature connections that benefit physical and mental health, wellbeing, and quality of life. Green infrastructure also helps to mitigate health risk factors such as urban heat stress, noise pollution, flooding, and poor air quality.

Why 3: Thriving and Prosperous Communities - GI helps to create and support prospering communities that benefit everyone and adds value by creating high quality environments which are attractive to businesses and investors, create green jobs, support retail and high streets, and help support the local economy and regeneration.

Why 4: Improved Water Management - Green infrastructure reduces flood risk, improves water quality and natural filtration, helps maintain the natural water cycle and sustainable drainage at local and catchment scales, reducing pressures on the water environment and infrastructure, bringing amenity, biodiversity, economic and other benefits.

Why 5: Resilient and Climate Positive Places - Green infrastructure makes places more resilient and adaptive to climate change and helps to meet zero carbon and air quality targets. Green infrastructure itself should be designed to adapt to climate change to ensure long term resilience.

WHAT good Green Infrastructure looks like (the attributes of good green infrastructure)

What 1: Multifunctional - Green infrastructure should deliver a range of functions and benefits for people, nature, and places, and be designed to meet their needs. Multifunctionality (delivering multiple functions from the same area of green infrastructure) is especially important in areas where provision is scarce or of poor quality.

What 2: Varied - Green infrastructure should comprise a variety of types and sizes of green and blue spaces, green routes, and

environmental features (as part of a network) that can provide a range of different functions, benefits, and solutions to address specific issues and needs.

What 3: Connected - Green infrastructure should function and connect as a living network for people and nature at all scales (e.g., within sites, across regions and at the national scale). It should enhance ecological networks and support ecosystems services, connecting provision of green infrastructure with those who need its benefits.

What 4: Accessible - Green infrastructure should create and maintain green liveable places that enable people to experience and connect with nature, and that offer everyone, wherever they live, access to good quality parks, green spaces, walking and cycling routes that are inclusive, safe, welcoming, well-managed and accessible for all.

What 5: Character - Green infrastructure should respond to an area's character so that it contributes to the conservation, enhancement and/or restoration of landscapes; or, in degraded areas, creates new high-quality landscapes to which local people feel connected.

HOW to Plan, Design, and Nurture Green Infrastructure

How 1: Partnership and Vision - Work in partnership and collaborate with stakeholders from the outset to identify opportunities and constraints, co-plan, develop and deliver a vision for green infrastructure in the area. Engage a diverse and inclusive range of people and organisations including citizens, neighbouring local authorities, developers, communities, landowners, green space managers, environmental, health, climate, transport, and business representatives.

How 2: Evidence - Use scientific evidence, and good land use practices when planning and enhancing green and blue infrastructure. Understand existing green infrastructure assets and the environmental, social, and economic challenges and needs in the area. Refer to good practice for caring for and enhancing green infrastructure.

How 3: Plan Strategically - Plan strategically and secure green infrastructure as a key asset in local strategy and policy, at all scales. Fully integrate and mainstream green infrastructure into environmental, social, health and economic policy. Create and maintain sustainable places for current and future populations, and address inequalities in green infrastructure provision and its benefits.

How 4: Design – Understand an area's landscape/townscape, natural, historic and cultural character to create well-designed, well-managed, beautiful, and distinctive places.

How 5: Managed, valued, monitored, and evaluated - Plan good governance, funding, management, monitoring, and evaluation of green infrastructure as a key asset from the outset and secure it for the long-term. Make the business case for green infrastructure. Engage communities in stewardship where appropriate. Celebrate success and raise awareness of green infrastructure benefits.

2.3 Green Infrastructure Standards

The Green Infrastructure Framework includes national **Headline Green Infrastructure Standards**, which set out the ambition for green infrastructure in terms of quantity, quality, and type to enable everyone to benefit from good green infrastructure. These standards will be voluntary and are referred to in the National Model Design Guide. National standards can then be applied through local strategies, plans and policies, engaging with communities and stakeholders, so that they respond to local context and needs. Green infrastructure delivery can be planned through a series of local targets.

The Headline Green Infrastructure Standards, when used together in a place will guide the quantity, accessibility/proximity, capacity, function, and quality of the green infrastructure, to deliver the 5 'What' Principles for good green infrastructure, enabling the resulting green infrastructure to deliver the main 5 'Why' or outcomes of green infrastructure. These Headline GI Standards will in due course be supported by a **wider Menu** of GI Standards, with a **signposting table** that allows users to identify the standards that match their purpose, context, and outcomes, and shows which standards help to deliver the Green Infrastructure Principles in different contexts.

The Green Infrastructure Standards can help to support good design. Local plan green infrastructure policies in development plans and local design codes will set the context for development and should be referred to for local development requirements.

The Headline Green Infrastructure Standards are set out below. They distinguish the recommended levels of achievement for **major new developments**[3] and for **area wide application.**

Summary of Headline Green Infrastructure Standards

1. Green Infrastructure Strategy Standard

Area wide:

- Local authorities, working in partnership with stakeholders including local communities, assess and strategically plan their green infrastructure provision, for example as part of a green infrastructure strategy. Plans set out how green infrastructure will help to create greener, beautiful, healthier, and more prosperous neighbourhoods, with a

[3] Major development - For housing, development where 10 or more homes will be provided, or the site has an area of 0.5 hectares or more. For non-residential development it means additional floorspace of 1,000m² or more, or a site of 1 hectare or more, or as otherwise provided in the Town and Country Planning (Development Management Procedure) (England) Order 2015.

thriving nature network that can reduce air and water pollution, support sustainable drainage, and help places adapt to climate change.

In doing this, they apply the National Green Infrastructure Standards locally (adapting them to local context where appropriate) and set green infrastructure policies, proposals and development requirements in development plans and local design codes. Local authorities set SMART targets in a Delivery Plan for achieving the national standards and local policies over time, as well as arrangements for the long-term management and maintenance of all green infrastructure.

- Plan and monitor and evaluate progress against delivery of these local targets every five years.

Major development:

- Each major new development has a green infrastructure plan (which may be part of a Design and Access Statement) setting out how the development will deliver the local green infrastructure policies, proposals and development requirements in development plans and local design codes. The green infrastructure delivered within (or associated with) major new developments should be managed, maintained, and monitored for a minimum of 30 years.

2. Accessible Greenspace Standards, including Quality Standards

Area wide:

- Accessible Greenspace Standards (AGS) – size and proximity criteria: Everyone has access to good quality green and blue spaces close to home for health and wellbeing and contact with nature, to meet the Accessible Greenspace Standard size and proximity criteria (see Figure 2), with an initial focus on access to green and blue spaces within 15 minutes' walk from home.

- Accessible Greenspace Standards – capacity criteria: Local authorities have at least 3 hectares of publicly accessible greenspace per 1,000 population and there is no net loss or reduction in capacity of accessible greenspace per 1,000 population. Local authorities specify capacity targets for all major residential development informed by a local accessible greenspace baseline, and considering local needs, opportunities, and constraints.

- Accessible Greenspace Standards – quality criteria: Accessible greenspace meets the Green Flag Award Criteria, and best practice in accessibility for all at an area wide scale.

Major development:

- Accessible Greenspace Standards – size and proximity criteria: For all major residential developments, the local authority specifies to the developer the quantity, size, and distance criteria (see Figure 2) for any accessible greenspace to be provided within/ associated with the development, based on the Accessible Greenspace Standards.

- Accessible Greenspace Standards – capacity criteria: All major residential development is designed to meet capacity

targets (hectares of accessible greenspace per 1,000 population), specified by the local planning authority.

- Accessible Greenspace Standards – quality criteria: Accessible greenspace meets the Green Flag Award Criteria, and best practice in accessibility for all in major new developments.

3. Urban Nature Recovery Standard

Area wide:

- In urban and urban fringe areas, the proportion of green infrastructure that is designed and managed for nature recovery is increased by an agreed percentage based on a locally defined baseline and considering local needs, opportunities, and constraints. This includes the creation and restoration of wildlife rich habitats, which can contribute to the delivery of local nature recovery objectives.

- Local authorities in urban and urban fringe areas set targets for nature recovery through provision and sustainable management of Local Nature Reserves and Local Wildlife Sites, to:

  - Provide 1 hectare of Local Nature Reserve (LNR) per 1,000 population (for nature conservation and quiet enjoyment).

  - Enhance existing and identify new areas that qualify as Local Wildlife Sites (for nature conservation).

Major Development:

- The developer identifies in the green infrastructure plan for the development (and in the Design and Access Statement, as appropriate), its contribution to nature recovery and the creation and restoration of wildlife rich habitats, which can contribute to the delivery of local nature recovery objectives, including the potential for creation or enhancement of Local Nature Reserves or Local Wildlife Sites.

4. Urban Greening Factor Standard

Area wide:

- Urban greening is at least 40% average green cover in urban residential neighbourhoods where they do not already meet that standard. There is no net loss of green cover in urban neighbourhoods.

Major Development:

- Major development meets National Urban Greening Factors of at least 0.3 for commercial development, 0.4 for residential development, (and, where appropriate, 0.5 for residential greenfield development).

5. Urban Tree Canopy Cover Standard

Area wide:

- Urban Tree Canopy Cover is increased by an agreed percentage based on a locally defined baseline and considering local needs, opportunities, and constraints.

Major Development:

- Major residential and commercial development is designed to meet these targets.

- New and existing trees are incorporated into new developments and new streets are tree lined (in line with National Planning Policy Framework (NPPF) requirements[4]).

Notes to accompany the Green Infrastructure Standards

- Long term management and maintenance underpins all the standards as set out in the Green Infrastructure Strategy Standard.

- Suitable Alternative Natural Greenspace (SANGS), which is the name given to greenspace that is of a quality and type suitable to provide alternative greenspace to divert visitors from visiting sensitive sites such as Special Protection Areas (SPAs). SANGS are intended to provide mitigation for the potential impact of residential development on the SPA by preventing an increase in visitor pressure on the SPA. To achieve this, a higher standard than the Accessible Greenspace Standards (above) is often set, i.e., a SANGs Standard of 8 hectares per 1,000 head of new population. The effectiveness of SANGS as mitigation will also depend upon the location and design.

- The Accessible Greenspace Standards refer to Green Flag Award criteria.

- The Accessible Greenspace Standards refer to best practice in accessibility for all. This is set out in The Sensory Trust By All Reasonable Mean: least restrictive access to the outdoors Commissioned by Natural England in collaboration with Natural Resources Wales, The Sensory Trust, Cornwall, England.

Access to Greenspace Close to Home Target

Local Authorities are encouraged to adopt a local Greenspace Close to Home Access target:

- Everyone has access to a variety of good quality green and blue spaces within fifteen minutes' walk of their home by date x (local authorities to set date).

This could be defined in terms of the Accessible Greenspace Standards, EITHER a Doorstep OR Local Accessible Greenspace:

[4] Paragraph 131

- A Doorstep Accessible Greenspace of at least 0.5ha within 200 metres.

- A Local Accessible Natural Greenspace of at least 2ha within 300 metres.

AND a Neighbourhood Accessible Natural Greenspace

- A medium sized Neighbourhood Accessible Natural Greenspace (10ha) within 1km.

As a minimum, there should be an ambition for everyone to have access to a variety of greenspace within 15 minutes' walk from home. This could be a stepping stone to achieving a fuller range of size-proximity Accessible Greenspace Standards.

Natural England has done initial baseline analysis of the 15-minute target in its Mapping Database, but further work is needed to refine this further. This will be available in 2023.

2.4 Monitoring and evaluation

Natural England has developed an Evaluation Plan for the Green Infrastructure Framework, to help monitor progress at a national level. This proposes the indicators for green infrastructure which relate to each of the Green Infrastructure Standards, to measure and monitor their achievement.

These indicators will contribute to reporting on the 25 YEP Outcome Indicator Framework, which includes an indicator (G3) for enhancing Green and Blue Infrastructure. The G3 indicator is in development for reporting in 2023, and will cover accessibility, greenness, and perceptions of green infrastructure quality.

In addition, we will provide guidelines for local authorities to undertake their own local monitoring against their locally set targets.

Self-Assessment and Accreditation

Local authorities can self-assess their green infrastructure against the emerging Green Infrastructure Standards. Further detailed guidance on applying the Green Infrastructure Standards can be found on the Green Infrastructure Framework website.

There are also several different accreditation systems that have a role in providing routes for verification and drivers for good quality green infrastructure. These mostly provide voluntary mechanisms to improve the delivery of multifunctional green infrastructure at a variety of scales. Examples include Green Flag Award; Country Park accreditation scheme; Building Research Establishment Environmental Assessment Method (BREEAM); Building for Life 12; Building with Nature Award; Arcadis Sustainable Cities Index.

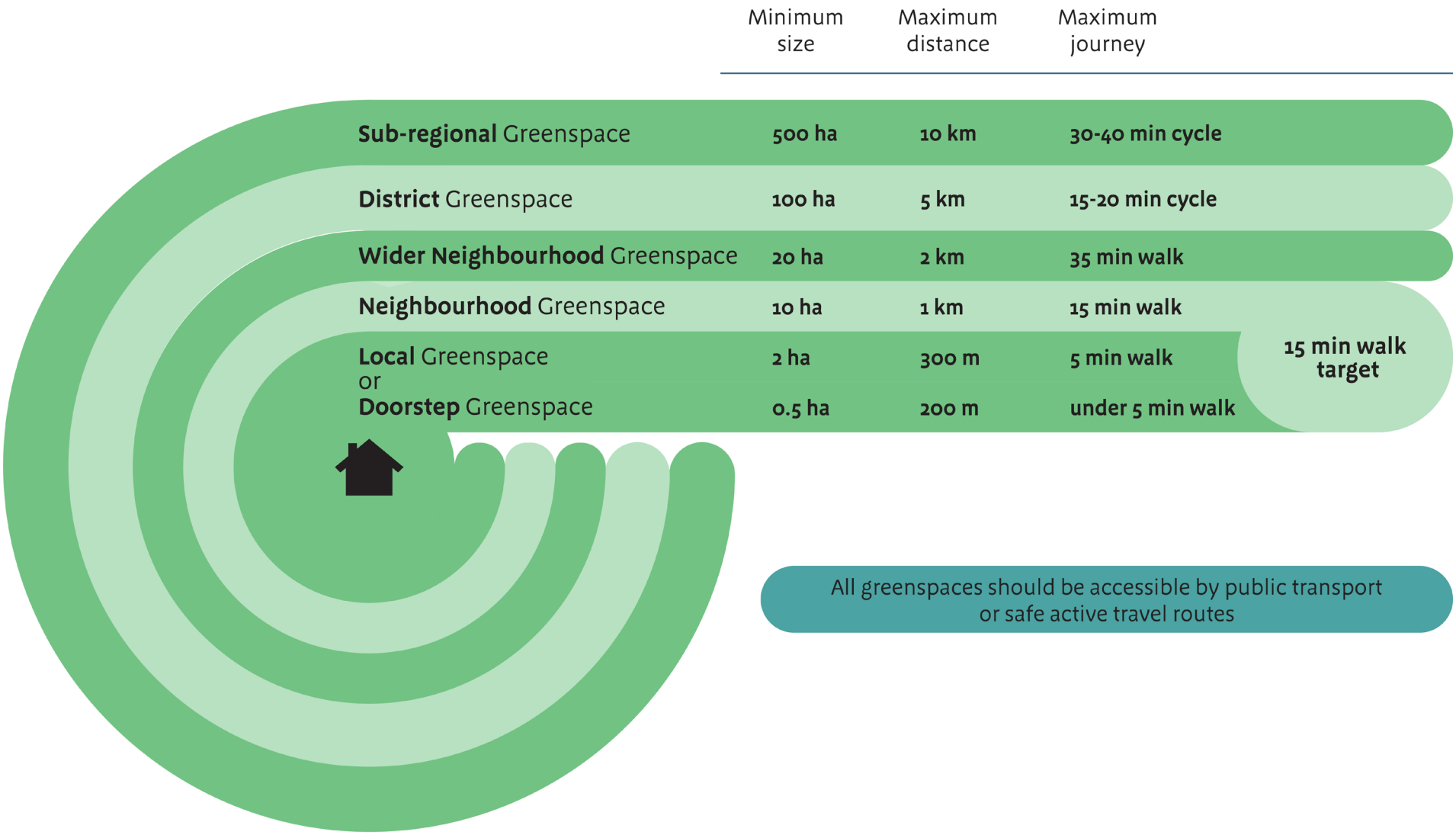


Figure 2: Accessible Green Space Standards

Chapter 3: Integrating Green Infrastructure into Well-Designed Places

Integrating Green Infrastructure into Well-Designed Places

3.1 Ten Characteristics of Well-Designed Places

The National Planning Policy Framework makes it clear that the creation of high-quality buildings and places should be fundamental to the planning and development process. The National Design Guide, the National Model Design Code (NMDC) and Guidance Notes for Design Codes, illustrate how places that are beautiful, healthy, greener, more biodiverse, enduring, and successful, can be designed.

The National Design Guide considers how we recognise well-designed places, by outlining and illustrating the Government's priorities in the form of ten characteristics.

These characteristics combine to create physical **Character**. The ten characteristics help to nurture and sustain a sense of **Community**. Although there are trade-offs, the characteristics can also positively address environmental issues affecting **Climate**. They contribute towards the cross-cutting themes for good design set out in the National Planning Policy Framework.

The ten characteristics of well-designed places are listed below and illustrated in Figure 3:

1. **Context** – enhances the surroundings.
2. **Identity** – attractive and distinctive.
3. **Built form** – a coherent pattern of development.
4. **Movement** – accessible and easy to move around.
5. **Nature** – enhanced and optimised.
6. **Public spaces** – safe, social, and inclusive.
7. **Uses** – mixed and integrated.
8. **Homes and buildings** – functional, healthy, and sustainable.
9. **Resources** – efficient and resilient.
10. **Lifespan** – made to last.

Green infrastructure is essential and integral to well-designed places and should not be regarded as an optional enhancement. Green infrastructure and its ecosystem functions are essential for successful urban, or rural environments.

Table 1 shows how green infrastructure can contribute to the 10 characteristics of a well-designed place through delivering 12 ecosystem services.

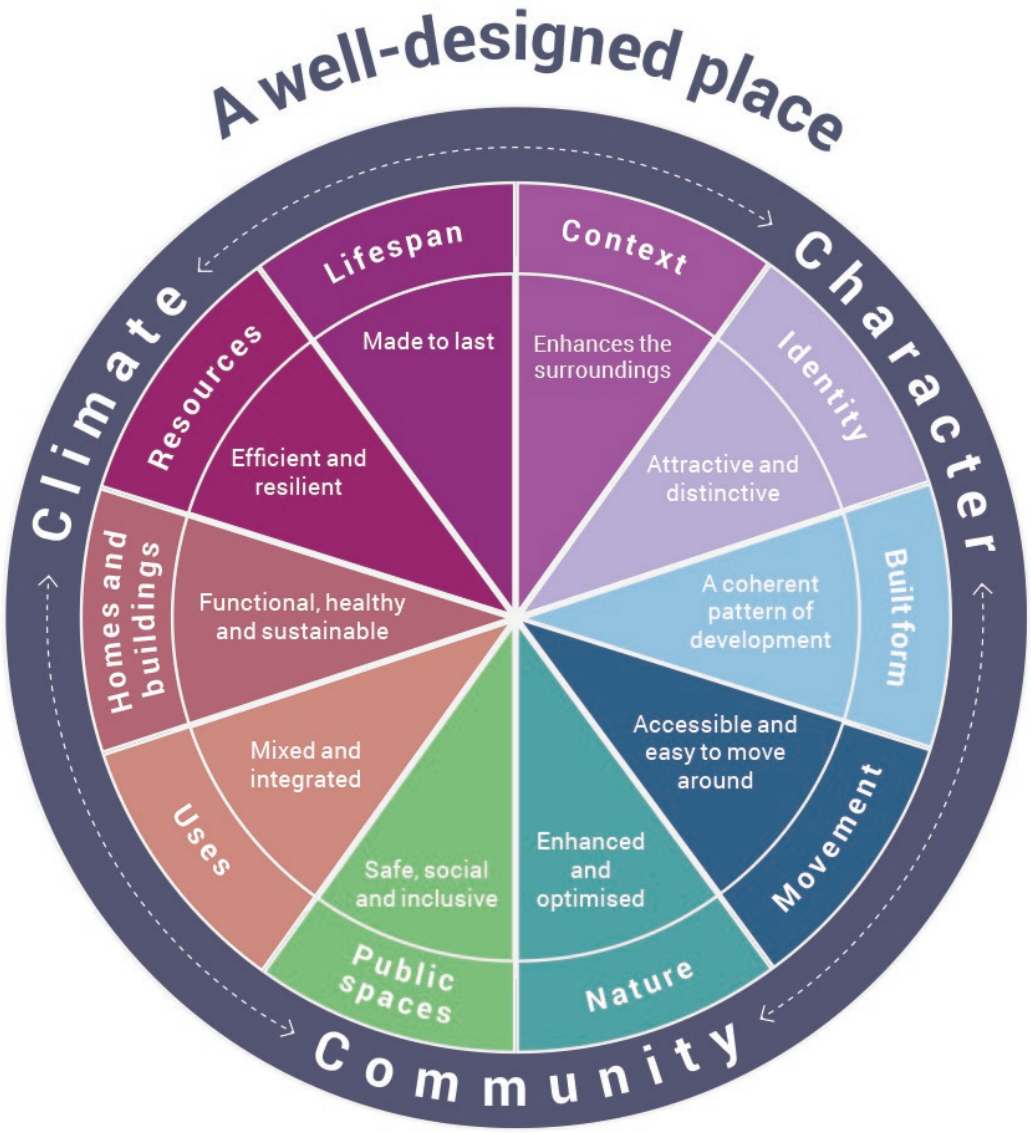


Figure 3: The ten characteristics of well-designed places, taken from National Design Guide

		Context, Identity and Built Form	Movement	Nature	Public spaces	Uses	Homes and Buildings	Resources	Lifespan
Nature-rich beautiful places	Biodiversity and soils	Local Nature Recovery and GI strategies set the context and identify suitable habitats and species	Wildlife corridors and stepping-stones improve access to GI and movement for people	GI network forms part of an ecological network	Parks and the public realm to include soils, water, and planting for biodiversity for all to enjoy	Recreation and education in nature	Incorporation of green roofs and walls into buildings. Gardening	GI provides pollinators for agriculture	Management of GI needs to be planned from the outset. Natural habitats can be lower input
	Landscape and geodiversity	Landscape character sets the context for local identity and locally appropriate GI	Access routes associated with terrain and landscape types	GI network should celebrate geodiversity and work with nature	Public space to feature local geology (e.g., stone) and echo wider landscapes	Improved access to the countryside for all through GI network	Use of locally appropriate and locally sourced materials	Locally sourced materials reflect local character and reduce transport carbon miles	Sustainable long-term management should maintain valued landscape character
Understanding and managing water	Water management	Catchment scale water management influencing local landscapes	Drainage patterns and restored rivers and waterways influence access and movement for people	Sustainable drainage systems and Nature-based Solutions that increase biodiversity	Public spaces can include water features, wetlands, and SuDS[5] as part of a safe and inclusive approach	Water as a tool to encourage use and engage with more people	SuDS, including green roofs, rain gardens - with appropriate management	SuDS help to recycle water	Design should consider management/ maintenance of wetlands, watercourse, waterbodies, and SuDS

[5] Sustainable Drainage Systems (SuDS)

		Context, Identity and Built Form	Movement	Nature	Public spaces	Uses	Homes and Buildings	Resources	Lifespan
Resilient and climate positive places	Carbon and energy	Consider the role of landscape in carbon storage and suitable locations for renewable energy generation	Low-carbon travel and traffic-free routes improve movement	Include habitats and soil that store carbon (wetlands, woodlands, grasslands)	Public spaces can include planting and soils to store carbon and sources of renewable energy	Potential for activities associated with carbon storage and energy production	Cooling effect of green infrastructure can reduce need for air conditioning. Biosolar roofs combine photovoltaic panels with green roofs	Sustainable energy from harvested biomass e.g., from parks and roadside grass cutting	Biomass for energy production and biochar incorporated into maintenance plans
	Urban cooling	Larger trees, green roofs, green walls, and wetter soils	GI provides cooling of active travel routes	Deep soils and dense vegetation best for reducing urban heat island, providing shade and evaporative cooling	Public space requires shade trees and water features to help with excess heat	Public spaces that are cooler are likely to support greater use, particularly in summer	Green roofs, green walls and carefully located larger trees provide shade and cool buildings	GI reduces heat island effect and need for air conditioning and cooling	Long term maintenance of tree canopy and urban greening will support cooling
Thriving and prosperous communities	Sense of place	GI contributes to the local landscape/to-wnscape/sou ndscape character	Attractive greener tree-lined transport corridors encourage walking and cycling	Nature-rich GI enhances sense of place	Public spaces add to local distinctivene-ss and foster community cohesion	Where GI is nurtured, it fosters safe and more inclusive use. Greater potential for cultural activities	Greener buildings can add to sense of place particularly if reflective of local character	Multi-functional GI can make places more attractive to investors.	Potential for increased community ownership and participation in management

		Context, Identity and Built Form	Movement	Nature	Public spaces	Uses	Homes and Buildings	Resources	Lifespan
	Education	GI in schools and other educational facilities can enhance neighbourho-ods and provide identity	More opportunities for active travel to school	Formal and informal education on nature. Nature-rich GI supports educational attainment	Public spaces can be used for educational visits and lifelong learning. Consider use of interpretati-on	Supports learning about nature. Consider use of interpretati-on and citizen science to gather data.	Nature incorporated into built features supports informal education. Consider use of interpretati-on	Local green jobs and apprenticesh-ips. Products from GI management	Connections between educational institutions and communities through joint stewardship of GI can be increased over the long term
Active and healthy places	Food production	Urban agriculture and community gardens integrated and considered strategically	Allotments within walking distance of homes promote active travel	Allotments support local food and provides habitats for nature	Potential for food growing in public space	Food growing helps to engage more people	Roof gardens and gardens can be used for food growing	Local food growing reduces food miles	Communities can be more involved in local food production
	Access to nature	Better integration with existing green infrastructure and new GI in areas of deficiency	Traffic-free routes increase access to nature on the doorstep or to wider landscape	Accessible nature-rich green space provides access to nature close to home	Public spaces to include more natural habitats and planting to provide local access to nature	Access to nature through a variety of activities attracting people from all backgrounds and age groups	Gardens, balconies, and other features such as green roofs can provide a greener outlook and attract wildlife	Access to nature on the doorstep can reduce carbon/ener-gy by reducing the need to travel to natural green space further afield	Management plans to include initiatives and activities that increase people's connection with nature

		Context, Identity and Built Form	Movement	Nature	Public spaces	Uses	Homes and Buildings	Resources	Lifespan
	Active lifestyles	Walkable neighbourhoods. Promotion of traffic-free routes in towns and cities	Vegetated traffic-free routes increase physical activity and promote access to green space	Accessible, nature-rich green space supports physical and mental wellbeing	Physical activities (e.g., Parkrun) and active travel to be promoted in public spaces	Active lifestyles promoted through a wider variety of uses and activities	Gardens, balconies, and other features support health and wellbeing and provide places to exercise	Planted traffic-free routes support low carbon travel	Management plans to promote opportunities for people have active lifestyles
	Air	GI to reduce air pollution and planted areas to provide shelter and open space	Low carbon travel through the GI network reduces air pollution. GI along transport routes helps to clean the air	GI cleans air	Consider how planting (especially along boundaries) can reduce air pollution	Increasing use of local GI helps to promote cleaner air and active lifestyles	Incorporate green roofs, green walls, and street level planting to capture air pollutants	Low carbon GI active travel network reduces resources used in motorised travel	Long term plans for management to increase ability of planting to improve air quality
	Noise	Natural sounds such as bird song or water to enjoy but also to mask unwanted noise	GI along transport routes help to reduce intensity and perception of noise	GI reduces negative impressions of noise and contributes to tranquility	Consider how planting can protect public spaces from noise pollution and enhance the soundscape	Noise reduction and enhanced soundscape encourages use	Green roofs/walls, hedges, vegetated bunds reduce noise. Natural soundscape features e.g., bird boxes	Natural sound barriers can reduce need for man-made noise barriers	Long term plans for management to increase tranquility and improve soundscapes

Table 1: How green infrastructure (GI) contributes to well-designed places

3.2 Using Green Infrastructure Principles in developing Local Design Codes

The National Model Design Code (NMDC) sets out three steps for developing local design codes. The Green Infrastructure Principles can support these three steps as set out below.

NMDC Steps	Green Infrastructure How Principles
a) Analysis of scope and baseline	How 2: Evidence How 3: Strategically planned
b) Vision	How 1: Partnership and Vision
c) Codes	How 4: Design How 5: Managed, valued, monitored, and evaluated

Table 2: The three steps of the National Model Design Code

a) Analysis of Scope and Baseline

The baseline should consider topography, geology, soils, ecology, river and waterways, flood risk, landscape character, including the wider area, and local distinctiveness, soundscape character; open space and green infrastructure, local character, heritage, and cultural assets, including conservation areas and ancient and veteran trees. It should understand the wider evidence base for the benefits of green infrastructure assets; and data on environmental, social, and economic challenges and needs in the area that green infrastructure could help to address.

Relevant information to consider in this baseline is:

- Local plan evidence and policies, including Biodiversity Net Gain and other green infrastructure policies
- Local Nature Recovery Strategies
- Green Infrastructure Strategies
- Tree and Woodland Strategies
- Surface Water Management Plans
- Local Resilience Forum Community Risk Registers
- Wildfire Management Plans
- Drainage and Wastewater Management Plans
- Flood Risk Management Plans
- National and local landscape characterisation studies
- Mapping of inequalities in green infrastructure provision and its benefits
- Natural Capital Atlases

b) Vision

Work in partnership with stakeholders from the outset to co-plan and develop a vision for green infrastructure in the area as a whole and for different area types or for a masterplan. Engage a diverse and inclusive range of people and organisations including citizens,

local authorities, developers, communities, landowners, green space managers, environmental, health, climate, transport, and business sector representatives.

The vision should consider the quantity and quality of green infrastructure, and how it will function as a key asset to meet needs and to deliver local strategy and policy, at all scales. It should consider how to address inequalities in green infrastructure provision and its benefits.

c) Codes

To integrate green infrastructure into individual development or area-wide design codes, refer to the following chapters:

- Information on the building blocks of green infrastructure (Chapter 4).
- Information on designing green infrastructure to deliver multiple functions (Chapter 5).
- Information on designing green infrastructure in different area types (Chapter 6).

Good governance, funding, management, monitoring, and evaluation of green infrastructure should be designed in from the outset and should consider how communities can be engaged in stewardship where appropriate.

More detailed guidance on how to take a strategic approach to planning green infrastructure is set out in Natural England's Process Journey for Local Planning Authorities.

Chapter 4: The Building Blocks of Green Infrastructure

The Building Blocks of Green Infrastructure

4.1 Introduction

The Green Infrastructure Principles (See Chapter 2) state that good green infrastructure should be multi-functional, varied, connected, accessible where possible, and respond to local character.

This chapter describes the different green infrastructure 'building blocks' that form part of a varied network, and the functions they perform. It sets out the important factors to consider when planning and designing each element.

Before looking in more detail at the building blocks of green infrastructure it is important to consider the context for each one.

4.2 Responding to local character

The distinctive character of places helps people to recognise and form meaningful and mutually beneficial connections with the environment where they live and work. 'Landscape character' embraces topographic features, geodiversity, wildlife and habitats, land use, sights, sounds, touch and smells, cultural associations, history, and memories. Understanding how the landscape is perceived, experienced, and valued by people is critical in planning and designing new green infrastructure and integrating existing green infrastructure assets like parks.

Before considering which building blocks of green infrastructure are incorporated into a scheme, it is important to take steps, in consultation with stakeholders, to identify valued elements in the local landscapes, and how places have changed over time, to ensure that new green infrastructure responds to a place appropriately. This requires taking account of information about local landscape and soundscape character and key characteristics, which can be found, for example, in: national character area profiles; local landscape character assessments, conservation area appraisals; World Heritage Site inscriptions; archaeological records; local listings and townscape character assessments; historic townscape assessments; green infrastructure and green space strategies; park management plans; socio-economic data; geodiversity action plans; noise action plans and noise important areas.

The green infrastructure approach to 'conserving character' is not only concerned with preserving or maintaining character, but also to manage change that brings about benefits that society and local communities value. 'Enhancement' is about taking opportunities to improve an area's character by strengthening existing characteristics or introducing appropriate new features. In World Heritage Sites, National Parks, Areas of Outstanding Natural Beauty and along Heritage Coasts, additional character considerations may apply.

In many cases, a mix of approaches will be appropriate. It is important that the feasibility of each intervention is considered in relation to the practical functions required of the landscape. There should be discussions with stakeholders on constraints and, along with what they currently value about the landscape, how it has evolved over time and how it might change. For example, options

considered may focus on the creation of a new, high-quality landscape in an area that has become degraded. In contrast, where the sense of place has been weakened by the losses, including characteristic features in the surrounding built environment, then the objective may be the restoration of historic character. New development should be responsive to local character and the historic environment, historic built environment, archaeology, ancient and veteran trees and landscape character.

4.3 Building Blocks

This section describes the different 'Building Blocks' of green infrastructure including:

- sustainable drainage systems,
- green and blue roofs,
- green walls,
- rain gardens,
- swales,
- features for species,
- trees in hard landscapes,
- street furniture and utility structures,
- traffic-free routes,
- allotments,
- orchards,
- private domestic gardens,
- green spaces (including parks and burial grounds),
- more natural spaces (including woodlands, grassland, scrub, and hedgerows),
- heritage features and the historic environment,
- blue spaces (including wetlands).

It's important to note that green infrastructure may be required as a statutory obligation to mitigate project impacts, to deliver mandatory Biodiversity Net Gain or other national or local policy requirements. In these circumstances, certain habitats, features or functionality may be required.

All organisations involved in the planning, design and delivery of green infrastructure must collaborate to identify the types of green infrastructure that will best provide the required functions or benefits, and to ensure that the building blocks work together to form a multifunctional interconnected network. All Green infrastructure features can form part of the national Nature Recovery Network, which is part of the Government's 25 Year Environment Plan. See Chapter 5 for the different functions of green infrastructure and Chapter 6 for how green infrastructure comes together in different area types.

It is important to note that some of the interventions described may be unsuitable in certain situations. Research may identify constraints, and collaboration with specialists may be required. For example, green roofs can only be retrofitted where an engineer has confirmed that a building has sufficient structural capacity to take the additional weight; green infrastructure has the potential to impact on the character of historic buildings and specialist advice should be sought; sustainable drainage and tree planting which

involves excavations may not be appropriate where below-ground archaeology or utilities occur.

4.4 Sustainable drainage systems

Sustainable drainage systems (SuDS) can include green roofs, blue roofs, rainwater harvesting systems, rain gardens, modified tree pits, swales, basins, ponds, wetlands, and other features, modified to store water and slow the flow. SuDS provide an alternative or addition to conventional drainage systems that rely on pipes and the rapid conveyance of rainwater to drains and watercourses.

SuDS originates from the Low Impact Development approach, which began in the United States in the 1990s. In the UK, with increasing interest in these practices, CIRIA published its first SuDS Manual in 2007. The Flood and Water Management Act 2010 (as amended) uses the term sustainable drainage and the National Planning Policy Framework (NPPF) has a policy that major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate.

The SuDS philosophy (as set out in CIRIA's SuDS Manual 2015) is to consider the quantity of water, the quality of water, and improvements to amenity and biodiversity, however there is a tendency for some practitioners to prioritise the reduction of flood risk, neglecting a comprehensive approach that delivers multiple benefits. Considering volumes alone, results in an overreliance on features that detain water (for example underground tanks or large ponds or basins) and the omission of a dispersed array of source-control features, including, for example, green roofs or rain gardens.

Another issue that will become increasingly important in urban areas is the storage of water in soils that can continue to support vegetation during drought, and which can provide evaporative cooling during heatwaves (conditions that are predicted to be more frequent with climate change). The objective of storing more water in soils is compatible with the SuDS objectives of infiltrating rainwater and slowing the flow of surface water.

Looking at the wider landscape and the integration of a catchment-based approach, there will be an increasing effort in using SuDS to reduce downstream flooding, strengthen Green infrastructure networks and assist with the recovery of nature. This means that interventions can work together and should also lead to landscape-scale projects that require more coordination between authorities and landowners.

The SuDS approach promotes a management train (or treatment train) for surface water. This involves a succession of features and connections (conveyances), taking surface water from source control features (e.g., green roofs, rainwater harvesting tanks and permeable paving) to site control features (e.g., rain gardens or small ponds) to regional control features (e.g., large ponds, wetlands, or detention basins), before sending water to watercourses. The building blocks of green infrastructure, described in the paragraphs that follow, include source control features, which should all individually be designed for amenity and biodiversity as well as their capacity to handle water. Source control features should be prioritised over site or regional controls to maximise overall effectiveness and minimise land take. The enhancement of biodiversity should be considered in all projects.

For example, green roofs (source control features), which tend to be shallow and often have a low plant diversity, should, wherever feasible, have a greater depth of substrate (to store more water) and should support a wider range of plant species (to increase biodiversity). Rain gardens should be as large as is practically possible. Where space is available, trees planted in hard landscapes can have larger pits than usual, designed to store, and clean surface water. Green space can be re-configured to temporarily detain water following exceptional rainstorms, thereby improving surface water management as well as providing an opportunity to improve the parks or grounds where these features are located.

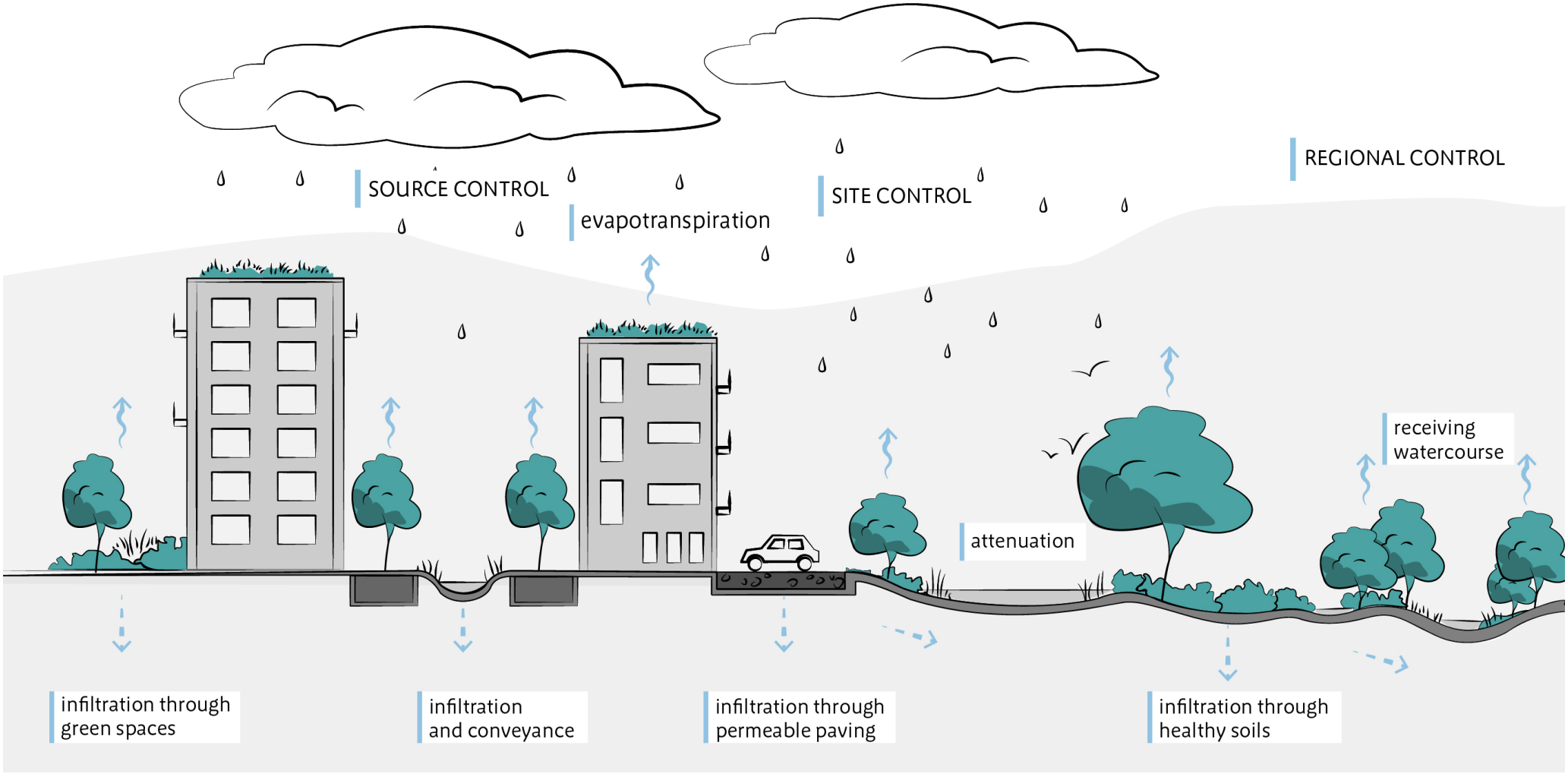


Figure 4: The sustainable drainage management train. Adapted from susdrain.org (CIRIA)

4.5 Green roofs and blue roofs

Green roofs (also known as living roofs) are roofs, decks, balconies, or terraces where vegetation or habitat is deliberately established. The German Landscape Research, Development and Construction Society (FLL), and the Green Roof Organisation (GRO) Code of Practice 2021, divides green roofs into two major categories: intensive and extensive. These terms refer to the intensity of maintenance required.

Intensive green roofs

Intensive green roofs (commonly known as roof gardens) are usually formal landscapes and are usually irrigated. They require frequent maintenance. Soils on roofs (known as substrates) are normally artificial, lightweight blends of material. Intensive green roof substrates are relatively deep (typically greater than 200mm).

With intensive green roofs, the primary consideration in the conventional approach is amenity, which means that the planted area may not be as biodiverse as it could be. More attention can be made towards adopting a wildlife gardening approach, with native species and non-native species with a documented value for wildlife. Also, the balance between areas of paving and planting, with paving often the dominant surface, can result in the loss of ecosystem services and a reduction in the Urban Greening Factor. Where feasible, increasing substrate depth is good for absorbing rainfall and providing evaporative cooling.

Plate 1: Intensive green roof (roof garden). Credit: Green Infrastructure Consultancy

Extensive green roofs

Extensive green roofs are usually vegetated with low-growing, drought-tolerant vegetation such as stonecrops (*Sedum* species) and dry meadow vegetation. They have a relatively shallow build-up of substrate, and typically vary in depth between 40mm and 150mm (although, to comply with the GRO Code 2021, they should have a substrate depth of not less than 80mm). They are low maintenance and not usually irrigated (except, on occasion, during establishment). With extensive green roofs, which are usually designed to be lightweight and low maintenance, there can be issues associated with insufficient depth of substrate (or in some cases sedum mats with no substrate beneath). This limits the

capacity of the roof to absorb water and to provide evaporative cooling. Sedum mats are also of limited value for biodiversity. An extensive green roof vegetated with many species of wildflowers is nearly always preferable to a sedum roof in terms of biodiversity value.

Plate 2: Biodiverse extensive green roof on the David Attenborough Building, Cambridge. Credit: Green Infrastructure Consultancy

Biodiverse extensive green roofs

Biodiverse extensive green roofs are designed to provide a particular native vegetation type or habitats for wildlife. These green roofs typically have slightly deeper soils than stonecrop-based extensive green roofs, may have varying substrate depth and a higher diversity of plant species. They often include habitat features, for example sand piles, stacks of dead wood or stones (see BugLife: Creating green roofs for invertebrates 2012).

Brown roofs

Brown roofs are designed to replicate the open-mosaic communities on brownfield sites and a typical approach to their establishment is to allow natural colonisation on a range of substrates. Experience has shown that slow colonisation, the use of unsuitable substrates that dry out too quickly, the risk of using recycled materials that are contaminated and colonisation by invasive species, mean that this approach is no longer recommended.

Biosolar roofs

A biosolar roof is an extensive green roof that is combined with photovoltaic (PV) arrays. Ideally, the green roof substrate ballasts the frames, to which the PVs are attached. Recent research shows that the combination of green roofs and PVs results in greater efficiency of the PVs. This is because the efficiency of the PVs falls when they overheat, and this negative effect can be reduced by evaporative cooling provided by the green roof. New configurations of PVs and green roofs are being developed, which means that this is a typology that is likely to change rapidly.

Designers should consider a range of options before choosing a supplier.

Plate 3: Biosolar roof. Credit: Green Infrastructure Consultancy

Blue roofs

A blue roof is a roof that has been designed to attenuate and store rainwater, thereby acting as a source-control feature in the sustainable drainage management train. A blue roof can be combined with a green roof (sitting below a green roof and irrigating the substrate through capillary action). Another, less common, approach to creating a blue roof, is to create an ephemeral wetland on a green roof. Blue roofs are a relatively new phenomenon and designers should follow the development of new approaches. Products are on the market, with advice available on design, and guidance is currently being prepared by CIRIA.

4.6 Green walls

Green walls can be divided into green façades (climbing plants) and living walls (intensive green wall systems that are composed of textiles, modules, pockets, or troughs). This is another fast-developing area, and new techniques and products are under development. Note that it may not be appropriate to vegetate the façades of historic buildings. Any attachments to external walls, including green walls, should be considered as part of a fire risk assessment and specialist advice on fire risk should be sought.

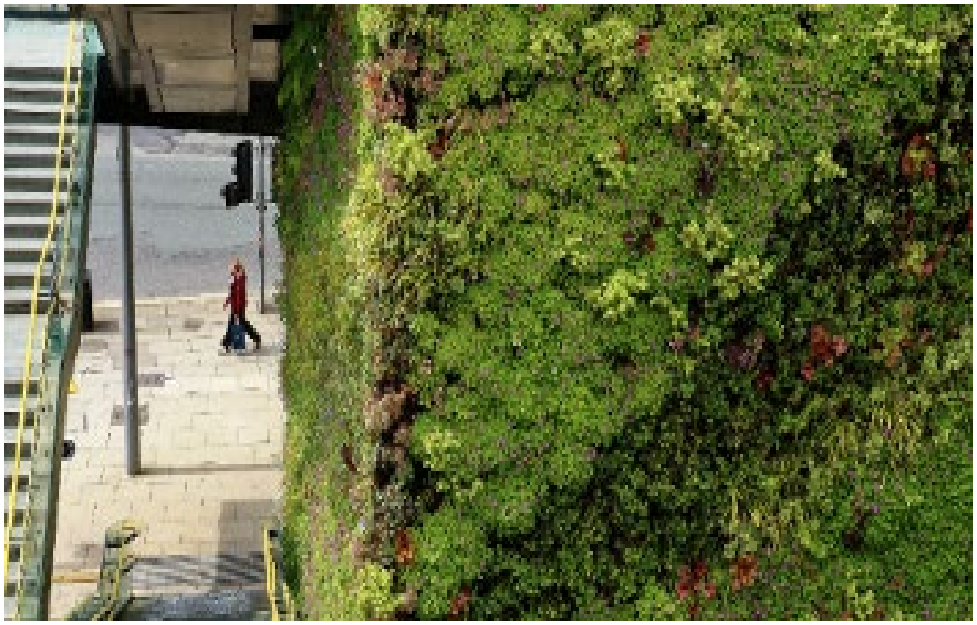


Plate 4: Intensive green wall, Manchester. Credit: Natural England

Green façades

Green façades are the traditional green walls where climbing plants are rooted into the ground or into planter boxes. Climbing plants may be grown directly onto the building façade or be trained against wires or trellises. Green façades may take some time to mature. Irrigation may not be necessary where plants are rooted into the ground. Maintenance requirements are low. It is important to take account of aspect and shade when choosing plants.

Living walls

Living walls are proprietary systems, often installed and maintained as a package. Textile, plastic, and metal modules are used to provide pockets, boxes or troughs that support plants. Some systems are substrate-based whilst others are hydroponic (without soil), with water held in the living wall by fabrics, mineral wool, or foam. Living walls are usually irrigated, normally with the use of pumps that are activated by timers. There are also examples of passive living walls (or vertical rain gardens) where water wicks into planters from tanks that collect rainwater.

Living walls can work well where high visual impact or highly diverse planting is sought, or where high evaporative cooling is an objective. Maintaining intensive green walls can be expensive, because several maintenance visits each year are recommended and specialist access equipment may be required. Monitoring of irrigation is advised, so that prompt action can be taken to rectify faults or interruptions in water supply. Green façades that use climbing plants may be more suitable if there are constraints on resources or management regimes cannot be assured in the long term.

Plate 5: Extensive green wall with climbing plants. Credit: Green Infrastructure Consultancy

4.7 Rain gardens

Rain gardens are relatively small, planted areas designed to receive rainwater flowing from paved surfaces or from drainpipes. In its simplest form, a rain garden is a shallow depression, partially filled with absorbent, yet free draining soil (usually a mixture of coarse sand, grit, and organic matter) and planted with vegetation that can withstand temporary inundation. Rain gardens are designed to intercept and slow the flow of water that might otherwise directly enter conventional drains. The microbes in the soil break-down

pollutants. Water enters the rain garden and infiltrates into the soil, to be taken up by plants and released back into the air through evapo-transpiration. Depending on the permeability of the sub-soil, and the underlying geology, a certain proportion of the water entering a rain garden may percolate into the ground. Once full, and depending on the topography, rain gardens may overflow into other rain gardens, rills, channels, swales or into the conventional drainage system.

When designing rain gardens, it is important to consider any constraints such as below-ground utilities and archaeology, as well as how water will drain away once storage capacity is exceeded. Raised planters, planter boxes, stormwater planters, or SuDS planters, which receive water directly from a downpipe are also sometimes described as rain gardens. The inlet of a rain garden may be armoured to prevent erosion. The most water-tolerant plants should be located near the inlet or in the lowest part of the rain garden and plants that can tolerate both wet and dry conditions elsewhere. Planting a rain garden presents an opportunity to increase biodiversity by using native species or non-native species that attract pollinators. For suggestions on planting for rain gardens, see the Rain Garden Guide.

Bio-retention strips or bioswales, designed to receive the polluted run-off from roads, are also sometimes described as rain gardens. These may include gravel layers, perforated under-drains and overflow drains. For advice on the planning and detailed design of these and other SuDS components see the CIRIA Susdrain website.

Plate 6: Rain garden at Bridget Joyce Square. Credit: Robert Bray Associates

4.8 Swales

A swale, in the context of sustainable drainage, is a shallow channel designed to store and convey surface water runoff. If the gradient is suitable, swales may include stop logs or check-dams designed to slow the flow. Inlets and outlets and other places that are subjected to high flow rates, that could cause erosion, may need to be armoured. On permeable ground, where the underlying geology is suitable, water may also infiltrate. A swale can also remove pollutants. This may be valuable where water is to be discharged into a natural waterbody. Adequate space should be made available to ensure that bioremediation objectives are met. Swales are often

damp, particularly in the lowest part, but have a range of soil conditions, which mean that they can support a high diversity of plants. The vegetation in a swale is often lightly managed, with plants being allowed to grow tall and provide visual interest. Plants should be selected that can withstand periods of drought. With most low-maintenance swales, it is advisable to establish vegetation by seeding with a variety of native species, including wetland, wet grassland, and dry grassland mixtures, chosen according to the local setting and conditions and predictions of how often the swale will convey water. Plantlife provides advice on selecting suppliers of native wildflower seed.

Plate 7: Wildflowers in swale (shallow channel) alongside path. Credit: Wildflower Turf Ltd

4.9 Features for species

It is now commonplace for landscapes to include features designed to benefit certain species or groups, for example nesting boxes for birds, roosting and hibernation boxes for bats, hibernacula for reptiles and amphibians, and refuges or micro-habitats for invertebrates. Passages, ducts, and structures that enable animals to crossroads, fences and other barriers are also used, usually as mitigation for impacts identified during the planning stage for projects. In the freshwater aquatic environment and in coastal locations, refuges and shelters for fish and aquatic invertebrates are also being installed.

The loss of natural habitats results in the loss of places for species to feed, shelter and reproduce. The loss of large trees, standing and fallen dead wood and natural exposures of soil and rocks means that hole-nesting or roosting species have suffered declines. The provision of artificial refuges and nesting and roosting boxes can mitigate for the losses of the natural features. It should be noted, however, that it is always preferable, wherever possible, to retain existing natural habitats and features.

The selection of features will depend on the location and setting, species that occur in the area and species to be targeted. This will range from common and widespread species to declining species and groups like house sparrow, hedgehog, and mining bees. Which species to target will be informed by the Local Nature Recovery Strategy and action plans for species. For barriers that need to be crossed, especially roads, affected species and suitable mitigation measures will be identified through the ecological impact assessment process or the mapping of opportunities to benefit

certain species. Note that features for species do not currently contribute towards Biodiversity Net Gain, which is based on habitats.

Plate 9: Invertebrate refugium. Credit: Green Infrastructure Consultancy

There can be issues with the procurement, installation, and monitoring of features for species. This includes a lack of knowledge of the life cycle of the species targeted, which can mean the selection of unsuitable boxes (e.g., with incorrect hole sizes for the species targeted) or boxes or refuges installed in unsuitable locations with too much or too little exposure to the elements). It is important that advice is sought from suitably qualified and experienced specialists about the species to be targeted, the best choice of feature (including materials), where it should be installed and what techniques, if any, are used to attract the target species to the feature. Most installations will require maintenance and the resources and responsibility for this will need to be considered, along with means of safe access. Some features (including for example boxes for hole-nesting birds) are well-proven, whilst some refuges (including for invertebrates and aquatic life) are less well studied, so the monitoring of effectiveness is valuable.

Bricks with a hole that do not conflict with building insulation requirements, can be good for a range of species including house sparrows, tree sparrows, swifts, starling, and bats. The selection and installation of integral nest boxes for birds should follow BS42021 (Integral nest boxes). A ledge under the eaves, can provide nesting space for species such as house martin. Recovering insect populations will be important alongside such measures. Many pollinating insects are vital to the provision of ecosystem services and are important food sources for birds and bats.

Plate 8: Swift brick. Credit: Dick Newell, Action for Swifts

Pollinators can be provided for in many ways, for example by installing bee bricks on south-facing walls where there is a pollen source nearby.

The field is changing rapidly, with new products and research, therefore reference should be made to organisations providing advice on each group, including for example the British Trust for Ornithology, the Bat Conservation Trust, and Buglife, amongst others. In addition, authoritative peer-reviewed evidence, is available on artificial refuges and breeding sites for a range of groups and species. See for example the journal Conservation Evidence. Note that it may not be appropriate to add features for species to historic buildings – permission may be required.

4.10 Trees in hard landscapes

Street trees and trees planted into paved areas are a mainstay and key component of urban greening. The conventional approach has been to plant trees for aesthetic reasons, and while that will continue to be an important consideration, it is now widely accepted that trees are important for a wide range of functions including summer shade and cooling, sequestering carbon, improving air quality, providing habitat for wildlife, and helping to reduce flood risk.

The size, configuration and make-up of tree pits is an important factor in helping trees to thrive, as well increasing their ability to absorb and store surface water and therefore improve resilience to drought. This can involve the use of amended and structural soils (e.g., Stockholm method) and soil cells (products that maintain free draining and well aerated soils). It is important that trees are planted into the ground in generously sized pits and that tree plantings are

Plate 10: Street trees with planted surrounds. Credit: Green Infrastructure Consultancy

integrated into sustainable drainage systems wherever feasible. It is recommended that the diversity of species planted is increased, to increase biodiversity, reduce vulnerability to the risk of disease and increase resilience in the face of climate change. Tree species should be carefully selected to be responsive to landscape and historic character and to suit the planting location (see Right Tree in the Right Place for a Resilient Future by Forest Research). Considerations include the eventual size of the tree, its attributes and benefits and local conditions, both below and above ground. For advice on how to plant and manage trees that are within the curtilage of the highway, see Operations Note 051 provided by the Forestry Commission.

It is important that adequate volumes of suitable soil are provided for tree roots to grow into. This means that load-bearing substrates or soil cells should be used (see illustrations), and pits should be expanded in to trenches wherever possible. Space should be allowed for future growth of roots and trunk and account should be taken of the species used. Street trees often require protective guards and need to be anchored or supported during establishment. It is also vital that street trees are watered during hot and dry weather, especially during the first two years following planting. Making space for both trees and utilities is critical, with advice provided by the National Joint Utilities Group.

When selecting locations for tree planting, careful consideration should be given to how the street is used and to ensure that the movement of people, including those in wheelchair and pushchairs, is not obstructed. Surfacing schemes should allow for changes in level around trees as they grow and the ground settles. Unnecessary felling should be avoided, and the Forest Commission provides advice on how to address this issue, through the

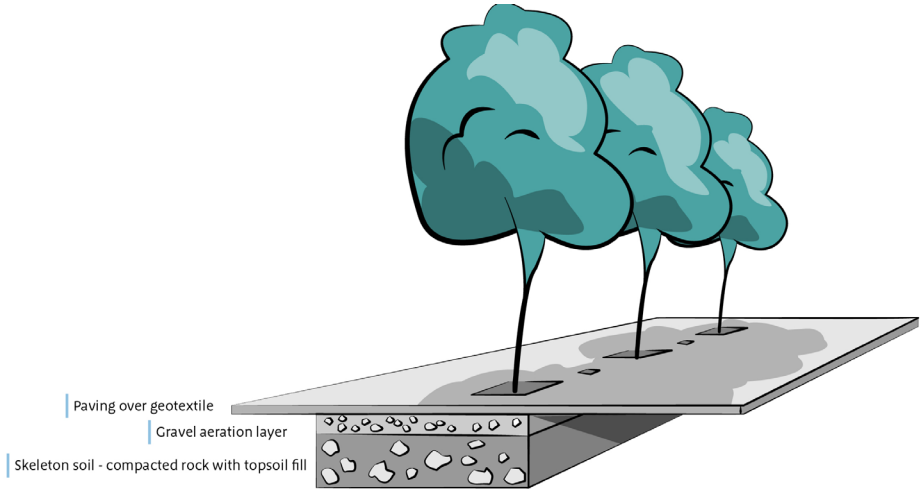


Figure 5: Engineered tree pits - Stockholm type

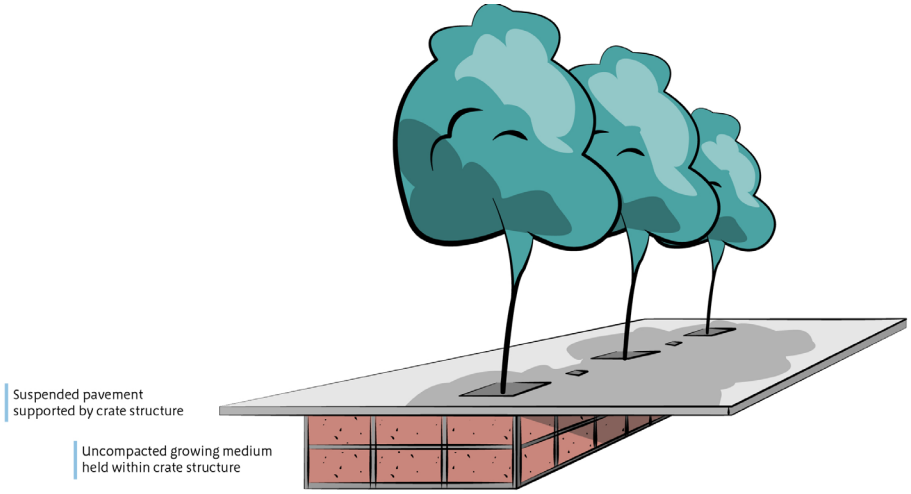


Figure 6: Engineered tree pits - soil cell

Joint Mitigation Protocol. For further information on tree selection and planting see Right Tree, Right Place, for information on planting trees in hard landscapes see Forest Research, and the Trees and

Design Action Group guidance. Reference should also be made to the Government's Manual for Streets.

4.11 Building fabric, furniture, and utility structures

The urban environment includes utilitarian structures associated with provision of services or storage. Examples include bollards, railings or security barriers protecting pedestrians or buildings from vehicles, cycle and bin stores, bins, kiosks, cabinets, poles for power and communications and seating. It is possible to vegetate many of these features – examples include planted hostile vehicle barriers, as well as bus stops, sub-stations, bin stores and cycle stores. Biodiversity should be a consideration, with diverse planting of drought-tolerant native species and other suitable non-native species with a documented value for wildlife. Other examples include streetlights and railings being used as supports for planters. When vegetating street furniture and utility structures, it is important that adequate growing media, light, water and is provided, that the planting is suitable and that biodiversity is considered, as well as aesthetics and maintenance. Techniques used to vegetate walls and roofs will be applicable.

It may also be possible to include features for species, including nest and roost boxes and refugia for invertebrates on suitable locations (see section 6.5). Some structures may also have associated parking spaces or driveways and it may be possible to vegetate these whilst maintaining vehicular access, using for example, permeable, durable and vegetated surfaces like Austrian gravel lawns. The integration of vegetation and features for wildlife onto street furniture and utility structures is a relatively new phenomenon and new products and insights are likely to emerge.

Plate 11: Bin store with green roof and habitat features. Credit: Green Roof Shelters

The fabric of buildings and street furniture often reflects local geodiversity. Locally sourced stone can be used to reinforce character and engage people with geology.

4.12 Traffic-free routes

Traffic-free routes include footpaths, cycle paths, and bridleways. These are often shared surfaces. Although these routes tend to be narrow (public footpaths are typically 1.5m and shared routes 3m wide) they can be part of important connectors in the wider Green infrastructure network, and being traffic-free, they can be relatively tranquil. Although the paths themselves are usually surfaced and unvegetated in urban settings, these routes often have vegetated shoulders (typically 1m wide) which are occasionally mown. There are sometimes opportunities to use canals, redundant railway infrastructure or industrial sites to create new traffic-free routes. There may be opportunities to bring geodiversity and industrial heritage into the design by, for example, revealing rock outcrops or including sculptures that use local materials or by displaying redundant industrial equipment.

Traffic-free routes can often be enhanced through the planting of trees, which provide habitat and create shade to encourage people to use cycle paths during hot weather. Care should be taken to provide adequate space for roots to spread without damaging surfaces. There may also be opportunities to include sustainable drainage features, that may also be valuable habitats (e.g., swales) as well as pocket parks for rest and play. Verges can be enhanced through changes in mowing regime or in some cases, re-seeding to become wildflower meadows on verges.

Plate 12: Traffic-free route for cyclists and pedestrians. Credit: Sustrans

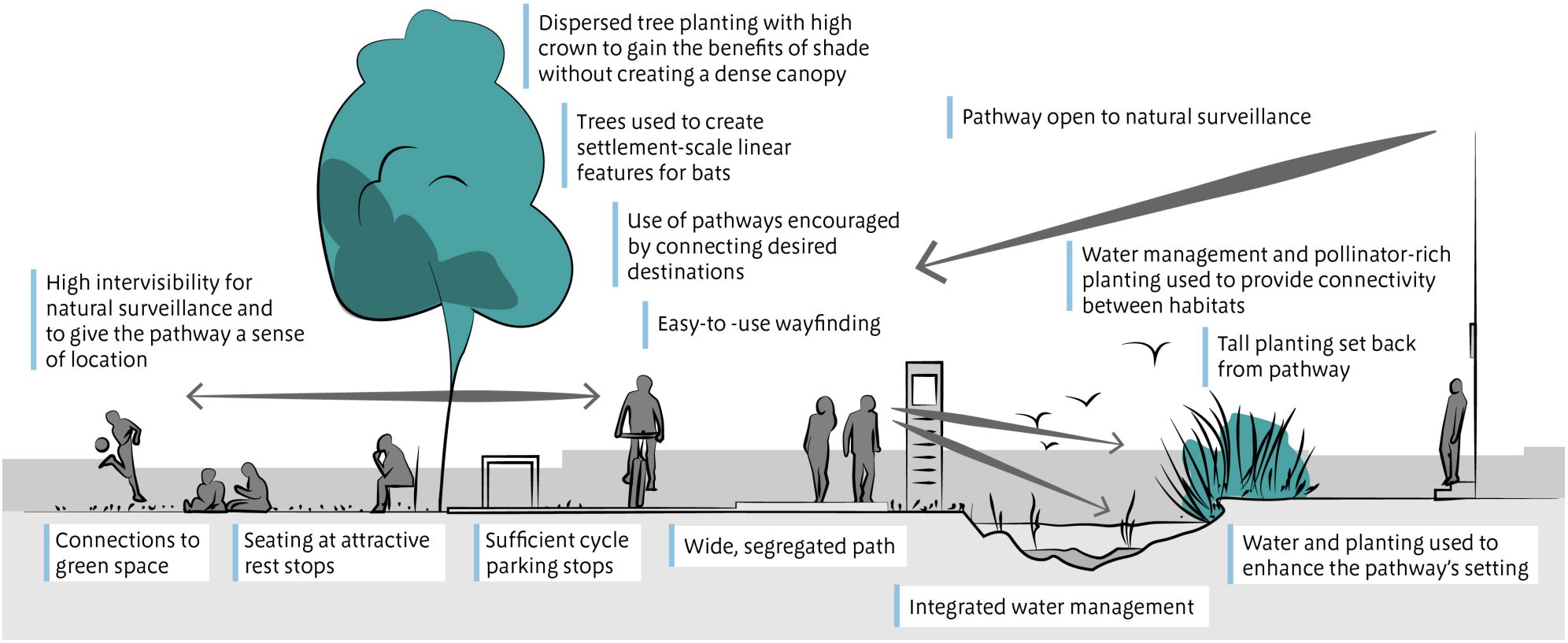


Figure 7: A typical traffic-free route with green infrastructure interventions

4.13 Orchards

Orchards are places where trees or shrubs are planted and maintained for food production. There is resurging interest in planting community orchards, with hundreds established during the last decade. Community orchards can be a way of bringing people in the local community together and regenerating underutilised spaces. Orchards help people to discover the pleasures of growing and eating organic fruit (apple is the most common fruit) and pressing fruit juice and cider. Orchards can be pleasant places to meet and relax, acting as a local park.

Plate 13: Bridport Community Orchard. Credit: Green Infrastructure Consultancy

The traditional orchard is a priority habitat and can be of historic importance. Community orchards can also help safeguard rare varieties of fruit tree. When planning a new orchard, it is important to find a sheltered site with enough sunlight and sufficient depth of soil. Sites with standing water or sites prone to frost should be avoided. Gently sloping sites are favoured. For more information on how to create and conserve community orchards see the Government's guide.

4.14 Allotments and urban food growing

Allotments are food growing sites where people rent a small plot, usually from their local council or an association that manages the site on behalf of the landowner. There are also examples of privately rented plots. In some districts, there are long waiting lists for people to rent a plot, so the provision of new sites would normally be part of a local authority green infrastructure strategy. Well-designed allotments provide people an opportunity to grow some of their own food, however they also promote an active lifestyle and facilitate interaction with nature and other gardeners, which improves mental health and wellbeing. Allotments are increasingly being used as venues for green social prescribing.

Although the emphasis is on food growing, allotment sites usually include lightly managed boundary planting, which can include hedges and trees, and these can be a valuable part of the wider green infrastructure network. There may also be opportunities to include features in communal areas, including ponds and orchards.

In urban areas, there is increasing interest from community groups and businesses to use underused places to grow food. By using planters and raised beds, even small places that would normally be

unvegetated, including places with hardstanding or even roofs or podiums, can become places for communities to gather, interact and grow food.

Plate 14: Allotment. Credit: Green Infrastructure Consultancy

4.15 Private domestic gardens

There are opportunities for gardens in new development to be designed as wildlife gardens with a variety of planting, including native species and non-native species with value for wildlife. This can include wildflowers, ponds, log piles and features for species such as hedgehog highways (see 4.9). Advice is available on how to attract wildlife to gardens.

Although the management of private domestic gardens is usually outside of the scope of the local planning system, these areas can strengthen the green infrastructure network and bring most of the benefits associated with green infrastructure close to home. Private domestic gardens make up a significant proportion of urban Green infrastructure , covering 30% of the total urban area in England. Gardens often combine to provide valuable links between other categories of green infrastructure. Gardens with sealed surfaces, including paving and artificial lawns, can exacerbate surface water flooding problems, therefore it is important that soil, water, and vegetation continue to be the dominant features. Gardens may also include trees of amenity value or old or interesting specimens. The value of these may be recognised through Tree Preservation Orders.

4.16 Green space

(For more on parks and green space see Chapter 6). Conventional green spaces are often designed for amenity purposes and support a range of informal recreation or more formal sport and recreational uses. They are places where people meet, socialise, relax, exercise, play sport and connect with nature, often daily. Evidence shows that green spaces play an important role in supporting physical and mental health and wellbeing.

Green spaces should be designed to meet the needs of the communities that they serve, taking account of the requirements of different cultural and social groups, ages, genders, neurodivergent

and disability needs. In any given neighbourhood it is good to have a variety of different sizes and types of parks and green space, for example pocket parks, doorstep green spaces and natural green space, connected physically or functionally with other green infrastructure as part of a network. Natural England's Accessible Green Space Standards (see Chapter 2 - which summarises the Green Infrastructure Framework) sets out different size/distance criteria for accessible green space.

Plate 15: Elephant Park, London. Credit: Lendlease

Parks and green spaces are often comprised of amenity grassland, with scattered native and non-native trees, with shrubberies and ornamental planted beds. Evidence shows that the visits and value of green space are greater where there is a diversity of vegetation types, including amenity grass, meadow, parkland, and woodland. This diversity will also provide more opportunities for wildlife.

New green space should be designed to deliver a range of functions as set out in Chapter 5. For example, there is often space for significant SuDS features, including swales and ponds.

Trees and other planting in new and existing parks should be diverse to increase biodiversity and resilience, with more use of native species and non-native species with documented value for wildlife.

In existing places, where tree planting is dense, the amenity grass beneath can be shaded and poor quality. This can present an opportunity to underplant trees with shade-tolerant woodland shrubs and ground flora, or woodland edge flora, which can increase biodiversity, improve surface water management, and reduce the requirement for mowing.

Mowing can be reduced and delayed, giving time and space for wildflowers to thrive (for example: see Plantlife's 'No Mow May' campaign). Where short grassland is required, this can be more species-rich, with low-growing wildflowers incorporated into the sward.

Green space is often shaped by geodiversity and can include former quarries. Incorporating geodiversity into the way green space is designed and presented adds to the diversity of the site and the richness of experience.

4.17 Natural green space

Natural green spaces are places where human control and activities are not intensive and there is a feeling of naturalness. Natural (often called semi-natural) green space exists as a distinct type of green infrastructure, but also as discrete areas, within most other green space types.

Semi-natural areas can be found in our towns, cities, and countryside. They may be designated, mostly as non-statutory wildlife sites (sites of County-wide or City-wide importance) or they may have a statutory designation such as Local Nature Reserve, National Nature Reserve or Site of Special Scientific Interest. Some may even have designations showing they are of international importance. Both statutory and non-statutory designations are identified in Local Plans.

Many natural green spaces in conurbations are managed as nature reserves. These sites are often encapsulated countryside – places that have survived as urban development has spread around them, or they can be previously-developed sites (brownfields) that have been colonised by flora and fauna after being abandoned. They can include remnants of their former use, including for example, the exposed rock faces of abandoned quarries. Some brownfield sites have their origins in the industrial revolution and can have significant cultural links to local communities. Other semi-natural sites are associated with past and current transportation infrastructure, particularly canals, railways, and major roads (see Chapter 6, which looks at various area types). Many conurbations are on rivers or coastal sites that may also be designated (see 4.18 Blue Space). Natural green spaces are often of historic importance and may include archaeological sites.

These natural green spaces form core sites for biodiversity and geodiversity in the wider green infrastructure network, sites from which wildlife can expand its range and recolonise. Core sites should be protected from development as key components of the Nature Recovery Network. They should also be expanded wherever possible, to create buffers that improve their condition, but also to improve their ecological value. Core sites should also be interconnected, directly through the establishment of ground level corridors, such as hedgerows, green access routes, street trees, but also functionally through patches (stepping-stones) that could include habitats on buildings. This process is supported at the local level by Local Nature Recovery Strategies, Green infrastructure strategies and other strategies that encompass everything from doorstep spaces and private gardens, to the wider countryside.

Natural green space can be incorporated into new development as a mosaic, with a range of features such as small patches of bare ground, tall flower-rich vegetation, scattered trees, scrub, woodland, or wetland to support a range of species and their life cycles. Many existing natural green spaces will have developed naturally and so designs should include opportunities for natural re-colonisation. Design should reflect local biodiversity priorities as identified in the Local Nature Recovery Strategy. Sites should be integrated physically and functionally with wider ecological networks.

Most existing urban wildlife and geological sites would benefit from enhancements and improvements in management. Engagement with communities and interpretation panels and

communications to explain the importance of interventions can be helpful to allay concerns.

When planning the establishment of habitats, it is important to understand the landscape context and special site characteristics. There may be opportunities and constraints, including the historic environment, rare or protected species and existing habitats of importance (e.g., species-rich grasslands, heathland, or wetlands). Easements or corridors which provide access to utilities and underground utilities must be avoided. Information on existing historic and protected sites, habitats and species are available from local environmental record centres, MAGIC, and Natural England's Green Infrastructure mapping database. Working with the site characteristics such as soil type, geology and drainage can reduce costs and help with establishment. Plans must be in place for nurture, especially during establishment and long-term stewardship of sites.

The establishment of woodland can involve planting, seeding or natural colonisation. The most common approach is to plant native tree and shrub species in natural associations. The Government and NGOs, including, the Woodland Trust provide guidance on woodland creation. There is increasing interest in using the Miyawaki method for creating woodland, which involves planting seedlings of native species at very high densities. Advocates of natural regeneration of woodland argue that it is cost-effective and results in healthier and more diverse woodlands.

Scrub consists of native shrubs and patches of open grassland, from scattered bushes to closed canopy stands which develop into woodland. Scrub is a very important habitat for invertebrates, reptiles, amphibians, small mammals, and breeding birds. Ideally, scrub includes a variety of woody and grassland species, of varying heights, age, and structure. Scrub is usually established alongside existing woodlands or hedgerows or as a buffer for a water body or watercourse. The preferred method of creating scrub is to allow it to develop naturally, however in some situations planting and seeding may be appropriate – detailed advice on creating and managing scrub is available from the RSPB.

Native hedgerows mark site boundaries, provide screening, reduce soil erosion and are valuable wildlife habitats. They are an important part of our cultural heritage. Hedgerows should be planted with species found in existing nearby hedgerows. Local Landscape Character Assessments will provide information about the contribution that hedgerows make to the character of a local area. Ecologists or the county Wildlife Trust may be able to advise on the species mix. Usually, a mixture of native species is used, with bare root stock planted in staggered, double rows.

Wildflower meadows are open habitats of permanent grassland, maintained by cutting or grazing. Wildflower meadows are not to be confused with beds seeded with cornfield or non-native annuals, a treatment now popular along some town centre verges. Wildflower meadows are best established where soil fertility is low. Careful ground preparation is important, and sites should be seeded with locally appropriate native species, suited to the soil type. Seed must come from trusted sources. If local sources are available, the spreading of green hay from a species-rich donor site can be very successful. Effective cutting or grazing is essential, and cuttings should be removed to maintain low fertility. Over time, management may need to be adjusted to get better results.

Plate 16: Woodland walks. Credit: Natural England

Incorporating geological features often involves vegetation and scrub management increasing both the visual and physical accessibility of rock exposure with the further benefit of increased habitat diversity. This can be particularly valuable for pioneer vegetation communities and invertebrate species associated with bare or more open ground.

4.18 Heritage features and the historic environment

Our rich heritage of buildings and green spaces is often the foundation of communities' sense of identity, and in turn their prosperity, confidence, social cohesion, and individuals' wellbeing. The public realm and the network of green and blue infrastructure that surrounds and enables access to this heritage has a material impact on the way in which any historic place is perceived, used, and enjoyed.

Historic buildings and green spaces represent investment by past generations and significant embodied carbon. Many features like public parks have stood the test of time and proved to be adaptable to meet the needs of successive generations whilst still retaining their historic interest. Historic England encourages 'constructive conservation', a positive, well-informed, and collaborative approach. This flexible process uses an understanding of the historic environment and its past stewardship to manage change.

Like new developments, climate adaptation, retrofit and nature-based solutions, and biodiversity measures can often be sensitively incorporated into historic places and improve the experience for local people and visitors. Past land and water management can inform and guide new low carbon, nature-rich green infrastructure approaches. There is scope for a wide range of measures from improving accessibility of streets and green spaces, to providing more shade and screening traffic and unsightly features, or restoring historic features such as hedges and verges, and enriching environments through better management, horticulture and creating more space for wildlife. New green infrastructure should be designed and maintained to both enhance the historic environment and add new interest that will be valued by future generations and prove to be a sustainable investment.

Character is one of the green infrastructure principles. Understanding the history of a place, its green spaces and other features like trees and wildlife habitats, and their development and

interrelationships, and wider landscape setting, is a key to that character assessment. Every settlement, whether a medieval market town or a post-war city centre, has a unique and distinctive history. There are often many layers reflecting the interaction between people and places through time whether 'visible, buried or submerged, or landscaped'[6]. The history and culture of a place should be used as an inspiration for identifying opportunities for new green infrastructure and its design. Historic England provides advice and guidance on understanding places and historic landscape and urban characterisation resources. Green infrastructure designers and managers can also draw on the expertise of local historic environment advisers and place making professionals and resources such as Historic Environment Records. The National Heritage List for England is the official, up to date, register of all nationally protected listed buildings, scheduled monuments, world heritage sites, protected wrecks, registered parks and gardens, and battlefields. There are also local heritage lists.

For those developing green infrastructure policies, the Government's Planning Practice Guidance includes a historic environment section and Historic England also offer a range of planning advice on plan-making and decision-taking, and other issues which are important in good decision-making affecting heritage assets.

Plate 17: Minster Park, Sunderland (part of Bishopwearmouth Townscape Heritage Scheme) Credit: Sunderland Echo

Heritage is a great springboard to engage with people and get them involved in designing, planning, and looking after green infrastructure features such as parks, and in doing so socialise and

[6] NPPF definition of historic environment 'All aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora'. https://www.gov.uk/guidance/national-planning-policy-framework/annex-2-glossary

bond, and revitalise and enrich their local culture. Evidence shows that local parks and green spaces are important features, so too the buildings and industrial heritage, in people's sense of pride about their place. However, although parks and green spaces are loved they are often overlooked as heritage perhaps because they are civic assets still very relevant in day-to-day lives rather than relics from the past. The public parks, gardens, squares, town walks and cemeteries of national special historic interest are included in the Register of Parks and Gardens and there many more stories to reveal about the history of parks and recreation grounds in every town.

By their nature and construction, historic buildings and sites often provide valuable and scarce habitat for wildlife such as roosts for bats and nesting sites for swifts, and old masonry for wall flora and insects. The coexistence of nature and art in cemeteries and old burial grounds are an example of notable combined historic, cultural and natural resources in towns and cities. Other features like old fruit trees, veteran trees and some habitats survive as vestiges from past countryside now locked into the urban fabric.

Through good horticulture, features such as flower borders can be valuable nectar and seed sources and offer an extended season of food sources for insects and birds as well as enrich visitors' experience. Historic sites and streetscapes often include mature non-native trees, as well as native species. These may prove to be important in the future urban treescapes as climate changes. Researchers are interested in historic tree collections to understand potential future tree species selection for urban environments. Trees and landscaping are likely to be distinct to the period of town development. Such treescapes often shape the character of areas and the amenity designation, Conservation Area includes protection for trees for this reason. Changes in design or management can unwittingly undermine local character and may even lead to exposing historic buildings and landscapes to new risks.

There a myriad of other historic features such as shrubberies, hedges, lakes and ponds, that contribute to the green infrastructure or add to the multifunctionality of green infrastructure such as bandstands and entertainment venues, associated museums and galleries, cafes and toilets, park benches and street furniture, promenades and paths, and play and sports facilities. The history of some sports is rooted in local public parks and greens spaces and the culture of their communities.

The management of waterways whether rivers or man-made features like canals has a long history that may include industrial heritage as well as designed landscaping that needs to be respected in integrated river management projects.

Maintenance of historic buildings and landscapes is vital both to their conservation and improved performance as infrastructure. Management plans for sites and places such as Conservation Areas are encouraged to tease out their significance and determine how best to look after them and plan maintenance, conservation, and repair. Plans for historic parks and other green spaces look at sites in the round and their multifunctionality including biodiversity interest, environmental sustainability and more recently climate change adaptation and can help work out green infrastructure priorities based on needs. Site plans should nest within green space strategies and in turn green infrastructure strategies.

There is often scope to integrate new green infrastructure, sustainable urban drainage, and habitat areas too and a historic

character-led approach should be used to identify locations and shape designs and maximise the benefits. Carefully sited low-carbon energy schemes such as water or ground sourced heat pumps in lakes could be installed to power nearby buildings. There are hundreds of examples of micro-solar panels already being used to power small scale or remote installations such as car parking ticket machines, lighting, and interpretation. Listed buildings and other historic buildings can be retrofitted with green infrastructure features such as climbing plants to create green walls or flat roofs converted to green roofs subject to the construction and fabric, and historic interest of the building and its setting being taken into account. Listed building or other heritage consents will be needed and proposals should be discussed with the local authority conservation officer at an early stage. Green wall vertical structures designed to be attached or fixed to walls, and irrigation systems may be problematic because of harm to the historic fabric. Tree planting on, or rewilding of, scheduled monuments and other archaeological features is not appropriate, and advice should be sought about protecting them.

Historic England's place making guidance offers more detailed advice on works in sensitive historic locations and how to make improvements to public spaces without harm to their valued character, including specific recommendations for works to surfaces, street furniture, new equipment, traffic management infrastructure and environmental improvements.

4.19 Blue space

Blue infrastructure or blue space are terms used to describe places where water is the key natural feature. Blue space includes waterbodies, watercourses, rivers, canals, wetlands, ponds, estuaries, the coast and the sea.

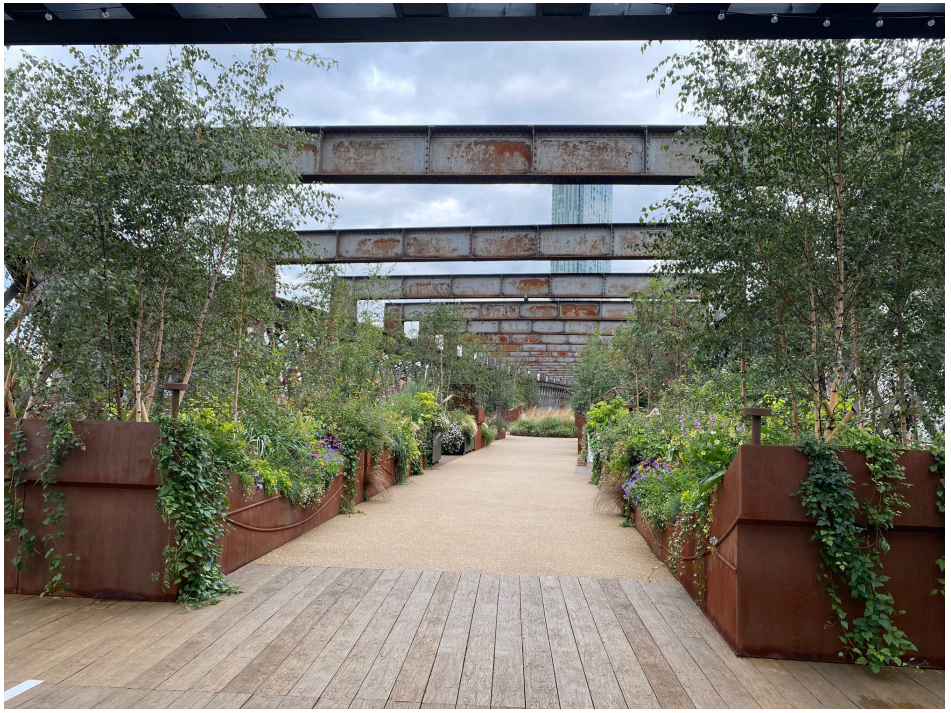


Plate 18: Castlefield Viaduct in Manchester is a 330 metre Grade II steel viaduct brought back into use as an urban sky park created by and for the benefit of local people. Credit: Natural England

Water is often the reason for conurbations being situated where they are, and blue spaces can be the most important and most dominant green infrastructure features. Blue spaces are often the setting for historic sites and features. Access to inland waterways, waterbodies and coast is particularly valuable for health and wellbeing. Wetlands and coastal habitats tend to store more carbon than terrestrial habitats.

Plate 19: Urban lake. Credit: Natural England

These habitats may be damaged by pollution, including that from sewage overflows, agricultural runoff, and urban surface water run-off. Poor water quality reduces biodiversity in the aquatic environment and makes waterbodies and watercourses unsafe because of pathogens and algal blooms. Watercourses and waterbodies may also be used as sources of drinking water and poor water quality adds to the cost of treatment.

The margins of blue spaces can be damaged by artificial, hard features and abrupt changes in topography (e.g., river walls), resulting in the loss of ecotones (marginal aquatic habitats), which are often important breeding and feeding sites for aquatic and wetland wildlife. Small watercourses are often culverted or piped, resulting in habitat loss, downstream flooding, and an increase in pollution. Opportunities should be sought to restore rivers and to soften the banks and walls that line waterbodies and watercourses. Development in floodplains can result in the loss of habitat, the flooding of property and an increase in downstream flooding, and a flood risk assessment may be required.

Wetlands occur where soils become saturated with water, which can be seasonal. Wetlands include salt marshes, mudflats, and other coastal and estuarine features as well as inland features including rivers and their floodplains, wet grasslands, fens, wet woodlands (carr), lakes, reedbeds, peat bogs, ponds, and ditches. On larger wetland sites intimate mixtures of wetland types may occur. Artificial drainage and extraction of peat over the centuries means that wetlands have largely disappeared from the landscape. Now, as part of our efforts to improve river catchment management, reduce flood risk and improve water quality, networks of interconnected wetlands of multiple types and sizes should be created or restored across both rural and urban areas.

The locations and types of wetlands will depend on the availability and movement of water and ground conditions; however, it is often possible to restore lost streams, rivers, ponds, and marshes, to extend existing blue features, including the margins of rivers and lakes and to restore coastal and estuarine habitats. This can involve de-culverting and the restoration of more natural ground conditions. The creation, restoration, planting and management of wetlands is a specialised activity that requires understanding of climate and predicted climate change, water level control, water quality and ground modelling and the ecology of the various wetland habitat types.

Planting of wetlands should always be undertaken using locally appropriate native species in natural associations. Wetlands are

particularly vulnerable to being damaged by invasive non-native aquatic plants and animals.

Plate 20: Urban wetland. Credit: Biodiversity by Design

Sustainable drainage systems (SuDS) can include wetland habitats such as reed beds, swales, and small ponds. In urban areas it may be possible to create mini wetlands at the individual property level, such as small garden ponds to provide wellbeing and biodiversity benefits where people live or work. Even small wetlands can provide useful connections and stepping-stones, enabling wildlife to move between larger habitats.

Improving the quality of runoff in catchments, particularly by using SuDS, will be an important part of the effort to improve water quality and green and blue infrastructure should be planned and designed with this in mind.

Blue spaces are often linear features (for example, river valleys) and these can provide opportunities to increase the network of cycle paths, bridleways, and footpaths. With climate change bringing about rises in sea levels and increasing the severity and frequency of flooding along the coast and blue corridors, and the inevitable associated need for changes to infrastructure, there will be opportunities to create new wetland habitats (for wildlife and carbon sequestration) and new access (particularly traffic-free routes for horse-riders, pedestrians, and cyclists).

4.20 Natural play space

The emphasis in conventional playground design is to provide places for physical activity, with the play space being an enclosed location for manufactured play equipment. As a result of this, play space tends to be devoid of vegetation and natural features and unvegetated surfaces often dominate. This means that play space does not usually provide the full range of benefits associated with green infrastructure.

Exposure to nature, vegetation and soil has many benefits for children and improves their development, health, and wellbeing. This can include exercise that builds strength and stamina, social interaction to improve wellbeing, and opportunities to interact with and develop an interest in the natural world. Exposure to soil microbes also benefits the immune system. These benefits have been recognised and promoted by many organisations, including, for example, the Forest Education Network, amongst others. Play areas benefit from the incorporation of shade trees and

wildflowers, which can add stimulating textures and colours. The fences associated with play areas often provide opportunities to grow climbing plants.

Plate 21: Natural play space, RHS Wisley. Credit: Davies White/RHS

Natural features like logs and boulders can be used as an alternative to manufactured play equipment. There are also opportunities to provide features and gathering space that encourage exploration and play in green space outside of designated play space. Play space should be seen as an opportunity to provide SuDS and biodiverse planting and it is also possible to include special features for wildlife, including nesting and roosting boxes and refuges for invertebrates. It is good practice to exclude dogs from play areas and sports pitches.

Most facilities provided for teenagers are Multi Use Games Areas (MUGAs) and skate parks, all with hard surfacing, and many spaces are not inclusive. It is important that more spaces are provided that are interesting but more inclusive. Comfortable seating and swings where people face each other are particularly helpful in making spaces suitable for teenage girls, and it will be particularly important to make these spaces feel safe.

Chapter 5: Designing Green Infrastructure for Multiple Functions

Designing Green Infrastructure for Multiple Functions

5.1 Introduction

This chapter considers how green infrastructure should be planned, designed, delivered, and maintained, to provide multiple functions. The National Design Guide identifies ten desirable characteristics of well-designed places - these cannot be achieved without green infrastructure and associated ecosystems, which provide the critically important functions that sustain people and places. Green infrastructure is therefore integral to good design.

It is important to be aware of the full range of functions that green infrastructure provides. It is also important to be mindful of the multiple functions that a single green infrastructure design can provide. Conventional approaches to green infrastructure design often have specialists focusing on single objectives in what can be a relatively simplistic approach, rather than working with nature to achieve a balanced mixture of interacting features and benefits.

Projects can address the issues of biodiversity loss, climate change, health and wellbeing, and deprivation, by providing multi-functional green infrastructure that is thoughtfully designed.

5.2 Ecosystem functions

Twelve ecosystem functions (see figure) are considered in turn in the paragraphs that follow. There are the foundational functions of nature (biodiversity, soil and geodiversity, and water), those most associated with climate (carbon and energy, temperature regulation), functions that help our health and wellbeing (access to nature, food, active lifestyles, clean air, enhanced soundscapes), and those associated with prosperous communities (including education and sense of place, amongst others). Whilst there may be drivers for individual functions, these individual functions will often work together to deliver multiple benefits, and consideration should be given to the full suite of benefits in a project, and how they can work together.

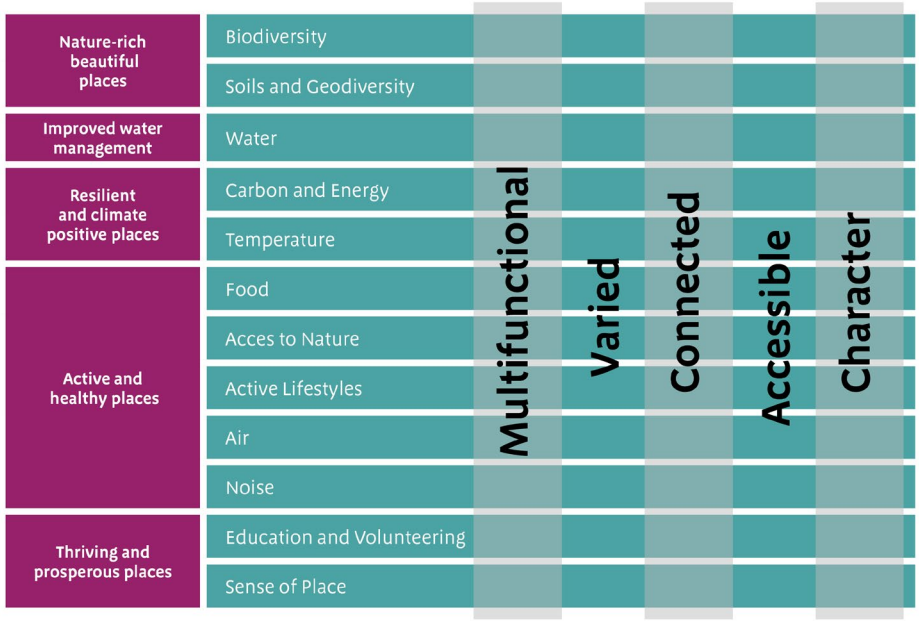


Figure 8: Delivering multiple ecosystem functions through green infrastructure

These functions will support the ten desirable characteristics in the National Design Guide (see Table 1) and the five 'Why' Green

Infrastructure Principles either directly or indirectly, with some functions making a stronger contribution than others. All the functions are essential and must be considered as interconnected and synergistic.

In some situations, the emphasis will be on protecting and restoring natural features and processes and changing management to increase biodiversity and wider functionality. In others, the emphasis will be on retrofitting or creating new multi-functional green infrastructure that is designed to meet the needs of the local community and society.

There are a number of tools, such as the Environmental Benefits from Nature Tool, that provide a common and consistent means of considering the impact of development and land use change on different ecosystem services or functions. Use of these tools can help to enable better consideration of losses and gains in ecosystem services from development.

The Building with Nature Award is built around themes of Core, Wellbeing, Water and Wildlife and can provide formal independent verification of high quality green infrastructure delivering multiple benefits in development and planning policy.

The following sections set out the individual functions of green infrastructure, however they will need to be considered in the round to ensure that green infrastructure is designed to deliver multiple benefits.

5.3 Biodiversity (including pollination)

Habitat loss and fragmentation are key causes of biodiversity decline. Fragmentation happens when parcels of habitat are destroyed, or significantly degraded, leaving behind smaller, unconnected fragments. This damages ecosystems, reduces the extent and quality of habitat, and reduces the ability of some species to move through the landscape, which in turn can quickly lead to inbreeding, loss of genetic diversity, and extinctions. Fragmentation also reduces the resilience of populations to climate change by cutting off potential migration pathways.

Well-designed green infrastructure can secure and buffer existing high-quality habitats and provide expanded habitat networks by reconnecting fragments of good quality habitats, thereby enhancing biodiversity, providing ecosystem functions, and making ecosystems more resilient. Addressing fragmentation means maximising and linking together habitat along linear infrastructure, including river valleys, waterways, roads, railways, footpaths, and cycleways. It also involves finding ways of crossing barriers (including for example busy roads) or providing stepping-stones (for example green roofs, school grounds or pocket parks) that allow species with limited ability to disperse to move through hostile environments like the urban core.

Local Nature Recovery Strategies (LNRSs), as set out in the Environment Act 2021, will help the public, private and voluntary sectors work more effectively together for nature's recovery. These strategies will set priorities for nature's recovery, map the most valuable existing areas for nature (for habitats and species), and

develop specific proposals for creating or improving habitat for biodiversity and wider environmental goals.

The habitats that are restored and created in the enlarged and strengthened Nature Recovery Network will depend on the context and setting, the land uses and developments within the area in question and capacity to maintain natural assets and features. Where large interconnected and ecologically degraded areas of land are available (including former agricultural or industrial sites), these can be restored to mosaics of woodland, scrub, wetland, and grassland through planting or seeding of native species of local provenance to reflect local character, or through natural succession (see rewilding).

Where wetlands are being restored it may be necessary to modify or restore watercourses. Reference to historic maps or lidar data may be helpful in identifying routes. A catchment management approach should be followed, whereby rainwater is held in the green infrastructure network's vegetation and soils, to improve water quality and to reduce the risk of downstream flooding.

Where large-scale infrastructure is planned, there is the potential to include features that strengthen the wider ecological network. These could include tree belts or native hedgerows with associated species-rich grassland verges. The objectives of increasing biodiversity through diverse planting and improving the quality of runoff that enters the aquatic environment must be added to the traditional consideration of reducing the visual impact of large infrastructure projects.

For large-scale development, masterplans should include green infrastructure strategies that take account of connections with the wider green infrastructure network, and which are fully coordinated with surface water management plans and sustainable drainage strategies. This will help to increase the likelihood of creating interconnected matrices of vegetation, soil and water which forms an improved setting and backdrop for the built environment.

For the built environment (including buildings themselves) where conventionally, the presence of soil, water and vegetation has not been seen to be an essential component of the design, habitats can be provided in the form of appropriately designed green roofs and green walls as well as the more traditional urban parks, gardens, and trees.

Figure 9: Habitat networks. Adapted from the National Model Design Code

The imperative to increase biodiversity means that planting should be with native species, ideally growing in natural associations. Where ornamental plantings are made, planting can include non-native species with a documented value for wildlife.

Plants that benefit pollinating insects (including wild bees) should also be used (see for example the Royal Horticultural Society's advice on Plants for Pollinators), as well as larval food plants, to ensure that invertebrates like moths and butterflies can complete their life cycles. Consider providing a diverse mix of native plants (flower-rich grassland, green roofs and walls, shrubs, hedges, trees) as well as structurally diverse vegetation for food, shelter and nest sites including standing dead wood, old trees with cracked bark and tree cavities. Consider leaving grass to grow longer before mowing and removing arisings.

The structural diversity of vegetation (varying height, density, and texture), exposed soils, standing and fallen deadwood, ponds and rougher, denser, vegetation to provide cover and refuge for wildlife should also be provided throughout the built environment. In planning and design, an assumption should be made that gardening for wildlife will become ordinary and routine. The principles of gardening for wildlife should be followed, which means finding out about habitats and wildlife in the area, providing food, water, shelter, and breeding places for the targeted species and avoiding the use of biocides.

Biodiversity Net Gain (BNG) is an approach which aims to leave biodiversity and the natural environment in a measurably better state when land use changes and when development occurs. BNG is already a requirement in many local plans. BNG still relies on the application of the mitigation hierarchy to avoid, mitigate, or compensate for biodiversity losses. It is additional to these approaches, not instead of them.

The Environment Act 2021 includes provisions that will make BNG mandatory in England for most development types. The Biodiversity Metric used to calculate biodiversity net gain includes within it many common Green infrastructure habitat features, such as SUDs, green roofs and walls etc and their inclusion in a scheme design can contribute towards meeting BNG requirements.

Natural England's Environmental Benefits from Nature tool is designed to work alongside BNG to enable more detailed consideration of wider environmental benefits for people and nature. Further information on the links between BNG and Green Infrastructure Standards is set out in Chapter 6.

5.4 Soils and geodiversity

Our landscapes and soils are strongly influenced by the underlying geology. It is important that planning for Green infrastructure recognises the opportunities and constraints associated with soils and rocks and celebrates the local distinctiveness of character areas, which are largely defined by geology. Understanding and conserving geodiversity is critical to successful green infrastructure design. For example, understanding underlying geology, topography, and natural process are all critical in determining what habitats work where, and how rivers, streams, and drainage systems function. As well as natural outcrops, active and former mineral workings, road and canal-side cuttings, and disused railways often provide opportunities to conserve and enhance

geodiversity, benefiting biodiversity, and providing links to cultural and industrial history.

The importance of soils is often underestimated or overlooked, and poorly understood. Soil is a key component of green infrastructure. Soils support agriculture (which supplies most of our food) and are the basis of terrestrial ecosystems. They are intimately connected with aquatic environments and the atmosphere. Soils store and filter water, store carbon and can contain records of our ecological and cultural past. Soils are complex ecosystems, derived from the rocks and minerals where they occur, but are also composed of plant roots and mycorrhizae, microbes, soil fauna, other organic matter, water, and gases. Soil microbes remove pollutants and are responsible for the cycling of nutrients.

Soils are being degraded through erosion (either by wind or water), compaction, being sealed over or contaminated with heavy metals, hydrocarbons, pathogens and microplastics. Soils can lose nutrients, become too nutrient-rich or suffer from losses of soil biodiversity. Eroded soils are deposited onto roads or washed into watercourses or the sea. It is estimated that more than 2 million tonnes of soil are eroded annually in the UK. These problems are predicted to become worse with climate change, with heavy downpours accelerating losses caused by runoff and droughts drying soils and increasing wind erosion.

Green infrastructure includes soils, and these must be conserved to protect existing biodiversity, geodiversity, and archaeological deposits. Where soils are modified, they should be prepared so that they support the habitats and sustainable drainage systems that are created. Degraded soils should be modified so that they are less compacted, and infiltrate and store more water.

Low nutrient soils are often preferable where species-rich grassland is being established, and exposed rocks, skeletal or bare soils are important habitats for some invertebrates (including for example mining bees) and basking sites for reptiles. Free-draining and water-absorbent soils are required for tree pits, rain gardens and green roofs.

The use of topsoil should be limited to horticultural applications, including food growing. Approaches used to replenish organic material and nutrients in agricultural soils will not be suitable for soils in most parts of the green infrastructure network. There is no need to use imported, manufactured topsoil on road verges and other infrastructure projects, particularly where the intention is to establish woodland or species-rich swards. Avoiding the unnecessary use of topsoil will reduce the carbon footprint and cost of projects as well as helping to increase biodiversity. It will also reduce the risk of introducing invasive non-native species to sites.

There is interest in modifying soils to store carbon. This can include the restoration of wetlands by re-wetting soils (wetlands are particularly efficient at sequestering carbon) or the creation of woodlands and species-rich grasslands. There is also interest in burying biochar in soils, to store carbon and improve water storage, drainage, and aeration.

There is insufficient data on the condition of our soils and better monitoring is required. Soil surveys and investigations should be commissioned when planning or designing large projects. Engagement of suitable specialists, including soil scientists, geoarchaeologists and geologists, alongside stakeholder

engagement, is therefore recommended. Geodiversity Action Plans should be referred to.

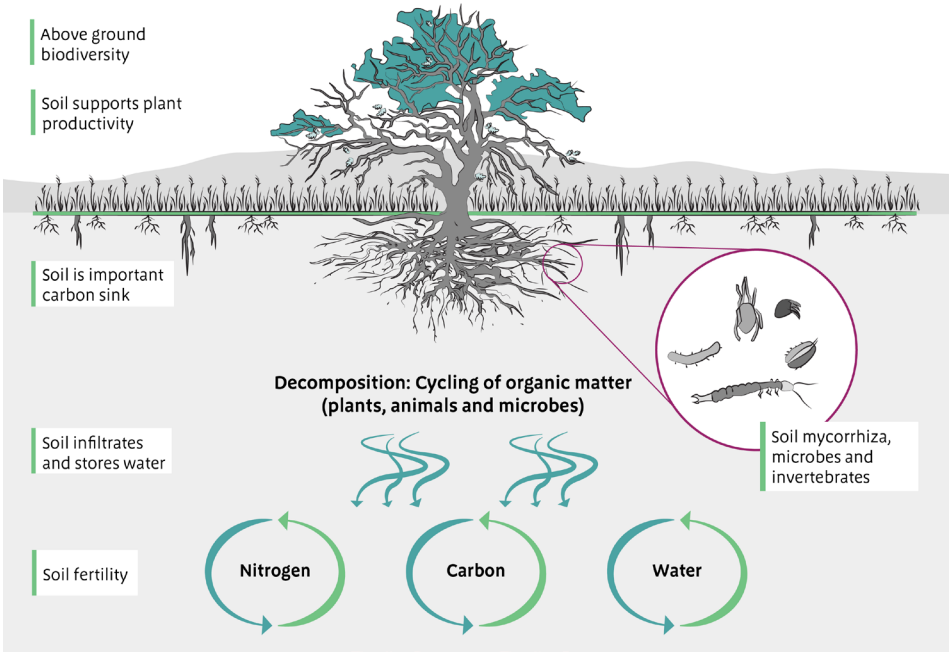


Figure 10: Functioning soils. Credit: IUCN (Conserving Healthy Soils)

As part of the 25-year environment plan there are several measures under development to improve and protect soil health in England. This includes the Sustainable Farming Incentive scheme that encourages sustainable approaches to farm husbandry that deliver for the environment, improve and protect soil health and support farm productivity. A range of soil monitoring measures are also being developed to help land managers and farmers track the health of our soil and the impact their management practices have over time, encouraging more appropriate soil management practices to be implemented.

5.5 Water

The water cycle (where precipitation falls onto the land, infiltrates into soil and rocks, flows into watercourses and the sea, evaporates into the atmosphere, and falls again) has been significantly modified by human activities. Large-scale removal of habitats for agriculture and urban development, has led to greater soil compaction and has increased the area of sealed surfaces, both of which have had the effect of drying out the landscape. Watercourses have been straightened and rivers disconnected from their floodplains. As a result of these changes, the risk of flooding is increased, and freshwater and marine environments have become more polluted.

To realise more benefits in terms of reductions in flooding and improvements in water quality and biodiversity, green infrastructure needs to be considered at a catchment (river basin) scale. Integrated Catchment Management (ICM) involves the participation of multiple organisations, landowners and managers through a partnership approach.

Green infrastructure helps to reverse the effects of urbanisation by reducing the extent of sealed surfaces, thereby allowing more water to infiltrate into soils. This is the sponge effect, which slows the flow and improves the quality of water that enters the aquatic environment. The risk of downstream flooding is decreased, and biodiversity is increased in both terrestrial and aquatic ecosystems.

In upland and rural areas, the sponge effect can be increased through the restoration of damaged or lost peatlands. In suitable locations, woodland can be re-established. Such schemes also store carbon in re-wetted soils and woody vegetation. Natural Flood Management (NFM) techniques can be used, including the installation of large woody debris barriers (leaky dams) across woodland streams. This can also be achieved through the re-introduction of beavers, which build dams that slow the flow, trap sediments and increase the area of wet woodland and other wetland habitats. Where farming continues, practices can be modified to slow runoff, for example through contour ploughing, by damming gullies, by planting hedges and trees belts across slopes or by modifying grazing regimes.

Most rivers and watercourses have been straightened and modified in the past. Some urban rivers have put underground into pipes. This has resulted in the loss of habitats, species, and amenity. Rivers have become disconnected from their floodplains. Some of these losses can be reversed through river restoration, where natural processes, features, recreational and aesthetic value, and biodiversity can be re-established. The restoration of rivers and floodplains is important in improving flood management, improving water quality and biodiversity, and plays an important role in helping people to reconnect with nature if access to, and alongside, water is also improved.

In conurbations or around infrastructure, sustainable drainage systems (SuDS) should be incorporated into new development or retrofitted around existing developments. The four pillars of the sustainable drainage philosophy are water quantity, water quality, biodiversity, and amenity. The approach is to, wherever feasible, capture rainfall at source, to minimise the use of pipes and underground drainage and to maximise the use of Nature-based Solutions. Source control features include green roofs and rain gardens. Water can be moved across sites on the surface, by using swales (vegetated shallow channels) and rills (unvegetated channels), and it can be slowed and stored, by using ponds and basins designed to hold water temporarily. By using SuDS, it is also possible to reduce combined sewer overflows (CSOs) by avoiding the discharge of surface into the combined sewer network. This approach improves downstream water quality.

With concerns increasing about over-abstraction of watercourses and aquifers and the increasing likelihood of drought associated with climate change, there is growing interest in harvesting rainwater within urban areas. Harvested rainwater can be used for irrigation and toilet flushing, reducing the demand on potable (treated) water supplies, and potentially reducing the volumes of water entering surface drains, rainwater harvesting usually involves collecting water from roofs or occasionally from paved surfaces and storing the water in tanks or cisterns.

Where they are used, rainwater harvesting schemes should be carefully integrated with plans for green infrastructure, both in terms of irrigation (where this is required) but also with respect to water features that might be used to store water.

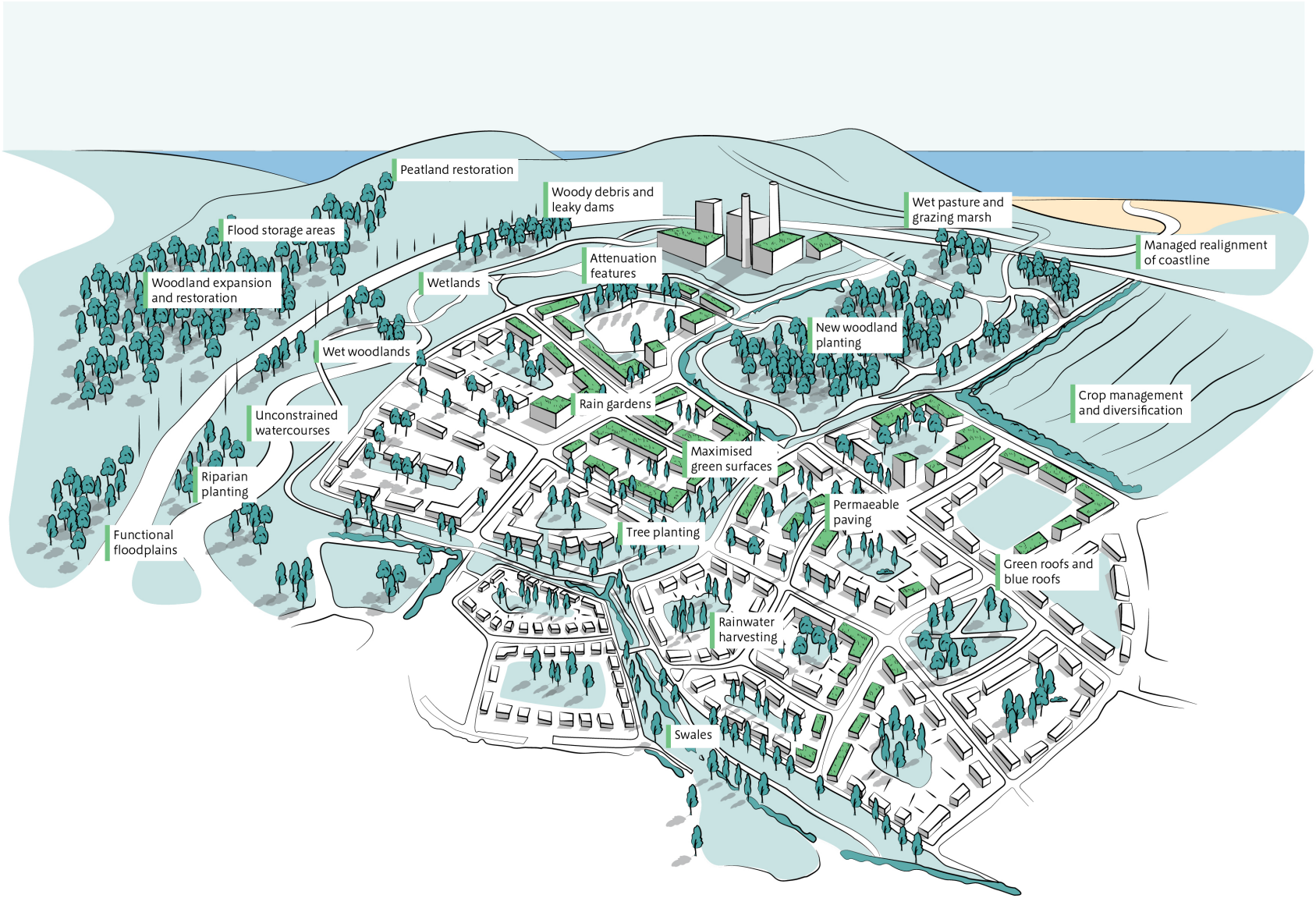


Figure 11: A catchment approach to flood prevention. Adapted from the National Model Design Code

5.6 Carbon and energy

The restoration and creation of habitat results in the removal of carbon dioxide from the atmosphere and the sequestration of carbon in soil and woody vegetation. Wetlands, woodlands, tree plantings and permanent grasslands all store carbon. Re-wetting the landscape and creating sponge cities increases this. Habitat restoration and creation through the provision of green infrastructure, represent the most effective means of climate change mitigation, however it should be noted that it can take many years for habitats to mature, and it is important that sites continue to be managed appropriately.

Green waste that is produced through the maintenance of green infrastructure, can be collected, and used to generate biogas, a renewable natural gas. Plantations can also be irrigated using wastewater to remove pollutants (bioremediation). Green waste can be used to make biochar, a form of carbon, which can be buried in urban landscapes or ploughed into arable fields. Biochar is a soil improver – it increases water-holding capacity and fertility – but it also doesn't decompose, which means that it becomes a long-term carbon sink. Biochar production from green waste is a promising way of turning a waste product into a valuable carbon store and those who collect green waste, can incorporate the production of biochar into their operations.

One of the most important sources of renewable power in urban areas is the sun. Photovoltaic panels (PVs) can be readily fitted to roofs and increasingly will be fitted to other structures, including for example, shade structures. PVs can be combined with green roofs (an arrangement known as biosolar roofs), where the benefits of a green roofs (source control for sustainable drainage, biodiversity, and cooling of the building) can be combined with the generation of electricity. Where there is space in suburban and rural areas, PVs can be fixed to frames at ground level, with vegetation able to grow around the panels. As PV technology develops, new configurations and combinations will become available so that energy generation can be co-located with green infrastructure.

Carefully sited low-carbon energy schemes such as water or ground sourced heat pumps in lakes could be installed to power nearby buildings. There are many examples of micro-solar panels already being used to power small scale or remote installations such as car parking ticket machines, lighting, and interpretation. The generation of power with wind and water needs to consider impacts on biodiversity and in the case of wind turbines, visual impacts. However, these methods will continue to evolve and clean electricity generation is likely to continue to occur within green infrastructure networks.

Parks, and other green spaces, can provide suitable locations for ground source and water source heat pumps, which use electricity to collect low-grade heat from the environment and boost this to provide hot water and heating for adjacent buildings. The noise impact of air source heat pumps and other mechanical and electrical equipment must be assessed before installation. Care should be taken to ensure that historic and archaeological features are protected when installing equipment.

Green infrastructure can assist with climate change adaption by providing shade and evaporative cooling. This can save energy and carbon by reducing reliance on air conditioning in summer.

Vegetation, including tree belts, hedges and green walls can also help to reduce the impact of cold winds in winter.

Pleasant and convenient cycling, horse riding and walking routes, promotes active lifestyles. Travelling on foot or cycling reduces car use and results in significant savings of energy and carbon. Healthier lifestyles also save energy and carbon costs associated with healthcare.

5.7 Temperature

Green infrastructure modifies microclimates, most notably by reducing ambient temperatures in summer. The built environment, which consists of dense and often dark materials like bricks, masonry, and asphalt, absorbs the sun's energy during the day and re-radiates that energy at night as heat. This is the main cause of the Urban Heat Island Effect (UHIE), where cities can be several degrees hotter than their rural hinterland, particularly on calm, summer days. This phenomenon is projected to become worse with climate change, with excess heat also exacerbating air pollution.

The vegetation, soil, and water of green infrastructure in urban areas reduces the urban heat island effect. This happens because leaves reflect sunlight (leaves have a higher albedo[7] than most roofs or pavements). Leaves also provide shade, preventing the sun's rays from reaching buildings and streets. Deciduous trees can be useful in blocking sunlight during the summer, but allowing in winter sunlight, which can be important for wellbeing.

Evapotranspiration from soils and vegetation and evaporation from waterbodies provides significant cooling. Green roofs and green walls protect buildings from the extreme surface temperatures (which can be more than 50 degrees Centigrade) that occur on exposed conventional roofs and walls on hot summer days. The cooling effect of different types of green infrastructure and planting can be modelled for buildings and neighbourhoods in detail, which is particularly useful when planning green infrastructure in urban settings.

When people travel by motor vehicle, waste heat is released, and air quality deteriorates. By incorporating routes that encourage people to walk and cycle, green infrastructure also has an indirect effect on temperature because journeys in motor vehicles are avoided.

Improving the capacity of soils to store water, associated with the sustainable drainage approach, can reduce summer temperatures. Trees with larger pits, designed to receive run-off, grow larger, cast more shade, and provide more evaporative cooling. Green roofs with deeper substrate hold more water and similarly, provide more evaporative cooling. Water features and irrigated landscapes in the urban core also provide evaporative cooling where people live and

[7] The more reflective a surface is, the higher the albedo value

work. If water used for irrigation or water features is from harvested rainfall, the use of potable water is avoided.

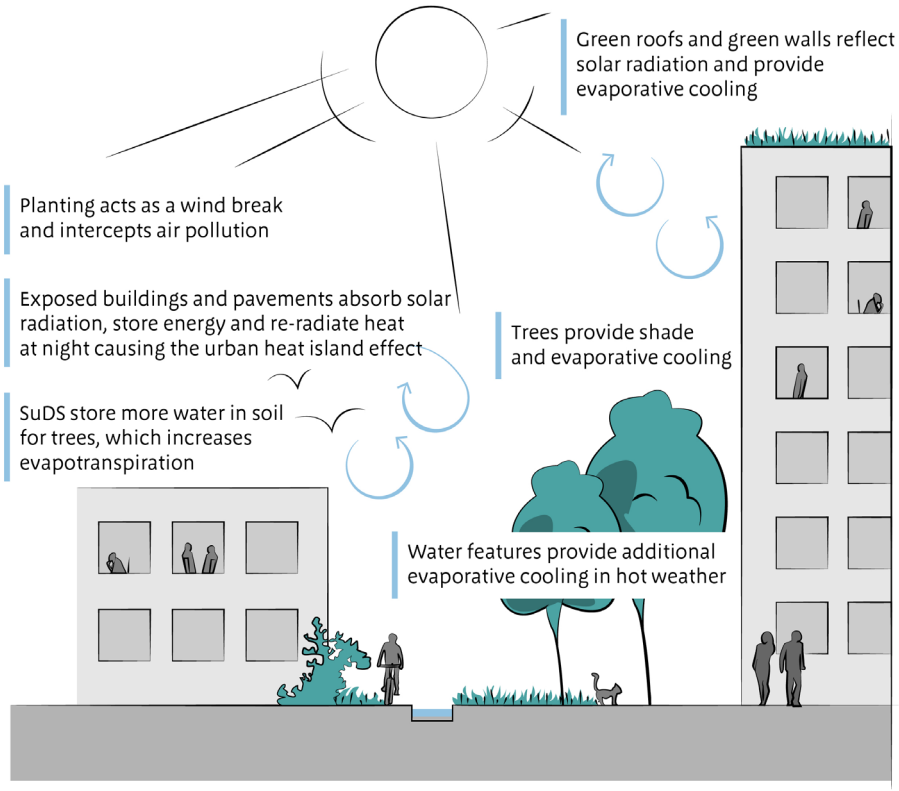


Figure 12: Summer cooling through green infrastructure. Adapted from Trees and Design Action Group

Green infrastructure elements such as extensive green roofs, green walls, grasslands, tree groups, heathland and scrub, can be vulnerable to fire, particularly in periods of drought. The use of harvested rainfall to irrigate features to reduce temperatures and help trees and other green infrastructure elements survive drought and heatwaves should be prioritised. Vegetation on buildings will be subject to fire risk assessments as set out in the Fire Safety Act 2021. Blue infrastructure, including watercourses and wetlands, will be important for wildfire resilience. Watercourses and wetlands can provide natural fire and fuel breaks and these features can be incorporated into a wider network of wildfire prevention measures identified in Wildfire Management Plans.

5.8 Food

There is a tradition of people growing some of their own food on allotments (see section 4.14). Local authorities have been obliged to provide allotments since the beginning of the twentieth century. Although the numbers of allotments have been in decline since the 1940s, the cultivation of allotments is still popular.

Most people, however, obtain their food from shops and restaurants, which means that many people may lack knowledge and experience of food growing. Although it is not feasible for everyone to grow their own food in cities, there are considerable personal and environment benefits associated with local food growing, which means that more allotments and food growing facilities should be included in plans and designs for green infrastructure.

Food growing sites are a component of the green infrastructure network. They can connect habitats and can include vegetation that supports pollinators and informal margins for a range of wildlife. Food growing sites can also:

- Provide access to nature and the open air
- Are educational and therapeutic

- Help to mitigate the urban heat island effect
- Can incorporate sustainable drainage
- Conserve soils and can store carbon in soils
- Provide exposure to microbes that benefits the immune system

It is important to integrate local food systems as part of a landscape-led approach to design and master-planning. Consideration should be given to local food opportunities in the context of movement, density, commercial activity, and land use to ensure their viability.

Public spaces and schools should be designed to incorporate local food-growing opportunities and households should have access to space to grow food whether in a private garden or in shared community space.

Allotments, small holdings, and orchards provide space to restore locally sourced food production. They also offer opportunities to learn about and gain apprenticeships in gardening, vegetable and fruit growing, beekeeping and horticulture, as well as providing for outdoor places and activities that help bring communities together and encourage an active lifestyle.

Community orchards provide opportunities for volunteers to be involved in the establishment and maintenance of sites where apples, other fruits and nuts are grown. There are hundreds of community orchards where people can meet new people and learn about fruit growing, keep active and harvest fruit. Community orchards are now a common feature of large-scale development proposals. Traditional orchards are a priority habitat, rich in biodiversity. For new housing development, there is an opportunity to plant a fruit tree in every garden, as a way of to reconnect children with nature and with the sources of their food. There are also more general initiatives, including for example, Incredible Edible, which promote community cohesion and local businesses through food growing and the enjoyment and celebration of locally produced food.

Plate 22: Food growing on a car park roof in Stockport. Credit: Natural England

There is a tradition of gardens being provided by local authorities, health facilities and charities for social and therapeutic horticulture. This is the process of using plants and gardens to

improve physical health and mental health and wellbeing. Gardening with others can reduce feelings of isolation or exclusion and participants can acquire new skills to improve the employment prospects. Gardening can be part of the rehabilitation process, to help recovery from illness or injury. This and other nature-based activities are increasingly being prescribed by doctors through green social prescribing.

In urban areas, there is now worldwide interest in providing food growing opportunities, both commercially and for community groups, on rooftops. On older buildings there are often constraints associated with the weight of accessible rooftop gardens, however there are former industrial buildings and multi-storey car parks that can support such activities. On new buildings the structural requirements for food growing can be considered. Food growing gardens have been provided on commercial and residential buildings as well as hospitals.

5.9 Access to nature and supporting health benefits

There are physical and mental health and wellbeing benefits associated with having access to good quality natural green space near to where people live. People from deprived neighbourhoods are more likely to suffer from poor health. This can be exacerbated by a lack of good quality green spaces and places for outdoor recreation, play, poor air quality, noise, traffic, poor housing, and higher rates of crime. The abundance of open space in a neighbourhood, however, should not be mistaken for availability of accessible green spaces or paths; some of the most deprived areas are in the countryside.

Evidence shows that Green infrastructure has a positive influence on population and individual level health and wellbeing, and more frequent exposure to Green infrastructure has a positive influence on mortality rates, certain types of morbidity, mental health, quality of life, and is associated with less stark inequalities in health. Greener environments are associated with better mental health and wellbeing outcomes including reduced levels of depression, anxiety, and fatigue, and enhanced quality of life for both children and adults. Greenspace can help to bind communities together, reduce loneliness, and mitigate the negative effects of air pollution, excessive noise, heat, and flooding. Disadvantaged groups appear to gain a larger health benefit and have reduced socioeconomic-related inequalities in health when living in greener communities, so greenspace and a greener urban environment can also be used as an important tool in the drive to build a fairer society.

For new green infrastructure, it is recommended that:

- In new developments, there is a mixed provision (e.g., a mix of different sizes and types of publicly accessible green spaces, domestic and shared gardens, green routes, street trees etc.) with appropriate connectivity. Mapping of existing green infrastructure assets and deficiencies can assist with planning.
- Improving the quality and management of green infrastructure and improving knowledge of and accessibility of spaces, to have a positive impact on perceptions and use.
- Interventions to promote use should involve both changes to physical spaces as well as complementary social programmes.

- Care is needed not to exacerbate inequalities through processes such as gentrification or restricted access.

- Green infrastructure to promote health and wellbeing is most likely to be successful if there is a good understanding of the local social, cultural, and economic context, where the health (both physical and mental) needs of target populations are understood, and where linkages are made with, and buy-in gained from wider networks of social and health services. Mapping of deprivation can assist with identification of target groups.

Detailed standards for accessible green space have recently been revised by Natural England. These Accessible Natural Green Space Standards (ANGSt), now known as Accessible Green Space Standards (AGS) are set out in Chapter 2 and Natural England's Mapping Database provides an England-wide baseline and analysis of AGS.

In terms of the design of green and blue infrastructure for access, the needs of a variety of users with different interests and capabilities, cultures and backgrounds should be considered. Inclusive design should ensure that spaces are suitable for under-represented groups including young people, older people, people living with disabilities, neurodivergent users, people living in low-income areas, and people from ethnic minority backgrounds.

Research highlights several cross-cutting barriers that should be considered:

- a lack of nearby good quality green space.
- personal safety concerns.
- a lack of partnership working with organisations run by or with under-represented groups.
- limited supportive infrastructure (such as toilets or picnic spaces) that build confidence in the routine use of nature space.

Plate 23: Design green infrastructure to take account of the needs of a variety of users with different interests and capabilities, cultures, and backgrounds. Credit: Natural England

Design to address these issues should tackle common assumptions and biases; promote co-production and co-participation; support peer-led initiatives; diversify the recreational offer; design the right infrastructure including exploring the potential of micro nature spaces as 'stepping stones' to nature engagement; and

communicate creatively. All these aspects should be considered in Design and Access (DAS) statements, which accompany and support planning applications, explaining how a proposed development responds to its site and setting.

Plate 24: West Gorton Community Park has three distinct design zones, a woodland, a meadow, and a community plaza. Underlying all these areas are water management design features, including a series of swales, raingardens, and bio-retention tree pits. Credit: Groundwork

For accessible green infrastructure to be successful it must be high quality and well maintained. The leading method of determining quality of parks is the Green Flag Award scheme, which considers how welcoming a place is, how healthy, safe, and secure it is, how well maintained it is, its impact on the environment (which includes how it is adapting to climate change), how biodiversity and heritage is conserved and enhanced and how the community is involved.

When considering the planning and design of residential communities, or facilities for employment, education and health care, spatial mapping should be undertaken to understand the provision of existing accessible green space. Where there are deficiencies, existing green space should be improved and new high quality, multi-functional, biodiverse green space should be created, ideally in areas of greatest need. Safe access connecting new and existing green space and places where people live, play, commute and work should be provided and whenever feasible, those linear connecting features should also enhance and connect biodiversity.

5.10 Active lifestyles

An active lifestyle integrates physical activity into daily routines. Also known as 'Active Living', this way of life typically involves walking and cycling to school, to places of work, to shops, or for leisure. It also encourages participation in active leisure and recreation, including sport. Advocates of active lifestyles recommend physical exercise to improve endurance (strengthening the heart and lungs), improve flexibility, and maintain strength of muscles and bones, with the aim of reducing the risk of chronic disease and improving overall health and wellbeing, including mental health.

Figure 13: Accessible Neighbourhoods for All. Adapted from The State of Victoria Department of Environment, Land, Water, and Planning, 2018

Green infrastructure networks include green spaces and connections for recreation, exercise, organised sports, and active travel. The network of spaces and connections that promote an active lifestyle include a range of diverse and widely dispersed assets throughout the urban and rural landscape, as well as the by the coast, rivers, and lakes.

The walkable neighbourhood is an organising principle for urban development and urban life. The intention is to provide residents access to most, if not all, of their needs within a short walk or cycle ride from their home to improve life for residents, by improving air quality and making neighbourhoods safer, quieter, more diverse, inclusive, and prosperous.

Cycling is particularly important for improving the health of the individual cyclist, increasing strength and stamina, increasing cardiovascular fitness, and reducing anxiety and depression. Cycling is a good option for commuting to the workplace or place of learning. Travel by cycle does not contribute to noise and air pollution.

Horse riding is particularly important for women and girls who make up most of the participants. Horse riding and care promotes physical activity and mental wellbeing. Horse keeping and riding is undertaken largely in peri-urban and rural areas, but horses are also kept in urban areas.[8] The provision of more, safer and better places to ride supports continuing participation in the sport and is particularly important to consider around new infrastructure and new developments in the urban fringe.

[8] https://www.stepneybank.co.uk/

Plate 25: Cyclists using green active travel route. Credit: Natural England

Wherever feasible, footpaths, bridleways and cycle lanes should be separated from motor vehicles to improve safety and encourage more people to take up cycling and walking. National Cycle Infrastructure Design Guidance (LTN/120) indicates that cyclists must be physically separated and protected from high volume motor traffic, both at junctions and on the stretches of road between them. Where traffic-free paths for cyclists, wheelchair users, horse riders and pedestrians are not available, streets and roads may also need to be greened, and speed limits reduced to promote an active lifestyle and improve access to green space. Natural features in streets, including, for example, street trees and rain gardens, are beneficial features in walkable neighbourhoods.

Greening encourages walking trips to destinations such as shops and schools. Street greening also leads to a reduction in driver speeds and therefore an improvement in road safety for pedestrians and cyclists.

To encourage their use, green and blue spaces and pathways must be aesthetically pleasing, inclusive, spacious, and flexible, to provide space for all types of activity and sport and to accommodate future needs. The attractiveness of green spaces will come, in part, from a strong sense of place. It is also important that places are tranquil and free of excessive noise.

Sport England also promote Active Design which promotes activity, health and stronger communities through the way we design and build our towns and cities.

5.11 Air quality

Air pollution, emitted by motor vehicles, heating systems and power generation plants, includes nitrogen dioxide, sulphur dioxide, ozone, carbon monoxide and particulate matter. Long-term exposure to air pollution can cause chronic conditions such as cardiovascular and respiratory diseases as well as lung cancer, leading to reduced life expectancy. During short-lived, high pollution episodes, children, older people, and people with chronic health problems are especially vulnerable. World Health Organisation air quality targets are regularly exceeded in cities in England.

The best way to improve air quality is to reduce the emissions of pollutants. This will be achieved over the longer term, primarily by more use of public transport, walking and cycling, the

electrification of the vehicle fleet and the generation of electricity and the heating of buildings using combustion-free methods. Green infrastructure can help to improve air quality through the creation of attractive spaces close to where people live or work or through the establishment of verdant cycling or walking routes, thereby encouraging people to walk or cycle, instead of using motor vehicles. The cooling and insulation of buildings with green infrastructure (by for example, green roofs) can also reduce electricity demands. Given that some electricity continues to be generated by burning gas or waste, this also indirectly reduces air pollution.

The vegetation and soil in green infrastructure can also improve air quality by intercepting pollutants as they spread from roads, filtering, and trapping particulates and in some cases absorbing gases. Pollutants are washed into soils where they are broken down by microbes. Finely branched vegetation, which slows air flows, and plants with sticky leaves, absorb or trap the most pollutants. Dense vegetation, including hedges and climbing plants, can act as a barrier, significantly reducing the amount of polluted air in busy roads from reaching adjacent homes, schools, colleges, or workplaces. Modelling has shown that green walls could be used to reduce air pollution in urban streets lined by rows of tall buildings (street canyons). Strategically situated planting, especially of trees, can also help with directing prevailing winds in ways that disperse air pollution.

It is important to note that trees, usually in combination with certain building forms, for example, street canyons, can also trap polluted air. Some species can also emit organic compounds that can react with vehicle emissions under certain conditions, which can contribute to air pollution. An understanding of the setting, prevailing wind patterns, the existing level of pollution and careful selection of species and planting arrangements is required, when using planting to reduce air pollution in city centre locations.

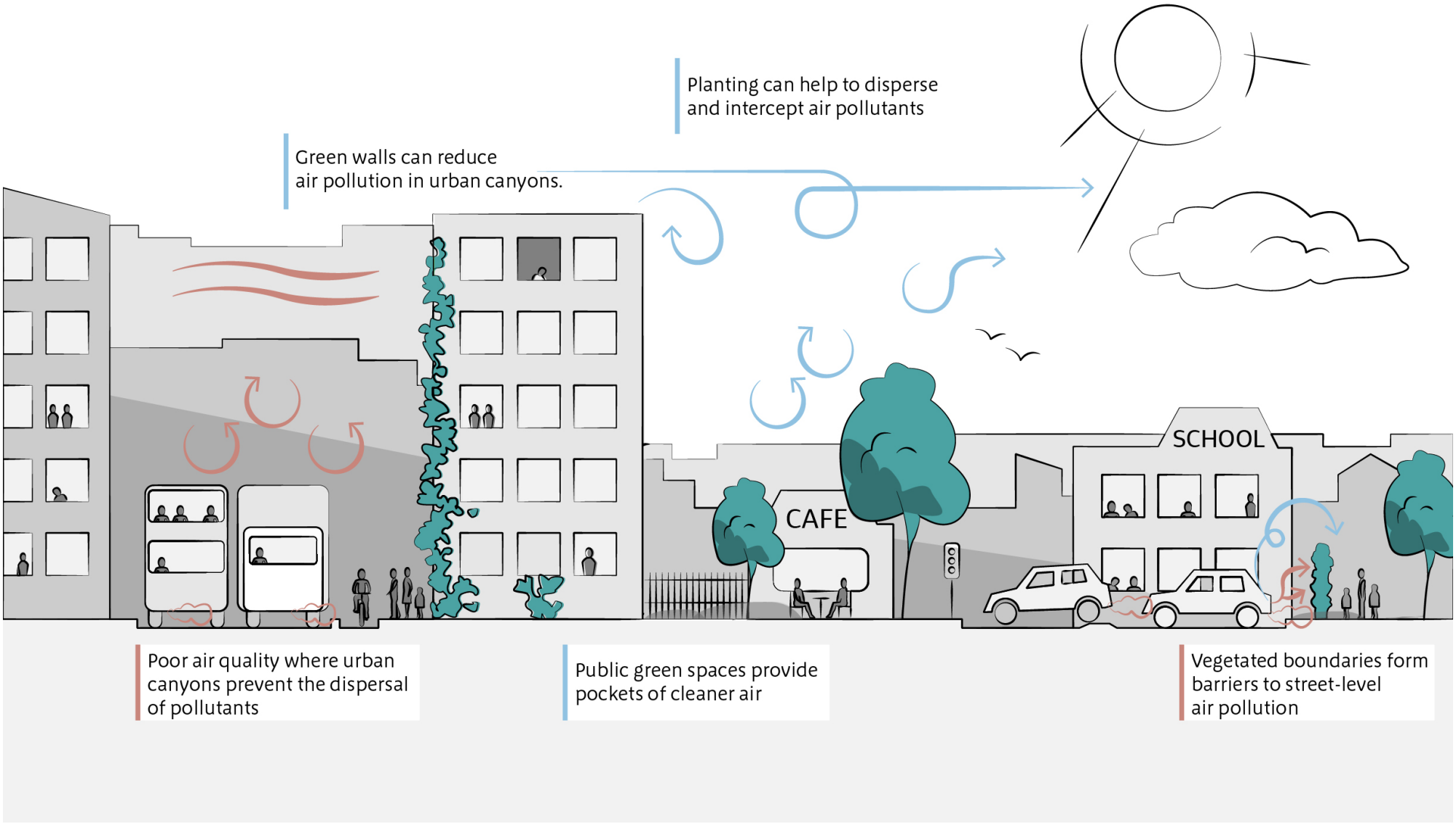


Figure 14: Improving air quality through blue green infrastructure. Adapted from Trees and Design Action Group

5.12 Noise and soundscapes

Excessive noise has a negative effect on both people and wildlife, affecting quality of life, health, and wellbeing. Long-term exposure to noise can disturb sleep, affect cardiovascular health, metabolism, cause psychological problems and can impair cognitive development in children. Noise pollution has impacts on birds, which have been shown to modify the pitch and timing of their singing.

The Environmental Noise (England) Regulations 2006 (as amended) apply to noise from the wider environment, particularly from transport, which is the main cause of noise pollution. Noise Action Plans are based on Strategic Noise Maps, which show noise problems in large urban areas with major roads and railways. Major airports publish their own Noise Action Plans.

Tranquillity is a state of being calm and worry-free, which we can often find in nature. Noise is one of the main causes of loss of tranquillity. Maps of places in England that are affected by noise and visual intrusion show a correlation between the road transport network and places that lack tranquillity. Where otherwise good quality green infrastructure and access routes to green infrastructure occurs, noise may result in a reluctance to travel to and use those spaces. Noise may affect the decision to visit a public open space, the length of time spent there, the types of activities, and the overall quality of the experience. There are mental health benefits associated with positive soundscapes, which are characterised by the presence of desirable sounds, not just the lack of noise. It is important to consider the effects of noise and soundscapes throughout the green infrastructure network.

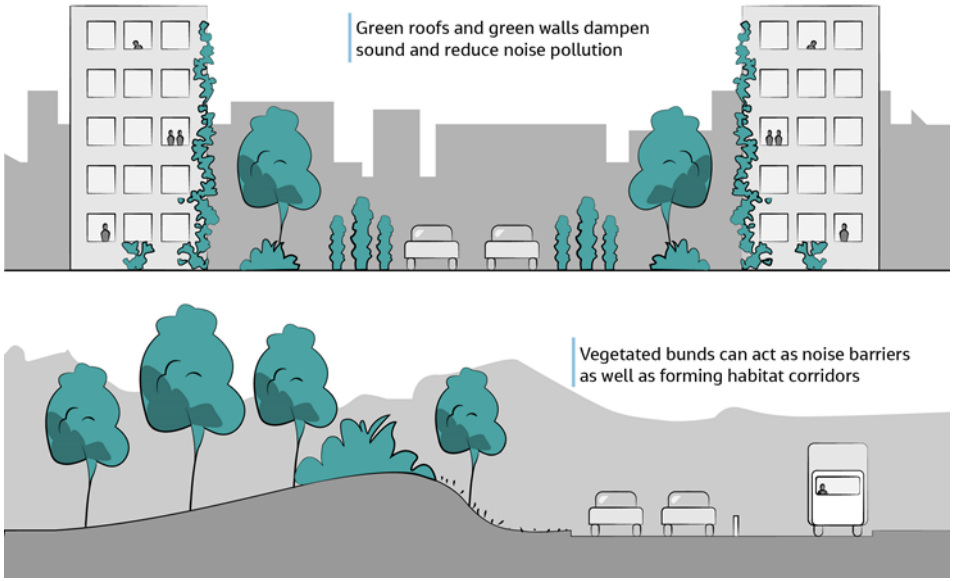


Figure 15: Mitigating noise using green infrastructure

The main effort in noise abatement is to reduce the production of noise, through more cycling and walking, switching to public transport, electrification of the vehicle fleet, and reductions in speed limits. Noise barriers can be effective, and these can be formed in part by soil and vegetation. Soil is a high-density material that forms an excellent sound barrier. Acoustic bunds can be created by ground modelling, and these can be planted with vegetation that further decreases noise. Noise buffers composed of trees and shrubs can reduce noise by up to 10 decibels for every 30 metres width of woodland. Leaves, and branches absorb and deflect sound energy and are particularly effective at reducing sharp tones, and this can reduce the noise experienced by people by up to 50%. Green infrastructure can be part of noise abatement strategy in the urban environment. Green roofs and green walls can

reduce the amount of noise entering a building by half, with wetter substrate performing better than dry, and deeper or thicker build-ups intercepting the most noise.

5.13 Education and volunteering

Blue green infrastructure can be a focus for community participation, providing opportunities for education, training, and volunteering, and provides a focal point for meeting and bringing together local communities. This contributes to social cohesion and improved health and wellbeing. There is evidence that spending time in nature is associated with a range of benefits including improved motor skills, better academic performance, and increased concentration. In supporting the delivery of local health, social, environmental, and economic priorities, good quality green space has the potential to deliver substantial benefits for public health and other local priorities at a relatively low cost.

There is evidence that children are spending less time in nature and are losing a sense of connection with the natural world. Urban dwellers, people living in low-income areas, and people from ethnic minority groups are particularly badly affected. Learning in the natural environment (LINE) or nature-based learning, has been shown to provide a range of benefits to students of all ages, including improved mood, resilience, wellbeing and cognitive, physical, and social development as well as academic progress in a range of subjects including maths and languages. From 2025, the new GCSE in Natural History will further encourage nature-based learning and to learn about wildlife.

The Natural Connections project found that most children have the perception of learning better and achieving more when working outside. 92 per cent of pupils involved in the project said they enjoyed their lessons more when outdoors, with 90 per cent feeling happier and healthier as a result.

Plate 26: Forest school. Credit: Kay Pallaris, Ringway Community Garden & Woodland

Green infrastructure can provide attractive and high-quality locations for formal and informal learning. This can range from small, specialised facilities like school wildlife gardens, through a campus-wide approach, whereby biodiverse and functional green space acts as both a setting and subject for learning. Increasing green infrastructure is part of national and local government

approach to climate change adaptation. This will result in an increase in green infrastructure features like sustainable drainage systems (including for example, rain gardens), tree plantings and green roofs. These new arrays of green infrastructure features will provide good settings for learning in nature.

Learning can also be fostered outside of the school or institute. An example of this is Forest Schools, where regular opportunities are provided for young people to develop confidence and self-esteem, and outdoor skills, as well as learning about the natural environment, in local woodland. Long established youth organisations, including the Scouts, continue to use natural space as a setting for activities that promote connection with the natural environment. Providing a range of sites within the local green infrastructure network, where these activities can be safely accessed and enjoyed by all age groups, including teenagers, is an important part of efforts to foster learning in the natural environment.

5.14 Sense of place

'Sense of place' is a term used to refer to the way in which people relate to and perceive the distinctive character, history, and spirit of an area. Green infrastructure can play an important role in reinforcing sense of place and local distinctiveness.

To support sense of place, green infrastructure design should be informed by an understanding of an area's character and the opportunities it affords. Landscape Character Assessment provides a strategic perspective on how areas of differing character relate to each other and identifies key characteristics, informing ways in which green infrastructure can create visual and physical links between areas and contribute to sense of place. Information on character can be found in National Character Area (NCA) profiles; county/district and local landscape character assessments; townscape and historic character studies; and protected landscape management plans. The NCA profiles include Statements of Environmental Opportunity that offer suggestions for where action can best be targeted to conserve and improve the natural environment. At a more local level, Landscape Character Assessments (LCAs) often include guidance for managing future landscape change and can inform landscape and green infrastructure strategies. Strategies can range from conservation and enhancement to restoration and creation and often use a mix of these. Local design guides can provide illustrated examples of how to take character into account in practice.

There are many ways in which investment in high quality, locally appropriate green infrastructure can respond to, and reinforce, a sense of place, whilst helping to restore nature and building resilience. For example, green infrastructure can help to revitalise high streets and towns through new tree and shrub planting to create shade; pocket parks and water features for people to connect with nature and find tranquillity; and attractive, sheltered places for activities such as al fresco dining. This can make towns and city centres more unique and attractive destinations, helping to increase footfall - whilst delivering benefits for climate and nature too. In addition, green infrastructure can create attractive gateways to urban areas, improving visitors' first impressions, and make business parks more attractive for investors and workers.

Green infrastructure design also has the potential to improve the setting of the historic environment through the restoration of historic assets (including replanting), repurposing areas and

creating new layers of design. Good traffic-free connections to local heritage and cultural sites, as well as homes and workplaces, also improve a sense of place. In contrast, taking a standardised, uniform approach to designing places with little reference to local character, materials and associations can weaken distinctiveness. Green infrastructure should be part of an effort to bring the best of the new without homogenising or diminishing what is already present.

Plate 27: The design of the new Mayfield Park, in the heart of Manchester, has drawn upon its industrial heritage to create a green oasis with a strong sense of place. The river Medlock has been opened up, new planting and play facilities introduced, and materials reused to help tell the story of the area and reinforce the associations that people have with it. Credit: Natural England

The planning, design, creation, and management of green infrastructure provides opportunities to facilitate collaboration and cooperation in local communities and with visitors. In addition, parks, waterside spaces, and other green infrastructure can provide focal points for cultural expression and events, helping to connect communities to their history and creating a vibrant setting for a wide range of activities and experiences. This creates more attractive places to live and work and helps to attract new investment, which builds prosperity.

Function	How to improve design
Biodiversity	Consider design within the context of strategic needs and local priorities for biodiversity set out in emerging Local Nature Recovery Strategies (LNRS). Consider providing mosaics of habitats including grassland, shrub, woodland, wetland to enhance locally important habitats identified in the LNRS. Consider how green infrastructure can contribute to bigger, better, more and joined up networks of green and blue spaces and natural features for biodiversity. For pollinators consider a diverse mix of native plants e.g., through flower-rich grassland, green roofs and walls, shrubs, hedges and trees, as well as structurally diverse vegetation for food, shelter and nest sites including standing dead wood, old trees with cracked bark and tree cavities. Consider leaving grass to grow longer before mowing and removing arisings.
Soils and Geodiversity	Consider design within the context of strategic needs and local priorities for soils and geodiversity. Consider underlying geology and how to avoid losing, eroding (either by wind or water), compacting, sealing over, or contaminating soils. Consider increasing the area of dense ground cover such as long grass, shrubs and woodland, especially on slopes, and adding hedges and buffer strips to reduce soil erosion in prone areas such as arable fields.
Water supply	Consider design in the context of strategic needs and local priorities for water supply. Development often leads to conversion of permeable land to impermeable surfaces which is likely to impact on water supply. Consider increasing permeable surfaces such as green spaces, vegetated gardens, and permeable paving, and adding sustainable drainage options such as rain gardens, retention basins and bioswales, to allow more rainwater to infiltrate into the ground and recharge groundwater supplies.
Flood regulation	Flood regulation will be impacted by land use throughout the catchment. Consider design in the context of strategic needs and local priorities for flood management. Consider increasing the area of woodland in places where it can intercept flow, permeable surfaces such as green space, vegetated gardens, and permeable paving, and adding sustainable drainage options such as wetlands, ponds, bioswales, raingardens, green walls and roofs, and retention basins to help slow the flow of water. Consider potential to de-culvert or re-naturalise rivers and streams.
Water quality	Consider design within the context of strategic needs and local priorities for water quality. Consider adding or retaining buffer strips of long grass, shrubs and trees between pollution sources (such as farmland or roads) and water courses.

Function	How to improve design
Carbon storage and energy	Consider design within the context of strategic needs and local priorities for carbon storage and energy. To enhance these functions, retain existing peat-based wetlands and woodland. Consider enhancing wetlands and creation of additional areas of woodland, putting the right trees in the right place to maximise the benefits of tree planting for other ecosystem services and ensuring there are no perverse outcomes. Design so that green waste that is produced through the maintenance of green infrastructure, can be collected, and used for renewable energy. Consider clean electricity generation within green infrastructure networks. Photovoltaic panels (PVs) can be readily combined with green roofs (biosolar) and increasingly will be fitted to other structures, including for example, shade structures. Carefully sited low-carbon energy schemes such as water or ground sourced heat pumps in lakes could be installed to power nearby buildings.
Temperature	Consider design within the context of strategic needs and local priorities for cooling and shading. Consider planting trees on the east, south or west side of buildings to provide shade in summer. Green roofs and walls can also help to keep buildings cool in hot weather and warm in cold weather. These actions can also benefit other services.
Food	Consider design within the context of strategic needs and local priorities for food production. Minimising the footprint of development on productive agricultural land could help reduce decline if continued food production is a priority. Consider inclusion of allotments or community orchards.
Active lifestyles	Consider design within the context of strategic needs and local priorities for recreation and active travel, with a focus on who is benefitting. Engaging with community groups and stakeholders will help inform appropriate measures. Consider improving public access to suitable areas or creating places that provide recreation opportunities close to where people live in line with Accessible Greenspace Standards. This could be open access or linear access, with features designed to meet the needs of users including walkers, cyclists, equestrians, and disabled people.
Access to nature	Consider design within the context of strategic needs and local priorities for access to nature. Consider improving public access to larger nature rich areas, close to where people live in line with Accessible Greenspace Standards. Consider retaining, enhancing, or creating semi-natural habitats, trees and green spaces that will support a mix of native species, as well as green roofs and walls, street trees, flower-rich grassland and water features which will allow people to connect with nature and encounter wildlife.

Function	How to improve design
Air quality regulation	Consider design within the context of strategic needs and local priorities for air quality regulation. Consider adding dense barriers of woodland or hedgerows between pollution sources, such as busy roads, and places used by people. This can also benefit noise reduction.
Noise and soundscapes	Consider design within the context of strategic needs and local priorities for noise reduction. Consider adding dense barriers of woodland or hedgerows between noisy roads or railways and places used by people. These actions can also benefit other services, such as air quality regulation.
Education and volunteering	Consider design within the context of strategic needs and local priorities. Engaging with community groups and stakeholders on local needs will help inform appropriate measures. Consider retaining, enhancing, or creating accessible semi-natural habitats, trees and green spaces that will attract a mix of native species, which could be used to help people learn about and connect with nature through a variety of nature-based activities. These actions can also benefit other services.
Sense of place	Consider design within the context of strategic needs and local priorities for local landscape/townscape and historic character. Engaging with community groups and stakeholders on local needs to find out what habitats, species and natural features are important locally will help inform appropriate measures. Consider retaining, enhancing, or creating distinctive semi-natural habitats, trees and green spaces, as well as green roofs and walls, street trees, flower-rich grassland and water features that reflect local landscape character and which will create or retain a 'sense of place'.

Table 3: Designing for Multiple Functions

Chapter 6: Designing Green Infrastructure in Different Area Types

Designing Green Infrastructure in Different Area Types

6.1 Introduction

Green infrastructure should be multifunctional, connected, varied and locally appropriate wherever it is located. This chapter considers how green infrastructure should be planned, designed, and delivered as a multifunctional network in different development area types, ranging from the urban core to the countryside, and into some major infrastructure types such as hospitals, schools, colleges, and linear infrastructure.

In this chapter we bring together information from preceding chapters (on Green Infrastructure Standards, green infrastructure building blocks and designing for multiple functions) to support the development of local design codes for different area types. This chapter follows the National Model Design Code approach whereby area types are identified and supported with guidance.

The intention of this chapter is to identify and characterise some of the main considerations for planning, designing, and managing green infrastructure within each area type. It is acknowledged that the distinction between area types is not always clearly defined, and that discretion may be required in characterising areas and applying any advice provided here.

6.2 Biodiversity Net Gain and Green Infrastructure Standards

Biodiversity Net Gain (BNG) is an approach which aims to leave biodiversity and the natural environment in a measurably better state when land use changes and when development occurs. BNG is already a requirement in many local plans. BNG still relies on the application of the mitigation hierarchy to avoid, mitigate, or compensate for biodiversity losses. It is additional to these approaches, not instead of them.

The Environment Act 2021 includes provisions that will make BNG mandatory in England for most development types. The Biodiversity Metric used to calculate biodiversity net gain includes within it many common green infrastructure habitat features, such as SUDs, green roofs and walls etc and their inclusion in a scheme design can contribute towards meeting BNG requirements.

Enhancing the biodiversity value of, or creating new, offsite green infrastructure, such as parks and other green and blue spaces can also be used to meet BNG requirements. Natural England's Environmental Benefits from Nature tool is designed to work alongside BNG to enable more detailed consideration of wider environmental benefits for people and nature.

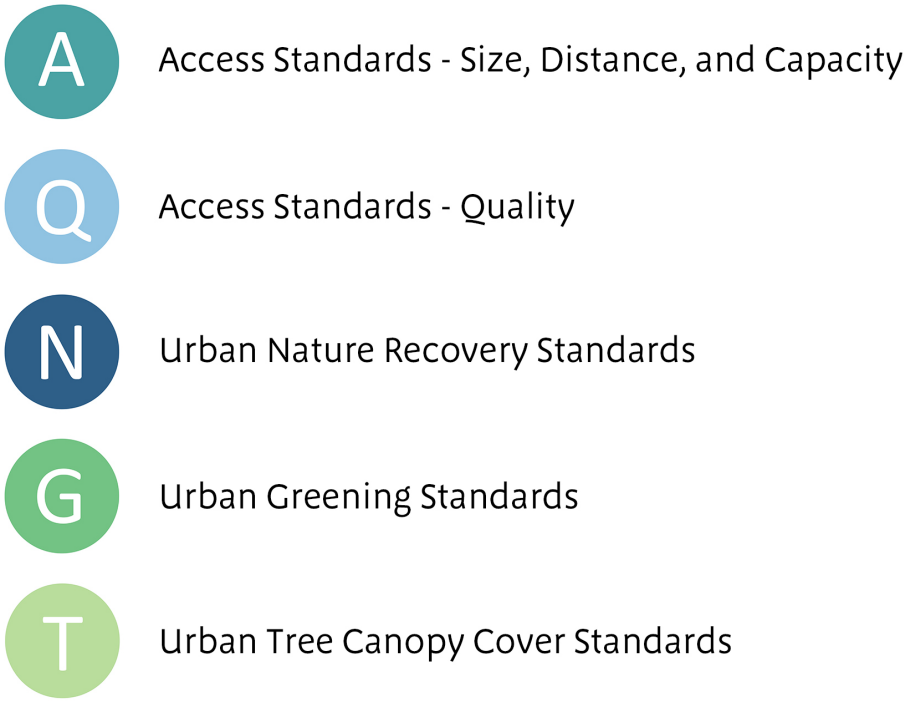
The Urban Greening Factor (UGF) promotes more nature-rich environments that increase the functionality, sustainability, and climate resilience of urban areas. UGFs can also be used alongside BNG, especially on sites with no or very limited pre-existing biodiversity value, to drive urban greening by helping to set the

quantity and functionality of green infrastructure that should be delivered on-site.

Guidance on applying BNG in development should be followed. There is existing good practice guidance published by CIEEM, IEMA and CIRIA for BNG. Guidance for mandatory BNG is currently being developed by Government and will be available shortly. Full guidance on the use and application of the Biodiversity Metric is available.

6.3 Applying the Green Infrastructure Standards in different area types

Chapter 2 sets out the Green Infrastructure Standards. The standards may not be applicable in all area types. For example, the Urban Greening Factor is a planning tool that focuses on the greening of urban areas, and it is recommended that it is applied through planning policy to urban or suburban development. Where appropriate, its use can also be targeted to development sites and locations where the level of greening is a significant planning issue or requirement. This may include the redevelopment of brownfield or post-industrial sites in rural locations or the creation of garden communities that would be expected to provide a significant proportion of green infrastructure across the entire development. This is also the case with Urban Tree Canopy Cover Targets, which are most applicable in urban or suburban areas, and only exceptionally in rural areas - where appropriate and in keeping with the rural landscape character. In this chapter we set out how the Green Infrastructure Standards can be applied in different area types. The Green Infrastructure Standards are depicted as follows:



Key messages are provided against each of the Green Infrastructure Standards, for each Area Type.

6.4 High density urban centres (including high streets)

These areas are characterised by a predominance of sealed surfaces. The central part of the conurbation is often of historic interest and there may be buildings, streets or precincts listed for their heritage value, alongside non-designated historic assets of importance. Street patterns usually follow ancient alignments, and many streets are relatively narrow. Buildings are usually multi-storey and in the larger cities can be tall, casting heavy shade and

creating urban canyons. The urban core is often congested, with buses, commercial vehicles, private cars, buses (and in some cities, trams), cyclists and pedestrians all competing for space. Air quality is often poor because of fumes from vehicles. Impervious surfaces means that the urban core is especially vulnerable to flash flooding and overheating in summer – problems that are predicted to become worse with climate change.

Traditionally, offices, shops, banks, restaurants, and other retail premises have been associated with High Streets, which are the main, historic streets of commerce in towns. High Streets have been in decline for decades, having been negatively affected by the development of shopping centres and retail parks and more recently, the growth of online shopping and banking. According to the ONS, employment on High Streets, fell sharply between 2015 and 2018. In addition, the trend away from High Street shopping has accelerated during the coronavirus pandemic. Addressing the decline of High Streets will require innovation, investment, and renewal. These initiatives are often linked to the concept of making city centres more attractive destinations offering new experiences and providing desirable places to visit and live in. Plans for renewal now also take the opportunity to address the climate and biodiversity emergencies and contribute towards recovery from the coronavirus pandemic. Such initiatives should include significant investments in green infrastructure in the urban core, including the High Street.

New development in urban centres should respond to local landscape/townscape character and enhance local distinctiveness through use of local materials and vegetation that help to tell the story of the area and reinforce the associations that people have with it. Green infrastructure can support urban regeneration by encouraging experiences like al-fresco dining or pocket parks, projects which can increase a community's sense of local ownership, as well as providing attractive places to sit and relax. Creating more attractive streets through pedestrianisation and increasing green infrastructure can help drive more footfall and encourage people to linger. It can improve air quality and soundscapes and increase opportunities for active travel.

Where new buildings are proposed, this approach will be supported by the Urban Greening Factor, Biodiversity Net Gain, and the drive for source control features (including green and blue roofs) as part of sustainable drainage approach. Biophilic design (where this is of interest to the project proponent) will also mean that buildings feature planting. Any new building can include green infrastructure and features for wildlife, providing this is considered at an early stage of the design process

There is an important role for linear features (see 6.13 below) which can include new and improved routes that bring pedestrians and cyclists to the city centre from the wide urban area, suburbs and even the countryside. Access routes and destinations can include planting, pocket parks and other features that encourage more visitors.

New or restored urban areas centred on rivers and canals can create new spaces for recreation, relaxation, and active travel. There may be opportunities to re-discover urban rivers by de-culverting, for example. Restored watercourses, ponds and mini wetlands can create restorative blue spaces in towns and city centres as key components of urban regeneration.

Much of the green infrastructure in the urban core is associated with streets (see section 6.6). In some cities there may also be squares or markets. As vehicular access to these places is reduced, to create a more pleasant experience for pedestrians and cyclists, there can be opportunities to add trees, preferably in the ground with large, modified tree pits to perform as SuDS features. Where space beneath ground is limited (because for example of underground services being too congested or when archaeological features may be present) above-ground planters may be an alternative. Another dividend associated with reducing vehicular access to the urban core, is the possibility of creating incidental green spaces (pocket parks) where parking spaces may no longer be needed. These may be entirely for the public or can be associated with cafes, restaurants, other businesses, or shared by businesses and the public.

There is significant potential for increasing green infrastructure in the urban core through retrofitting existing buildings and by including green infrastructure on new buildings. Retro-fitting green roofs, green terraces and green walls onto existing buildings may also be possible where the structure and fabric is suitable. Opportunities to retrofit existing buildings with green infrastructure will vary according to the type of building, however many flat-roofed commercial buildings built in the twentieth century can be retrofitted with green roofs and most walls (unless they are part of an historic building) can be greened.

Opportunities to retrofit green infrastructure can be identified through the green infrastructure audit process, which was pioneered in London by the GLA and Business Improvement Districts. Other considerations when planning green infrastructure in the urban core include, excessive summer heat, gusting winds, poor air quality and localised surface water flooding. Mapping and computer modelling of these factors can be helpful in predicting the effectiveness of proposals.

Biophilic Design

Biophilic design is an approach which is growing in popularity in the design and construction industry. It seeks to improve health and wellbeing and the wider environment by connecting the occupants of buildings with nature. Biophilic design is supported by certification schemes, which track the process of incorporating nature within and outside of buildings. Biophilic design promotes direct experience of nature (for example natural light, water, and plants) and indirect experience of nature (for example images of nature or natural materials) and is therefore compatible with the green infrastructure approach set out in this guidance.

Safety & Security

Significantly increasing the amount of planting in urban areas can raise concerns regarding visibility, safety, and crime, however these issues can be addressed by implementing good design principles. These include maintaining visibility and sightlines to facilitate surveillance, avoiding the creation of isolated spaces, and ensuring good maintenance, including the prompt repair of damage caused by vandalism. The Design Council provides advice on strategies and techniques for crime prevention. Advice for designers is available from the Secured by Design and related schemes, on how to improve the security of buildings as well as their immediate surroundings.

Application of the GI Standards - high density urban centres (including high streets)

- Small (at least 0.5ha) but frequent greenspaces and pocket parks most likely to fit into the context of high density urban centres, though there may be opportunities for more generous larger greenspaces.
- Design accessible greenspace as part of visitor experience and for wellbeing of workers and residents.
- Buildings may need to be taller in dense urban centres, so that there is room for greenspace that meets local capacity standards (e.g., hectares of accessible greenspace per 1,000 population).
- There is no net loss of accessible green space per head of population at an area-wide level.
- Look for opportunities to convert unused land to natural greenspace.
- Provide attractive green routes for active travel to and from greenspaces.

- Design green space to meet Green Flag Award criteria and best practice in accessibility for all.
- Ensure that greenspaces feel safe, welcoming, and well maintained to encourage inclusive use and attract visitors.
- Utilise natural features to create high quality settings to historic buildings and to enhance public realm.
- Engage local communities/retailers/friends of groups in design and management of green infrastructure e.g., watering street trees as they establish.

- Consider whether development in urban centres could contribute to nature recovery and the creation and restoration of wildlife rich habitats to deliver local nature recovery objectives, for example through incorporating features for species, biodiverse green roofs, species-rich grassland, rain gardens, hedgerows and trees.
- Whilst less likely in this context, in some instances there may be opportunities to contribute to the creation or enhancement of Local Nature Reserve or Local Wildlife Sites.

- UGF of 0.3 for predominately commercial and 0.4 for predominately residential.
- There is no net loss of green cover in urban neighbourhoods.
- Create rain gardens, biodiverse green roofs or roof gardens and planted terraces, green walls.
- Use GI to create attractive places to meet and relax as part of enhanced public realm.

Urban Tree Canopy Cover

- Design to meet locally set urban tree canopy cover uplift targets.
- Plant trees to create shaded high streets that benefit from the soil volume of connected tree pits and provide sensory interaction with nature, as well as sequestering carbon.
- New and existing trees are incorporated into new developments and new streets are tree-lined, ideally in large tree pits to enhance resilience.

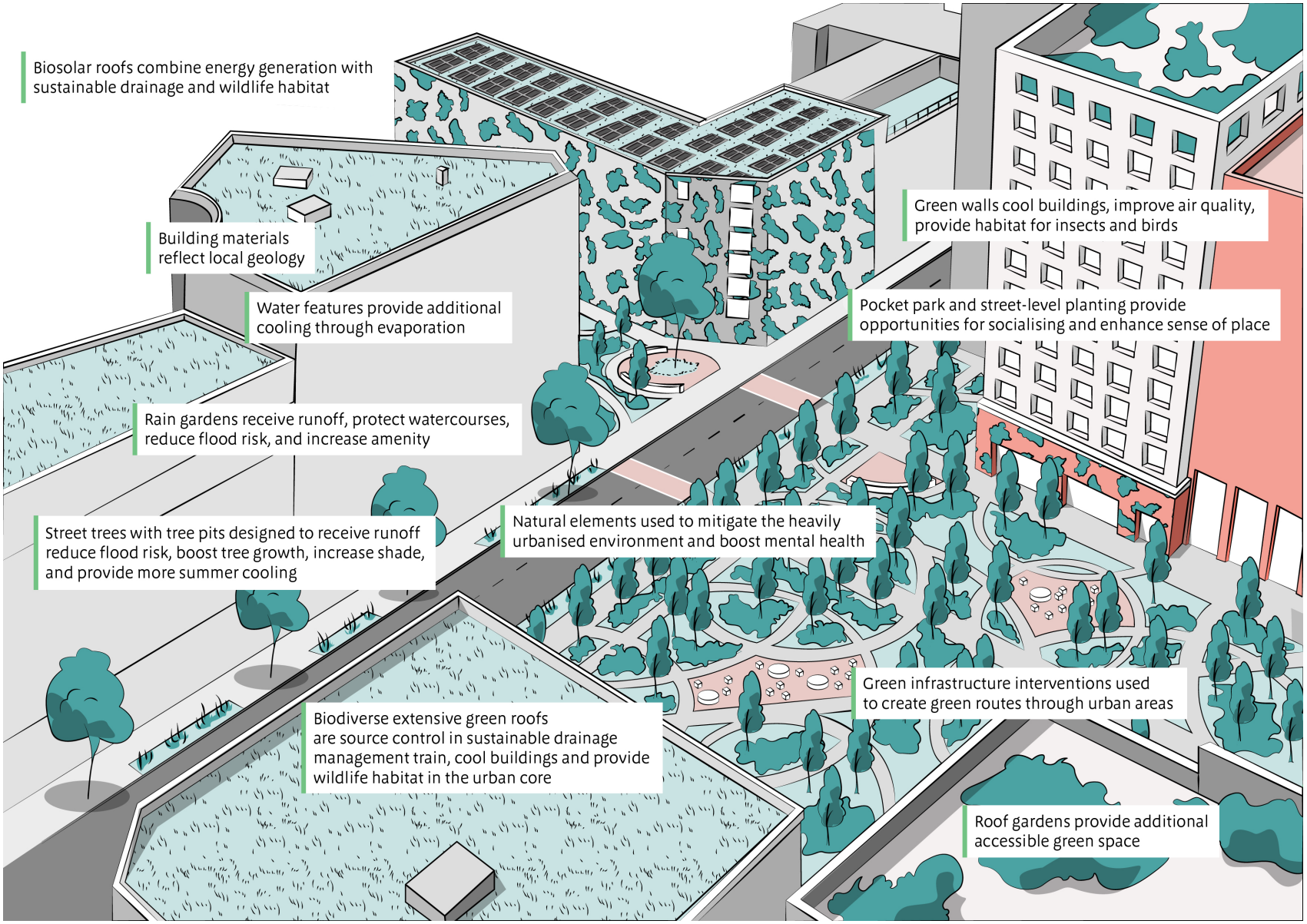


Figure 16: Urban Centre

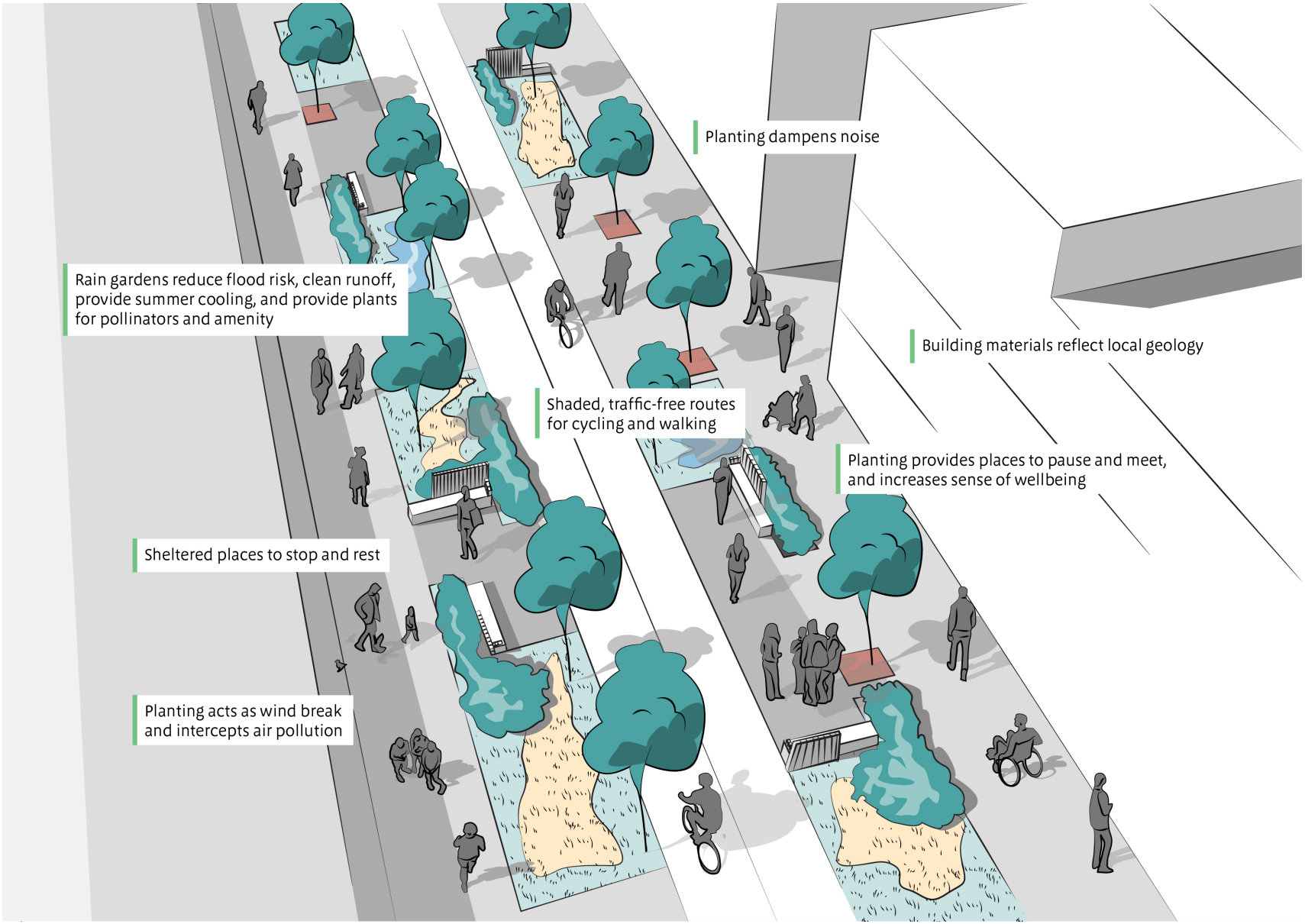


Figure 17: High Streets

6.5 Urban

Conurbations outside of the historic urban core, referred to here as urban areas, usually have a more modern road system than the historic urban core. Impervious surfaces still dominate; however, it is likely that there will be more opportunities to remove asphalt and paving to make space for street trees, rain gardens and pocket parks. Twentieth century transport planning tended to prioritise the provision of extra space for private motor vehicles, and as cities review this, more space can be made available for people and planting. The removal of lanes and parking spaces for motor vehicles provides opportunities for avenues of trees, rain gardens, linear parks, pocket parks and routes for active travel.

Housing in urban areas, particularly twentieth century social housing and flats, is often high density, with little or no gardens and shared green space, parks or verges that are often predominantly amenity grassland, requiring frequent mowing, and have limited value for biodiversity. There is potential to modify these places by amending mowing regimes, planting hedges, planting orchards, creating vegetable plots, planting trees, and retrofitting sustainable drainage systems, including for example, rain gardens, as well as play features and spaces for teenagers. Changes to planting and maintenance regimes should always be developed in partnership with residents, who may also be able to increase their use these spaces and their participation in decision-making and maintenance.

New development in urban areas should respond to local landscape/townscape character and enhance local distinctiveness through use of local materials and vegetation that help to tell the story of the area and reinforce the associations that people have with it. New development will be supported by the Urban Greening Factor, Biodiversity Net Gain, and the drive for source control features (including green and blue roofs) as part of sustainable drainage approach. New or restored urban areas centred on rivers and canals can create new spaces for recreation, relaxation, and active travel. There may be opportunities to re-discover urban rivers by de-culverting, for example. Restored watercourses, ponds and mini wetlands can create restorative blue spaces in urban areas as key components of regeneration.

There will be opportunities to green buildings in the urban area, in common with buildings in the urban core. The urban core tends to be dominated by commercial and institutional buildings, with more residential and retail land uses dominating in the wider urban area, which may have an influence over the type, use and maintenance of green infrastructure provided. Retrofitting existing residential buildings with green infrastructure can be challenging, however where new residential buildings are planned, every opportunity should be taken to include green roofs, terraces, and green walls. Many of these can be accessible (roof gardens and planted terraces and balconies), providing residents with opportunities to enjoy nature at home. In residential areas, there will be more opportunities to involve people with planting initiatives and the maintenance of green infrastructure, including the watering of trees during drought, food growing and tending gardens in the public realm. For example, the Arboricultural Association has a programme that encourages volunteers to water street trees. Urban greening can be underpinned by green infrastructure strategies and audits, climate change adaptation and flood resilience initiatives,

health and wellbeing and educational programmes, with partnerships that encourage volunteer involvement.

Application of the GI Standards - Urban

- Small (0.5ha – 2ha) but frequent greenspaces and pocket parks most likely to fit in urban context, though there may be opportunities for more ambitious larger greenspaces.
- Gentle densification through terraced houses or mid-rise flats will help to create opportunities for accessible greenspace which meets local capacity standards (e.g., hectares of accessible greenspace per 1,000 population).
- Look for opportunities to convert unused land to natural greenspace.
- There is no net loss of accessible green space per head of population at an area-wide level.
- Provide attractive green routes for active travel to and from greenspaces and to connect urban to rural.

- Design green space to meet green flag award criteria and best practice in accessibility for all.
- Ensure that greenspaces feel safe, welcoming and well maintained to encourage inclusive use and attract visitors.
- Utilise natural features to create high quality settings to historic buildings and to enhance public realm.
- Engage local communities/retailers/friends of groups in design and management of green infrastructure.

- Consider whether development in urban areas could contribute to nature recovery and the creation and restoration of wildlife rich habitats to deliver local nature recovery objectives, for example though incorporating features for species, biodiverse green roofs, species-rich grassland, rain gardens, hedgerows and new woodland.
- Whilst less likely in this context, in some instances there may be opportunities to contribute to the creation or enhancement of Local Nature Reserves or Local Wildlife Sites.

- UGF of 0.3 for predominately commercial and 0.4 for predominately residential.
- There is no net loss of green cover in urban neighbourhoods.
- Create a variety of green infrastructure including rain gardens, biodiverse green roofs or roof gardens for pollinators, planted terraces, green walls.

- Use GI to create attractive places to meet and relax as part of enhanced public realm.
- Provide opportunities for urban food growing.
- Proactively integrate GI as part of the planning and development process rather than leaving it to the margins or left-over spaces.

- Design to meet locally-set urban tree canopy cover uplift targets.
- New and existing trees are incorporated into new developments and new streets are tree lined.
- Plant trees along streets and in parks to create shade, clean the air, sequester carbon, reduce flood risk and provide sensory interaction with nature.
- Consider the resilience of tree species to long term climate change

6.6 Streets

Streets often have a role in providing connections in the green infrastructure network. Some cities already have many street trees, whilst others have few. Where there are already mature or veteran trees, efforts should be intensified to find ways of retaining them. Trees may be historic features and notable within the streetscape. Where there are relatively few trees, efforts to plant more should be prioritised. There may be opportunities to reinstate historic planting where it can enhance landscape character. Some cities (for example, Manchester) have Tree Action Plans that provide strong protection for trees and require replacement of any trees that are lost. Many streets in the urban core are too narrow or may have such underground congestion caused by utilities, so that significant new in-the-ground planting is not feasible. Where there are street trees, there will be the issue of suitable replacement species as trees fail or need to be felled for safety reasons. Expert advice is needed when tree works are required, and local authority tree officers can advise. Tree works generate many concerns and local people need to be briefed and involved in decisions. When tree works or planting is required it should be undertaken promptly and to a high standard.

There is also increasing interest in maximising the role of street trees in the sustainable drainage systems and as part of the wider ecological network. Increasingly, where there is space, cities are looking to install rain gardens and other similar features in streets. These are planted beds that are designed to receive surface-water runoff, thereby taking pressure off the existing conventional surface water drainage system. Water can be cleaned and stored in rain gardens, which when full, can overflow into other rain gardens or the existing drains or watercourses. An example of this approach is Sheffield's Grey to Green scheme.

The Healthy Streets approach, developed by Transport for London, includes indicators, which relate to pedestrians from all walks of life and active travel, public transport, clean air, safety, noise abatement, road crossings, places to stop and rest, feeling calm and safe, shade and shelter and things to see and do. Green infrastructure contributes towards these objectives in a cost-effective way. Examples of green infrastructure features in streets that support this approach include:

- Build outs (for example rain gardens) that make it easier for pedestrians to cross lanes of traffic.
- Shade trees that keep people cool and relaxed.
- Green walls and other planting in street canyons that improve air quality, reduce noise pollution, and improve perceived soundscape quality.

Application of the GI Standards - Streets

- Small but frequent greenspaces and pocket parks incorporated into streets.
- Use GI interventions to enhance access routes to natural greenspaces, so that routes themselves are attractive and multi-use.

- Look for opportunities to involve communities in street planting, growing food and maintaining GI. e.g., watering street trees as they establish.

- Consider how urban streets can contribute to nature recovery for example though incorporating features for species, biodiverse green roofs or rain gardens, or front gardens designed for wildlife with hedges or native species can add to the street scene, and how streets can help to connect wildlife areas.

- Consider how urban streets can contribute to meeting UGF of 0.3 for predominately commercial and 0.4 for predominately residential, when urban streets are within the development boundary.
- There is no net loss of green cover in urban neighbourhoods.
- A variety of GI interventions can be incorporated into the street scene including rain gardens, street trees, meadow verges. Ensure adequate specification and space for growth of trees and planting schemes.
- Front gardens designed for wildlife with hedges or native species can add to the street scene.
- Use GI to create attractive places to sit and relax as part of enhanced street scene.

- Design to meet locally set urban tree canopy uplift targets.
- New and existing trees are incorporated into new developments and new streets are tree lined, ideally in large tree pits to enhance resilience.
- Use trees to create shaded active travel routes, to give streets local identity and to sequester carbon.

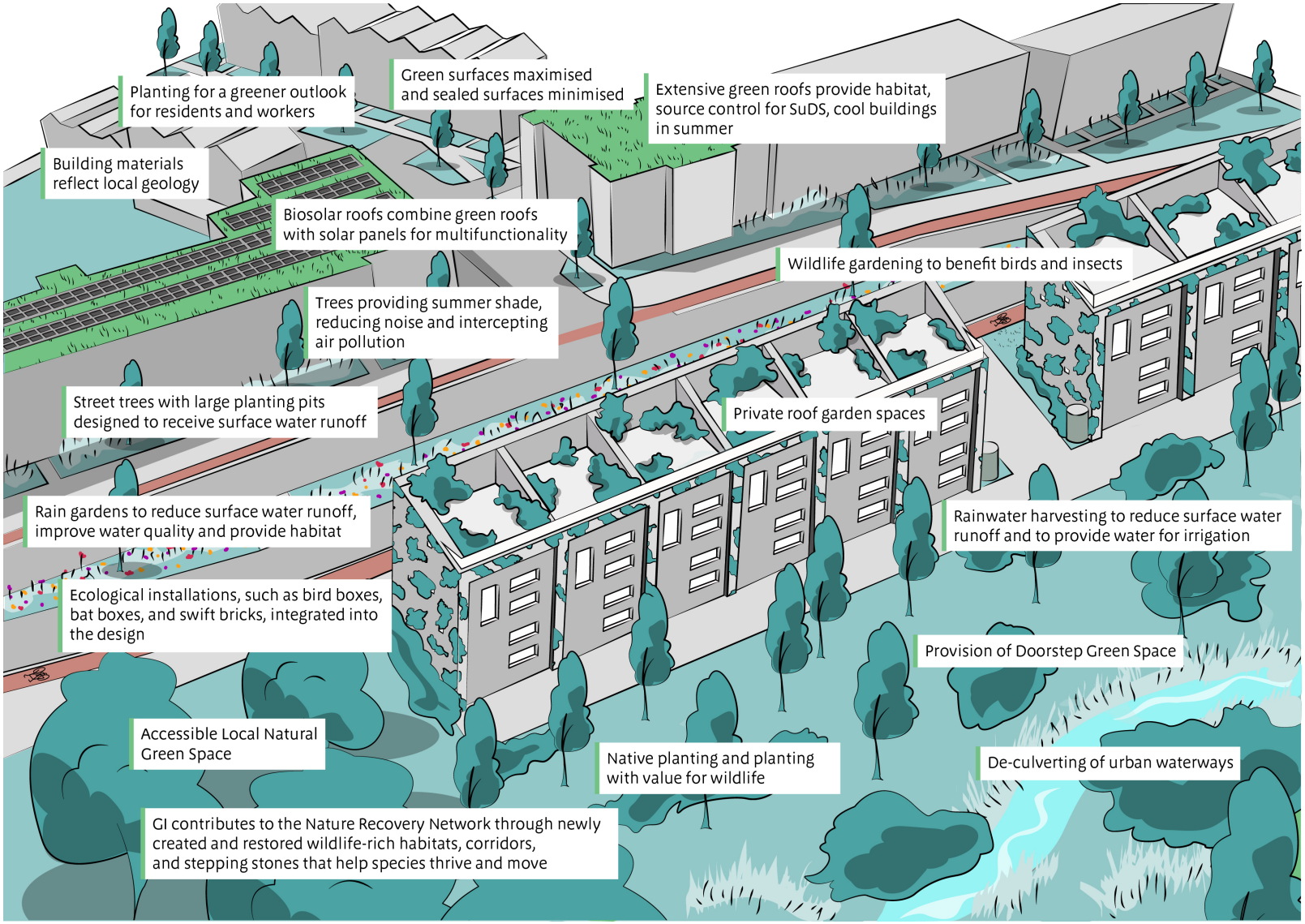


Figure 18: Urban and Streets

6.7 Suburbs/urban fringe

Suburbs on the edges of towns and cities became commonplace during the nineteenth and twentieth centuries when the development of rail and road transport made commuting to the workplace viable. Many were carefully laid out with tree-lined roads, front and back gardens, local amenities and bus routes that provided connections with town centres and places of work. Suburbs have continued to expand; however, landscape character has declined. Housing density is relatively low in suburbia. The interface between the suburbs and the wider countryside can be critical in wildfire-prone landscapes.

Residents of suburbs tend to rely on the car for transport and roads take up a relatively high proportion of space. The reliance on private transport means that social and commercial amenities can be some distance from where people live. Suburbs are usually within reach of town centres and the countryside, however there are often barriers to the movement of pedestrians and cyclists, caused by major highways and railways or other land uses. Some suburbs are very extensive. Large suburbs can be difficult to navigate, with confusing road patterns, and a lack of through routes. The creation of walkable neighbourhoods, with amenities and public transport will help to alleviate these problems.

Where gardens occur, there is a tendency for these to be lost to car parking, paving, decking and artificial grass. The loss of gardens, the sealing of soils and the removal of planting contributes to declines in biodiversity and can increase the risk of surface water flooding and high temperatures in summer. The government provides guidance on how to use permeable surfaces in front gardens. The RHS has also issued advice on the greening of front gardens, driveways, and parking areas.

New development in sub-urban areas should respond to local landscape/townscape character and enhance local distinctiveness through use of local materials and vegetation that help to tell the story of the area and reinforce the associations that people have with it. New development will be supported by the Urban Greening Factor, Biodiversity Net Gain, and the drive for source control features (including green and blue roofs) as part of sustainable drainage approach. New or enhanced suburban areas centred on rivers and canals can create new spaces for recreation, relaxation, and active travel. Restored watercourses, ponds and mini wetlands can create restorative blue spaces in suburban areas. There may be opportunities to re-naturalise watercourses for example.

Roads in suburbs often have a greater capacity to accommodate more tree planting with larger pits, verges, sustainable drainage features like rain gardens, traffic-free routes for cyclists and subtle fire breaks. Often, new green infrastructure can be combined with traffic calming and other improvements to the public realm. Facilities and routes can be established to create more walkable neighbourhoods. Residents can be involved in environmentally friendly gardening, encouraging wildlife through gardening, the provision of bird nesting and bat roosting boxes, making routes for hedgehogs, rainwater harvesting and other activities that improve the green infrastructure network. Where dwellings are extended or redeveloped, there will be opportunities (encouraged through the planning approval process) to plant new hedges, make replacement plantings of trees, to install rain gardens and small-scale green roofs.

Application of the GI Standards – Suburbs/urban fringe

- Design to meet a mix of size/proximity access standards including small, medium, and large greenspaces (2ha, 10ha, 20ha, 100ha etc).
- Gentle densification through terraced houses or mid-rise flats will help to create opportunities for more accessible greenspace which meets local capacity standards (e.g., hectares of accessible greenspace per 1,000 population).
- There is no net loss of accessible green space per head of population at an area-wide level.
- Look for opportunities to convert unused land to natural greenspace. Utilise former industrial or heritage locations to provide locally distinctive greenspaces.
- Provide attractive green routes for active travel to and from greenspaces and to connect urban and rural.

- Design green space to meet green flag award criteria and best practice in accessibility for all.
- Ensure that greenspaces feel safe, welcoming. There may be more opportunities for wilder semi-natural areas in larger greenspaces.
- Engage local communities/retailers/friends of groups in design of green infrastructure.
- Manage for wildlife including wildlife gardening.

- Consider how development in sub-urban/urban fringe areas can contribute to nature recovery and the creation and restoration of wildlife rich habitats to deliver local nature recovery objectives, for example though incorporating features for species, biodiverse green roofs or rain gardens, species-rich meadows, hedgerows, new woodland, or wetland to enhance nature.
- Explore opportunities to create or enhance an area that could contribute to the 1 hectare of Local Nature Reserve per 1,000 population standard or enhance/create a Local Wildlife Site.

- UGF of 0.3 for predominately commercial and 0.4 for predominately residential development in existing sub-urban or urban fringe areas. For predominately residential development on greenfield sites such as garden suburbs or garden villages Local authorities can choose to add higher target scores such as 0.5 or higher where appropriate and at their discretion.
- Retain and enhance existing green infrastructure.

- Create a variety of green infrastructure including rain gardens, biodiverse green roofs, or roof gardens for pollinators, planted terraces, green walls, as well as larger semi-natural or wilder green and blue spaces.
- Proactively integrate GI from the outset rather than leaving it to the margins or left-over spaces.

- Design to meet locally set urban tree canopy cover uplift targets.
- Plant trees along streets and in parks to create shade, clean the air, sequester carbon, reduce flood risk, and provide sensory interaction with nature.
- New and existing trees are incorporated into new developments and new streets are tree lined, ideally in large tree pits to enhance resilience. Consider the resilience of tree species to long term climate change.
- Ensure that tree planting is appropriate to the local landscape character.

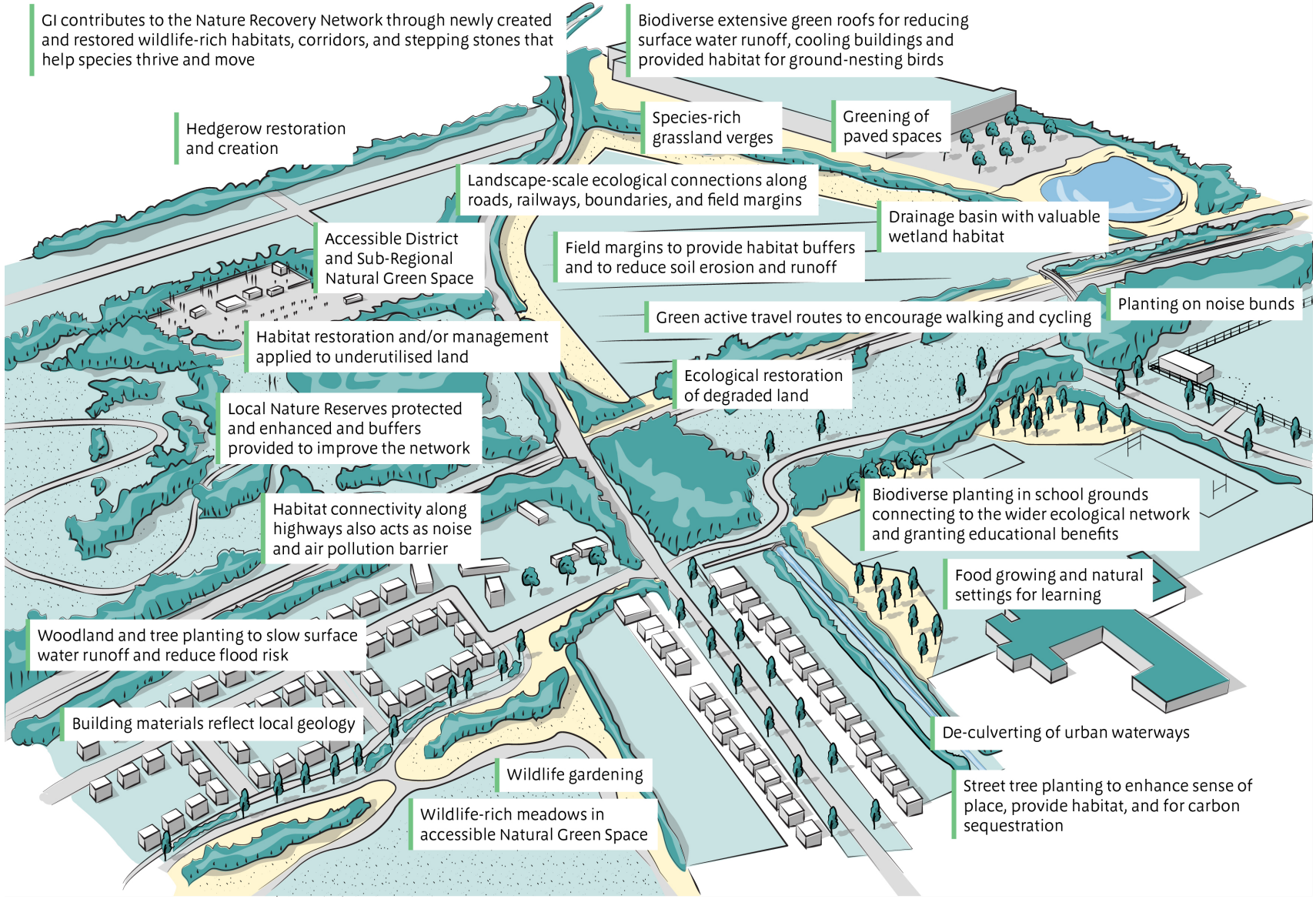


Figure 19: Suburb/Urban Fringe

6.8 Rural

Rural areas are dominated by agriculture. Although most of the space in the rural landscape is green infrastructure in the widest sense, and although some farmland is managed in a way that supports nature, reduces flooding, and increases access for people, intensive agriculture has dramatically negatively affected wildlife and reduced the range and amount of ecosystem services provided. Fragments of important habitats, which can be ancient, and of and cultural importance, do occur, and most of these will be designated by statute (e.g., SSSIs) or, if not of the highest value, through the County-wide non-statutory nature conservation system. Most semi-natural areas are however isolated to some extent by intensive agriculture and roads. There are positive aspects of roads in otherwise degraded landscapes - the verges and hedges often provide refuges for the flora and fauna that was once more widespread across farms and verges and hedges also act as important ecological corridors. Authorities responsible for highway maintenance are also making efforts to increase the biodiversity of road verges, with advice on best practice available from Plantlife.

Woodland cover in England is relatively low (10%) and 90% of wetlands have been lost in England over the last century. The loss of wetland has contributed to the decline in biodiversity, however the combination of low woodland cover and draining of wetlands means that accelerated surface water runoff in catchments (especially the upper catchments of river basins) contributes to downstream flooding, where human populations are higher and where settlements, businesses and infrastructure are often close to rivers or in some cases, on floodplains. Another problem in the rural landscape is unsustainable soil erosion and degradation, which is often associated with poor farming practices and surface water runoff.

A green infrastructure approach in rural areas can help to address problems with habitat loss, soil erosion and flooding in lower catchments, by encouraging strategic interventions that buffer and connect existing sites of value. The interception and slowing of surface water run-off (particularly on higher ground and slopes), through, for example, the tree planting or habitat restoration, should be prioritised. Cross-slope plantings can be very effective in slowing runoff and reducing soil erosion where available land is limited. The identification of opportunities to re-naturalise watercourses or re-wet areas that were once wetlands is also recommended. The restoration of wetlands and increases in woodland cover will also sequester carbon in timber and soils.

People in rural areas without access to private vehicles can find it difficult to reach essential services. Improvements to public transport, footpaths, bridleways, and cycle routes can help to alleviate these problems. Safe traffic-free routes for walking and cycling can also increase visitor numbers and boost tourism.

Development on greenfield sites should retain existing habitats, geological, archaeological and heritage features. Development should follow Biodiversity Net Gain requirements as set out in legislation. Though not principally used in urban areas, local authorities may wish to add Urban Greening Factor scores where appropriate in greenfield development, to set the quantum of on-site greening. Source control features (including green and blue roofs) may help to deliver a sustainable drainage approach. Vegetated boundaries and other natural linear features should connect with the wider green infrastructure network. Connections

for walking and cycling and access to public transport should be provided. Within greenfield sites, plans should be developed with multi-functional and biodiverse green infrastructure and sustainable drainage in mind, before attention is paid to roads and buildings.

Application of the GI Standards - Rural

- Protect and enhance existing green infrastructure.
- Design new accessible green or blue space to meet a mix of size/proximity access standards including small, medium, and large greenspaces (2ha, 10ha, 20ha, 100ha, 500ha) and to meet capacity standards (minimum of 2ha/000 population).
- There is no net loss of accessible green space per head of population at an area-wide level.
- Seek opportunities to create district or sub-regional greenspaces, ensuring that features, activities, and facilities are appropriate in scale.
- Provide attractive green routes for active travel to and from greenspaces and to connect rural areas with urban centres.

- Where appropriate, design accessible green space to meet Green Flag Award criteria, without urbanising. Consider application of best practice in accessibility for all.
- Ensure that more formal greenspaces feel safe, welcoming. There may be more opportunities for wilder semi-natural areas in larger greenspaces.
- Enhance the natural quality of historical sites as appropriate to their setting.
- Engage local communities in design of green infrastructure.
- Manage for nature including wildlife gardening.

- There may be opportunities to consider how development in rural areas can contribute nature recovery and the creation and restoration of wildlife rich habitats to deliver local nature recovery objectives, for example though incorporating features for species, biodiverse green roofs or rain gardens, and creating or enhancing larger areas species-rich meadows, hedgerows, new woodland, or wetland to enhance nature.
- Explore opportunities to create or enhance an area that could contribute to the 1 hectare of Local Nature Reserve per 1,000 population standard or enhance/create a Local Wildlife Site, or to buffer and enhance existing designated sites and form part of the Nature Recovery Network.

G

Urban Greening Factor (UGF)

where appropriate

- Whilst UGF is principally used in urban areas, Local authorities can choose to add target scores where appropriate and at their discretion e.g., for residential development on greenfield sites in rural areas such as new garden communities, garden suburbs and garden villages.
- Retain and enhance existing green infrastructure.
- Protect, buffer, and connect key sites. Create and restore semi-natural habitats such as woodland, peatland and grasslands to reduce flood risk, improve water quality and reverse soil erosion.
- Proactively integrate GI from the outset.

T

Urban Tree Canopy Cover

where appropriate

- This standard has been designed for urban areas. It may be appropriate to consider tree canopy cover uplift in rural areas, but it would be particularly important to ensure that tree planting is appropriate to the local landscape character.
- Allow existing woodlands and groves to expand and build on the characteristics of the area such as hedgerows with trees, tree-lined watercourses, field trees and orchards.
- New and existing trees are incorporated into new developments and new streets are tree lined ensuring that this reflects and enhances local landscape character.

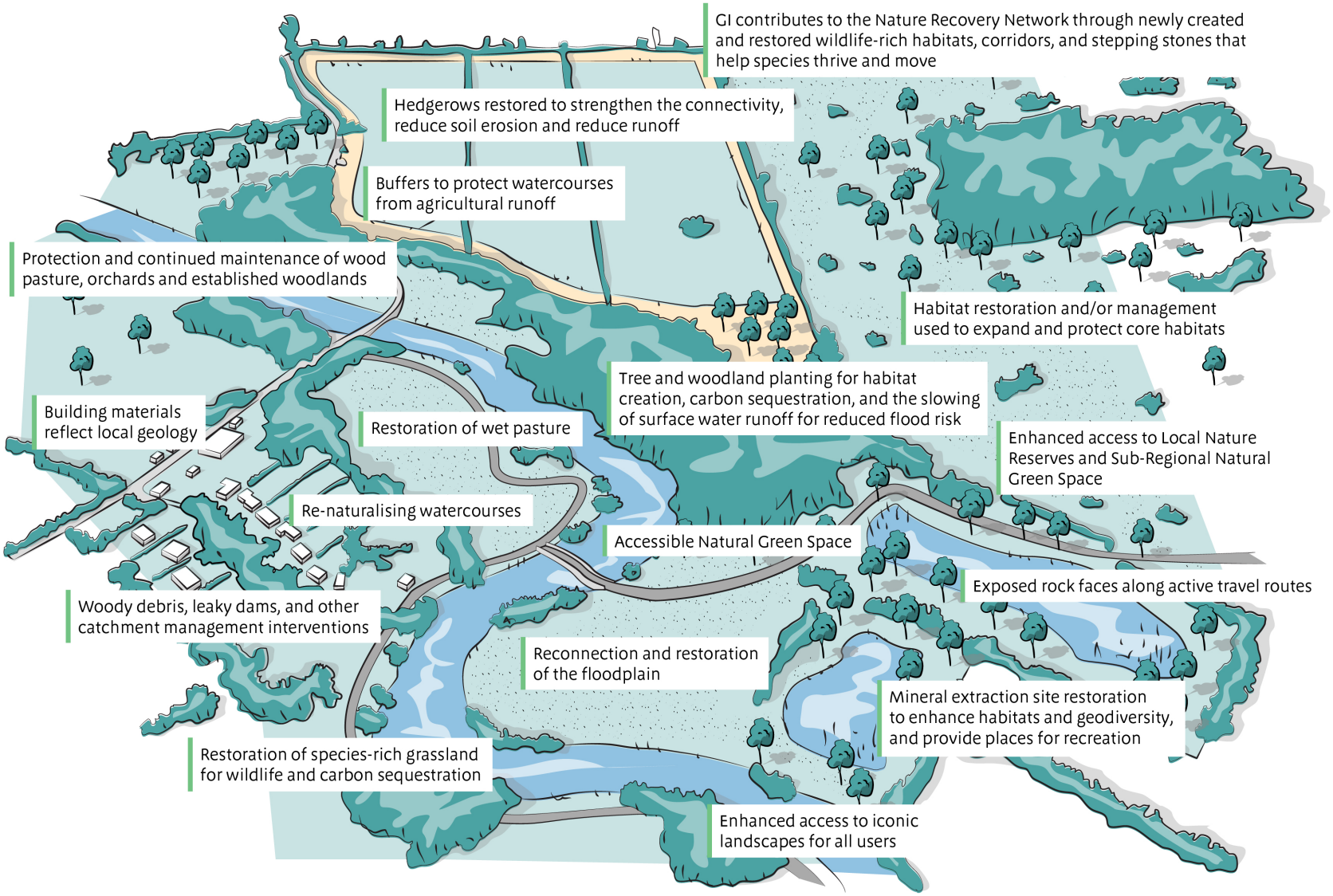


Figure 20: Rural

6.9 Parks and green space

Public parks, gardens, and other green spaces such as burial grounds and commons are often the key components of urban green infrastructure networks. Public parks are maintained for the public and are free to access year-round. There are also privately owned parks. Some are free to visit, and others may charge a fee. Parks are often designed for amenity purposes and support a range of informal recreation or more formal sport and recreational uses. They are places where people meet, socialise, relax, exercise, play sport and connect with nature, daily. Many are of historic or cultural importance and contribute towards sense of place. Evidence shows that they play an important role in supporting physical and mental health and wellbeing.

Parks and green space have proved to be long-lasting and adaptable, however there is often scope for improvements that take account the needs of different age, cultural and social groups Parks and green space should have equality of access including disabled access and should adhere to the standards set in the UK Equality Act 2010 (as amended) as a minimum. They should be designed for equality of access from the outset through engagement with representative local groups.

Country parks were first created in the 1970s. They are designed to give people experience of the countryside and were established on former country house estates, industrial sites, mineral workings, farms, or around historic monuments. Most are accredited by Natural England. They are public green spaces, often at the edge of urban areas, which provide places for people to enjoy the outdoors and experience nature in an informal, rural setting.

Plate 28: Design greenspace through engagement with representative local groups. Credit: Natural England

In a neighbourhood it is good to have a variety of different sizes and types of parks and green space, for example pocket parks, doorstep green spaces and natural green space, connected physically or functionally with other green infrastructure as part of a network. Natural England's Publicly Accessible Green Space Standards (see Chapter 2) set out size and distance criteria for accessible green space.

Parks and urban green spaces are often comprised of amenity grassland, with collections of exotic and native specimen trees, sports pitches, flower borders and shrubberies. Evidence shows that the visits and value of green space, to both people and wildlife,

are greater where there is a more diverse landscape, including for example meadows and woodland. Opportunities to provide more variety and structure should be sought.

Amenity grassland is important many in parks for recreation and sports, however in many cases some of this can be replaced with meadows to enhance biodiversity. It may be necessary to plant wildflowers or to remove turf and re-seed since much amenity grassland is dominated by grasses that out-compete wildflowers. Meadows require less intensive mowing regimes to conventional lawns, and grass cuttings should be removed to reduce fertility, which increases diversity.

There are schemes that use the biomass in grass clippings and other green waste to produce energy or to make biochar (a soil improver that sequesters carbon). Parks should be designed with this in mind with either composting facilities or collection points for clippings and green waste.

There may be opportunities to extend tree planting in parks and green spaces. Tree planting can include more native species and a wider range of species (including non-native species), to increase biodiversity and decrease the risk of losses associated with stresses brought about by climate change. It is vital that successor planting is planned for existing mature trees. The choice of trees and planting locations should be in keeping with historic designs, local landscape character and consideration of pests and diseases. Parks and green spaces should be designed to include features for wildlife, including native flora to increase the diversity of invertebrates, refuges for invertebrates, bird boxes, bat boxes and hedgehog highways.

Public parks often include lakes, ponds, and water features. These are popular with the public. Demand for water features is likely to increase in concert with warmer summers. Consideration should be given to incorporation of more water bodies, wetlands, and other blue infrastructure features in parks – see Chapter 4. Water bodies should be designed with marginal emergent aquatic vegetation, which provides habitat and improves water quality. Consideration should be given to facilitating public access in and on water bodies (for boating and swimming), providing safety and water quality requirements are met, and wildlife is not impacted.

Urban runoff can be intercepted with rain gardens and constructed wetlands to improve water quality before it enters water bodies. In some parks and gardens, there may be space to provide sustainable drainage features that protect the wider urban environment from flooding. This might include detention basins that only come into use infrequently so that intensive recreational uses can continue unhindered.

In districts where local access to allotments may be limited, or where there are long waiting lists, consideration might be given to providing space for growing food or creating community orchards in parks and green spaces.

Play is critical for child development. Facilities should be available for structured and unstructured play and recreation, offering adventure, exercise, and fun. This can include places for natural play (for example play areas that use fallen trees and boulders) and places for teenagers, including teenage girls. Provision of tranquil places in natural settings with positive soundscapes will attract people who like to spend time in quiet contemplation.

By situating green spaces close to dwellings, workplaces, and recreational facilities, we can promote natural surveillance of places that are open, regularly used and overlooked. Carefully considered pathways and lighting will also increase safety. Design of new green space should consider access points and signage so that it is easy to find ways into and out of the park. Consideration should be given to whether perimeter features are needed or whether the park seamlessly integrates into its surroundings. If perimeter features are needed, native hedgerows are a way of combing a screening effect with habitat creation.

For accessible green infrastructure to be successful it must be high quality and well maintained. The leading method of determining quality is the Green Flag Award scheme, which considers how welcoming a place is, how healthy, safe and secure it is, how well maintained it is, its impact on the environment (including how it is adapting to climate change), how biodiversity and heritage is conserved and enhanced and how the community is involved. Natural England's quality indicators can be used alongside the Green Flag scheme and applied to networks of green infrastructure.

Whilst this guide focuses on green infrastructure, there will be a need to consider the design of built facilities that support access and enjoyment of the sites, such railings, walls, stores, kiosks, cafés, car and cycle parking, signage and toilets depending on the size and purpose of the park. These can be designed to incorporate green features such as green roofs, green walls, and features for species such as bird and bat boxes and invertebrate refuges (see Chapter 4).

Parks can be centres for nature-based activities and clubs, such as community gardening and food growing, practical conservation such as tree planting, nature walks, cycling, green exercise, or can be the places where communal events or celebrations are held. Working with communities to understand what kind of activities they would like their green space to support, can aid design. These activities could support green social prescribing which focuses on providing patients with accessible and local places where they can spend time in nature.

As part of Biodiversity Net Gain implementation, parks and greenspaces could provide biodiversity units that are made available in the BNG market, as long as this provision complies with the regulations e.g., is legally secured, registered and meets the additionality rules. Given that BNG requires management for a 30-year period, it could provide a mechanism for long term funding of biodiversity enhancements in existing parks and greenspace. Consideration should be given to how BNG can be delivered alongside other benefits such as access, recreation, and other ecosystem services.

Application of the GI Standards – Parks and green space

- Consider how parks or green space can be designed to meet accessible greenspace standards, particularly in areas of high deprivation or where there is a lack of private garden space.
- Consider how it can best meet local capacity standards (e.g., hectares of accessible greenspace per 1,000 population)

- There is no net loss of accessible green space per head of population at an area-wide level.
- Provide attractive green routes for active travel, connecting green spaces to residential areas and other facilities.

- Design green space to meet Green Flag Award criteria and best practice in accessibility for all.
- Ensure that greenspaces feel safe, welcoming and have a sense of arrival. Ensure they are designed to encourage inclusive use, including for older people, people living with disabilities, under-represented groups, low-income families, and people from ethnic minority backgrounds.
- Ensure urban green spaces offer a wide range of activities and utilise each as an opportunity to incorporate experiences of nature.
- Consider opportunities for nature-based activities as part of Green Social prescribing initiatives.

- Consider how sites can contribute to nature recovery and the creation and restoration of wildlife rich habitats to deliver local nature recovery objectives, for example though incorporating features for species, biodiverse green roofs or rain gardens, species-rich grassland, hedgerows, trees and woodland or wetland to enhance nature.
- Explore opportunities to enhance or create Local Nature Reserves or Local Wildlife Sites within parks and greenspace.

- Consider how parks and green space can contribute to wider urban greening.
- There is no net loss of green cover in urban neighbourhoods.
- Connect to the wider GI network to create park systems and provide diverse habitats and features for wildlife.
- Design features that attenuate urban runoff.
- Consider opportunities for using the green estate to generate renewable energy.

- Design to meet locally set urban tree canopy cover uplift targets.
- Consider opportunities for planting large tree species in open ground and utilise ability of trees to give character to open space and to contribute to net zero targets.
- Consider the resilience of tree species to long term climate change.

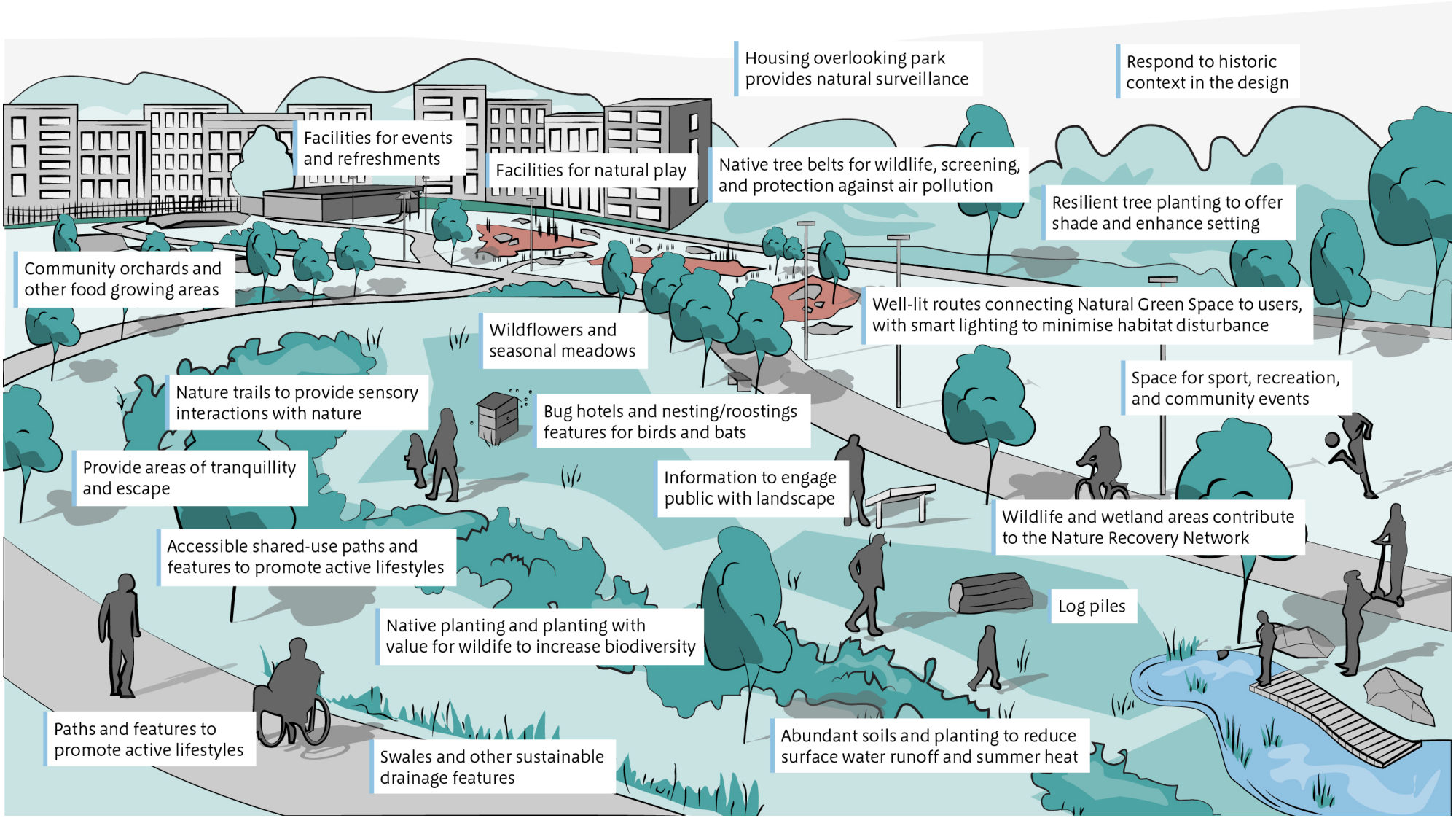


Figure 21: Parks and Green Space

6.10 Commercial, business, and industrial sites

Commercial, business, and industrial sites tend to be on the edge of conurbations and are dominated by roads and vehicle parking spaces. They may also be closely associated with transportation infrastructure, for example motorway junctions, railway yards or ports. In common with other urban development types, sealed surfaces dominate. Industrial buildings can be large and are invariably surrounded by hardstanding. However, grass verges, ornamental planting and tree planting are commonly encountered. Traditionally, planting around commercial and industrial sites is usually designed for visual screening. Sealed surfaces can lead to surface water flooding (or even where the drainage system can cope locally, these developments may contribute to downstream flooding). Ecological value is usually limited, with planting being primarily ornamental.

The retrofitting of green infrastructure in these places is almost always possible. Rainwater from downpipes can be intercepted and rain gardens can be incorporated into verges. The maintenance of existing landscape can be adjusted to encourage more species-rich grassland instead of amenity grassland. This will involve reduced mowing regimes, with delays to allow flowering and the removal of arising to reduce fertility (which increases diversity). Topsoil should not be used when establishing species-rich swards – subsoils or low-nutrient substrates are preferred.

Sealed surfaces can be removed and replaced with swales, rain gardens and trees. Initiatives to encourage travel to work on foot, by cycle or public transport have the potential to free car parking space, where asphalt can be removed to expose soil and establish vegetation. The roofs on industrial and commercial buildings tend to be lightweight and therefore retrofitting with green roofs is usually not feasible, however screening walls with vegetation, using intensive green wall systems or climbing plants may be an option.

When planning and designing commercial, business, and industrial sites, development should follow Biodiversity Net Gain requirements as set out in legislation. An Urban Greening Factor of 0.3 for predominantly commercial development is recommended. Consideration should be given to providing links to adjacent ecological networks to maintain and strengthen wider connectivity. Sustainable drainage should feature Nature-based Solutions and should not rely on tanks or detention basins alone. With new buildings, there is the opportunity to include green roofs in the design, which makes a significant contribution to the sustainable drainage system, helps to cool the building in summer and can provide valuable habitat, notably for ground-nesting birds. Vehicle parks should include trees, swales, and rain gardens. Consideration should be given to more use of free-draining vegetated surfaces that are designed to take vehicular traffic, including for example, Austrian gravel lawns. Plans for active travel to work mean that storage should be provided for cycles (and these can have green roofs and features for wildlife). Cycle routes and footpaths should provide people with the opportunity to cycle or walk to work. As is the case in other areas, green infrastructure can improve the physical and mental health and wellbeing of people.

Application of the GI Standards – Commercial, business, and industrial sites

- Small (0.5ha – 2ha) but frequent greenspaces and pocket parks most likely to fit in commercial, business and industrial sites, though there may be opportunities for more ambitious larger greenspaces.
- Local capacity standards (e.g., hectares of accessible greenspace per 1,000 population) tend to apply to residential developments, but where greenspace in commercial, industrial, and business sites serves both workers and local residents they may be appropriate.
- There is no net loss of accessible green space per head of population at an area-wide level.
- Look for opportunities to convert unused land to natural greenspace.
- Provide attractive green active travel commuting routes, connecting workplaces and local residential areas.

- There may be opportunities to design green space in this context to meet Green Flag Award criteria and best practice in accessibility for all.
- Ensure that greenspaces feel safe, welcoming, and well maintained to encourage inclusive use and attract visitors.
- Utilise natural features to create high quality settings to historic buildings and to enhance public realm.
- Engage local businesses and communities in design and management of green infrastructure.

- Consider how sites can contribute to nature recovery and the creation and restoration of wildlife rich habitats to deliver local nature recovery objectives, for example though incorporating features for species, biodiverse green roofs or rain gardens, species-rich grassland, hedgerows, trees and woodland or wetland to enhance nature.
- Explore opportunities to enhance or create Local Nature Reserves or Local Wildlife Sites within commercial development.

- UGF of 0.3 for predominately commercial development.
- There is no net loss of green cover in urban neighbourhoods.
- Create a variety of green infrastructure including rain gardens, biodiverse or bio-solar green roofs, green walls. Enhance amenity grassland with seasonal meadows and diversified planting.

- Minimise sealed surfaces and prioritise permeable paving to improve water infiltration and create space for sustainable drainage.
- Use GI to create attractive places to eat and relax for workers as part of enhanced public realm.
- Proactively integrate GI rather than leaving it to the margins or left-over spaces.

- Design to meet locally set urban tree canopy cover uplift targets.
- Utilise species mix, variations in density and form, to create tree planting that integrate developments into the surrounding landscape, provides shade for buildings and for people, and sequesters carbon.
- Consider the resilience of tree species to long term climate change.

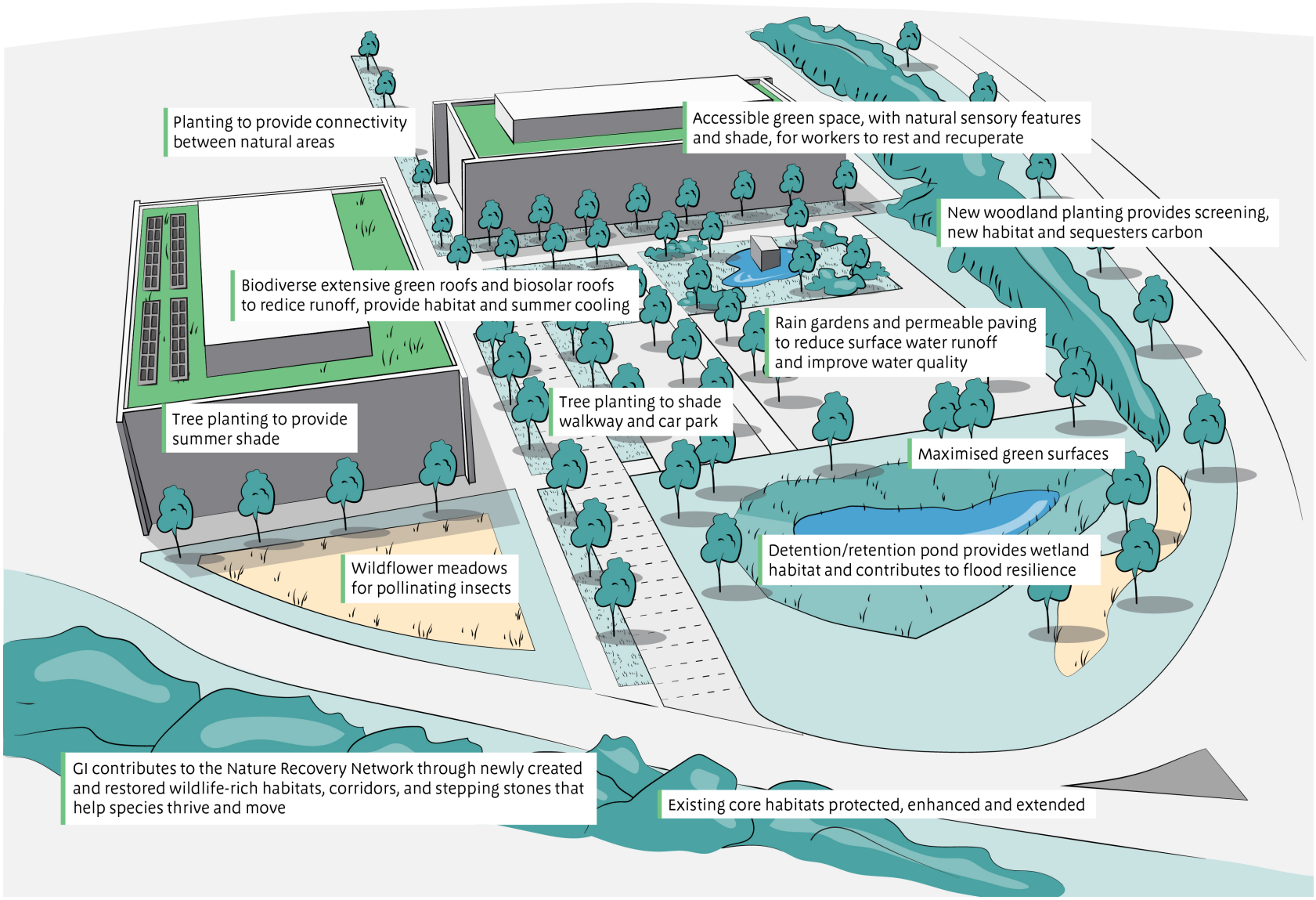


Figure 22: Commercial, Business, and Industrial Sites

6.11 Schools and colleges

Schools and colleges typically include several buildings; however, grounds make up 80% of the English Schools estate. This provides opportunities to create nature-rich, park-like spaces as the settings for buildings. This aligns with the Department for Education's National Education Nature Park initiative. This approach will enhance air quality, improve surface water management, reduce excess summer heat, and allow children and young people to have experience of nature that will enhance, and provide context for, their learning. The Children and Nature Programme demonstrated that interventions within school grounds have most success when the whole school (including the leadership team, teachers and maintenance staff) is involved.

Planting should be used to make the sense of arrival at a school comparable to that of a park or neighbourhood green space. Paths should take people through nature-inclusive outdoor spaces. Where space is limited, it may be appropriate to use planters (including SuDS planters) and pre-planted fences (pre-grown ivy, and other climbing plants trained onto wire fence panels). The latter are used to help reduce exposure to air pollution from traffic in urban areas. Retrofit of recycling or cycle stores with Nature-based Solutions should also be considered. This kind of intervention can provide screening and bring nature close to classrooms, providing inspiration and educational opportunities. There may also be opportunities for green infrastructure to be the setting for natural play. For more advice on outdoor learning and play see Learning Through Landscapes.

The planning of facilities in school grounds should take account of summer heat. For example, artificially surfaced games areas, including MUGAs, should not be installed close to the south side of buildings. Trees, hedges and climbing plants help to reduce temperatures. Strategically planted trees and/or the retention of existing trees can help to reduce glare and provide summer shade. When considering the design of new buildings, the connection to nature from within the building should be designed as part of strategic site planning. Views of seasonal events in nature (e.g., falling leaves, swaying branches, birds in flight) can benefit pupils, students and staff and improve mental health and wellbeing.

The design of new buildings should follow Biodiversity Net Gain requirements as set out in legislation. DfE's advice on Urban Greening Factors for education sites should be followed. Green infrastructure integrated into new schools and colleges could include green roofs or biosolar roofs (biosolar roofs are green roofs combined with photovoltaic panels). Green roofs are important for summer cooling, as interiors are vulnerable to overheating during peak summer temperatures. Green roofs also act as a source control method in the sustainable drainage systems and can also contribute towards a development's BNG requirements.

To reduce the risk of flash flooding, caused by heavy downpours, schools and colleges may include a range of sustainable drainage measures, e.g., rainwater harvesting systems, planters that store water, rain gardens, trees with large pits that store water, swales, wetlands, and ponds. Consideration should be given to the remodelling of landscaped areas and lawns so that they act as temporary rainwater detention basins following storms. Extensive boundary planting, particularly around playing fields, can include

hedges, swales, and belts of native trees, helping to strengthen wider green infrastructure and ecological networks.

The Department for Education recognises the role of green infrastructure in improving the health and wellbeing of pupils and students, in supporting learning and care for environment, and increasing resilience to climate change. Strategies should maximise the educational value of green infrastructure with community and pupil engagement, seasonal planting events and communication strategies. Targeted Continuing Professional Development for school staff will increase knowledge and confidence, ensuring better utilisation of green infrastructure and communication of its benefits. This will help create a sense of stewardship and increase ecological literacy. The provision of natural green space and natural play features on-site or within walking distance will help integrate the natural world into the curriculum, removing barriers to learning, particularly time and transport costs.

Strategic site planning should consider the access points into the site, connected to safe, green, active routes to school or college, to support healthy and independent travel by children and students, and to reduce the need for travel by car. Working with the local authority, connections to an active travel network can be improved and this can help reduce costs and reduce travel times.

The retrofitting of green infrastructure, for example green roofs and SuDS, should take account of building structure, topography, geology, heritage features and archaeology. Rural, suburban, and urban sites will vary in terms of the extent and types of greening that can be applied. Whatever is created, robust maintenance regimes must be included to ensure long-term success.

Application of the GI Standards – Schools and colleges

- Utilise natural settings and experience of nature as a way of creating diversified learning and play environments.
- Look for opportunities for the education estate's green space to be safely used by the wider community as accessible green space.
- There is no net loss of accessible green space per head of population at an area-wide level.
- Provide attractive green routes for active travel to and from education sites.

- There may be opportunities to design green space in this context to meet Green Flag Award criteria and best practice in accessibility for all.
- Build on the strong community links of schools to engage children and families in the design and management of natural features and to enhance connection with nature.
- Consider introducing species-rich meadows, hedgerows, and woodland to enhance nature and explore opportunities to create an area that could become a LNR and form part of the nature recovery network.

N Urban Nature Recovery ✓

- Consider how sites can contribute to nature recovery and the creation and restoration of wildlife rich habitats to deliver local nature recovery objectives, for example though incorporating features for species, biodiverse green roofs or rain gardens, species-rich grassland, hedgerows, trees and woodland or wetland to enhance nature.
- Explore opportunities to enhance or create Local Nature Reserves or Local Wildlife Sites within schools and colleges.

G Urban Greening Factor (UGF) ✓

- Follow Department for Education advice on UGF for education sites.
- There is no net loss of green cover in urban neighbourhoods.
- Create a variety of green infrastructure including rain gardens, biodiverse or bio-solar green roofs, green walls, wildflower, and wetland areas. Design GI so that it provides opportunities for learning and adopts the principles of biophilic design.
- Minimise sealed surface to improve water permeability and create space for sustainable drainage.
- Use planting to provide cleaner air and provide separation from busy external environments.

T Urban Tree Canopy Cover ✓

- Design to meet locally set urban tree canopy cover uplift targets.
- Use trees to create shade in playgrounds, to create play opportunities, and to engage children in seasonal change.
- Consider the resilience of tree species to long term climate change.

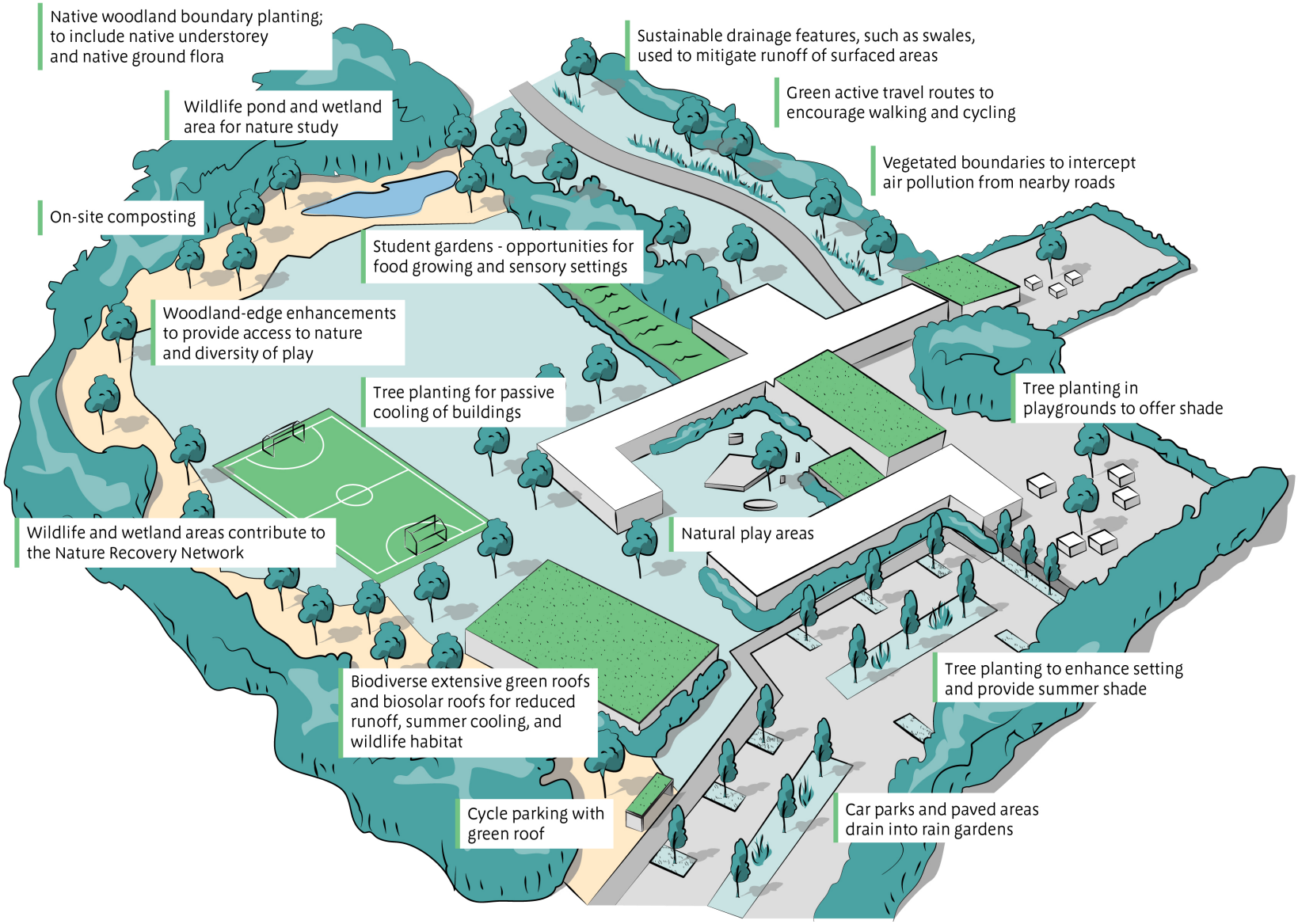


Figure 23: Schools

6.12 Healthcare facilities

Healthcare facilities are usually dominated by large buildings or complexes of buildings and in most locations, large car parks. Hospitals usually feature amenity landscapes, similar in character to the incidental plantings found around commercial sites, with ornamental trees, shrubberies, and amenity grassland.

Retrofitting older hospital buildings with green infrastructure can be problematic because of structural and operational issues and the siting of mechanical and electrical plant. However, it is usually possible to improve hospital grounds to make them more functional in terms of, for example, sustainable drainage and replacing amenity grassland with trees or meadows. Recognition of this is demonstrated by the NHS Forest project, which encourages local people to plant trees in hospital grounds.

As with schools, where new hospitals and clinics are planned, development should follow Biodiversity Net Gain requirements as set out in legislation. Urban Greening Factors may be set by local authorities or healthcare provider. There may be opportunities to include green roofs which can save energy on air conditioning and can also act as a source control method in the sustainable drainage systems and can also contribute towards a development's BNG requirements.

In the healthcare setting there is interest in the therapeutic value of green infrastructure. This can involve providing accessible planted terraces and gardens for patients, visitors, and staff, but can also involve planting that is overlooked from windows, which has been shown to have a calming effect on patients, reduce the need for medication and reduce recovery times - shortening hospital stays. It improves quality of life for both patients and staff.

Gardens can also provide suitable settings for art installations. This understanding of the therapeutic value of green infrastructure and the biophilic design philosophy means that new hospitals are now featuring green roofs, gardens, natural water features, sensory rich environments, access to nature-rich green space as well as interior planting. An example of the is the Alder Hey Children's Hospital in Liverpool. The Maggie Centres also have a strong connection between inside and outside planting. In addition to the greening of buildings, the grounds and vehicle parking areas of hospitals can include sustainable drainage, dense tree planting and biodiverse perimeter planting.

Application of the GI Standards – Healthcare facilities

- Look for opportunities to make green space in healthcare setting accessible to the public.
- Look for opportunities to convert hard landscape to accessible greenspace.
- Utilise natural settings and sensory experiences of nature as a way toward creating healing environments for patients, visitors, staff, and the local community.
- There is no net loss of accessible green space per head of population at an area-wide level.

- Provide attractive green active travel commuting routes, connecting healthcare settings and local residential areas.

- There may be opportunities to design green space in this context to meet Green Flag Award criteria, and designing to meet best practice in accessibility for all will be particularly important in healthcare settings.
- Ensure that greenspaces feel safe, welcoming, and well maintained to encourage inclusive use.
- Utilise good horticultural design to structure sensory experience for a wide range of abilities and needs. Connect users to nature through changing colours, movement, scent, and wildlife.
- Consider opportunities for nature-based activities as part of Green Social prescribing initiatives.

- Consider how sites can contribute to nature recovery and the creation and restoration of wildlife rich habitats to deliver local nature recovery objectives, for example though incorporating features for species, biodiverse green roofs or rain gardens, species-rich grassland, hedgerows, trees and woodland or wetland to enhance nature.
- Explore opportunities to enhance or create Local Nature Reserves or Local Wildlife Sites within healthcare settings.

- UGF to significantly increase GI provision to be agreed with local authorities and healthcare providers.
- There is no net loss of green cover in urban neighbourhoods.
- Create a variety of green infrastructure including rain gardens, ponds, green roofs, green walls, wildflower meadows, growing spaces, occupational therapy gardens, and outdoor gyms.
- Use the perceptual quality of plants and water to create sensory environments that support mental wellbeing for staff, patients, visitors, and the local community.
- Minimise sealed surface to improve water permeability and create space for sustainable drainage.

- Design to meet locally set urban tree canopy cover uplift targets.
- Design woodlands and orchards as natural spaces for wellbeing and for shade and to sequester carbon.
- Consider the resilience of tree species to long term climate change.

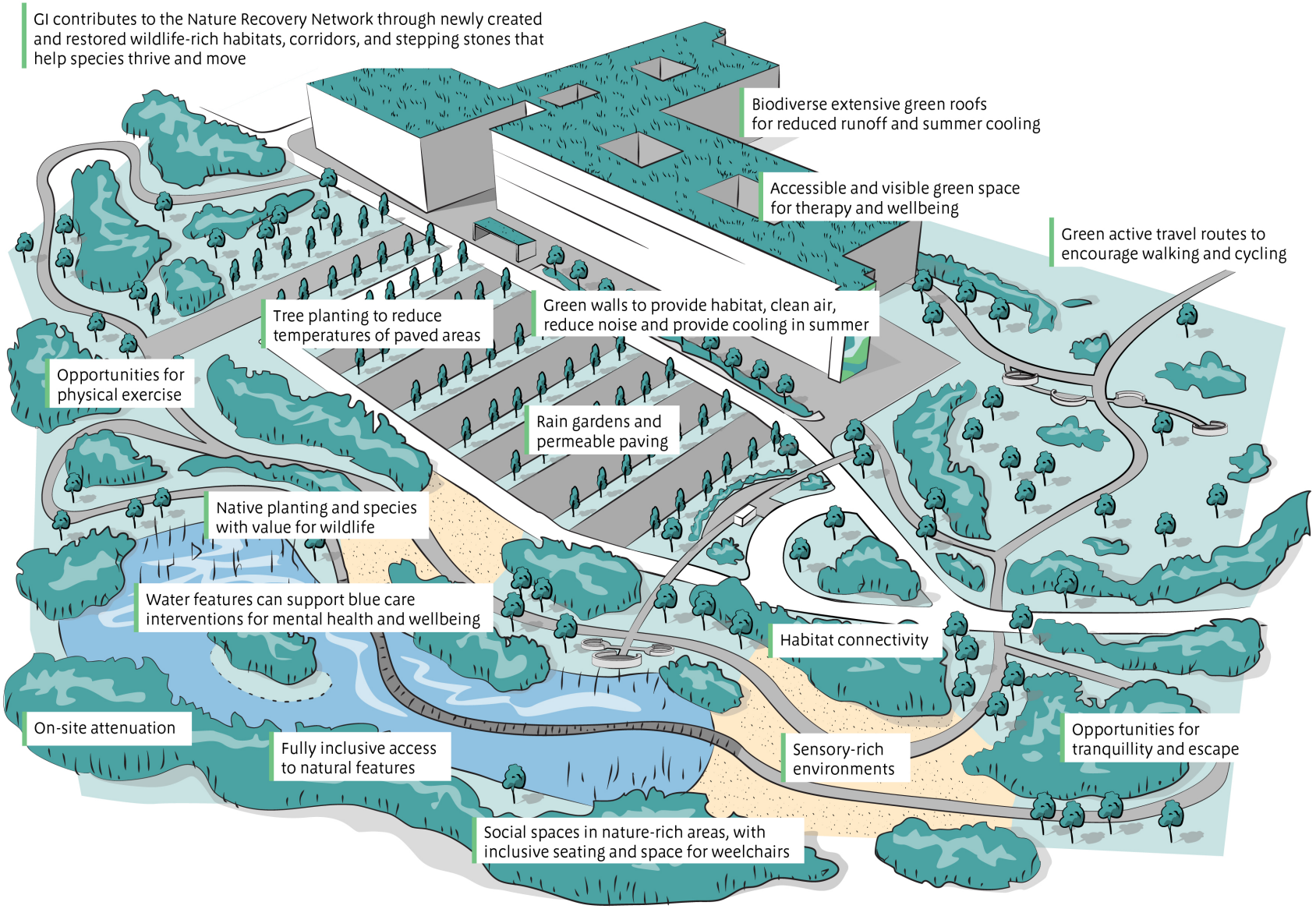


Figure 24: Healthcare Facilities

6.13 Linear infrastructure (roads, railways, and waterways)

Linear infrastructure includes road verges, railway embankments and cuttings and canal and river towpaths. These features are often lightly managed and densely vegetated and can continue for long distances, making them some of the most valuable features in district green infrastructure networks. Where access is restricted for safety reasons, these areas provide refuges for wildlife. Roads, however, can be major barriers to movement and a cause of injury and fatalities for people as well as wildlife. Linear infrastructure can also create major barriers for pedestrians, particularly children, as well as cyclists, horse riders and people with disabilities.

Linear infrastructure is often narrow and ecological corridors can cease to function where vegetation has been removed. Roads are the source of noise, air, and water pollution, which has a negative impact on wildlife and people. Roads often direct surface water runoff directly into watercourses, which is a contributing cause of poor water quality.

The role in linear infrastructure in providing district wide green infrastructure networks needs to be more fully acknowledged and management should be adjusted to take account of the issues and opportunities. New planting can strengthen existing tree lines and hedgerows. The use of sustainable drainage systems to intercept and clean surface water run-off from roads should be expanded. Good progress has been made in some counties in adjusting management of grass verges to encourage longer more species-rich swards in suitable locations, however, more can be done.

Plate 29: Traffic-free route and ecological corridor associated with railway. Credit: Green Infrastructure Consultancy

Where roads and railways pollute and disturb nearby residents, more use of green infrastructure, including narrow vertical features like hedges and green walls, can be made. Where roads constitute a barrier to the movement of people and wildlife, more can be done to provide green bridges, underpasses, and ducts, depending on the species affected. Bridges for people can be modified to make them greener and more suitable for as crossing points for wildlife, particularly mammals, reptiles, and amphibians. Green bridges can be designed in from the outset in new schemes, helping to connect important landscapes, habitats and foraging sites and providing crossing points for people and wildlife.

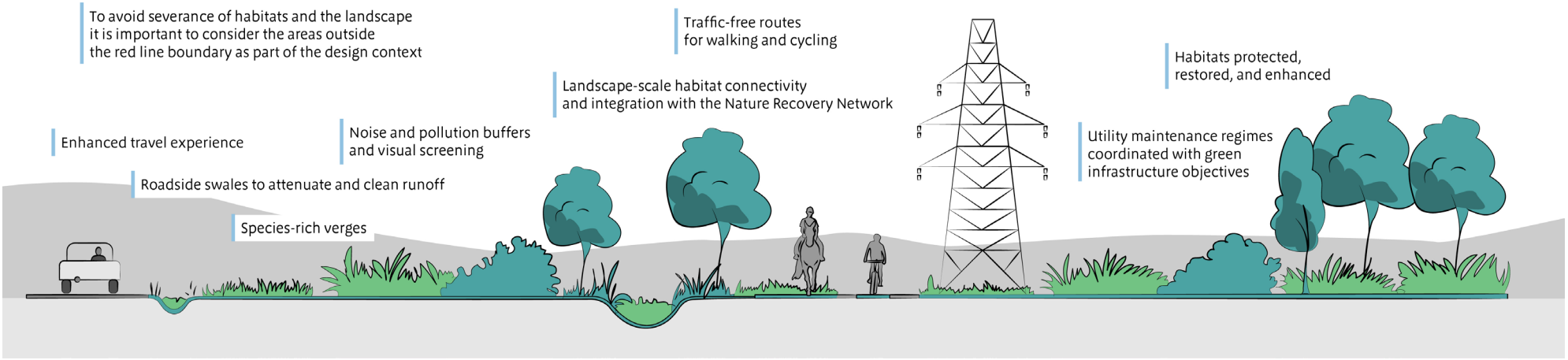


Figure 25: Green infrastructure along linear corridors

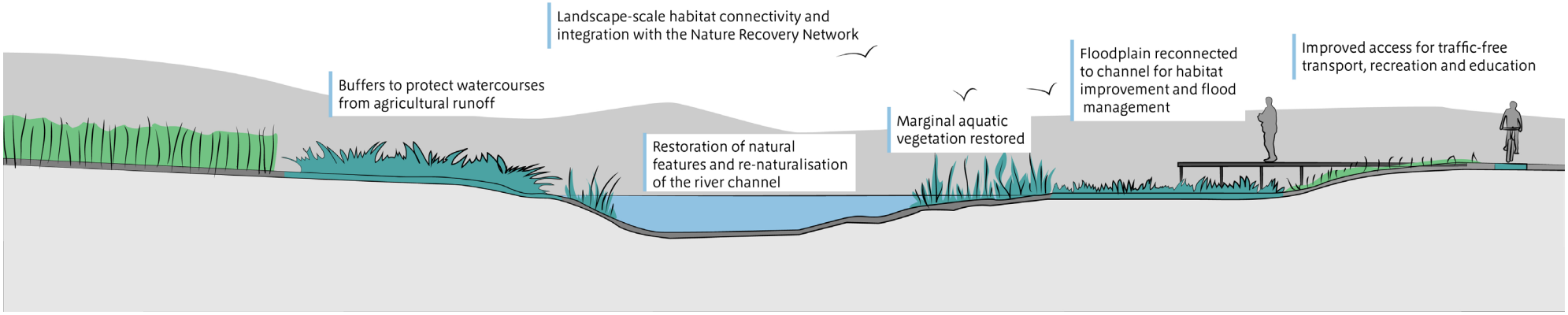


Figure 26: Green infrastructure along rural waterways

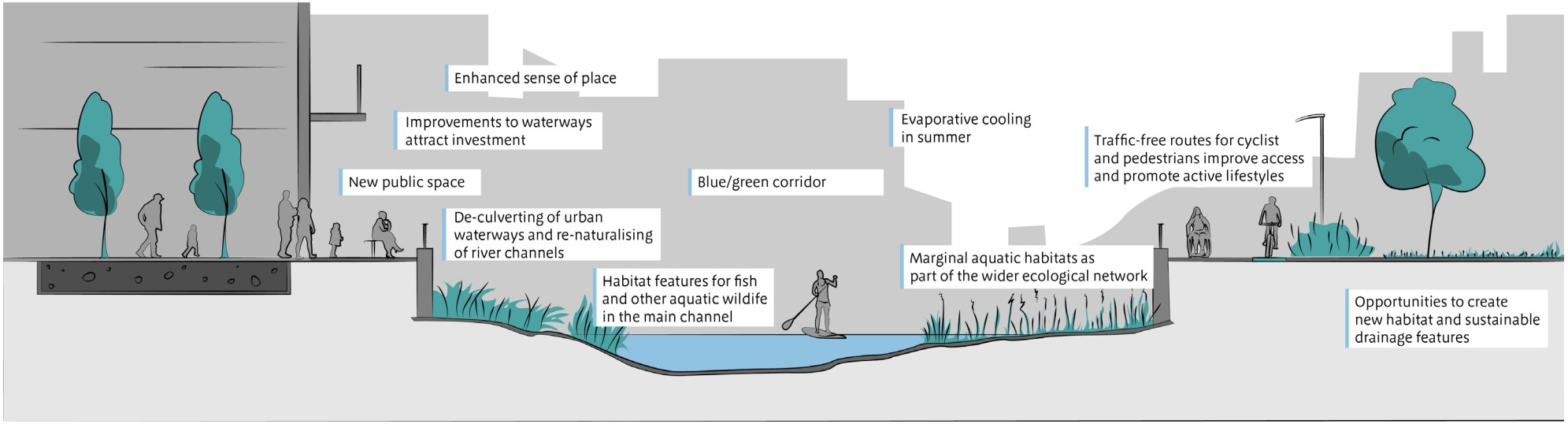


Figure 27: Green infrastructure along urban waterways

Along river valleys, there are opportunities to create more long-distance cycle paths, bridleways, and footpaths. Most rivers have been modified and there are usually opportunities to restore wetlands and reconnect the floodplain with watercourses and waterways. Access improvements can be fully integrated with flood management, water quality and biodiversity objectives and can provide further opportunities to improve access for people. There is often space within the floodplain (which is usually unsuitable for urban development) to create regionally important parks (see for example Bedford River Valley Park).

As part of Biodiversity Net Gain implementation, linear green infrastructure features that are found within the biodiversity metric can count towards a project's BNG requirement. Offsite linear green infrastructure could also provide biodiversity units that could be made available in the BNG market, as long as this provision complies with the regulations e.g., is legally secured, registered and meets the additionality rules.

Application of the GI Standards – Linear infrastructure (roads, railways, and waterways)

- Linear corridors can be accessible greenspaces. Consider how linear corridors could contribute to meeting Accessible Greenspace Standards and local capacity standards.
- In rural areas aim to reflect the habitats found in the wider landscape. In urban areas, create accessible corridors that provide sensory experience, shade, and tranquillity.
- Linear corridors can provide attractive green routes for active travel, connecting green spaces to residential areas and other facilities.
- There is no net loss of accessible green space per head of population at an area-wide level.

- Linear corridors can be designed to meet many of the Green Flag Award criteria and best practice in accessibility for all.
- Ensure access along linear infrastructure is well signed and maintained appropriately (with biodiversity in mind, this may mean reduced mowing regimes). Ensure linear routes are accessible to a wide variety of users where possible. Provide strategic crossings for both people and nature.
- Consider opportunities for linear corridors and the activities they support to be part of Green Social prescribing initiatives.

- Consider how linear features can contribute to nature recovery and the creation and restoration of wildlife rich habitats to deliver local nature recovery objectives, for

example though incorporating features for species, biodiverse green roofs or rain gardens, species-rich grassland, hedgerows, trees and woodland, and wetland to enhance nature.
- Explore opportunities to enhance or create Local Nature Reserves or Local Wildlife Sites along linear corridors.

- Consider how urban linear features can contribute to meeting UGF of 0.3 for predominately commercial and 0.4 for predominately residential developments or area wide greening standards.
- There is no net loss of green cover in urban neighbourhoods.
- Designs reflect the importance of linear infrastructure in the wider GI network. Use GI interventions to increase ecological connectivity and reduce severance of habitats caused by transport and other linear infrastructure.
- Design linear features with green infrastructure that attenuates urban runoff and improves water quality e.g., rain gardens and sustainable drainage systems, and connects to the wider blue infrastructure network.
- Consider opportunities for using the linear green estate to generate renewable energy.

- Design to meet locally set urban tree canopy cover uplift targets.
- Use tree and hedgerow planting to screen visual, air and noise pollution where appropriate and to sequester carbon.
- Consider the resilience of tree species to long term climate change.
- New and existing trees are incorporated into linear infrastructure and new streets are tree lined. Consider the resilience of tree species to long term climate change.

Appendix: Green Infrastructure (GI) Case Studies - Summary Table

		New?		Area Types										GI Principles - How to plan, design and nurture GI					GI Principles - What good GI looks like (attributes)					GI Principles - Why GI is important (benefits/ outcomes)				
Project (including hyperlink)	**Description**	New GI?	Retrofit or enhancement?	High-density Urban & High Streets	Urban	Suburban	Streets	Rural	Commercial, Business, Industrial	Schools & Education	Healthcare Facilities	Parks & Gardens	Linear Infrastructure	Partnership & Vision	Evidence	Plan Strategically	Design	Managed, Valued, Monitored & Evaluated	Multifunctional	Varied	Connected	Accessible	Character	Nature-rich beautiful places	Active and healthy	Thriving & prosperous communities	Improved water management	Resilient & climate positive places
Paris Greening Permit	Permit scheme for gardening in the public realm		✓	✓	✓									✓				✓		✓		✓	✓	✓	✓		✓	✓
Incredible Edible Todmorden	Promoters of community-based food growing		✓	✓	✓	✓	✓					✓		✓				✓				✓	✓		✓	✓		
Stockholm City Plan	City plan with good consideration of accessibility of GI	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						✓			✓			
Essex Green Infrastructure Strategy	Good example of county-wide GI strategy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓												
Whitehill & Bordon Green Loop	Strengthened GI network for growth area	✓	✓		✓	✓		✓				✓		✓	✓	✓												

		New?		Area Types										GI Principles - How to plan, design and nurture GI					GI Principles - What good GI looks like (attributes)					GI Principles - Why GI is important (benefits/ outcomes)				
Barton Park, Oxford	Large-scale long-term housing scheme with design code that includes GI	✓				✓	✓							✓	✓	✓	✓	✓	✓	✓								
Knights Park, Eddington, Cambridge	Winner of the inaugural Building with Nature Housing Design Award	✓			✓									✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Clapton Park Estates, Hackney	Estate management adjusted to increase collaboration with residents, boost biodiversity and encourage food growing		✓		✓									✓				✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Blyth Estuary Green Travel Project	Cycling and walking promoted as part of GI strategy		✓	✓	✓	✓	✓						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Topsham Road, Exeter	Road verges seeded with wildflowers for pollinating insects		✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓
Weymouth Relief Road	Road cutting/verges seeded with wildflowers	✓						✓					✓															

		New?		Area Types										GI Principles - How to plan, design and nurture GI					GI Principles - What good GI looks like (attributes)					GI Principles - Why GI is important (benefits/ outcomes)				
East Street, Bristol	Traffic-free Street, with new trees and pocket parks		✓	✓				✓						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Surrey Street Design Guide	Design guidance for Surrey Streets (in development)	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		
Eastcote Rain Gardens, Hillingdon	Rain gardens in shopping street		✓	✓		✓					✓			✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓
Grey to Green, Sheffield	Rain gardens in busy, sloping, city street		✓	✓							✓			✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓
The Avenue Country Park, Wingerworth	Country Park on post-industrial site with emphasis on flood alleviation		✓				✓			✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Bean Parklands, Dagenham	New parklands in river valley		✓					✓		✓		✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
London Wetlands Centre	Large development-linked urban wetland	✓			✓						✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cator Park, Kidbrooke Village	New Park with SuDS, habitat and play facilities	✓		✓	✓						✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

		New?		Area Types										GI Principles - How to plan, design and nurture GI					GI Principles - What good GI looks like (attributes)					GI Principles - Why GI is important (benefits/ outcomes)				
Elephant Park, Southwark	New Park in urban regeneration scheme. Scheme meets 0.4 UGF target	✓	✓	✓							✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
West Gorton Community Park, Manchester	Local Park with strong emphasis on demonstrating SuDS			✓							✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mayfield Park, Manchester	Large new public park on former industrial site	✓			✓									✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Minster Park, Sunderland	Park refurbishment in conservation area		✓	✓							✓			✓	✓	✓	✓	✓			✓	✓	✓		✓	✓		
David Attenborough Building, Cambridge	Retrofit biodiverse extensive green roof		✓	✓			✓	✓						✓	✓	✓	✓	✓	✓	✓			✓				✓	✓
Rubens at the Palace Hotel Green Wall	Large retrofit intensive green wall with rainwater harvesting		✓	✓			✓							✓	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓
Spa Fields, Islington	Improvements to local park with strong emphasis on consulting local women on safety		✓		✓						✓			✓	✓			✓				✓			✓			

		New?		Area Types										GI Principles - How to plan, design and nurture GI					GI Principles - What good GI looks like (attributes)					GI Principles - Why GI is important (benefits/ outcomes)				
East Oxford Access to Green Space	Project to improve access to local green space and nature for vulnerable teenage girls in deprived area		✓		✓	✓					✓			✓	✓			✓				✓					✓			
Alder Hey Children's Hospital	New children's hospital integrated into a park	✓			✓					✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Westfield Court, University of Hull	SuDS and planting for biodiversity around new student village	✓		✓				✓						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Black Country UNESCO Global Geopark	Large number of multi-functional green spaces in a single region, celebrating geodiversity		✓		✓	✓	✓				✓			✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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